INTRODUCING MISLIYA CAVE, MOUNT CARMEL, ISRAEL: A NEW CONTINUOUS LOWER/MIDDLE PALEOLITHIC SEQUENCE IN THE LEVANT

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Abstract

Misliya Cave, Mount Carmel, Israel, contains a rich Middle Paleolithic faunal and lithic assemblage. Archaeological deposits extend over a fairly large area and go down to an equally promising depth. Bones appear to be well preserved and some spatial differentiation in both lithic and faunal assemblages could be demonstrated. Significant, furthermore, is the occurrence of Lower Paleolithic (Acheulo-Yabrudian) stratified layers. Results of this study may enable conclusions regarding formation and depositional processes at the site, and the length and duration of its occupation. The Middle Paleolithic assemblages were defined as “Tabun D-type” (or “Abu-Sifian”), based on the unipolar convergent flaking, abundance of elongated Levallois items (blades and points) and presence of elongated Mousterian (“Abu-Sif”) points. The obtained luminescence date (130±33 ka) is a minimum age due to signal saturation. Location of brecciated layers and configuration of the enclosing walls suggest a gradual step-wise recess of the cave’s ceiling. Taphonomic observations show depletion of soft skeletal parts reflecting the effect of attritional processes. As no surface modifications were found and evidence of carnivore activities was absent, it would appear that bones were transported principally by the site’s inhabitants. This is supported by micromorphological analysis of the lithified layers which suggests integration of anthropogenic residues and post-depositional cementation.

INTRODUCTION

Misliya Cave (also known as Brotzen Cave, Brotzen and Baumgartel, 1927; Olami, 1984), is located on the western slopes of Mount Carmel, slightly to the south of Nahal (Wadi) Sefunim, some 12 km south of Haifa and 7 km north of Nahal Me’arot (Wadi el Mugarah) and the caves of Tabun, Jamal, el-Wad and Skhul (Fig. 1). The site has not been excavated previously, but surface collections suggested that it contains Lower and Middle Paleolithic lithics (Olami, 1984; Weinstein-Evron and Kaufman, 1998), as well as identifiable faunal remains (Olami, 1984). While the Middle Paleolithic material had not been assigned to any specific “Tabun” industry, the limited Lower Paleolithic assemblages exhibited Yabrudian affinities (Olami, 1984). A preliminary survey at the site found brecciated, archaeological layers widely exposed on the slope below the cave with well-preserved bone fragments easily observable in the sediments (Olami, 1984; Weinstein-Evron and Kaufman, 1998). A geophysical investigation recently conducted on the Upper Terrace of the site (Weinstein-Evron et al., in
press) indicated that the lithified, prehistoric sediments are preserved to a depth of ca. 4 meters in its north-central portion. These findings suggest the potential existence of a long, continuous Lower to Middle Paleolithic sequence, much like that at Tabun (Garrod and Bate, 1937; Jelinek et al., 1973). In addition, the preservation of bones enhances the feasibility of a detailed archaeozoological and taphonomic study. The history of research in the region and especially the fact that there is probably no other site in the area where an opportunity to expose such a sequence still exists aroused new interest in the site and the initiation of a pilot excavation.

The pilot research presented here was conducted in winter-spring 2001 in order to determine the extent of the archaeological layers at the site, their cultural content, and the condition of any preserved bones. More specifically, the trial excavation aimed at a preliminary mapping of the breccia exposures, excavating selected squares, initial sorting of the finds, preliminary taphonomic and archaeozoological analyses, and sampling for radiometric dating.

**THE SITE AND TRIAL EXCAVATION**

Misliya Cave is located in the northwestern Mount Carmel, at an elevation of ca. 95 m a.s.l. within the reefal Muhrqa limestone formation of Turonian age (Bein and Sass, 1980). To the north and east of the reef, various Upper Cenomanian marls and limestones, chiefly of the Shamir Formation, are exposed on the surface (see below). To the south, marls and limestone of the Dalia Formation, dated to the Upper Turonian, are widespread. Senonian and Eocene sedimentary rocks occur in the Ramat Menashe area which borders Mount Carmel from the southeast. Of these formations, Shamir, Khureibe, and Isfiya are rich in high-quality, exploitable flints.

Today the site appears as a rock shelter or overhang, carved within a rudistic reef. However, its form, together with the remnants of enclosing walls and the numerous boulders along the slope, suggests that it is a collapsed cave. The reefal cliff at Misliya, facing W/ SW, is ca. 10–15 m high, with three major niches (Figs 2, 3a). The northern and southern niches are covered by massive flowstones, whose deposition is clearly associated with the inundation of the cave by carbonate rich water. Water is still dripping in the southern niche, which is ca. 2 m above the surface of the site, and to a lesser degree in the eastern niche, suggesting that in these parts of the site karstic processes remain active. Strongly cemented archaeological sediments (breccia) are found on an upper, flat terrace-like surface, ca. 10–15 m wide, at the base of the cliff. From the Upper Terrace the surface of the site slopes to the SW in a series of geomorphic steps. In the NW area, another brecciated surface has been tentatively defined as a Lower Terrace (Fig. 2). Other in situ breccia exposures are observable further down, up to ca. the 35 m line. At a distance of ca. 30 m below the surface of the Upper Terrace, the talus slope descends to the Carmel coastal plain. Blocks of breccia, in various sizes, removed from their in...
situ original locations, are scattered along the terraced slope.

Our field survey suggests that the brecciated layers on the Upper Terrace cover an area of ca. 100 m² in front of the rock cliff and indicates the occurrence of a vertical, natural exposure within the breccia, some 1.5 m high, separating the Upper Terrace from the lower one (Fig. 2). This exposure, which is 30 m in length, shows continuous breccia in the northern part of the site and the existence of only isolated lumps of breccia in the south. In order to assess the vertical differentiation of the layers, an excavation was conducted on the Upper Terrace, within the exposed section,
Fig. 3. Misliya Cave – reeval cliff and site. a) The Misliya cliff and the various niches (a view from the west). Arrows indicate the northern, eastern and southern niches, from left to right, respectively. b) The Upper Terrace of Misliya Cave before excavation (viewed from the south). The white rope designates the N grid line. Note the collapsed rocks at the bottom of the picture. At the upper part, the white areas are the hardened surface of the brecciated layers that are exposed underneath the surface sediments. c) The brecciated layers exposed underneath the surface soil in squares N22–N26, within the Lower Terrace.
and on the Lower Terrace. Observations on the stratigraphy and lithology of the existing exposure, as well as that of a lump of isolated breccia in square N34, located ca. 10 m below the surface of the Upper Terrace, provided a better understanding of the site formation processes that occurred during (and following) the time of occupation.

The trial excavation was conducted in six squares (Fig. 2), from the center of the cave (squares N11–N13), the northern part of the Upper Terrace (H16), the section separating the two terraces (O17), and the Lower Terrace (R19). An additional square (N34) was excavated within the lowermost exposure of the in situ archaeological breccia, some 10 m down slope. Due to the hardness of the lithified layers, only samples from the upper layers have been excavated thus far. The excavation and exposure of in situ artifacts from the brecciated layers was performed by using an industrial electric hammer (Bosch GBH 2-24 DFR), as we found that using this ostensibly more destructive tool resulted in less breakage than caused by a hand hammer and chisel, or small, personal electric hammers. Excavation was conducted in 5 cm spits. When possible, information regarding vertical and spatial location was gathered.

Taphonomic observations were documented while the bones were still in situ. All the retrieved sediments, by now in fragments of breccia in various sizes (not exceeding 10 cm in diameter), were transferred to the laboratory for further extraction of flints and bones using hand hammers and chisels. For the extraction of yet smaller chips, selected sediment samples were submerged in diluted (5%) HCl solution (to extract flints) or 5% acetic acid (to extract bones). Bone fragments with new, excavation fragments were not included in the analysis.

The excavation unearthed Middle Paleolithic assemblages in all areas. In square N34 the occurrence of Lower Paleolithic sediments could be tentatively suggested. Although the excavated sediments represent only a small portion of the site, several observations can be noted. All of the excavated sediments are rich in lithics and bones. In square N11, for example, where ca. 0.2 m³ of sediments were excavated, some 2,200 flint implements (including chips and chunks) and 204 bones (excluding splinters smaller than 10 mm in length) were recovered. In square H16, further to the north, 1,460 flint implements and 143 bones were unearthed. Many of the flints and bones exhibit signs of burning.

THE LITHIC ASSEMBLAGE

The lithic assemblage of Misliya can be roughly divided into two main units. A Levallois-Mousterian assemblage was derived from the Upper and Lower Terraces and a probable Lower Paleolithic assemblage was retrieved from the topographically lower part of the site (square N34).

Some 5,200 artifacts were unearthed from the various excavation units. These were derived from less than one cubic meter of sediments excavated to date, suggesting that the site is both rich and dense in finds. Most of the pieces (3,621) are chips and chunks (Table I). Tools (retouched pieces and Levallois products) constitute about 8% of the assemblage.

The Upper Terrace assemblages

The composition of the Middle Paleolithic assemblages is presented in Table I. To facilitate the identification of spatial variations within the site, assemblages from the northern part of the Upper Terrace near the cave wall (square H16) and samples from the central part (squares N11 and O17) were analyzed separately.

We found no essential differences in lithic preservation between the two parts of the Upper Terrace. Both areas are characterized by extremely sharp and mostly unpatinated flint artifacts. The percentages of broken pieces are also similar (52% near the wall and 48% in the middle part of the cave).

The two assemblages, from the northern and central parts of the Upper Terrace, exhibit a similar frequency of flakes (34.7% and 23.6% respectively), which constitutes the main element (excluding debris). However, they differ in the frequency of blades, which are rather abundant in the central part of the cave, where they account for 4.6% of the assemblage. Tool percentages are rather similar (1.7–1.9 %), while cores (0.2–0.3%) are scarce.

Typology

The typological classification of the assemblage is based on Bordes’ list (1961), which is
Breakdown of the Misliya Cave lithic assemblages

<table>
<thead>
<tr>
<th></th>
<th>Northern area</th>
<th>Central area</th>
<th>Total</th>
<th>%</th>
<th>N34</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(H16)</td>
<td>(N11, O17)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tools</td>
<td>26</td>
<td>63</td>
<td>89</td>
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<td>4</td>
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<tr>
<td>Cores</td>
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<td>10</td>
<td>13</td>
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<td>2</td>
</tr>
<tr>
<td>Blades</td>
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<td>144</td>
<td>169</td>
<td>3.7</td>
<td></td>
</tr>
<tr>
<td>Flakes</td>
<td>506</td>
<td>734</td>
<td>1240</td>
<td>27.1</td>
<td>132</td>
</tr>
<tr>
<td>CTE</td>
<td>3</td>
<td>9</td>
<td>12</td>
<td>0.3</td>
<td>0</td>
</tr>
<tr>
<td>Burin spall</td>
<td>0</td>
<td>4</td>
<td>4</td>
<td>0.1</td>
<td>0</td>
</tr>
<tr>
<td><strong>Sub-total</strong></td>
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<td><strong>964</strong></td>
<td><strong>1527</strong></td>
<td></td>
<td><strong>138</strong></td>
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<tr>
<td>Chunks</td>
<td>111</td>
<td>354</td>
<td>465</td>
<td>10.2</td>
<td>38</td>
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<tr>
<td>Chips</td>
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<td>1798</td>
<td>2584</td>
<td>56.5</td>
<td>534</td>
</tr>
<tr>
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<td><strong>1460</strong></td>
<td><strong>3116</strong></td>
<td><strong>4576</strong></td>
<td></td>
<td><strong>710</strong></td>
</tr>
</tbody>
</table>

Table 1

routinely adapted, with minor modifications, to typological descriptions of Lower and Middle Paleolithic sites in the Levant (e.g., Ronen, 1974, 1984; Goren-Inbar, 1990; Hovers, 1997; Chazan, 2000). A summary typological list of the assemblages is presented in Table 2.

Levallois products (Fig. 4: 1–6; Fig. 5: 3, 4; 46.2% and 36.5% in the northern and central areas respectively) constitute the main typological component of the assemblage, followed by sidescrapers (Fig. 4: 7, 9; 15.4% and 14.3%). Naturally backed knives (7.7–7.9%) and retouched pieces (7.7–20.6%) are relatively abundant in both areas. Other tool types are represented in small numbers.

Worth noting is the occurrence of elongated Mousterian (“Abu-Sif”) points, made on long blades, with regular, stepped retouch on two edges (Fig. 4: 8). Blades with similar dimensions and retouch have been recently described from the lower layer E at Hayonim Cave (Meignen, 1998, 2000). Similar items are also known from Abu-Sif (Neuville, 1951), Hummel (Copeland, 1985), and Tabun Unit IX (Meignen, 1998, 2000).

Comparison between the two areas shows a prevalence of elongated pieces in the central part of the cave. Moreover, only two (7.7% of the tools) Levallois points were found in H16 compared to 9 (14.3%) in the central part of the cave (8 in N11, for example). Mousterian points and retouched blades were completely absent from the area near the wall, while in the central area blades were the main blank type for tool production (43.5% of the tools in square N11, for example).

Technology

The technological analysis of the Misliya assemblages is still in its initial stage. Nevertheless, some preliminary remarks can be made. The Levallois method appears to have been widely used at Misliya. Cores are rare, with only two small, exhausted Levallois cores (Fig. 5: 5, 6) with radial preparation, unearthed to date.

Amongst the Levallois blanks, flakes and points are the most common. Most of the Levallois points are elongated; very few are broad-based, short items. Their preparation is usually unipolar convergent. Butts are commonly carefully prepared. Levallois flakes are usually triangular, contributing to the rather elongated, pointed appearance of the industry; some are bipolar and only one shows a clear radial preparation.

Blades are outnumbered by flakes in the entire assemblage. However, they are carefully prepared and the number of tools that were made on blades is much higher than the relative frequency of blades in the industry. For example, in square N11 43.5% of the tools were made on blades,
Typological composition of the Middle Paleolithic assemblage at Misliya Cave

<table>
<thead>
<tr>
<th></th>
<th>Northern area</th>
<th></th>
<th></th>
<th>Central area</th>
<th></th>
<th></th>
<th>N34</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N</td>
<td>%</td>
<td>N</td>
<td>%</td>
<td>N</td>
<td>%</td>
<td></td>
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<tr>
<td>Levallois flake</td>
<td>9</td>
<td>34.6</td>
<td>8</td>
<td>12.7</td>
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<td></td>
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<tr>
<td>Levallois blade</td>
<td>1</td>
<td>3.8</td>
<td>3</td>
<td>4.8</td>
<td></td>
<td></td>
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<td>1</td>
<td>1.6</td>
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<tr>
<td>Levallois point</td>
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<td>7.7</td>
<td>9</td>
<td>14.3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
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<td>0.0</td>
<td>2</td>
<td>3.2</td>
<td></td>
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<tr>
<td>Mousterian point</td>
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<td>0.0</td>
<td>2</td>
<td>3.2</td>
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<tr>
<td>Sidescrapers</td>
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<td>14.3</td>
<td>3</td>
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<td>1.6</td>
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<td></td>
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<td>Nat. backed knife</td>
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<td>7.9</td>
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<td></td>
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<tr>
<td>Truncations</td>
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<td>3.2</td>
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<tr>
<td>Notches</td>
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<td>1.6</td>
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<td></td>
</tr>
<tr>
<td>Retouched flake</td>
<td>2</td>
<td>7.7</td>
<td>6</td>
<td>9.5</td>
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<td></td>
<td></td>
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<tr>
<td>Retouched blade</td>
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<td>7</td>
<td>11.1</td>
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<td></td>
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<tr>
<td>Items with use signs</td>
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<tr>
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<td>0.0</td>
<td></td>
<td></td>
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</tr>
<tr>
<td><strong>Total</strong></td>
<td>26</td>
<td></td>
<td>63</td>
<td></td>
<td>4</td>
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<td></td>
</tr>
</tbody>
</table>

while blades account for only 17% of the blanks. Here, too, differences between the northern and central parts of the Upper Terrace are evident, with higher blade ratios and significantly higher proportions of tools on blades in the latter.

Blades were detached from unipolar cores and have well-prepared butts. Similar blades, detached from Levallois cores, were reported for Tabun Unit IX (Jelinek, 1981). However, non-Levallois blade production has been reported from other Middle Paleolithic assemblages (Meignen, 1994, 1998, 2000 and references therein). The thick triangular sections of some of the Misliya blades may suggest the use of non-Levallois blade production methods. Another possible indication for the use of non-Levallois methods is crested blades, two of which were found at the site (Fig. 5: 2).

Although the blades are relatively large (50–120 mm in length), the blade cores are small (Fig. 6: 1–3). The lengths of four cores, carrying obvious bladelet scars, range between 40–60 mm; three show one striking platform and the fourth has two opposite striking platforms. One of the bladelet cores was found in square H16 and the other three in the central part of the cave. (Similar core forms are sometimes referred to as burins; cf. Garrod and Kirkbride, 1961.)

Another, relatively common, Levantine Middle Paleolithic core type is the “truncated faceted” piece first recognized by Schroeder (1969) in the northern Levant and later named Nahr Ibrahim truncation, after the type-site (Solecki and Solecki, 1970). This method has since been identified in other Lower and Middle Paleolithic sites in the Levant (e.g., Goren-Inbar, 1988, 1990; Hovers, 1997; Chazan, 2000). Of the four Nahr Ibrahim cores found at Misliya, only one is complete.
Fig. 4. Middle Paleolithic flint artifacts from the Upper Terrace of Misliya Cave: 1–3, 6 – Levallois points; 4, 5 – Levallois flakes; 7, 9 – sidescrapers; 8 – Mousterian ("Abu-Sif") point
Fig. 5. Middle Paleolithic flint artifacts from the Upper Terrace of Misliya Cave: 1, 5, 6 - cores; 2 - crested blade; 3, 4 - Levallois blades
Fig. 6  Middle Paleolithic cores from the Upper Terrace of Misliya Cave
Table 3

<table>
<thead>
<tr>
<th></th>
<th>Northern area</th>
<th>Central area</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N</td>
<td>%</td>
</tr>
<tr>
<td>Indeterminate</td>
<td>292</td>
<td>52.1</td>
</tr>
<tr>
<td>Plane</td>
<td>173</td>
<td>30.9</td>
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<tr>
<td>Cortical</td>
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<td>0.5</td>
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<tr>
<td>Dehidual</td>
<td>14</td>
<td>2.5</td>
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<tr>
<td>Facette</td>
<td>46</td>
<td>8.2</td>
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<tr>
<td>Convex</td>
<td>32</td>
<td>5.7</td>
</tr>
<tr>
<td>Total</td>
<td>560</td>
<td></td>
</tr>
</tbody>
</table>

On three of the cores the ventral face was used as the striking platform and the dorsal face was used as a flaking surface. On the fourth core (Fig. 6: 4), the truncation was made on the dorsal face and flakes were removed from the ventral face.

About half of the butts (Table 3) are undeterminable (including broken items). The most common type is the plain butt. Only Levallois products and retouched tools exhibit consistently prepared butts, which are mostly faceted or convex; Levallois points usually have convex or chapeau de gendarme butts.

The N34 square assemblage

The assemblage unearthed in square N34 is relatively small (Table 1), comprising only 138 artifacts (excluding chips and chunks). However, a few characteristics are noteworthy. The raw material used and the physical condition of the artifacts themselves differ from those of the Upper Terrace assemblages; the flint texture is rougher and artifacts are less sharp. The pieces are covered by a white patina notably absent from the artifacts of the Upper Terrace.

The assemblage consists of 132 unretouched flakes, two flake cores, and four tools (Table 1). Technologically, this assemblage is different from those of the Upper Terrace, since here the Levallois and other debitage methods described above, are absent. Moreover, the flakes are relatively thick, usually with wide, plain butts.

Four tools were identified (Table 2), three sidescrapers and a notch, all shaped on thick flakes. One of the scrapers was made by a regular bifacial retouch (Fig. 7: 3), another is a transverse scraper with Quina retouch (Fig. 7: 2), and the third has scaled, semi-abrupt retouch. The notch was also executed on a thick déjeté flake.

Typologically, the features of this industry are clearly distinct from the Mousterian assemblages of the Upper Terrace. The thick déjeté pieces and the Quina retouch are considered typical Yabrudian characteristics, as apparent in, e.g., the nearby Tabun (Garrod and Bate, 1937; Jelinek, 1981; Shifroni and Ronen, 2000) and Jamal (Weinstein-Evron and Tsatskin, 1994) caves.

A small handaxe (Fig. 7: 1), collected during surface cleaning of the Upper Terrace, south of the remnants of a recent enclosure wall (Fig. 2), may well belong to a similar industry. It is slightly rounded, thick and irregularly shaped. Significantly, the biface is covered with a white patina similar to the artifacts from N34.

So far, then, two distinct lithic assemblages were unearthed at the site: Middle Paleolithic, on the Upper Terrace, and Lower Paleolithic, at the lowermost, western end.

The Middle Paleolithic is a typical Levantine Mousterian industry, with the common use of the unipolar, convergent Levallois method. The prevalence of laminar debitage, notably regarding the elongated Levallois and Mousterian ("Abu Sif") points, suggests that this assemblage belongs to the "Tabun D-type" industries (e.g., Garrod and Bate, 1937; Neuvill, 1951; Ronen, 1975; Copeland, 1975; Jelinek, 1981; Marks and Monigal, 1995; Bar-Yosef, 1998; Meignen, 1998, 2000). The Lower Paleolithic assemblage is still very small. Its technological and typological affinities suggest that it may belong to a Yabrudian industry.

PROVENANCE OF RAW MATERIAL

Mount Carmel is an isolated mountain belt in which Upper Cretaceous (mainly Cenomanian and Turonian) marine sedimentary rocks are exposed (Bein and Sass, 1980). The lithology is composed of chalk, limestone, and dolomite, representing a variety of environmental facies that results from the unique paleogeographical location of Mount Carmel at the edge of a shallow platform.

Flint can be found on Mount Carmel in differ-
Fig. 7. Lower Paleolithic artifacts from Misliya Cave: 1 – handaxe; 2, 3 – scrapers
ent geological formations and variable densities. Shamir, Khureibe and Isfiya are amongst the formations richest in flint (Weinstein-Evron, 1998 and references therein). The flint appears in the shape of thin layers, geodes, nodules, lenses, and veins inside layers of chalk, limestone, and dolomite (Karcz, 1959; Kashai, 1966). The Misliya flint provenance survey is part of a wider study of Mount Carmel flint distribution (Druck, in preparation) that incorporates detailed mapping and classification of raw materials, and aims to create a Mount Carmel "litho-library". This reference collection will serve as a basis for determining the provenance of archaeological lithic assemblages for sites in the Mount Carmel area and beyond. A similar collection has been recently established for the Galilee (Delage, 2001).

The criteria used for the classification and provenance determination of the Misliya flint resources include such characteristics as color, cortex (color, shape and texture), the contact between the cortex and the core (abrupt or diffuse), flint texture (smooth or crystallized), and the presence or absence of fossils (following Delage, 1997, 2001).

The sample analyzed to date includes 367 flakes from square N11. Eleven flint types were determined and classified into six major groups (Fig. 8). The first four, together representing 85.1% of the studied items, could be further related to possible exposures that can be found in the Mount Carmel area today (Fig. 8: 1) flints of the Shamir Formation from Nahal Galim (61.9% of the items); 2) items made on flint from the Shamir Formation as occurring in the Mount Oren area (12.8%); 3) flints of the Khureibe Chalk from the Rom Carmel area (5.2%); 4) items belonging to the Khureibe/Isfiya formation from the Nahal Me’arot area (5.2%). Burnt or heated items comprise ca. 8% of these main flint types. 5) includes several minor types, presented here according to their characteristic color or texture (8.1% of the assemblage). Comparable types do occur in the Mount Carmel area; however the items could not as yet be ascribed to specific, potential sources. Worth noting are two broken blades made on whitish flint with a pattern of longitudinal, parallel reddish stripes, for which approximate potential sources could not be established to date, and; 6) items in this group (6.8% of the assemblage) were undeterminable due to severe breakage or thermal fracturing.

Most of the flint utilized by the Misliya Middle Paleolithic inhabitants likely originated from the Shamir Formation (74.7% of the studied items). These include a major component derived from the Nahal Galim area, some 2.5 km north of the site, where a variety of shapes and sizes of high quality flint from the Shamir Formation can be found. Numerous pieces, recognized by their unique fine texture, originated in the Mount Oren Shamir Formation (Fig. 8), located some 2 km east of the site (Fig. 9). The Rom Carmel area, in which flint of the Khureibe chalk formation occurs, is located ca. 7 km east of Misliya. The north bank of Nahal Me’arot, with flint from the Khureibe/Isfiya formations (some 5.2% of the finds), is located ca. 8 km to the southeast of the site.

The distribution of possible raw material sources used by the inhabitants of Misliya indicates that local Mount Carmel flints, from an area within a radius of 2–2.5 km around the site (Fig. 9), were preferred for the manufacture of flint artifacts. Reefs of the Muhrqa Formation from the immediate vicinity of the cave do not contain flints. The main source, in the Nahal Galim area, includes an array of high-quality flint of various shapes and sizes, with a characteristic fine texture that renders the material highly suitable for knap-
suitable for a straightforward (i.e., with minimal core preparation) extraction of Levallois implements. The less frequently occurring flint types were likely derived from a distance of up to 5 km from the site; even the relatively rare Nahal Me’arot flints can be found not more than 8 km away. In sum, in Misiya, there is a clear negative correlation between the source distance from the site and degree of abundance of the utilized flint types (i.e., the further away the raw material sources lies, the lower its frequency in the archeological sample). The Misiya Middle Paleolithic inhabitants utilized the high-quality flint sources found in nearby areas, with only sporadic use of flints originating in slightly farther provenances.

ARCHAEOZOOLOGICAL ANALYSES

A detailed taphonomic study of the faunal remains was performed in order to gain insights into the depositional history of the bone assemblage. Cave bone assemblages dating from the Middle Paleolithic (e.g., Bate, 1937; Haas in Jelinek et al., 1973; Speth in Bar-Yosef et al., 1992; Speth and Tchernov, 1998; Tchernov, 1998) are rare and their preservation is selective and found to be related to various geogenic, biogenic, and anthropogenic agents (e.g., Weiner et al., 1993; Goldberg and Bar-Yosef, 1998).

Abundant bone fragments and, in particular, long bone splinters were observed within the brecciated layers throughout the site. From the start it was assumed that, due to the hard breccia, the fragile bone remains risked damage by the excavation process itself. To reduce the loss of information, a first stage of identification and classification was carried out while the bones were still partially embedded within the lithified layers. Later, additional faunal material was extracted from the excavated sediments in the laboratory, in a procedure similar to that used for flint.

Faunal analysis in the field, as well as in the laboratory, proceeded as follows: 1) skeletal elements were identified to the closest possible taxonomic unit; 2) shaft fragments and highly fragmented cranial and post-cranial elements were identified to size class only; 3) the degree of fragmentation of each fragment was documented (i.e., percentage of the proximal or distal end and whether lateral or medial); 4) degree of burning was documented for each recorded fragment (i.e.,...
partly carbonized, completely carbonized, or calcined); 5) every bone fragment larger than 10 mm (fragments with recent breakage caused by the excavation were ignored) was measured for its longitudinal length to the nearest millimeter. As implied by Villa and Mahieu (1991), the size of diaphysis fragments is a good measure of the intensity of fragmentation.

Documented bones were examined for surface modifications. We searched for modifications indicating post-depositional agents (i.e., bone weathering, see Behrensmeyer, 1978; abrasion, see Shipman, 1981), butchery marks (Binford, 1981), percussion marks (Blumenschine and Selvaggio, 1988) and signs of animal activities (Fisher, 1995). The mode of bone fragmentation was analyzed for all bone fragments bearing ancient fractures. Fracture angle, fracture outline, and fracture edge were assessed in order to determine the stage at which the bones were broken (i.e., fresh vs. dry; see Villa and Mahieu, 1991 for description of fractures), as well as the bone circumference preservation index in order to discern the role of carnivores in creating the assemblage (Bunn, 1983).

A total of 500 bones were measured from the center of the cave, along an east-west line from the Upper Terrace to the section separating the Upper and Lower Terraces. These were from squares N11 (204), N12 (105) and O17 (191). In addition, 143 bones from Square H16 from the northern part of the Upper Terrace were recorded. From this collection, a sample of 79 bone fragments from the center of the cave, together with a sample of 52 bone fragments from the northern part (square H16), were analyzed for their fracture angle, fracture outline, fracture edge, and shaft circumference. The same samples were used for observing abrasion signs and for recording the rate of weathering.

Square H16 is located in a much more solid breccia in comparison with the center of the cave and contained dense concentrations of large mammal bone fragments in various sizes and lengths. Since the potential to recover the bone debris with no further harm was relatively low, and we did not want to ignore these bones altogether (in fact the majority of the bones proved to be heavily fragmented with recent fractures, thus preventing further laboratory analysis), taphonomic observations were carried out in situ, before their extraction. The analysis of the assemblage from this square is based on pooled data gathered both in the laboratory (90 bones) and in the field (54 bones), using the same taphonomic research protocol. In order to avoid double checking, the examined bones in the field, which were excavated subsequently, were separated from the finds extracted in the laboratory. Comparison between the data collected in the field and in the laboratory shows no major differences between the two methods of sampling. For example, fracture lengths show similar frequencies (ANOVA; F=0.57, p=0.45). The relative frequencies of body-size group and the degree of fragmentation are similar as well. These results demonstrate that the taphonomic observations taken while bones were still embedded within the breccia did not differ considerably from the information recorded in the laboratory.

The composition of the faunal samples from the two areas of the cave is quite similar (Fig. 10; χ²=3.47, p=0.18; based on NISP). In both, deer sized animals (most likely dominated by Dama mesopotamica), and large bovids (most likely dominated by Bos primigenius) appear in higher percentages than do mountain gazelle (Gazella gazella) with only slight differences between the two areas.

A single tooth fragment (mandible molar) has been identified as an equid (Equus sp.), and four teeth (two right-M3 mandible, right-M3 maxilla, right-M3-M2-M1 mandible) have been identified...
as belonging to an adult gazelle (based on tooth wear). The majority of the identified elements at both areas are long bone shaft fragments (58 out of 86, ~70% in the northern part; 67 out of 92, ~70% in the center). Other skeletal elements include highly dense compact bones (over 0.28 g/cc; Lyman 1994) and teeth; spongy bones and less dense epiphyses are absent from the entire assemblage. The over-representation of highly dense elements points towards the significant role of either pre-depositional or post-depositional attrition processes (Lyman, 1994). Although the sample size of the faunal assemblage is too small to formulate reliable comparisons, it seems that the proportion of damaged specimens is equal for the three represented body-sized groups.

The lengths of fragments differ significantly between the northern and central parts of the cave (ANOVA: F=62.01, P<.001). The frequency distributions of the percentage of total specimens per one-cm-size class shows a similar trend (χ² =64.05, P<.001). The greatest differences occur in the 10–30 mm size classes (fragments smaller than 10 mm were not measured), with proportionately more fragments from the center of the cave occurring in these size classes. In contrast, the sample from the northern part has proportionately more specimens that are 30–80 mm long. The frequency distribution of fragment size class (Fig. 11) suggests that bones from the central part of the cave are more intensively fragmented than the northern part. The two areas are also considerably different in terms of the ratio of burnt bones; with almost no burned bones in the northern part (6 out of 143, 4%), and a high number of burned bones in the center (207 out of 502, 40%; χ²=41.79, P<.001). It appears that burning was more common on smaller fragments (average length of the burnt fragments are 22.4 mm and their standard deviation is 7.9 mm) most of which could not be identified to skeletal elements (i.e., mid-shafts). As argued by Speth (in Bar-Yosef et al., 1992), the incidence of burning and specimen size supports the view that burning is related to food preparation (if bones were accidentally burned by later activities, the larger bones would display an equal or even higher rate of burning). Arguably, the near absence of burnt bones in the northern part may be related to different spatial uses of the various parts of the cave (with the caveat, of course, that this observation is based on only a small sample).

The long bone assemblage from the northern part of the cave contained major signs of surface weathering; 60% (of 52 examined bones) were in the range of high weathering (stages 3–5; according to Behrensmeyer, 1978). This percentage contrasts significantly with the low rate of weathering (stages 1–2) found in the center of the cave (92% of 79 examined bones; χ²=16.02, P<.001; Fig. 12). This finding suggests that bones from the northern wall were vigorously damaged owing to exposure for an extended period of time prior to their deposition. None of the bone edges displayed rounding or smoothing of the break surfaces, suggesting that abrasion caused by physical erosion was insignificant in biasing the whole assemblage. In addition, signs of animal activities—
Relative frequencies of fracture angle, fracture outline, fracture edge, and shaft circumference from the northern and central areas of Misliya Cave (oblique, V-shaped, and jagged fractures represent fresh fractures [Villa and Mahieu, 1991]; less than ½ diaphysis circumference represent human subsistence processing [Bunn, 1983])

<table>
<thead>
<tr>
<th></th>
<th>Fracture angle</th>
<th>Fracture outline</th>
<th>Fracture edge</th>
<th>Shaft circumference</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Oblique</td>
<td>Right</td>
<td>V-shaped</td>
<td>Transverse</td>
</tr>
<tr>
<td>Northern area</td>
<td>28 (54%)</td>
<td>18 (34%)</td>
<td>6 (12%)</td>
<td>25 (48%)</td>
</tr>
<tr>
<td>Central area</td>
<td>70 (88%)</td>
<td>6 (8%)</td>
<td>3 (4%)</td>
<td>65 (82%)</td>
</tr>
</tbody>
</table>

chewing, gnawing, and scratch marks of carnivore and rodents–are totally absent from the entire assemblage.

The mode of bone fragmentation, based on fracture angles, fracture outlines, and fracture edges, reflects some supplementary distinctions between the areas of excavation. High proportions of dry bone fractures characterize the northern part, while high proportions of “green” (fresh) bone fractures characterize the central part of the cave (Table 4). Comparison between the two areas shows major differences within every one of the typological fractures studied (fracture angle: \( \chi^2=17.69, P<.001 \); fracture outline: \( \chi^2=17.99, P<.001 \); fracture edge: \( \chi^2=14.67, P<.001 \)). These results suggest that the mode of bone fractures found in the northern part of the cave shows a relatively high proportion of dry bone fractures resulting from bone trampling, and indicate that fractures from the center of the cave were made on fresh bones, probably for marrow extraction, an action that produced a large number of fresh fractures and account for the overall high number of small fragments found. In addition, we found four signs of percussion marks, close to the fracture edges, which also could have been made during marrow processing (Blumenschine and Selvaggio, 1988). It could be that the high rate of weathering found in the northern part enhanced the effects of trampling by further reducing the strength of the bone. Shaft circumference (Table 4) does not differ significantly between the two areas (\( \chi^2=6.35, P=.10 \), with the majority of fractures less than half of the complete diaphyses circumference. This line of evidence, together with the absence of carnivore marks, leads to the conclusion that the bone remains are exclusively associated with human occupation.

**DEPOSITS OF THE EXPOSED SURFACES**

Sedimentological analysis of deposits at Misliya has been primarily restricted thus far to a natural breccia exposure, ca. 1.5 m long, on the Upper Terrace in squares N16 and N17, and to the observations in square N34 from the western part of the site. The vertical section of the breccia, separating the Upper from the Lower Terrace, was divided in square N17 into three layers (Fig. 13): I) an uppermost brown breccia with blocks of limestone rock, ca. 70 cm thick, which suggests that the rocks were enclosed in the layer before breccia consolidated; II) brown breccia, ca. 50 cm thick, incorporating abundant lithics and faunal remains, with ochre-yellow phosphatic nodules and carbonate concretions of various forms, gradually changing into III) a lower, reddish breccia, up to 1 m thick, resting on a collapsed rock and containing many lithics, bone fragments, as well as phosphatic and carbonate concretions similar to layer II.

In petrographic thin sections (Fig. 14) the brown breccia (Unit II) is a strongly heterogeneous calcareous mass with less than 10% fine
quartz sand, dark-brown tiny clay pellets 10–25 μm in size, chips of bones in different stages of calcification, and abundant limestone clasts (Fig. 14a). Noticeable is the presence of large, well-delineated red decalcified aggregates up to 2 mm in size (Fig. 14b). The latter apparently derived from local terra rossa soils from outside the cave. An accumulation of invased terra rossa soil materials was reported from Tabun Cave, ca. 7 km to the south of Misliva, since Lower Paleolithic times (Tsatskin, 2000) and through the Middle Paleolithic (Goldberg, 1973; Jelinek et al., 1973; Albert et al., 1999). Strong compaction of the layer is obviously a result of intense accumulation of calcite both in the groundmass and in the voids, as well as in the fissures within burnt flint and larger bone fragments. Calcite has been also determined by preliminary FTIR (Fourier-transform infrared) spectrometry (S. Weiner, personal communication, 2001).

The reddish breccia in thin sections demonstrates a similar type of heterogeneous fabric, composed of clayey groundmass, some quartz sand, clayey soil with largely disrupted aggregates of fluffy appearance, flint and bone chips, and abundant calcite accumulations. Compared with the brown breccia, micritic and sparitic calcite accumulations are more abundant here within fissures and voids. Significantly, disrupted soil aggregates (a result of burning?) still demonstrate the type of aggregation pre-dating the episode of massive calcification and associated lithification (Fig. 14c, d). The presence of surface soil aggregates apparently accounts for the red hue of the lower part of the breccia. Several phases of calcite crystallization are evidenced by micritic calcite juxtaposed with large sparitic crystals, indicating that the rate of evaporation and concentration of solutes varied through time. Micromorphological observations show two types of bone fragments: 1) yellowish, with low birefringence, with osteoclasts and cells; 2) reddish, isotropic, with no preserved structure, apparently burnt (Courty et al., 1989). Both types are of variable shapes with sharp edges, suggesting their mechanical destruction. However, chemically the bones are almost intact.

In the breccia retrieved from the Lower Terrace (square N34), the type of microfabric is similar to the specimens from the Upper Terrace breccia. As in the upper breccia, the cementation is due to the massive accumulation of micritic calcite in the groundmass and primarily sparitic infills in the pores. However, the process of postdepositional calcification did not erase the micromorphological features of biological activity (i.e., coprolites), which is evidenced by polyphase calcite neoformations, encompassing tiny brown soil aggregates. Numerous bones and flint pieces are also affected by weathering and secondary calcite infillings in fissures and rounded caverns (Fig. 14e, f). Note here the perforated character of the edge of a larger bone fragment with clay-stained micritic infills as well as sparitic infills.

**DATING**

Five samples for luminescence dating were collected along the deep section separating the
Fig. 14. Photomicrographs of samples from square N17 section and square N34 (for location of units see Figure 13); plane polarized light (PPL); crossed polarized light (XPL); scale bar = 500 μm. (a) Heterogeneous matrix of brown breccia (Unit II) in square N17 with abundant limestone clasts (arrow) (PPL); (b) Large terra rossa soil aggregate (arrow) in brown breccia (Unit II) in square N17 in-washed into the cave from outside (XPL); (c) Strongly compacted fabric of reddish breccia in square N17 with mechanically disrupted bones (arrows) (PPL); (d) the same (XPL); note disrupted terra rossa soil aggregates (arrow); (e) Massive infilling of rounded cavities by micritic and sparrite calcite within larger bone in the breccia from square N34 (PPL); (f) the same (XPL); note signs of re-crystallization of calcite (arrow).
Upper and Lower Terraces in square O17. Three samples, all from the Middle Paleolithic Unit II, were prepared (from top to bottom): MS-2, MS-5, and MS-6. From each sample, 88–125 micrometer quartz was extracted and purified (Porat et al., 2002). The Equivalent dose (De) was determined using the optically stimulated luminescence (OSL) signal and the multiple aliquot ‘slab’ method (Prescott et al., 1993). All measured samples show a high degree of signal saturation and for only one sample (MS-2; from the upper part of the section) the De could be determined with any certainty. Its age, 130±33 ka, should therefore be considered as a minimum age. Since many of the flints exhibit signs of burning, ESR dating of burnt flints will be attempted in the future.

DISCUSSION AND CONCLUSIONS

Misliya Cave, Mount Carmel, Israel, has been found to contain rich Middle Paleolithic faunal and lithic assemblages. The archaeological deposits extend over a fairly large area and are of an equally promising depth. Bones appear to be well preserved and we were able to demonstrate some spatial differentiation in both the lithic and faunal assemblages. Significantly, we could also confirm the occurrence of Lower Paleolithic stratified layers. Results of this study may enable us to draw conclusions about the formation and depositional processes at the site, and the length and duration of its occupation.

The spatial and vertical distribution of the brecciated layers, and especially the fact that, as indicated by field observations and by the geophysical data (Weinstein-Evron et al., submitted), the deepest layers occur in the northern part of the site, suggests that the cave had undergone major changes in its configuration. These changes were most likely related to the collapse and subsequent regression of the cave's ceiling and enclosing walls. The apparent lack of brecciated layers on the slope beneath the southern part of the Upper Terrace may suggest that archaeological sediments were eroded from successively exposed areas as a result of the postulated overhang recession. Alternatively, a rock wall could have originally confined the south-southwestern part of the Upper Terrace. This may explain why sediments were not deposited in the southwestern parts of the slope and only thin brecciated layers occur at the southern part of the Upper Terrace of the site. Large rocks along the northern part of the slope and especially within the breccia constitute evidence for previous rock falls, which may account for an eastward movement of the cliff.

The configuration of the enclosing walls of the Upper Terrace is also suggestive of a former, more delimited, cave. The location of the karstically active niches at the southeastern end of the Upper Terrace, where water is still dripping today, may also support the latter interpretation. Of these, the southern niche is the best defined of the Upper Terrace niches (Fig. 3a), and it is quite likely that its walls have not yet been subjected to the smoothing effects of prolonged erosion. The outer shape and location of the various niches may indicate a southeastern movement of the karstic base of the cave with time. One may thus envisage that during the deposition of the Middle Paleolithic layers, the Upper Terrace was still covered by the now collapsed cave ceiling and that the cave was smaller than it is today, which may also explain why the archaeological deposits are largely limited to the northern-central half of the Upper Terrace. A similar picture arises from the Lower Terrace, where a continuous breccia exposure (in squares N22–N26), containing Middle Paleolithic finds emerges below the surface sediments (Fig. 3c), once again in the central part of the terrace.

To assess the stages and pace of the assumed rock shelter recess, through the evaluation of times when parts of the cliff wall had been exposed to sunlight, rock samples were collected for quartz content measurements, as a basis for potential berilium dating. Unfortunately, the bedrock at the site does not contain sufficient quartz for such age determinations to be made (E. Boaretto, personal communication, 2001).

Micromorphological evidence suggests that the accumulation of archaeological sediments was characterized by a complex mode of deposition, integration of anthropogenic residues, and post-depositional cementation in a strongly calcareous environment, under conditions of intermittent inundation during intensive rainwater supply. The increase in humidity was likely to coincide with the collapse of the roof at the Upper Terrace and activation of slope processes which, in turn, may account for the increased accumulation of intact
terra rossa aggregates and fragments of limestone rocks in the uppermost breccia layer of the Upper Terrace. The sample taken ca. 10 m down slope in square N34, albeit showing features of strong calcification and weathering, does not seem to relate to the same episode of breccia formation as that of the upper surface. Hence the earlier suggestion of the gradual step-wise recession of the cave’s ceiling seems to be corroborated. It also follows that the Lower Paleolithic layers and the transition to the Middle Paleolithic are within sediments of the lower, western parts of the site.

Two distinct cultural entities were identified at the site: Lower Paleolithic (most probably Acheulo-Yabrudian), and Middle Paleolithic ( Mousterian). The Yabrudian assemblage was unearthed in the lower part of the site. However, the handaxe, together with other finds of an Acheulo-Yabrudian affinity discovered previously on the Upper Terrace (Oiami, 1984; Weinstein-Evron and Kaufman, 1998), suggest that Lower Paleolithic sediments still exist on the upper part of the site as well. The most likely location for such sediments is at the eastern part of the Upper Terrace (east of the 10 m excavation grid line), where the surface sediments are relatively soft and from where the last handaxe found at the site (Fig. 7: 1) originated.

Since only small samples were extracted from the lower, western part of the site, data concerning the Lower Paleolithic occurrence are still meager. The Middle Paleolithic assemblages are characterized by a high density of artifacts. The assemblages include all blank types as well as primary elements and core trimming elements. This, together with the high number of chips, may indicate that all stages of core reduction took place on site. Alternatively, the low frequency of cores found to date, may suggest that preliminary processing was carried out at the raw material sources, with blanks then being curated to the site, similar to the model proposed for other Mousterian sites in the Levant (e.g., Marks and Friedel, 1977; Hovers, 1990; Henry, 1992). The freshness of the artifacts indicates that they had not undergone significant movement or rolling.

The Middle Paleolithic inhabitants of Misliya Cave utilized mostly local, high-quality flint, derived primarily from an area within a radius of 2.5 km from the site. Flint from more distant sources is rare. Similar patterns were demonstrated for other Middle Paleolithic sites in northern Israel (e.g., Hayonim Cave, see Delage, 1997; Sefunim Cave, see Ronen, 1984; Tirat Carmel, see Ronen, 1974, and; Kebara Cave, see Frachtenberg and Yellin, 1992, Bar-Yosef et al., 1992).

The dominant flint source is at Nahal Galim. At this stage of research it is impossible to ascertain whether the inhabitants of Misliya used nodules extracted from suitable outcrops or collected flint pebbles incorporated in the wadi bed or terraces. The nearby Nahal Sefunim drains only areas covered with rocks of the Khureibe and Isfiya formations, whose contribution to the raw material assemblage is relatively minor. It is worth noting that, in the Mousterian layers of Sefunim, the utilized raw material was found to originate from the mountain area to the east of the site, as opposed to the Neolithic assemblages where the use of pebbles from the nearby wadi bed could be demonstrated (Ronen, 1984).

The Middle Paleolithic assemblages belong to a “Tabun D-type” (or “Abu-Sifian”; Bar-Yosef, 1998) industry, as can be gathered from the essentially unipolar convergent flaking, the abundance of elongated Levallois items (blades and points) and the presence of elongated Mousterian (“Abu-Sif”) points. The possible use of non-Levallois blade technology is also in accordance with other Middle Paleolithic industries of this type (Meignen, 1994, 2000; Bar-Yosef, 1998).

The obtained luminescence date of 130±33 ka. for the Middle Paleolithic layers should be considered a minimum age. It has been suggested recently that the boundary between the Lower and Middle Paleolithic in the Levant should be set at OIS 7 (Porat et al., 2002). Other age determinations, however, suggest that it may be considerably older (e.g., Mercier et al., 1995; Schwarcz and Rink, 1998) and that “Tabun D-type” assemblages range between ca. 270/250–170/150 ka.

Results of the taphonomic analysis demonstrate that much vital information can be gathered from bones while they are still in place, even with the risks of damage through excavation of lithified layers. Thus, the presence of an archaeozoologist throughout the dig is crucial for taphonomic observation and bone classification. In spite of the difficulties in extracting the bones, crucial evidence can be gathered regarding the composition
of the assemblages, human behavior, and site formation processes. Depletion of low density parts largely reflects the significant effect of attritional processes, which played a role on the entire assemblage of Misliya Cave. The relative frequencies of the different body-size groups, lack of surface modifications (except weathering), and especially the absence of carnivore activities show that the bones were transported into the site principally by humans.

A certain spatial variation was identified within the Upper Terrace, in both the lithic and faunal assemblages. Compared with that of the northern area, the lithic assemblage of the central area shows greater preference for the production of blades, tools on blades and Levallois points. Levallois products are also generally larger and tools are more carefully shaped than in the northern squares. This can be related to various activities carried out in the center vs. the areas near the walls of the cave. The taphonomic analysis also reveals some differences between the two areas in terms of weathering profiles and modes of bone fragmentation. The high frequency of weathered bones along the northern wall may be related to the bones’ extended exposure prior to deposition. This result is also in accordance with the relatively high proportion of dry bone fractures found in this area. The frequency distribution of fragment size classes suggests that bones from the central part of the cave are more intensively fragmented than the northern part. This, together with the near absence of burnt bones in the northern part, may be related to different human activities in the various areas of the cave. Thus, based on both the lithic and taphonomic data, it seems reasonable to suggest that the central area constituted a major activity area while flint and bone debris were discarded near the northern wall (a similar pattern was suggested by Bar-Yosef et al., 1992).

No distinct spatial variations in aspects such as the selective preservation of bones (e.g., Kebara and Hayonim; Weiner et al., 1993; Goldberg and Bar-Yosef, 1998; Stiner et al., 2001) could be observed. However, our geoarchaeological studies, with the incorporation of micromorphology, corroborated by preliminary FTIR analyses, indicate the great potential of FTIR analysis for a better understanding of site formation processes and their bearing on observed archaeological variations. So far, no distinct hearths or ash layers were observed at the site. However, the use of fire is evidenced by the many flint artifacts and bones that exhibit burn marks. Evidence of burning could be also observed in the sediment matrix in the micromorphological slides.

Misliya Cave provides a unique opportunity to investigate “Tabun D-type” Middle Paleolithic industries that are preserved on the surface of the site. Dating of the long, continuous sequence will help resolve some of the uncertainties regarding the dating of the Tabun Cave and its human remains (e.g., Mercier et al., 2000). Dating of previously unexcavated deposits, in which the provenance of the various types of samples used for the different dating methods is clear and the necessary background radiation measurements can be performed, is of utmost importance. Even in Jamal Cave, Nahal Me’arot, where the layers are very shallow, good control of the sampling produced reliable age determinations (Weinstein-Evron et al., 1999). Moreover, the results of our taphonomic investigations indicate the potential for paleoenvironmental reconstructions at the site, not only through geological and sedimentological studies (as have been performed recently in both Tabun and Jamal Caves due to a lack of bones; Jelinek et al., 1973; Tsatskin et al., 1995), but also through detailed archaeozoological studies (e.g., Speth and Tchernov, 1998; Stiner and Tchernov, 1998). More importantly, the preservation of animal bones suggests that there is a good chance for the recovery of human remains. Such remains, especially with detailed paleoecological studies and well-controlled dating, can shed important light on the continuing question of the passage from the Lower to Middle Paleolithic, the origins of anatomically modern humans in the Levant, as well as the yet not fully understood relationships between them and Levantine Neandertals (e.g., Bar-Yosef, 1998, 2000; Kaufman, 1999).

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REFERENCES


GOREN-INBAR N. 1990. Quneitra: a Mousterian site
RONEN A. 1974. Tirat-Carmel: a Mousterian open-air site in Israel. Institute of Archaeology, Tel-Aviv University, Tel-Aviv, 68 pp.
Bulletin du Musee de Beyrouth, 23, 137–142.