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İçindekiler / Contents

Agricultural Practices at Mentesh Tepe (Kura Valley, Azerbaijan) during the Neolithic, Chalcolithic and Bronze Age: An Overview from Sickle Elements and Botanical Remains

Laurence Astruc[a], Alexia Decaix[b], Denis Guilbeau[c], Bertille Lyonnet[d], Farhad Guliyev[e]

Abstract

The Neolithic process took place in the South Caucasus between the very end of the 7th and the early 6th millennium BCE, at least two millennia after it had already taken place in neighboring Anatolia and Iran. Agriculture appeared at that time, and was the main basis of the economy, together with herding. Cereals, mainly barley and different kinds of wheats, were the dominant cultivar. Mentesh Tepe, one of the rare multi-period settlements of the region, allows us to witness the development of ancient agricultural practices, since Neolithic, Chalcolithic and Bronze Age occupations have been identified there. The site is located in Azerbaijan in the vicinity of the Zeyem Cay, a tributary of the Kura River, some 10 km from the foothills of the Lesser Caucasus. We present here data originating from the analyses of botanical remains and techno-functional lithic tools studies. We have thus been able to identify trends and changes through time affecting cultivation and harvesting techniques. These are the result of economic

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and socio-cultural changes and reflect both the organization of communities and the technical skills of local inhabitants.

Keywords: Caucasus, Neolithic, Chalcolithic, Bronze Age, agriculture

Özet

Güney Kafkasya'da Neolitik Dönem, Anadolu ve İran gibi komşu coğrafyalardan en az iki binyıl daha geç, MÖ 7. binyılın sonu ve 6. binyılın başlangıcında başlamıştır. Bölgede aynı dönemde ortaya çıkan tarım, hayvancılıkla birlikte ekonominin temelini oluşturur. Arpa ve farklı buğday türleri başta olmak üzere tahıllar ekimi en yoğun yapılan türlerdir. Bölgedeki ender çok dönemli yerleşmelerden biri olan Menteş Tepe Neolitik'ten Tunç Çağı'na dek tarımsal faaliyetlerin gelişiminin takip edilebilmesini sağlamaktadır. Yerleşme Azerbaycan'da, Kura Nehri'nin kollarından biri olan Zeyem Çayı'nın yakınında, Küçük Kafkas Dağlarının eteklerine 10 km mesafede yer almaktadır. Bu çalışmada, yerleşmede bulunan botanik kalıntıların analizleri ile taş aletlerin teknolojik ve kullanım izi analizlerine dayanan veriler sunulmaktadır. Bu veriler, yerleşmede zaman içerisinde tahılların kültüre alınması ve hasadındaki değişimleri tanımlayabilmemizi sağlamaktadır. Bu değişimler, ekonomik ve sosyo-kültürel değişimlerin sonucudur ve hem toplulukların sosyal organizasyonunu hem de yerleşme sakinlerinin teknolojik becerilerini yansıtmaktadır.

Anahtar Kelimeler: Kafkasya, Neolitik, Kalkolitik, Tunç Çağı, tarım

Introduction

The process of Neolithic transformations in the South Caucasus took place between the very end of the 7th and the early 6th millennium BCE, at least two millennia after it had already occurred in neighboring Anatolia and Iran. Clusters of settlements belonging to the Shomu-Shulaveri culture appear along the Middle Kura River valley, and related or other cultural groups along the Araxes River valley and in the Ararat plain (Badalyan et al. 2004, 2007, 2010; Martirosyan-Olshansky et al. 2013; Chataigner et al. 2014; Nishiaki et al. 2015a; Nishiaki and Guliyev 2020; Palumbi et al. 2021). They are a testimony to increasing sedentism and bear witness to the rise of an economy predominantly relying on domesticated species, as shown by botanical and faunal analyses. The Near Eastern origin of this fully developed Neolithic is still debated, as the possible input of local Mesolithic groups (Nishiaki et al. 2019).

In this agricultural context, cereals were the most important cultivar. These plants are of paramount importance in the models of food production, marking not only the Neolithic but also the entire Chalcolithic period (5th and first half of the 4th millennium BCE) and Bronze Age (3500-2500 BCE). Profound modifications in settlement patterns, architecture, acquisition of raw materials, technical preferences and skills, the appearance and development of metallurgy, changes in relations with groups from other regions and in the cultural and socio-economic background, undoubtedly occurred through time. A cereal-based economy was supplemented by the cultivation of pulses. Species of cereals were not necessarily the same but sowing and harvesting them were important moments of the year for the inhabitants of most settlements. Apart from botanical remains (identifiable chaff and seeds), the ancient inhabitants of the Caucasus left behind tools, testimonies of their agricultural practices, for instance stone lithic blanks used as sickle elements. These were fixed to wooden, bone or antler hafts, and were used to cut crops. Complete sickles are sometimes found at archaeological sites. The lithic elements of these sickles vary in their raw material, shape, and size; moreover, their evolution through time can be illustrated, the changes revealing the farmers' technical know-how and permitting reconstructions of the harvesting techniques.

Botanical remains and sickle elements are key to reconstructing ancient agricultural practices. The goal of this paper is to follow the evolution of these practices at Mentesh Tepe (Figure 1) over a long-time span, one of the rare multi-period sites in this region. Three major occupations have been identified for the Neolithic (Mentesh I), Chalcolithic (Mentesh II and III) and Early Bronze Age (Mentesh IV), and these were each separated by hiatuses.

Presentation of the Site

The site of Mentesh Tepe is located in the vicinity of the Zeyem Cay, a tributary of the Kura River, at a distance of about 10 km from the foothills of the Lesser Caucasus. The site is surrounded by houses and gardens. This region is now deeply transformed by human settlement and activity, notably by cereal and potato farms. Better-preserved natural landscapes still exist on the alluvial plain and the slopes of the Lesser Caucasus, which is marked by various kinds of vegetation: (1) riparian forests along the rivers on the alluvial plain, where the main species of trees belong to the *Salicaceae* family, followed by tamarix (*Tamarix* sp.), alder (*Alnus glutinosa*) and elm (*Ulmus laevis, U. minor*); (2) the *shibliak,* an open shrub land developing at lower altitudes on dry slopes and dominated by Christ's thorn (*Paliurus spina-christi*); (3) a mixed forest with several species of oaks (*Quercus iberica*, *Q. robur, Q. macranthera*) (Bohn et al. 2003; Gabrielian and Fragman-Sapir 2008). Anthracological analyses undertaken in the Middle Kura Valley have shown that, from the Neolithic to the Early Bronze Age, the inhabitants collected wood mainly in the riparian forest, and secondarily in the open woodlands where heliophilous trees were growing (Decaix 2016; Decaix et al. 2016). A more densely forested landscape has been identified through the presence of yew (*Taxus baccata*). The continuous development of maple trees (*Acer* sp.), of others from the *Rosaceae* family and of Christ's thorn (*Paliurus* sp.) may be an indication of a decrease in the forested cover and of a more open environment, with the creation of drier *shibliak* landscape formations, perhaps caused by an increase in the anthropogenic impact at the beginning of the Bronze Age (Decaix 2016; Decaix et al. 2016).

Neolithic occupation at Mentesh Tepe was not of long duration (between ca. 5880-5536 cal. BCE). The geographical location of the site makes it the easternmost known settlement of the Shomu-Shulaveri culture (henceforth SSC). Two main phases have been identified, separated by a thick layer of burnt ashes, but the upper one is very poorly preserved (Lyonnet et al. 2016, 2017). The architecture, with round constructions of plano-convex mudbricks and cob that are either above-ground or semi-subterranean, is typical of the SSC. Most of the finds (lithics, pottery, botanical and zoological remains) come from the first phase, and almost all were discovered in a large man-made pit used as for the deposition of refuse, while the buildings themselves were almost totally void of any implements. Pottery is not very abundant and, during phase 1, is exclusively tempered with vegetal seeds of Poaceae, a rather rare temper occurrence in the Shomu-Shulaveri culture that may be due either to not yet well understood regional differences or to chronology. Relations in shapes with the more easterly region of the Karabagh and Mil Plain have been identified. The scarce sherds from phase 2 are closer to SSC standard pottery (Lyonnet 2017).

After a hiatus of ca. 800 years, very short and ephemeral occupation is attested in the Early Chalcolithic period (Mentesh II, ca. 4800-4500 cal. BCE), consisting of post-holes and pits containing specific pottery types that share similarities with those known in the Alazani valley (Lyonnet et al. 2012; Lyonnet 2017). This period was followed by a short gap in occupation, until the site was settled during the Middle/Late Chalcolithic 1 period (Mentesh III, ca. 4300-4050 cal. BCE). This time was marked by well-planned architecture made of flat mudbricks (with possibly the remains of a tripartite building), and by the testimonies of many different activities (several pottery kilns, metallurgy) (Lyonnet et al. 2012, 2017). One finds several indications of relations with northern Mesopotamia at that time, that further increasingly developed slightly later, during the Late Chalcolithic period, the time of the Leilatepe culture, which, however, is absent from Mentesh Tepe itself.

This was followed by a long period of abandonment, until the site, becoming a shapeless small mound, was re-used in the Early Bronze Age as the location of two funerary chambers dug into previous layers, each caped with a kurgan of river pebbles. The first funerary construction pertains to the Early Kura-Araxes period I, ca. 3500-2900 cal. BCE, and contained 39 individuals (Lyonnet 2014; Pecqueur in Poulmarc'h et al. 2014). The second one dates to the Early Kurgan/Martkopi period, ca. 2500-2400 cal. BCE, and was rather lavish since it contained 3 individuals and a wagon with four wheels (Pecqueur et al. 2017). Several pits, especially found around the second kurgan, are associated either with its construction or with ephemeral occupation from a time a little earlier. They yielded some archaeological material, unfortunately often mixed with that of earlier layers.

Archaeobotanical Remains

Method

More than 2000 liters of sediment, sampled from various contexts such as pits, floor layers, or hearths, were sieved in the excavation house: a flotation device with a 0,5mm mesh sieve was used. After drying, the samples were studied using a binocular microscope for seeds and fruits and an optical reflecting-light microscope for charcoal fragments. Macrobotanical remains were mainly preserved in charred form, and some of them were biomineralized (Boraginaceae, *Celtis* sp.). Modern reference collections of seeds and fruits and atlases were used for comparisons (Berggren 1981; Jacomet 2006; Nesbitt and Goddard 2006; Cappers et al. 2009, 2011; Neef et al. 2012; Cappers and Bekker 2013). Fragments of charcoal were identified by using a collection of modern wood, as well as wood anatomy atlases (Schweingruber 1990; Parsa Pajouh et al. 2001; Benkova and Schweingruber 2004; Schweingruber et al. 2011).

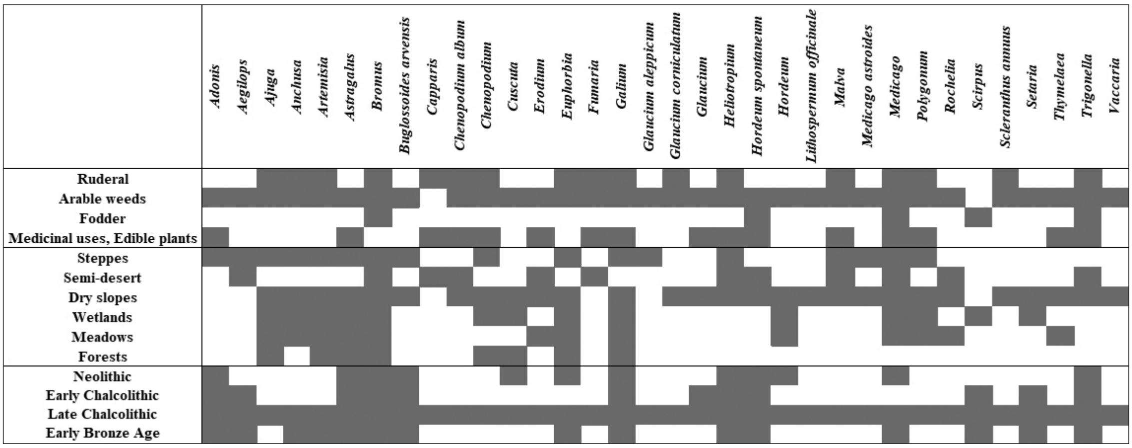
Results

Analysis of seeds and fruits from Mentesh Tepe was based on more than 40,000 items, belonging to 88 stratigraphic units, and covering the various phases of the site's occupation; Mentesh III, belonging to the last third of the 5th millennium BCE, gave most of the samples. Only those with secure chronological attribution will be discussed in this paper (71 samples).

Cereal remains were predominant since the Neolithic (Figure 2). Their morphology shows that they were already fully domesticated cereals. Three cereal species have been identified: barley, emmer, and free-threshing wheat. Although barley was the main crop identified in all periods, free-threshing wheat became more important during the Chalcolithic, while emmer less so. Pulses, as lentil, grasspea and pea/vetch type, were identified in the entire chronological sequence, which was not the case for flax found only in Mentesh III. Most of the samples are made up of cereals, pulses, with some remains of certain fruit trees and wild plants, which tend to show that we are dealing with detrital assemblages, where the remains might be of various origins, scattered in small quantities in the stratigraphic units. 47 taxa of wild plants have been identified, some probably arable weeds (Willcox 2012).

The vague identification of wild plants, mostly at the genus level, does not allow for a very thorough analysis of this category, which would for instance make use of the FIBS method (*Functional Interpretation of Botanical Surveys*). Indeed, in order to apply this method, it would be necessary to identify the taxa as precisely as possible—i.e., at the species level—because elements considered by the analysis are specific to each species (biological type, germination period, flowering period, leaf height, average leaf area). This type of analysis can address important issues like crop intensity, sowing seasonality, use of irrigation systems or manuring systems (Charles and Jones 1997; Bogaard et al. 1999; Jones et al. 2000; Charles 2002). However, despite the unfeasibility of this type of analysis as a result of the current state of taxa identification, a first approach can look at sowing seasonality by studying the beginning and duration of the flowering period of wild herbaceous plants. This would provide an estimation of the sowing seasonality of the cultivated plants with which they are associated. Table 1 indicates, for each taxa of wild plants, their possible 'function' (arable as weeds, ruderal plants, fodder or even as medicine or food), as well as their possible environment of growth.

Table 1. Taxa of wild plants identified at Mentesh Tepe, with possible uses and environments of growth.



Thus, in the case of cereals sown in the autumn and harvested in the spring/early summer, early germinating and flowering weeds would have had a survival advantage over later germinating or flowering weeds. On the other hand, if cereals were sown in spring and harvested in summer, the autumn wild species would have been eliminated during pre-sowing tillage, and the spring germinating weeds would have had the best chance of survival (Bogaard et al. 2001; Bogaard 2004).

For each genus identified in the botanical assemblage, the flowering period (as well as its duration in months) of the various species potentially growing in the Southern Caucasus has been recorded thanks to the use of flora inventories (Bobrov et al. 1934; Davis et al. 1965; Gabrielian and Fragman-Sapir 2008).

Neolithic Period (Mentesh I)

Cereals were the main plants represented among the crops (97%) during the Neolithic (Figure 2). It should be emphasized here that a majority of cereal remains were not determined beyond the family level (68%), due mainly to their state of preservation. Among identified remains, barley was dominant (Figure 3, 16%), followed by emmer (7%) and naked wheat (5%). Unidentified wheat remains were also present (4%). Caryopses (96%) dominated in relation to chaff remains (4%), regardless of the cereal concerned.

Pulses were also attested (2%, mainly lentils, and only one seed of an undetermined pulse was found). While no plant remains used for manufacturing items (such as flax) were identified, fruit trees from woodlands and wild plants each accounted for 7% of seed and fruit remains. Fruit trees from woods were represented by hackberry (*Celtis* sp.) and grapevine (*Vitis vinifera*). There were twenty taxa of wild plants, mainly 'harvest' or ruderal species (*Adonis* sp., *Astragalus* sp., *Bromus* sp., *Cuscuta* sp., *Euphorbia* sp., *Galium* sp., *Heliotropium* sp., *Hordeum* sp., *Medicago* sp., *Trigonella* sp.). Spontaneous barley, a plant belonging to semi-desert environments or dry mountain slopes, as well as corn gromwell (*Buglossoides arvensis*), were also present. 91% of the wild plants discovered have a beginning of their flowering period between January and June (Figure 4), and 63% a flowering period from March to June. 82% have a short flowering time-span extending from one to three months.

Early Chalcolithic Period (Mentesh II)

Due to the smaller number of samples from this period, the data presented should be considered from a qualitative more than from a quantitative viewpoint.

At the beginning of the Chalcolithic, cereals still largely represent the main excavated plant remains (Figure 2). Once more, a majority of cereal remains were not identified beyond the family level (70%) due to their poor state of preservation. Among the more precisely determined remains (Figure 3), barley dominates (17%), followed by naked wheat (7%) and emmer (3%). 3% of the cereal remains were identified only at the level of one genus: wheat. The proportion of chaff (7%) is slightly higher than in the Neolithic, but in the cases of the three cereals identified, caryopses still remain dominant (93%). Pulses (3%) are in greater proportions than during the previous period. Once again, lentils were the main legume identified (one seed from the pea/vetch type and one from an undetermined pulse were also found).

Also, during this period, no plants used in manufacturing items were recognized. Fruit trees from woodlands are represented only by a grapevine seed (*Vitis vinifera*). 21 wild plant taxa were identified. These are mainly messicolous and ruderal plants (*Adonis* sp., *Aegilops* sp., *Artemisia* sp., *Astragalus* sp., *Bromus* sp., *Galium* sp., *Glaucium* sp., *Heliotropium* sp., *Setaria* sp., *Trigonella* sp.). Two taxa representative of semi-desert environments or dry sloping areas are also present (*Buglossoides arvensis* and *Hordeum spontaneum*), while taxa more closely related to wetlands were identified (*Scirpus* sp.). During this phase, 89% of the wild plants were flowering between January and June (Figure 4), and 65% from March to June. For 82% of those plants, the flowering duration would have been short, between one to three months.

Middle/Late Chalcolithic (Mentesh III)

In the last third of the 5th millennium BCE, wild plants were apparently more important than in the previous period. However, this is probably an artifact of a single sample, which has biased the picture. Indeed, a sample from the filling of jar 14 (FLOT 052) yielded numerous euphorbia (*Euphorbia* sp.) remains, and although some of them could have been subjected to the action of fire, this does not seem to have been the case of a large majority. They could, therefore, be modern seeds, or at least more recent than the site's occupation phases. Keeping this sample, wild plants represent 55% of the identified assemblage, and the crops 45%. By removing this specific sample, the situation is reversed: cultivated plants were the main remains identified (53%), followed by wild ones (47%) (Figure 2). Among the cereals (Figure 3), barley constituted the greater part, with 27% of the remains, followed by free-threshing wheat at 6%, while emmer represented only 1%. It should be noted, however, that while remains of undetermined wheat represented only 2% of the total of cereal remains, undetermined cereals only made up 64% of the total. Caryopses constituted most of the cereal remains (93%).

Among pulses, lentils were dominant, but grass pea (*Lathyrus sativus*) was also present, as were the remains of peas or vetch (*Pisum/Vicia*) and those of undetermined cultivated pulses. Flax was identified for the first time at the site during this period.

Among the fruit trees from woodlands, hackberry (*Celtis* sp.) and grapevine (*Vitis vinifera*) were attested. For the latter, it should be noted that two of the four pips identified were mineralized. Their age was therefore difficult to assess. Finally, 47 taxa of wild plants were identified, mainly messicolous or ruderal plants, as well as a few taxa from dry environments and wetlands, for instance the bulrush (*Scirpus* sp.). 84% of the potential weed species would have a beginning of the flowering period before June and 57% a flowering period from March to June. 80% of these plants had a short flowering period lasting between one and three months (Figure 4).

Early Bronze Age (Mentesh IV)

Cereals were the main crops identified in the Early Bronze Age samples (Figure 2). These mainly originated from contents of jars excavated in kurgan 54 but were also found in pits and hearths. The results should thus be taken with caution since the latter contexts are not perfectly secure as explained earlier. Barley, free-threshing wheat and emmer were present in proportions of 19%, 15% and 3% respectively (Figure 3). Barley and naked wheat mainly appeared as chaff (respectively 14% and 13% of chaffs against 5% and 2% of caryopsis), while emmer, which was present in minute quantities, was identified by almost as many caryopses as chaff (2% of each). Cultivated pulses represented less than 1% of the recognized remains: apart from a few remains of unidentified ones, only lentils were identified.

Flax was absent from samples attributed to this period. Among fruit trees, only one grapevine seed was identified. There were twenty-two taxa of wild plants, mainly messicolous or ruderal. Some taxa are more suited to dry or semi-desert environments (*Hordeum spontaneum, Buglossoides arvensis*), while others are more likely to be found in humid areas (*Scirpus sp.* for example). 61% of the wild plants would have flowered between March and June, with a flowering period starting before June for 86%. 82% of those plants would have had a short flowering duration (Figure 4).

To conclude, based on the analysis of seeds and fruits, crops, particularly cereals, formed a substantial component of the diet from the Neolithic to the Early Bronze Age. In each period, wild plants identified in the botanical samples were most probably arable weeds, growing jointly with crops in the fields. Most of them would have had a flowering period between March and June and would have grown between January and June. Most of them also had a short flowering season, between one and three months. Those weeds would have therefore been associated with autumn sowing (Bogaard et al. 2001) and were probably harvested in late June/early July. As already mentioned, it is not possible to go deeper in the analysis of weeds to reconstruct agrarian practices. A preliminary isotopic analysis on charred grains nevertheless allows further insight into the farming practices (Herrscher et al. 2018). Considering all periods, these analyses show that manure was probably used in wheat and barley fields, whereas pulses were presumably watered. One should now investigate the biochemical composition of cereals and pulses in a diachronic perspective, to identify possible changes over time in agrarian practices. As for cereal processing, the analysis of phytoliths (Decaix et al. 2016) from several of the site's structures has shown their presence during all periods, a result of inflorescence. This indicates that the de-husking phase took place on site, a fact consistent with the identification of chaff remains in macrobotanical samples. Chaff remains may have been used as fuel or mudbrick temper and for pottery during the Chalcolithic period. This analysis also shows that during the Neolithic and Chalcolithic periods cereal grains were brought in the houses directly without straw. These two components of the plant may have been separated outside the dwellings, whereas de-husking of cereals could have been done either inside or outside the houses. The analysis of macrolithic tools demonstrated the presence of many querns; some of these were probably related to cereal processing (C. Hamon, personal communication, October 2021).

Sickle Elements

Method

The expression 'sickle elements' traditionally refers to a typological group within the lithic industry. A macroscopic gloss is visible on these blanks by the naked eye. Use-wear experiments have demonstrated that such a gloss is often the result of a contact with cereals, but that it can also be the result of contact with other materials, for instance other siliceous plants such as reeds, or pottery, stone and hide worked in relatively humid conditions or/and with additives. This gloss is visible on most raw materials (chert, flint, chalcedony, silicified marls, etc.), except on obsidian since this volcanic glass naturally reflects light. In the case of obsidian tools, a matte surface can be seen by the naked eye when the blanks have been damaged by post-depositional action; sickles, however, cannot be detected unless a complete use-wear determination is carried out. The 89 elements with a gloss presented in this article, after analysis of a sample of blanks at low and high magnification (stereomicroscope and reflection microscopes with a magnification of up to 200x), were clearly used to harvest cereals. The method does not allow identifying the cereal species. Their dimensions and morphology lead to the thought that they were part of composite instruments whose hafts were of wood or bone/antler (Arazova and Skakun 2017; Arai 2020), into which several lithic blanks were inserted. There is a single mention of a handle made of slate in Neolithic levels at Chokh in Daghestan (Korobkova 1996, 69).

Results

Mentesh Tepe provides an opportunity to follow the way these tools were selected (technology and typology) and used (use-wear-analysis) over time, during the Neolithic, the Chalcolithic and the Bronze Age. Some differences can be seen over the long time-lapse.

Neolithic Period

38 sickle elements are known from the Neolithic contexts (Figure 5, 6), 22 of them made of chalcedony (Figure 5.1-2), four of flint and 12 of obsidian (Figure 5.3-7). All the tools of chalcedony are flakes knapped by direct hard percussion. The quality of the rock is variable: it can be either fine and homogeneous or rough and heterogeneous. The used edge is unique, opposed to cortical surfaces or abrupt edges that are either natural, knapped or retouched. The blank can be cortical (one with a lateral, natural surface, one with a cortical back and two with residual cortex). 16 tools are complete and two are residual, as they were re-used as wedges (‘*pièces esquillées*’). The lengths of the complete tools vary between 26mm and 60mm. Six blanks have a convex back, which was fully or partially retouched. The gloss in most cases largely extends over both the ventral and dorsal surfaces. In three cases, however, it is marginal. The blanks are inserted obliquely into the hafts. Five of them show remains of bitumen. The polish is well developed on the flakes made of chalcedony used to harvest cereals (Figure 6), and appears on the cutting edge, extending over the ventral and dorsal surfaces. It is compact, bright, and bears a tiny dotted striation.

Four flint sickle elements are also flakes. The complete ones measure 26, 33 and 45mm in length. Two fragments have revealed traces of bitumen. Wear is similar to that appearing on chalcedony (see the descriptions on Chalcolithic material).

Ten obsidian sickle elements are unipolar blades knapped by the standing pressure technique, while two are flakes. Eight blades were analyzed chemically, and they all come from the Sarıkamış area (Astruc et al. in press). As is often the case for obsidian blades, seven of them are multiple tools; sickle elements transformed into burins (n=2), lateral retouch (n=1), a denticulate (n=1), a *pièce esquillée* (n=1), a lateral retouch/burin (n=1), and a lateral retouch/*pièce esquillée* (n=1). One flake is a burin and the other is a denticulate. This typological diversity is proof that sickle elements could be made from what were previously other tools or transformed in different ones after their use as sickles. It is worth noticing, however, that in our sample no blank has revealed traces of secondary use. Four complete sickle elements have lengths between 22 and 37mm, but three fragments are 42mm long. The obsidian pieces show no bitumen, and the wear is clearly parallel to the edge on four specimens, indicating longitudinal hafting (Figure 5.3-7). The use-wear seen on these tools is described below.

Chalcolithic Period

Regarding the Chalcolithic period, 49 sickle elements were recognized in our sample. Nine are made of chalcedony (Figures 7, 8, 9), four of obsidian (Figure 10), 35 of flint (Figure 11.2-4, Figure 12), one of jasper (Figures 11.1, 13). The sickle elements in chalcedony are all flakes knapped by hard direct percussion. The quality of the rock is variable, either fine and homogeneous or rough and heterogeneous. The complete items are between 26 and 46mm long, but one fragment is 51mm. Four tools show a residual cortex. In five instances, the wear reflecting cereal harvesting is visible on one side, while the opposite edge is retouched: backed pieces (n=4; direct, inverse or crossed retouch, partial or total), partial lateral semi-abrupt retouch (n=1). The wear is oblique to the edge, indicating diagonal hafting. Six tools show traces of bitumen. On the Neolithic sickle elements made of chalcedony, the wear is similar to the one observed here. The general distribution of the traces depends on the more or less rough nature of the raw material: they are in any case more developed on the top of the micro-topography, and the difference is clear when the material is rough (Figure 8.1, Figure 9.1, 9.2B) or fine (Figure 8.2). The photograph (Figure 9.2A) shows a zone where a polish is highly developed (compact thread, flat micro-topography), scratched by a tiny scar produced during use (the interior of the scar is not polished).

The three obsidian blades were chemically analysed (Astruc et al. in press), and come from Tsakhkunjats 1 (North Armenia), Gegham (West of the Sevan Lake) and Sjunik 3 (South of the Sevan Lake). A laminar flake with lateral retouch is complete and measures 50mm in length. Blades are all knapped by using the pressure flaking technique: one has lateral retouches and the other, a lateral retouch and a back. Fragments are 44 to 60mm long. Hafting is parallel to the edge. The illustrated tool in Figure 10.1 is most probably to be attributed to the Chalcolithic period, as shown by its typological characteristics, although it comes from a mixed context. This tool's two lateral cutting edges were used to harvest cereals. The wear on the obsidian is totally different from the one appearing on chalcedony, flint or jasper. For this raw material, the rock itself reflects light, as does the polished area. Microscope with a magnification of 100x-200x is necessary to identify and locate the polish. In some cases, the tool is damaged by post-depositional processes (Figure 10.A-B), and the surface of the used area is matte, as are the abrasive features (abrasion and striation are highlighted). The cutting edges are always smoothed. After its use as a sickle, the illustrated blade was re-shaped on both edges by pressure retouch: the wear is thus no longer present in the retouched zones of the dorsal surface. Part of the left edge has been secondarily used to scrape a relatively hard vegetal material: a tiny continuous polish along the very edge is visible on the dorsal surface (Figure 10.C). The Chalcolithic blade illustrated Figure 10.2 was used as a sickle element and the edge was rejuvenated by direct coarse denticulation. Its use as a sickle continued after this sequence of retouch.

A blade made of high-quality red jasper was knapped by pressure flaking, probably by means of a lever (Figure 11.1). The active edge was retouched by a careful pressure flaking and the opposite edge was transformed by marginal direct retouch. Wear is highly influenced by the nature of the raw material: a fine texture with tiny fossils. Polish is very much apparent, compact and bright. Striation is absent. The cutting edge is slightly smoothed and polished.

During the Chalcolithic period, sickle elements were most often made of flint (n=34). Complete blades are between 65 and 88mm long. Most, if not all, were detached by pressure flaking in a standing position. The typology is diverse: a scraper (n=1), a scraper/lateral retouched back (n=1), pointed (n=1), pointed/lateral retouch (n=4), lateral retouch (n=17), truncation (n=1), and lateral retouch/truncation/burin (n=1). The use of pressure retouch is predominant in this sample. In nine cases, the gloss is visible on both edges. 28 blades bear traces of a longitudinal hafting, and three of oblique hafting. 10 tools show traces of bitumen. Figure 12.1 shows a tiny tool (this module is rare in the sickle assemblage) made on a bladelet. The left edge was used as a sickle and the wear is clearly visible on the ventral surface, but not in the dorsal one since the blank has been retouched by a micro-denticulation. Figure 12.2 shows a large blade used on both sides. The polish is very extensive and has a compact and flat aspect (Figure 12.2A). The cutting edge is smoothed and highly polished. No striation is visible. On the left edge, a direct partial retouch was made by pressure flaking. The tool was used for harvesting, after a sequence of retouch, as shown by the partial polishing of retouch scars (Figure 12.2B).

Bronze Age

Among the 41 sickle inserts found in mixed or possibly disturbed contexts, only two could be confidently attributed to the Bronze Age based on technological and typological comparisons with other sites (Figures 14, 15, 16). They are the only artifacts found at Mentesh Tepe made on siliceous marl. The tools are complete: one flake is about 62 x 31 x 10 mm, the other is 60 x 26 x 5.5 mm. Both were shaped with a bifacial retouch made by percussion and pressure flaking. They both have a denticulated edge. They are hafted longitudinally. One of them bears traces of bitumen. The wear is once again highly influenced by the raw material. The large sickle element shown in Figure 15 is made on marl with a low content of silica. The wear is mainly due to abrasive phenomena (Figure 15A) with a small and dull polish component. Higher magnification reveals spots of highly polished silica (Figure 15B). By contrast, the second insert contains a higher degree of silica, and the wear is more like that of flint tools. The polish is highly developed and extensive, and the edge is smoothed and polished (Figure 16A, B). The thread is compact, the micro-topography is slightly domed and a striation parallel to the edge is visible. The polish is bright, but in some areas is a little duller.

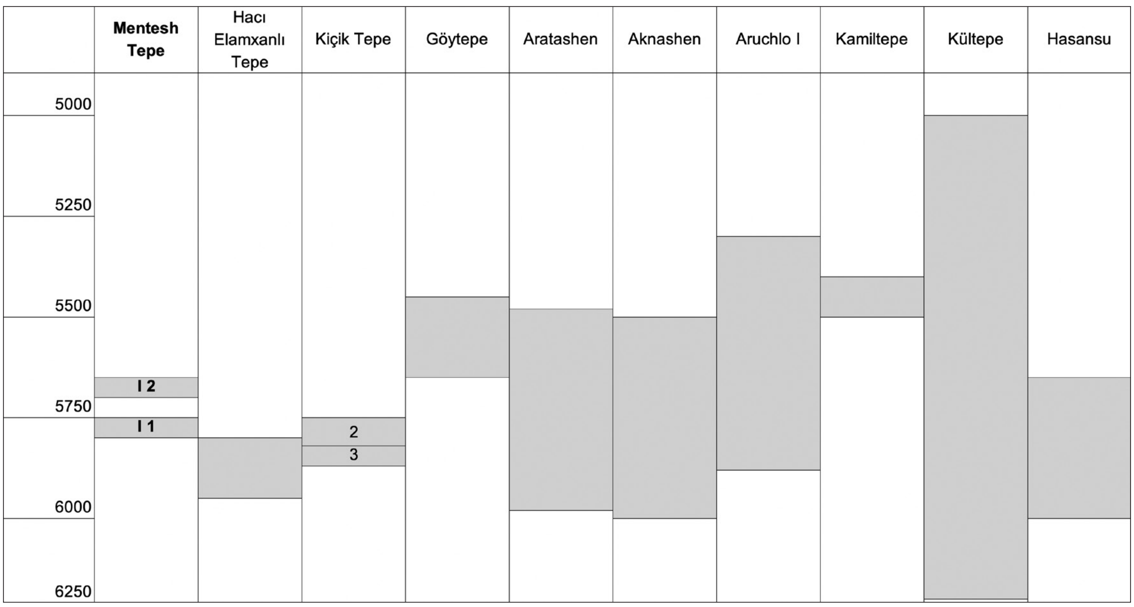
Discussion

The sickle elements of Mentesh are testimonies of the agricultural practices at the site, in a context where cereals were the main cultivar. As at neighboring sites in the Kura valley like Kiçik Tepe and Göytepe (Table 2), and frequently observed at archaeological sites of the Southern Caucasus, barley is the most frequently encountered cereal, regardless of the period, followed by wheat varieties. This is also the case, for instance at the Neolithic sites of Aratashen and Aknashen in Armenia, where barley grains are the most numerous, followed by free-threshing and hulled wheat (Hovsepyan and Willcox 2008; Badalyan et al. 2010). It is by looking at this last genus that we can see an evolution through time, with a shift from hulled wheat (mainly emmer) to free-threshing wheats. This change seems to have taken place during the first half of the 6th millennium BCE (Decaix 2016; Akashi et al. 2018; Palumbi et al. 2021). This evolution in the cultivated wheats might also be visible at Mentesh Tepe, but our periodization of the samples is not yet refined enough. During the following periods—the Chalcolithic and Early Bronze Age—free-threshing wheat remained predominant among cultivated wheats (Hovsepyan 2008, 2010; Berthon et al. 2013; Decaix et al. 2020a, 2020b). During the Early Bronze Age, the gap between the proportions of barley and naked wheat at Mentesh Tepe is narrowing even more (Figure 3). The cultivation of pulses (lentils, peas, grasspeas, *vicia*, bitter vetch) and flax was also common in the region (Hovsepyan 2008; Badalyan et al. 2010; Berthon et al. 2013; Decaix 2016; Neef et al. 2017), with the exception of the Early Bronze Age, when proportions of pulses decreased (less than 1% at Mentesh Tepe) and flax seems to have disappeared from the botanical corpus (Decaix 2016; Decaix et al. 2020a).

Few remains of fruit trees were found in the seeds and fruit samples of Neolithic Mentesh Tepe, as was for example the case at the nearby Middle Kura Valley sites like Kiçik and Goytepe

(Akashi and Tanno 2020; Palumbi et al. 2021). Indeed, for instance at Kiçik Tepe, one can see a shift between phases 3 and 2, with an increase in the proportion of free-threshing wheat in phase 3, at the expense of hulled wheats (Palumbi et al. 2021). Then from the Chalcolithic onwards, more fruit trees are present, identified mainly by means of anthracological analysis, since hackberry and grape remain the only species recognized by looking at seeds and fruits. This stands in contrast with what can be seen in the Araxes valley, where there is a higher diversity in fruit trees as from the Neolithic (Decaix 2016). It is noteworthy that not so many Chalcolithic sites have been investigated from an archaeobotanical perspective, so diachronic occupation at Mentesh Tepe is essential to better grasp agricultural practices and their evolution. Our study demonstrates that sickles at Mentesh Tepe were composite tools made with a wooden or bone haft, with lithics inserted either obliquely or parallel. Experiments with long lithic inserts have demonstrated that a slightly curved haft and oblique hafting were more efficient for harvesting than a straight haft and parallel hafting (Astruc et al. 2012). Botanical analysis shows that the harvest took place in the spring/early summer. It was most probably a collective activity conducted by members from different households.

Table 2. Chronology of the Neolithic sites mentioned in the text (Badalyan et al. 2007, 2010; Nishiaki et al. 2013; Lyonnet et al. 2016; Hansen et al. 2017 Museibli 2017; Helwing and Aliyev 2018; Marro et al. 2019; Nishiaki and Guliyev 2020; Palumbi et al. 2021). No precise dates for Shomutepe, Ilanlytepe, Toyretepe, Chalagantepe, Alilemektepe, Polutepe, Gagalartepe (6th millennium BCE). For the Chalcolithic and Bronze Age periods, Mentesh Tepe is the only well-dated site.



The way the inhabitants of the village manufactured the sickles reflect the acquisition routes of lithic raw materials and the community's technical know-how in the production of the tools.

Obsidian, flint, jasper and siliceous marls were chosen for sickle elements. The origins of some of the raw materials are known, and they reveal how villagers were exploiting a large territory through direct acquisition or exchanges with other communities. Bitumen could also be sourced (see below). In Neolithic levels, the raw materials are 85% obsidian, 12.5% chalcedony, 1.5% flint, and 1.2% other rocks, and in the Chalcolithic levels, 97% are obsidian, 1,7% flint, 0.8% chalcedony, and 0.5% other rocks. During the Bronze Age, obsidian (from Chikiani) and siliceous marls are present. The sources of most of the lithic raw materials (chalcedony, flint, jasper, Ostaptchouk 2017; the marl is of unknown origin) are 30-50 km distant from Mentesh Tepe. Obsidian sources are distributed across Georgia, Armenia and North-Eastern Anatolia, and lie at a distance between 100 and 270 km from the site (for sources and pathways see Astruc et al. in press). The main source during the Neolithic was Şarıkamış (other sources were Tsaghkunyats, Chikiani, Gegham, Arteni, Yaglica, Gutansar, Hatis), and Gegham for the Chalcolithic (other sources: Şarıkamış, Tsaghkunyats, Chikiani, Gutansar, Syunik, Arteni, Khorapor, Hatis). It seems that the inhabitants of Mentesh Tepe did not care about the geographical origin of obsidian glass. Technological and typological analysis have shown that it is considered in the same way, regardless of its provenance (Astruc et al. in press). It is therefore unlikely that, during the Neolithic, they would have selected obsidian exclusively from Şarıkamış to harvest cereals: although the eight blades come from this same source, this is due only to its predominance at this period.

Deposits of chalcedony are known in the region of the lower Agstafachaj/Aghstev valley on the Azeri (Ostaptchouk 2017) and the Armenian side near the village of Sarigyugh (Chataigner et al. 2020). The amount of chalcedony found in the assemblages markedly decreases from 12.5 to 0.5% between the Neolithic and Chalcolithic. One must bear in mind that artifacts made of chalcedony were preferentially used as sickle elements: the use-wear analysis conducted for items from Chalcolithic levels did not reveal any other function. Likewise, flint tools were mainly used as sickle elements during the Chalcolithic period. To complete this inventory of materials involved in sickle manufacture, one should mention the bitumen visible on some of the sickle elements made of chalcedony and flint. It is worth noting that the composition analysis of a lump of bitumen, most probably used for decorating the Chalcolithic ceramic tableware, indicates its probable origin in the Shirvan region (Abbasova 2012). Arazova and Skakun (2017) mention the use of plant gum to fix lithic elements into the groove of the haft, but no analysis was conducted.

Sickle elements at Mentesh reveal the main trends of lithic assemblages during the Neolithic and the Chalcolithic, namely flakes in chalcedony knapped by direct percussion and blades of flint, jasper and obsidian knapped applying the pressure technique. Blades were selected within the main production at the site, pressure flaking was carried out in a standing position. Smaller nodules were rarely chosen (a single example in our sample, Figure 12.1) and larger nodules—pressure flaked by means of a lever—were on the contrary not selected to make sickles—with the possible exception of red jasper blades (Figure 11.1). Sickle elements were used mainly with unretouched edges. Micro-denticulation, denticulation or lateral retouch by pressure flaking were done to rejuvenate the edge after initial use to cut cereals. Most sickle elements show traces of use on a single edge, while the opposite one is not used (often a natural or retouched edge was prepared to facilitate hafting). Some were used on both sides: the lithic element was turned around and fixed once more in the haft's groove. Multiple tools are frequent in sickle typology, being also burins, scrapers, truncations, lateral retouched tools or pointed edges. In our sample, however, only one lithic element (a lateral pressure-flaked retouched tool) was reused for another activity, i.e., for the scraping of a vegetal material. Typical sickle elements of the Bronze Age were made of flakes that were all shaped by percussion and pressure retouch: the techno-typology is radically different from that of older specimens of the Neolithic and Chalcolithic periods.

Secure data is now available on harvesting techniques, but subsequent treatment of crops is not well documented. Since self-propagating plants (weeds) were collected together with cereals, careful sorting probably took place after the harvest to separate the wild plants fulfilling functions different from that of cereals. The use of threshing-sledges to produce chaff and grain is not attested at Mentesh Tepe during the Neolithic and Chalcolithic periods. Evidence for this technique is nevertheless well-known in Near Eastern contexts as from the beginning of the Neolithic (Anderson 2006; Anderson et al. 2006) and later in the South Caucasus (*infra*). Macro-tools such as querns were discovered at the site and a fraction of these are related to cereal treatment (Hamon 2012; C. Hamon, personal communication, October 2021). Grain processing and storage are unknown, as no concentrations of grains were seen in the excavation area. A large number of jars and silos were found in the Chalcolithic period, but there were no traces of their original contents, and the samples studied are the result of secondary fillings (Lyonnet et al. 2011, 2017; Decaix 2016).

In the Lesser Caucasus, sickle elements are identifiable when one follows typological approaches. A few use-wear studies were carried out (Arazova 1986; Badalyan et al. 2007, 2010; Chabot et al. 2009, in press; Esakia 2017; Arazova and Skakun 2017, 2019). In their review of "the oldest harvesting tools of Azerbaijan", Arazova and Skakun (2017) examined material from sites "located in the middle reaches of the Kura River on the Ganja-Qazakh plain (Shomu Tepe, Gargalartepe, Toyretepe, Göytepe, Hasansu, etc.), on the Karabakh plain (Ilanlytepe, Chalagantepe), on the Mugan plain (Polutepe, Alikemektepe), and in the middle reaches of the Araxes River, particularly on the territory of Nakhchivan Autonomous Republic (Kültepe I)." They claim that "flint and obsidian inserts from sickles are numerous and account for 20 to 40% of the whole stone industry of the site." We were not able to evaluate the percentage of sickle elements at Mentesh Tepe, because we only characterized a sample of tools, but it is clearly far less. In the same study, Arazova and Skakun (2017) identified several types of sickles: straight handles with parallel inserts, slightly curved handles with slightly curved oblique inserts, slightly curved handles with parallel inserts, and a single element within a slightly curved haft (Arazova and Skakun 2017, figure 4). At Shomu Tepe (Arazova 1986; Narimanov 1987), sickles with antler and mandible hafts were identified, as well at Göytepe. At Mentesh Tepe, there were no indications of the degree of haft curvature. We only know that parallel and oblique inserts coexisted during the Neolithic and Chalcolithic periods, and that parallel hafting is attested during the Bronze Age. This suggests a picture different from the one expressed by these authors who say that "it could be supposed that the transition from sickles with an oblique cutting edge to those with a straight one can be traced throughout the early stages of agricultural communities in Azerbaijan." Arazova and Skakun (2017) make an interesting comment on the Bronze Age sickles: "The latter were widespread in the Caucasus during the Bronze Age. However, their cutting edge was made of bifacial flint blades with denticulated working edge. It was during this period that metallic sickles appeared (Kushnareva and Chubinishvili, 1970: 126-7; Munchaev, 1975: 380)." Following a use-wear analysis, Esakia (2017) mentioned the presence of sickles at Aruchlo I during the Neolithic, one of them being on the lateral edge of a scraper used with its front-edge to scrape wood.

At the neighboring Neolithic site of Göytepe (Arai 2020; Nishiaki and Guliyev 2020), sickles made with bone hafts and oblique obsidian or flint inserts are well documented. They are made of antler or of cattle mandible. Several examples are complete, made with oblique inserts. Studies on the lithic industry (Nishiaki 2020) have made it obvious that flakes and blades have a matte surface or gloss, and in some cases traces of bitumen were detected. Blanks are between 17 and 58mm in length and 12 to 28mm in width. The working edge is retouched, denticulated or unmodified, and the tools can be associated with burins, backs or 'Aknashen tools'. Takase (2020) confirmed through use-wear analysis that those blanks were used for cutting/sawing grass plant material. One can note that chalcedony was not exploited by the inhabitants of Göytepe and Haci Elamxanli Tepe.

Use-wear analysis of obsidian tools was conducted at two Armenian sites, Aratashen (Badalyan et al. 2007; Chabot et al. 2009) and Aknashen (Badalyan et al. 2010; Chabot et al. in press). At Aratashen, use-wear analysis has shown that "a large proportion of the segments of retouched blades as well as those used in the raw form have a function related to agricultural work" (Badalyan et al. 2007, 46). The detailed use-wear analysis is not published, but the articles mention the presence of sickle elements and tribulum inserts. Illustrations show an example of each item made of obsidian. At Aknashen (Horizons VII-II, Neolithic; Horizon I, Chalcolithic), the importance of agricultural work is also clear (Badalyan et al. 2010; Chabot et al. in press).

Three activities in which obsidian tools were involved are mentioned: harvesting with sickle elements, stripping (harvesting with a simple blade in one's hand, a motion where the harvester firmly wedges the seed head between their thumb and the blade then pulls it toward pulls it toward him/herself; this technique may have been used to harvest emmer wheat and hulled barley present at the site, Hovsepyan and Willcox 2008), and threshing. These two activities are not documented at Mentesh Tepe. Sickle elements were identified in all horizons at Aknashen, except in the Chalcolithic one (but study is still in progress). Blanks can be knapped by pressure with a crutch or a lever, or by indirect percussion. The typology is diverse: unretouched, with fine teeth, with a notch or retouched. Some of the blanks show use on both their lateral edges. The tools used to strip were identified in horizons I, V, VII. Tools are unretouched, with a notch or with partial retouch. Threshing elements are present in horizons I, V and VII. They were knapped by pressure with a crutch or a lever or using another undefined technique. Typologically, they are retouched segments, notches, with fine teeth or unretouched. Two burins were identified, the burin being struck after the use in threshing. Double use was noticed in the case of some elements: harvesting and threshing or stripping and threshing. They were knapped by several techniques: standing-up pressure with a crutch, pressure with a lever and another unknown technique; they were either retouched blades or a denticulate.

The sickle inserts found in other Neolithic sites in the South Caucasus are rarely well-described. As far as one can notice, most consist of fragments of blades, and sometimes flakes inserted obliquely into the haft (see for an overview Korobkova 1996; for Hacı Elamxanlı Tepe, Nishiaki et al. 2013, 2015a/b; Kadowaki et al. 2016; for Shomu Tepe, Arazova 1986). At Kiçik Tepe as well, obliquely hafted flint sickle elements were identified. In the Mil Steppe, at Kamiltepe, one sickle insert with a denticulate edge was found, at MPS5 an obsidian blade was probably used as a sickle insert with longitudinal hafting with both edges used (Guilbeau et al. 2017, 396).

As for the Chalcolithic period (5th millennium-early 4th millennium BCE), sickle inserts are not documented elsewhere in the South Caucasus, but there is a lack of data on Chalcolithic sites, and an even more acute paucity of publications on chipped stone industries associated with this period. Narimanov (1987) did mention "clay sickles" at Leilatepe and compared them with those found in Ubaid contexts in Mesopotamia (Lyonnet and Guliyev 2010, 222). Akhundov (2007) has also indicated the presence of sickles at the sites of Leilatepe and Böyük Kesik but has not provided further information. Based on the drawings, one could say that elements with parallel wear appear to have been identified at Böyük Kesik.

As for the Bronze Age, large flakes with a bifacial shaping were documented elsewhere in the South Caucasus at sites attributed to the Kura-Araxes culture, and even very much later (see for instance the Mil Steppe Iron Age, Guilbeau et al. 2017, 396). Jayez et al. (2017) published the industry of Kohne Tepesi (East Azerbaijan, Iran) in which the authors underline, like in

Mentesh, a clear dichotomy in the nature of the lithic assemblage: specialized, highly skilled production with flint bifacial sickle elements versus obsidian opportunistic production. Similar types of sickle inserts (with variations of size and shape) were more widely used in this period, even far beyond the Caucasus (Kourtessi-Philippakis and Astruc 2002; Kourtessi-Philippakis 2010; Gatsov 2012).

Conclusion

At Mentesh Tepe in the middle Kura Valley, during the Neolithic and Chalcolithic periods and the Bronze Age, the local economy was based on herding and agriculture. During all these times, cereals were the main cultivar, predominantly barley and various kinds of wheat. Sowing took place in the autumn and harvesting in the spring/early summer. During each period, farmers manufactured their sickles in a specific fashion. No complete sickle has ever been found during excavations, but their reconstruction is possible through the study of lithic artifacts. Sickles were always composite instruments made of a haft (in wood, antler or bone) in which stone elements were inserted. During the Neolithic, the latter were predominantly flakes made of chalcedony, but sometimes of obsidian blade fragments. The inserts, often unretouched, were hafted either in oblique to form a jagged cutting-edge in the case of chalcedony, or in parallel to form a continuous cutting-edge in the case of obsidian. Local or imported rocks—sometimes brought from nearly 270 km away—were therefore selected, and the level of skill required to produce blanks varied from the implementation of a simple *chaîne opératoire* and direct percussion in the case of chalcedony, to a complex reduction sequence and pressure technique for obsidian. To sum up, chalcedony inserts could be produced by everyone, but obsidian ones were manufactured by specialists. During the Chalcolithic, chalcedony inserts with oblique gloss declined in favor of flint and, exceptionally, jasper elements. However, obsidian was still in use. Parallel hafting was predominant. Inserts were mainly blades made by pressure flaking and were probably produced by skilled craftsmen. Edges were often retouched by pressure flaking. During the Bronze Age, lithic inserts were completely different. The morphology of flakes, made of silicified marls, was entirely the result of percussion and pressure retouch, and the edge was denticulated. For these elements, skills were no longer geared towards knapping, but towards retouching. They were specialized tools, while everyday industry was simple and opportunistic and made of obsidian. Throughout the sequence, players involved in the production of sickles probably did not have the same skills and status within communities. Mentesh Tepe is a good example of the hidden complexity of some of the agricultural practices of these ancient societies. Other techniques of harvesting and post-harvesting, such as stripping and threshing, were not identified at the site, no matter the period. Such techniques were identified, nonetheless, in the Ararat plain as early as the Neolithic. Our knowledge of agricultural practices in the South Caucasus is merely incipient. The development of multi-disciplinary approaches is now imperative. Botanical studies, including work on self-propagating plants and weeds, phytoliths, and isotope analyses, as well as techno-typological and use-wear observations on lithic tools (both chipped stone and macro-tools) and the study of storage facilities will no doubt reveal new aspects of these ancient communities' daily lives in the near future.

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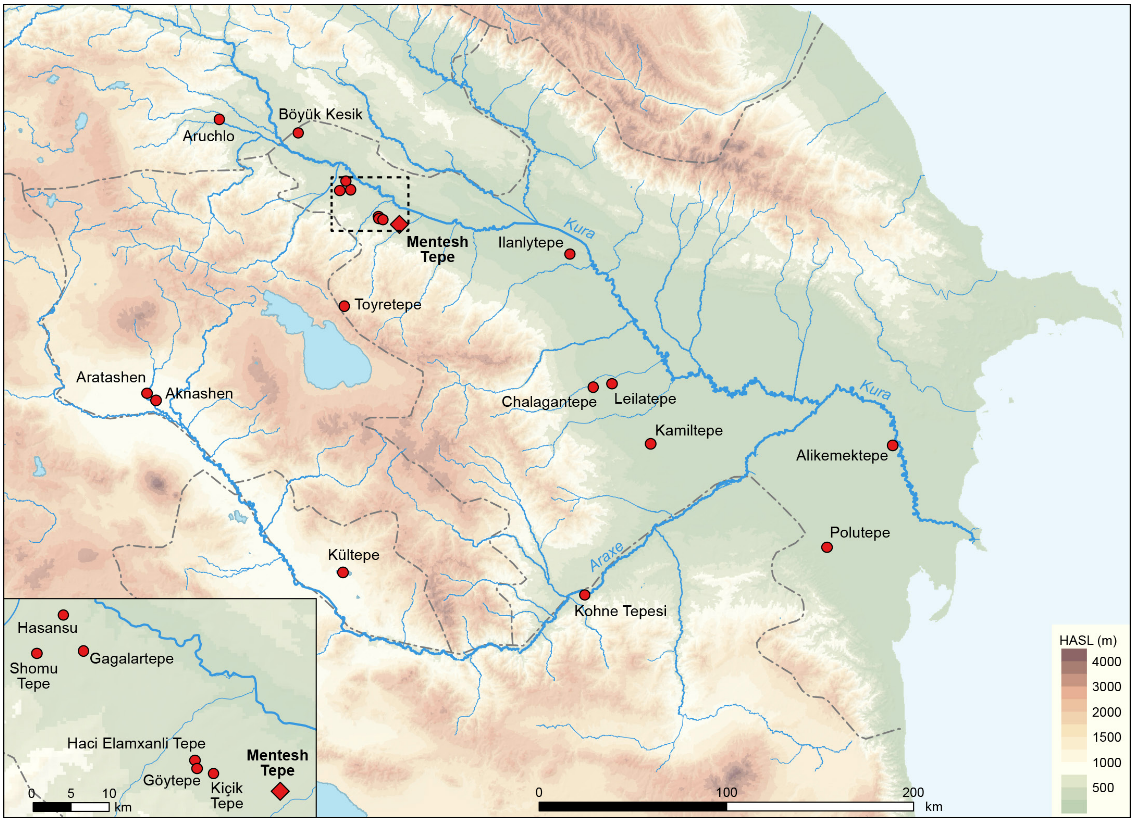


Figure 1.
Location of Mentesh Tepe and other sites mentioned in the text.

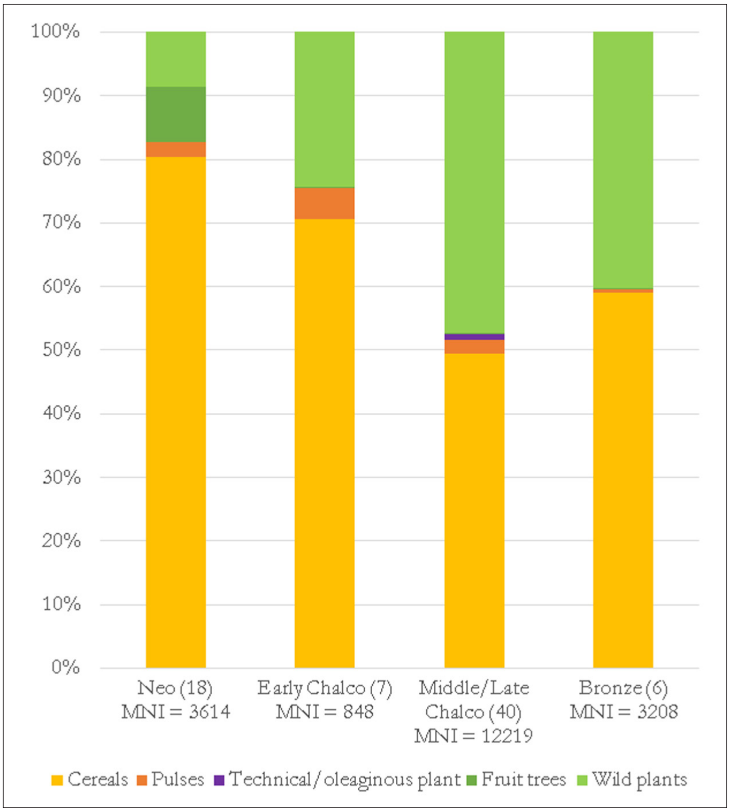


Figure 2.
Proportions of each plant category identified at Mentesh Tepe (Number of contexts indicated inside parentheses next to the period/phase; MNI=Minimum Number of Individuals).

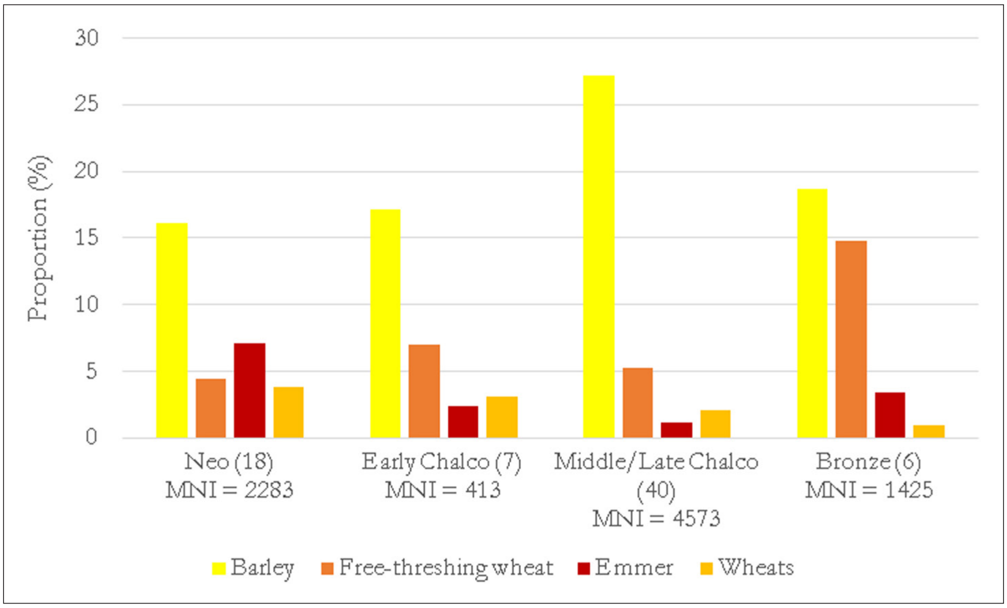


Figure 3. Cereal proportions during the site's various occupation phases (Number of contexts indicated inside parentheses next to the period/phase; MNI=Minimum Number of Individuals).

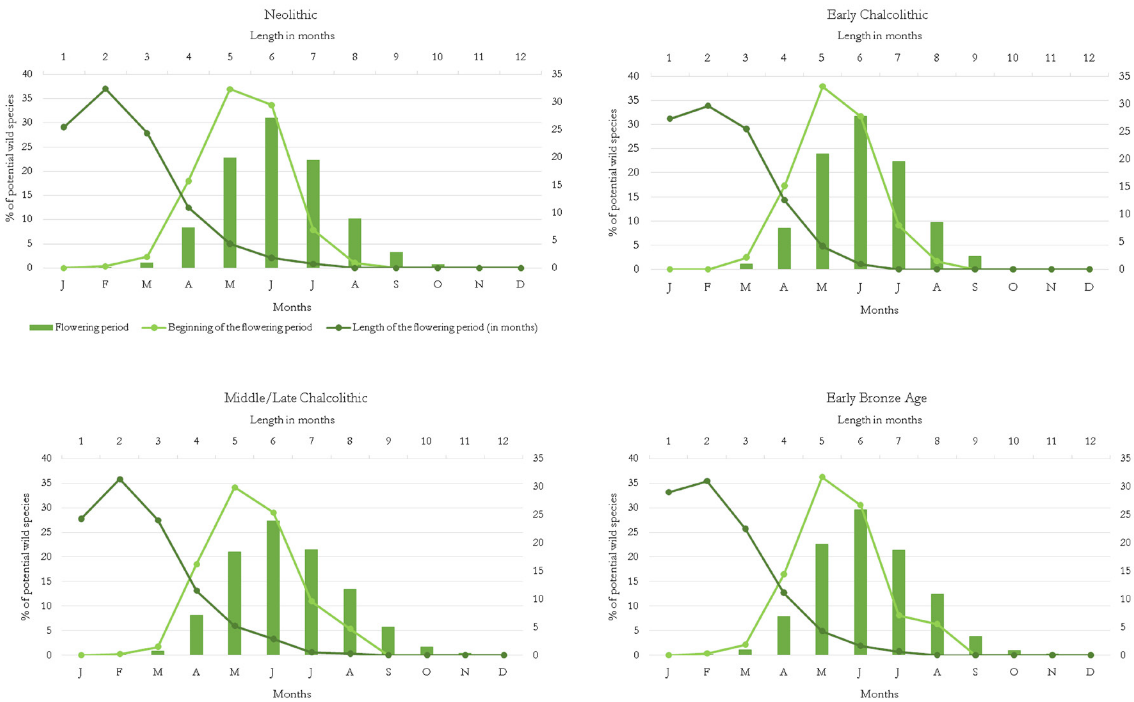


Figure 4. Synthetic diagrams specifying flowering periods and their lengths (in months) of potential weed species identified in samples from Mentesh Tepe.

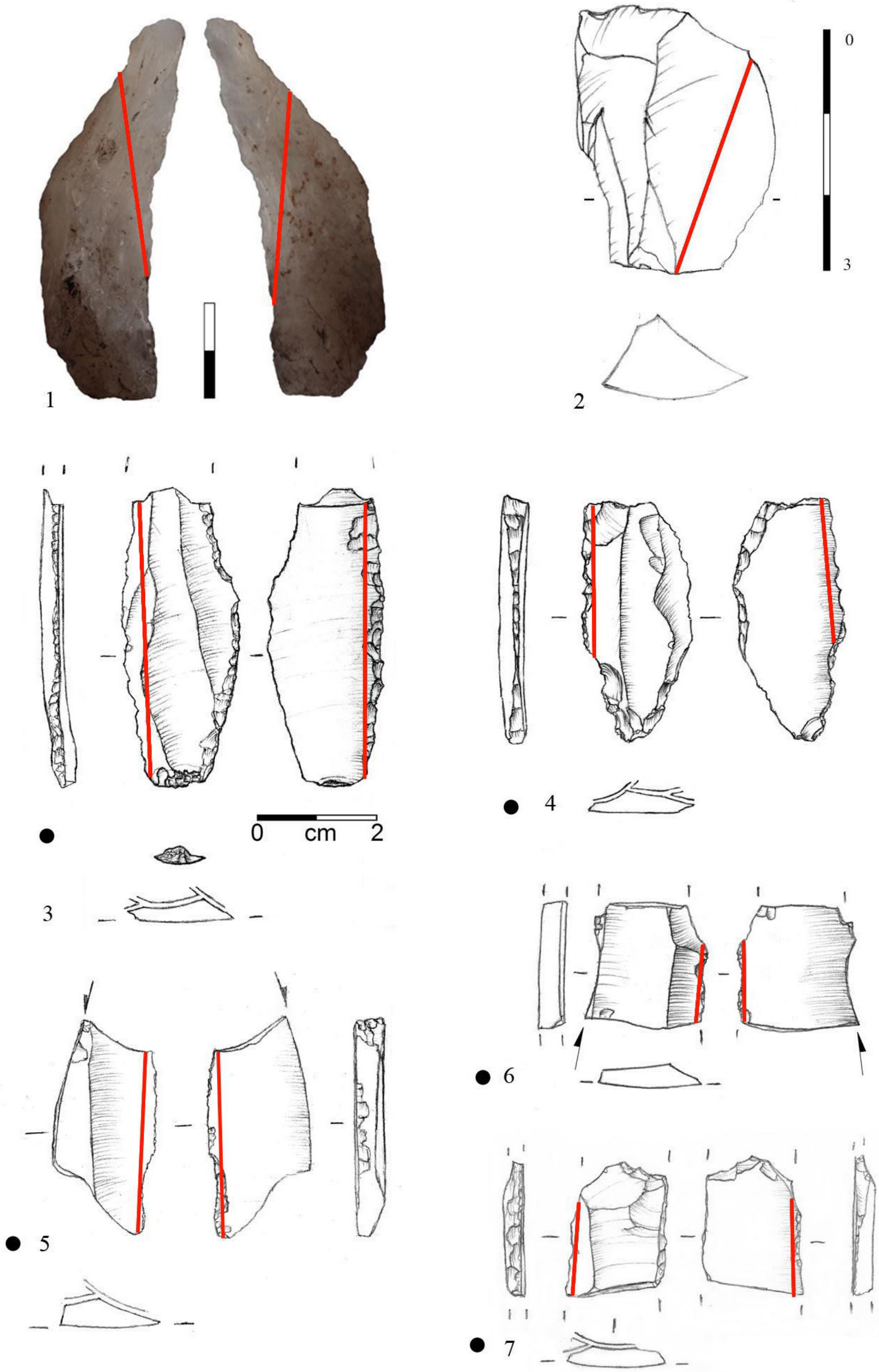


Figure 5. Neolithic. Sickle elements made of chalcedony (1-2) and obsidian (3-7). They are, respectively, flakes and blades. The distribution of the gloss is oblique in the case of chalcedony, and parallel to the edge in the case of obsidian. The red line indicates this polished zone's interior edge.

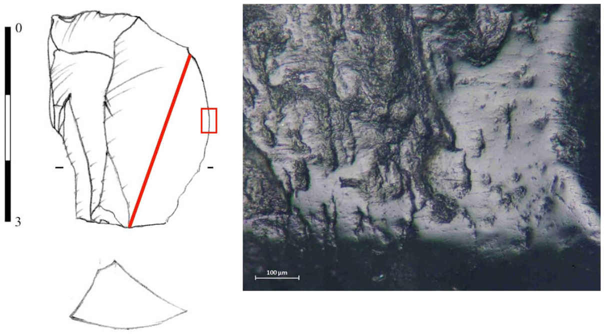


Figure 6.
Neolithic. Flake made of chalcedony with oblique gloss (magnification 100x). The raw material is slightly rough, and the development of polish follows the micro-topography (it is particularly visible here, since one can notice at the ventral surface, where hackles can be seen: the lower part of the micro-topography is not polished). The edge is rounded and fully polished. The polish is compact and bright. Fine striations run parallel to the edge.

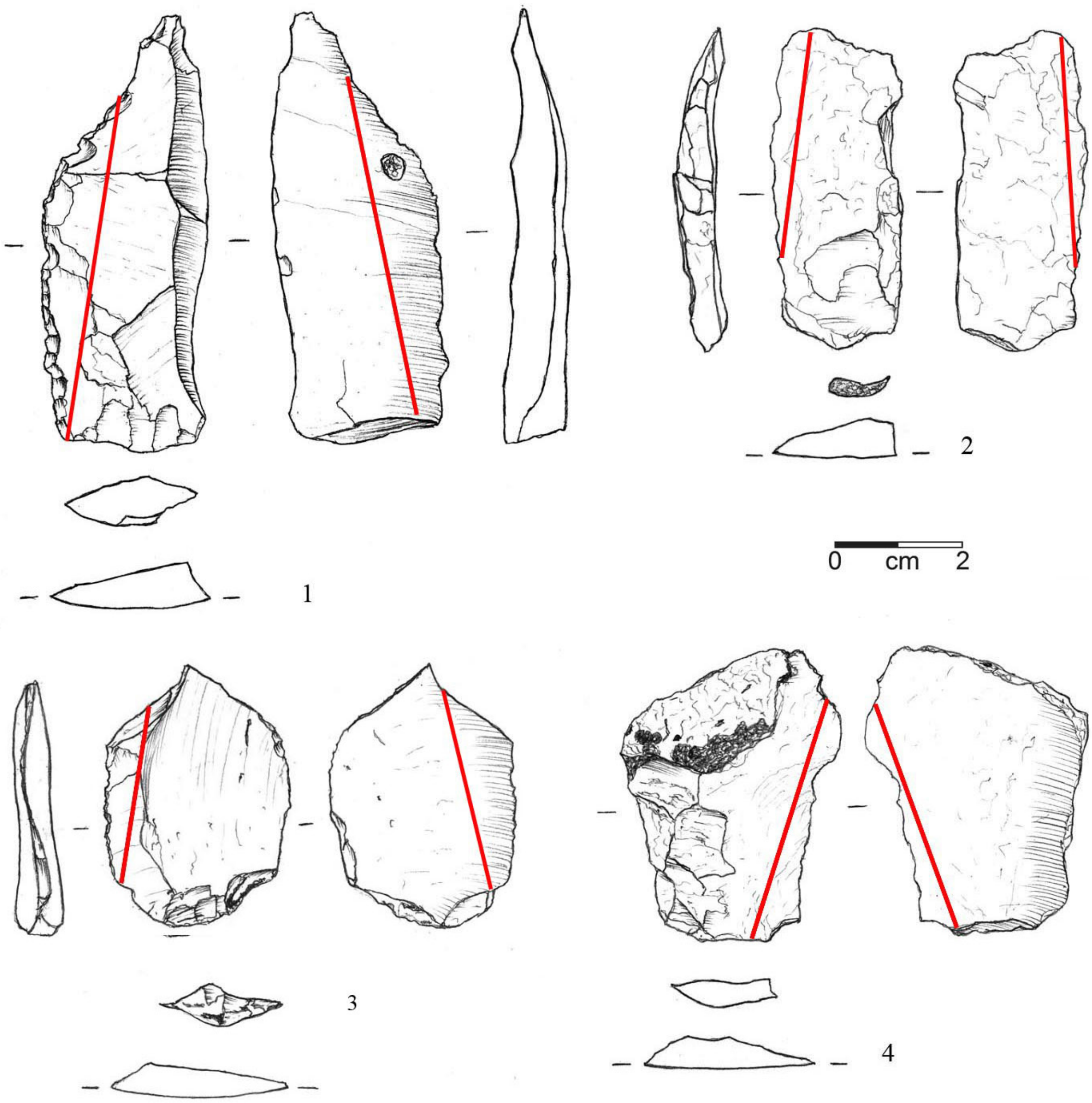


Figure 7. Chalcolithic. Irregular flakes used as sickle elements made of chalcedony with oblique gloss. Remains of bitumen are clearly observed on pieces 2, 3, 4.

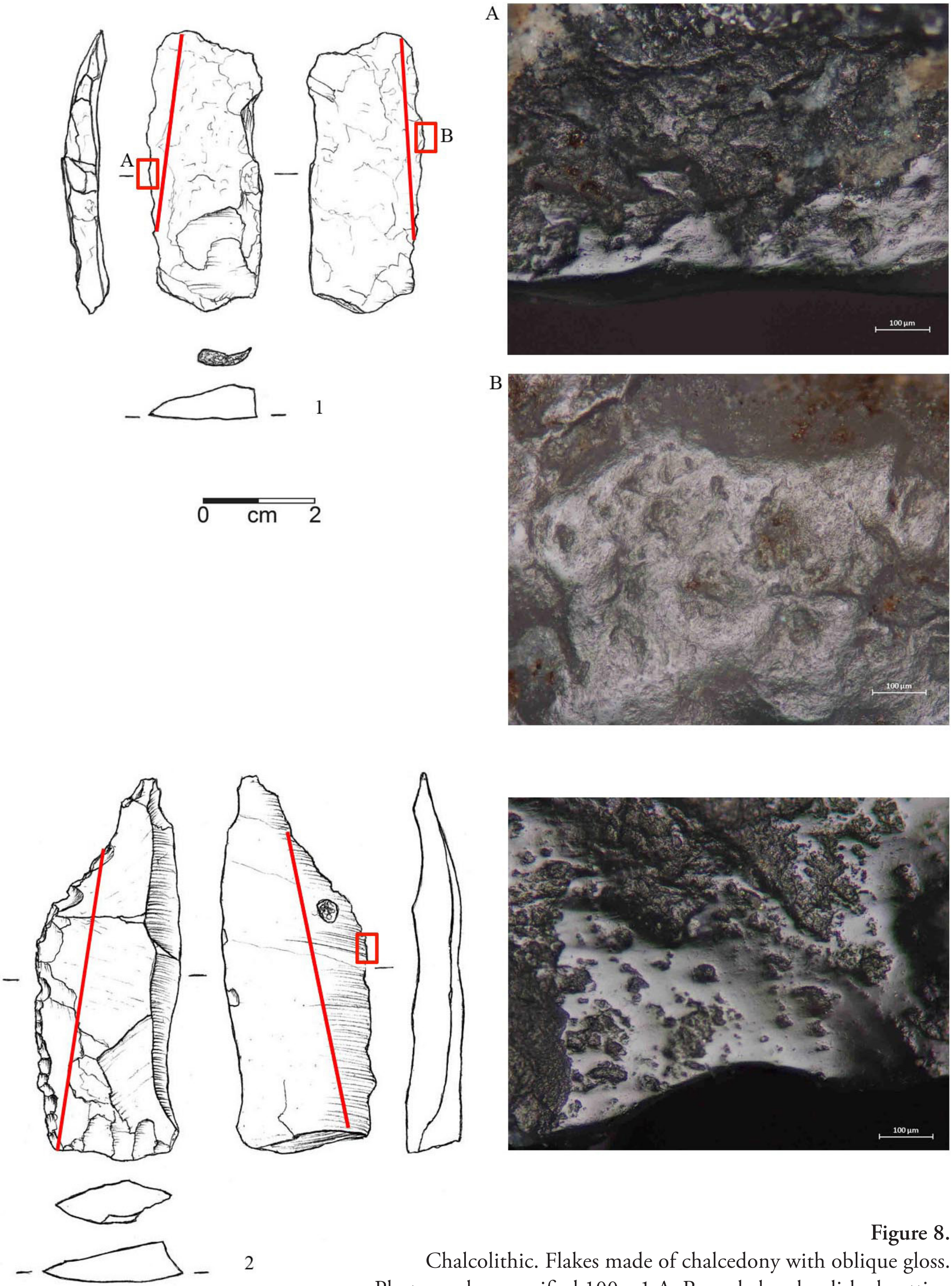


Figure 8.
Chalcolithic. Flakes made of chalcedony with oblique gloss. Photographs magnified 100x. 1.A. Rounded and polished cutting edge and well-developed polish on the dorsal side. 1.B. Compact polish seen on the ventral surface in the cutting edge's immediate vicinity. 2. Rounded and polished cutting edge and polish extending on the ventral surface with parallel and fine striations.

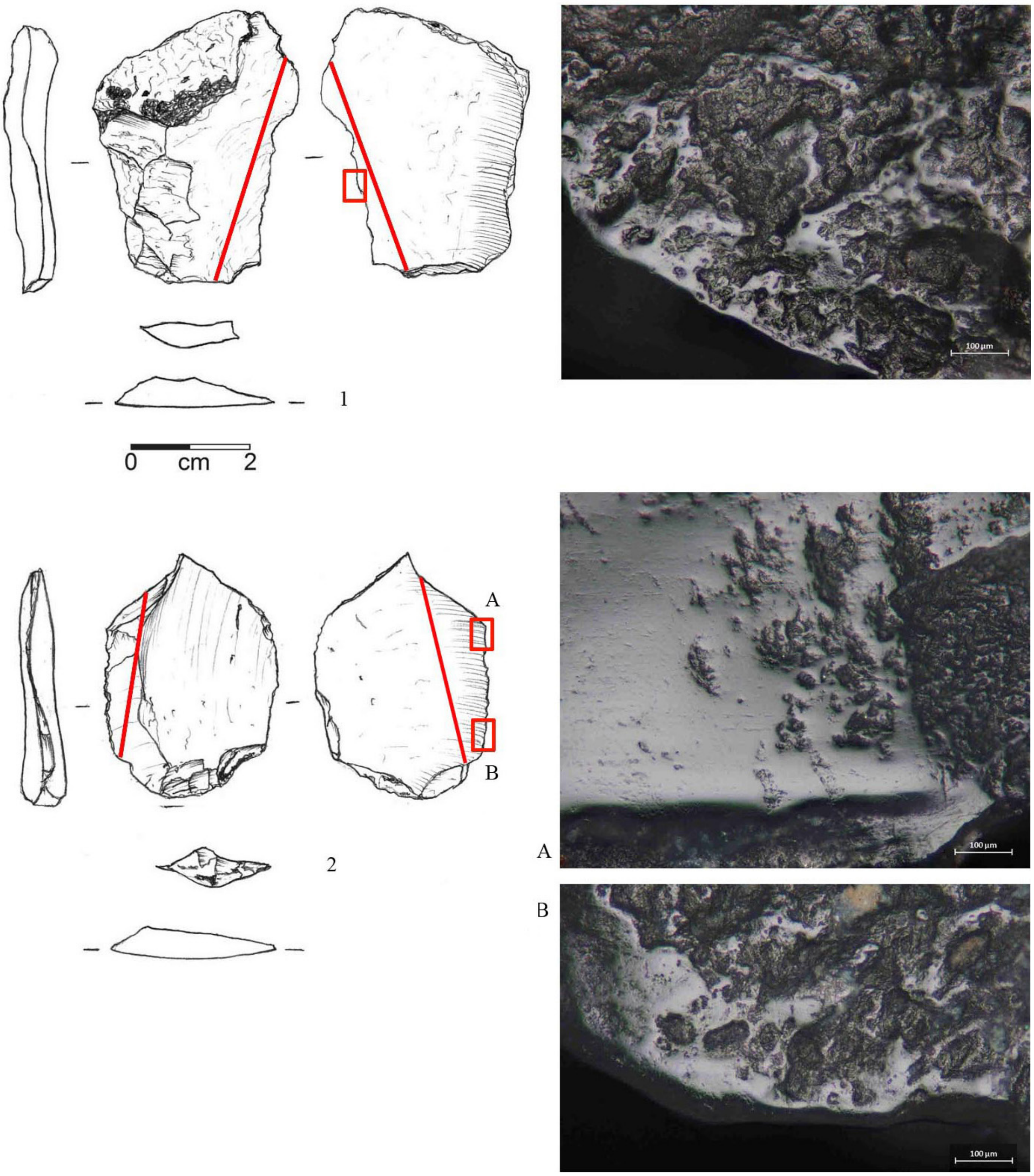


Figure 9. Chalcolithic. Irregular flakes made of chalcedony with oblique gloss. Photographs magnified 100x. 1. Rough micro-topography. Rounded and polished cutting edge. Compact polish on the ventral surface more apparent on the topography's upper part. 2.A. Fully polished area with a flat and compact surface and dotted fine parallel striation. The area is bordered by two scars with incipient polish (scaling probably created during time of use). 2.B. Rounded cutting edge and compact polish, especially in the immediate vicinity of the edge and on the upper part of the topography.

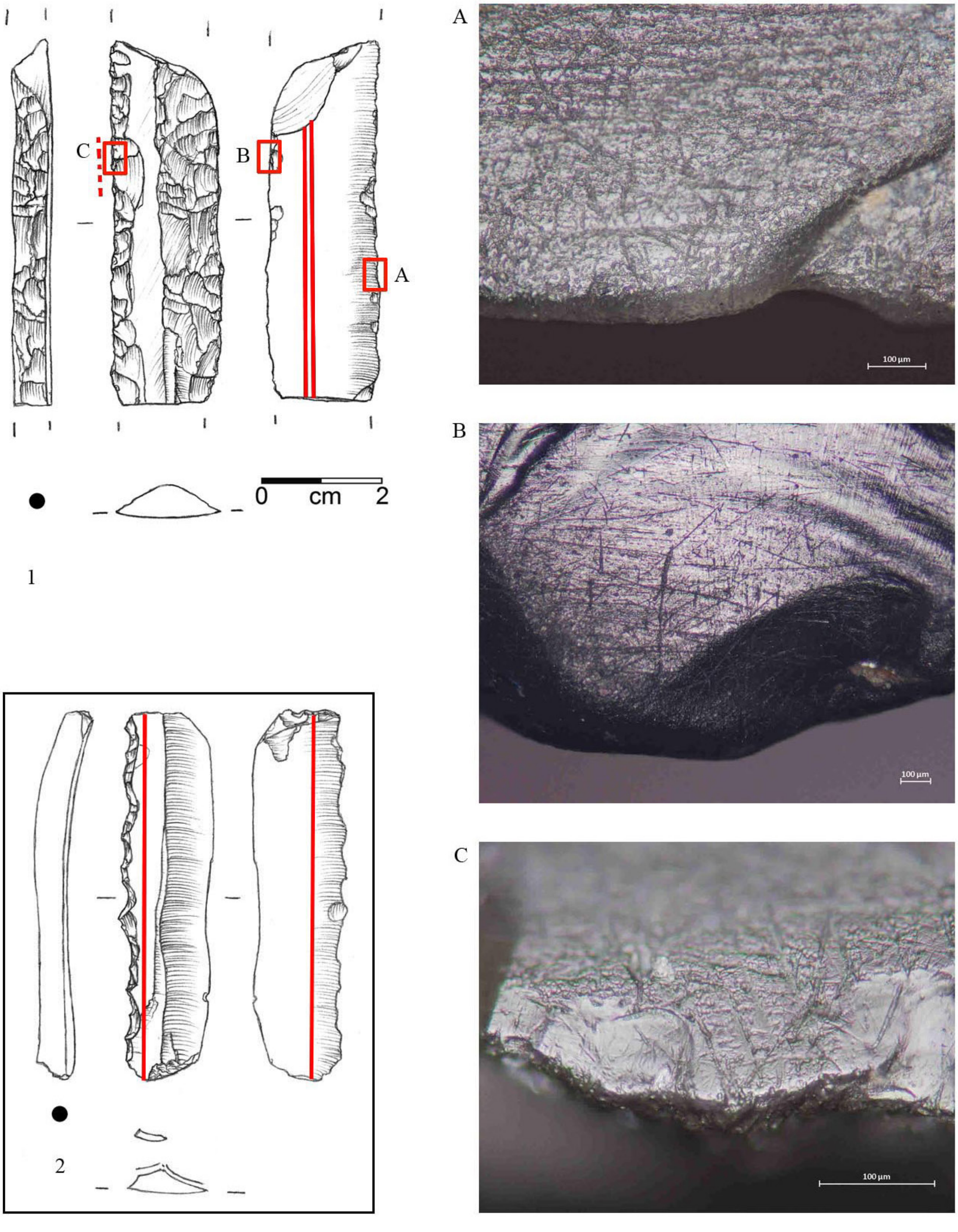


Figure 10. 'Multi-period' (1) and Chalcolithic (2) blades made of obsidian, used as sickle elements with hafting parallel to the edge. 1. Blade with semi-abrupt retouch made by pressure flaking, with three areas of use: both edges were used to harvest cereals (A, B, magnification 100x); a third zone on the left edge (C, magnification 200x) was used to scrape vegetal material. Note that the natural surface of obsidian reflects the light (see photo B at the top). 1.A. Rounding of the cutting edge and the edges of scars. Matte surface defined by longitudinal striation. 1.B. Matte rounding of the edge and matte surface in its immediate vicinity, due to abrasion and longitudinal striation. 1.C. Direct tiny scaling. A small continuous polish extends on the very edge.

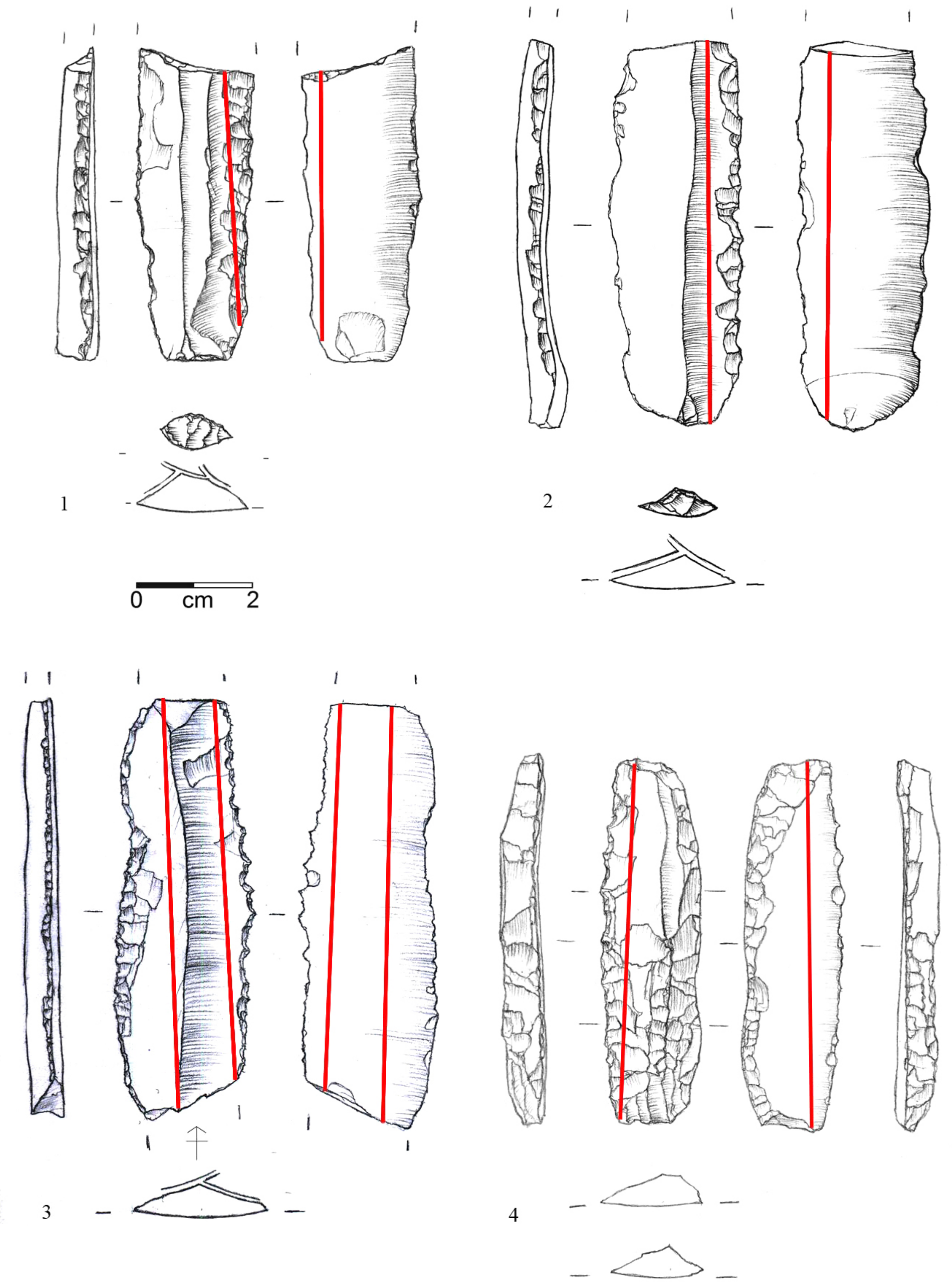


Figure 11. Chalcolithic. Blade sickle elements made of jasper (1) and flint (2-4).
They all show pressure flaking retouch and are worn on one (1, 4) or two edges (2, 3).
Gloss largely extends on the ventral and dorsal surfaces. Its distribution is parallel to the cutting edge.

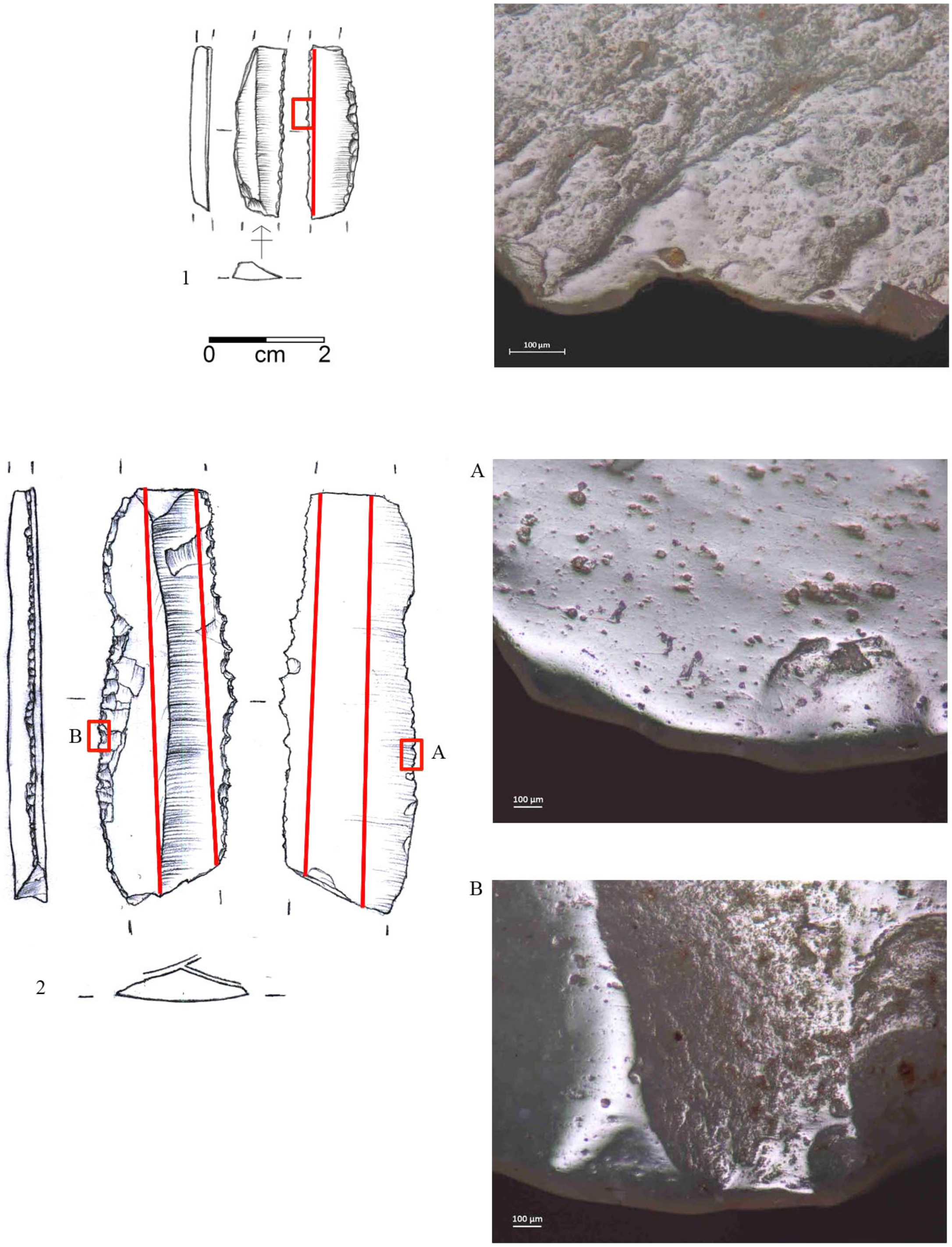


Figure 12. Chalcolithic. Bladelet (1) and blade sickle elements made of flint, with pressure retouch applied to make tools for harvesting cereals. 1. The direct micro-denticulation is later than the use. Polished and rounded cutting edge (magnification 100x). Extended compact polish on both faces. 2.A. Highly developed polish with compact thread, high brightness and a fine dotted striation parallel to the edge. 2.B. Same polish on the dorsal surface (on the left) cut by rejuvenating retouch (direct pressure flaking). The retouch is partly polished, showing that use as a sickle element continued after rejuvenation.

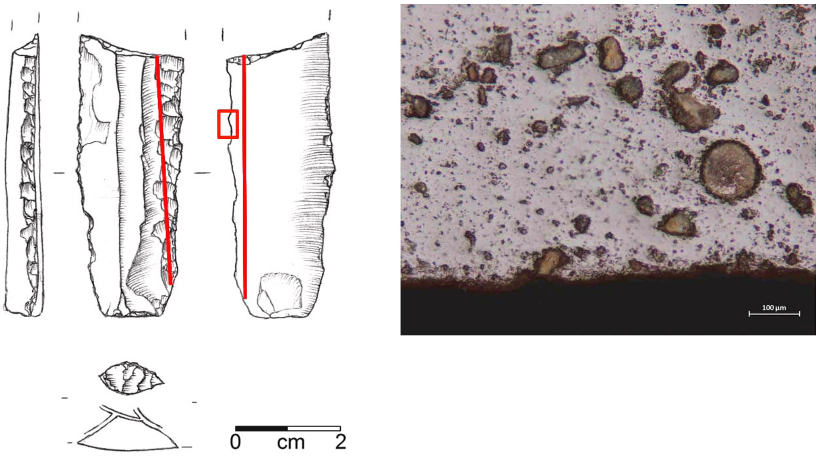
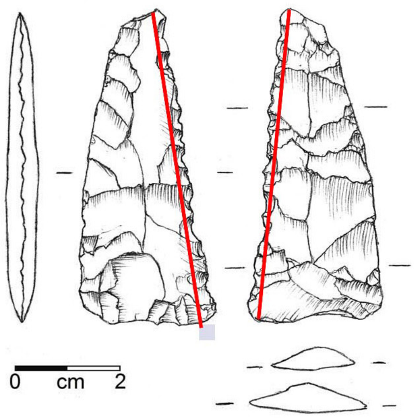


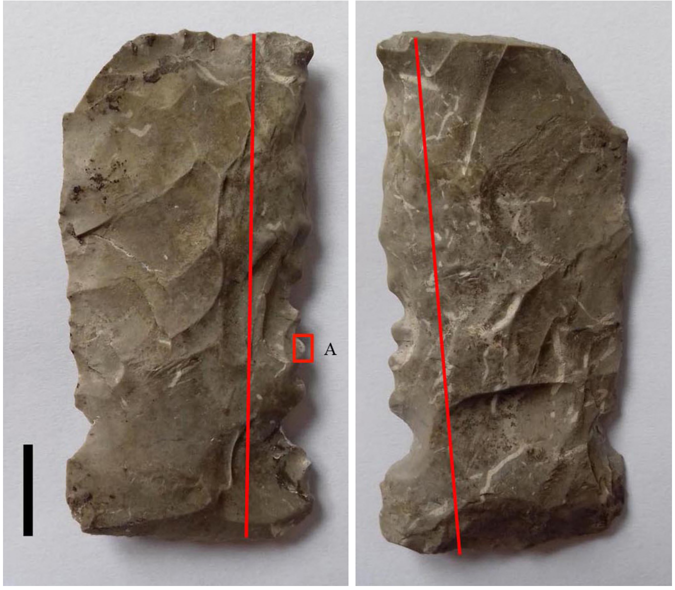
Figure 13.
Chalcolithic. Proximal fragment of a pressure blade made of jasper with pressure flaking lateral retouch. This edge was used to harvest cereals. The inserts were fixed in the haft, parallel to each other. Well-developed compact and bright polish with no striation (magnification 100x).

1



2

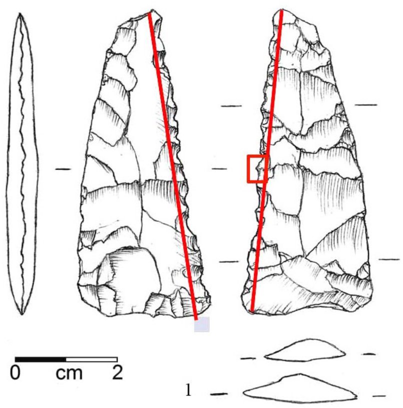
Figure 14.
Bronze Age. Two bifacially retouched elements, shaped by complete invasive retouch made by percussion and pressure flaking. Used edges on each blank are denticulated. The edge and the adjacent surfaces shaped by use are rounded and smoothed.



A

Detail

Figure 15.
Bronze Age. The raw material of the first tool is a fine marl. The main use-wear is abrasion. The cutting edge is completely rounded. A dull polish is also present and is hardly developed. Detail shows a highly polished circular patch of silica (magnification 50x and 100x).



A

B

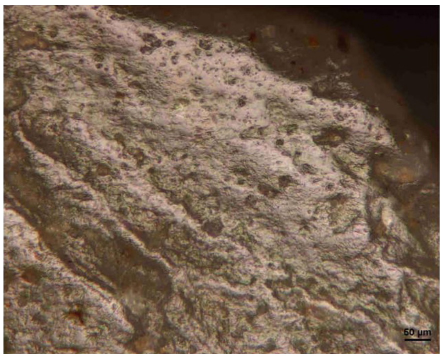


Figure 16.
Bronze Age. The second element is made of siliceous marl. Wear is different, as polish is highly developed. A. The cutting edge is completely rounded and polished (magnification 50x). B. The polish is compact, bright and extends all over the surface. Parallel fine dotted striations are visible (magnification 100x).

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Türkiye'de de doğa bilimleriyle iş birliği içindeki çalışmaların olduğu kazı ve araştırma projelerinin sayısı her geçen gün artmakta, yeni uzmanlar yetişmektedir. Bu nedenle Arkeoloji Bilimleri Dergisi, Türkiye'de arkeolojinin bu yeni ivmenin bir parçası olmasına ve arkeoloji içindeki arkeobotanik, arkeozooloji, alet teknolojileri, tarihlendirme, mikromorfoloji, biyoarkeoloji, jeokimyasal ve spektroskopik analizler, Coğrafi Bilgi Sistemleri, iklim ve çevre modellemeleri gibi uzmanlık alanlarının çeşitlenerek yaygınlaşmasına katkı sağlamayı amaçlamaktadır. Derginin ana çizgisi arkeolojik yorumlamaya katkı sağlayan yeni anlayışlara, disiplinlerarası yaklaşımlara, yeni metot ve kuram önerilerine, analiz sonuçlarına öncelik vermek olarak planlanmıştır.

Arkeoloji Bilimleri Dergisi uluslararası hakemli bir dergidir. Dergi, Ege Yayınları tarafından çevrimiçi olarak yayınlanmaktadır. Kazı raporlarına, tasnif ve tanıma dayalı çalışmalara, buluntu katalogları ve özgün olmayan derleme yazılarına öncelik verilmeyecektir.

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Archaeology is being transformed by the integration of innovative methodologies and scientific analyses into archaeological research. With the establishment of new departments, institutes, and programs focusing on "Archaeological Sciences", archaeology has moved beyond the traditional approaches of the discipline. When placed within their archaeological context, studies can provide novel insights and new interpretive perspectives to the study of archaeological materials, settlements and landscapes.

In Turkey, the number of interdisciplinary excavation and research projects incorporating scientific techniques is on the rise. A growing number of researchers are being trained in a broad range of scientific fields including but not limited to archaeobotany, archaeozoology, tool technologies, dating methods, micromorphology, bioarchaeology, geochemical and spectroscopic analysis, Geographical Information Systems, and climate and environmental modeling. The Turkish Journal of Archaeological Sciences aims to situate Turkish archaeology within this new paradigm and to diversify and disseminate scientific research in archaeology. New methods, analytical techniques and interdisciplinary initiatives that contribute to archaeological interpretations and theoretical perspectives fall within the scope of the journal. The Turkish Journal of Archaeological Sciences is an international peer-reviewed journal. The journal is published online by Ege Yayınları in Turkey. Excavation reports and manuscripts focusing on the description, classification, and cataloging of finds do not fall within the scope of the journal.

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Makale Gönderimi ve Yazım Kılavuzu

* *Please see below for English*

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Makalelerin konu aldığı çalışmalar, Arkeoloji Bilimleri Dergisi'nin amaçları ve kapsamı ile uyumlu olmalıdır (bkz.: Amaç ve Kapsam).

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Yazarın Türkçesi veya İngilizcesi akıcı değilse, özet ve anahtar kelimelerin Türkçe veya İngilizce çevirisi editör kurulu tarafından üstlenilebilir.

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- Özet (Türkçe ve İngilizce)
- Anahtar kelimeler
- Metin
- Kaynakça
- Figürler
- Tablolar

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Metin ve Başlıkların Yazımı

- Times New Roman karakterinde yazılan metin 12 punto büyüklüğünde, iki yana yaslı ve tek satır aralıklı yazılmalıdır. Makale word formatında gönderilmelidir.
- Yabancı ve eski dillerdeki kelimeler *italik* olmalıdır.
- Başlık ve alt başlıklar **bold** yazılmalıdır.
- Başlıklar numaralandırılmamalı, italik yapılmamalı, altları çizilmemelidir.
- Başlık ve alt başlıklarda yalnızca her kelimenin ilk harfi büyük olmalıdır.

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Ayrıca bkz.: Metin içi Atıflar ve Kaynakça Yazımı

- Referanslar metin içinde (Yazar yıl, sayfa numarası) şeklinde verilmelidir.
- Referanslar için dipnot ve son not kullanımından kaçınılmalıdır. Bir konuda not düşme amacıyla gerektiği taktirde dipnot tercih edilmelidir.
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- Görüntü çözünürlüğü basılması istenen boyutta ve 300 dpi'nin üzerinde olmalıdır.
- Görseller Photoshop ve benzeri programlar ile müdahale edilmeden olabildiğince ham haliyle gönderilmelidir.
- Excel'de hazırlanmış tablolar ve grafikler var ise mutlaka bunların PDF ve Excel dokümanları gönderilmelidir.

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- MÖ ve MS kısaltmalarını harflerin arasına nokta koymadan kullanınız (örn.: M.Ö. yerine MÖ).
- "Bin yıl" ya da "bin yıl" yerine "... binyıl" kullanınız (örn.: MÖ 9. binyıl).
- "Yüzyıl", "yüz yıl" ya da "yy" yerine "yüzyıl" kullanınız (örn.: MÖ 7. yüzyıl).
- Beş veya daha fazla basamaklı tarihler için sondan sayarak üçlü gruplara ayırmak suretiyle sayı gruplarının arasına nokta koyunuz (örn.: MÖ 10.500)
- Dört veya daha az basamaklı tarihlerde nokta kullanmayınız (örn.: MÖ 8700).
- 0-10 arasındaki sayıları rakamla değil yazıyla yazınız (örn.: "8 kez yenilenmiş taban" yerine "sekiz kez yenilenmiş taban").

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- Sayfa numaraları, tarih ve yer aralıklarını lütfen tek çizgi (-) ile ayırınız: 1989-2006; İstanbul-Kütahya.

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- Sık kullanılan bazı kısaltmalar için bkz.:

Yaklaşık:	yak.	Circa:	ca.
Bakınız:	bkz.	Kalibre:	kal.
Örneğin:	örn.	ve diğerleri:	vd.

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- Makalede özel bir font kullanıldıysa (Yunanca, Arapça, hiyeroglif vb.) bu font ve orijinal metnin PDF versiyonu da gönderilen dosyalar içerisine eklenmelidir.

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- Her makale, metin içerisinde atıf yapılmış çalışmalardan oluşan ve "Kaynakça" olarak başlıklandırılan bir referans listesi içermelidir. Lütfen metin içerisinde bulunan her referansın kaynakçaya da eklendiğinden emin olun.
- Metin içerisindeki alıntılar doğrudan yapılabilir: '…Esin (1995)'in belirtmiş olduğu gibi' ya da parantez içerisinde verilebilir: 'analiz sonuçları gösteriyor ki … (Esin 1995).'
- Aynı parantez içerisindeki referanslar yayın yılına göre sıralanmalı ve ";" ile ayrılmalıdır: '… (Dinçol ve Kantman 1969; Esin 1995; Özbal vd. 2004).'
- Aynı yazarın farklı yıllara ait eserlerine yapılan atıflarda yazarın soyadı bir kere kullanılmalı ve eser yılları "," ile ayrılmalıdır: '... (Peterson 2002, 2010).'
- Aynı yazar(lar)ın aynı yıl içerisindeki birden fazla yayınına referans verileceği durumlarda yayın yılının yanına harfler 'a', 'b', 'c' gibi alfabetik olarak koyulmalıdır.
- Tek yazarlı kaynakları, aynı yazar adıyla başlayan çok yazarlı kaynaklardan önce yazınız.
- Aynı yazar adıyla başlayan fakat farklı eş yazarlara sahip kaynakları ikinci yazarın soyadına göre alfabetik sıralayınız.
- Aynı yazara ait birden fazla tek yazarlı kaynak olması durumunda kaynakları yıllara göre sıralayınız.
- Dergi makaleleri için doi bilgisi varsa kaynakçada mutlaka belirtiniz.

Aşağıda, farklı kaynakların metin içerisinde ve kaynakçada nasıl yazılacağına dair örnekler bulabilirsiniz.

Tek yazarlı dergi makaleleri, kitap içi bölümler ve kitaplar

Metin içerisinde:

Yazarın soyadı ve yayın yılı (Esin 1995).

Sayfa sayısı bilgisi verilecekse:

Yazarın soyadı ve yayın yılı, sayfa sayısı (Esin 1995, 140).

Dergi makalesi:

Bickle, P. 2020. Thinking Gender Differently: New Approaches to Identity Difference in the Central European Neolithic. *Cambridge Archaeological Journal* 30(2), 201-218. https://doi.org/10.1017/S0959774319000453

Kitap içi bölüm:

Esin, U. 1995. Aşıklı Höyük ve Radyo-Aktif Karbon Ölçümleri. A. Erkanal, H. Erkanal, H. Hüryılmaz, A. T. Ökse (Eds.), *İ. Metin Akyurt - Bahattin Devam Anı Kitabı. Eski Yakın Doğu Kültürleri Üzerine İncelemeler*, İstanbul: Arkeoloji ve Sanat Yayınları, 135-146.

Kitap:

Peterson, J. 2002. *Sexual Revolutions: Gender and Labor at the Dawn of Agriculture*. Walnut Creek, CA: AltaMira Press.

İki yazarlı dergi makaleleri, kitap içi bölümler ve kitaplar

Metin içerisinde:

Her iki yazarın soyadı ve yayın yılı (Dinçol ve Kantman 1969, 56).

Dergi makalesi:

Pearson, J., Meskell, L. 2015. Isotopes and Images: Fleshing out Bodies at Çatalhöyük. *Journal of Archaeological Method and Theory* 22, 461-482.
https://doi.org/10.1007/s10816-013-9184-5

Kitap içi bölüm:

Özkaya, V., San, O. 2007. Körtik Tepe: Bulgular Işığında Kültürel Doku Üzerine İlk Gözlemler. M. Özdoğan, N. Başgelen (Eds.), *Türkiye'de Neolitik Dönem. Yeni Kazılar, Yeni Bulgular*, İstanbul: Arkeoloji ve Sanat Yayınları, 21-36.

Kitap:

Dinçol, A. M., Kantman, S. 1969. *Analitik Arkeoloji, Denemeler*. Anadolu Araştırmaları III, Özel sayı, İstanbul: Edebiyat Fakültesi Basımevi.

Üç ve daha çok yazarlı dergi makaleleri ve kitap içi bölümler

Metin içerisinde:

İlk yazarın soyadı, "vd." ve yayın yılı (Özbal vd. 2004).

Dergi makalesi:

Özbal, R., Gerritsen, F., Diebold, B., Healey, E., Aydın, N., Loyet, M., Nardulli, F., Reese, D., Ekstrom, H., Sholts, S., Mekel-Bobrov, N., Lahn, B. 2004. Tell Kurdu Excavations 2001. *Anatolica* 30, 37-107.

Kitap içi bölüm:

Pearson, J., Meskell, L., Nakamura, C., Larsen, C. S. 2015. Reconciling the Body: Signifying Flesh, Maturity, and Age at Çatalhöyük. I. Hodder, A. Marciniak (Eds.), *Assembling Çatalhöyük*, Leeds: Maney Publishing, 75-86.

Editörlü kitaplar

Metin içerisinde:

Yazar(lar)ın soyadı ve yayın yılı (Akkermans ve Schwartz 2003).

Akkermans, P. M. M. G., Schwartz, G. M. 2003. (Eds.) *The Archaeology of Syria. From Complex Hunter-Gatherers to Early Urban Societies (c. 16.000-300 BC)*. Cambridge: Cambridge University Press.

Web kaynağı:

Soyad, Ad. Web Sayfasının Başlığı. Web Sitesinin Adı. Yayınlayan kurum (varsa), yayın tarihi. Erişim tarihi. URL.

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Each manuscript should include a Turkish and an English abstract of up to 200 words and five keywords in both Turkish and English. Citations should not be included in the abstract.

If the author(s) are not fluent in the language of the manuscript, a translation of the abstract and the keywords may be provided by the editorial board.

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- Affiliation (where applicable)
- E-mail address
- ORCID ID

The manuscript should contain:

- Title
- Abstract (in English and Turkish)
- Keywords
- Text
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- The manuscripts should meet scientific standards.
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- Titles and subtitles should appear in **bold**.
- Titles and subtitles should not be numbered, italicized, or underlined.
- Only the first letter of each word in titles and subtitles should be capitalized.

References

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- The footnotes should be written in Times New Roman 10-point font, justified and single-spaced, and should be continuous at the bottom of each page.

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- Each figure should be submitted separately as a jpg or tiff file.
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- Please avoid editing the figures in Photoshop or similar programs but send the raw version of the figures if possible.
- Tables and graphs prepared in Excel should be sent as both PDF and Excel documents.

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- Please use BCE/CE and please avoid using dots without dots (i.e., BCE instead of BC or B.C.).
- Please use a dot for numbers and dates with 5 or more digits (i.e., 10.500 BCE).
- Please avoid using dots for numbers and dates with 4 or less digits (i.e., 8700 BCE).
- Please spell out whole numbers from 0 to 10 (e.g., “the floor was renewed eight times” instead of “the floor was renewed 8 times”).

Punctuation

- Please prefer em dashes (—) for parenthetical sentences: “Children were buried with various items, the adolescents—individuals between the ages of 12-19—had the most variety in terms of grave goods.”
- Please prefer an en dash (-) between page numbers, years, and places: 1989-2006; İstanbul-Kütahya.

Abbreviations

- Commonly used abbreviations:

Approximately:	approx.	Figure:	Fig.
Confer:	cf.	*Id est:*	i.e.,
Circa:	ca.	*Exempli gratia:*	e.g.,
Calibrated:	cal.		

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- If a special font must be used in the text (e.g., Greek or Arabic alphabet or hieroglyphs), the text in the special font and the original manuscript should be sent in separate PDF files.

In-Text Citations and References

- Each article should contain a list of references in a section titled "References" at the end of the text. Please ensure that all papers cited in the text are listed in the bibliography.
- Citations in the text may be made directly, e.g., 'as shown by Esin (1995) ...' or in parenthesis, e.g., 'research suggests ... (Esin 1995)'.
- References within the same parenthesis should be arranged chronologically and separated with a ";", e.g., '... (Dinçol and Kantman 1969; Esin 1995; Özbal et al. 2004).'
- In references to the studies by the same author from different years, please use the last name of the author once, followed by the years of the cited studies, each separated by a ",", e.g., '... (Peterson 2002, 2010).
- More than one reference from the same author(s) in the same year must be identified by the letters 'a', 'b', 'c' placed after the year of publication.
- When dealing with multiple papers from the same author, single authored ones should be written before the studies with multiple authors.
- When dealing with papers where the first author is the same, followed by different second (or third, and so on) authors, the papers should be listed alphabetically based on the last name of the second author.
- When dealing with multiple single-authored papers of the same author, the papers should be listed chronologically.
- Please provide the doi numbers of journal articles.

Below, you may find examples for in-text citations and references.

Single-authored journal articles, book chapters, and books

In-text:

Last name and publication year (Esin 1995).

If the page number is indicated:

Last name and publication year, page number (Esin 1995, 140).

Journal article:

Bickle, P. 2020. Thinking Gender Differently: New Approaches to Identity Difference in the Central European Neolithic. *Cambridge Archaeological Journal* 30(2), 201-218. https://doi.org/10.1017/S0959774319000453

Book chapter:

Esin, U. 1995. Aşıklı Höyük ve Radyo-Aktif Karbon Ölçümleri. A. Erkanal, H. Erkanal, H. Hüryılmaz, A. T. Ökse (Eds.), *İ. Metin Akyurt - Bahattin Devam Anı Kitabı. Eski Yakın Doğu Kültürleri Üzerine İncelemeler*, İstanbul: Arkeoloji ve Sanat Yayınları, 135-146.

Book:

Peterson, J. 2002. Sexual Revolutions: *Gender and Labor at the Dawn of Agriculture*. Walnut Creek, CA: AltaMira Press.

Journal articles, book chapters, and books with two authors

In-text:

Last names of both authors and publication year (Dinçol and Kantman 1969, 56).

Journal article:

Pearson, J., Meskell, L. 2015. Isotopes and Images: Fleshing out Bodies at Çatalhöyük. *Journal of Archaeological Method and Theory* 22, 461-482.
https://doi.org/10.1007/s10816-013-9184-5

Book chapter:

Özkaya, V., San, O. 2007. Körtik Tepe: Bulgular Işığında Kültürel Doku Üzerine İlk Gözlemler. M. Özdoğan, N. Başgelen (Ed.), *Türkiye'de Neolitik Dönem. Yeni Kazılar, Yeni Bulgular*, İstanbul: Arkeoloji ve Sanat Yayınları, 21-36.

Book:

Dinçol, A. M., Kantman, S. 1969. *Analitik Arkeoloji, Denemeler*. Anadolu Araştırmaları III, Özel sayı, İstanbul: Edebiyat Fakültesi Basımevi.

Journal articles and book chapters with three or more authors

In-text:

Last name of the first author followed by "et al." and the publication year (Özbal et al. 2004).

Journal article:

Özbal, R., Gerritsen, F., Diebold, B., Healey, E., Aydın, N., Loyet, M., Nardulli, F., Reese, D., Ekstrom, H., Sholts, S., Mekel-Bobrov, N., Lahn, B. 2004. Tell Kurdu Excavations 2001. *Anatolica* 30, 37-107.

Book chapter:

Pearson, J., Meskell, L., Nakamura, C., Larsen, C. S. 2015. Reconciling the Body: Signifying Flesh, Maturity, and Age at Çatalhöyük. I. Hodder, A. Marciniak (Eds.), *Assembling Çatalhöyük*, Leeds: Maney Publishing, 75-86.

Edited books

In-text:

Last name(s) of the author(s) and publication year (Akkermans and Schwartz 2003).

Akkermans, P. M. M. G., Schwartz, G. M. 2003. (Eds.) *The Archaeology of Syria. From Complex Hunter-Gatherers to Early Urban Societies (c. 16.000-300 BC)*. Cambridge: Cambridge University Press.

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