CHRONOLOGICAL FRAMEWORKS AND DISPARATE TECHNOLOGY : AN EXPLORATION OF CHIPPED STONE VARIABILITY AND THE FORAGER TO FARMER TRANSITION AT 'IRAQ ED-DUBB, JORDAN

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Abstract : *This report presents a detailed analysis of the chipped stone assemblages from the Late Natufian and Pre-Pottery Neolithic A (PPNA) occupations of 'Iraq ed-Dubb, Jordan. Excavations recovered artifacts from radiocarbon dated deposits from both periods, and in light of the relatively brief occupational hiatus between occupations, it is important to assess the degree to which the spatial distribution and frequency of diagnostic tool forms were influenced by site formation processes. Our contextual analysis of site and sub-sample scale collections provide important insights into occupational history. The horizontal and vertical distribution of diagnostic tool forms illustrate that while some diagnostic tools, such as projectile points and hagdud truncations, co-occur in PPNA levels, others such as lunates are generally found in the stratigraphically deeper Late Natufian layers. Co-occurrence of some tool types is a by-product of mixing of cultural deposits, probably through the construction of semi-subterranean structures by PPNA people and by bioturbation.*

Résumé : *Est présentée ici une analyse détaillée de l'industrie lithique des occupations du Natoufien final et du PPNA d''Iraq ed-Dubb, Jordanie. Les fouilles conduites sur ce gisement ont permis de recueillir des artefacts provenant de dépôts datés par le radiocarbone, les uns se situant avant, les autres après la transition chasseurs-cueilleurs/producteurs ; un hiatus a été constaté dans l'occupation du site entre les deux. Aussi est-il apparu important d'estimer à quel point aussi bien la présence de certains outils diagnostiques que l'industrie dans son ensemble avaient pu être affectées à 'Iraq ed-Dubb par les processus de formations sédimentaires ayant façonné le site ; par ailleurs dans quelle mesure des associations d'artefacts et certaines formes diagnostiques peuvent réellement s'identifier à des dépôts bien définis culturellement. Deux sujets sont traités : d'une part, les résultats apportés par la description des outils taillés d''Iraq ed-Dubb ; d'autre part, une étude approfondie de leurs contextes, l'idée étant d'apprécier dans quelle mesure ces derniers peuvent aider à comprendre l'histoire de l'occupation de ce site. Cette analyse des contextes a été conduite à deux niveaux : l'un, à l'échelle du site ; l'autre, plus restreint a été limité à l'étude d'échantillons choisis spécifiquement. Cette recherche portant sur la distribution des outils diagnostiques fut conduite à la fois horizontalement – analyse spatiale – et verticalement – analyse stratigraphique –. Elle a montré que des formes spécifiques – pointes de projectile, troncatures Hagdud – apparaissent ensemble dans les niveaux PPNA ; les segments de cercle, eux, sont attestés dans les niveaux stratigraphiquement les plus profonds (Natoufien final). Leur association résulterait d'un mélange causé par la construction de maisons semi-souterraines par les groupes humains PPNA et les perturbations qu'elles ont pu engendrer. Cette contribution prend en compte la technologie de débitage, celle liée au façonnage des outils, la variabilité typologique des outils, les différences constatées dans la répartition des outils entre le Natoufien final et le PPNA, périodes qui sont critiques.*

Key-Words : *Lithic technology, Natufian, Pre-Pottery Neolithic, Levant, Jordan.*
Mots Clefs : *Technologie lithique, Natoufien, PPNA, Levant, Jordanie.*

Manuscrit reçu le 10 mai 2005, accepté le 21 juin 2006

The transition from foraging to agricultural food production economies in the Near East represents a dramatic change in settlement systems, economy, and social changes in human communities. A number of researchers[1] have noted that in the Near East this transition occurs from the Natufian to the Pre-Pottery Neolithic A periods. The Natufian can be divided into two facies where the Late Natufian is characterized by a reversion to a more mobile adaptive system, with smaller and less substantial residential architecture when compared to the Early Natufian[2]. These researchers argue that deteriorating climatic conditions made it economically advantageous for humans to exist in smaller and more mobile groups in the Late Natufian. They also note that depending on the region, this period is characterized by people utilizing settlements that were occupied on a seasonal or a semi-sedentary basis.

After the Late Natufian, semi-sedentary / sedentary communities emerged in the Pre-Pottery Neolithic A (PPNA) by around 11 500 cal. BP[3]. These communities were larger with an increased economic focus on the control of wild plants and animals. While characterized by new lithic tool types, there are a number of broad similarities in lithic technology between these two periods. Despite the considerable amount of archaeological research that has explored the Late Natufian and Pre-Pottery Neolithic A (PPNA), researchers continue to actively debate the extent to which some tool types and systems of reduction were shared during both periods of time. At least part of this confusion is linked to the lack of well-dated single component archaeology sites from this period.

The site of 'Iraq ed-Dubb is one of only a few sites in the Mediterranean Zone of the southern Levant identified with both Late Natufian and PPNA occupations that contains well dated cultural materials attributed to each period, and that cover the economic transition from the Late Natufian forager-collectors to Early Neolithic forager-farmers (fig. 1). This study addresses the trajectory and character of lithic technology during foraging to farming transition. The excavation of 'Iraq ed-Dubb recovered a significant number of lithic artifacts from the combined Late Natufian and the Pre-Pottery Neolithic A period occupations (table 1). This includes various geometric and non-geometric microliths, El-Khiam and Salibiya projectile points, and Hagdud truncations. Moreover, research by Kuijt[4] on the stratigraphic and radiocarbon calibration data illustrate that there is a significant temporal gap between the Late Natufian and PPNA occupations at 'Iraq ed-Dubb (fig. 2). The initial publication of the early results of this

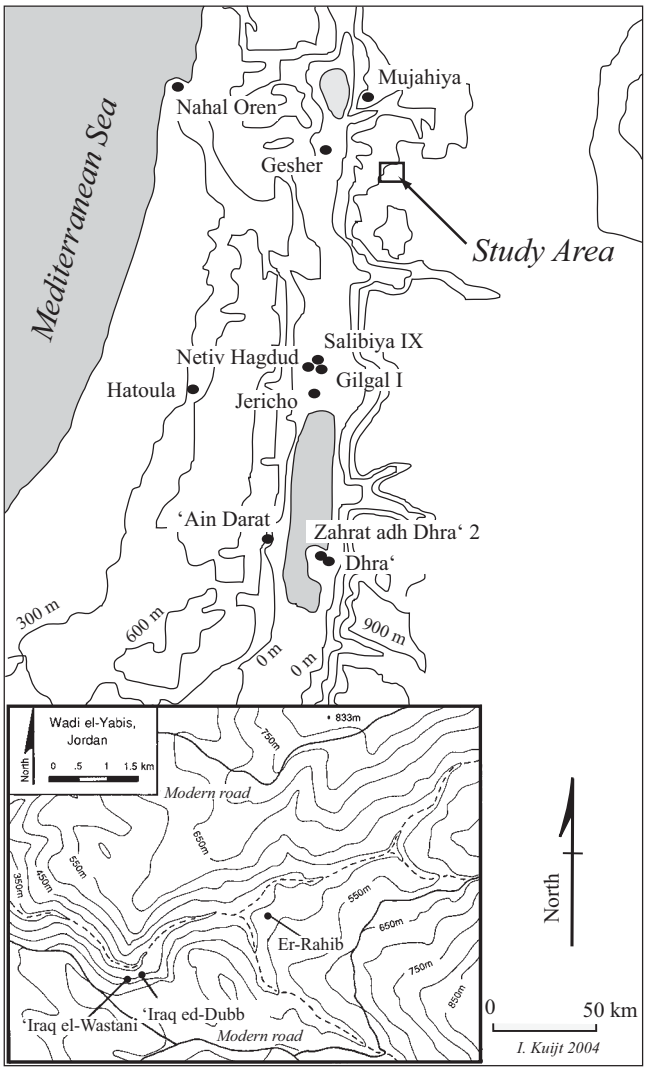

Fig. 1 : *Location of "Iraq ed-Dubb.*

1. BAR-YOSEF, 1998 ; GORING-MORRIS and BELFER-COHEN, 1998 : 80-82 ; HENRY, 1989 ; MUNRO, 2004.

2. Researchers debate if the Natufian should be sub-divided into two or three facies. Traditionally the Natufian has been divided into the Early Natufian (*ca* 15 000-13 500 cal. BP) and Late Natufian (*ca* 13 500-*ca* 11 500 cal. BP). Alternatively VILLA (1982) and GORING-MORRIS and BELFER-COHEN (1998) argue that the Natufian period should be envisioned as consisting of the Early Natufian (*ca* 15 000-13 500 cal. BP), the Late Natufian (*ca* 13 500 – 12 700 cal. BP) and the Final Natufian (*ca* 12 700 - *ca* 11 500 cal. BP). In our view there are merits to both arguments. For the purposes of this paper we use the general label of Late Natufian, but would like to stress that in using this label we are not discounting proposed revision of Natufian culture historical framework. In many ways, the Natufian occupation of 'Iraq ed-Dubb supports the economic and settlement characteristics of the Final Natufian.

3. BAR-YOSEF, 2000 ; KUIJT and GORING-MORRIS, 2002.

4. KUIJT, 2004.

Table 1 : *Frequency and percentage of individual tool classes, all areas, 'Iraq ed-Dubb, Jordan.*

Tool Group	General Tool Category Count (%)	Specific Tool Category Count (%)
Projectile Points	**80 (7.3)**	
Points, El-Khiam		41 (3.7)
Points, Jordan Valley		14 (1.3)
Points, Salibiya		7 (0.6)
Points, unknown		18 (1.6)
Scrapers	**49 (4.5)**	49 (4.5)
Burins	**20 (1.8)**	20 (1.8)
Non-Geometric Microliths	**236 (21.4)**	
Bladelets, with retouch		66 (6.0)
Bladelets, backed		47 (4.3)
Bladelets, obliquely truncated		18 (1.6)
Bladelets, obliquely truncated and backed		21 (1.9)
Bladelets, Helwan		2 (0.2)
Bladelets, retouched fragments		51 (4.6)
Bladelets, backed fragments		31 (2.8)
Geometric Microliths	**320 (29.0)**	
Lunates, asymmetric		63 (5.7)
Lunates, backed		224 (20.3)
Lunates, Helwan		8 (0.7)
Triangles		19 (1.7)
Rectangles, Trapezes		6 (0.5)
Retouched Blades	**147 (13.3)**	
Blades, retouched		122 (11.1)
Backed and truncated blades		8 (0.7)
Blades, retouched/backed fragments		17 (1.5)
Sickle Blades	**21 (1.9)**	
Sickle blades, un-retouched		8 (0.7)
Sickle blades, backed		13 (1.2)
Perforators/awls	**30 (2.7)**	30 (2.7)
Notches & Denticulates	**28 (2.5)**	28 (2.5)
Bifacial Tools	**3 (0.2)**	3 (0.3)
Truncations	**162 (14.7)**	
Hagdud truncations, concave base		46 (4.2)
Hagdud truncations, rectangular		116 (10.5)
Varia	**6 (0.5)**	6 (0.5)
Total	**1102 (100)**	**1102 (100)**

excavation[5] provided a brief overview of the range of materials that were recovered. As an initial report, however, this overview was put forth before completion of radiocarbon dating, detailed stratigraphic analysis, and the broader excavation program. With the completion of these additional studies[6], and an on-going detailed study of the spatial distribution of materials from 'Iraq ed-Dubb[7], it is now possible to provide a detailed analysis and interpretation of the recovered materials from this site as well as the two major occupation periods represented.

In this paper we address two topics. First, we present the descriptive results of the lithic analysis of the chipped stone tools from 'Iraq ed-Dubb. Second, we undertake a contextual analysis to assess if this aids us in understanding the occupational history of this site. The contextual analysis is conducted on two levels : that of the broader site-level assemblage and analysis of specific sub-samples. Exploration of the horizontal and vertical distribution of diagnostic tool forms illustrate that specific tool forms occur in different radiocarbon dated levels and are from different periods. To make this argument we first present a coarse-grained overview of the general lithic assemblage from 'Iraq ed-Dubb and from select general areas, such as deposits inside of residential structures. This level of analysis, both in form and organization, is similar to traditional site-level treatments of a collective lithic assemblage, as this combines materials from multiple components of an archaeological site. Second, we present a fine-grained analysis of lithic materials from discrete cultural layers from 'Iraq ed-Dubb to illuminate distinctive patterns between the Late Natufian and PPNA components. This analysis is guided by radiometric and stratigraphic analysis. As should be expected in a settlement inside of a cave, field excavation and our laboratory analysis identified disturbance from modern occupations and bioturbation, as well as evidence for mixing of sediments and cultural materials with the construction of PPNA features and structures[8]. This issue is addressed in forthcoming spatial research focusing on distinguishing strata containing Late Natufian and PPNA lithic assemblages[9].

The analyses presented in this report are multi-level, considering both the site level (which combines materials from multiple periods), as well as contextual, which in some cases

5. KUIJT *et al*., 1991.
6. See KUIJT, 1994 and 2004.
7. GOODALE and KUIJT, in prep.
8. For further consideration of cave site formation processes readers are directed to VILLA, 1982 and VILLA and COURTIN, 1983.
9. GOODALE and KUIJT, in prep.

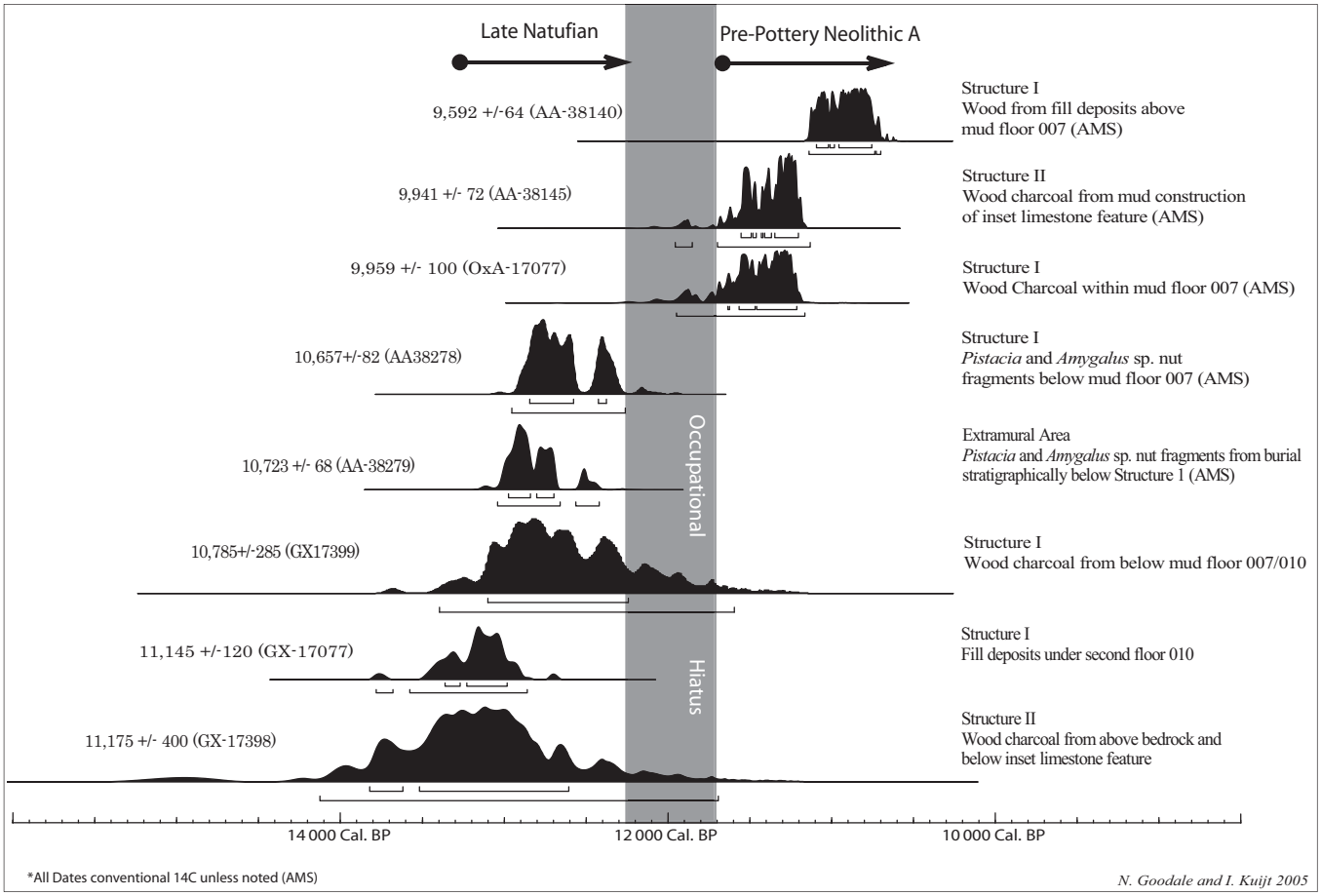

Fig. 2 : *The calibrated radiocarbon chronology for 'Iraq ed-Dubb.*

contain material from a single period and at times a mixture of materials. In light of anthropomorphic and biogenic processes, it is not always possible to identify or determine if specific items are intrusive in an earlier or later occupation, or if spatial patterning was linked to refuse behavior and site abandonment[10]. In several cases, however, it is possible to determine that specific deposits are from either the PPNA or Late Natufian. Bearing this in mind, in this paper we explore how intact deposits can inform us as to the degree of mixing that has occurred in other areas, and in a more general sense, consider how this informs us about the prehistoric sequence at 'Iraq ed-Dubb and lithic technology of the forager-farmer transition.

10. HARDY-SMITH and EDWARDS, 2004.

BACKGROUND RESEARCH AT 'IRAQ ED-DUBB

'Iraq ed-Dubb is located approximately 7 km northwest of Ajlun in Wadi el-Yabis. The cave of 'Iraq ed-Dubb is one of several caves and rock shelters along a limestone escarpment 150 m above the extensively vegetated part of the Wadi el-Yabis (fig. 1). The site encompasses approximately 150 m^2 within the cave, and the terrace at the mouth of the cave is about twice this size. At the time of excavation the cave floor was covered in goat dung, indicating that the site had been utilized as a temporary or seasonal animal holding pen in modern times. Excavation methodology for the site incorporated a technique commonly employed for Paleolithic sites to understand the complex stratigraphy of the site and to facilitate the thorough recording of this multi-component site. A 4 x 4 m arbitrary grid was placed on the inside and outside of the cave. Each 4 x 4 m

was subdivided into sixteen 1 x 1 m squares that were then further subdivided into four 50 by 50 cm units. Excavation took place within natural cultural strata and horizontal placement as well as arbitrary 5 cm levels. All sediments were screened with 2 mm mesh and all materials were collected.

The project exposed and excavated the remains of two oval stone structures within the cave (fig. 3). Although natural and anthropogenic processes have mixed some of the cultural sediments, intact deposits were dated indicating that the upper deposits date to the Pre-Pottery Neolithic A (11 700 / 11 500-

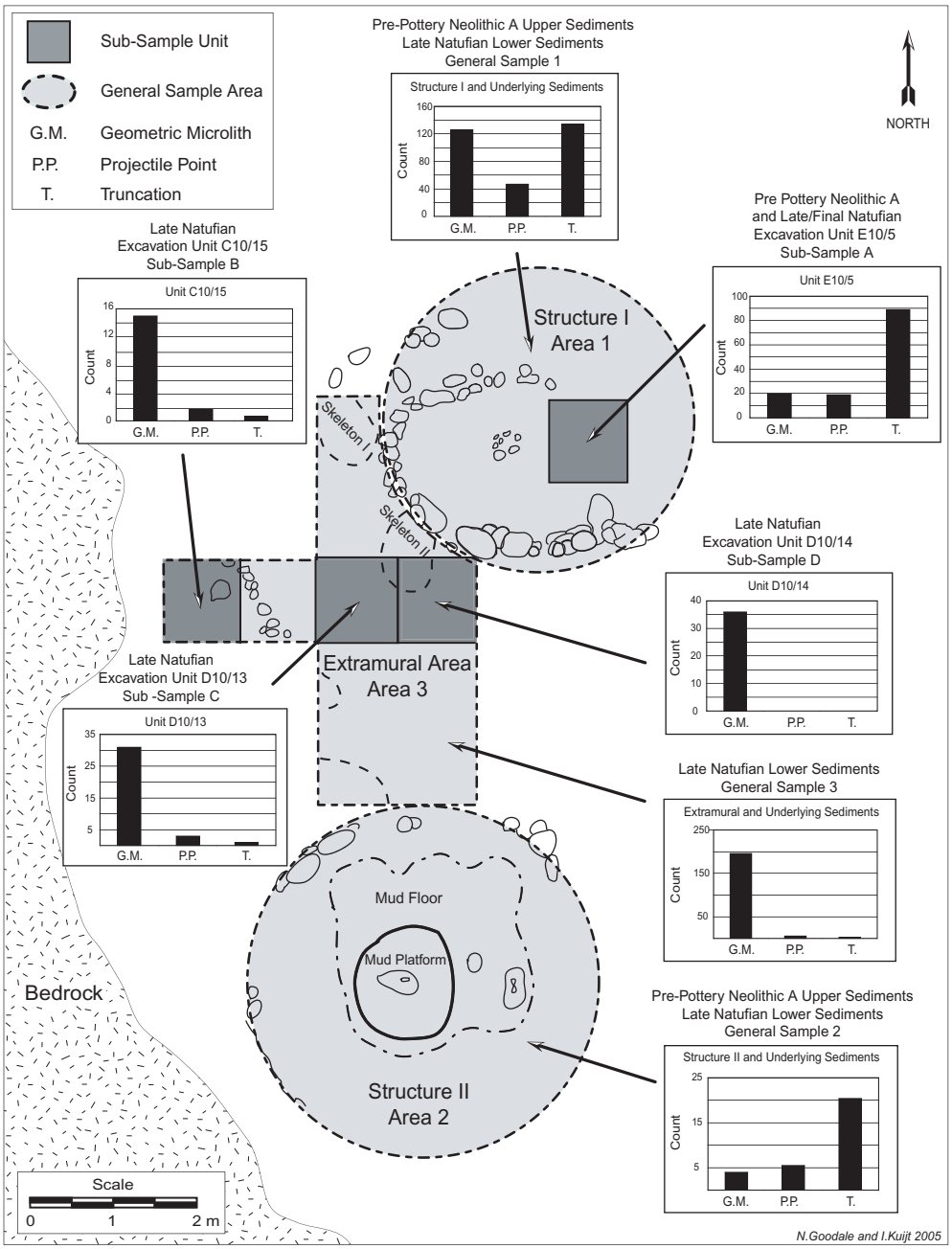

Fig. 3 : *Tool type frequencies for general samples and sub-sample areas at 'Iraq ed-Dubb.*

10 500 cal. BP) and the lower deposits date to the Late Natufian (13 500-11 700 / 11 500 cal. BP). The site was excavated for three field seasons and led to the identification of two oval stone structures, multiple pit features, fire hearths, and several burials[11]. All cultural materials were recovered from within less than 1,5 m of vertical cultural deposits, and most units were excavated to bedrock.

Both structures were 4-5 m in diameter and had mud floors. Structure I was almost entirely excavated, had multiple episodes of mud floor plastering events and had an internal fire hearth. Beneath Structure I were several Late Natufian adult and sub-adult burials that typically lacked grave goods and were placed in small hollows between bedrock outcrops[12]. Structure II had large grinding and anvil stones inset into the floor with a stone collar foundation, and a central 10-15 cm circular mud platform. Although, in total, less than 36 m^2 were excavated at the site, considerable quantities of faunal, archaeobotanical, and lithic materials were recovered. There were over 50 000 pieces of chipped stone, approximately 30 ground stone objects, 30 pieces of ground and polished bone, more than 25 complete or partial sea shells, and some clay objects[13].

OVERVIEW OF THE LITHIC ASSEMBLAGES FROM 'IRAQ ED-DUBB

For this analysis we followed the systems and definitions by Tixier and Bar-Yosef[14] and frequently consulted the published and unpublished research for other Neolithic and Natufian archaeological sites.

CHIPPED STONE TOOLS

In sum, the formal and non-formal tool category of the chipped stone assemblage is composed of 1 102 pieces that makes up approximately 2% of the total lithic assemblage (table 1). The most common tool types are geometric microliths (29%) followed by non-geometric microliths (21%), Hagdud truncations (14,7%), and retouched blades (13,3%). The tool assemblage is also composed of other tool categories with fewer numbers including projectile points, scrapers, burins, sickle blades, perforators, notches and denticulates, bifacial tools, and varia pieces.

The projectile point assemblage is composed of 80 items. Khiam points are the most frequent, with Jordan Valley, and Salibiya points also being recovered. The projectile points from 'Iraq ed-Dubb are on average 20 mm in length and 7 mm in width. Interestingly, these points are on average much smaller than the points found at Dhra'[15] but almost identical in size to the points found at Netiv Hagdud[16]. This may be an indication of either site function or raw material availability. There were 162 Hagdud truncations recovered from the site. In light of the limited excavation areas, this is a very high number and similar in percentage to that of Zharat ehd-Dhra 2[17]. Metric data show that the mean length for rectangular Hagdud truncations is 5,6 mm in length and 9,2 mm in width. The mean length of concave Hagdud truncations is 7,7 mm in length and 10,7 mm in width. The Hagdud truncations at 'Iraq ed-Dubb are characteristically very small when compared to Dhra' and more similar, but still smaller than the truncations found at Netiv Hagdud[18].

Two hundred and thirty-six non-geometric microliths were recovered from the site. The largest percent comes from complete and fragmented retouched bladelets, with backed bladelets also contributing significant numbers to the assemblage. By far the largest tool group found at 'Iraq ed-Dubb is the geometric microlith category with backed lunates being the most prevalent. Metric data show an average size of 21 mm in length and 7 mm in width for Helwan lunates (N=8), 14 mm in length and 6 mm in width for asymmetric lunates (N=56), and 14 mm in length and 4 mm in width for backed lunates (N=205). Comparatively, the asymmetric and backed lunates are very similar in size to those found at Fazael IV[19] and somewhat smaller than those found at Givat Hayil[20]. The Helwan lunates from 'Iraq ed-Dubb were recovered from the deep deposits under Structure I and are indicative of the Early Natufian period of the southern Levant. Other than these few Helwan lunates, there is no other evidence to indicate a substantial Early Natufian occupation at 'Iraq ed-Dubb.

11. See KUIJT, 2004 for a detailed description of features, chronology and architectural elements.
12. KUIJT, 2004.
13. KUIJT, 2004.
14. TIXIER, 1963 ; BAR-YOSEF, 1970 : 202-203.
15. GOODALE *et al.,* 2002.
16. NADEL, 1997 : 89.
17. EDWARDS and SAYEJ, 2001.
18. NADEL, 1997 : 112.
19. GROSMAN *et al*., 1999.
20. GORING-MORRIS, 1997.

Table 2 : *Frequency and percentage of core types, all excavation areas, 'Iraq ed-Dubb, Jordan.*

Core Type / Area/ Cultural Affiliation	90 degree platform blade cores	Bipolar Blade Core	Bipolar Bladelet Cores	Blade Core Fragment	Bladelet Cores	Flake Cores	Flake Core Fragment	Opposed Platform Blade Cores	Opposed Platform Bladelet Cores	Single Platform Blade Cores	Total
Extramural Area LNAT	1		3	1	15	3	1	1	8	1	**34**
Structure 1 PPNA	1	1	1		3	2		1	4		**13**
Structure 1 LNAT/ PPNA					1			1		1	**3**
Structure 1 LNAT			2			1					**3**
Structure 2 PPNA						3		1			**4**
Structure 2 LNAT						1				1	**2**
Disturbed top 10 cm	1								1		**2**
Total	**3**	**1**	**6**	**1**	**19**	**10**	**1**	**4**	**13**	**3**	**61**

A variety of scrapers were found at the site with 41 made on flake blanks and eight made on blade blanks. All of the flake scrapers are side or end scrapers and have characteristically steep normal retouch. Twenty burins were found at the site, eight were dihedral burins, two were double dihedral, four were burins on a break, two were burins on a truncation, one was transverse on a natural surface and three were single removal burins. One hundred and forty-seven retouched blades were found with blades bearing normal retouch making up the highest proportion. A small number of sickle blades were found at the site and were either backed or unretouched. A large percentage of the sickles were backed and very similar to those found at Fazael IV, indicating that Natufian and PPNA peoples at the site may have been utilizing cultivation of local vegetation on a regular basis. Thirty perforators / awls were found at 'Iraq ed-Dubb. This is a very low number and percentage compared to other PPNA sites such as Dhra', Netiv Hagdud, and Zahrat ehd-Dhra' 2 which have very high percentages of awls and borers[21]. Notches and Denticulates contribute 28 pieces to the assemblage at 'Iraq ed-Dubb. Three bifacial tools were found at the site, indicating at least a minimal need for wood-working to prepare the superstructure for the PPNA houses at 'Iraq ed-Dubb.

CHIPPED STONE CORES AND DEBITAGE

In total, 61 cores were recovered from the site (table 2). Metric data taken from all 61 cores demonstrate that the average length is 4,16 cm and the average width is 3,20 cm. Comparatively, this average is very similar to Netiv Hagdud[22] and less than the average core size from Dhra'[23]. This small size may indicate that lithic material source was some distance from the site. The occurrence of different core types (*i.e*. blade cores, bladelet cores, and flake cores) shows a predominance of bladelet cores, followed by blade cores and flake cores (table 2). When the spatial occurrence is also examined, it is overwhelmingly evident that the majority of cores, especially bladelet cores, occur in Late Natufian sediments (fig. 4).

The debitage category is composed of a high percentage of bladelets (44%) and flakes (42%), with lower percentages of blades (9%), cortical elements (3%), core trimming elements (1%), and less than one percent composed of burin spalls and microburin technique elements. This pattern also fits with a model suggesting that the lithic source(s) used by the prehistoric peoples at 'Iraq ed-Dubb was not in the immediate vicinity of the site. It appears that most of the initial reduction was conducted elsewhere and cores were then brought in ready for flake, blade/bladelet, and tool pro-

21. GOODALE *et al.,* 2002 ; FINLAYSON *et al*., 2003 ; NADEL, 1997 ; EDWARDS and SAYEJ, 2001.

22. NADEL, 1997.

23. GOODALE *et al*., 2002.

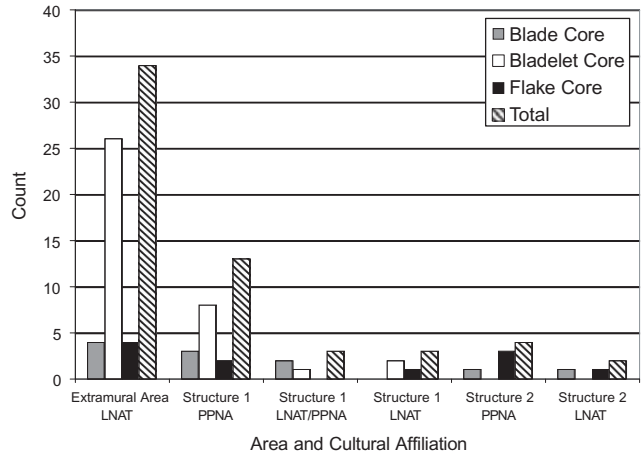

Fig. 4 : *Core type by provenience and time period.*

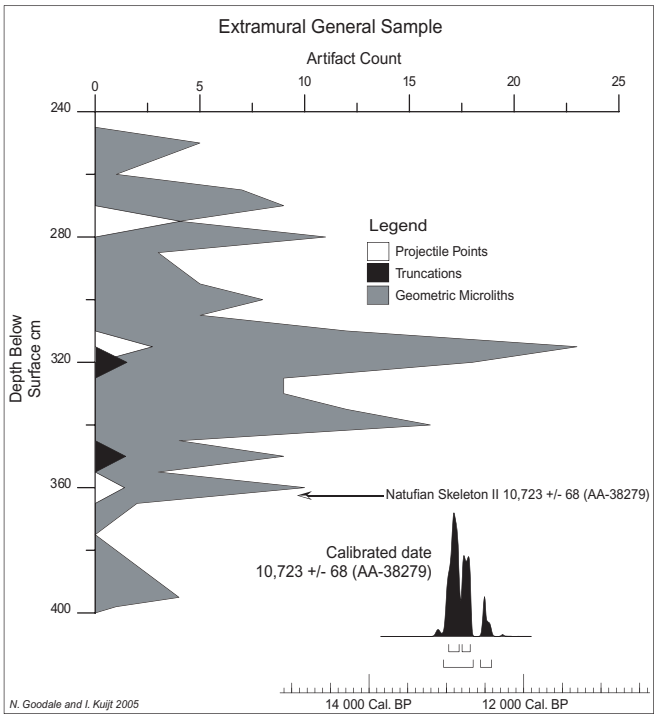

Fig. 5 : *Tool types by depth and associated radiocarbon dates for the extramural area.*

duction at the site. Given the Late Natufian occupation, the high percentage of bladelets at 'Iraq ed-Dubb is not surprising. This pattern is in stark contrast to flake dominated assemblages of Dhra', Netiv Hagdud and many other sites and may be partially attributed to the availability of lithic raw material.

The debris from the site makes up the largest portion of the lithic assemblage. Although at the time of writing the debris were not counted, weight data suggest that the debris assemblage is composed of approximately 49 000 pieces. This would comprise approximately 98% of the entire lithic assemblage. Most of the pieces are chips or less than 15 mm in size and a small percentage are chunks or larger than 15 mm in size.

Taken as a whole, and without any consideration of stratigraphic context, chronology or spatial patterning, the 'Iraq ed-Dubb assemblage outlines a pattern of limited local raw material that was intensively exploited on-site. For both periods of occupation, the residents at 'Iraq ed-Dubb practiced core reduction focused on small bladelet cores prepared for the removal of bladelet blanks. All of the tool metric data presented above illuminates the trend that the inhabitants were making and utilizing very small tools at 'Iraq ed-Dubb, suggesting a lack of raw material availability and possibly indicating a broader site use pattern for both periods as a short-term seasonal camp, although the PPNA residents may have occupied the site for longer periods of time therefore justifying the construction of houses.

'IRAQ ED-DUBB : DIFFERENT PICTURES FROM SITE *VS* CONTEXTUAL LEVEL ANALYSIS

Detailed analysis of numbers and percentages of diagnostic tools from different stratigraphic levels helps us to understand the level of mixing of cultural materials and deposits in distinct areas of 'Iraq ed-Dubb. This fine-grained analysis also assists us in understanding the taphonomic origins of specific deposits, how this contrasts to a more traditional coarse grained analysis, and by extension, helps us identify what diagnostic tools are likely to be time specific. Drawing upon the data from 'Iraq ed-Dubb, we first present the results from the Late Natufian deposits that occur outside of the PPNA structures, and therefore, less likely to be disturbed by the construction of the semi-subterranean buildings. Following this we examine the coarse and fine-grained picture from the deposits inside PPNA Structure II. Building upon this understanding in the last part of this section we elucidate patterns for PPNA Structure I.

LATE NATUFIAN EXTRAMURAL DEPOSITS

GENERAL SAMPLE 3 AND SUB-SAMPLES B, C AND D (fig. 6 and 7)

Drawing upon radiocarbon and stratigraphic evidence, Kuijt[24] argues that the majority of these deposits date to the Late Natufian period. The occupational sediments outside of the PPNA semi-subterranean structures illustrate a high level of geometic microliths and a very low frequency of Hagdud truncations and Khiam projectile points (fig. 3). Both Hagdud truncations and Khiam projectile points are widely held to be chronologically limited to the PPNA and do not occur in the Late Natufian period.

The presence of these tool forms indicates several things. First, it shows that, other than the construction of the semi-subterranean dwellings, PPNA people did not excavate extensively into the Late Natufian levels in the extramural areas. It is possible, but yet to be demonstrated, that the Late Natufian occupation extended throughout most of the site. Second, the absence of Hagdud Truncations and Khiam projectile points in other Late Natufian sites indicates that these tools at 'Iraq ed-Dubb have been mixed into the Late Natufian deposits. Although limited in numbers, Hagdud truncations and projectile points do occur within most of the deposits of the extramural area (fig. 5), but these are almost always restricted to the upper 10 cm of deposits where one would anticipate mixing of cultural materials from the two different occupation periods. It is also possible that some of these objects were mixed into the Late Natufian by bioturbation.

Table 3 : *General tool types for sub-sample C excavation unit D 10/13.*

Tool Group	Count	(%)
Projectile points	3	4
Scrapers	3	4
Burin	1	1
Non-Geometric Microliths	20	27
Geometric Microliths	31	42
Retouched Blades	4	5
Sickle Blade	0	0
Perforators/Awls	4	5
Notch & Denticulate	0	0
Bifacial Tool	0	0
Hagdud Truncation	1	1
Cores	7	9
Varia	0	0
Total	**74**	**100**

Table 4 : *General tool types for sub-sample D excavation unit D 10/14.*

Tool Group	Count	(%)
Projectile point	0	0
Scrapers	4	5
Burins	2	2
Non-Geometric Microliths	24	29
Geometric Microliths	36	44
Retouched Blades	8	10
Sickle Blade	0	0
Perforators/Awls	3	4
Notch & Denticulate	0	0
Bifacial Tool	0	0
Hagdud Truncation	0	0
Cores	5	6
Varia	0	0
Total	**82**	**100**

Table 5 : *General tool types for sub-sample B excavation unit C 10/15.*

Tool Group	Count	(%)
Projectile points	6	12
Scrapers	4	8
Burins	2	4
Non-Geometric Microliths	6	12
Geometric Microliths	15	30
Retouched Blades	10	20
Sickle Blade	0	0
Perforator/Awl	1	2
Notches & Denticulates	3	0
Bifacial Tool	0	0
Truncation	1	2
Cores	2	4
Varia	0	0
Total	**50**	**100**

24. KUIJT, 2004.

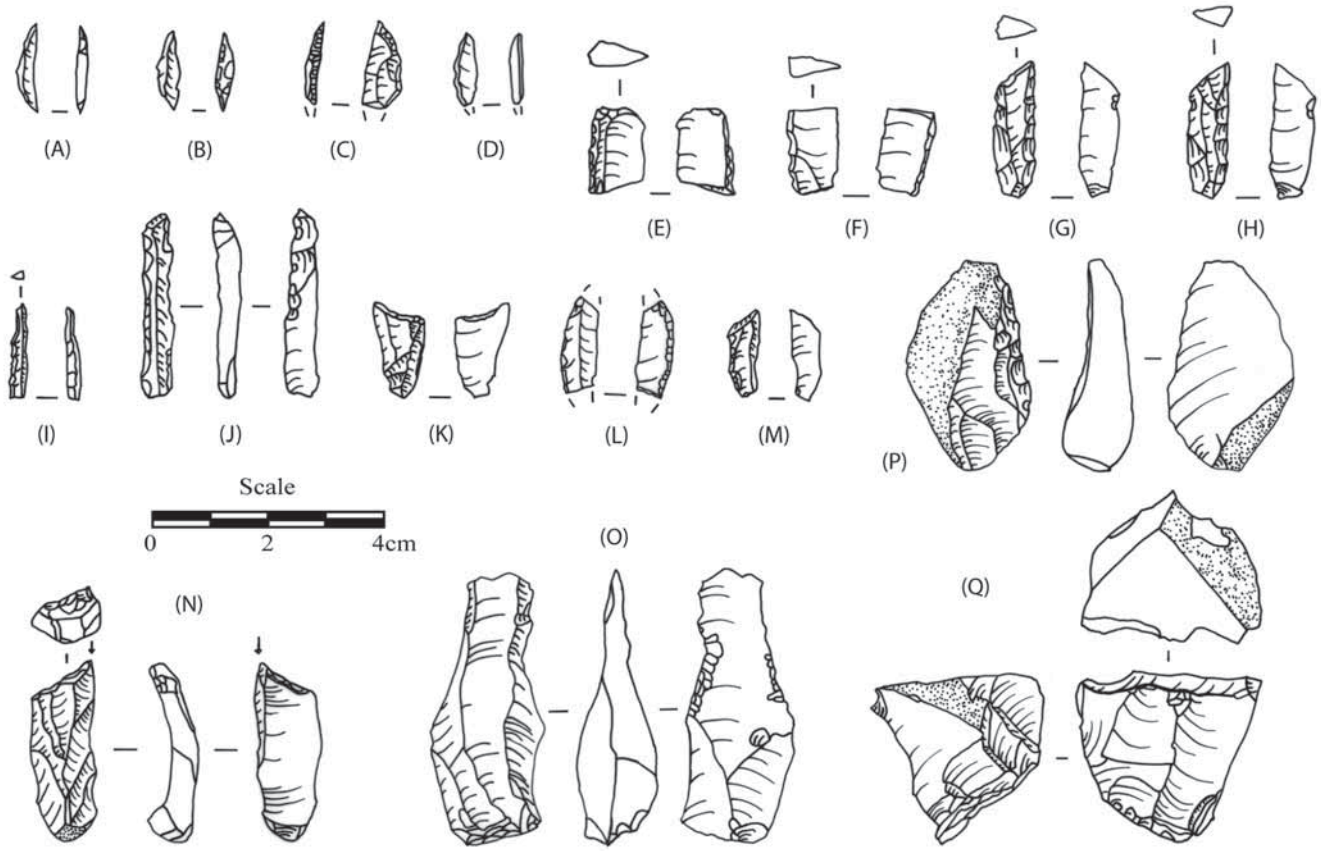

Fig. 6 : *Selected tools from the extramural area : lunates (A – M), retouched burin (N), retouched blades (O – P), and single platform core (Q).*

Sub-samples B, C, and D in excavation units D10/13 (table 3), D10/14 (table 4), and C 10/15 (table 5) illustrate that the proportions of PPNA tools are very low compared to Structures I and II, also indicating that their provenience is derived from disturbance. Examination of sub-sample D provides strong evidence for this argument. In this sub-sample unit, dated by an AMS date (AA-38279, fig. 2) over 35 geometric microlithics were recovered but no projectile points or Hagdud truncations were encountered. This is strongly suggestive of temporally intact deposits from a single period of time with relatively limited mixing due to bioturbation. As demonstrated in tables 3, 4 and to a lesser extent table 5, geometric and non-geometric microliths make up an overwhelmingly significant proportion of the lithic assemblage from the extramural area. Also demonstrated in sub-sample D is the pattern that a very limited array of tools may be indicative of the Late Natufian occupation.

PPNA STRUCTURE II AND UNDERLYING DEPOSITS

GENERAL SAMPLE 2 (figs 8-11)

Stratigraphic and radiocarbon data presented elsewhere[25] indicate that Structure II was built in the early stages of the Pre-Pottery Neolithic A at approximately 11 500 cal. BP and is roughly contemporaneous with Structure I. Structure II is an oval structure defined by a few upright stones that formed walls on the west, and with bedrock outcrops that acted as the north and eastern sides of the structure (fig. 3). The structure contained a prepared mud floor and a centrally located mud platform, and several built-in stone features. It appears that some portions of Structure II were built on top of Late Natufian deposits, and in some areas built into earlier deposits.

25. KUIJT, 2004.

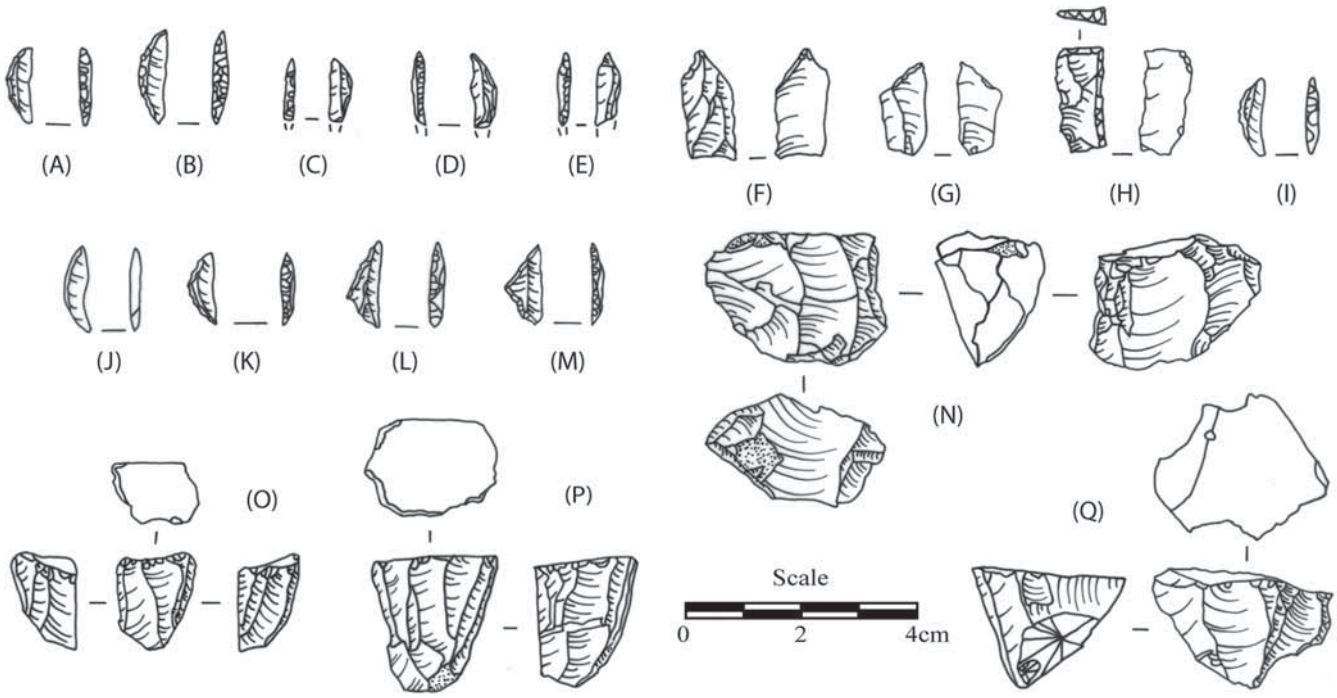

Fig. 7 : *Selected tools from the extramural area : lunates (A – E and I – M), burins (F – G), and single platform cores (N – Q).*

Excavations revealed that the sediments in the area of Structure II had minimal mixing and a relatively simple occupation sequence compared to Structure I.

Viewed as a collective sample, and without consideration of the multiple periods of occupation represented here, it is clear that Structure II and the deposits underlying the structure show percentages of both Late Natufian and PPNA typological elements including geometric microliths, Hagdud truncations, and projectile points. Hagdud truncations are the most common tool found within the sediments associated with Structure II and underlying deposits (table 6). On the whole, the Late Natufian occupation appears to be less extensive in the area compared with Structure I.

Our general understanding of Structure II is, however, misleading. When depth and stratigraphy are taken into consideration, the patterning of Structure II is very different and provides insight into what is taking place in other areas of the site. Figure 12 depicts the number of geometric microliths in association with the floor of Structure II and the depth relationships of radiocarbon dates attributed to both the Late Natufian and the PPNA occupation. The pre-14 000 to 12 000 cal BP Late Natufian deposits contain geometric microliths, but no Hagdud Truncations or Khiam projectile points. In the overlying sediments we see the opposite : a total absence of microliths and the presence of Hagdud truncations and projectile points. The calibrated radiocarbon data illustrate that the PPNA and Late Natufian occupations did not overlap and that there is a substantial occupational hiatus. In sum, we see that there are very different tools from different layers. These layers are radiocarbon dated to different periods, and as with analysis of the extramural area, other than in the interface between two deposits where we would anticipate sediment mixing, geometric microliths are not recovered with Hagdud truncations and Khiam projectile points.

PPNA STRUCTURE I AND UNDERLYING DEPOSITS

GENERAL SAMPLE 1 AND SUB-SAMPLE A (fig. 13)

Structure I was initially built in the early stages of the Pre-Pottery Neolithic A at around 11 500 cal. BP[26]. After excavating

26. *Ibid.*

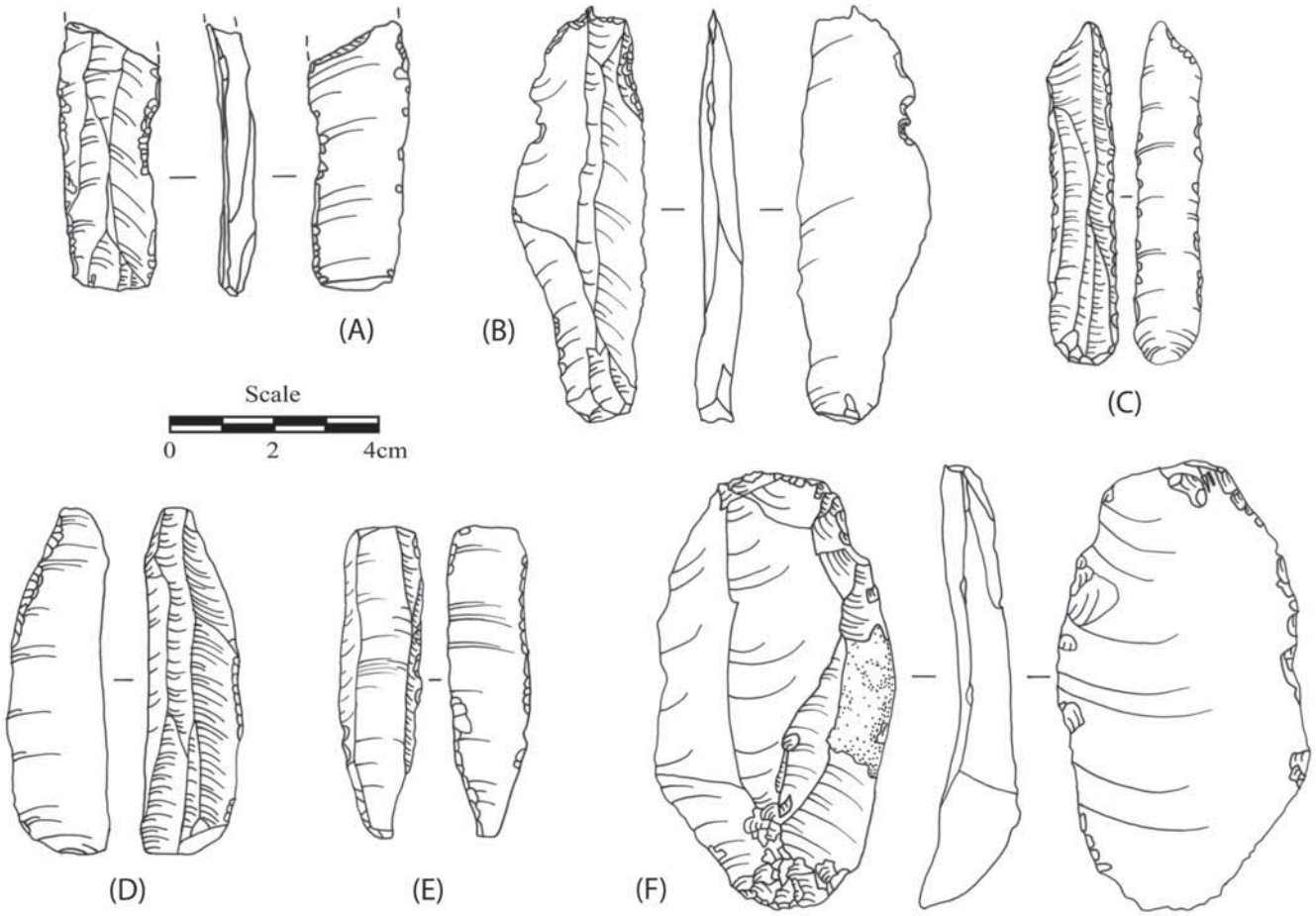

Fig. 8 : *Selected tools from Structure II. Retouched Blades (A and C – E), perforator/awl (B), and end scraper (F).*

Table 6 : *General tool types for excavation units in Structure II.*

Tool Group	Count	(%)
Projectile points	9	8
Scrapers	5	5
Burin	1	1
Non-Geometric Microliths	9	8
Geometric Microliths	4	4
Retouched Blades	34	31
Sickle Blades	9	0
Perforators/Awls	3	3
Notches & Denticulates	6	0
Bifacial Tools	2	0
Truncations	21	19
Cores	6	6
Varia	0	0
Total	**109**	**100**

into the earlier Late Natufian layers the builders covered the interior with a series of prepared mud floors (*loci* 007 and 010) and probably used a combination of Late Natufian sediments and PPNA sediments to level the initial floor over the bedrock. Major areas of the floor remained intact. Under the southern part of the structure there is an earlier mud floor (*locus* 010) that predates the upper floor and the construction of the stone walls. *Locus* 010 represents the best evidence for the first occupied permanent structure at 'Iraq ed-Dubb. This floor was then replaced by the second occupation that built the latest mud floor (*locus* 007) and destroyed some of the earlier floor (*locus* 010).

The sediments in the area of Structure I illustrate a complex occupation sequence in building and rebuilding in the PPNA period, excavating into the underlying Late Natufian occupation, and after abandonment, the natural in-filling of Structure I with PPNA and Late Natufian sediments from ups-

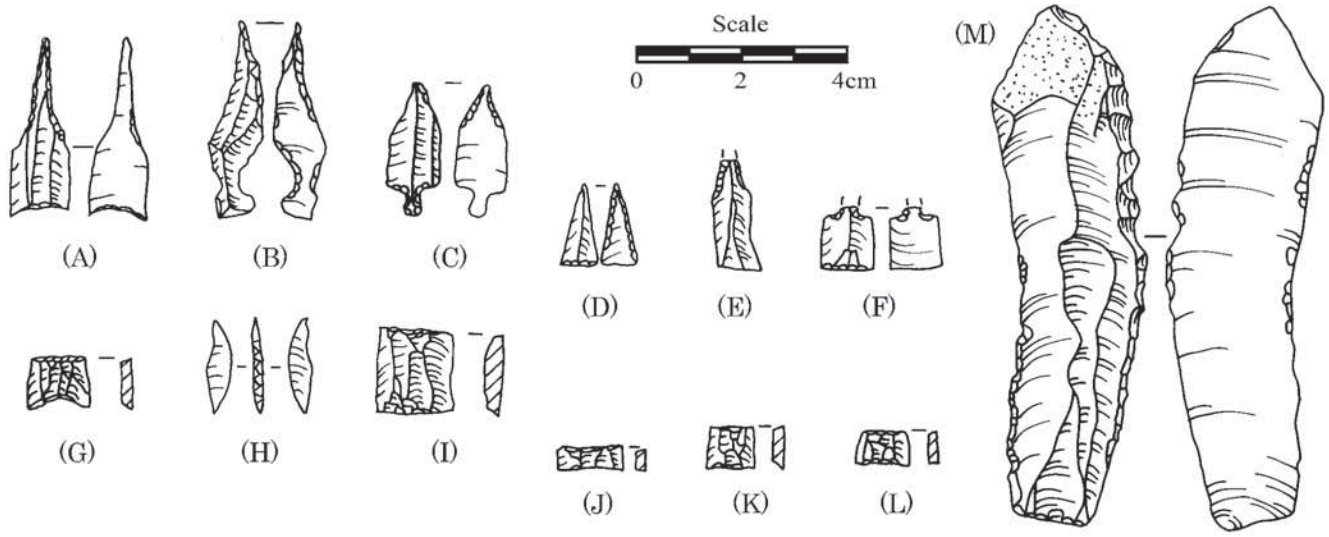

Fig. 9 : *Selected tools from Structure II. Salibiya points (A and D), el-Khiam point (B), Jordan Valley Point (C), point fragment (E), el-Khiam base (F), Hagdud truncations (G and I – L), lunate (H), and retouched blade (M).*

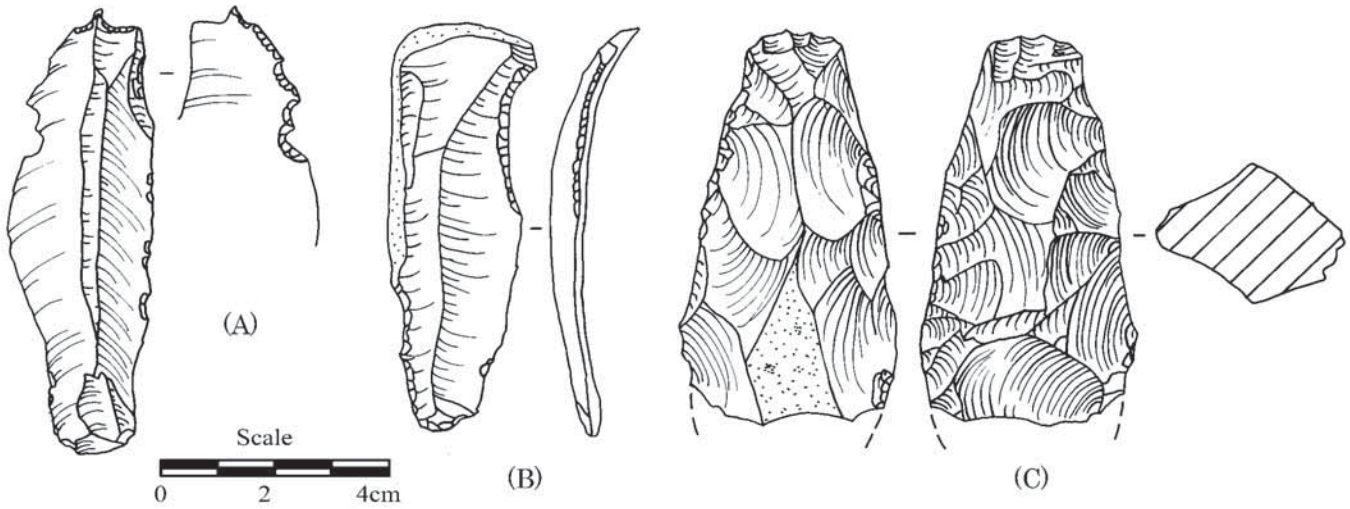

Fig. 10 : *Selected tools from Structure II. Perforator (A), retouched blade (B), and bifacial chisel (C).*

lope[27]. Without any consideration of depth associations, and by extension chronology, the collective assemblage from Structure I shows a high percentage of both Late Natufian and PPNA typological elements including geometric microliths, Hagdud truncations, and projectile points (table 7). In some portions of Structure I, mixing of cultural sediments appears to be more extensive as shown in excavation unit E10/5 (fig. 3, Sub-Sample A). In this unit, there are both larger percentages of geometric/non-geometric microliths and Hagdud truncations. Interestingly, there is no clear evidence that the Late Natufian occupants created any permanent residential structures, although there is evidence for multiple fire hearths, pit features, and two burials.

Consideration of stratigraphy, depth, and association of the Structure I deposits helps us understand the degree of mix-

27. Detailed discussion and illustration of this process are provided by KUIJT, 2004 : fig. 8.

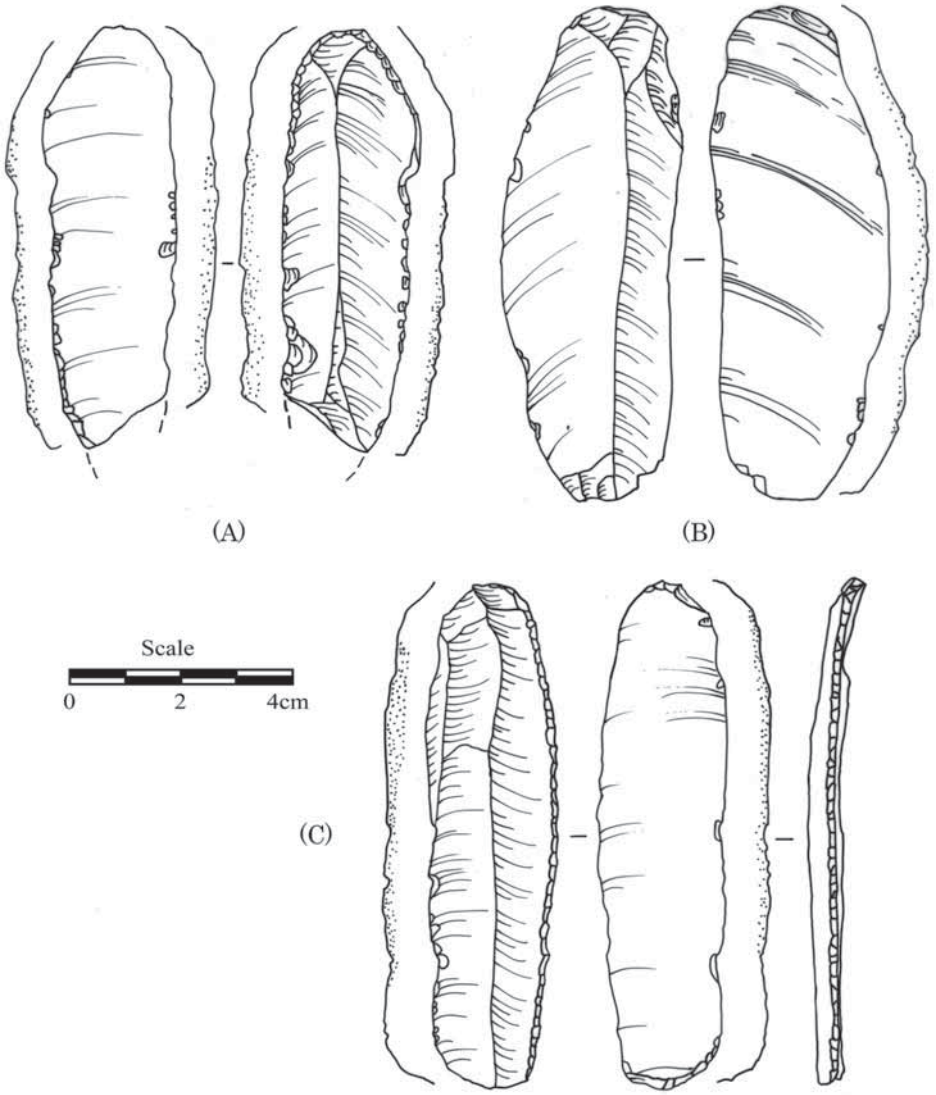

Fig. 11 : *Selected tools from Structure II. Sickle Blades (A – C).*

ing in some locations at 'Iraq ed-Dubb. Figure 14 shows the number of tool types, their depth and chronological relationships for both the Late Natufian and the PPNA occupation at 'Iraq ed-Dubb. In this coarse-grained analysis the 13 500-13 000 cal. BP sediments show a high percentage of geometric microliths with Hagdud truncations and projectile points. It appears that the dated Late Natufian sediments that are stratigraphically below the dated floor of Structure I contain a very high percentage of both geometric microliths, Hagdud truncations, and Khiam projectile points. This is, however, misleading in that the majority of Hagdud truncations and Khiam projectile points were recovered from some form of pit feature or cut to the east of this area[28]. Figure 3, sub-sample A, illustrates a different pattern with a high representation of Hagdud truncations, and low numbers of geometric microlithics and Khiam projectile points.

Given that these three artifact types have never been recovered from a dated single component Late Natufian site or layer, we believe that this association is a reflection of taphonomy and mixing, not a broader cultural pattern. As is outlined elsewhere[29], Hagdud truncations and Khiam projec-

28. See KUIJT, 2004 : 299.
29. NADEL, 1997 ; KUIJT and GORING-MORRIS, 2002.

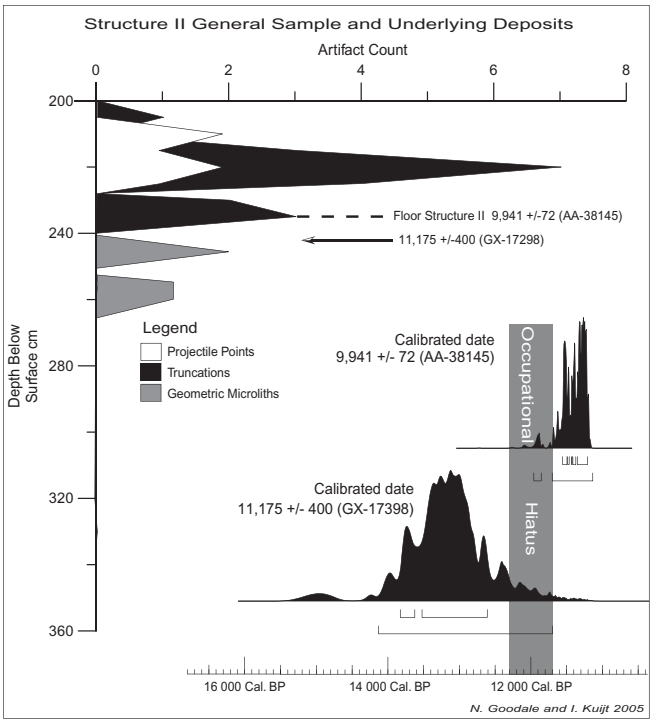

Fig. 12 : *Tool types by depth and associated radiocarbon dates for Structure II.*

Table 7 : *General tool types for sub-sample A excavation unit E 10/5.*

Tool Group	Count	(%)
Projectile points	21	10
Scraper	1	0
Burins	3	1
Non-Geometric Microliths	31	15
Geometric Microliths	20	10
Retouched Blades	9	4
Sickle Blades	4	0
Perforators/Awls	7	3
Notches & Denticulates	7	0
Bifacial Tool	0	0
Truncations	91	45
Cores	8	4
Varia	0	0
Total	**202**	**100**

tile points are temporally restricted to the PPNA period. Moreover, since these mixed deposits are stratigraphically below those of *loci* 010 and 007, there is good reason to argue that there has been some degree of mixing of these deposits and lithic materials stratigraphically above. The overlying sediments (dated to 11 200 to 10 800 cal. BP) illustrate a rapid decline of geometric microliths, and this is probably related to reduced mixing of deposits. The calibrated radiocarbon data also show that the PPNA and Late/Natufian occupations do not overlap. Moreover, there appears to be an occupational hiatus between them. Collectively, these data, as well as the strong patterning from Structure II and the extramural areas discussed earlier, demonstrate that the geometric microliths, and more specifically the presence of lunates occurring in the PPNA deposits (dated to 11 200 to 10 800 cal. BP) were actually made during the Late Natufian occupations (fig. 14).

DISCUSSION

This analysis provides new insights into the technological aspects of the forager-farmer transition in the Near East, and how these different manifestations can be identified through chipped stone tools. Drawing upon clearly delineated and well-dated stratigraphic layers, we have outlined how the distribution of chipped stone materials recovered from 'Iraq ed-Dubb are spatially patterned both vertically and horizontally. Examination of larger collection units, as well as sub-units, illustrates that specific tool types are associated with specific deposits from specific periods of occupation. For example, typological analysis of sub-sample units from extramural areas dating to the Late Natufian period illustrate that geometric microliths such as lunates, are the major tool type recovered. While Hagdud truncations and Khiam points are also recovered, it appears that these are mixed in through bioturbation.

Examination of the vertical patterning of deposits from Structure II, as well as consideration of radiocarbon dating, reveal that this PPNA structure was constructed on top of earlier Late Natufian deposits. Importantly, there is a clear vertical separation between diagnostic tool types. Geometric microliths are associated with the Late Natufian occupation while the Hagdud truncations and Khiam points are associated with the PPNA occupational sediments. Using this foundation we then looked at the cultural materials from Structure II. This is a more complex case with considerable mixing of tools from different periods. In this case, it appears that considerable Late Natufian sediments, containing diagnostic tools, filled in the PPNA structure after abandonment. In light of the slope of the cave and that PPNA people excavated into the earlier Late Natufian

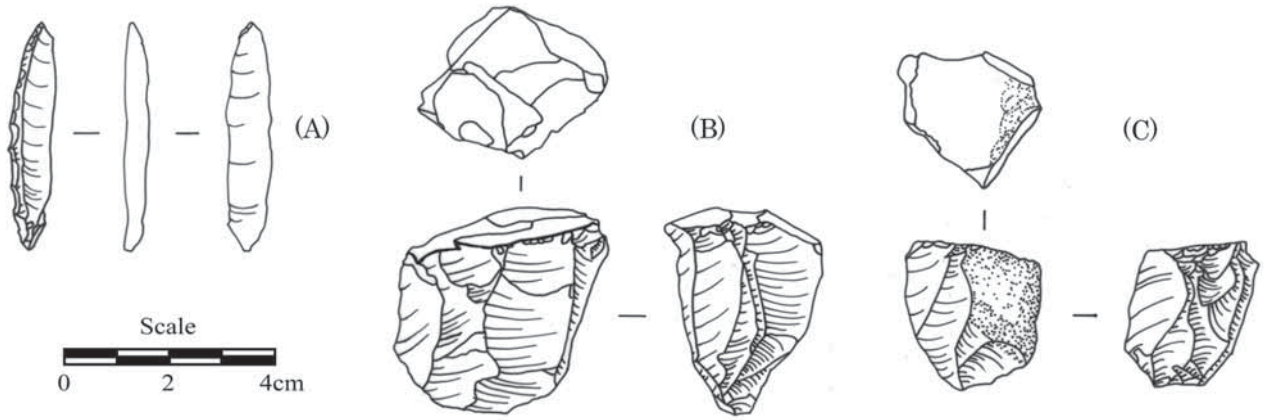

Fig. 13 : *Selected tools from excavation unit E 10/5 sub-sample A. Backed bladelet (A), single platform cores (B and C).*

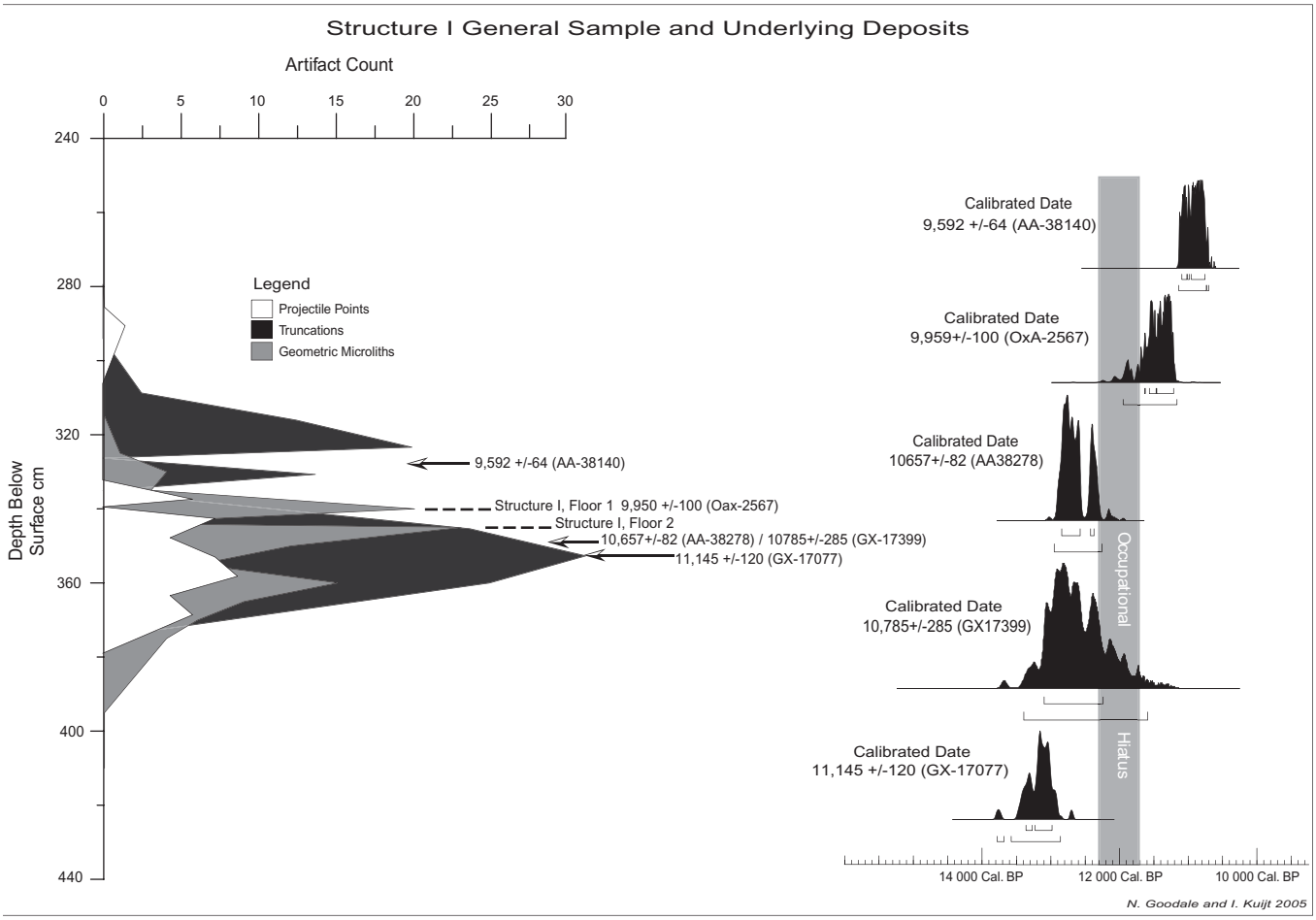

Fig. 14 : *Tool types by depth and associated radiocarbon dates for Structure I.*

layers this should come as no surprise. We think that the spatial analysis presented here, as well as our observations during excavation, support the argument that the PPNA and Late Natufian occupations resulted in distinct chipped stone assemblages that are characterized by different diagnostic tools. Examples of co-occurrence of Khiam points, Hagdud truncations and geometric microliths are linked to the PPNA construction of features, mixing of cultural deposits and bioturbation after abandonment.

IMPLICATIONS AND CONCLUSION

This current research provides an important descriptive overview of chipped stone technology and tool forms for the Late Natufian and Pre-Pottery Neolithic A. Drawing upon stratigraphic and radiometric data from both components, it is possible to clearly place the chipped stone tools and technology from both periods of time into a chronological context. On another level, this research provides new data to critically examine and revise current cultural-historical models for the forager-farmer transition. Among researchers there is strong general agreement that the transition between more mobile Late Natufian and increasingly sedentary forager-farmers of the Pre-Pottery Neolithic A period occurred around 11 500 BP. The views of researchers differ, however, as to the question of the materials and chronological character of the later Pre-Pottery Neolithic A period. Some argue that the forager/farmer boundary is characterized by a shift from the Late Natufian to two later sequential facies of the PPNA : the Khiamian and the Sultanian. Noting the presence of considerable mixing at purported type sites for these facies, as well as different sampling and recovery methods employed at the excavation of these type sites, other researchers argue that this cultural-historical framework of sub-dividing the PPNA into two facies is not supported by current archaeological data.

Among the more problematic issues of the sub-division of the PPNA into two facies is the failure of researchers to identify convincingly radiocarbon-dated archaeological sites, with intact deposits excavated by standard recovery methods that support this cultural-historical model. Several studies have pointed out that the Khiamian has yet to be adequately defined[30]. Expanding upon the concerns expressed by others[31], we are concerned that the existing chronological model of the Khiamian and Sultanian as articulated by Crowfoot-Payne[32] does not satisfactorily account for the data we have on regional technological and typological patterning in the south-central Levantine PPNA. The post-1990 archaeological research and publication of data from Netiv Hagdud, Salibiya IX, Gilgal I and Dhra‘ illustrate that : a) data from new excavations, and publication of previous research do not fit the technological, typological, and chronological explanatory model for two facies ; and b) researchers neither clearly understand the reasons for, nor processes by which, technological and typological variability is created in PPNA lithic assemblages by investigating aspects of material culture that serve as effective and reliable criteria for distinguishing individual deposits in different period sites.

One of the unfortunate trends in the analysis of the majority of early Pre-Pottery Neolithic chipped stone collections is a lack of consideration of site formation processes and the publication of their data as collective analysis. Possible mixing of materials from different features and levels is a significant interpretative challenge, one that requires careful consideration of site formation processes[33]. This is not to suggest that researchers do not recognize the possibility of contamination and mixing of materials from different periods of time. Rather, while acknowledging this point, researchers often only pay limited attention to this question and treat their samples as reliable and representative collections for the purpose of developing cultural-historical sequences and/or examination of inter-assemblage variability. We believe that this has probably masked unrecognized levels of variability in analysis and has led researchers to develop cultural-historical reconstructions on the basis of weak understandings. In the case of the early Pre-Pottery Neolithic A period we believe that our reconstruction of culture-history has been undermined by several factors.

First, it is clear from several sites, such as Hatoula[34] and Salibiya IX, that there is a mixing of cultural materials from multiple periods of occupation. Second, although a number of researchers have acknowledged that the microlithic component, specifically lunates, are possibly derived from earlier occupations, the intellectual division of the PPNA into two facies is based on the microlithic materials as the key criterion for differentiating the Khiamian from the Sultanian. Finally,

30. BAR-YOSEF and BELFER-COHEN, 1989 ; GARFINKEL and NADEL, 1989 ; NADEL, 1990 ; BAR-YOSEF, 1991.

31. *E.g.* GARFINKEL and NADEL, 1989 ; NADEL, 1997, 1990.

32. CROWFOOT-PAYNE, 1976, 1983.

33. VILLA, 1982 ; VILLA and COURTIN, 1983.

34. GARFINKEL, 1996.

it is clear from the case of Jericho, the site upon which Crowfoot-Payne's[35] definition is based, the lack of screening for artifacts has led to the confusion of the cultural-historical model[36]. In sum, researchers have not been able to put forth, in a convincing, reliable and comprehensive manner, the specific criteria that can be used to differentiate the Khiamian from the Sultanian. Just as importantly, proponents of the two facies model of the PPNA have yet to address why other researchers should accept such a division if there are no radiocarbon dated single component sites, with clear cultural deposits with associated diagnostic tools, that fit into a chronological transition between the Late Natufian and Pre-Pottery Neolithic A period.

The analysis presented in this paper clearly illuminates the complexity of site formation processes occurring at 'Iraq ed-Dubb. It is clear that there has been some mixing of materials from the two major periods at the site. While this study has elucidated the complexity of utilizing lithic assemblages from multi-component sites in developing cultural-historical sequences, it has not addressed how to overcome these problems. In this sense, we return to the fact that complex sites require complex methods of pattern extraction, not just the presentation of lithic tools and debitage at the site level. As one approach to this problem we[37] are exploring several possible method utilizing statistical and spatial analyses techniques to help solve these issues. In the end, only testing by explicit methodology, looking at component level variability, will Near Eastern archaeologists be able to integrate complex and mixed site assemblages to cultural historical modeling. It is clear, moreover, that it is necessary to do this with both ongoing excavation projects but also previously excavated archaeological sites upon which existing cultural-historical frameworks are built.

ACKNOWLEDGMENTS

This paper draws upon research that the senior author started many years ago. The excavation of 'Iraq ed-Dubb was supported by the National Science Foundation, the Social Sciences and Humanities Research Council of Canada, and Harvard University. While delaying the publication of these results, searching for and gaining a teaching position has now, finally, facilitated the publication of these results. With additional funding from the Institute for Scholarship in the Liberal Arts, University of Notre Dame, the Dean of Art and Letters, University of Notre Dame, and the British Academy, it has been possible to complete this research and make it available to other researches. We want to thank Jenny Stahl for her illustrations of the lithics. This paper has emerged out of discussions with and comments by G. Rollefson, N. Goring-Morris, O. Bar-Yosef, and most of all, Meredith. S. Chesson. Additionally, N. Goodale would like to thank the Department of Anthropology at Washington State University who provided the Nicholas Michael Scoales Scholarship in Lithic Technology and the Edward Meyer Graduate Student Fellowship which offered additional financial support for this study. N. Goodale especially thanks W. Andrefsky Jr., G.O. Rollefson, T.A. Kohler, A. Duff, B. Finlayson, W.D. Lipe, and W.C. Prentiss for continued support in research and career opportunities as well as conversations and reviews of research related to 'Iraq ed-Dubb. We also extend our warm thanks to the editor and staff at Paléorient for their hard work and support, as well as several anonymous reviewers whose comments immeasurably improved the clarity of this paper. While none of the above may agree with all of the concepts and interpretations presented in this essay, the constructive criticism and advice of all of these people has immeasurably improved the clarity and organization of this essay. Any errors or flaws in logical thought are completely ours.

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35. CROWFOOT-PAYNE, 1976, 1983.
36. KUIJT, 1996.
37. GOODALE and KUIJT, in prep.

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