The Lithic Assemblage from Tabaqat al-Bûma: A Late Neolithic Site in Wadi Ziqlab, Northern Jordan

by

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A thesis submitted in conformity with the requirements for the Degree of Doctor of Philosophy
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Abstract
Studies of Late Neolithic stone tools from the Levant have concentrated on the formed tools and morphological typology, and typically pay little attention to retouched flakes or unretouched used flakes (Cauvin 1968; Stekelis 1972; Noy 1976; Crowfoot-Payne 1983; Gopher 1985), even though the latter represent a fundamental shift in the perception and application of technology. Throughout the history of the study of prehistoric stone tools, formed or shaped lithics have received far more attention than ones produced with simpler technologies, such as bipolar or other "expedient" tools (Hayden 1977, Parry and Kelly 1987, Gero 1991 and Casey 1993).

The objective of this thesis is to examine a sample of chipped stone tools from Tabaqat al-Bûma, a Late Neolithic site in northern Jordan, and use the findings of this analysis to investigate the marked shift in lithic technology that occurs during this period. This change in technological orientation is characterised by a reliance on flake tools as opposed to the blade-dominated industries of preceding Neolithic periods. I will argue that Late Neolithic stone tools are often a reflection of the degrees of risk that new activities entailed.
To my parents,
Joy and Peter Siggers
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Chapter 1

1.0 Introduction

This thesis is concerned with the technological analysis of the lithic assemblage from Tabaqat al-Bûma, a small Late Neolithic site in northern Jordan (see figures 1.1 and 1.2). I will use the results of this analysis to highlight weaknesses in the current methodological approaches of lithic research in the Levantine Neolithic, and to present a new perspective on changes in lithic technology during this critical transitional period. This study also investigates larger issues surrounding the dramatic changes that occur in Holocene lithic technology worldwide. Despite its relatively small size, Tabaqat al-Bûma's lithic assemblage has proven to be informative in understanding the rationale behind the adoption of Late Neolithic flake tool technology.

It could be argued that, because of their great time depth and universal distribution, lithic tools represent the most important category of material culture for the interpretation of prehistoric behaviour. In the last 25 years, lithic analysts have begun to use an increasing range of new techniques to explore questions relating to style, use, technological change and economy. After an examination of past and recent studies of Late Neolithic lithics in the Levant, however, the static nature of research in that area is striking.

The primary question that this thesis will address is why lithic technology underwent a dramatic change coincidental with the adoption of fully developed sedentary agricultural lifeways in the Levantine Late Neolithic. Neolithic studies from this area have long neglected the fundamental changes in lithic technology that took place during this period (Siggers 1992). Collection of lithic data and lithic analysis of Neolithic aggregates are overdue for a dramatic revitalisation and
Figure 1.1  Map showing the location of Tabaqat al-Bûma and other Late Neolithic sites in the Levant
reorientation in this region. The primary concern of Neolithic studies is, quite understandably, the shift from mobile hunting and gathering to sedentary, agriculturally-based lifeways. Traditionally, the analysis of material culture from Late Neolithic sites has been based on architectural styles and pottery assemblages (Mellaart 1975; Redman 1977; Kenyon 1981; Moore 1985). The prevailing theoretical orientations of Levantine lithic analysis are limited to two broad approaches: the culture-historical approach, focussing on typo-chronological analysis (Bar- Yosef 1971; Gopher & Gophna 1993; Noy 1976); and environmental determinism (Henry 1989).

Scholars working in this area have been preoccupied with the definition of the successive cultural entities (Moore 1985). This is a necessary first step, but new approaches are now overdue. Unfortunately, questions relating to flaked-stone technological adaptation are rarely asked of the Late Neolithic record, except those couched in the most simplistic fashion. The Late Neolithic lithic assemblages, although representative of important behavioural changes, have remained unpopular among lithic analysts. Lithic reports from this period have concentrated only on descriptive accounts of the few formed¹ tools. The "unstandardised" flake tools² that usually make up the majority of assemblages have received minimal attention.

¹ A formed stone tool is one that has been retouched to produce the morphological and technological attributes that enable it to be designated to a specified type (e.g., endscraper or backed blade).

² Lithic tools that some authors (Binford 1977) describe as "expedient" are those that do not conform to any standardised morphology. These are usually flakes with minimal or no retouch - and are normally associated in ethnographic cases with one use-incident.
With these considerations in mind, my research objectives for this thesis are threefold:
1) To undertake a comprehensive technological analysis of all aspects, both of formed and less deliberately shaped tools, of a Neolithic lithic assemblage. By this I mean that equal emphasis will be placed on technology of flake production and on formed tools.
2) To offer an explanation as to why tools are unstandardised during the Late Neolithic in the Levant in particular but also in other Holocene prehistoric contexts.
3) To use design theory (Pye 1963; Kleindienst 1977) and risk-management studies (Torrence 1989) to investigate how different types of stone tools from this site articulated with Late Neolithic behaviour. This is achieved by attempting to associate the various technological lithic components with the tasks for which they may have been used during the Late Neolithic. These activities are reconstructed using other lines of evidence, such as faunal, botanical and architectural data and modern and ethnographic analogy.

For the purposes of this thesis, emphasis is on the interaction of tools as a technological system, which, in turn, meshes with a larger behavioural system. Investigation of the nature of this system involves contrasting the design features of formed tools with the smaller degree of workmanship and design in unretouched, utilised tools. Levels of design investment are then compared with potential tool-use to investigate the interaction of tool design with the nature and degree of behaviour-related risk entailed in the task for which these tools were intended. In brief, my argument is that the greater the degree of risk a task involves, the greater the investment of design in the tools that are used to undertake it.
1.1 The Neolithic Canvas and Technological Variability in the Levantine Neolithic

Since the publication of Childe's (1952) "oasis theory' for the origins of food production, the importance of the "Neolithic Revolution" has been widely accepted. At present, the Neolithic in the Levant is divided into the Aceramic or Pre-Pottery Neolithic and the Pottery Neolithic or Late Neolithic (Moore 1982; Redman 1977). Pre-Pottery Neolithic settlements are characterised by nucleated villages that increased in size through time and some authors (e.g., Bar-Yosef 1989; Rollefson and Kohler-Rollefson 1989) have inferred a concomitant increase in social complexity. The subsistence base, while initially broadly-based in the Pre-Pottery Neolithic A, became increasingly more reliant on domesticated cereals and ovi-caprids in the Pre-Pottery Neolithic B (de Vaux 1966; Kenyon 1981; Moore 1985; Köhler-Rollefson et al. 1988). The Pre-Pottery Neolithic A (PPNA) sees the consolidation of sedentism that was initiated in the preceding Natufian period (Rollefson 1992: 123). The viability of sedentism in the PPNA appears to have been due to the increased productivity and storability of domesticated wheat and barley. During this period, meat protein was obtained from hunting a diverse range of mammal species, but with some focus on gazelle (Köhler-Rollefson et al 1988).

By the end of the tenth millennium bp, there is a new shift in Neolithic adaptation, the Pre-Pottery Neolithic B, which is divided into early, middle and late phases. PPNB occupations at Jericho (Kenyon 1982), Beidha (Kirkebirde 1966) and 'Ain Ghazal (Rollefson 1989) vary in size from small hamlets to small villages. These settlements are generally more common and larger than those
from the preceding PPNA period. Rollefson (1992) points out that every major survey in the southern Levant has recorded PPNB occupation. The major population increase during this period indicates that new agricultural practices and new domesticates (peas and lentils) were successful. The advent of goat herding was probably also a contributing factor to PPNB expansion (Köhler-Rollefson et al. 1988).

By 8200 bp, the southern Levant experienced a major shift in settlement pattern. Many sites were abandoned and new sites appeared in ecological contexts that were apparently previously not exploited. Examples of this settlement shift include Abu Ghosh to the north of Jerusalem and Beisamoun (Lechevalier 1978) in the northern Jordan Valley.

Excavations at 'Ain Ghazal, however, indicate that not all PPNB sites were abandoned at this time (Rollefson and Köhler-Rollefson 1989; Rollefson et al. 1992). Rollefson (Rollefson et al. 1990; 1991; 1992) argues that the populations that occupied sites such as 'Ain Ghazal and Wadi Shu'eib (Simmons et al. 1989) during the PPNB did not abandon these settlements, but may have begun to occupy them for only part of the year. Around 8000 bp the PPNB at these two sites was replaced by a new Neolithic culture, the Pre-Pottery Neolithic C (PPNC). PPNC settlements were smaller and indicate a shift in settlement practices from those practised in the PPNB. During the PPNC, greater emphasis was placed on arid steppe and desert resources than in the PPNB, and pastoralism no longer focused on goat herding, but on the less environmentally-damaging herding of cattle and pigs (Köhler-Rollefson 1988; Rollefson and Köhler-Rollefson 1989; Köhler-Rollefson and Rollefson 1989). The artifactual record (i.e., the low frequencies of sickle blades and grinding equipment) indicates that methods of cereal production also changed (Rollefson et al. 1992). It is important to note that, while the subsistence data from PPNC 'Ain Ghazal are markedly different from those of the PPNB
occupation, they are at present insufficient for us to view clearly how PPNC subsistence was structured. PPNC settlement and lithic data, however, are sufficiently different to warrant Rollefson's distinction between the two occupations.

After a period of abandonment of most sites towards the end of the Pre-Pottery Neolithic B, Late Neolithic settlement and subsistence stand out in sharp contrast. Moore (1973) subdivides the "Late Neolithic" into Neolithic 3 and 4. Pottery Neolithic sites, apart from the widespread introduction of pottery technology, are characterised by much smaller settlements that may have had a greater emphasis on pastoralism (Perrot 1968; Mellart 1975; Rollefson 1989) and cereal cultivation. Explanations for the change in lifeways in the Later Neolithic include increasing aridity associated with climatic change in the mid-Holocene (Perrot 1966; de Vaux 1966), and environmental deterioration caused by the subsistence practices of the Pre-Pottery Neolithic (Rollefson and Köhler-Rollefson 1988). More specifically, a combination of goat overgrazing and wholesale land clearance, to obtain fuel for burning lime to make plaster floors and beams for construction of houses, may have led to topsoil exhaustion, erosion and environmental instability (Rollefson and Köhler-Rollefson 1989). For whatever reason, the behaviour that replaced that of the Prepottery Neolithic in the Later Neolithic appears to be very different.

As one might expect, this behavioural change is reflected in Late Neolithic lithic technology. The formed tools that are present in significant numbers, such as sickle blades and ground stone tools, have close agricultural associations. Many of the others, such as adzes and burins, pertain to wood-working activities. The rarity of arrowheads indicates a shift away from the hunting practices of the preceding periods. As shall become apparent, the majority of tools from Late Neolithic assemblages, such as the one from Tabaqat al-Bûma, are representative
of a flexible and practical approach to problem-solving that suited the new economic circumstances of this period.

Although there is a tendency to perceive evidence of sedentism in the Early Neolithic as indicative of fully agricultural lifeways, faunal and botanical data from Prepottery sites in the Levant and early Neolithic sites in Britain constitute another body of evidence to indicate that Early Neolithic settlers had subsistence strategies including a broad spectrum of wild resources (Thomas 1991; Edmonds 1995; Rollefson et al. 1992). In this they were more akin to the mobile hunter-gatherers of preceding periods. Technological similarities, especially the relatively high proportions of formed tools, appear to corroborate this observation. A poignant example would be the PPNB site of 'Ain Ghazal (Rollefson et al. 1992). During the early phases of its occupation more than 100 plant species and 60 animal species were exploited. Early plant domesticates were only a few of many resources in use. The many varied tasks that this broad subsistence base must have entailed provide us with a key for explaining Early Neolithic blade-based technology.

Late Neolithic lithic technology in the Levant encompasses, to varying degrees, the technological repertoire of preceding periods – blades, flakes, bifaces and microliths have all been recorded from Late Neolithic sites in this area. In addition to these known technologies, ground and polished stone technologies rapidly increased in use (Wright 1993). The most marked technological change in material culture during the Neolithic, apart from the introduction of pottery, is a shift from a blade-oriented technology in the Prepottery Neolithic to a flake-dominated technology in the Late Neolithic. In many respects the technologies of the Prepottery Neolithic A and B have more in common with the Epipalaeolithic Industries that preceded them than with the Late Neolithic, such as prepared blade core technology. Correspondingly, the subsistence strategies of the two "periods"
are also similar, in that they are both broadly based. Continuity between the Natufian and the Prepottery Neolithic A (PPNA) is especially noticeable. The only divergence between the two is that during the PPNA plant domesticates clearly make up a proportion of the subsistence base, although not necessarily a large one.

Interestingly enough, the same observation has been made by a number of scholars working in British Neolithic studies. Early Neolithic blade industries in Britain have far more similarities with the British Mesolithic than with later flake-based Neolithic assemblages. Lithic studies in the British Neolithic have moved away from descriptive typochronological studies to concentrate on solving technologically-related behavioural issues (Bradley 1987).

With the advent of the Holocene, many lithic assemblages from diverse geographical contexts stand out in sharp relief to technologies that preceded them (Torrence 1989; Jacobi 1989). Unlike Upper Palaeolithic, Epipalaeolithic and Pre-Pottery Neolithic assemblages, the emphasis during the Late Neolithic is not on formed tools, although formed tools are present, but on highly variable flake tools. These tool types require minimal time and expertise to make, and many were probably discarded after a single, relatively short-term, use. Difficulties surrounding the analysis of many flake tools in the Levantine Holocene are compounded because the degree of standardisation of tools fluctuates throughout the terminal Pleistocene and Holocene. This "degree of standardisation" refers to the level of regularity and morphological consistency of formed tool types. During the Natufian, some tool forms become "destandardised" but, during the Pre-Pottery Neolithic that follows, the level of standardisation increases, only to decline once again in the Late Neolithic (Crowfoot-Payne 1981).

Gopher and Gophna (1993) have proposed that the Late Neolithic in the southern Levant includes three cultures: the Yarmukian Culture; Jericho IX Culture; and the Wadi Raba Culture. They advocate that these be viewed as
"archaeological cultures," as defined by Clarke (1978). Each culture, or cultural stratigraphic unit, is comprised of similar assemblages and occurs in a definable spatial and temporal context. The relationship between these cultures remains poorly understood, but Gopher and Gophna's recent synthesis marks the first attempt to clarify the complex mechanics of cultural variability in the Late Neolithic of the southern Levant.

The Yarmukian culture, first defined by Stekelis (1950) on the basis of his excavations at Shaar Hagolan, is the earliest pottery-producing Late Neolithic culture. Finds of rare, crudely made sherds in the Late PPNB and PPNC at 'Ain Ghazal may indicate that experiments with pottery occurred in the PPNB, but that pottery technology was not widespread until the Late Neolithic (Banning, pers. comm). Yarmukian ceramics include distinctive painted and incised wares, with "herring-bone" incised-band decoration being a particularly distinctive "type-fossil." With regard to Yarmukian lithic technology, Gopher and Gopna (1993) state:

Technologically, there was still a high standard of blade production, and bipolar cores are still present, although less common. Thedebitage, however, is dominated by flakes.

The number of flakes that are actually tools, as this research will illustrate, is open to question. It is more than likely that many of these flakes were used. Buildings have a dry-stone construction, and are circular or rectilinear with the occasional plaster floor. Yarmukian occupations in Jordan include Jebel Abu Thawwab (Kafafi 1988) and the Yarmukian component at 'Ain Ghazal (Rolfeson et al 1990 and 1992).

Jericho IX was initially defined by Garstang's excavation at Jericho (Garstang 1935; 1936) on the basis of pottery (Ben-Dor 1936) and lithic types (Crowfoot 1937). The pottery is recognised by burnished decorations and form. Lithic tool types
include "arrowheads, sickle blades, axes, bifacial knives, awl/borers, scrapers, notches and denticulates, and retouched flakes and blades (Gopher and Gophna 1993:318)." Gopher and Gophna (1993: 319) caution that blades are "over represented because of preferential selection." Here, once again, flake tools may have played an important role in the lithic technological repertoire. The architecture and economy of Jericho IX are poorly defined. Only a few sections of wall have been excavated (Gopher and Gophna 1993; Kenyon 1957), and faunal data indicate an emphasis on sheep and goats (Clutton-Brock 1971). Lod (Kaplan 1977) and Teluliot Batashi (Kaplan 1958) are also said to have Jericho IX occupations. Although the pottery of Jericho IX is distinctive, the recognition of other Jericho IX occupations is difficult because of the lack of other information about this culture (Gopher and Gophna 1993).

The Wadi Rabah culture was proposed by Kaplan based on his research in the Tel Aviv area (Kaplan 1958; Gopher and Gophna 1993). Stratified Wadi Rabah assemblages occur above Yarmukian and Jericho IX. The culture is poorly dated: it appears to be earlier than the Ghassulian but later than the Yarmukian and Jericho IX. New dates from Tabaqat al-Bûma, which appears to be contemporary to Wadi Rabah (Banning et al. 1994), have added to our chronological understanding of this period, clustering around 6700 - 6200 bp. Included within this cultural unit are several other variants such as Tel Dan in the Huleh Valley (Gopher and Greenberg 1987), and the sites of Tell es-Shuneh and Tell Abu Habil in the Jordan Valley (de Contensen 1960). These variants are defined by slight variations in the pottery assemblages. Pottery from the Wadi Rabah sensu stricto is coil-constructed and made from a variety of fabrics.

The assemblage includes a variety of bowls: rounded, straight upright, V-shaped or carinated, with inverted, everted, or cutoff rims (Gopher and Gophna 1993: 328).
Most Late Neolithic typologists particularly emphasize "bow rim" jars and a distinctive dark-faced burnished ware as indicative of the Wadi Rabah occupation. Architecture is usually rectangular with field stone foundations, often with evidence of internal subdivision (Kaplan 1972).

While Gopher and Gophna's (1993) paper does present a coherent synthesis of many aspects of Late Neolithic, the overview of lithic technology, once again, is restricted to formed tools. No other tools are illustrated or discussed, except for brief references to flakes being found in considerable quantities in all three cultural units. As this research will demonstrate, the assumption that Neolithic assemblages remained blade-oriented can no longer be taken for granted.

Yarmukian stone tool assemblages are reported as being dominated by blades, with the occasional bipolar core (Gopher and Gophna 1993). Common formed tools include sickle blades, retouched flakes and blades, axes, arrowheads, bifacial knives, awls/borers, notches, denticulates and scrapers. The Wadi Rabah tool inventory is largely made up of retouched flakes (Gopher and Orelle 1990), but to date no attempt has been made to investigate the functions or behavioural implications of these tools. Arrowheads are very rare; this is seen as indicating the relative unimportance of hunting, or at least, of hunting using the bow and arrow. Approximately half of most Wadi Rabah lithic assemblages consists of notches, denticulates and retouched flakes. Other common tool forms include sickle blades, awls, borers and endscrapers. Cores are usually irregular with one striking platform (Gopher and Gophna 1993).

Many of the formed tools from the Late Neolithic levels at Byblos (Cauvin 1968), such as denticulated sickle blades and some formed flake tool types, have marked similarities with those recovered from Tabaqat al-Bûma. The formed tools from Tabaqat al-Bûma also have technological similarities with the Yarmukian (Stekelis 1972) and Wadi Rabah cultures (Gopher 1988).
The pottery, lithics and architecture from Tabaquat al-Bûma seem to have closest affinities to the Wadi Rabah Culture, although important differences do exist (Banning, pers. comm). Pottery especially has many similarities to Wadi Rabah assemblages from Munhatta (Commenge, pers. com.). However, the site of Jebel Abu Thawwab, a Yarmukian site also in northern Jordan, contains a lithic assemblage that appears to be similar to that of Tabaqat al-Bûma (Kaffafi 1985; 1986; 1988). Unfortunately, the only published material on Jebel Abu Thawwab is found in interim reports. Brief examination of the collection at Yarmouk University showed that tool forms such as sickle blades had a high degree of morphological variability that was not apparent from the selection of lithics appearing in Kaffafi's (1985; 1988) reports. One test unit at the Late Natufian site of 'Ain Rahub yielded Yarmoukian material (Muheisen et al. 1988). This site is not far from Tabaqat al-Bûma (13km north of Irbid), and future excavation of Yarmoukian horizons may produce comparable data. New $^{14}$C determinations from each of these two sites – 6350 ± 90 bp for Abu Thawwab and 6410 ± 115 bp for Ain Rahub (Gopher and Gophna 1993) – raise a number of issues. Gopher and Gophna (1993) claim that Yarmukian ends at around 7100 bp. The dates from 'Ain Rahub and Abu Thawwab are therefore far too recent to coincide with their chronological sequence. As mentioned above, the lithics from Abu Thawwab are similar to those from Tabaqat al-Bûma and pottery from the latter's lower layers does include some Yarmukian sherds. It would appear that at least from the present dating evidence, Late Neolithic sites from the Jordanian plateau do not fit into Gopher and Gophna's Late Neolithic chronological sequence. Even with the scanty data available, the Jordanian plateau has a number of regional idiosyncrasies. This is not surprising when one considers how different the

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3 I would like to thank Dr. Z. Kafafi for allowing me access to this collection.
environmental conditions on the plateau are, compared to those from Jordan Valley and Coastal strip.

1.2 The Location and Environment at Tabaqat al-Bûma

The site of Tabaqat al-Bûma is located near a stream bed, in one of the tributary valleys of the Wadi Ziqlab drainage system, in northern Jordan (figures 1.2 and 1.3). This drainage system flows westward into the Jordan Valley, and was part of the biblical region of Gilead, which biblical references suggest was heavily forested (Jer 22.6; Zech 10.10; Banning et al. nd). Travelers in this area in the nineteenth century also observed the heavily forested nature of this region (Burckhardt 1822; Buckingham 1825; Robinson 1856; Doughty 1936a; 1936b). The mean average rainfall is relatively high at 400 mm per annum, but high evaporation rates reduce its effectiveness for plant growth (Zohary 1962). The bedrock geology is largely made up of grey siliceous limestone, with beds of chert and chert nodules in its upper layers (Bender 1974). The site is located at the bottom of the valley, where the soils are a mixture of colluvial and alluvial wadi fill. Field (1994) notes that the valley floor at the site was broader and flatter during the Late Neolithic than it is today, and the stream may have been perennial. The soils are made up of a sandy clay with a high acid and stone content. The modern climate is predominately Mediterranean, with a vegetational cover of Oak-Pistachio forest parkland still preserved (or re-established) in areas upstream of the site. In the immediate vicinity of the site, however, anthropogenic factors such as land clearance and overgrazing by sheep and goats have rid the landscape of most arboreal cover (Banning et al. nd).
1.3 Late Neolithic Occupation at Tabaqat al-Bûma

At present, the nature of the Late Neolithic and that of its associated lithic assemblages, in particular, are poorly understood. The excavations of Late Neolithic horizons at Tabaqat al-Bûma in Wadi Ziqlab have provided an opportunity to rectify this situation. During the summers of 1990 and 1992, several structures of what was probably a farmstead or, at most, a small hamlet, were excavated together with ceramic, faunal and botanical remains and a large lithic assemblage (figures 1.2 and 1.3). This evidence has the potential to provide much-needed information on the subsistence practices at the site during the Late Neolithic. In addition, greater understanding of Late Neolithic subsistence will help clarify the dynamics of this new form of settlement. Alluvial and colluvial wadi-bottom sediments together with the proximity to a spring and stream would have made this location highly desirable for Late Neolithic occupation.

The central theme of my research is that a significant component of the Late Neolithic lithic assemblage reflects subsistence behaviour as well as other behaviours. Therefore the lithics can be studied using the appropriate methodological and theoretical tools in order to investigate what these behaviours were.

During the 1987 season in Wadi Ziqlab (Banning et al. 1989) a 3m x 1m test unit excavated in the WZ 200 terrace uncovered a Late Neolithic cist grave, cut into a layer containing mixed Late Neolithic and Kebaran lithics (Banning 1996; Banning et al. 1989). A second test unit (1.25 x 1.25 m) intersected Late Neolithic deposits and Kebaran deposits in undisturbed contexts. From the information derived from these test units, the nature of Late Neolithic and Kebaran occupation at WZ 200 was equivocal. In order to investigate the character of Late Neolithic and Kebaran occupation at the site, a second, larger excavation was undertaken in the summer of 1990. The primary focus of the 1990 season was to investigate the
Areas
Topography and Excavation
WZ 200 Tabgaat Al-Buma

Wadi Ziqlab Project
Figure 1.3

Wadi Ziqlab Project
WZ 200 Tabaqat al-Bûma
Late Neolithic Architecture
Excavated Areas 1992
nature of Late Neolithic occupation of site WZ 200. Geomorphological and paleobotanical research strategies were constructed to determine a detailed picture of local Late Quaternary environment at the site (Banning et al. 1989; Field 1994). The excavation was comprised of 16 units, most of which were 3m x 3.5m in area (figure 1.3). One of these units, Area E34, was located to examine the character and extent of Kebaran deposits. Unfortunately, the Kebaran deposits were heavily disturbed by colluvial episodes (Field 1994), and their spatial integrity was lost.

The Late Neolithic occupation contained substantial architecture, and appears to have been a farmstead of medium size. An estimated 50% or more of the structures were excavated during the 1990 season (see figure 1.3). Three structures and several walls representing outdoor terraces and possible fences were uncovered. Included within these structures were domestic and storage pottery, storage bins and pits, and grinding stones. The pottery was predominately plain and poorly fired. The size and layout of the architecture together with the associated artifactual assemblage are consistent with site use as a small-scale agricultural community (Banning et al. 1991; 1995). The composition of the lithic assemblage, with its large component of sickle blades and ground-stone cereal-processing tools, is part of the evidence suggesting this. More cist graves were also uncovered in spaces adjacent to the building in Area F36.

Excavation of Tabaqat al-Bûma was continued for another season during the summer of 1992. This season's excavation had a number of goals (Banning et al. 1995):

1) To test for undetected Neolithic structures.
2) To investigate further the Late Neolithic stratigraphic sequence and the nature of Late Neolithic occupation at this site.
3) To understand the histories of the structures themselves.
4) To recover more faunal and botanical data (both forms of evidence have been rare).

5) To use the distributions of microdebitage, pottery, botanical and faunal remains on floors and surfaces to look for spatial patterning.

Units excavated in 1990 were reopened and extended and several more added. This season's work indicated that the Late Neolithic occupation was slightly larger than was previously assumed (Banning et al. n.d.). Moreover, there are at least five episodes of Late Neolithic occupation (Blackham 1994). The 1992 excavations uncovered a new large rectangular structure in areas F33 and E33. Stratigraphically this structure is later than those from D35, E35, E36 and G34, but still Late Neolithic in date. The structure from F33 and E33 is of particular interest because it has a cobbled floor with fragments of an earlier underlying white plaster floor. At least part of the structure would have been semi-subterranean. All of the structures have indications of rebuilding. Much of the masonry that was used was probably appropriated from existing abandoned structures in the immediate vicinity.

Pottery recovery in the 1992 season yielded a better sample than that of the previous season. The structure in Areas E33 and F33 contained some much finer, harder, thoroughly fired wares, but, as in the other structures, most of the assemblage was made up of poorly fired, friable, plain wares. Of particular interest were some hitherto unencountered fine wares. These included bowls with a black or grey burnished surface or, more rarely, burnished red graduating into black. While the pottery styles from different occupation episodes show some, albeit slight, changes, the lithic assemblages are similar.

As mentioned previously, the Kebaran deposits that underlay the Late Neolithic structures proved to be moderately to severely disturbed through colluvial and later cultural action, such as pitting for grave construction.
The lithic collection of 1992 was, for the most part, similar to that from the 1990 season. The only new tools recovered were a partially polished adze and an unusual ground-stone implement that may be the working end of a hoe (see figure 4.1.2). Both of these tools were recovered from the latest occupation in Areas E33 and F33.

Botanical recovery, despite the implementation of a comprehensive flotation programme, was once again meagre. Faunal data were more plentiful and continued to indicate the stock-raising of sheep-goat (68%) supplemented with very limited numbers of bovidae (9%) and suidae (8%) species, including Cervus elaphus, Cervus dama, Bos sp. and Sus scrofa (Banning et al. 1994). The combination of faunal data, and the high recovery rate of sickle blades exhibiting polish associated with grass or cereal harvesting, indicates a mixed farming economy.

Radiocarbon dates from various occupations are given in Table 1.1. At present, there are eleven calibrated dates from the Neolithic levels. Using these and stratigraphic data, five building episodes have been isolated (Blackham 1994). All dates, except the sample from the surface locus in area G34, fall comfortably within the parameters of the Late Neolithic or the Neolithic 3 and 4 as defined by Moore (1985:54). These dates also indicate that the occupation of the E33/F33 structure may have occurred a few hundred years after the abandonment of the other buildings.
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<th>Date (Calibrated)</th>
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Table 1.1. Radiocarbon dates from Late Neolithic contexts at Tabaqat al-Būna, Wadi Zqlab. The calibrated date ranges are the 68.3% confidence intervals, some with multiple solutions. Determinations were by the Isotrace laboratory, University of Toronto. (After Banning et al. 1992)
Chapter 2

2.0 The Analysis of Late Neolithic Flake Technology

"....technology should be seen as a system of knowledge rather than an inventory of objects" (Ridington 1988:471).

Neolithic scholarship occupies an anomalous position in prehistoric research. Both prehistoric and historic period archaeologists are active in this period, and this is reflected in the diverse range of excavation methods that are practised (Gopher and Gophna 1993). Prehistorians are generally interested in the fundamental socioeconomic transitions that took place in the Neolithic; and historic archaeologists are intrigued by the origins of sedentism and social complexity that have their roots in this period. Moreover, prehistorians are sometimes forced to excavate and interpret Neolithic sequences in order to study the underlying Late Pleistocene and earlier deposits; and historic archaeologists are often obligated to excavate Neolithic levels that lie beneath Bronze or Iron Age ones. Traditionally, archaeologists whose training is in the proto-literate and literate periods give lithic recovery low priority on the excavation agenda. Lithic analysis, when it is attempted, is usually descriptive and restricted to a few illustrations of formed tools.

Studies of Late Neolithic stone tools from the Levant have largely ignored the behavioural implications of the marked changes in lithic technology. Much of the literature concentrates on the tool traditions of the Pre-pottery traditions, but interest in the Late Neolithic is notably absent. Crowfoot-Payne's (1981) study of the tools from Jericho spends only a few pages on Late Neolithic formed tools and presents no data on any of the other tools recovered. Cauvin's (1968) report on the Byblos lithics provides comprehensive coverage of Late Neolithic formed tools,
and does mention backed flakes, but makes no mention of minimally-retouched flakes or unretouched, used flakes. Noy (1976) and Gopher (1985) both focus on stone tools from the Levantine Neolithic for their Ph.D theses. Gopher is largely concerned with refining projectile point typology and employed seriation to delineate chronological markers for the Neolithic using projectile point morphology and other factors. Using multi-dimensional seriation analysis, Gopher (1985; 1988) attempted to correlate projectile point types with stratigraphic data and $^{14}$C dates, to investigate the potential for various projectile point types being used as regional chronological markers. Noy’s work focused on tool description and investigated typological variation within four geographical zones in Israel. Although such studies are useful and important, they do not take advantage of what Late Neolithic lithic assemblages can offer to help understand Late Neolithic social, economic and lithic technological change.

Below is a tool type frequency table from Gopher’s (1989:88) study of the Pre-pottery Neolithic B and Pottery Neolithic lithic assemblages from the site of Munhata. While Gopher’s study pays great attention to formed tools, little attention is given to flake tool technology, although he does record retouched flake tools. The primary agenda is to investigate how tool type frequencies change through time. Layer 3/2, the oldest, contains mixed PPNB and Pottery Neolithic material. This is followed stratigraphically by Layer 2B, containing lithic types attributed to the Yarmukian, and then Layers 2A2, 2A1 and 2 General, all of which contain tool types associated with the later Wadi Rabah Phase.
Table 2.0 Table showing Gopher's Tool Type Frequencies from the Pottery
Neolithic Units at the Site of Munhata (Gopher 1989:88)

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<tr>
<td>Bifacial &amp; Tabular Knives</td>
<td>-</td>
<td>-</td>
<td>2</td>
<td>-</td>
<td>4</td>
<td>-</td>
<td>2</td>
<td>1</td>
<td>9</td>
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<td>%</td>
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<td></td>
</tr>
<tr>
<td>Retouched Flakes</td>
<td>29</td>
<td>5</td>
<td>16</td>
<td>16</td>
<td>37</td>
<td>4</td>
<td>23</td>
<td>50</td>
<td>180</td>
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<tr>
<td>%</td>
<td>12.66</td>
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<tr>
<td>Chopping Tools</td>
<td>-</td>
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<td>4</td>
<td>-</td>
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<td>1</td>
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<tr>
<td>Varia</td>
<td>33</td>
<td>9</td>
<td>18</td>
<td>5</td>
<td>26</td>
<td>3</td>
<td>6</td>
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<td>149</td>
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<tr>
<td>%</td>
<td>14.41</td>
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<tr>
<td>TOTAL</td>
<td>229</td>
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<td>107</td>
<td>83</td>
<td>257</td>
<td>35</td>
<td>148</td>
<td>287</td>
<td>1233</td>
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<tr>
<td>%</td>
<td>100.87</td>
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</table>

The majority of the lithic tools from the Tabaqat al-Bûma assemblages consists of unretouched or minimally-retouched stone tools. Similar flake-based tool technology occurs in a wide variety of other contexts from the mid-Holocene onwards. In North America, some authors (Jeske 1985) have described flake technology of the Late Woodland in the Midwestern United States as representing a "dark age" in lithic technology, and archaeologists working in the Southwest describe the "degradation" of stone tools during the Pueblo period as an episode of
lithic "devolution" (Schiffer 1976). The same phenomenon can be observed during the Hoabhinian of Holocene Southeast Asia (Bellwood 1986).

It might be instructive to compare, in their many forms, the broad strokes of Neolithic technological change in England, which has many parallels to the Levantine Neolithic. The early phases of the British Neolithic, with emphasis on blades and narrow flakes, had greater similarities with the later Mesolithic than with later British Neolithic Industries (Pitts and Jacobi 1979; Bradley 1987). The early Neolithic industry of blades and narrow flakes was replaced by one dominated by broad flakes similar to the flake-dominated industries of the Levantine Late Neolithic.

The notion that less standardised tools are qualitative indicators of the "debasement" of lithic technology is unfounded. Throughout the history of the study of prehistoric stone tools, formed or shaped lithics have received far more attention than ones produced with other technologies such as bipolar or others to produce "expedient" tools (Hayden 1977; Gero 1991; Casey 1993). Why is this the case? To answer this question, one has to step back from the literature and attempt to evaluate the values and biases of its current and past practitioners. It appears that most lithic analysts subconsciously place stone tools in a hierarchy of craftsmanship, aesthetics and efficiency. Within this hierarchy, regularised formed tools, such as those worked on prismatic blades, are at the top and flake and piece tools at the bottom. Formed tools represent beauty, skill and, therefore, it is assumed, concomitant functional efficiency. Gero (1991) is correct when she asserts that analysts' fascination with formed tools has hindered our ability to explain and understand the possible behaviours behind stone tools. All too often lithic analysts, in an informal context, will refer to post-Epipalaeolithic or Mesolithic assemblages, with the exception of ground or polished tools, as the "ugly stuff." The language that lithic analysts often use overtly betrays their
overemphasis on formed tools and their dismissal of other lithic tools. The following passages illustrate this quite clearly. Edmonds (1987:155) quoting Pitts and Jacobi (1979) on the "decline" of stone working in later British prehistory calls it,

... a gradual chronological decline in the standard of flintworking, resulting in a slow change from the _fine blade technology_ of the Mesolithic to the _crude, squat flakes_ of the Bronze Age (my emphases).

The idea of most flake technology being "crude" appears to be widespread. Betts (1992:8) describes fourth-millennium stone tools from the Jordanian Badiya by saying, "knapping techniques are crude and basic."

Lee (1973:254) when commenting on the Chalcolithic lithic assemblage from the site of Ghassul, which has many similarities to the Late Neolithic lithic assemblages that preceded it, states:

Retouched flakes and blades make up a large category of rather inelegant tools. They are in most cases rough pieces of every conceivable shape and quality of flint, making them the despair of the typologist.

Finally, Oswalt's (1976) views on the nature of technological development appear to be typical,

Technological change is cumulative. No one denies that the earliest known artifacts are elementary in technological terms or that with the passage of time increasingly more complicated forms have been made.

Earlier evaluations of unstandardised technology are even more absurdly value-laden. Adnan viewed Oaxacan flake industries as the technology of slaves or an "inferior race" (Adnan 1927 cited in Parry and Kelly 1987:296). Contemporary
analysts certainly do not go this far, but the implicit assumption of technological inferiority remains embedded in their texts.

If we accept that unilinear evolutionary theory has no place within the cosmology of contemporary lithic analysts, or of any archaeologists, why does it persist? Students who have specialised in stone tools often receive practical instruction in the manufacture of stone tools. Learning how to flintknap can provide invaluable lessons on the mechanics and parameters of working with stone. During this process, however, the students are imbued with a craftsman's approach to stone tool manufacture. The result of adopting this approach is that the analyst develops an aesthetic sensibility that aggrandises technological finesse. Personally, I find it hard to avoid aesthetic appreciation for the Egyptian ripple-flake knife as one of the pinnacles of stone tool technology. Herein lies the danger. I value these tools for their craftsmanship and aesthetic content; subconsciously I grade all other stone tools accordingly, applying a hierarchy of skill and beauty. Complexity does not necessarily mean efficiency; the jet engine has fewer moving parts than its piston-driven predecessor but is more efficient on every level (Pye 1963). The flake tool is as efficient as the ripple-flake knife for many tasks; in addition, the flake tool requires a fraction of the energy and skill for its production. The more experience in the "art" of flint-knapping analysts acquire, the greater their empathy with prehistoric tool makers. The conclusion to which this empathic link often leads analysts is, more often than not, false. Highly stylised and technologically-accomplished tools can be relatively as inefficient as some utilitarian tools. Some Solutrean pressure-flaked knives are undoubtably examples of the "highest" state of the Upper Palaeolithic flint-

\[4\]The relative scale of a tool's efficiency is the ratio of work achieved compared to the cost and effort expended.
knappers' art, but are also too thin and fragile to be used for anything but ritual or symbolic purposes or, perhaps, as units of currency (Clough and Cummins 1988; Bradley and Edmonds 1993; 1995).

As post-processual theorists continually remind us, archaeologists are products of their contemporary cultural milieu, and, therefore, the direction, perspectives and goals of their research are structured accordingly (Hodder 1986; Skanks and Tilley 1987a; 1987b). Lithic analysts find it just as difficult to maintain an objective distance from their objects of study as do other social scientists. It is not surprising, therefore, that we are predisposed to value the formed tool over the seemingly "chaotic," unformed flake tool. To us, consistency of shape represents order and predictability. I believe our template of what form is, is derived from how we see and explain shape using Euclidean geometry. For shape to be effectively described it has to have recognizable characteristics that conform to geometric principles. These would include a number of sides of equal length or consistent arcs. If a shape does not have these or other culturally-recognisable characteristics, it is reduced to being simply "amorphous." My point is that our notions of shape conform to our cultural constructs. The "amorphous" or "shapeless" object surely is one of our more effective metaphors for the incomprehensible. Through recognising a culturally acknowledged pattern in form – in others words, shape – we assume we can derive understanding and, eventually, explanation. My research indicates that the flake or lithic piece tools may be produced with seemingly amorphous shapes, but they have, ironically, a very significant formed component. This is the design criterion of the used edge (Knudson 1973). To undertake a task, often the edge of a tool has to fall within a set of physical constraints. Flake tools were selected on the basis of the physical characteristics of the the "working edge." I will elaborate on the design of flake tools' working edges later in the text.
The emergence of non-standardised flake technology in the later Holocene represents a reorientation in the technological approach to daily tasks that involve low levels of risk. The unretouched or minimally-retouched flake or piece is capable of performing a wide range of tasks efficiently. Such tools are comparatively easy to make, and, if raw material was readily available, it would simply make good economic sense to use basic flaking technology for everyday tasks. Production of flake and piece tools requires relatively little expertise and energy to produce efficient tools that can be used for a diverse range of tasks. These tools are not the only solution to everyday tasks – different cultural value systems may favour other technological approaches – but in the context of the Late Neolithic, they are a plausible solution. The high proportions of such tools in an assemblage may also imply that a greater proportion of individuals within Holocene communities were engaged in the manufacture, as well as the use of, stone tools. Formed tools are found in the Late Neolithic, and in significant numbers, but these tools are usually ones that appear to be more task-specific (sickle blades, projectile points, axes, adzes and chisels), and these may have uses involving greater economic risks.

2.1 Neolithic Tool Typology

Over the past two decades there has been a major shift in the type of questions that archaeologists ask of their data. For some time now, many lithic analysts have adopted methodologies that go beyond defining horizon markers and cultural types (Henry and Odell 1989). The primary objective of most lithic analysts working in the Levant, however, is still to construct and refine lithic typology in order to impose a chronological framework on the archaeological record. Chronological typologies are easier to construct when lithic assemblages
have high proportions of standardised formed tools than when they are made of nonstandardised flake tools (Henry and Odell 1989). By focussing almost exclusively on typology, however, analysts severely limit the interpretive potential of their data. Lithic analysis, in fact, has the potential to derive key behavioural information from the static lithic artifactual record (Schiffer 1976; Grace 1988), and not just chronologically-useful typology.

Ignoring for a moment the problems inherent in lithic typology (Grace 1988; Torrence 1989), there is nothing inherently wrong with using typology as an initial research agenda for typochronological purposes. Establishing and refining *fossils directeurs* is a useful starting point for any regional study, providing, of course, that they are flexible. The problem, however, is that the typologies that almost all researchers have used in the Levant are versions of the typological scheme that Bar-Yosef (1971) used to classify the Epipalaeolithic lithic tradition. In turn, this typology is closely based on European and North African Palaeolithic/Epipalaeolithic typologies by Bordes (1961; 1970) and Tixier (1963). Therefore the typology used to classify Levantine Neolithic lithics is based on typologies from quite different spatial and temporal contexts. Bordesian typology focuses almost exclusively on formalised tool types. The primary considerations are tool morphology, blank production technology, and inferred use. The implicit assumption of all of the above typologies is that lithic technological change follows a roughly unilinear progressive trajectory through time\(^5\). This concept of increasing tool complexity and efficiency through time has its roots in unilinear evolutionary theory (see Oswalt 1976), which disappeared from most anthropological thought at least 40 years ago (Trigger 1989).

\(^5\)The notable exceptions are Hole (1977) and Braidwood *et al* (1983), who used broad functional categories to type lithic artifacts.
A flake tool from the Levantine Neolithic resulted from the same technology responsible for many Middle Paleolithic flake tools (except Levallois flakes), although the nature of the behaviour associated with the application of this technology was probably very different. As the emphasis in European, and therefore in Levantine typology, is on formed tools, one wonders to what extent artifacts that previous analysts have classed as waste flakes may actually be tools. In many cases, the only way to differentiate between an unretouched flake tool and waste flakes is by use-wear microscopy (Tringham et al. 1974). This is a comparatively new method whose application is not widespread. I was only alerted to the high percentage of flake tools from Tabaqat al-Bûma after undertaking an exploratory use-wear analysis on flakes that I had classed as "debitage" in the field. Approximately 71% of the "debitage" were in fact used flakes. It is likely that significant components of assemblages from many different geographical areas and periods are similarly made up of unrecognised tools (Siggers 1992). Indeed, an argument could be made that basic tools, and not formed tools, were the norm for most prehistoric periods (M. Kleindienst pers. comm). Any future typology of Levantine Neolithic lithics should incorporate the variability in flake and piece tools into its framework.

2.2 Flake Tools of the Late Neolithic

The inclusion of flake and piece tools in any typological scheme poses a problem. How do you define unretouched tools that display wide morphological

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6Even by using use-wear analysis some tools will be missed. A lithic tool can have been used but show no observable wear traces if it was not used for long enough or with insufficient force, or if no abrasive materials were present.
variability? Before any classification of such tools can be constructed, I have to investigate why they were made. The key criterion of the manufacturer, I believe, is probably the production of a working edge suitable for the task at hand. All other considerations, including raw material and morphology, are secondary. I would propose a classificatory scheme, following Knudson (1973), that incorporates traditional technological and morphological metric observations, but is based primarily on two criteria: the use of the tools concerned and the method of flake production (e.g., bipolar core, multi-platform flake core). Knudson (1973) in her analysis of organisational variability in stone tools from Late Paleo-Indian assemblages employed analytical units she termed "employable units (EUs)." These EUs are areas of the working edges on stone tools that were used to perform tasks such as cutting, scraping, perforating, drilling and chopping (Knudson 1973: 17).

Morphological classification should be primarily concerned with attributes of the working edge. It is the physical character of a given tool's working edge—edge angle, edge thickness and edge morphology—that dictates or limits possible uses.

Casey (1993) in her study of bipolar technology from the Ghanaian Kintampo culture, proposes, following Kleindienst (1992), that flake and piece tool technology should be described as "basic" technology. She chose the term basic in an attempt to avoid linguistically loaded terms such as "simple," "expedient," "unstandardised" or "informal." Such tools have been previously described in the literature as "expedient" (Parry and Kelly 1987; Binford 1977). Binford (1973; 1977; 1980) places technological organisation in a continuum ranging from curated to expedient. "Expedient" tools are technologically simple and are created to undertake an immediate task and then discarded. After Knudson's (1973) work on utilised stone flakes, Binford's definition of expedient tools marks the first
recognition of the behaviours associated with minimally-retouched or unretouched flake tools. Unfortunately this term has two definitions, which leads to ambiguity:

1) "useful for effecting a desired result: suited to the circumstances of the occasion; advantageous; convenient."

2) "based on or offering what is of use or advantage rather than what is right or just." (Websters New World Dictionary 1988).

The first definition, which encorporates the ad hoc nature of flake tools, is appropriate. Unfortunately, it could also refer to some formed tools. The second definition, with its implications of political chicanary, would be completely inappropriate. It is very difficult to appropriate any linguistic element that possesses no interpretive variability7. If basic technology will henceforth mean bipolar flake technology – and I see no reason why it should not – is the term equally applicable to other flake technologies such as the one from Tabaqat al-Búma? The methods of production there are quite different: most of the flake tools from Tabaqat al-Búma are made from flakes that result from single-platform pyramidal cores. The flakes themselves are also different from those made with a typical bipolar technology. They are larger and less morphologically variable. On the other hand, the application of these two flake traditions was probably quite similar. Casey's bipolar technology and the Levantine Late Neolithic flake technology share the same criteria that define what was initially termed "expedient" technology. While the two modes of flake production differ, their applications are remarkably similar.

7In Britain, for example, any individual or exercise that is termed "basic" is seen to be ridiculously simple.
I believe that both technologies should be termed basic, but this classification should be further delineated by production mode. Therefore Casey's assemblage should be termed a basic bipolar technology and the Tabaqat al-Bûma flakes should be termed a basic pyramidal-core technology (figure 5). The classification of basic assemblages not based on bipolar production is only possible in this system if the cores from which the flakes were struck are recovered. This is not always possible. Moreover, many assemblages contain flakes made from more than one technique of core reduction. When this is the case, as long as no bipolar flakes are recorded, the flake assemblage can be termed simply a basic flake/piece technology.

Figure 2.1 Classification of Basic Flake/Piece Technologies

<table>
<thead>
<tr>
<th>Production Technique</th>
<th>Basic Tool Classification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bipolar Core</td>
<td>Basic Bipolar Technology</td>
</tr>
<tr>
<td>Pyramidal Core</td>
<td>Basic Pyramidal Technology</td>
</tr>
<tr>
<td>Multi-Platform Core</td>
<td>Basic Multi-Platform Technology</td>
</tr>
<tr>
<td>Bifacial Core</td>
<td>Basic Bifacial Technology</td>
</tr>
<tr>
<td></td>
<td>}</td>
</tr>
<tr>
<td></td>
<td>Direct Precussion</td>
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</tbody>
</table>

Flakes made from pyramidal cores are always going to be morphologically more predictable than those made from bipolar ones; in fact, the bipolar technique produces few flakes. To a certain extent the type of core used determines the morphology of the flakes or blades struck from it (Knudson 1973). Bipolar technology, because of the randomness of percussion, placement and core selection, always produces the most irregular pieces and flakes of any reduction method, whereas prismatic blades produced by indirect punching are the most consistently regular. The regularity of a lithic reduction strategy refers to
predictability with which lithic pieces, flakes or blades are produced. The predictability of these lithics refers to their level of replicability, or how similar they are to each other. Figure 2.2 illustrates along the continuum of one axis the regularity of flakes and blades according to method of production.

Figure 2.2 The regularity of flake/blade production according to core type and associated striking method.

My definition of the basic flake tool is not restricted to used unretouched flakes. If a flake has received a modicum of edge retouch to improve the physical characteristics of the working edge, it still comes under the umbrella of basic technology. This immediately begs the question of how much retouch is a "modicum?" I do not believe that by attempting to quantify degrees of retouch we will be able to arrive at a meaningful equation to distinguish a basic flake from a formed one. When retouch has been performed on a flake or piece to modify the specifications of the working edge, it is a basic tool. If, however, a flake or, more importantly, a group of flakes, has been retouched to facilitate hafting or to fulfill stylistic criteria, it should not be considered basic. Here, once again, the degree of form replication is an important factor. If a number of tools have been retouched
to produce a form that is morphologically similar, they should be considered to be formed tools.

Any evaluation of the stylistic component of stone tools will always entail a certain degree of subjectivity (Close 1978; Wiesner 1983; Sackett 1982). The analysis of style in lithic artefacts is contentious, but the majority of analysts interested in style agree that the formed tools allow greater scope for stylistic input. Stylistic attributes can be present during the selection of blanks or edge modification of basic tools, but, because of the physical properties of lithic material, the stylistic options of working edge modification, when utilitarian function has primacy, are limited. It should be noted, however, that the lack of creative "style" in the traditional sense is itself a style.

Basic flake tools can have a regular mode of production if they are produced using a defined and consistent core-reduction strategy, such as use of single-platform pyramidal cores. Flakes that result from these core-reduction sequences will still have an irregular morphology, but will be less variable than flakes and pieces produced using a bipolar sequence. Stone tools, if not heavily modified, can give some indication of the method of production. It is important to remember that regularity of flake or blade production is not only determined by core type, but also by the methods of core reduction and the skill of individual tool makers. There are few rules that one can expect the prehistoric knapper of this type of core reduction sequence to have followed. The only real limitations on stone tool manufacture are those set by the limits of concoidal fracture. The literature of lithic technology repeatedly tells us stereotypic ideas about how tools were made: the techniques, motions and equipment used. From personal experience I know that it is quite possible to produce a serviceable blade from a flake core using a hard hammer instead of the accepted soft billet; the stereotypes are misleading.
One of the most striking features of tools from Tabaqat al-Būma is that they do not conform to production techniques that analysts would consider orthodox. The blade tools from Tabaqat al-Būma, most of which are denticulated sickle blade elements, are usually fairly irregular, single-ridged elements. Morphological variability is not usually a trait associated with blade technology. My research on the production strategies of these blade tools indicates that many of the sickle "blade" blanks were, in fact, single-ridged flakes. As Kleindienst (Clark and Kleindienst 1974) has so succinctly pointed out, tool-replicating analysts often believe that their method of replication, derived from experiment, is the only method possible. Often, however, a method for replicating a given tool is one among many possibilities. The correct one can only be inferred from material representing a full reduction sequence. Recovery and analysis of such material does occasionally occur (Roberts and Bergman 1988), but is not common.

The idea of what actually constitutes a stone tool was challenged by the ethnographic experiences of White (1967) in New Guinea, and Gould et al. (1971) and Hayden (1977) in Western Australia. Hayden (1977: 179), in his research among the Pintupi, Yankuntjara and Wankayi aborigines of Western Australia, was surprised to find that many of his assumptions, largely derived from occidental male scholars, were simply wrong. First, he was alarmed to find that the group he studied seldom used what an archaeologist would call a "tool." The bulk of all tools used were unretouched flakes. These appear to have been selected by a cursory evaluation of the working edge and the tools' potential to afford a good grip. If this evaluation proved negative, the piece was discarded, and another selected. The critical observation that Hayden makes is that in no part of the selection procedure were flakes chosen according to a preconceived ideal or "classic shape" (Hayden 1977:179). During the process of shaving a spear, one of Hayden's informants (1977: 185) selected a flake with a a potential working edge
similar to that of an intentionally made burin and used it for shaving. If this tool were recorded on a Levantine site or, for that matter, on any site, it would probably be classified as a primary flake, and, unless subjected to use-wear analysis, as "debitage." Many of the basic tools that Hayden recorded in use were used for modifying wood. Interestingly, the use-wear results from the basic tools from Tabaqat al-Bûma indicates that they too were mostly used to work wood.

Formed lithic tools in the archaeological literature are defined as elements that have undergone some form of modification by retouch. Kleindienst (1959) and Gero (1991: 166) argue what now seems obvious to me: a stone tool is any piece of stone that shows traces of being used. Our standards of what constitutes a sophisticated and, by implication, an efficient tool is ethnocentric, and leads us to construct an uneven picture of much of Holocene prehistoric technology. After considering the ethnographic data discussed in the previous chapter, the major differences in production and function between these two tool categories is summarised in the table below.
Table 2.1 Production and Functional Features of Formed and Basic Tools in the Levantine Neolithic

<table>
<thead>
<tr>
<th>Raw Material Selection</th>
<th>Basic Tools</th>
<th>Formed Tools</th>
</tr>
</thead>
<tbody>
<tr>
<td>Locally available, often of medium to coarse quality</td>
<td>Fine grade material usually from off-site sources</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Design Considerations</th>
<th>Basic Tools</th>
<th>Formed Tools</th>
</tr>
</thead>
<tbody>
<tr>
<td>Suitable working edge modifications</td>
<td>All round high level of design input to ensure tool efficiency</td>
<td></td>
</tr>
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</table>

<table>
<thead>
<tr>
<th>Energy Investment</th>
<th>Basic Tools</th>
<th>Formed Tools</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low</td>
<td>High</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Element of Risk associated with intended use</th>
<th>Basic Tools</th>
<th>Formed Tools</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low level of risk</td>
<td>Medium to high levels of risk</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Use</th>
<th>Basic Tools</th>
<th>Formed Tools</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single use incident or limited-term use</td>
<td>Used until tool is inefficient and cannot be remodeled</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Risk involved with related tool use</th>
<th>Basic Tools</th>
<th>Formed Tools</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low</td>
<td>High</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Reuse and Remodification</th>
<th>Basic Tools</th>
<th>Formed Tools</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rare</td>
<td>Working edge is modified until tool is inefficient, broken or lost</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Stylistic Input</th>
<th>Basic Tools</th>
<th>Formed Tools</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minimal apart from choice of reduction strategy</td>
<td>Higher levels of conscious or unconscious stylistic input in production process</td>
<td></td>
</tr>
</tbody>
</table>

Basic tools have also been tentatively linked to gender. George Michaels (pers comm), using Mesoamerican ethnographic accounts, has proposed that nonstandardised tools were primarily used for food-processing tasks by women. While the processing tasks can probably be inferred with use-wear techniques, assigning tool forms to gender is problematic. Many formed tools have been interpreted as hunting tackle, while the ethnographic record suggests that hunting is a male activity (Casey 1993:199). Although there are exceptions, as among the Agata in the Phillipines (Estioko-Griffin 1990), this appears generally to be the case. If so, the emphasis on formed tools has the effect of overemphasizing male
activities in prehistory. It is well known that hunting very seldom represents the only form of subsistence strategy in any society. During the Neolithic, especially the Late Neolithic, faunal data indicates that hunting was often only a small contributor to subsistence (Gopher and Gophna 1993). By not studying flake tools fully, archaeologists unintentionally deny themselves insights into much of the everyday Neolithic technology and its associated behaviour. The ethnographic record of groups using stone tools is limited, but it does clearly demonstrate that basic technology is associated with both men and women (Gould et al. 1977 and Hayden 1977). Moore (1988:32) and Gero (1992) speculate that, if anything, the stone tools women made and used would be more plentiful in the archaeological record than those used by men. If, as they reasonably assume, many of the tasks women undertook were focussed in household areas, one would expect household contexts to be where most of their tools would be recovered (Gero 1992:169). By contrast, many male-oriented activities, such as hunting, occur off-site. Therefore, the potential for the recovery of the artefacts associated with these behaviours is diminished. My own preliminary observations of the assemblage from Tabaqat al-Bûma (Banning et al. 1990; 1991), suggest that approximately 80% of all tools are basic. If the Later Neolithic saw radical changes in settlement and subsistence practices, it is likely that these were associated with a response in their lithic technology.

Unlike lithic studies in the Levant, British Neolithic studies have begun to move away from typochronological concerns and have become more focussed on explaining the changing structure of lithic assemblages during this period. In these studies, however, most explanations have focussed on changing availability of raw materials (Ford 1987). Because blade technology is more economical than other methods of blank production, Care (1982) sees it as the solution to limited access to raw material. Gardiner (1984) points out, however, that lithic raw
material was not only procured from mines, but also from clay-with-flints sources. These sources are readily available across much of the British Neolithic landscape. Lithic raw material is also widely available in most areas in the Levant. This suggests that Neolithic technological change there, as well as in Britain, has little to do with material availability, or at least more to do settlement, subsistence, and the many other socioeconomic factors with which this thesis is concerned.

**Style and Late Neolithic Stone Tools**

Because the lithic sample from Tabaqat al-Bûma does include a significant range of formed tools, it is profitable to evaluate recent work on the stylistic component of stone tools for its potential application to this material. Stylistic studies can be divided into 'information exchange' and 'social interaction' approaches (Wobst 1977). The 'information exchange' theory deals primarily with style as a social function (Clark 1989,29). In other words, it emphasises style as a means of transmitting information about group affiliation and ownership in order to mediate social intercourse. Here, style is seen as an active phenomenon used consciously to express emotional, social, and economic dialogue (Clark1989; Hodder 1986).

While the 'information exchange' approach emphasizes dissimilarities, the 'social interaction' theory for interpreting style tends to do the reverse. In this case, variability in the stylistic record is reduced, and is seen from a modal or normative perspective. Style is viewed as a method of emphasizing the similarities between people sharing the same ideological contexts. From this particular perspective, style is usually seen as a long-lived phenomenon.

The majority of analysts in this field have leanings toward one or other of the above perspectives. Clark (1989) points out that it is not so much a question of dichotomy, but of different emphasis. It appears reasonable to suggest that both
models would have different levels of applicability according to the stylistic problem at hand. It would be naïve to suggest that any one model of stylistic interpretation could be applied to every lithic manifestation in the archaeological record.

Sackett (1982; 1985) argues that it is impossible to view style in lithic artefacts in isolation. He perceives style as being inseparable from function, and describes the interrelationship as 'isochrestic' style. Isochrestic style occurs when style and function share equal responsibility for all formal variation within lithic artefacts. Sackett concedes that separating these variables is an almost impossible task, noting that it is difficult enough for ethnologists to separate function and style, even though they have the opportunity to see the tools in use (Sackett 1982: 68). Part of the impetus for Sackett's research into style was Osgood's (1940: 25-29) concept that subsystems or 'realms' are present and reflected in material culture. These three realms consist of the material (technology and economics), the societal (social organisation and behaviour), and the ideational (ideas, beliefs and values). But while we may recognise these factors in our own socio-cultural context, it is highly unlikely that we can infer them from an archaeological lithic assemblage (Sackett 1982: 69). By analysing style and function in an isochrestic format, Sackett argues that it is possible to unravel lithic variability by systematically recording the components of overall morphology. While variability in the lithic assemblages can be measured by comprehensive observation of lithic morphology, the meaning of this variability is by no means always clear. Sackett suggests that style can manifest itself in every step of the production of a lithic entity; from the selection of raw material to the type of retouch. Isochrestic style is contrasted with 'iconic' style, in which the manufacturers of an artefact consciously invest it with meaning. Most researchers, with the exception of Binford (1973), are skeptical of archaeologists' ability to interpret these kinds of styles in lithics.
Binford (1973; 1986) has applied his concept of style to fairly wide-ranging archaeological scenarios. Initially, Binford (1962) modelled his method for stylistic interpretation on Osgood's (1940) triple-realm system for material culture. In Binford's system, artefacts were described as 'technomic', 'socio-technic', or 'ideo-technic' items. He was later to modify this model to enable all three categories to interrelate (Binford 1973). Binford fundamentally opposed Sackett's 'isochrestic style' and insisted on the style–function dichotomy. He sees style as a marker for ethnicity that can be used to gauge social distance on micro and macro levels. Binford's stylistic ideology is most clearly seen in his debate with Bordes over the Middle Palaeolithic Mousterian facies. Essentially, style is considered to be a residual category that is secondary to raw material and functional constraints (Clark 1989).

Close (1977, 1978) refers to style as a micro-tradition passed on unconsciously through inheritance. She sees style as operating within spatial and temporal boundaries, and broadly defines it as a mode of manufacture that is separate from functional considerations (Close 1978: 223). The method Close advocates for recognizing style in lithic artefacts is one of variable attrition. This involves the elimination of the causal vectors responsible for functionality and technology. Once this has been achieved – Close is never clear on how exactly – stylistic variability is left. The study of tool efficiency through the analysis of use and design can help to delineate style (Close 1977). This assumes that style and function are independent variables.

Wobst (1977), in his paper on style, outlined the most common uses for stylistic variation. These include social and economic status, rank, ownership, and boundary delineation. While Wobst's ideas on this subject were generated from research among living pastoral communities in upland eastern Europe, they are applicable to many prehistoric formed tools.
A synthesis of the literature on style in stone tools establishes a number of points of consensus (Clark 1989):

1) Style is transmitted from one generation to the next;
2) Often this inherited stylistic tradition is learned imperfectly from one generation to the next, and so can be seen gradually to evolve or drift;
3) With the exception of Sackett, most analysts perceive style as being independent of function and raw material. Sackett (1977) argues that style manifests itself continually through the manufacturing process;
4) Style can encapsulate meaning or not. Examples of conscious stylistic meaning would include Sackett's 'iconic' style, Wiessner's 'emblemic' and 'assertive,' and Close's 'deliberate' styles;
5) Regardless of whether style is a conscious phenomenon or not, it can take on social and symbolic meaning for the maker and analyst (Hodder 1986).

The formed tools from the lithic assemblage from Tabaqat al-Bûma undoubtedly contain many of the stylistic features mentioned above. One of the most interesting stylistic features of the formed tools is how poorly "formed" they are. Most of the tools have a distinctly utilitarian appearance. It is as if their makers gave little consideration to appearance; utility and efficiency take precedence. The adzes and axes are good examples. If I may be permitted a strictly subjective, value-laden observation, formed tools from Tabaqat al-Bûma are exactly what one would expect a farmer's tools to look like—especially if he or she had limited resources. A farmer's tools usually have a utilitarian aspect where efficiency takes precedence over aesthetic appearance. The same tools from larger Late Neolithic settlements, such as Byblos (Cauvin 1968), are technologically similar but notably more "finished." This points to different levels of craft appreciation even within the formed tool component. It is possible that at some of the larger Neolithic settlements, such as Late Neolithic Byblos, the higher
standard of formed tool finish is a reflection of craft specialisation, increased leisure time and, perhaps, higher economic status.

2.3 Stone Tool Optimisation and Design in the Neolithic Tradition

Any explanation of Neolithic lithic assemblages will require the adoption of an alternative theoretical perspective to those currently employed in the Levant. The emphasis must shift away from a cultural-historical approach, and, instead, be placed on lithic technology as part of the problem-solving process. To appreciate the role of lithic technology within the rubric of subsistence strategy, one should see stone tools as a component of a larger set of behaviours, not merely as a sequence in a grand technological evolutionary scheme. A first step in any future investigation of the Neolithic lithic tradition is to recognise the importance of the dichotomy between basic tools and formed tools. Traditional lithic concerns, such as raw material sourcing and acquisition, technological modes of production, and metrics and classification of formed tools can then be addressed. I will incorporate risk-management studies as a potential area for obtaining significant insights into the changes in technology that occur in the Levantine Neolithic.

Torrence (1986 and 1989) claims that, by viewing a given lithic technology as a mode of economic risk reduction, one may gain insight into why a particular subsistence strategy was chosen. Choices are made in response to risk at every step of stone tool construction, beginning with raw material choice, and through every stage of tool manufacture (Sheppard 1987). These decisions are dynamic, and are influenced by cultural constraints as well as by utilitarian considerations.

While Torrence has applied her analysis of risk to hunters and gatherers (see also Wiessner 1982; Hutchings 1991), it can also be profitably applied to the more sedentary populations of the Neolithic. The advent of subsistence strategies
based on agriculture and pastoralism involved a greater degree of control over resources, thus altering the nature of the risks involved. The degree of risk that individual elements of a subsistence strategy entail may well be a factor in the technology chosen to cope with it. Analysis of the organisation of lithic technology as response to risk has the potential to provide insight into the decision-making processes of Late Neolithic populations. These decisions may be conscious or unconscious, as I will discuss later.

Before proceeding any further, I should clarify and discuss some of the issues surrounding "risk," "tool optimisation" and "stone tool design requirements."

Design Theory

A number of lithic analysts have turned to investigations of technological design to gain an appreciation of the range and complexity of factors behind stone tool construction and application (Hutchings 1991; Bleed 1986; Kleindienst 1979; Kukan 1978). These researchers have followed, as do I, Pye's (1964) principles of design theory. For the purposes of this research I am exclusively concerned with the design considerations of tools, and not technology at large.

The design of a tool does not refer to its predetermined physical specifications, but to the way its physical characteristics and their application transfer kinetic energy from the user to achieve a desired goal or goals. Design, by this definition, takes into account the motions, or the way energy is transformed via the physical characteristics of the tool in question. When one refers to technology, one is not referring just to materials and machines, but also to the behaviours associated with their use. All too often traditional stone tool analyses proceed as though tools were self-contained units of technology, and underplay the motions with which they were used. Wagner (1960) and Oswalt (1976) both
devised typologies of hunter-gatherer technological material culture based on the way various tools transform kinetic energy. Only by acknowledging the interactive processes behind design can we begin to look at the anthropology of technology. By viewing the tools within an assemblage as the prehistoric solutions to design problems, we can obtain a greater appreciation of what these problems were (Kleindienst 1977: 59). Design theory, therefore, can be an aid in the clarification of technological variability. When dealing with a basic flake tool assemblage, which is extremely morphologically variable, design theory has great explanatory potential. Indeed, when Hayden (1977:6) discusses the design theory as advocated by Kliendienst, he states: "......design theory deals directly with the decision making process (behind tool manufacture)."

The central tenet of design is that every aspect of technology exists within a larger dynamic system (Pye 1964: 15). All components of this system are interactive. Archaeologists, especially prehistoric archaeologists, have a tendency to study stone tool technology in isolation. To understand technology, however, one must examine its interaction with an environment, subsistence economy, settlement and social systems. In many ways, viewing technology as a dynamic system has many parallels with the study of hermeneutic circles used by some post-structural archaeologists (Johnsen and Olsen 1992). The study of hermeneutics, developed as a method of historical understanding, is best summarised by Droysen:

The part is understood from the whole from which it originated, and the whole is understood from the part in which it finds expression (Droysen 1977 cited in Johsen and Olsen 1992:421)

To understand how technologies in the past functioned, we must attempt to understand the cultural factors with which it meshed. On the basis of Pye's (1964) work, four broad themes can be outlined, all of which have significant
implications for the study of stone tool technology:

1) The components that make up a tool must be physically strong enough and arranged in such a fashion that they can undertake the task for which they are intended.

2) Technology has the potential for failure. Design failure can be mechanical or behavioural. Following Torrence (1989), I would go on to say the that the frequency of tool failure is directly linked to the consequences of that tool's failure. For instance, consequences of a parachute's failure are substantial, so that any degree of parachute design failure is unacceptable. Tools whose failure will entail particularly adverse consequences are often over-designed so that they perform beyond standard functional requirements, or have a high degree of redundancy. Prophylactics would be another example. Canadian law requires that prophylactics undergo seven prescribed tests. Manufacturers, to inspire confidence in their product, stress that their testing exceeds statutory requirements.

3) All tool design is the result of compromise on the part of the designer. Interacting variables with the potential for compromise include material selection, cultural stylistic requirements, whether conscious or subconscious, and methods of tool construction.

4) Tool efficiency can be gauged in levels of accepted efficiency that are culturally and circumstantially determined. Pye (1963) states that design problem solutions are never 'optimal' – *they are good enough*.

5) The manufacture of tools must be made within accepted economic parameters, as measured in the cost of raw materials, manufacturing time, labour and the costs of tool failure.

All of the above considerations place limits on the tool-designer's freedom (Pye 1964:21). In the case of stone tools, the design choices are limited from the outset by the nature of raw material and the methods for reducing it. Another critical
limitation on the range of design possibilities is the relation of the working edge of a stone tool to its intended task. While many researchers have recognised broad correlations between the nature of edge angle and tool function (Lewenstein 1991; Wilmsen 1970; Semenov 1964), ethnographic work has shown that cultural perceptions of efficiency, as discussed earlier, can take precedence over the relationship between the two variables (Hayden 1977). The analyst cannot, therefore, make a priori assumptions about the relationship between the tool's edge angle and its use. The correlation can be investigated, on an assemblage-by-assemblage basis, by comparing the possible uses of various tool types and the characteristics of their working edges.

Optimal Tool Use Modeling

Design theory sets out the criteria behind the manufacture of tools. Optimal tool-use models and design theory give functional efficiency a position of primacy in the equation of tool construction. Tools are made first and foremost to achieve a goal, and to perform within parameters that are seen to be acceptable. However, functional efficiency is not always the primary concern in the design and manufacture of all tool types. Parameters of tool efficiency will vary culturally and also on an individual basis. This understood, I believe that it is fair to assume that if a tool, such as a flake, was not primarily a symbolic item, it would be made to succeed in performing physically within the expectations of the maker. As outlined in the last section, this does not deny the existence of a stylistic component in lithic tools.

Hunters and gatherers often attempt to minimise the high risks associated with resource procurement by increasing the reliability of their technology and by organising it to maximise return (Wiessner 1982; Bleed 1986; Torrence 1989; Hutchings 1991). This reliability is achieved in the design requirements of tools.
crucial to acquiring critical resources, as in the “over-design” of the composite microlithic arrowhead in the Epi-Palaeolithic (Hutchings 1991). The over-design of the composite arrow minimises the risk of equipment failure, reduces the "down time" for tool repair, and therefore maximises the potential for quarry procurement where the quarry are encountered sporadically and are literally "fleeting". By viewing tools as solutions to design problems, we can gain a clearer understanding of the tools’ behavioural raison d'être.

With the advent of more sedentary settlements in the Neolithic, the nature of subsistence risk changed. With subsistence now focused on pastoralism, agriculture, or both, the risks involved were no longer the short-term risks associated with hunting and gathering, but ones associated with crop and storage failure (Torrence 1989). The assemblage at Neolithic sites such as Tabaqat al-Bûma probably reflects the risks involved with this fundamentally different mode of subsistence.

Tool forms whose manufacture represents a high level of expertise, and large amounts of time and energy input, such as the sickle blades and adzes, could reflect a technology that needs to be more reliable because its role in the subsistence economy was critical. The inferred use of sickle blades, for example, is cereal reaping. The window of opportunity for harvesting can be narrow (Borowski 1987; Unger-Hamilton 1989). Moreover, harvesting is well attested as "the most important activity of the agricultural year" for cereal-based agricultural communities in ancient Syro-Palestine (Borowski 1987:57). This was probably also the case in Neolithic agricultural communities such as Tabaqat al-Bûma. Unlike the subsistence base of the Prepottery Neolithic, which spread risk out by exploiting many strategies, Late Neolithic communities appear to have focused on far fewer resources. Although the exploitation of wild bovidae in the Late Neolithic would help to buffer against subsistence failure, the degree of risk that a
predominantly agricultural subsistence entailed would be high, especially when compared with the Prepottery Neolithic. Consequently the efficiency and reliability of the sickles used would be of great importance.

On the other hand, the ad hoc nature of basic tools may be a reflection of the lack of critical risk in the tasks for which they were used. In turn, this would imply that the set of behaviours with which the basic tools were involved required a low level of spatial and temporal control. By this I am referring to non-critical tasks that were undertaken in and around the household. If we look at technology as a series of interconnected systems, these basic tools may have been used for non-critical components, but that is not say that other stages of these systems did not have critical components. Also, this does not imply that basic tools are less efficient than formed tools. In fact, the majority of tasks undertaken throughout prehistory could have been efficiently undertaken using the simple tools. If this is the case, it is the formed tools, not the basic tools, that are the anomaly in Late Neolithic lithic assemblages. Basic tools are the tools that are far more common and used more frequently.

It is possible to gain information regarding the relationship between lithic technology and subsistence behaviour by studying the organisation of technology within the assemblage. The two major variables under consideration here are tool complexity and tool function. After identifying the possible uses of the formed and basic tools, one can attempt to determine the relationship between function and complexity. One measure of complexity is Oswalt's "technounit":

an integrated, physically distinct, and unique structural configuration that contributes to the form of the finished artifact (Oswalt 1976: 38).

Tool complexity is determined by the number of technounits per tool. For example, the sickle is usually made up of three to seven blade elements, a haft and mastic. Consequently, the sickle has a high index of complexity. Oswalt's model
equates increasing complexity with increasing efficiency and associates it with activities that involve higher degrees of risk. By examining technological complexity from diverse ethnographic subsistence and ecological contexts, Oswalt posits a direct correlation between tool complexity, environment and subsistence pattern. Generally speaking, he argues that the ethnographic record indicates that tool complexity increases with mobility and subsistence specialisation. The tools of hunters and gatherers tend to made up of more technounits, and are more complex than tools used by traditional agriculturalists, which contain fewer technounits. Moreover, Oswalt finds that the colder and more adverse the climate, the more complex are tools: hunting tools are most complex in the Arctic, less complex in temperate and tropical climates, and least complex in the desert.

This thesis will show that to view and categorise the assemblage of tools used by a community by a single evaluation of complexity is too simplistic. Certain tools of any farmer's tool kit will be complex, and others less so. Each individual tool type should be evaluated on its own merits.

The link between tool complexity and tool efficiency, while valid in many instances, is certainly not in all. Some of the of the world's most efficient tools have few technounits. At the other end of the technological spectrum, basic tools with their lack of complexity – often only one technounit – reinforce the idea that the activities for which they were used had a low risk index. Basic tools here, contrary to Oswalt's model, illustrate that tool simplicity is not always related to tool efficiency.

There is not always a direct simple correlation between tool complexity, tool efficiency and risk. However, a investigation of the potential relationships between these variables using design theory can provide a fruitful avenue of inquiry to determine how lithic technology, subsistence and other behaviours were articulated at Neolithic sites. The results of this type of investigation could
have ramifications for the study of basic lithic assemblages for the whole of the Neolithic phenomenon.

Future analyses of Neolithic lithic assemblages require more sophisticated methods of data collection (including a priori excavation planning), as well as the adoption of a more anthropological theoretical orientation. Excavation methods in particular must incorporate more rigorous and systematic methods of recording contextual information. These contextual data are vital for the interpretation of intra-site behaviours, and can also provide information relevant to site-formation processes (Schiffer 1976).

I propose to refocus the current typologically-oriented analytical techniques with analysis incorporating the following considerations.

1) Significant components of Levantine Holocene lithic assemblages consisted of basic technology. Formed tools were still in production, right up to the Early Bronze Age (Rosen 1997), but the technological norm was increasingly the informal basic flake tool. Lithic basic tools increased in frequency as the Holocene progressed. I postulate that this technological phenomenon reflects changing settlement strategies and socioeconomic conditions as the Neolithic proceeded.

2) Traditional typological metric classification should be superseded by a classificatory scheme that incorporates observation of metrics and raw material, but gives primacy to basic tool use. The potential uses of formed and basic tools can be explored by examining other types of archaeological and ethnographic data to reconstruct possible Late Neolithic agricultural and pastoral systems.

3) Once the possible uses of formed and basic tools from an assemblage have been assessed, this information can be considered in conjunction with risk management and design theory.

The above guidelines are not meant to represent an all-encompassing strategy for Neolithic lithic analysis. Factors such as stylistic variation and
interpretation are not specifically targeted in my research agenda. However, this behaviourally-oriented approach to lithic analysis represents a marked departure from the typological approach as currently practiced. By considering the Late Neolithic assemblage in terms of use, risk management and design theory, I will contribute to a greater understanding of the articulation between lithic technology and subsistence strategy.

2.4 The Nature of the Lithic Sample from Tabaqat al-Bûma

*Summary of Stone Tool Types*

The Tabaqat al-Bûma Late Neolithic lithic assemblage is made up of two major categories of tools: basic tools and formed tools. Basic flake tools make up the majority of the sample (table 2.3) and the formed tools are limited to few classes, among which sickle blades predominate. There is considerable variability in the sickle blades, of which there are 151 in our 1992 sample alone (Table 2.3). Most have a denticulated working edge with either abrupt or semi-abrupt backing, and about 90% exhibit sickle polish. Other formed tools include adzes, awls, borers, burins, scrapers and retouched and unretouched blades. Retouched blades include endscrapers, burins and backed pieces. No complete projectile points have been found and there are only recognisable fragments of one, or possibly two. Of the formed tools recorded, there is considerably more variability among the Late Neolithic tools than among the corresponding tool forms recorded in the early Neolithic (Rollefson *et al.* 1992). Included in Table 2.2 are significant numbers of blade and bladelet tools from mixed contexts near the interface with Kebaran levels on the site.
The majority of the formed tools were made of chert of high to medium quality, available 500 m west of the site. Basic flakes were made of material of medium to poor quality, available in its immediate vicinity.

The ground-stone repertoire is fairly small, but includes large querns, handstones, a stone bowl, small mortars, one very large limestone mortar, some basalt pestle fragments and a complete small pestle, and a single pecked basalt, adze-like tool. We also have small limestone objects that are likely capstones for bow-drills.

When one considers the range of prehistoric tasks that the inhabitants of Tabaqat al-Bûma encountered, the dichotomous nature of the two chipped-stone tool types is understandable.
<table>
<thead>
<tr>
<th>Tools</th>
<th>1992 Sample</th>
<th>Analysis Sample</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>n</td>
<td>%</td>
</tr>
<tr>
<td>Retouched Flakes</td>
<td>188</td>
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<td>Used Unretouched Flakes</td>
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<tr>
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<td>1.2</td>
</tr>
<tr>
<td>Awl/Borers</td>
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<td>1.6</td>
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<tr>
<td>Misc. Formed Flake Tools</td>
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<td>Bladelet Fragments</td>
<td>18</td>
<td></td>
</tr>
<tr>
<td>Waste Flakes</td>
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</tbody>
</table>

Table 2.2 Distribution of lithics recovered from Tabaqat al-Bûma during the 1992 season (including contexts with mixed Late Neolithic and Kebaran materials) and the analysis sample.
**Sampling Strategy**

The 1990 and 1992 seasons at Tabaqat al-Bûma recovered a large lithic collection from a wide variety of contexts. Because of its size, a smaller sample of tools and debitage was selected for analysis. First and foremost, artifacts were chosen on the basis of their contextual integrity. Lithics from archaeological horizons that were in the most secure contexts were included. Disturbed horizons such as building collapse and fill were not included in this analysis, nor were loci containing tools from mixed Late Neolithic and Kebaran contexts. Initially these "mixing episodes" were perplexing, considering how high in the depositional sequence some of these loci were found, at least in the northeast part of the site. Further excavation showed that these mixed contexts were made up of earlier sediments that were removed from Kebaran contexts during building and grave-digging episodes and redeposited at a higher level. These contexts were also excluded from the final analysis. Lithics from the living surfaces within the excavated structures were given the highest priority. This strategy reduced the sample to manageable proportions. As the focus of this research is an evaluation of the rationale behind lithic technological choice at this site in particular, and the Levantine Late Neolithic in general, an evaluation of the spatial patterning of lithic artifacts was not attempted. In addition, because of the disturbed nature of most of the archaeological contexts from Tabaqat al-Bûma (Blackham 1994), an analysis of the spatial patterning of stone tools would be of limited value.

In addition to tools from secure contexts, extraordinary tools such as polished formed tools and ground stone were also examined, but are not included in the statistical sample. Any behavioral conclusions drawn from these pieces have to remain tentative because their relationship to the Late Neolithic
occupation is not fully supported by contextual evidence. The contexts included in the lithic sample in this analysis can be found in Appendix I.

2.5 Analysis of Basic Flakes and Formed Tools

Basic Flake Tools

As mentioned in the previous two chapters, the lithic assemblage is predominately made up of unretouched and minimally-retouched flake tools. At the initial stages of analysis it was immediately apparent that the assemblage included many flake tools. What was not obvious was that a large proportion of unretouched flakes, classed during field analysis as "debitage" or waste, were actually utilised tools. While undertaking a routine examination of a bag of "waste flakes" from Area J34, 25 of the 44 pieces showed distinct edge-damage traces on one or more of their edges. At this juncture I realized that many of the flakes that would normally be classed as "waste" have the potential to be tools. All flakes, and other pieces, in fact, have the potential to be highly efficient tools (Gero 1991). Whether a given unretouched flake was used as a tool is not easy to determine unless low-power (0x - 80x) or high-power (80x - 400x) microscopic inspection is undertaken (Tringham et al. 1974; Grace 1988). Even using these techniques does not mean that all used lithic pieces will be detected, because some used tools may not have been used long enough or with sufficient force to cause detectable damage. These flakes were from a secure context, and by using low-power microscopy alone, approximately 70% of the flakes inspected exhibited edge fractures that are indicative of tool use. Other processes, natural (soil movement) and anthropogenic (trampling and "box damage" caused by improper post-exavation storage), can also result in edge damage of stone tools. Use-wear studies have shown, however, that edge-damage resulting from factors other than
tool use are easy to differentiate (Tringham et al. 1974; Odell and Odell-Vereeken 1980). Simulation experiments have shown that non-use related edge damage is made up of fractures that are random and that do not have consistent patterning (Grace 1988).

I faced a major problem at the outset of this analysis: how does one look for and record meaningful variability in a highly variable assemblage? One solution would be to adopt an inductive approach and record as many variables as one could think of. As most current analysts are cast in a processual mold, this approach is frowned upon, even though one would expect that many salient observations are inductive in origin. The discipline is awash with lithic reports overflowing with "high resolution" descriptive observations of formed tools that fail to give the same attention to predomately flake-based assemblages. Existing lithic typological systems are going to be of limited value for a study such as this one because the functional applications behind basic tools are likely to be different from those of formed tools. Perhaps a clean slate is needed (Knudson 1973). Descriptive analysis can provide numerous insights into prehistoric technological lithic patterning, but is of limited interpretive value unless undertaken in conjunction with explicit theoretical considerations (Edmonds 1987:155). When deciding on lithic variables to record we should ask ourselves, "what are our measurements measuring?" (Bradley 1987).

I am trying to investigate why tools are "unstandardised" in the Late Neolithic in general, and at this site in particular compared to earlier cultural units. My theoretical vehicle for this investigation involves the application of tool-use optimisation and the analysis of risk-reduction strategies. The variables that I choose to record, therefore, should have relevance to this issue. Here I faced a dilemma that is common in problem-oriented research. By using a focused research design to explore a specific issue, am I ignoring other relevant behavioral
data? My goal was to record observations that not only help the investigation of destandardisation but also of lithic production as practiced at the site. By examining tool production, some insight into the behavioral changes that are reflected in this new technological approach may be gained. This research is justified for a number of reasons. First, examining the formed and basic tool dichotomy is the most profitable starting point to examine the Levantine Late Neolithic technological shift. After all, this analysis is the first to look at all aspects of a Late Neolithic tool repertoire. Second, having defined a question to answer does not mean that inductive observations will escape you during the analytical process. One of the first challenges of this analysis was the wide range of technological choices and raw material selection: tools, especially the flake tools, were highly variable. With the flake tools, each piece had to be treated, at least initially, on an individual technological basis, because, at the time this analysis was undertaken, no work had been published on a similar sample that represents all aspects of the stone tools of an assemblage of this nature.

Tool observations were recorded using the 4th Dimension™ database program for the Apple Macintosh™ and data were statistically explored using Statview™. The variables that were recorded for the flake and formed tools are briefly discussed below. These relate to tool morphology, production techniques, working edge design, tool production, raw material type, tool condition and context. Database syntax appears in Appendix I.

Lithic Tool Types

Tools were assigned to type using the typological attributes in Appendix I. Most categories were consciously broad. Tools with retouch were coded as "retouched flake tools" rather than, for example, as "side scrapers". Because many lithic pieces exhibited retouch, I adopted this posture to minimise the a priori
allocation of lithics to a preconceived type. My goal was to study variability using the metric, morphological and retouch observations. My final goal is to interpret tools in the context of "function." By "function" I do not only mean utilitarian use but also how basic tools form components of the technological and broader cultural system of the Late Neolithic inhabitants of this site. As a prehistorian attempting anthropological interpretation, I assume that these systems of knowledge, rather than the tools in and of themselves, will inform us about the modes of Late Neolithic behavior.

**Raw Material type**

All of the flaked stone assemblage was manufactured, not surprisingly, of chert. Cherts in this area of Jordan are from Eocene limestone formations and are highly variable in quality. During the Late Neolithic at this site, many different types of chert were used. These are categorised according to colour and, more importantly, grain size. Grain size is divided into subjectively-observed categories of fine, medium and coarse. Similarly, colour types are broken down into light, medium and dark. A typical raw material entry would be; medium gray, fine grain. Grain size is the critical feature here: the smaller or finer the grain size, the more predictable the fracture of raw material is and, therefore, the easier it is to use for producing tools. Raw material colour, on the other hand, has no direct effect on the flaking properties of chert of which I am aware, but may have cultural significance.

**Tool Dimensions**

Dimensional observations include maximum length parallel to the longitudinal axis, maximum width perpendicular to it, and maximum thickness (see Appendix I). All observations are recorded in millimetres using calipers.
accurate to the nearest millimetre. In addition, flakes were assigned a generalised morphological type based on outline morphology. These outline shape types, can be seen in figure 1.1 in Appendix I. I hope that by recording these flake morphology types, potential patterns of standardised flake production can be investigated.

*Edge Angle of the working Edge*

The angle of the working edge of a stone tool is one of the functional parameters of its prehistoric uses (Semenov 1963; Tringham *et al.* 1974; Lewenstein 1992). I assumed *a priori* that edge angle and design (the morphological nature of the tool) were the prime factors for basic tool selection at this site. Working edge angle is measured using an architect's goniometer. The working edge was located by the presence of retouch or use-related fractures observable at the macro scale. Microscopic examination was undertaken using a Nikon low-power microscope at x10 to x30. Because the edge angle on some tools varied along the working edges, three angle measurements were taken and then averaged.

*Backing type*

Backing was only present on formed tools, and was almost exclusively restricted to sickle blades. Backing data has the potential to yield some light on hafting methods, motions of use and technological change (Kukan 1978).

*Retouch*

Retouch type, along with edge angle and morphology, is a critical feature of the design intentions of the tool maker. Retouched types were recorded following Tixier's (1983) classification. Utilised flakes, by definition, had no retouch on their
working edges but retouched flakes did. Earlier, I mentioned that typologies such as those devised by Tixier (1983) are not strictly appropriate to Late Neolithic assemblages. However, his classifications of manufacturing features such as retouch type and platform type can be used to investigate the reduction sequence and manufacturing techniques employed to produce tools.

**Arêtes / Ridges on the Dorsal Surface**

The number of arêtes or ridges on the dorsal surface can yield information regarding the type of reduction sequence responsible for flake and blade production. With regard to flake production, the number of ridges can provide some indication of flake standardisation.

**Percentage of Tool**

If a tool was broken, a percentage of the remaining tool was recorded. This percentage is usually subjective, especially with basic tools whose morphology can be highly variable. This observation does enable the analyst to see which tools are complete and which are not.

**Platform / butt feature**

Following Tixier (1983), platform type was recorded, as was platform length and width. As with outline morphology, flake platform data can help to explore the nature of flake standardisation.

**Geological Condition**

The geological condition of recorded tools has the potential to inform the analyst about the geological history of a given tool, and, therefore, to tell us something of the context of the piece. The tools analysed in this study were
invariably from secure contexts, but geological condition was a measure that allowed me to assess my success at excluding redeposited artifacts.

*Presence of Heating*

Evidence of thermal alteration was detected by the presence of surface linear fracture lines on the surface of chert in combination with pot-lid fractures and surface discoloration.

2.6 Formed Tool Analysis

Formed tools are pieces interpreted as stone tools that have been retouched to conform to a form that is more-or-less closely replicated from one piece to another. This is a preconceived mental template which we, the analysts, have devised or simply applied. Observations on the formed tools incorporate many of the variables recorded for the basic flake tool inventory, but also include observations pertaining to retouch, backing and edge modification. For sickle blades a number of other observations were recorded to investigate the nature of variation. These will be discussed and presented in the following chapter. Below are the variables that were recorded in addition to those recorded for basic tools as outlined above. Illustrations of the variable types can be seen in Appendix I.

*Retouch Position*

Retouch position records the direction of the retouch blows. The relevant categories are shown in Appendix I. This category of observation has the potential to yield information relating to design and stylistic similarities between tools.
Retouch Location

The location of retouch refers to the area or areas of the flake or blade that were retouched. There were 20 possible locations and these observations were recorded for the same reasons as observations for retouch position. The classification of these retouch locations appears in Appendix I.

Retouch Extent

Extent is the degree of retouch invasiveness on tools. Five ordinal categories were used, ranging from < 2 mm to covering the entire surface. Once again, the degree of invasiveness has potential stylistic and design implications.

Retouch Type

Retouch type describes the predominate type of flake scar on a formed tool. The type categories follow Tixier's (1980) typology with a few additions.

Shape of Retouched Area

This category records, in plan view, the shape of the retouched area of a tool and therefore records the shape of its working edge. The shape of a working edge has important implications for its potential function.
Chapter 3  The Results of the Analysis of the Flake Tool Sample

3.0  Introduction to the Flake Tools

One of the goals of this analysis was to investigate the extent and nature of flake standardisation. Were flakes as amorphous as they appeared? In this chapter, I shall present a general breakdown of the flake assemblage, and then discuss the implications of the recorded variables mentioned in the previous chapter. This chapter presents a host of statistical observations that, initially, will appear abstract. Once the data have been presented, I will draw my conclusions from the patterns in this mass of statistics.

The flake tools are divided into three categories: 1) unretouched flakes with use-related features on their working edges (figure 3.0); 2) flakes exhibiting retouch but not conforming to a particular tool type (i.e., they are not formed tools) (figure 3.1); and 3) flakes that are formed tools. The first general observation is that most flake tools appear to have highly irregular morphologies, and were made from many different types of raw material. As mentioned previously, it was also apparent that a large proportion of the sample is made up of flakes. From the cores recorded from WZ 200 it appears that most flakes were manufactured from the reduction of single-platform flake cores (n=29) using the hard-hammer technique. The core type was not used exclusively; there were also eight multi-platform cores.

Figure 3.2 presents the frequency distribution of the major tool categories. Flake tools make up 75% of the analysed sample. The most common of these are the unretouched flake tools, which make up 41% of the sample. As previously mentioned, this figure may be an underestimate, as a some used flakes many have been consigned to the waste category because no use-related features could be detected. Retouched flake tools are the next most common category at 26%,
Figure 3.0  Unretouched used basic flake tools  Scale 1:1
Figure 3.1 Retouched basic flake tools Scale 1:1
Figure 3.1.1  Retouched basic flake tools  Scale 1:1
Figure 3.2  Frequency distribution of major tool categories from the stone tool sample  
(n = 308)

KEY:

Flakes - Used Unretouched Flakes  
Ret Flakes - Minimally Retouched Flakes  
Flake Tool - Formed Flake Tools  
Blade - Used Blade and Bladelet Tools  
Core Tools - Core tools (adzes and chisels)
and are easily recognised by the presence of retouch scars. If retouch scars were thought to be the result of use (Tringham et al 1974; Grace 1988), rather than edge modification, the specimen was classified as an unretouched, used flake. Flake-based formed tools, such as burins, awls and notches, comprise 9% of the sample.

3.1 Unretouched Flake Tools
Those flakes showing use wear but no retouch are the category of tools associated with basic flake technology. These tools were recorded from every context of the site from both inside and outside house structures. In many respects, because these flake tools are precisely those most frequently ignored, the key to greater understanding of the Late Neolithic shifts in technology may lie in them.

Raw Material Selection
These basic flakes are made from a wide variety of locally available chert. Fine-grained material is available less than 1 km from the Neolithic homestead. Poor (coarse-grained) and medium-grained chert is available in the immediate vicinity of the site. The stream bed and bank, which lie directly east of the site, are a good source for both these raw material types. It is also possible to find the occasional nodule or chunk of fine-grained raw material in the immediate vicinity. These pieces have been transported by the stream flow from as yet unidentified chert outcrops further upstream, possibly in the chert beds of the Ajlun series (Bender 1978). The vast majority of flakes and, for that matter, all tool types, are made from chert that is light to dark gray (39.8%) or brown (60.2%). There does not appear to have been any significant preference for one of these colours, and nodules made up of both colours are reasonably common around the site today.
Figure 3.3  Frequency distribution of raw material type for used unretouched flakes  

\( (n = 125) \)

![Graph showing frequency distribution of raw material type for used unretouched flakes.]

**KEY:**

1.1 - Fine-Grain Chert  
1.2 - Medium-Grain Chert  
1.3 - Coarse-Grain Chert
Figure 3.3 outlines the frequency distributions and percentages of flakes found in each raw material category. Most unretouched flake tools are made of medium-grained chert (53%). The most interesting feature is that 65% of these tools are made of poor to medium-quality chert. These raw material types are available in large quantities. Indeed, it seldom takes more than a casual glance to locate a suitable nodule of medium-grained chert in the stream channel. There is no real reason to use poor material except easy availability or that it makes no difference. It should also be noted, however, that more than one-third of these basic flakes are made of fine-grained chert. It is possible that a greater quantity of fine-grained chert was available in the immediate vicinity of the site during the Late Neolithic. Today fine-grained material is not as readily available.

These observations have a number of implications for lithic raw material selection. When the occupants of the farmstead looked for a potential core for basic flake production, most often it appears that they found the prospect of using the poor to medium quality flint acceptable, even though these two raw materials do not have optimum flaking properties. Wherever possible, it seems that raw material of the best quality was chosen, but the notable appearance of tools made from cherts of poor quality indicates that the tool maker was not always prepared to look hard, or to travel far, to make a basic flake tool. Of course, personal choice cannot be overlooked. Some tool makers may have made basic flakes only from the most finely-grained material possible. The fine-grained flakes may have been manufactured from the limited supplies of fine-grained raw material available in the immediate vicinity, or from material garnered from more distant sources. It is also possible that utilised flakes were selected from the debitage of fine-grained material intended for formed tools. Conversely some of these flakes may have been manufactured of raw material of poor to medium quality that the tool-
makers deliberately sought out because of some real or perceived functional advantage.

Outline Morphology

As mentioned in the previous chapter, outline-morphology types were devised following Knudsen's (1973: 187) flake outline typology (Appendix I). As these flake tools were used but unretouched, I assumed that one of the factors that influenced production and selection of unretouched flakes was flake morphology. The types of reduction strategies the flintknappers adopted can yield a great variety of flake morphologies, especially if they are undertaken in a haphazard manner. Figure 3.4 presents the frequency distribution of the observed morphology types for unretouched basic flakes. The largest category is parallel-sided flakes (33%), followed by distally contracting (21%) and expanding flakes (14%), and then by flakes whose width exceeded their length. The first three categories, which make up 68% of the sample, show a level of flake standardisation in basic flake-reduction techniques; flakes from these categories have reasonably straight working edges. This degree of standardisation is to be expected from the relatively high frequency of single-platform, pyramidal cores in this sample. During the reduction sequence of these pyramidal cores, flakes have a tendency to have lateral edges that are nearly straight, whether they are parallel or distally expanding or contracting. It is possible that the likelihood of producing flakes with this morphology was the reason that this reduction sequence was chosen. Unretouched, straight-sided flakes could be useful for wide variety of tasks including, most notably, cutting, scraping and shaving. These tasks, I believe, are precisely the sort of activities one would expect to call for speedy production of an unretouched flake. Alternatively, pyramidal cores may have been employed for flake production for unknown cultural reasons.
Figure 3.4 Frequency distribution of the outline morphology types of unretouched flake tools

<table>
<thead>
<tr>
<th>Outline Morphology Type</th>
<th>Count</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>100.1</td>
<td>41</td>
<td>32.800</td>
</tr>
<tr>
<td>100.2</td>
<td>18</td>
<td>14.400</td>
</tr>
<tr>
<td>100.3</td>
<td>26</td>
<td>20.800</td>
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<tr>
<td>100.4</td>
<td>3</td>
<td>2.400</td>
</tr>
<tr>
<td>100.5</td>
<td>2</td>
<td>1.600</td>
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<tr>
<td>100.6</td>
<td>17</td>
<td>13.600</td>
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<tr>
<td>100.7</td>
<td>18</td>
<td>14.400</td>
</tr>
<tr>
<td>Total</td>
<td>125</td>
<td>100.000</td>
</tr>
</tbody>
</table>

Figure 3.5 Histogram showing the distribution of outline morphology types of unretouched flake tools \((n = 125)\)

KEY:

100.1 - Parallel sided, square or long
100.2 - Distally expanding
100.3 - Distally contracting
100.4 - Long oval
100.5 - Round
100.6 - Width > Length
100.7 - Indeterminate
However, 32% of the sample had other morphologies, notably flakes whose width exceeds their length. These other morphological types were probably also from single-platform, pyramidal cores. It may be that these morphologies were more appropriate for undertaking certain tasks. Indeed, the morphology of straight-sided flakes may have been a disadvantage when undertaking some tasks. It is also possible that, as long as other criteria, such as edge angle, were satisfied, flake morphology was not really a significant factor in flake selection for some tasks. Figure 3.4 displays the distribution of the sample by flake morphology types\(^1\).

*Edge Angle*

Table 3.6 shows the frequency distribution of edge angles at ten intervals of 6° each. There is an obviously skewed distribution in favour of more acute edge angles (see histogram in figure 3.7 and cumulative frequency chart in figure 3.8). The largest cluster appears to include edge angles between 26° and 44°; 54% of the sample falls within this range. Two other peaks are observable at the more obtuse end of the angle range, the first with angles between 48° and 56°, and the second with angles between 60° and 72°.

Unfortunately, while much research has been undertaken on the relationship between stone tool use and edge angle, there is little consensus as to whether edge angles correspond to specific functions (Semenov 1964; Tringham *et al* 1974; Lewenstein 1991). Having said this, there is a correlation between the suitability of edge angles, tool motion and the nature of materials on which tools can be effectively used. Generally, more acute angles are more efficient at cutting

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\(^1\)Nine unretouched basic flake tools were not included in these statistics because these tools were analysed in Jordan, before this attribute was included in my analysis, and they are not currently available for reanalysis. These tools are in the Irbid museum of the Department of Antiquities of Jordan.
Figure 3.6 Frequency Distribution of edge angles of used unretouched flakes

<table>
<thead>
<tr>
<th>From (≥)</th>
<th>To (&lt;)</th>
<th>Count</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>20.000</td>
<td>26.000</td>
<td>12</td>
<td>9.600</td>
</tr>
<tr>
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<td>32.000</td>
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<td>19.200</td>
</tr>
<tr>
<td>32.000</td>
<td>38.000</td>
<td>25</td>
<td>20.000</td>
</tr>
<tr>
<td>38.000</td>
<td>44.000</td>
<td>19</td>
<td>15.200</td>
</tr>
<tr>
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<td>3</td>
<td>2.400</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td><strong>125</strong></td>
<td><strong>100.000</strong></td>
</tr>
</tbody>
</table>

Figure 3.7 Histogram showing the edge angles of used unretouched flakes at ten intervals (n = 125)
Figure 3.8  Cumulative Frequency of the edge angles of used unretouched flakes

(n = 125)
and shaving, and more obtuse angles are better suited to scraping, incising and robust chopping activities (Semenov 1964). The question of how edge angle relates to a tool's intended function is an extremely complex issue that has by no means been resolved (Lewenstein 1991). The implications of how the edge angle of these basic flakes relates to use will be discussed at the end of this chapter. At this stage, however, it should be noted that the two peaks in the distribution may have significance corresponding with the intended uses of these flakes. The high frequency of basic flakes with relatively acute angles suggests that the majority of these tools were used to undertake cutting tasks. It may also be true that the spread of edge-angle measures simply corresponds with the distribution of flake edge angles that results in this particular type of lithic reduction strategy, so that the tools are simply a random sample of flakes from pyramidal core reduction. It is very difficult to determine exactly how much attention the users of these tools paid to edge angle. Use-related damage indicates that these tools were used: but the flake traits on which the users based their decision to select a particular tool for a particular task are unclear. This may have varied according to the physical nature of the task at hand, its relative importance, and the perceptions of the individual tool users themselves. These basic flake tools could have been selected because they were adequate for some tasks: most flakes produced by this reduction sequence have edge angles that were suitable. This could explain the variability in the edge angles of flake tools of this type.

Unretouched Flake Tool Metric Observations

Unlike flake morphology, the metric observations on the unretouched flake tools indicate a high degree of variability (figures 3.9, 3.10 and 3.11). This is not surprising considering the core-reduction techniques involved with their production. The typical used, unretouched flake is, however, on the short and
Figure 3.9  Histogram showing the maximum lengths of used unretouched flakes at ten intervals

\(n = 125\)

Figure 3.10  Histogram showing the maximum widths of used unretouched flakes at ten intervals

\(n = 125\)
wide side with a variable maximum thickness (99% between 4 and 24 mm); these tools are small. The majority of flakes are between approximately 30 and 55 mm long, 20 and 50 mm wide and have thicknesses between 5 and 17 mm. The greatest metric variability is in the length and width of the flakes. Edge angle and morphology are of greater functional importance, because the design features of a tool's edge are usually the critical factors that set the parameters for potential tool uses.

*Unretouched Flake Butt Observations*

Approximately 79% of the platforms or butts in this category can be categorised as flat (figure 3.12). Once again, this is in keeping with the straightforward approach to the production of these tools. A flat butt is the simplest form as no platform preparation has been undertaken. It also takes the least amount of time to produce flakes, with the possible exception of bi-polar reduction. Other categories include cortical, linear, gull-winged, punctiform and unidentified (other) butts. These types occur in very limited numbers. Only one flake shows any evidence of multifaceted butt preparation. This is what one would expect from *ad hoc* flake production. Butt length and width metrics display a fairly large range of variation (figure 3.13 and 3.14). Figure 3.13, a histogram depicting butt length, illustrates a number of features. There are two peaks: one where butt length is small, between 0 and 5.5 mm; and another larger peak between 11 mm and 16.5 mm. The general trend is that, as butt length increases, the flake count decreases. It should be pointed out that the average butt length is large at 11 mm. The same general trends can be seen in figure 3.14 for butt width. The largest peak here includes flakes with a butt width ≤ 2.1 mm. The majority of flakes (72%) have butt widths ≤ 8.4 mm. At the further end of this scale, these butt widths are on the thick side. As with butt length, the flake
Figure 3.11  Histogram showing the maximum heights of used unretouched flakes at ten intervals  
\( n = 125 \)

Figure 3.12  Histogram showing the platform types of used unretouched flakes  
\( n = 106 \)

KEY: Platform Types
1 - Cortical  
2 - Flat  
3 - Dihedral  
4 - Facetted  
5 - Gull Winged  
6 - Linear  
7 - Punctiform  
8 - Other
Figure 3.13  Histogram showing the maximum platform length of unretouched used flakes \( (n = 106) \)

Figure 3.14  Histogram showing the maximum platform width of unretouched used flakes \( (n = 106) \)
Figure 3.15 Scattergram showing the relationship between the maximum heights and platform widths of used unretouched flakes (n = 106)
count decreases as butt width increases. As one would expect, butt width is positively correlated with flake height. The scattergram in Figure 3.15 of the flake height and butt width data clearly illustrates this observation. In many cases, the butt width and flake thickness are identical.

The spread of butt metrics suggests, once again, that the flake reduction strategy was casual. The general dimensions of a flake's butt would be consistent with its overall metric observations and morphologies. Essentially the variability of butt metrics suggests that the aim of the knappers producing them was inconsistent, but that the knappers were still able to produce flakes that fell within the users' functional parameters.

3.2 Retouched Flake Tools
This category contains flakes that have been modified by intentional retouch (figure 3.1). The amount of retouch they received, however, is minimal and this category does not include flakes that have been retouched into distinct, formed tools such as burins, awls and points. These tools occurred in the same contexts as the rest of the lithic sample under consideration.

Raw Material Selection

The retouched flake tools are made from the same chert types as the unretouched flake tools and formed tools. There are, however, some key differences in raw material selection for this category of flakes. The most noticeable difference is the greater number of tools made using fine-grained chert. Here 62% of the retouched flakes were made using finer material and 30% were made using medium-grained chert (figure 3.16). Only 8% of the flakes from this category were produced from coarse-grained material. This compares with the
Figure 3.16  Histogram showing the frequency distribution of raw material type for retouched flakes

(n = 79)

KEY:

1.1 - Fine-Grain Chert
1.2 - Medium-Grain Chert
1.3 - Coarse-Grain Chert
unretouched flakes which were made on material that was of a coarser nature (65% made on coarse- or medium-grained chert).

The greater attention paid to raw material selection is in keeping with my hypothesised *modus operandi* of stone-tool production at this site. These flakes are retouched, however minimally. This would imply that attention was being paid to the design properties of the working edge of the tool. It would follow that similar attention might be paid to the raw material used to produce the flakes themselves. It is easier to produce flakes from more finely-grained cherts, and these flakes would also be easier to modify. It is also possible that retouched flakes made using coarse-grained chert (n=6) were made using this material because of the physical properties of this type of chert. Percussive actions, for example, would be better suited to tools made from coarse-grained material.

Another issue is whether the Late Neolithic inhabitants were collecting the fine-grained material used to make retouched flakes from the sparse nodules available in the immediate vicinity of the site, or from the outcrops of this material 500 m west of the site. It is possible that cores were prepared at the latter location and brought back to the site for flake removal. The medium- to coarse-grained chert could be procured near the dwellings.

*Retouched Flake Metric Observations*

Metric frequency observations for retouched flakes are illustrated in figures 3.17, 3.18 and 3.19. Metric observations for maximum length show more variation than those for flake thickness and width (figure 3.17). Most retouched flakes have maximum lengths between approximately 22mm and 55mm (= 60%), which is similar to the maximum lengths of the unretouched used flakes. The longest retouched flakes are ≤ 82 mm. The width and thickness of retouched flakes show less variability (figures 3.18 and 3.19); 90% are from 48 mm to 155 mm.
Figure 3.17  Histogram showing the maximum lengths of retouched flakes at ten intervals  
(n = 79)

Figure 3.18  Histogram showing the maximum widths of retouched flakes at ten intervals  
(n = 79)
Figure 3.19  Histogram showing the maximum heights of retouched flakes at ten intervals

(n = 79)
in width and 83% are from 3 mm to 11.4 mm in thickness. Unlike other observations for the unretouched flake tools, the metric observations are rather similar to those from unretouched flake tools. Because both flake technologies employ the same core-reduction strategy, this is not surprising.

*Retouched Flake Outline Morphology*

Retouched flake outline morphology showed a higher level of consistency than among the unretouched used flakes (figure 3.20). Edge retouch could obscure the initial flake morphology but, as the extent of retouch is usually minimal, this was usually not the case. In the few instances when it was, the tools were classed as indeterminate. Most retouched flakes have a straight-sided morphology, with sides that are either parallel-sided (33%), distally expanding (27%) or distally contracting (8%). Other morphologies include oval, round, and flakes with width greater than length. Straight-sided flakes are again to be expected from pyramidal flake production, but the morphologies for this tool category show a greater level of standardisation than those for unretouched flake tools, even though they were made using a similar core-reduction strategy. This may be because greater attention was being paid to flake removal or because cherts of better quality were more commonly used for retouched flakes. These factors point to greater attention to design in this tool category.

*The Edge Angles of Retouched Flakes*

While these tools are retouched, it is important to remember that these are still *ad hoc* flakes with only minimal design input. The edge angles illustrate this point. Figure 3.21 shows the edge angles of retouched flakes with the data split by 10 intervals. The histogram shows that edge angles where spread over a wide range, from 24° to 80°. Six tools fall into the two intervals between 24° and 33° –
Figure 3.20  Histogram showing the distribution of outline morphology types of retouched flake tools (n = 79)

KEY:

100.1 - Parallel sided, square or long
100.2 - Distally expanding
100.3 - Distally contracting
100.4 - Long oval
100.5 - Round
100.6 - Width > Length
100.7 - Indeterminate
Figure 3.21  Histogram showing the edge angles of retouched flakes at ten intervals

(n = 79)

Figure 3.22  Cumulative frequency of the edge angles of retouched flakes

(n = 79)
these angles are fairly acute and therefore sharp, perhaps suitable for cutting implements. The most notable peak (n=13) occupies the two intervals of readings between 330 and 430. These edge angles are suitable for a number of different activities, from cutting to scraping.

Other key observations that should be analysed in conjunction with edge angle include working-edge morphology, retouch type and retouch extent. These will be considered later. The process of retouching the edge of a tool automatically increases its edge angle. Edge angles over 450 can be considered to be obtuse or steep. It is possible to use flakes with this edge angle as cutting tools, but they are better suited to activities such as scraping, incising and more heavy-duty tasks, such as chopping (Semenov 1964; Grace 1988). Approximately 75% of the retouched flakes have edge angles greater than 450 but less than 800 (n=59). This would indicate that many of these tools may have been used for robust activities. These steeply angled flakes have angle readings that are spread across the scale, from 450 to 800. This points to a number of possibilities. First, edge angle exactitude on the flint knappers' part was not critical. As long as the angle was steep enough for the task at hand, users were satisfied. Another possibility is that the edge angle was variable along the working edge and the recording methods of this analysis failed to record this fact. As the recorded edge angle on variable pieces was the average of three measurements, I believe the former observation is the more likely. Moreover, a lack of exactitude in edge angle design is more in keeping with the overall design nature of this tool category. As long as the tool functioned within reasonable parameters, it was acceptable.

In summary, the data on edge angles point to three tentative edge angle groups: a small, acute-angle group with angles between 240 and 330; a group with steeper angles between approximately 330 and 450; and a large group of steeply retouched flakes with edge angles between 450 and 800. The functional
implications of the categories that define these groups will be investigated once the remaining attributes of retouched flakes have been discussed.

Retouch Types of Retouched Flake Tools

To investigate the nature of edge modification on retouched flakes, the analyst must consider the nature of salient retouch characteristics. Retouch observations have been made with respect to five attributes: retouch type, retouch position, retouch location, retouch extent and the shape of the retouched area. Each attribute is investigated initially on its own, and then the interaction of these variables is considered.

Retouch is the deliberate secondary modification of a stone tool (Rosen 1997: 29). As Rosen (1997) has pointed out, however, it is sometimes difficult to differentiate between retouch that is due to secondary modification and damage that is a result of tool use. In the case of tools from this sample, tools that were classified as retouched were tools whose edges had overt retouch flake scars that were unlikely to have been the result of use because of their size and degree of invasiveness (Grace 1988).

Flake retouch was assigned to one of nine categories (see figure 3.23), following Tixier's work on stone tool retouch (Tixier 1973; Tixier et al. 1980). The most common category includes flake tools that had been retouched in an irregular fashion (79%). The remaining flakes are thinly spread across the other categories of retouch. Irregular retouch is a retouch type in which a number of different types of flake scars can co-occur. It is indicative of retouch that has been undertaken quickly, and with little attention to retouch flake-scar consistency. It can also be the result of inexpert flint-knapping, although I do not believe this is the case in this particular assemblage. Here, irregular retouch has been undertaken to modify the working edge of a flake quickly to produce suitable edge
Figure 3.23  Histogram showing the frequency of retouch types on retouched flakes  

(n = 79)

KEY:

1 - Scaled
2 - Stepped
3 - Parallel
4 - Sub-Parallel
5 - Irregular
6 - Denticulated
7 - Notched (single)
8 - Notched (multiple)
9 - Serrated
Figure 3.24  Scattergram showing the edge angles of retouched flakes according to retouch type

(\(n = 79\))

KEY:

1 - Scaled
2 - Stepped
3 - Parallel
4 - Sub-Parallel
5 - Irregular
6 - Denticulated
7 - Notched (single)
8 - Notched (multiple)
9 - Serrated
characteristics for the task at hand. Figure 3.24 is a scattergram showing the spread of edge angles within each category of retouch. What is clearly shown here is that the edge angles do not cluster, but are evenly spread across the spectrum of readings. One would expect edge angles to cluster if they were intentionally retouched with edge angle in mind. This wide variation of edge angle may mean that edge modification was undertaken, in many cases at least, for design features other than edge angle itself, including simply to blunt the working edge of the tool or to shape it.

The remaining flakes are thinly diffused across the other categories of retouch, the largest group being assigned to sub-parallel retouch (n=6). This retouch type is indicative of a more regular style of edge modification, and is probably a result of a need for the working edge of the flake conform to stricter design criteria. The same would also be true for those few flakes that were retouched to have a notched or serrated working edge.

Retouch Position of Retouched Flake Tools

In terms of position, the majority of flakes were retouched from a direct position (72%, see figure 3.25). This means that retouch was unifacial and located on the dorsal surface of the flake. Approximately 19% of tools were retouched using the indirect method, being unifacially retouched but with the retouch scars located on the ventral surface. The least common categories of retouch were alternate (8%) and bifacial (1%).

Direct retouch is the most common form of retouch in many stone tool traditions. The reason is simple; the angle of flaking when using the ventral surface to remove retouch flakes from the dorsal, usually makes flake removal easier than flaking from the dorsal surface. Following the rationale behind basic flake technology, this retouch strategy would be logical. It is straightforward and
Figure 3.25  Histogram showing the retouch position of retouch on retouched flake tools

(n = 79)

KEY:
1 - Direct
2 - Indirect
3 - Alternate
4 - Bifacial
Figure 3.26 Scattergram showing the edge angles of retouched flakes according to retouch position (n = 79)

KEY:
1 - Direct
2 - Indirect
3 - Alternate
4 - Bifacial
predictable. Indirect retouch, however, could not be described as a particularly difficult procedure either. Usually indirect retouch makes the working edge sharper. This is because the nature of flake cross-sections is such that retouch of the ventral surface makes the edge more acute. But in the scattergram in figure 3.26, which illustrates the edge angles of tools from each of the retouch position categories, edge angles are dispersed among the categories, and many flakes have relatively obtuse edges. Once again, no relationship between edge angle and retouch position is apparent.

Shape and Location of Retouch on Flake Tools

These two attributes are used to record where on the edge of each tool retouch was carried out, and the shape of the retouched edge area. Location was recorded according to 20 possible retouch locations, depending on which surface and which area or areas of the tool edge were modified (Appendix I). By including this attribute I had hoped to see patterns in the retouch methodology of these flake tools. Unfortunately, it was not always possible for assign retouch location, as many retouched flakes did not have the features necessary to orient the tool (e.g., bulb of percussion, platform or ripple scars).

The areas in which retouched flakes were modified were, once again, variable. Most flakes were retouched around the left or right lateral edge or on both edges and the distal tip (69%). 31% of the retouched flakes exhibited more localised retouch; either along the distal, medial or proximal portions of the tool edge. The localisation of this retouch would indicate that these are the areas of the edge that were used. Other unretouched areas of the tool could also have been used, but this cannot be assessed.
Figure 3.27  Histogram showing the frequency of retouch form type on retouched flakes

Histogram  (n = 79)

KEY:

1 - Straight
2 - Convex
3 - Concave
4 - Shouldered
5 - Nosed
6 - Circular
7 - Tanged
8 - Convergent (projectile point)
9 - Convergent (awl / piecer)

Count

Retouch Form Type
The shape of the retouch area was recorded on a nominal scale with five types (see figure 3.27). The most frequent is a straight working edge (69%). The next most common edge type is convex (23%) followed by concave (9%).

The shape of a tool's working edge can help to elucidate its use, when this variable is taken into account along with other factors of the tool morphology and design (Semenov 1964; Tringham et al 1974; Keeley 1980; Grace 1988; Lewenstein 1991).

The tool retouched to a straight edge can be used for a wide variety of purposes. These could include cutting and scraping of a range of materials. When retouched edge morphology is correlated with edge angle, a complex picture emerges. The flakes with a straight edge have a wide range of edge angles (figure 3.28). One must also consider that edge angles are evenly spread in this group of tools. Even so, there are two, or possibly three peaks in the data. One such peak includes tools with a straight edge and edge angles between approximately 240° and 500° and another those with edge angles between 510° and 800°. This last group could be further subdivided into two categories; angles between 500° and 680° and angles between 690° and 800°. The more acute angles could be used for cutting activities and the more obtuse, for scraping. Whether these divisions are artificial is open to question. Of these, 43% are straight-edged flakes that had irregular retouch. Whatever these tools were used for, little attention was being paid to style of edge modification.

The edge angles for convex-edged tools are more clustered (figure 3.29). The majority of these tools have an obtuse angle (n=14). Only three tools are not in this cluster, and these tools all have edge angles less than <360°. The flakes with steeper angles would be highly suited to scraping activities. Typologically, a scraper is a tool made on a flake or a blade with continuous retouch that is flat or abrupt with a straight, convex or concave working edge (Bordes 1961:25).
Figure 3.28  Histogram showing the edge angles of retouched flakes with straight retouched working edges  
(n = 48)

Figure 3.29  Histogram showing the edge angles of retouched flakes with convex retouched working edges  
(n = 17)
Figure 3.30 Histogram showing the edge angles of retouched flakes with concave retouched working edges 

$\text{(n = 7)}$
However, other lithic analysts emphasize that tools commonly assigned to the scraper type could be used for a variety of purposes (Debenath and Dibble 1993: 70). (As mentioned in the last chapter, formalised typologies have little relevance to Neolithic assemblages such as this one.) In this case, the definition for the scraper appears to be partially applicable. But if one approaches these tools from a design perspective, the "type" is irrelevant. What is more important is that these tools have been designed to have a convex edge with a steep angle to perform their tasks more efficiently. The advantage of an edge design of this nature is that the convex edge allows more pressure to be exerted, because force is applied to a smaller surface area. This design would be useful when scraping comparatively hard contact material. The steep angle of edge ensures that the edge is strong enough to transmit this force. However, for other scraping tasks, when the contact material is soft, some of the straight-sided flakes could be usable scrapers.

Very few retouched flakes have a concave retouched profile (n=7, see figure 3.30). This edge design is suitable for spoke-shaves used for shaving, and this may be what these particular flakes were used for. The concave profile could be tailored to suit the task at hand. Three of these tools have edge angles between 38° and 49°. The angles are acute enough to have been used for shaving medium to soft materials, but four have angles between 69° and 80°. These angles are too obtuse for effective shaving, but are suitable for finishing and smoothing wooden implements (Senenov 1964; Grace 1988; Lewenstein 1991).

One retouched flake had a nosed profile and one had a circular retouched area. The nosed tool has an edge angle of 27°, and the one with a circular retouched area has one of 72°.
Number of Ridges and Striking Platform Observations

Retouched flakes from this sample either had no, one or two ridges or arêtes on the dorsal surface. In some cases the ridges may have been absent because the flake was retouched and used after the piece was broken and, in some cases, the process of retouch could remove a dorsal ridge. The flakes with one (48%) or two (14%) ridges were consistent with what one would expect from a single-platform, pyramidal core-reduction technology.

Five different categories of striking platform, or butt, were recorded (figure 3.31). The most common was the flat type (79%). Other platform types included cortical (8%), dihedral (3%), gull-winged (3%) and other (8%). Once again the most common type of platform is one that requires no facetting and little preparation, completely in keeping with basic technology.

Most platforms are no more than 4.8 mm long (52%) and 2.3 mm wide (43%). From these dimensions, the other platforms are fairly evenly spread to reach a maximum of 48 mm long and 23 mm wide (figures 32 and 33). Figure 34 shows the relationship between platform length and width: length is greater than width and, as width increases, in most cases so does platform length.

Summary of Unretouched Used Flakes and Retouched Flakes

These two categories of tools made up the bulk of the sample. While both types are predominately made using the same core-reduction strategy, there are several important technological differences between the two. The most obvious difference is the presence of retouch on the working edge. The retouched tools are also made with greater attention to raw material selection; the flint tends to be more fined-grained and, therefore, of better flaking quality. The outline morphologies of the two tool types are also reasonably similar, being mostly straight-sided. The retouched flakes, however, show a greater level of
Figure 3.31 Histogram showing the frequency of platform types on retouched flake tools (n = 40)

**KEY:** Platform/Butt types

1 - Cortical
2 - Flat
3 - Dihedral
4 - Facetted
5 - Gull winged
6 - Linear
7 - Punctiform
8 - Other
Figure 3.32  Histogram showing the maximum length of platforms on retouched flakes at ten intervals  
\((n = 40)\)

Figure 3.33  Histogram showing the maximum width of platforms on retouched flakes at ten intervals  
\((n = 40)\)
Figure 3.34  Scattergram showing the relationship between the maximum platform lengths and widths on retouched flakes

(n = 40)
standardisation. It is in the edge-angle attribute that the greatest differences between the classes lie. The edge angles for the unretouched flake tools are usually more acute, while on retouched flakes they are more obtuse. The steepness of the edge angle on many of the retouched flakes is due to the retouch itself, which tends to be irregular. It is highly likely that the unretouched flakes with their sharp working edges would be suitable cutting tools, whereas the steeper-edged retouched flakes would be better suited to scraping/shaving activities.

On the whole, then, when a flake was retouched, the retouch was usually direct, irregular, non-invasive, fairly steep and used to construct a straight, convex or, in a few instances, a concave working edge. The observations made on the retouched flake sample point to basic technology, albeit one that has a greater design input than that of the unretouched flake tools. These retouched flakes were only modified, and modified quickly, when the design criteria of the unretouched flake proved unsuitable to undertake a particular job, such as scraping. It is also possible that retouched flakes were used, when the need arose, to do simple tasks for which an unretouched flake would also have been suitable.

3.3 Formed Flake Tools
This category of formed tools makes up the smallest proportion of the flake tools (9%). These formed tools were made on flake blanks that were retouched to conform to the design requirements of a distinct tool shape or form (figure 3.35. Like the other tools, the blanks used to make these formed tools were struck from single-platform flake cores. It has often been assumed that they were designed to undertake a particular function; in some cases this may be true (Rosen 1997). Analysts who work in Near Eastern Neolithic usually focus on these tool types,
for the reasons discussed in Chapters 1 and 2. I shall discuss this category by tool type.

**Endscrapers on Flakes**

Five endscrapers on flakes were recorded. As the type name implies, the assumed use of these tools is scraping. Retouch is located on the dorsal surface at the distal end of the flake, as the name implies. This tool type is found from the Upper Palaeolithic onward in the Near East (Debenath and Dibble 1994) and these tools may well have been hafted. By setting an endscraper into a handle, greater pressure through increased leverage can be applied during the scraping process.

Three endscrapers were retouched with sub-parallel retouch, and two with irregular retouch. All were retouched in a direct position with convex working edges. Four tools were made using fine-grained material, and one using medium-grained. Retouch extent was characterised as long (retouch scars between 4 mm and 8 mm in length) and was always located on the distal end of the tools. The five endscrapers did not seem to have consistent dimensions. The maximum length varied between 45 mm and 74 mm, the width between 28 mm and 40 mm and the height between 7 mm and 17 mm. Edge angles varied between 39° and 72°. The two tools that had the steep edge angles also had the largest dimensions. It is possible that these larger endscrapers with steeper edge angles were intended for more robust scraping activities.

**Convex Scrapers**

Four convex scrapers made on flakes were recorded. These tools are typed as scrapers, but this does not mean that they were used only for scraping. Two that had edge angles of 38° and 40° are equally well suited for cutting and chopping soft materials. Flakes that could potentially be used as scrapers are
much in evidence in the retouched flake category. These particular formed flakes are not included in this category because of the nature of their retouch. All of these tools had direct and invasive retouch with sub-parallel flake scars. This level of design standardisation indicates that these tools are better suited to the formed tool category.

Like most tools in the formed flake tool category, these tools were made using fine-grained material. The invasiveness and regularity of their sub-parallel retouch implies that particular attention was given to the design characteristics of their working edges. Two had moderately steep edge angles of 380 and 400, and two had steep angles of 780 and 800. It is possible that last two tool had steeper edge angles because of edge rejuvenation. When an edge is retouched to rejuvenate it, the angle will become steeper.

Notched Flake Tools

Two types of notched flake tools were recorded, single-notched flakes (n=3) and multiple-notched flake tools (n=1). The design of the edges of these tools is suited to planing and scraping activities, particularly of cylindrical wooden implements. In many respects they have a design similar to that of a modern carpenter's draw-knife. The notches can be tailored to be applied to specific wooden pieces, which would be circular in cross-section.

All notched pieces were made on flakes that were consistent in size with other flake tools from the assemblage. Two were made using fine-grained material, one with medium-grained and, interestingly, one with coarse-grained material. It is possible that the last piece was made on this material to enhance its functional capabilities. Perhaps coarser-grained material would be better suited to planning tasks. All notches had a concave working edge, with irregular retouch. Edge angles of the notches were similar, between 650 and 750. Although these
tools, like the endscrapers, are classed as formed tools, because the reduction sequence of these flakes is the same as that of the basic flakes, they appear alike. It is this fact that gives the assemblage a homogenous aspect.

_Awls_

_Awls_ are tools that are primarily used for piercing or drilling into material. When used to pierce, the material must have a soft or medium density – the incision is made by pushing into it (Grace 1988:61). Drilling is a rotational motion, either in one or two directions (backwards and forwards). This motion can penetrate denser materials. A chert awl, because of the relative hardness of the chert (7 on the Mohs scale), when hafted and used with a bow-drill, can be used to drill relatively hard material such as carnelian (Calley and Grace 1988; Unger-Hamilton et al 1987).

Eight awls were recorded in this sample (figure 3.35), making them the largest group of formed flake tools. All of these could be used to pierce and drill. Awls used to drill, however, tend to have been retouched to produce a point with a regular thickness and height along its length (see figure ?). This enables the tool to drill further into the contact material, without the hole becoming wider as the tool penetrates. Only two of the awls have this regular point morphology. The remaining six awls, that were just retouched to a point, were probably only used for piercing soft material such as hide.

All of the awls were made using fine-grained chert and were retouched using irregular and direct retouch. Retouch was usually restricted to the point of the awl. It is difficult to say whether these tools were hand-held or hafted. Calley and Grace (1988), using high- and low-power use-wear microscopy, failed to detect

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2 Chert drills are especially effective if they are used in conjunction with an abrasive, such as sand (Calley and Grace 1988).
Figure 3.35  Illustrations of formed flake tool types - Awls/Borers
any hafting traces on similar tools from Abu Salabikh, in Iraq. They concluded that, while the use-wear traces on the distal tips of some of the awls were consistent with experimental, hafted drill-wear patterns, hafting leaves no observable traces.

Three capstones were recovered from Late Neolithic deposits. These were small rounded limestone pieces that had a concavity 1 cm deep carved into them. These may have been used as the tool to steady and align a hafted drill when it was used as a bow-drill. A number of drilled pieces of pottery (possible loom weights), pieces of bone and a bone tool drilled in several places were also recovered (Banning and Siggers 1997). The drilled holes in all of these pieces were bi-conical, suggesting that they were drilled from both surfaces of the objects in question.

Once again these formed tools were made on a variety of flake sizes consistent with the flakes from the other flake categories in the sample.

**Burins**

Three burins were recorded in this sample (figure3.35.1). The working edge of a tool, shaped by the "coup de burin" blow, is steep and chisel-like. These tools are thought to have been used for incising medium to hard material such as bone and antler (Tixier et al. 1980; Grace 1988). All of the burins were made on fine-grained chert. The lateral edges of these tools had direct retouch and the burin spalls had been removed from one edge only. Retouching the edge along which the burin blow will follow greatly increases the chance of the blow being successful. One of the burins had received two burin blows to the same edge, giving a stepped appearance. It is possible that these tools were hafted but this is, as yet, unknown. All of the burins had macro-observable edge fracture damage on their chisel-like tips. This would indicate that they were used to incise robust
Figure 3.35.1  Illustrations of formed tool types - Burins    Scale 1:1

1) & 2) Burin on a flake  3) Stepped burin on a blade
materials. The flakes on which these tools were produced are consistent with those of the other flake tools. No burin spalls were recovered from this sample.

**Summary of the Formed Flake Tools**

Analysis of the formed flake tools shows some important differences between them and other flake tools from the assemblage, but also some interesting similarities. Unlike basic flake tools, these formed flake tools show signs that greater attention was paid to the design of their working edges. This can be seen in their morphology, nature of retouch and edge angles. The majority, with only a few exceptions, are made on fine-grained chert. This selection of fine-grained chert was probably made because of its superior flint-working characteristics.

While these formed flake tools, by the nature of the design of their edges, are more standardised, they show some similarities with the non-standardised basic flake tools. First and foremost, they also are made from single-platform, pyramidal cores. The flakes themselves, prior to their modification into formed tools, are very similar to basic flake tools. They are of a similar size and morphology. While attention to the design of the edges is apparent among the formed flake tools, little attention was paid to the non-functional standardisation of the flakes. This fact emphasizes the utilitarian nature of this assemblage, which can be seen not only in the basic flakes, but also in the flakes used to make the small sample of what would usually be regarded by Levantine archaeologists as formed flake tools. Because the design input is higher in the formed flake tools, I assume that the tasks in which they were used required a greater level of functional efficiency not afforded by the application of basic flake tools or were too critical to allow risk of failure. Therefore, I have treated them as a separate category.
Chapter 4  The Results of the Analysis of the Blade and Bladelet Tool Sample

4.0  Introduction to the Blade and Bladelet Tools
Blade and Bladelet tools make up 24% of the tool sample, of which 72% are blade or blade tool fragments, and the rest (28%) are bladelet tools or bladelet fragments. These tools are "formed" because of selection of blanks that have morphological parameters and the level of standardisation associated with both tool types. (Definitions are given below).

No blade cores were recovered, and all bladelet cores found were from Late Neolithic deposits that contained considerable residual Kebaran material. The bladelet cores that were recorded appear to have been used to produce the much thinner bladelets of the Kebaran (Bar-Yosef 1971). The Late Neolithic bladelets, as I will discuss later, are markedly different from those of the Epipalaeolithic microlithic industries in this region. Because no blade cores have been recovered, the exact nature of the blade-reduction process is unknown. The absence of blade cores, however, does suggest that blade blank production was done off-site, possibly at the location of raw material acquisition.

Blades and bladelets were used as unretouched and retouched tools. In all, 79% of these tools were made from fine-grained chert – a figure much higher than among the flake tools – with 20% made on medium-grained and 1% on coarse-grained material. These tools will be discussed according to blade and bladelet tool type.

4.1  Blade Tools
I have assigned blades to five categories: unretouched used blades, retouched or backed blades, blade fragments, formed blade tool types and sickle blades (figure
Sickle blades are a blade tool type but, because of their economic significance, will be discussed later in a separate section.

With the sickle blade elements excluded, most blade tools were made on fine-grained material (72%), but a significant component was made on medium-grained material (28%). The Late Neolithic blade assemblage differs significantly from the blade tool traditions of the Pre-Pottery Neolithic. At "classic" Pre-Pottery Neolithic settlements, such as 'Ain Ghazal (Rollfson et al 1992), Beidha (Mortensen 1970; Byrd 1987) and Jericho (Crowfoot-Payne 1983), lithic assemblages are characterised by a finely worked blade tradition. These blades are usually made from keeled or naviform cores, have two ridges and are struck using the punch technique. They are highly standardised because of the reduction strategies employed in their construction. In contrast, Late Neolithic blades are usually single-ridged (70%) and much less regularised in their morphology and dimensions. They are wider and shorter than blades from the preceding Pre-Pottery Neolithic (Banning et al 1995). Often they are actually long flakes, only just making the metric criterion of blades (length/width ≥ 2). In addition, the nature of the striking platform indicates that these blades were struck using hard-hammer direct percussion (when present, the bulbs of percussion are pronounced (Wenban-Smith 1985). Blade tools from other Late Neolithic settlements, such as Byblos (Cauvin 1968), can sometimes be similar to the regularised blades of the Pre-Pottery Neolithic. Blade tools from the nearby Late Neolithic site of Jebel Abu Thawwab (Kaffafi 1985; 1986; 1988), in contrast, have much in common with the less standardised blades from Tabaqat al-Bûma.

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Rollefson et al (1992: 455) point out that utilised flakes are also found in Pre-Pottery Neolithic occupations but, still, the emphasis is on the blade tradition.
Utilised Blade Tools

Utilised blade tools are blades that have been used, but not retouched or backed. Whether a blade was utilised or not is inferred from the presence of use-related fractures on the working edges. The fractures were observed at a magnifications between 10x and 30x.

Nine utilised blades were recorded, five of which had maximum lengths that were barely long enough to make the blade category according to Tixier's definition (1963)⁴. As Tixier (1980:59) acknowledges, this cut-off point between blades (lames) and bladelets (lamelles) was formulated for Epipalaeolithic microlithic assemblages from the Maghreb, and is arbitrary and perhaps not relevant to blade tool traditions elsewhere. The five blades to which I refer could be considered either "short blades" or "long bladelets" (figure 4.0). The four remaining blades were not much longer, ranging between 60 mm and 70 mm.

Blade width was quite variable, with all blades except two having widths between 19 mm and 24 mm. Considering how short many of these blades are, these widths are relatively great. Also, these blades are on the thick side. Five blades have heights between 6 mm and 9 mm, two are around 12 mm and one was extremely thick at 16 mm. The variability of these measurements is consistent with a hard-hammer reduction process. While it is quite possible to produce regularised blades using a hard-hammer percusor (Newcomer 1977), provided the flint-knapper has the required level of proficiency, the comparative difficulty of striking the core at exactly the same place usually leads to a greater variability in blade metrics.

Raw material selection for these utilised blades was atypical for formed tools: five were made on medium-grained chert and four on fine-grained. Usually, at this site, formed tools were made from fine-grained material. As the

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⁴ The minimum length of a blade is 50 mm (Tixier 1963).
sample of these tools is so small, it is difficult to say if this raw material selection was conscious, and therefore functionally or culturally significant. The platforms of these blades were usually flat (n=5) or cortical (n=2). In one case a punctiform platform was recorded. This is unusual as punctiform platforms are often associated with indirect percussive techniques, such as the punch technique. Apart from this one case, platforms tended to be long and wide. This would also be consistent with a hard-hammer reduction strategy. While no blade cores were recovered from Tabaqat al-Bûma, the variable morphology of the blades suggests that the cores would have been far less regular than the cores from the Pre-Pottery Neolithic.

The edge angles of utilised blades range between 26° and 55°. Five utilised blades have angles that are reasonably acute, between 26° and 37°, and four are steeper, with angles between 43° and 55°. Utilised blades, because of their comparatively long, straight and sharp edges, can be effectively used as cutting implements. Even utilised blades with a steep angle are perfectly serviceable as cutting tools. They could have been used as they are, or hafted as composite tools. No traces of hafting on these particular tools were detected.

Retouched and Backed Blade Tools

There were 11 blade tools of this type: nine were retouched blades (seven partially and two completely retouched); one was retouched and backed; and one was only backed. Eight of these tools were made on fine-grained chert and three were made using medium-grained chert.

On the whole these blade tools were short, ranging from <40 mm to 70 mm in length. Blade width was also variable ranging from 10 mm to 25 mm. Blade thickness, however, clusters into three groups: one blade is 4 mm, six are between
6 and 7 mm and four are between 8 and 9 mm. Butt types, when discernible, include four that were flat, and one each of cortical, linear and punctiform types.

Retouch types included seven blades with irregular retouch and three blades with sub-parallel retouch. The invasiveness of the retouch was always marginal when the retouch was irregular and short when sub-parallel. Eight blades had straight retouched edges, one had a convex edge and one a concave one. Edge angles clustered into two groups: one between 350 and 470; and one between 550 and 600.

Four blades were under 40 mm long, making them more bladelet-like than blades by Tixier's definition. Their width, however, was too great for them to be bladelets *sensu stricto*. Of these small blades, two were partially retouched and two were retouched all the way around the edge of the tool.

Because of their metric dimensions, these small blades may have been destined for sickle blade production. Perhaps they were rejected during the blade reduction process because of inappropriate edge angles. Alternatively, these blades may have been a fortuitous by-product of flake-core reduction. I have found, when producing flakes from a single-platform pyramidal core, that small blades can often be inadvertently struck.

The longest two retouched blades were partially retouched with edge angles of 350. The two backed blades may have been unfinished sickle blades.

*Blade Fragments*

Twenty-three blade fragments were recorded, and these were assigned to three types: unretouched blade fragments; retouched blade fragments; and backed blade fragments. The most common were unretouched blade fragments with 19 pieces. Three were backed, and one was retouched.
It is likely that the majority of these pieces are the by-product of sickle blade manufacture. As mentioned earlier, no blade cores were recovered from any context, so blade blanks were probably brought back to the site and fashioned into sickle blades there. These blades, as I will elaborate in the next section, were short, so were only truncated at one end. Seventeen of these fragments were proximal pieces – the striking platforms were present – and they appear to have simple snap truncations (Tixier et al 1980). I believe the majority of these pieces to be sickle blade truncations for two reasons: first, they have very similar morphologies to the blades used to make sickle blades, and, second, they have edge angles that fall into the parameters for those blades chosen to make sickle blades. Eleven fragments have one ridge and 12 have two. Five different platform types were recorded. Eight were flat, three were cortical, four were gull-winged, one was linear and one was punctiform. The last three platform types point to a level of platform preparation not found in the flake tools.

Most of these fragments were made on fine-grained chert (74%), but some were made on medium-grained chert (26%). None were made using coarse-grained material. Edge angles, as one would expect from pieces chosen to make sickle blade elements, are consistent. 78% of all fragments had edge angles between $30^0$ and $41^0$. This is consistent with the edge angles of the sickle blades themselves. The length of these fragments usually lies between 11 mm and 32 mm (91%). Four fragments are between 30 and 38 mm in length and 13 and 22 mm in width. Fragment thickness was usually between 3.5 and 8.5 mm. Many of the pieces may be sickle blades that were unfinished, or for some reason were deemed unsuitable and rejected, or, perhaps, lost. One fragment has sickle polish on the working edge and, therefore, was used. This piece may have been broken during use but perhaps the element it came from was modified after it had been used for a while.
The three retouched blade fragments were all modified by direct retouch with only marginal retouch on straight edges. Most sickle blades from this site have a denticulated working edge. I believe that in some cases the edge of the sickle blade blank was marginally retouched to facilitate the removal of denticulations through pressure flaking. In these cases, before the denticulations were produced, the blade was truncated, usually by snapping.

**Blade Tool Types**

Apart from sickle elements, formed tools made on blades were rare. Only seven tools were recorded: an endscraper on a blade, a transverse burin, three single burins, and an awl on a blade. All of the tools were made on fine-grained chert. While all of the formed blade tools conformed to "types"; they all, like most stone tools from the sample, have an ad hoc aspect. The retouch on these tools is non-invasive and of the irregular type. Five of the blade tools were made on single-ridged blade blanks and two were made on double-ridged blanks. The limited number of blade tool forms is a further indication of the reliance that Late Neolithic farmers placed on flake tools.

4.2 Bladelet Tools

Bladelets as blanks for tools are not usually associated with Late Neolithic occupations. Gopher and Gophna (1993), in their overview article of the Levantine Late Neolithic, make no mention of bladelet tools. At the Late Neolithic levels of Byblos, to the North, in Lebanon, many of the tools from Cauvin's (1968:130) excavations were made on bladelets. The bladelets from the Late Neolithic occupation of Tabaqat al-Bûma are not bladelets sensu stricto. While the maximum lengths (≤ 40 mm) fall into Tixier's (1963) definition of bladelets, their maximum width is usually a little too wide. In many respects,
Figure 4.0 Illustrations of blade and bladelet tools  Scale 1:1
1) Burin on a blade 2) & 3) Used unretouched bladelet
whether these tools are large bladelets or small blades is irrelevant. What is more important is how these bladelets fit into Neolithic behaviours at this site. No Neolithic bladelet cores were recovered from the Neolithic deposits at the site. Bladelets may have been produced at the site of chert acquisition and brought back to the site as bladelet blanks.

Twenty-one bladelets were recorded and assigned to one of five categories: used unretouched bladelets; unused, unretouched bladelets; backed bladelets; unretouched bladelet fragments; and retouched bladelet fragments. All bladelets were made of fine-grained light brown chert. This would indicate that the bladelets were made from chert from the same source. No other tool type is made exclusively from one chert type in this sample. The design criteria for raw material selection appears to be inflexible: only fine-grained chert of this particular grain and colour would do. Light brown chert, however, is no better for stone tool production than fine-grained dark brown chert, or, indeed, fine-grained chert of any colour. Perhaps the makers of bladelets chose this colour out of custom alone. Alternatively, this type of chert may have some advantages of which we are unaware.

Striking platforms, where present, were cortical (n=6), linear (n=3) or punctiform (n=4). All of the cortical platforms were actually linear in their morphology. This would indicate that these bladelets may have been made using percussive techniques different from the hard-hammer reduction strategies of most the assemblage's tools. It is possible a punch technique was employed for their production.

The largest group of bladelets was assigned to used, unretouched bladelets, of which there were 13 pieces. All of these pieces show use-related fractures along one or both of the lateral edges. The fractures can usually be observed at magnifications of 30x or less. All but one of the bladelets had a single ridge.
Metric dimensions were usually between 28 mm and 40 mm in length, 8 mm to 12 mm in width and 2.5 mm and 4 mm in thickness.

Two bladelets were retouched and backed, and two were backed. Retouch was direct; one example had irregular retouch and one had sub-parallel. In both cases retouch was marginal on a straight working edge. In all cases backing of the these tools was the abrupt type. Two backed bladelet fragments were also recorded.

The uses of the bladelet tools are difficult to infer. Many authors (Bar-Yosef 1970, 1980, 1981; Kukan 1978; Hutchings 1991) have assumed that bladelets are often used as components of composite hafted tools. This is especially true in the case of backed bladelets. While no hafting traces were found on the bladelets in this sample, it is possible that these tools were recessed into a wooden haft to form cutting implements.

4.3 Adzes

Only one adze was recorded in this sample (figure 4.1 (no.1)). This adze was unifacially worked on fine-grained chert. The working edge of this tool, as it is now, was formed by a single blow at the distal tip. This resulted in a large plano-concave working edge well suited to adzing activities. Adzes (Lee 1973; Clough and Cummins 1988; Edmonds 1995) are usually bifacially worked core tools, but are also sometimes made on thick flakes (Rowan 1990:61). This adze has been chipped using hard-hammer percussion and appears to have rough-hewn appearence: it may been constructed with strictly functional criterion in mind. Lewenstein (1991) notes that tools of this type are often resharpened after the edge has become blunted or dulled, often resulting in a steeper edge angle than in the original design, because adzing is an activity that involves high loading stress. Other adzes from the Levantine Neolithic have been completely or partially
Figure 4.1  Illustrations of robust tools  Scale 1:1
1) Adze  2) Adze/chisel
Figure 4.1.1  Illustrations of robust tools  Scale 1:1
1) Partially polished adze  2) Adze on a large flake
polished. From this piece, large hard-hammer flakes have been removed to provide the bare minimum outline morphology and edge design characteristics needed to undertake adzing.

Axes, which are used for chopping, and adzes, which used for planing, are defined according to their edge symmetry (axes) or asymmetry (adzes) (Lee 1973). The entire assemblage contained no axes, and only four adzes (figure 4.1). Even though only one was in the analysed sample, the three other adzes are worthy of mention. While all would be considered adzes according to Lee's definition (1973), they are really quite different in outline morphology, construction and design. All of these tools were made on fine-grained material.

Figure 4.1 (no.2) depicts an adze that has a working edge similar to that of a chisel. Lee (1973) states that the difference between an adze and a chisel is that the working edge of the chisel is tapered to produce a converging, as opposed to a diverging, distal morphology. In the case of this tool, the edge is only very slightly tapered (wasted), so that whether it is an adze or a chisel is open to question. The nature of the flaking used to produce this tool and regularity of the outline morphology indicates a greater level of standardisation than does the adze shown in figure 4.1 (no.1).

Figure 4.1.1 (no.1) shows the only polished tool recorded from the Late Neolithic occupation. The tool is an adze that may be a core tool. Retouch is so extensive that is difficult to determine whether it was made from a core or large flake. Approximately 60% of the surface of this adze has been finely polished by abrasion, a process that is extremely time-consuming (Clough and Cummins 1988). The polishing of working edges of adzes, axes and chisels is a design feature that extends the working life of these tool types. By polishing the edge of a percussive tool, the frequency of edge breakage is reduced. Polished tools of these types are found in Neolithic settlements all over the Old World (Edmonds 1995);
Initially these tools are only polished along the working edge of the tool, but gradually more of the tool – the non-functional areas – are polished until the entire surface is polished, obliterating all flake scars caused by knapping. At this juncture, the tools may have taken on symbolic and economic functions above and beyond their intended purposes of employment, the chopping and working of wood (Hodder 1982; Thomas 1991; Bradley and Edmonds 1993). Evidence of these polished tools, often made from exotic lithic material, traded over long distances, is well attested in the Neolithic of Europe (Edmonds 1995). In the context of design this changing role of polished tools seems plausible. The adze in figure 4.1.1 (no.1) is a functional wood-working tool. When the edge was blunt or broken it could be resharpened through further retouching of the working edge – a quick procedure. The grinding of the working edge does increase the reliability of an adze but does involve a time-consuming process. Polishing, especially of the non-use-related areas of the tool, would be worthwhile if the tool had economic and symbolic functions apart from, or in addition to, wood working. It is possible that the semi-polished adze from the site was not made there, but was produced elsewhere and exchanged.

Figure 4.1.1 (no.2) shows an adze-like tool made on a large partially-cortical flake. Initially I believed this tool to have been a large end-scaper on a flake/blade. Microscopic examination of the convex working edge at the distal end show large use-related fractures consistent with percussive wood-working (Tringham et al. 1974; Grace 1988). While I could find no comparable tools with similar form other Levantine Late Neolithic sites, similar wood working adzes are reasonably common from Mayan workshop areas (Lewenstein 1991).
Figure 4.1.2  Ground basalt tool, possibly a hoe  Scale 1:1
4.4 Miscellaneous Tools

Figure 4.1.2 shows an enigmatic tool made of ground basalt, a lithic material only available some distance from the site of Tabaqat al-Bûma. This tool has the design features, most notably outline morphology and edge design, of a broad-edged adze. Basalt, however, is a lithic material that crushes easily: it is far from ideal for adzing activities. This tool could also have used as a hoe, to till plots of land for cereal cultivation. S. Rosen (pers. comm.) believes this tool to be a stylised figurine. I do not agree because the beveled edge of the tool appears to be deliberately shaped as a working edge.

One of the many interesting technological features of the late Neolithic assemblage from this site is the almost complete absence of projectile points from the tool assemblage. One point, however, was recovered. This was not included here because it was from a disturbed context. According to Gopher's (1985) typology of Neolithic points from the Levant, this arrowhead is similar to the side-notched Helwan points.
5.0 Introduction to the Sickle Blades of the Late Neolithic

The importance of the relationship between the appearance of sickle blades and the advent of agriculture has been known since the publication of Spurrell's work on early Egyptian sickles (Spurrell 1892). Stone sickle blades have been directly associated with cereal/grass harvesting since Petrie's excavation of the Egyptian site of Kahun in 1890 (Spurrell 1892:54). Of all of the tools of the Neolithic, the stone-edged sickle has enduring economic and ritual significance. In the Levant, sickles made of composite alignments of stone blades were used from the Natufian period through to the Early Historic periods (Rosen 1982). Indeed, the flint sickle appears to have developed symbolic significance through these periods. In Greek mythology, the deity of the sky, Uranus, was ritually emasculated by a flint sickle wielded by the Titan, Cronos (Graves 1960:37). Graves states that in Greek mythology, flint sickles continued to be used in a ritual capacity long after the introduction of bronze and iron instruments (Graves 1960:39).

Stone-edged sickles were used in a wide variety of Neolithic contexts across the Old World (Curwen 1930; Korobkova 1983; Anderson-Gerfaud 1983, 1988; Bienenfield 1986; 1988; Unger-Hamilton 1989). Spurrell (1892:57) as far back as the late nineteenth century, demonstrated through experiment that the lustrous polish or "sickle sheen" that is often found along the working edge of sickle blade elements was in fact a use-wear trace associated with the harvesting of grass/cereals. Spurrell (1892:58) also tried using hafted sickle elements on bone, wood, and hide, and concluded that only cutting the stems of cereal plants produces the bright varnish-like polish that is commonly described as "sickle sheen." Unger-Hamilton's (1985; 1989) exhaustive experimental analyses of use-
wear traces on Levantine sickle blades has added further insights into the uses of sickles. She hafted a total of 295 Natufian and Neolithic sickle blades using replicas of sickle hafts from the sites of Kebara B, Haçilar and Fayum (Unger-Hamilton 1989:90). These sickles were used to harvest wild and domesticated cereals in a number of different Levantine environmental contexts, and she compared the resulting polishes to those of more than 1000 archaeological sickle blades from a variety of Neolithic settlements. The results of Unger-Hamilton's research will be compared to my observations on sickle elements from Tabaqat al-Bûma at the end of this chapter.

In the Levant, sickle blades first appear in the Natufian period (Unger-Hamilton 1989), but the design concept of the blades hafted along the longitudinal axis of a bone, antler or wooden haft may have developed as early as the Upper Palaeolithic (Wymer 1982; Gamble 1986). Natufian sickle blade elements are made up of long thin blades that are sometimes backed, but whose edges are usually unretouched. The sickle blades of the Prepottery Neolithic are similar; but, because of the regularising effect of naviform core reduction technology, they tend to have more standardised metric dimensions than those from the Natufian.

Sickle blades from the Late Neolithic or Pottery Neolithic, on the other hand, are quite different from those of preceding periods (Rosen 1982; Gopher and Gophna 1992). These sickle blade elements tend to be shorter, truncated pieces, often heavily backed with abrupt or semi-abrupt retouch, and have denticulated working edges (Rosen 1982:139). The sickle blades of the Chalcolithic period which follows the Late Neolithic, are also denticulated, but the denticulations are are much more invasive (Rowan 1990; Rosen 1982). Some sickle elements from this period were denticulated on both of their lateral edges. Because sickle polish is often present on both edges of pieces of this type, the
working edges have probably been reversed once the first edge was blunted. There is, however, a great degree of metric and stylistic variability within this tool type from this period. As I will later elaborate, sickle blade metrics, backing and edge modifications display variability on an inter- and intra-site basis.

Unlike other Late Neolithic stone tool types, sickle blades are usually well represented in the lithic reports from sites of this period. They are perhaps the most obvious tools of the Late Neolithic, and are also the most easily recognised. Therefore, comparison of the sickle blades from Tabaqat al-Bûma with other sites was possible.

The hafting designs for these sickles may have varied from site to site, and also through time. Few sickle blade hafts, because of their organic nature, are extant, and the nature of this variation is difficult to determine. One example is the bone Natufian sickle handle found at the site of 'Ain Mallaha. This handle had a straight profile and it is possible that sickle blade handles from the Late Neolithic employed a similar design. It is also possible, however, that the Late Neolithic sickle blade handles were sometimes slightly curved. Because the Late Neolithic sickle elements tend to be shorter and wider than sickle blades from the earlier Neolithic, it is quite likely that more of them were needed to construct a sickle.

The Sickle Blade Sample

The sickle blade sample was much larger than that of other formed tools recovered from Tabaqat al-Bûma. Throughout this study I have stressed the interpretive hazards of overemphasizing Late Neolithic formed tools at the expense of utilised pieces. Because of my close scrutiny of the sickle blade assemblage, it may appear that I am guilty of the same bias that I have criticized. There are several reasons why the sickle blades from this site warrant special
attention. First, as I have noted above, it is often through comparing the basic and formed tools that we can learn which activities entailed the most risk. Second, in the Late Neolithic cereal agriculture apparently increased in importance, but unequivocal information regarding the nature of plant husbandry is lacking (Unger-Hamilton 1989:89). The cultivation of cereals involves a number of stages. These stages include plant propagation, plant husbandry, harvesting of the crops, processing of these crops, and storage of the grain. The sickle blade is one of the few surviving technological links to the harvesting stage of the system and should therefore receive special attention. Third, harvesting was probably one of the high-risk activities. To investigate this I have included sickle blades from contexts outside the main sample which was made up only of tools from the most secure contexts. However, an effort was made only to include tools that were from reasonably secure contexts. In addition, while these sickle blades do exhibit a degree of variability, they are technologically and stylistically similar enough to be assigned to the Late Neolithic.

_Sickle Blade Observations_

Recorded attributes for the sample of sickle blades were the same as for the formed tool sample. In addition to these observations, six other categories of information were included. The reason for the inclusion of the other observations was to enhance the study of sickle blade variation, design and use. Because most sickle blades were denticulated, the number of these denticulations was recorded. The nature of the truncations at the proximal and distal ends of the pieces was also recorded, as was their cross-sectional profile type. Many of the sickle blades exhibited sickle polish on their working edge. The nature and location of this polish can provide information regarding the use and duration of
use of Late Neolithic sickles at this site. The location, density and extent of edge rounding was also recorded. The rationale behind each of these six new observational categories will be discussed in their appropriate sections.

5.1 Backed and Denticulated Sickle Blades

_Sickle Blade Types_

Denticulated sickle blades are common in lithic assemblages from the Yarmoukian (Stekelis 1972) and Wadi Rabah cultures (Gopher and Orelle 1990; Gopher and Gophna 1993) of the Levantine Late Neolithic and Protohistoric periods (Rosen 1982). The denticulated sickle blades from Tabaqat al-Bûma, however, tend to differ from those at other Late Neolithic settlements: 1) their denticulations are smaller, and 2) denticulations appear to have been manufactured using the pressure flaking technique exclusively. The coarser denticulations on the sickle blades from other Levantine Late Neolithic contexts appear to have been done using direct percussion.

There are two broad types of sickle blades in this sample of 131 elements: first, and most numerous, are backed and denticulated sickle blades (96%); second are the backed sickle blades with an unretouched working edge (4%). This suggests a high degree of design standardisation within this tool type. All of these tools had backed truncated proximal and distal ends, which produced a rectangular outline morphology (figure 5.8).

The majority of these tools exhibited sickle polish observable to the naked eye. (Whether these tools are those that had been discarded after their useful life will be discussed later.) Because no blade cores were recovered from the excavation of the Late Neolithic levels of the site, the blade core-reduction strategy is unknown. It would be reasonable to assume, however, that, like other blade tools from this sample, the sickle blade blanks were made at a location off-
site, possibly near the point of raw material acquisition, and were brought back to
the homesteads to be retouched, backed and hafted, to form the final product.

**Raw Material Selection**

Raw material selection strategy for the backed and denticulated sickle blades is consistent with other formed tools from the sample (figure 5.1). The majority of sickle blades are made on fine-grained chert (88.5%), with a few made using medium-grained (10.7%) and only one on coarse-grained chert. In fact, sickle blades are more consistently made on fine-grained chert than are tools of any other formed tool category from the assemblage. This is not surprising considering the critical role sickles play in the agricultural system of farming communities of this type (Banning and Siggers 1997). As previously mentioned in other sections, fine-grained material would fracture in a more predictable fashion than medium- or coarse-grained materials, and it would be easier to meet stricter design parameters using it – *i.e.*, to produce blades consistently.

The data in figure 5.1 indicate a feature of raw material selection that was not observed in other tool types. The most common types of chert selected were brown and gray. The colours were recorded in light, medium or dark shades. Figure 5.1 indicates not only that fine-grained chert was selected, but also that lighter colour tones were given preference. There may have been a number of reasons for this. It is possible that fine-grained chert from this area tends to be of a lighter shade whether it is brown or gray. There may also have been a perception among the flintknappers at this site that lighter shades of chert had better flaking qualities than did darker shades. It is also possible that other cultural factors were directing the flintknappers to favour light shades of chert for sickle production.

One sickle blade was of particular interest. The piece was from a reasonably secure context but was made from a fined-grained, pink chert, that is not available
Figure 5.1 Histogram showing the frequency of chert types used to make denticulated sickle blades (n = 131)

KEY:

1.1 Light Brown/Fine-Grain
1.2 Light Brown/Medium-Grain
1.3 Light Brown/Coarse-Grain
2.1 Medium Brown/Fine-Grain
2.2 Medium Brown/Medium-Grain
2.3 Medium Brown/Coarse Grain
3.1 Dark Brown/Fine-Grain
3.2 Dark Brown/Medium-Grain
4.1 Light Grey/Fine-Grain
4.2 Light Grey/Medium Grain
5.1 Medium Grey/Fine-Grain
5.2 Medium Grey/Medium-Grain
6.1 Dark Grey/Fine-Grain
8.1 Pink/Fine-Grain
anywhere remotely near the site. The nearest documented sites that used this material seem to be the PPNB site at Jerash, approximately 40 km southeast of Tabaqat al-Bêma, as observed in surface finds, and the PPNB site of 'Ain Ghazal (Rollefson 1989), near Amman further to the south. The source of this chert is, however, unknown. Crowfoot-Payne (1983) suggests that the colour of the chert is due to heat treatment. Gopher (1989) and Miller (1985) have argued that no unequivocal experiments have been done to substantiate this.

_Sickle Blade Metric Observations_

Only sickle blades that were complete or practically complete were included in the metric analysis of this tool type. This sample was made up of 96 pieces out of a potential 131.

The maximum length of denticulated and backed sickle blades varied between 18 mm and 58 mm (figure 5.2). The majority of pieces, however, were between 22 mm and 38 mm (74%). Figure 5.2 illustrates two peaks in the data. The first includes sickle blades between 22 mm and 26 mm (16%); the second is a much larger peak with elements between 30 mm and 38 mm (49%). Neolithic sickles from the Levant are usually made up of a number of elements hafted in a linear fashion. The maximum length of these sickle blades invariably corresponded to the length of their working edge (figure 5.2). Therefore the longer an individual element is, the longer its cutting edge is. It follows that, if long elements were employed, fewer would have been needed to make up the required cutting edge of an efficient tool. The sickle blades from Levantine Late Neolithic assemblages such as this one, however, tend to contain sickle blades that are shorter than in the preceding periods. This means that more elements would be needed to make one sickle or, perhaps, sickles were shorter.
I believe that there are two potential explanations for the reduction in sickle blade size in this period. First, as I have argued, the Late Neolithic saw a reorientation in lithic technological emphasis. The focus was on flake tools and not on the highly standardised blade tools of the preceding periods. The flintknappers of the Late Neolithic did not employ a blade-core reduction technology (such the naviform technology of the PPNB) that would produce long blades. Blade cores were not recovered from Tabaqat al-Bûma, but the blade tools that were recovered tended to have variable morphologies, indicative of a far less standardised blade-reduction sequence. Hence blades produced for sickle blade production tended to be short. The second explanation is that shorter blades were used in the Late Neolithic because of a change in sickle design. The preservation of Neolithic sickle hafts is extremely rare. The Natufian sickle from Kebara B (Unger-Hamilton 1989) has three long blades hafted in a bone handle. The cutting edge of this sickle is more or less straight. The long blades of the Natufian and Prepottery Neolithic are suited to this design because few elements are needed to make up a long cutting edge. But if, in the Late Neolithic, sickle design changed from a straight-edged to a curved-edge tool, I would argue that shorter blades are more suitable. For a curved-edge sickle design, the curvature of the working edge is formed, not by the stone blades, which are straight, but by the curvature of the haft itself. In the case of this sickle design, long blades would interfere with the curvature of the tool, whereas shorter ones would not.

Figure 5.3 shows the distribution of the maximum widths of sickle blades. Here there appears to be less variability in the range of measurements. Most sickle blades have widths between approximately 12 mm and 18 mm (83%). The largest peak in the data is for maximum widths between 13 mm and 17 mm (41%).
Figure 5.2  Histogram showing the frequency of the maximum lengths of denticulated sickle blades at ten intervals (n = 131)

Figure 5.3  Histogram showing the frequency of the maximum widths of denticulated sickle blades at ten intervals (n = 131)
Figure 5.5 is a percentiles plot showing the cumulative frequency of the sickle blade measurements. The relative steepness of the plots for maximum width and thickness illustrate how consistent these metric variables were. The range of maximum lengths, however, with its less steep curve, is considerably more spread out.

The maximum thickness for backed and denticulated sickle blades was reasonably consistent (figures 5.4 and 5.5). This is not surprising when one considers how the thickness of a blade affects the design of the sickle handle. Measurements ranged from 3 mm to 13 mm. Most sickle blades had a thickness between 5 mm and 9 mm (75%). The thickness of the sickle blade, and its design (i.e., the nature of backing or its absence), are critical to the design of the haft. The groove into which the individual pieces were slotted would have been manufactured to fit their thickness. The hafting implications will be discussed further later in this chapter.

5.2 The Working Edges and Backing of Denticulated Sickle Blades

The following observations record the design features of the working edges of the sickle blade assemblage. In addition to the observations recorded for all retouched tools, the number and nature of the denticulations on the edge of the tools were included.

Edge Angles

Of the design features on the denticulated sickle blades from this assemblage, I assumed, because of the critical cutting functions associated with the harvesting of cereals, that the edge angle of these tools would be the most

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5 The sickle hafts known archaeologically, be they bone, antler or wooden (Unger-Hamilton 1985), have a groove incised to fit the the thicknesses of the individual sickle elements.
Figure 5.4  Histogram showing the frequency of the maximum heights of denticulated sickle blades at ten intervals

(n = 131)
Figure 5.5 Cumulative frequency of the maximum lengths, widths and heights of denticulated sickle blades

KEY:

- ○ Maximum Length
- □ Maximum Width
- △ Maximum Height

(n = 131)
Figure 5.6  Histogram showing the edge angles on denticulated sickle blades at ten intervals  

\[ n = 131 \]

![Histogram showing the edge angles on denticulated sickle blades at ten intervals](image)

Figure 5.7  Cumulative frequency of the edge angles on denticulated sickle blades  

\[ n = 131 \]

![Cumulative frequency of the edge angles on denticulated sickle blades](image)
controlled. In other words, the edge angles of these tools would be consistent to enable them to function with predictable efficiency.

Figure 5.6 is a histogram showing the distribution of edge angles throughout the sample. The histogram, which has 10 intervals, shows a skewed pattern of data that indicates that most edge angles were acute. The cumulative frequency data shows that approximately 80% of the edge angles were between 22° and 36° (figure 5.7). 59% of the angles were between 30° and 37°. The cumulative frequency graph (figure 5.7) also shows a steep curve, indicating that edge angles are similar for at least 80% of the sample. The remaining 20% are more spread out, with angles ranging between approximately 38° and 61°. I conclude from this that acceptable edge angles for this tool type, in the overwhelming majority of cases, are acute between 22° and 44°, with optimum angles 30° and 37°.

Of the ten intervals that the histogram shows, the largest single peak is the one that represents tools with edge angles between 30° and 33° (37%). As I have mentioned previously, most edges, regardless of angle, can cut plant material after a fashion. The more acute angles of these sickle blades, however, would be more efficient than less acute ones (Semenov 1964; Tringham et al 1974; Grace 1988).

The edge angle of the sickle blades is largely determined by the nature of the blade itself. Because blades are by definition long thin flakes, the edge angles of their lateral edges tend to be acute, especially if the blades have two ridges on the dorsal surface. Usually, the thinner the flake, the more acute are the angles of its lateral edges. This is probably one of the reasons that blades were selected as sickle elements.
Retouch Type

By definition, sickle blades of this category have been retouched to produce a denticulated working edge. These denticulations produce a saw-like serrated edge (figure 5.8). The sizes of the denticulations are fairly consistent, ranging from 2 mm to 4 mm. All but three tools had a straight denticulated edge (two were slightly convex and one slightly concave). The number of denticulations along a working edge largely depends on the length of the edge. The longer the working edge the greater the number of denticulations. Figure 5.9 shows this relationship in the form of scattergram, which plots the number of denticulations compared to the maximum length of complete sickle blades from the sample (for these tools, maximum length invariably equals length of the working edge).

The denticulations were retouched using the pressure flaking technique, probably using a pressure-flaker made of antler or, perhaps, bone. I replicated a number of the these denticulated sickle blades, and made a number of interesting observations. First, to produce denticulations of this nature, the pressure flaking tool had to have a strong but narrow point. This involved grinding an antler tine or sliver of bone to a fine point. If the point was not narrow enough, the resulting denticulations were too large to pass as accurate replicas of this tool type. Second, the process of retouching the denticulations caused the bone and antler pressure flakers to blunt very quickly. The antler pressure flakers had to be sharpened by grinding (on a coarse stone) after producing eight to ten denticulations and the bone tool had to be resharpened after only three to five denticulations. The antler pressure-flaker was made from the comparatively durable caribou antler and the bone pressure-flaker was made from a sliver of Bos sp. humerus. In the light of this, it seems likely that antler pressure-flakers would have been preferable. The constant resharpening of the pressure-flakers
Figure 5.8 Illustrations of denticulated sickle blades
1) Backed and denticulated sickle blade
2) Lunate-shaped backed denticulated sickle blade
3) & 4) Backed and denticulated sickle blade
5) Denticulated sickle blade
6) Backed and denticulated sickle blade
(Shaded areas indicate sickle polish)
Figure 5.9  Scattergram showing the relationship between number of denticulations and the maximum lengths of denticulated sickle blades (n = 81)
illustrates another design feature of these formed tools, and indicates that they were relatively costly to make.

The pressure-flaker is used to remove small notches with a conical profile. The invasiveness and distance between these notches determines the size of the denticulations along the edge. The edge of the tool is not prepared so the flat distal end of the "tooth" of each denticulation is unretouched. Usually more than one conical flake was removed to prepare the notch. Most sickle blades had pressure flakes removed bifacially from the ventral and dorsal surfaces of the working edge (61%), but 39% of the sickle blades were pressure flaked on one surface only, either by direct retouch on the dorsal (25%) or indirect retouch on the ventral surface (14%). During the analysis of these tools I noticed that seven of them had heavy concentrations of polish on the working edge. But while on one side the polish was distributed evenly over the edge, on the other side, polish was absent from the flake scars of the conical notches. I assumed, therefore, that the denticulations had been retouched (sharpened) on the side with no retouch, to make the tool bifacially retouched, after the tools had been used for some time. Initially, I thought that the sickle blades were only retouched on one surface, and then the denticulations were retouched on the other surface once they had become blunt. To test this I compared the retouch position (direct, indirect or bifacial) of the sickle blades to their stages of use. As a sickle blade is used to harvest cereals the accumulation of polish on the working edge increases (Anderson-Gerfaud 1983; Unger-Hamilton 1989). Also the edge of the tool becomes progressively more rounded and therefore blunt. The edges of the sickle blades were examined at 10x to 30x magnifications and, by reference to the buildup of polish and the extent of edge rounding, were assigned to one of four stages of use. These were as follows:

1) Unused – No traces of sickle polish and edge in mint condition
2) Light use – Light concentrations of polish restricted to the edge of the denticulations only. The edge is still sharp with minimal evidence of rounding.

3) Medium use – The edge is rounded and sickle polish is not only restricted to the edge but is invasive up to 2 mm away from it.

4) Heavy use – The edge is heavily rounded and polish distributions have an invasiveness greater than 2 mm from the edge.

Figures 5.10, 5.11, 5.12 and 5.13 are bar graphs that show the distribution of retouch position according to each of the categories of use. It is immediately apparent in these data that the distribution of retouch positions is similar at all four stages of sickle blade use. Therefore, some sickle blades were bifacially retouched after they had been used for a while, probably to rejuvenate the working edges, but it seems unlikely that bifacial retouch was solely undertaken for resharpening purposes.

Whether bifacially pressure-flaked denticulations are sharper than unidirectional denticulations is open to question. I suspect, however, that there would be minimal or no difference in functional efficiency. The efficiency of a denticulated edge compared to an unretouched edge is worth investigating. However, Unger-Hamilton (1989:95) noted that retouched sickle blades were no sharper than unretouched sickle blades. In fact unretouched blades are sharper, but the retouching of sickle edges did extend the functional life of sickle blades. We should note, however, that Unger-Hamilton (1985; 1989) focused her studies on sickle blades from the Natufian and Prepottery Neolithic. While many of her findings are directly relevant to sickle blades of the Late Neolithic, she did not include denticulated sickle blades in any of her experiments.
Figure 5.10  Histogram showing the retouch position on denticulated sickle blades with edges showing no traces of use  (n = 16)

Figure 5.11  Histogram showing the retouch position on denticulated sickle blades with edges showing traces of light use  (n = 26)

KEY:
1 - Direct
2 - Indirect
5 - Bifacial
Figure 5.12  Histogram showing the retouch position on denticulated sickle blades with edges showing traces of medium use  
(n = 60)

Figure 5.13  Histogram showing the retouch position on denticulated sickle blades with edges showing traces of heavy use  
(n = 28)

KEY:
1 - Direct
2 - Indirect
5 - Bifacial
**Backing and Truncation Types**

Backing is retouch that has been undertaken either to facilitate hafting or to blunt the edge of a tool that is not the working edge (Tixier et al. 1980:73). Six types of backing were recorded on the denticulated sickle blade sample (figure 5.14). Most were backed in an abrupt fashion, with the backing angle between $85^0$ and $90^0$ (76%), 60% of which were backed in a direct manner (abrupt type) and 16% from the ventral and dorsal edges (abrupt and crossed type). Twenty-four sickle blades were backed in a semi-abrupt manner, with backing angles between approximately $50^0$ and $85^0$. One sickle blade had a shallower type of backing at around $45^0$. Two had a natural backing (cortical) that was in both cases abrupt. Here, the natural acuteness of the blade edge angles precluded the need for backing. All of the above backing types produced a straight backed edge. Two sickle blades were backed to produce a curved "lunate" edge. Both of these pieces were backed in the abrupt fashion.

The backing of these sickle blades can inform us about the potential designs of the sickle hafts into which they were fitted (Cauvin 1983). The abruptly backed tools would have required a rectangular or square-profiled groove to fit the cross-sectional morphology that this type of backing produces (figure 5.16). Similarly, the semi-abruptly backed sickle blades would necessitate a more acute groove. It may be that sickle blades where only hafted with sickle elements of same backing type, because this would mean that the haft groove could be uniform and would not have to be tailored to the vagaries of individual backing types.
Figure 5.14  Histogram showing the frequency of backing types on denticulated sickle blades (n = 121)

KEY:
1 - Abrupt
2 - Abrupt and Crossed
3 - Semi-Abrupt
4 - Low-Angle
5 - Natural
6 - Indeterminate
Figure 5.15  Histogram showing the frequency of truncation types on denticulated sickle blades  
(n = 126)

KEY:

1 - Abrupt and Abrupt
2 - Abrupt and Semi-Abrupt
3 - Semi-Abrupt and Semi-Abrupt
4 - Snap and Abrupt
5 - Snap and Semi-Abrupt
6 - Snap and Snap
7 - Semi-Abrupt and Platform
8 - Lunate
9 - Indeterminate
10 - Snap and Platform
While the shape of the haft's groove could be uniform in the shape of its cross-section, it could only be truly uniform if the thickness of each piece was more or less the same. The assemblage is made up of elements with a narrow range of maximum thicknesses (figure 5.3), but many of the pieces vary in thickness along their backed edge; this may have meant that careful selection of individual sickle blades was needed prior to hafting.

The backing of the truncations at the proximal and distal ends of the sickle blades also affects the design options of the sickles. Ten categories of truncation were recorded. 85% of these were combinations of abrupt backing, semi-abrupt backing and snap terminations (left unbacked). Interestingly, any combination of the truncation types seemed to be more-or-less equally popular (figure 5.15) On two examples one end was the unbacked platform of the blade. Two pieces that did not have truncations were the lunate sickle blades mentioned in the last section. Apart from these two, all pieces had proximal and distal edges that were straight. How these truncations affected haft design is uncertain. A straight truncation would be suitable for a straight-edged sickle design. However, the
comparatively small size of the blades also means that a curved or slightly curved edge design was possible.

**Backed and Denticulated Sickle Blade Cross-Section**

As previously mentioned, no blade cores were recovered from Neolithic contexts at Tabaqat al-Bûma. To explore further the nature of blades selected for sickle blades the cross-sections of 100 sickle blades were recorded. Figure 5.17 illustrates the range of cross-sections of sickle blades from this sample. Types 1 to 5 had a single ridge on the dorsal surface and types 6 to 10 had two. The nature of the sickle blade cross-section morphology largely depends on two factors. The first was the number of ridges and the second was the type and extent of backing employed.

The single-ridged sickle blades were the most numerous (72%) but a significant number of double-ridged flakes were also recorded (28%) (figure 5.16). It is possible, in my experience, to produce single- and double-ridged blades from the same core. It is, however, easier to produce them on separate cores if you intend to produce single- or double-ridged flakes exclusively. In light of the probable economic importance of these harvesting tools, I believe that sickle blades were manufactured with strict design requirements in mind (i.e., retouch type, edge angle and metric criteria), but as long as these requirements were fulfilled, the number of ridges that a blade had was of less design significance. The presence of both types of blade and their differing cross-section could be important for hafting concerns, however; it is possible that certain cross-section types had to be hafted together.

Because most sickle blades have abrupt retouch and are made on single-ridged blades, the cross-section types reflect this. Types 3 and 5 are the most common (50%). It appears that single-ridged flakes are on the whole thicker than
Figure 5.17  Histogram showing the frequency of cross-section types on denticulated sickle blades (n = 113)

KEY:
1 - Single-ridge / No Backing
2 - Single-ridge / Semi-abrupt away from ridge
3 - Single-ridge / Abrupt away from ridge
4 - Single-ridge / Semi-abrupt at ridge
5 - Single-ridge / Abrupt at ridge
6 - Double-ridge / No backing
7 - Double-ridge / Semi-abrupt away from ridge
8 - Double Ridge / Abrupt away from ridge
9 - Double-ridge / Semi-abrupt at ridge
10 - Double-ridge / Abrupt at ridge
Figure 5.18  Box plots showing the variability of maximum thickness (heights) according cross-section type on denticulated sickle blades  

Maximum thickness (mm)

KEY:

1 - Single-ridge / No Backing
2 - Single-ridge / Semi-abrupt away from ridge
3 - Single-ridge / Abrupt away from ridge
4 - Single-ridge / Semi-abrupt at ridge
5 - Single-ridge / Abrupt at ridge
6 - Double-ridge / No backing
7 - Double-ridge / Semi-abrupt away from ridge
8 - Double Ridge / Abrupt away from ridge
9 - Double-ridge / Semi-abrupt at ridge
10 - Double-ridge / Abrupt at ridge

(n = 113)
their double-ridged counterparts. Figure 5.18 shows with box plots the
distribution of maximum blade thickness according to cross-section types.
Double-ridged flakes are thinner and have less variability in the range of their
thickness. It is important to note that there are fewer sickle blades with
double ridges, and this may partially explain the smaller degree of variability of
this sickle blade type. The one exception is double-ridged type 10, which has 20
pieces and a reasonable degree of sickle blade variability.

5.3 The Nature of Polish Formation on Backed and Denticulated Sickle Blades

Most denticulated sickle blades from the sample (88%) exhibited traces of sickle
polish and therefore were used. The extent of use can be determined by
examination of three variables: 1) the amount of polish present on the working
edge; 2) the invasiveness of the polish away from the working edge, and 3) the
extent of edge rounding (Unger-Hamilton 1985, 1989; Anderson-Gerfaud 1983,
1988). Each of these variables is affected by a wide range of variables, including
the plant species harvested, the water content in the plant stems, where on the
stem it is cut, the time of harvest, the harvesting methods of the worker; and the
type of lithic raw material used (Unger-Hamilton 1983: 244). To this list I would
add the design of the sickles in which sickle blades were hafted. Different sickle
designs could be used in different manners, and this may affect the intensity and
distribution of sickle polish formation along the edges of the sickle blades. Unger-
Hamilton (1989:90) believes that her experimental programs indicate that the use
of sickles was intense and the variables were limited, while the contact material
can be deduced through high-powered use-wear microscopy (Keeley 1980).

For the sample of sickle blades from Tabaqat al-Bûma, I recorded four stages
of use: unused, light use, medium use and heavy use. The criteria used to assign
sickle blades to these ordinal categories of use are outlined in the preceding section of sickle blade retouch. Figure 5.19 shows the distribution of the stages of use of the sickle blades. The largest category contains sickle blades with a medium degree of use (46%). Sickle blades that showed light traces of use account for 20% of sample and 21% showed traces of heavy use. Interestingly, 12% (N=16) show no traces of wear. It is possible that these tools were only used for a short period of time. Unger-Hamilton (1989:91) found that 10,000 strokes were needed to produce "reasonably intense" sickle polish. How many strokes are needed to produce traces of any kind is unclear, but if 10,000 are needed to produce a reasonably intense polish, it would be a fair number. It appears that most sickle elements were not replaced until they were heavily worn (the heavy use category). At this stage of the sickle blades' use-life, their cutting efficiency may have been unacceptable, even after the denticulations had been resharpened. It is also possible, however, that tools that reached this stage of use were immediately discarded. As this would have occurred during the harvesting process, they could have been discarded in the fields and would not be found on-site. What was considered to be a functionally acceptable level of efficiency may also have varied from individual to individual and according to circumstance. If users had a very limited time to undertake harvesting, which seems to be the case, and the harvest was almost complete, they may have considered it better to continue using a well worn sickle, which in other circumstances would have been replaced.

Most sickle blades displayed polish on both the ventral and dorsal surface of the working edge (98%) but, apart from three pieces, one side had a greater amount of polish than the other. When a blade or flake is used to cut plant stems, the underside will have greater accumulations of polish than the top
Figure 5.19  Histogram showing the stages of use of denticulated sickle blades 
(n = 130)

KEY:

0 - Unused
1 - Light Use
2 - Medium Use
3 - Heavy Use
surface (Grace 1989)\(^6\). Therefore if we know which side has a greater amount of
polish we can also determine which side was hafted up – the side with less polish.
In this sample, most sickle blades were hafted with the ventral side up (67\%), but
a fair proportion were used with the dorsal side up (30\%). To ensure a cutting
edge that was aligned, it would make sense to haft sickle blades with same side up
in their sickles. I would be fair to assume, given these data, that approximately
two-thirds of the sickles at Tabaqat al-Bûma were hafted with the ventral side up
and one third with the dorsal side up.

Use-Wear Analysis and Polished Sickle Blades

Jensen (1988) notes that use-wear, like any new methodology, has gone
through three phases of development: first, a period of over-optimism in which
the potential of the methodology is stretched beyond its abilities; second, a time
of reassessment, in which there is a growing awareness of the need to define
limitations; and last, a period during which there is a level of acceptance of the
strengths and weaknesses of the method. Whether use-wear analysis has
successfully navigated through all three phases is open to question. Most
researchers in the field, however, would concede that both low-power analysis of
fracture types and high-power investigations of polish provide data that are
pertinent to an understanding of tool use (Shea 1988; Jensen 1988; Grace et al.

Grace (1988; Grace et al. 1988) has demonstrated that polish itself is not as
diagnostic a use-wear trace as many analysts claim it to be. Polish accumulation,
the alteration of the surface of stone due to mechanical contact with other
materials, occurs as a continuum at different rates according the materials being

\(^6\) I have confirmed this observation by using experimental denticulated-
edge sickles to reap modern domesticated wheat (Triticum aestivum).
worked, the way the tool is used and the design features of the tool itself. Polish cannot, at least as yet, be quantified. This fact is demonstrated by the subjective terminology that use-wear analysts who focus on polish alone employ. However, the only way, to date, to describe polish, especially considering the variability caused by different optical systems, is to attempt, with the aid of photography, to describe patterns in polish distribution as objectively as possible. For example, one type of sickle polish is often described as "inflated" (figure 5.20). This polish type is recognisable only after an analyst has examined a number of polished sickles. To sum up, polishes alone, contrary to claims of researchers such as Keeley (1980) and Moss (1983), are not necessarily diagnostic of the contact material that produced them (Newcomer et al. 1986; Grace 1988).

Use-Wear Examination of Sickle Blades from Tabaqat al-Bûma

Researchers who have conducted experimental use-wear programs to examine sickle polishes all believe, to one degree or other, that they can extract use-related information by analysing the polishes on stone sickle blades from Neolithic and later contexts (Korobkova 1983; Anderson-Gerfaud 1983; 1986; Unger-Hamilton 1983; 1988; 1989). Of the three analysts mentioned, Unger-Hamilton (1989) has conducted the most comprehensive experimental program. While I did not conduct a comprehensive assessment of the use-wear traces on stone tools from Tabaqat al-Bûma, I did compare polishes on a small sample of denticulated sickles with the polishes that Unger-Hamilton claimed to be diagnostic of particular uses. In total, 30 sickle blades were selected from the Late Neolithic assemblage to be examined at magnifications between 50x and 400x using a Nikon™ optical microscope (Optiphot), and on a sample of eight sickle blades, at the same range of magnifications, using a Scanning Electron Microscope (Hitachi™, hereafter referred to as SEM). All of the sickle blades displayed
marked sickle polish observable with the naked eye. These blades were cleaned with a mild biological detergent to remove any finger oils that might confuse polish observations.

I hoped that by observing the polishes from this sample, and then by comparing them to the observations of Unger-Hamilton, Anderson-Gerfaud and Korobkova, I would be able to gain a greater insight into the use of these tools. Both optical and SEM microscopes were used because they have different strengths and weaknesses, I hoped to maximise the former and reduce the latter by using both types. The SEM has a much greater depth of field than a conventional microscope, a far higher range of magnifications (not an advantage in this study) and presents the observer with a clear, digitised image. It is also, however, expensive and very time-consuming to use, so that it was only possible to examine a sample of eight sickle blades with the SEM. Optical microscopes require less training and are comparatively simple to operate, but suffer from many of the constraints that all optical instruments of magnification have. Depth of field is poor and gets progressively worse as magnification increases. Because the object is lit by an artificial light source, in this case one directed through the lens itself, the nature of the image varies according to the intensity of light, the angle at which it is directed and the nature of the optical system through which it is transmitted.

All of the sickle blades selected had strongly developed polished edges. Unger-Hamilton and Anderson-Gerfaud looked at two major types of observation related to sickle polish: 1) the nature of polish and its distribution, and 2) the striations that are incised in the polish. In most cases the polish itself is not diagnostic of a blade's use on any particular plant species. Polish will build up when a sickle blade is used to cut any species of the grass family (Poaceae). The factors that influence the nature of this polish are not only related to the species
Figure 5.20 Plate showing of the "inflated" polish on the working edge of a denticulated sickle blade at 100x with a Nikon™ optical microscope (Optiphot)

Figure 5.21 Plate showing of the "medium" polish on the working edge of a denticulated sickle blade at 100x with a Nikon™ optical microscope (Optiphot)
Figure 5.22 Plate showing "parallel" striations in the polish on the working edge of a denticulated sickle blade at 50x with a Nikon™ optical microscope (Optiphoto)

Figure 5.23 Plate showing "criss-cross" striations in the polish on the working edge of a denticulated sickle blade at 50x with a Nikon™ optical microscope (Optiphoto)
of grass being cut, but to factors such as how long the tool was used, the water content of the plant stems (i.e., riper plants have higher water content), where on the stem the plant was cut and the motion with which the sickles were used (Unger-Hamilton 1989:90; 1991).

Unger-Hamilton observed three types of sickle polish: "inflated" with the polish showing a very "buoyant" appearance; medium, in which the polish was less inflated than in the inflated category; and flat where the polish did not appear buoyant at all. The categories demonstrate the inherent difficulties associated with the use-wear analysis of polish. The categories are subjective and the analyst who wishes to use data generated by other analysts can often only use the photographs of the polish types that these analysts have chosen to publish. Unfortunately, a leap of faith is also sometimes required.

After examining the use-wear sample of the sickle blades from Tabaqat al-Bûma, polishes did seem to be inflated (looked raised) to varying degrees (figures 20 and 21). My sample included ten sickle elements that I had assigned to each of the stages of use (light, medium and heavy). Interestingly, all sickle blades, regardless of their stage of use, exhibited polish that appeared consistent with what Unger-Hamilton would term "inflated" or "medium." In other words, the polish appeared to be raised on the surface of the chert (Table 5.1). No flat polishes were recorded.
Table 5.1  Unger-Hamilton's (1989) polish types from a sample of denticulated sickle blades from Tabaqat al-Bûma, split by stages of use

<table>
<thead>
<tr>
<th>Stage of Use</th>
<th>Inflated Polish</th>
<th>Medium Polish</th>
<th>Flat Polish</th>
</tr>
</thead>
<tbody>
<tr>
<td>Light Use (N=10)</td>
<td>6</td>
<td>4</td>
<td>-</td>
</tr>
<tr>
<td>Medium Use (N=10)</td>
<td>7</td>
<td>3</td>
<td>-</td>
</tr>
<tr>
<td>Heavy Use (N=10)</td>
<td>10</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>TOTAL (N=30)</td>
<td>23</td>
<td>7</td>
<td>-</td>
</tr>
</tbody>
</table>

Most sickle blades, regardless of their stage of use, appeared to have polish that was heavily inflated (76%) (figure 20). Unger-Hamilton (1989:94) found that in her experimental studies the degree of the "inflation" in sickle polish varied with the ripeness of the plants she harvested. When wild barley, wild emmer and domesticated T. durum were harvested green, two weeks before they were ripe, the polish appeared very inflated. She suggests that the inflated look of polish may be related to the water content of plant stems; the greater the water content, the greater the degree of polish inflation. This would suggest that the cereal plants at Tabaqat al-Bûma were harvested before they were ripe. Initially, I found this surprising. These sickle blades are from Late Neolithic contexts and one would expect them to have been used to harvest domesticated grain, which had tough rachises. The tough rachises allow domesticated cereals to be harvested without dropping grain when the plants are ripe. Why, then, would the farmers at Tabaqat al-Bûma choose to harvest domesticated grains before they were ripe? One possibility is that, while the denticulated blade is an efficient harvesting tool, the sawing action needed to cut plant stems caused some of the grains of even tough-rachised cereals to fall off and be lost. It is important to reiterate that the
notion of green harvesting at Tabaqat al-Bûma is based on polish observations, which, as yet, are not quantifiable. Therefore these are based upon some level of observer subjectivity. Also, Unger-Hamilton’s study incorporated sickle blades from many Neolithic contexts; it was focused on the sickle polishes from the Natufian and the Prepottery Neolithic. Sickle blades from these periods, and especially those of the Natufian, were probably used to harvest wild plants.

While analysts agree that sickle polish is usually caused by harvesting of grasses, it is also tacitly assumed that these grasses are wild or domesticated cereals. Sickles may also have been used on other grasses, or indeed for other cutting tasks altogether. Near the site of Tabaqat al-Bûma is a small stream. Here sickles may have been used to harvest reeds (Arundo sp.) that grew there, for thatching, basketry or matting. Unger-Hamilton (1989:92) notes that, in some cases, polish distribution is specific to plant species. Among these, the polish on sickles used to harvest reeds is evenly distributed across the polished area. In contrast, sickle polish from cereal harvesting is "....concentrated at the very edge and diffuses towards the interior of the blade" (Unger-Hamilton 1989:92). All polish distributions from the sample of sickle blades from Tabaqat al-Bûma have polish distributions that conform to the latter distribution type. Therefore it is likely that these sickle blades were not used to harvest reeds, but cereals of one species or another. It is necessary to point out, however, that the Unger-Hamilton experimental study, while being the most comprehensive to date, does not take all possible harvesting scenarios into account. It is possible, for example, that sickles could be used to harvest both cereals and other grasses, including one used as hay. The nature of the resulting polish that would result from using sickles on a combination of species is, as yet, unknown.

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7 Today, in this area of Jordan, farmers use sickles for a wide variety of cutting tasks, including scrub clearance.
All but two of the sickle blades had striations that appeared to be incised into the polish formations (figures 22 and 23). Anderson-Gerfaud (1983; 1988) and Unger-Hamilton (1985; 1989) agree that these striations are not caused by the plant species themselves, or by weeds that grow among them, but by soil particles adhering to the lower parts of stems. The side of the blade closest to the ground tended to have more striations than the upper side (Unger-Hamilton 1989:93). In every case, striations on the Tabaqat al-Bûma sample were more pronounced on the side of the blade that had the greater polish accumulations associated with the lower position. Unger-Hamilton notes that striations occur most frequently when sickles are used to harvest cultivated cereals on tilled soils, when the plants are cut near the bottom of the stalk (Unger-Hamilton 1989:93). The fact that all but two of the sickles had striations in their polish formations suggests that the inhabitants of Late Neolithic Tabaqat al-Bûma did indeed farm cultivated cereals.

The orientation of the striations on the sickle blades can also tell us about the motions with which the sickles were used. Figure 22 shows how typical striations on the working edges of the sickle blades were oriented. The striations appear to have two types of orientation: one that runs parallel to the working edge and one that runs at a shallow, oblique angle from the edge. These slightly oblique striations are often initiated near the edge and follow a path leading into the tool, overlapping each other (figure 23). Because these striations overlap in a criss-crossing manner, they are indicative of a sawing motion. The first striation type is indicative of the sickle being used in a cutting or sawing motion. This type of striation can occur with unidirectional cutting. As 90% of the striations recorded were of the overlapping type, I conclude that a sawing motion was the most commonly employed harvesting technique.

Even though much experimental research remains to be done before the interactions of the many variables behind the formation of polish on sickle blades
used for harvesting plants is fully understood, I believe that the results of Unger-Hamilton's (1983; 1985; 1989) and to a lesser extent Anderson-Gerfauds' (1983) experimental programs have allowed a number of tentative conclusions concerning the polishes and striations on the sample from Tabaqat al-Būma. The majority of denticulated sickle blades were used to harvest domesticated cereals planted on tilled soils. They were cut near their base with a sawing motion. It is possible that the comparatively "inflated" appearance of most polish formations indicates that the cereals were harvested before they were fully ripened.

**SEM Sickle Polish Observations**

The polish on eight sickle blades was observed using a SEM at magnifications between 50x - 400x. While no further observations were made concerning sickle polish and striations using this microscope, the increased depth of field and clarity of the magnified image made observation easier than with conventional optical microscopes.

5.4 Summary of the Sickle Blade Sample

Why, then, is there a shift to denticulated sickle blades in the Late Neolithic? Unger-Hamilton found that unretouched sickle blades were initially sharper than retouched sickle blades, but became blunt and unusable far more quickly. I believe the key to the shift to denticulated sickle blades lies in this observation. Denticulated sickle blades actually do not cut as well as an unretouched sickle blade, over the short run, when both blade types are new, but the denticulated sickle blades work within acceptable levels of efficiency and maintain that efficiency for a far greater period of time. Longevity of efficiency is the design feature that cereal farmers of the Late Neolithic valued. The window of opportunity for cereal harvesting is small: it needed to be exploited as quickly as
possible. An unretouched sickle would be efficient for a short period of time, but then grow dull and become unusable. A new set of sickle blades would have to hafted on to a handle – a time consuming occupation that the harvester could probably ill afford. By using denticulated blades, harvesting could proceed at a level of acceptable efficiency and continue to do so without the harvester having to discard the sickle elements. Moreover, if resharpening entails removing flakes by pressure-flaking from existing denticulations, this could be done speedily and in the field of harvesting activity.

Today, in this area of Jordan, small-scale cereal harvesting is still done with a sickle, albeit one made of mild steel and made in China. The dimensions of these modern sickles show remarkable similarities to their Neolithic antecedents. They are crescent shaped, which of course is not unusual, but they too have similar edge angles (25° to 30°) and a serrated edge. The steel edge of these tools would be sharper without the serrations but would be quickly blunted by the silica-rich cereal stems. The seller of these tools at a hardware store in the nearby town of Irbid informed me that the serrated edge on the modern tools makes it unnecessary to resharpen them. This may be an exaggeration, but the serrated edge design would mean that the efficient use of the tool would be extended considerably. The modern farmers who use these tools are harvesting cereals, although more modern strains, on a scale similar to that of Late Neolithic farmers. Even though these farmers are participants in a market economy with wage labour, they would also require an efficient tool to harvest their cereals without the delays and inconveniences caused by resharpening during the middle of the harvesting process. It would be logical, therefore, that the design features of their sickles would be along the same lines as Late Neolithic ones, but made using more contemporary raw materials.
Chapter 6  Summary and Conclusions of the Analysis of the Chipped Stone Sample from Tabaqat al-Bûma

Technology is not the sum of the artifacts, of the wheels and gears, of the rails and electronic transmitters. Technology is a system. It entails far more than its individual material components. Technology involves organisation, procedure, symbols, new words, equations, and, most of all, a mind set (Franklin 1990).

6.0 Introduction
The purpose of this thesis was to investigate the nature of a chipped stone assemblage from a Late Neolithic site, Tabaqat al-Bûma, in northern Jordan. At the outset of this research I outlined the four main issues for this analysis. First, what was the nature of chipped stone technology at this site? This has been presented in the preceding three chapters. Second, how does this technology articulate with the larger behavioral systems of Late Neolithic life at this site? Third, why were the chipped stone technologies from this period, the Levantine Late Neolithic, so different in approach and execution from those of preceding Neolithic periods? And last, what are the implications of the conclusions of this research for Neolithic technology at a wider level. The examination of these four issues represents the major contributions of this research to our understanding of Neolithic technology.

6.1 Late Neolithic Stone Tool Technology at Tabaqat al-Bûma
Stone tools from Tabaqat al-Bûma are made up of four lithic components, used unretouched basic flakes, minimally retouched basic flakes, formed flake tools and blade and bladelet tools. Of these, the most numerous are the basic flake tools.
These simple yet versatile tools are probably the most commonly made tools for a number of reasons. First, the nature of risk in the Late Neolithic had changed and many aspects of stone tool technology shifted to reflect this. Tabaqat al-Bûma was a small farmstead settlement and, as such, would probably have had to be largely autonomous, technologically and economically. In this it was very different from the larger contemporary sites. Larger late Neolithic sites were large enough to possibly allow some degree of craft specialisation. Here, at Tabaqat al-Bûma, the economic system was based on cereal cultivation with limited sheep and goat husbandry (Banning et al. 1994, Banning and Siggers 1997). The nature and extent of subsidiary hunting and foraging activities are unknown, but these appear to have made no more than a minor contribution to the economy. This limited emphasis on hunting is unlike many of the economies from the earlier Neolithic in this region. Because the risks associated with an economy that had a significant component made up of hunting are very different from the agro-pastoral economy at Tabaqat al-Bûma, it is not surprising that the tool technologies from different economies reflect this.

In the case of Tabaqat al-Bûma's economic system, where human labour was limited, the critical elements of risk were focused on various stages of the agricultural year, and, most importantly, on the storage of agricultural surplus. To gain a clearer understanding of the different stages of cereal production it may help to isolate them, and investigate where in this system various elements of the lithic tools may have been used. Figure 6.1 is a flow diagram of the various processes commonly associated with the small-scale production of cereal crops.
In addition to the cereal agricultural system, stone tools from this site would also have played important roles in other activities such as sheep and goat husbandry, the construction and maintenance of domestic architecture, and, most importantly, the undertaking of everyday domestic tasks in and around dwellings.

*Cereal and Pulse Agriculture*

1) **Tilling/Soil Turning.**

Tilling, undertaken to aerate the soil, usually in the spring, can be achieved by a number of methods. Perhaps the most likely method is with a digging stick with a beveled end, but a sharpened stick would also be suitable. To make these wooden tools utilised flakes and retouched flakes would be suitable. Lewenstein (1991) in her study of woodworking tools from the Mayan site of Cerros, was surprised to
discover that 67% of lithic tools that showed diagnostic traces of woodworking were utilised flakes. Considering the high proportion of basic flakes from the Tabaqat al-Bûma sample (75%), I believe that it is highly likely that many were used to make wooden tools such as digging sticks. Stone-tipped hoes could also have been used for tilling, but from this site at least, we only have one potential example (figure 4.1.2).

Although tilling is important, it is a relatively low-risk activity in that the length of time it takes is not too critical and failures are easily corrected.

2) Planting/Sowing

The planting of cereal grains was probably done using the "broadcast" technique; a method that requires no special tools to do, except a container technology to hold the seeds. These containers could have been made of hide, basketry or woven from wool or goat hair. Some of the wide-mouthed pottery vessels could also have been used. Although the risk of failure here would be critical, it entails the timing of sowing relative to early winter rains rather than the container technology itself. Construction of containers would occur in the off-season when there was adequate time for basket-weaving or pottery manufacture.

3) Tending/Weed Management

While cereal plants grow towards maturity, competing weeds will grow alongside them (Unger-Hamilton 1989). Usually they do not grow in sufficient quantity to jeopardize the health of the cereal crop. However, the weeds can be uprooted by hand or removed with digging sticks. This is a low-risk activity in that weeds overlooked on one occasion can always be removed later.

4) Reaping/Harvesting

This is the most critical phase of the agricultural year (Borowski 1987). The window of opportunity for harvesting can be narrow (Borowski 1987; Unger-Hamilton 1989). The critical economic importance of this stage of the agricultural cycle, and the limited
time frame in which it has to be accomplished, necessitates the application of a technological solution that enables the process to be carried out at speed and at a level of reliability that ensures success or, at least, minimises the chance of failure. The partial solution is the composite sickle with denticulated sickle elements hafted in a linear arrangement, which is reliable in that it can be used efficiently for much longer, without repair or resharpening, than an unretouched blade. However, the solution is not restricted to the tool, but includes the organisation of behaviours associated with its use.

5) Threshing and Winnowing
Threshing and winnowing are the sorting processes that separate the "wheat from the chaff." Threshing, the process that separates the seeds of cereals and pulses from their stalks, can be done by a number of methods (Watson 1979). One of the simpler methods is to beat bundles of stems against the ground until the seeds separate. More complex devices such as animal-drawn threshing sledges can also be used, but, as yet, there is no physical evidence of their use in the Levantine Late Neolithic (Rosen 1997; Ataman 1992; Whallon 1978). Winnowing, the final separation process, can be achieved with a sieve or, more commonly, with a wooden fork, which is used to pitch seeds and chaff into air, allowing a prevailing breeze to carrying the lighter chaff away and the heavier seed to fall to the ground. Sieves can be made from basketry and forks from wood (Watson 1979:82). Again, basic flakes would be suitable to make wooden threshing forks. The relative high level of design in a winnowing fork reflects the importance of avoiding failure here, as the crop must be winnowed and readied for storage before it is damaged. Unfortunately no Neolithic winnowing forks, assuming they existed, are known to survive.

6) Storage
After the harvest, storage is the most critical phase of the agricultural cycle (Torrence 1989). The successful storage of cereal grains and pulses ensures the survival of the
Figure 6.1   Illustration of basalt quern
site's inhabitants throughout the year, and also provides the seeds for planting the following year's crop. New technology was needed to keep the risks of storage within acceptable limits. Risks associated with the storage include rodents, insects, damp and mold. To minimise these risks, grains could have been stored in pottery vessels and/or in silos that were excavated close to the Late Neolithic structures (Banning et al. 1995; Banning and Siggers 1997). Because Late Neolithic communities such as Tabaqat al-Bûma focused on fewer resources than those from the preceding Neolithic periods, the risk of economic failure through damage to stores was intensified. Probably this risk contributed to the development of pottery technology.

7) Grain Processing
The processing of grain, turning the seeds to flour, was probably done with grinding technology (Wright 1993). Although pulses such as peas and lentils could also be made into flour, they may have been used unground, and processed by boiling. Two complete saddle querns (figure 6.1), and many quern fragments, made from basalt were recovered from the Neolithic deposits of Tabaqat al-Bûma. It is reasonable to assume that these were used for flour production even if grinding stones could also be used for other purposes. Grain could also have been used to make simple beer. Simple beers such as those recorded in Mesopotamia and Egypt offer many nutritional benefits and are easy to make (Carscallen 1992; Katz and Voigt 1986; Katz and Maytag 1991). A large limestone mortar recorded in area F33, could have been used to pound malted grains into flour, and some of the larger pottery vessels with restricted orifices would have been suitable for the fermentation process.

Animal Husbandry
Chipped stone tools probably also played important roles in the husbandry of sheep and goats at Tabaqat al-Bûma. The extent and nature of sheep and goat husbandry at the site are not clear, but the high percentages of ovis/capra bone
fragments indicate that sheep and goat stock-raising was a significant component of the subsistence system (Banning et al. 1994; Banning and Siggers 1997). Livestock were raised for their meat and probably also for secondary resources such as wool, goat hair, hides and dairy products (Flannery 1969; Watson 1979). Exploitation of wool or goat hair is indicated by the recovery of spindle whorls made from pierced disks of limestone and pottery shards. These could be manufactured with drills and flakes, and then be used to twist fibres into yarn.

Sheep and goat stock-raising would also provide a buffer against potential cereal crop failure thus reducing risk. Watson (1979), in her ethnographic studies from Iran, states that 200 head of sheep can be looked after by only a single individual, often an adolescent. As long as the herd was reasonably small, perhaps between 100 and 200 individuals, they could be adequately pastured on the flanks of the surrounding hills and on the stubble left over from the harvest (Banning and Siggers 1997). During the winter, it is likely that animal fodder would have to have been stored. In the case of Tabaqat al-Bûma, one or two members of the farmstead may have been involved with animal husbandry, while other members of the extended family unit focused on cultivation. The high proportion of ovis/capra bones partially explains the almost total absence of stone projectile points. If the farmsteaders at Tabaqat al-Bûma could adequately provide for their protein intake from stock-raising, their would be little need for the hunting of game. Stock raising provides secondary products that hunted game does not, and is also a form of meat storage: storage "on the hoof."

Stone tools could have been used in this pastoral system for a number of tasks. Wood-working tools could have been used to construct corrals to secure animals at night, and also during shearing and milking. Stone tools used for cutting tasks could also be used to shear sheep's wool and goat hair. Essentially any tool with a sharp edge, retouched or unretouched, would be adequate for this purpose. Henry (1995) has proposed that cortical "scrapers" may have been used to shear sheep. While this
assemblage has only one cortical scraper, and this piece was from a surface context, many of the unretouched and retouched flake tools have similar edge designs (steep angled convex edge, see section 3.2) to this tool type, and may also have been used for shearing. Similarly, blade tools would have been suitable for this purpose. In Iraq, as recently as sixty years ago, obsidian blades were occasionally used to shear sheep (Mallowan 1977).

Stone tools would also have been used for livestock butchery and hide preparation. These tasks, however, involve a low degree of risk – the chances of task failure are low. Because stock-raised animals are usually corralled, the risks associated with hunting (Hutchings 1991; Torrence 1989; Wiessner 1982) no longer apply. Animals can be slaughtered and butchered as the need arises. As the design requirements for cutting and scraping stone are straightforward – a sharp cutting edge and a dulled scraping edge respectively – it is therefore likely that the tools used to undertake them are basic flakes; many of these have design criteria more than adequate for these activities.

Land Clearance. Lumber Acquisition and Architecture

Chipped stone axes and adzes were probably used to clear forests for arable land near the site. The lumber from this process could be used for house construction. The single-room rectangular structures at Tabaqat al-Bûma are built with three to five courses of fieldstones and mud (Banning and Siggers 1997) but would have also required some timber framework and roofing which was probably worked with chipped stone axes, adzes and other wood-working stone tools. Land clearance may also have been done with the use of controlled fire (Steensburg 1980). Formed wood-working tools like axes and adzes are comparatively rare in the stone tool sample.

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1 However, stock-raising does present new risks, most notably the risk of epidemic disease, which can cause heavy losses within a herd.
This may be due to the fact that once land had been cleared for farming and the living structures were completed, there was need for only a limited number of these tools at a small farmstead settlement. Once land clearance and house construction had been undertaken, lumber was needed for wooden tools, fuel and perhaps fencing for corrals. Only a few hafted axes and adzes would be required to fulfill these wood-working requirements. These tool types have a high level of design so they can carry out the tasks for which they were intended. Axing and adzing wood require tools with fairly strict design parameters if they are to perform.

6.2 Discussion of Stone Tools in the Technological System at Tabaqat al-Bûma

The stone tool sample does contain some formed specialised tools, most notably sickle blades. There are also limited numbers of formed tools such as burins and awls (9% of the tool sample). Obviously some tasks required tools that were specifically designed for the purposes for which they were intended. In these cases, it may be that basic flake tools simply did not have the design requirements to undertake the intended tasks. Some basic flakes, especially those that have undergone a minimum of retouch, can be used to engrave and drill like burins and awls. However, as these basic flakes are not designed for these specific functions, it is possible that they could not undertake the task to required standards regardless of the amount of time employed. In these cases, formed tools specifically designed for these tasks would have to be manufactured. For example, if a basic flake had a morphology with a pointed tip, it could be used to drill a hole in material such as wood or bone, but it could only drill a fairly shallow hole. If a deeper hole was required, such as the holes found on the recovered drilled bone and pottery fragments, a formed awl or drill would be required.

However, in many respects the lack of formed tools in the sample is a testimony to the versatility of basic flake technology. The limited numbers of formed tools (25%)
could indicate that the tool users at Tabaqat al-Bûma only had to resort to formed tools for a limited number of tasks. It is possible, also, that the low recovery of formed tools is due to activity patterning. The excavation of Tabaqat al-Bûma was primarily concerned with the occupation site itself, particularly the areas in and immediately around the Late Neolithic architecture. As the sample of stone tools was selected from the most securely undisturbed contexts, much of the material was from living surfaces near or in the structures. If basic flakes make up the majority of the sample from these areas, it is possible that they reflect the activities taking place there. Perhaps tasks that required specialised formed tools more often took place off-site, and many of the formed tools that were used were not recovered. This scenario still does not explain, however, the high recovery rate of the most numerous formed tool type, the denticulated sickle blade. These sickles were obviously used off-site, and yet are present in significant numbers in and around the household units. Burins and awls may have been used off-site, but were just as likely to be used on-site.

The nature of stone tools from the Tabaqat al-Bûma seems to point to a closed technological system. The tools that were required were made by the inhabitants. This settlement appears to have been a largely self-sufficient unit. This is not to say that the inhabitants of Tabaqat al-Bûma were not in contact with other Late Neolithic settlements. Stylistic similarities in architecture, pottery and lithic technology points to some degree of regional interaction, but the technological equipment needed for this settlement to function could all be made by its occupants. The pottery assemblage seems to corroborate this observation (Banning et al. 1994; Banning and Siggers 1997). The pottery from this site appears to be made on site, and is, like the stone tool assemblage, of a utilitarian aspect. The forms are simple and poorly fired, and this is indicative of a relatively new technology that has not been fully developed. Indeed, as pottery is a technological achievement of the Late Neolithic, it is likely that some of the design expenditure previously channeled into lithic technology was, at least
partially, redirected into this new technology (Banning and Siggers 1997). The design transfer to pottery in the Late Neolithic is particularly critical because of the role it played in food storage and processing in a site occupied year round, and in a subsistence economy that concentrated on a limited number of resources.

The stone tool technology of the Levantine Late Neolithic in many ways encapsulates the technological expertise of the lithic technologies that preceded it, with some additions, such as polished and ground stone technology. In short, the people of the Late Neolithic were aware of the full range of prehistoric stone tool technology and able to adapt it to their own particular needs and circumstances. This body of stone tool expertise would have varied from settlement to settlement, depending on what was required of it. Perhaps the formalisation of tool technology increases as the size of the settlement increases. In theory, in larger settlements one may expect increasing craft specialisation to play an increasing role in the standardisation of stone tool technology, but Rosen (1997) has indicated that, while this observation is partially true, basic flake technology continues to be a significant component of technology from the Early Bronze Age through to the early Proto-historic period, when settlements were relatively large. Interest in the stone tool use in the Metal Ages in the Levant is comparatively recent, and much work remains to be done to clarify the nature of continuing stone tool use during these periods (Rosen 1997).

In the case of Tabaqat al-Bûma, the size, economy, and nature of this Neolithic farmstead helps explain the chosen stone tool technology. The settlement was small, with only one or two conjugal family units. The inhabitants practiced a limited agro-pastoral economy that produced resources for internal consumption, storing cereal grain surplus for the lean periods of the year and replanting in the following year. Sheep and goat husbandry was practiced to obtain protein, to exploit pastoral secondary products and to act as a resource buffer in times of economic stress. It also negated the need for hunting; a practice that is time-consuming, risky and usually necessitates at
least a partially mobile life-style. The inhabitants of Tabaqat al-Bûma appear to have been self-sufficient in their needs. Shelter, nutrition and clothing were all potentially available by their chosen settlement mode, group size and technological system. It is the interactions of these components to form a larger system that allowed the inhabitants of this site to succeed. It also, as mentioned above, provides the key to understanding the nature of their chosen stone tool technology.

6.3 Conclusion
After considering the above factors, it becomes apparent that the most plausible explanations for the chosen lithic technology at Tabaqat al-Bûma cannot be found by studying the tools alone, but by examining how technology operates within the larger behavioral system at the site. The results of the analysis of the stone tool sample clearly indicates a dichotomous approach to stone tool technology. On the one hand the majority of tools were made from simple basic flakes; on the other, there was a limited selection of formed tool types.

Part of the explanation of the "rude" appearance, as Late Neolithic assemblages have been characterised, may well be due, in part, to the self-sufficiency of a small settlement such as the one at Tabaqat al-Bûma. Self-sufficiency, especially when labour is limited, requires that a community sets priorities. The activities that entail the greatest degree of risk are the ones that will receive the highest priority. If, as is the case at Tabaqat al-Bûma, a settlement has focused on cereal production and sheep and goat husbandry, in many cases the tools associated with the riskiest components of these food production systems will have a greater degree of design to minimise failure. This equation of the tools used to undertake tasks entailing the greatest degree of risk having the greatest degree of design investment, is epitomised in the denticulated sickle blades. Activities that do not entail a high degree of risk can be done using simpler tools, such as basic flakes, that are simple to use and versatile.
In addition, further explanation of the nature of the tool sample can be provided by considering the scheduling of activities. Many of the wooden agricultural tools needed to undertake tasks at Tabaqat al-Bûma could have been made during the agricultural off-season. During this period, time would not be at a premium and basic flakes could be used to make many of them. The majority of routine cutting and scraping activities, such as butchering and hide preparation, were not temporally critical, and could therefore be achieved by using basic flake tools with little or no retouch.

The Late Neolithic occupation of sites such as Tabaqat al-Bûma was dramatically different from earlier Neolithic occupations. Critical risk is largely encapsulated in subsistence systems that are focused on growing a limited number of cereal crops and some pulses, such as lentils, peas and vetch, and sheep and goat husbandry. The successful storage of cereal produce is of vital importance to the viability of these small farmstead settlements. Therefore, design expenditure would have shifted away from some elements of the stone tool assemblage, and been transferred into storage systems such as silos and pottery once agriculture had largely replaced hunting and gathering as the core of the subsistence economy.

6.4 Some Implications of the Conclusions of this Research and Future Research on the Stone Tools of the Levantine Late Neolithic

As I mentioned in Chapter 2, the so called "decline" in stone tool technology in later prehistory is not restricted to the Levant. Similar technological changes occur in Britain (Pitts and Jacobi 1979 and Bradley 1987), in the Late Woodland in North America (Jeske 1989; Parry and Kelly 1987), and in many parts of Southeast Asia during the Hoabhinian (Bellwood 1986). The findings of this research would suggest that traditional explanations of technological "devolution" are inaccurate, and that a more plausible direction of explanation would be the analysis of how
much lithic technological change is due to changing demands that shifts in settlement and socioeconomic practices place on it. The "unstandardisation" of stone tools in each of these instances probably has more to do with changes in the expectations of technology caused by key shifts in settlement patterns and subsistence strategies, as is seen in the Levant.

This research also provides a starting point for further research on the nature and use of stone tools from the Levantine Late Neolithic. While this analysis has offered insights into the technological rationale of the Late Neolithic at one site, further analysis of material from other environmental and economic contexts from Levantine Neolithic sites is needed to explore this issue comprehensively. For many years the political climate in the southern Levant has hindered the interaction of Jordanian and Israeli scholars. Now that this is no longer the case, the time is ripe to undertake comparative analyses of the stone tools from Late Neolithic sites in Israel and Jordan. Many, but not all, of the excavated Neolithic lithic assemblages from this region are compromised because large numbers of flake tools were not at the time recognised as such, so they were discarded. Future excavation strategies should acknowledge the potential for all flakes to be tools until examined for microscopic traces of use.

In addition, much work remains to be done to investigate the nature of stone tool production, use and the technological mind-set in different environmental contexts at a small-scale, regional level. Further work must also be done to investigate the different applications of Late Neolithic stone tool technologies in settlements of different sizes. It is quite likely that the application and nature of stone tool technologies in larger settlements was markedly different from those employed at smaller farmstead settlements such as Tabaqat al-Bûma.

Finally, this research was unable to employ comprehensive use-wear analysis to explore how tools within the larger tool categories were used. As
discussed in the last chapter, use-wear analysis is problematic for Late Neolithic samples of this nature. Many of the basic flakes were probably used on more than one material and in different motions. Moreover, the post-depositional movement that much Late Neolithic material undergoes precludes confident use-wear analysis. However, with a modicum of archaeological serendipity, future research may provide Late Neolithic stone tool samples more appropriate for more detailed use-wear analysis. Such work has the potential to help clarify this issue considerably.
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*Paléorient* 4: 319 - 324.


Appendix I

Observations of the Stone Tool Sample From Tabaqat al-Bûma
Database Syntax for Tool Types
(After Bar-Yosef 1970; Tixier et al. 1983)

<table>
<thead>
<tr>
<th>Tool Type</th>
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<tbody>
<tr>
<td>1) Cores</td>
<td>000-099</td>
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<tr>
<td>2) Blade tools</td>
<td>100-199</td>
</tr>
<tr>
<td>3) Flake tools</td>
<td>200-299</td>
</tr>
<tr>
<td>4) Core tools</td>
<td>300-399</td>
</tr>
<tr>
<td>5) Debitage</td>
<td>400-499</td>
</tr>
</tbody>
</table>

1) Cores
- Single platform blade core 001
- Pyramidal blade core 002
- 90% platform blade core 003
- Opposed platform blade core 004
- Multi platform blade core 005
- Single platform bladelet core 006
- 90% platform bladelet core 008
- Opposed platform bladelet core 009
- Multi platform bladelet core 010
- Single platform flake core 011
- Pyramidal flake core 012
- 90% platform flake core 013
- Opposed platform flake core 014
- Multi platform flake core 015
- Discoidal flake core 016
- Discarded flake core 017

2) Flake Tools
- Used unretouched flake 100
- Retouched flake 101

3) Blade and Bladelet tools
- Used unretouched blade 200
- Unused unretouched blade 201
- Used unretouched bladelet 203
- Unused unretouched bladelet 204
- Partly retouched blade 205
- Completely retouched blade 206
- Blade retouched on both lateral edges 207
- Backed blade 208

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1 General outline as follows:
<table>
<thead>
<tr>
<th>Tool Type</th>
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<tr>
<td>Partially backed blade</td>
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<tr>
<td>Backed blade fragment</td>
<td>210</td>
</tr>
<tr>
<td>Retouched blade fragment</td>
<td>211</td>
</tr>
<tr>
<td>Blade fragment</td>
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<tr>
<td>Endscraper on a blade</td>
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</tr>
<tr>
<td>Double endscraper on a blade</td>
<td>214</td>
</tr>
<tr>
<td>Unretouched sickle blade</td>
<td>215</td>
</tr>
<tr>
<td>Backed sickle blade</td>
<td>216</td>
</tr>
<tr>
<td>Backed and denticulated sickle blade</td>
<td>217</td>
</tr>
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<td>Burin on a truncation: straight</td>
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</tr>
<tr>
<td>Burin on a truncation: concave</td>
<td>219</td>
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<tr>
<td>Burin on a truncation: convex</td>
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<td>Burin on a break</td>
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<td>Transverse burin</td>
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<td>Multiple burin</td>
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<td>Perforator on a blade</td>
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<td>Double perforator on a blade</td>
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<tr>
<td>Drill bit</td>
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<tr>
<td>Partially retouched bladelet (lateral edge)</td>
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<td>Completely retouched bladelet</td>
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<td>Obliquely truncated bladelet</td>
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<td>Bladelet Fragment</td>
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<tr>
<td>Backed bladelet fragment</td>
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<td>Retouched bladelet fragment</td>
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222
# Database Syntax for Observations of the Stone Tool Sample

*(After Tixier et al 1983)*

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Figure 7.1  Outline Morphology Types of Flake Tools – Dorsal View
(After Knudson 1973:187)

A) Parallel sided, square or long  
B) Distally expanding

C) Distally contracting  
D) Long oval

E) Round  
F) Width > Length

G) Indeterminate
Key for the abbreviated titles of the data spread sheets

Artifact No.  The site number of the lithic artifact\(^1\)
Max. L.    Maximum tool length
Max. W.    Maximum tool width
Max. H.    Maximum tool height
E. Angle  Edge angle
B. Type   Backing type
Ret. Type  Retouch type
Ret. Ext.  Backing type
Ret. Pos.  Retouch position
Ret. Loc.  Retouch location
No. of R.  No. of ridges
Butt L.    Butt length
Butt W.    Butt width
Geo. Cond. Geological condition
% of tool  Percentage of tool recorded
Tool Cat.  Tool category
No. of Dent No. of sickle blade denticulations
Trunc. T   Type of sickle blade truncation
Pol. Sides Which surface (s) of the sickle blade exhibit polish
S. of > P  Which surface exhibits greater polish
E. Round  The degree of sickle blade edge rounding
C-Sect    Type of sickle blade cross-section

\(^1\) The artifact number also contains the archaeological provenience of each artifact. Each number is made up of three units of data that are separated by periods. The first, which starts with a capital letter, refers to the area from which the artifact came (see figure 1.3). The second refers to the bag number in which the artifact originates. The bag number refers to a 3-dimensional volume of sediment which goes, in part, to make up a locus. A locus is a single depositional episode which is spatially discrete (Blackham 1994:11). It can include such archaeological events as sediments, facies, interfaces, pits, rock features, walls or burials (Blackham 1994:8). The final number is the number given to the artifact itself.
## Appendix I  Observations of the Stone Tool Sample from Tabaqat al-Bûma

<p>| G34.40.14  | 101.1 | 65  | 36  | 15  | 2.2 | 35* | 5  | 1  | 2  | 16 | 1 |
| G34.40.85  | 101.1 | 38  | 22  | 6   | 1.1 | 38  | 1  | 4  | 1  | 1  | 17 | 1 |
| E34.46.20  | 101.1 | 45  | 34  | 10  | 4.2 | 28* | 9  | 2  | 1  | 9  | 1 |
| E35.09.14  | 101.1 | 51  | 25  | 8   | 3.2 | 24  | 3  | 5  | 1  | 1  | 1* | 1 |
| E35.05.17  | 101.1 | 35  | 21  | 5   | 5.2 | 48  | 5  | 1  | 2  | 15 | 1 |
| G35.14.32  | 101.1 | 50  | 36  | 11  | 1.1 | 42  | 5  | 2  | 3  | 19 | 1 |
| G35.37.09  | 101.1 | 64  | 41  | 24  | 4.2 | 42  | 7  | 4  | 5  | 3  |
| G34.39.52  | 101.1 | 26  | 20  | 6   | 1.1 | 72  | 5  | 3  | 1  | 5  | 3 |
| H34.34.12  | 101.1 | 35  | 21  | 7   | 4.1 | 50  | 5  | 3  | 1  | 19 | 1 |
| G35.48.22  | 101.1 | 50  | 28  | 17  | 1.1 | 55  | 5  | 2  | 3  | 15 | 1 |
| G34.40.141 | 101.1 | 25  | 16  | 5   | 4.3 | 55  | 4  | 2  | 1  | 1* | 1 |
| G34.39.59  | 101.1 | 53  | 45  | 24  | 2.2 | 70  | 9  | 3  | 1  | 18 | 1 |
| F33.03.32  | 101.1 | 62  | 38  | 10  | 2.1 | 50  | 5  | 3  | 1  | 17 | 3 |
| E36.21.20  | 101.1 | 82  | 47  | 17  | 4.2 | 40  | 5  | 1  | 1  | 18 | 1 |
| F33.14.98  | 101.1 | 26  | 24  | 5   | 5.1 | 65  | 5  | 1  | 1  | 18 | 1 |
| E33.09.22  | 101.1 | 59  | 52  | 18  | 4.2 | 70  | 5  | 2  | 1  | 14 | 1 |
| E33.34.16  | 101.1 | 29  | 20  | 6   | 1.1 | 32  | 4  | 2  | 1  | 18 | 1 |
| E32.15.21  | 101.1 | 35  | 28  | 7   | 2.2 | 55  | 5  | 1  | 1  | 19 | 1 |
| F34.57.05  | 101.1 | 28  | 15  | 14  | 1.1 | 58  | 5  | 2  | 2  | 17 | 1 |
| E35.09.10  | 101.1 | 47  | 34  | 10  | 3.1 | 75  | 5  | 2  | 2  | 17 | 1 |
| F33.04.89  | 101.1 | 38  | 34  | 12  | 4.1 | 40  | 5  | 1  | 1  | 18 | 1 |
| E33.16.31  | 101.1 | 47  | 34  | 6   | 4.2 | 35  | 5  | 2  | 1  | 3  | 1 |
| F34.65.06  | 101.1 | 25  | 20  | 8   | 3.1 | 35  | 5  | 1  | 2  | 1* | 1 |
| F33.26.26  | 101.1 | 45  | 30  | 11  | 1.1 | 52  | 5  | 1  | 1  | 1* | 1 |
| E32.01.44  | 101.1 | 81  | 50  | 22  | 4.2 | 39  | 5  | 3  | 3  | 19 | 1 |
| F33.13.20  | 101.2 | 39  | 30  | 11  | 2.1 | 38  | 5  | 2  | 3  | 1* | 1 |
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| G35.48.30  | 101.2 | 25  | 40  | 13  | 2.1 | 76  | 5  | 3  | 1  | 5  | 3 |
| E33.11.27  | 101.2 | 47  | 32  | 11  | 4.1 | 73  | 5  | 3  | 1  | 18 | 1 |
| F33.12.34  | 101.2 | 48  | 37  | 12  | 4.1 | 70  | 5  | 2  | 1  | 14 | 2 |
| G34.40.56  | 101.3 | 34  | 22  | 12  | 1.2 | 34  | 6  | 2  | 1  | 14 | 2 |
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| E33.34.12  | 101.3 | 43  | 20  | 6   | 5.1 | 74  | 5  | 2  | 2  | 16 | 1 |
| G34.39.66  | 101.3 | 57  | 42  | 16  | 2.2 | 35  | 5  | 1  | 2  | 11 | 1 |
| F33.13.19  | 101.3 | 49  | 24  | 10  | 1.2 | 60  | 5  | 2  | 1  | 1* | 1 |
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**Appendix 1**

Observations of the Stone Tool Sample from Tell el-Burha
# Appendix I  Observations of the Stone Tool Sample from Tabaqat al-Būma

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Observations of the Nile Delta Blade from Tabaqual al-Buma