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Morphological and functional variation in points from the Ahmarian layers at Üçağızlı Cave, Turkey

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Abstract

Technological analyzes of stone tools expands our understanding of behavior and hunting strategies of Pleistocene humans. Studies of the functions of the points demonstrate that points provided significant advantages for prehistoric hunters by keeping the prey at a distance, reducing the likelihood of injury, and/or increasing the range of potential prey (Sahle et al., 2013). This paper provides information about variation on the forms and functions of pointed artifacts from the Ahmarian layers at Üçağızlı Cave, Turkey. Attributes recorded include point types, impact scars, basal modification, notching, overall shapes, and retouch types, as well as dimension of the artifacts. These attributes of the points were compared with the Ahmarian layers to determine whether there were changes in the use of points during the Ahmarian period at Üçağızlı Cave. The results indicated that the dominant point type was the Ksar 'Akil point. In all, 24,5% of these artifacts showed flute-like impact scars on their distal ends, but a majority of the points showed basal modification on the proximal end. Also, 16% of the points demonstrated both notching and basal modifications, something not observed previously on Ahmarian points in the Levant. These findings lead us to conclude that points with impact scars, basal modification and notching could have been used as projectile points at Üçağızlı Cave during the Ahmarian period. Additionally, the comparisons between the layers and attributes of the points demonstrated no significant changes in the shapes and uses of points across the Ahmarian layers at Üçağızlı Cave.

Introduction

Many Paleolithic assemblages contain artifacts with converging distal margins, which are often called points, but not all points were used in the same way. In Paleolithic studies, the term “projectile point” refers to tips of weapons, such as thrusting spears, spears thrown by hand, and projectiles launched by spear thrower (atl-atl) or by bow (Villa et al., 2009*a*). Paleolithic archeologists assume that projectile weapons could have been made of wood, bone, antler as well as stone. However, researchers generally focus on stone tools in projectile weapon studies, since they are more durable and are more often part of the archaeological record (Shea et al., 2010).

Projectile weapons were one of the major hunting tools for early human ancestors and provided significant advantages during hunting activities, whether used on spears hurled at a distance thrust into the prey at a close range. One of the advantages of projectile points is that they enabled humans to kill dangerous animals or enemies from a distance, thereby reducing the possibility of injury. Additionally, some kinds of projectile weapons may have enabled prehistoric hunters to procure fast-moving prey such as birds and as well as large, dangerous prey species. Some researchers believe that projectile weapons might have been one of the main technological advantages that facilitated *Homo sapiens* dispersal from Africa to western Eurasia in the Late Pleistocene (Sahle et al., 2013; Shea et al., 2010). Although researchers often state that projectiles were important hunting weapons for early human ancestors, studies of lithic points from the prehistoric kill sites confirm that points must have some features to be used as hunting weapons. Minimally, such artifacts must have a sharp point to penetrate an animal’s hide and open a hole for the remainder of the point and shaft, and some modification of the opposite end to facilitate hafting. Impact scars are one of the most reliable sources of evidence that points were actually used as parts of hunting weapons (Villa et al., 2009*c*).

Impact and hafting traces on the edges or the surfaces of stone tools have been examined to illuminate the function of stone tool assemblages and the hunting strategies of early human ancestors. Studies of wear traces on stone tools from Europe, the Levant and Africa indicate that mechanically- processed projectile points were widely utilized for hunting animals after 40-50 ka by *Homo sapiens* populations (Shea, 2006). Recent evidence demonstrates that stone points were employed as parts of hunting weapon by the antecedents of *Homo sapiens* in Africa and Neanderthals in Europe (Villa et al., 2009*a*, 2009*b*; Sahle et al., 2013). For instance, pointed obsidian artifacts from Ethiopia represent that the earliest composite projectile weapons were used as projectile weapons at least 279,000 years ago (Sahle et al., 2013). Pointed wooden spears from Schöningen, Germany, dating to ~400 ka, and a perforated a horse scapula from Boxgrove, dating to ~500 ka, further show that spears, with and without stone points, were hunting equipment of the Lower Paleolithic in Europe. However, these early weapons were not true projectiles, but were hand-delivered thrusting spears (Wilkins et al., 2012; Sahle et al., 2013).

The Levanting region has been a focus for research on the early use of projectile point assemblages during the Middle and Upper Paleolithic periods. For instance, analyses of the frequency of impact scars on assemblages from the Levant, and microwear analysis of the Kebara and Umm el Tlel assemblages show that Levallois points were used for butchery, woodworking, and other tasks in the Levant. A broken Levallois point found as embedded in the cervical vertebrae of an equid from Umm el Tlel, Syria (ca. 60,000 years old) demonstrates that Levallois points were sometimes utilized as projectile points during the Middle Paleolithic period in the Near East (Boeda et al., 1999). Shea (2006) examined possible Levantine Upper Paleolithic projectile points in terms of tip cross-sectional area values (TCSA, calculated as ½ maximum width x maximum thickness). A group of 122 points from Üçağızlı Cave layers B-H were included in Shea’s sample: the points from Üçağızlı Cave include Levallois points, Mousterian points, Ksar ‘Akil points, backed points, obliquely truncated points and El-Wad points. The TCSA values suggest that these early Upper Paleolithic artifact types could have been used as projectile points, and the values suggest that hafted artifacts were possible tips for spear-thrower (atl-atl) darts (Shea 2006).

This paper investigated further evidence for Upper Paleolithic projectile point use by describing and analyzing evidence of impact scars and basal modification on stone points from the Ahmarian layers (B, B1-B3, and C) at Üçağızlı Cave, Turkey. Frequencies of different morphological point types, impact scars, and basal modification among the Ahmarian layers were analyzed in order to determine whether there were changes in the use of projectile weapons during the Ahmarian period at Üçağızlı Cave.

Location and excavation history of Üçağızlı Cave

Üçağızlı Cave is located on the Mediterranean coast of the Hatay region in south central Turkey (Figure 1A). The cave is situated about 15 km south of the Orontes (Asi) River on a limestone promontory at an elevation of about 18 meter above present sea level. The topography around Üçağızlı Cave is very steep. During the cold periods of the Late Pleistocene, sea level would have been lower and the site would have been just a few kilometers farther from the shore (Kuhn et al. 2009). The ecological and topographical situation of the site is more similar to the Mediterranean Levant than to central or Mediterranean Anatolia; therefore, Üçağızlı Cave can be regarded as being at the northern edge of the Mediterranean Levant. The cultural sequence at Üçağızlı Cave, which includes Initial Upper Paleolithic and Ahmarian cultural phases, is very similar to other northern Levantine sites such as Ksar ‘Akil (Azoury, 1986).

The initial excavations at Üçağızlı Cave were conducted by A. Minzoni-Deroche in the 1980s in the tubular southern chamber. The second phase of excavations at Üçağızlı Cave were conducted as a collaborative project of the University of Arizona and Ankara University. This second phase of excavation at the site began with test excavations in 1997, and it was followed by full-scale excavations between 1999-2002 (Kuhn et al., 2009). Since 2003, excavations have been continued by Ankara University. The recent excavations have conducted at the north end of the site where a deeper stratigraphic sequence is located (Figure 1B). Excavations in the northern area produced an abundance of stone tools, faunal assemblages, shell ornaments, and human remains).

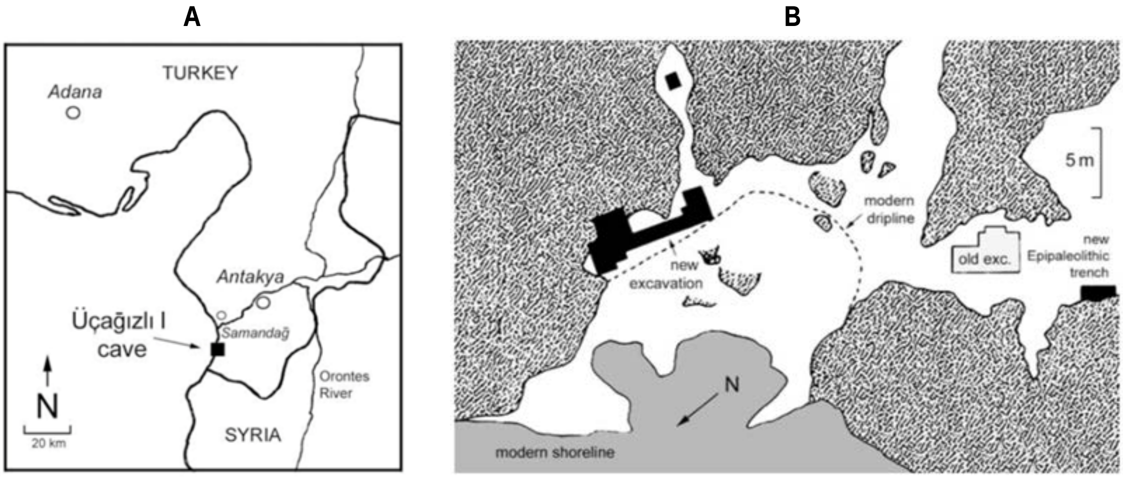

Figure 1. Location of Üçağızlı Cave (A), and site plan of Üçağızlı Cave (B) (Kuhn et al., 2009).

Geology, stratigraphy, and radiometric dates

Üçağızlı Cave is a collapsed remnant of a large cave, which formed during the early Pleistocene Epoch. This collapse caused the loss of about three meters of archaeological deposits to erosion. Accessing the site from the sea is very difficult because of the steep topographic features of the site; however, it is convenient to access the site from the hill slope above it through a hole in the roof. This passage in the southern part of the site contains colluvial material and large blocks of limestone, which were most probably derived from erosion into the cave and roof collapse. The tubular southwestern chamber terminates in a cliff face. The northern part of the site is richest in geological and archaeological deposits, with sediments reaching a depth of more than 4.5 m. The walls of the central area contain weathered speleothems and brecciated deposits. Weathered speleothems and scars of erosion on the walls of central area indicate that the chamber of the cave was formerly larger (Mentzer, 2011).

Intact Pleistocene sediments are located in two main areas at the site: the tunnel like chamber at the south end of the site, which was excavated by Minzoni-Deroche, and the north end of the site, along what was once the back wall of the cave (Kuhn et al., 2009). A large segment of Epipaleolithic and possibly Upper Paleolithic layers was lost to erosion after the cave's vault collapsed in the Late Pleistocene or Holocene periods. Remnant Epipaleolithic deposits is discontinuous across the site: they were found as brecciated deposits along the cave's northeast wall and in a bedrock cavity in the south chamber (Mentzer, 2011).

The lithology of the sediments at the cave is quite homogeneous. At Üçağızlı Cave, the main geogenic component in all layers is reddish clay or silty clay (*terra rossa*). The main stratigraphic units are identified alphabetically (from I through B), and they are differentiated by changes in the amount and nature of anthropogenic contents (Figure 2). The abundance of anthropogenic elements, such as ash, charcoal, artifacts, bones, and shells, suggest variation in the patterns of human occupation at the cave. Artifact assemblages from layers B, B1-B3 and C at Üçağızlı Cave are Ahmarian in character, whereas layers Fa, Fb, Fc, H1-3, and layer I contain Initial Upper Paleolithic assemblages. Layers E and D are difficult to characterize since the assemblages are much smaller but they are more similar to the Ahmarian than to the Initial Upper Paleolithic period (Kuhn, 2012).

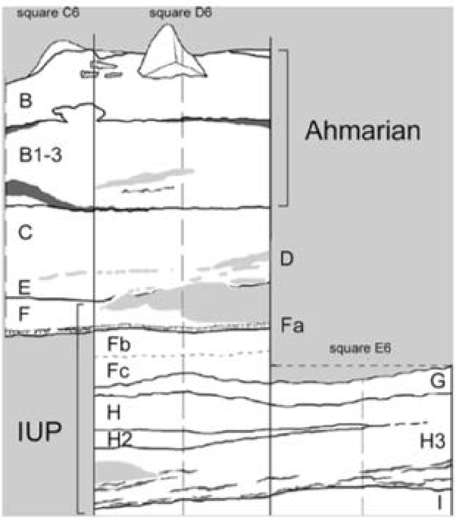

Figure 2. Stratigraphic sections of Üçağızlı Cave in the northern excavation trench (Kuhn et al., 2009).

According to Accelerator Mass Spectrographic (AMS) radiocarbon dates, the sequence of layers in Üçağızlı Cave has been dated between about 41,000 and 29,000 uncalibrated radiocarbon years BP. AMS radiocarbon dating analysis in the cave indicates that dates from the layers B, B1-B3, and C range from 29,000 to 34,000 radiocarbon years BP. Layers G, H, H1-H3, and I have been dated between approximately 35,000 and 41,400 radiocarbon years BP. These uncalibrated dates represent the minimum ages of the layers and current calibration programs indicate that actual ages are 3000-6000 years older. Therefore, calibrated radiocarbon age ranges for layers B, B1-B3 and C are between about 34,000 and 40,000 years before present while the layers G-I range have been dated between 40,500 and 46,000 calibrated radiocarbon years BP (Kuhn et al., 2009). At Üçağızlı Cave, small-scale post depositional disturbance and problems of contamination with old radiocarbon samples most probably caused reversals and changes in the radiocarbon sequences.

Archaeological findings

Fauna

Faunal remains at Üçağızlı Cave include both small and large game animals, but the faunal assemblages are composed mainly of bones from diverse ungulate species. The remains of six ungulate species were found in the most of layers: aurochs or wild cattle (*Bos primigenius*), red deer (*Cervus elaphus*), pig (Sus scrofa), fallow deer (*Dama mesopotamica*), bezoar goat (*Capra aegagrus*) and roe deer (*Capreolus capreolus*). There is significant variation in the presence of specific ungulate species in the Upper Paleolithic layers. Red deer and aurochs were found in most of the layers, but their frequencies are lower than other ungulate species. Additionally, pigs (suidae) appear in all layers, but the frequency of suide bones declines over time. Frequencies of roe deer, fallow deer and caprine remains show that these species had a significant role in forager diets at Üçağızlı Cave. However, the frequency of goat and fallow deer are correlated negatively. While fallow deer are abundant in the Layers E through C, the frequency of caprines is noticeably lower in these layers (Kuhn et al., 2009). In contrast, caprines are more common in earlier and later levels.

Additionally, the presence of marine shellfish in layer I and in layers from D to B can relate to climate oscillations, sea level changes and tectonic activity around the site. The horizontal distance between the cave and sea was always short, but the vertical distance would have changed as sea levels rose and fell. Thus, the frequency of shellfish suggesting that exploitation of edible shellfish must be related to position of shoreline (Stiner, 2009). It is assumed that edible shellfish species were most probably carried to the site when the marine littoral was closest. The scarcity of edible shellfish in the layers E-H3 can be related to decrease of sea level and difficulty accessing to the shore from the site. Besides the ungulate species and shellfish, small mammals, such as hare (*Lepus capensis*), tortoises, birds, Persian squirrel (*Sciurus anomalous*) and a few large fish, were exploited during the Upper Paleolithic period. The frequency of small game at the site is very low between layers I and E. However, the importance of small game in the diet increases steadily from the Ahmarian (from Layer D) to Epipaleolithic periods (Kuhn et al., 2009).

Lithic assemblages

At Üçağızlı Cave, most of the stone artifacts were made from flint and related to cryptocrystalline silicate rocks. Both primary and secondary sources for flint raw materials were determined to exist within nearby area, Yayladağı and Şenköy, around 30 km of the site.

Primary flint sources can be found in the Upper Cretaceous limestone bedrock on the high plateau north and east of the site. One flint source is located near the town of Yayladağ, about

15 km inland from the cave. A second set of flint sources appears in Oligo-Miocene limestone, which is 30 km from the cave, and near the village of Şenköy. Secondary deposits of rolled flint pebbles occurred in fossil beaches, close to Üçağızlı Cave. Two deposits were identified within 5 km of the site and most of the pebbles are smaller than 12 cm in length, much smaller than nodules from primary sources (Kuhn, 2004).

Üçağızlı Cave shows changes in the exploitation of raw material types and sources over time. In the Initial Upper Paleolithic layers, both primary and secondary sources were used. In the Ahmarian layers, occupants of the cave preferred to use flints from primary sources and transport them to the site for tool manufacture, although the secondary pebble source is the closest raw material source to the cave. Most probably these differences are related to changes in occupation duration and intensity at the cave (Kuhn et al., 2009).

The lithic assemblages from Üçağızlı Cave are classified into three main industries. Assemblages from layers I to F are related to the Initial Upper Paleolithic (IUP). Also, lithic assemblages from layers B, B1-B3, and C at the cave represent the Ahmarian tradition, and the last assemblage type corresponds with the Epipaleolithic. However, these last assemblages are small, rare and distributed discontinuously; therefore, they are not easily characterized (Kuhn et al., 2009).

In this study, only Ahmarian assemblages from Üçağızlı Cave were analyzed. The Ahmarian assemblages at the site contain blades blanks produced by using soft hammer or indirect percussion on bidirectional prismatic cores (Kuhn, 2004). Ahmarian assemblages contain elongated endscrapers on blades, retouched or pointed blades, and few burins. 75 artifacts from the early Upper Paleolithic sequence, mainly endscrapers, were examined with microwear analysis revealed that endscrapers and burins were used primarily for working dry and wet hides (Kuhn et al. 2009).

In this study, points and pointed retouched blades from the layers B, B1-B3, C and C/D were examined (Table 1). The pointed stone tools from the layers B, B1-B3, C, and C/D were originally classified based on Hour's typology (1974). Point types in the sample include Ksar 'Akil, El Wad, Levallois, Mousterian, ordinaire, and Aurignacian points.

Table 1. Distribution of pointed blades in the Ahmarian layers at Üçağızlı Cave

Types	B	B1-B3	C	C/D	Total
Levallois	1	3	2	0	6
Mousterian	1	0	2	0	3
ordinaire	1	6	2	0	9
Ksar 'Akil Point	56	157	18	2	233
El Wad Point	4	18	1	0	23
Aurignaician point	2	0	0	0	2
Undefined (broken)point	10	20	3	0	33
Total	75	204	28	2	309

Bergman defines the Ksar 'Akil point as "a blade pointed by fine, semi-abrupt, or abrupt retouch or combinations of these on the dorsal surface at the distal end. The retouch can be continuous or discontinuous along one or both lateral edges. These points are usually symmetrical and are often straight or only slightly curved in profile. The butt usually remains on the piece" (Bergman 1981: 322). This definition fits the Ksar 'Akil points from Üçağızlı Cave. Ksar 'Akil points are present in all Ahmarian layers and are the dominant pointed form in the layer B1-B3. El Wad and Levallois points are also present in all Ahmarian layers, except the layer C/D. El Wad points have been defined as "a blade or bladelet pointed by fine, semi abrupt, or abrupt retouch or combination of these on the dorsal face at the distal end. The retouch may occur on one or both lateral edges, which may also continuous or discontinuous retouch. The points may be symmetrical or offset and are either straight, curved or curved and twisted in profile. The butt usually remains on the piece" (Bergman 1981: 326) and this definition corresponds with the El Wad points from Ahmarian layers at Üçağızlı Cave. Aurignacian blades with pointed ends were found in the Layer B, but they appear in very small numbers. Other point types are present but quite uncommon in the Ahmarian layers

Materials and methodology

A total of 309 lithic points were used in this study. These lithic assemblages were obtained from the 1999-2012 excavation seasons and from the layers B, B1-B3, C and C/D. All of the artifacts classified as points and selected for this study have sharp tips. Attributes recorded include point types, impact scars types on the dorsal and ventral faces of points, the existence or absence of basal modification, retouch types, overall shapes, the existence of notching, as well as length and width measurements of stone tools. Impact scars were defined based on Frison's (1974) description of impact damage on points from the Casper site. Typological distinctions of points were identified based on Hours' (1974) typology. Additionally, butt shapes and the retouch types of points were identified in this study (Inizan et al. 1999). Basal modification was examined by analyzing the retouch in dorsal and ventral face of proximal end of points. Also, the cluster analysis was used to classify point shapes in this study. Shapes of the points were described by a system of radial measurements (Figure 3). First, an unaltered rectangular framework was drawn around scanned images of each of the point. The center of the frame was defined by the intersection of perpendicular lines indicating maximum length and mid-point width. Then, 16 lines were drawn at regular angular intervals of 22.5 degrees from the geometric center of the rectangle points to the margins. The distance from the center to the point's edge was then measured for each line. The 16 equally-scaled measurements for each point were then subjected through a k-means cluster analysis to search for groupings of overall point size and shape.

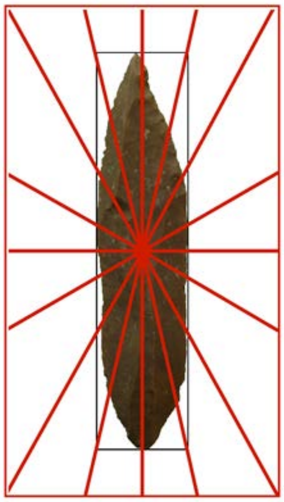

Figure 3. An unaltered rectangular framework was drawn around scanned images of each of the point for discription of the point shapes.

Results

Frequency of impact damage and basal modification

The functional analyzes on points provides important information about the behavior and hunting strategies of prehistoric humans. Studies of points indicate that points must have some features to be used as hunting weapons, such as impact scars, hafting modification and sharp tip (Villa et al., 2009*b*). Studies of impact scars on lithic points starts with Frison's work (1974) on projectile points at the Paleo-Indian bison kill site of Casper, and followed by the experimental work by Bergmann and Newcomer (1983), Fischer et al. (1984), Odell and Cowan (1986) and O'Farrell (1996, 2004). In this study, identification of impact scars is based on Frison's (1974) description of impact damage on Casper points. These include flute scars, step terminating, crushing damage, burin-like, and spin-off scars. However, points from the Ahmarian period at Üçağızlı Cave exhibited three kinds of impact scars: flute-like, step terminating and burin like impact scars (Figure 4). These scars are seen at the distal end on the ventral or dorsal faces of the points. Flute scars refer to bending fracture scars with feather termination in the terminology of Fischer et al. (1984). Step terminating scars are identified as blunt fractures at the distal end of the point and appear stair like in cross section. Finally, burin-like impact scars originate from the tip or from a bend breaks, and extend obliquely along the lateral edge of the point (Fischer et al., 19849.)

Roughly 24.5% of points from the Ahmarian layers at Üçağızlı Cave showed evidence of impact damage at their distal (pointed) ends. Of 309 lithic points, 44 (14.23%) showed impact scars only on the dorsal face at the distal end, and 26 points (8.41%) showed impact scars only on the ventral face. Only 6 of 309 points (1.94%) showed impact scars on both the ventral and dorsal face. However, impact scars on 23 of the 309 specimens could not be defined because distal ends of these tools were broken. The flute-like scar was the most common impact damage type on the dorsal faces of lithic points, with 34 of 309 points showed flute-like scars on the dorsal face (11%). It was followed by burin-like scars (3.88%) and by step-terminating scars (1.29%). On the ventral face, the dominant impact scar was the burin-like scars, with 14 of 309 points displayed burin-like scars on the ventral face (4.53%). It was followed by flute-like scars (3.56%), and by step-terminating scars (2.27%).

Additionally, the distribution of impact scars across the Ahmarian layers was examined to see if there might have been differences in how the points were used (Figure 5). The results showed that there were no important differences between layers in terms of the frequency of impact scars on the dorsal face. In all layers the dominant impact scar type was the flute-like scar, followed by burin-like and step-terminating scars. Layer C/D yielded only two points, neither of which contained impact scars on the dorsal face. Although the points from layers B1-B3 showed more impact scars than the other layers, there was great homogeneity between the Ahmarian layers in terms of appearance of impact scars on the dorsal face. On the other hand, the main impact scar type on the ventral face was the burin-like scar. This appears mostly in the layers B1-B3. As with scars on the dorsal face, frequency of appearance of impact scars on the ventral face did not vary much among three Ahmarian layers.

The studies of point types indicated that the frequencies of point types were similar across all Ahmarian layers. Analysis of point types showed that 233 of 309 points were defined as Ksar 'Akil points (75%), and this form was common in all Ahmarian layers. It was followed by El Wad point, which included 23 of 309 points (7%). Since 33 points were badly broken, their types could not be defined in this study.

Figure 4. Impact scars on points from Üçağızlı Cave: A flute-like scars: B step-terminating scar; C burin-like scar.

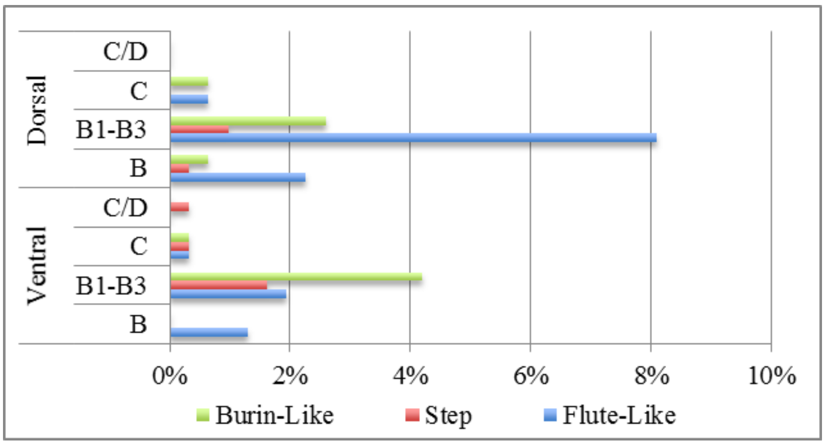

Figure 5. Comparison of impact scars on dorsal and ventral faces of the points with the Ahmarian layers.

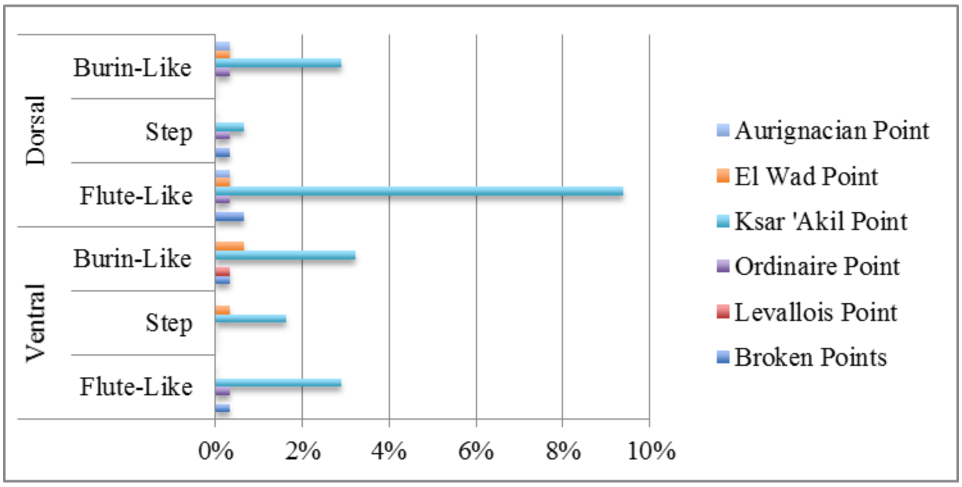

Figure 6. Comparison of point types and impact scars on the dorsal and ventral face of points from Üçağızlı Cave.

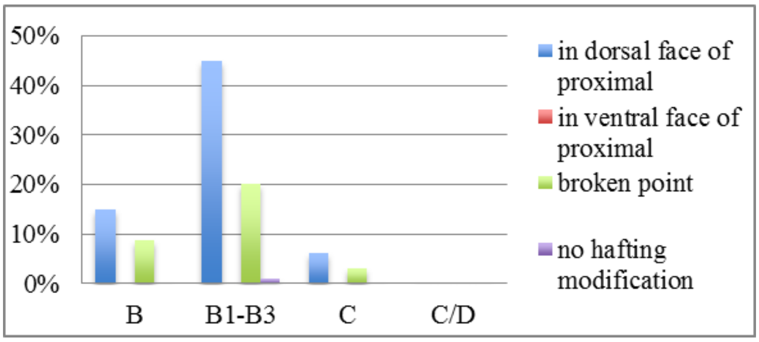

Figure 7. Comparison of the Ahmarian layers and basal modification on lithic points from Üçağızlı Cave.

The impact scars on the dorsal and ventral faces of different point types were compared to determine if there were important differences in the frequency of impact scars according to artifact morphology. This analysis demonstrated that only three of the 33 undefined broken points presented impact scars on the distal edge of the dorsal face (9.7%). Levallois and Mousterian points did not show any impact scars. However, majority of the impact scars were found on Ksar ‘Akil points. In all, 29 (9.39%) Ksar ‘Akil points showed flute-like scars, nine (2.91%) of them showed burin-like scars, and two (0.65%) of them showed step-terminating scars on the distal end of dorsal faces. Among the El Wad and (scarce) Aurignacian points only burin-like and flute-like scars were recognized, and their frequency of appearance was same in both point types. Also, impact scars on the ventral face of the points were also compared with point types. According to this analysis, most of the impact scars were observed on the Ksar ‘Akil points, since these points represented the majority of specimens. However, the distribution of impact scars among the point types demonstrated that there were more similarities in frequency of impact scars on ventral face than on the dorsal face (Figure 6).

Besides the impact scars, basal modification on Ahmarian points from Üçağızlı Cave was examined in this study. Studies present that thinning or modification of proximal ends of points may have accommodated the bases of points to the hafting (Villa et al., 2009*a*; Rots et al., 2014; Wilkins et al., 2015). Hafting modification is among the important indicators of tool function in prehistoric studies. Therefore, hafting studies shed light on prehistoric technology and human behavior (Rots, 2013). Lombard suggests that employing of hafted spears for hunting tools implies the planned manufacture of tools at the site (Lombard, 2005). At Üçağızlı Cave, the majority of the points exhibited some form of modification on the proximal end of the point, which could be facilitated or resulted from hafting. In all 206 of 309 lithic points preserved some modification on the proximal end (67%), and most of them were seen in the layers B1-B3. Only one point showed basal modification just on the ventral face and four points lacked any basal modification on the dorsal or ventral faces of proximal end. However, 99 of 309 points (32%) had broken proximal end, so their basal modification could not be recognized. A total of 56 of 309 points (18%) showed both basal modification and impact scars (Figure 7).

The points were also divided into three general shape classes, symmetric, semi-symmetric and asymmetric (Figure 8). Overall shapes were identified on 254 objects, which were either unbroken or broken but with their shapes still definable. After recording the overall shapes of the points, the frequencies of impact scars and possible hafting damage or basal modification were compared. In layers B and B1-B3, the most frequent category of points was asymmetric, while in the layer C symmetric points were more common. In layer B1-B3, frequencies of symmetric and semi symmetric points were very similar, while the number of asymmetric points was higher. The comparison of overall shapes with impact scars on the dorsal face included only 59 points, which were unbroken and showed impact scars. The results demonstrated that there was no significant difference in the frequencies of impact scars on points corresponding to various shape classes. In symmetric, semi-symmetric and asymmetric points, flute-like scar was the most common impact scars (52.54%), followed by burin-like scars (18.64%) and step-terminating scars (5.08%). The comparison of impact scars on ventral face and over all shape provided similar results although only 28 lithic points with definable shape were examined (Figure 9). Basal modification also occurred at similar frequencies across the three main point shape groups (Figure 10).

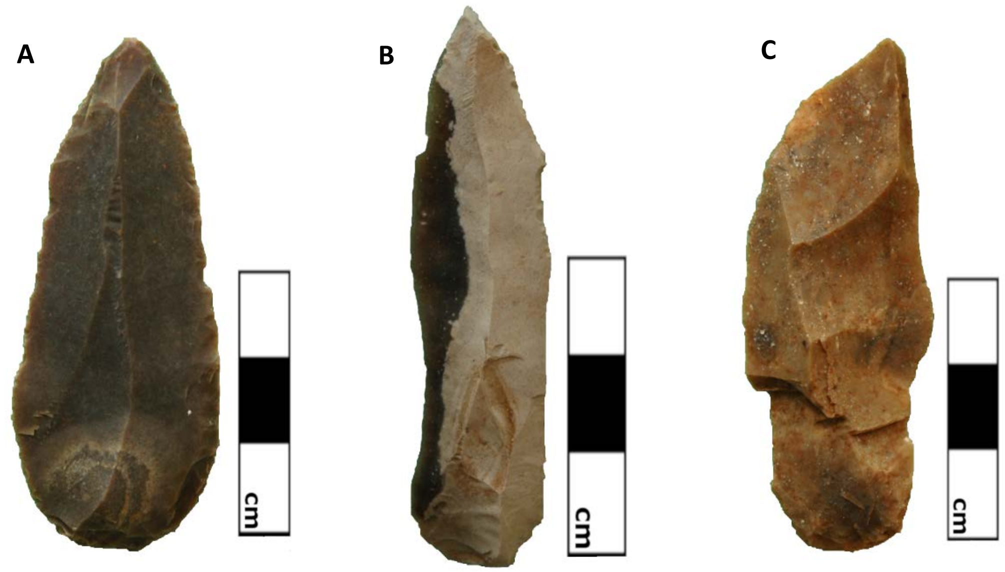

Figure 8. Overall shapes of points from Üçağızlı Cave: A symmetric; B semi-symmetric; C asymmetric points.

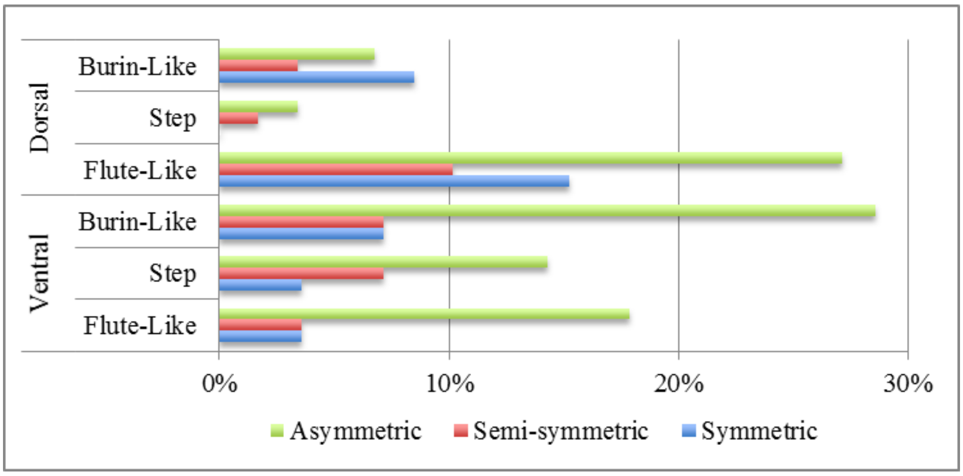

Figure 9. Comparison of overall shape of points and impact scars on dorsal and ventral faces of the points.

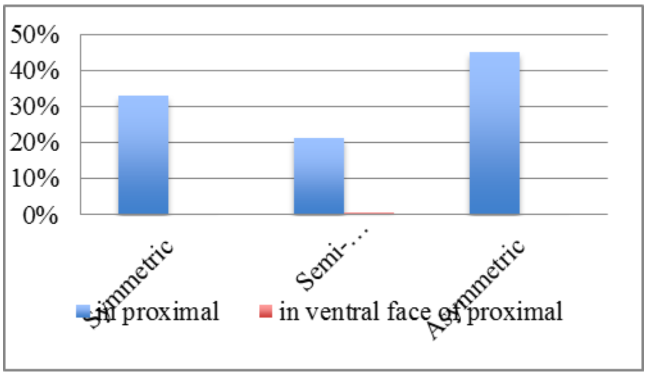

Figure 10. Comparison of overall shape of points and basal modification.

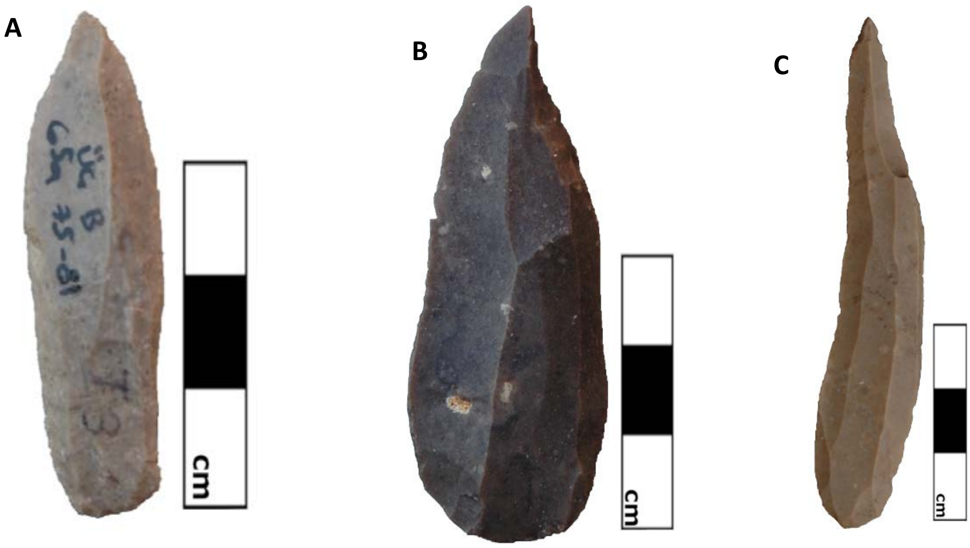

Figure 11. Butt shapes of points from Üçağızlı Cave: A straight; B lightly constricted; C heavily constricted.

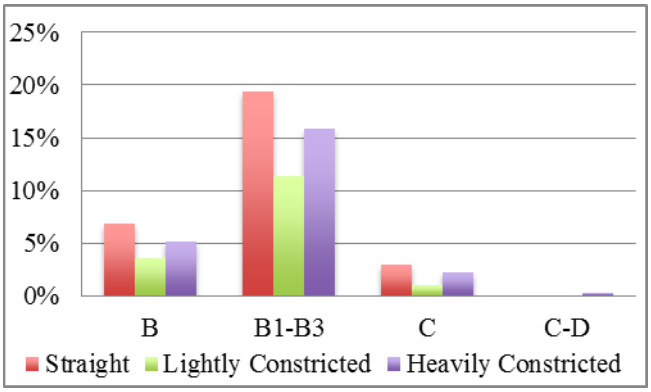

Figure 12. Comparison of butt shapes of points with Ahmarian layers at Üçağızlı Cave.

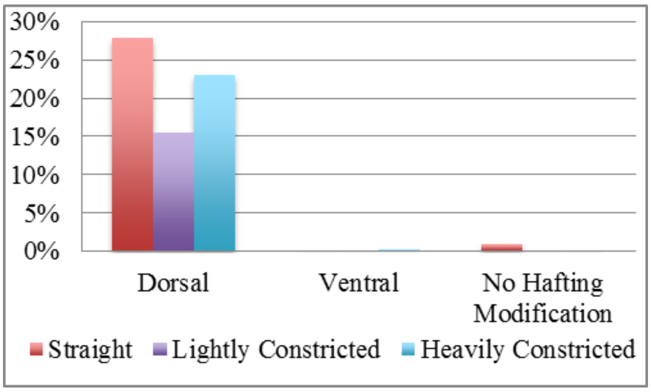

Figure 13. Comparison of butt shapes and basal modification on lithic points from Üçağızlı Cave.

Butt shape is another attribute that could be related to the function of points and/or basal modification. The butt shapes of the points from the Ahmarian layers at Üçağızlı Cave were analyzed as expanding, straight, lightly constricted, and heavily constricted (Inizan et al. 1999). In this study, 97 of 309 points (31.39%) had broken proximal end; therefore, the butt shapes were identified on 232 points. The points from the Ahmarian period at Üçağızlı Cave exhibited three kinds of butt shapes: straight, lightly constricted and heavily constricted (Figure 11). Most of the points in all layers had a straight butt shape (29.13%), and it was followed by heavily constricted (23.62%) and lightly constricted (15.86%) butt shape (Figure 12). Additionally, the comparison between the butt shapes and basal modification of points showed that mostly the points with straight and heavily constricted butt shapes included basal modification on their proximal end (Figure 13).

In addition to basal modification and impact scars, edge notching was documented on the pointed tools from Üçağızlı Cave. Notching can be defined as an indentation on the sides, corners, or at the base of the projectile points. Notching has been applied to projectile points throughout history to aid in hafting. Notching modification facilitates attaching the point to a spear, dart, or arrow shaft. It could also help points to fracture in a controlled, predictable way. Notches are not commonly identified on Ahmarian points in the Levant. However, 75 of 309 points (24%) exhibited shallow unilateral or bilateral notching at Üçağızlı Cave (Figure 14). Notches can be closer to the base or tip of the points. Some 49 of 309 points (16%) showed both basal modification and side notching. Most of the side notching was defined on points from layer B1-B3.

Figure 14. Notched points from Üçağızlı Cave.

Point shape clusters

An alternative approach to classifying point shapes, using K-means cluster analysis, was also attempted for this study. The cluster analysis, which was conducted using the 16 measurements described in figure 3 (above) provides a rough description of point shapes. According to the cluster analysis, the most parsimonious solution involved three size/shape classes (Figure 15). As the schematic diagram shows, differences between cluster centroids are subtle. Cluster 1 represented short and symmetric points, Cluster 2 included medium-sized and semi symmetric points, and Cluster 3 showed longer, narrower and slightly more asymmetric points.

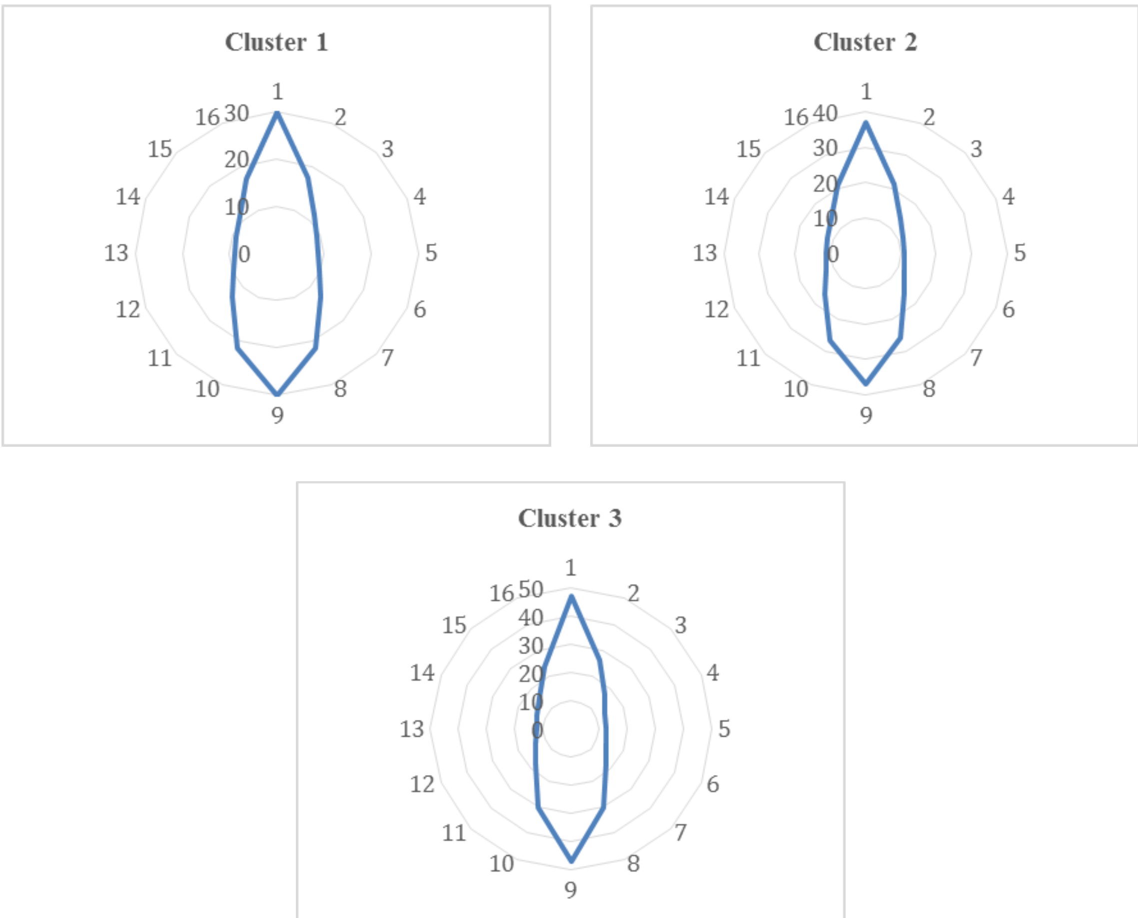

Figure 15. Three clusters representing morphological variability among points from Üçağızlı Cave. Vertical scale from center to top of figure represents dimension in mm.

These three clusters were compared in terms of impact scars on dorsal and ventral face, basal modification and retouch types to determine whether they were treated or used in different ways. The analysis of impact scars and clusters indicated that impact scars on dorsal face and on ventral face mostly appear in Cluster 1. In each three cluster, the dominant impacts scar on the dorsal face was the flute-like (12.8%) scars, and it was followed by burin-like (4.74%) and step-terminating (0,95%) scars. On the dorsal face 18.49% of points showed impact scars on dorsal face, while 10.42% of points exhibited impact scars on the ventral face. Additionally, on the dorsal face, most of the impact scars were seen in Cluster 1 (9.48%). However, the frequency of impact scars on the ventral face was not very different among the clusters (Figure 16).

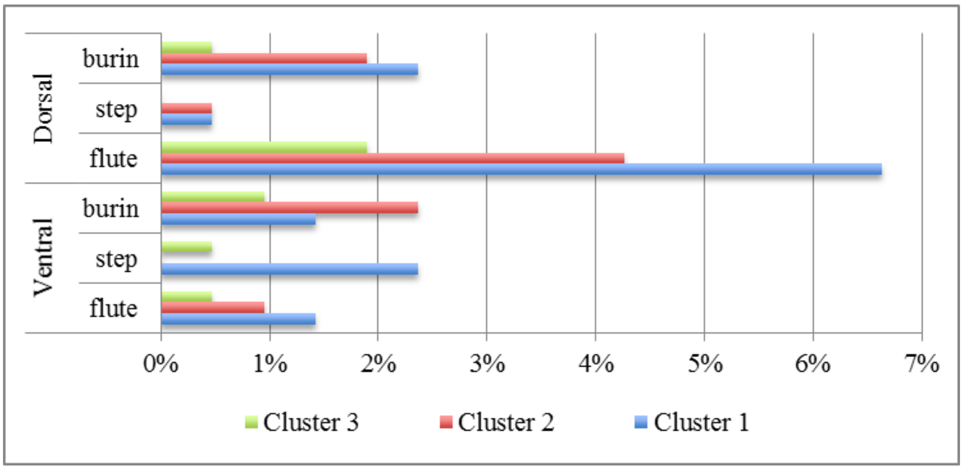

Figure 16. Comparison of three clusters and impact scars on dorsal and ventral faces of points.

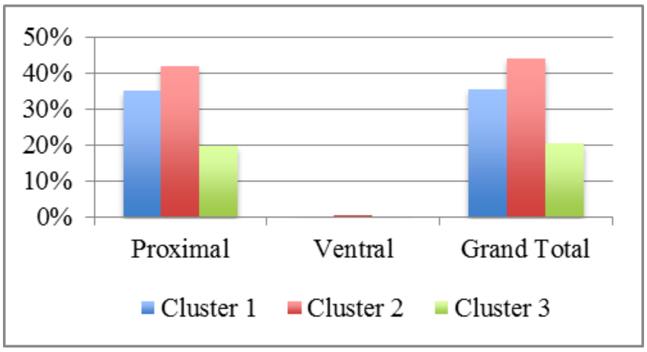

Figure 17. Comparison of three clusters and basal modification on points.

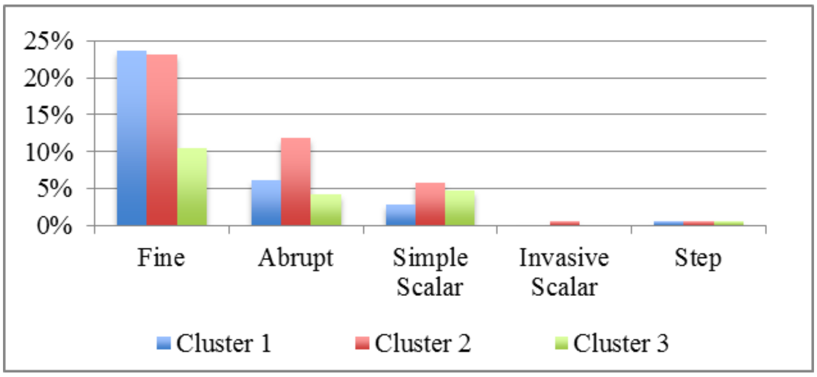

Figure 18. Comparison of three clusters and retouch types on points.

Further, the appearance of basal modification in Clusters 1 (35.55%) and Cluster 2 (44.08%) was very close to each other. Basal modification was less common on points belonging to Cluster 3 (20.38%) (Figure 17).

Additionally, the clusters and retouch type analysis demonstrated that the three clusters indicated similar results (Figure 18). In all clusters, the dominant retouch type was fine retouch (57.35%), and it was followed by abrupt (22.27%) and simple scalar (13.27%) retouch types. Also, invasive and step retouch types were seen very rarely in each clusters.

Discussion and conclusion

Ahmarian assemblages have been found in the Levant in cave, rockshelter, and open-air sites, such as in Kebara Cave, Ksar Akil Cave, Tor Sadaf, Üçağızlı Cave, Qafzeh Cave and in open air-sites of Syria, Jordan, and southern Israel, and all sites have been dated to between 43–29 ka. The assemblages from these sites and time period are dominated by blade and bladelet tools, with El Wad and Ksar 'Akil points and endscrapers and burins. In the Levant, Ahmarian assemblages often include a large number of pointed tools; however, there are few studies of the functions of these points and impact scars on them. This study analyzed the impact damages and basal modification on the points from Ahmarian layers at Üçağızlı Cave to contribute to information about the function of the projectile points from the Ahmarian period in the Levant. Also, this study aimed to determine if there were any changes in the use of pointed tools across the Ahmarian period at Üçağızlı Cave.

The results presented in this study show that impact scars, basal modification, point types, and overall shapes vary little across the Ahmarian layers at Üçağızlı Cave. This similarity implies that there is a high level of technological homogeneity among the Ahmarian layers at Üçağızlı Cave.

Impact scars on the points occur when a point strikes against any hard material, such as bone, wood, or rock. At Üçağızlı Cave, the dominant point type is the Ksar 'Akil point and these points frequently show flute-like scars on the distal end. On the other hand, retouch on the distal end of points can reduce the effect of the impact on the point by strengthening the tip and erasing traces of past impact scars. Therefore, the absence of the impact scars on many of the points from Üçağızlı Cave could be related to the retouching on the tips.

The studies related to hafting modification indicated that proximal ends of the points were often modified, perhaps to attach them to the ends of spears. The analysis of basal modification showed that most of the points, 67%, preserved possible basal modification on their proximal end. Analyses of butt shape indicated that the Ahmarian points at the cave mostly had straight butt shape, and it was followed by heavily constricted. The butt shape is another modification that might be related to hafting. Lateral notching is another attribute that might be related to hafting. In an unexpected finding, 24% of the points at the cave showed shallow uni/bilateral notching and 16% of the points exhibited both basal modification and side notching. Notched points have not previously been identified in other Ahmarian sites of the Levant. Additionally, 33 of 309 points were incomplete. Some of these points were broken at their distal ends, and they exhibited possible shallow side notching closer to the tip of the points. Since, notched points have not been identified at other Ahmarian sites of the Levant, the notched specimens from Üçağızlı Cave provide new information about the possible functions of Ahmarian points.

Nadel et al. (1991) studied Levantine arrowhead types, and suggest that side notching at the distal end of the points may cause a potential weakness on points. The study by Bergman and Newcomer (1983) shows that the breaking occurs on the distal ends of the points when they were used as arrowheads. Most of the notches on Ahmarian points from Üçağızlı Cave are located in the distal half of the point, suggesting one of two possibilities. Perhaps the points were placed very deeply in the shaft, so that the notches were actually part of the hafting modification. Alternatively, the forward-placement of the notches could have been intended to cause the point to break off in the wound, causing greater bleeding in the prey. For this reason, it is thought that these broken notched points at Üçağızlı Cave were most probably used during the hunting activities as projectile points, and they were broken from their distal ends across the side notches sides when they impacted hard material.

Previous studies of stone points indicate that hafting modification, impact scars and sharp tips must be present to be reasonably certain that artifacts were projectile points (Villa et al., 2009c). In this study, the cluster analysis results showed that many of the short and medium-sized points (clusters 1 and 2) often included all these attributes, such as basal modification and impact scars. Therefore, these short and medium sized points from Ahmarian layers at Üçağızlı Cave can be regarded as possible projectile points. The longer, narrower points (cluster 3) possess the attributes less often, and may represent multi-functional artifacts (knives for example).

The results of analyses of basal modification, impact scars, and notching support the idea of that many pointed artifacts were parts of projectile weapons during the Ahmarian period at Üçağızlı Cave. Shea's work (2006), the tip cross-sectional area values (TCSA) suggest that early Upper Paleolithic points from Üçağızlı Cave could have been used as projectile points. However, it is important to note that faunal remains at Üçağızlı Cave imply that these points could have other functions, rather than projectile weapons. For instance, tool marks found on some ungulate bones at the site related to de-fleshing and butchering activities, and lots of cut marks on shafts of limb bones were recognized at the site (Stiner, 2009). These findings compel us to think that some of the points without all of the attributes of projectile tips could have been used as knives or perforators. It is also possible that some of the impact scars on these points occurred during butchering activities when knives came into contact with bones.

The development of new tool types in prehistoric periods resulted from changing in conditions or requirements. For instance, population growth and stress on prey populations may require changing hunting strategies and hunting of broader range of animals. Therefore, employing projectile points may have helped Ahmarian groups increase the hunting success rate and diet breadth by reducing the pursuit time for hunting (Kelly, 1995). Faunal remains from Üçağızlı Cave show that small game animals, such as rabbit, bird, squirrel, began to play an important role in diet from Ahmarian to Epipaleolithic periods (Kuhn et al., 2009). In the light of this information, it could be thought that projectile points were used to exploit the fast and small animals at Üçağızlı Cave. Alternatively, they could have helped people exploit larger game more effectively, thereby offsetting declining abundance of big animals.

Most of the studies of the functions of points are based on experimental and use-wear analyses. Since this study does not involve either experimental or use-wear analyses, it is difficult to draw precise conclusions about the function of the points. Nevertheless, this study revealed important data to suggest that points, which exhibit impact scars, notching, and basal modification, could have been used as projectile points during the Ahmarian period at Üçağızlı Cave. Further, all the comparisons among layers demonstrated homogenous results. These findings indicated that there were no important changes in the use of projectile points across the Ahmarian period at Üçağızlı Cave. It is hoped that this study will contribute to a better understanding of the technological and functional aspects of the points from the Upper Paleolithic in the eastern Mediterranean region. Additionally, this study could serve as a possible basis for more detailed analyses about the Ahmarian points aimed at a more complete understand of their functions.

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