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QUANTIFYING DIACHRONIC VARIABILITY: THE 'AIN DIFLA ROCKSHELTER (JORDAN) AND THE EVOLUTION OF LEVANTINE MOUSTERIAN TECHNOLOGY

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Abstract

Typological, technological, and metrical analyses of a lithic assemblage from the 'Ain Difla rockshelter in west-central Jordan are consistent with the results of previous studies that align 'Ain Difla with the Tabun D-type Levantine Mousterian. Technological and typological affinities are discernible from a direct comparison of tools from this assemblage with those found in Tabun layer D, as well as metrical and categorical comparisons between 'Ain Difla and other well-known Tabun D Mousterian sites. The 'Ain Difla sample is dominated by elongated Levallois points. Blanks were obtained from both uni- and bipolar convergent and predominantly Levallois cores that show evidence of bidirectional flaking. The typological and technological comparisons reported here suggest that the evolution of the blade-rich Mousterian can be viewed as a continuum between the early (Tabun) and late (Boker Tachtit) Mousterian; that (on any index) 'Ain Difla falls somewhere around the middle of this continuum, and that Mousterian laminar technologies develop more or less continually into the early Upper Paleolithic Ahmarian.

INTRODUCTION

The 'big deal about blades' is that their presence in lithic repertoires has great temporal depth, extending far back in time before any construal of the Upper Paleolithic (Bar-Yosef and Kuhn, 1999; Bar-Yosef, 2001; Bar-Yosef and Meignen, 2001; Meignen and Bar-Yosef, 2002), and that there is no justification for linking blade production to any particular hominid, aspect of hominid anatomy, or to any major change in the behavioral capacities of hominids. This study utilizes a blade-dominated assemblage to shed light on the dynamics of modern human origins. In the Levantine Mousterian, some researchers (e.g., Monigal, 2002) argue that the evolution of laminar technologies can be viewed as a continuous progression from early Mousterian (i.e., Tabun layer D) to late Mousterian (i.e., Boker Tachtit levels 1 and 2), thus leading up to the unmistakably blade-rich technologies of the early Upper Paleolithic Ahmarian (e.g., Marks, 1983a, b). Here we assess the empirical support for this contention by examining a sample of lithic artifacts from 'Ain Difla, a Jordanian site that appears to fall 'in the middle' of this progression, both temporally and in terms of its lithic industries. If continuity in the evolution of laminar technologies is established through 'Ain Difla, it would constitute evidence relevant to the now-global debate on the origin of anatomically modern humans.

The origin of anatomically modern humans continues to be the subject of a heated and ongoing debate (see, e.g., papers in Mellars and Stringer, 1989; Mellars, 1990; Bräuer and Smith, 1992; Nitecki and Nitecki, 1994; Clark and Willermet, 1997; Bar-Yosef and Pilbeam, 2000; Straus and Bar-Yosef, 2001; Straus 2005) between two competing models or conceptual frameworks: 1) the multiregional continuity model (e.g., Wolpoff, 1989; Wolpoff *et al*., 1994, 2000 and references therein) and 2) the recent African origin (RAO) or replacement model (e.g., Stringer, 1989, 1994; Stringer and Gamble, 1993; Stringer and MacKie, 1996 and references therein). Convinced that continuity is visible in the archaeological and human fossil data (Clark and Lindly, 1989a, 1989b; Frayer *et al*., 1993; Wolpoff *et al*., 2001) and supported by studies of symbolic and mortuary behavior (Lindly and Clark, 1990; Riel-Salvatore and Clark, 2001), the multiregional continuity model (MC) holds that archaic *Homo sapiens* populations in Africa and Eurasia evolved independently into anatomically modern humans and that gene flow through interactions between neighboring groups was sufficient to maintain species integrity. The differences between archaic and modern *Homo sapiens* are thus argued to be subspecific or populational, rather than specific (Hawks and Wolpoff, 2001a–b).

Emphasizing the results of genetic analyses of human mitochondrial DNA (Stringer and Andrews, 1988; Stoneking and Cann, 1989), Neanderthal DNA sequences (Krings *et al*., 1997), and 'spread-and-replace' scenarios drawn from certain construals of pattern in the archaeological record (e.g., Klein, 1992), the recent African origin model maintains that anatomically modern humans arose as a speciation event in an isolated region of east (and possibly south) Africa, and that they migrated, radiated or dispersed from Africa into Eurasia after c. 100 kya, eventually replacing all other archaic hominids over the range originally colonized by *Homo erectus.* It has also been argued that stratigraphic gaps might reflect a 'non-continuous occupation' of the Levantine sites (Bar-Yosef, 1991: 580), thus making an empirical assessment of the credibility of both models suspect (e.g., Bar-Yosef, 1991; cf., Clark, 1992).

For a long time, it was assumed that the origins of anatomically modern humans coincided with the archaeological transition from the Middle to the Upper Paleolithic in the 10 millennia bracketing 40 kya. With the help of new dating techniques, however, the emergence of anatomical modernity was uncoupled from the archaeological transition (Bar-Yosef, 1993) except, according to Bar-Yosef (2002), in Western Europe. The modern human fossils from the Israeli sites of Qafzeh and Skhul are dated to early oxygen isotope stage (OIS) 5, from 125 to 100 kya, although absolute chronological orderings that agree with stratigraphy remain elusive (cf. Jelinek, 1992; Bar-Yosef, 1992). In any event, the available evidence suggests that anatomically modern humans have been around much longer than previously thought and, given a date of c. 127 kya for the C1 Neanderthal woman at nearby Tabun (Grün *et al*., 1991; Grün and Stringer, 2000), they might have coexisted (Bar-Yosef *et al*., 1992) and interacted (Kaufman, 2001) with archaic human populations for an extended period of time. Faunal analyses indicate that, although these two human populations could have occupied neighboring territories, they might have used their environments in different ways, with modern humans practicing a strategy of circulating, seasonal, residential mobility, while archaic humans were more logistically organized, hunted more frequently, and were more residentially stable (Lieberman and Shea, 1994; Shea, 2003), thus tending to confirm the climatically-driven settlement-subsistence models for the central Negev highlands originally proposed by Marks and Freidel (1977) on the basis of archaeological survey data.

In searching for archaeological evidence that might help resolve the question of our origins, Jelinek (1977, 1981, 1982a, 1994) identified a gradual increase in the variance of the width-to-thickness ratio of complete flakes from Garrod's Layer D at Tabun cave on Mt. Carmel, Israel. This suggested a local "continuity in cultural development" (Jelinek 1982a: 1369). Despite the significant stratigraphic hiatus between Tabun D and C as documented for example by Farrand (1979), Jelinek (esp., 1981 and 1982b) and Mercier *et al.* (1995), the Mousterian levels in this site do not show an obvious intrusive element as reflected by the trend toward the production of wider and thinner flakes which was gradual and continuous over the represented sequence. Jelinek argued that this pattern of technological stability reflected a distinctive 'paleocultural' behavioral repertoire that contrasts with the fully modern 'cultural' behavior evident in the Levantine Upper Paleolithic (Jelinek, 1982a: 1375). He also suggested that in the "absence of *conclusive contrary evidence* (his italics), this trend strongly supports a local development of later more gracile hominids from earlier more robust forms” (Jelinek, 1994: 85). While technological continuity is not necessarily related to directional changes in hominid morphology (e.g., Bar-Yosef, 1989) and is, in any event, not definitive proof for multiregional continuity, it nevertheless elevates multiregional continuity as the hypothesis best supported by the available record of lithic technology. Continuity in adaptation as monitored by the archaeology is rendered more plausible when clear technological trends are present without evidence of intrusive elements. The assumption is that, if anatomically modern African immigrants were moving into the Levant and were replacing indigenous archaic populations there, they should: 1) carry with them their own distinctive cultural repertoire; 2) have a cultural repertoire that differs from that of the indigenes; and 3) be discernible in the Mousterian archaeological record as “assemblages . . . produced from local raw materials but in techniques that prevailed in the original homeland of the newcomers” (Bar-Yosef, 1994: 25).

Acknowledging that Jelinek’s index cannot be generalized to other sites, the research reported here uses the basic idea behind it (vectored change in blank morphology over time) to search for technological continuity in the evolution of laminar technology at the west-central Jordanian rockshelter site of ‘Ain Difla. The ‘Ain Difla assemblage is analyzed: 1) to determine where its chronological placement in the Levantine Mousterian falls with regard to Jelinek’s index; and 2) with regard to TL and ESR dates from the site; 3) and compared with those from Tabun and Boker Tachtit.

The null hypothesis (H_o) is that ‘Ain Difla occupies an intermediate position in the Levantine Mousterian sequence, that it dates, on average, to c. 125 kya, and that its lithic technology falls toward the middle of the Tabun sequence, being neither ‘early’ nor ‘late’. The alternative hypothesis (H_1) is that ‘Ain Difla is either ‘early’ chronologically (i.e., older than 150 kya) and technologically (resembling Tabun D) or ‘late’ chronologically (i.e., younger than 70 kya) and technologically (resembling Boker Tachtit 1 and 2). If H_o cannot be rejected, it would imply that blade-rich technologies developed continuously *in situ*, and without significant external influence, thus lending support to multiregional continuity scenarios. If H_o is rejected, and ‘Ain Difla is shown to be ‘late’ chronologically and ‘early’ technologically, that would tend to strengthen support for the relatively recent (<100 kya) Levantine colonization models that are the cornerstone of the RAO scenarios.

‘AIN DIFLA

‘Ain Difla is a Middle Paleolithic site located at c. 780 m above sea level in the Wadi Ali, a southern tributary of the Wadi Hasa in west-central Jordan. Fluctuations in the course of the Wadi Ali, now located some 17 m below the site (Fig. 1), removed much of the fill originally present in the enormous (c. 100 m long) rockshelter when human use of it ceased around 100 kya. Still, ‘Ain Difla covers an area of c. 35 m^2 while its cultural deposits span a little over 7 m at its deepest sections. The site has emerged as an important Middle Paleolithic site partly because of its deep cultural sequence and location outside the Mediterranean coastal ‘heartland’, but mainly because ‘Ain Difla has been systematically investigated and published (Coinman, 1998, 2000) in modern times by an array of specialists (Lindly and Clark, 1987, 2000; Roler and Clark, 1997; Clark *et al*., 1987, 1988, 1992, 1997; Schuldenrein, 1998; Schuldenrein and Clark, 2001, 2003) who appreciate the site’s relevance to the study of the Levantine Mousterian technology, its evolution, and its potential significance for modern human origins research.

‘Ain Difla was discovered in 1982 by G. O. Rollefson during the Wadi Hasa Survey (WHS, 1979–83) directed by B. MacDonald (MacDonald, 1980, 1988; MacDonald *et al*., 1983). The site was assigned to the Middle Paleolithic based on the absence of any later materials, and the presence of elongated Levallois points in the preliminary surface collection. Further testing and excavations were carried out in 1984 (Clark *et al*., 1987), 1986 and 1992 (Clark *et al*., 1997) by the Wadi Hasa Paleolithic Project (WHPP) directed by G. A. Clark. In the absence of clear stratigraphic distinctions, the site was dug in arbitrary 10 cm levels, with level depths recorded from a datum point on the rockshelter wall. The 1984 Test

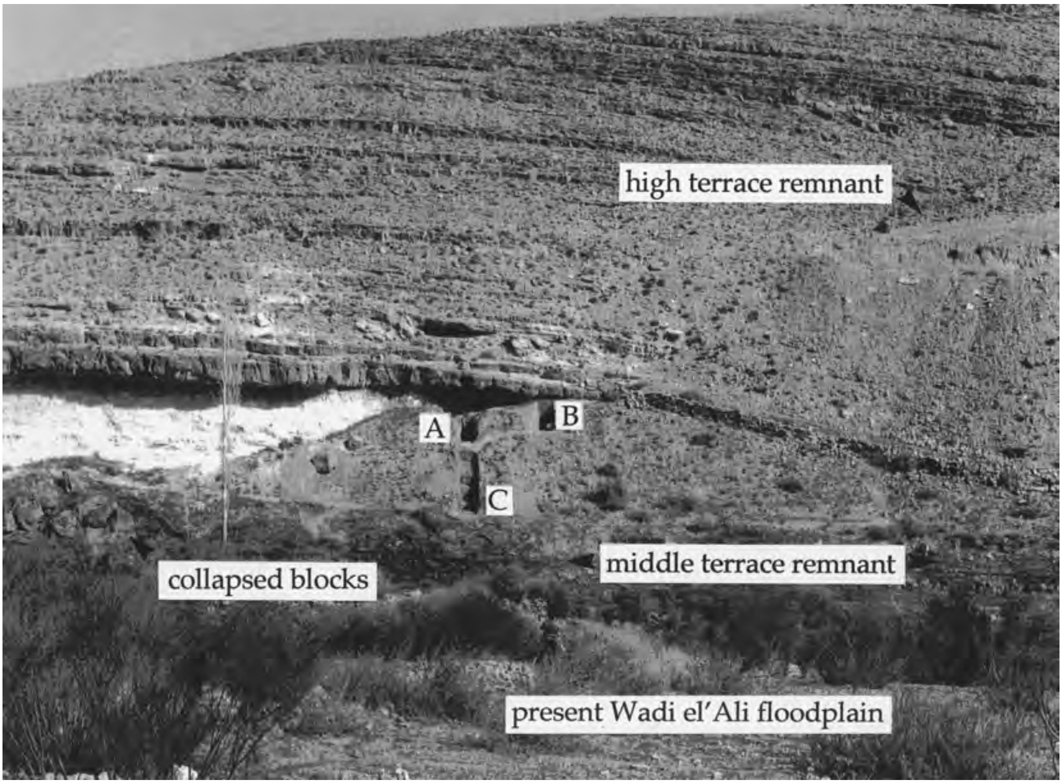
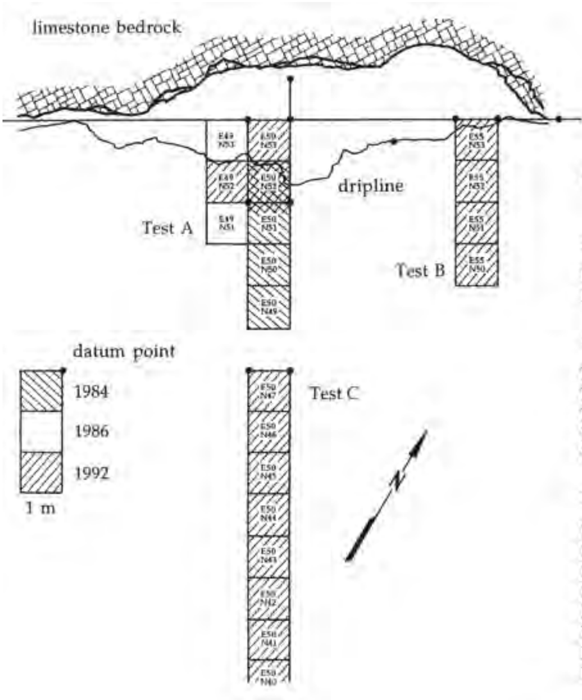


Fig. 1. View of 'Ain Difla rockshelter from the south bank of the Wadi Ali (April, 1992) showing the locations of Tests A-C, the High (12–30 m) and Middle (3–7 m) Terraces, and the present wadi flood plain (foreground). A linear pile of boulders from a major collapse of the shelter overhang can be seen to the left. The position of these rocks indicates that this particular collapse occurred during the Mousterian occupation, and that the shelter overhang extended at least 10 m beyond its present location (after Clark *et al*., 1997: 78)

A excavations produced an assemblage of 4,159 stone artifacts, while the 1986 and 1992 field seasons yielded 8,399 and 6,574 lithics respectively. Samples from a total of 19,132 lithic specimens have been studied previously (Lindly and Clark, 1987, 2000). A preliminary statistical description of the entire lithic assemblage, using standard Bordesian indices and ratios, has been published, as has the basic stratigraphy, sedimentology, landscape geomorphology and palynology (Clark *et al*., 1997: 77–86). Dated by TL and ESR to 180–90 kya (OIS 5, 6) (Clark *et al*., 1997: 91–94), 'Ain Difla is assigned to the Tabun D-type Mousterian based on the dominance of elongated Levallois points. Test locations, levels, and profile depths for the three main excavation seasons are given in Figure 2.

Several specialized studies provide additional insights on 'Ain Difla's lithics, stratigraphy and paleoenvironment. Roler and Clark (1997) undertook a use-wear analysis where a sample of 16 elongated Levallois points was examined by low power microscopy for patterns of use wear and edge damage. The marks on the tools appeared to have been caused by four basic motions, implying various broad functional categories: 1) longitudinal (slicing and/or sawing); 2) transverse (scraping); 3) longitudinal and transverse (engraving, whittling); and 4) and longitudinal and transverse (multipurpose). The elongated Levallois points were apparently used on soft, medium, or hard materials whereas the presence of polish indicates that some of the soft materials worked were plants. In agreement with previous attempts to



Ain Difla Rockshelter (WHS 634)
Units Excavated

1984

E50/N52: levels 1-5 (90 cm)
E50/N50: levels 1-6 (95 cm)

1986

E49/N53: levels 1-5 (50 cm)
E49/N52: levels 1-5, 5A-E, (no 6), 7 (90 cm)
E50/N52: levels 1-4 (balk only - 40 cm)
E50/N52 + E50/N51: levels 5, 6 (over 1 x 2 m unit - 20 cm)
E50/N50: levels 1-6 (60 cm)

1992

E49/N52: levels 9-20 (120 cm)
E50/N53: levels 4-20 (170 cm)
E50/N52: levels 11-20 (100 cm)
E50/N51: levels 16-20 (50 cm)
E55/N53: levels 1-19 (190 cm)
E55/N52: levels 13-19 (70 cm)
E55/N51: levels 13-19 (70 cm)
E55/N50: levels 15-19 (50 cm)

Fig. 2. A plan view of the ‘Ain Difla rockshelter (WHS 634): units excavated during the 1984, 1986, and 1992 field seasons in Tests A, B and C (after Clark *et al.*, 1997: 80)

identify the function(s) of Levallois points (Shea, 1988, 1990, 1998; Boëda *et al.*, 1996, 1998), the authors confirm that there is evidence for both hafting and prehension damage in their sample, but no clear cut evidence that the ‘points’ were used to tip throwing or thrusting spears.

As part of an experimental assessment of Middle Paleolithic point function using modern replicas shot into animal carcasses with a calibrated crossbow, Shea and colleagues (2001) determined that the ‘Ain Difla points overlapped with the narrower ‘broken’ experimental points, suggesting that they might have been used as knives, rather than as spear points, thus confirming the results obtained earlier by Roler and Clark (1997). Longer points preserve more cutting edge than shorter ones, and flintknappers attempting to make versatile and long-lasting knives would tend to produce elongated blanks (Shea *et al.*, 2001: 814). Finally, in an unpublished study, Eighmey (1994) sought to isolate the factors affecting resolution in high, medium and low-power microscopic techniques to determine their relative effectiveness for the analysis of large samples of lithic artifacts. To illustrate problems with standard low-power techniques, he analyzed 179 Levallois points and blades from ‘Ain Difla and found that paleolithic use-wear studies suffered from problems of: 1) replicability and detection (differentiating different kinds of microflakes and polishes was somewhat arbitrary and depended upon the experience of the investigator); 2) quantification (no consensus on variable definitions, a confounding of analytical scales); 3) sampling (the fundamental ambiguity that results from formal convergence in artifact classification); and 4) the limitations of experimental studies (a failure to hold constant boundary conditions, raw material and reduction stream variables). Despite these very real analytical difficulties, the (very broad) hafting and edge damage patterns originally identified by Roler and Clark (1997) were confirmed in the larger sample.

Sedimentology

Schuldenrein (1998) reports on the morphology and stratigraphy of a number of prehistoric sites in the Wadi al-Hasa, including ‘Ain Difla. Three primary sediment packages are observed there:

(1) surface debris including overhang spall, rubble, deflated silts and organic residues (0.0–0.6 m); deposition is a function of recent mechanical weathering, human activity and slope and surface degradation;

(2) ‘upper rubble’, organic silts and oxidized sands associated with weathering and water-laid sedimentation (0.6–1.4 m), the latter perhaps related to seasonal water flow; and

(3) ‘lower’, more consolidated flowstones and breccias capped by organic lenses and cave travertines (>1.4 m); these accumulated episodically and were subsequently calcified (Schuldenrein, 1998: 214).

A more detailed statigraphy for Test A was published after the 1984 season by Lindly and Clark (1987: 284); a synthesis of the landscape geomorphology for the Wadi Hasa drainage appeared in 2003 (Schuldenrein and Clark, 2003: 1–16). Figure 3 is a schematic of gross stratigraphy of the cultural deposits in relation to bedrock and the Middle Terrace of the Wadi Ali. Figure 4 is a geological section through the *cuesta* ridge dividing the Wadi Ali from the Wadi Wanid indicating the position of ‘Ain Difla in relation to an enormous tufa block, ESR dated to 141 ± 20 kya. The west profile of the lower extension of Test C, an 8 m long and 5 m deep geological section, is illustrated in Figure 5.

Chronology

The radiometric chronology of the Levantine Mousterian is in considerable disarray, in part at least because of very old TL dates for the appearance of the Mousterian at Tabun (Mercier *et al.*, 1995). Unfortunately, the dates from ‘Ain Difla do little to resolve this issue. Nine chronometric dates have been reported from ‘Ain Difla, all of them from Test A (Clark *et al.*, 1997). An Oxford thermoluminescence (TL) date on burnt bone is reported from level 5; eight early and linear uptake electron spin resonance (ESR) dates from McMaster University are reported from levels 12, 19, and 20. Based on these dates, the cultural deposits at ‘Ain Difla are generally thought to have accumulated episodically between 90 and 180 kya (Clark *et al.*, 1997; Henry, 1998; Lindly and Clark, 2000). Contrary to its typological and technological placement, the dates suggest that the site might correspond in time with the Tabun C-type Mousterian which, if one were to generalize from the TL chronology at Tabun, is bracketed between 170 and 90/85 kya (Bar-Yosef, 1998: 47). If the Tabun ESR chronology were to be followed, ‘Ain Difla would overlap both the Tabun C Mousterian, ESR dated from 130 to 80 kya, and the Tabun D Mousterian, ESR dated between 170 and 130 kya (Bar-Yosef, 1992, 1994). TL dates from Tabun indicate that layer D accumulated between 270 and 170 kya (Bar-Yosef, 1998: 36–37).

Pollen and fauna

A preliminary study of pollen samples recovered from levels 1 and 3 during the 1986 field season shows that the upper part of the sequence is dominated by non-arboreal taxa indicating steppe vegetation (Clark *et al.*, 1997: 88). The pollen samples hint that the rockshelter was occupied during a cool interval characterized by a relatively xeric flora dominated by Chenopodiaceae, Tubuliflorae, Artemisia, Gramineae, and Cruciferae. Dry conditions are evident from the dominance of Chenopodiaceae and Liguliflorae. This cool, dry climate could coincide with OIS 6 (186–127 kya), which would place the last use of the rockshelter toward the older estimate. The TL determination from level 5 (105 ± 10 kya) dates the latest possible occupation of ‘Ain Difla because the pocket of sediment that constitutes the site extended up to within about 50 cm of the shelter overhang. Faunal analyses are somewhat consistent with the reconstruction of a cool, dry, steppic environment. The sparse assemblage is dominated by equids (wild ass, horse or possibly zebra – *Equus hemionus/asinus; Equus* sp. indet.) and caprids (goat or ibex – *Capra* spp.), but gazelle (*Gazella* sp. indet.) are also present. Gazelle and equids (three species) are indicators of steppe or steppe/desert conditions, and are thus consistent with the dry,

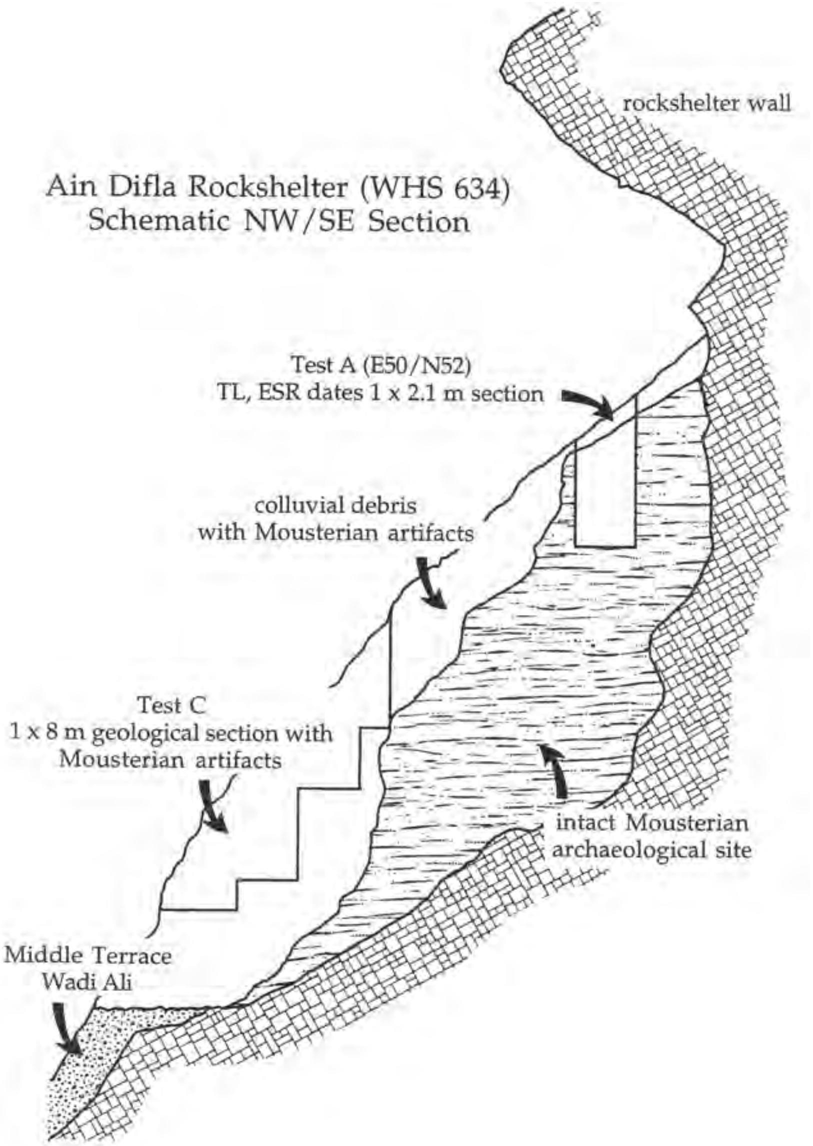


Fig. 3. A schematic NW/SE section through the ‘Ain Difla rockshelter showing gross stratigraphy in relation to bedrock and to what is probably the Middle Terrace of the Wadi Ali – not drawn to scale (after Clark *et. al*., 1997: 79)

although not necessarily cold, conditions indicated by the pollen (Clark *et al*., 1987, M. Stiner pers. comm.). Chronometric dates, pollen, and faunal analysis thus tend to converge, and would indicate a mid to late Tabun D placement, if the TL and ESR chronologies from the type site are used as a baseline for comparison.

Objectives

Our aims here are twofold. First, we attempt to shed light on the technological assignment of ‘Ain Difla with reference to the long stratigraphic sequence at Tabun and the much shorter one at the open site of Boker Tachtit (Marks 1983a). Using a sample of 3,175 artifacts (16.6% of the total) se-

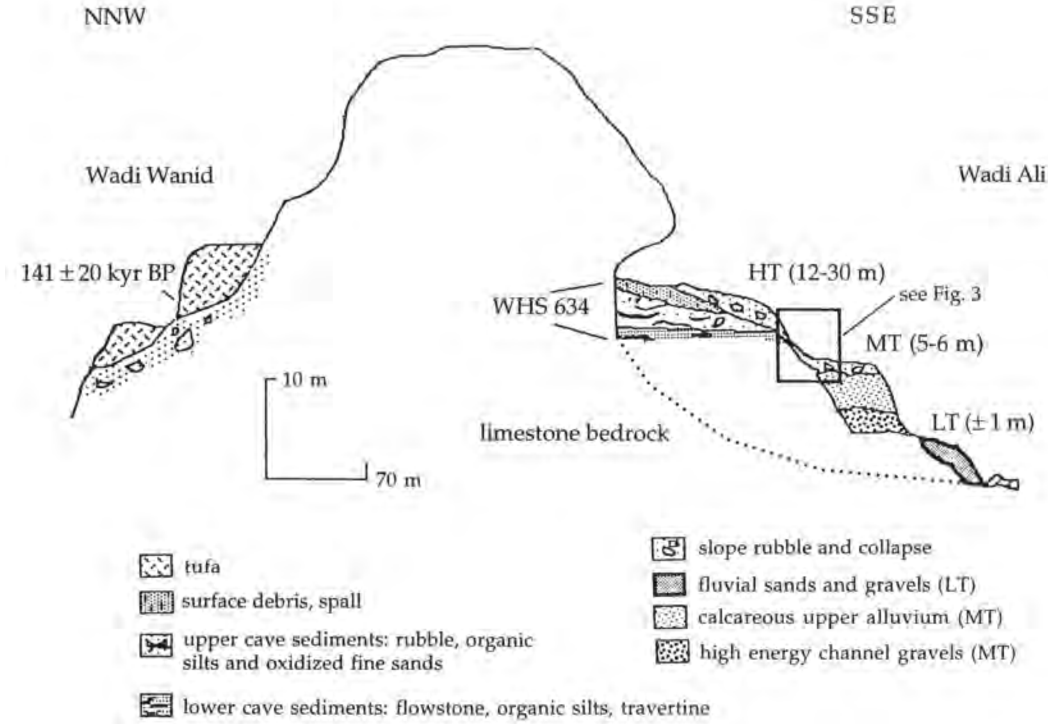


Fig. 4. A schematic NNW-SSE transect through the *cuesta* ridge separating the drainages of the Wadi Ali and the Wadi Wanid – vertical scale exaggerated (after Clark *et al*., 1997: 80)

lected on the basis of the completeness of the flakes, we describe the lithic assemblage in terms of standard typological, technological and metrical indices. While the research confirms that 'Ain Difla is a Tabun D-type Mousterian site, we also try to determine where in the Tabun TL chronology the assemblage most likely fits (i.e., is there vectored or directional change in the sequence? Is it an 'early', 'middle' or 'late' Tabun D Mousterian?). We accomplished this by comparing the tool assemblage from 'Ain Difla with those of the type site, Mugharet et-Tabun on Mount Carmel, where the layer D assemblage is 'early', and Boker Tachtit, an open 'transitional' site in the central Negev highlands, where the D-type assemblage is 'late' (Marks, 1983a, b). The well-known Tabun cave (Garrod and Bate, 1937; Jelinek, 1975, 1977, 1981, 1982a, b, 1994; Jelinek at al., 1973; Farrand, 1979; Mercier *et al*., 1995; Albert *et al*., 1999) yielded the classic Tabun D assemblage and is used here as a reference point for studying 'Ain Difla. Boker Tachtit lowermost levels 1 and 2 are also compared with 'Ain Difla to determine where the latter might 'fit' in the Tabun chronology.

Second, the study examines the nature of technological change over time. Acknowledging that it cannot be generalized, and that it is determined primarily by a host of site-specific contextual factors (e.g., raw material type, 'package' size; degree of forager mobility, size of the local group, duration of site occupation, etc.), we use Jelinek's index to determine whether or not there is a decrease in flake dimensions over time, as expected from vectored change in the variance of the width to thickness ratio of whole flakes at Tabun. The 20 levels that constitute the 'Ain Difla sequence are arbitrarily divided into lower (levels 20–16), middle (15–6), and upper (5–1) parts. These divisions are compared with Tabun layer D

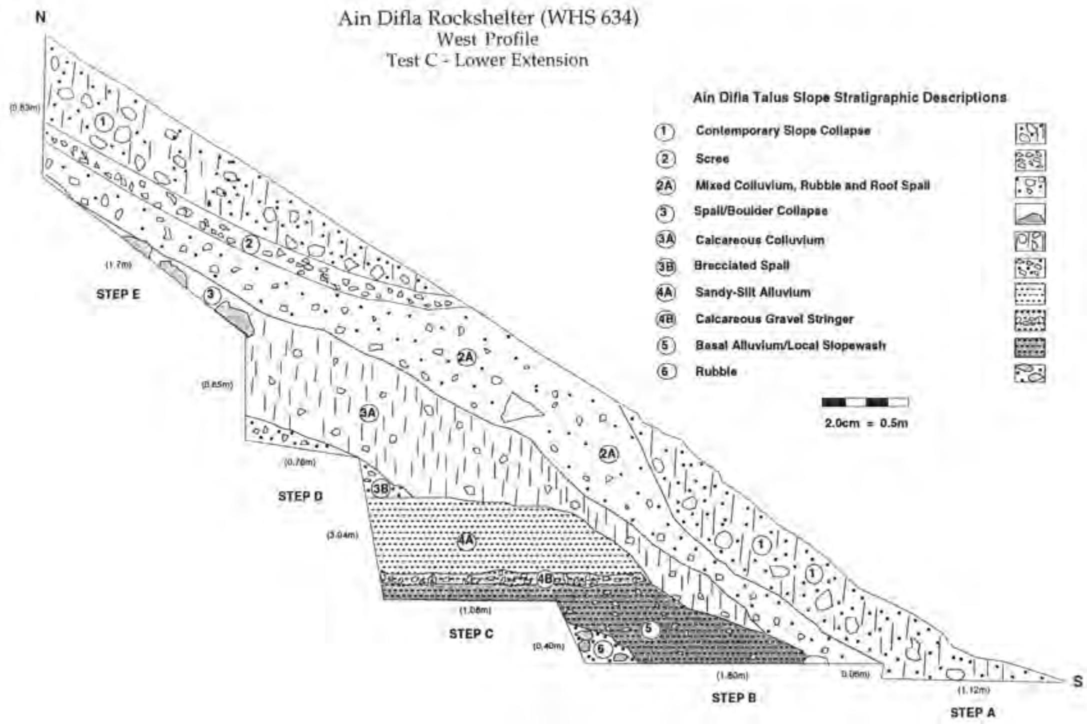


Fig. 5. ‘Ain Difla rockshelter (WHS 634) Test C, west profile, lower extension (after Clark *et al.*, 1997: 82)

and Boker Tachtit levels 1 and 2 to establish whether or not, and how closely, the lowest levels at ‘Ain Difla resemble Tabun technologically, and whether or not the upper levels resemble their counterparts at Boker Tachtit, as suggested by Monigal (2001). The three divisions are also examined for evidence indicative of intra-assemblage technological variability and/or technological change over time within the ‘Ain Difla sequence.

METHODS AND MATERIALS

The methodology employed here can best be described as an attribute/metric approach, and is based on Kuhn’s (1995) analysis of Pontinian (micromousterian) assemblages from Latium in west-central Italy. Three dimensions of this approach, namely typological, technological, metric, should provide useful information about the assemblage at hand. We also reconstruct the basic aspects of the operational sequences or *chaînes opératoires* (e.g., Audouze, 1999), starting with raw material acquisition and ending with the final discard of lithic implements.

The sample was divided into four categories: 1) cores; 2) end products or elongated elements; 3) flakes > 2 cm; and 4) debitage pieces < 2 cm. The distribution of these lithic categories in the ‘Ain Difla and Tabun samples is given in Table 1. The elongated elements generally regarded as the desired endproducts of stone tool manufacture, and often considered finished tools, includes all complete points, blades, and elongated blades (Fig. 6). The ‘Ain Difla sample analyzed here is drawn from all levels (1–20) in Tests A and B; it derives from squares E50/N52, E49/N52, E50/N51, E50/N52, E50/N53, E55/N51, E55/N52 and E55/N53 (see Fig. 2). The Tabun sample is also an elongated endproduct sample of all retouched and complete flakes, blades, and points from Garrod’s layer D, (layers 66–68 in Jelinek’s terminology [1982a]). Data on Boker Tachtit were taken from published sources (Marks, 1983a).

Table 1
The composition of the ‘Ain Difla and Tabun lithic samples pertinent to this study

Artifact Samples	*n*	%
'Ain Difla		
Cores	66	2.1
Elongated elements	182	5.7
Flakes >2cm	1,310	41.3
Debitage <2cm	1,617	50.9
Total	3,175	100.0
Tabun		
Elongated elements	168	100.0

Table 2
The distribution of core types at ‘Ain Difla

Core Type	*n*	%
Tested	10	15.15
Centripetal Levallois	6	9.1
Levallois point core	9	13.6
Levallois, unidirectional or bidirectional	17	25.75
Single/double platform	12	18.2
Prismatic blade core	8	12.1
Amorphous	4	6.1
Total	66	100.0

Table 3
Elongated element blank form frequencies at ‘Ain Difla levels 1 to 20 and Tabun D layers 66 to 68

Blank form	'Ain Difla		Tabun	
	n	%	*n*	%
Cortical blade and/or blade	0	0	1	0.6
Naturally backed flake	0	0	1	0.6
Naturally backed blade	0	0	8	4.8
Plain flake	0	0	3	1.8
Plain blade	3	1.6	46	27.5
Levallois flake	9	4.9	14	8.4
Levallois blade	27	14.8	64	38.3
Broad Levallois point	4	2.2	6	3.6
Elongated Levallois point	110	60.4	17	10.2
Pseudo Levallois point	3	1.6	0	0
Eclat debordant	0	0	1	0.6
Crested blade	0	0	1	0.6
Flake fragment	26	14.3	4	2.4
Nahr Ibrahim	0	0	1	0.6
Total	182	100.0	167	100.0

Core morphology and blade technology

All cores were placed into a category according to their morphological attributes. Tested, centripetal Levallois, Levallois point, uni- or bidirectional Levallois, single and double platform, prismatic blade, and amorphous cores were noted at ‘Ain Difla (Tab. 2). Similarly, all tools were assigned to a given blank form based on their morphological attributes (Tab. 3). Cortical flakes and blades, naturally backed flakes and blades, plain flakes and blades, Levallois flakes and blades, broad, elongated, and pseudo Levallois points, *éclats debordants* or core edges, and crested blade or core trimming elements were observed at ‘Ain Difla and Tabun. Here we follow the volumetric definition of Levallois typology (Boëda, 1995). It has been argued that Levallois lithic production is an efficient core reduction strategy that enables toolmakers to minimize raw material waste while maximizing tool blank and cutting edge productivity (Brantingham and Kuhn, 2001).

Technology – qualitative variables

To reconstruct the core reduction strategies and lithic technologies at ‘Ain Difla, the following 11 qualitative and six quantitative attributes were observed: (1) raw material type was recorded in terms of color of the flint, which at ‘Ain Difla was gray, brown, dark brown semi-translucent, tan ‘spotty’ opaque and reddish brown. Data on (2) burning were collected for each artifact (i.e., whether a piece was burned, discolored and/or pot lidded, fire shattered or unburned). The (3) condition of each piece was also recorded (i.e., whole, proximal, distal, medial, and split), and the (4) platform type was scored as cortical, plain, dihedral, faceted, *châpeau de gendarme*, linear, or

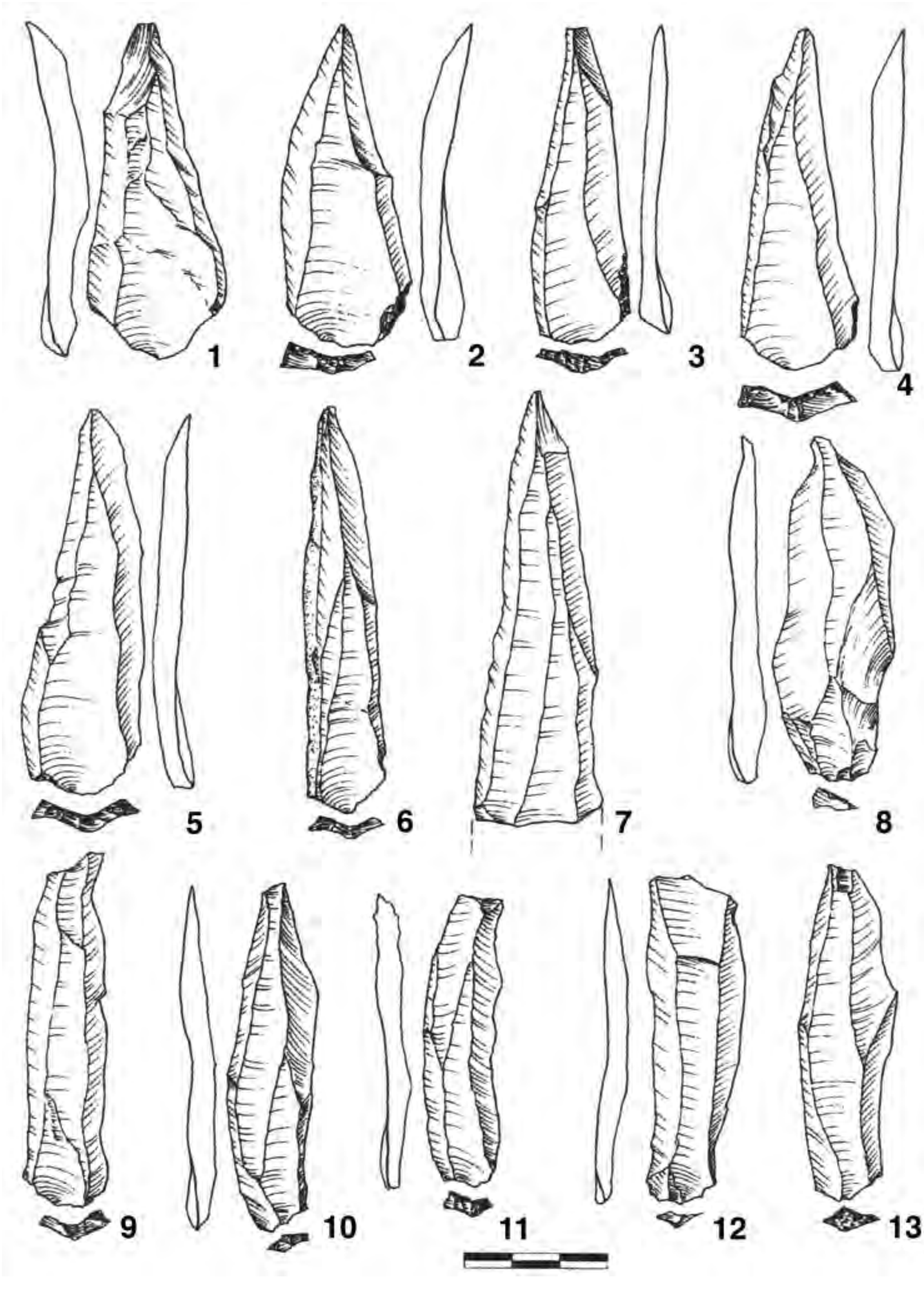


Fig. 6. Bidirectional and elongated ‘Ain Difla Levallois points (1, 4–7) and blades (8–13) (after Monigal, 2002: Fig. 11-7)

Fig. 7. Observed platform types at 'Ain Difla (after Monigal, 2002: Fig. 6-1)

punctiform (Fig. 7). The (5) percentage of dorsal surface cortex was recorded. The (6) number and origin point of dorsal scars (i.e., proximal, proximal plus distal trimming, bidirectional, orthogonal, centripetal, and lateral) (Fig. 8) and (7) orientation (i.e., parallel, convergent symmetrical and asymmetrical, and multidirectional) (Fig. 9) were noted for each piece. Observations about (8) retouch types and (9) edge damage were made. For cores, raw material type, condition, and cortex readings were scored like the analogous variables

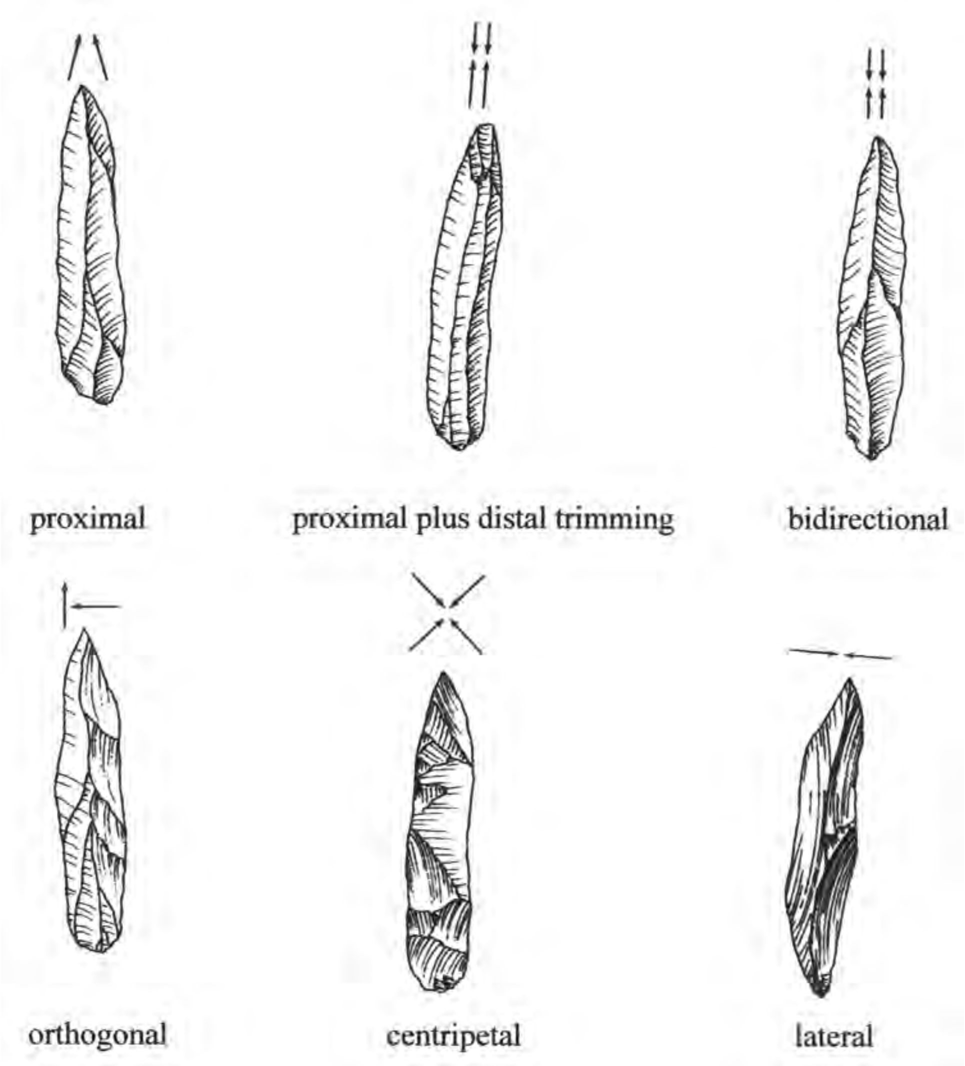


Fig. 8. Origin of dorsal scar types observed at 'Ain Difla (after Monigal, 2002: Fig. 6-6)

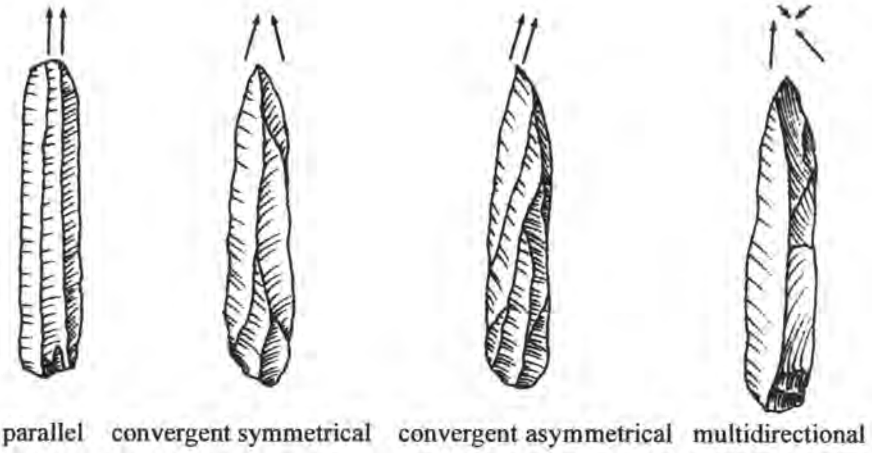


Fig. 9. Schematics of dorsal scar orientations observed at ‘Ain Difla (after Monigal, 2002: Fig. 6-6)

on blanks. Cores were also analyzed in terms of (10) reduction (i.e., tested, lightly exploited, moderately and heavily used) and (11) platform orientation (i.e., one platform, opposed same face, opposed offset, opposed opposite faces, orthogonal, variable, and centripetal; Fig. 10).

Technology – quantitative variables

The metrical dimension of this study incorporates length, width, and thickness of all pieces following Andrefsky (1998; see Fig. 11). 1) technical length is defined as the maximum distance from the proximal to the distal end along a line

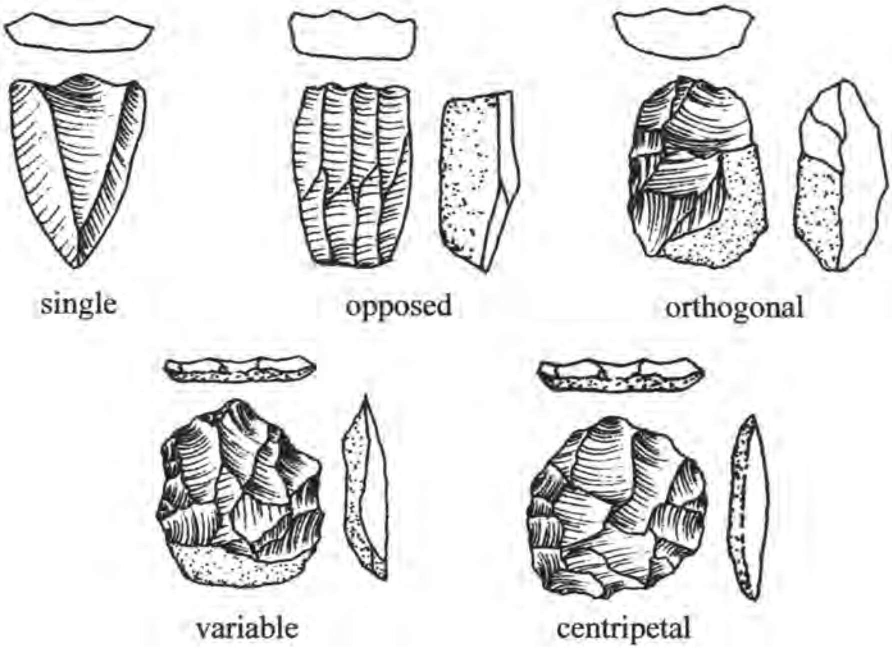


Fig. 10. Schematics of core platform orientation types observed at ‘Ain Difla (after Monigal, 2002: Fig. 6-12)

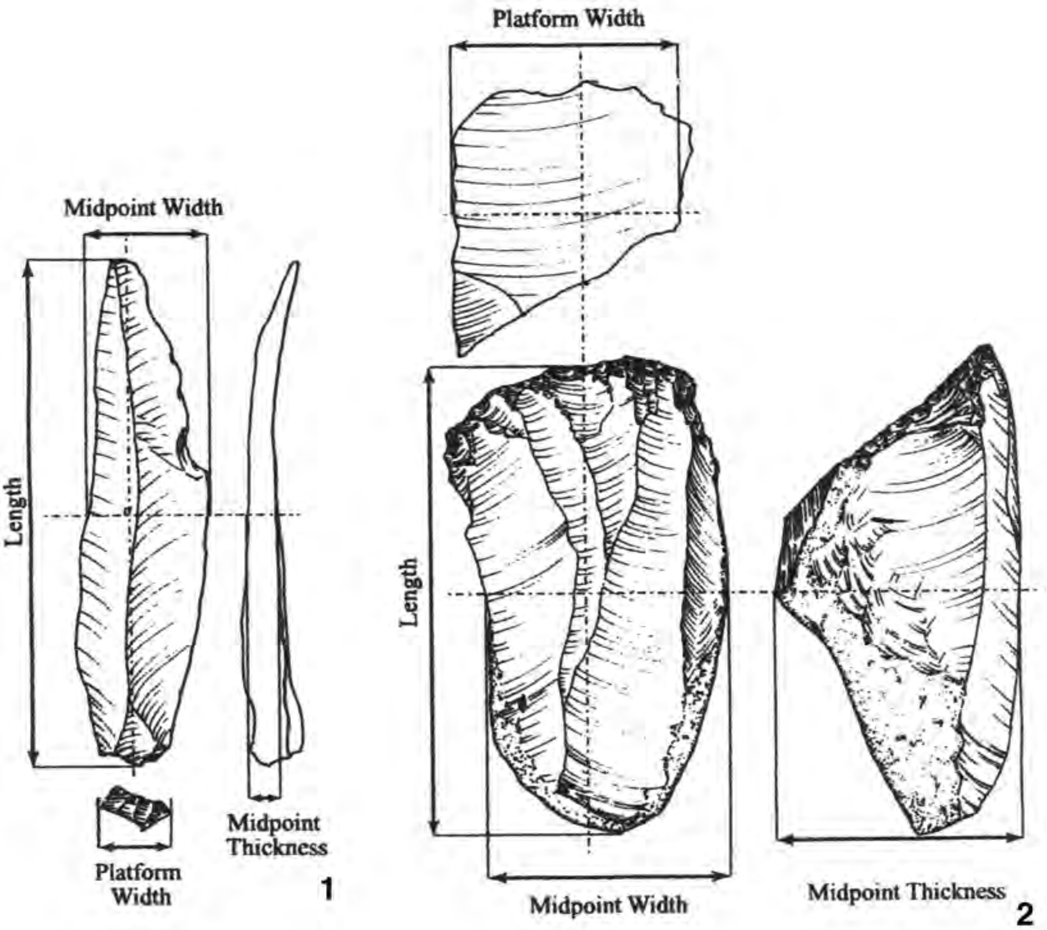


Fig. 11. Schematics of metrical measurements for blades and flakes (1) and cores (2) (after Monigal, 2002: Fig. 6-8 and 6-13)

perpendicular to striking platform width; 2) width is measured across the interior face, perpendicular to length at the mid-point of the length; 3) thickness is measured perpendicular to the plane of length and width at the mid-point of length. Complete flakes are those where all three of the above variables can be measured. For cores, maximum width, length and thickness were recorded, following Andrefsky (1998); 4) maximum length is defined as the maximum distance from the proximal to the distal end of the core along a line that is perpendicular to the striking platform width; 5) maximum thickness and width are measured at the mid-point of the length perpendicular to the plane of length.

The core reduction sequence can be inferred from the analysis of the distribution of the above-mentioned attributes. Cores themselves contain information about the end of the reduction sequence, and were classified according to the number, direction, and orientation of the negative scars left by previous removals, the amount of residual cortex, and the morphology of the striking platform. Dorsal scar orientation and origin on elongated elements allows us to infer the core reduction strategy during the production of blanks and finished tools. The earliest stages of the reduction strategy can be reconstructed from attributes on primary flakes.

Table 4

Statistical parameters for ‘Ain Difla cores’ maximum width, length, and thickness

Measure	**Mean**	**Median**	**Variance**	**Maximum**	**Minimum**	***n***
Width	42.6	40.5	109.4	82	25	66
Length	53.0	53.5	107.6	80	31	66
Thickness	26.6	25.0	58.9	53	11	66

Monitoring diachronic change

To examine technological change over time, the cultural sequence at ‘Ain Difla was divided into three parts: the uppermost part comprises levels 1–5, the middle portion levels 6–15, and the lowermost segment levels 16–20. The distribution of technological attributes can then be compared across the sequence using χ^2 tests. Chi-square allows for assessment of the significance of differences or similarities between the three partitions of the stratigraphic sequence. These partitions can also be compared with Tabun and Boker Tachtit. If the lowermost layers at ‘Ain Difla show strong technological similarities to Tabun while the uppermost layers resemble those at Boker Tachtit, this would be consistent with the directional change in Mousterian technology suggested by Jelinek’s index. The metrical comparison between sites compares the mean values of every observed attribute, while the results of the categorical comparisons are tested for significance using the χ^2 test.

RESULTS

Table 4 presents the statistical parameters of the ‘Ain Difla core assemblage. In terms of morphological and technological attributes the cores are lightly (39.4%) to moderately exploited (34.8%). Tested (13.6%) and heavily used or completely exhausted cores (10.6%) are also present. Most of the cores (53%) contain anywhere from > zero to 25% cortex. The rest of the collection (47%) is about equally divided between cores with no cortex and those with cortex > 25%.

Most of the ‘Ain Difla implements (81%) are made on a gray, semi-translucent flint, as are a substantial number (42%) of the elongated elements, flakes and debitage. Brown semi-translucent flint is the next most frequently used raw material (32%). Tan spotty opaque flint, reddish brown and dark brown flints are also present, although they are not common.

Combining all lithic categories, 95% of the sample shows no evidence of burning. About 4% of the pieces analyzed are discolored, pot lidded or both, and only 12 pieces (.004%) out of the total of 3,175 are fire shattered, which would be consistent with prolonged and/or recurring exposure to fire. About 12% of the lithics are patinated, suggesting relatively prolonged exposure to physical and/or chemical weathering prior to deposition. A large plurality (47%) of the blanks are whole, while the remainder are about equally divided among proximal, distal, medial, and split pieces (27%), and indeterminate fragments (26%).

Aggregating the flakes and blades ≥ 2 cm with preserved platforms (i.e., all whole and proximal specimens), a significant plurality (44%) have plain platforms, followed by those with faceted platforms (26%) and by dihedral platform types with one plain and one cortical facet (15%). Cortical, *châpeau de gendarme*, linear, and punctiform platforms together account for the remaining 15% of the sample.

Generally speaking, there is quite a bit of cortex on the ‘Ain Difla lithics, probably indicating either relatively small ‘package’ sizes and/or relatively early stages in the reduction sequences. While most of the blank sample (65%) lacks dorsal cortex, 20% of the pieces analyzed have 0-25% cortex, and the remaining 15% more than 25% of their dorsal surfaces covered in cortex. Primary elements (specimens with more than 50% dorsal cortex) are absent. Cores with significant amounts of cortical surface are also uncommon, suggesting that most chert nodules were heavily exploited and reduced to exhaustion before being discarded. The absence of primary elements suggests that initial decortication might have taken place away from the rockshelter or at least away

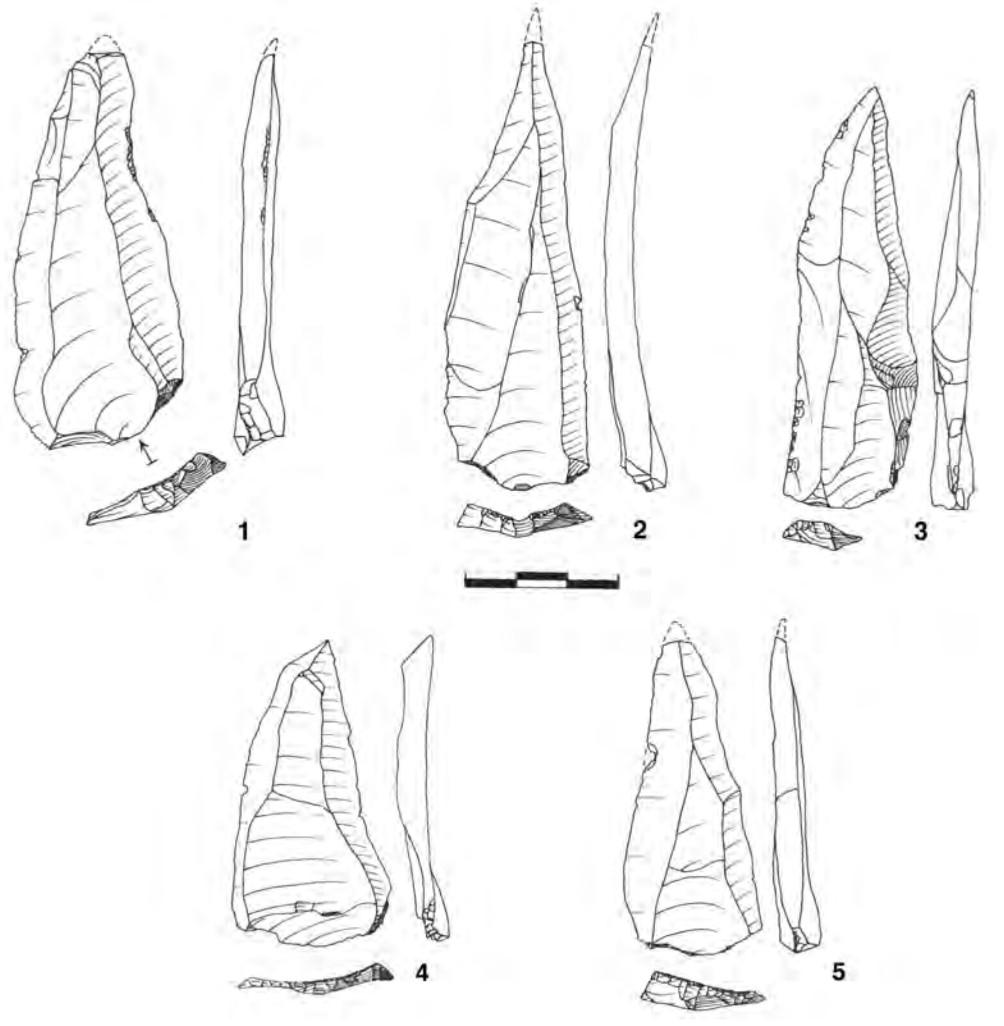


Fig. 12. ‘Ain Difla elongated elements with convergent asymmetrical scar patterns from layer 20 (1, 4), layer 19 (2, 5) and layer 12 (3)

from the preserved pocket of sediment that constitutes the archaeological site. While not uncommon in the Levantine Mousterian (e.g., Hovers, 1998: 145), no cortical pieces were recovered from the site peripheries during the three major field seasons.

At ‘Ain Difla, blanks were produced throughout the sequence using a convergent reduction strategy as determined from the orientation of dorsal scars. Seventy-one percent of the end products exhibit convergent symmetrical dorsal scars. However, the picture becomes more complex when end products and flakes > 2 cm are combined. Dorsal scar orientations are predominantly multi-directional (38%) and parallel (31%), followed by convergent asymmetrical (Fig. 12). Dorsal scar origins among end products are bidirectional (39%; Figs. 6 and 13), followed by proximal only, suggesting that unidirectional reduction is also present at ‘Ain Difla. When end products and flakes are combined, proximal origins are most common (30%), followed by the centripetal (23%) and bidirectional (13%) categories (Fig. 14).

‘Ain Difla is by no means an extensively retouched assemblage. When it is present at all,

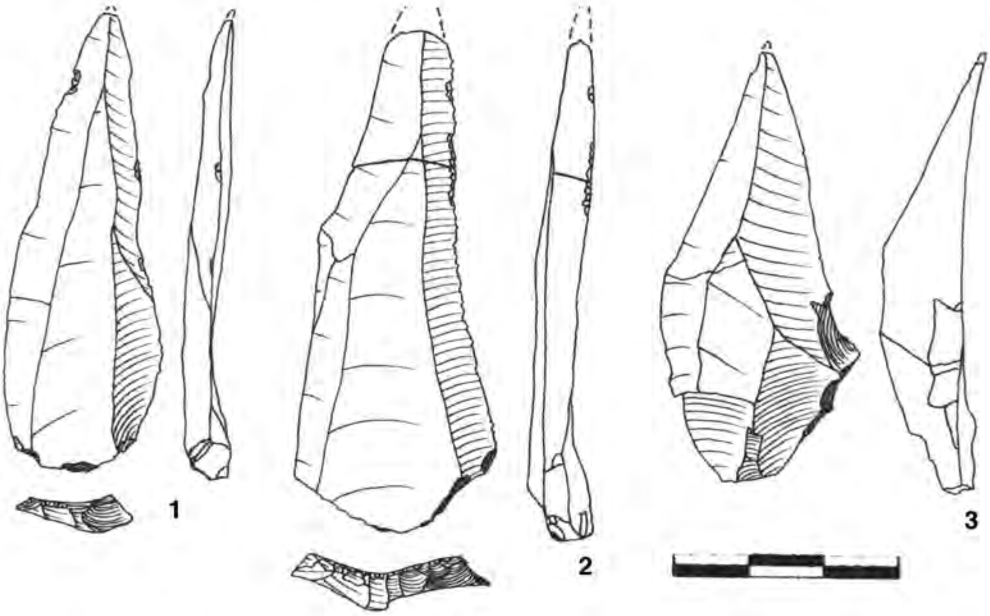


Fig. 13. Additional bidirectional implements from ‘Ain Difla’s layers 10 (1), 17 (2) and 4 (3)

retouch is overwhelmingly simple and scalar. Only 10 out of 182 endproducts (5.5%) show some evidence for retouch, most commonly discontinuous over less than half the edge’s length. The scarcity of retouched pieces at ‘Ain Difla supports Bar-Yosef’s observation that Levantine Mousterian cave sites are typically more heavily retouched assemblages in comparison to rockshelters and open-air sites (O. Bar-Yosef, pers. comm.). Pieces with possible use wear are generally rare, but constitute 28% of all points and 12% of all flakes ≥ 2 cm. The sample shows some evidence of edge damage (25% of the tools, 28% of the flakes) that might indicate possible trampling, rolling, and/or abrasion.

DISCUSSION

‘Ain Difla compared with Tabun and Boker Tachtit

To better understand where ‘Ain Difla fits in the Levantine Mousterian, it is compared with the Tabun type sequence, the longest in the region. Based on her excavations there in the 1930s, Garrod divided the Levantine Mousterian into three temporally-ordered facies: Tabun D, C, and B-type Mousterian (Garrod and Bate, 1937; Jelinek, 1982b; Bar-Yosef, 1995, 1996, 1998). Tabun D-type Mousterian was initially defined by:

> . . . an abundance of Levallois points, frequently elongated; high proportions of blades, frequently with plain platforms; high proportions of Upper Paleolithic tool types; and, by inference, relatively low frequencies of broad, radially prepared, Levallois flakes (Jelinek, 1982b: 74).

‘Ain Difla reflects this characterization quite well with the exception of a relatively higher incidence of prepared platforms. Levallois points dominate the tool category and most of them (61%) are elongated (i.e., length ≥ 2 x width). This figure compares favorably with other Tabun D sites like Tabun, Rosh Ein Mor, and Tor Abou Sif (Tab. 5). Length to width ratios for complete Levallois points and width to thickness ratios for complete flakes also support a Tabun D assignment, although ‘Ain Difla flakes tend, on average, to be slightly smaller (Tab. 6). The ‘Ain Difla assemblage can be characterized as ‘blade dominated’ since it shows a high incidence (40%) of

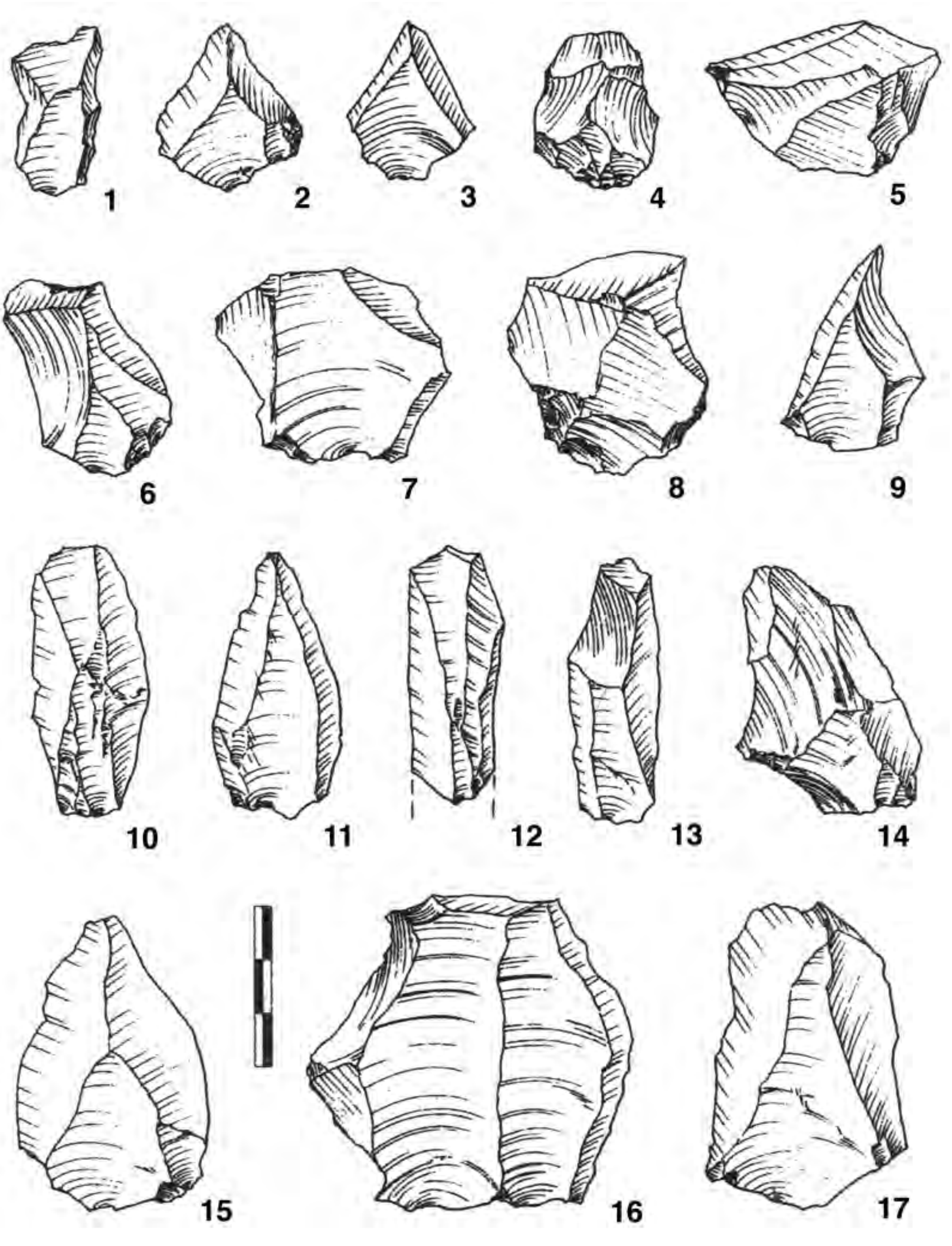


Fig. 14. ʻAin Difla Levallois flakes with proximal (3, 10, 11, 17), centripetal (1, 4–8, 13, 14, 16), and bidirectional (2, 9, 12, 15) scar origins (after Monigal, 2002: Fig. 11-8). Note: 6, 8, and 14 are marginally retouched

Table 5

Comparison of length to medial width ratios of complete Levallois points among Tabun type D Mousterian sites

Site and Bed	Mean	Median	% Elongate	*n*	Variance
'Ain Difla 1-20	3.43	3.26	60.9	110	1.248
Tabun IX*	2.45	2.33	34.1	179	na
Rosh Ein Mor*	2.41	2.39	36.4	11	na
Nahal Aqev 3*	2.48	2.48	28.2	39	na
Abou Sif B*	2.70	2.57	43.4	76	na
Abou Sif C*	2.69	2.67	40	50	na
'Ain Difla 16-20	2.92	2.93	37	24	0.29
'Ain Difla 6-15	3.14	3.04	57	42	1.03
'Ain Difla 1-5	4.00	3.67	79	44	1.46

(*after Jelinek 1982b: 93:Table XVII)

Table 6

The width to thickness ratios for complete flakes from ‘Ain Difla and other Tabun type D Mousterian sites in the Levant

Site and Bed	Mean	Median	Variance	*n*
Ain Difla 1-20	3.885	3.625	3.17	907
Tabun IX*	4.25	3.99	3.13	743
Rosh Ein Mor*	4.44	4.11	4.24	373
Nahal Aqev3*	4.925	4.72	3.90	332
Abou Sif B*	4.51	4.00	3.34	214
Abou Sif C*	4.13	3.875	1.73	173
'Ain Difla 16-20	3.83	3.60	2.58	285
'Ain Difla 6-15	3.995	3.67	3.86	511
'Ain Difla 1-5	3.74	3.50	1.46	109

(*after Jelinek 1982b: 95:Table XVIII)

lamellar elements, taken in the earlier literature as indicative of ‘Upper Paleolithic tendencies’ (for discussion, see Meignen, 1998; Bar-Yosef and Kuhn, 1999). The scarce retouched tools (Clark *et al*., 1997: 84) comprise sidescrapers, endscrapers, burins, perforators, and naturally backed knives (Fig. 15).

While the ‘Ain Difla assemblage conforms pretty well to known Tabun D characteristics as defined at Tabun, it differs in respect of a much higher incidence of prepared platforms (Fig. 16). ‘Ain Difla end product platforms are predominantly of the faceted and *châpeau de gendarme* types (87%), and not plain, as are those from other Tabun D assemblages. An exception is whole flakes ≥ 2 cm in length, where only 27% have prepared platforms.

Published reports on other Tabun D-type assemblages from Rosh Ein Mor (Crew, 1976; Marks and Monigal, 1995), Hayonim (Meignen, 1998), and Douara (Akazawa, 1979, 1987; Nishiaki, 1989) allow for a more exhaustive definition of this Levantine Mousterian facies:

Typical blanks were obtained from essentially unipolar convergent cores with evidence for bi-directional flaking that is often predominantly Levallois but could be non-Levallois in certain assemblages. The bi-directional flaking often ad-

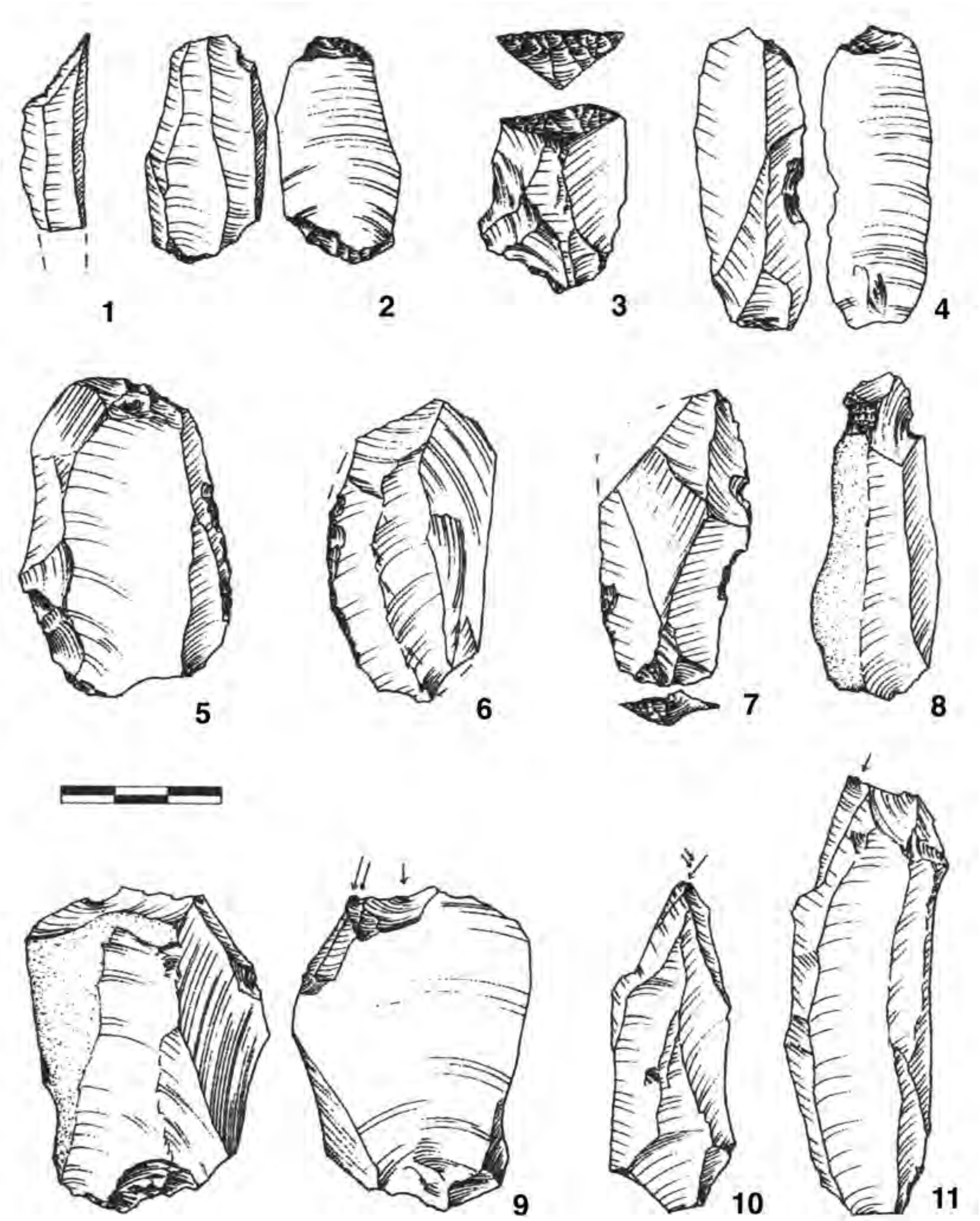


Fig. 15. ‘Ain Difla tools: perforator (1), endscrapers (2–3), sidescraper (6), notched blades (4, 8), discontinuously retouched Levallois flakes (5, 7), and burins (9–11) (after Monigal, 2002: Fig. 11-9)

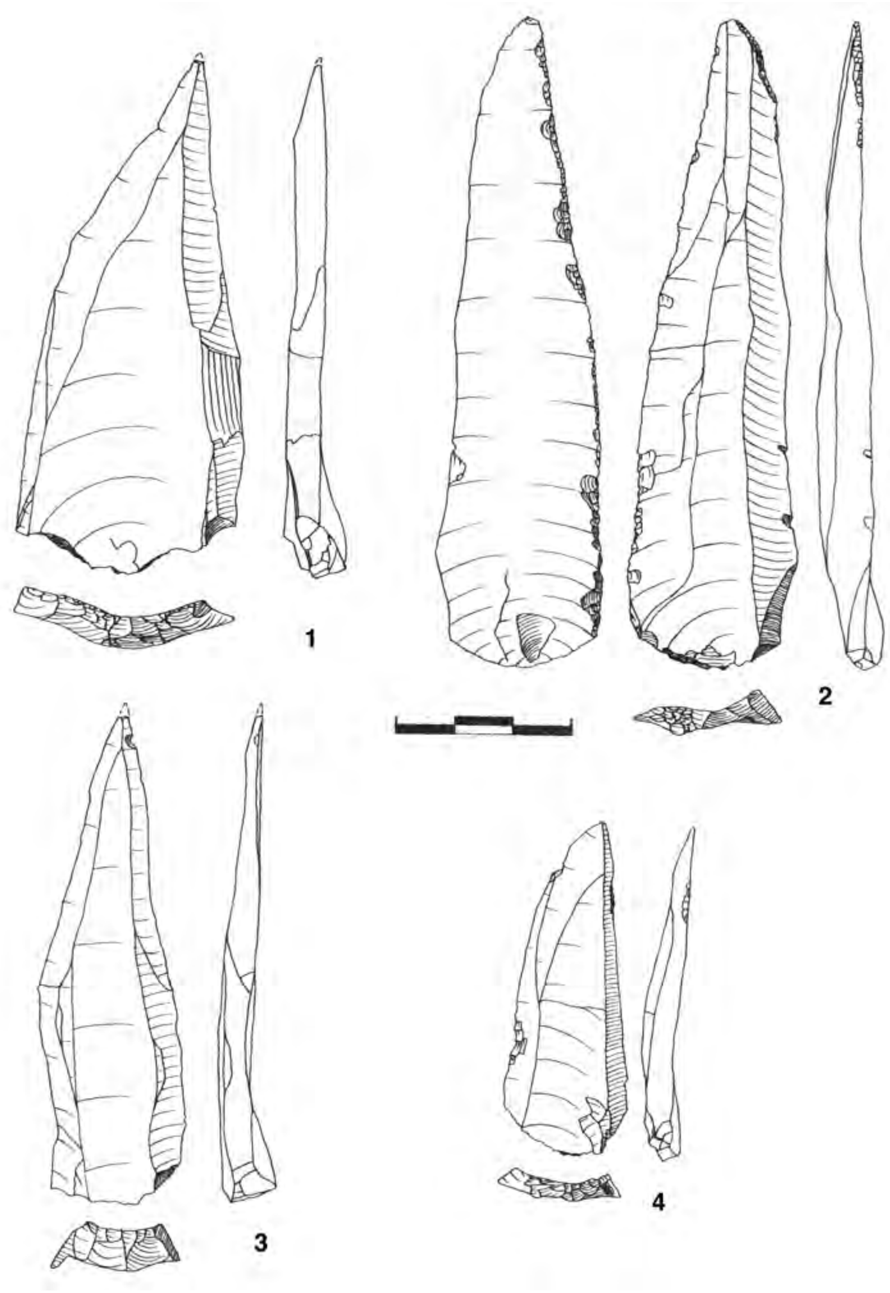


Fig. 16. Elongated ‘Ain Difla lithics with prepared platforms from layers 16 (1) and 4 (2, 3)

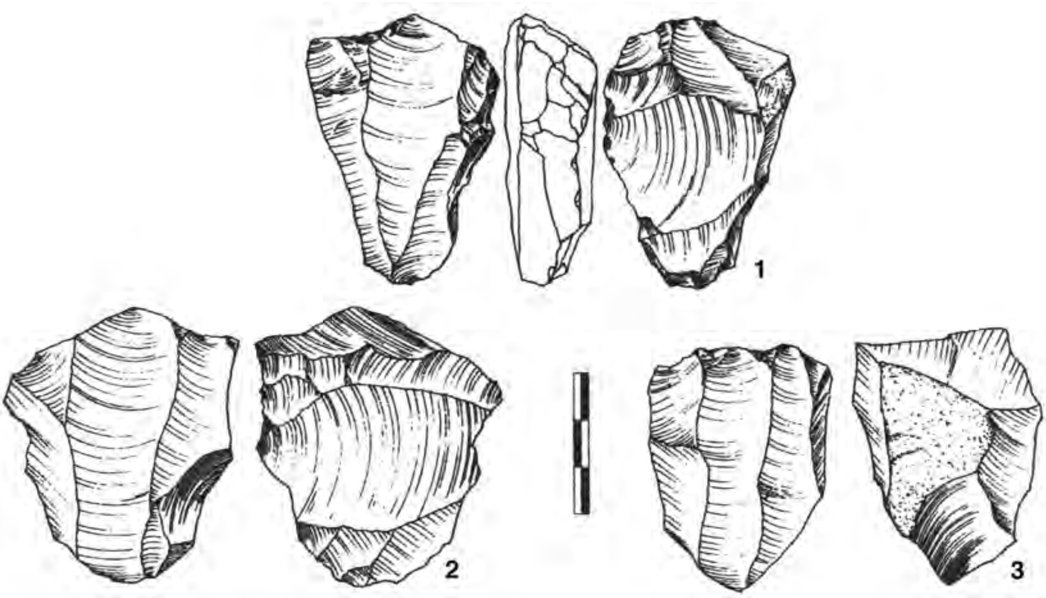


Fig. 17. Opposed platform point cores (1, 2) and single platform unidirectional core (3) at ‘Ain Difla (after Monigal, 2002: Figs. 11-4 and 11-3)

dressed the need for shaping the opposite end of the core in order to secure the removal of elongated, pointed blades. Minimal preparation is evident on the striking platforms. The blanks are classified as blades and elongated points. In some cases the presence of crested blades indicates a change in the volumetric concept of the reduction sequence to one that corresponds to the prismatic volume that characterizes the Upper Paleolithic blade industries (Bar-Yosef, 1998: 44; cf. Meignen, 1994).

Although intersite variability has been noted in the Tabun type D Mousterian (e.g., Akazawa, 1979: 24; Marks, 1981), the above-mentioned characteristics are now generally considered to identify this particular Levantine facies.

How well do the ‘Ain Difla lithics concur with the revised definition just given? Most ‘Ain Difla cores are of the Levallois type; combining all Levallois cores, they account for 48.5% of the core total. Tabun D core attributes confirmed at ‘Ain Difla include predominantly Levallois cores with light platform preparation; uni- and bidirectional Levallois cores make up the largest plurality of the core assemblage (25.7%; Fig. 17). Many cores (42.4%) have only one identifiable striking platform; however, cores with two striking platforms account for 33.3% of the core total. Levallois point and prismatic blade cores are also present at ‘Ain Difla (Fig. 18).

Having established that blanks were obtained primarily from both uni- and bipolar cores, dorsal scar orientation can be used to determine core reduction strategies at ‘Ain Difla. Where the orientation of dorsal scars could be determined, most (84.1%) of the end product component of the assemblage does indeed show convergent dorsal scar orientation (Tab. 7). A good number of the end products (39.6%) show bidirectional reduction, while proximal or unidirectional detachments account for 44%.

Are other Tabun D Mousterian characteristics also present at ‘Ain Difla? Forty-two percent of the cores have only a single identifiable platform while opposed platform cores account for an additional 39%. Perhaps, like other Tabun D assemblages, the opposite end of the core was shaped in order to secure the removal of elongated pointed blades. Demidenko and Usik (1993) also report the presence of crested blades at ‘Ain Difla – artifacts often associated with the Upper Paleolithic technologies. A curious feature of the ‘Ain Difla

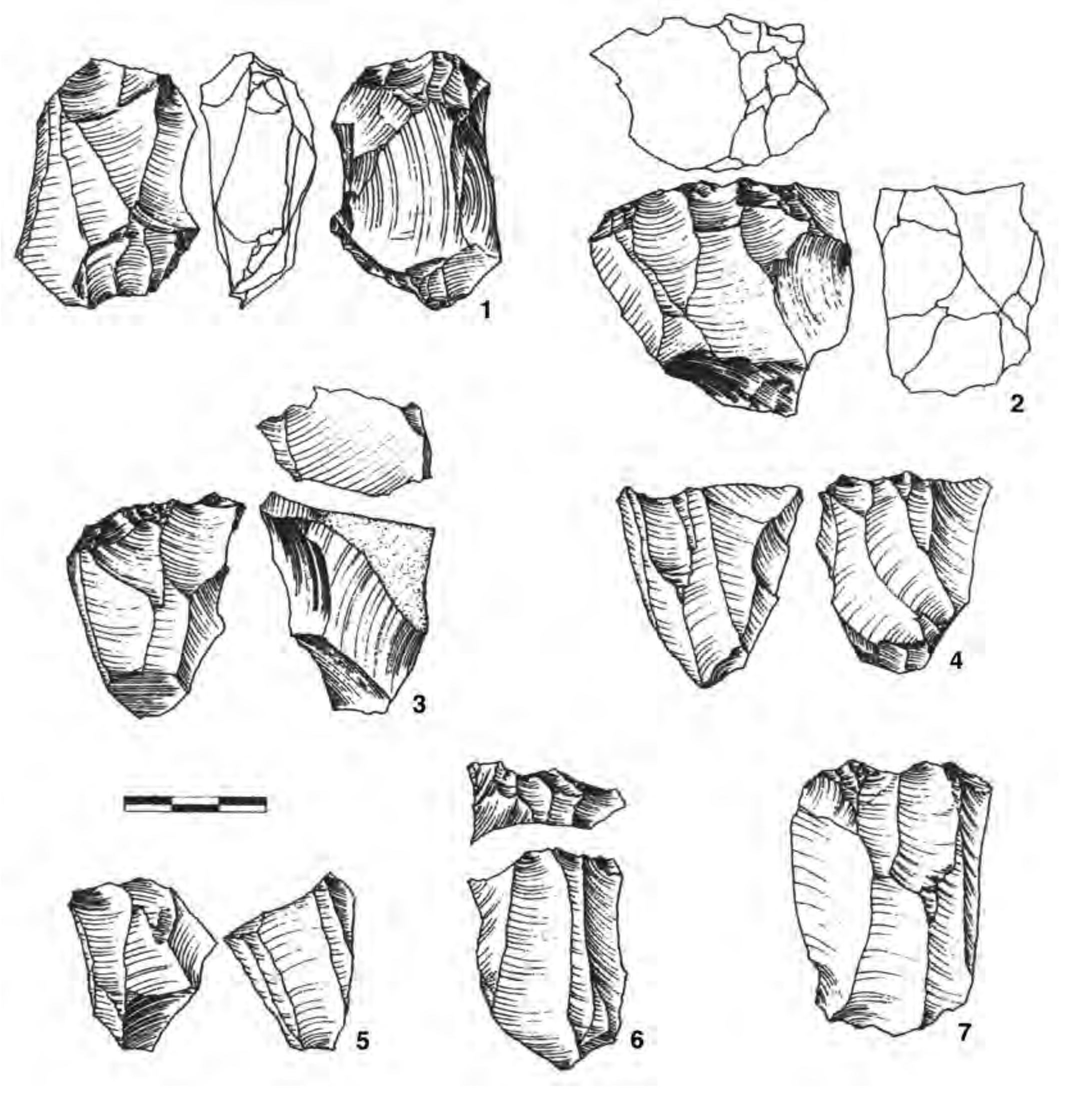


Fig. 18. ‘Ain Difla cores: opposed platform core (1, 7), opposed platform partial prismatic cores (4-5), and partial prismatic single platform cores (2, 3, 6) (after Monigal, 2002: Fig. 11-4 and 11-3)

cores is the presence of a crested back on six cores derived from the uppermost layers. Significantly, crested blades and crested backs were also observed in the lowermost level 1 at Boker Tachtit, where crested backs were produced after the preparation of two opposing platforms. The subsequent removal of these crested backs resulted in typical *lames à crète* (Marks, 1983a: 71; Fig. 19).

Additional metrical comparisons presented on Tables 5 and 6 show that the mean length to width ratios of complete Levallois points across all Tabun D Mousterian sites lies within one standard deviation of the ‘Ain Difla mean, as does the mean width to thickness ratios of whole flakes, suggesting statistical affinities across the sample of sites analyzed, despite ‘Ain Difla’s slightly higher elongation index and smaller flakes. Variability within the Tabun D (see, e.g., Akazawa, 1979; Clark *et al.*, 1997; Meignen, 1995, 1998; Bar-Yosef, 1998) and other Levantine Mous-

Table 7

Elongated element technological attribute frequencies at 'Ain Difla's lower, middle and upper levels

Attribute/Levels	Lower 20–15		Middle 14–6		Upper 1–5	
	n	%	*n*	%	*n*	%
Platform Type						
Missing	5		6		1	
Cortical	0		0		0	
Plain	1		2		1	
Dihedral	3		3		1	
Faceted	66	81	36	68	45	94
Châpeau de gendarme	6		6		0	
Scar Origin						
Proximal	21	26	29	54	14	29
Proximal with distal trimming	1		0		0	
Bidirectional	36	44	15	28	21	43
Orthogonal	3		4		0	
Centripetal	1		0		0	
Indeterminate	19		5		13	
Scar orientation						
Parallel	10		4		2	
Convergent symmetrical	49	60	42	79	39	81
Convergent asymmetrical	12		5		6	
Multi-directional	5		2		1	
Indeterminate	5		0		0	
Total	81		53		48	

terian sites (i.e., Meignen and Bar-Yosef, 1992), has been noted before and may be attributed to a complex nexus of factors including duration of site-use and associated activity variation (Kuhn, 1991), desired tool blank morphology (Kuhn, 1992), 'package size' and quality of available raw material (i.e. Kuhn, 1994; Kuhn *et al*., 1996), behavioral factors affecting style or lithic production including use and discard patterns (i.e., Shea, 1992, 1995), technological shifts, and the formal convergence (Clark, 2002: 62, 63) that is a part of all lithic technology. Technological variability among Tabun D Mousterian sites is clearly documented in core reduction strategies. At Hayonim, for example, a laminar system of blade production in a volumetric concept is recognized, as opposed to the Levallois elongated blank production noted here and at sites in the central Negev highlands (Meignen, 1998: 177).

Technological variation within the 'Ain Difla sequence

The results presented here are consistent with previous studies (Lindly and Clark, 1987, 2000; Clark *et al*., 1997) that align 'Ain Difla with the Tabun type D Mousterian. Although these *en bloc* comparisons are useful for crude site characterizations, it is also reasonable to ask whether or not the entire 'Ain Difla sequence is technologically homogeneous, or whether there are discernible technological changes over time in the tripartite division of the assemblage? The sequence at 'Ain Difla presents a good opportunity to tackle this question. The 20 levels recorded in 2 m deep Test A probably accumulated episodically over several tens of millennia during the 180–190 kya interval. In a much deeper (27 m) sequence at Tabun, Jelinek's index indicated a gradual and uninterrupted progression towards thinner flakes. Index com-

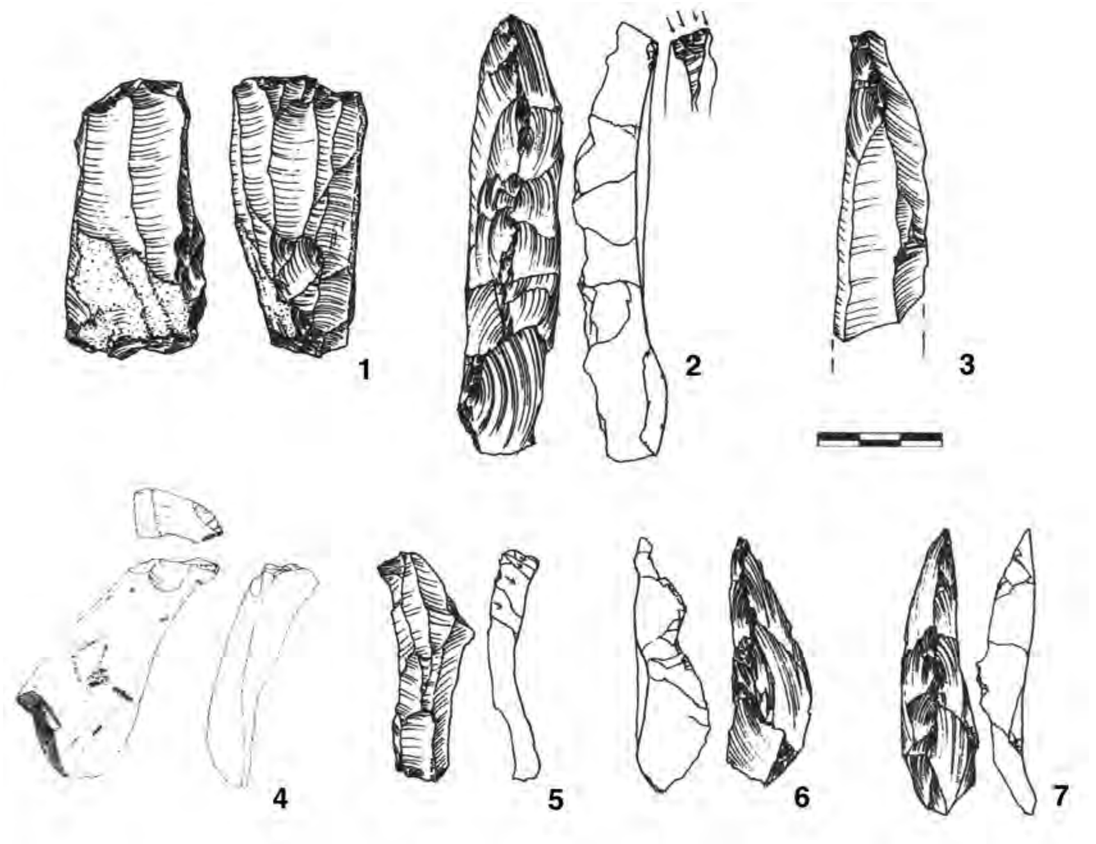


Fig. 19. ‘Ain Difla cores with crested back (1), core trimming elements (4–6) and *lames à crête* (2–3, 7) (after Monigal, 2002: Figs. 11-5 and 11-3 and Demidenko and Usik, 1993: Figs. 2–3)

parisons with other sites aiming to establish whether or not this trend was part of a broader, regional pattern have so far showed negative results. Schroeder (1969) analyzed the Middle Paleolithic sequence at Jerf Ajla (Syria), and concluded that the time trend noted at Tabun was not apparent there. At ‘Ain Difla, too, the ratio decreases over time, thus contradicting the pattern noted at Tabun (Tab. 8). One distinction between Tabun, on the one hand, and Jerf Ajla and ‘Ain Difla, on the other, is that in the long Tabun sequence many episodic occupations were reported, while the other two sequences are relatively ‘short’ (tens of thousands *versus* hundreds of thousands of years).

The distribution of platform types, scar origins, and scar orientations for the elongated endproducts (Tab. 9) and flakes > 2 cm in length was also traced over time at ‘Ain Difla (Tab. 10). Faceted platform types are dominant on elongated elements across all three stratigraphic divisions, as indicated by χ^2 tests comparing elongated element platform types by level block. No significant change over time is evident for the lower/middle comparison ($\chi^2 = 0.5$, $p=0.99$), nor for the middle/upper comparison ($\chi^2=2.2$, $p=0.99$). Elongated element scar origins are predominantly bidirectional in the lower and upper levels, and proximal in the middle levels. The middle section is significantly different from the lower section ($\chi^2=4.8$, $p=0.91$ for the lower/upper comparison; $\chi^2=18.14$, $p=0.035$ for the lower/middle comparison, $\chi^2=7.8$, $p=0.64$ for the upper/middle comparison). While there is a significant increase in the incidence of convergent symmetrical blanks from bottom to top, this scar pattern is the dominant type in all three sections.

Table 8

Statistical parameters by stratigraphic layer of the width to thickness ratio of complete flakes > 2 cm in length

Levels	Mean	Median	Variance	*n*
1-2	3.25	2.79	2.74	10
3-4	3.76	3.50	1.66	53
5-6	3.64	3.50	1.54	108
7-8	3.59	3.545	1.74	51
9-10	3.54	3.57	1.91	35
11-12	4.02	3.75	2.99	138
13-14	4.19	3.67	6.85	129
15-16	3.98	3.545	3.34	177
17-18	4.00	3.68	2.63	130
19-20	3.63	3.82	2.49	74

Table 9

Elongated element technological frequencies for ‘Ain Difla and Tabun D without the indeterminate elements

Attribute	‘Ain Difla				Tabun D
Levels	1-20	1-5	6-15	16-20	
Platform type					
Plain	4	1	2	1	52
Dihedral	7	1	3	3	17
Faceted	147	51	45	43	83
Châpeau de gendarme	12	2	6	4	8
Total	170	55	56	51	160
Scar Origin					
Proximal	64	18	34	9	88
Bidirectional	72	24	15	29	19
Orthogonal	7	1	4	2	17
Centripetal	1	0	0	1	2
Total	144	43	53	41	126

So far as flake platforms are concerned, plain platforms dominate in the lower and middle levels, while faceted platforms become more common in the upper levels. There is also a change in scar origins. Whereas the lower section is centripetal, the upper two sections are predominantly proximal, and increasingly so over time. Scar orientations are predominantly multidirectional in all three sections of the stratigraphy, although the incidence of multidirectional scar patterns decreases over time as parallel and convergent asymmetrical dorsal scar orientations are well represented in the flake assemblage.

‘Ain Difla – ‘Early’ versus ‘Late’?

Given its nearly unique position east of the Jordan Valley, there has been some discussion whether ‘Ain Difla represents an ‘early’ or a ‘late’ Tabun D assemblage (see esp. Clark *et al*., 1997; Lindly and Clark, 2000). Much of the discussion is rendered moot, however, because there is no

Table 10

Flake technological attribute frequencies at ‘Ain Difla’s lower, middle and upper levels

Attribute/Levels	Lower	20–15	Middle	14–6	Upper	1–5
	n	%	*n*	%	*n*	%
Platform Type						
Missing	2		14		1	
Cortical	23		40		3	
Plain	88	35	221	48	13	27
Dihedral	55	22	80	17	10	25
Faceted	72	29	91	20	19	40
Châpeau de gendarme	2		0		0	
Linear	1		0		0	
Punctiform	5		17		0	
Scar Origin						
Proximal	68	27	150	32	21	45
Proximal and distal trimming	7		6		0	
Bidirectional	47	19	43	9	7	14
Orthogonal	30		19		2	
Centripetal	79	32	97	21	4	
Lateral	1		1		0	
Indeterminate	17		146		13	
Scar orientation						
Parallel	48	19	127	27	13	27
Convergent symmetrical	16		25		8	
Convergent asymmetrical	52	21	86	18	8	17
Multi-directional	114	45	164	35	14	29
Indeterminate	19		61		4	
Total	249		463		47	

consensus as to what constitutes ‘early’ and ‘late’ because of the confusing chronology at the type site (Bar-Yosef, 1994). By the mid-1990s, and depending upon the dating technique used, the temporal span of the Mousterian at Tabun had increased more than three-fold since Jelinek’s publications in the early 1980s (Mercier *et al.*, 1995). A comparison of the width to thickness ratios of whole flakes from ‘Ain Difla and other D-type Mousterian sites shows that ‘Ain Difla has the smallest ratio (3.9) in the group, although it does not depart significantly from those of the rest of the sites (Tab. 6). The ‘Ain Difla blanks tend to be either narrower or thicker compared to those from other sites. The presence of bidirectional flaking at ‘Ain Difla has been cited as evidence for a late temporal assignment (Lindly and Clark, 2000: 116–117), as has the pollen from the upper level block (levels 1–5; Lindly and Clark, 1987). The elongated elements analyzed here are for the most part bidirectional. However, TL and ESR dates (90–180 kya) from ‘Ain Difla now fall more toward the middle (120–195 kya) of the current Mousterian temporal range (c. 47–270 kyr BP; Clark *et al.*, 1997; Bar-Yosef, 2006: 307–308). The ‘Ain Difla assemblage can also be compared with the very early Tabun D Mousterian from the type site, and with Boker Tachtit levels 1 and 2, a much later open site in the central Negev highlands (Marks, 1983a). A stronger affinity between ‘Ain Difla and Tabun would suggest that ‘Ain Difla is an early Mousterian site, while similarities

Table 11

Summary of elongated elements typological and technological frequencies for ‘Ain Difla all levels and Tabun D

Attribute	Category	'Ain Difla	Tabun
Burning	Unburned	179	165
	Burned	3	3
Cortex	No cortex	164	122
	>25%	14	40
	25-50%	4	6
Platform	Cortical	0	3
	Plain	4	53
	Dihedral	7	17
	Faceted	147	84
	Châpeau de gendarme	12	8
Number of scars	<4	54	43
	4-5	91	79
	>5	36	45
Scar Orientation	Parallel	16	76
	Convergent symmetrical	130	29
	Convergent asymmetrical	23	41
	Multi-directional	8	22
	Indeterminate	5	0
Scar Origin	Proximal	64	88
	Proximal plus distal trimming	1	18
	Bidirectional	72	19
	Orthogonal	7	17
	Centripetal	1	2
	Indeterminate	37	23
Retouch Type	No retouch	171	104
	Fine marginal	0	3
	Simple scalar	10	52
	Undercut/stepped	1	6
	Burin	0	1
Retouch Distribution	No retouch	171	104
	Sporadic	0	1
	Discontinuous	0	5
	Continuous	11	58
Edge Damage	No Damage	84	62
	Possible use wear	53	84
	Possible trampling	45	17
Condition	Whole	148	156
	Proximal	22	9
	Distal	10	2
	Medial	2	0
	Split	0	1
Total		182	168

Table 12

Average blade metrics and standard deviations for ‘Ain Difla and Boker Tachtit Levels 1 and 2

Site and Bed			Blank Metrics		Platform Metrics	
	Length/sd	Width/sd	Thickness/sd	*n*	Length/sd	*n*
'Ain Difla 1-20	67.3/13.1	21.6/5.9	6.9/3.5	272	18.1/7.1	272
Boker Tachtit* Level 1	52.5/23.5	19.4/9.4	5.8/3.5	262	10.8/5.9	188
Boker Tachtit* Level 2	51.5/21.2	19.8/8.7	6.5/3.6	968	12.0/6.2	855
'Ain Difla 1-5	69.4/12.5	19.7/5.1	5.6/1.9	76	18.7/5.7	76
'Ain Difla 6-15	66.1/13.7	21.3/5.9	7.1/2.9	112	16.9/6.9	112
'Ain Difla 16-20	67.0/12.5	23.8/5.9	7.7/4.7	85	19.2/8.0	85

(*after Marks 1983a: 346, 349:Table B-5, B-9)

with the oldest levels at Boker Tachtit would suggest just the opposite.

Table 11 summarizes the technological attribute frequencies from the ‘Ain Difla and Tabun samples of elongated elements. Frequencies of burning, cortex and platform morphology are similarly distributed in both assemblages. Where ‘Ain Difla and Tabun differ is in the origins of dorsal scars and the incidence of retouch. At Tabun, most dorsal scars originate from the proximal end of the piece, while at ‘Ain Difla they are more often bidirectional. Dorsal scar origin, too, is more convergently symmetrical at ‘Ain Difla in comparison with Tabun. The comparison of blank form frequencies (Tab. 3) shows that both sites have substantial numbers of blade-like pieces, but those from ‘Ain Difla are predominantly elongated (i.e., length at least 3x width) while at Tabun only a small fraction actually corresponds with the formal definition of an elongated blade. ‘Ain Difla also has a higher incidence of prepared platforms and a significantly different distribution of elongated element platform types than does Tabun. Chi-square tests between the two sites showed no similarities on these variables or on comparisons of the elongated elements across ‘Ain Difla level blocks, either individually or in aggregate, with the elongated element sample from Tabun. A comparison of the distribution of scar origins among the elongated element samples from ‘Ain Difla and Tabun showed significant differences between all parts of the assemblages except for the middle levels (6–15) at ‘Ain Difla, which were statistically similar to Tabun D (χ^2=5.6, p=0.85). The selected finished tool sample from Tabun is heavily retouched while its counterpart from ‘Ain Difla is not. The differences in retouch, however, are restricted to the small samples chosen for comparison. If a larger and more diverse Tabun lithic sample were to be selected (e.g., one including flakes > 2 cm), then the incidence of retouch would not appear as overwhelming as it does among the finished tool sample actually analyzed. The strong metrical affinities between Levallois points (Tab. 5) and flakes (Tab. 6) noted above also underscores technological similarities.

Boker Tachtit

The comparison of ‘Ain Difla with Boker Tachtit layers 1 and 2 also shows some overall technological similarities between the two sites. There are two dimensions to this comparison: metrical and categorical. The metrical study compares length, width, thickness and platform width of whole blades (Tab. 12) and flakes (Tab. 13). At Boker Tachtit, blades were defined as flakes with a maximum length equal to or exceeding twice its maximum width, a maximum length ≥ 50 mm and a maximum width ≥ 12 mm (Marks, 1983a). A blade sample meeting these definitional requirements was selected from ‘Ain Difla and the analysis were extended to include whole flakes > 2 cm from both sites. Note, however, that width and thickness at Boker Tachtit are maximum dimensions recorded at any point along or parallel to the axis of the blow whereas at ‘Ain Difla the width and thickness of any piece was measured at the midpoint of length.

Table 12 shows some striking similarities between blade metrics at ‘Ain Difla and Boker

Table 13

Average whole flake metrics for ‘Ain Difla and Boker Tachtit

Site and level	Blank Metrics				Platform Metrics	
	Length/sd	Width/sd	Thickness/sd	*n*	Length/sd	*n*
'Ain Difla 1-20	44.1/18.9	22.1/10.6	6.4/3.3	906	15.7/7.6	906
Boker Tachtit* Level 1	33.0/13.5	28.5/12.7	6.2/4.6	586	15.5/9.6	451
Boker Tachtit* Level 2	35.5/15.2	30.9/13.5	6.6/4.0	2,404	17.2/9.9	2,121
'Ain Difla 1-5	59.1/19.1	19.1/ 6.0	5.4/2.1	109	17.6/6.0	109
'Ain Difla 6-15	40.3/17.4	22.1/12.1	6.3/3.3	511	14.8/7.4	511
'Ain Difla 16-20	45.0/18.2	23.1/ 8.6	6.9/3.8	286	16.5/8.4	286

(*after Marks 1983a: 347, 349: Table B-6, B-9)

Table 14

Whole flake typological and technological attribute frequencies for ‘Ain Difla and Boker Tachtit

Attribute	1–20	Level 1	Level 2	1–5	6–15	16–20
Platform type						
Cortical	66	59	149	3	40	23
Plain or simple	326	225	1,000	14	223	89
Dihedral	152	63	493	11	83	58
Faceted/multiple	310	104	484	77	129	104
Châpeau de gendarme	12	na	na	2	5	5
Punctiform	23	na	na	1	17	5
Total	889	451	2,126	108	497	284
Scar Pattern						
Proximal/unidirectional	295	292	1,127	42	176	75
Proximal plus distal trimming	14	na	na	0	7	7
Bidirectional	158	62	415	33	56	68
Orthogonal	58	na	na	3	23	32
Centripetal	181	na	na	4	97	80
Lateral	2	na	na	0	1	1
Total	708	354	1,542	82	360	263

(*after Marks 1983a: 344: Table B-2)

Tachtit. The means for length, width, and thickness at ‘Ain Difla (all levels) are within one standard deviation of the corresponding means at Boker Tachtit (levels 1–2). Basal width at ‘Ain Difla compares well with the same measure at Boker Tachtit; level 2 of Boker Tachtit is closer to the ‘Ain Difla mean (within one standard deviation) than level 1. The blade comparison of Boker Tachtit (levels 1–2) with ‘Ain Difla’s lower, middle and upper sections shows that the five uppermost levels at ‘Ain Difla most closely resemble Boker Tachtit in terms of blade width and thickness measures.

Similarly, the metrical comparison of flakes shows that Boker Tachtit’s average values are within one standard deviation of ‘Ain Difla’s means for length, width, thickness, and platform length (Tab. 13). Level 1 at Boker Tachtit is almost identical to ‘Ain Difla in terms of flake thickness and platform width which, combined with the results of the blade comparisons above, confirm the presence of significant metrical

Table 15

Blade typological and technological attribute frequencies for ‘Ain Difla and Boker Tachtit

	‘Ain Difla	Boker Tachtit*		‘Ain Difla		
Attribute	1–20	Level 1	Level 2	1–5	6–15	16–20
Platform type						
Cortical	10	7	22	1	3	6
Plain or simple	45	79	355	6	27	12
Dihedral	25	23	155	5	12	8
Faceted or multiple	174	79	320	62	60	52
Châpeau de gendarme	10	na	na	1	4	5
Punctiform	7	na	na	1	5	1
Total	271	188	852	76	111	84
Scar Pattern						
Proximal	101	98	369	31	49	27
Prox. + dist. trimming	5	na	na	0	4	1
Bidirectional	89	99	404	28	36	32
Orthogonal	19	na	na	3	11	6
Centripetal	17	na	na	5	9	11
Lateral	0	na	na	0	0	0
Total	231	197	773	67	109	77

(*after Marks 1983a: Table B-1, pg. 343)

affinities between the two sites. Unlike the blade comparison, however, the mean values for flakes in the upper levels at ‘Ain Difla do not more closely resemble those from Boker Tachtit with the exception of platform width and blade thickness.

The second dimension of the comparison examines the distribution of platform types among flakes > 2 cm in length (Tab. 14) and whole blades (Tab. 15). Although a number of different platform types were observed at ‘Ain Difla and Boker Tachtit, only plain, dihedral, and faceted types were compared because only these types were recorded in similar ways. The frequencies of observed platform types and scar patterns in ‘Ain Difla’s lower, middle and upper sections and at Boker Tachtit levels 1 and 2 are given in Table 14. The chi-square test can be used to test for differences and/or similarities in the distribution of platform types, but the system used to record scar patterns is very different between the two sites. Where comparisons could be made, the results of the χ^2 test show that ‘Ain Difla as a whole, and Boker Tachtit levels 1 and 2 are different.

However, there are no significant differences in the distribution of platform types between ‘Ain Difla levels 1–5 and Boker Tachtit level 1 (χ^2=10.8, p=0.37), ‘Ain Difla levels 6–15 and Boker Tachtit level 1 (χ^2=3.2, p=0.98), and ‘Ain Difla levels 6–15 and Boker Tachtit level 2 (χ^2=8.9, p=0.54) (Tab. 14). Chi-square is used to test for differences and similarities in the distribution of plain, dihedral, and faceted platforms at the two sites. It shows that there are significant differences between ‘Ain Difla’s lower and upper level blocks, and with Boker Tachtit levels 1 and 2. ‘Ain Difla’s middle section (levels 6–15) and Boker Tachtit level 1 are not significantly different from one another (χ^2=8.25, p=0.60).

CONCLUSIONS

Most Tabun D-type Mousterian characteristics are present at ‘Ain Difla. Metrical comparisons between ‘Ain Difla and other well-known Tabun D Mousterian sites showed that the site fits well within this Mousterian facies. A significant affinity was noted in the distribution of scar origins for the elongated samples in ‘Ain Difla’s middle section (levels 6–15) and Tabun D.

In an effort to determine its relative chronological placement, each of the lower, middle, and upper level blocks at ‘Ain Difla was compared to Tabun and to Boker Tachtit (levels 1–2). Both the length to width ratio comparison for complete Levallois points and the width to thickness ratio for complete flakes suggest that lowermost levels 16–20 at ‘Ain Difla are more similar to Tabun D Mousterian sites overall than are the rest of its cultural deposits. The grand mean for Tabun D Mousterian sites is within one standard deviation of those at ‘Ain Difla, suggesting strong affinities among the sites in question. ‘Ain Difla levels 1–5 also yielded a number of cores with crested backs; Boker Tachtit level 1 is also known to contain similar cores (Marks, 1983a: 71). Metrical comparison of flakes and blades showed that the uppermost layers at ‘Ain Difla most closely resemble Boker Tachtit overall. This assessment, however, is limited to only two variables, namely flake platform widths and blade width to thickness ratios.

Categorical comparisons between ‘Ain Difla, Tabun D and Boker Tachtit showed that there are some significant statistical affinities among the three sites, although they do not extend to all the technological attributes. Similarities in the distribution of flake platform types were noted between ‘Ain Difla’s upper levels and Boker Tachtit level 1, as well as between ‘Ain Difla’s middle levels and Boker Tachtit levels 1 and 2. ‘Ain Difla’s middle section and Boker Tachtit level 1 resembled one another with respect to blade platform types.

By themselves, these comparisons do little to resolve the question of the temporal placement of ‘Ain Difla because, on most measures, it is intermediate between Tabun layer D (early) and Boker Tachtit levels 1 and 2 (late). When chronometric, pollen and faunal data are combined with these statistical assessments, an intermediate placement is also indicated. Coinman and Fox (2000) have suggested that the evolution of laminar technologies in the Levant is roughly linear, and that ‘Ain Difla can be viewed as a ‘bridge’ linking the early and late Levantine Mousterian, and leading up to the initial Upper Paleolithic Ahmarian.

To the very arguable extent that changes in lithic industries can be correlated with changes in human biology, the *in situ* evolution of blade-rich Mousterian industries culminating in the Ahmarian perhaps lends more support to the multiregional continuity model (e.g., Thorne and Wolpoff, 2003) than to the RAO model (e.g., Klein 1992) as an explanation for the appearance of anatomically modern humans in the region. If populations of anatomically modern people were moving into the Levant periodically, replacing – over a long interval – the Neanderthals, such an intrusion should be visible in the archaeological record. Instead, and in accordance with the tenets of multiregional continuity, the archaeology of the Levantine Middle Paleolithic appears to document a considerable amount of technological continuity.

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