Issues of Chronological and Geographical Distributions of Middle and Upper Palaeolithic Cultural Variability in the Levant and Implications for the Learning Behavior of Neanderthals and *Homo sapiens*

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Abstract

This paper examines chronological and geographical cultural variability during the Middle and Upper Palaeolithic in the Levant, using part of the archaeological database covering a temporal range from ca. 300 to 20 kya and the geographic areas of Africa and Eurasia. This database has been constructed in order to organize archaeological data available from the time periods and geographic areas where *Homo sapiens* presumably emerged and dispersed with a replacement or assimilation of preceding populations, including Neanderthals. The purpose of this examination is to discuss research issues regarding the potential differences in learning behavior between Neanderthals and *Homo sapiens*, that are in line with the primary objectives of the research project entitled "Replacement of Neanderthals by Modern Humans: Testing Evolutionary Models of Learning" (the RNMH project; Akazawa, 2012). Although theoretical links between learning strategies and patterns of cultural change are proposed on the basis of cultural evolutionary theory, an attempt to test this objective empirically with archaeological data entails a number of challenges. The paper addresses these problems through empirical examinations of chronological and geographic distributions of lithic industries.

Keywords

Chronology • Levant • Lithic industry • Middle Palaeolithic • Upper Palaeolithic

4.1 Introduction

4.1.1 Aims of the Study

This paper derives from one of the many archaeological workshop investigations conducted by the research project entitled "Replacement of Neanderthals by Modern Humans: Testing Evolutionary Models of Learning" (the RNMH project; Akazawa 2012). The research group "A01" for this project has been compiling archaeological data relevant to the RNMH process with two purposes in mind. The first is to collect and organize updated material evidence regarding the RNMH in a comprehensive manner, and the second is to obtain insights into prehistoric learning behaviors through the observation of diachronic and geographic patterns of cultural variability (Nishiaki 2012). Using part of the archaeological database compiled since 2010 (i.e., the beginning of the RNMH project), this paper first examines chronological and geographical cultural variability during the Middle and Upper Palaeolithic (hereafter MP and UP respectively) in the Levant and then discusses some implications of this archaeological evidence on the anthropological processes that took place in the region.

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The temporal and spatial range covered by the database of this project is set from ca. 300 to 20 kya in Africa and Eurasia, that is broader than those directly related to the RNMH events per se. This is because our aim is not just to trace the timings and frontiers of the RNMH events on the a priori assumption that such anthropological events are directly reflected in archaeological records, but to organize archaeological data available from the time periods and geographic areas, where *Homo sapiens* presumably emerged and dispersed with replacement or assimilation of preceding populations, including Neanderthals. Because much remains to be clarified in the association between archaeological remains and hominin taxa, we put more emphasis in this study on the systematic presentation and assessment of archaeological data broadly related to the RNMH process rather than attempting to provide definitive archaeological answers to anthropological problems of the RNMH.

On the other hand, the broad temporal and spatial ranges (i.e. 300–20 kya in Africa and Eurasia) of our archaeological investigations are expected to provide us with sufficient data to examine diachronic changes and geographic shifts by *Homo sapiens* and other preceding hominins, particularly Neanderthals. This analysis is intended to discuss the feasibility of conducting archaeological research on potential differences in learning behaviors between Neanderthals and *Homo sapiens*, that is the primary objective of the RNMH project. Although theoretical links between learning strategies and patterns of cultural changes are proposed on the basis of cultural evolutionary theories (the research group "B01": Aoki 2012), an attempt for their empirical testing with archaeological data entails a number of challenges. First of all, archaeological remains that can be securely associated with hominin taxa are limited. Moreover, it is difficult to reliably assess the speed and cumulativeness of cultural changes, which are considered significant aspects in cultural evolutionary theories, because of numerous chronological issues and variable definitions of prehistoric cultures. Because these challenges cannot be readily resolved, the present study would rather address and clarify these problems through empirical examinations of chronological and geographic distributions of archaeological cultures. We will then propose parsimonious interpretations of the patterns of cultural changes during the MP and UP periods in terms of prehistoric learning behaviors as one of our contributions to the goals of the RNMH project.

4.1.2 Using the Lithic Industry as a Unit of Cultural Variability and a Proxy Measure of Prehistoric Learning: Reasons and Limitations

As a means to organize archaeological data and examine cultural patterns relevant to the RNMH, this study employs the concept of lithic industry as a fundamental feature of prehistoric cultures. There are two reasons for this. First, for almost any project dealing with broad temporal and spatial ranges, lithics are the only archaeological remains that are consistently available under various conditions and can provide a sufficient sample size to justify plausible interpretations. In fact, lithic technology constitutes the main descriptive features of Palaeolithic archaeology across wide regions, including those targeted in this project (e.g., Barham and Mitchell 2008; Dennel 2009; Hovers and Kuhn 2006). Second, recent definitions of lithic industries tend to be based on the concepts of patterned technological behaviors/choices, e.g., *chaîne opératoires*, in the course of lithic production activities rather than mere morphological similarity of finished products (e.g., Bar-Yosef 2003, pp. 268–270). Because such archaeologically recognizable patterns of technological behaviors/choices should have been socially shared, i.e., disseminated through social learning, it would be reasonable to expect that the patterns in the continuity or changes of lithic industries are primarily products of social communications, that are mediated by members who can also practice individual learning and/or exploratory individual learning strategies.

Although the concept of the lithic industry may be useful for the cultural-historical organization of archaeological data over broad temporal and spatial ranges, how reliable is the concept when analyses are directed towards the interpretation of prehistoric learning? For example, according to some cultural evolutionary models, learning strategies can affect the speed and rate of accumulation of cultural evolution (Borenstein et al. 2008). If one attempts to examine this model with archaeological data, the rate and accumulative nature of prehistoric culture change needs to be measured. Can this be accomplished by referring to cultural chronologies based on lithic industries? If so, how reliable are these measurements and interpretations? Additionally, if we are to compare learning behavior between *Homo sapiens* and Neanderthals by inferring them from cultural patterns, we have to identify lithic industries made by these two hominin groups respectively. How plausible are these links? These questions will be discussed in this paper, dealing with actual lithic data from the MP and UP of the Levant.

4.1.3 Construction of the Archaeological Database: *Neander DB*

Consistent with the above research questions and theoretical concerns, we designed our archaeological database, named *Neander DB*, to include four data sets (See the chapter by Kondo and Nishiaki in this volume for details). The first set is related to the archaeological sites and their specific geographic locations (i.e., longitude and latitude), and the site type (e.g., cave, rock shelter, or open-air). The second set includes various kinds of data on cultural layers, such as the name of the lithic industry, to which excavated assemblages are assigned, estimated ages, radiometric dates, the presence/absence of hominin fossils, and the presence/absence of non-lithic materials, particularly those indicative of modern human behaviors, e.g., bone tools and portable art. The third dataset describes technological characteristics of lithic industries that are included in the database, and finally the forth dataset is the bibliography of data sources (e.g., site reports and articles).

The collection of these data is mostly a result of a literature survey supplemented with unpublished data from our own fieldwork. To achieve efficient data collection and construction of the database on numerous sites over vast regions (i.e., Africa and Eurasia), and time periods, ca. 300–20 kya, we have employed a network-based database system, in which multiple researchers around the world can access the same database through the internet and cooperate in its construction (Kondo et al. 2012). In the past 2 years, about 2,000 archaeological sites have been entered into the database, and as described in the next section, data on ca.120 sites in the Levant have been used in the examination of MP and UP lithic industries.

4.2 Theoretical and Methodological Concerns Regarding the Lithic Industry Concept

4.2.1 Lithic Industries Examined in This Study

Table 4.1 and Fig. 4.1 show the list of lithic industries and their several recent chronological schemes dealt with in this study. The industries proposed by Bar-Yosef (1995) and Henry (2004) cover mainly the MP period, and that by Bar-Yosef (2000) ranges from the late MP to the UP. Chronologies of the Upper and early Epipalaeolithic industries have been organized by Goring-Morris (1995) and, more recently, by Belfer-Cohen and Goring-Morris (2003). Lithic industries that are widely recognized for the MP period in the Levant are Tabun D-type, Tabun C-type, and Tabun B-type industries, while the Levantine UP industries include the Initial Upper Palaeolithic (IUP or Emiran); Early Ahmarian; Levantine Aurignacian A; Classic Levantine Aurignacian; Atlitian; Arqov/Divshon; and Late Ahmarian. For the early Epipalaeolithic period, the Nebekian and Kebaran are examined in this study.

Table 4.1 List of lithic industries and some of archaeological sites examined in this study

	Lithic industries	Sites with hominin remains[a]	Some of other excavated or systematically surveyed sites[b]
Early Epipalaeolithic	Nebekian		Ain Qasiyya (Area D), Tor Hamar (E), Uwaynid 14 & 18, Jilat 6 (C), Yabrud III (6–7), Yutil Hasa (C, E)
	Kebaran	Ain Qasiyya (Area A&B), Ein Gev I, Kebara (C), Kharaneh IV (B)	Fazael III, Hayonim (Ca-Ce), Nahal Oren (9), Raqefet (I), Urkan el-Rubb II
Upper Palaeolithic	Arqov/Divshon		Boker BE (I), Boker C, EinAqev, Har Horesha I, Tor Fawaz?
	Atlitian	Nahal Ein Gev I	Antelias (I & II), el-Wad (C), Ksar Akil (6)
	Classic Levantine Aurignacian	el-Wad (D)	Antelias (III & IV), Hayonim (D), Kebara (I&II), Ksar Akil (7–8), Raqefet (III)
	Levantine Aurignacian A?		Ksar Akil (11–13), Umm el-Tlel
	Late Ahmarian (including Masraqan)	Ohalo II	Ain al-Buhayra (Unit C, F, and H-I), Ein Aqev East, Fazael X, Lagama X, Yutil al-Hasa (Areas A and B)
	Early Ahmarian	Ksal Akil (14–20) and Qafzeh (D)	Abu Noshra I, Boker A, Boker BE, Erq el-Ahmar (E-F), Jebel Humeima, Kebara (III-IV), Lagama VII, Thalab al-Buhayla, Tor Aeid, Tor Hamar (F-G), Yabrud II (5–6)
	Initial Upper Paleolithic (Emiran)	ÜçağızlıMughara?[c]	Boker Tachtit, KsarAkil (21–25), Tor Sadaf (A & B), Umm el-Tlel (IIbase& III2a’), WadiAghar
Middle Palaeolithic	Tabun B	Neanderthals from Amud (B 1&2), Dederiyeh (3, 11, & 13), Kebara (VII-XII), Shukba (D), and Tabun (C1)?[c]	Bezez (B), Erq el-Ahmar (H), Keoue, Sefunim, Tor Faraj, Tor Sabiha
	Tabun C	Qafzeh (XV-XXII), Skhul (B), Tabun (C2)?[c]	Dederiyeh (D), Douara (III), Hayonim (upper E), Naamé, Nahr Ibrahim, Ras el-Kelb
	Tabun D sensu lato		Abu Sif, Ain Difla, Dederiyeh (E), Douara (IV), Hayonim (lower E and F), Hummal (II), Jerf Ajla, Nahal Aqev, Rosh Ein Mor, Tabun (D), Yabrud I

[a]*Homo sapiens* unless indicated
[b]Layer numbers/alphabets are shown in parentheses following site names
[c]See discussions in the text

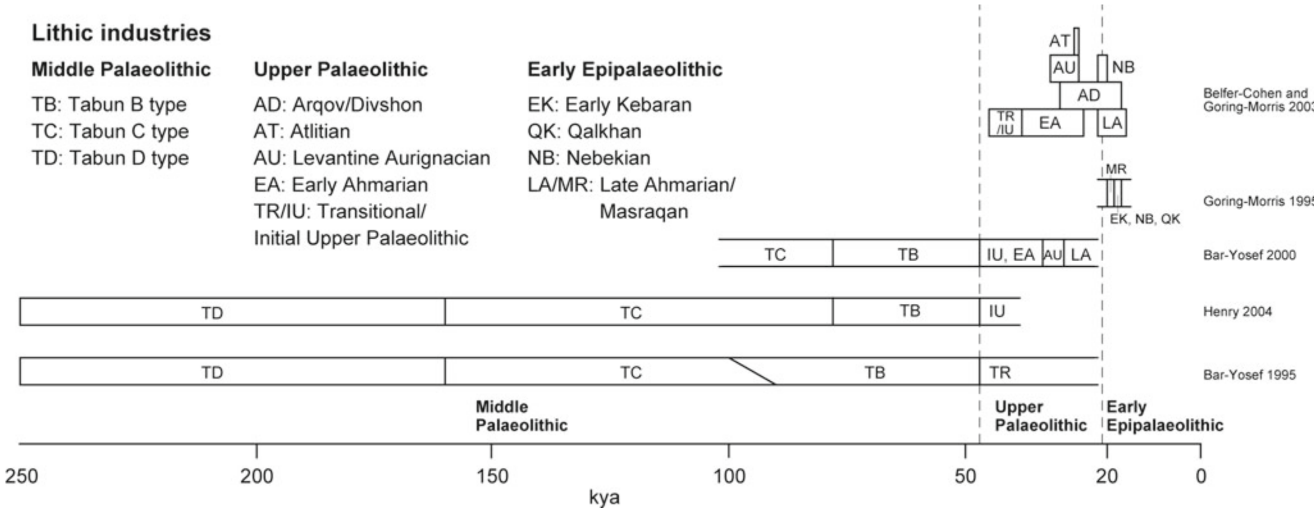

Fig. 4.1 Several chronological schemes of the Middle and Upper Palaeolithic industries in the Levant

The collection and organization of data on these lithic industries is not a straightforward task. It cannot be done by simply copying the contents of site reports because the study of lithic industries involves ongoing controversial issues. Additionally, various researchers do not always share the same views on the definition of lithic industries, their identification of actual lithic assemblages, and chronological relationships. To deal with this problem, it is necessary to distinguish current and widely accepted data from outdated ones regarding the definitions, identification, and chronology of lithic industries. Moreover, we built multiple models for the definition, identification, and/or chronology of some lithic industries when several different scenarios are conceivable or proposed by different researchers. The following section addresses these concerns before presenting the chronological and geographic analyses of lithic industries.

4.2.2 Definitions and Interpretations of Lithic Industries in the Levant

A lithic industry is defined by techno-morphological characteristics that are repetitively observable in multiple lithic assemblages, that are primary components of and provide material evidence to define and understand the lithic industry concept. A lithic assemblage is a collection of lithics usually defined by stratigraphy and/or context at archaeological sites. According to Marks (2003), who puts more emphasis on technological aspects rather than morphology, criteria for defining lithic industries include core reduction methods, the choice of blanks to be retouched, and retouch technology. The grouping and/or classification of lithic assemblages can be hierarchical depending on the degree of similarity. For example, Henry (1989, pp. 82–83) defines a phase/facies as a group of lithic assemblages sharing the highest degree of techno-morphological similarity. Phases/facies sharing similar techno-morphological traits are then grouped into the same industry, and similar industries are further grouped into the same complex. A lineage concept is proposed by Marks (2003, p. 251) to group lithic industries that are observable over a long time period and over wide areas with gradual variation. Both concepts of complex and lineage belong to categories in a higher hierarchical level than that of industry, and cover wider temporal and geographical ranges.

Among these several different classificatory levels, this study employs the concept of industry as a unit for analyzing the variability of lithic remains because the definition and identification of lithic industries are frequently discussed for the classification of lithic assemblages in the Levant as well as in other areas studied in the RNMH project. Additionally, an archaeological entity is also often mentioned as a temporal and spatial unit of material remains. This concept is applied to various material remains including more than lithics, but its level in the hierarchical classification appears to be similar to lithic industries (Belfer-Cohen and Goring-Morris 2003, pp. 2–9).

While the concept of a lithic industry is empirically based on lithic morphology and production technology, as described above, there is a great deal of controversy over what it represents. In the past few decades, a number of Levantine Palaeolithic studies examined diachronic and geographic variability in lithic technology in terms of climatic shifts (e.g., Jelinek 1981). Recent studies on the variability of MP and UP lithic assemblages also examine ecological factors, such as the distance to raw material sources and water, behaviors of raw material acquisition, duration of settlement, and hunting (Hovers 2009, pp. 207–223; Williams 2003).

On the other hand, this study considers social and cultural factors more relevant to the definition of lithic industries as the study is directed towards the interpretation of prehistoric learning and takes a theoretical position that a lithic industry is defined by patterned technological behaviors/choices that are disseminated among group members through social learning. For example, Hovers (2009, p. 227) suggests that the variability of MP lithic assemblages from Qafzeh Cave is principally organized by "technological tradition, embedded in the overall social system" rather than environmental or ecological factors. The technological tradition means socially and culturally patterned choices of technological behaviors that are not necessarily co-related with function or efficiency. A similar interpretation of a lithic industry is addressed by Marks (2003, p. 251) who suggests that technological characteristics that define lithic industries transcend the contents of activities or raw material availability at each site. In addition, Goring-Morris and Belfer-Cohen (2006, p. 308) criticize Williams' (2003, pp. 206–207) explanation on the technological difference between the Ahmarian and the flake-based assemblages in relation to the distance of sites from water sources. Instead, Goring-Morris and Belfer-Cohen (2006) suggest that Levantine Upper Palaeolithic industries, such as the Ahmarian, Classic Levantine Aurignacian, Arqov/Divshon, and Atlitian, correspond to different social groups or cultures, and propose the influx/replacement of populations or indigenous cultural changes as primary factors for the variability of lithic industries.

4.2.3 Some Issues on the Identification of Lithic Industries in the Levant

This section describes various issues on the identification of lithic industries and how they have affected the structure and meaning of actual lithic assemblages, and describes how this study deals with these problems in the construction of the *Neander DB* archaeological database.

4.2.3.1 Middle Palaeolithic

This study employs a widely recognized tripartite scheme, similar to that of the Tabun D/C/B types or Phases 1–3, for the MP industries in the Levant (Copeland 1975). The three industries are grouped under the Levantine Mousterian tradition, and their common use of the Levallois technique distinguishes them from the preceding Yabrudian complex. The Tabun D-type is characterized by the production of blades and elongated points both created using the Levallois method and the "laminar system." A significant number of Upper Palaeolithic tool types occur in the D-type assemblages. In contrast, unilateral side scrapers are representative of the Tabun C-type industry, that often produces oval flakes with some points and blades from centripetally and/or bi-directionally prepared Levallois cores. The Levallois cores of the Tabun B-type are frequently prepared by uni-directional convergent flaking that produces broad based points with some blades. Side scrapers dominate the retouched tool inventory with few Upper Palaeolithic types.

The identification of these industries in prehistoric lithic assemblages is primarily based on recent descriptions (e.g., Henry 2004; Shea 2003; Bar-Yosef 2000). When the same assemblage is assigned to different industries by different researchers, we adopt all the opinions in the database unless they are outdated in light of current evidence so that multiple scenarios can be examined without a priori selection of various interpretations. In addition, there are some assemblages whose techno-typological characteristics do not clearly fit any one of the three MP industries, such as those from Yabrud Rockshelter I and the el-Kowm basin including Umm el-Tlel. Although a single ESR date from Quneitra (No. 289 and 290 in Table 4.2) might suggest that it is contemporary with the Tabun B-type industry or Phase 3 (Ziaei et al. 1990), this chronological position is not corroborated on techno-typological grounds as I discuss later. The assemblages, named the Late Mousterian or Levalloiso-Mousterian in the el-Kowm basin, are stratigraphically located above the Hummalian, which is contemporary with the Tabun D type industry (Le Tensorer et al. 2008). Thus, the chronological position of the former may be close to the Tabun C-type or B-type industries.

4.2.3.2 Upper Palaeolithic and Early Epipalaeolithic

While the identification of lithic industries from these time periods has been traditionally based on the cultural sequence constructed by Neuville (1951), this study refers to recent terms and definitions.

The beginning of the UP is marked by the Initial Upper Palaeolithic (IUP or Emiran) industry that is technologically characterized by the introduction of prismatic cores and the production of pointed blades with relatively large, sometimes facetted, striking platforms. The IUP is also typologically defined by the high occurrences of Upper Palaeolithic tools (i.e., burins and end scrapers) with some fossil indices, such as Emireh points and chamfered pieces. Despite the accumulation of IUP assemblages at sites such as Boker Tachtit (Marks 1983); Ksar Akil XXI-XXV (Ohnuma 1988); Üçağızlı F-H (Kuhn et al. 2009); Wadi Aghar (Coinman and Henry 1995); and Tor Sadaf (Fox and Coinman 2004), the debate over their interpretations continues (Bar-Yosef and Belfer-Cohen 2010) with a view that this industry represents a transitional phase from the Middle to Upper Palaeolithic period, and an alternate position maintaining that the IUP culture was brought by *Homo sapiens* dispersing from Africa.

Discussions regarding the techno-typological variability of Upper Palaeolithic chipped stones following the IUP often refer to two cultural traditions, the Ahmarian and the Levantine Aurignacian (Marks 1981; Gilead 1981). The for-

Table 4.2 List of radiometric dates of Middle Palaeolithic sites in the Levant

No. in the plot	Site name	Layer	Dating method	Laboratory No.	Samples	Date (mean)	SD (positive)	SD (negative)	Selected dates
1	Tabun Cave	Layer D	TL	T36	Burnt flint	276,000	29,000	29,000	
2	Tabun Cave	Layer D	TL	T23	Burnt flint	266,000	35,000	35,000	
3	Tabun Cave	Layer D	TL	Unit IX average (2003)	Burnt flint	256,000	18,000	18,000	O
4	Tabun Cave	Layer D	TL	T34	Burnt flint	248,000	27,000	27,000	
5	Tabun Cave	Layer D	TL	T33	Burnt flint	243,000	24,000	24,000	
6	Tabun Cave	Layer D	TL	T21	Burnt flint	237,000	29,000	29,000	
7	Tabun Cave	Layer D	TL	Unit V average (2003)	Burnt flint	222,000	36,000	36,000	O
8	Tabun Cave	Layer D	TL	T19	Burnt flint	215,000	23,000	23,000	
9	Tabun Cave	Layer D	TL	T25	Burnt flint	198,000	22,000	22,000	
10	Tabun Cave	Layer D	TL	Unit II average (2003)	Burnt flint	196,000	17,000	17,000	O
11	Tabun Cave	Layer D	TL	T18	Burnt flint	191,000	23,000	23,000	
12	Tabun Cave	Layer D	TL	T22	Burnt flint	188,000	22,000	22,000	
13	Tabun Cave	Layer D	TL	T20	Burnt flint	183,000	15,000	15,000	
14	Tabun Cave	Layer D	ESR EU	Revised average	Tooth	133,000	13,000	13,000	O
15	Tabun Cave	Layer D	ESR LU	Revised average	Tooth	203,000	26,000	26,000	O
16	Tabun Cave	Layer D	US/ESR	Revised average	Tooth	143,000	41,000	28,000	O
17	Tabun Cave	Layer D	U-series	556	Tooth	110,680	880	870	
18	Hayonim	F	TL	525	Burnt flint	251,000	20,000	20,000	
19	Hayonim	F	TL	50	Burnt flint	235,000	26,000	26,000	
20	Hayonim	F	TL	518	Burnt flint	233,000	20,000	20,000	
21	Hayonim	F	TL	522	Burnt flint	227,000	24,000	24,000	
22	Hayonim	F	TL	523	Burnt flint	225,000	41,000	41,000	
23	Hayonim	F	TL	57	Burnt flint	224,000	21,000	21,000	
24	Hayonim	F	TL	F top average	Burnt flint	221,000	16,000	16,000	O
25	Hayonim	F	TL	527	Burnt flint	221,000	22,000	22,000	
26	Hayonim	F	TL	F base average	Burnt flint	210,000	25,000	25,000	O
27	Hayonim	F	TL	516	Burnt flint	205,000	35,000	35,000	
28	Hayonim	F	TL	60	Burnt flint	204,000	17,000	17,000	
29	Hayonim	F	TL	519	Burnt flint	189,000	20,000	20,000	
30	Hayonim	F	TL	526	Burnt flint	187,000	20,000	20,000	
31	Hayonim	F	TL	524	Burnt flint	183,000	60,000	60,000	
32	Hayonim	F	TL	520	Burnt flint	175,000	22,000	22,000	
33	Hayonim	F	ESR EU	95,601 (E/F)	Tooth	158,000	20,000	20,000	O
34	Hayonim	F	ESR LU	95,601 (E/F)	Tooth	164,000	221,000	221,000	O
35	Hayonim	Lower E	TL	416	Burnt flint	208,000	35,000	35,000	
36	Hayonim	Lower E	TL	406	Burnt flint	202,000	28,000	28,000	
37	Hayonim	Lower E	TL	410	Burnt flint	200,000	29,000	29,000	
38	Hayonim	Lower E	TL	58	Burnt flint	197,000	18,000	18,000	
39	Hayonim	Lower E	TL	403	Burnt flint	194,000	28,000	28,000	
40	Hayonim	Lower E	TL	E base average	Burnt flint	186,000	24,000	24,000	O
41	Hayonim	Lower E	TL	Unit4 (north) average	Burnt flint	176,000	28,000	28,000	O
42	Hayonim	Lower E	TL	Unit4 (south) average	Burnt flint	168,000	27,000	27,000	O
43	Hayonim	Lower E	TL	417	Burnt flint	163,000	23,000	23,000	
44	Hayonim	Lower E	TL	414	Burnt flint	160,000	22,000	22,000	
45	Hayonim	Lower E	TL	Unit5 (south) average	Burnt flint	160,000	22,000	22,000	O
46	Hayonim	Lower E	TL	409	Burnt flint	159,000	13,000	13,000	
47	Hayonim	Lower E	TL	415	Burnt flint	157,000	19,000	19,000	

(continued)

Table 4.2 (continued)

No. in the plot	Site name	Layer	Dating method	Laboratory No.	Samples	Date (mean)	SD (positive)	SD (negative)	Selected dates
48	Hayonim	Lower E	TL	401	Burnt flint	154,000	17,000	17,000	
49	Hayonim	Lower E	TL	402	Burnt flint	151,000	17,000	17,000	
50	Hayonim	Lower E	TL	418	Burnt flint	140,000	16,000	16,000	
51	Hayonim	Lower E	TL	412	Burnt flint	105,000	9,000	9,000	
52	Hayonim	Lower E	ESR EU	97,042	Tooth	200,000	32,000	32,000	O
53	Hayonim	Lower E	ESR EU	95,606	Tooth	177,000	32,000	32,000	O
54	Hayonim	Lower E	ESR EU	97,040	Tooth	172,000	33,000	33,000	O
55	Hayonim	Lower E	ESR EU	95,602	Tooth	160,000	28,000	28,000	O
56	Hayonim	Lower E	ESR EU	97,230	Tooth	158,000	28,000	28,000	O
57	Hayonim	Lower E	ESR EU	97,228	Tooth	150,000	21,000	21,000	O
58	Hayonim	Lower E	ESR EU	97,232	Tooth	142,000	30,000	30,000	O
59	Hayonim	Lower E	ESR EU	97,229	Tooth	136,000	25,000	25,000	O
60	Hayonim	Lower E	ESR LU	97,042	Tooth	211,000	35,000	35,000	O
61	Hayonim	Lower E	ESR LU	95,606	Tooth	182,000	34,000	34,000	O
62	Hayonim	Lower E	ESR LU	97,040	Tooth	175,000	33,000	33,000	O
63	Hayonim	Lower E	ESR LU	97,228	Tooth	164,000	26,000	26,000	O
64	Hayonim	Lower E	ESR LU	95,602	Tooth	160,000	28,000	28,000	O
65	Hayonim	Lower E	ESR LU	97,230	Tooth	159,000	28,000	28,000	O
66	Hayonim	Lower E	ESR LU	97,232	Tooth	143,000	30,000	30,000	O
67	Hayonim	Lower E	ESR LU	97,229	Tooth	136,000	25,000	25,000	O
68	Ain Difla	1–20	TL	Oxford	Burnt flint	105,000	15,000	15,000	O
69	Ain Difla	1–20	ESR EU	94,812	Tooth	114,900	14,200	14,200	O
70	Ain Difla	1–20	ESR EU	94816B	Tooth	112,500	14,600	14,600	O
71	Ain Difla	1–20	ESR EU	94814C	Tooth	95,800	12,000	12,000	O
72	Ain Difla	1–20	ESR EU	94816A	Tooth	88,300	11,500	11,500	O
73	Ain Difla	1–20	ESR LU	94816B	Tooth	185,600	26,600	26,600	O
74	Ain Difla	1–20	ESR LU	94,812	Tooth	165,700	20,500	20,500	O
75	Ain Difla	1–20	ESR LU	94814C	Tooth	154,700	21,300	21,300	O
76	Ain Difla	1–20	ESR LU	94816A	Tooth	142,800	20,700	20,700	O
77	Nahal Aqev	D at nearby fossil spring	U-series	76NZ6d-4	Travertine	85,200	10,000	10,000	O
78	Nahal Aqev	D at nearby fossil spring	U-series	76NZ1	Travertine	74,000	5,000	5,000	O
79	Jerf Ajla	Yellow 1	C14		Charcoal	43,000	2,000	2,000	
80	Douara Cave	Horizon IV	Fission-track		Barite from a Hearth	75,000			
81	Douara Cave	Unit IVB	C14	GrN-7599	Hearth ash	>52,000			
82	Douara Cave	Unit IVB	C14	TK-166	Hearth ash	>43,200			
83	Douara Cave	Unit IVB	C14	TK-167	Hearth ash	>43,200			
84	Douara Cave	Unit IVB	C14	TK-168	Hearth ash	>43,200			
85	Douara Cave	Unit IVB	C14	TK-165	Hearth ash	38,900	1,700	1,700	
86	Douara Cave	Layer E	C14	TK-111	Charcoal	45,000	5,000	5,000	
87	Douara Cave	Layer E	C14	GaK-3537	Charcoal	30,600	2,800	2,100	
88	Douara Cave	Layer E	C14	GaK-3539	Charcoal	20,400	750	750	
89	Douara Cave	Layer E	C14	GaK-3541	Charcoal	16,800	500	500	
90	Douara Cave	Layer D	C14	GaK-3540	Charcoal	19,850	550	550	
91	Tabun Cave	Layer C	TL	T5	Burnt flint	195,000	18,000	18,000	
92	Tabun Cave	Layer C	TL	T14	Burnt flint	179,000	16,000	16,000	
93	Tabun Cave	Layer C	TL	T13	Burnt flint	175,000	18,000	18,000	
94	Tabun Cave	Layer C	TL	T10	Burnt flint	172,000	17,000	17,000	
95	Tabun Cave	Layer C	TL	T9	Burnt flint	168,000	17,000	17,000	
96	Tabun Cave	Layer C	TL	Unit I average (2003)	Burnt flint	165,000	23,000	23,000	O
97	Tabun Cave	Layer C	TL	T8	Burnt flint	139,000	14,000	14,000	

(continued)

Table 4.2 (continued)

No. in the plot	Site name	Layer	Dating method	Laboratory No.	Samples	Date (mean)	SD (positive)	SD (negative)	Selected dates
98	Tabun Cave	Layer C	TL	T15	Burnt flint	128,000	14,000	14,000	
99	Tabun Cave	Layer C	ESR EU	Revised average	Tooth	120,000	16,000	16,000	O
100	Tabun Cave	Layer C	ESR LU	Revised average	Tooth	140,000	21,000	21,000	O
101	Tabun Cave	Layer C	US/ESR	Revised average	Tooth	135,000	60,000	30,000	O
102	Tabun Cave	Layer C	U-series	552	Tooth	105,360	2,580	2,520	O
103	Tabun Cave	Layer C	U-series	551	Tooth enamel	101,690	1,360	1,340	O
104	Tabun Cave	Layer C	U-series	551	Tooth	97,840	430	420	O
105	Hayonim	Upper E	TL	75	Burnt flint	178,000	29,000	29,000	
106	Hayonim	Upper E	TL	76	Burnt flint	169,000	17,000	17,000	
107	Hayonim	Upper E	TL	68	Burnt flint	163,000	19,000	19,000	
108	Hayonim	Upper E	TL	65	Burnt flint	162,000	22,000	22,000	
109	Hayonim	Upper E	TL	Unit2 (south) average	Burnt flint	156,000	10,000	10,000	O
110	Hayonim	Upper E	TL	Unit3 (south) average	Burnt flint	156,000	18,000	18,000	O
111	Hayonim	Upper E	TL	23	Burnt flint	155,000	19,000	19,000	
112	Hayonim	Upper E	TL	84	Burnt flint	155,000	16,000	16,000	
113	Hayonim	Upper E	TL	67	Burnt flint	149,000	15,000	15,000	
114	Hayonim	Upper E	TL	10	Burnt flint	148,000	18,000	18,000	
115	Hayonim	Upper E	TL	20	Burnt flint	146,000	13,000	13,000	
116	Hayonim	Upper E	TL	11	Burnt flint	146,000	13,000	13,000	
117	Hayonim	Upper E	TL	3	Burnt flint	144,000	16,000	16,000	
118	Hayonim	Upper E	TL	80	Burnt flint	144,000	17,000	17,000	
119	Hayonim	Upper E	TL	Unit3 (north) average	Burnt flint	144,000	3,000	3,000	O
120	Hayonim	Upper E	TL	7	Burnt flint	143,000	14,000	14,000	
121	Hayonim	Upper E	TL	4	Burnt flint	142,000	13,000	13,000	
122	Hayonim	Upper E	TL	5	Burnt flint	140,000	11,000	11,000	
123	Hayonim	Upper E	TL	26	Burnt flint	139,000	13,000	13,000	
124	Hayonim	Upper E	TL	61	Burnt flint	129,000	11,000	11,000	
125	Hayonim	Upper E	TL	Unit2 (north) average	Burnt flint	129,000	12,000	12,000	O
126	Hayonim	Upper E	TL	82	Burnt flint	128,000	14,000	14,000	
127	Hayonim	Upper E	TL	24	Burnt flint	127,000	14,000	14,000	
128	Hayonim	Upper E	TL	21	Burnt flint	126,000	12,000	12,000	
129	Hayonim	Upper E	TL	63	Burnt flint	125,000	13,000	13,000	
130	Hayonim	Upper E	TL	25	Burnt flint	125,000	12,000	12,000	
131	Hayonim	Upper E	TL	27	Burnt flint	124,000	12,000	12,000	
132	Hayonim	Upper E	TL	22	Burnt flint	119,000	12,000	12,000	
133	Hayonim	Upper E	TL	9	Burnt flint	119,000	10,000	10,000	
134	Hayonim	Upper E	TL	62	Burnt flint	114,000	15,000	15,000	
135	Hayonim	Upper E	ESR EU	95,603	Tooth	183,000	28,000	28,000	O
136	Hayonim	Upper E	ESR EU	94,902	Tooth	180,000	27,000	27,000	O
137	Hayonim	Upper E	ESR EU	95,605	Tooth	178,000	21,000	21,000	O
138	Hayonim	Upper E	ESR EU	94,901	Tooth	176,000	30,000	30,000	O
139	Hayonim	Upper E	ESR EU	94,881	Tooth	163,000	26,000	26,000	O
140	Hayonim	Upper E	ESR LU	95,603	Tooth	191,000	31,000	31,000	O
141	Hayonim	Upper E	ESR LU	94,902	Tooth	190,000	30,000	30,000	O
142	Hayonim	Upper E	ESR LU	95,605	Tooth	187,000	23,000	23,000	O
143	Hayonim	Upper E	ESR LU	94,901	Tooth	182,000	32,000	32,000	O
144	Hayonim	Upper E	ESR LU	94,881	Tooth	164,000	26,000	26,000	O
145	Hayonim	Upper E	U-series	94,902	Tooth	156,400	9,800	9,000	O
146	Hayonim	Upper E	U-series	95,605	Tooth	117,300	900	900	O
147	Qafzeh Cave	Layer XXIII	TL	76	Burnt flint	95,000	7,700	7,700	O

(continued)

Table 4.2 (continued)

No. in the plot	Site name	Layer	Dating method	Laboratory No.	Samples	Date (mean)	SD (positive)	SD (negative)	Selected dates
148	Qafzeh Cave	Layer XXII	TL	66	Burnt flint	91,200	8,700	8,700	O
149	Qafzeh Cave	Layer XXII	TL	65	Burnt flint	86,600	7,400	7,400	O
150	Qafzeh Cave	Layer XXII	TL	67	Burnt flint	85,400	6,900	6,900	O
151	Qafzeh Cave	Layer XXI	TL	1	Burnt flint	109,900	9,900	9,900	O
152	Qafzeh Cave	Layer XXI	TL	61	Burnt flint	90,900	8,700	8,700	O
153	Qafzeh Cave	Layer XXI	TL	2	Burnt flint	89,200	8,900	8,900	O
154	Qafzeh Cave	Layer XXI	ESR EU	369B	Tooth	118,000			O
155	Qafzeh Cave	Layer XXI	ESR EU	369A	Tooth	95,900			O
156	Qafzeh Cave	Layer XXI	ESR EU	369E	Tooth	95,300			O
157	Qafzeh Cave	Layer XXI	ESR EU	369D	Tooth	74,200			O
158	Qafzeh Cave	Layer XXI	ESR EU	369C	Tooth	73,700			O
159	Qafzeh Cave	Layer XXI	ESR LU	369B	Tooth	143,000			O
160	Qafzeh Cave	Layer XXI	ESR LU	369A	Tooth	118,000			O
161	Qafzeh Cave	Layer XXI	ESR LU	369E	Tooth	116,000			O
162	Qafzeh Cave	Layer XXI	ESR LU	369C	Tooth	94,000			O
163	Qafzeh Cave	Layer XXI	ESR LU	369D	Tooth	89,100			O
164	Qafzeh Cave	Layer XIX	TL	45	Burnt flint	98,800	8,900	8,900	O
165	Qafzeh Cave	Layer XIX	TL	77	Burnt flint	95,900	8,100	8,100	O
166	Qafzeh Cave	Layer XIX	TL	49	Burnt flint	84,900	7,300	7,300	O
167	Qafzeh Cave	Layer XIX	TL	47	Burnt flint	82,400	7,700	7,700	O
168	Qafzeh Cave	Layer XIX	ESR EU	371B	Tooth	119,000			O
169	Qafzeh Cave	Layer XIX	ESR EU	368D	Tooth	111,000			O
170	Qafzeh Cave	Layer XIX	ESR EU	371A	Tooth	107,000			O
171	Qafzeh Cave	Layer XIX	ESR EU	368C	Tooth	102,000			O
172	Qafzeh Cave	Layer XIX	ESR EU	368B	Tooth	99,700			O
173	Qafzeh Cave	Layer XIX	ESR EU	368A	Tooth	87,700			O
174	Qafzeh Cave	Layer XIX	ESR EU	371C	Tooth	82,000			O
175	Qafzeh Cave	Layer XIX	ESR LU	371B	Tooth	145,000			O
176	Qafzeh Cave	Layer XIX	ESR LU	371A	Tooth	128,000			O
177	Qafzeh Cave	Layer XIX	ESR LU	368D	Tooth	124,000			O
178	Qafzeh Cave	Layer XIX	ESR LU	368C	Tooth	117,000			O
179	Qafzeh Cave	Layer XIX	ESR LU	368B	Tooth	112,000			O
180	Qafzeh Cave	Layer XIX	ESR LU	368A	Tooth	106,000			O
181	Qafzeh Cave	Layer XIX	ESR LU	371C	Tooth	101,000			O
182	Qafzeh Cave	Layer XIX	U-series	368	Tooth	106,350	2,360	2,310	O
183	Qafzeh Cave	Layer XIX	U-series	371	Tooth enamel	88,610	3,240	3,120	O
184	Qafzeh Cave	Layer XVIII	TL	42	Burnt flint	93,400	8,200	8,200	O
185	Qafzeh Cave	Layer XVIII	TL	40	Burnt flint	89,500	7,000	7,000	O
186	Qafzeh Cave	Layer XVIII	TL	38	Burnt flint	87,900	7,200	7,200	O
187	Qafzeh Cave	Layer XVII	TL	29	Burnt flint	107,200	8,800	8,800	O
188	Qafzeh Cave	Layer XVII	TL	14	Burnt flint	106,000	9,600	9,600	O
189	Qafzeh Cave	Layer XVII	TL	36	Burnt flint	100,700	8,200	8,200	O
190	Qafzeh Cave	Layer XVII	TL	13	Burnt flint	94,300	8,800	8,800	O
191	Qafzeh Cave	Layer XVII	TL	33	Burnt flint	89,200	8,400	8,400	O
192	Qafzeh Cave	Layer XVII	TL	34	Burnt flint	87,800	7,200	7,200	O
193	Qafzeh Cave	Layer XVII	ESR EU	372	Tooth	95,200			O
194	Qafzeh Cave	Layer XVII	ESR LU	372	Tooth	103,000			O
195	Qafzeh Cave	Layer XV	ESR EU	373	Tooth	94,700			O
196	Qafzeh Cave	Layer XV	ESR EU	370B	Tooth	94,200			O
197	Qafzeh Cave	Layer XV	ESR EU	370A	Tooth	92,100			O
198	Qafzeh Cave	Layer XV	ESR LU	373	Tooth	116,000			O
199	Qafzeh Cave	Layer XV	ESR LU	370B	Tooth	114,000			O
200	Qafzeh Cave	Layer XV	ESR LU	370A	Tooth	112,000			O
201	Skhul	Layer B	TL	Average	Burnt flint	119,000	18,000	18,000	O
202	Skhul	Layer B	ESR EU	521d	Tooth	101,000	19,000	19,000	

(continued)

Table 4.2 (continued)

No. in the plot	Site name	Layer	Dating method	Laboratory No.	Samples	Date (mean)	SD (positive)	SD (negative)	Selected dates
203	Skhul	Layer B	ESR EU	521c	Tooth	94,900	15,600	15,600	
204	Skhul	Layer B	ESR EU	521a	Tooth	88,100	17,900	17,900	
205	Skhul	Layer B	ESR EU	521b	Tooth	86,100	13,100	13,100	
206	Skhul	Layer B	ESR EU	Average (1989)	Tooth	81,000	15,000	15,000	O
207	Skhul	Layer B	ESR EU	522b	Tooth	73,000	7,000	7,000	
208	Skhul	Layer B	ESR EU	522a	Tooth	68,000	5,400	5,400	
209	Skhul	Layer B	ESR EU	522c	Tooth	54,600	10,300	10,300	
210	Skhul	Layer B	ESR LU	521d	Tooth	119,000	25,100	25,100	
211	Skhul	Layer B	ESR LU	521c	Tooth	109,000	20,500	20,500	
212	Skhul	Layer B	ESR LU	521a	Tooth	102,000	22,700	22,700	
213	Skhul	Layer B	ESR LU	521b	Tooth	102,000	18,000	18,000	
214	Skhul	Layer B	ESR LU	Average (1989)	Tooth	101,000	12,000	12,000	O
215	Skhul	Layer B	ESR LU	522b	Tooth	99,900	12,400	12,400	
216	Skhul	Layer B	ESR LU	522a	Tooth	98,300	10,600	10,600	
217	Skhul	Layer B	ESR LU	522c	Tooth	77,200	15,700	15,700	
218	Skhul	Layer B	U-series	521	Tooth	80,270	550	550	
219	Skhul	Layer B	U-series	856-2	Tooth	45,530	740	730	
220	Skhul	Layer B	U-series	856-1	Tooth	43,460	140	140	
221	Skhul	Layer B	U-series	854	Tooth	43,030	470	460	
222	Skhul	Layer B	U-series	854	Tooth	41,410	390	380	
223	Skhul	Layer B	U-series	522	Tooth	40,430	210	210	
224	Naamé	Vermet	U-series			90,000	10,000	10,000	O
225	Naamé	Strombus	U-series			93,000	5,000	5,000	O
226	Naamé	Strombus	U-series			90,000	20,000	20,000	O
227	Tabun Cave	Layer B	ESR EU	Revised average	Tooth	102,000	17,000	17,000	O
228	Tabun Cave	Layer B	ESR LU	Revised average	Tooth	122,000	16,000	16,000	O
229	Tabun Cave	Layer B	US/ESR	Revised average	Tooth	104,000	33,000	18,000	O
230	Tabun Cave	Layer B	U-series	550DE	Tooth	50,690	230	230	
231	Amud Cave	B4	TL	51	Burnt flint	75,900	5,300	5,300	
232	Amud Cave	B4	TL	49	Burnt flint	70,800	3,800	3,800	
233	Amud Cave	B4	TL	52	Burnt flint	66,900	4,900	4,900	
234	Amud Cave	B4	TL	46	Burnt flint	64,700	4,000	4,000	
235	Amud Cave	B4	TL	47	Burnt flint	55,600	4,400	4,400	
236	Amud Cave	B4	TL	average	Burnt flint	68,500	3,400	3,400	O
237	Amud Cave	B4	ESR EU	95504am	Tooth	112,000	18,000	18,000	
238	Amud Cave	B4	ESR EU	95501-2ak	Tooth	68,000	10,000	10,000	
239	Amud Cave	B4	ESR LU	95504am	Tooth	115,000	19,000	19,000	
240	Amud Cave	B4	ESR LU	95501-2ak	Tooth	73,000	12,000	12,000	
241	Amud Cave	B4	MSUS/ESR	95504Den1	Tooth	113,000	18,000	18,000	
242	Amud Cave	B4	MSUS/ESR	95504Den2	Tooth	113,000	18,000	18,000	
243	Amud Cave	B4	MSUS/ESR	95501-2Den	Tooth	70,000	11,000	11,000	O
244	Amud Cave	B2	TL	27	Burnt flint	59,500	4,500	4,500	
245	Amud Cave	B2	TL	26	Burnt flint	55,400	4,000	4,000	
246	Amud Cave	B2	TL	10	Burnt flint	53,100	5,500	5,500	
247	Amud Cave	B2	TL	32	Burnt flint	52,700	5,500	5,500	
248	Amud Cave	B2	TL	62	Burnt flint	52,400	6,800	6,800	
249	Amud Cave	B2	TL	63	Burnt flint	45,600	3,000	3,000	
250	Amud Cave	B2	TL	13	Burnt flint	44,500	3,900	3,900	
251	Amud Cave	B2	TL	64	Burnt flint	44,100	3,100	3,100	
252	Amud Cave	B2	TL	Average	Burnt flint	56,500	3,500	3,500	O
253	Amud Cave	B2	ESR EU	95507alk	Tooth	66,000	8,000	8,000	
254	Amud Cave	B2	ESR EU	95508alk	Tooth	54,000	7,000	7,000	
255	Amud Cave	B2	ESR EU	95506alk	Tooth	51,000	5,000	5,000	
256	Amud Cave	B2	ESR LU	95507alk	Tooth	77,000	11,000	11,000	
257	Amud Cave	B2	ESR LU	95506alk	Tooth	65,000	8,000	8,000	

(continued)

Table 4.2 (continued)

No. in the plot	Site name	Layer	Dating method	Laboratory No.	Samples	Date (mean)	SD (positive)	SD (negative)	Selected dates
258	Amud Cave	B2	ESR LU	95508alk	Tooth	63,000	9,000	9,000	
259	Amud Cave	B2	MSUS/ESR	95507Den1	Tooth	70,000	10,000	10,000	
260	Amud Cave	B2	MSUS/ESR	Average	Tooth	61,000	9,000	9,000	O
261	Amud Cave	B2	MSUS/ESR	95508Den1	Tooth	59,000	8,000	8,000	
262	Amud Cave	B2	MSUS/ESR	95506Den1	Tooth	53,000	7,000	7,000	
263	Amud Cave	B1	TL	12	Burnt flint	70,600	6,900	6,900	
264	Amud Cave	B1	TL	37	Burnt flint	61,300	5,200	5,200	
265	Amud Cave	B1	TL	38	Burnt flint	59,400	5,100	5,100	
266	Amud Cave	B1	TL	41	Burnt flint	58,100	4,100	4,100	
267	Amud Cave	B1	TL	40	Burnt flint	51,600	3,700	3,700	
268	Amud Cave	B1	TL	11	Burnt flint	49,000	4,600	4,600	
269	Amud Cave	B1	TL	Average	Burnt flint	57,600	3,700	3,700	O
270	Amud Cave	B1	ESR EU	95505alk	Tooth	50,000	6,000	6,000	
271	Amud Cave	B1	ESR LU	95505alk	Tooth	57,000	8,000	8,000	
272	Amud Cave	B1	MSUS/ESR	95505Den1	Tooth	53,000	7,000	7,000	O
273	Kebara	Layer XII	TL	Average	Burnt flint	59,900	3,500	3,500	O
274	Kebara	Layer XI	TL	Average	Burnt flint	60,000	3,500	3,500	O
275	Kebara	Layer X	TL	Average	Burnt flint	61,600	3,600	3,600	O
276	Kebara	Layer X	ESR EU	Average	Tooth enamel	60,400	5,900	5,900	O
277	Kebara	Layer X	ESR LU	Average	Tooth enamel	64,300	5,500	5,500	O
278	Kebara	Layer IX	TL	Average	Burnt flint	58,400	4,000	4,000	O
279	Kebara	Layer VIII	TL	Average	Burnt flint	57,300	4,000	4,000	O
280	Kebara	Layer VII	TL	Average	Burnt flint	51,900	3,500	3,500	O
281	Kebara	Layer VI	TL	Average	Burnt flint	48,300	3,500	3,500	O
282	Tor Sabiha	Layer C	AAR	AAL-5736	Ostrich eggshell	69,000	6,000	6,000	O
283	Tor Faraj	Layer C	TL		Burnt flint	52,800	3,000	3,000	O
284	Tor Faraj	Layer C	TL		Burnt flint	47,500	3,000	3,000	O
285	Tor Faraj	Layer C	TL		Burnt flint	43,800	2,000	2,000	O
286	Tor Faraj	Layer C	U-series		Ostrich eggshell	62,400	14,000	14,000	O
287	Tor Faraj	Layer C	U-series		Ostrich eggshell	28,900	3,900	3,900	
288	Tor Faraj	Layer C	AAR	AAL-5739	Ostrich eggshell	69,000	6,000	6,000	O
289	Quneitra	Un-stratified	ESR EU		Tooth	39,200			
290	Quneitra	Un-stratified	ESR LU		Tooth	53,900	1,700	1,700	O
291	Ksar Akil	27A	U-series	G-8881777S	Animal Bone	51,000	4,000	4,000	O
292	Ksar Akil	27A	U-series	G-888178	Animal Bone	49,000	5,000	5,000	O
293	Ksar Akil	26A	U-series	G-888174S	Animal bone	47,000	9,000	9,000	O
294	Ksar Akil	26A	U-series	G-888173B	Animal bone	19,000	5,000	5,000	
295	Ksar Akil	26A	C14-AMS	GrN-2579	Dark clay	43,750	1,500	1,500	
296	Far'ah II	Floor 1	ESR EU	95368A	Tooth	54,400	3,200	3,200	
297	Far'ah II	Floor 1	ESR EU	95370A	Tooth	50,100	3,100	3,100	
298	Far'ah II	Floor 1	ESR EU	Mean	Tooth	49,100	4,100	4,100	O
299	Far'ah II	Floor 1	ESR EU	95367A	Tooth	46,200	2,700	2,700	
300	Far'ah II	Floor 1	ESR EU	95,366	Tooth	45,600	2,700	2,700	
301	Far'ah II	Floor 1	ESR LU	95368A	Tooth	72,000	4,900	4,900	
302	Far'ah II	Floor 1	ESR LU	95370A	Tooth	62,700	4,700	4,700	
303	Far'ah II	Floor 1	ESR LU	Mean	Tooth	62,200	7,000	7,000	O
304	Far'ah II	Floor 1	ESR LU	95,366	Tooth	57,100	4,100	4,100	
305	Far'ah II	Floor 1	ESR LU	95367A	Tooth	57,100	4,100	4,100	
306	Far'ah II	Floor 1	U-series	95367A	Tooth enamel	74,500	1,500	1,500	O
307	Douara Cave	Horizon III	C14	GrN-8058	Ostrich eggshell	>53,800			

mer appeared earlier, following the IUP, and is dominated by the production of blades/bladelets that are modified into pointed or backed forms. In contrast, the beginning of the Levantine Aurignacian is dated to at least a few millennia later, and it is characterized by numerous flakes fashioned into burins and scrapers, and high occurrences of twisted bladelets detached from carinated tools/cores.

It is generally recognized that the Ahmarian is part of a technological complex whose autochthonous evolution can be traced from the IUP through the Early Ahmarian to the Late Ahmarian (Goring-Morris and Belfer-Cohen 2006, p. 308; Belfer-Cohen and Goring-Morris 2007, pp. 200–201). This local technological tradition, characterized by blade production, is named the "Levantine Leptolithic Lineage" by Marks (2003, p. 253). The Late Ahmarian is characterized by the increase of Ouchtata bladelets replacing el-Wad points, as well as the employment of multiple core-reduction strategies for bladelet production (Ferring 1988; Belfer-Cohen and Goring-Morris 2003; Coinman 2003; Marks 2003). In addition, some of the Late Ahmarian assemblages, such as Ohalo II and Fazael X, include microlith types, such as micropoints, obliquely truncated backed bladelets, and proto-triangles, that are hallmarks of the Kebaran, one of the early Epipalaeolithic entities (Nadel 2003), indicating the continuity of the Levantine Leptolithic lineage from the beginning of the UP to the early Epipalaeolithic period. It is, however, debatable if this apparent technological continuity represents that of local populations, and in turn any "accumulative cultural changes."

The variations within the Levantine Aurignacian have been traditionally grouped into Phases A, B, and C on the basis of stratified assemblages from Ksar Akil layers VI-XIII (Bergman 2003; Williams and Bergman 2010). Among the three phases, part of the Levantine Aurignacian B and C (i.e., layers VII and VIII) shows "classic" Aurignacian elements, such as flat frontally carinated and nosed scrapers along with bone and antler artifacts, such as split-based points, similar to the European Aurignacian. Belfer-Cohen and Goring-Morris (2003) re-define the Levantine Aurignacian by restricting it to the assemblages with "classic" Aurignacian characteristics, excluding some flake-based assemblages from the Aurignacian tradition and classifying them into separate industries, such as the Arqov/Divshon or the Atlitian.

However, there are some assemblages that are not included in the Levantine Aurignacian sensu stricto but remain to be assigned to any of other industries, such as those from Ksar Akil layer IX-XIII (Bergman 2003). According to Copeland (2003, p. 246), the assemblages from Ksar Akil XI-XIII should be placed within the Levantine Aurignacian A industry, to which UP assemblages from Kebara Unit I-II and Umm el-Tlel can also be assigned. A similar view is proposed by Olszewski and Dibble (2006, p. 363), who suggest that the high occurrence of blades in the Levantine Aurignacian A assemblages also characterizes the Zagros Aurignacian industry, that is typified by the assemblages from Warwasi layer P-Z. On the other hand, Belfer-Cohen and Goring-Morris (2003, p. 274) class the UP assemblages from Umm el-Tlel as the Late Ahmarian instead of the Levantine Aurignacian, and the Aurignacian assemblages from Kebara (Bar-Yosef et al. 1996) are included in the Classic Levantine Aurignacian instead of the Levantine Aurignacian A (Goring-Morris and Belfer-Cohen 2006, p. 311). In addition, a recent study of the UP assemblages from Umm el-Tlel suggests that some assemblages show technological characteristics of the late Ahmarian, while others show core-reduction technology indicative of the Aurignacian (Ploux and Soriano 2003). Interestingly, these assemblages of apparently different technological traditions are interstratified at Umm el-Tlel. In this way, there are ongoing issues and various positions regarding the definition of the Levantine Aurignacian and its identification in excavated lithic assemblages. These alternative perspectives are considered in this study by organizing them within the database.

In contrast to the Ahmarian, that is generally recognized as representing part of the endemic technological tradition in the Levant, the Levantine Aurignacian is usually interpreted to have been brought by foreign groups outside of the Levant (Bar-Yosef 2000, p. 136; Gilead 1995, p. 137; Marks 2003, p. 256). An ongoing debate on the origin of the Levantine Aurignacian appears to hinge on what is defined as "the Aurignacian" (Goring-Morris and Belfer-Cohen 2006, p. 308; Olszewski and Dibble 2006). While the Classic Levantine Aurignacian, typified by Ksar Akil VII-VIII, is comparable to the Aurignacian I in Europe, the claimed similarity between the Levantine Aurignacian A (including the assemblages of Ksar Akil XI-XII and Umm et-Tlel) and the Warwasi P-Z assemblages (Olszewski 2009) is not as clear. Goring-Morris and Belfer-Cohen (2006) further suggest that the occurrence of other flake-based industries (i.e., the Arqov/Divshon and Atlitian) are also likely to represent the influx of populations with different cultural traditions.

As for the Nebekian industry in the early Epipalaeolithic, this study adopts its recent definition and identification proposed by Olszewski (2006; 2008) that incorporates some assemblages, formerly named the Qalkhan industry (Henry 1995, pp. 215–242), as part of the Nebekian. The recent identification of the Nebekian also includes some assemblages that were once reported as the Kebaran, such as Wadi Hammeh 26, 31, and 33, because of the presence of the microburin technique that characterizes the Nebekian (Olszewski 2008).

On the basis of the above understandings of lithic industries as units for the examination of cultural variability, we now present chronological and geographical patterns of lithic industries during the Middle and Upper Palaeolithic in the Levant.

4.3 Chronological Examination of the Middle and Upper Palaeolithic Industries

4.3.1 Middle Palaeolithic

Although the Tabun B-, C-, and D- type industries were originally recognized at Tabun Cave as a stratigraphic sequence of three assemblages from Layers B, C, and D from the top to the bottom, the same stratigraphic occurrence is observable at only a few sites, such as Hayonim Cave (the D-type in layers F and the lower part of layer E, followed by the C-type in the upper layer of E), and probably Douara Cave (the D-type in Unit IV followed by the C-type in Unit III: Akazawa 1974). As such, the current scheme of the Levantine MP chronology primarily draws upon radiometric dating methods, e.g., TL, ESR, U-series, Amino acid racemization (AAR), and radiocarbon (for the youngest MP: Rebollo et al. 2011), that have been applied to these sites, including Tabun, Hayonim, 'Ain Difla, Rosh Ein Mor, Qafzeh, Skhul, Naamé, Kebara, Amud, Tor Faraj, Tor Sabiha, Quneitra, Ksar Akil, and Far'ah II.

We collected 307 radiometric dates from 40 cultural layers at 16 sites from published data (Table 4.2). Among these datasets, radiocarbon dates cannot be used as reliable age estimations because the temporal range of the MP is beyond the limit of this dating method (except for the youngest MP: Rebollo et al. 2011). Thus, 288 dates by either TL, ESR, U-series, and AAR are considered in the following discussions. Figure 4.2 shows the distribution of these radiometric dates by cultural layer that are then grouped into Tabun D-, C-, and B-type industries. Although recently reported radiocarbon dates for the youngest MP at Kebara, associated with the Tabun B-type assemblages (Unit V: Rebollo et al. 2011), are not included in Table 4.2, they are taken into account in the following discussions.

The overall pattern indicates that the three industries occurred in a general order from the Tabun D- through C- to B-type between ca. 250/200 and 50/45 kya. Although several dating results might suggest temporal overlap between different industries, they are not sufficient to replace the sequential model that is consistent with the stratigraphic evidence mentioned above. For example, some dates from 'Ain Difla (Clark et al. 1997) and Nahal Aqev (Schwarcz et al. 1979) might indicate that the Tabun D-type industry lasted longer in the southern arid areas, while it was replaced by the Tabun C-type in the north. However, if the error intervals are taken into account, the age estimations range widely between 90 and 180 kya for the former site (Clark et al. 1997, p. 91), while the dates of the latter site were actually obtained from travertine at the fossil spring 150 m away from the site (Schwarcz et al. 1979, p. 559). In addition, ESR dates (ca. 164–191 kya) for upper layer E at Hayonim Cave look anomalous in comparison with other dates for Tabun C-type assemblages (ca. 80–140 kya), as seen at Qafzeh, Skhul, Tabun layer C, and Naamé.

As for the dates of the Tabun B-type assemblages, revised ESR dates for Tabun layer B (ca. 100–120 kya: Grün and Stringer 2000) are anomalous, being closer to the dates of the Tabun C-type assemblages at Qafzeh and Skhul than those of other Tabun B sites, such as Kebara (Valladas et al. 1987) and Amud (Valladas et al. 1999). Thus, these revised ESR dates of Tabun layer B are not congruent with regional chrono-cultural patterns and require additional examples or further explanations to be accepted as reliable evidence. Otherwise, the dates of the Tabun B-type industry range between ca. 50/45 kya and 75 kya. Although this temporal range encompasses ESR dates from Quneitra and Far'ah II, the lithic assemblages from these sites do not show technological characteristics of the Tabun B-type industry (Shea 2003, p. 337). In fact, the dominance of flake forms in the Levallois products as well as the frequent employment of centripetal flaking in core-reduction at Quneitra (Goren-Inbar 1990) are more indicative of the Tabun C-type industry. This cultural attribution also explains the recovery of a flint flake with incised concentric lines from Quneitra because a stone tool with incised lines was also recovered in association with the Tabun C-type assemblages at Qafzeh (d'Errico et al. 2003).

U-series dates from Ksar Akil layers XXVI and XXVII, obtained many years ago, are in the temporal range of the Tabun B-type although the validity of these dates has not been further tested (van der Plicht and van der Wijk 1989). Some researchers find the assemblages from these layers similar to the Tabun C-type industry (Bar-Yosef 2000, p. 116; Shea 2003, p. 336). However, the stratigraphic changes in lithic technology from layers XXVIII to XXVI, i.e., an increase of the ovoid-shape Levallois products and a decrease of the converging form, is similar to those of Tabun-B assemblages from Unit XII to VII at Kebara, i.e., an increase of Levallois flakes and centripetal flaking in contrast to a decrease of unidirectional convergent flaking that produces Levallois points (Marks and Volkman 1986; Meignen and Bar-Yosef 1992).

In addition to the radiometric dates, the faunal sequence has contributed to the definition and construction of the Middle Palaeolithic chronology outlined here. For example, faunal assemblages, particularly micromammals, from layers XV-XXV of Qafzeh, associated with the Tabun C-type assemblages, are characterized by an increase in Afro-Arabian fauna adapted to savanna conditions (Tchernov 1998, pp. 84–85). This is interpreted to represent a northward expansion of Afro-Arabian species

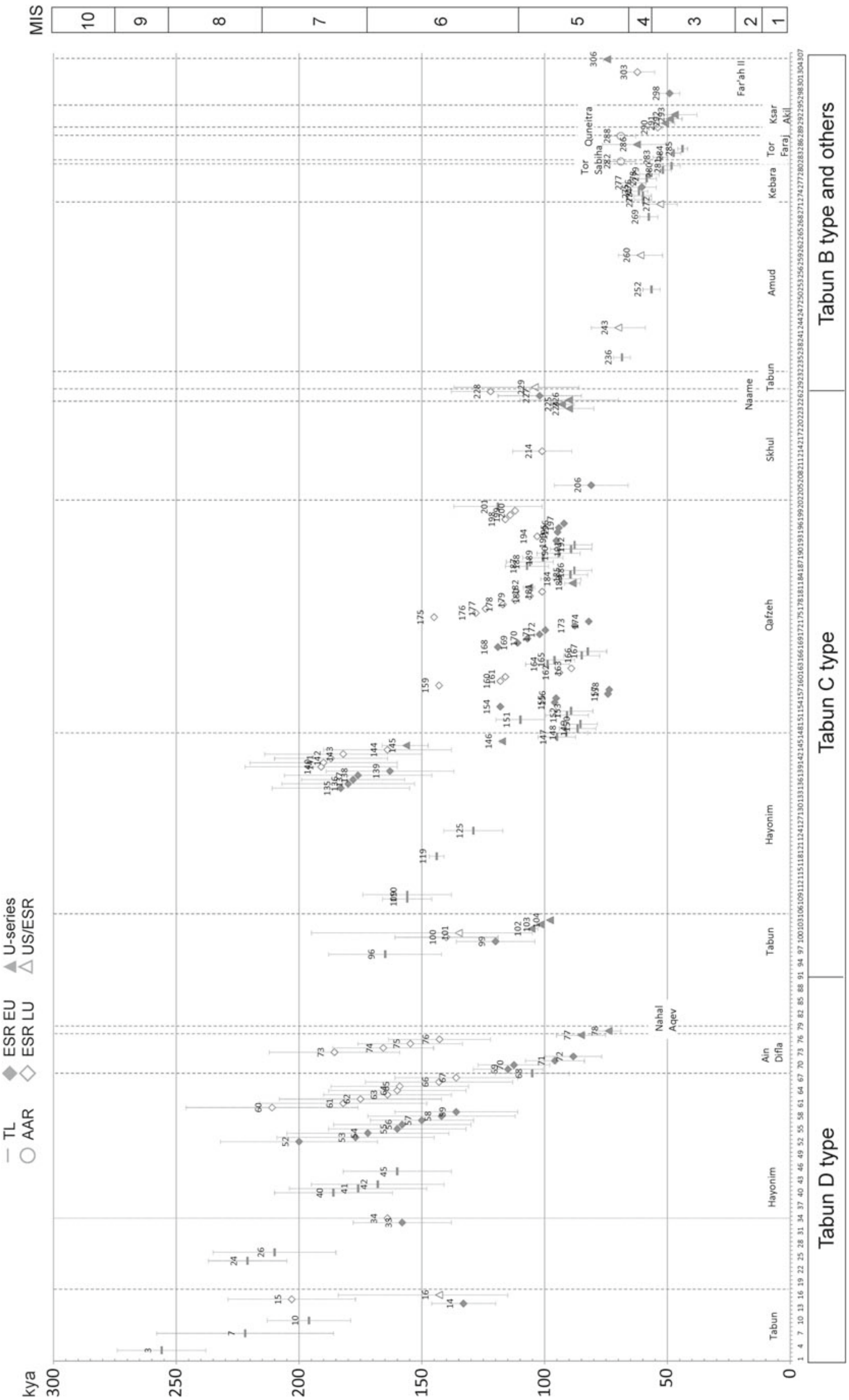

Fig. 4.2 Radiometric dates of Middle Palaeolithic sites in the Levant. Note that the dates are grouped by lithic industries and arranged in the descending order. Numbers in the plots correspond to those in Table 4.2

with *Homo sapiens* during MIS 5. In contrast, almost all of the Afro-Arabian environmental elements are absent in the faunal assemblages at Tabun-B sites, such as Kebara and Amud, where Palearctic-European fauna are dominant as a result of their southward dispersal with Neanderthals during the cold and dry climate of MIS 4 (Tchernov 1998, p. 86; Bar-Yosef 1989). The faunal assemblages from both Hayonim lower and upper E, associated with Tabun D-type and C-type industries respectively, are characterized by the presence of earlier Pleistocene fauna and the predominance of Palearctic mammals, indicating their chronological precedence to Qafzeh. These patterns in bio-cultural chronology generally fit the radiometric dates for Qafzeh, Kebara, Amud, and Hayonim E. The suggested correlation of the fauna from Tabun layer B to MIS 4 does not support the revised ESR dates mentioned above, questioning the validity of the dating results (Grün and Stringer 2000).

4.3.2 Upper Palaeolithic and Early Epipalaeolithic

Despite the presence of key stratigraphic evidence for cultural sequences at some cave and rock-shelter sites, such as at Ksar Akil, much of the archaeological remains of these time periods come from open-air sites particularly in the arid zone, necessitating the use of radiometric dates for the establishment of cultural chronology. For the UP and early Epipalaeolithic, our database includes 200 dates from 82 layers at 47 sites (Table 4.3). Most of them are radiocarbon dates with some TL dates from Jerf Ajla and Umm el-Tlel. Excluding radiocarbon dates on bone or shell as well as clearly anomalous dates, we plot the distribution of 152 dates from cultural layers, and grouped into lithic industries (Fig. 4.3). Some cultural layers, e.g., Umm el-Tlel, Ksar Akil (Tixier's VII), and Wadi Kharar 16R (Nishiaki et al. 2012a), are not classed into any of the industries because their cultural attribution is still under examination or controversial.

The overall pattern observable in this cultural chronological scheme conforms to an earlier suggestion that the IUP or Emiran is followed by the Ahmarian, that precedes the appearance of the Levantine Aurignacian regardless of its various definitions and interpretations, as described above (Belfer-Cohen and Goring-Morris 2003; Gilead 1995; Marks 2003).

The distribution of dates for the Early and Late Ahmarian are continuous, indicating that these two industries occurred sequentially. This is consistent with the idea that the technological shift from the Early to the Late Ahmarian is gradual (Coinman 2003). Such a gradual transition may also apply to the boundary between the Late Ahmarian and the Kebaran. Their temporal ranges indicated by C14 dates appear sequential, and some assemblages, e.g. Ohalo II and Fazael X, are suggested to represent technological transition from the Late Ahmarian to the Kebaran (Nadel 2003). If these observations are valid, the periodical boundary between the UP and Epipalaeolithic in the Levant may be characterized by gradual technological transition rather than sudden shift.

On the other hand, there is considerable overlap in the temporal range between the Early Ahmarian and the IUP, although it is widely recognized that the technological change from IUP to the Early Ahmarian is sequential, as attested by the stratigraphic sequence at Ksar Akil (Ohnuma 1988) and Üçağızlı (Kuhn et al. 2009). The apparent chronological overlap is created by the radiocarbon dates from Kebara Units III and IV (Early Ahmarian; No. 22–29 in Table 4.3) that are dated distinctively earlier than other Ahmarian assemblages as well as by a younger group of dates for IUP assemblages from Üçağızlı, Jerf Ajla, and Umm el-Tlel (No. 9, 10, 12, 13, 17–21 in Table 4.3). It is untenable to suggest, solely based on the distribution of radiometric dates, the contemporaneity between the IUP and the Ahmarian considering the difficulties in obtaining reliable radiocarbon dates close to the methodological limit, as discussed by Kuhn et al. (2009, pp. 90–91), and possible contamination of charcoal samples at Kebara due to complicated depositional processes from the latest Middle Palaeolithic (Unit V) to the early Ahmarian layers (Units III and IV) (Zilhão 2007, p. 11 and the chapter by Zilhão in this volume), as well as large error ranges of TL dates. However, I suggest that the IUP industry may have lasted somewhat later in inland Syria than in the Levant because (1) TL and radiocarbon dates at Umm el-Tlel (No. 20 and 21 in Table 4.3) are consistent with each other and (2) we have so far no Early Ahmarian assemblages comparable to those of Ksar Akil XVI-XVII or Üçağızlı B-C in inland Syria.

In this way, I suggest more or less sequential occurrences of blade dominant industries, including the IUP, the Early and Late Ahmarian, and the Kebaran, that is interpreted by some researchers to constitute a long-term autochthonous lithic tradition (i.e., the Levantine Leptolithic Lineage: Marks 2003). On the other hand, the distribution of available dates for the Levantine Aurignacian sensu lato appears discontinuous. This observation is exemplified by the cluster of dates for the assemblages of the Classic Levantine Aurignacian, such as Kebara Units I-II, Raqefet layer III, and Ksar Akil (Tixier's Phase VI) between ca. 35–30 kya (uncalibrated). Somewhat younger radiocarbon dates measured on bones from Hayonim D and shells from Ksar Akil VIII are not considered here. There is a general contemporaneity with this period based on a cluster of dates from Umm el-Tlel, Ksar Akil (Tixier's Phase VII), and Wadi Kharar 16R (Nishiaki et al. 2012a). Although the cultural attribution of these assemblages is still controversial or under examination, this cluster of dates may indicate

Table 4.3 List of radiometric dates of Upper Palaeolithic and early Epipalaeolithic sites in the Levant

No. in the plot	Site name	Layer	Dating method	Laboratory No.	Samples	Date (mean)	SD (positive)	SD (negative)	Selected dates
1	Boker Tachtit	1	C14	SMU-580	Charcoal	47,280	9,050	9,050	O
2	Boker Tachtit	1	C14	SMU-259	Charcoal	46,930	2,420	2,420	O
3	Boker Tachtit	1	C14	SMU-184	Charcoal	>45,570			
4	Boker Tachtit	1	C14	GY-3642	Charcoal	>34,950			
5	Boker Tachtit	4	C14	SMU-579	Charcoal	35,055	4,100	4,100	O
6	Üçağızlı Magara	H [locus 2: test trench]	C14-AMS	AA-35625	Charcoal	41,400	1,100	1,100	O
7	Üçağızlı Magara	H [locus 2: test trench]	C14-AMS	AA-27994	Charcoal	39,400	1,200	1,200	O
8	Üçağızlı Magara	H [locus 2: test trench]	C14-AMS	AA-27995	Charcoal	38,900	1,100	1,100	O
9	Üçağızlı Magara	H [locus 2: test trench]	C14-AMS	AA-35261	Charcoal	35,670	730	730	O
10	Üçağızlı Magara	H [locus 2: test trench]	C14-AMS	AA-37623	Charcoal	33,040	1,400	1,400	O
11	Üçağızlı Magara	G	C14-AMS	AA-37626	Charcoal	39,100	1,500	1,500	O
12	Üçağızlı Magara	F	C14-AMS	AA-37624	Charcoal	35,020	740	740	O
13	Üçağızlı Magara	F	C14-AMS	AA-35260	Charcoal	34,000	690	690	O
14	Jerf Ajla	Brown 1 (Units A, B, C)	TL	JA-7	Burnt flint	42,600	5,800	5,800	O
15	Jerf Ajla	Brown 1 (Units A, B, C)	TL	JA-2	Burnt flint	40,700	6,400	6,400	O
16	Jerf Ajla	Brown 1 (Units A, B, C)	TL	JA-3	Burnt flint	37,300	4,900	4,900	O
17	Jerf Ajla	Brown 1 (Units A, B, C)	TL	Average	Burnt flint	35,600	3,400	3,400	O
18	Jerf Ajla	Brown 1 (Units A, B, C)	TL	JA-8	Burnt flint	35,500	4,400	4,400	O
19	Jerf Ajla	Brown 1 (Units A, B, C)	TL	JA-1	Burnt flint	31,000	3,400	3,400	O
20	Umm el-Tlel	III2a'	TL	GifA-93215	Burnt flint	36,000	2,500	2,500	O
21	Umm el-Tlel	III2a'	C14-AMS	GifA-93216	Charcoal	34,530	750	750	O
22	Kebara	E (IV)	C14-AMS	Pta-5141	Charcoal	43,700	1,800	1,800	O
23	Kebara	E (IV)	C14-AMS	Pta-5002	Charcoal	42,500	1,800	1,800	O
24	Kebara	E (IV)	C14-AMS	Pta-4987	Charcoal	42,100	2,100	2,100	O
25	Kebara	E (IV)	C14-AMS	OxA-3978	Charcoal	28,890	400	400	
26	Kebara	E (III)	C14-AMS	OxA-3977	Charcoal	43,800			O
27	Kebara	E (III)	C14-AMS	OxA-3976	Charcoal	43,500	2,200	2,200	O
28	Kebara	E (III)	C14-AMS	Gif-TAN-90037	Charcoal	42,500			O
29	Kebara	E (III)	C14-AMS	Gif-TAN90168	Charcoal	41,700			O
30	Kebara	E (III)	C14-AMS	Pta-4267	Charcoal	36,100	1,100	1,100	O
31	Kebara	E (III)	C14-AMS	OxA-1567	Charcoal	35,600	1,600	1,600	O
32	Abu Noshra II		C14	SMU-2372	Charcoal	48,250	2,810	2,810	
33	Abu Noshra II		C14	SMU-2122	Charcoal	38,924	1,529	1,529	O
34	Abu Noshra II		C14	ETH-3076	Charcoal	33,940	790	790	O
35	Abu Noshra II		C14	ETH-3075	Charcoal	33,470	680	680	O
36	Abu Noshra II		C14	SMU-1762	Charcoal	31,585	2,275	2,275	O
37	Abu Noshra II		C14	SMU-1772	Charcoal	31,023	8,537	8,537	O
38	Abu Noshra VI		C14	SMU-2371	Charcoal	31,100	300	300	O
39	Abu Noshra I		C14	SMU-2254	Charcoal	35,824	1,090	1,090	O
40	Abu Noshra I		C14	SMU-2007	Charcoal	35,805	1,520	1,520	O
41	Abu Noshra I		C14	SMU-1824	Charcoal	31,330	2,880	2,880	O
42	Abu Noshra I		C14	B-12125	Charcoal	>30,440			

(continued)

Table 4.3 (continued)

No. in the plot	Site name	Layer	Dating method	Laboratory No.	Samples	Date (mean)	SD (positive)	SD (negative)	Selected dates
43	Abu Noshra I		C14	B-13898	Charcoal	29,580	1,610	1,340	O
44	Abu Noshra I		C14	B-13897	Charcoal	25,950	360	360	O
45	Boker A	I	C14	SMU-578	Charcoal	37,920	2,810	2,810	O
46	Boker A	I	C14	SMU-187	Charcoal	>33,600			
47	Boker A	I	C14	SMU-260	Charcoal	>33,420			
48	Qseimeh I		C14	DRI-2965	Ostrich eggshell	34,010	510	510	
49	Qadesh Barnea 501		C14	Pta-2819	Ostrich eggshell	33,800	940	940	
50	Qadesh Barnea 601B		C14	Pta-2964	Ostrich eggshell	32,470	780	780	
51	Lagama VIII		C14	SMU-119	Ostrich eggshell	32,980	2,140	2,140	
52	Lagama VII		C14	SMU-172	Charcoal	34,170	3,670	3,670	O
53	Lagama VII		C14	SMU-185	Charcoal	31,210	2,780	2,780	O
54	Lagama VII		C14	RT-413A	Charcoal	>19,900			
55	Üçağızlı Magara	C [locus 1]	C14-AMS	Gif-8766	Marine shell	32,250	800	800	
56	Üçağızlı Magara	B1	C14-AMS	AA38201	Marine shell	32,670	760	760	
57	Üçağızlı Magara	B	C14-AMS	AA38203	Marine shell	29,130	380	380	
58	Qafzeh Cave	11	C14-AMS	GifA-97338	Charcoal	31,520	490	490	O
59	Qafzeh Cave	11	C14-AMS	AA-27290	Charcoal	29,320	360	360	O
60	Qafzeh Cave	9	C14-AMS	GifA-97337	Charcoal	28,340	360	360	O
61	Qafzeh Cave	9	C14-AMS	AA-27291	Charcoal	28,020	320	320	O
62	Qafzeh Cave	9	C14-AMS	GifA-98230	Charcoal	29,060	390	390	O
63	Qafzeh Cave	9	C14-AMS	AA-27292	Charcoal	28,380	330	330	O
64	Qafzeh Cave	8	C14-AMS	GifA-98229	Charcoal	27,510	340	340	O
65	Qafzeh Cave	8	C14-AMS	AA-27294	Charcoal	27,080	270	270	O
66	Qafzeh Cave	8	C14-AMS	GifA-97336	Charcoal	26,720	300	300	O
67	Qafzeh Cave	8	C14-AMS	AA-27289	Charcoal	27,000	280	280	O
68	Qafzeh Cave	8	C14-AMS	Gif-98231	Charcoal	28,460	360	360	O
69	Qafzeh Cave	8	C14-AMS	AA-27293	Charcoal	26,540	280	280	O
70	Qafzeh Cave	D (8–9)	C14	asparatic acid	Bone	46,950			
71	Qafzeh Cave	D (8–9)	C14	asparatic acid	Bone	38,950			
72	Qafzeh Cave	D (8–9)	C14	asparatic acid	Bone	31,950			
73	Boker BE	III	C14	SMU-188 (Level III)	Charcoal	27,450	1,300	1,300	O
74	Boker BE	III	C14	SMU-229 (Level III)	Charcoal	26,660	500	500	O
75	Boker BE	III	C14	SMU-228 (Level III)	Charcoal	26,030	600	600	O
76	Boker BE	II	C14	SMU-227	Charcoal	26,950	520	520	O
77	Boker BE	II	C14	SMU-565	Charcoal	24,630	390	390	O
78	A306A		C14	Pta-2950	Ostrich eggshell	27,100	410	410	
79	Thalab al-Buhayla	E	C14-AMS	Beta-129817	Charcoal	24,900	130	130	O
80	Thalab al-Buhayla	C	C14-AMS	Beta-129818	Charcoal	25,680	100	100	O
81	Lagama IIID		C14	SMU-118	Ostrich eggshell	30,050	1,240	1,240	
82	Ksar Akil	Tixier's III	C14-AMS	OxA-1798	Charcoal	29,300	800	800	O
83	Ksar Akil	Tixier's III	C14-AMS	OxA-1797	Charcoal	26,900	600	600	O
84	Ksar Akil	Tixier's III	C14	MC-1191	Charcoal	26,500	900	900	O

(continued)

Table 4.3 (continued)

No. in the plot	Site name	Layer	Dating method	Laboratory No.	Samples	Date (mean)	SD (positive)	SD (negative)	Selected dates
85	Ksar Akil	Tixier's III	C14-AMS	OxA-1796	Charcoal	21,100	500	500	O
86	Ain al-Buhayra	Unit F	C14-AMS	Beta-55928	Charcoal	25,950	440	440	O
87	Ain al-Buhayra	Units H-I	C14-AMS	Beta-55931	Charcoal	23,560	250	250	O
88	Ain al-Buhayra	Units H-I	C14-AMS	Beta-56424	Charcoal	23,500	270	270	O
89	Ain al-Buhayra	Units H-I	C14-AMS	Beta-118757	Charcoal	20,670	600	600	O
90	Ain al-Buhayra	Units H-I	C14-AMS	UA-4395	Charcoal	20,300	600	600	O
91	Yutil al-Hasa	Area A	C14-AMS	Beta-129813	Charcoal	22,790	80	80	O
92	Yutil al-Hasa	Area A	C14-AMS	UA-4396	Charcoal	19,000	1,300	1,300	O
93	Shunera XVI		C14	RT-1084N	Carbonate	22,200	400	400	
94	Shunera XVI		C14	RT-1072N	Ostrich eggshell	16,200	170	170	
95	Shunera XVI		C14	Pta-3703	Ostrich eggshell	16,100	150	150	
96	Shunera XVI		C14	Pta-3702	Ostrich eggshell	15,800	160	160	
97	Shunera XVI		C14	RT-1069	Charcoal	102	2	2	
98	Meged		C14-AMS	AA-26552	Charcoal	20,485	155	155	O
99	Meged		C14-AMS	AA-26551	Charcoal	18,840	140	140	O
100	Ohalo II		C14-AMS	RT-1625	Charcoal	21,050	330	330	O
101	Ohalo II		C14-AMS	RT-1624	Charcoal	20,840	290	290	O
102	Ohalo II		C14-AMS	RT-1620	Fraxinus s.	20,830	180	180	O
103	Ohalo II		C14-AMS	RT-1622	Pistacia a.	20,190	170	170	O
104	Ohalo II		C14-AMS	Pta-5387	Charcoal	20,100	440	440	O
105	Ohalo II		C14-AMS	RT-1621	Rhamnus	20,070	270	270	O
106	Ohalo II		C14-AMS	RT-1619	Tamarix	19,860	190	190	O
107	Ohalo II		C14-AMS	RT-1248	Charcoal	19,800	360	360	O
108	Ohalo II		C14-AMS	Pta-5386	Charcoal	19,600	400	400	O
109	Ohalo II		C14-AMS	RT-1616	Pistacia a.	19,590	150	150	O
110	Ohalo II		C14-AMS	RT-1342	Charcoal	19,500	170	170	O
111	Ohalo II		C14-AMS	Pta-5374	Charcoal	19,400	220	220	O
112	Ohalo II		C14-AMS	OxA-2565	Hordeum	19,310	190	190	O
113	Ohalo II		C14-AMS	RT-1250	Tamarix	19,250	460	460	O
114	Ohalo II		C14-AMS	RT-1618	Tamarix	19,220	180	180	O
115	Ohalo II		C14-AMS	OxA-2566	Hordeum	19,110	390	390	O
116	Ohalo II		C14-AMS	RT-1251	Charcoal	19,000	190	190	O
117	Ohalo II		C14-AMS	RT-1252	Tamarix	18,900	400	400	O
118	Ohalo II		C14-AMS	RT-1358	Charcoal	18,760	180	180	O
119	Ohalo II		C14-AMS	RT-1617	Populus e.	18,700	180	180	O
120	Ohalo II		C14-AMS	OxA-2564	Hordeum	18,680	180	180	O
121	Ohalo II		C14-AMS	RT-1343	Charcoal	18,600	220	220	O
122	Ohalo II		C14-AMS	RT-1244	Charcoal	18,360	230	230	O
123	Ohalo II		C14-AMS	RT-1623	Tamarix	18,210	240	240	O
124	Ohalo II		C14-AMS	RT-1297	Charcoal	17,500	200	200	O
125	Azariq XIII		C14-AMS	RT-1105	Carbonate	19,700	400	400	
126	Azariq XIII		C14-AMS	OxA-2142	Charcoal	15,160	190	190	
127	Azariq XIII		C14-AMS	RT-1081	Charcoal	10,700	230	230	
128	Fazael X		C14-AMS	OxA-2870	Charcoal	15,450	130	130	
129	Azraq 17 (trench 2)		C14-AMS	OxA-869	Charcoal	13,260	200	200	
130	Meged		C14-AMS	AA-22314	Charcoal	18,125	135	135	O
131	Meged		C14-AMS	AA-22313	Charcoal	18,065	120	120	O
132	Ain Qasiyya	Area A Unit IIIa	C14-AMS	Poz-33101	Charcoal	19,690	150	150	

(continued)

Table 4.3 (continued)

No. in the plot	Site name	Layer	Dating method	Laboratory No.	Samples	Date (mean)	SD (positive)	SD (negative)	Selected dates
133	Ain Qasiyya	Area A Unit IIIa	C14-AMS	OxA-1883	Charcoal	17,555	75	75	O
134	Ain Qasiyya	Area A Unit IIIa	C14-AMS	OxA-18832	Charcoal	17,495	70	70	O
135	Ain Qasiyya	Area B Unit IIIa	C14-AMS	Poz-33103	Charcoal	16,960	110	110	O
136	Kharaneh IV	Area B	C14-AMS	OxA-22273	Charcoal	15,890	90	90	O
137	Kharaneh IV	Area B	C14-AMS	OxA-22274	Charcoal	15,770	80	80	O
138	Ein Gev I		C14	GrN-5576	Burnt bone	15,700	415	415	
139	Urkan II		C14-AMS	OxA-2841	Charcoal	15,730	130	130	O
140	Urkan II		C14-AMS	OxA-2835	Charcoal	15,190	130	130	O
141	Urkan II		C14-AMS	OxA-2838	Charcoal	15,050	160	160	O
142	Urkan II		C14-AMS	OxA-2842	Charcoal	14,980	200	200	O
143	Urkan II		C14-AMS	OxA-2840	Charcoal	14,880	120	120	O
144	Urkan II		C14-AMS	OxA-2836	Charcoal	14,860	130	130	O
145	Urkan II		C14-AMS	OxA-2839	Charcoal	14,800	130	130	O
146	Urkan II		C14-AMS	OxA-2837	Charcoal	14,650	120	120	O
147	Urkan II		C14-AMS	OxA-1503	Charcoal	14,440	150	150	O
148	Umm el-Tlel	V (= II 1) Ahmarian	C14-AMS	Gif-90034	Charcoal	30,310	670	670	O
149	Umm el-Tlel	II 2a Ahmarian	TL		Burnt flint	34,000	2,500	2,500	O
150	Umm el-Tlel	II 2b Aurignacian	C14-AMS	Gif A-93212	Charcoal	32,000	580	580	O
151	Umm el-Tlel	XII (= II 4?) unknown	C14-AMS	Gif-90040	Charcoal	30,790	760	760	O
152	Ksar Akil	Tixier's VII	C14	MC-1192	Charcoal	32,000	1,500	1,500	O
153	Kharar 16R	Area 2	C14-AMS	IAAA-103837	Charcoal	33,130	160	160	O
154	Kebara	D (II)	C14-AMS	Gx-17276	Charcoal	42,800	4,800	4,800	
155	Kebara	D (II)	C14-AMS	OxA-1230	Charcoal	36,000	1,600	1,600	O
156	Kebara	D (II)	C14-AMS	Gif-TAN-90028	Charcoal	34,300	1,100	1,100	O
157	Kebara	D (II)	C14-AMS	OxA-3975	Charcoal	33,920	690	690	O
158	Kebara	D (II)	C14-AMS	Gif-TAN-90151	Charcoal	32,670	800	800	O
159	Kebara	D (II)	C14-AMS	Pta-4263	Charcoal	31,400	480	480	O
160	Kebara	D (II)	C14-AMS	Pta-4269	Charcoal	28,700	450	450	
161	Kebara	D (I)	C14-AMS	OxA-3974	Charcoal	34,510	740	740	O
162	Kebara	D (I)	C14-AMS	Pta-4268	Charcoal	32,200	630	630	O
163	Kebara	D (I)	C14-AMS	Pta-4247	Charcoal	22,900	250	250	
164	Raqefet	III	C14-AMS	RTT4945	Charcoal	30,540	440	440	O
165	Hayonim	Layer D	C14-AMS	OxA-2805	Bone	29,980	720	720	
166	Hayonim	Layer D	C14-AMS	OxA-2801	Bone	28,900	650	650	
167	Hayonim	Layer D	C14-AMS	OxA-2802	Bone	27,200	600	600	
168	Ksar Akil	Tixier's VI	C14-AMS	OxA-1805	Charcoal	32,400	1,100	1,100	O
169	Ksar Akil	Tixier's VI	C14-AMS	OxA-1804	Charcoal	31,200	1,300	1,300	O
170	Ksar Akil	VIII	C14	GrN-2195	Shell	28,840	380	380	
171	Ksar Akil	VIII	C14	MC-686-688	Shell	27,000			
172	Ksar Akil	VIII	C14	MC-680-684	Shell	26,000			
173	Qseimeh II		C14	DRI-2966	Ostrich eggshell	30,500	330	330	
174	Boker BE	I	C14	SMU-186	Charcoal	25,610	640	640	O
175	Boker BE	I	C14	SMU-566	Charcoal	25,250	345	345	O
176	Ein Aqev	12	C14	SMU-5	Charcoal	19,980	1,200	1,200	O
177	Ein Aqev	11	C14	SMU-8	Charcoal	17,390	560	560	O
178	Ein Aqev	9	C14	SMU-6	Charcoal	17,890	600	600	O
179	Ein Aqev	7	C14	I-5495	Charcoal	17,510	560	560	O
180	Ein Aqev	5	C14	I-5494	Charcoal	16,900	250	250	O
181	Madamagh	D	C14	KN-3594	Bone	15,300	600	600	

(continued)

Table 4.3 (continued)

No. in the plot	Site name	Layer	Dating method	Laboratory No.	Samples	Date (mean)	SD (positive)	SD (negative)	Selected dates
182	Ksar Akil	Tixier's IV	C14-AMS	OxA-1803	Charcoal	30,250	850	850	O
183	Fazael IX		C14-AMS	OxA-2871	Charcoal	17,660	160	160	O
184	Tor Sageer		C14-AMS	Beta-129810	Charcoal	22,590	80	80	O
185	Tor Sageer		C14-AMS	Beta-129811	Charcoal	20,840	340	340	O
186	Tor Sageer		C14-AMS	Beta-129809	Charcoal	20,330	60	60	O
187	Gaiyfa X		C14	DRI-3001	Charcoal	19,525	199	199	O
188	Wadi Hammeh 26		C14-AMS	SUA-2101	Charcoal	19,500	600	600	O
189	Uwaynid 18	Upper	C14-AMS	OxA-864	Charcoal	19,800	350	350	O
190	Uwaynid 18	Upper	C14-AMS	OxA-868	Charcoal	19,500	250	250	O
191	Uwaynid 14	Upper	C14-AMS	OxA-865	Charcoal	18,900	250	250	O
192	Uwaynid 14	Middle	C14-AMS	OxA-866	Charcoal	18,400	250	250	O
193	Tor Tareeq	Lower	C14-AMS	UA-4391	Charcoal	16,900	500	500	O
194	Tor Tareeq	Lower	C14-AMS	UA-4392	Charcoal	15,580	250	250	O
195	Ain Qasiyya	Area D Unit IIIa	C14-AMS	Poz-33106	Charcoal	16,080	100	100	O
196	Madamagh	A	C14	KN-3593	Bone	14,300	650	650	
197	Jilat 6	Phase C	C14-AMS	OxA-539	Charcoal	7,980	150	150	
198	Jilat 6	Phase B	C14-AMS	OxA-522	Charcoal	11,740	80	80	
199	Jilat 6	Phase B	C14-AMS	OxA-523	Charcoal	11,450	200	200	
200	Uwaynid 18	Lower	C14-AMS	OxA-867	Charcoal	23,200	400	400	

the timing of technological diversification between ca. 35–30 kya (uncalibrated).

The number of dates obtained for the Arqov/Divshon and the Atlitian assemblages are limited, but currently available dates are later than the Classic Levantine Aurignacian by thousands of years or more than ten thousand years, except for a single early date for Ksar Akil (Tixier's IV). This chronological gap between the Classic Levantine Aurignacian and other flake-based industries (i.e., the Arqov/Divshon and the Atlitian) is consistent with the position that these three industries should be separate entities rather than lumping them as the Levantine Aurignacian sensu lato (Goring-Morris and Belfer-Cohen 2006). It is notable that the temporal ranges of the Arqov/Divshon and Atlitian significantly overlap that of the Nebekian, that is conventionally included in the Epipalaeolithic period. This chronological overlap between ca. 22 and 17 kya (uncalibrated) may represent another phase of technological diversification at the transition from the latest UP to the early Epipalaeolithic period.

In sum, the above chronological examination allowed us to detect a sequential occurrence of blade dominant industries from the IUP through the Ahmarian to the Kebaran that may represent a long-term technological tradition. On the other hand, discontinuous clusters of dates for other industries may indicate a period of increased cultural variability. However, the apparent chronological overlap in the distribution of radiocarbon dating plots may only be a product of error ranges. To obtain further insights, we examine geographical distributions of lithic industries below.

4.4 Geographical Examination of the Middle and Upper Palaeolithic Industries

4.4.1 Middle Palaeolithic

Figures 4.4, 4.5, and 4.6 show the distribution of sites where Tabun D-, C-, and B-type assemblages were recovered. The sites with Tabun D-type assemblages are distributed widely in the Levant from the south at Rosh Ein Mor and Nahal Aqev in the Negev to the north at Dereriyeh Cave in the Afrin basin (Nishiaki et al. 2011). They are also distributed in the coastal as well as inland areas. In contrast, the Tabun C-type assemblages are mainly distributed from the central to the northern Levant, and no Tabun C-assemblages have been recovered in the southern Levant. While explaining this geographic pattern is beyond the scope of this paper, the technological attribution of the Quneitra assemblage to the Tabun C-type is consistent with its geographical proximity to other Tabun C-type sites (Fig. 4.5). In addition, the lack of Tabun C-type sites in the southern Levant cannot be taken as a support for the persistence of some Tabun D-type sites in the southern Levant (e.g., Nahal Aqev and 'Ain Difla) and their contemporaneity with the Tabun C-assemblages in north unless the dates proposed for Nahal Aqev and 'Ain Difla are validated.

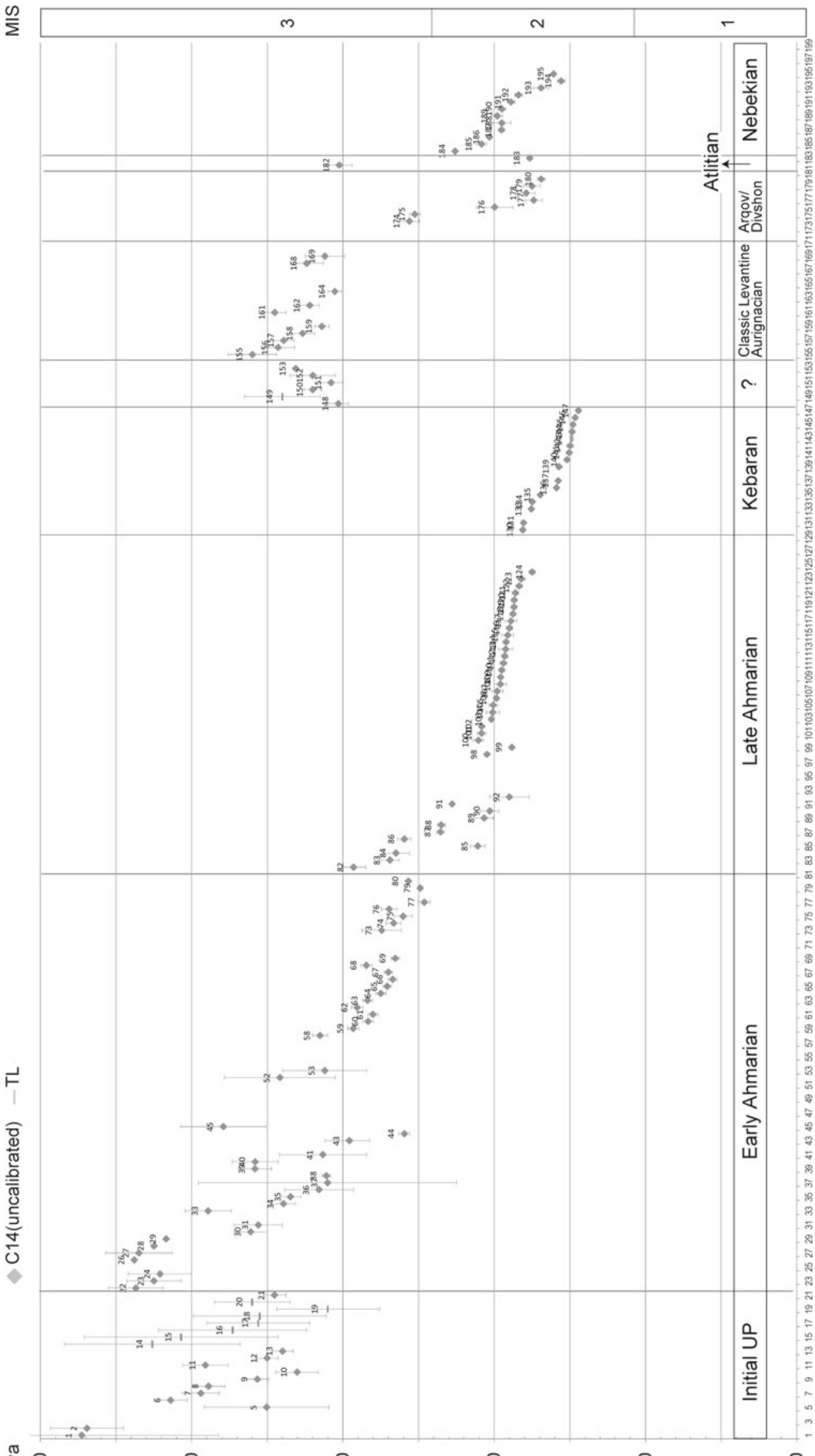

Fig. 4.3 Radiometric dates of Upper Palaeolithic and early Epipalaeolithic sites in the Levant. Note that the dates are grouped by lithic industries and arranged in the descending order. Numbers in the plots correspond to those in Table 4.3

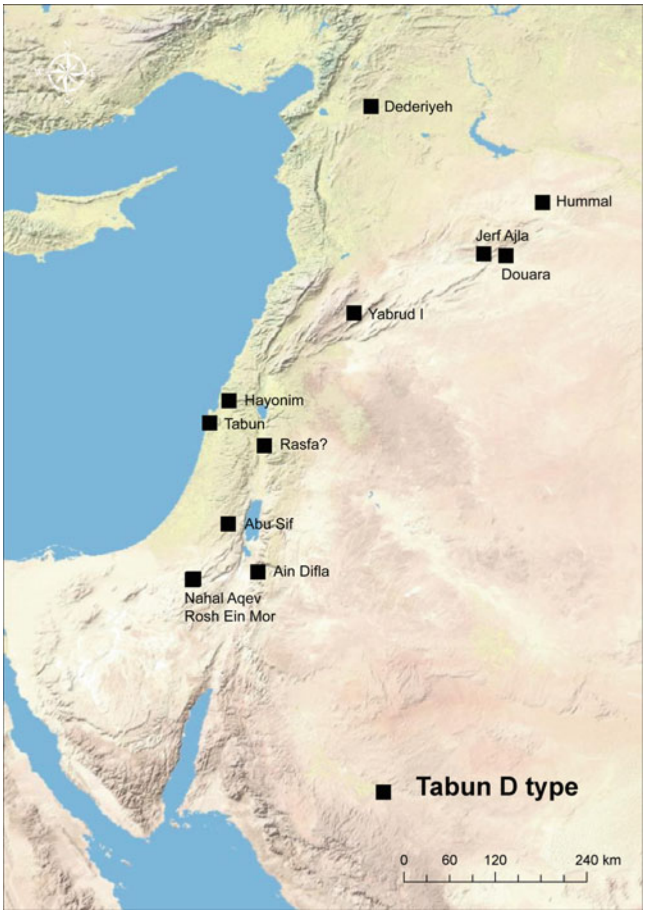

Fig. 4.4 Geographic distributions of the Tabun D-type assemblages in the Levant

Fig. 4.5 Geographic distributions of the Tabun C-type assemblages in the Levant

The Tabun B-type assemblages are distributed widely from the north at Dederiyeh Cave (Nishiaki et al. 2011) to south at Tor Faraj (Henry 2004), but their distribution in the inland zone is not well attested, as the assemblages there are distinguished from the Tabun B-type industry on techno-typological grounds and named the Late Mousterian, that may represent a regional cultural variation.

4.4.2 Upper Palaeolithic

The IUP sites are widely distributed in the Levant from Üçağızlı (Kuhn et al. 2009) in the north to Wadi Aghar (Henry 1995) in the south as well as from coastal areas through to the inland zones (Fig. 4.7). Although such a wide geographic range of the IUP is comparable to (or even greater than) that of the preceding Tabun B-type industry, the former is characterized by clearer regional patterns, that are observable in the occurrence of some tool types. For example, the IUP assemblages in the northern Levant are characterized by chamfered pieces along the coastal areas, such as at Ksar Akil and Üçağızlı (Ohnuma 1988; Kuhn et al. 2009), and by Umm el Tlel points in the inland areas (Bar-Yosef 2000). To their south in the central to southern Levant, the IUP assemblages are characterized by Emireh points (e.g., Marks 1983; Copeland 2000).

The distribution of the Early Ahmarian sites is also broad in the Levant, significantly overlapping the range of the preceding IUP industry (Fig. 4.8). This is consistent with some researchers' understanding that the Early Ahmarian appeared as a local technological change from the IUP. However, I argue that this technological change was not uniform in the Levant. This is because the assemblages that are currently grouped under the label of "the Ahmarian" encompass regional variability, for example, in the form and frequency of pointed tools and the dimension of blade products. While Ksar Akil points and *pointes a fáce plane* made on relatively large blades characterize the northern coastal areas (Bergman 1981; Kuhn et al. 2009), backed or pointed bladelets occur frequently in the southern Levant (Bar-Yosef and Phillips 1977; Marks and

Fig. 4.6 Geographic distributions of the Tabun B-type assemblages in the Levant

Fig. 4.7 Geographic distributions of the Initial Upper Palaeolithic assemblages in the Levant

Kaufman 1983; Coinman 2003). In the Sinai Peninsula, no IUP assemblages have been recovered despite clear evidence for the Early Ahmarian industry in this region (Bar-Yosef and Phillips 1977; Phillips 1988), indicating either a lack of human occupation prior to the Early Ahmarian or the lack of discovery of such archeological remains. In contrast, despite the presence of the IUP in the northern inland zone, particularly at Umm el Tlel in the el-Kowm basin, no Early Ahmarian assemblages comparable to those from Ksar Akil XVI-XVII or Üçağızlı B-C have been recovered there. Instead, in the northern inland zone, there are bladelet dominant assemblages at Umm el Tlel (Ploux and Soriano 2003) and Wadi Kharar 16R (Nishiaki et al. 2012a), whose radiocarbon dates around 33–30 ka (uncalibrated) (No. 148, 150, 151, and 153 in Table 4.3) follow those of IUP assemblages at Umm el-Tlel (No. 20–21 in Table 4.3).

Cultural regionality during the period of the Early Ahmarian is also evident in the geographic distribution of the Classic Levantine Aurignacian industry (Fig. 4.9), whose techno-typological difference from the Early Ahmarian is widely recognized among researchers (e.g., Goring-Morris and Belfer-Cohen 2006; Marks 2003). In contrast to the broad distribution of the Early Ahmarian assemblages, that of the Classic Levantine Aurignacian is restricted in the central Levant. Two sites, located east of the coastal mountain ranges, are Yabrud Rockshelter II and el-Quseir. The coastal areas may be the central zone of the Classic Levantine Aurignacian industry given that the cultural attribution of the Yabrud II assemblages varies among researchers (compare Gilead 1991, p. 128 with Goring-Morris and Belfer-Cohen 2006, p. 311).

Although the Late Ahmarian assemblages are widely distributed in the Levant (Fig. 4.10), they are not found in the northern coastal and inland areas or southern Jordan and the Sinai, where the Early Ahmarian assemblages have been recovered. This difference in geographic extent between the Early and Late Ahmarian indicates a chrono-cultural gap after the Early Ahmarian in the areas without the Late Ahmarian sites. Unless this is merely caused by the lack of discovery or recognition of the Late Ahmarian assemblages, I suggest that the technological change from the Early Ahmarian involved regional variations

Fig. 4.8 Geographic distributions of the early Ahmarian assemblages in the Levant

Fig. 4.9 Geographic distributions of the Classic Levantine Aurignacian assemblages in the Levant

that researchers have not yet clarified. At present, it is notable that the narrow distribution of the Late Ahmarian is similar to that of the following Kebaran industry. This is consistent with the chronological and technological observations that the Kebaran emerged from the Late Ahmarian.

Despite the reduced range of the Late Ahmarian, in comparison to the Early Ahmarian, it is still wider than the extent of the Arqov/Divshon, the Atlitian, and the Nebekian (Fig. 4.11), that are partly contemporary with the Late Ahmarian or the Kebaran, according to their radiocarbon dates. For example, the Arqov/Divshon assemblages are mainly located in the Negev, and the Atlitian assemblages are currently known only from the central coast and the Jordan Valley. On the other hand, the Nebekian assemblages are mostly distributed in the inland areas to the east of the Jordan Valley, partly occupying the areas beyond the range of the Late Ahmarian. The geographic distributions of these three industries are, thus, restricted and distinct from each other. Such regionally specific distributions are consistent with the possibility of their contemporaneity suggested by their chronological overlaps in the distribution of radiocarbon dates (Fig. 4.3).

4.5 Discussions

4.5.1 Chronological and Geographical Patterns of Lithic Industries

This section summarizes the observations obtained from the above examinations on the chronological and geographical patterns of the MP and UP lithic industries in the Levant. As for the MP, currently available radiometric dates and stratigraphic occurrences of the three MP industries (i.e., Tabun D-, C-, and B-types) indicate that they occurred sequentially. The lack of the Tabun C-type assemblages in the southern Levant, where young radiometric dates have been reported for two Tabun D-type sites (i.e., Nahal Aqev and Ain Difla), cannot be taken as evidence for the temporal overlap between the Tabun D-type and C-type industries because these radiometric dates are either with wide error ranges or without a reliable link to the lithic assemblages as discussed earlier. Other radiometric dates that indicate the chronological overlap between different MP industries are anomalous and can-

Fig. 4.10 Geographic distributions of the Late Ahmarian and Kebaran assemblages in the Levant

not be accepted without further support (i.e., ESR dates for Hayonim Upper E and revised ESR dates for the Tabun Layer B). In fact, the possibility of these overlaps does not gain support from the geographic patterns.

During the UP and early Epipalaeolithic periods, there are generally two patterns in the chronological and geographic distributions of the lithic industries. The first consists of the IUP, the Early and Late Ahmarian, and the Kebaran. Their chronological ranges are sequential, and the geographic distributions are broad with significant overlap existing among the industries, although the range may have been somewhat reduced at the transition point from the Early to the Late Ahmarian. These patterns, as defined by the sequential occurrence and the wide overlapping geographic distribution, appear in accord with some researchers' understanding that these blade dominant industries represent the local lithic tradition (Marks 2003; Belfer-Cohen and Goring-Morris 2007, pp. 200–201).

The second pattern, involving the Classic Levantine Aurignacian, the Arqov/Divshon, the Atlitian, and the Nebekian, is characterized by the appearance of industries in restricted time and space. The chronological ranges are either discontinuous or significantly overlapping, and in the latter case, multiple industries may have co-existed because they tend to be clustered in different regions. Researchers

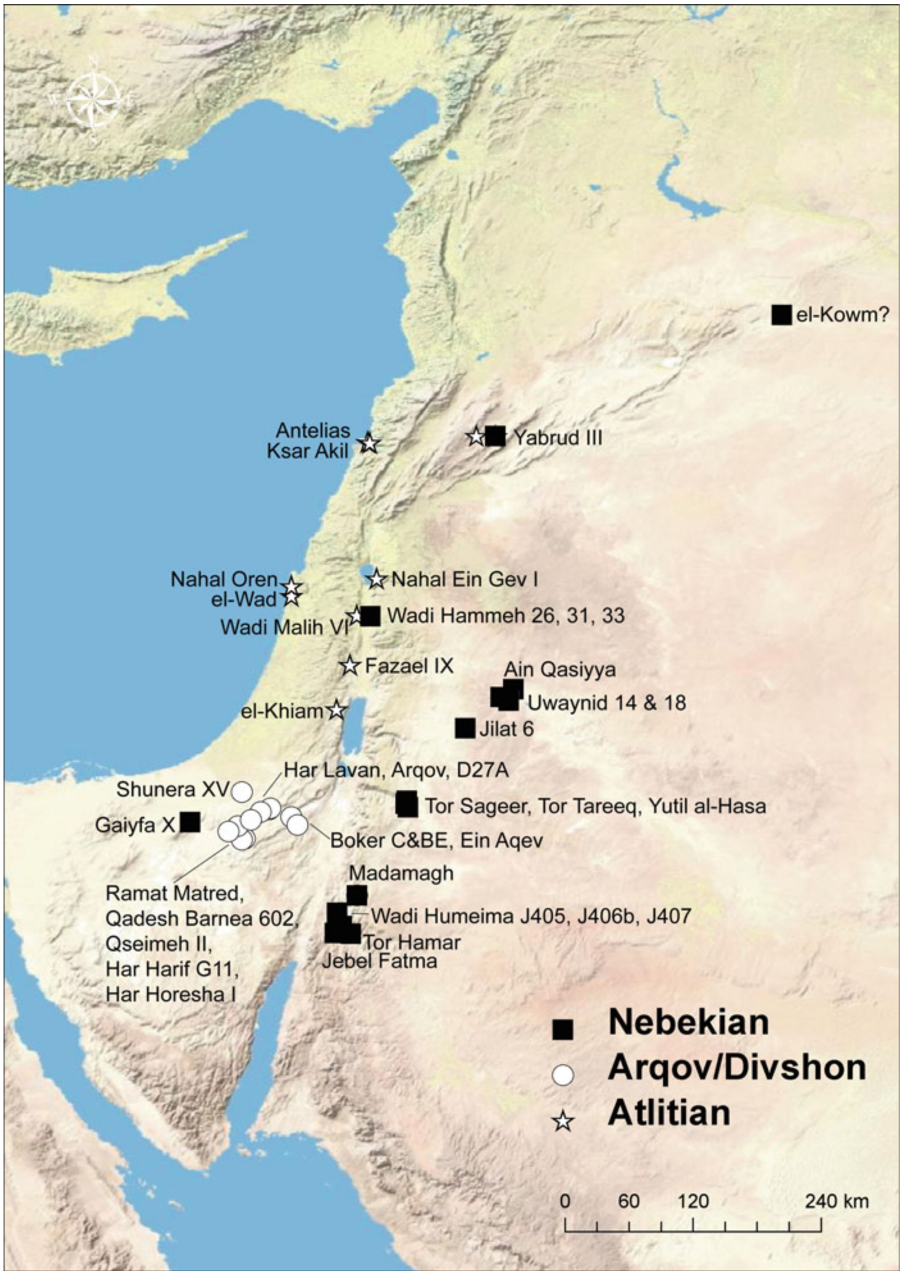

Fig. 4.11 Geographic distributions of the Nebekian, the Arqov/Divshon, and the Atlitian assemblages in the Levant

consider these industries to be technologically different from the local blade industries that show the first pattern although it is difficult with available data to determine whether the second cultural pattern resulted from technological innovations/adaptations by local populations, an influx of ideas/traits from migrating populations, or a change of local cultures under the influence of different cultural groups.

4.5.2 Fossil Evidence in Relation to the MP and UP Industries

4.5.2.1 Middle Palaeolithic

One of the objectives of this paper is to discuss the plausibleness of interpreting the chronological and geographic patterns of lithic industries as they related to the learning behaviors of Neanderthals and *Homo sapiens*. For this purpose, the following briefly reviews current records on human fossils from the MP and UP periods in the Levant (Table 4.1). First, the Neanderthal occupation in the Levant is attested to by the fossil evidence from Kebara, Amud, Tabun, Dederiyeh, and Shukhba (Akazawa and Muhesen 2002; Bar-Yosef and Meignen 2007; Garrod and Bate 1937; Hovers et al. 1995; Shea 2003; Suzuki and Takai 1970). The contexts of Neanderthal fossils are mostly dated to the late Middle Palaeolithic between ca. 45 and 75 kya during MIS 4 on the basis of radiometric dates, stratigraphic positions, and/or faunal spectra. This time period corresponds to the chronological range of the Tabun B-type assemblages, that are in fact associated with Neanderthal fossils found in the above sites.

Early *Homo sapiens* remains recovered in the Middle Palaeolithic strata of Qafzeh and Skhul correspond to MIS 5, having been dated by a series of radiometric dates (ca. 75–130 kya) corroborated by faunal species representation. Lithic assemblages associated with these early *Homo sapiens* are the Tabun C-type. Human teeth associated with the Tabun C-type assemblages at Ras el-Kelb were once suggested to be similar to those from Qafzeh and Skhul. However, a recent reanalysis concludes that the specimens are unidentifiable (Bourke 1997). In addition, there is currently no evidence for the existence of *Homo sapiens* between 45 and 75 kya in west Asia.

Although the above records indicate the association of Neandertals with the Tabun B-type industry and that of *Homo sapiens* with the Tabun C-type, the interpretation of some fossil finds is controversial. For example, the Tabun C1 skeleton, associated with the Tabun C-type assemblage, is broadly recognized as possessing anatomical characteristics representative of Neanderthals (Smith 1995, p. 62; Rak 1998), but some researchers, including the excavators, consider (on the basis of field observations) that the bones may have shifted downward from layer B (Garrod and Bate 1937, p. 64; Bar-Yosef and Callander 1999). This view is supported by a recent analysis of U/Th ratios (Grün and Stringer 2000). This means that the skeleton was originally associated with the Tabun B-type assemblage, that is consistent with other Neanderthal fossils in the Levant, such as Amud and Dederiyeh.

Another controversial specimen is the Tabun C2 fossil. Its stratigraphic association with Layer C (and the Tabun C-type lithic assemblage) is unequivocal, but its biological affinity has been controversial, representing both Neanderthal and *Homo sapiens* attributes (Quam and Smith 1998). If the Neanderthal affinity is accepted, the TL and ESR dates of Tabun layer C (120–180 kya) suggest that Neanderthals appeared in the Levant before *Homo sapiens* at Qafzeh and Skhul and produced the Tabun C-type assemblage. If we accept the attribution of the fossil to *Homo sapiens*, its chrono-cultural association is more consistent with the cases at Qafzeh and Skhul. Alternatively, the controversial anatomical features of the Tabun C2 showing characteristics of both Neanderthal and *Homo sapiens* could imply problems underlying the dichotomous classification of late Middle to Late Pleistocene hominins in this region into "Neanderthal" or "*Homo sapiens*."

Additionally, no identifiable human fossils have been discovered in association with the Tabun D-type industry.

4.5.2.2 Upper and Early Epipalaeolithic

All the identifiable human fossils that have been recovered from these time periods are reported to be *Homo sapiens* (Gilead 1995, p. 136; Smith 1995, p. 64). As listed in Table 4.1, the UP and early Epipalaeolithic industries associated with *Homo sapiens* include the Early and Late Ahmarian, the Classic Levantine Aurignacian, the Atlitian, and the Kebaran. Given this pattern, it would be reasonable to expect that the other industries, such as the Arqov/Divshon and the Nebekian, are also the products of *Homo sapiens*.

The hominin species associated with the IUP has been a significant issue since the Tabun B-type industry, immediately preceding it, is associated with Neanderthals, and the following one, the Early Ahmarian, is associated with *Homo sapiens* (Bergman and Stringer 1989). A report of human teeth recovered in association with the IUP and Early Ahmarian assemblages at Üçağızlı describes that their morphology is "consistent with an attribution to *Homo sapiens*, but at least one possesses features more commonly associated with Neandertals" (Kuhn et al. 2009, p. 108). In addition, recent re-examinations of a partial maxilla ("Ethelruda") from Ksar Akil XXV suggested that it may represent an anatomically modern human (Douka et al. 2013 and references therein) although more complete specimens or detailed analyses are necessary in future to clarify the taxonomic status of the makers of the IUP industry.

4.5.3 On the Approach to Learning Strategies of Neanderthals and *Homo sapiens* from Lithic Industry Records

On the basis of the current fossil evidence, as reviewed above, this section discusses how insights into learning behaviors by Neanderthals and *Homo sapiens* can be obtained from the chronological and geographical patterns of the MP and UP lithic industries. The discussion will focus on the issues related to the attempt to use lithic industry records to measure the rate and cumulativeness of cultural changes as these aspects are considered key variables in the evolutionary model of learning behaviors (Borenstein et al. 2008).

4.5.3.1 Duration of the Lithic Industry: A Rate of Culture Change?

One of the methods for assessing the speed of culture change is to compare the duration of lithic industries. In fact, the

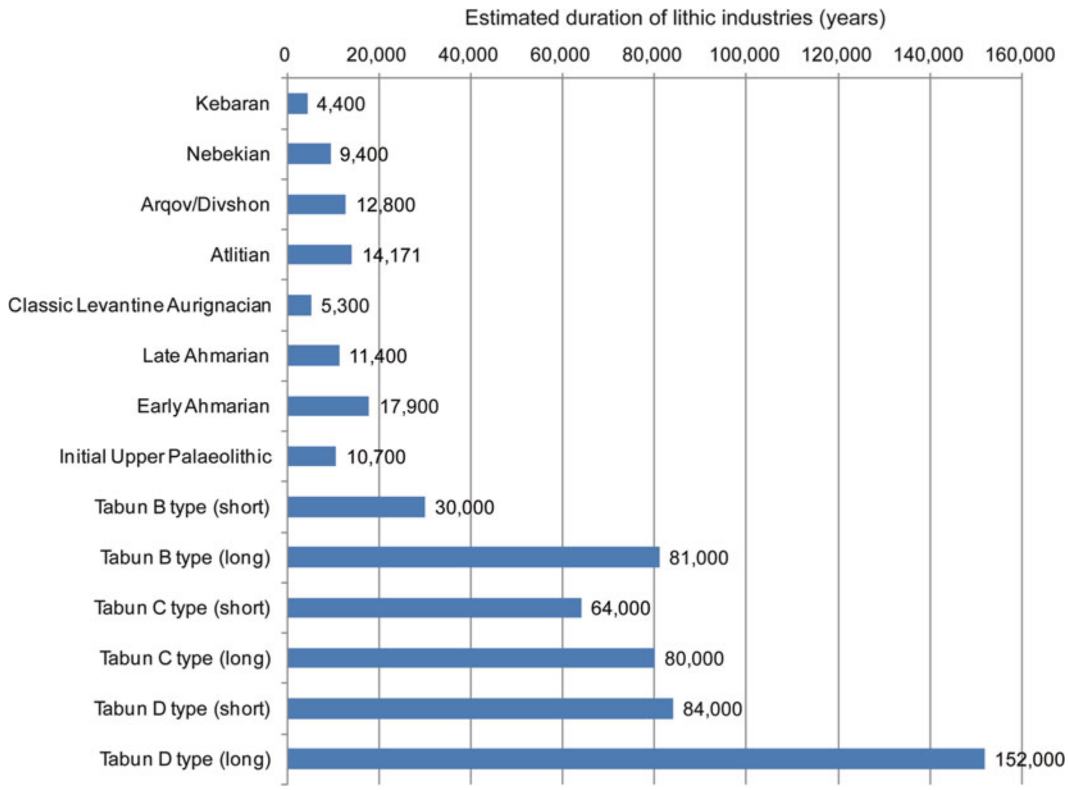

Fig. 4.12 Durations of the Middle, Upper, and early Epipalaeolithic industries in the Levant. Note that short and long chronological models are created for each of the MP industries (see Sect. 4.5 in the text)

time spans of Palaeolithic industries have recently been discussed by Bar-Yosef (2003), who shows that the approximate durations of lithic industries are longer for the MP and shorter for the UP and Epipalaeolithic periods. According to Bar-Yosef, this pattern indicates the "rigid teaching and transfer of knowledge within a closed society that persisted over the course of many generations among Middle Palaeolithic groups" (Bar-Yosef 2003, pp. 270–272). In contrast, during the Upper and Epipalaeolithic, "[f]aster changes… of operational sequences, and shifts in retouched tools…reflect flexible social systems, and rapidly increasing populations."

We estimated the duration of lithic industries from their radiomeric dates, that were screened for reliable dates, as described above (Tables 4.2 and 4.3). The selected dates were used to calculate the start and end dates as well as the duration of each lithic industry. The calculation was done using phase modeling in the Oxcal program (and partly by the Calpal program for some radiocarbon dates) with the 68% confidence level (Bronk Ramsey 2009; Danzeglocke et al. 2012). We made multiple models for the three MP industries because their radiometric dates, if taken at face value, could indicate different scenarios of either start or end date, although the short chronology that models sequential occurrences of the Tabun D/C/B industries without temporal overlap is more likely the case as discussed in the chronological examination. Strictly speaking, multiple models can also be considered for some UP and Epipalaeolithic industries due to the uncertainty and different views on the cultural affiliation of some lithic assemblages, as discussed earlier. However, the multiple scenarios for the UP and Epipalaeolithic periods are not discussed here because they do not affect their general comparison with the MP industries.

As a result, Fig. 4.12 shows the durations of the MP and UP industries in the Levant. Despite several different models, the duration of MP industries is longer than UP ones as expected from previous studies. It is notable that the duration of the IUP is closer to the UP pattern than the Tabun B-type. Does this pattern suggest that UP cultural changes (probably by *Homo sapiens*) were more rapid than that of the Tabun B-type industry, that is currently only associated with Neanderthal fossils? Although this observation may fit a stereotypical characterization of the MP and UP cultural patterns, we have to keep in mind that the criteria for classifying lithic industries usually differ between the MP and UP periods. The classification of the MP industries tends to be based on the characteristics of core reduction technology, while the identification of the UP industries puts more emphasis on the morphology and composition of retouched tools, that are amenable to finer scales of classification. In fact, from the perspective of core reduction technology, several Levantine UP blade industries, such as the IUP, the Early Ahmarian, the Late Ahmarian, and the Kebaran, can be grouped together in what is known as the Leptolithic Lineage (Marks 2003). The chronological span of the Leptolithic is comparable to the Tabun B-type industry.

Additionally, the apparent long duration of the Tabun C-type industry, associated with *Homo sapiens*, contradicts a conventional view that contrasts the slow culture change by Neanderthals with the more rapid shift by *Homo sapiens*. This study estimates that the Tabun C-type industry lasted from either 160 kya or 140 to 80 kya according to the methods described earlier. This could mean that this industry's interval was significantly longer than those of the UP industries despite their common association with *Homo sapiens*. Moreover, the time span of the Tabun C-type is apparently longer than the Tabun B-type. The time range of Qafzeh and Skhul occupations, where *Homo sapiens* fossils are actually associated with the Tabun C-type assemblages, is shorter than that of the whole Tabun C-type industry. TL dates of Qafzeh and Skhul are 102–85 kya and 119 ± 18 kya respectively (Valladas et al. 1998, p. 71), that are more or less confirmed by ESR dates. These radiometric dates correspond to MIS 5 and are consistent with the occurrences of Afro-Arabian micromammals in the faunal spectra from Qafzeh (Tchernov 1998). In this case, the duration of the Tabun C-assemblages at Qafzeh and Skhul is ca. 40,000 years, that is still distinctively longer than any UP industries, even considering the error range.

4.5.3.2 Cumulativeness of Culture Change

The cumulativeness of culture change is defined here as the continuity of some elements and the change in others from one culture to another. This aspect is considered significant in the cultural evolutionary model that considers learning behaviors (Borenstein et al. 2008) because the continuity may represent a result of social learning by creators of a new culture, while the change may indicate exploratory individual learning including innovations. Despite this theoretical expectation, it is difficult, in a practical sense, to assess the degree of continuity or change between lithic industries. Although this cannot be quantitatively analyzed by using the kinds of data in our database, it is discussed here on the basis of the chronological and geographic patterns of lithic industries.

The most likely case for cumulative cultural change, or at least technological continuity, is the cultural sequence from the IUP through the Early and Late Ahmarian to the Kebaran. As described above, these industries are generally considered as representing the local evolution of blade dominant technological traditions from Levallois-based technology through the development of prismatic blade-core reduction, to the microlithization of blade tools, labeled the Levantine Leptolithic Lineage by Marks (2003). This study examined the sequential chronological occurrence of these industries in the same geographic space covering more or less wide areas in the Levant (Figs. 4.3, 4.7, 4.8, and 4.10). Strictly speaking, the apparent technological continuity does not necessarily mean the continuity of local populations and could involve the population replacement if the preceding and the following groups share the same technology. However, this case does not contradict the notion of cumulative culture change if there was a contact between the two groups and hence the opportunity for the transmission of lithic technological knowledge.

Is such a cultural pattern observable for the Tabun B-type industry, that is often associated with Neanderthal fossils? In order to examine this question, a seriation analysis was conducted for some Tabun B-type assemblages from Amud, Kebara, and Dederiyeh, where Neanderthal fossils were discovered. Although the details of this study are published in another paper (Nishiaki et al. 2012b), the summary of the results relevant to this discussion is described here. Nishiaki et al. (2012b) examined frequencies of four different ways of core reduction, tool blank types and tool types by levels at each cave to see if there was any chronological pattern among the Tabun-B type assemblages. As a result, the core reduction method shows the clearest change according to the stratigraphic sequences at the three sites. At Kebara, the earlier phase is characterized by the dominance of convergent core flaking, typical of the Tabun B-type industry, followed by the later phase, in which the multiple flaking increases. At Amud in contrast, the convergent flaking occurs in the later phase, while in the earlier phase, multiple and opposed flaking are more frequent. At Dederiyeh Cave, the use of convergent flaking is dominant throughout the sequence. These stratigraphic changes in the core reduction method can be seriated from Amud through Dederiyeh to Kebara, that represents a diachronic technological change from a dominance of opposed and multiple flaking to an increase in convergent flaking, which then decreases in the last stage. This relative chronology is in accord with radiometric dates from the three sites, indicating that the Tabun B-type industry involved some degree of diachronic technological variability.

The primary issue is how these results are to be interpreted. One could argue that the pattern of changes (i.e., the increase in convergent flaking followed by its decrease) of the Tabun B-type can be aptly described as "fluctuation" rather than "accumulation," and thus differs from the directional development of blade technology (i.e., from the Levallois-based method, through the typical prismatic blades with small butts, to the microlithization) during the UP in the Levantine Leptolithic Lineage. Alternatively, one could also argue that the diachronic patterns of the core-reduction method in the Tabun B-type industry indicate the rate of technological change that is no less frequent, if not more, than the UP Leptolithic tradition.

In addition, it should be noted that there are UP industries that do not show chronological or geographic patterns indicative of cumulative culture change. In the Levantine case, these industries are the Classic Levantine Aurignacian, the Arqov/Divshon, the Atlitian, and the Nebekian. The chronological ranges of these industries are either discontinuous or clustered, and tend to occur in different geographic areas making it difficult to observe any culture-historical relationship with other industries. The apparent lack of cumulative culture change does not necessarily mean a specific type of learning strategies because it can result from a number of different backgrounds, including technological innovations/adaptations, an influx of ideas/traits from migrating populations, or a change of local cultures under the influence of different cultural groups. The cumulative culture change is not apparent either in some Tabun C-type assemblages associated with *Homo sapiens*, like Qafzeh and Skhul, where no stratigraphic technological patterns are observable (Boutié 1989; Hovers 2009).

4.6 Summary and Future Directions

Making plausible interpretations about prehistoric behavior, and past cultures in general, is not an easy task due to the fragmentary nature of archaeological remains, where one always encounters the problem of sample size. In an attempt to deal with these unavoidable conditions, we are constructing a database to organize currently available archaeological records relevant to the RNMH process. Through this database, we aim to obtain insights into prehistoric learning behavior by *Homo sapiens* and Neanderthals to examine whether learning behavior differed between the two groups. As part of this endeavor, this paper examined the MP and UP cultural variability in the Levant, focusing on the chronological and geographic patterns of lithic industries. These archaeological records were then discussed in terms of the anthropological events that took place in the Levant by reviewing the MP and UP fossil records. Lastly, this was followed by a discussion on the duration of lithic industries and the cumulativeness of culture change, that is considered a key variable in evolutionary models of learning behavior.

A simple comparison of the time span among lithic industries (Fig. 4.12) might suggest that the rate of technological changes by *Homo sapiens* during the UP is more rapid than those by Neanderthals (that produced the Tabun B-type industry during the MP). However, considering the use of different criteria for classifying MP and UP lithic industries, it can be argued that the duration of the UP blade tradition (i.e., Leptolithic Lineage) is comparable to that of the Tabun B-type. Another inconsistency with the conventional cultural distinction between *Homo sapiens* and Neanderthals is an apparently long chronological range of some Tabun C-type assemblages associated with *Homo sapiens*, such as Qafzeh and Skhul.

Changes that may represent the cumulative nature of cultural change are observable only for some UP lithic industries that constitute the Levantine Leptolithic Lineage and not for other UP industries or the Tabun C-type. The Tabun B-type industry, associated with Neanderthals, may show diachronic shifts in the core reduction method, that indicate the rate of technological change that is no less frequent than the UP industries, although the Tabun B-type pattern could be interpreted to represent "fluctuation" rather than "accumulation."

The above discussion suggests that the pattern of culture change by *Homo sapiens* and Neanderthals in the Levant is elusive and variable. It is elusive because it depends on the criteria and interpretations in the measurement of the rate and cumulativeness of culture change; and it is variable because some lithic industries may indicate rapid and cumulative changes while others do not. The latter case is represented by the Tabun B-type and C-type industries in the MP and the Classic Levantine Aurignacian, the Arqov/Divshon, the Atlitian, and the Nebekian in the UP and early Epipalaeolithic. As described earlier, the emergence of new lithic industries could have resulted from various factors including innovations by local populations, the influx of foreign groups who can either change or inherit preceding technological traditions, and changes by local groups under the social/cultural influence from surrounding populations. Because available data do not allow us to narrow down the range of relevant factors, it is difficult to identify specific types of learning strategies based on chronological and geographical patterns of lithic industries.

In an effort to augment the examination of cultural patterns associated with *Homo sapiens* and Neanderthals, we need to look beyond the Levant and collect more records from other regions. In particular, two essential aspects require further investigation: (1) the first is the chronological and geographical patterns of Neanderthals because this is limited to the Tabun B-type industry in the Levant. For this purpose, we are collecting relevant records from the European MP; (2) the second is an understanding of cultural variability by *Homo sapiens* during the MP because this is limited to some Tabun C-type assemblages in the Levant. For this purpose, we are constructing a database for Middle Stone Age cultures in Africa. These additional data should help us examine cultural variability by *Homo sapiens* and Neanderthals at a broader temporal and spatial scale so that we may contribute to a more accurate understanding of their cultural and behavioral evolution.

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