Jordan River Dureijat: 10,000 Years of Intermittent Epipaleolithic Activity on the Shore of Paleolake Hula

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ABSTRACT

For more than 10,000 years between the peak of the Last Glacial Maximum and the beginning of the Holocene, people repeatedly returned to the same spot on the southern edge of Paleolake Hula in the Upper Jordan Valley to fish, hunt, and exploit other aquatic or semi-aquatic resources at the Epipaleolithic site of Jordan River Dureijat. Preliminary data from the site reveal intermittent occupation of this locale by small groups of hunter-gatherers who engaged in short-term, task-specific activities when lake levels dropped and exposed the site. The unique waterlogged conditions at Jordan River Dureijat capture an unusually well-preserved record of human subsistence and other activities, as well as local environmental conditions across much of the Epipaleolithic. Here we report the results of the first four seasons of excavation and interpret the understudied logistical activities of Epipaleolithic hunter-gatherers who we know best from their more sedentary camps.

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INTRODUCTION

Over the past few decades, research on the Epipaleolithic (EP) period in the southern Levant has focused on the development of socio-economic complexity since the Last Glacial Maximum (LGM; e.g., Goring-Morris 1995; Goring-Morris and Belfer-Cohen 2013; Maher et al. 2016; Munro et al. 2018), especially themes such as human population growth, economic diversification, reduced mobility, emergent sedentism, and growing territoriality (Bar-Yosef and Valla 2013; Maher et al. 2012a; b). Much study has been dedicated to the emergence of the sedentary village, leading to the excavation of a number of habitation sites (Grosman et al. 2016; Maher et al. 2016; Richter et al. 2016; Yaroshevich et al. 2014). Yet, many elements of the diverse EP adaptation remain to be studied, including shorter-lived, task-specific sites, which are nearly absent in the Mediterranean EP record. Such sites are essential for reconstructing the EP adaptation that incorporated a wide range of locales on the regional landscape.

The site of Jordan River Dureijat (JRD) is located in the Hula Valley in northern Israel. While sites documenting most phases of the EP cultural sequence are rare in the Levantine archaeological record, the JRD sequence preserves evidence for intermittent occupation across the entire EP period. The site thus provides a rare opportunity to investigate subsistence strategies, socioeconomic evolution, and environmental change at a single locale. The JRD sequence documents ephemeral, repeated visits to a lakeshore environment where people utilized aquatic and terrestrial resources. As such, it can fill several important gaps in current narratives of Levantine EP sociocultural adaptations. The long EP sequence allows investigation of cultural diversity and human mobility in the Mediterranean zone of the southern Levant. Furthermore, the task-specific focus of the site reduces the "background noise" typical of large, intensively occupied, multifunctional sites, making it easier to isolate change or continuity in specific technologies, subsistence practices, and mobility patterns.

The EP begins at the peak of the LGM and includes the subsequent deglaciation period, and the Younger Dryas, and ends at the beginning of the Holocene Interglacial (Almogi-Labin et al. 2009; Bar-Matthews 2014; Bar-Matthews et al. 2017; Langgut et al. 2011, 2018; Maher et al. 2011; Torfstein and Enzel 2017). Thus, the EP encompasses rapidly changing climatic conditions, the nature of which are still under debate. Poor preservation of organic material, particularly botanical remains, in Levantine sites has hampered discussion of EP subsistence and environmental change (Goring-Morris and Belfer-Cohen 2013). Fortunately, the unusual, waterlogged environment at JRD has created outstanding conditions for organic preservation. Botanical remains including pollen, seeds, fruits, and charcoal are plentiful in all layers at the site. Ostracods and mollusks are also well-preserved, enabling a more comprehensive reconstruction of environmental and climatic change and the opportunity to closely monitor human-environment interactions across the EP sequence.

In the Mediterranean zone of the southern Levant, the EP is typically divided into Early, Middle, and Late chronological phases. Much of the early research focused on defining the local cultures, based primarily on lithic typology (Belfer-Cohen and Goring-Morris 2013; Goring-Morris 1995; Goring-Morris and Belfer-Cohen 2013). EP lithic assemblages are dominated by microliths (Bar-Yosef 1970; Belfer-Cohen and Goring-Morris 2013; Goring-Morris and Belfer-Cohen 2017), which vary in their typological composition over time. The cultural sequence, especially the Early EP, is characterized by a mosaic of contemporary and dynamic cultural entities, rather than the linear replacement of one culture by another. This phase began with the appearance of the Masraqan culture at the peak of the LGM (ca. 23,000 cal BP). The Kebaran cultural entity (ca. 23,000–18,500 cal BP) partially overlaps with the Masraqan in time and is also contemporaneous with the Nizzanan (ca. 22,000–18,000 cal BP). The Middle EP is characterized by Geometric Kebaran industries (ca. 18,000–15,000 cal BP), and the Late EP is associated with the Natufian culture (ca. 15,500–11,500 cal BP; chronological frame after Goring-Morris and Belfer-Cohen [2017] and Grosman [2013]).

Most researchers see a clear dichotomy between EP adaptations in the Mediterranean phytogeographic zone and the more arid steppe and desert regions of the Levant (Olszewski and Al-Nahar 2016). This dichotomy is exemplified in the intensity of site occupation, the composition of lithic assemblages and site function (Belfer-Cohen and Goring-Morris 2013; Goring-Morris 1995; Goring-Morris and Belfer-Cohen 2013). In the Mediterranean zone, the EP is characterized by increased territoriality (evident in distinct morpho-stylistic microlith types; Belfer-Cohen and Goring-Morris 2013; Goring-Morris 1995), reduced mobility, and the diversification of subsistence strategies. The appearance of hut-like structures and more intensive cereal collection suggests reduced mobility of hunter-gatherer groups under certain conditions. This occurs early at the Masraqan site of Ohalo II located on the southern shore of the Sea of Galilee (e.g., Nadel 2003; Nadel et al. 2012; Snir et al. 2015; Weiss et al. 2008), while evidence of more intensive site occupation is documented at Kebaran sites such as Nahal Hadera V (Godfrey-Smith et al. 2003) and Kharaneh IV (ca. 19,000 cal BP) in the Azraq Basin of Jordan (Maher et al. 2016; Maher et al. 2012a; b; Richter et al. 2009). The trend toward sedentism intensifies in the Natufian, before culminating in the agricultural communities of the Neolithic (Yeshurun et al. 2014; Grosman and Munro 2017).

Despite recent advances in Levantine EP research, many gaps remain, especially for the Early and Middle EP. Few sites have been intensively excavated and, in many cases, limited areas have been exposed in excavations. Sites excavated in recent years in the southern Levant include Neve David on the coastal plain (Bar-Oz et al. 1999; Kaufman et al. 2017; Yeshurun et al. 2015) and Ein Qashish in the Jezreel Valley (Yaroshevich et al. 2016). In the northern Jordan Valley, all cultural entities of the Early EP have been reported: the Masraqan at Ohalo II (Nadel 2003), the Nizzanan at Ein Gev IV, and the Kebaran at Ein Gev I (Bar-Yosef 1970). The Middle EP Geometric Kebaran is also represented at Ein Gev III (Bar-Yosef 1970), Haon III (Bar-Yosef 1975), and Ain Miri in the Upper Galilee (ca. 20km from JRD; Shimelmitz et al. 2004). In the Late EP, the Early Natufian was unearthed at Hof Shahaf (Marder et al. 2013) on the southern shore of the Sea of Galilee and the Late Natufian at Nahal Ein Gev II (Grosman et al. 2016). Yet, in the Hula Basin, in the areas closest to JRD, EP sites are limited to the large, long-lived Natufian site of Eynan (e.g., Valla 1995; Valla et al. 2004; 2007; 2017). It is important to note that of all of these sites, JRD is the only short-term, task-specific site. All others are habitation sites with rich archaeological assemblages representing diverse activities accumulated over longer-term occupations.

In this report, we provide preliminary results from the 2014–2018 excavation seasons. Our aim is to characterize the archaeological and environmental assemblages, differentiate cultural from natural accumulations when possible, determine some of the primary activities that took place at the site, and explore how site occupation and fishing activities may have changed over time.

THE SITE

JRD is located in the Hula Valley, a northern segment of the Dead Sea rift valley. The valley is bordered by the Naftali Mountains (700–800m above sea level (masl) of the Upper Galilee to the west, Mt. Hermon (2814m) to the northeast and the Golan Heights (ca. 1000masl) to the east (Figure 1). The Mediterranean climate is hot and dry in summer and cool and wet in winter. Mean annual precipitation is ca. 430mm in the valley and 600–900mm in the western and eastern mountain ranges. Mean January, July, and annual temperatures in the Hula Valley are 11.4, 27.7 and 20.3 °C, respectively (Israel Meteorological Service, unpublished data). The climate primarily supports oak- (*Quercus ithaburensis)* pistachio (*Pistacia atlantica)* woodland or park-forest in the valley and on the lower slopes. This grades into pistachio- (*Pistacia atlantica*) almond (*Amygdalus korschinskii*) woodland and oak- (*Quercus calliprinos)* pistachio (*Pistacia palaestina*) maquis at higher elevations (Zohary 1973). Today, large areas have been converted to farmland and natural vegetation is restricted to protected areas and less accessible canyons.

JRD was discovered during an archaeological survey preceding a massive drainage operation of the Jordan River in December 1999 (Sharon et al. 2002a; b). The site was discovered on the east bank of the Jordan River some 1300m north of the Benot Ya´aqov Bridge (Figure 2). The archaeological material-bearing horizons from JRD stretch over 50m of the river bank near the outlet of the small Dureijat Stream (see Figure 2). In the summer of 2002, a survey and 1m x 1m test excavation was conducted to evaluate the damage of the drainage operation. Full accounts of the survey and test excavation have been published by Marder et al. (2015) and Sharon et al. (2002a; b). The archaeological layers are comprised of a sequence of lacustrine sediments deposited as water levels fluctuated in Paleolake Hula. These are interspersed with layers containing archaeological materials. A preliminary radiocarbon chronology attributed Early to Middle EP ages to the archaeological horizons of the site (ca. 17,100–16,400 cal BP). Additional preliminary results highlighted excellent preservation of botanical remains and a rich faunal assemblage including an unusually rich mollusk community. The lithic assemblage evidenced at least two archaeological entities, attributed to the Early and Middle EP (Marder et al. 2015; Sharon et al. 2002a; b).

Since the site's discovery, five seasons of excavation have been completed. These began with a short test season in 2014, during which six geological trenches were dug by tractor and four limited areas were excavated by hand (see Figure 2) to estimate the eastern limit of the site and evaluate the stratigraphy and density of artifacts in the archaeological horizons. The sections exposed in the 2014 geological trenches revealed a sequence of very shallow water littoral (near-shore) deposits that alternated between dark silt and mollusk-rich silt. The density of archaeological material was difficult to estimate from the trench sections. Nevertheless, three of the test excavations (Areas A, B2, and C; see Figure 2c) revealed a substantial sequence of archaeological horizons separated by layers of archaeologically sterile silt.

Area A is located in the northern part of the site, immediately south of the present-day artificial outlet of the small Dureijat Stream into the Jordan River. The archaeological horizons in Area A are primarily located at the base of the stratigraphic sequence within mollusk-rich, sandy lakeshore deposits. The finds comprise numerous flint artifacts including microliths, limestone net sinkers (Nadel and Zaidner 2002; Rosenberg et al. 2016), animal bones, and large quantities of charcoal and other botanical remains. The recovery of numerous basalt flakes suggests the *in situ* manufacture of tools in the southern squares of Area A. Three basalt fragments may have originated from broken basalt grinding stones. Preliminary observations suggest that the lithic assemblage should be attributed to the Early EP. Area A was excavated only during the 2014 test season.

The 6m^2 test excavation in **Area B** exposed a sequence of archaeological horizons embedded within mollusk-rich sediment on the bank of the Jordan River. Based on the data collected and the stratigraphic sequence, Area B was selected as the primary site of excavation in the following seasons. The test excavation in **Area C**, located a few meters south of Area B at the western end of Trench 3 (see Figure 2c), covered only 2m^2. Yet, it exposed a sequence of archaeological horizons rich in stone tools and bones. Area C yielded a significant lithic assemblage that included a large, finely-retouched scraper manufactured from a basalt blade. Unfortunately, the small Area C assemblage lacks diagnostic tool types and thus it is difficult to assign cultural affiliation.

The 2014 results highlighted the difficulty of interpreting and dating the archaeological sequence prior to full-scale excavation. Study of the lithic assemblages from the test excavations led us to conclude that the site was occupied primarily during the Early EP. It was only during the first full excavation season in 2015 that we also identified Geometric Kebaran and Natufian industries that re-

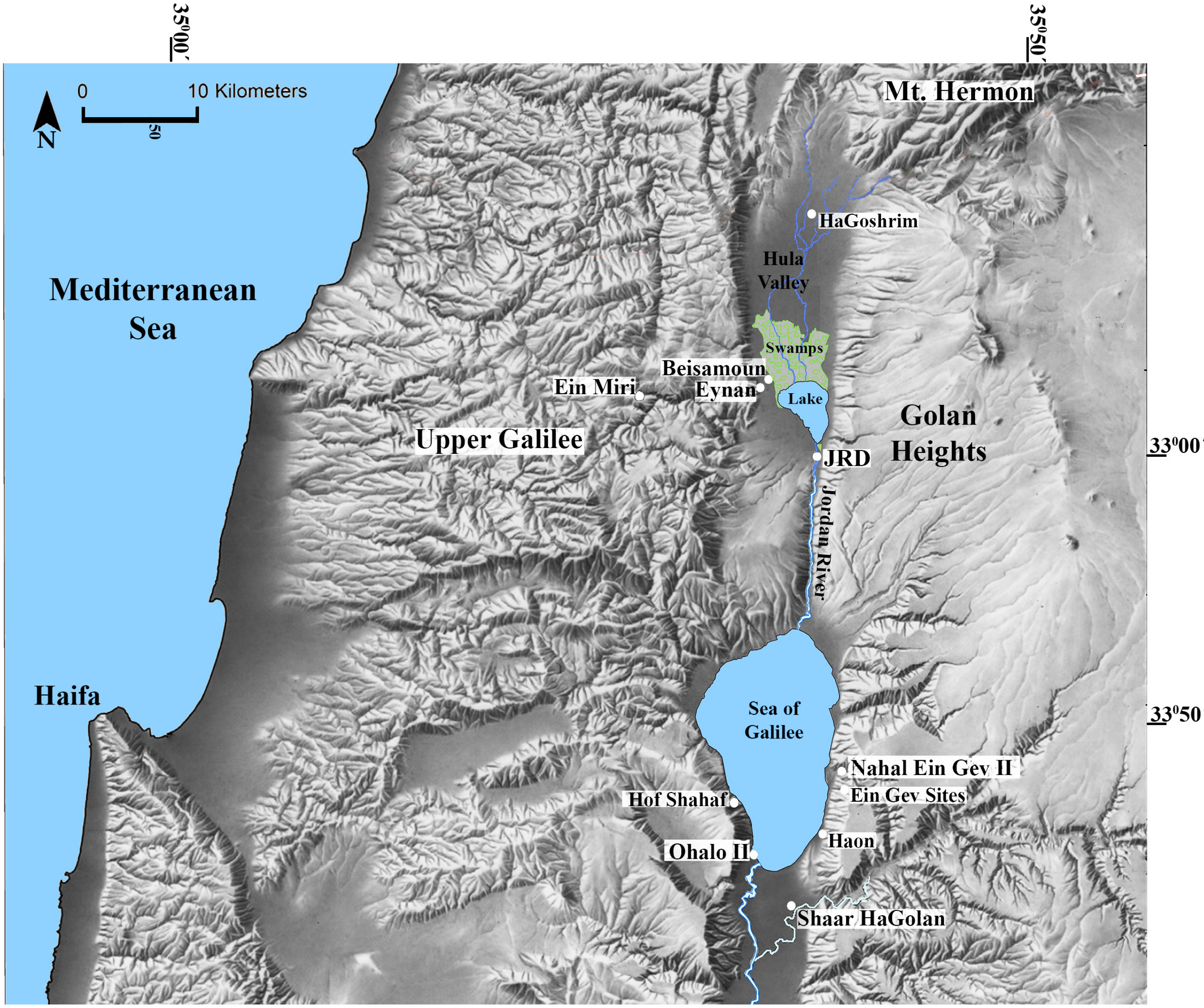

Figure 1. Map of the Northern Dead Sea Rift Valley with approximate location of sites mentioned in text.

vealed repeated visits to JRD throughout the EP. The first full-scale excavation of Area B in 2015 aimed to expose a large horizontal area of the site (>30m^2). The stratigraphy and chronology of JRD are only generally described here; a more detailed account is in preparation.

JRD STRATIGRAPHY AND CHRONOLOGY

The stratigraphic sequence of JRD presented here is based on the east section of Area B. The two upper layers of the sequence, Layers 1 and 2 postdate the EP and include minute quantities of archaeological materials. The stratigraphic sequence below Layer 2, the focus of this presentation, is comprised of alternating layers of near-shore, shell-rich silty sediments and layers of silt with very few shells. All of the shell-rich horizons in the sequence contain archaeological remains. The shell-poor silt beds (marked as M layers; Figures 3 and 4) were deposited when the lake-water level was high enough to permanently submerge the site, preventing occupation even during short periods of lowered lake levels. Dry climatic conditions probably resulted in short-duration drops in lake levels that occasionally exposed the lake sediments, allowing occupation of the site. The alternation of shore-proximal shell horizons and deeper-water lacustrine mud layers reflect the fluctuation of lake-water levels over the 10,000 years represented by our stratigraphic record. These water-level variations are suggested to reflect changing environmental conditions in the lake catchment.

To date, six near-shore layers have been exposed in Area B below Layers 1 and 2 (see Figure 4). These layers contain archaeological remains including stone tools, and botanical and faunal remains. These near-shore layers were further subdivided into sublayers (i.e., Layer 4 is subdivided into 4a, 4b, and 4c) based on minor stratigraphic differences such as a change in mollusk density or sediment color. The mud beds between the near-shore layers are

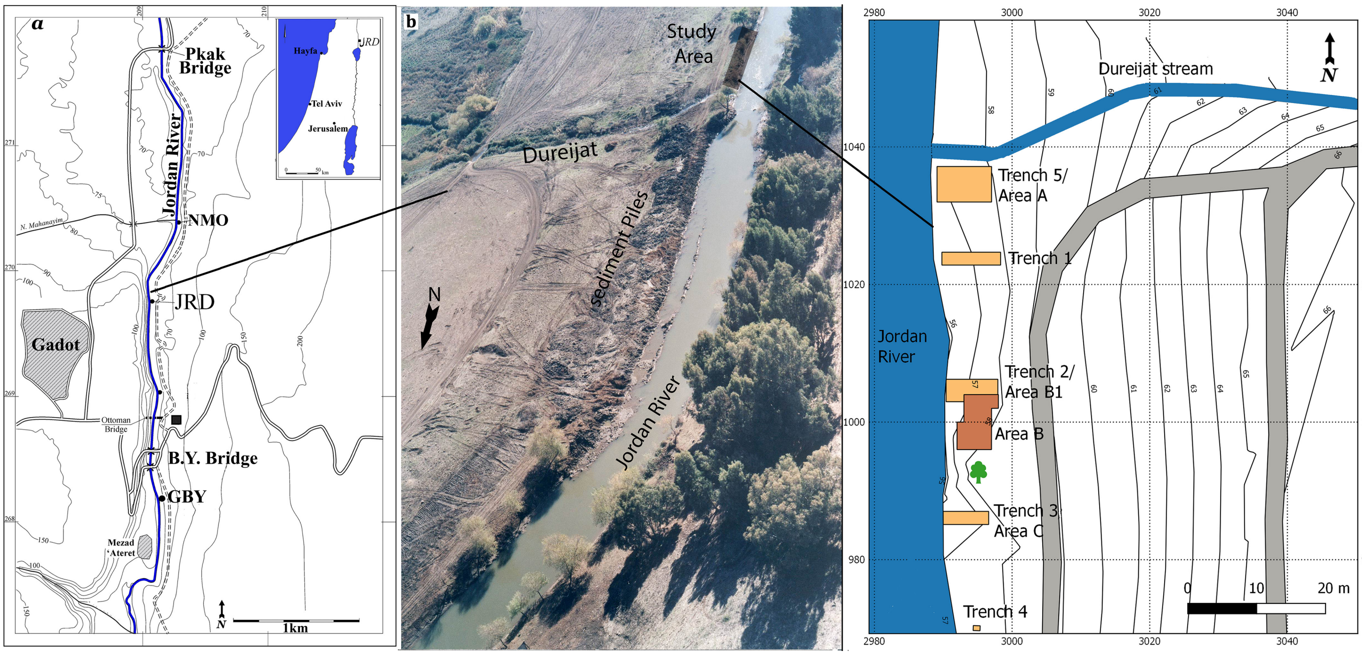

Figure 2. a) Location of JRD, b) JRD when it was discovered during the 1999 drainage operation, c) JRD excavation plan.

termed "M" or "mud" layers and named according to the near-shore bed they underly (i.e., the mud layer under Layer 3c is named M-3c and so on; see Figure 3). As is typical of many shallow-water environments, the Paleolake Hula margin was likely characterized by a variety of micro-environments related to local variations in, among other things, bathymetry, vegetation, and energy level (wave and current action). This local variability has resulted in significant variation in the site's layers over the lateral extent of Area B. For example, Layer 3c increases from 6–7cm thick at its south end to more than 30cm thick 5m to the north. Nonetheless, we interpret the entire bed as being deposited during the same low-water event.

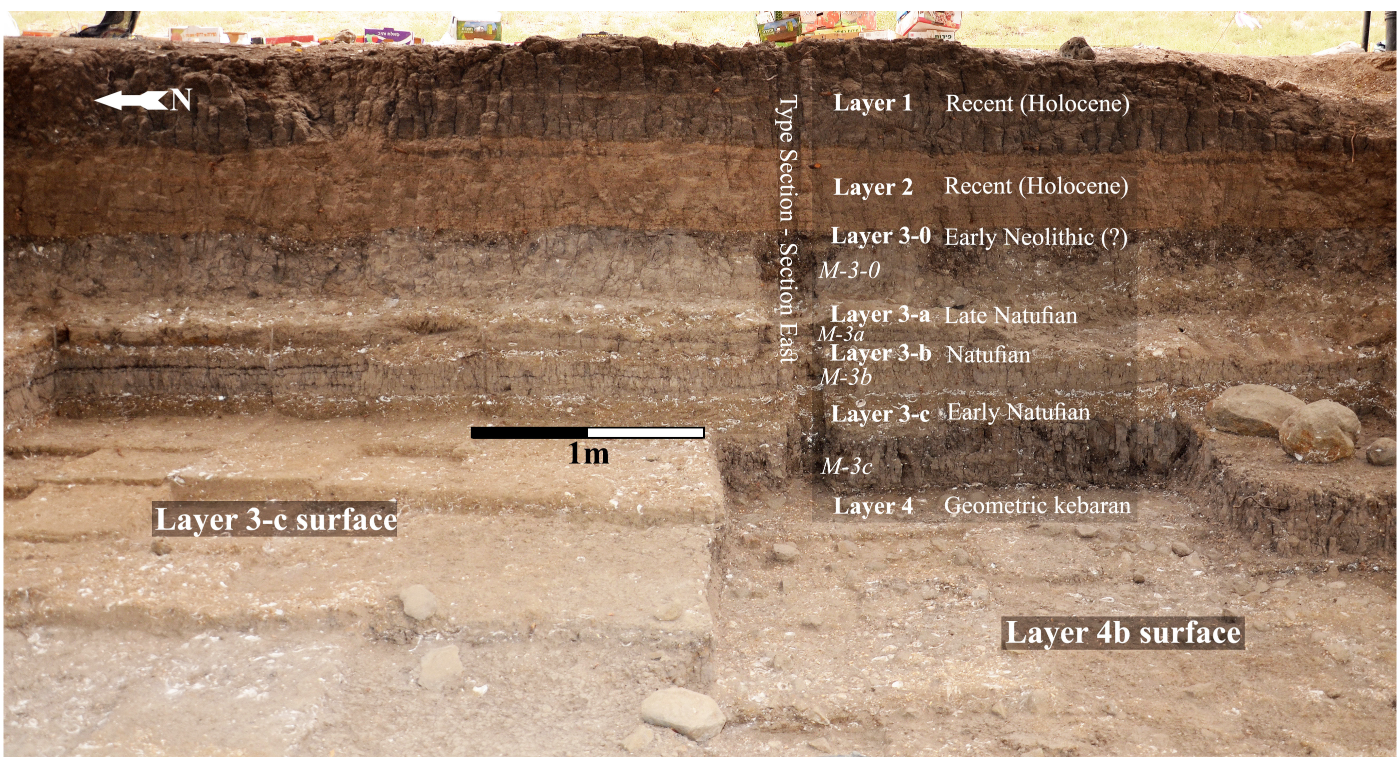

Figure 3. Stratigraphy of the east section of Area B at JRD with cultural affiliations indicated.

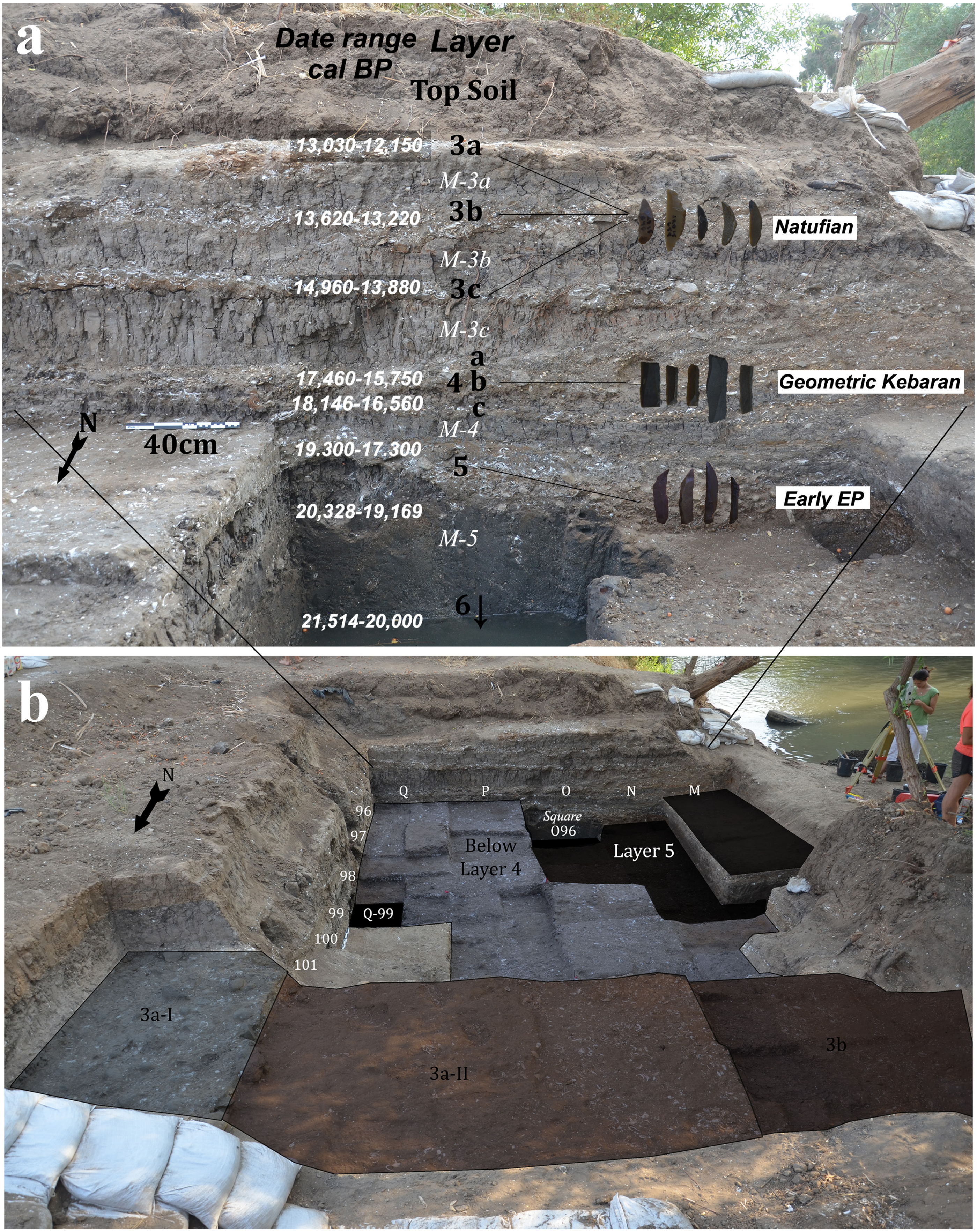

Figure 4. Area B at the end of the 2017 season. a) stratigraphy, cultural affiliation and radiocarbon stratigraphy of the south section of Area B, b) Area B stratigraphy and excavation grid.

TABLE 1. JRD ^{14}C DATES AND CONTEXT.*

Lab. Number	Sample Context	Layer	Additional Information	Measured Age [BP]	Calibrated Age [BP], 2σ
Beta-457485	East Section	2		190±30	<400
Beta-457486	East Section	3-0		10010±60	11512±242
Beta-457487	East Section	3a	Top of Layer 3a	9570±40	10920±182
Beta-457488	Arch. horizon	3a	3a archaeological horizon	8887±37	10037±149
Beta-457489	East Section	3b	Top of Layer 3b	11270±40	13341±95
Beta-457490	East Section	3b	Top of Layer 3b	11490±40	13341±95
Beta-457491	Arch. Horizon	3b	3b archaeological horizon	11815±47	13675±185
Poz-94107	East Section	3c	Bottom of Layer 3c	12460±70	14625±403
Poz-94108	East Section	3c	Middle of Layer 3c	12350±60	14419±321
Poz-94109	Arch. Horizon	3c	3c archaeological horizon	12416±47	14516±335
Poz-94158	East Section	3c	Bottom of layer 3c	13320±40	16033±183
Poz-94159	Arch. Horizon	4a	Layer 4 (between levels 4a and 4b)	13368±53	16076±195
Poz-94160	South Section	4b	Bottom of Level 4b	14350±40	17527±177
Poz-100196	East Section	4b	Below Level 4a	13960±80	16911±310
Poz-100197	East Section	4c	Top of level 4c	14433±40	17612±188
Poz-100198	Arch. Horizon	5	5 archaeological horizon	14414±58	17582±222
Poz-100258	Arch. Horizon	5	5 archaeological horizon	16549±72	19948±242
Poz-100259	South Section	5	Layer 5 on the south wall	13870±80	16781±300
Poz-100295	East Section	5	Below Layer 5	16612±72	20045±240
Poz-100320	East Section	6	ca. 10cm above layer 6	16867±71	20333±225
Poz-100321	East Section	3a	Below Layer 3a (mud below 3a). Recent age (post 1950). contamination	-	-
Poz-100322	South Section	5	Layer 5 south wall – problematic context	16660±50	20103±193
Poz-100323	East Section	-	Too small to date	-	-

*Dating was conducted by Beta Analytic (lab numbers Beta) and the Poznań Radiocarbon Laboratory (Poz).

Radiocarbon chronology

Twenty-four charcoal samples were used for radiocarbon dating (Table 1). Of these, fifteen come from systematic samples taken at 1cm intervals along the east section of Area B (see Figure 3), and three came from the lower part of the south section in Area B (see Figure 4a). The rest were from charcoal collected during the excavation of Area B. All samples but one proved large enough for dating. Sixteen samples were submitted to the Poznań Radiocarbon Laboratory, Poland, while eight samples were dated at Beta Analytic in Miami, USA (see Table 1). The calibrated age ranges presented here (see Figure 4a) were generated using OxCal v. 4.3 (Bronk Ramsey 2009) and the calibration curve IntCal13 (Reimer et al. 2013). One sample from Layer 3a in the east section of Area B gave a recent date (post-1950) and likely represents contamination from modern charcoal (see Table 1). Work on the chronostratigraphic age model for JRD is ongoing and will be presented in following publications.

The Stratigraphic Sequence

Layer 1. The upper part of the sequence is comprised of two layers of Late Holocene age. The uppermost Layer 1 comprises the top 50cm of the Area B section (see Figure 3). It is characterized by dark silt that resembles the surface sediment of today's artificial slopes of the Jordan River that were cut intentionally into the dark soil during drainage operations in the twentieth century (Goren-Inbar et al. 2018; Sharon et al. 2002a; b). Today, the slopes gradually rise above the river and then plateau a few meters east of the site. This dark sediment may be part of the Holocene Ashmura Formation that accumulated in the slow-flowing river or in the swampy environment that characterized the Jordan River prior to the drainage operations (Horowitz 1973, 1979, 2001).

Layer 2. At its base, the dark sediment of Layer 1 cuts the homogenous, reddish-brown sediment of Layer 2. The sharp contrast between the two layers suggests a rapid change in accumulation conditions. Layer 2 is a ca. 50cm thick sandy deposit that is almost devoid of mollusk shells

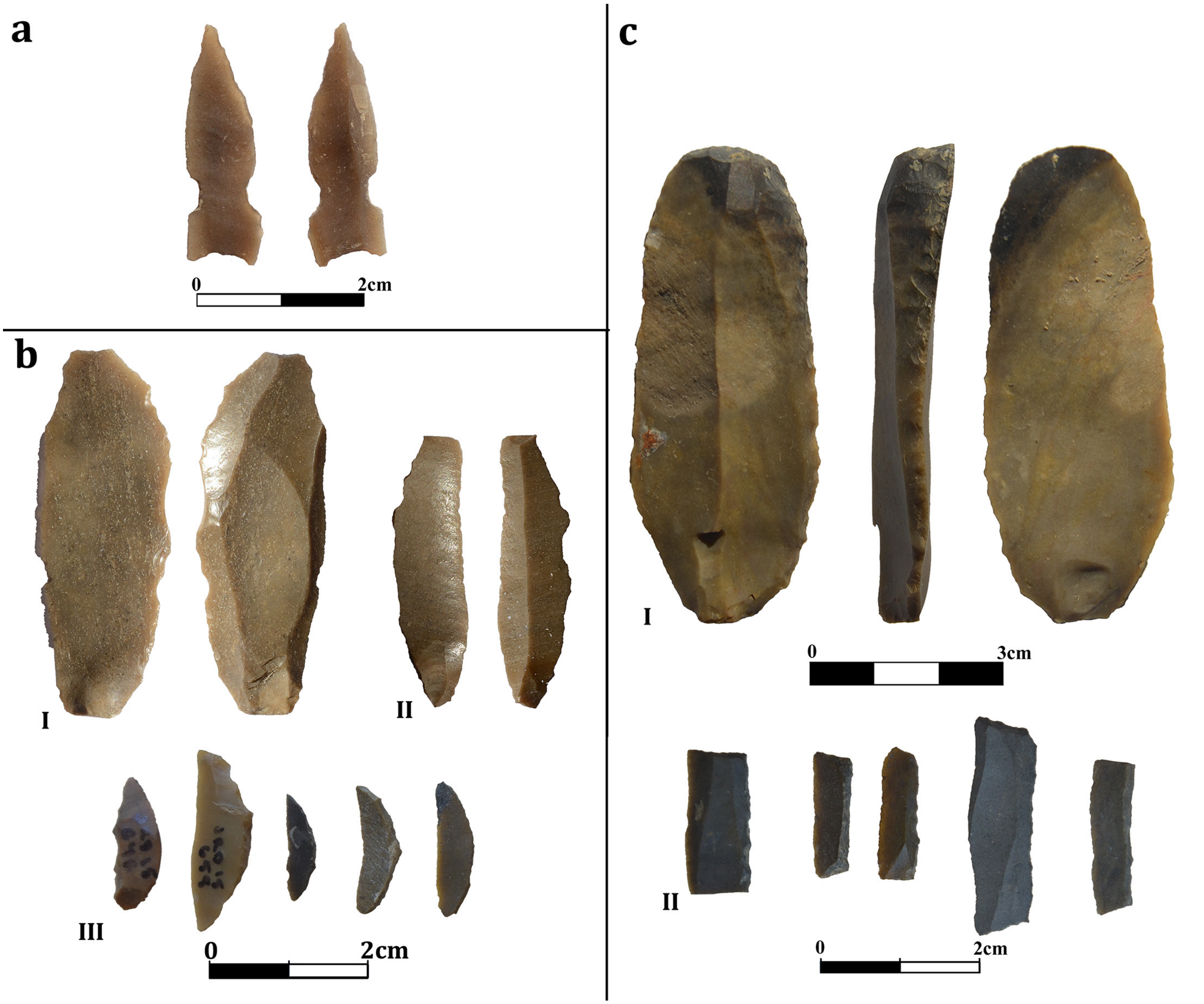

Figure 5. Tools indicative of cultural affiliation. a) el-Khiam point from the top of Layer 3a, b) Natufian tool types from Layers 3a, 3b, and 3c (I & II - sickle blades, III - lunates), c) Geometric Kebaran tool types from Layer 4 (I - end scraper made from a blade, II - geometric microliths).

and artifacts. A sharp erosional contact between Layer 2 and the underlying shell horizons of Layer 3 may represent a significant gap in the sedimentary record (see Figure 3).

Layer 3-0. The uppermost archaeological horizon at the site (Layer 3-0) sits directly below a clear but uneven unconformity that separates Layer 3-0 from Layer 2 (see Figures 3 and 4). Layer 3-0 begins at ca 57.8masl. It is comprised of a silty sediment matrix containing sparse archaeological remains, including angular basalt cobbles, a few limestone pebbles, most of them heavily weathered, and a handful of flint flakes (<10 for the layer). Some of the basalt cobbles may have been modified or transported by humans, but some may have been moved from their original position when part of the fine-grained matrix was resuspended in water as the lake level rose and shallow water recovered the site.

Layer 3a. This layer begins at ca 57.5masl and dates 13,030–12,150 cal BP. It varies significantly in thickness and density of archaeological remains (see Figures 3 and 4). To better understand the nature of this variation, the excavation was expanded into the northeast corner of Area B in 2018. This excavation revealed an uneven surface marked by shallow trenches and pits (some up to 20–30cm in depth) in the east, stony surfaces in the center and concentrations of shells, stone tools, and animal bones in the west. Only the top of the layer has been exposed, but excavation will continue in future seasons. Nevertheless, it is clear that human manipulation of this surface is heavier in the east and more intensive activities are represented by Layer 3a in comparison to the other archaeological horizons of Layer 3. The lithic assemblage that was recovered from Layer 3a is attributed to the Natufian based on the presence of lunates

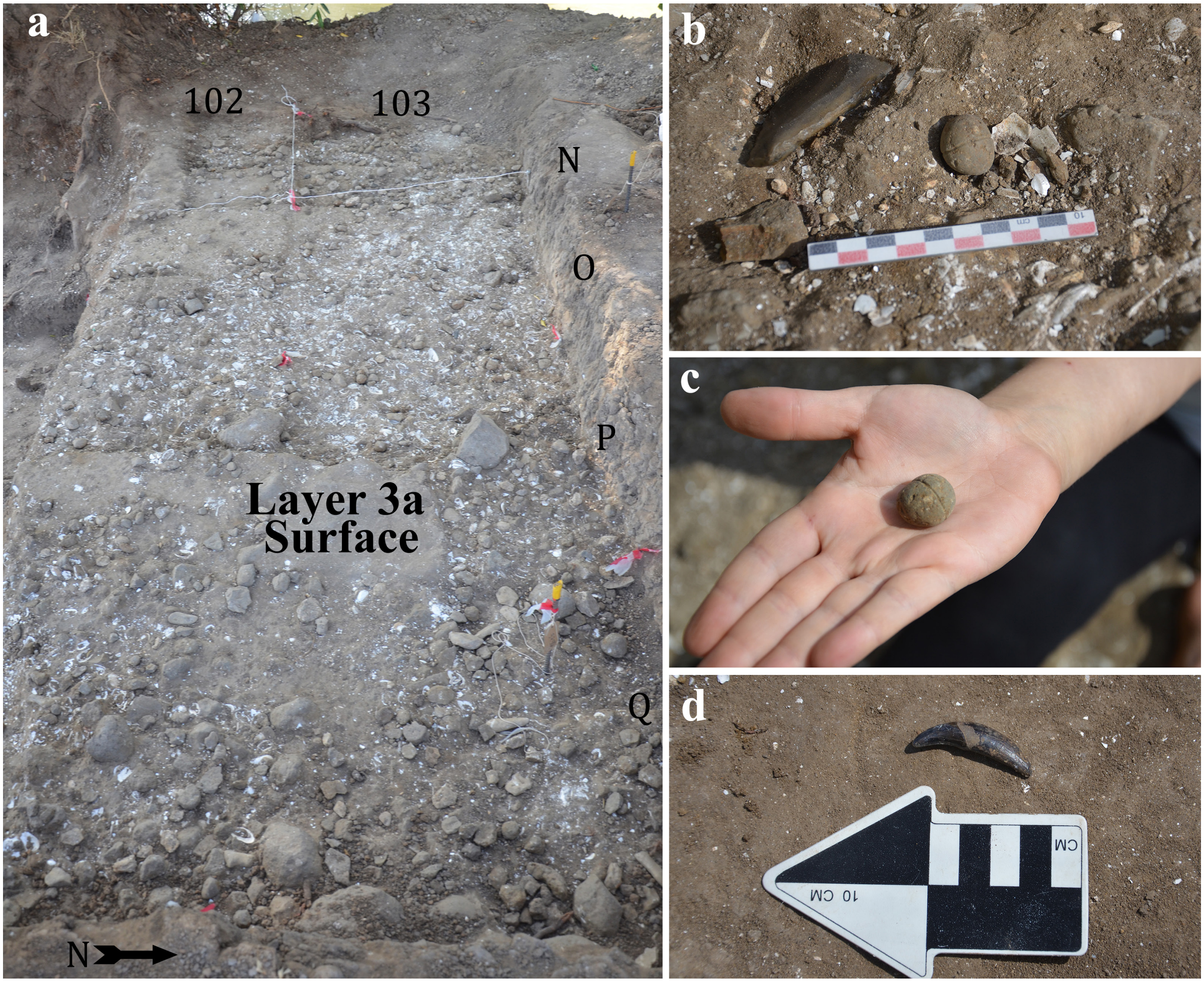

Figure 6. Layer 3a surface and archaeological remains. a) Layer 3a surface during excavation, b) basalt line weight and flint tools in situ*, c) basalt line fishing weight, d) carnivore canine* in situ*.*

and typical sickle blades (Figures 5b and 6). Many animal bones were recovered, including gazelle horn cores and a wolf canine (see Figure 6). A few juvenile human remains were scattered across the surface of Layer 3a at the northwestern part of Area B and likely belong to a single individual. Due to the lack of evidence of later intrusion or pits we can suggest that a burial was disturbed in antiquity. The presence of human remains in the context of this short-term occupation, suggests that the human occupation of Layer 3a was more substantial than those of other layers (see below).

Layer 3b. Layer 3b is a 10cm thick layer of shallow lacustrine sediment rich in *Unio* shells (see Figure 4). The layer begins at ca. 57.3masl and dates to 13,620–13,210 cal BP. Layer 3b appears in most squares within Area B, however, the sparse archaeological remains in this level reflect minimal human activity. Of special interest are three bone fish hooks found during the sorting of sieved sediments, indicating the presence of fishing activity during the accumulation of Layer 3b.

Layer 3c. Layer 3c is an accumulation of silt sediment rich in *Unio* shells. The layer begins at ca 57.1masl and formed between 14,960–13,880 cal BP (see Figure 4). Layer 3c covers the entire surface of Area B (see Figure 4b) and varies in thickness from 8cm in the south to as much as 30cm in the north. The layer slopes gently down toward the west (see Figure 4b). Flint artifacts are dispersed throughout this layer, but at low density. The layer is preliminarily assigned to the Natufian based on the presence of lunates (see Figure 5b; see also below). Layer 3c is rich in limestone cobbles and pebbles, some of which were modified by humans. Numerous basalt cobbles are also scattered throughout the layer. Many of the basalt cobbles show evidence of human manipulation in the form of battering and flaking. Dominant features of this layer are medium-sized basalt cobbles (up to 20cm in length) that are often found in pairs

Figure 7. Layer 3c surface. Note scattered large cobbles.

(Figure 7). The stones are typically spaced 50cm apart and were likely transported to the site by humans for a specific purpose. Based on their morphology and the presence of pits and battering marks, some of these stones may have been used as anvils or other working surfaces (see Figure 7c), others may have been used for cooking or as stable surfaces in the muddy environment. Two large basalt boulders were also located at the southeast corner of Area B. Layer 3c is also rich in small (<1cm) charcoal fragments.

Layer 4. Layer 4 is comprised of thick muddy sediment, rich in basalt and limestone cobbles and pebbles and *Unio* shells (Figure 8). The layer is subdivided into Layers 4a, 4b, and 4c. The stony Layer 4b is the primary archaeological horizon. Layer 4 begins at ca. 56.7masl. The radiocarbon dates obtained for Layers 4a and 4b suggest they formed between 17,460–15,750 cal BP. Layer 4 is clearly visible in the eastern part of Area B but becomes less defined toward the west. In the western-most squares in Row M (see Figure 4b), the stratigraphy is difficult to read as Layer 3c appears to merge into Layer 4. In the eastern squares, Layer 4 is covered by a sterile grey mud that separates it from Layer 3c. However, in most squares, starting in Row O, the stony horizon of Layer 4 is covered by rapidly-changing sediments that vary in color, grain size, and the density of mollusks. In some areas, the layer is comprised of coquina horizons, rich in small shells, primarily *Bithynia* spp. These blanket a horizon of very large, almost cemented *Melanopsis* shells. The microstratigraphy changes rapidly within Area B, sometimes within a single square meter. This variation reflects the dynamic depositional environment in the shallow waters near the lakeshore, where wave-driven currents and patches of emerged and submerged plants cause large differences in micro-depositional conditions.

A large number of medium-sized limestone cobbles found in Layer 4 are of similar shape and size (Figure 9). The majority are flat and elongated and some have a battered appearance, while others are notched by flake removals. These resemble what Marder et al. (2015) termed “net sinkers” known from other EP sites (Nadel and Zaidner 2002; Rosenberg et al. 2016). Many smaller spherical limestone pebbles (2–4cm) in Layer 4, may have been imported as fishing line weights (see below). Basalt is more common than limestone in Layer 4 (see Figure 8). Many of these also show evidence of human handling and battering. Some of the basalt objects are flaked cores or flakes and some are fragmented chunks. Of special note are two broken basalt pestles discovered on the layer’s surface (see Figure 8b). As in the case of the limestone, it seems that many, if not all, of the basalt objects in this horizon were imported by humans. Hence, Layer 4 represents a muddy lacustrine environment that includes numerous stones transported for use as weights and tools. The lithic assemblage from Layer 4 includes trapeze-rectangles, and end-scrapers produced on blade blanks (see Figure 5c) among other tool types. Together, these attribute this archaeological horizon to the Middle EP Geometric Kebaran culture affiliation.

Layer 5. Layer 5 is comprised of silty sediment with concentrated mollusk shells that vary in density and relative species abundance (primarily *Unio* spp. and *Melanopsis* spp.). It contains a rich archaeological horizon, possibly representing repeated visits or high-intensity occupation, at least in the western part of Area B, within rows O, N, and M (Figure 10). The top of the layer is ca. 56.3masl. Two radiocarbon dates obtained from the upper part of the layer suggest that sediments accumulated between 19,300–17,300 cal BP. The archaeological horizon of Layer 5 thins out in the

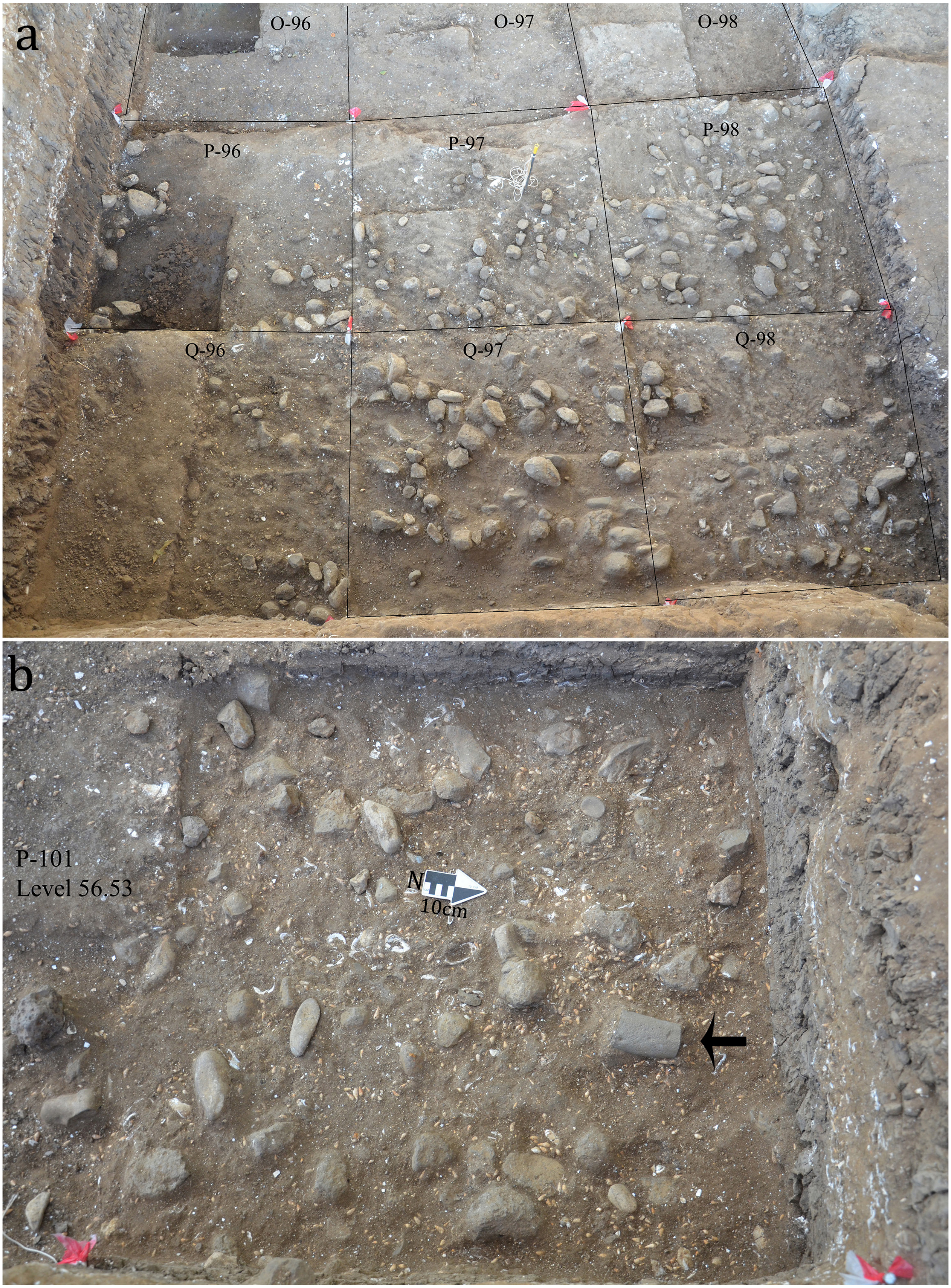

Figure 8. Layer 4 surface. a) Layer 4b stony surface, b) close-up of Layer 4 surface in Square P-101. Arrow indicates broken pestle.

Figure 9. Limestone cobbles on surface of Layer 4b.

eastern part of Area B and ultimately disappears beyond the O squares where sediments were clearly deposited in shallow water. In this area, Layer 5 consists only of concentrations of *Unio* shells (see Figure 10). The high density of shells with their valves still attached suggest that these were deposited following their natural death in the mud beneath shallow water. Layer 5 grows thicker in the western part of Area B. This part of the layer may have formed within a shallow basin that became deeper toward the east. The layer contains numerous small basalt and limestone cobbles, and numerous flint artifacts and animal bones (see Figure 10b). The western edge of Layer 5 is bordered by basalt boulders of unknown origin (see Figure 10a) that were clearly present when the layer was formed. Although 15m^2 of the upper part of Layer 5 surface were excavated, we lack details on its maximum thickness, the nature and time span represented by the accumulation, and the role of human agency in the formation of the layer. Preliminary study of the flint tools suggests an early EP affiliation for the assemblage, which is supported by the radiometric dates from this layer.

Layer 6. Layer 6 was reached only in a deep sounding, excavated in square O96 (Figure 11). The top of the deep sounding is immediately below Layer M5 at ca. 56.0masl. The stratigraphic sequence in the sounding was difficult to interpret as most layers were in a steeply inclined to vertical orientation indicating that post-depositional processes disturbed the primary layering. The sediments alternated between fine dark silt and mollusk‐rich silt. A few basalt pebbles, isolated flints, and bones were exposed within the mud matrix across the sequence (see Figure 11). The mollusks, particularly the *Melanopsis* shells, preserved their dark color, indicating very good preservation conditions.

At a depth of ca. 55.60–55.55masl, we reached the water level of the Jordan River (the water level fluctuates daily, sometimes up to 20–40cm). This made excavation more challenging (see Figure 11a). At 55.20masl, 80cm below Layer 5, we reached Layer 6 (see Figure 11c). This layer contains pebble- to cobble-sized weathered limestone and basalt stones embedded within a matrix of silt and crushed mollusk shells. Well-preserved flint tools, including a massive scraper and a bladelet core attest to human activity in Layer 6. Still, no bones and only a few botanical remains, mostly charcoal, were recovered.

A notable feature of Layer 6 is the steep inclination of sedimentary boundaries in the lowermost 50cm of the sounding which probably represents a post-depositional water-escape structure (see Figure 11a). Here, a bed of fine-grained silt was deposited atop highly concentrated mollusk‐shell fragments (Layer 6). The movement of pore water in the lower unit was probably impeded by relatively rapid deposition of the overlying finer-grained sediments. Compression of Layer 6 under the increasing weight of newly deposited sediments created instability within the layer. A disturbance such as an earthquake probably caused liquification of the sediments of Layer 6 and the escape of trapped pore waters through the overlying sediments to the surface, creating the soft-sediment deformation structure preserved in the section today (see Figure 11). Thus, the steeply to vertically oriented sediment boundaries of Layer 6 likely resulted from the escape of pore water and simultaneous deformation of the affected sedimentary layers.

Figure 10. Layer 5 during the 2018 season. a) general view indicating the limited extent of the archaeological material in this layer, b) a view of Layer 5 surface during excavation, c) a close-up view of the archaeological remains in Layer 5.

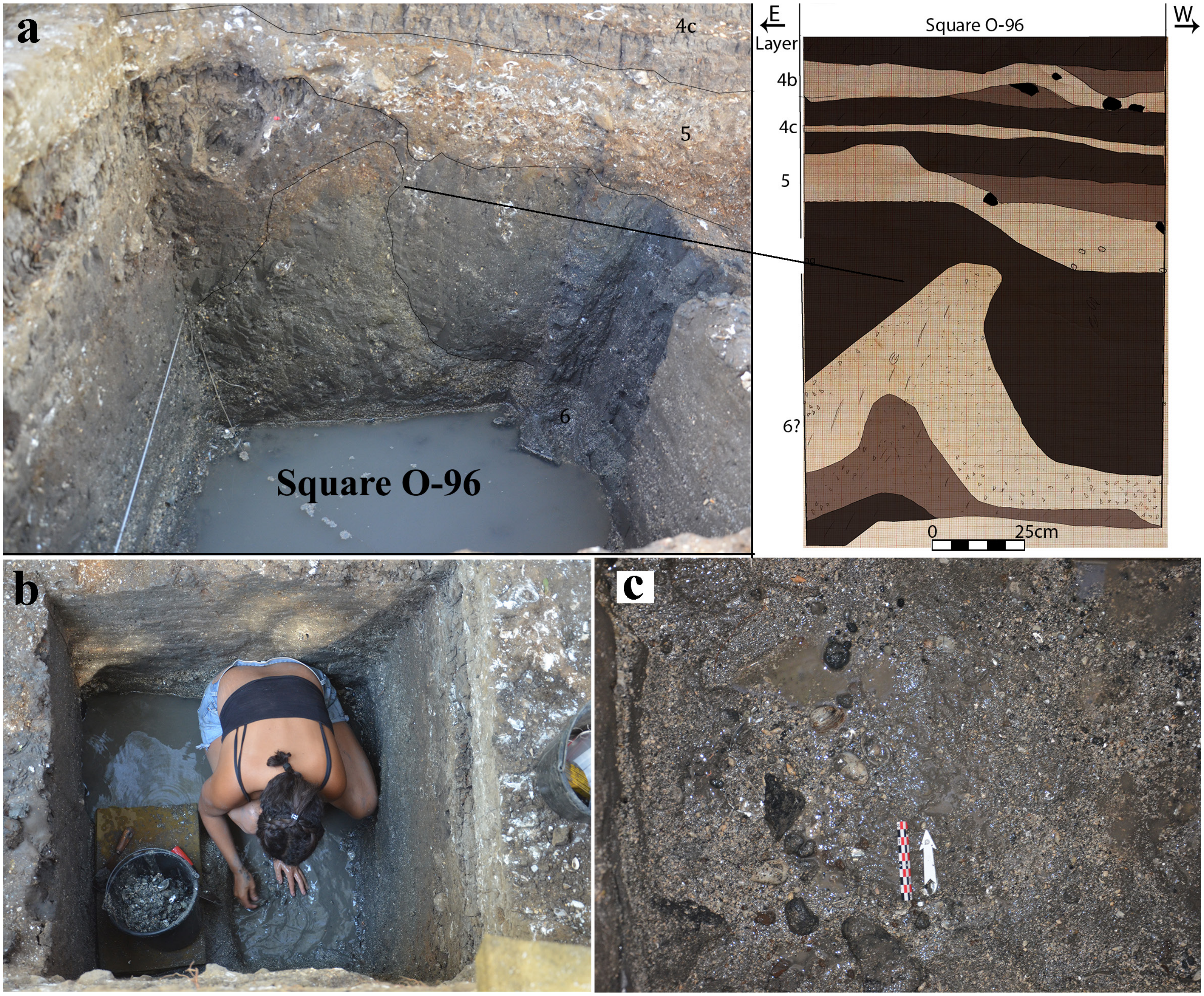

Figure 11. Layer 6, exposed during the 2017 excavation season. a) stratigraphy of south section of Area B below Layer 5 in deep sounding of Square O-96, b) excavation of Layer 6 in deep sounding of Square O-96, c) Layer 6 surface.

Because of the intermittent nature of occupation and the dynamic fluctuations of Lake Hula, the site of JRD was created by both natural and cultural processes. At times, this makes it difficult to distinguish materials that were contributed by humans and those that were naturally deposited. Distinguishing natural from cultural deposition is an ongoing research question at JRD and for some material classes it will require large samples to resolve. We highlight the current state of our knowledge on this issue where relevant in our reports of the individual data classes below.

THE FLINT ASSEMBLAGE

The study of the JRD flint assemblage is in its early stages. Nevertheless, a few preliminary observations can be presented. A sample of 2,101 artifacts from all JRD archaeological layers, except Layer 6, has been studied thus far (Table 2; see Figure 5). Unlike most EP sites in the Mediterranean Levant, the density of artifacts in all archaeological horizons at JRD is low. This is likely related to the short-term, task-specific nature of the JRD occupation. The best represented category of debitage in the flint assemblage is flakes (Table 3), but blades and bladelets are also well represented in all layers. The presence of core trimming elements (CTEs) and primary flakes suggest that at least some of the stone tools in every layer were manufactured on site.

A preliminary typological analysis of the lithic assemblages (Tables 4 and 5) demonstrates that at least three EP cultures are represented at JRD. The three upper Layers 3a, 3b and 3c are ascribed to the Late EP Natufian culture due to the presence of diagnostic lunates and small sickle blades with un-worked edges (see Table 5; see Figure 5b). Layer 4 yielded trapeze-rectangle microliths and end-scrapers, mostly shaped from blade blanks (see Tables 4 and 5; see Figure 5c)—these are typical of the Middle EP

TABLE 2. COUNTS AND FREQUENCIES OF FLINT OBJECTS AT JRD BY LAYER.

	Layer 3a		Layer 3b		Layer 3c		Layer 4		Layer 5	
	N	%	N	%	N	%	N	%	N	%
Debitage	137	61	10	71	249	75	383	74	629	62
Chips and chunks	29	13	-	-	18	5	28	5	64	6
Hammerstones	-	-	-	-	2	1	-	-	1	-
Natural	8	4	-	-	8	2	23	4	6	1
Cores	9	4	1	7	9	3	10	2	61	6
Tools	43	19	3	21	46	14	77	15	247	25
Total	**226**	**100**	**14**	**100**	**332**	**100**	**521**	**100**	**1008**	**100**

Geometric Kebaran culture. No clear culturally diagnostic traits have been observed in the Layer 5 assemblage to date, yet the absence of geometric microliths and the presence of narrow-fronted bladelet cores suggest an Early EP affiliation for this assemblage (Figure 12). In addition, the presence of microburins in Layer 5 (see Table 3) suggests that this assemblage should not be attributed to the Kebaran or Geometric Kebaran traditions. Instead, the notable presence of carinated scrapers hints at an Early EP Masraqan affiliation. Carinated items are difficult to definitively categorize as cores or scrapers (Belfer-Cohen and Grosman 2007). Most of the items in this class from JRD are typologically described as broad (31%) or narrow (27%) carinated scrapers. Other relevant types are shouldered/nosed scrapers (15%) and core-scrapers (15%). Lateral carinated scrapers are rare. Thus, each of the three chronological phases of the EP (Early, Middle, and Late) are represented in the JRD sequence. Interestingly, an el-Khiam point, diagnostic of the Early Neolithic Khiamian culture (see Figure 5a), was also unearthed in Layer 3a, suggesting that the use of JRD probably extended beyond the Epipaleolithic into the Neolithic.

High frequencies of burins are present in Layers 3c, 4, and 5, but they are rare in Layer 3a (see Table 5; Figure 13). Such exceptional percentages of burins hint that a specific activity was executed at the site, possibly related to the acquisition of aquatic resources. The size of the Layer 5 burin assemblage (see Figure 13) is sufficient to present preliminary frequencies of the types represented. Burins on the break or natural surface (38%) and burins on notch or truncation (30%) are by far the best represented. Among the latter, the most frequent sub-types are burins on concave (8%) and straight truncations (7%). Dihedral burins are also represented (12%). Sickle blades, mostly of the unretouched or curved-backed variety, are present in all layers, except Layer 5. Finally, perforators and notches/denticulates are well represented in Layers 3a and 5 (see Table 5).

Future technological analysis of the JRD assemblage will provide a more detailed picture of the cultural and functional aspects of the occupations and the reduction sequences (*chaînes opératoire*) used to produce tools. To date, preliminary observations suggest that many tools were manufactured on byproducts of reduction (CTEs and primary flakes) rather than on 'formal' blanks. Some tools were also recycled for new purposes. Currently, it is difficult to connect the lithic assemblages to a specific set of tasks; although the quantities are small, a large repertoire of tool types is represented. Still, the unusually high incidence of burins in Layers 3c, 4, and 5 suggests continuity

TABLE 3. COUNTS AND FREQUENCIES OF FLINT DEBITAGE TYPES AT JRD BY LAYER.

	Layer 3a		Layer 3b		Layer 3c		Layer 4		Layer 5	
	N	%	N	%	N	%	N	%	N	%
Primary flakes	17	12	4	40	26	10	44	11	89	14
Flakes	55	40	4	40	132	53	196	51	290	46
Blades	19	14	-	-	14	6	42	11	20	3
Bladelets	12	9	1	10	31	12	31	8	58	9
Core trimming elements (CTE)	34	25	1	10	39	16	70	18	168	27
Microburin technique (MBT)	-	-	-	-	1	-	-	-	1	-
Other	-	-	-	-	6	2	-	-	3	-
Total	**137**	**100**	**10**	**100**	**249**	**100**	**383**	**100**	**629**	**100**

TABLE 4. GEOMETRIC AND NON-GEOMETRIC MICROLITHS BY LAYER.*

	Layer 3a	Layer 3c	Layer 4	Layer 5
Non-geometric microliths				
I4 - Inversely retouched bladelet	-	1	-	-
I6 - Partially retouched bladelet	-	1	-	1
I7 - Completely retouched bladelet	1	-	-	-
I8 - Bladelet retouched on both edges	-	-	-	1
I10 - Pointed backed bladelet	1	2	-	-
I12 - Curved pointed bladelet	-	1	1	-
I15 - Obliquely truncated bladelet	1	-	-	-
I17 - Microgravette	-	-	-	1
I29 - Helwan bladelet	1	-	-	-
I30 - Retouched/backed bladelet-varia	-	1	-	-
I31 - Retouched/backed bladelet fragment	1	1	4	2
Total	**5**	**7**	**5**	**5**
Geometric microliths				
J1 - Straight truncated and backed bladelet	-	5	4	-
J3 - Trapeze/rectangle	-	-	3	-
J5 - Trapeze	-	1	1	-
J6 - Asymmetric trapeze	-	1	-	-
J9 - Helwan lunate	-	2	1	-
J11 - Backed lunate	1	1	-	-
J12 - Atypical backed lunate	1	-	-	-
Total	**2**	**10**	**9**	**-**

*based on type list from Bar-Yosef (1970) and Goring-Morris (1987)

in the activities performed across the long sequence of repeated occupations.

FAUNA

Macrofauna

Analysis of the JRD faunal assemblage recovered during the 2014–2017 excavation seasons is ongoing. The assemblage includes large bone fragments >1cm that were hand-collected during excavation and smaller remains which were carefully picked from wet-sieved sediments that did not pass through the 2mm screen (most <1cm in length).

A small pilot study of bones from the large faunal fraction recovered from multiple contexts revealed an extraordinarily diverse vertebrate fauna. In a sample of only 70 identified bones, multiple species of mammals, birds, reptiles, and fish were identified. Mammalian taxa are most common and are represented by small game such as hare (*Lepus capensis*), carnivores like wolf (*Canis lupus*), and a number of ungulates including red deer (*Cervus elaphus*), fallow deer (*Dama mesopotamica*), mountain gazelle (*Gazella gazella*), and wild boar (*Sus scrofa*). Initial sorting of the fauna recovered from the picked sediments indicates that fish, snakes, and rodents are the most common taxa in the small fraction. The body-size, relative taxonomic abundance and skeletal part-representation suggest that much of the water-sieved fauna may have accumulated naturally (Zohar and Biton 2011; Zohar et al. 2008). However much larger samples and more specific identification are needed before natural and cultural deposits can be differentiated with any certainty. The presence of a number of terrestrial and larger aquatic taxa (large fish, waterfowl, and freshwater turtle) suggests that humans chose this lakeside for its ecotonal setting that allowed broad spectrum foraging in both terrestrial and aquatic habitats. The focus on aquatic (fish, turtles, waterfowl) and terrestrial (hare, ground birds, tortoises) small game taxa is consistent with models of subsistence intensification developed for the terrestrial landscapes of the Mediterranean zone (Davis 2005; Munro 2004; Stiner et al. 2000).

Amphibians, Lizards and Snakes

The herpetofaunal remains (i.e., anurans, lizards, snakes, and turtles) reported here derive from Layers 3 and 4 and provide only preliminary results. Further study of all units using quantitative and taphonomic tools will provide important additional information on environmental and anthropological topics at this multi-layered archaeological

TABLE 5. TYPOLOGICAL COMPOSITION OF THE JRD FLINT ASSEMBLAGE.*

	Layer 3a		Layer 3b		Layer 3c		Layer 4		Layer 5	
	N	%	N	%	N	%	N	%	N	%
A - Scrapers	1	2	-	-	4	9	16	21	27	11
B - Carinated scrapers	-	-	-	-	3	7	1	1	21	9
C - Burins	2	5	-	-	6	13	11	14	60	24
D - Multiple tools	2	5	-	-	-	-	2	3	3	1
E - Retouched/backed blades	1	2	-	-	2	4	-	-	12	5
F - Sickle blades	4	9	1	33	2	4	3	4	-	-
G - Truncations	3	7	-	-	-	-	1	1	5	2
H - Points	2	5	-	-	-	-	-	-	-	-
I - Non-geometric microliths	5	12	-	-	7	15	5	6	5	2
J - Geometric microliths	2	5	-	-	10	22	9	12	-	-
K - Projectile points	1	2	-	-	-	-	2	3	-	-
L - Perforators	6	14	-	-	2	4	6	8	29	12
M - Notches and denticulates	3	7	-	-	3	7	6	8	29	12
N - Heavy duty tools	2	5	-	-	2	4	3	4	9	4
O - Various	11	26	2	67	5	11	12	16	47	19
Total	**43**	**100**	**3**	**100**	**46**	**100**	**77**	**100**	**247**	**100**

*based on type list from Bar-Yosef (1970) and Goring-Morris (1987)

site.

The remains retrieved to date consist of 136 bones. Three anuran species were identified: the Levant green frog (*Pelophylax bedriagae*; n=8), the Hula painted frog (*Latonia nigriventer*; n=2), and a tree frog (*Hyla* sp.; n=1). A total of 27 turtle shell fragments were also recovered. Three bones were assigned to the Western Caspian turtle (*Mauremys rivulata*) and seven to the spur-thighed tortoise (*Testudo graeca*). The lizard remains were restricted to three bones: a scute and a vertebra assigned to the European glass lizard (*Pseudopus apodus*) and a small fragment of an upper jaw of a Mediterranean chameleon (*Chamaeleo chamaeleon*). The most abundant microfaunal vertebrate remains are snake vertebrae (n=85). The majority are from the dice snake (*Natrix tessellata*). One vertebra was from a Schokari sand racer (*Psammophis* cf. *schokari*) and another was assigned to an Eastern Montpellier snake (*Malpolon insignitus*).

The presence of the Levant green frog (*Pelophylax bedriagae*) and the dice snake (*Natrix tessellata*) in Layers 3a, 3c, and 4 suggests that a vegetated permanent water body or river bank was situated close to the site at the time of occupation (Werner 2016). Identification of two additional anuran species, the Hula painted frog (*Latonia nigriventer*; Layer 4) and a tree frog (*Hyla* sp.; Layer 3c), as well as the Western Caspian turtle (*Mauremys rivulata*; layers 3a, 3c), reinforce this conclusion.

All of the identified species currently occupy the Hula Valley. Except for the chameleon, remains of these species have been recovered from other Pleistocene sites in the Hula Valley such as Gesher Benot Ya'aqov (GBY) and Nahal Mahanayeem Outlet (Biton et al. 2013; 2017; 2019; Hartman 2004).

Mollusks

Mollusks constitute one of the most abundant remains recovered at JRD. A previous preliminary study of mollusks from the test excavation led to the identification of 46 different taxa from a single square meter of the river bank (Marder et al. 2015). The study of mollusks from the recent excavations is ongoing. These preliminary results primarily include species identified to the genus level from a variety of stratigraphic layers at the site. A total of 17,419 specimens were sorted (number of identified specimens, NISP).

Table 6 shows changes in the composition of the malacofauna over time (but see O'Connor 2017). It should be possible to reconstruct changing conditions by documenting the preferred ecological conditions of the molluskan taxa represented at the site in combination with the ecological reconstructions based on non-molluskan taxa. Whereas many of the tiny gastropods that dominate the assemblage (e.g., *Heleobia* and *Bithynia*) are difficult to see in the sediments, valves of the *Unio* bivalve shells are prominent in the JRD layers. These were found mostly within the mud sediments formed in shallow water stands, in many cases the paired valves were still closed (Figure 14a), suggesting a natural death assemblage. In some of the layers, the *Unio* shells reach up to 12–15cm in maximum length, which is significantly larger than the *Unio* species living in the area

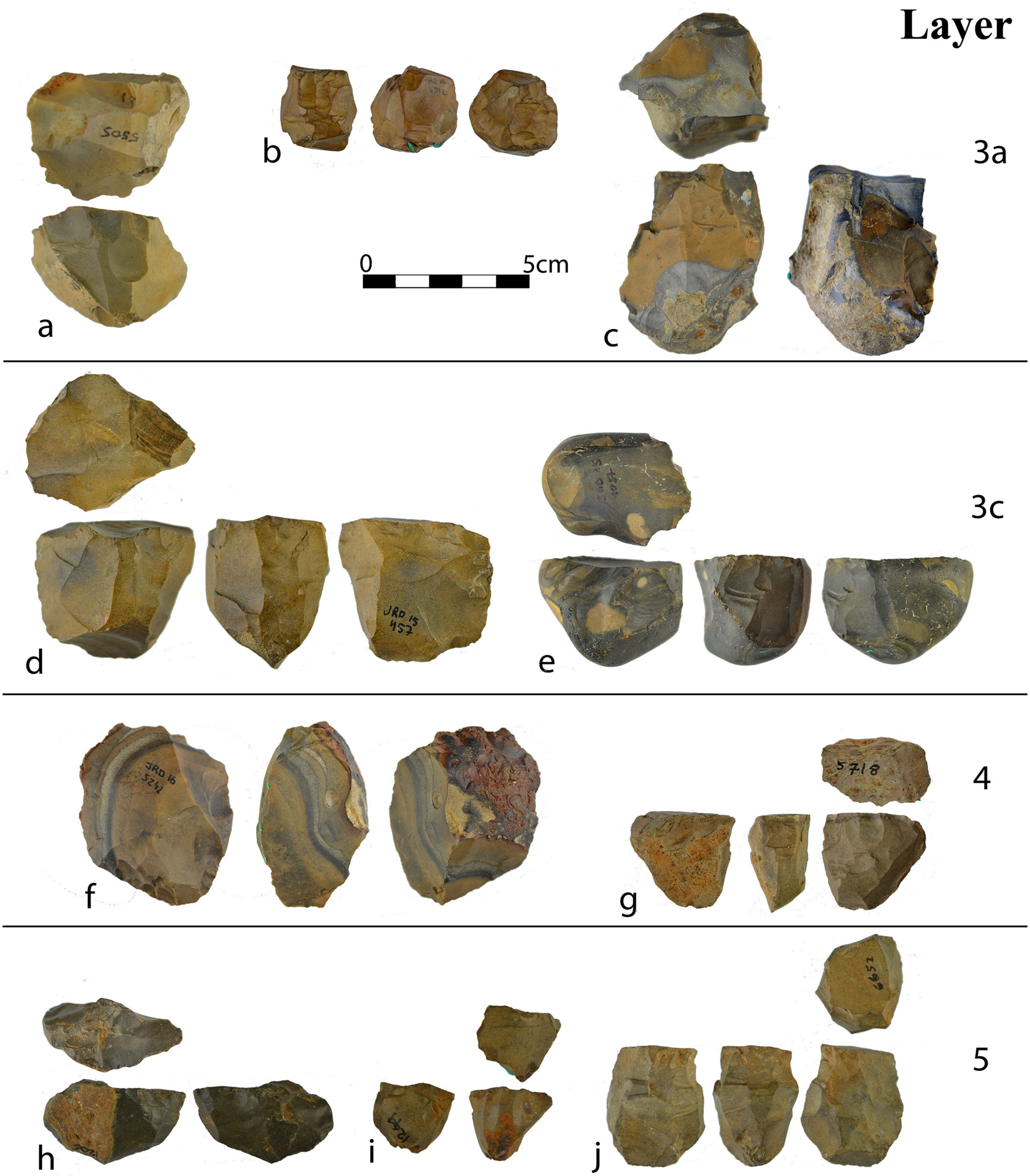

Figure 12. Flint cores from JRD by layer.

today (Milstein et al. 2012; see Figure 14c). The presence of these large shells is explained by exceptionally favorable ecological conditions at the time of deposition or they may belong to a new (or at least yet unidentified) species of *Unio*. *Unio* shells are also extremely abundant in some of the archaeological horizons formed during low water stands at JRD. Their exploitation by humans is under investigation. Heating bivalves causes their shells to open, allowing the

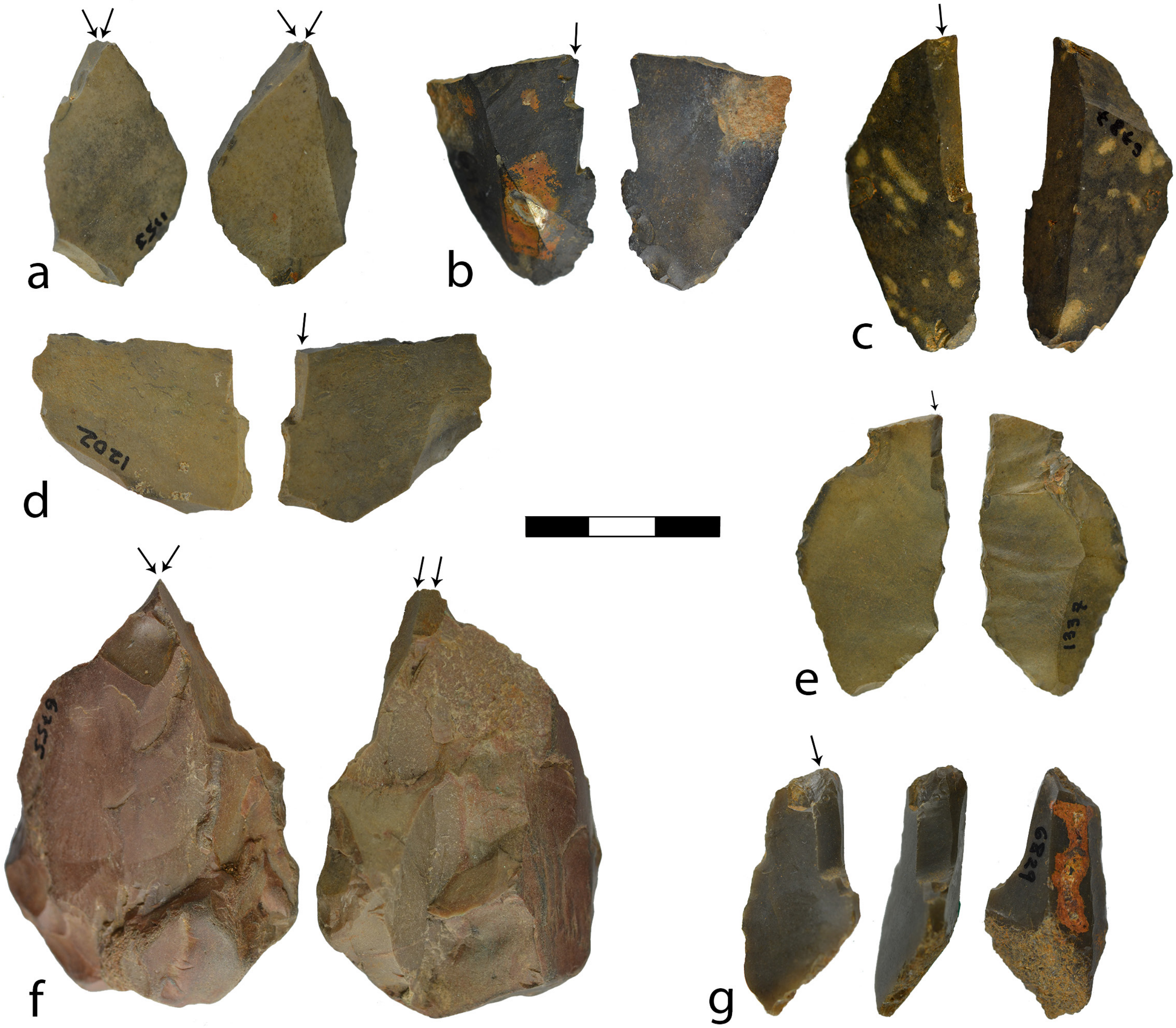

Figure 13. Burins from Layer 5.

meat to be extracted. This can be achieved by placing the shells on heated stones (Meehan 1982). Thus, meat extraction does not require that the shells be broken, making it difficult to distinguish human discard from natural deposition. A thin, isolated basalt slab found in the mud layer below Layer 4 may have been placed within or above a fire to provide a hot surface upon which to open the shells (Figure 15). The strong correlation between *Unio* valves, living floors, and artifacts in some archaeological layers suggests that the accumulations are cultural (Hardy 2017; Waselkov 1987). This hypothesis will be tested in the future.

Ostracods

The sediments from JRD also contain abundant valves of ostracods (micro-crustaceans) representing 21 species (Valdimarsson 2017). The valves belong primarily to *Ilyocypris* spp., *Neglecandona neglecta*, and *N. angulata*. Valves of *Pseudocandona* sp. and *Darwinula stevensoni* are also relatively abundant. *Heterocypris salina, Humphcypris subterranea, Limnocythere inopinata, Psychrodromus* sp., *Paralimnocythere* sp., *Trajancypris* sp., *Potamocypris* sp., and *Gomphocythere ortali* are only rarely found in the sediments (Figure 16).

The presence of ostracod valves in samples from all sediment types excavated thus far at JRD and the types of recorded taxa indicate that the sediments formed relatively continuously in the stagnant waters of a stable lake habitat (Mischke et al. 2014a; b). Most of the taxa from JRD are or were also present in the modern and pre-drainage water bodies of the Hula Basin. Thus, relatively similar shallow, freshwater conditions are inferred for the ancient water body at JRD. The presence of a few valves of taxa such as *Prionocypris zenkeri*, *Psychrodromus* sp., and *Humphcypris*

TABLE 6. MOLLUSK COUNTS AT JRD BY LAYER.

Sample No	17#1	17#2	17#3		17#4	17#6	17#5	
Layer	Layer 3a	Layer 3b	Layer 3c	Layer 4a	Layer 4b	Layer m4	Layer 5	Total
Theodoxus michonii	32	81	33	941	130	162	74	**1453**
Valvata saulcyi	-	-	6	90	99	153	36	**384**
Gyraulus sp.	-	-	-	-	-	2	3	**5**
Heleobia spp.	47	-	145	2556	-	2497	734	**5979**
Bithynia spp.	-	-	-	1653	142	692	103	**2590**
Melanopsis spp.	221	384	125	3418	399	366	159	**5072**
Unio spp.	563	79	79	405	145	20	183	**1474**
Corbicula spp.	9	120	1	-	-	-	-	**130**
Pisidium spp.	39	-	26	55	57	148	7	**332**
Total	**911**	**664**	**415**	**9118**	**972**	**4040**	**1299**	**17419**

subterranea suggests that springs and streams flowing from springs existed close to JRD at times when the lake level was low.

FLORA

Pollen

In total, 57 samples were collected for palynological investigation from the JRD sediment outcrop. Of these, ten are reported on in this preliminary study. Pollen extraction procedure followed a chemical treatment which was found to be successful in other nearby lacustrine sediments (Weinstein-Evron et al. 2015). Non-pollen palynomorphs such as algae were also identified (following Langgut 2018). In most samples, pollen was well preserved through the sequence. The assemblages are composed of trees typical of the Mediterranean forest/maquis, such as evergreen oak (*Quercus calliprinos* type), deciduous oak (*Quercus ithaburensis* type), pine (*Pinus*), and terebinth (*Pistacia*). In addition, small shrubs and herbs, predominantly from the aster (Asteraceae), goosefoot (Chenopodiaceae), and carrot (Apiaceae) families were recovered. The palynological spectra also include plants from the bank vegetation of Paleolake Hula such as reed (*Phragmites*) and sedge (*Cyperus*), and

Figure 14. Mollusks from JRD. a) Unio *shells in their natural position in Layer 4, b)* Unio *shells with color still preserved in Layer 4, c) Giant* Unio *shells in Layer 3c.*

Figure 15. Basalt slab found isolated in mud Layer M-3c (between Layers 3c and 4).

aquatic plants, e.g. watermilfoil (*Myriophyllum*) and barreed (*Sparganium*).

The lower part of the sequence, corresponding to the end of the Last Glacial period, is characterized by relatively low percentages of Mediterranean arboreal pollen (1.6–10.7%) and relatively high frequencies of sagebrush (*Artemisia*) and chenopods (up to 21.1% and 39.0%, respectively). These taxa are common in dry environments. Chenopods are also common in saline soils. Higher arboreal pollen values (up to 28.9%) and a profound decrease in sagebrush and chenopod values (not exceeding 4.8% and 9.3%, respectively), are documented in the upper part of the sequence, corresponding to the period of the deglaciation and the beginning of the Holocene.

Seeds and fruits

Samples of waterlogged sediment containing botanical remains from Layers 3a, 3b, 3c, and 4 were sorted for seeds and fruits. Seed and fruit remains were collected from 99 samples. This preliminary analysis yielded the remains of 25 seeds and fruits, some of which are charred. The preservation of most specimens is poor, and thus only nine items could be assigned to one of three taxa: wild almond (*Amygdalus communis* var. *korschinskii*), oak (*Quercus* cf. *calliprinos*), and wild barley (*Hordeum spontaneum*). All of these taxa are common in the vicinity of the site today.

Most of the identified remains (n=7) come from Layer 3c, while one derives from Layer 3b and one from Layer 4. A small piece (8.7mm) of almond stone (endocarp) from Layer 3c derives from *A. communis* var. *korschinskii* according to its diagnostic wall tunnels and grooved, irregularly pitted surface (Figure 17a). Today this Irano-Turanian species grows in open woodland, steppe-forest, and rock fissures and wadis in steppe environments (Danin 2004: 124). It is very common on the western slopes of the Hula Valley.

A well-preserved cupule (11.8mm x 11mm) that almost completely covered a young acorn was found in Layer 3b (see Figure 17b). The dimension and morphology of the cupule and the position of its scales suggest that it probably originated from Kermes Oak (*Q.* cf. *calliprinos*). Kermes Oak, the most common tree in the Mediterranean region of Israel, is the main component of maquis vegetation west of the Hula Valley. Two acorn-bases (hilum), one fragmented and one complete, were recovered but could not be identified to a specific oak taxon. The fragment was found in Layer 3c. The estimated diameter (16mm) suggests that it derived from a mature acorn. The complete base (8.3mm in diameter) was found in Layer 4.

Eight charred grass grains from Layer 3c were identified. Four of these are wild barley (*Hordeum spontaneum*) and the other four are still under study. *H. spontaneum*, the progenitor of cultivated barley, is very common in the Hula Valley and its surroundings today. In Israel, it grows in grasslands, bathas, abandoned fields, semi-steppe bathas, and sometimes in wadis in steppes and deserts (Danin 2004). Charred grains may represent food waste, but given many small fragments of charcoal at JRD, they may also mean that fires were fueled by a mixture of annual and perennial plants.

Charcoal

Charcoal is well preserved in all layers at JRD. Many of the layers are rich in small (up to a few mm in size) dispersed fragments. Larger pieces (up to a few cm in size) are also

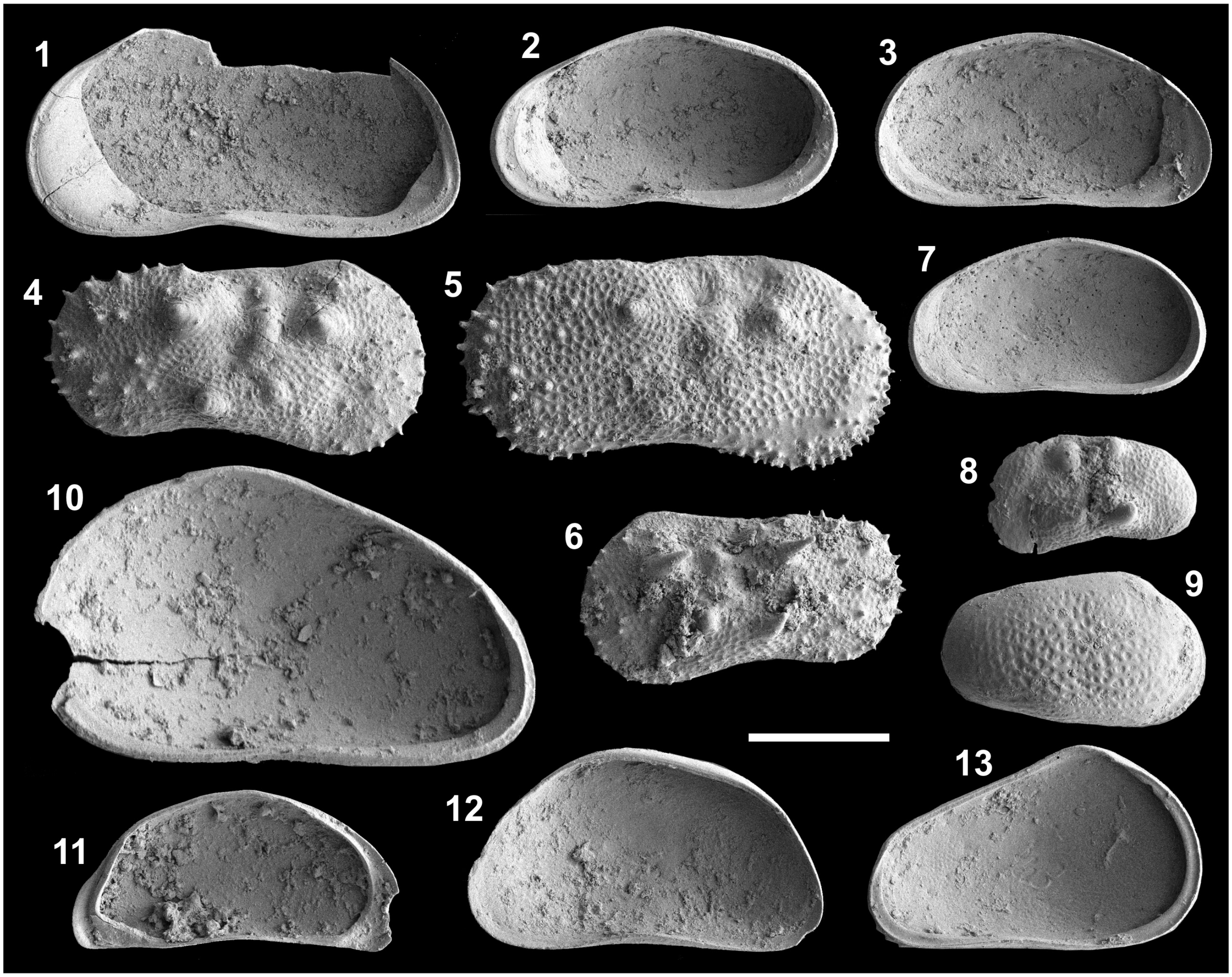

Figure 16. Ostracod valves of rare taxa recorded at JRD. 1) Psychrodromus *sp. right valve (RV) internal view (iv); 2-3) probably juvenile (juv)* Psychrodromus *sp., 2) RV iv, 3) left valve (LV) iv; 4-6)* Ilyocypris hartmanni, *4) juv RV external view (ev), 5) RV ev, 6) juv LV ev; 7) juv* Heterocypris incongruens *RV iv; 8) juv* Paralimnocythere *sp. LV ev; 9) juv* Gomphocythere ortali *RV ev; 10) juv* Trajancypris *RV iv; 11–12).* Potamocypris *sp., 11) LV iv; 12) RV iv; 13) juv Prionocypris zenkeri LV iv (scale is 0.5mm for 1–3 and 7, and 0.25mm for all other valves; specimens housed at Institute of Geological Sciences, Freie Universität Berlin [Germany]).*

found in most archaeological layers but are less common. Charcoal was recovered using a variety of procedures to assure good recovery. These included handpicking individual samples during excavation after recording their position with the aid of a total station, hand-picking from sediments excavated from 50cm x 50cm x 5cm sub-squares in the sieve, and hand-picking from water-sieved sediments sampled from selected excavation units.

To date, no well-defined concentrations of charcoal that could represent a hearth have been identified at JRD. This may be related to short occupation duration and/or to taphonomic factors related to fluctuations in the water level. The dispersed distribution of charcoal fragments suggests that fires were made near the shore of the lake when water levels had receded. Then, when the lake rose again, the water dispersed the charcoal remnants over a much larger area.

Work on the JRD charcoal is ongoing and a full report on the unique assemblage is forthcoming. In the meantime, a total of 1,043 charcoal fragments from five archaeological layers (3a, 3b, 3c, 4, and 5) covering the entire sequence of the site have been studied. Identifications were made using a reflected light optical microscope (Olympus BX41) with magnifications of 50x, 100x, 200x, 500x, and wood anatomy atlases (Fahn et al. 1986, InsideWood (2017–2018); Schweingruber et al. 2011).

The most ubiquitous and abundant taxa in all layers are *Salix* sp. (willow), *Quercus* sp. including deciduous oaks, and *Fraxinus* sp. (ash). Other identified taxa are *Ficus* spp. (fig), *Prunus* spp. (plums), Maloideae (pomes), *Ulmus* sp./*Celtis* sp. (elm/hackberry tree), *Fagus* sp. (beech), and Monocotyledon (reeds; Figure 18). The results indicate the

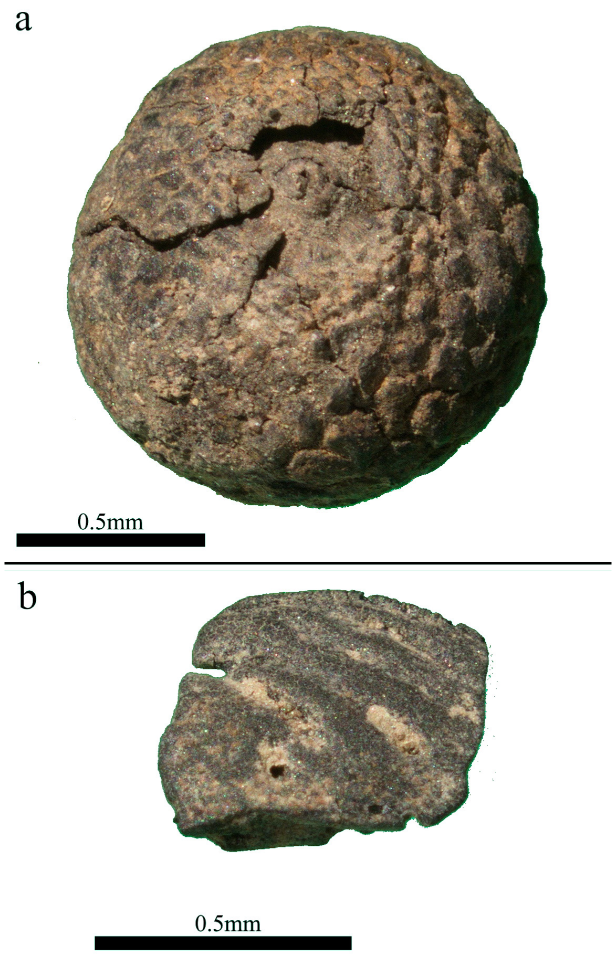

Figure 17. Fruit remains from JRD. a) endocarp fragment of Amygdalus communis *var.* korschinskii, *b) young acorn of Kermes Oak (*Q. *cf.* calliprinos*).*

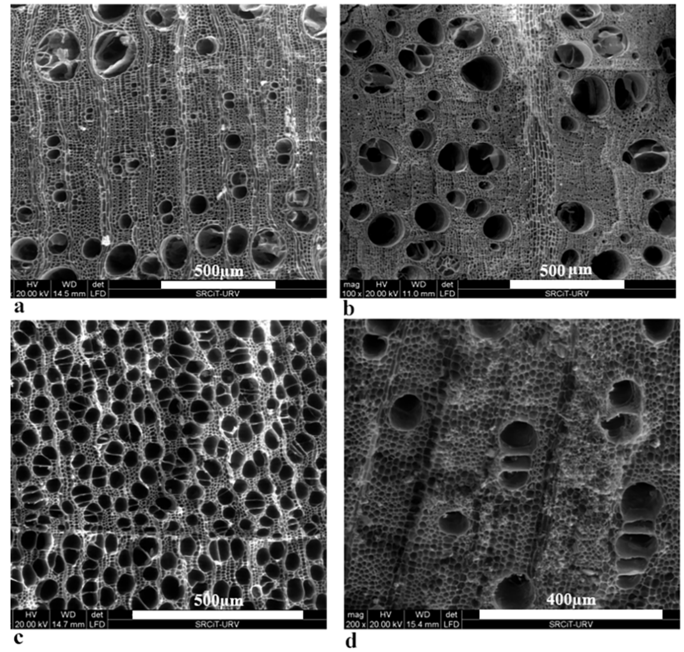

Figure 18. Images of transverse sections of most common taxa identified at JRD. a) transverse section of Fraxinus *sp. charcoal fragment showing ring porosity and paratracheal parenchyma in latewood small pores, b) transverse section of* Quercus *sp. deciduous charcoal fragment showing ring-porous and uni and multiseriated rays, c) transverse section of* Salix *sp. charcoal fragment showing diffuse pores with mostly isolated pores and uniseriated rays, d) transverse section of* Ficus *sp. charcoal fragment showing pores isolated or in small groups and banded parenchyma.*

constant presence of emerged plants such as reed and arboreal plants including willow and ash near the shore. This is strongly corroborated by the microvertebrate, mollusk, micro-crustacean, and palynological record that also indicate the existence of a permanent waterbody in the Hula Basin. Local forests were composed of deciduous oaks as well as smaller trees and shrubs and were present from the Late Glacial period until the end of the deglaciation. The rate of spread of these forests was likely constrained both by the environment and human action. Future analysis will provide insight into past vegetation and its change over time, as well as fuel management by the humans occupying the site.

HUMAN REMAINS

This preliminary report concerns only the human remains recovered during the 2015 excavation season. These include a mandible and tibia found within a reddish oxidized sand rich in *Melanopsis* shells in squares N100 and N101 of Layer 3a. This part of the site is stratigraphically complex and further research into the context and chronology of the human remains is needed. A broken femur, a metacarpal, and four teeth were exposed in the same layer (Figure 19), but are still under study. All human bones were found within the same archaeological horizon and likely derive from the same young individual. Nevertheless, the bones were broken and dispersed over $10m^2$ suggesting that a burial was disturbed in antiquity.

Both sides of the mandible were recovered but each lack the mandibular ramus, the dental arcade, and the inner alveolar corpus (Figure 20a). The mandibular body is 5.5cm long with a pronounced mental protuberance. No pathologies are apparent on the bone. The small size of the mandible and the gracile appearance of the mental eminence (score 2 according to Buikstra and Ubelaker [1994]) indicate that the mandible belonged to a gracile female adult or a young adolescent of unknown sex. The tibia is represented by a left mid-shaft fragment (see Figure 20d) measuring 22cm in maximum length. It is gracile with thin cortical bone, suggesting that it belonged to a young individual. No pathologies are visible. The size of the mandible and tibia suggest that they could have derived from the same individual.

FISHING TECHNOLOGY

Many of the finds excavated at JRD suggest that fishing was an important activity throughout the use of the site. Among these, fish bones, bone fishing hooks, limestone

Figure 19. Human remains from JRD. a) mandible, b) tibia.

line weights, and net sinkers provide the most obvious evidence.

Fish Hooks

The most significant evidence for fishing recovered from JRD thus far (at the end of the 2019 season) are 18 bone fish hooks. Seven of the hooks are complete and the other eleven are fragments representing different parts of the hook (see Figure 20 a-d). The hooks all derive from Natufian Layers 3a and 3b. The great majority of the hooks were found during the sorting of water-sieved sediments in the field and lab. The hooks are made of bone and demonstrate high-quality workmanship. Each hook is unique in its shape, size and design. Still, it is clear that all were shaped so that they could be tied to a fine rope for line fishing. Bone fish hooks are known from a few Natufian sites in the Levant, including one complete and two nearly complete examples from the Natufian layers of Kebara Cave (Turville-Petre 1932) and numerous fragments from Eynan (Valla et al. 2007). The Neolithic coastal site of Atlit Yam also yielded evidence for bone-fish-hook use (Galili et al. 2004; 2013).

Net Sinkers and Line Weights

The most common lithic objects from JRD are basalt and limestone cobbles and pebbles, distributed across all archaeological horizons. Sedimentological and archaeological evidence including the size and shape of the stones and their recovery from fine-grained sediments deposited in a low-energy aquatic setting indicate that most, if not all, of these stones were brought to the site by humans (see Figures 8 and 9). Some of the largest basalt stones in the archaeological horizons could have been used as anvils or working surfaces. However, the size, morphology, and modification of the vast majority of the limestone and basalt cobbles suggest that they were brought to be used as line weights or net sinkers. Unlike the limestone, the basalt cobbles and pebbles rarely show evidence for further shaping, in an attempt to form net-sinkers. Only two basalt cobbles were notched to produce a net-sinker form. Hence, the following discussion focuses on the limestone artifacts.

Across the intermittent archaeological sequence at JRD, large numbers of elongated limestone cobbles of similar size (~15cm in length) and shape were selected and brought to the site. Some of these elongated cobbles show no evi-

Figure 20. Fishing gear. a-d) bone fish hooks from Layers 3a and 3b, e-f) limestone line weights, g) basalt line weight.

dence of modification, possibly because their natural shape was suitable for use. Others were modified with a notch at the center of one, or both lateral edges (Figure 21a). Many of the limestone cobbles are unmodified, but because they are of similar size and weight as the modified cobbles, they were clearly imported to the site, and appear in the same contexts as similar modified pieces, these were likely also used as weights. The selection and import of "standardized" cobbles, the presence of lateral, and in many cases opposed notches (see Figure 21a) on a number of the stones, and their long-term use across the duration of the site suggest that they were used as net sinkers (Nadel and Zaidner 2002; Rosenberg et al. 2016). Future study of microwear on the artifact surfaces will investigate potential activities. The elongated limestone cobbles were probably collected from the alluvial fans of one of the streams running into the Hula Valley from the west. For example, abundant similar cobbles were observed from the Nahal Dishon fan near Kibbutz Ayelet Hashahar, some 5km west of JRD.

The limestone net sinkers are found in all archaeological layers at JRD, but they are most common in Layers 3c and 4. A preliminary study of close to 200 of these stones indicates interesting differences in the frequency of notched specimens in Layers 3c and 4. Seventeen of the 39 (43.5%) studied cobbles in Layer 3c were notched on their lateral edge while only 14 of the 134 net sinkers (11.6%) in Layer 4 were notched. The modification of net sinkers during the Natufian was much more intensive than in the earlier Geometric Kebaran.

In the southern Levant, net sinkers were first reported at the Early EP site of Ohalo II (n=47), (Nadel and Zaidner 2002). These objects are also abundant in Neolithic sites such as Sha'ar Hagolan and Beisamoun, the latter containing the largest assemblage (n=96) reported from the Levant until now (Rosenberg et al. 2016). The net sinker assemblage collected from JRD thus far is notably larger, numbering more than 1,000 artifacts at the end of the 2018 excavation season.

Of additional interest are a group of five small round pebbles, three made of limestone and two of basalt, from the Natufian layers of JRD. These pebbles have clear grooves running around their circumference (see Figure 20 e-g). Their small size and weight suggest that they were line-weights for fishing rods. Similar artifacts are known from the Natufian site of Eynan at the northern edge of the Hula Valley (e.g., Valla et al. 2004: 215; 2007: 359).

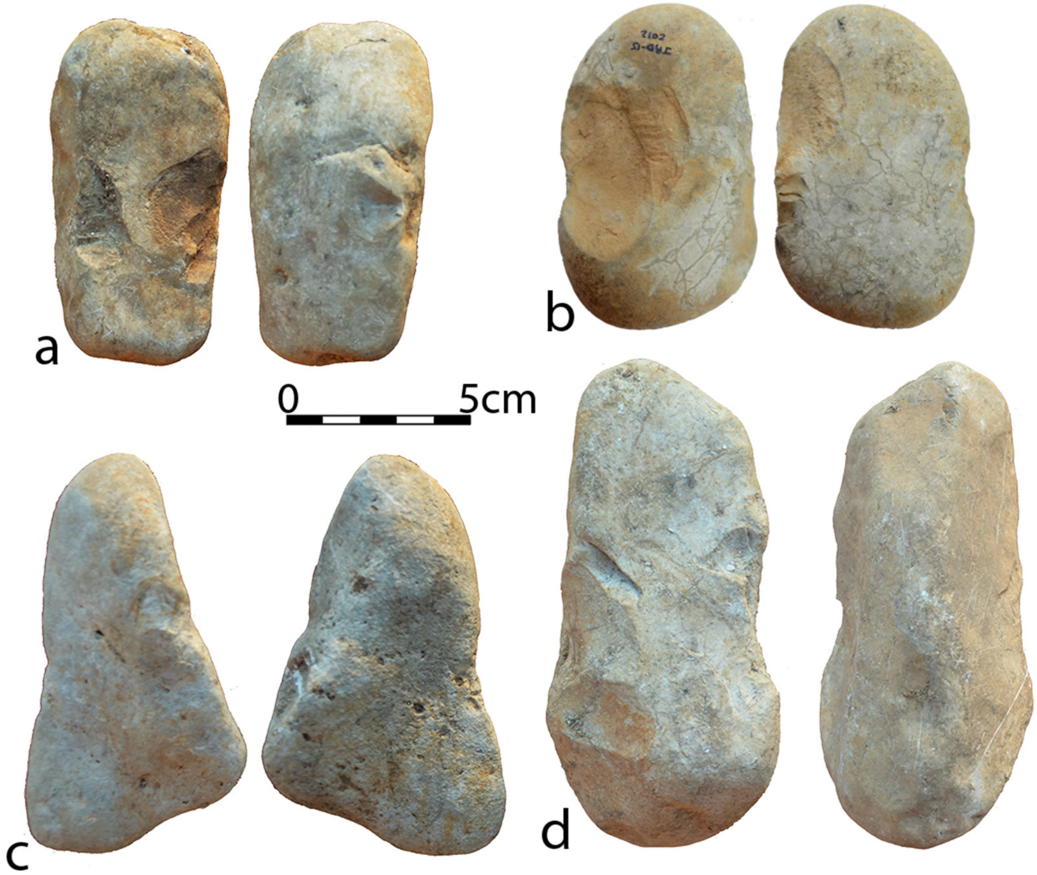

Figure 21. Limestone tools from JRD. a) limestone net sinkers, b) limestone flat and rounded "medallions."

DISCUSSION AND CONCLUSIONS

The long chronological sequence and the unique preservation of organic materials at JRD provide a dynamic record of human socioeconomic adaptations and their relationship to local environmental conditions. Our preliminary analyses indicate that for more than 10,000 years, people returned to the same spot on the southern edge of Paleolake Hula to fish, hunt, and engage in other activities. Despite the consistent use of the site as an intermittent, short-term location, environmental proxies and technological and subsistence evidence reveal important details about paleoenvironment, human activities, and occupation intensity within the JRD sequence.

The lithic assemblages and the radiometric data suggest that the uppermost archaeological horizon at the site, Layer 3-0, dates to the very beginning of the Holocene while Layers 3a, 3b, and 3c yield typical Natufian flint tools. Layer 4 artifacts are ascribed to the Geometric Kebaran of the Middle EP, and Layer 5 is assigned to the yet undefined Early EP cultural entity. Although limited, Layer 6, located some 80cm below Layer 5, is dated to slightly older than 20,000 cal BP. Hence, although occupation was intermittent, the stratigraphic sequence exposed at JRD covers 10,000 years and almost the entire span of the Levantine EP. Sites documenting most of the EP sequence are rare in the southern Levant. To date, only the open-air sites of Ein Qashish in the Jezreel Valley (Yaroshevich et al. 2016), Hefzibah (Bar-Oz and Dayan 2003; Ronen et al. 1975) on the coastal plain, and the Mediterranean cave site of Raqefet (Lengyel 2007; Nadel et al. 2013; Yeshuron et al. 2013) have produced industries from three EP cultures.

The stratigraphic sequence of JRD is comprised of alternating layers of silt and near-shore sediments. The sediments were mostly accumulated in the shallow waters of Paleolake Hula, which by 10,000 years ago extended more than 2km south of its historically documented boundaries. Alternating layers of shell-rich and shell-poor sediments indicate fluctuations of the lake level over time. These fluctuations did not occur on an annual scale, but represent longer cycles of changing hydrological conditions that in some cases may have lasted hundreds to thousands of years.

Not surprisingly, the archaeological layers excavated so far at JRD coincide with short periods of exposure of near-shore sediments during low-water events. The character of the lakeshore environment influenced many aspects of the archaeological horizons. For example, the wealth of mollusk shells in these layers are typical of near-shore environments where shells tend to accumulate in large numbers. Likewise, the absence of well-defined hearths in the archaeological horizons and the abundant, but random distribution of small charcoal fragments may be explained by the redistribution of the remnants of the hearths by water when lake levels rose and covered the site.

JRD is unique among EP Levantine sites in the outstanding quality of preservation of organic remains. The water-logged sediments have enabled recovery of exceptional assemblages of charcoal, wood, seeds, fruits, pollen, and many other organic remains. Such remains are poorly preserved in contemporary sites (Belfer-Cohen and Goring-Morris 2013; Goring-Morris and Belfer-Cohen 2017). Preliminary study of the charcoal, pollen, ostracod, and mollusk remains confirms that JRD occupied a complex setting close to wetland habitats around Paleolake Hula. However, shifts in relative plant abundance across the stratigraphic sequence also signal environmental changes within this sequence. Most of the plant remains recovered from JRD belong to species that grow in the Hula Valley today. Our understanding of the modern habitat preferences of these species will form the foundation for more detailed environmental reconstructions to follow. The residents of JRD also had access to a variety of other resources, especially aquatic types. Some of these—mollusks, turtles, and crabs—are abundant and may have been consumed by humans.

Flint tools are not abundant in the JRD lithic assemblages, especially in comparison to other EP sites in the region (Valla et al. 2004; 2007). Typical tool types, such as backed vs. Helwan lunate microliths in the Natufian Layers 3a to 3c and geometric microliths in Geometric Kebaran Layer 4 are highly indicative, but larger samples are required before cultural affiliations can be validated. The flint tool assemblages at JRD are also unique among EP sites in their typological composition, especially the high frequency of burins in some layers. This may reflect specific activities executed at the site. Limestone artifacts, many of which have been classified as net sinkers, are also common in all archaeological horizons (Nadel and Zaidner 2002; Rosenberg et al. 2016). In fact, the JRD net sinkers are by far the largest collection of such tools in the Levant. Other limestone artifacts, including possible hammerstones, flakes, and knapped items are also abundant at JRD, but their function is not yet fully understood. Basalt artifacts, mainly flakes and partially worked cobbles, are also found in all layers. Of these, the broken grinding implements (grinding stones and pestles) are most notable. Such broken artifacts may have been recycled and used as weights at JRD.

The technological remains from JRD reflect numerous activities. A bone sickle blade haft and flint blades bearing sickle polish suggest plant harvesting, potentially of cereals for food or wetland plants that may have been used to build traps or fishing lines (e.g., Dounias et al. 2016). More importantly, multiple lines of evidence suggest that fishing was a central activity at JRD. The EP residents deposited the remains of fish and fishing technology in all archaeological horizons at the site. Fish are the most common taxon in the assemblage studied so far, in terms of NISP, although these were likely deposited by both natural and cultural processes. The technological data evidence the use of multiple fishing strategies including, at minimum, line and hook, and net fishing (Nadel and Zaidner 2002; Rosenberg et al. 2016). The diverse fish bones range in size from tiny fish to the giant, 2.5m long carp of Paleolake Hula (Marder et al. 2015; Zohar and Biton 2011).

The fishing gear shows technological evolution across the sequence at JRD. Together, the limestone net sinkers, fish hooks, small weights, and fish bones allow us to trace changes in fishing strategies. The net sinkers are evidence for the use of sophisticated fishing techniques from the very beginning of the occupation. Nevertheless, in the Early EP Layer 5 the net sinkers are simple imported cobbles of similar size and weight and generally lack any modifications such as incising or notching. More advanced technology emerges as time progressed, starting with the appearance and rise in the number of worked (notched) sinkers. This trend continues into the Natufian, when sophisticated bone fish hooks first appear. The fish hooks are found only in the Natufian layers of the site and demonstrate a high level of knowledge, dexterity, and sophistication. Small grooved line weights are also limited to the Natufian layers and provide further support that line and hook fishing was only used later in the sequence. Preliminary analysis of the fish remains reveals differences in the relative abundance of fish taxa and body parts in Layers 3, 4, and 5. Future research will evaluate the role of natural and cultural accumulation and relate changes in human collected fish to technological change.

The density of archaeological remains at JRD also fluctuates over time. The sparse archaeological record in Layer 3c, the lower Natufian horizon, suggests short visits of a task-specific nature—particularly fishing and hunting. On the other hand, evidence for more diverse activities in more discrete localities within Layer 3a suggests more intensive activity, potentially including the modification of the living surface to create structures and human graves. The nature of occupation in Layer 5 is less well understood, despite the fact that artifacts are more concentrated here than in many other areas of the site. The layer was exposed in a limited area and was not entirely excavated to its maximal depth in all squares (see Figure 10). Additional sedimentological and archaeological analysis is needed before we can determine the nature of Layer 5 accumulation and the role of human agency. The differences in the density of the archaeological remains likely reflect the changing intensity and range of human activities practiced at the site, within the larger context of population mobility and socioeconomic change. Despite variability in the intensity of site use, the low density of artifacts and the artifacts represented indicate that JRD served as a locale for specific, short-term activities throughout the duration of its use—i.e., as a fishing and hunting locality within a broader residentially mobile settlement pattern (Binford 1980). Though some visits were longer and more intensive, especially in the Natufian, this was never a sedentary site. JRD was obviously a "persistent place" on the EP landscape (Olszewski and al-Nahar 2016), a place to which people returned again and again to take advantage of the confluence of diverse aquatic and terrestrial resources, abundant water and other attributes that will be illuminated as investigation of this unique archaeological site continues.

The ephemeral, intermittent occupation of JRD, in combination with a large repertoire of tools and other material culture classes, suggests that JRD was a task-specific site where certain activities were performed repeatedly for 10,000 years. Traces of hunting and fishing activity can be observed in all layers in the sequence, allowing us to track the evolution of technology and subsistence strategies. Clear continuity is observed in the use of similar net sinkers for thousands of years. At the same time, the increase in the number of worked net sinkers and the innovation of new, more sophisticated fishing methods, exemplified by the bone fish hooks, reflects technological evolution across the EP. A rich array of aquatic and terrestrial resources including fish, clams, crabs, birds, mammals, and, in particular, water plants, with both subsistence and technological utility are represented at the site.

In conclusion, the preliminary results from JRD, the exceptional state of preservation and the short-term, task-specific nature of the site have shown its potential to address gaps in our knowledge of human-environment interactions at a time of some of the most significant cultural and environmental changes in human history. Continued study of the material from JRD will allow much more detailed, quantitative assessments of these issues in a series of upcoming publications.

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