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Flint Type Analysis of Bifaces From Acheulo-Yabrudian Qesem Cave (Israel) Suggests an Older Acheulian Origin

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Abstract

This paper presents the results of a flint type analysis performed for the small assemblage of bifaces found at the Acheulo-Yabrudian site Qesem Cave (QC), Israel (420–200 kya), which includes 12 handaxes, three bifacial roughouts, one trihedral, and one bifacial spall. The analysed artefacts were measured and classified into flint types based on visual traits. Also, extensive fieldwork aimed at locating potential sources was carried out. The bifaces were then assigned to potential flint sources, using both macroscopic and petrographic data, and were compared with a large general sample ($n = 21{,}102$) from various typo-technological categories and from various QC assemblages, studied by the same analytic process. Our results show that while the site is located within rich flint-bearing limestone outcrops of the Bi'na Formation (Upper Cretaceous Turonian), which dominate the general sample, non-Turonian flint types dominate the biface assemblage. The presence of roughouts and complete handaxes, alongside the complete absence of bifacial knapping by-products, as well as the absence of a clear spatial distribution pattern of the bifaces throughout the site's sequence, stresses the fragmentation of the bifacial *chaîne opératoire* and suggests that the bifaces were not produced at the site but, rather, were brought to the cave in their current state. The extremely low quantity of bifaces at QC, compared with the overall rich lithic assemblages, suggests that handaxes did not play a major functional role in the QC hominins' everyday lives. It is therefore possible that the QC bifaces originated from older contexts, most likely Acheulian sites existing in the vicinity of the cave, as part of the habit of the QC hominins of collecting older, previously knapped artefacts.

Keywords Acheulo-Yabrudian · Lower Palaeolithic · Bifaces · Levant · Flint types · Acheulian

This article belongs to the Topical Collection: *The bifacial shaping phenomenon over time and space*
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Introduction

The Acheulo-Yabrudian Cultural Complex (henceforth AYCC) is a local Levantine entity, characterized by a set of significant and innovative human cultural and biological adaptations, including the constant and systematic use of fire (Blasco et al. 2016; Shahack-Gross et al. 2014; Shimelmitz et al. 2014a, b), complex strategies of procurement and exploitation of lithic materials (Boaretto et al. 2009; Verri et al. 2004, 2005; Wilson et al. 2016), intensive and systematic flint recycling (e.g. Assaf et al. 2015; Lemorini et al. 2015; Parush et al. 2015; Shimelmitz 2015; Wojtczak 2015), technological innovations such as blade and Quina scraper production (Lemorini et al. 2016; Shimelmitz et al. 2011, 2014a; Zupancich et al. 2016a, b; Zaidner and Weinstein-Evron 2016) (Weinstein-Evron & Zaidner 2017), systematic fallow deer group hunting and butchering (Barkai and Gopher 2011; Stiner et al. 2009, 2011; Blasco et al. 2016), and the sharing of meat (Stiner et al. 2009). Within this context, the presence of handaxes in the AYCC stands out as an almost isolated element of technological continuation and preservation of Acheulian lifeways, alongside the presence of spheroids (Barkai and Gopher 2016), in an otherwise completely innovative technological system. Numbers of handaxes found in Acheulo-Yabrudian contexts vary from a few isolated artefacts (as in Zuttiyeh Cave; see Gisis and Bar-Yosef 1974) to several dozen (as in Tabun Cave; see Shimelmitz et al. 2017).

In this paper, we study the small assemblage of bifaces found at the Acheulo-Yabrudian site Qesem Cave (QC; 420–200 kya) by analysing the flint types from which they were produced and by identifying the potential geologic/geographic sources from which they could have originated. We compare the results to a flint type analysis of a large general sample of artefacts ($n = 21{,}102$) taken from 12 different assemblages from within QC, which is part of a large-scale ongoing project (Wilson et al. 2016). We also compare it with a sample taken from the Late Acheulian site of Jaljulia (Israel), which is situated approximately 6 km north of QC. Our results suggest that the manufacture of the QC bifaces did not take place at the cave, but, rather, that these artefacts were brought to the site in their current state, possibly from older Acheulian sites. Finally, we discuss the significance of these results and their implications for Levantine Late Lower Palaeolithic human behaviour.

The Acheulo-Yabrudian Lithic Industries

The Acheulo-Yabrudian Cultural Complex has been subdivided into three major lithic industries:

- The Amudian (Pre-Aurignacian)—characterized by the production of blades.
- The Yabrudian—a flake industry characterized by the production of Quina scrapers made on thick flakes with stepped retouch (resembling the scrapers known from the European Middle Palaeolithic Mousterian), alongside the appearance of demi-Quina scrapers.
- The Acheulo-Yabrudian—characterized by the production of flakes, bifaces and scrapers.

Rust (1950) and Garrod (1956) suggested that each of these industries represents a different culture, or a different group of people. Copeland and Hours (1983), on the other hand, viewed these industries as reflecting different activities within the same cultural complex. The latter hypothesis is supported by recent observations made at QC, where Yabrudian (scraper dominated) and Amudian (blade dominated) assemblages show spatial differentiation within the same stratigraphic units (Gopher et al. 2016). This suggests the coexistence of Amudian and Yabrudian industries at QC (and see Barkai et al. 2009; Shimelmitz 2009). The technological similarities between scraper (Quina and demi-Quina) and blade production in the Amudian and the Yabrudian industries further support this interpretation. Indeed, it seems that the differences between the industries are mostly quantitative rather than qualitative (Assaf et al. 2015; Parush et al. 2016).

Handaxes—a Brief Overview

Handaxes are, in most cases, relatively large artefacts (often 10 cm long or longer), which were bifacially knapped and shaped (Machin 2009; Sharon 2010; Wynn and Gowlett 2018). They repeatedly appear throughout the Old World, starting from 1.8 mya, and until 200,000 years ago in the Levant, and even later in Europe. Since they continuously present the same general morphology, and show the same production technology, handaxes are often viewed as the expression of a technological stagnation (e.g., Elias 2012; Renfrew and Morley 2009). It should be noted, however, that while there are some general traits appearing in all handaxes, handaxes vary widely in terms of size, shape, technological details, the type of blank selected, and the degree of regularity (Wynn and Gowlett 2018). It should also be noted that the production of handaxes was accompanied by several technological innovations, such as the development and adoption of the Levallois method (Adler et al. 2014; Nowell and White 2010), and the production of small flakes by means of systematic lithic recycling (e.g. Agam et al. 2015; Agam and Barkai 2018a; Shimelmitz 2015), implying that the Acheulian Cultural Complex was not as stagnant as previously thought. These innovations, however, were not as widely distributed in time and space as the Acheulian handaxes (Finkel and Barkai 2018).

While the nature of the function(s) for which handaxes were used is still debated (see discussion below), Wynn and Gowlett (2018) describe the form of the handaxes as being “over-determined”, meaning that their makers invested more effort in the shaping of the handaxes than was necessary for their functionality. This suggests that there were considerations other than functionality affecting the manufacture and shaping of handaxes.

Within the AYCC, handaxes are found mostly in the Acheulo-Yabrudian industry (alongside the production of flakes). They are, however, also found, in lower proportions, in Amudian contexts at AYCC sites. Handaxes have been found, for example, at Qesem Cave, Tabun Cave, Misliya Cave, Bezez Cave, and Yabrud I (Barkai et al. 2013; Gisis and Ronen 2006; McPherron 2003; Shimelmitz et al. 2017; Zaidner et al. 2006). Handaxes disappear from the archaeological record of the Levant with the emergence of the Levantine Middle Palaeolithic Mousterian, some 200,000 years ago (Falguères et al. 2016; Mercier and Valladas 2003; Valladas et al. 2013).

Qesem Cave

Qesem Cave (QC) (Fig. 1) is located approximately 12 km east of the Mediterranean coast of Tel Aviv, Israel, 90 m a.s.l., on the western foothills of the Samaria Hills. It has been excavated since 2000 and has yielded many rich lithic and faunal assemblages (Barkai and Gopher 2013; Gopher et al. 2005). Based on the composition of these assemblages (Barkai et al. 2005, 2009; Gopher et al. 2005), and supported by a long series of radiometric dates (Barkai et al. 2003; Gopher et al. 2010; Mercier et al. 2013; Falguères et al. 2016), the QC sequence has been assigned to the Acheulo-Yabrudian Cultural Complex (AYCC) of the Lower Palaeolithic of the Levant and dated to between 420,000 and 200,000 years ago. The cave's sediments comprise two major cycles of deposition—a lower sequence (~5.5 m thick), deposited while the karst chamber cave was closed, and an upper sequence (~4.5 m thick), deposited when the cave was more open (Parush et al. 2016).

Systematic and repetitive use of fire has been detected at the site, dated to ca. 400,000 years ago (Barkai et al. 2017; Blasco et al. 2016; Karkanas et al. 2007; Stiner et al. 2009, 2011; Shahack-Gross et al. 2014). The repeated use of a central hearth, starting at least 300,000 years ago, has also been identified (Barkai et al. 2017). The hearth is located in the centre of the cave and is associated with butchering and knapping activities. Its location, as well as the activities associated with it, implies the organization of space at the cave (Barkai et al. 2017). In the north-western part of the cave, a rock "shelf" was found; layers on top of this shelf were dated to 300,000 years or older. Further excavation exposed a deep sequence of layers under the shelf, which therefore has a minimum age of 300,000 years (Gopher et al. 2010).

The cave inhabitants exploited mainly fallow deer, in addition to other taxa, and brought selected body parts to the cave, following the application of cooperative group hunting. The animals were then butchered, cooked, and shared by the Qesem hominins (Karkanas et al. 2007; Stiner et al. 2009, 2011).

Most of the lithic assemblages from QC are assigned to the Amudian industry, dominated by blades (Barkai et al. 2005, 2009; Gopher et al. 2005; Shimelmitz et al. 2011). The Yabrudian industry, present in several spatially and stratigraphically distinct areas within the cave, is dominated by Quina and demi-Quina scrapers (Barkai et al. 2009). Only a few isolated handaxes have been found at the cave (Gopher et al. 2005; Barkai et al. 2013), making the Acheulo-Yabrudian industry practically absent from the cave's assemblages. Systematic lithic recycling has also been recognized as a significant component within the site's assemblages, aimed mainly at the manufacture of small sharp flakes and blades from parent flakes and blades (Assaf et al. 2015; Barkai et al. 2010; Parush et al. 2015). A few spheroids have also been found, made mainly of limestone (Barkai and Gopher 2016).

Thirteen human teeth have been discovered at QC and are described as closer to the later populations (e.g. Skhul/Qafzeh) of this region, rather than to *Homo erectus*, although they also bear some Neanderthal traits (Fornai et al. 2016; Hershkovitz et al. 2011, 2016; Weber et al. 2016).

Fig. 1 QC map, with three related Acheulian sites: Jaljulia, Eyal 23, and Revadim

The Bifaces of Qesem Cave—an Overview

In this study, the term *bifaces* relates to all artefacts which bear bifacial knapping; the term *roughout* refers to artefacts which bear only preliminary bifacial knapping; the term *handaxe* refers to items which were fully (or almost fully) bifacially knapped, and which are considered complete products. This study includes an assemblage of 17 artefacts—16 bifaces and one bifacial spall, found in a variety of stratigraphic contexts at QC. This small assemblage stands in strong contrast to the abundance of blades and Quina and demi-Quina scrapers found at the cave.

One giant roughout of a biface (item number 13 in this study, see Tables 1 and 4) was found in an almost horizontal position, a little to the north of the central hearth, buried under a collapse of massive blocks. The context in which the giant biface was found postdates the hearth, and it is part of an Amudian assemblage covered by the collapse (Barkai et al. 2013). The deposition of the large biface was dated to between 280,000 and 250,000 years ago. This roughout did not show any use-wear, suggesting that it was never used.

It is as yet unclear whether handaxes were produced at the site (for more on this see the discussion below). Barkai et al. (2013) suggested, based on the presence of the bifacial roughout, that biface production was indeed practiced at the site, although only rarely. However, bifacial knapping waste is completely absent from the site's assemblages, reducing the likelihood that this procedure took place inside the cave. New results, presented below, suggest that the QC bifaces were brought to the site in their current state.

Materials and Methods

Materials

The QC biface assemblage (Table 1; Fig. 3) can be divided into four typo-technological sub-groups: handaxes ($n = 12$), bifacial roughouts ($n = 3$), a trihedral pick ($n = 1$), and a single bifacial spall ($n = 1$). These items originate from various assemblages within the

Table 1 The biface assemblage of Qesem Cave, with their stratigraphic origin, the assemblage to which they are assigned, and their sub-category

Number	Square	Elevation	Assemblage	Type
1	I15	605–615	South of hearth	Handaxe
2	M9	150–160	Northern section	Handaxe
3	Top of cave	-	-	Handaxe
4	D12b	650–655	Yabrudian below the shelf	Handaxe
5	C10d	724–724	–	Handaxe
6	D7c	1070–1075	Deep shelf (unit I)	Handaxe
7	E7c	925–930	Deep shelf (unit II)	Handaxe
8	I7b	440–448	–	Handaxe
9	E21	635–635	Unit V	Handaxe
10	D8b	950–955	Deep shelf (unit II)	Handaxe
11	D16b	570–575	Yabrudian in southern area	Handaxe
12	P14c	177–177	Top-most Amudian	Handaxe
13	J11a	525–530	Gigantic bifacial assemblage	Roughout
14	G22	815–815	G-I/19-22	Roughout
15	E16a	575–580	South-West Amudian	Roughout
16	C7d	1070–1075	Deep shelf (unit I)	Trihedral
17	J11a	520–525	Gigantic bifacial assemblage	Bifacial spall

site, without any vertical or horizontal clustering, excluding items number 13 and 17, which were found in proximity to each other (Fig. 2). It should also be noted that some isolated artefacts which might be related to bifacial knapping stages were also found at the cave. However, as their assignment to this technological procedure was not secure, we excluded them from this study.

Flint types of the biface assemblage were compared with flint types of a large sample of artefacts (n = 21,102; see Table 2 and Appendix Table 6) taken from 12 different lithic assemblages from various contexts at QC. This is a part of a large-scale ongoing project analysing the QC raw materials, for which preliminary results were previously published (Wilson et al. 2016). The bifaces are not counted as part of the general sample.

Methods

Each artefact was weighed and then classified, with the help of a × 10 hand lens, to a flint type, based on visual traits such as colour, texture, traits of cortex, sub-cortical layers, any distinctive patterns, degree of translucency, degree of homogeneity, and any visible fossils. This procedure follows the methods provided in Wilson (2007) and Browne and Wilson (2011). Flint types are labelled alphabetically by order of identification, from A to CS. For each flint type, we defined the degree of homogeneity (from homogenous to heterogeneous, scaled from 1 to 3); roughness (from fine to coarse,

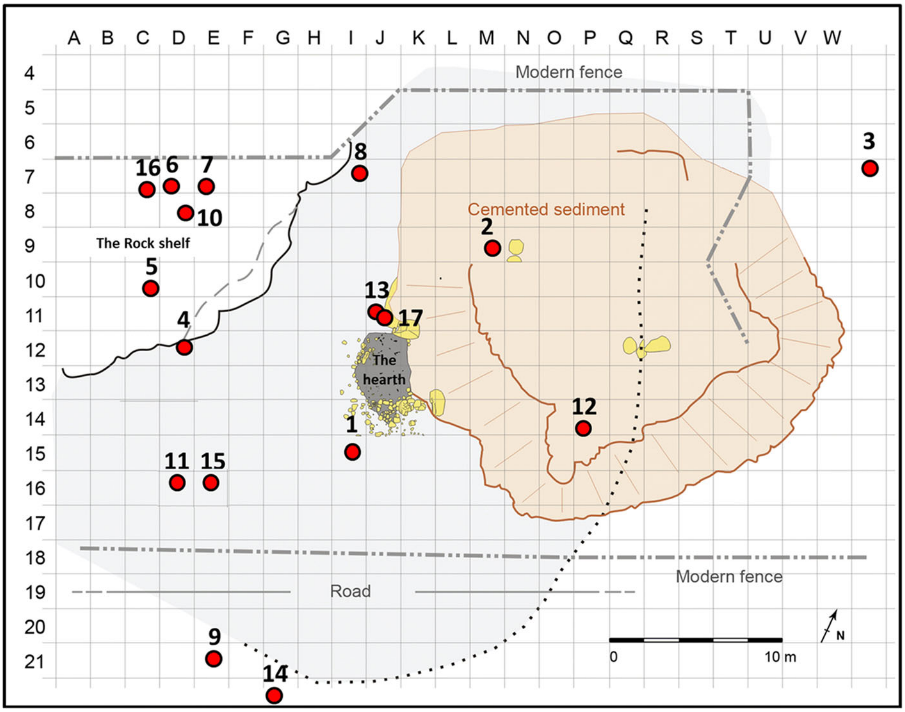

Fig. 2 Spatial distribution of the QC bifaces (and see details in Table 3). Dotted line represents the estimated original contour of the cave

Table 2 A breakdown of the analysed assemblages by technological categories, numbered from youngest to the oldest

Number	Assemblage	Flakes	Shaped items	Cortical flakes[a]	Naturally backed knives	Core trimming elements	Recycled items[b]	Cortical blades[a]	Blades	Cores	Special spalls[c]	Bladelets[d]	Total
1	Top level Amudian	1132	345	437	148	154	16	104	115	123	23	57	2654
2	Top level Yabrudian	168	108	54	14	25	29	14	14	9	8	12	455
3	K-10	437	121	95	77	65	0	2	97	18	7	46	965
4	Hearth	514	149	589	296	65	183	120	59	83	34	0	2092
5	South of hearth	1131	131	525	89	111	246	90	76	79	49	121	2648
6	G-19/20	277	535	101	20	114	80	134	195	45	28	29	1558
7	Southwestern Yabrudian	537	255	140	88	55	88	20	48	38	28	9	1306
8	The southern area	1042	159	335	125	257	0	36	39	88	0	13	2094
9	Yabrudian below the shelf	358	645	189	298	159	190	0	0	42	90	0	1971
10	Amudian below the shelf	232	203	175	305	250	312	155	135	72	109	43	1991
11	Amudian (shelf)	166	110	77	53	41	39	26	42	5	17	2	578
12	Deep shelf—unit I	943	564	462	150	55	0	286	163	69	60	38	2790
Total		6937	3325	3179	1663	1351	1183	987	983	671	453	370	21,102

[a] Cortical flakes and blades are flakes or blades with at least 30% cortex on their dorsal face

[b] This category includes cores-on-flakes and the blanks produced from cores-on-flakes

[c] The special spalls category includes burin spalls, scraper spalls, and tool spalls

[d] Bladelets are defined as artefacts with their length being less than 2 cm, and at least two times their width

scaled from 1 to 3); and degree of translucency (from translucent to opaque, scaled from 1 to 3). In total, in the general sample, 96 different flint types were classified and grouped into 42 groups of flint types, based on visual characteristics. Each of the bifaces was also measured for metrics (i.e. length, width, and thickness).

In addition, fieldwork was undertaken in order to locate potential sources of flint, following the flint-bearing outcrops, guided by the 1:50,000 geologic maps of Hildebrand-Mittlefehldt (2011), Yechieli (2008), and Ilani (1985). Potential sources located east of QC were not surveyed during this study, due to security and logistics constraints, but are mentioned below.

Petrographic thin sections were produced for selected archaeological and geologic samples and were analysed using a ZEISS Axio Scope.A1 polarized light microscope ($n = 106$). Each flint type was compared with the samples collected from the geologic sources and assigned to potential flint sources, whenever possible, using both macroscopic and petrographic data. Finally, flint types were grouped into groups of sources, based on their potential geologic origins.

For the Jaljulia sample, we classified the artefacts from area D to typo-technological categories, and then, the samples from both areas B and D were further classified into flint types, based on macroscopic traits, in the same procedure as that performed for the QC material. The Jaljulia material was not assigned to potential flint sources.

Results

Potential Geologic Flint Sources Around QC

QC is located within rich flint-bearing limestone outcrops of the Bi'na Formation, of the Upper Cretaceous Turonian (Fig. 3). In total, 21 flint-bearing localities, both primary and secondary, most likely of the Bi'na formation, were located within the immediate vicinity of the cave, in a radius of up to 8 km from the site.

Flint sources of the Mishash formation (Upper Cretaceous) were found in the area of Ben-Shemen forest, ~ 15 km or more south of QC. In total, 9 potential sources were found in that area. Other, more distant sources of the Mishash formation are known to exist some 25 km and more east of QC (Sneh and Shaliv 2012).

Six flint sources were located 12–13 km north of QC, on the borderline between Cenomanian and Turonian exposures, making them either of the Sakhnin or the Bi'na Formations. Two sources of the Upper Cenomanian-Turonian Eyal Formation were found in Eyal Forest, 12–13 km north of QC. Cenomanian flint of the Beit Meir Formation can be found in outcrops located 25 km or more east of QC (Sneh and Shaliv 2012).

One Eocene source of the Adulam formation (Yechieli 2008) was found near the city of Lod, ~ 16 km south of QC. It currently contains very low quantities of flint, and we cannot say whether flint would have been available there during prehistoric times. Another low-density Eocene source was sampled at Tel-Gezer, 30 km south of Qesem. More Eocene sources, of the Timrat formation, exist ~ 25 km east of the cave (Sneh and Shaliv 2012).

The abundance of the sources located to the east of QC, as well as their extent, nature, and variety, is currently unknown. They are, however, located along the current

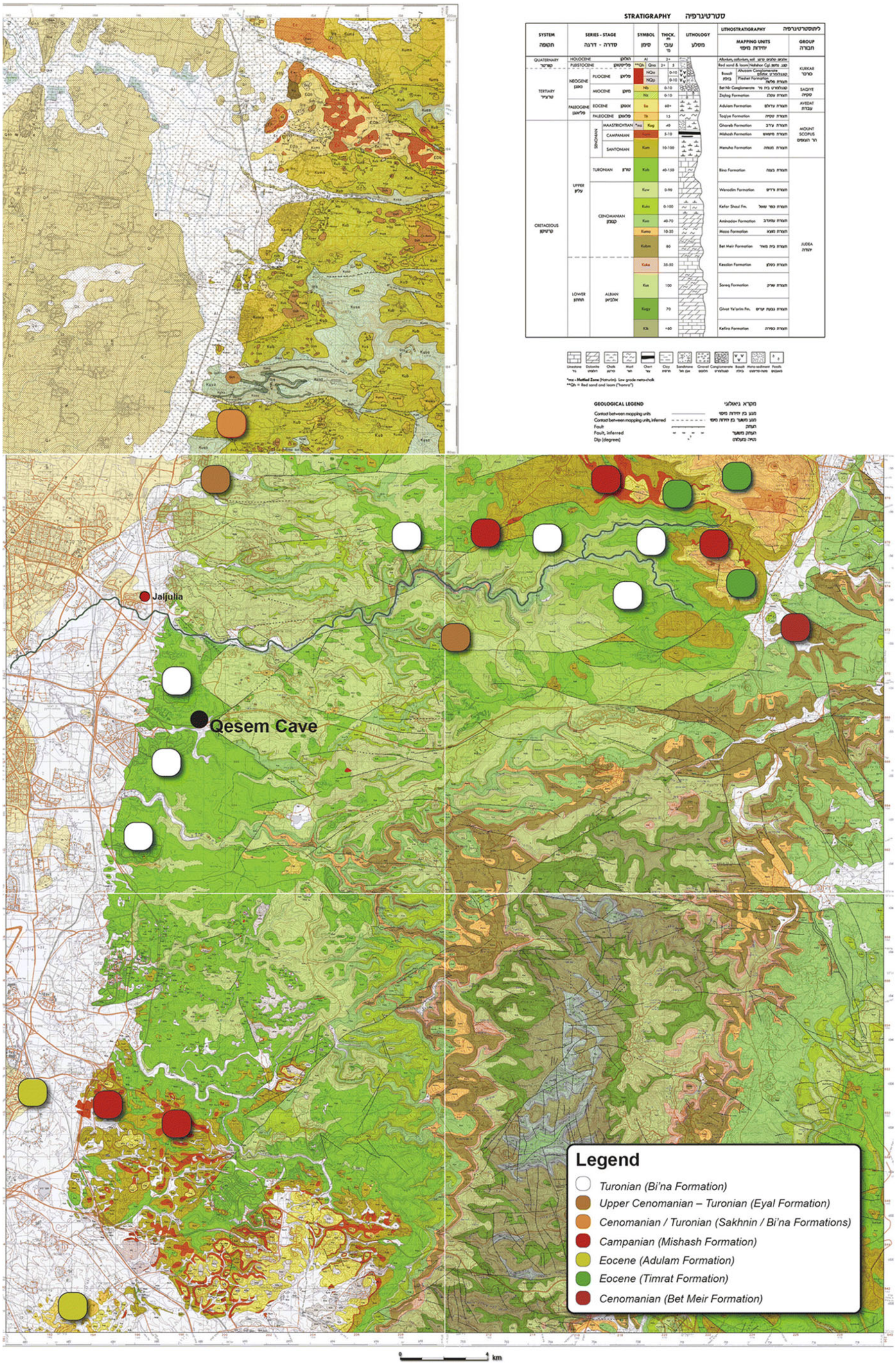

Fig. 3 Qesem Cave and the potential flint bearing sources, based on geologic age and distance. Wadi Qana (the blue line) which passes 3 km north of QC

course of Wadi Qana (Fig. 3), which passes ~3 km north of QC at its closest point. Therefore, the wadi could potentially have carried flint nodules from their geologic sources closer to the cave and made them more likely to be exploited by the QC hominins.

Recent surveys conducted in the segment of Wadi Qana closest to QC found no conclusively non-Turonian flint. However, the site of Jaljulia provides significant data in this respect. Jaljulia is located about 6 km north of QC, and 100 m north of the closest point of Wadi Qana. At the southeastern part of the site, an ancient stream was revealed, probably related to Wadi Qana. A preliminary survey of this ancient stream revealed a wider selection of flint than in the current wadi, including the possible presence of Campanian and Cenomanian flints, suggesting that the ancient course of Wadi Qana might have transported flint from the eastern sources. In this case, these relatively distant flint types would become more likely to be used. However, more work is necessary to confirm or refute these identifications.

The Bifaces Analysis

Turonian flint was often exploited by the cave's inhabitants, and it strongly dominates the site's lithic assemblages (74.0% of the general sample Table 4). The biface assemblage, on the other hand, reflects a different pattern. Out of the 17 bifacial artefacts, 13 are made of non-Turonian flint types (76.5%; non-Turonian flints within the general sample: 26.0%). Six items (35.3%) are made of Campanian flint (Campanian flint in the general sample: 8.2%); six more (35.3%) are of an undetermined origin (flint of undetermined sources in the general sample: 5.1%); four (23.5%) are made of Turonian flint (Turonian flint in the general sample: 74.0%), and one (5.9%) is made of Eocene flint (Eocene flint in the general sample: 1.2%). No Upper Cenomanian-Turonian or Cenomanian/Turonian flints were detected among the bifaces.

The six artefacts which are of Campanian origin are made of type AQ (item numbers 1, 5, 7, 13, 14, and 17; Fig. 4 and Table 3). This is a brecciated flint type, composed of clasts of light brown fine-textured opaque flint in a light brown matrix. Brecciated textures are a known component of Mishash flints (Kolodny 1969). This flint type constitutes only 1.4% of the general sample and reaches a maximum of 2.5% in any of the other typo-technological categories (the highest proportion being within the cores).

The six artefacts made of type AQ include three handaxes, two roughouts, and one bifacial spall. The average weight of these six artefacts is 1047.3 g. This result is, however, strongly influenced by the presence of the two roughouts. In the general sample (which does not include bifaces), the average weight of pieces made of type AQ is 20.4 g, while the average weight of all pieces in the entire general assemblage is 10.3 g, implying that type AQ was often used for the production of relatively large blanks. Our survey of the sources has shown that type AQ tends to be found in large nodules and beds, or remnant bed fragments. This large size of nodules may have played a role in the decision to use this flint type for the production of bifaces. Indeed, it has already been suggested that size and shape of the naturally available raw materials played an important part in determining which blank would be selected for biface production (Sharon 2008). However, large nodules of flint have also been observed in Turonian sources (such as Horashim Forest, located 5 km north of QC), and handaxes

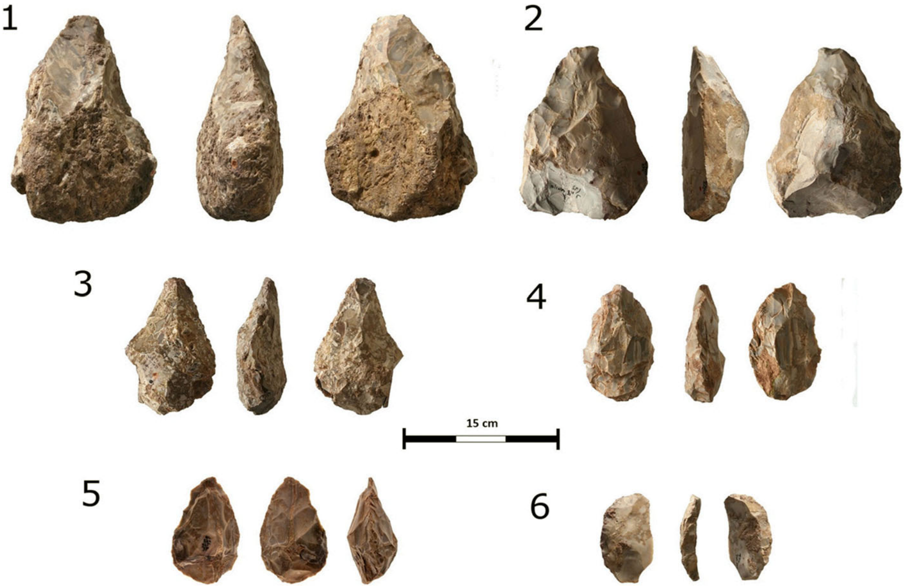

Fig. 4 The bifaces made of type AQ. (1, 2) Roughouts (item numbers 13 and 14). (3–5) Handaxes (item numbers 1, 5, and 7). (6) Bifacial spall (a tranchet spall; item number 17)

were in fact also manufactured of Turonian flint, as demonstrated below. Moreover, the existence of relatively small handaxes in many sites implies that size and shape were

Table 3 Flint types and metrics of the bifaces

Number	Type	Flint type	Weight (g)	Length (cm)	Width (cm)	Thickness (cm)
1	Handaxe	AQ	680	15.1	9.5	5.2
2	Handaxe	T	401	12.7	8.5	3.7
3	Handaxe	T	344	11.1	8	4.2
4	Handaxe	T	343	11.1	7.4	4.2
5	Handaxe	AQ	305	11.5	7.2	3.6
6	Handaxe	AU	259	10.9	7	3.5
7	Handaxe	AQ	239	10.2	6.3	4.9
8	Handaxe	M	207	8.1	6.4	3.6
9	Handaxe	W	165	8.6	5.9	2.9
10	Handaxe	T	129	8.7	5.7	2.5
11	Handaxe	W	119	9.1	5.2	2.6
12	Handaxe	AI	114	10	6.4	2
13	Roughout	AQ	3285	22	15	10
14	Roughout	AQ	1680	17	14	7.5
15	Roughout	T	1555	13.9	10.9	7.5
16	Trihedral	BJ	103	8.3	4.7	3.4
17	Bifacial spall	AQ	95	9.3	5.3	1.9

Table 4 Comparison of the frequency of different geologic origins in the general sample and in the biface assemblage

Origin	General sample (%)	Biface assemblage (%)
Turonian	74.0	23.5
Campanian	8.2	35.3
Cenomanian / Turonian	6.3	–
undetermined	5.1	35.3
Upper Cenomanian – Turonian	2.9	–
unidentifiable	2.4	–
Eocene	1.2	5.9
Total	100.0	100.0

not necessarily significant factors in the decision as to what lithic materials are going to be used for the production of bifaces (Sharon 2008).

Five of the six bifaces of undetermined source (29.4% of the bifaces) are made of type T (item numbers 2, 3, 4, 10, and 15), which is a dark grey-brown and light brown roughly zoned heterogeneous medium-to-coarse-textured opaque flint type, with macroscopically visible sponge spicules (Fig. 5). Type T constitutes 1.5% of the general sample and reaches a maximum proportion of 2.2% of the cores and of the core-trimming elements (CTEs).

Item number 6 is made of type AU (5.9%), which is also a flint type from an unknown source (Fig. 6). It is a rich chocolate brown homogenous fine-textured opaque flint, with a faintly striped appearance. Type AU constitutes 2.3% of the general

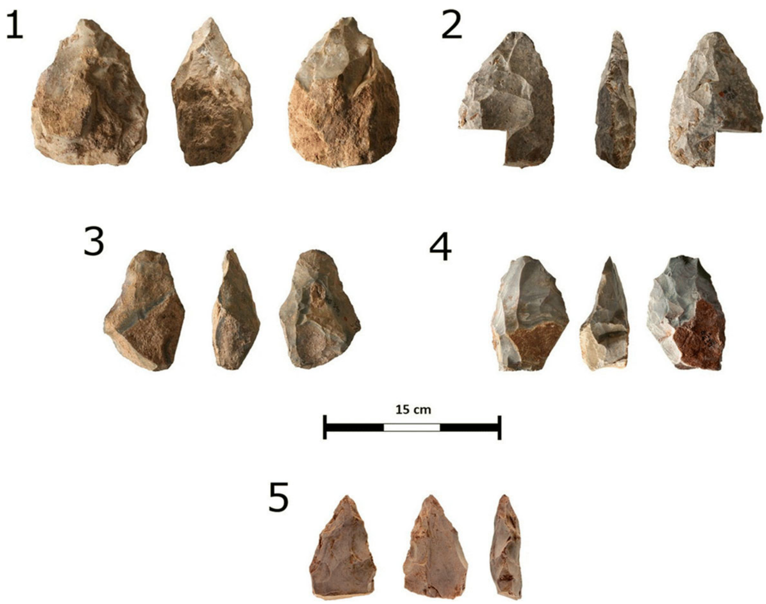

Fig. 5 The bifaces made of type T. (1) A roughout (item number 15). (2–5) Handaxes (item numbers 2, 3, 4, and 10, respectively)

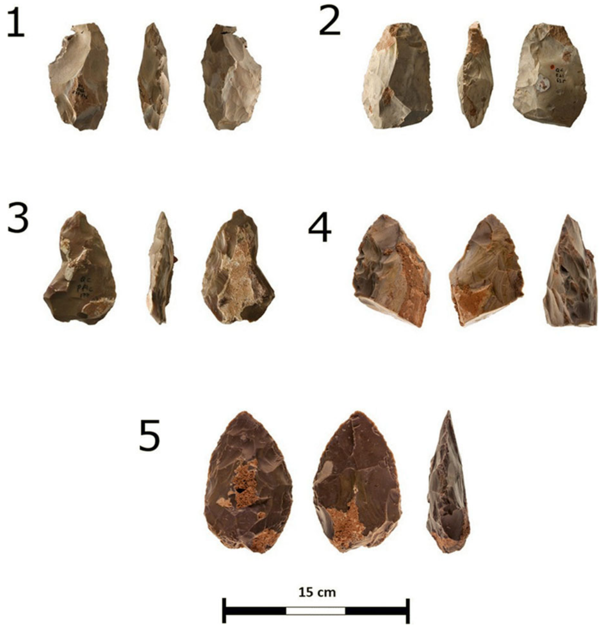

Fig. 6 Group 1: the homogenous fine-textured handaxes, four of which are made of Turonian flint (1–4), and one of a flint of an undetermined source (5). (1) Item number 11. (2) Item number 9. (3) Item number 12. (4) Item number 8. (5) Item number 6

sample. Its highest proportion within the other categories is 3.3% of the tools and of the special spalls.

Four artefacts are made of Turonian flint types. Two handaxes (11.8% of the biface assemblage) are made of type W (item numbers 9 and 11; versus 2.8% of the general sample), a fine-textured brown roughly striped flint type. Its highest proportion in any other technological categories is 5.1%, in the special spalls.

One handaxe (5.9%) is made of type M (item number 8), a Turonian flint type which is distinctly striped, in beige, grey, and pink (4.8% of the general sample). Type M is a common flint type within the general sample, and its proportions within the other categories range between 1.9% (of the bladelets) and 9.9% (of the naturally backed knives).

The last biface made of a Turonian flint is a handaxe made of type AI (item number 12; 5.9%; versus 1.7% of the general sample). It is a greenish-brown fine-textured flint. The highest proportion of type AI in any of the other technological categories is 3.5% (of the recycled artefacts).

One artefact—the trihedral pick—is made of type BJ, a coarse-textured Eocene flint. It is presented in detail and discussed further below.

The Roughouts

Two of the three bifacial roughouts found at QC (item numbers 13 and 14) are made of type AQ (Campanian) and one (item number 15; Fig. 5a) of type T (from an unknown source). The heaviest roughout (item number 13) is significantly heavier than the two other roughouts. The heaviest roughout is also the longest, the widest, and the thickest (for more details on this item, see Barkai et al. 2013).

Item numbers 13 and 15 were produced from large nodules, and a significant proportion of both is still covered in cortex, on both faces. Item number 14, on the other hand, was produced on a large flake, with its ventral face and bulb of percussion still clearly preserved. Most of its dorsal face is still covered in cortex. It has several surfaces bearing patina, and some post-patina flaking, mainly on its ventral face, suggesting it was recycled for the production of flakes, or for further processing as a biface. Item numbers 14 and 15 (as well as item number 1) were analysed for ^{10}Be (Beryllium-10) content, which is related to the measurement of cosmic radiation (Boaretto et al. 2009). They presented low levels of ^{10}Be, suggesting that they were procured from primary geologic sources, possibly involving quarrying (for more details see Verri et al. 2004, 2005; Boaretto et al. 2009).

The Handaxes

Six of the twelve handaxes (50%; item numbers 3, 4, 6, 8, 11, and 12) were produced on nodules. Three handaxes were produced on flakes (25%; item numbers 5, 9, and 10). For the remaining three handaxes (25%; item numbers 1, 2, and 7), the blank could not be determined. Four of the handaxes (item numbers 1, 2, 3, and 11) are covered in patina, while one of them (item number 11) bears post-patina removals, indicating it was recycled after being produced.

Three handaxes (item numbers 5, 10, and 11) bear removals of large flakes from their circumference, removals which were most likely not related to their bifacial shaping. These removals probably reflect the recycling of these handaxes into cores, taking advantage of the handaxe convexities. The phenomenon of handaxes with preferential flake scars has been suggested by some scholars to reflect a possible link between Acheulian handaxes and the emergence of the Levallois method (see DeBono and Goren-Inbar 2001; Shimelmitz 2015; White et al. 2011).

Seven of the 12 handaxes (58.3%; item numbers 1, 2, 3, 4, 5, 7, and 10) are made of heterogeneous flint types—three of type AQ and four of type T. Five others (41.7%; item numbers 6, 8, 9, 11, and 12) are made of homogenous flint types—two of type W, one of type AU, one of type M, and one of type AI. This pattern implies that the degree of homogeneity did not play a role in the decision about what flint types to use for the production of these handaxes.

There is however a clear correlation between the degree of homogeneity, the texture, and the size of the handaxes. First, the five homogenous handaxes are also fine-textured, while the seven heterogeneous flint types are coarse-textured. Second, the average weight of the homogenous fine-textured handaxes is 172.8 g, while the average weight of the heterogeneous coarse-textured handaxes is 348.7 g. These results suggest that the handaxes can be divided into two groups: one (henceforth, group 1; Fig. 6) consists of handaxes made of homogenous, fine-textured flint types, which tend to be smaller, and the second (henceforth, group 2) consists of handaxes made of heterogeneous, coarse-textured flint types, which tend to be larger. Four of the five handaxes of group 1 were produced on nodules, while only two handaxes of group 2 were clearly produced on nodules, while two others were produced on flakes, and for the remaining three, the blank could not be determined. Moreover, three handaxes of group 2 are covered in patina, while only one handaxe of group 1 is covered in patina. Finally, four of the five handaxes of group 1 are made of Turonian flint types (with the fifth being from an undetermined source), while three of the seven handaxes of group 2 are made of Campanian flint, and four of flints of unknown origin. These differences (summarized in Table 5) suggest that there may have been two separate procedures for acquiring flint for each of these two groups, although the nature of these two procedures is still unclear. It is not our contention that each group represents a single distinctive accumulation process. Rather, we merely suggest that there were at least two different strategies of bringing handaxes to the cave.

One handaxe is not included in this study because its whereabouts are, unfortunately, currently unknown, but it does deserve some special attention (Fig. 7). This is a patinated handaxe, produced on a homogenous flint type (R. Barkai, personal observation), which bears several post-patina blade removals, indicating that it was recycled into a blade core (Parush et al. 2015; Shimelmitz 2009). We can therefore see the Acheulian hallmark, the handaxe, and one of the main Acheulo-Yabrudian hallmarks, the systematic production of blades, on one artefact, with a clear time gap between these two stages.

The Bifacial Spall

One bifacial spall has been found in the QC assemblages (item number 17). It was found in the same sub-square (1/4 m^2) as part of the same assemblage as the largest roughout (item number 13), and it is made of the same flint type as the large roughout—type AQ, which is of Campanian origin. However, it was not flaked from the roughout.

This artefact is a product of a transversal blow, using the tranchet blow technique (Inizan et al. 1992: 72). Such spalls are known from several Lower Palaeolithic sites (e.g. Bergman and Roberts 1988; Roberts and Parfitt 1999; Rollefson 2016; Sharon 2010; and for more information, see Barkai 2005). These blows were aimed at shaping the active edge of handaxes, and at creating a very sharp edge. It has two ventral faces, indicating that the original biface was most likely produced on a large flake. The spall

Table 5 Summary of differences between the two groups of handaxes

	Group 1	Group 2
Blanks	Nodules (80%)	Undetermined (60%)
Patina	20%	60%
Homogeneity	Homogenous (100%)	Heterogeneous (100%)
Texture	Fine	Coarse
Average weight	172.8 g	393.8 g
Average length	9.34 cm	12.12 cm
Average width	6.18 cm	7.9 cm
Average thickness	2.92 cm	4.32 cm
Origin	Turonian (80%)	Non-Turonian (100%)

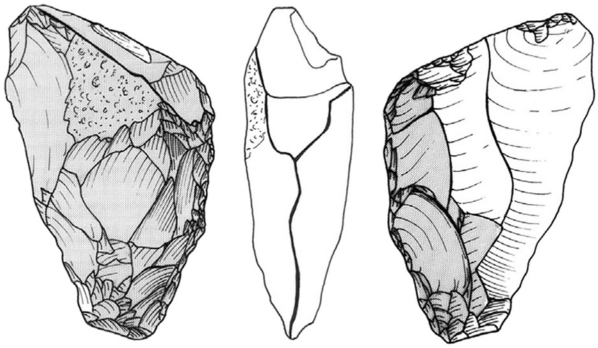

Fig. 7 A handaxe recycled into a blade core

could not be directly associated with any of the bifaces found at the cave. Moreover, no biface from QC bears scars of the tranchet blow technique. Its presence does, however, imply that at least one additional biface from which this artefact was flaked exists or formerly existed at the cave, or, alternatively, that this artefact was brought from outside the cave in its current state.

The Trihedral Pick

The trihedral pick is made of type BJ, which is a semi-translucent grainy light brown flint with abundant small macroscopically visible white fossils (Fig. 8). Its thin section revealed some nummulitic debris (Fig. 9), conclusively assigning it to the uppermost Lower-to-Middle Eocene (Racey 2001). Additionally, an echinoid spine similar to ones detected in other Eocene samples was also observed (Fig. 9). Type BJ is found in low proportions in the general sample (0.3%). The trihedral pick bears some patinated surfaces. No waste related to its manufacture was found at the cave.

Trihedral picks are well-known from several Levantine Acheulian sites (Gilead 1970; Shea and Bar-Yosef 1999; Tchernov et al. 1994), including Eyal 23, an

Fig. 8 The trihedral pick, made of type BJ, of Eocene origin

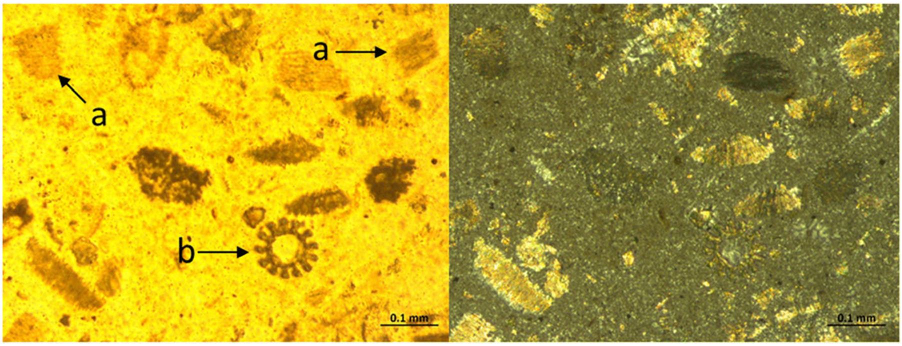

Fig. 9 Type BJ—nummulitic debris (**a**) and an echinoid spine (**b**), in plane- and cross-polarized light

Acheulian site located ~ 12 km north of QC (Ronen and Winter 1997). These tools are, however, usually absent from Acheulo-Yabrudian contexts. Besides Jaljulia (Shemer et al. 2018) and Eyal 23 (Ronen and Winter 1997), other Acheulian contexts could also have existed in the area of QC. It is, therefore, possible that this trihedral pick was collected from outside the cave, possibly from an older Acheulian site located somewhere in the vicinity of QC, rather than being produced in it.

Discussion

The Role of Handaxes in Lower Palaeolithic Lifeways

While many studies have tried to understand the functionality of handaxes, the nature of their use is still strongly debated. Past studies have proposed that handaxes were used during the Lower Palaeolithic for the processing of vegetal materials (e.g. Binneman and Beaumont 1992), the processing of wood (e.g. Domínguez-Rodrigo et al. 2001; Kohn and Mithen 1999), in butchering activities (e.g. Keeley 1977, 1980; Machin et al. 2007; Mitchell 1996; Solodenko et al. 2015), and even as hunting hurled/thrown weapons (e.g. Calvin 1993; O'Brien 1981, but see Whittaker and McCall 2001). Handaxes are also often referred to as general-purpose tools (e.g. Keeley 1980). Other, less common, proposals have suggested that handaxes should be viewed as cores, intended for the efficient production of flakes (e.g. Jelinek 1977). In addition, other, non-utilitarian, potential roles of handaxes are also often discussed (Gamble 1998; Kohn and Mithen 1999; Wynn and Gowlett 2018).

Most recent studies, however, suggest a relationship between handaxes and the processing of meat, including the skinning, dismembering, defleshing, and cutting of animal carcasses (e.g. Claud 2008; Machin et al. 2007, 2016; Solodenko et al. 2015). Of special note is the relationship between the presence of handaxes and the presence of the remains of very large game, mainly proboscideans, during the Lower Palaeolithic (Finkel and Barkai 2018). Indeed, several Acheulian sites have yielded elephant remains bearing cut marks (e.g. Blasco et al. 2013; Solodenko et al. 2015), as well as elephant bones which were found in direct association with bifacial tools (e.g. Goren-Inbar et al. 1994; Zutovski and Barkai 2016, and see additional references therein). The important role of elephants in the diet and adaptation of Acheulian populations has already been suggested in the past (Agam and Barkai 2016, 2018b; Ben-Dor et al. 2011), and is further supported by many Acheulian sites containing elephant remains (e.g. Anzidei et al. 2011; Goren-Inbar et al. 1994; Rabinovich et al. 2012).

Finkel and Barkai (2018) propose that handaxes were a useful tool in the processing of elephant carcasses, allowing the removal of meat and fat, as well as the disarticulation of elephant body parts in order to enable their transportation to habitation sites. Handaxes are highly suitable for massive and continuous butchering activities, enabling the application of force and leverage required in cutting and dismembering activities. Evidence of transportation of proboscidean-selected body parts is provided by Palaeolithic cave sites containing elephant remains, and especially elephant heads (Agam and Barkai 2016 and see references therein). Thus, Finkel and Barkai suggest that handaxes were an essential tool in large game processing during the Acheulian. The appearance of bifacial tools made of elephant bones further implies that elephants had major nutritional and social roles in the lives of these hominin groups (Zutovski and Barkai 2016). Additional support for the connection between handaxes and elephants is provided by the geographical and chronological synchronization between these two elements (Finkel and Barkai 2018). This set of evidences is used by Finkel and Barkai (2018) to propose that when elephants cease to be a part of early human diet, the manufacture and use of handaxes stop as well.

For our case, the above proposed scenario implies that with the demise of elephants from the Levant at the end of the Acheulian, and with the emergence of the Acheulo-Yabrudian, handaxes lose their role as essential functional and social tools. Therefore, we consider a “non-functional” explanation for the presence of these few bifaces within the cave’s assemblages.

Explaining the Presence of Bifaces at QC

While Turonian flint dominates the QC assemblages, non-Turonian flint types are predominant in the QC biface assemblage. The presence of three roughouts and 12 complete handaxes, alongside the complete absence of bifacial knapping by-products, as well as the absence of a clear spatial distribution pattern of the bifaces throughout the site’s sequence, stresses the fragmentation of the bifacial *chaîne opératoire* and suggests that the bifaces were not produced at the site but, rather, were brought to the cave in their current state.

Some other Acheulo-Yabrudian sites present similar patterns. In Tabun Cave Layer E, for example, by-products of biface production are also rare (Shimelmitz et al. 2017), leading the authors to suggest that the AYCC handaxes of Tabun Cave were produced outside the site. In the case of Yabrud I, Rust (1950) suggested that bifaces were not manufactured in the AYCC level in which they were found but, rather, were retrieved from older, biface-rich layers.

The two different groups identified within the QC handaxes (groups 1 and 2) may reflect two different types of life histories. The different circumstances behind the formation of each group are, however, yet unclear. It should be noted that similarly to group 1, homogenous flint types strongly dominate the general sample as well (62.6%), suggesting that artefacts from group 1 might be more related to the general pattern detected at QC than artefacts from group 2.

In any case, the extremely low quantity of bifaces at QC, compared with the rich lithic assemblages, suggests that handaxes did not play a major functional role in the QC hominins' everyday lives. It is therefore possible that the QC bifaces originated from older contexts, most likely Acheulian sites in the vicinity of the cave, such as the Acheulian sites of Jaljulia and Eyal 23 (Ronen and Winter 1997; Shemer et al. 2018). Both sites have yielded bifaces, and Eyal 23 has also yielded trihedral picks (the lithic analysis of the Jaljulia material is still ongoing). Interestingly, handaxes from Jaljulia are dominated by brecciated flint types which resemble flint type AQ (A. Agam, personal observation), further supporting such a scenario. However, it is premature to suggest a direct relationship between the bifaces from QC and those from Jaljulia. Additional petrographic thin sections and geologic surveys are needed in order to test such a relationship. Furthermore, as Wadi Qana could have served as a source for flint for the QC inhabitants, it is plausible that the QC hominins explored this area and were familiar with features throughout it, older sites reflecting older human occupations included. It is of note that brecciated flint types also dominate the handaxes from the Late Acheulian site of Revadim (Israel) (A. Agam, personal observation), suggesting a general preference for brecciated flint types in the production of Lower Palaeolithic bifaces.

It is possible that the QC bifaces were brought to the site due to economic motivations. Prepared bifaces could have been brought in as tools already suitable for use in various tasks, including the processing of meat and wood, or as blanks suitable for further knapping. Such a suggestion was made by Gravina and Discamps (2015) concerning the recycled bifaces found at the late Middle Palaeolithic site Le Moustier (Southwestern France). However, given the low number of bifaces found at Qesem Cave, and as they most likely were not produced at the cave, it is our view that this is not the case. Furthermore, most of the QC bifaces were not knapped after their original production, reducing the likelihood of their collection as blanks for future knapping.

Some scholars argue that Acheulo-Yabrudian handaxes tend to be smaller in size than Acheulian handaxes, less refined, and that they present novel reduction sequences compared with those of the Acheulian (e.g. Jelinek 1975; Matskevich et al. 2002; Zaidner et al. 2006). While these suggestions are not generally agreed upon, and do not reflect our own view, the QC biface assemblage does not present any clear pattern in terms of shape and size, as it includes both small and large handaxes, in various shapes and different degrees of fineness. Therefore, it seems that the QC bifaces do not accord with the typology occasionally associated with Acheulo-Yabrudian handaxes, further supporting a scenario of an older origin.

The habit of prehistoric societies to collect older previously knapped artefacts is well documented in archaeological sites (e.g. Agam and Barkai 2018a; Hiscock 2015; Gravina and Discamps 2015; Vaquero et al. 2015; Whyte 2014). Similar patterns of behaviour have also been observed among recent hunter-gatherers. The aborigines of the Western Desert in Australia, for example, were documented collecting and re-fashioning prehistoric tools, while being fully aware of their old lives as tools produced by past societies (Gould 1980: 134).

At QC, the inhabitants of the cave often collected old artefacts covered by heavy patina and brought these previously knapped items to the cave (Barkai and Gopher 2016). Efrati et al. (2018) argued that 12% of all analysed assemblages at QC in general are made on patinated previously knapped artefacts, which were most likely collected as knapped artefacts from outside the cave, as indicated by the presence of patina and of post-patina removals.

Caricola et al. (2018) analysed the spheroids assemblage from QC, using both technological analysis and use-wear and residue analyses, and showed that at least some of these spheroids are covered by pre-use patina, suggesting that they were collected from outside the cave as knapped objects. Also, some side scrapers found at QC were produced from old patinated flakes, with post-patination scalar retouch reflecting the existence of a time gap between the two stages of manufacture (Parush et al. 2015). Another example of the collection of old knapped blanks from outside the cave is the trajectory aimed at the production of small blanks by means of lithic recycling from parent flakes or blades (Assaf et al. 2015; Parush et al. 2015). This trajectory includes the exploitation of both fresh blanks, without patina, and patinated blanks, with post-patina removals of flakes (for more details see Parush et al. 2015). It was suggested that the patinated blanks were collected from outside the cave, rather than being originally produced in it (Parush et al. 2015).

Finally, some of the handaxes found at QC also show evidence of a second use cycle. As mentioned above, one heavily patinated handaxe was recycled into a blade core after being covered in patina (Parush et al. 2015; Shimelmitz 2009). Although most of the bifaces were not used for the production of flakes after their original manufacture, a few were.

Given the data presented above, we suggest that the collecting of old knapped artefacts from outside the cave was a repetitive pattern of behaviour at QC. The QC hominins were most likely highly familiar with the surroundings of the cave. They must have explored the land in search of various resources, such as food, rocks for tool production, and wood for fire, and were well aware of the different features and localities around them. These included, most likely, old, yet-uncovered hominin sites. The knapped lithic artefacts spread on the ground in these sites, as well as the likely presence of fragmented animal bones, could have led the QC hominins to realize and conceptualize past human presence at these localities. Early humans had an intimate relationship with the lithic materials surrounding them, and stone tools played an important role in these early humans' lives (Berleant 2007). Moreover, the fact that the lithic artefacts spread on the ground were part of and had meaning in the lives of earlier human groups could have enhanced the sensory effect they had over the later human groups seeing them (Berleant 2007). Therefore, and given the tendency of the QC hominins to collect old knapped artefacts (Parush et al. 2015), these encounters might have inspired them to collect some of these old knapped artefacts (Berleant 2007). Within this context, bifaces were more likely than other artefacts to raise interest, given their large size, high visibility, and high aesthetic value (Hodgson 2015; Mithen 2003; see Wynn and Gowlett 2018 for additional details). It has already been suggested that the QC hominins brought artefacts to the cave due to their aesthetic characteristics (Assaf 2019), so the possible collection of bifaces for similar reasons fits within the same behavioural model.

Conclusions

The exploitation of previously produced flint artefacts by means of lithic recycling was often practiced by the QC hominins as a regular technological trajectory (Parush et al. 2015). The QC biface assemblage, on the other hand, reflects, in our view, a different pattern of behaviour, possibly more related to the awareness and appreciation of the antiquity of these old knapped artefacts, rather than to their economic/technological value.

The QC bifaces were not produced at the site but, rather, were brought to the cave in their current condition. The very small number of bifaces in the outstandingly large lithic assemblages (many tens and hundreds of thousands of other lithic artefacts) found at the cave, and especially compared with the thousands of blades and many hundreds of scrapers found within the cave's assemblages, implies that handaxes did not play a major functional role in the everyday lives of the QC hominins. While some technological trajectories detected at QC also involved, to a certain degree, the exploitation of old knapped artefacts (e.g. the production of Quina scrapers on old patinated blanks, the production of small flakes from old parent flakes), the scope of these trajectories was far more extensive than that implied by the small biface assemblage. Moreover, the complete absence of bifacial knapping waste at the site demonstrates that bifacial knapping was rarely performed at the site, if at all. The relationship between the Levantine Acheulian handaxes and proboscideans, discussed above, provides a possible explanation for the decay in the everyday use of handaxes. We, therefore, suggest that bifaces were not brought to the cave for their utilitarian qualities, but possibly as a result of the awareness and appreciation of their antiquity, as well as an understanding of their long life history. Future use-wear analysis will further explore this hypothesis.

Berleant (2007) wrote that "there is [a] sensory frisson that comes from handling a tool that we know some unknown person, twenty thousand or two hundred thousand years ago, made and used". As archaeologists, we often experience that special tremor, picking up an old knapped artefact from the ground, holding it to the light, admiring the knapping skill of its creator, as well as the lithic material chosen for its production. It is, then, possible to assume that prehistoric people, professional knappers in their own right, most likely with their own sensory appreciation, felt that very same way.

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Compliance with Ethical Standards

Conflict of Interest The authors declare that they have no conflict of interest.

Appendix

Table 6 List of the QC flint types, their description, and their example pieces

Number	Type	Description	Example piece(s)
1	A	Reddish brown, lightly striped homogenous opaque fine-textured flint, with light pink inner cortex (2–3 mm thick), thin white layer and thin light orange layer outer cortex (less than 1 mm thick together).	QC G9d 545–550 no. 1 NBK-BL
2	B	Striped reddish-brown, pink and light grey homogenous fine-textured opaque flint, with the light grey a sub-cortical layer, and with a thin (< 1 mm) pinkish to rusty red (iron-stained) rough cortex	QC G9d 580–585 NBK-BL
3	C	Finely striped homogenous opaque fine-textured grey + grey-brown flint with rough beige to slightly orange thin (1–2 mm) cortex	QC G9d 555–560 NBK-BL
4	D	Finely striped homogenous opaque fine-textured brown to grey-brown flint with rough beige to slightly orange thin (< 1–2 mm) cortex	QC G9b 570–575 NBK-BL
5	E	Zoned + spotted grey-brown fairly homogenous fine-textured opaque flint with subcortical stripes of grey and beige and rough beige to yellowish beige cortex 1–3 mm thick (some spots may be fossils?)	QC G9c 650–655 NBK-BL
6	F	Striped yellowish to brown fine-textured homogenous opaque flint, with rough orange, then white, grey, white, grey striped cortex 2–3 mm thick (orange on the outside). Yellow colour may be patina.	QC G9b 550–555 no. 1 NBK-BL
7	G	Pale grey-brown/cream and beige faintly striped homogenous fine-textured opaque flint with rusty red (inside) to yellowish beige (outside) rough, thin (1–2 mm) cortex	QC G9b 575–580 NBK-BL
8	H	Grey-brown + grey + brown + beige striped fairly homogenous medium-textured opaque flint with some thin sub-cortical (greys) stripes and other stripes oblique to those; cortex beige, thin (1–3 mm)	QC G9b 635–645 NBK-BL
9	I	Light brown, spotty homogenous fine-textured opaque flint with thin (<1 mm) beige rough cortex.	QC G9b straightening of the northern section to elevation of 590 NBK-BL
10	J	Reddish-brown lightly striped fairly homogenous fine-textured opaque flint with many small (< 1 mm) dark slightly elongate possible fossils; cortex rough, orange, thin (1–2 mm), with light and dark subcortical stripes ~ 1 mm thick	QC G9b 650–655 no. 3 NBK-BL
11	K	Light grey-brown homogenous slightly translucent fine-textured flint with rough beige cortex (1–3 mm thick), orange on the surface.	QC G9b 650–655 no. 1 NBK-BL
12	L		QC G9d 650–655 no. 1 NBK-BL

Table 6 (continued)

Number	Type	Description	Example piece(s)
		Pink to grey-brown striped homogenous fine-textured opaque flint with thin sub-cortical stripes and very thin (< 1 mm) red cortex	
13	M	Distinctly striped beige, grey and pink homogenous fine-textured opaque flint, stripes 1–2 mm thick, with rough beige-pink thin cortex (1–2 mm thick).	QC G9d 630–635 no. 1 NBK-BL
14	N	Roughly zoned grey-brown, yellowish-brown and white, rough-textured, fairly homogenous opaque flint, with red patina on some surfaces	QC G9d 610–615 no. 2 NBK-BL; QC G9d 545–550 core
15	O	Zoned and spotted browns semi-translucent fine--textured heterogeneous flint with smooth (worn) beige cortex 1–2 mm thick.	QC G9b 615–620 no. 1 NBK-BL
16	P	Yellowish-brown homogenous fine-textured opaque flint with rough, fairly thick (2–4 mm) beige to slightly orange cortex	QC G9b 615–620 no. 2 NBK-BL
17	Q	Dark grey-brown and light grey-brown striped heterogeneous medium-textured opaque flint with a fossil shell segment and thin, worn dark red and beige zoned cortex (<1 mm thick)	QC G9a 640–645 no. 1 NBK-BL
18	R	Pale pinkish-brown, very faintly striped homogenous fine-textured opaque flint with 2–4-mm-thick beige cortex, partially worn	QC G11c 570–575 core
19	S	Pinkish (sometimes) café-au-lait homogenous fine-textured opaque flint, with irregular darker subcortical stripes (thin, < 1 mm) and white cortex (2–15 mm thick), beige on the surface	QC G9b 595–625 NBK-BL
20	T	Dark grey-brown and light brown roughly zoned heterogeneous medium-to-coarse-textured opaque flint with sponge spicules and thin (< 1 mm) yellow, rough, cortex	QC G9d 640–645 NBK-BL; QC F11a 560–565 MB-FL
21	U	Slightly purplish-grey or grey-brown (if not burnt) homogenous fine-textured opaque flint with smooth surface (burnt), with white stripe parallel to cortex but ~ 1 mm from it (purplish-grey between stripe and cortex), and white thin (1–2 mm) cortex which is orange on surface	QC G9b 610–615 no. 1 NBK-BL
22	V	Medium brown spotted slightly striped homogenous fine-textured opaque flint with fairly thick to thin (1–6 mm) rough white cortex, orange on the surface	QC G9d 570–575 no. 2 NBK-BL
23	W	Fine-textured homogenous opaque brown to cream, roughly striped flint with thin (< 1 mm) beige-to-orange cortex	QC G9b 600–605 NBK-BL
24	X	Pale brown and pale grey-brown zoned fairly homogenous medium-textured opaque flint with thick (~ 3–7 mm) rough white cortex, beige on the surface	QC G9d 600–605 no. 2 NBK-BL
25	Y	Pink + grey concentrically striped homogenous fine-textured opaque flint with pink inside, stripes closer to cortex; cortex thin, worn, dark red-pink	QC G9b 635–640 no. 1 NBK-BL

Table 6 (continued)

Number	Type	Description	Example piece(s)
26	Z	Café-au-lait homogenous slightly translucent finely textured fossiliferous flint (spicules; foraminifera??) with thick white cortex (up to 10 mm thick)	QC G9d 630–635 no. 4 NBK-BL
27	AA	Medium slightly purplish brown fine textured homogenous opaque flint with thin (< 1 mm) concentric stripes (lighter and darker) and rough, thick (4–8 mm) beige cortex	QC G9d 595–600 no. 2 NBK-BL
28	AB	Lighter and darker grey-brown striped fairly homogenous medium-textured opaque flint, with a light grey-brown zone containing small grey spots (fossils?), cortex thin (1–2 mm) white or red on surface	QC G9a 635–640 no. 1 NBK-BL
29	AC	Medium brown with paler brown areas, homogenous fine-textured opaque flint with traces of orange patina on one surface	QC F10d 650–655 core
30	AD	Slightly greenish-brown fairly homogenous fine-textured slightly translucent flint with some darker irregular lines; cortex beige-to-orange but very worn (secondary source)	QC G10b 550–555 core
31	AE	Medium-grained fairly homogenous opaque very finely spotted grey to grey-brown flint	QC F10b 650–655 core
32	AF	Slightly translucent fairly homogenous fine-textured dark brown homogenous flint with a thin (1–2 mm) rough orange cortex	QC G11c 585–615 NBK-FL
33	AG	Slightly translucent medium-textured homogenous medium grey flint.	QC G11d 630–650 no. 4 blade
34	AH	Translucent pale grey heterogeneous fine-to-coarse-textured flint with thin white to beige cortex (< 1 mm thick)	QC G11c 640–645 no. 5 BL
35	AI	Greenish-brown fine-textured homogenous opaque flint with a thin (< 1 mm) dark immediately sub-cortical stripe, a paler thicker (2–3 mm) stripes under that, and a darker thicker (~ 5 mm) thick stripe under that, then zones of paler colour; partly rubefied by burning (type specimen); cortex thin (1–2 mm), rough and beige to orange	QC F10a 650–655 core FL
36	AJ	Brown and darker brown banded fairly homogenous opaque to slightly translucent flint, with the darker bands or stripes slightly translucent and concentric with the cortex; cortex beige to slightly orange, and thin (1–2 mm), rough	QC G11c 585–615 core FL
37	AK	Grey slightly translucent homogenous fine-textured flint with thin (< 1 mm) subcortical grey and lighter grey lines and a dark red smooth cortex (~ 1–2 mm thick).	QC G10d 565–570 NBK-FL
38	AL	Specimen of highly burnt flint, fairly homogenous, fine-textured and opaque, black and grey with red stain on some surfaces, but with possible fossils showing: small (1/4–1/2 mm) oval forms	QC G9b 560–565 no. 1 PE-FL
39	AM		QC G11c 650–655 CTE

Table 6 (continued)

Number	Type	Description	Example piece(s)
		Pale cream-coloured homogenous fine-textured opaque flint with darker subcortical stripes (< 1 mm), similar to type G, except rounded and with heavy ~ 1 mm thick dark yellow patina (e.g. wadi E of QC, "egg")	
40	AN	Medium brown, fine-grained, homogenous opaque flint with a heavy (~ 1 mm thick) dark yellow patina (e.g. wadi E of QC, "egg")	QC G9b 565–570 CTE FL overshot regular
41	AO	Dark chocolate brown opaque to slightly translucent homogenous fine-textured flint with tiny white spots (fossils?); cortex 1–2 mm thick, mainly grey but orange on the surface, with very thin red line between the grey and the orange; shape of piece suggests slab rather than rounded nodule.	QC G9b 605–610 no. 1 PE-BL
42	AP	Fine-textured heterogeneous opaque flint with mottled brown colours; traces of cortex thin (< 1 mm) and orange	QC E12b 625–630 BL-varia-shaped item
43	AQ	Siliceous breccia composed of pieces of light brown fine-textured opaque flint of various shapes and sizes (~ 1 mm to > 55 mm) in a light brown matrix	QC E11a 660–665 shaped item, varia
44	AR	Fine-textured homogenous opaque medium brown flint with a white subcortical band of variable thickness (up to 10 mm) and a thick (~ 10 mm) orange cortex with a rough surface. The specimen contains one vug (2 × 6 mm) containing white flint and inside that larger crystals: possible fossils	QC D12b 600–610 shaped item, varia
45	AS	Very fine-textured translucent heterogeneous brown with ~ concentric lighter and darker bands or mottles; cortex thick (up to 7 mm), white to beige underneath and orange on the surface, and fairly smooth (weathered?)	QC E11d 655–660 CTE overshot correction BL
46	AT	Breccia composed of flat fine-textured opaque flint pieces with matrix sandwiched between them; matrix is medium brown, ~ fine grained, and well silicified. Specimen of type is from a cobble. Flint is pink (burned)-to-brown, and fine-textured	QC F11b 595–600 no. 1 PE-FL
47	AU	Rich chocolate brown homogenous fine-textured opaque flint, with a faintly striped appearance. Specimen has 2 or 3 patinas but no cortex present	QC E11d 655–660 BL with dorsal retouch on 2 edges, shaped item
48	AV	Pale yellowish-brown homogenous fine-textured opaque flint with a slightly chalky texture and a faint set of stripes (well-spaced) or zones within it; may have a pale (white or beige) subcortical layer (< 1 to 5 mm thick); cortex is orange, rough, ~ 1–3 mm thick. May have small fossils	QC G9c 565–570 no. 2 shaped item, BL with dorsal + ventral retouch
49	AW	Yellowish-brown homogenous fine-textured opaque flint with thick (up to 10 mm) reddish and white (mixed) cortex	QC J13a 590–595 no. 2 PE-FL
50	AXE	Homogenous medium-textured opaque grey-brown with a slightly greenish tinge flint with many tiny	QC I13b 600–605 no. 56 (drawn) shaped item, BL backed knife

Table 6 (continued)

Number	Type	Description	Example piece(s)
		to small beige spots; cortex 2 to 5 mm thick, beige, with a thin red layer near the outside	
51	AY	Medium brown homogenous opaque fine-textured flint with distinct pale grey-blue concentric stripes and a thin, rough, orange-beige cortex	QC F10d 625–630 SW FL-COF varia
52	AZ	Light grey-green-to-brown slightly translucent, fairly homogenous fine-textured flint. With rough beige cortex (1–4 mm thick), orange on the surface, and a thin purple translucent subcortical layer	QC K10 410–415 NMB-FL
53	BA	Light grey opaque heterogeneous fine-to-medium-textured flint, speckled with lighter beige to orange zones. Specimen has one patinated platform, but no cortex	QC K10 410–415 NMB-FL
54	BB	Slightly translucent, medium greenish-brown rough-textured heterogeneous flint with nummulitic forams (and possibly other fossils, too). Cortex can be thick (up to 5 mm) and white	QC I14a 565–570 shaped items ventral scraper
55	BC	Pale grey to white opaque homogenous medium-textured flint with abundant translucent spots which include foramaniferal (and other?) fossils.	QC K15a 555–560 MB-FL (number 1)
56	BD	Light grey to light blue quartzite-like lightly striped homogenous coarse-textured slightly translucent flint. No cortex on specimen	QC K10 380–385 NMB-FL (item number 1)
57	BE	Brown to black fine-textured opaque homogenous finely striped flint. No cortex on specimen	QC K10 380–385 NMB-FL (item number 17)
58	BF	Grey, light grey-to-beige, and white homogenous fine-textured opaque flint, with a concentric pattern, of thin, fine-lined circles. No cortex on specimen. Related to type AY	QC K10 375–380 NMB-FL (item number 5)
59	BG	Grey or brown translucent medium-textured homogenous flint.	I15c 570–575 (MB-FL)
60	BH	Grey and beige somewhat striped and spotted opaque fine-textured fairly homogenous flint with abundant very small white fossils and/or specks	QC J14a 550–560 COF-lateral ventral multi
61	BI	Opaque homogenous fine-textured flint, with light brown with irregular faint bluish stripes as the background, and obvious thin red stripes in the foreground, (see Tsipori type F; source Eocene?). Cortex thin, orange-beige, with dark thin subcortical line	QC C17a 615–620 (ret. BL)
62	BJ	Slightly translucent grainy light brown homogenous flint with abundant small white fossils (see Tsipori type AD).	QC C16d 590–595 (ret. BL)
63	BK	Half dark brown, half beige-light brown, finely striped fine-textured homogenous opaque flint. No cortex on specimen	QC K10 375–380 NMB-FL (item number 37)
64	BL	Grey homogenous fine-textured slightly-translucent to opaque flint with very abundant small white fossils pf sponge spicules, etc.	QC C17b 630–635 (ret. BL)

Table 6 (continued)

Number	Type	Description	Example piece(s)
65	BM	Grey and grey to black homogenous fine-textured opaque flint, with some fossils in it. Some patinated platforms on specimen, and no cortex	QC J13d 580–585—recycled—lateral + Ret. on patina Fl. (item 13)
66	BN	Breccia of small clasts of fine-textured type O (translucent brown) and an abundant paler, silicious matrix which weathers to a slightly orangy-creamy-beige	QC C15d 600–605 PE FL
67	BO	Grey (?) medium- to coarse-textured fairly homogenous flint (burned in type specimen) with thin red cortex, containing shell fragments, short spike-like fossils, and large (several mm) net-like, cross-hatched shapes	QC K14 a + b 551-580b (PE FL)
68	BP	Brown opaque fairly homogenous faintly striped fine-textured flint, with some white disturbances, and a thick (up to 4 mm) white to beige cortex. May have a blue patterning to it	QC J13d 555–560 (hearth) ret. Fl.—patina (item 6); C16b 600–605 (NMB-FL)
69	BQ	Opaque, probably weathered, white homogenous fine-textured flint with many tiny red spots (likely iron oxide)	QC C16a 590–595 (SW varia)
70	BR	Brown-orange opaque slightly spotted homogenous fine-textured flint. No cortex on specimen. Probably a heated version of type AC	QC J13d 540–545 (hearth)—ret. Fl.—(item 14)
71	BS	Opaque fine-textured light blue-white homogenous flint with a rough cortex (smooth but bumpy in type specimen, which is from a secondary source), probably Turonian	QC H16d 645–650 (unit 1)—core—1 plat.
72	BT	Grey to grey-green zoned heterogeneous fine-textured opaque flint, with singular stripes, and parts of yellow breccia, packed with tiny pieces of yellow and grey flint. Cortex is beige and thin (< 1 mm). Related to type BC	QC H16b 600–605 (unit 2)—CTE—partial ridge
73	BU	Brown with a pink core slightly translucent striped homogenous fine-textured flint, with a thin (~ 1 mm) beige cortex, and a thin (~ 1 mm) beige subcortical layer. Related somehow to type AI	QC K10 385–390 (PE FL; item 1)
74	BV	Light brown opaque fairly homogenous fine to medium-textured flint with white spots (fossils?), with dark red smooth cortex (< 1 mm thick), white subcortical layer, and below it is a dark grey slightly translucent layer, about 1 mm thick each.	QC G17b 625–630 (PE FL)
75	BW	Brown-to-dark brown opaque densely spotted homogenous medium-textured flint, slightly translucent towards the cortex, with some darker and a little larger spots (fossils?), and a thin (~ 1 mm) rough white cortex, with orange on the surface	QC G16b 595–600 (PE FL)
76	BX	Grey slightly-translucent homogenous fine-textured flint, densely striped and rubefied. Cortex is rough, thin (< 1 mm) and deeply reddened, along with some burnt red-patinated platforms.	QC K10385–390 (core—1 plat.)
77	BY		QC K10 370–375 (BL)

Table 6 (continued)

Number	Type	Description	Example piece(s)
		Brown-red opaque heterogeneous coarse-textured flint, with some zones of dense white foram. No cortex on specimen	
78	BZ	Breccia constituted of grey-brown opaque medium-textured flint, with "lenses" of white-grey slightly translucent flint, with a dark red thin (< 1 mm) cortex	QC K10 370–375, item number 37 (PE BL)
79	CA	A coarse-textured homogenous opaque light grey-brown flint, weathered to a coarse-grained grey-to-white opaque flint. No cortex on specimen	QC H17b 620–625, item 1 (BL) (Aviad)
80	CB	Fine-textured slightly translucent homogenous brown flint, with zones of dark brown and creamy brown (possibly a subcortical layer of creamy brown) with abundant small white spots in both layers, and darker spots more visible in the lighter-coloured layer, and a white cortex. Reminiscent of Eocene flint from the BEM source in the Tsipori project	QC F8c 720–730, scraper
81	CC	Light brown fine-textured slightly translucent homogenous flint, with a thick (up to 6 mm) white to orange cortex, and a thin (~ 1 mm) white opaque subcortical layer	QC H16c 615–620 NBK-BL
82	CD	Wide stripes of slightly translucent medium brown and opaque fine-textured fairly homogenous light brown flints, with beige up to 3-mm-thick cortex, with a thin (< 1 mm) dark brown translucent sub-cortical layer. Possibly related to type T, should be checked for spicules	QC G17b 645–645 NMB-FL (item number 2)
83	CE	Fine-textured light rosy-brown slightly translucent homogenous flint with scarce nummulites (only one visible in type specimen)	QC F8a 750–755 (secondary burin)
84	CF	Zoned and spotted brown translucent fine-textured homogenous flint with dark red to pink striped cortex 1–2 mm thick	QC G19 580–585 NMB-FL (item number 3)
85	CG	A yellow coarse-textured homogenous opaque lime stone, with some black spots	QC G20 560–565 BL (item number 9)
86	CH	Fine-textured homogenous opaque spotted grey opaque flint, with an orange on the surface, white underneath thin (~ 1 mm) cortex	QC G19 565–570 BL (item number 4)
87	CI	Tabular thin nodules of brown-yellow slightly translucent homogenous fine-textured striped flint, with a thick opaque light yellow stripe in its centre. The cortex is rough, white to orange, 1–2 mm thick	QC G20 560–565 (item number 7, PE BL)
88	CJ	Brown spotted opaque fairly homogenous fine-textured flint, with bivalve shell fragments, and possibly other fossils as well. Cortex is thin (< 1 mm), smooth (worn), white-beige-to-light orange. There is an opaque light brown sub-cortical layer, 1–2 mm thick, sandwiched by two very thin slightly translucent dark brown layers	QC G19 560–565 (tool, br. tool)
89	CK		QC O12a 155–160 (core—1 plat.)

Table 6 (continued)

Number	Type	Description	Example piece(s)
		Slightly translucent mottled blue and brown medium-textured fairly homogenous flint with common nummulites and probable sponge spicules; thin white cortex	
90	CL	A yellow, grey, black, and orange opaque homogenous coarse-textured limestone, broadly striped, with very thin yellow-orange cortex, with white on the surface, with very thin brown translucent subcortical layers (2 or 3 such layers)	QC Q9 120–125 NMB-FL (number 4)
91	CN	Light brown slightly-translucent heterogeneous fine-to-medium-textured flint with very abundant small nummulites and spiny forms, and sponge spicules	QC E8b 900–905 (deep shelf) NMB-FL
92	CO	Medium-textured opaque fairly-homogenous grey-brown-white flint, with foramaniferas, mollusks, ostracods, shell fragments, and possible sponge spicules. No cortex on specimen	QC C8b 945–950 (deep shelf, unit I), NMB-FL
93	CP	Brown faintly striped opaque homogenous fine-textured weathered flint, with some faint grey zones, spotted with tiny red spots, with sporadic visible foraminiferal fossils (nummulites? Others?). Cortex is thin (< 1 mm), orange and rough, with white rough sub-cortical layer, about 2–3 mm thick	QC C16c 590–605, side scraper
94	CQ	A red (burned) fine-textured slightly translucent fairly homogenous flint, with a zone packed with small objects, possibly fossils (sponge spicules being clearly visible). Cortex is orange on surface, white beneath, 1–2 mm thick, with a white opaque sub-cortical layer, 3–4 mm thick	QC G8a 625–625, side scraper
95	CR	Light yellow-to-light orange medium-to-coarse-textured fairly homogenous flint, with small holes in it, with a rough beige-to-orange cortex, 1–2 mm thick, and a whiter layer towards the cortex, and a very thin opaque grey subcortical layer	QC D7d 1055–1060 NBK-BL (deep shelf)
96	CS	Light brown-to-orange opaque fairly homogenous medium-textured flint, with abundant grey spots, probably with fossils, with possible sponge spicules, and with concentrations of iron. No cortex on specimen	QC D7a 1130–1135 notch (FL) (deep shelf)

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