A bioarchaeological investigation of three late Chalcolithic pits at Ovçular Tepesi (Nakhchivan, Azerbaijan)

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Socio-economic organisation, subsistence strategies and environmental exploitation still remain largely open questions for the Late Chalcolithic period (*ca.* 4500–3500 BC) in southern Caucasus even though they are of prime importance for understanding the development of post-Neolithic societies in these semi-arid and mountainous areas. Interdisciplinary bioarchaeological research can, however, provide valuable new insights into these issues. In the Late Chalcolithic occupation layers at Ovçular Tepesi (Nakhchivan Autonomous Republic, Azerbaijan), the fills of pits, composed mainly of domestic refuse, proved to contain the richest and most diverse assemblages of biological remains at the site. These remains, retrieved by the use of flotation and sieving techniques, therefore constitute ideal assemblages for understanding subsistence strategies and the exploitation of natural resources. It is shown here that the agricultural economy at Late Chalcolithic Ovçular Tepesi was based mainly on the cultivation of cereals and pulses and the herding of sheep and goat. The river and its surroundings provided wood fuel and fish. The results of the bioarchaeological study further suggest that the Late Chalcolithic village was occupied permanently as shown by the development of commensal populations of small mammals.

Keywords: Transcaucasia, Late Chalcolithic, Domestic rubbish, Pastoralism, Cultivation, Riparian forest exploitation, Commensalism, Fishing

Introduction

The period between the mid-5th and the mid-4th millennium BC (roughly 4500–3500 BC) is, from a Mesopotamian-centred perspective, often called the "Post-Ubaid" period, but is also referred to as the Late Chalcolithic (Rothman 2001). During this time span, major social and economic changes occurred in a vast territory comprising Mesopotamia and adjacent regions (Marro 2012a). Settlements became organised in a hierarchic way and were connected to each other through complex networks. Within settlements social differences appear more distinct than in previous periods. The production system was also reorganised with the emergence of new crafts, such as mining and extractive metallurgy (Marro 2012b). During the Late Chalcolithic the Caucasus region seems to undergo social and economic changes similar to those of neighbouring Mesopotamia and Anatolia. However, they are less well known in this region due to the limited number of sites that have so far been excavated. In southern Caucasus (the Arax river basin), occupation layers dating to the Late Chalcolithic have been intensively studied at the site of Ovçular Tepesi (Marro *et al.* 2009, 2011). A contemporary settlement has also been discovered in the cave site of Areni (Areshian *et al.* 2012; Wilkinson *et al.* 2012). Unfortunately, the Chalcolithic layers are too badly preserved at the site of Aratashen to provide any significant information (Badalyan *et al.* 2007). In central Caucasus (the Kura river basin), the settlements of Boyuk Kesik and Mentesh Tepe belong

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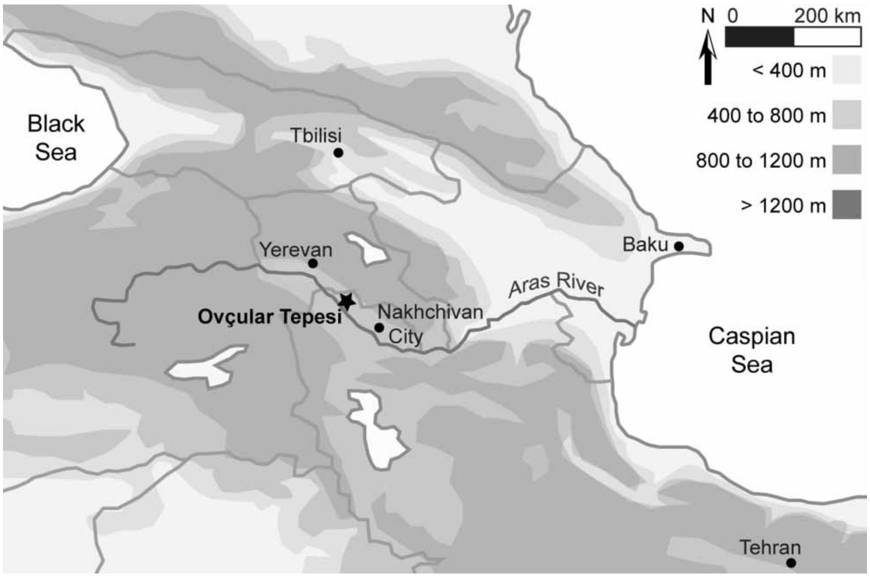

Figure 1 Location of Ovçular Tepesi.

to the same Late Chalcolithic chronological and cultural horizon as Ovçular Tepesi (Müseyibli 2007; Lyonnet and Guliyev 2010). The social and economic transformations that occurred in the late 5th to early 4th millennium BC certainly also had an impact on subsistence strategies and the way human communities exploited their environment. Until recently these topics were difficult to approach due to a lack of bioarchaeological analyses. In order to fill this gap, we implemented interdisciplinary bioarchaeological investigations at the site of Ovçular Tepesi.

Ovçular Tepesi is located in the valley of the Arpaçay river in the Nakhchivan Autonomous Republic of Azerbaijan (see Fig. 1). Following small-scale excavations led by Azerbaijani colleagues in 1986 and 2001, extensive archaeological investigations started in 2006 within the framework of a Franco-Azerbaijani joint project (Marro *et al.* 2009, 2011). The site lies on top of a natural hill rising above the river. This part of the larger Aras river valley, bordered to the north by the Zangezur mountains, has a dry continental climate.

At Ovçular Tepesi, the Chalcolithic layers lie directly under less well-preserved Early Bronze Age levels. The Late Chalcolithic occupation is divided into two phases. The earlier phase I is characterised by the presence of semi-subterranean circular structures surrounded by post-holes. In phase II the architectural remains consist of free standing, multicellular, mud brick houses (Marro *et al.* 2009, 2011). According to radiocarbon dates, both phases date to the rather narrow 4350–3940 cal. BC time span. Phase I probably corresponds to the *ca.* 4350–4250 BC period, while phase II should be dated to *ca.* 4250–3940 BC (Marro *et al.* 2009, 2011). During the entire Late Chalcolithic period Ovçular Tepesi was no more than a small village with dimensions never exceeding 2 ha. Despite its small size, the settlement is highly representative of the changes and innovations that occurred during this period. The emergence of extractive metallurgy is for instance evidenced by the discovery of three copper tools with a combined weight of more than one kilogram. The discovery of these tools in a burial jar also containing the skeleton of a new-born infant attests to a form of kinship-based social hierarchy (Marro *et al.* 2011). The Late Chalcolithic communities at Ovçular Tepesi also seem fully integrated into a complex interregional network. The pottery, for example, shows links to eastern Anatolia (the Upper Euphrates river basin) as well as to regions situated to the north that is beyond the Lesser Caucasus Mountains, in particular the Kura river basin (Gülçur and Marro 2012). Other technological and cultural aspects also suggest a broader network of interactions including western Iran and northern Mesopotamia (Marro *et al.* 2011; Marro 2012b).

Our paper focuses on the study of bioarchaeological remains retrieved from the earliest occupation level (phase I). The single-roomed circular structures that characterise this phase are generally associated with one or more refuse pits (see Fig. 2). Pit fills of this type usually attract the attention of excavators as they are likely to contain the accumulation of biological and other remains in a context less exposed to destructive taphonomical factors that affect for example occupational floors. At Ovçular Tepesi the phase I pits, dug into virgin soil, were sealed and thus not subject to contamination by material from later periods. Furthermore, each pit yielded an important quantity of zooarchaeological and archaeobotanical remains. For this reason, we selected three large pits in order to explore a large range of questions related to the socio-economic organisation of the

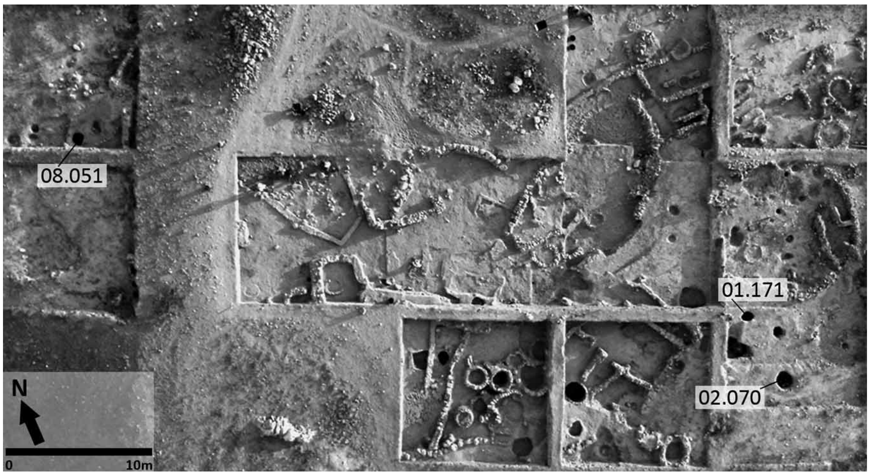

Figure 2 Aerial photograph of the excavations area with the location of the three Late Chalcolithic pits.

inhabitants and the exploitation of the environment in which they settled.

Material and Methods

Each pit is approximately 60 cm in diameter and more than 150 cm deep. The fill was composed of sediment-lenses of variable thickness that could be differentiated on the basis of their texture and colour. Still, it was not possible during the excavation to recognise distinct stratigraphic layers within the fill and thus sample lenses individually. The entire fill of each pit was therefore considered as a single excavation unit and sub-sampled for plant and animal remains, excluding sediment from the uppermost layers in order to avoid any risk of pollution. Only a small amount of sediment was treated from pit 02·070 because it was excavated before the establishment of a sampling procedure. About a quarter of the volume of the two other pits was sampled; in total 800 l of sediment were sampled from the three pits (see Table 1).

Samples were processed in the field. Flotation was carried out in order to recover the charred materials using a 500-micron mesh. The heavy fraction was recovered using a 1-mm mesh and then water sieved using 8-, 2-, and 1-mm mesh screens. Sorting of the remains into different categories of biological (large/small mammals[1], fish, amphibian, reptile, bird, egg-shell, mollusc shell and botanical remains) and non-biological remains (lithics, beads, sherds) was carried out in the excavation house. Large mammal remains were studied on site while fish remains were brought to the Royal Belgian Institute of Natural Sciences in Brussel (Belgium) and small mammal remains to the Natural History Museum in Budapest (Hungary) and the Muséum national d'Histoire naturelle in Paris (France). The botanical samples were studied in the laboratory of bioarchaeology (UMR 7209) of the Muséum national d'Histoire naturelle in Paris and at the Institute for Near Eastern Prehistory at Jalès, France (CNRS, UMR 5133).

[1]In this paper all mammals smaller than hare (e.g. insectivores and rodents except beaver) are considered as small mammals, the other ones being considered as large mammals.

Table 1 Volume of sediment samples, number of seed and fruit remains identified and density of remains (N/l) in the samples

Pit	Volume of soil sample (l)	Number of seed and fruit remains (*N*)	Density (*N*/l)
01·171	285	95	0·33
02·070	70	73	1·04
08·051	445	192	0·43
Total	800	360	–

Results

Large mammals

The faunal assemblages varied in abundance from one pit to another (see Table 2). Despite the fact that the volumes retrieved from the three pits were similar, the large mammal remains are less frequent in pit 01·171 than in pits 02·070 and 08·051. Large mammal bones were mainly collected by hand during excavations, parallel to the recovery of remains through the above-mentioned flotation and sieving procedures. Therefore, the differences in the amount of bones in each pit correspond to their density in the pits rather than to sampling biases.

Large mammal remains from the three pits were heavily fragmented, especially the long bones from the largest species. This was probably due to human activities (i.e. butchering and cooking) but also to increased fragility caused by the soil conditions. The fragmentation explains why only 30% of the remains were identified to the sub-family level (see Table 2). Traces of burning on bones were rare from pits 01·171 and 02·070 but are present on 25% of the remains from pit 08·051. In pit 02·070, almost 40% of the bones show signs of weathering indicating that the bones were exposed to the elements for some

Table 2 Number and frequency of various categories and taxa of large mammals remains in the three pits

		Number of remains			Frequency (%)		
		01·171	02·070	08·051	01·171	02·070	08·051
Castor fiber	Beaver			3			1·7
Canis familiaris	Dog	1	1	4	1·3	0·9	2·2
Vulpes vulpes	Red fox	3	1	1	3·9	0·9	0·6
Sus cf. *scrofa*	Probably wild boar	1	2		1·3	1·9	
Cervus elaphus	Red deer		2	4		1·9	2·2
Bos taurus	Cattle	1	3	3	1·3	2·8	1·7
Caprinae	Sheep and goat	70	97	163	92·1	91·5	91·6
Incl. *Capra hircus*	Included goat	1	4	8			
Incl. *Ovis aries*	Included sheep	6	14	27			
	Identified (NISP)	76	106	178	31·1	24·5	33·9
	Unidentified	168	326	347	68·9	75·5	66·1
	Total (NR)	244	432	525			

NISP, number of identified specimen.

Table 3 Number and frequency of large mammals remains burnt, wheathered or showing carnivores or rodents gnawing marks

	Burnt		Weathering		Carnivore gnawing		Rodent teeth marks		
Pit	NR	%	NR	%	NR	%	NR	%	Total number of remains
01·171	7	2·9	18	7·4	8	3·3	1	0·4	244
02·070	18	4·2	168	38·9	13	3	1	0·2	432
08·051	132	25·1	11	2·1	7	1·3	1	0·2	525

time before being buried or that the pit remained open. It appears that this was not the case for the two other pits where gnaw marks from dogs on the bones are rare. It suggests that dogs did not have much access to the refuses or that the pits were closed. Despite the fact that mice remains were found in the pits (see below), their gnaw marks are rare (see Table 3).

Sheep and goat are the most frequent mammals representing more than 90% of the number of identified specimens in each pit. Sixty specimens could be identified to either goat or sheep suggesting that sheep are three times more abundant than goat. In order to estimate a kill-off pattern with a sufficient number of remains, all sheep and goat teeth from the three pits were taken as a whole. The general trend (see Fig. 3) suggests that sheep and goat were mainly slaughtered between the ages of six months and two years. This pattern corresponds to a "Meat B" type of exploitation aiming at individuals with an optimal weight for meat (Helmer and Vigne 2004). This pattern is similar to that obtained at Sheikh Hassan, in Syria, from contexts dated to the second quarter of the 4th millennium BC (Helmer *et al.* 2007).

Other large mammals are rare in the assemblage. Among the domestic taxa, cattle (*Bos taurus*) and dog (*Canis familiaris*) are both represented by less than 3% of the total assemblage of each pit. Wild taxa amount to 5% of the assemblage on average. The diversity of wild species is low with beaver (*Castor fiber*), fox (*Vulpes vulpes*), red deer (*Cervus elaphus*) and wild boar (*Sus scrofa*). Concerning the Suidae, one upper fourth decidual premolar was identified as coming from a wild boar. The distinction between wild and domestic pig in two other specimens was not possible: at present, however, there is no evidence for the presence of domestic pig in the Late Chalcolithic occupation phases at Ovçular Tepesi.

Faunal remains collected outside pits in phase I layers have also been analysed. They are not presented in detail here as the stratigraphic analysis of the

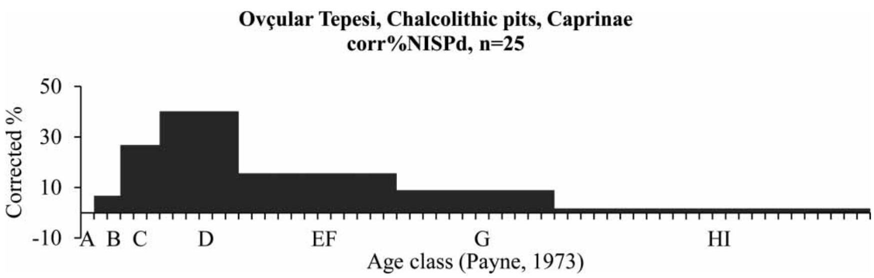

Figure 3 Kill-off pattern for sheep and goat based on corrected frequencies (see Vigne and Helmer 2007) of dental remains.

different contexts is still ongoing but the preliminary results of their study corroborate the patterns obtained from the pits. The faunal remains from phase II layers have also been studied. Preliminary results suggest that a shift occurred in the herding strategies between the phase I and II with a slight increase in the proportion of cattle corresponding in the later phase to 10% of the assemblage (Marro *et al*. 2011; Kovács *et al*. 2013).

Small mammals

Rodent and insectivore remains, and particularly the house mouse, are frequent in the pits with a total of 2130 fragments of which 561 (26%) were identified at least to the family level (see Table 4). Despite the large number of remains, species diversity is limited to six taxa. The number of remains is lower in pit 02·070 due to the limited volume of sediment sampled but also because only layers with a concentration of charred remains were selected. In this pit the fact that only one small mammal taxon was identified was probably due to the small sample size; taxa diversity often being correlated with the number of remains identified (Grayson 1984). The dominant taxa are rodents belonging to the Muridae and Cricetidae families. The most frequent is the house mouse, identified on the basis of geometric morphometric analysis of the molar shape as the *Mus musculus domesticus* subspecies (Cucchi *et al*. 2013). A few remains of jird (*Meriones* sp.) and grey hamster (*Cricetulus migratorius*) were also identified as well as one fragment of vole (Arvicolinae). The samples contain a few insectivores, namely two species of white-toothed shrews (*Suncus etruscus* and *Crocidura* sp.). All these taxa represent synantropic species (Evstafiev 2006; see also Savarin 2006). They are known to live near habitations where they feed on human food. The pits contain more small mammals than other structures on the site (Kovács *et al*. 2013) and this may be due to the animals falling into open pits, or animals that nested or fed in the pits and died there. The presence of burnt rodent droppings in the pits suggests that the mice were living in the pits. Some small mammal bones were burnt (*ca*. 200 fragments). It is likely that the bones became burnt while they were in the pits. It therefore supports the idea that rubbish was, at least occasionally, burnt inside the pits (Marro *et al*. 2009).

Table 4 Small mammals categories and taxa of rodents and shrews from the three pits

	01·171	02·070	08·051
Suncus etruscus (pygmy white-toothed shrew)	5	–	–
Crocidura sp.	9	–	–
Soricidae (shrew)	–	–	1
Cricetulus migratorius (grey hamster)	8	–	1
Arvicolinae (vole)	–	–	1
Meriones sp. (jird)	2	–	38
Mus musculus domesticus (house mouse)	245	77	171
Total identified (NISP)	*269*	*77*	*215*
Micromammalia unidentified (hamster size)	3	17	88
Micromammalia unidentified (mouse size)	264	7	1190
Total unidentified	*267*	*24*	*1278*

NISP, number of identified specimen.

Fish

Due to the location of the site on the bank of the Arpaçay river, one of the Aras river tributaries, it is not surprising that fish remains were abundant. Over 2500 fish bones were identified but species diversity is very limited, consisting almost exclusively of cyprinids (carp family) and with only six bones from other families (see Table 5). The latter belong to catfish (*Silurus glanis*) and a salmonid (*Stenodus leucichthys*, the only salmonid living in the region). The difficulty of identifying species within the cyprinid family explains why only 7% of the fish remains could be identified to genus or species level. Two bones were identified as barbel (*Barbus* sp.); the remaining bones come from *Capoeta capoeta* that seem to have been the preferred fish. Most of the fish remains are small in size compared to the mean size of the species (Kovács *et al*. 2013). This suggests that a majority of juvenile and medium-sized fish were caught from near the banks in shallow water. The capture of fish with small-sized nets or basket traps is technique that might have been used.

Seeds and fruits remains

The preliminary study of seed and fruit remains from Ovçular Tepesi has allowed the identification of 31 taxa belonging to 11 botanical families. Cultivated species dominate the assemblage but wild/weed taxa are also present in all the studied pits (see Table 6). Seed densities vary from less than 0·5 items per litre in pits 01·171 and 08·051 to 1·5 items from pit 02·070 (see Table 1).

Table 5 Fish remains from the three Late Chalcolithic pits (number of identified specimen)

	01·171	02·070	08·051
Silurus glanis (catfish)	2	1	1
Stenodus leucichthys (sheefish)	1	–	1
Barbus sp. (barbel)	1	–	1
Capoeta capoeta (Sevan khramulya)	38	14	121
Cyprinidae indet	693	319	1334
Total	*735*	*334*	*1458*

Table 6 Results from the analysis of seeds and fruits at Ovçular Tepesi*

		US	01·171	02·070	08·051	TOTAL NR	Frequency (%)
Cereals	Barley	*Hordeum vulgare*	5	17	19	41	11·4
	Hulled barley	*H. vulgare*, hulled caryopses	–	1	–	1	0·3
	Wheat	*Triticum*	5	1	4	10	2·8
	Cereals		23	–	42	65	18·1
		Cereals total	33	19	65	117	32·5
Pulses	Grass pea	*Lathyrus*	6	6	3	15	4·2
	Lens	*Lens culinaris*	1	1	–	2	0·6
	Pea/Vetch	*Pisum/Vicia*	–	7	9	16	4·4
	Cultivated pulses	Fabaceae	4	3	47	54	15·0
		Pulses total	11	17	59	87	24·2
Fruits	Hackberry	*Celtis* sp.	5	2	6	13	3·6
		Fruits total	5	2	6	13	3·6
Wild Poaceae	Goatgrasses type 1	*Aegilops* sp.	–	–	1	1	0·3
	Goatgrasses type 2	*Aegilops* sp.	–	–	2	2	0·6
	Goatgrasses, spikelet	*Aegilops*	–	–	1	1	0·3
	Panicoids	Panicoideae	4	–	–	4	1·1
	Poaceae type 5	*Setaria*	2	–	1	3	0·8
		Poaceae	3	3	5	11	3·0
		Poaceae total	9	3	10	22	6·1
Wild Fabaceae	Camelthorns	cf *Alhagi*	1	–	–	1	0·3
	Alfalfa	cf *Medicago*	2	–	1	3	0·8
	Fenugreek	cf *Trigonella*	5	5	5	15	4·2
	Pea family	Fabaceae	6	8	12	26	7·2
		Wild Fabaceae total	14	13	18	45	12·5
Wild taxa		cf *Arnebia*	1	1	1	3	0·8
	Daisy family	cf Asteraceae	–	1	–	1	0·3
	Borage Family	Boraginaceae	1	–	–	1	0·3
	Gromwells	*Buglossoides* cf *arvensis/sibthorpianum*	2	–	8	10	2·8
	Goosefoot family	Chenopodiaceae	2	–	–	2	0·6
	Bedstraw	*Galium* sp.	–	5	1	6	1·7
	Heliotropes	*Heliotropium*	–	2	–	2	0·6
	Knotweed family	Polygonaceae	1	–	–	1	0·3
	Rose family	Rosaceae	2	–	1	3	0·8
		Thymelaea	–	1	–	1	0·3
	Cowcockle	*Vaccaria*	1	–	–	1	0·3
		Other wild taxa total	10	10	11	31	8·6
		Undetermined	13	9	23	45	12·5
		Total	95	73	192	360	100

*Each identification counted as one item – except in the case of hackberry stone where two halves were counted as one item.

Crop plants

Cereals are by far the most frequently encountered crop plants. In the Aras river valley the average rainfall (200–400 mm/year) is sufficient for dry farming even though irrigation using water from the Arpaçay river cannot be excluded either. Wheat and barley are both well adapted to the local climatic and edaphic conditions. Barley is, however, less demanding in water resources and soil quality than wheat. The study of wheat rachis segments from other contexts than the pits in Ovçular Tepesi indicates that the wheat cultivated by the inhabitants corresponds to a hexaploid form of naked wheat (*Triticum aestivum* cf *avestivum*). Hexaploid wheats result from a hybridisation between a tetraploid cultivated wheat of emmer type (*Triticum turgidum*) and the wild goat-face grass (*Aegilops tauschii*) (Zohary and Hopf 2000). In view of the natural distribution of the goat-face grass, it is possible that some hexaploid wheats originated from the Caucasus area or from the Caspian Sea region (Gabrielian and Zohary 2004). Early finds of naked wheat come from the early 6th millennium BC Aratashen and Aknashen (Hovsepyan and Willcox 2008) and bread wheat, ideal for the baking of leavened bread, was thus already well-established crop in the area during the Chalcolithic period. The weed assemblage is not sufficient to establish with certainty whether the cereals were sowed in autumn or in spring even though autumn sowing seems more secure with regard to the local rainfall pattern.

Among the pulses, *Lathyrus* and *Pisum/Vicia* are the most frequent. Pea (*Pisum*) is an important source of protein and has a wide climatic tolerance occurring frequently on sites over a wide area including the Caucasus. The grass pea (*Lathyrus*) grows in dry areas on relatively poor soils. Nowadays this pulse is commonly used for human food in India but rather considered as a fodder plant in the near and middle East (Zohary and Hopf 2000). Only two seeds of *Lens culinaris* were identified. This pulse is present in the Caucasus already in the Neolithic period (Badalyan *et al*. 2010) and has also been identified from Chalcolithic occupations at Arukhlo 1 and 2, Imiris Gora (Georgia) and Gijlar (north-western Iran) (Chataigner 1995). In the Aras river valley, pulses could, like cereals, have been sown either in autumn or early spring.

Fruits

Stones from hackberry (*Celtis*) were identified and were probably gathered near to the site. Due to biomineralisation, the stones survive without charring and are therefore over represented compared to charred remains. Four edible species of hackberry occur in the Caucasus (*C. australis*, *C. caucasica*, *C. glabrata* and *C. tournefortii*).

Wild/weed taxa

Twenty-two wild plant taxa, belonging to 10 different families have been identified in the three Late Chalcolithic pits at Ovçular Tepesi: Boraginaceae (*Arnebia, Buglossoides* cf *arvensis/sibthorpianum, Heliotropium*), Caryophyllaceae (*Vaccaria*), Chenopodiaceae, Fabaceae (*Alhagi, Medicago, Trigonella*), Poaceae (*Aegilops, Setaria* as well as other morphotypes not yet identified), Polygonaceae, Rosaceae, Rubiaceae (*Galium*) and Thymelaeaceae (*Thymelaea*). Among the wild plants the Boraginaceae family is particularly well represented due to the preservation of nutlets by mineralisation in the same way as the hackberry. Many taxa in the group of wild plants correspond to arable weeds and their presence in the Ovçular Tepesi refuse pits probably results from post-harvest cleaning of crops.

Table 7 Results from the charcoal analysis at Ovçular Tepesi*

	US	01·171	02·070	08·051	Total
Riparian forest	*Elaeagnus angustifolia*	2	–	1	3
	Fraxinus	–	–	1	1
	Populus	–	5	–	5
	Populus/Salix	25	40	23	88
	Tamarix	5	–	–	5
	Ulmaceae	–	1	–	1
	Total	32	46	25	103
Open formation	*Juniperus*	4	2	1	7
	Prunus	1	–	5	6
	Rhamnus	1	–	–	1
	Total	6	2	6	14
	Parenchyma tissue	1	1	–	2
	Undetermined	11	1	16	28
	Undeterminable	–	–	3	3
	Total	50	50	50	150

*This study was a sub-sample of 150 fragments picked out arbitrarily.

Wood charcoal

Ten taxa were identified from 150 charcoal fragments, chosen arbitrarily from flotation samples (see Table 7). Wood belonging to the Salicaceae family dominates the charcoal record. The distinction between the two possible genera (poplar/willow; *Populus/Salix*) based on the structure of wooden rays (homogenous in poplar, heterogeneous in willow) is not always applicable. Still poplar could occasionally be determined. Another taxa characteristic of riparian formations or gallery forests is Russian olive (*Elaeagnus angustifolia*) present in lesser quantities in two of the pits. Russian olive is frequent in the Caucasus, for example in Armenia where it grows, between 400 and 2000 m, in damp habitats particularly riparian forests or along irrigation channels. In riparian formations *Elaeagnus angustifolia* is associated with *Populus euphratica*, *Hippophaë rhamnoides*, *Lycium*, *Tamarix* and *Salix*. Gabrielian and Zohary (2004) also noted its presence in open formations on drier ground, where it grows together with *Juniperus polycarpos*, *Crataegus*, *Pyrus* and *Sorbus.* This species is, however, more commonly found in riparian forests and is classified here as such. This is also the case for ash (*Fraxinus*), characterised by ring-porous wood and homogeneous and multiseriate rays. Several *Fraxinus* species are recorded from the Caucasus region where they grow in moist mountain forests or along rivers (Akhalkatsi 2009). The tamarisk tree (*Tamarix*), easily recognisable by its wide and heterogeneous rays with a storied structure, was identified in one sample. This genus is represented in the region by several species, which grow on the flood plains and near canals. The tamarisks are often halophilous and regenerate easily even after repeated cutting. Tamarisk is common in the present-day vegetation along the Arpaçay river, near the site of Ovçular Tepesi.

Four forest/steppe taxa were also identified. Wood belonging to a species from the elm family (Ulmaceae) is noted but could not be identified beyond the family level. At present the Ulmaceae are represented in the region by hackberry (*Celtis*), elm (*Ulmus*) and zelkova (*Zelkova*). Juniper woods (*Juniperus*) was identified in samples from the three pits. In the Caucasus several species of this genus grow on dry stony slopes between 500 and 1200 m. Finally, wood from wild almond (*Prunus*) and buckthorn (Rhamnus) complete the charcoal record.

Discussion

The pit fill contents

Whatever the primary function of the pits, we suggest that their fill results from an accumulation of domestic refuse that led to the lenticular deposition. In other words the fill was not made up of rubble that could contain material from levels much earlier than the fill itself. This interpretation is also based on the heterogeneous nature of the finds that appear to be in a secondary position. For example, unfinished beads (in different stages of manufacture), waste (microflakes) from obsidian knapping and food remains, including large mammal remains, fish bones and various plant foods (cereals, pulses and fruits). In addition, residues from crop processing are represented by weed taxa. These items come from rubbish that was deliberately thrown into the pits. As each habitation unit is associated to one or more pits, it is likely that the remains discarded in each pit originated from the activities of one household. Although it is difficult to estimate the length of the period during which the pits were used, radiocarbon evidence from phase I suggest a time span shorter than a century. Contrary to the other remains, we consider that the rodent and shrew may have fallen unintentionally into the pits. The charred material can have different origins. Charred botanical remains and part of the burnt bones may have resulted from the cleaning out of hearths (hence the dark lenses). Although the walls of the pits do not bear clear traces of fire, it is possible that some rubbish thrown into the pits was also burnt *in situ*. Indeed, it is unlikely that rodent bones and rodent droppings were burnt elsewhere and then discarded in the pits.

Wood exploitation and forest cover

The results obtained through the study of biological content of the pits indicate that the inhabitants of Ovçular Tepesi during the first phase of occupation exploited two main biotopes: the river valley and the drier foothills. Trees from the river valley habitat (e.g. poplar/willow, tamarisk, Russian olive and ash tree) are well represented in the charcoal assemblage and their wood was probably mainly used for fuel. Other possible uses of these species are for construction material, basketry and tool making. In general, the river and its banks represented an attractive and rich environment where beaver was hunted and fishing practiced. The riparian forest could also have been used for pasture. A second group of trees include juniper, *Prunus/Amygdalus*, buckthorn and hackberry which indicate an open steppe/forest formation of shrubs and trees located at some distance from the river but probably closer to the site than such formations are today.

Subsistence strategies

The subsistence strategy of the inhabitants during the first phase of occupation at Ovçular Tepesi was based on mixed farming with pastoralism and in particular meat production focusing on sheep and goat. In earlier studies from the Caucasus area, such as those compiled by Chataigner (1995), an exploitation pattern with more than 90% of sheep and goat was unknown in Caucasian Neolithic and Chalcolithic settlements. However, new data from nearby Neolithic and Chalcolithic settlements in the Aras and Arpaçay river valleys show that a form of pastoralism almost exclusively specialised on sheep and goat did exist in this area (Balasescu *et al*. 2010; Wilkinson *et al*. 2012). At Ovçular Tepesi, fishing in the nearby river completed the meat diet but hunting appears to have been rare. Cultivation played an important role in the subsistence economy. Barley grain could have been used as human food but also as a fodder for the herds particularly during the dry summer months. Naked wheat grain is normally reserved for human consumption, but chaff, stubble and straw constituted a possible source of fodder. Pulses are an important nutritional compliment to the diet and three taxa are present in relatively high frequencies compared to other archaeobotanical assemblages from the area where pulses are sometimes even completely absent.

The valley bottom and the river appear to have played a central role in local subsistence economies. The inhabitants exploited trees from the nearby riparian forest rather than the steppe/forest. This choice was probably due both the quality of the wood from the gallery forest which is easier to cut and more suitable for construction, and located nearer the settlement than the steppe/forest. Fishing in the shallows near the banks entailed methods such basket traps or nets to catch juvenile and medium-sized fish.

Conclusion

What is the evidence for seasonal activities or even seasonal occupation at Ovçular Tepesi? The importance of cereal and pulses cultivation suggests permanent occupation. These crops were probably autumn sown as suggested by weed taxa such as *Galium*, *Heliotropium*, *Thymelaea* and *Vaccaria*. The kill-off pattern for sheep and goat does not indicate a seasonal pattern. If the site was only occupied in summer, one would expect animals slaughtered between an age of two and six months which was not the case. A kill-off pattern typical of a winter camp would have included a higher proportion of older individuals (Vigne and Helmer 2007). It has to be stressed though that the bioarchaeological data, which suggest permanent occupation, are not exactly in keeping with the stratigraphic and architectural data (Marro *et al*. 2009, 2011), which suggest non-permanent occupation, more work in every field is certainly necessary before clear conclusions about the general occupation patterns at Ovçular Tepesi may be reached. The possibility that part of the herd occupied higher pastures during the summer will be investigated in the future by using stable isotopes signatures.

It is not possible to estimate precisely the period of time during which the fill of the pits at Ovçular Tepesi accumulated. Thus, we treated the fill as a single stratigraphic unit. The accumulation of rubbish represents a large range of human activities that provide information on the natural resources available around the site and the subsistence strategies. The results of archaeobotanical and archaeozoological studies from the pit contents, which date to the Late Chalcolithic phase I at Ovçular Tepesi (*ca*. 4350–4250 BC), suggest that they were filled with domestic refuse. The study of this rubbish suggests that the Late Chalcolithic settlement during phase I consisted of permanent occupation with sufficient food storage and domestic rubbish to attract an important population of synanthropic rodents and shrew. The inhabitants herded sheep and goat and specialised in meat production, as well as cultivation of cereals and pulses. Hunting was not practiced on a large scale but fishing appears to have been extensively practiced. The riparian forest was exploited for timber.

A standard sampling strategy with flotation and wet sieving of large-scale samples was essential to the study. We concentrated particularly on the heavy fraction from the water sieving that produced a unique assemblage of fish, rodent and shrew bones. Future studies will show whether the pit contents correlate with sampling from other areas of the site. Finally, on a broader scale we need to compare our data with other sites in the Caucasus in order to understand the diffusion of plants and animals, such as the house mouse, pulses and naked wheat. Such a comparison would benefit from the systematic use of standard sampling strategies.

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