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Palynological and Archaeological Evidence for Ritual Use of Wine in the Kura-Araxes Period at Aradetis Orgora (Georgia, Caucasus)

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Pollen and non-pollen palynomorphs found in two zoomorphic Kura-Araxes vessels (3000 BC ca) from Aradetis Orgora in Georgia suggest their use for ritual consumption of wine. The hypothesis is supported by archaeological and geoarchaeological data: the vessels resemble more recent wine-drinking vessels from Georgia and elsewhere, and were found in a building, whose context is suggestive of a small shrine. Their palynological spectra match those of present-day wine and wine containers of other periods. One of the vessels was intact, with only a small hole, preventing contamination of its contents; consequently, its palynological spectrum can be prospectively used as a standard in determining the presence of wine in archaeological vessels. Significant results were also obtained about the conditions of viticulture and the cultural relevance of wine during the Kura-Araxes period. We show that the Aradetis Orgora vessels represent the beginning of the long-lived tradition of animal-shaped wine-drinking containers in Georgia.

Keywords: Southern Caucasus; Early Bronze Age; Kura-Araxes culture; Palynology, Soil micromorphology; Ceramics; Wine; Ritual.

Introduction

Palynological research on archaeological materials started in the second half of the 20th century. This research field was not paid proper attention in its first stages, but it gradually acquired importance, until it developed into a separate discipline, i.e. “Archaeological Palynology” (Holloway and Bryant 1986). Subsequently, palynological analyses became a standard practice in archaeology.

However, the main object of archaeological palynology is still in most cases the reconstruction of past environments, while few attention is paid to the remains of artifacts. In fact, the remains of vessels contents, as well as residues on grinding stones, grinders and mortars have a high potential in answering questions about paleo-diet and similar issues. These objects were first analyzed by American palynologists (Bohrer 1968; Hevly 1970; Briant and Hollawey 1983), who noted that pollen grains of numerous edible plants were preserved on their surfaces and walls.

Palynological analyses on contents residues proved useful in establishing what food or drink had been stored or consumed in archaeological vessels – e.g. ancient mead and honey (Dickson 1978; Rösch 1999; Kvavadze 2007; Kvavadze and Narimanishvili 2010), or beer (Rösch 2014) – as an alternative or in association with archaeobotanical, chemical or isotopic analyses. Manfred Rösch (2005) first noted that palynological methods could be used to show that wine had been stored in archaeological vessels. He analyzed the contents of Coptic wine amphorae of the Early Medieval Period from Šaruna, Middle Egypt, including also the palynological study of modern wine, and concluded that a considerable amount of grape pollen grains enters into wine. This very important conclusion laid the foundations for introducing palynology into the study of wine history.

Pollen monitoring in vineyards and annual studying of wine from the same vineyards started in Georgia immediately after Rösch's publication (Kvavadze and Chichinadze 2007; Kvavadze et al. 2010a). Since 2007, palynological studies on Neolithic vessels proved that they had contained wine (Kvavadze et al. 2010b, 2014). It must be emphasized that a number of palynomorphs of non-palynomorph character occur alongside grape pollen in wine, representing additional evidence in identifying ancient wine. Residues from Neolithic vessels were investigated also by chemical analyses, definitively confirming the results of the palynological studies (Magradze et al. 2016; McGovern et al. 2017a, b).

In this paper we present new palynological evidence of the use of wine and the diffusion of viticulture during the Kura-Araxes period (end of the 4th millennium BC) from the site of Aradetis Orgora in the Shida Kartli province of Georgia (Southern Caucasus), resulting from analyses carried out on the contents of two peculiar zoomorphic vessels. The hypothesis of ritual/religious use of wine by the ancient population of the site is corroborated by the unique shape of the vessels and by the unusual discovery context, which is put into evidence also by the geoarchaeological characteristics of the sediments.

Regional setting

Aradetis Orgora is located in the Kura (Mtkvari) River valley in Shida (Inner) Kartli, about 4 km NE of the modern town of Kareli, at 42°02'47.80" N, 43°51'37.23" E. The archaeological site includes a cemetery (Doghlauri) and three mounds; the most important one ("Dedoplis Gora") is 34 m-high, situated on the left bank of the Western Prone (Phsiula) River, near its confluence with the Eastern Prone and the Kura (**Figure 1**). The top of this hill lies between 675 and 680 m a.s.l.

The Shida Kartli hydrographic network is represented by the Kura River and the branched system of its tributaries. The region is enclosed between the northern slope of the Lesser Caucasus and the southernmost fringe of the Greater Caucasus; it is characterized by Tertiary marine sediments shaped by river erosion and partly overlain by Quaternary deposits, mostly alluvial fans and river sediments (Maruashvili 1970; Furlani et al. 2012).

Climatic conditions are slightly cooler in this region, compared to Kvemo (Lower) Kartli to the south. The yearly average temperature is 12-13 °C in the lower areas of Shida Kartli, and 9-10 °C on the elevated edges of the region. Winter temperatures vary from +1 to -2-3 °C, but can occasionally reach -16 °C. The annual amplitude of temperature is 18-24 °C. The average annual cloudiness is 30 %; the annual rainfall in the central lowlands is 400-500 mm (Maruashvili 1970).

The present-day vegetation is wholly anthropogenic. Secondary phytocenoses consist of arid forest-steppes and steppe valleys, where oriental hornbeam (*Carpinus orientalis*) and bushes of garland thorn (*Paliurus spina-christi*) prevail. Residual forests are preserved only on the higher hills and crests, where box-tree (*Buxus*), ivy (*Hedera*) and winterberry (*Ilex*) grow besides oak (*Quercus*) and hornbeam (*Carpinus*) (Maruashvili 1970). The valleys and plains of the region are presently used for horticulture as well as for growing wheat (*Triticum*) and other cereals, whereas viticulture is not practiced on a large scale.

Materials and methods

Samples for palynological analysis were collected from stratigraphic profiles and pottery vessels at the Aradetis Orgora Main Mound settlement during the 2015 fieldwork of the "Georgian-Italian Shida Kartli Archaeological Project" of Ca' Foscari University in collaboration with the Georgian National Museum of Tbilisi (GISKAP), and from various graves of the neighboring Doghlauri cemetery, investigated in the framework of salvage excavations headed by I. Gagoshidze (Gagoshidze and Rova 2018, in press; Bertoldi 2016). Here, we focus only on the results of analyses carried out on samples from Kura-Araxes contexts.

The samples were processed by standard methods (Moore et al. 1991) in the Laboratory of Palynology of the Georgian National Museum Institute of Palaeobiology. During the first stage of the analysis, 50 g of sample were boiled in 10% potassium hydroxide, then the material was centrifuged in cadmium solution in order to separate all kinds of organic remains and to isolate them from the mineral fraction. Acetolysis, i.e. coloration of the separated microfossils, was carried out in the final stage of the process.

Samples of modern wine were also processed and studied in order to confirm the methodological issues. All organic remains existing in wine were deposited and extracted from one liter of wine by centrifuging. Acetolysis was performed also here in the final stage of processing. Pollen grains of modern vine – as well as other non-palynological palynomorphs – collected from leaves, grapes bunches and stalk were also investigated. Seeds remaining after squeezing the grapes were also studied in order to verify if remains of vine pollen grains are associated with seeds.

The material was identified, counted and photographed under a transmitted light microscope Olympus BX43. No less than 250-300 pollen grains and an even larger number of other kinds of palynomorphs were counted in every sample. Eventually, statistical processing of the registered pollen grains and of the other palynomorph types, and graphical representation of the results was carried out by the palynological program Tilia (Grimm 2004). Modern standard preparations, as well as atlases were used for the identification of both non-palynological remains and pollen grains (Bobrov et al. 1983; Kuprianova and Alioshina 1972, 1978; Ertdman 1956; Chernova and Tselikova 2004; Fujuki et al. 2005; Beug 2004; Moore et al. 1991; Piperno 2006; Reille 1992, 1994, 1997; Richter et al. 2004; Stuchlik 2001, 2002, 2009, 2014; Toshiyuky et al. 2005; Torrence and Barton 2006; van Hoeve et al. 1998).

Soil micromorphological observations were systematically carried out on large part of the lithologic units of the Aradetis Orgora sequence. The microscopic characteristics of selected samples collected from the “shrine” area during 2015 fieldwork are described here in order to characterize construction techniques, use and management of the area.

Three 90 x 60 mm thin sections were prepared from loci contemporary with the "shrine" area. Undisturbed sediment monoliths for thin section preparation were collected one per locus. The monoliths were air-dried at 30 °C in ventilated oven for 7 days and then impregnated by low-viscosity acetone-diluted polyester resin under moderate suction; polymerization was carried out under atmospheric pressure. The thin sections were cut by diamond disk and ground to 30 μm by corundum abrasive powders, using petroleum for cooling, and covered by a standard optic glass slide. The thin sections were observed under a Zeiss Axioscope.A2 standard petrographic microscope. The descriptions follow the standard formalized by Stoops (2003) for soil thin sections.

The cultural milieu: the tradition of wine and wine containers in Georgia and elsewhere

Interdisciplinary research carried out by archaeological, palaeobotanic and chemical methods on archaeological materials proved that – in the territory of present-day Georgia – viticulture and wine-making originated during the Neolithic (McGovern et al. 2017a, b). Viticulture and wine-making were part of the agricultural economy of the region several thousand years ago and are still a fundamental resource of this area.

The origins and evolution of viticulture and wine-making fostered the creation and development of specific vessels and tools for making and preserving, as well as for transporting and consuming wine. Georgian archaeology traced the evolution of wine vessels back for a period of nearly eight thousand years, from the 6th millennium B.C. to the present day. For example, the so-called *qvevri* (**Figure 2a**) – a special type of large ceramic vessel used for wine making, fermentation and preservation – was first produced in its most typical shape around 1000 BC in the Near East, including the Southern Caucasus (Chilashvili 2004; Lordkipanidze 2017). It then spread into all the regions of ancient wine-making in Europe, Asia and North Africa without undergoing significant changes; however, only in Georgia was it preserved until now in its original form.

Wine, however, was not (and still is not) only a food product or a simple beverage. Apparently, it was connected with religious beliefs, cults and rituals since the oldest times; e.g. it is not necessary to remind the significant role played by red wine in Christian religion. Until recently, there was a special *qvevri* (the so-called “*qvevri* for communion wine”) in the wine cellar of every wine-making villager of Georgia, which was used for keeping the wine to be consumed on the festival of the patron saint of the village (or region). If the family moved from the village, it had to leave this *qvevri* at the local sanctuary: in Kakheti, even today such *qvevris* are laid in many village churches. In old times – and in Georgia even nowadays – both festive (wedding, baptism etc.) and mourning (wake) feasts were unconceivable without wine. The blessing of living people and the remembrance of the deceased were celebrated with wine, as it still happens.

Supposedly, specific kinds of vessels were used for toasts of different types and by different populations: it would be impossible, otherwise, to explain the variety of wine-drinking vessels in the Near East and in the Mediterranean region from the Bronze Age to the Middle Ages. Even today in Georgia, the main toast of the festive parties is drunk from a particular drinking vessel – the *rhyton*. This is perhaps because the shape of the oldest kind of wine-drinking vessel was inspired by the horns of domestic or wild animals (oxen, aurochs). *Rhyta* of different materials (gold, silver, bronze, ivory, glass, ceramics) were very popular in the Eastern Mediterranean and in the Near East, as well as in the countries belonging to the Achaemenids and, later on, in the whole Hellenistic and Roman world, but their tradition is presently preserved only in Georgia (Jorjadze et al. 2011).

Zoomorphic drinking vessels, often mentioned as *rhyta*, were particularly popular in wine-making countries in the first millennium BC (**Figure 2b**). The large number and variety of zoomorphic drinking vessels, particularly in the Achaemenid and Hellenistic periods, is really surprising. In Georgia, ceramic drinking vessels of this period were shaped as horses, oxen, sheep, boars, elephants and fishes (Khundadze 2010). These *rhyta* normally have two openings: one for pouring wine, and the second for drinking.

The aspect of long-necked water birds (swans, geese) probably inspired the shape of the two vessels from the Kura-Araxes "shrine" of Aradetis Orgora (Dedoplis Gora) (see *infra*): their bodies are ovoid and slightly flattened, with a low crest in the middle of the back and a single opening on the back side. The neck raises vertically on a bulged breast and performs the function of a handle, ending with a flat head. In contrast to later *rhyta*, however, these drinking vessels have only one hole; for this reason, we could define them as proto-*rhyta*.

On the other hand, spatially distant, but chronologically nearer analogues of the Aradetis Orgora vessels may be found at sites of the Cycladic culture. Stone and ceramic zoomorphic vessels (shaped as oxen) were produced in the Cyclades already in the Early Cycladic period, i.e. from the first half of the 3rd millennium BC (Sidorova 1972, 47; Thimme 1976, 98-99). The so called *askoi* and saucers of the third phase of the Early Cycladic period (second half of the 3rd millennium) are definitely inspired by the forms of birds (Sidorova 1972, 46). In our opinion, whatever the name attributed to them, these are drinking vessels as well. In contrast with the Aradetis Orgora vessels, however, these *askoi* have holes in the place of the bird's head, and not on the back (Thimme 1976, 530, Kat Nos 420-421). Be that as it may, they also belong to the widespread tradition of zoomorphic wine containers.

The Aradetis Orgora zoomorphic vessels

In 2013 the "Georgian-Italian Shida Kartli Archaeological Project" started excavations at the Aradetis Orgora Main Mound in order to explore the settlement's stratigraphic sequence (which comprises of up to 14 m of anthropic layers, dating from the end of the 4th millennium BC to the 6th century AD), and to obtain a set of stratigraphically reliable artifacts, ecofacts and samples from its different occupation phases (Gagoshidze and Rova 2015, 2018, in press).

In 2015, two unique zoomorphic vessels were recovered (**Figure 3**) from the Kura-Araxes levels of the site. One (2414-M-2) was almost complete – only the head was missing – (**Figure 4a**), while the other one (2434-M-5 + 2414-C-3)[1] was refitted from several fragments (**Figure 4b)**[2]. These two vessels are quite similar, differing only in few minor details. Both have thick walls and a reddish-brownish burnished surface[3]. The body is hollow and squat oval, with a large hole on the back and three small feet (two on the front and one on the back); the head resembles stylized animal/human features. The feet of the first vessel are roughly conical, while those of the second one are modeled more accurately and convey the impression that the figure is standing on tiptoe. Only the head of the second vessel is preserved: it widens from the solid oval-

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1 The vessels are presently kept in the Dedoplis Mindori ("Queen's field") fund of the Georgian National Museum. Their museum inventory are 27-977:11926 and 27-977:11927.

2 One fragment (2414-C-3, corresponding to the figure's feet) was recovered separately from, and at a slightly higher level than, the remaining ones. Its fabric is also slightly different from those of the other fragments: it is not totally excluded, therefore, that it originally belonged to a third vessel, similar to the other ones.

3 The surface of the second vessel is partially abraded and shows traces of heavy burning, possibly due to the fire event which caused the destruction of the building. The smooth red surface of the other vessel is covered by a net of microscopic cracks, which are characteristic of the Kura-Araxes ceramics.

section neck into a sort of flattened triangle with a slightly curved top, whose sides suggest schematic ears; the nose is represented by an elongated clay pellet. The eyes are slightly hollow and, in their centre, the pupils are represented by a small protruding spot. Faint traces of the original painted decoration are preserved: a thin dark reddish band runs along the top of the head and continues on its back, one (or two?) black band(s) run around the neck, which is surrounded at the base by a wider band of lighter reddish color.

To our present knowledge, the Aradetis Orgora vessels are unparalleled within the published Kura-Araxes corpus. Their shape is unique, however the stylized facial traits represented on the second vessel do not appear out of place in the Kura-Araxes period. They remind some of the numerous anthropomorphic or zoomorphic figures which decorate Kura-Araxes hearths and andirons (Sgomorzewska 2004) or pottery (Sagona 1984, part III, *passim*). More generally, they can be compared to a long series of more recent *rhyta* and other zoomorphic containers (see *supra*) traditionally used for wine consumption in Georgia and in other South-Caucasian countries.

The Aradetis Orgora vessels may be functionally related – although quite different morphologically – to fragments of recently discovered "*rhyta*" with human foot-shaped pedestals, found in a Level VIB1 hut of Arslantepe/Malatya, which were possibly used for consuming special kinds of liquids (maybe alcoholic beverages) in a ritual context (Palumbi et al. 2017, fig. 12, bottom row).

The archaeological context

Two trenches (Field A, located on the eroded SW slope of the mound overlooking the Prone River, and Field B, situated on the eastern side of the mound) put into light similar occupation sequences.

Field B was excavated down to the natural soil, to the bottom of a 13 m-thick sequence of anthropic deposits spanning the Hellenistic, Iron, Late, Middle and Early Bronze Age periods. The Kura-Araxes levels were excavated in the lowermost quadrants of the trench, and comprised of densely packed layers (**Figure 5**) that were divided into six main phases (Gagoshidze and Rova 2015, 2018, Georgian-Italian Shida Kartli Archaeological Project). Their age is bracketed between the 31st and the 28th centuries BC, as suggested by Bayesian modeling of selected ^{14}C dates (Passerini et al. 2016).

The top of the Kura-Araxes sequence (Phase 1) was largely damaged by a large Late Bronze Age terracing wall. Remains of architectural structures, mostly circular and sub-rectangular huts built by different techniques (wattle-and-daub, clay, mud bricks) were unearthed in Phases 2, 3, 4 and 6. Conversely, an open area with fireplaces and inconspicuous installations was found in Phase 5.

Evidence for ritual use of wine was found in an area of about 3.5 x 3 m of Kura-Araxes Phase 4 (**Figure 6)**. The age of Phase 4 is constrained at the top by the burnt floor of some Phase 3 wattle-and-daub structures, destroyed by a fire dated to 2900-2880 BC by high-precision radiocarbon dating (Passerini et al. 2016). A *terminus post quem* is provided by a single radiocarbon date from Phase 6, which can be placed in the 31st century BC (*ibid.*)[4].

Few pottery is associated with the Phase 4 occupation and, except for the vessels described above, it mainly consists of sherds (**Figure 7**), mostly belonging to Red-Black

4 Note that phase numbering changed between 2014 and 2015. Consequently, the sample described in Passerini et al. 2016 as from "Phase 4" is instead from Phase 6. The excavation of Phase 5 and Phase 6 was completed during the 2015 and 2016 fieldwork.

Burnished Ware, with typical shapes of the Shida Kartli variant of the Kura-Araxes production, which can be ascribed to the (late) KA II phase (Rova 2014).

The thickness of Phase 4 deposits varied between 50 and more than 80 cm. At first (sub-phase 4b) the whole excavated area was an open space (2471) with numerous firing installations (shallow rounded hollows filled with ashes and burnt material) situated in different sublayers. The top of this sequence was sealed by a homogeneous grayish fill (2467).

In sub-phase 4a, a structure (locus 2413) delimited by a 35 cm thick wall of compact yellowish clay (2435) was built in the northern part of the excavated area, whereas the southern one was used as an open space, where a grayish homogeneous fill similar to 2467 (locus 2427, up to 25 cm thick) accumulated.

Unfortunately, only the south-eastern corner of building 2413 could be excavated. It was an unusually large structure, probably rectangular with rounded corners, EW-oriented. Its floor (locus 2434) consisted of an 8-10 cm-thick sequence of repeatedly renewed layers of compacted yellowish-greenish silt, covered by a thin whitish layer of phytoliths (locus 2429). It was overlain by 15-30 cm of burnt daub fragments and ash (locus 2414-2424), probably remains of the collapsed structure roof and walls.

A row of four small post-holes run NS in the central part of the floor, dividing the space into two different areas. To the west, fragments of a 50 cm wide concave round-shaped hearth (locus 2433) were recovered. In the eastern part of the room, the remains of three vessels were lying on the burnt floor, close to the SE corner (**Figure 6**). The first one was a relatively large typical Kura-Araxes carinated jar with two eyelet-shaped handles (**Figure 7,** right), evidently leaning to the eastern wall and broken into several fragments. The fragments of the two zoomorphic vessels were lying about 30-50 cm to the west of this jar; the first one (2414-M-2) was unbroken and almost complete, while the second one (2434-M-5 + 2414-C-3) was broken into few fragments.

Results

Pollen analyses

Figure 8a shows the palynological spectra of the contents of the two zoomorphic vessels recovered in the Kura-Araxes "shrine" (space 2413). Samples Nos 1 and 2 were collected from the fragments of the broken vessel (2434-M-5 + 2414-C-3), while Sample No. 3 was collected from the contents of the unbroken one (2414-M-2). Abundant pollen occurs in all samples, which is quite rare in archaeological vessels. The taxonomic as well as the quantitative composition are large.

Samples Nos. 1 and 2. Pollen of 16 different tree and 28 grass taxa was detected. Pollen of grape (*Vitis vinifera*) is present in the spectra **(Figures 8a, 9a**). Walnut (*Juglans regia*) pollen dominates among tree plants, but there are also frequent pollen grains of hornbeam (*Carpinus*) and pine (*Pinus*); alder (*Alnus*), beech (*Fagus*), hazelnut (*Corylus*), oak (*Quercus*) and spruce (*Picea*) are well represented as well. Pollen of fir (*Abies nordmanniana*), maple (*Acer*), chestnut (*Castanea sativa*), oriental hornbeam (*Carpinus orientalis*), elm (*Ulmus*), lime-tree (*Tilia*) and buckthorn (*Rhamnus*) is few.

Cultivated cereals – especially wheat – dominate among the herbaceous taxa. There is a large amount of pollen of goosefoot and other garden, crop fields and vineyard weeds, e.g. knotweed, cornflower, sorrel, and chicory (cf. **Figure 8a**). Wild cereals, sedges, wormwood, common cocklebur, yarrow, stinging nettle, plantain are also attested. These species are weeds, generally associated with anthropized environments and growing in yards, along roads and paths, in waste areas and dumps.

Spores of forest ferns and pollen grains of bur-reed (*Sparganium*) living close to water were also observed.

Starch and plant epidermis dominate the non-palynological composition (**Figures 8b**, **10a, 10b**). Tissue fibers are also very common, mainly belonging to flax and cotton, although wool fibers were also observed. Insect hairs of *Drosophila* are well represented as well **(Figure 10c**). These tiny flies use to fly around grapes and wine during the first stages of its production and are present in large number during fermentation and easily fall in the large vessels where wine is usually placed. Consequently, wine is contaminated by flies, whose remains are found in archaeological vessels used to contain wine (Chyb and Gomped 2013). Finally, spores of fungi and phytoliths of cereals occur in small amounts in the analyzed samples (**Figure 8b**).

Sample No. 3. This sample was collected from the second zoomorphic vessel (2414-M-2). Considering that its body was intact, with only a small hole in the lower part, we can presume that the contents had not been contaminated by soil and that its palynological spectrum is clean. Consequently, it can be considered as a standard in defining fossil wine in any archaeological vessel.

This palynological spectrum is also rich in terms of grain quantity and number of taxa. Pollen grains of 13 tree and 19 herbaceous taxa were identified. Among the trees, the dominant species are walnut, hornbeam and pine. Additionally, there is a large amount of pollen of beech, alder, spruce, nut, and vine, whereas birch, oak, wingnut, oriental hornbeam, elm and dog rose are few. Among the herbaceous taxa, cultivated cereals dominate here as in the spectra of the previous vessel. Pollen of vineyard, garden and field weeds and of ruderal weeds growing close to the settlements occurs as well.

As for the non-palynological remnants, this sample includes very common starch, some tissue fibers of flax and wool, small amounts of parenchymal cells of wood, phytoliths of cereals, hairs of the fruit fly *Drosophila* and epidermis of other insects.

The lower part of the palynological diagram presents the results obtained from two samples of modern wine. The first one was squeezed from grapes growing in the surrounding of Aradetis Orgora, while the second was sampled in the village of Kvemo Magharo (Sighnaghi municipality), in the Kakheti province of Eastern Georgia. In both cases it was home-made wine. The diagram shows that the spectrum of modern pollen of grape (*Vitis vinifera*) is not very rich in pollen (**Figure 9b**). In our opinion, this can be due to modern methods of pressing and storing: nowadays, large vessels are easily available, therefore wine can be decanted and transferred several times from a vessel with lees into a clean one. However, pollen grains are still observed in the palynological spectrum of wine, mostly in the wine pressed in Kakheti, where they occur in large number (**Figure 8a**). Pollen of walnut and nut, two cultivated species that usually grow close to vineyards, was also found in the same wine.

Regarding the herbaceous taxa, pollen of garden and vineyard weeds was observed here, as in the fossil spectra. Ruderal taxa growing along roads and paths were also detected: a good example of these is the common cocklebur, which is widespread on the territory around vineyards, where grapes are picked and wine is made. Artemisia, stinging nettle and plantain, which grow in abundance near vineyards, were also observed in the palynological spectrum of wine.

Among the non-palynological remains, starch dominates (**Figure 10a**) in both samples of modern wine (cf. **Figure 8b**). Fibers of cotton and flax are frequent, as well as of wool and artificial tissues. Plant epidermis also occurs, and small amounts of fungi spores, wood cells, and phytoliths of cereals are also present. Zoological residues are well represented: hairs of *Drosophila* (**Figure 10c**), scales of moth, and microscopic fragments of bird feathers have been identified. Interestingly, algae of fresh water were also found in the first sample of wine, which, in our opinion, means that this wine must have been diluted with water.

The pollen spectra of wine residues in the zoomorphic vessels from Aradetis Orgora show a remarkable similarity not only with the spectra of modern wine, but also with the residues of fossil wine found in vessels of various archaeological epochs. The contents of unbroken vessels, which are almost free from impurities, are of greatest interest, e.g. a Kura-Araxes vessel from a child burial at Nachivchavebi (Bitadze et al. 2011), some *amphorae* of classical age from Vani (Chichinadze et al. 2012), a *qvevri* from the wine cellar of Treli Gorebi, dated to the 1st millennium BC (**Figure 11a**), a Middle Ages *qvevri* and some tools from the wine cellar of Abulmeki (**Figure 11b**).

There is always a fairly large amount of grape pollen grains in the palynological spectra of these samples. Walnut and nut, i.e. evidence of horticulture, also occur among the components of these spectra, which also include a large amount of pollen of cereals. Finally, many starch grains, some hairs of *Drosophila* and plant epidermis were observed among the non-pollen palynomorphs, like in the spectra of the Aradetis Orgora zoomorphic vessels.

The pollen contents of the large-size wide-mouthed jar (2414-C-5) found together with the zoomorphic vessels, of the samples collected from the vertical profile of the Kura-Araxes Phase 4 levels to which the "shrine" is ascribed (**Figure 5**), and those collected in a Kura-Araxes grave from the Doghlauri cemetery were also investigated.

Kura-Araxes jar (2414-C-5). Pollen of *Triticum* (wheat), *Avena* (oat), *Hordeum* (barley) and other cereals is abundant in both samples from the jar. Among the arboreal species, *Pinus*, *Alnus*, *Carpinus*, and *Quercus* were recorded; pollen grains of *Vitis vinifera* are present as well (**Table 1).** The amount of pollen of field and garden weeds is also rather large. Phytoliths and starch of wheat and other *Cerealia* are well present among the non-palynological remains.

There are also frequent remains of insects and ticks, as well as spores of mould fungi (*Mucoraceae*). These support the hypothesis that the vessel was filled with grain, which was subsequently destroyed by insects and mould. This is indicated also by the occurrence of spores of the *Glomus* fungus, which abundantly grows on tilled, loose soil and whose spores easily penetrate into wheat ear and corn (van Hoeve et al. 1998).

Profile No 1. (Field B, quadrant 105.099c, western profile). Four samples were collected from this profile, at vertical intervals of 15 cm (**Figure 5b**). They can all be ascribed to the Kura-Araxes Phase 4, i.e. to the same occupation phase of space 2413, where the zoomorphic vessels were discovered. The samples were collected in space 2471, the open area located to the south of "shrine" 2413: the uppermost one was collected from the part of the filling that is contemporary to the use of 2413 (sub-phase 4a), whereas the other ones predate it (sub-phase 4b)**.**

A prevalence of pollen of cereals (including wheat) is characteristic of the spectra of this profile, which also includes many pollen grains of weeds of crops. Garden and vineyard weeds, as well as of areas close to human dwellings were observed as well, e.g. *Polygonum aviculare*, *Carduus*, *Chenopodium album* and *Convolvulus*. Pollen of grape brought in from nearby vineyards was also found in this profile **(Table 1**). Among the tree taxa, pollen of pine, spruce, fir, hornbeam, alder was found. Spores of forest ferns were also observed as well as indicators of horticulture, such as pollen of walnut and nut.

Phytoliths of cereals, including cultivated forms, dominate among the non-palynological fossils **(Table 1).** A particularly large number of phytoliths of sowing cereals was recorded in the sample from *locus* 2436, which corresponds to the top of the filling of open space 2471. A considerable amount of starch grains and wood parenchymal cells was also observed. Fibers of flax textile and epidermis of plants were less frequent, and zoological material was present only in very small quantity.

Doghlauri cemetery, Grave No. 2. This grave was a rectangular stone-covered, stone-lined pit, 2.20 x 2.15 m wide, containing the *in situ* remains of a 35-45 years old female in the centre, and sparse bones of two other individuals in the NW corner (Bertoldi et al. 2016). Burial goods consisted of two Kura-Araxes vessels (an open pot and a bowl), a metal spiral, three metal hair-rings, and three cylindrical beads of whitish paste or bone.

The investigated palynological samples were collected from the two ceramic vessels (DG 2015 G2-C-1 and DG 2015 G2-C-2) and from beneath the skull and the abdomen of the *in situ* individual. The palynologically richest sample was the one collected from beneath the skull, where pollen of 15 taxa was detected (**Table 2**). Pine, beech, oak, walnut, alder, hornbeam, elm, lime and vine were observed among the trees and bushes. Herbaceous taxa were mainly represented by pollen grains of ruderal weeds. As for the non-palynological remains, fibers of flax cloth prevail in the sample from under the skull. In particular, some light blue fibers were observed: these might represent the remains of a colored scarf worn by the deceased. In addition, the sample contained a large amount of cereal starch, some spores of fungi, cells of wood and phytoliths, and few remains of insects and ticks (**Table 2**).

In the sample collected from the abdomen area there is a huge amount of pollen of edible plants. These are walnut, nut, plumeless saw-wort (*Serratula*), buckwheat and thistle. Pollen of medicinal plants, e.g. yarrow, cornflower, and black spleenwort (**Table 2**) is found only here. Parenchymal cells of wood, starch of cereals and phytoliths dominate in non-palynological remnants. Spores of fungus *Glomus* and fibers of flax cloth, including green and blue-colored fibers, are present in small amount.

Sowing cereals and weed pollen are better represented in the contents of one vessel (DG 2015 G2-C-2), which also contained pollen of pine, ephedra, beech, hornbeam, oak, walnut, alder, and vine. Starch, phytoliths, and parenchymal cells of wood are frequently represented in the group of non-palynological palynomorphs (**Table 2**).

The spectra from the contents of pot DG 2015 G2-C-2 included sparse pollen grains of arboreal taxa like *Pinus*, *Fagus*, *Quercus*, *Alnus*, *Tilia*, *Vitis vinifera*, and a small amount of pollen of herbaceous taxa. Starch and burnt parenchymal cells of wood prevail among the non palynological remains, as in the spectrum of the other vessel. However, remains of fresh water algae were also found here. Following the characteristics of these pollen spectra, it can be hypothesized that both vessels from Grave No. 2 were kitchen tools. Not surprisingly, both contained many grains of starch and burnt cells of wood, which usually get into vessels when preparing food on an open fire. The freshwater algae are often present in drinking water and, in this specific case, they probably occurred in the water where food was cooked.

Soil micromorphology

The “shrine” area is comprised of several lithologic units, i.e. the encircling wall (locus 2435) and the other units included within its exposed perimeter (**Figure 6**).

Locus 2434 is layer-shaped and represents the slightly concave bottom of the "shrine" area, which is delimited by Locus 2435. At eye-scale (**Figure 12a**, layers 1-4), large part of the unit comprises of yellowish sediments, with some dark brown/blackish laminae at the top (**Figure 12b**, layer 5); at microscope scale, it can be divided into several layers:

1. the bottom one is a relatively homogeneous light brown silty clay loam, comprised of local marine silt with some very fine sand. Carbonates, mainly micrite, are common within the fine fraction and clay can be identified from some diffuse areas with striated b-fabric around clods of poorly disaggregated sediment. The sandy fraction includes angular quartz, feldspar, and few volcanic minerals. This layer includes numerous compact clods (**Figure 12g**) of very fine sediment with few fine sand fraction, clearly identifiable at eye-scale (**Figure 12a**, layer 1), deriving from poor disaggregation of the original sediment. The unit is rather compact, the voids being represented by desiccation cracks and some channels and chambers deriving from the activity of soil mesofauna. It does not include anthropic inputs.
2. This unit is texturally very similar to the underlying one, but it is more homogeneous and includes very few clods. The sandy fraction is concentrated in randomly distributed areas, suggesting that texturally different sediments were pugged together. Some lenses of articulated phytoliths occur in the uppermost 20 mm of the layer, and a discontinuous line of single-layer articulated phytoliths is situated 2-3 mm below the top (**Figure 12f**).
3. This rather wavy layer is about 300-400 μm thick and overlies layer 2. It comprises of fine clay mixed with fine and very fine sand and includes minute bits and flakes of amorphous organic matter (**Figure 12f**).
4. Light brown layer, slightly darker and redder than 1 and 2; it does not differ significantly from 1, but it is much richer in clay and the aggregates are well

accommodating, with looser sediment of the same texture filling the spaces between aggregates.

5. Sequence of fine dark brown to black to light brown laminae, about 1.5-2.0 cm thick (**Figure 12a,** layer 5). The bottom 3-4 mm of the layer (5.1) are characterized by local marine silt mixed with variable proportions of evenly and horizontally layered fibers of dark amorphous organic matter (**Figure 12e**), which masks any possibly occurring phytoliths. The more abundant the organic matter, the darker the lamina; consequently, the two fine dark laminae visible at eye-scale are in fact just layers where the organic fibers are more frequent and closely packed.

These laminae are overlain by an about 0.5-0.75 cm-thick layer (5.2) of loosely and chaotically packed aggregates of reddened marine sediment, dark brown aggregates of thermally altered clay mixed with remains of vegetal fibers (probably daub), and few short bundles of articulated phytoliths. This mix sometimes changes laterally to fine marine silt resembling the underlying layer 4.

Layer 5 ends with two laminae (5.3) of opaque amorphous organic matter, each one overlain by 2-4 mm of evenly layered and articulated phytoliths, sometimes mixed with variable amounts of sand-size reddened marine sediment granules. These two laminae are separated by about 1.5 mm of brownish-reddish granules of marine sediment, well compacted and with few packing voids (**Figure 12d**).

6. Light brownish to grayish, 1.5-2.0 cm-thick layer of fine silt, including with minute rounded reddish aggregates usually not included within the local marine sediments, probably burned daub fragments. Groups of more or less articulated phytoliths representing vegetal residues are present (**Figure 12c**).

Locus 2414 is a roughly tabular unit filling the depression formed by Loci 2434-2435. It is rather inhomogeneous and characterized by colors ranging from light reddish to dark grayish (**Figure 12a**, layer 7). It comprises of a loose and chaotic mix of unsorted clods of burned daub that include numerous casts of stems, leaves, etc. of herbaceous plants and cereals (**Figure 12b**). The clods are very porous, hard and compact, somewhat gritty but not vitrified, and tend to break into highly angular aggregates, suggesting relatively high temperature burning. At microscope scale, the clods are dark under plane polarized light, but still show a crystallitic b-fabric under crossed polars, indicating that the burning temperature did not exceed the first step of clay thermal modification (~500°C). Phytoliths are very common and are often organized in wavy bundles compressed among the clods. Marine sediment, thermally unmodified, partly fills the voids between daub clods and phytoliths.

The area outside the “shrine”, i.e. the surface of the excavation area situated to the south of the wall (**Figure 6**), is occupied by **Locus 2427,** a roughly tabular lithologic unit whose top surface is depressed at the centre and “grows” at the outer side of Locus 2435 (wall of the "shrine"). It is characterized by an apparently homogeneous grayish color, with diffuse very light brownish mottles. Charcoal fragments, sometimes up to 2-3 cm wide, are widespread. At microscopic scale, the sediment is also generally homogeneous, massive and unlayered. It includes fine sand- to clay-size components deriving from the disaggregation of local marine sediments (micrite-clay aggregates, quartz and feldspar grains) and some volcanic components (amphibole and lava grains). These are randomly mixed with unsorted fragments of vegetal tissues that may be thoroughly charred or variably humified, very common phytoliths, common micrite pseudomorphs on calcium oxalates (ash residues), frequent faecal spherulites (**Figure 12i**).

Complex features can be observed at higher organization level. Common residues of sheep/goat coprolites, sometimes ashed, are represented by rounded aggregates of randomly packed vegetal fibers and phytoliths (**Figure 12j**). Elongated, subhorizontal voids including long chains of articulated phytoliths (**Figure 12h**) occur sparsely within the sediment and represent residues of plants (stems, leaves, etc.), probably *Gramineae*. Bone fragments, burned and unburned, are frequent, as well as fragments of pottery and daub.

Discussion

Palynological research carried out on the contents of the two zoomorphic vessels demonstrates that their spectra are rich in pollen quantity as well as in taxa number. Vine is well represented and – most interestingly – the spectra of the zoomorphic vessels, of modern wine, and of the contents of wine containers of other periods are very similar. Consequently, we can conclude that both the Aradetis Orgora vessels must have contained wine.

The pollen spectra of the large jar associated with the zoomorphic vessels also include grape pollen, suggesting that the origin of this wine was local. Moreover, the profile of the excavated area and the filling of the Kura-Araxes Grave No. 2 also yielded grape pollen, which must have originated from vineyards growing in the surroundings, because pollen grains of cultivated grape do not disseminate over large distances (Turner and Brown 2004; Langgut et al. 2013). Grape pollen found beneath the skull in Grave No. 2 corroborates this hypothesis: the deceased had possibly visited a vineyard in her last days of life, and pollen grains may have got into her hair. This is not surprising, because our experiments demonstrated that grape pollen is always frequent in vineyards, not only on the flowers, but also on leaves, branches and bunches of grape, even after flowering is over.

Another aspect suggests that the wine contained in the zoomorphic vessels was local. The other components of the spectra –woody and herbaceous taxa – resemble the local vegetation ones. Pollen of warmth-loving broadleaves as hornbeam, oak, lime-tree, walnut and others is represented in all the spectra of the Kura-Araxes period; elements of floodplain forest, where alder probably dominated, occur in the spectra of all studied samples; wingnut grew in these forests as well.

At present, these mesophilic species do not grow in the Shida Kartli arid and continental climate. It can be concluded that the climate was warmer and more humid than the present-day one during the Kura-Araxes period. Along with the mesophilic vegetation complex, spores of mould fungi and of other fungi are also good evidence of a more humid climate. Agriculture was fostered by these conditions and played an important role in the economy of the Kura-Araxes population. Grain crop growing was well developed, and horticulture and viticulture were intensive.

Previous research suggests that viticulture was particularly well developed in Georgia during the Kura-Araxes period, not only in the lowlands but also in the highlands. Cultivated vine pollen was discovered by us at 2010 m a.s.l. in ash layers, on hand-mills and on other artifacts of the Paravani burial mound; at 1615 m in settlement layers at Chobareti; at about 1342 m in Tiselis Seri. The burial mound of Nachivchavebi is also located higher than 1212 m. Viticulture cannot be developed presently at such altitudes because of their cold climate conditions. However, it has been observed that climate was warmer and humid 6000-5000 years ago in the Southern Caucasus and nearly all over southern Europe, during the "Atlantic Climate Optimum" period (Roberts 1998; Davis et al. 2003), when the climate was the warmest and most humid of the whole Holocene.

Additionally, our research produced new hints to demonstrate that wine had been kept in archaeological vessels. To this purpose, it was believed until recently (Rösch 2005) that grape pollen and well-preserved palynomorphs should occur in the vessels contents, but new studies showed that these two indicators are not enough. In fact, abundant and well preserved grape pollen was found in a vessel from the Early Bronze Age Ananauri-3 burial mound; however, wine had not been kept in it, but honey instead, which was identified by the pollen of several other melliferous plants and by hairs, epidermis, claws and other microscopic remains of bees (Kvavadze 2016). In this case, grape pollen had presumably been gathered by bees, as vine flowers produce sweet nectar.

The analysis of non-palynological remnants in fossil and modern wines provides much stronger additional evidence, making the identification of wine in archaeological vessels more reliable and convincing. Our research has shown that large amounts of starch are also characteristic of the wine spectrum, because a peculiar starch forms within all organs of vine (fruits, seeds, leaves and stems) (Winkler et al. 1945; John et al. 1973). A peculiar form of plant epidermis belonging to vine, which can be observed also in fossil and modern wines, was revealed in our analysis of the peel of modern vine stems (**Figure 10b**). Finally, there are always insect hairs belonging to the tiny fly *Drosophila* among the non-palynological remnants in the spectrum of wine (**Figure 10c**) (Chyb and Gomped 2013).

The following features are shared by the palynological spectra of the Aradetis Orgora zoomorphic vessels and by modern wine:

1) splendid preservation of pollen grains and taxonomic richness, because alcohol inhibits the multiplication of microbes and fungi, which consequently cannot alter and destroy the pollen grains;

2) rather large amount of vine pollen;

3) occurrence of vineyard weeds pollen;

4) dominating single and specific type of starch in non-palynological remnants;

5) occurrence of vine epidermis;

6) occurrence of insect hairs (*Drosophila*) in the spectrum.

The unique shape of the two zoomorphic vessels and their analogies with vessels of other periods suggest they had a special ritual purpose; the same purpose was shared by their content, which was identified as probable wine by palynological evidence. This evidence corroborates the hypothesis of a strong cultural value of this beverage among the Kura-Araxes people (Batiuk 2013). Consequently, these two vessels become the most ancient zoomorphic *rhyton*-like containers recovered in the region, and can be set at the origin of a long tradition of ceremonial vessels specifically designed for libation and/or convivial consumption of alcoholic beverages in ritualized circumstances.

Soil micromorphology provides information regarding the use of the area, and highlights interesting aspects of human activity in and around the “shrine”. The most relevant components of Locus 2427 are calcareous faecal spherulites (**Figure 12i**) formed within the guts of the ruminants (Canti 1998), and sheep/goat coprolites (**Figure 12j**), suggesting that these animals were kept in the area. Considering that Locus 2427-2467 extends below as well as around the "shrine" area, it testifies to the presence of animals in the area prior to the construction of the "shrine", and around it in a slightly later phase. The phytoliths are also indicators of the presence of ruminants, as straw and grass can be used as fodder or litter, or may be included in the faeces.

However, Locus 2427 does not show the typical characteristics of the sediments found in penning areas, where phytoliths and spherulites are typically organized in alternating layers (Boschian and Montagnari-Kokelj 2000; Matthews 2005; Angelucci et al. 2009). Conversely, it is homogeneous and compact, the voids always representing casts of vegetal remains still including single phytolith lines, suggesting strong trampling and compaction. It also embeds various components generally deriving from domestic activities (humified vegetal remains, charcoal, ash, bone, pottery fragments). These components suggest that Locus 2427 formed in an open space/courtyard/street (Matthews et al. 1997), temporarily used for the parking or transit of animals, and where household refuses were frequently swept.

The laminated aspect of Locus 2434 is typical of settlements of various ages in the Levant and neighboring areas, and can be interpreted as a living floor or as a sequence of successively rebuilt living floors and occupation layers (Shahack-Gross et al. 2005; Karkanas and Efstratiou 2009; Shillito et al. 2011; Shillito and Ryan 2013).

The lower part of Locus 2434 (sublayers 1 and 2), is made up of very similar local marine silt and sand. The clods occurring in layer 1 are texturally finer than the rest of the sediment and are cemented by fine micrite, which is probably the reason why they were not disaggregated. Considering the facies variability of the local marine silt, it is not unlikely that slightly different sediments were casually used in preparing this layer. Even if there is evidence of pugging, no organic components (straw, chaff, dung, etc.) were added.

A relatively continuous line of single articulated phytoliths occurs at the top of layer 2, probably remains of some matting of the surface; it is covered by about 300-400 μm of loose sediment deriving from the decay of layer 2, mixed with few coarse sand and bits of amorphous organic matter. This sediment represents dirt, either deposited during a short phase of use, or remains of a thicker accumulation surviving sweeping.

Layer 4 testifies to a refashioning of the floor, obtained by laying 1.5-2.0 cm of marine sediment, likely from the same source used for layers 2.

Layer 5 represents the topmost part of a repeatedly prepared floor whose bottom part is Layer 4. Here, fibers of amorphous organic matter and relatively thick layers of phytoliths, all laid evenly and parallel to the floor testify to the extensive use of grass and/or straw for matting the floor. The thin white laminae observed at eye-scale are comprised uniquely of phytoliths, and are situated at the top of the organic layer, where primary mineralization completely destroyed the organic component. The absence of faecal spherulites and herbivore coprolites suggests that the area was not used for penning animals. At least four phases or floor refashioning and re-matting are testified by organic layers of variable thickness, alternating with thin layers of slightly thermally altered marine silt, that may represent the spreading of combustion feature decay products within the area.

Layer 6 is the inorganic part of another relatively thick prepared floor comprised of well-packed local marine silty loam, which in this case also includes minute grains of burned daub/clay and some sparse bundles of phytoliths.

Locus 2414 was observed at microscope scale only where the floor sequence was sampled. Unlike the floors, this locus is strongly inhomogeneous and the observations carried out do not represent confidently its general aspect. Apparently, it is limited to the inside of the "shrine", and it lies upon an erosion surface that cuts the underlying floor sequence. At microscope scale, it is largely comprised of unsorted, burned daub fragments loosely embedded in marine silt matrix, indicating very moderate compaction, if any. However, it must be pointed out that the burned daub is very poorly compressible and consequently the structure tends to remain loose even after intentional compression; this may have been a specific reason for choosing this material to fill the area. In any case, no thermal modification can be observed on the silt matrix, showing that daub did not burn *in situ*. Bundles of phytoliths chaotically mixed with the daub fragments also indicate that the material was accumulated rather roughly .

Already before the results of the pollen analyses were known, the unique shape of the vessels and the peculiarity of the finding area suggested that the uncommonly wide space where they were lying was not a normal domestic unit, but rather a special building, most probably with religious functions (a Kura-Araxes "shrine"[5]), where ceremonies involving ritual use of wine (libations, or collective consumption events) possibly took place (Gagoshidze and Rova 2018).

This hypothesis is now corroborated by palynological evidence. Further evidence comes from soil micromorphological analyses and from the study of the artifacts and ecofacts recovered in Phase 4 contexts, particularly from the floor and filling of "shrine" 2413, as well as from the filling of the open area 2471 (**Figure 6**). The results of these analyses confirm that the two areas were used for very different purposes.

The sediments filling space 2471 (locus 2427) are typical of open areas like courtyards or streets, which are located in the proximity of domestic units and were temporarily used for the parking or transit of animals, as well as for dumping domestic refuse. This interpretation is also supported by the cultural remains found within the layer, including a large amount of pottery sherds and animal bones fragments. The pollen spectrum of this sediment matches this interpretation, showing a fairly large number of pollen grains of ruderal taxa connected with human activity.

At microscopic level, the filling of "shrine" 2413 (locus 2414) shows the typical features of architectural collapse, in this case of walls and roof, possibly accumulated and compacted intentionally after the destruction of the building. This also explains the very small amount of pottery and other finds recovered from this layer. The most interesting results, however, derive from the micromorphological analysis of the shrine

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5 While Kura-Araxes cults appear to have been home-based, the presence of special installations and finds suggests that a few buildings may have served as "village shrines" for public cult. On this topic, see most recently Sagona 2017, pp. 248-250.

floor (2434), which testifies to multiple refashioning of a surface carefully prepared and covered by mats of vegetal material, alternating with short phases of use, and confirms the presence of a fireplace in the room. The scarcity of finds, except for the *in situ* vessels and a perforated deer antler, confirms that this floor was kept intentionally free from refuse. Animal bone fragments are almost absent, contrasting with their abundance in the filling of the nearby open space.

Conclusions

The zoomorphic Kura-Araxes vessels discovered at Aradetis Orgora are unique in their form, and – to the present state of research – lack any contemporary analogues in Georgia and elsewhere in the distribution area of the Kura-Araxes culture. Their shape is strongly suggestive of a ritual use, and the context of their discovery, based on archaeological data underpinned by soil micromorphological analysis, supports this hypothesis.

The results of pollen analyses suggest that these vessels contained wine of high quality, which had been squeezed from grapes grown on large nearby vineyards. This is indicated by the discovery of vine pollen in the samples, and also confirmed by the occurrence of large amounts of vine starch, vine epidermis, and *Drosophila* hairs. These components may be prospectively considered as additional, useful hints that wine had been kept in archaeological ceramics.

Pollen of vine was found not only in these two vessels, but also in all other sediment samples of the Kura-Araxes period collected within the settlement and cemetery of Aradetis Orgora, indicating that viticulture was widespread in this period in the Shida Kartli region of Georgia, and that it played a significant cultural role for the Kura-Araxes people. The Kura-Araxes vessels from Aradetis Orgora also represent the prototypes of a long series of special wine consumption vessels, whose tradition is still alive in present-day Georgia.

Our research also yielded important results on the environmental conditions of viticulture in the Shida Kartli region during the Kura-Araxes period. The occurrence of pollen grains of chestnut, wingnut and alder in the palynological spectra, none of which presently grows in the lowland territory of Shida Kartli, indicates warmer and more humid climate conditions. Finally, the occurrence of nut and walnut pollen in the samples from the zoomorphic vessels, from the stratigraphic profile and from Grave No. 2 suggests that gardens of walnut and nuts were present close to the vineyards, and that these cultivations were other important component of the Kura-Araxes agricultural landscape together with viticulture and wheat production.

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Captions

Table 1. Aradetis Orgora, quantity of pollen and non-pollen palynomorphs from Western section and jar.

Table 2. Abulmeki Marani, quantity of pollen and non-pollen palynomorphs from *qvevri* and pots.

Figure 1. View of the Aradetis Orgora Main Mound (above) and position of the site in the Kura Valley (below) (GISKAP, satellite view from Google Earth).

Figure 2. *Qvevri* (a) and examples of 1st millennium BC zoomorphic wine-drinking containers from Treli Gorebi (b).

Figure 3. Zoomorphic vessels 2414-M-2 (a) and 2434-M-5 + 2414-C-3 (b), after restoration (GISKAP).

Figure 4. Vessels 2414-M-2 (a) and 2434-M-5 + 2414-C-3 (b) (GISKAP).

Figure 5. Drawing (a) and composite photo of the W section of quadrant 105.099c (b) with Kura-Araxes phases and location of 2015 palynological (black) and soil micromorphological samples (white) (GISKAP).

Figure 6. View of the finding spot of the zoomorphic vessels, from S (a) and plan of the Kura-Araxes sub-phase 4a occupation (b) (GISKAP).

Figure 7. Kura-Araxes pottery from Phase 4 (GISKAP).

Figure 8. Pollen diagram (a) and non-pollen palynomorphs diagram (b) of zoomorphic vessels content and modern wine.

Figure 9. *Vitis vinifera* pollen grains from vessels N. 1 (1-3), and No. 2 (4-9) (a) and from Kakheti modern wine (b).

Figure 10. Starch grains in fossil (1, 2, 4, 5, 8) and in modern wine (3, 6, 7, 9) (a); epidermis of *Vitis vinifera* in fossil (1, 2) and in modern wine (3) (b); *Drosophila* hairs in fossil (1-3) and modern wine (5, 6) (c).

Figure 11. Arboreal pollen diagram from *qvevri* and pots content from Treli Gorebi (a) and Abulmeki Marani (b).

Figure 12. Soil micromorphological characteristics of Loci 2434 and 2414, on the north profile of quadrant 105.099C, and microphotographs (b-g) under parallel (PPL) or crossed (XPL) polarized light. Microphotograph b pertains to Locus 2414, c-g to Locus 2434, h-j to Locus 2427 (G. Boschian).

a: close-up of Loci 2434 and 2414, showing micromorphological sample detachment negatives. Numbers refer to unit subdivisions described in the text. Arrows indicate whitish pure phytolith laminae;

b: loose crumb microstructure with burned (bd) and unburned (ud) daub clods, and wavy phytolith bundles. PPL;

c: layer 6, marine silt with minute clay/daub fragments (arrows) and phytolith bundles (fb). XPL;

d: layer 5.3, fibers of amorphous organic matter (aom), grading upwards to pure phytolith bundles (fb) and overlain by a mix of reddened marine silt (rs), dispersed phytoliths and some black amorphous organic matter fragments. PPL;

e: layer 5.1, layer of marine silt, including subhorizontally laid vegetal fibers decayed to amorphous organic matter, overlain by a dark layer (dl) including more frequent fibers, phytoliths (dispersed or in short bundles), sand, residues of organic matter. PPL;

f: layers 2 (l2), 3 (l3), and 4 (l4). The top of layer 2 is marked by an almost continuous line of single phytoliths, still articulated (arrow). Layer 3 includes very fine amorphous organic matter, loose material originated from the decay of l2 and very fine to fine sand. Layer 4 is comprised of compact marine silt. PPL;

g: layer 1, marine silt, embedding clods of finer silt (sc) cemented by very fine micrite. Moderately developed granostriated b-fabric is sometimes present (arrows) around the clods. XPL.

h: homogeneous sediment, with articulated phytoliths within subhorizontal vegetal voids (horizontal arrows), organic matter and charcoal (black patches), dispersed phytoliths, one diatom (vertical arrow). PPL;

i: cluster of calcareous faecal spherulites (small yellowish round features, with black cross at the centre. XPL;

j: rounded fragment of sheep/goat dropping, including digested vegetal fibers.

Table 1

Aradetis Orgora, W section and jar					
Samples	**1**	**2**	**3**	**4**	**5**
	2436	**2445**	**2450**	**2455**	**Jar**
Abies	2	3		1	
Picea	1	1			
Pinus	11	20	4	5	2
Juglans	2	2	1	2	
Alnus	1	3	1	2	1
Quercus					1
Carpinus betulus	2	3	2	1	2
Corylus		2	1	2	
Vitis vinifera	1	2	1	1	2
Poaceae		6		3	2
Cerealia	10	23		13	28
Triticum	3	12			16
Avena					3
Hordeum					12
Cichorioideae	3	7		3	4
Artemisia	2	2	1		2
Carduus	3	7			
Cirsium		1			
Achillea		3			1
Chenopodiaceae		3	2	2	5
Chenopodium album		3		2	4
Fagopyrum					2
Polygonum		19		5	3
Polygonum aviculare	2	17		3	3
Ranunculus		2			
Malva		1	2		
Knautia					1
Caryophyllaceae	1	1			
Convolvulus	1	2			
Plantago major/P. media			1		
Polypodiaceae	2		3	3	
Ophioglossum		3	2	1	
Undiff. ascospores	1	1	3		5
Glomus	1			2	4
Sordaria					38
Chaetomium					21
Alternaria	1				
Thecaphora		3			
Mucoraceae					2
Dictyosporium heptasporium					3
Fiber of flax			19	4	3
Fiber of wool			1		
Tracheal cells of undiff. wood	19	105	22	68	95
Tracheal cells of Pinus		2			
Tracheal cells of Ulmus		4			
Woodvessel				3	
Phytolith of Pooideae	110	84	19	102	37

Phytoliths of Cerialia	65	15	4	15	15
Starch grains	28	46	106	85	20
Plant epidermis	4	5	2	6	8
Undiff. zoomaterial			2		
Zooepidermis		3		1	
Hair of animal		1			16
Hairn of insecta					4
Insecta remains					14
Hair of acari					4
Chela of acari					2
Acari			1		
Trees and Shrubs	20	36	10	14	8
Upland Herbs	25	109	6	31	86
Total Pollen Sum	**47**	**148**	**21**	**49**	**94**
Total NPP Sum	**229**	**269**	**179**	**286**	**291**
Total Palynomorphs Sum	**276**	**417**	**200**	**335**	**385**

Table 2

Doglauri III, tomb 2						
Samples	**Top of pot 4**	**Top of pot 5**	**Abdom. Area**	**Bottom of pot 4**	**Under skull**	**Bottom of pot 5**
Pinus	6	2	4	1	12	3
Ephedra						1
Fagus	1				1	
Quercus	1				1	1
Juglans			2		2	2
Alnus				1	1	1
Carpinus betulus		1			1	
Carpinus orientalis			1			
Tilia	1				1	
Ulmus					1	
Corylus			1			
Vitis vinifera		1		1	2	1
Poaceae	1				3	2
Cerealia	1	2				
Cichorioideae		3	1	2	3	1
Aster					2	
Echinops			1			
Achillea	1		2	1		1
Carduus	4	1		1		1
Cirsium			9			1
Serratula			35			
Centaurea			4			
Chenopodiaceae				1	2	1
Fagopyrum	5		1			
Polygonum		2				
Polygonum aviculare				1		
Urtica					1	
Apiaceae		3				
Caucalis-type			2			
Plantago lanceolata						1
Plantago major/P. media		1			1	1
Polypodiaceae						3
Polypodium vulgare			1			
Undiff. ascospores	18	42		13	18	37
Sordaria				4		1
Sordariaceae					35	
Glomus	1	2	3	1	4	3
Mucoraceae	1	2		1	5	7
Brachysporium						1
Fiber of flax (Linum)	2	2	7	10	50	11
Fiber of flax (Green)			1			
Fiber of flax (Blue)			1		15	1
Tracheal cells of Pinus			2		2	
Parenchimal cells of undiff. wood	13	48	87	15	18	65
Phytoliths	52		4	5	4	4
Phytoliths of Cerealia		2	3			

Epidermis of plants		5		3		5
Starch grains	95	82	61	97	79	89
Zooepidermis		3			3	
Claw of acari				2		1
Acari remains		6	2		2	4
Hairs of acari				2		1
Hairs of insecta						6
Dinoflagellata	4			6		
Spirogyra				2		
Undiff. NPP	11	4				
Total Pollen Sum	**21**	**16**	**64**	**9**	**34**	**21**
Total NPP Sum	**186**	**194**	**171**	**161**	**235**	**236**
Total Palynomorphs Sum	**207**	**210**	**235**	**170**	**269**	**257**

Figure 1

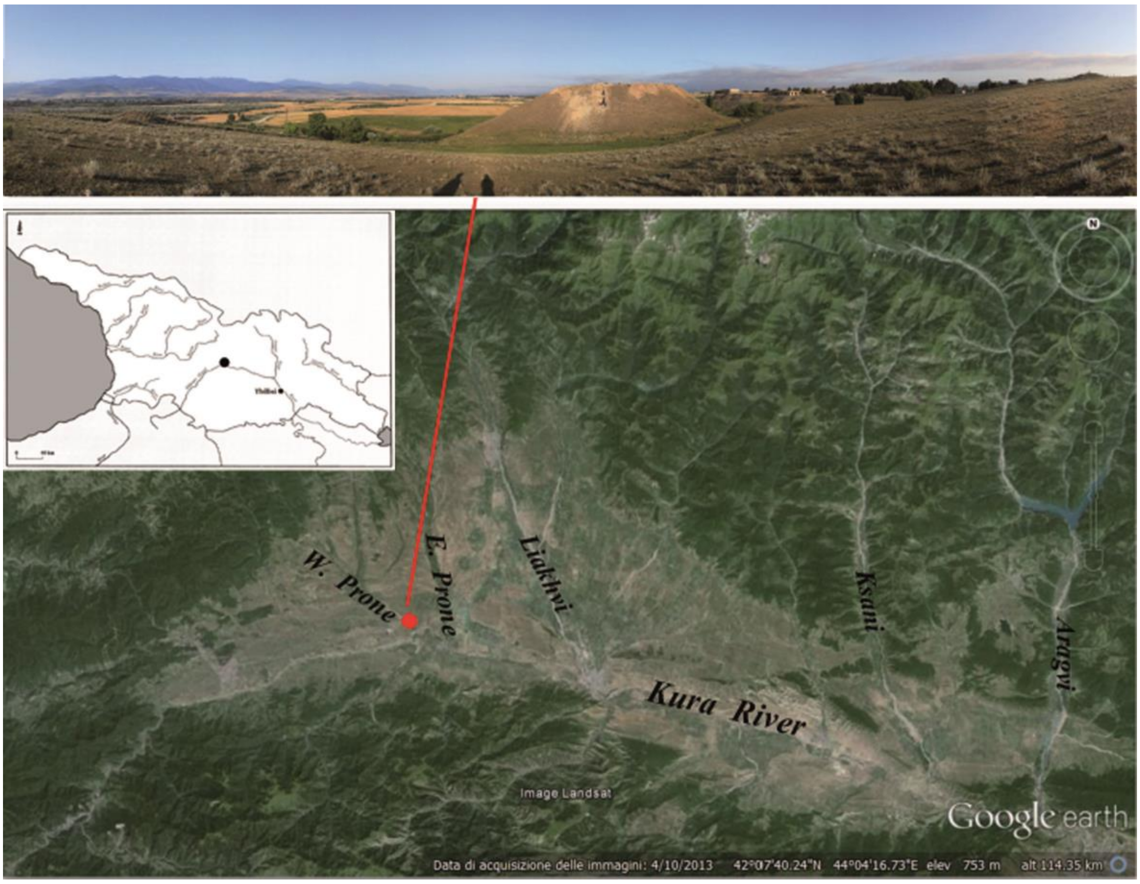
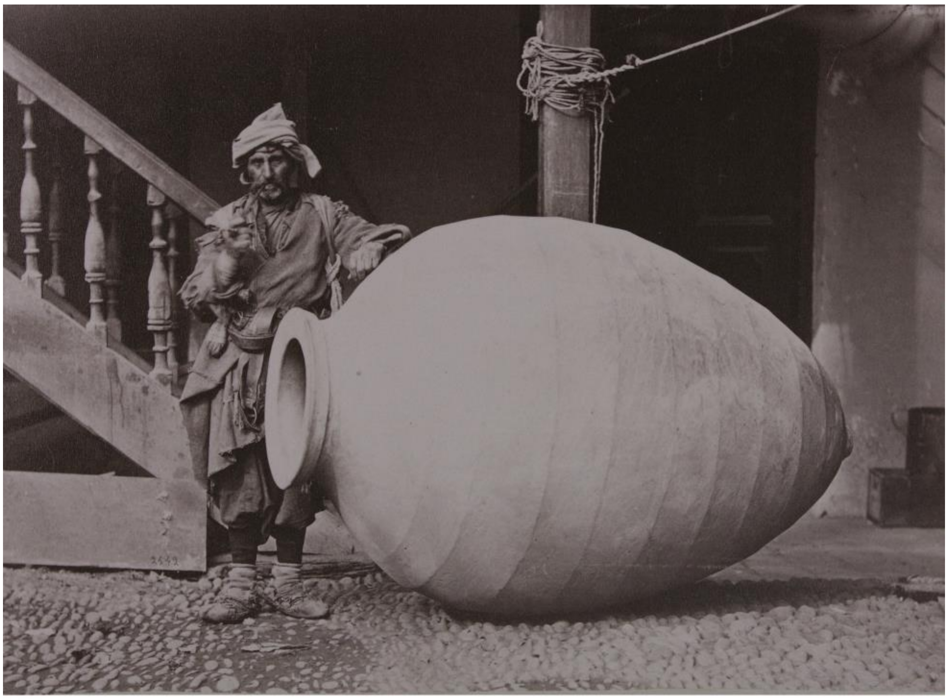

W. Prone
E. Prone
Liakhvi
Ksani
Aragvi
Kura River
Image Landsat
Google earth
Data di acquisizione delle immagini: 4/10/2013 42°07'40.24"N 44°04'16.73"E elev 753 m alt 114.35 km

Figure 2

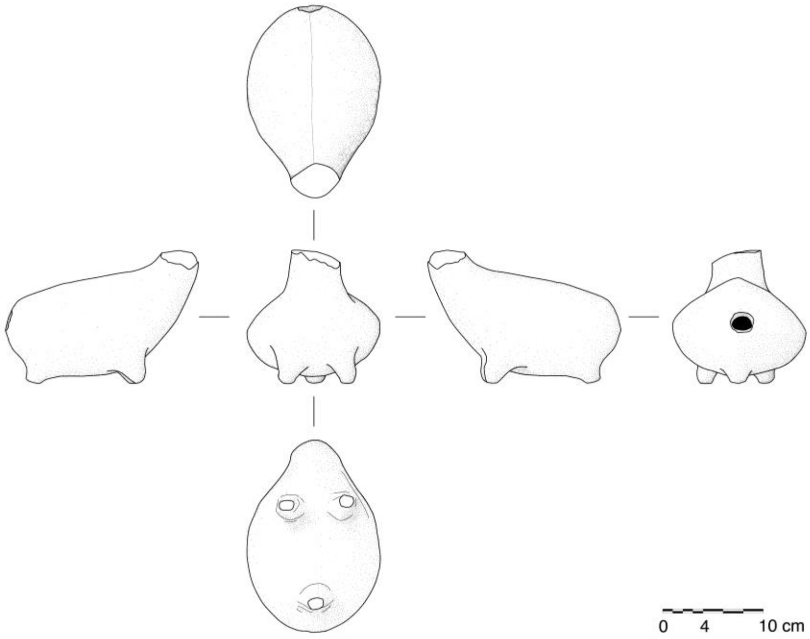


a

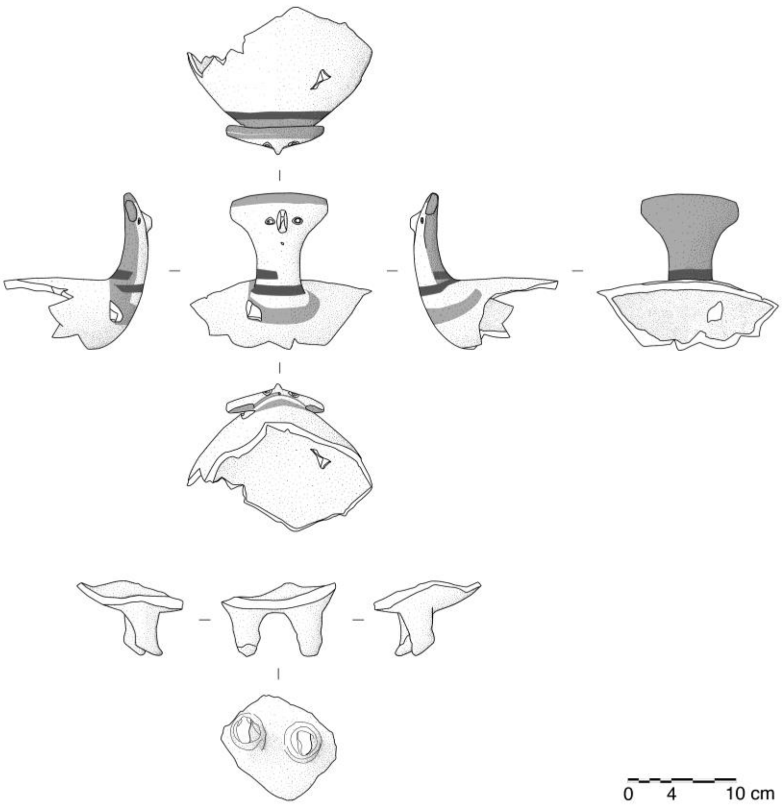
b

Figure 3

Figure 4

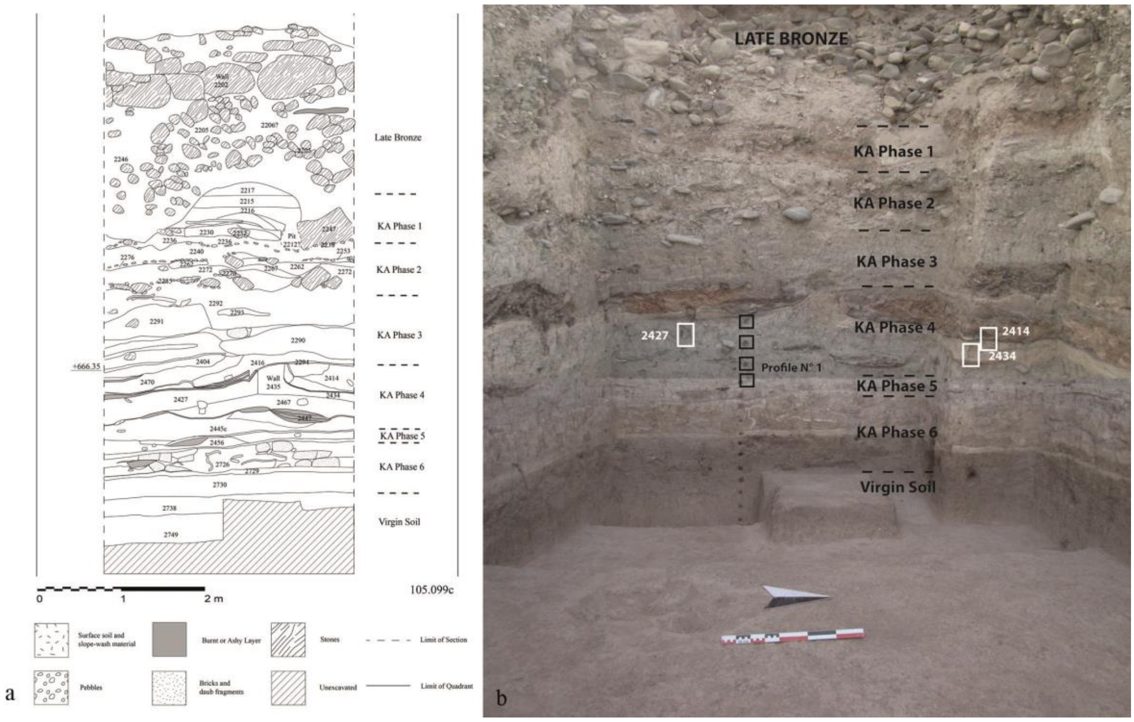


a



b

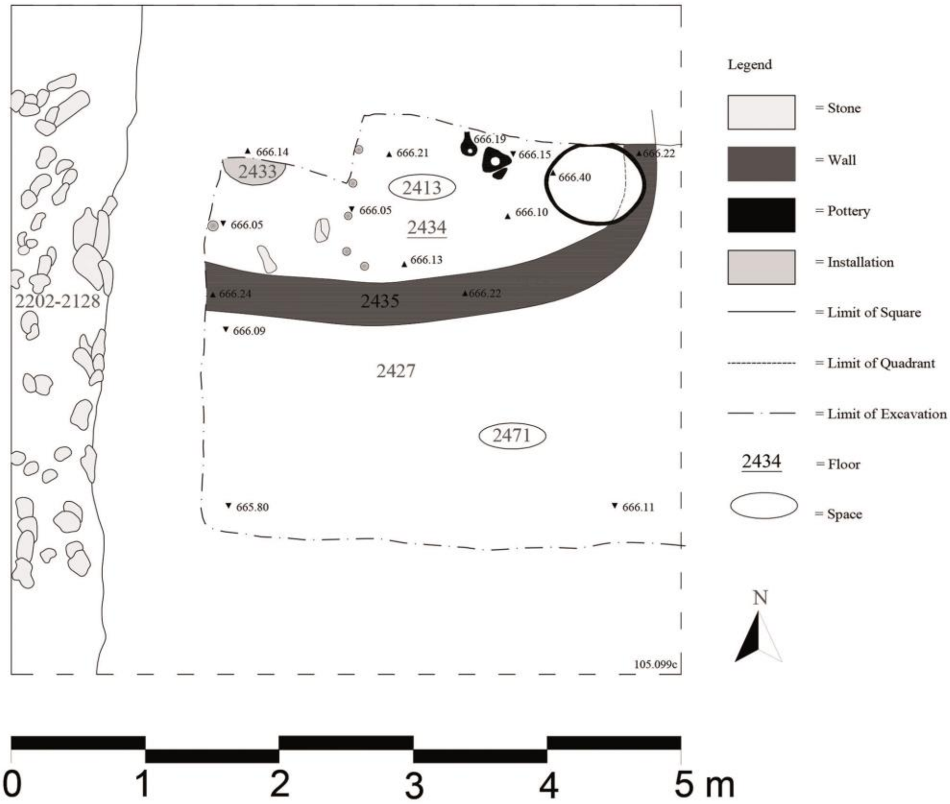
Figure 5



Late Bronze
KA Phase 1
KA Phase 2
KA Phase 3
KA Phase 4
KA Phase 5
KA Phase 6
Virgin Soil
0
1
2 m
105.099c
Surface soil and slope-wash material
Burnt or Ashy Layer
Stones
Limit of Section
Pebbles
Bricks and daub fragments
Unexcavated
Limit of Quadrant
a
LATE BRONZE
KA Phase 1
KA Phase 2
KA Phase 3
KA Phase 4
KA Phase 5
KA Phase 6
Virgin Soil
2427
2414
2434
Profile N° 1
b

Fig. 6

a



2202-2128
2433
666.14
666.21
666.19
666.15
666.22
666.40
2413
666.05
666.05
2434
666.10
666.13
666.24
2435
666.22
666.09
2427
2471
665.80
666.11
105.099c
Legend
= Stone
= Wall
= Pottery
= Installation
= Limit of Square
= Limit of Quadrant
= Limit of Excavation
2434
= Floor
= Space
N
0
1
2
3
4
5 m

b

Figure 7

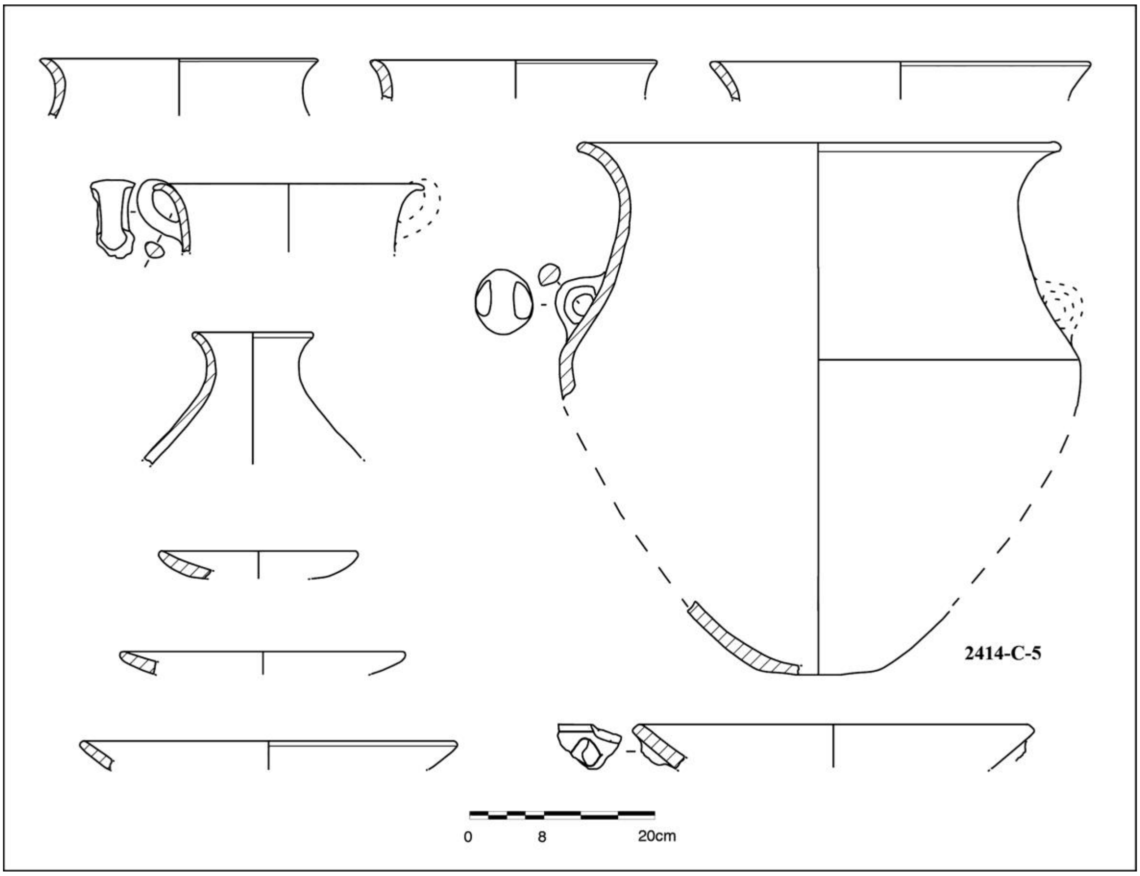
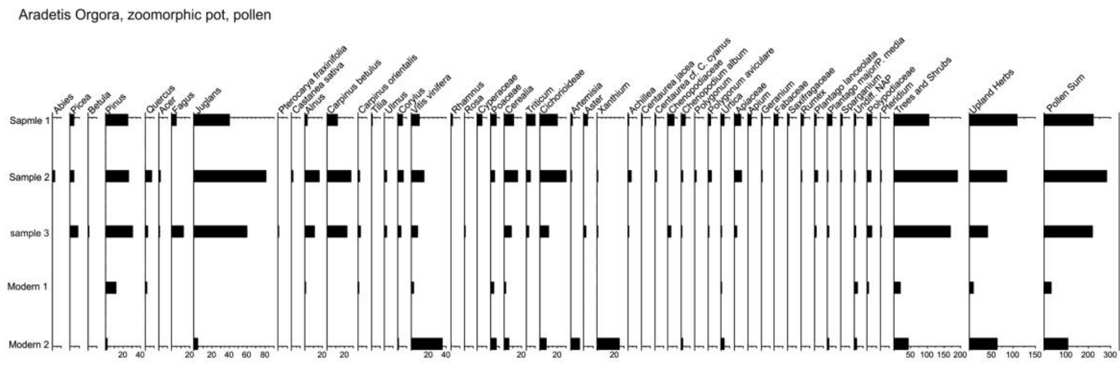
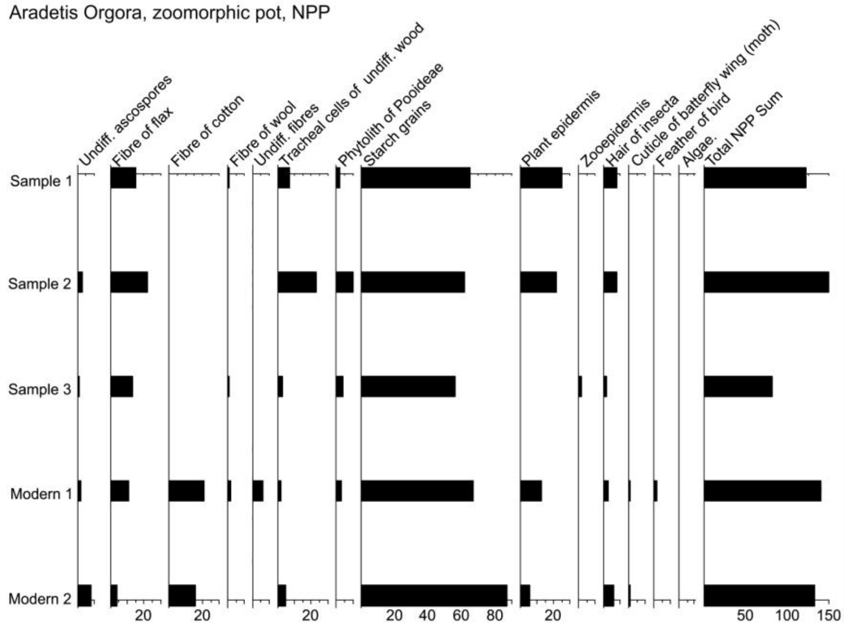


Figure 8

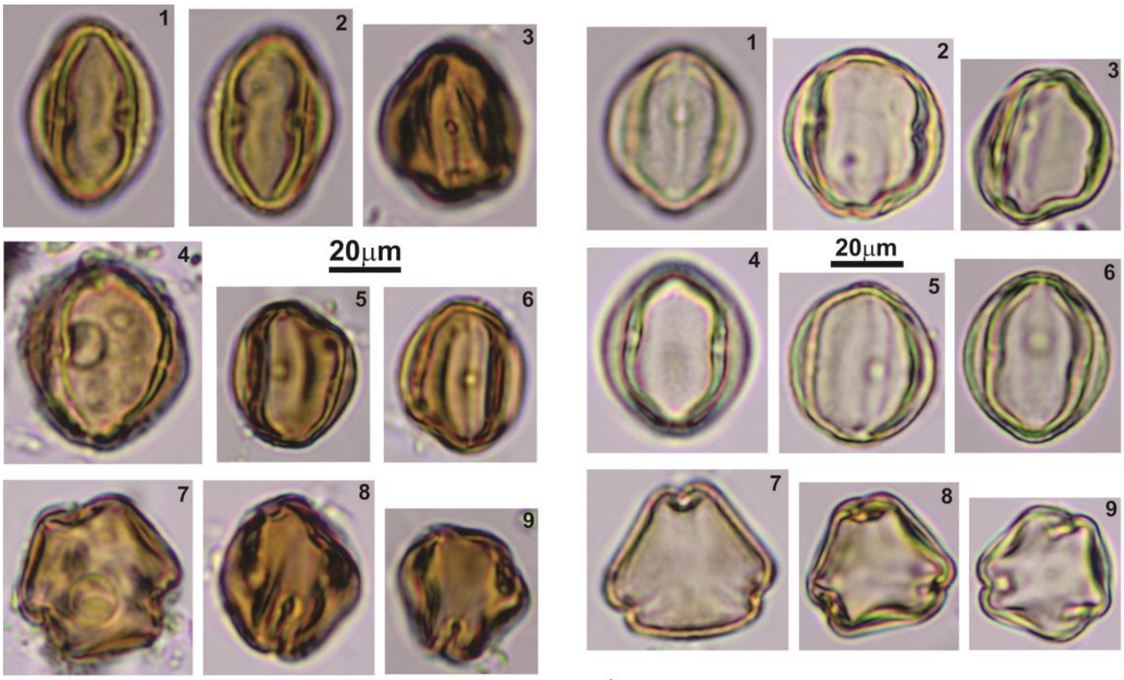

Aradetis Orgora, zoomorphic pot, pollen
Abies
Picea
Betula
Pinus
Quercus
Acer
Fagus
Juglans
Pterocarya fraxinifolia
Castanea sativa
Alnus
Carpinus betulus
Carpinus orientalis
Tilia
Ulmus
Corylus
Vitis vinifera
Rhamnus
Rosa
Cyperaceae
Poaceae
Cerealia
Triticum
Cichorioideae
Artemisia
Aster
Xanthium
Achillea
Centaurea jacea
Centaurea cf. C. cyanus
Chenopodiaceae
Chenopodium album
Polygonum
Polygonum aviculare
Urtica
Apiaceae
Apium
Geranium
Fabaceae
Saxifragaceae
Rumex
Plantago lanceolata
Plantago major/P. media
Sparganium
Undiff. NAP
Polypodiaceae
Pteridium
Trees and Shrubs
Upland Herbs
Pollen Sum
Sapmle 1
Sample 2
sample 3
Modern 1
Modern 2

a


Aradetis Orgora, zoomorphic pot, NPP
Undiff. ascospores
Fibre of flax
Fibre of cotton
Fibre of wool
Undiff. fibres
Tracheal cells of undiff. wood
Phytolith of Pooideae
Starch grains
Plant epidermis
Zooepidermis
Hair of insecta
Cuticle of batterfly wing (moth)
Feather of bird
Algae.
Total NPP Sum
Sample 1
Sample 2
Sample 3
Modern 1
Modern 2
20
20
20
20 40 60 80
20
50 100 150

b

Figure 9



a

b

Figure 10

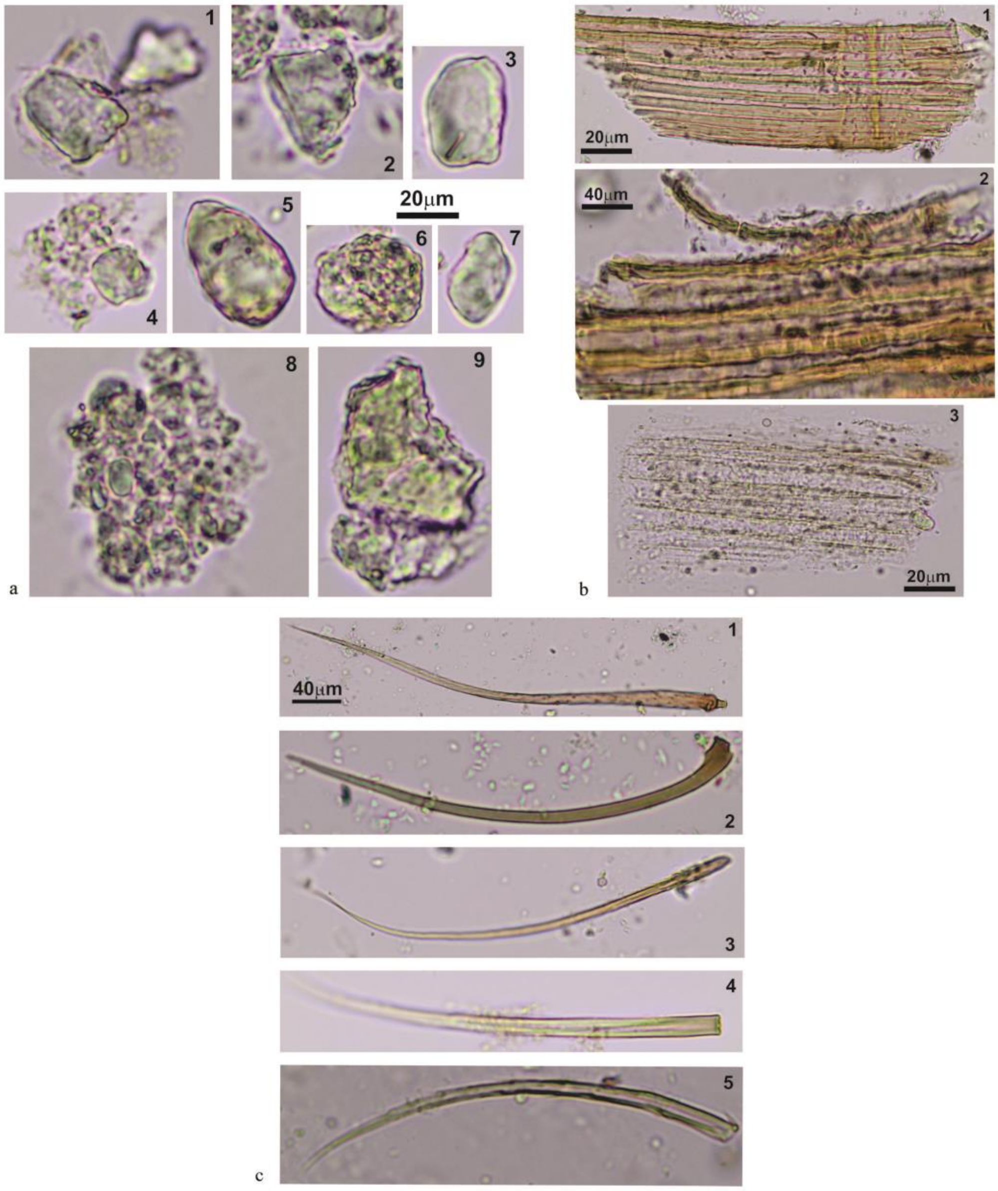
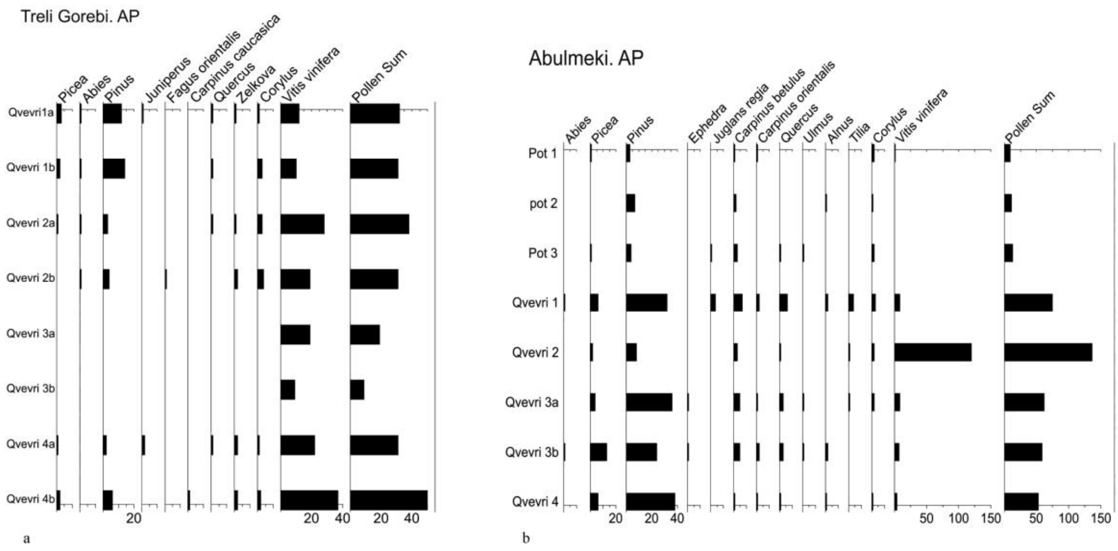
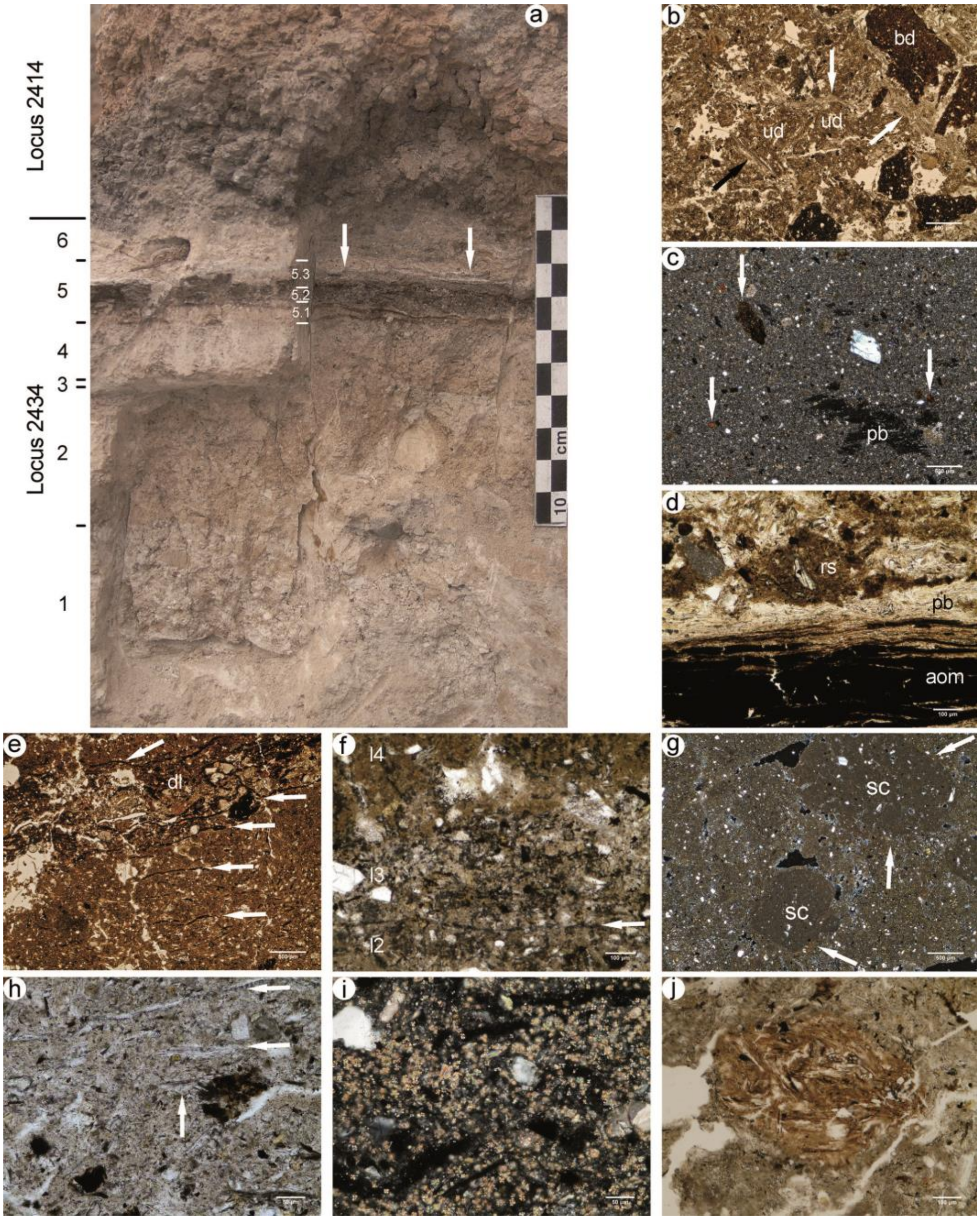


Figure 11



Treli Gorebi. AP
Picea
Abies
Pinus
Juniperus
Fagus orientalis
Carpinus caucasica
Quercus
Zelkova
Corylus
Vitis vinifera
Pollen Sum
Qvevri1a
Qvevri 1b
Qvevri 2a
Qvevri 2b
Qvevri 3a
Qvevri 3b
Qvevri 4a
Qvevri 4b
20
20 40
20 40
a
Abulmeki. AP
Abies
Picea
Pinus
Ephedra
Juglans regia
Carpinus betulus
Carpinus orientalis
Quercus
Ulmus
Alnus
Tilia
Corylus
Vitis vinifera
Pollen Sum
Pot 1
pot 2
Pot 3
Qvevri 1
Qvevri 2
Qvevri 3a
Qvevri 3b
Qvevri 4
20
20 40
50 100 150
50 100 150
b

Figure 12



a
Locus 2414
Locus 2434
6
5
4
3
2
1
5.3
5.2
5.1
cm
10
b
bd
ud
ud
c
pb
d
rs
pb
aom
e
dl
f
l4
l3
l2
g
sc
sc
h
i
j

Elena Rova is professor of Near Eastern Archaeology at Ca' Foscari University of Venice. Her research interests concentrate on the study of the first urban civilisations of the Near East, with a special focus on the archaeology of Upper Mesopotamia (Northern Iraq, North-Eastern Syria, South-Eastern Turkey) and the bordering areas (Southern Caucasus, Anatolia) during the Late Chalcolithic and the Bronze Age (4th-2rd millennia BC). She conducted fieldwork in Iraq, Syria, and Turkey and, since 2009, she is co-director of the "Georgian-Italian Shida Kartli Archeological Project" of Ca' Foscari University in collaboration with the Georgian National Museum of Tbilisi. She organised the international congress Humboldt Kolleg "At the Northern Frontier of Near Eastern Archaeology: Recent Research on Caucasia and Anatolia in the Bronze Age " (Venice, 09-11/01/2013). She is the author (or co-author) of 6 monographies, ca 100 articles and books reviews in scientific journals, congress proceedings, and miscellaneous volumes; alone or in collaboration with other scholars, she edited 4 volumes of miscellaneous studies.

Color figure

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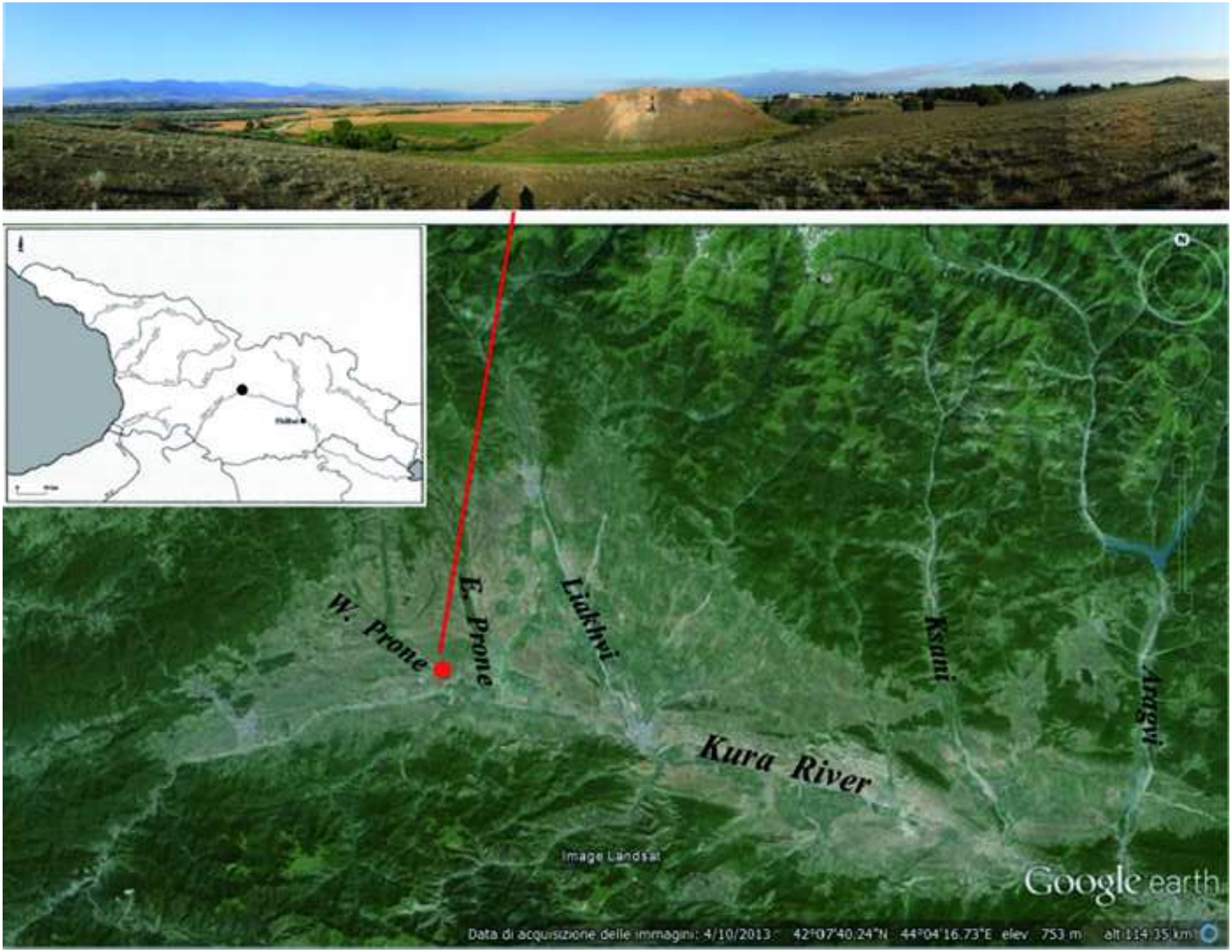
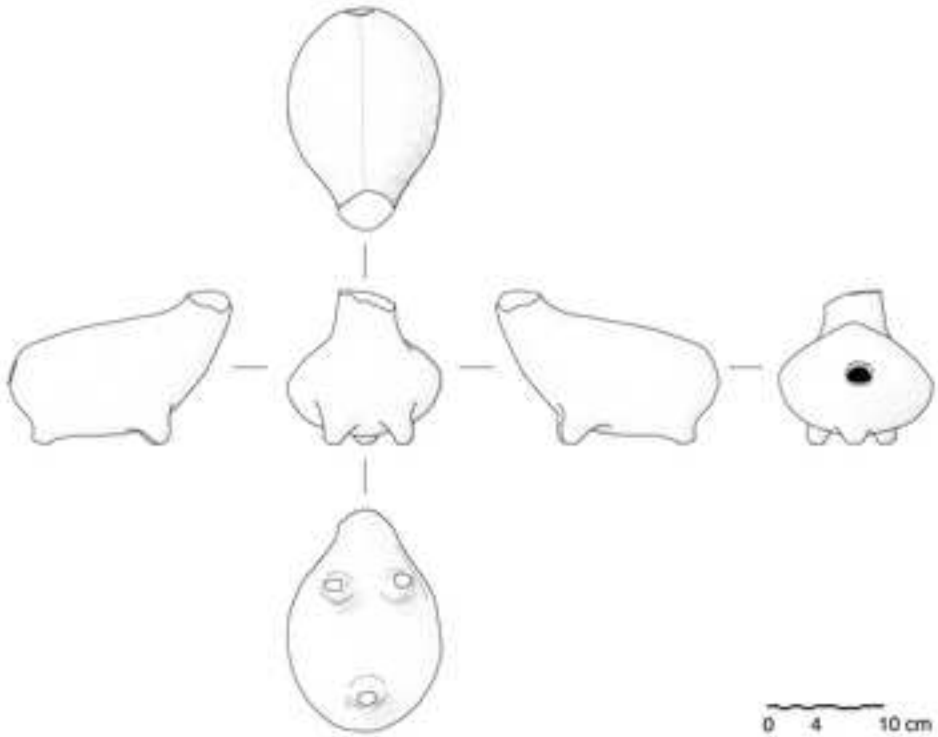


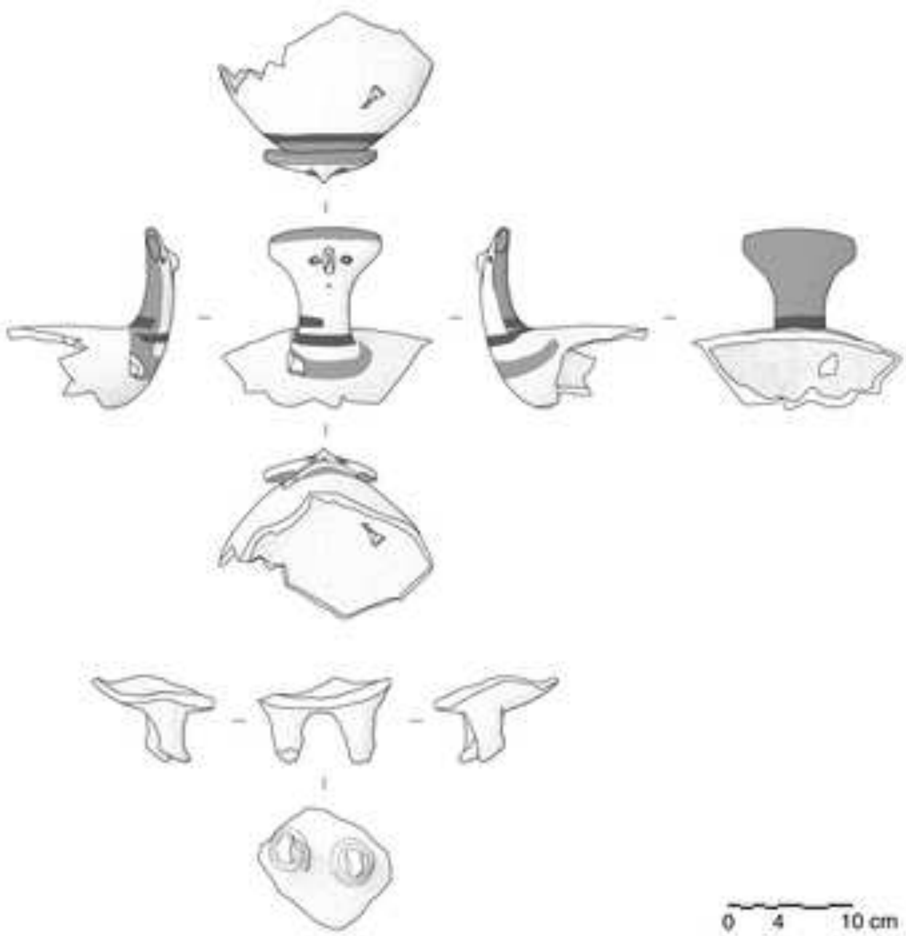
a

b


a
b



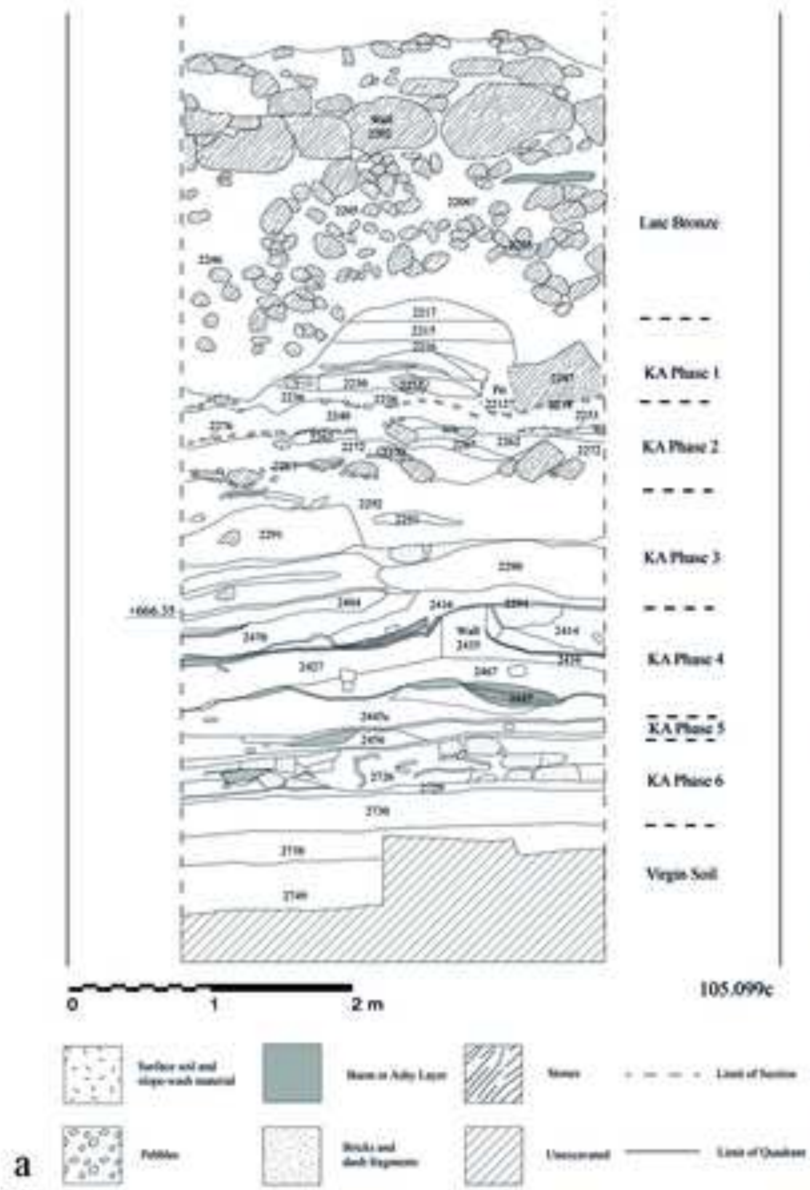
a

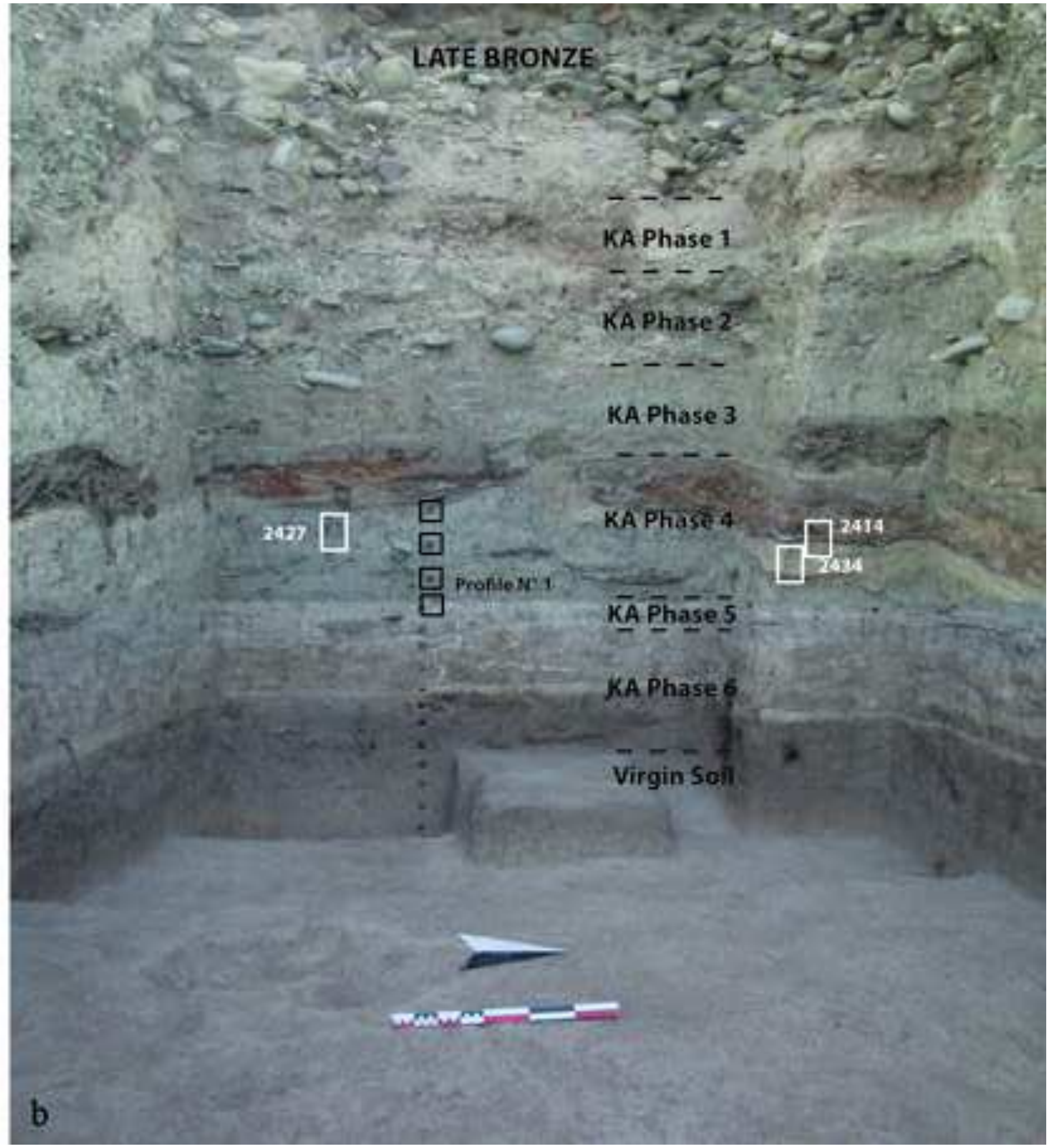


b

Color figure

Click here to download Color figure Fig. 5 low.tiff

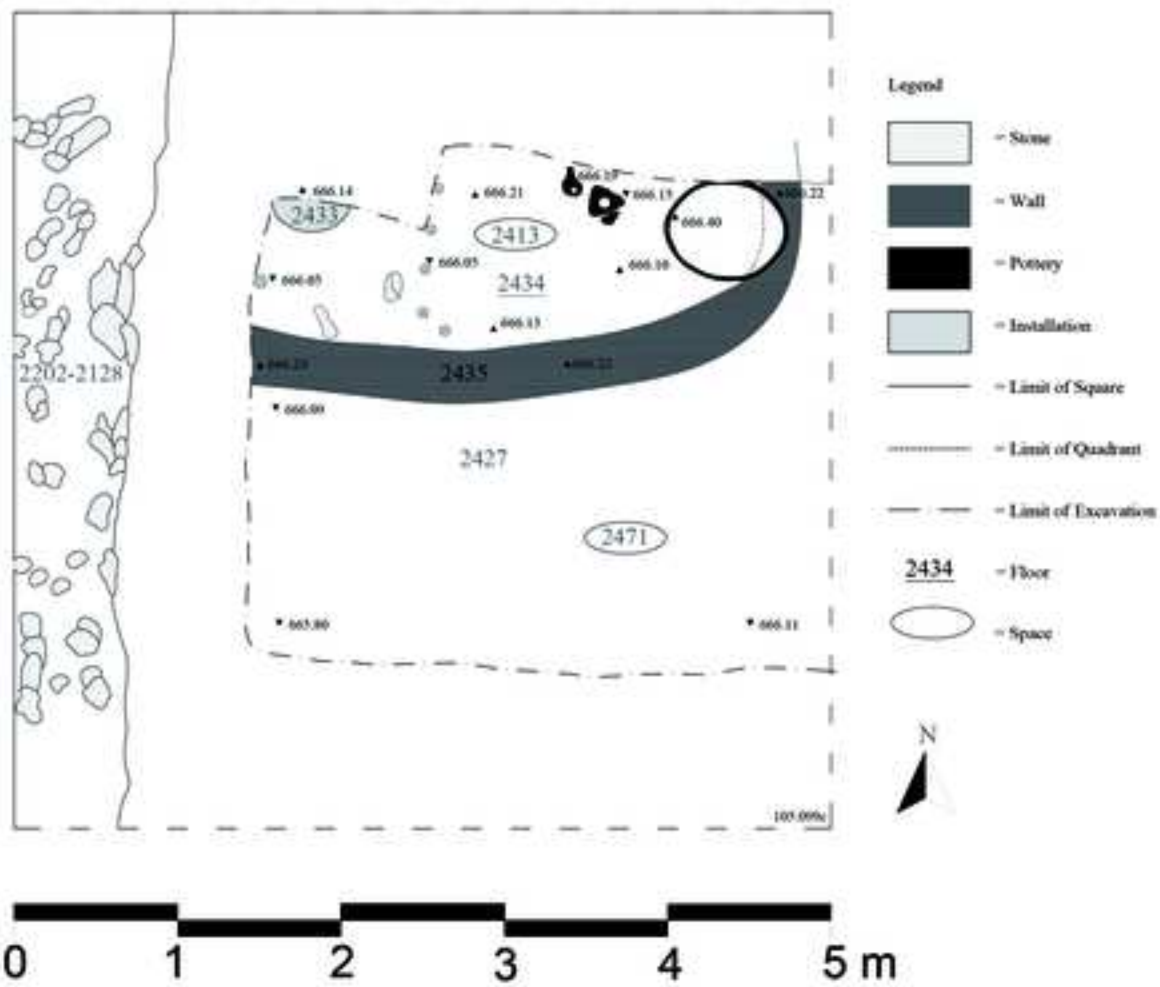




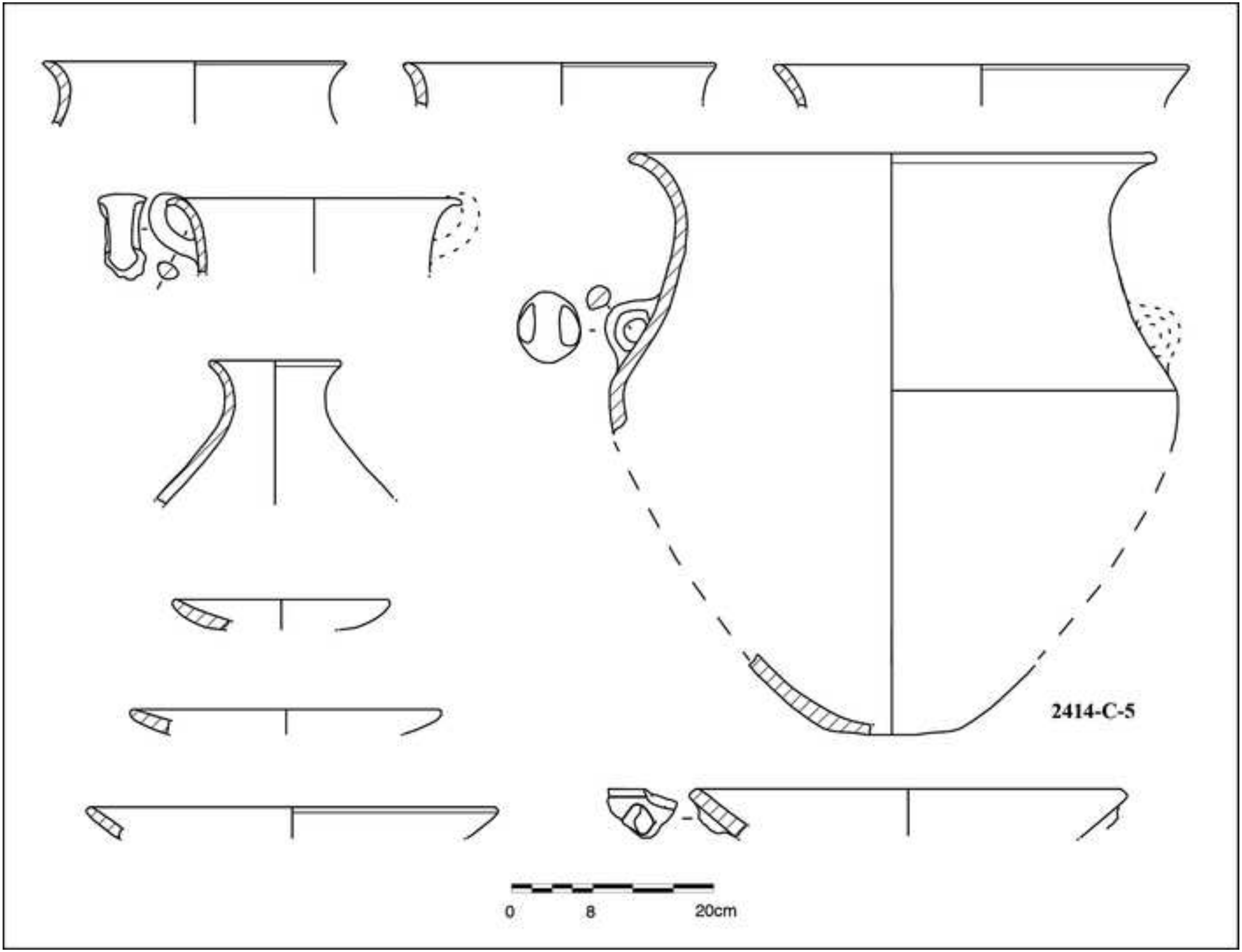
Color figure

Click here to download Color figure Fig. 6 low.tiff

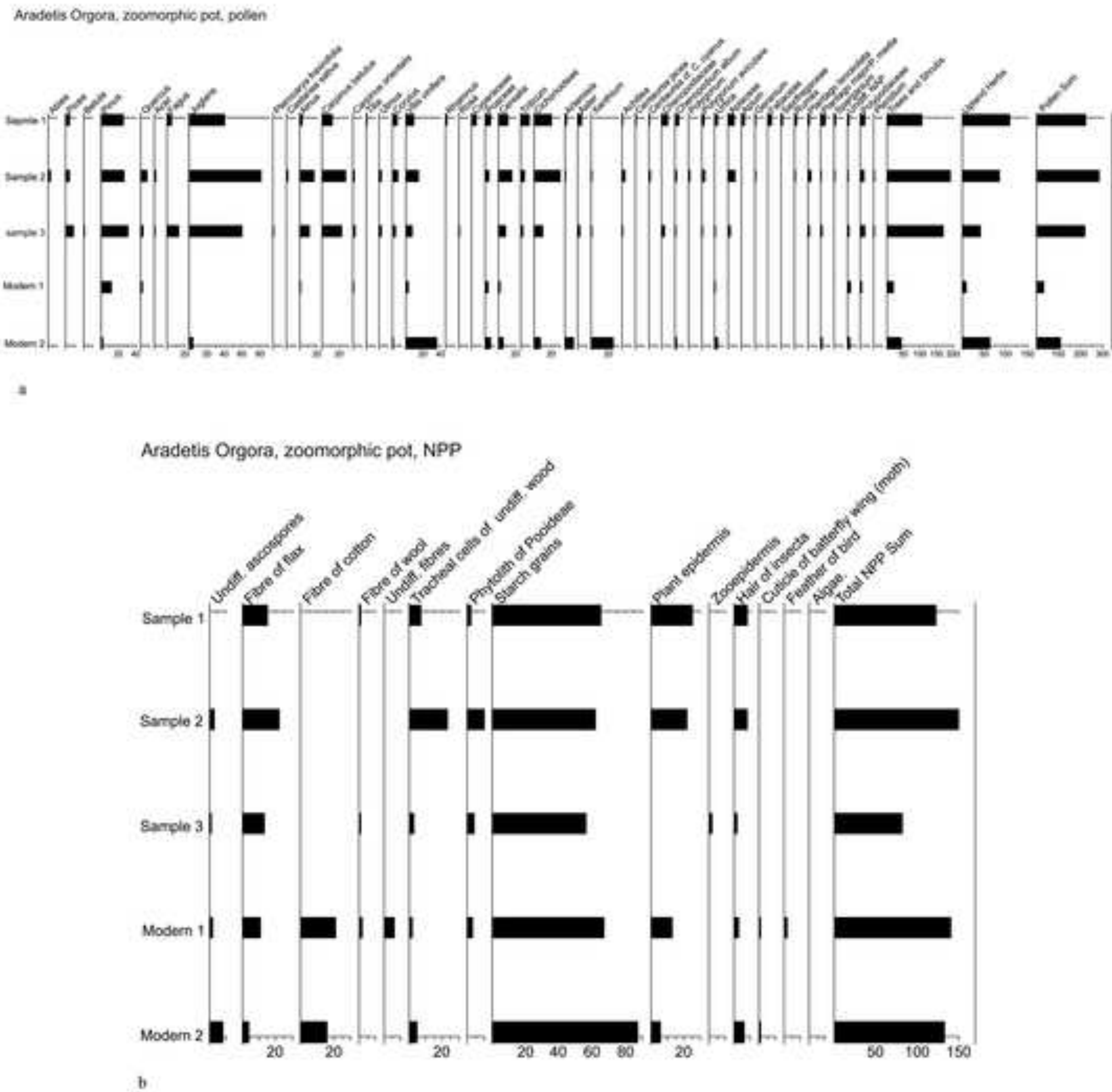
a

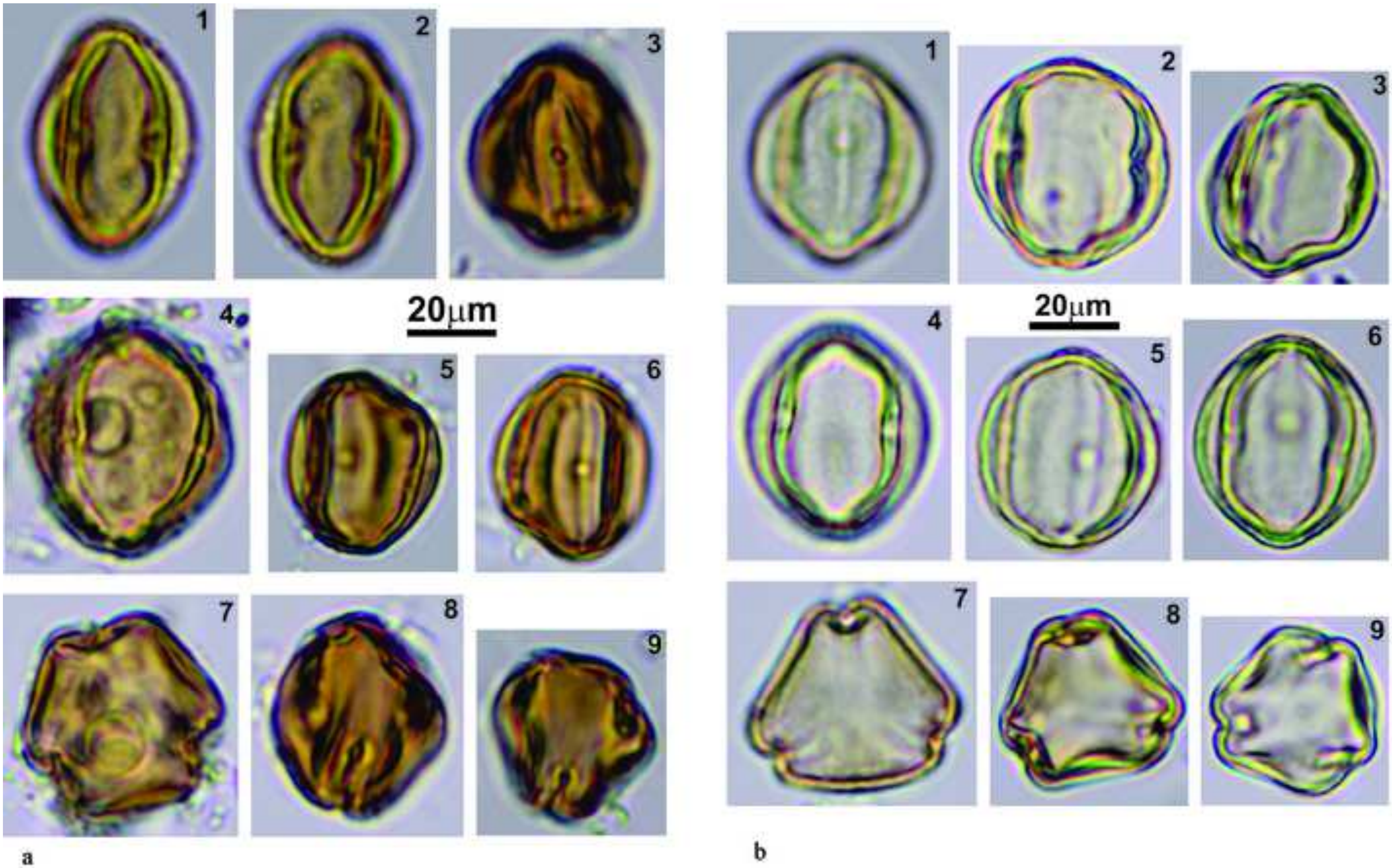


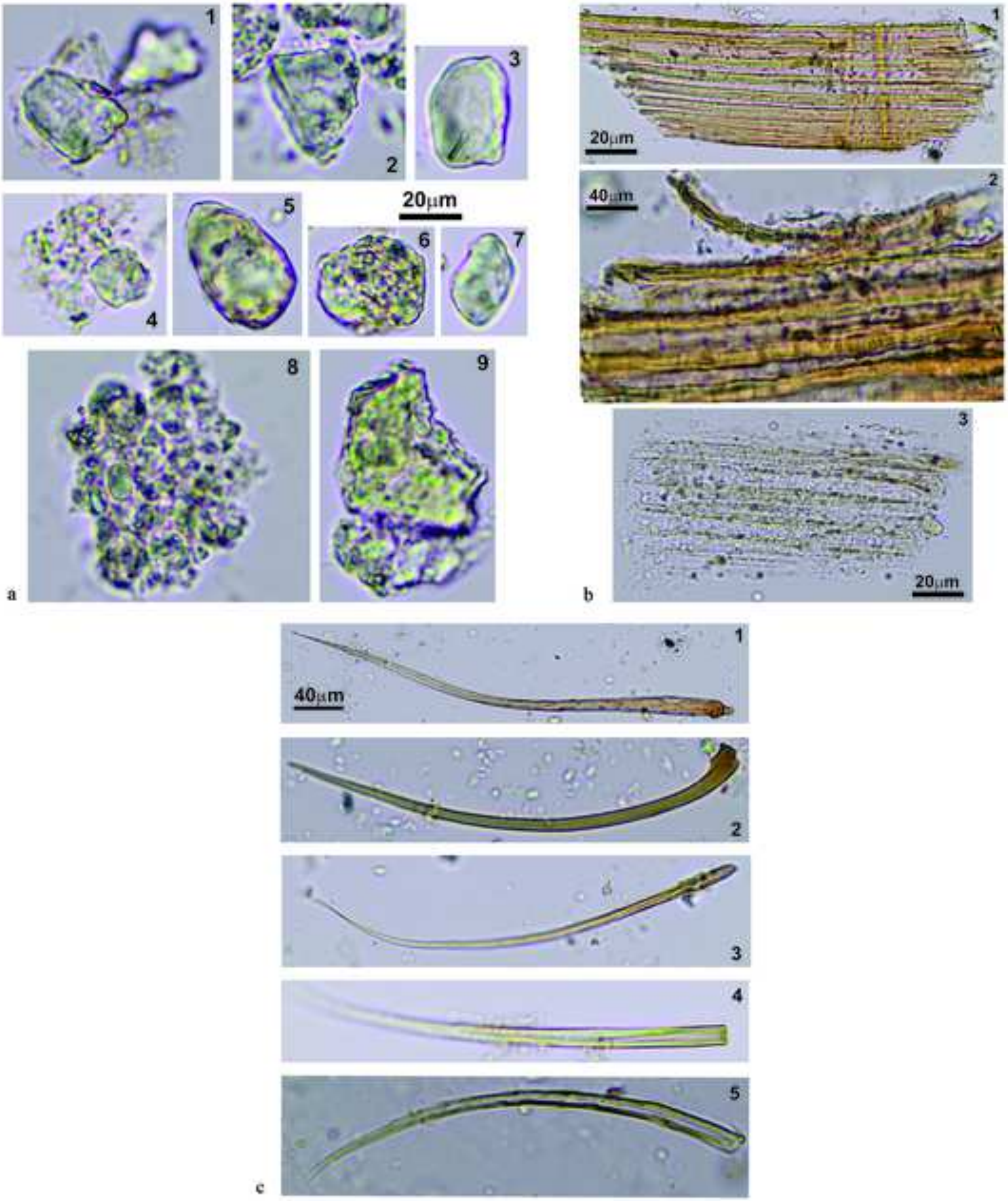
b



2414-C-5
0
8
20cm

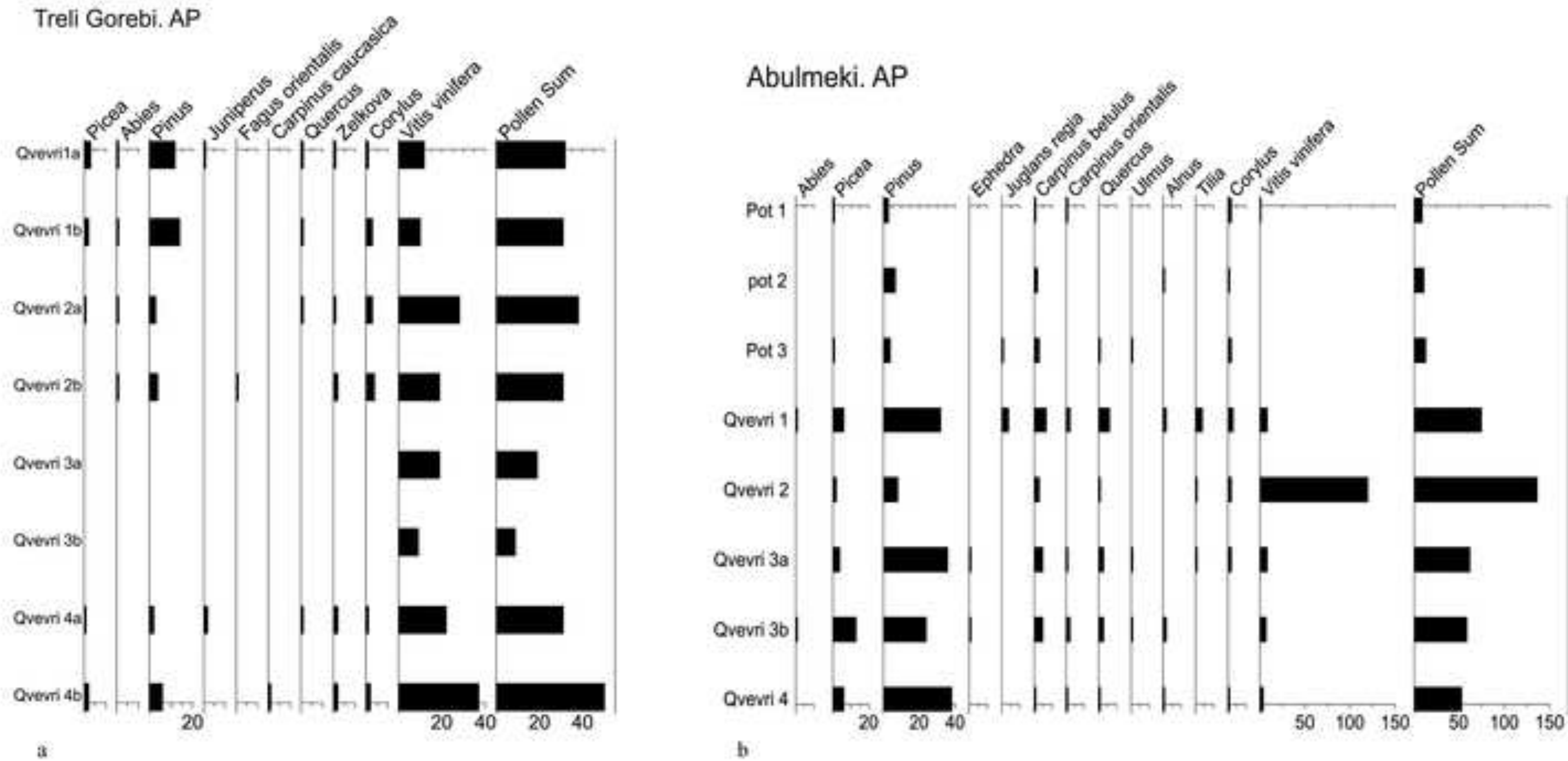

Aradetis Orgora, zoomorphic pot, pollen
Sample 1
Sample 2
sample 3
Modern 1
Modern 2
a
Aradetis Orgora, zoomorphic pot, NPP
Undiff. ascospores
Fibre of flax
Fibre of cotton
Fibre of wool
Undiff. fibres
Tracheal cells of undiff. wood
Phytolith of Pooideae
Starch grains
Plant epidermis
Zooepidermis
Hair of insecta
Cuticle of butterfly wing (moth)
Feather of bird
Algae
Total NPP Sum
Sample 1
Sample 2
Sample 3
Modern 1
Modern 2
20
20
20
20 40 60 80
20
50 100 150
b

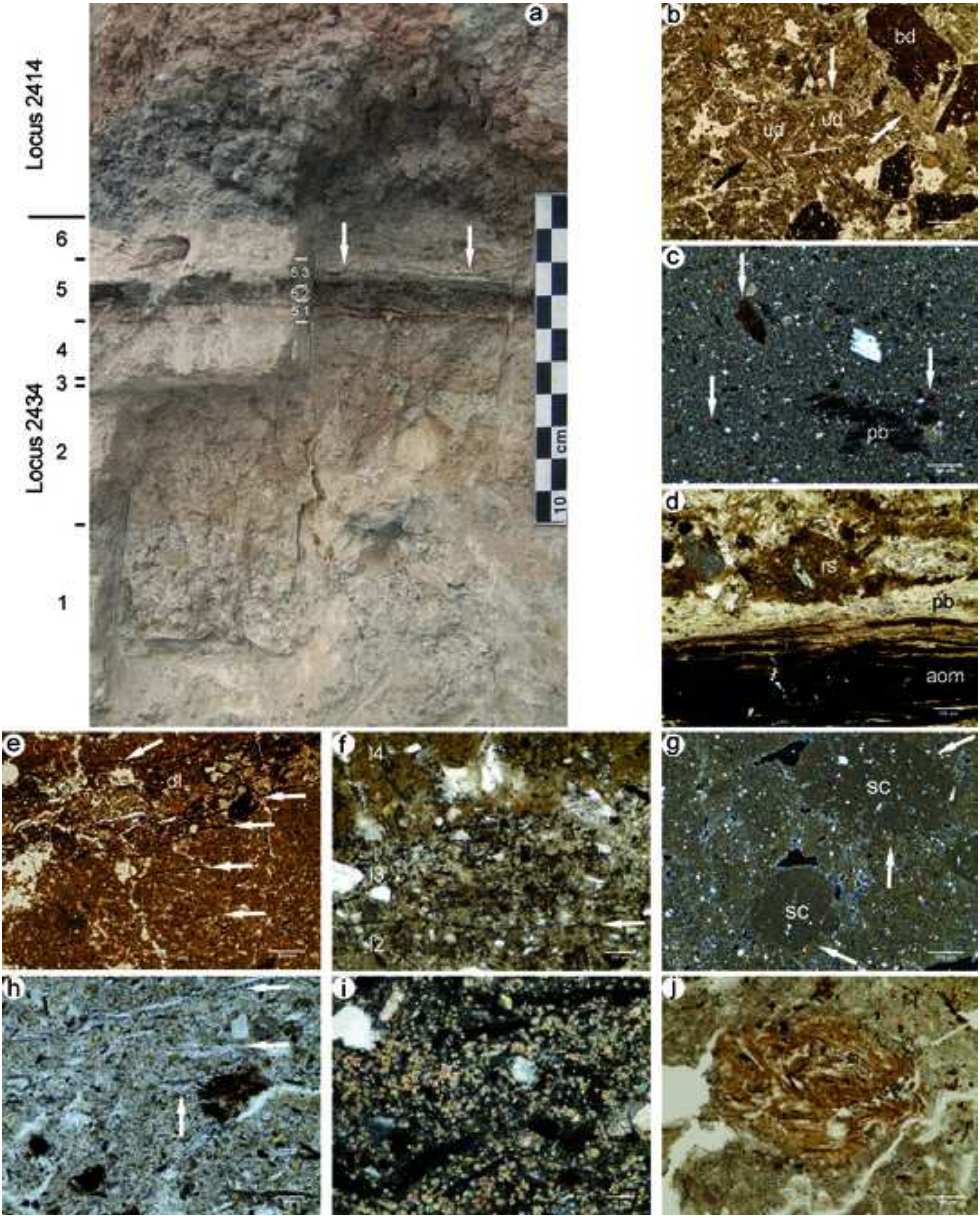

1
2
3
4
5
6
7
8
9
20µm
a
1
2
3
4
5
6
7
8
9
20µm
b


1
2
3
20μm
4
5
6
7
8
9
a
1
20μm
2
40μm
3
20μm
b
1
40μm
2
3
4
5
c

Non-color figure

Click here to download Non-color figure Fig. 11.tif




a
b
c
d
e
f
g
h
i
j
Locus 2414
Locus 2434
6
5
4
3
2
1
cm
10
bd
ud
ud
pb
rs
pb
aom
dl
l4
l3
l2
sc
sc