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 from two zoomorphic Kura-Araxes vessels (ca. 3000 B.C.) from Aradetis Orgora suggest they were utilized for the ritual consumption of wine and likely represent the beginning of the enduring tradition of animal-shaped wine-drinking containers in Georgia. This hypothesis is supported by archaeological and geoarchaeological data: they resemble later wine-containing 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 them was intact, with only a small access hole; consequently, its palynological spectrum can be utilized as a standard for determining the presence of wine in other archaeological vessels. Palynological analyses from different contexts of the Aradetis Orgora settlement and its cemetery (Doghlauri) yielded other significant results regarding the practice of viticulture and the cultural relevance of wine during the Kura-Araxes period.

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 and slowly acquired importance until it developed into a separate discipline, i.e. “Archaeological Palynology” (Holloway and Bryant 1986), finally becoming a standard practice in archaeology.

However, the main object of archaeological palynology is generally the reconstruction of past environments, with little attention paid to the contents of artifacts. In fact, the analysis of vessel contents and of residue on grinding stones, grinders and mortars can be very informative in answering questions about paleo-diet and related issues, such as the cultural use of food and drinks (Kvavadze and Martkoplishvili in press). These archaeological artifacts were first analyzed by American palynologists (Bohrer 1968; Hevly 1970; Bryant and Holloway 1983), who noted that pollen grains from various edible plants were preserved on their surfaces and walls.

Palynological analysis on content residues proved useful in establishing what food or drink had been processed, stored, or consumed in vessels—e.g. ancient mead and honey, or beer (Dickson 1978; Rösch 1999; Kvavadze and Narimanishvili 20c)—as an alternative to or in association with archaeobotanical, chemical or isotopic analyses. Manfred Rösch (2005) first observed that grape pollen grains enter into wine and demonstrated that wine had been stored in archaeological vessels by combining analyses of their content and of modern wine. This very important research laid the foundations for introducing palynology into the study of the development of wine-making.

Pollen monitoring in vineyards and the annual study of wine from the same vineyards began in Georgia immediately after Rösch's publication (Kvavadze and Chichinadze 2007; Kvavadze, Chichinadze, and Martkoplishvili 2010). Since 2007, palynological studies on Neolithic vessels revealed that they had contained wine (Kvavadze, Jalabadze, and Shakulashvili 2010). It must be emphasized that a number of pollen grains of other taxa as well as non-pollen palynomorphs occur also alongside *Vitis* pollen in wine, representing further proof of the presence of ancient wine. The results of palynological studies were definitively confirmed (Maghradze et al. 2016; McGovern et al. 2017a, 2017b) by chemical analyses carried out on residue from Neolithic vessels.

We present here new palynological evidence for the use of wine as well as for the diffusion of viticulture during the Kura-Araxes period (end of the 4th millennium B.C.) that results from analyses carried out on the contents of two unique zoomorphic vessels and on other samples from the site of Aradetis Orgora/Doghlauri in the Shida Kartli province of Georgia (Southern Caucasus). The hypothesis that the ancient population of the site used wine in ritual/religious practices is corroborated by the singular shape of the vessels and by the unusual excavated context , and is also supported by the geoarchaeological characteristics of the sediments.

Regional Setting

Aradetis Orgora is located in the Kura (Mtkvari) River valley in Shida (Inner) Kartli, about 4km NE of the modern town of Kareli, at 42°02'47.80" N, 43°51'37.23" E (Figure 1a). The site includes a cemetery (Doghlauri) and three mounds; the most important of these (“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 1b). The top of this mound lies between 675 and 680 masl.

The Shida Kartli hydrographic network is represented by the Kura River and the branched system of its tributaries. The region, bounded by the northern slope of the

Lesser Caucasus and the southernmost fringe of the Greater Caucasus, 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, 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 temperature ranges between 18–24 °C. Average annual cloudiness is 30%; annual rainfall in the central lowlands is 400–500 mm (Maruashvili 1970).

Present-day vegetation is wholly anthropogenic. Secondary phytocenoses consist of arid forest-steppes and steppe valleys dominated by oriental hornbeam (*Carpinus orientalis*) and bushes of garland thorn (*Paliurus spina-christi*). Residual forests are preserved only on the higher hills and crests, where box-tree (*Buxus*), ivy (*Hedera*) and winterberry (*Ilex*) grow in addition to 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 season 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 in the neighboring Doghlauri cemetery, investigated in the framework of salvage excavations headed by I. Gagoshidze (Gagoshidze and

Rova 2018a, 2018b; Bertoldi et al. 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, Webb, and Collinson 1991) in the Laboratory of Palynology of the Georgian National Museum Institute of Palaeobiology. During the first stage of the analysis, 50 g of the sample were boiled in 10% potassium hydroxide, then the material was centrifuged in cadmium solution in order to separate various 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 refine the methodological approach. All organic remains occurring in wine were deposited and then extracted by centrifuging one liter of wine. Acetolysis was carried out also in this case. Pollen grains from modern grapevines—as well as other non-pollen palynomorphs collected from leaves, grape bunches and stalks—were also investigated. Seeds remaining after pressing the grapes were then studied in order to verify if remains of vine pollen grains were associated with seeds.

The material was identified, counted, and photographed under a transmitted light microscope Olympus BX43. No fewer than 250–300 pollen grains and an even larger number of other kinds of palynomorphs were counted in every sample. Finally, statistical processing of the registered pollen grains and other palynomorph types, including the graphical representation of the results, was carried out by the 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; Erdtman 1952; Chernova and Tselikova 2004; Fujuki, Zhou, and Yasuda 2005; Beug 2004; Moore, Webb, and Collinson 1991;

Piperno 2006; Reille 1992, 1995, 1998; Richter et al. 2004; Stuchlik 2001; Toshiyuky, Zhekun, and Yoshinori 2005; Torrence and Barton 2006; van Hoeve and Hendrikse 1998).

Soil micromorphological observations were systematically carried out on the lithologic units of the Aradetis Orgora sequence. The microscopic characteristics of selected samples collected from space 2413 during 2015 fieldwork are described here in order to characterize construction techniques, use and management of the area.

Three 90 × 60 mm thin sections were prepared from loci contemporary with space 2413, collecting one undisturbed sediment monolith per locus. The monoliths were air-dried at 30 °C for 7 days and then impregnated with low-viscosity acetone-diluted polyester resin under moderate suction; polymerization was carried out under atmospheric pressure. The thin sections were cut with a diamond disk and ground to 30μm 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 petrographic microscope. The descriptions follow the standard formalized by Stoops (2003) for soil thin sections.

The Aradetis Orgora Zoomorphic Vessels

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

In 2015, two unique zoomorphic vessels were recovered (Figure 2) from the Kura-Araxes levels. One (2414-M-2) was nearly complete, missing only the head (Figure 2a), while the other (2434-M-5 + 2414-C-3) was restored from several fragments (Figure 2b). One of these (2414-C-3, the figure's feet) was recovered separately, and at a slightly higher level. Its fabric is also slightly different from the other fragments: it is not totally excluded, therefore, that it originally belonged to a third vessel, analogous to the other two.

These two vessels are quite similar, differing only in a few minor details. Both have thick walls and a reddish-brownish burnished surface. The exterior of the second vessel is partially abraded and shows traces of heavy burning, possibly due to the fire that destroyed the building. The smooth red surface of the other vessel is covered by a network of microscopic cracks, which are characteristic of the Kura-Araxes ceramics. The body is hollow, squat, and oval, with a hole on the back and three small feet (two in the front and one in the back); the head shows stylized animal/human features. The feet of the first vessel are roughly conical, while those of the second one are formed more accurately and convey the impression that the figure is standing on its tiptoes. Only the head of the second vessel is preserved: it widens from the solid oval-section neck into a somewhat flattened triangle with a slightly curved top; the sides suggest schematic ears and the nose is represented by an elongated clay pellet. The eyes are slightly recessed, with pupils represented by small protruding dots in the center. 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.

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) exposed similar occupation sequences.

Field B was excavated down to the natural soil, reaching 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 densely packed layers (Figure 3) representing six main phases (Gagoshidze and Rova 2015, 2018a; Georgian-Italian Shida Kartli Archaeological Project) dated between the 31st and the 28th centuries B.C. by Bayesian modeling of selected ^{14}C dates (Passerini et al. 2016).

The highest part of the Kura-Araxes sequence (Phase 1) was largely damaged by a large Late Bronze Age terrace wall. Remains of circular and sub-rectangular huts built with 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 exposed in Phase 5.

Evidence for ritual use of wine was found in an area of about 3.5 × 3m of Kura-Araxes Phase 4 (Figure 4). The date 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 B.C. by high-precision context-specific radiocarbon dating. A terminus post quem is provided by a single radiocarbon date from Phase 6, which can be situated in the 31st century B.C. (Passerini et al. 2016).

Except for the vessels described above, the Phase 4 occupation yielded few pottery remains; mainly sherds (Figure 5) belonging mostly to Red-Black 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 fire installations (shallow rounded hollows filled with ashes and burnt material) belonging to 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. The southern part 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 space 2413 could be excavated. It was an unusually large structure, probably rectangular with rounded corners and oriented EW. 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 roof and walls of the collapsed structure.

The space was divided into two different areas by a row of four small post-holes running NS in the central part of the floor. 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 4). The first one was a relatively large typical Kura-Araxes wide-mouthed carinated jar (2414-C-5) with two eyelet-shaped handles (Figure 5e), evidently leaning on the eastern wall and broken into several fragments. The fragments of the two zoomorphic vessels were lying 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 a few fragments.

Results

Pollen analyses

Figure 6 shows the palynological spectra of the contents of the two zoomorphic vessels recovered in 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).

Unlike in most archaeological vessels, pollen is taxonomically and quantitatively abundant in all samples.

SAMPLES NOS. 1 AND 2

Pollen from 16 different tree/shrub taxa and 28 herbs was detected. Pollen of grape (*Vitis vinifera*) is present in both spectra (Figures 6, 7). Walnut (*Juglans regia*) pollen dominates among the trees, but pollen grains of hornbeam (*Carpinus*) and pine (*Pinus*) are also frequent; alder (*Alnus*), beech (*Fagus*), hazelnut (*Corylus*), oak (broadleaved *Quercus*), and spruce (*Picea*) are well represented as well. It is important to note that all these taxa, especially walnut and hornbeam, produce much higher amounts of pollen than grapes (Turner and Brown 2004; Kvavadze, Chichinadze, and Martkoplishvili 2010; Kvavadze Jalabadze, and Shakulashvili 2010; van der Knaap et al. 2010). Pollen of fir (*Abies nordmanniana*), maple (*Acer*), chestnut (*Castanea sativa*), oriental hornbeam (*Carpinus orientalis*), elm (*Ulmus*), lime-tree (*Tilia*), and buckthorn (*Rhamnus*) are not frequent.

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, such as knotweed (*Polygonum*), cornflower (*Centaurea*), common cocklebur (*Xanthium*), sorrel (*Rumex*), and chicory (Cichorioidea) (Figure 6). Poaceae wild grass group and sedges (Cyperaceae) are also attested, together with wormwood (*Artemisia*), nettle *(Urtica*), and plantain (*Plantago*). These last species are weeds, generally associated with anthropized environments, which grow in yards, along roads and paths, in waste areas, and dumps. Spores of forest ferns (Polypodiaceae) and pollen grains of bur-reed (*Sparganium*) living close to water were also observed.

Starch and plant epidermis dominate within the non-pollen palynomorph assemblage composition (Figures 8, 9, 10). Tissue fibers, mainly flax and cotton, are also very common, and wool was also observed. Insect hairs of *Drosophila* (fruit fly) are well represented (Figure 11). These tiny flies typically fly around grapes and wine during the first stages of its production, swarm in large numbers during fermentation and easily fall into the large vessels where wine is usually placed. Consequently, wine is often contaminated by flies whose remains can be found in archaeological vessels that had contained wine (Chyb and Gomped 2013). Finally, small quantities of spores of fungi and phytoliths of cereals occur in the analyzed samples (Figure 8).

SAMPLE NO. 3

This sample was collected from the second zoomorphic vessel (2414-M-2), the body of which was intact, with only a small hole in the lower part, so that we can assume that its contents had not been contaminated by soil. Thus, their palynological assemblage is clean and can be used as a reference while searching for fossil wine in archaeological vessels.

A total of 13 woody plants and 19 herbaceous taxa were identified in this sample. *Vitis* pollen is present, though not in a high quantity, because this species produces few pollen and its pollen tends not to preserve well (Turner and Brown 2004;

Kvavadze, Chichinadze, and Martkoplishvili 2010; Kvavadze Jalabadze, and Shakulashvili 2010). Among the trees, the dominant taxa are walnut (*Juglans regia*), hornbeam (*Carpinus betulis*), and pine (Pinus). In addition, beech (*Fagus orientalis*), alder *(Alnus*), spruce (*Picea orientalis*), and hazelnut (*Corylus*) are well represented, whereas birch (*Betula*), oak (*Quercus*), wingnut (*Pterocarya fraxinifolia*), oriental hornbeam (*Carpinus orientalis*), elm (*Ulmus*), and dog rose (*Rosa canina*) are present in very low amounts. Among the herbaceous taxa, cultivated cereals dominate here as in the spectra of the previous vessel. Pollen from vineyards, gardens and arable and ruderal weeds which grow close to the settlements also occur.

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

SAMPLES FROM MODERN WINES

The lower part of the palynological diagram (Figure 6) presents the results obtained from two samples of modern home-made wine. The first one was pressed 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. The diagram shows that modern wine spectra are not very rich in pollen, in our opinion, because of 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, grape pollen grains are still observed in wine spectra, mostly in the Kakheti one, where they occur in large numbers (Figure 12). Pollen of walnut and hazelnut, two cultivated species usually grown close to vineyards, were also found in the same wine.

Among the herbaceous taxa, pollen of garden and vineyard weeds was observed here, as in the fossil spectra, together with ruderal taxa growing along roads and paths: a good example of these is the common cocklebur (*Xanthium*), which is widespread on the territory around vineyards where grapes are harvested and wine is made. *Artemisia, Urtica,* and *Plantago*, which grow in abundance near vineyards, were also observed.

Starch dominates (Figure 9) among the non-palynological remains in both modern wine samples (Figure 8). Fibers of cotton and flax are frequent, as well as wool and artificial textile fibers. Plant epidermis and small amounts of fungal spores, wood cells, and phytoliths of cereals are also present. Animal residues are well represented: hairs of *Drosophila* (Figure 11), scales of moth, and microscopic fragments of bird feathers have been identified. Interestingly, freshwater algae 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 the zoomorphic vessels from Aradetis Orgora are not only remarkably similar to the spectra of modern wine, but also to those of fossil wine residues found in archaeological vessels of various periods. 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 the classical period from Vani (Chichinadze et al. 2012), a *qvevri* (large ceramic vessel used for wine making, fermentation, and preservation) from the wine cellar of Treli Gorebi, dated to the 1st millennium B.C. (Figure 13a), a Medieval qvevri and some tools from the wine cellar of Abulmeki (Figure 13b).

There is always a fairly large amount of *Vitis* in the palynological spectra of these samples. Walnut and hazelnut, which are evidence of horticulture, also occur, as well as a large amount of pollen of cereals. Finally, many starch grains, some hairs of

Drosophila and plant epidermis were observed, as in the spectra of the Aradetis Orgora zoomorphic vessels.

In order to provide sounder evidence of viticulture at Aradetis Orgora in the Kura-Araxes period, pollen spectra from other local contexts were compared with those from the contents of the zoomorphic vessels. These are: the contents of the Kura-Araxes jar (2414-C-5) found close to the zoomorphic vessels; sediment samples from the Kura-Araxes Phase 4 layers, stratigraphically correlated with space 2413, collected from excavation profiles (Figure 3); and sediments from a Kura-Araxes grave of the Doghlauri cemetery.

KURA-ARAXES JAR (2414-C-5)

Pollen of *Triticum* (wheat), *Avena* (oat), *Hordeum* (barley), and other cereals are abundant in this sample. *Pinus*, *Alnus*, *Carpinus*, and *Quercus* were recorded among the arboreal species; pollen grains of *Vitis vinifera* are present as well (Table 1). Pollen of field and garden weeds is also rather abundant. 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 mold fungi (Mucoraceae). These support the hypothesis that the vessel was filled with grain, which was subsequently destroyed by insects and mold. This is indicated also by the occurrence of spores of *Glomus*—a fungus, which commonly grows on tilled, loose soil, whose spores easily penetrate wheat ear and corn (van Hoeve and Hendrikse 1998).

PROFILE NO. 1 (FIELD B, QUADRANT 105.099C, WESTERN PROFILE)

Four sediment samples were analyzed from this profile, at vertical intervals of 15 cm (Figure 3b). All of them come from Kura-Araxes Phase 4 layers—from the same occupation phase of space 2413 where the zoomorphic vessels were discovered. They were collected in space 2471, the open area located to the south of space 2413: the topmost one corresponds to a filling contemporary with the use of 2413 (sub-phase 4a), whereas the other samples predate it (sub-phase 4b).

The pollen spectra of this profile are characterized by prevalent cereals (mainly wheat) and also include many pollen grains of crop weeds. Garden and vineyard weeds, as well as of areas close to human dwellings were also observed, such as *Polygonum aviculare*, *Carduus*, *Chenopodium album,* and *Convolvulus*. *Vitis* pollen from nearby vineyards was also found (Table 1). Among the tree taxa, pollen of pine, spruce, fir, hornbeam, and alder was found. Spores of forest ferns as well as indicators of horticulture, such as pollen of walnut and hazelnut were also observed.

In addition to cereal pollen, phytoliths of Poaceae, including cereals, dominate among the non-pollen palynomorphs (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 the 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, whereas animal remains were present only in a very small quantity.

DOGHLAURI CEMETERY, GRAVE NO. 2

This grave was a rectangular stone-covered, stone-lined pit, 2.20 × 2.15 m wide, containing the in situ remains of a 35–45 year old female in the center, 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.

Sediment samples for palynological analysis 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 sample from beneath the skull had the richest floristic list, including 15 pollen taxa (Table 2). Pine, beech, oak, walnut, alder, hornbeam, elm, lime, and vine were observed among the trees and shrubs. Herbaceous taxa were mainly represented by ruderal weeds. Among the non-palynological remains, several fibers of flax cloth were observed and, in particular, some light blue fibers that 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).

A huge amount of pollen of edible plants is included in the sample from the abdomen area. These are walnut (*Juglans regia*), hazelnut (*Corylus*), plumeless saw-wort (*Serratula*), buckwheat (*Polygonum*), and thistle (*Carduus*). Pollen of medicinal plants, such as *Achillea, Centaurea, Serratula, Cirsium* (Table 2) is found only here. Parenchymal cells of wood, cereal starch, and phytoliths dominate among the non-palynological remains, whereas *Glomus* spores and fibers of flax cloth, including some green and blue-colored ones, are present in a 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, as well as frequent starch, phytoliths, and parenchymal cells of wood among the non-palynological palynomorphs (Table 2).

The spectrum from the contents of pot DG 2015 G2-C-1 includes sparse pollen grains of arboreal taxa like *Pinus*, *Fagus*, *Quercus*, *Alnus*, *Tilia*, *Vitis vinifera*, and a small amount of herbaceous taxa. Starch and burnt parenchymal cells of wood prevail among non-pollen palynomorphs, as in the spectrum of the other vessel. However, remains of fresh water algae were also found here.

Following the characteristics of these palynological assemblages, it can be hypothesized that both vessels from Grave No. 2 were cooking ware. 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 in which food was cooked.

Soil micromorphology

The area of space 2413 is comprised of several lithologic units, such as the encircling wall (locus 2435) and the other units included within its exposed perimeter (Figure 4).

Locus 2434 is layer-shaped and represents the slightly concave bottom of the space, which is delimited by Locus 2435. Looking with the naked eye (Figure 14a, layers 1–4), a large part of the unit comprises yellowish sediments, with some dark brown/blackish laminae at the top (Figure 14b, layer 5); at microscope scale, it can be divided into several layers.

The bottom layer (1) 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 14g) of very fine sediment with few fine sand fraction, clearly identifiable with the naked eye (Figure 14a, 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.

The second unit (2) 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 20mm of the layer, and a discontinuous line of single-layer articulated phytoliths is situated 2–3 mm below the top (Figure 14f).

The third (3) rather wavy layer is about 300–400 µm thick and overlies layer 2. It comprises fine clay mixed with fine and very fine sand and includes minute bits and flakes of amorphous organic matter (Figure 14f).

The fourth unit (4) is a 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.

Finally, the fifth unit (5) is a sequence of fine dark brown to black to light brown laminae, about 1.5–2.0 cm thick (Figure 14a**,** layer 5). The bottom 3–4 mm of the layer (Figure 14a, 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 14e), masking any possibly occurring phytoliths. The more abundant the organic matter, the darker the lamina; consequently, the two fine dark laminae visible to the naked eye 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 (Figure 14a, 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 (Figure 14a, layer 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 14d).

The sixth (6) unit is a light brownish to grayish, 1.5–2.0 cm thick layer of fine silt, along 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 14c).

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 14a, layer 7). It comprises 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 14b). 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 (ca. 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 space 2413 or the surface of the excavation area situated to the south of the wall (Figure 4), is occupied by Locus 2427**,** a roughly tabular lithologic unit whose top surface is depressed at the center and “grows” at the outer side of locus 2435 (wall of space 2413). 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), and frequent faecal spherulites (Figure 14i).

Complex features can be observed at a higher organization level. Common residues of sheep/goat coprolites, sometimes ashed, are represented by rounded aggregates of randomly packed vegetal fibers and phytoliths (Figure 14j). Elongated, subhorizontal voids including long chains of articulated phytoliths (Figure 14h) 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

As far as we can ascertain, the Aradetis Orgora zoomorphic 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 recall the numerous anthropomorphic or zoomorphic figures that decorate Kura-Araxes hearths and andirons (Smogorzewska 2004) or pottery (Sagona 1984, part III). Although quite different morphologically, they may be related 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 (perhaps alcoholic beverages) in a ritual context (Palumbi et al. 2017, fig. 12, bottom row).

More generally, they can be compared to a long series of different zoomorphic containers (*rhyta*, *askoi*, *bibru*, etc.) used for liquid consumption, usually in ritual contexts, over a wide area including the Near East, the Southern Caucasus, the Aegean, and the Mediterranean region from the Bronze Age to the Classical period. In contrast to proper rhyta and also to many Near Eastern bibru (Koehl 2006, 2013), the Aradetis Orgora vessels have only a single opening on the backside.

Their bodies are ovoid and slightly flattened, with a low crest in the middle of the back. The solid ceramic neck rises vertically on a convex breast and functioned as a handle; it terminates in a flattened head. Their shape was possibly inspired by long-necked water birds (swans, geese); in this respect, they look similar to West Anatolian bird-shaped askoi of the Early Bronze Age (Cultraro 2005, 31–33), which also share with them the presence of three small conical feet, or to bird-shaped Cycladic askoi of the late 3rd and early 2nd millennium B.C. (Thimme 1976, 530, Kat. nos. 420–421). Unlike the Aradetis Orgora items, however, these vessels have holes in place of the animals’ heads, and not in the back, and are provided with a handle.

The precise use (for libation, drinking, presentation) of the above-mentioned groups of vessels may have differed, as well as the liquids they contained, but there is little doubt of the fact that all of them are connected with ritual practices.

In Georgia, as more in general in the Southern Caucasus, viticulture and wine-making were part of the agricultural economy of the region throughout its history, and they still constitute one of its fundamental resources. Interdisciplinary research carried out by archaeological, palaeobotanical 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, 2017b). Currently, vine pips and branches have been found at more than 15 archaeological sites (Rusishvili 2010), and microscopic remains (pollen and non-pollen palynomorphs) of wine and grapes have been found at 24 sites (Bitadze et al. 2011; Kvavadze and Martkoplishvili in press) dating from the Neolithic to the Medieval period.

The origins and evolution of viticulture and wine-making fostered the introduction and development of specific vessels and tool types for making and preserving, as well as for transporting and consuming wine. Archaeological investigations in Georgia have traced the evolution of wine vessels for a period of nearly eight thousand years, from the 6th millennium B.C. until today.

For example, the so-called qvevri—a special type of large ceramic jar used for wine making, fermentation, and preservation—was first produced in its most typical shape around 1000 B.C. in the Near East (Chilashvili 2004; Lordkipanidze 2017). It then spread to all the regions of ancient wine-making in Europe, Asia, and North Africa without undergoing significant change; however, only in Georgia was it preserved in its original form (Jorjadze, Priudze, and Glonti 2011).

Wine, however, was not (and still is not) only a food product or a simple beverage. Evidently, it was connected with religious beliefs through cult and ritual practices from earliest times; for example, it is not necessary to recall the significant role played by red wine in Christianity. Until recently, there was a special qvevri (the so-called “qvevri for communion wine”) in the wine cellar of every wine-making villager in Georgia, which was used for keeping the wine to be consumed during the festival of the patron saint of the village (or region) (Jorjadze, Priudze, and Glonti 2011). If the family moved from the village, it had to leave this qvevri at the local sanctuary. Even today in Kakheti such qvevris are found in many old village churches (Figure 15a).

In earlier periods—as well as in contemporary Georgia—both festive (weddings, baptisms, etc.) and funerary (wakes) feasts were inconceivable without wine. If we look at the archaeological record from Georgia, vessels with organic remains of wine have been found in burial contexts from the Early Bronze to the Middle Ages (Bitadze et al. 2011; Kvavadze and Martkoplishvili in press).

Specific vessel shapes were likely used for toasts of different types and by different populations: this could explain the variety of wine-drinking vessels attested in the country. Even today, in Georgia, the main toast of the festive parties is drunk from a particular type of drinking vessel: the *kantsi,* whose shape is inspired by the horns of domestic or wild animals (oxen, aurochs).

Zoomorphic drinking vessels of different materials, often mentioned as rhyta as they normally have two openings (one for pouring wine, and the second for drinking), were particularly popular in the country in the 1st millennium B.C. (Figure 15b-c). Their large number and variety, particularly in the Achaemenid and Hellenistic periods, is surprising. Ceramic drinking vessels of this period in Georgia were shaped as horses, oxen, sheep, boar, elephants and fish (Khundadze 2010).

Palynological research carried out on the contents of the two zoomorphic vessels from Aradetis Orgora 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 two vessels, of modern wine, and of the contents of wine containers of other periods are very similar. Consequently, we can conclude that both vessels must have contained wine.

The pollen spectra of the large jar associated with the zoomorphic vessels also include *Vitis* 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 surrounding vineyards, 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 gotten 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 grapes, 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. Pollen of warmth-loving broadleaves as hornbeam, oak, lime-tree, walnut, and similar plants 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 mold fungi and 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. Cereal farming 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 asl in ash layers, on hand-mills and on other artifacts of the Paravani burial mound (Kvavadze et al. 2013); at 1615 m in settlement layers at Chobareti and at about 1342 m in Tiselis Seri (Bitadze et al. 2011). 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 more 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; Connor and Kvavadze 2008, 2014), when the climate was the warmest and most humid of the whole Holocene. On the other hand, viticulture on the territory of Georgia arose precisely during the first climate warming, which occurred 8000 years ago (Connor and Kvavadze 2008; McGovern et al. 2017a, 2017b).

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 *Vitis* 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-pollen palynomorphs 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 vine starch are also characteristic of the wine spectrum, because a peculiar starch forms within all organs of vine (fruits, seeds, leaves, and stems) (Winkler and Willaims 1945; John, Downton, and Hawker 1973). A peculiar form of plant epidermis belonging to grapevines, which can be observed also in fossil and modern wines, was revealed in our analysis of the peel of modern vine stems (Figure 10). Finally, there are always insect hairs belonging to the tiny fly *Drosophila* among the non-palynological remnants in the spectrum of wine (Figure 11) (Chyb and Gompel 2013).

The following features are shared by the palynological spectra of the Aradetis Orgora zoomorphic vessels and by modern wine: excellent preservation of pollen grains and high taxonomic richness, because alcohol inhibits the multiplication of microbes and fungi, which consequently cannot alter and destroy the pollen grains; rather large amount of grapevine pollen; occurrence of pollen from vineyard weeds; non-pollen palynomorph assemblages dominated by single and specific type of vine starch; occurrence of *Vitis* epidermis; and the occurrence of insect hairs (*Drosophila*) in the spectra.

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 wine having a strong cultural value among the Kura-Araxes people (Batiuk 2013). Consequently, these two vessels become the most ancient zoomorphic wine-drinking 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 space 2314. The most relevant components of locus 2427 are calcareous faecal spherulites (Figure 14i) formed within the guts of the ruminants (Canti 1998), and sheep/goat coprolites (Figure 14j), suggesting that these animals were kept in the area. Considering that locus 2427–2467 extends below as well as around space 2314, it testifies to the presence of animals in the area prior to the construction of this structure 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 detainment or transit of animals, and where household refuse was 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 little 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 layer 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 to the naked eye 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 of 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 non-homogeneous and the observations carried out do not securely represent its general aspect. Apparently, it is limited to the inside of space 2314 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 context 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"), where ceremonies involving ritual use of wine (libations, or collective consumption events) possibly took place (Gagoshidze and Rova 2018a). In fact, 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 cultic use (Sagona 2017, 248–250).

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 4). 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 confinement 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 bone 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 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 its 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—at the present state of research—lack any contemporary analogues in Georgia and elsewhere within 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, which had been pressed from grapes grown in 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 grapevine starch, grapevine epidermis, and *Drosophila* hairs. These components may be prospectively considered as additional, useful hints that wine had been kept in archaeological ceramics.

Pollen of grapevines were 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 thus represent the prototypes of a long series of special wine consumption vessels, whose tradition is still represented 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 hazelnut 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 hazelnuts were present close to the vineyards, and that these cultivations were other important components 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 the Western section and jar.

Table 2. Doghlauri cemetery, Grave No. 2, quantity of pollen and non-pollen palynomorphs.

Figure 1. A) Position of the Aradetis Orgora/Doghlauri site in the Kura Valley and B) view of the "Dedoplis Gora" Main Mound (GISKAP, inset map from Wikipedia, satellite view from Google Earth).

Figure 2. Zoomorphic vessels 2414-M-2 (A] photo after restoration; B] drawing) and 2434-M-5 + 2414-C-3 (C] photo after restoration; D] drawing) (GISKAP). The vessels are presently in the Dedoplis Mindori ("Queen's field") collection of the Georgian National Museum. Museum inventory numbers: 27-977:11926 and 27-977:11927.

Figure 3. A) Drawing and B) composite photo of the W section of quadrant 105.099c with Kura-Araxes phases and location of 2015 palynological (squares) and soil micromorphological (rectangles) samples (GISKAP).

Figure 4. A) View of the find spot of the zoomorphic vessels, from south and B) plan of the Kura-Araxes sub-phase 4a occupation (GISKAP).

Figure 5. Kura-Araxes pottery from Phase 4 (GISKAP).

Figure 6. Pollen diagram of zoomorphic vessels content and modern wine.

Figure 7. *Vitis vinifera* pollen grains from vessels No. 1 (1–3), and No. 2 (4–9).

Figure 8. Non-pollen palynomorphs diagram of zoomorphic vessels content and modern wine.

Figure 9. A, B, D, E, and H) Starch grains in fossil and (C, F, G, and I) in modern wine.

Figure 10. A–B) Epidermis of *Vitis vinifera* in fossil and C) in modern wine.

Figure 11. A–C) *Drosophila* hairs in fossil and (D–E) modern wine.

Figure 12. A–I) *Vitis vinifera* pollen grains from Kakheti modern wine.

Figure 13. Arboreal pollen diagram from qvevri and pots content from A) Treli Gorebi and B) Abulmeki Marani.

Figure 14. Soil micromorphological characteristics of Loci 2434 and 2414, A) on the north profile of quadrant 105.099C, and (B–J) microphotographs 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 center. XPL;

J: Rounded fragment of sheep/goat dropping, including digested vegetal fibers.

Figure 15. A) Qvevris near old village church in Kakheti and B) examples of 1st millennium B.C. zoomorphic wine-drinking containers from Treli Gorebi.

Table 1: Aradetis Orgora, W section and Jar

Samples	**1** **2436**	**2** **2445**	**3** **2450**	**4** **2455**	**5** **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
Deciduous *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 undiff.	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 undiff.		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 Cerealia	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
Hair of insect					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 cemetery, Grave No. 2.

Samples	**Top of pot 4 (G2-C-1)**	**Top of pot 5 (G2-C-2)**	**Abdom. Area**	**Bottom of pot 4 (G2-C-1)**	**Under skull**	**Bottom of pot 5 (G2-C-1)**
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 undiff.		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 insect						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

Rova_01_CMYK

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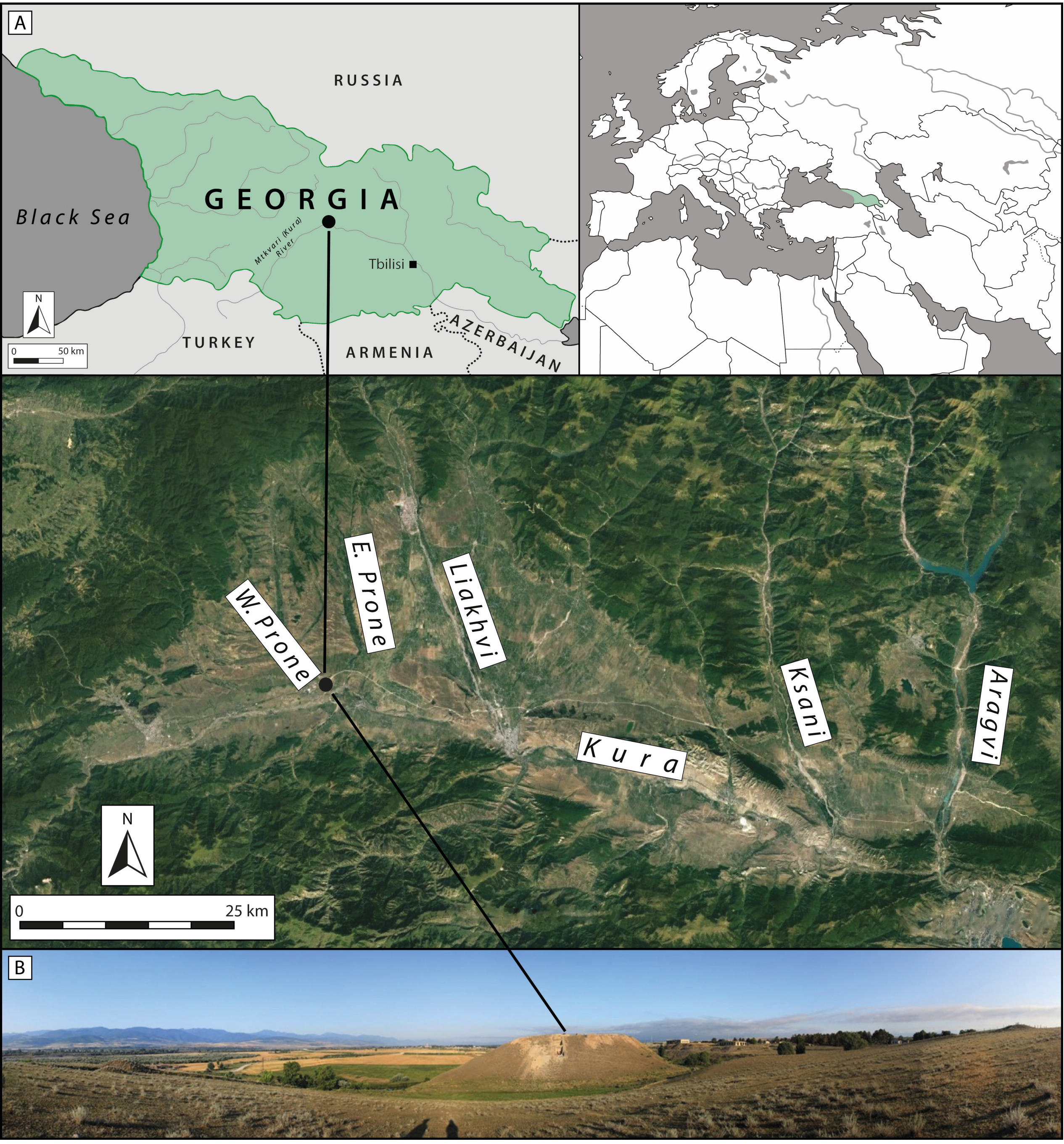

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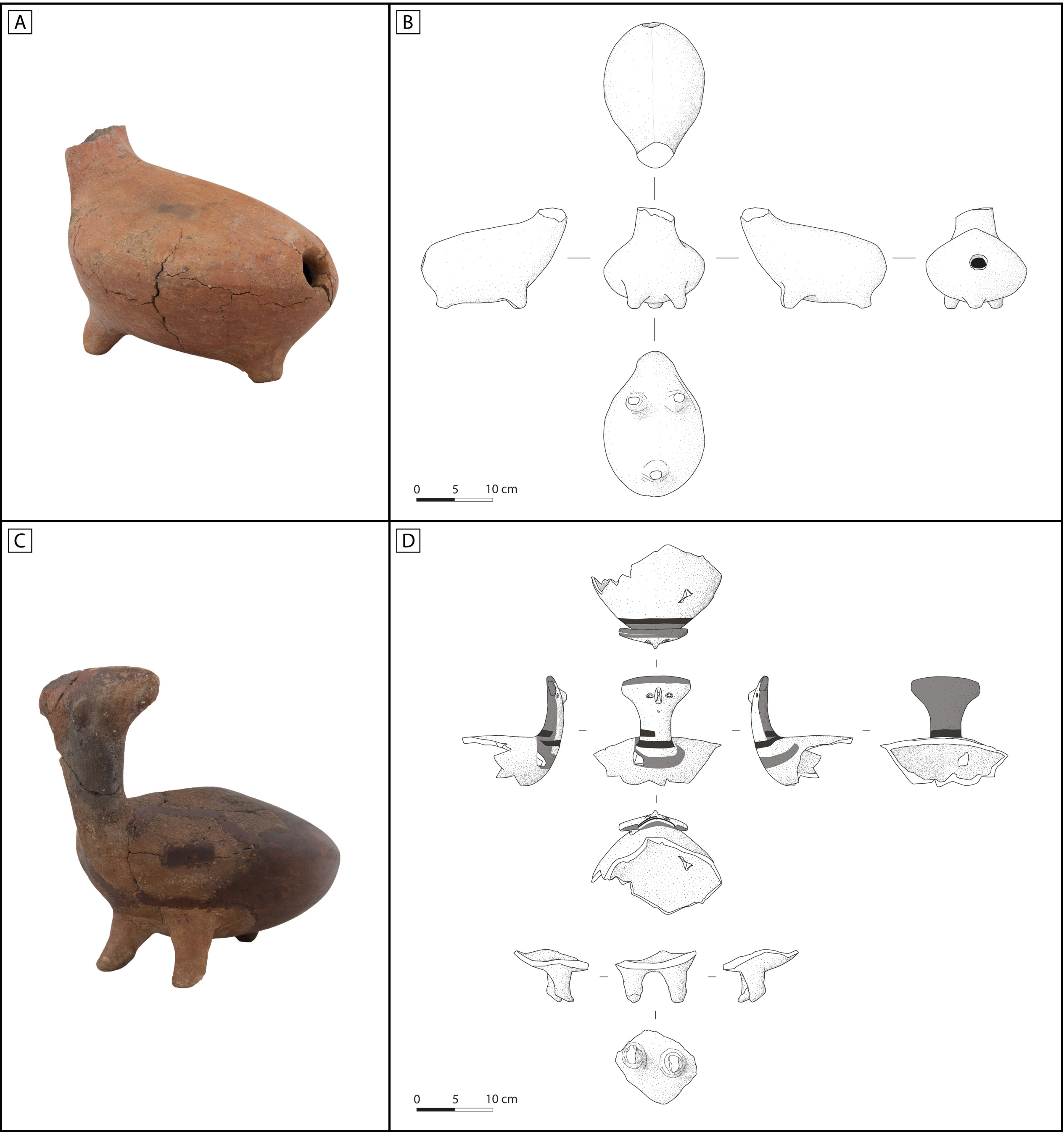

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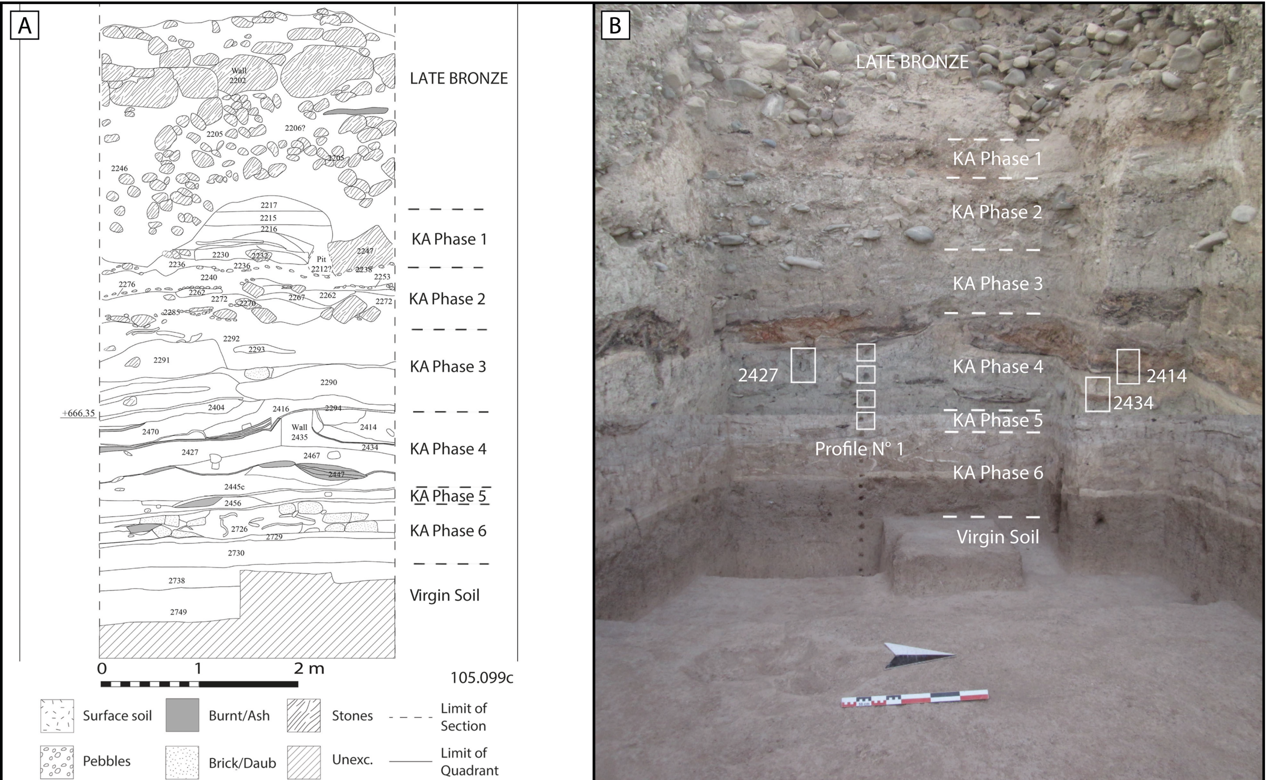
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Wall
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KA Phase 5
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KA Phase 6
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Virgin Soil
2749
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1
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105.099c
Surface soil
Burnt/Ash
Stones
Limit of Section
Pebbles
Brick/Daub
Unexc.
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B
LATE BRONZE
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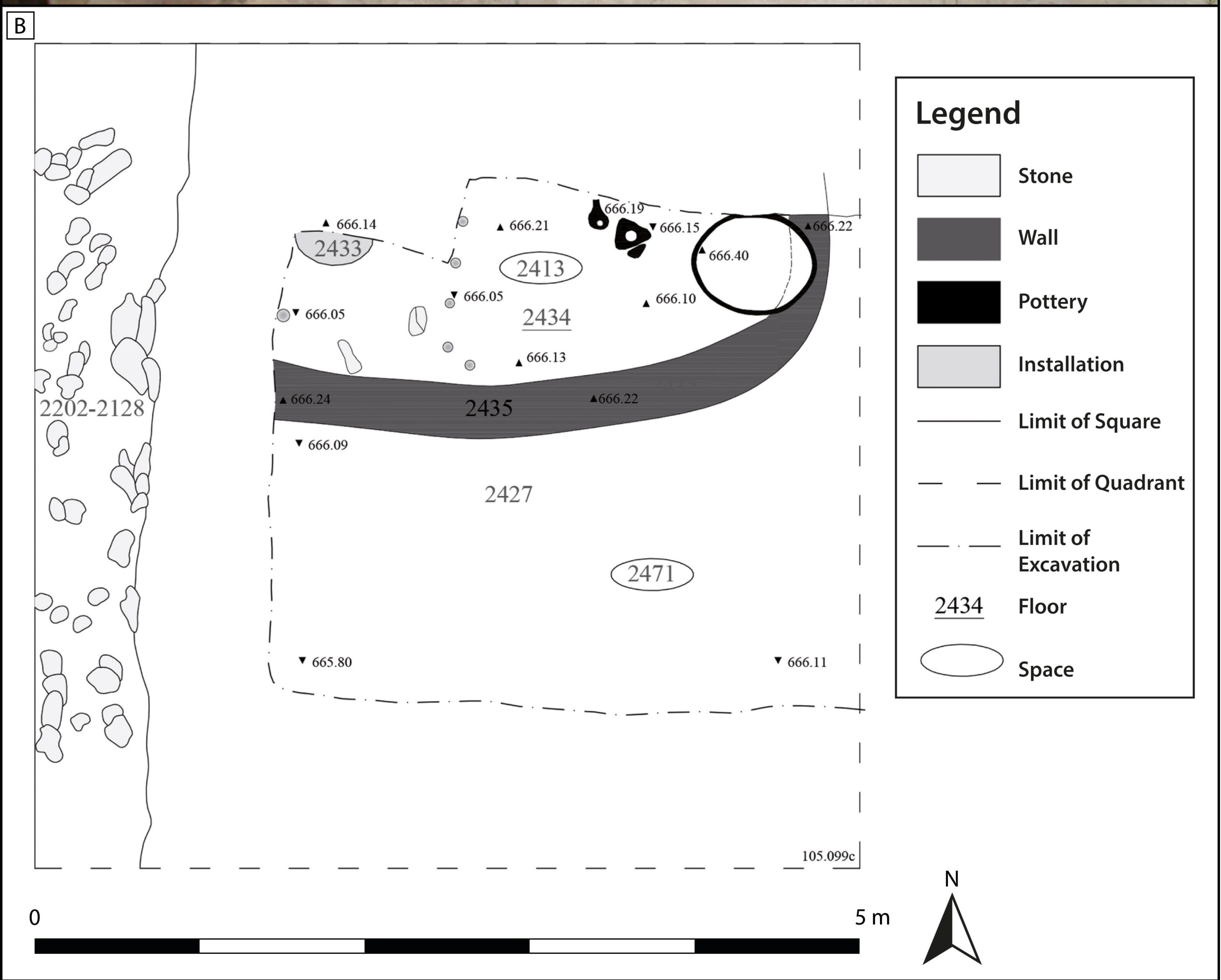
KA Phase 6
Virgin Soil

Rova_04_CMYK


A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665.80
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Legend
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Wall
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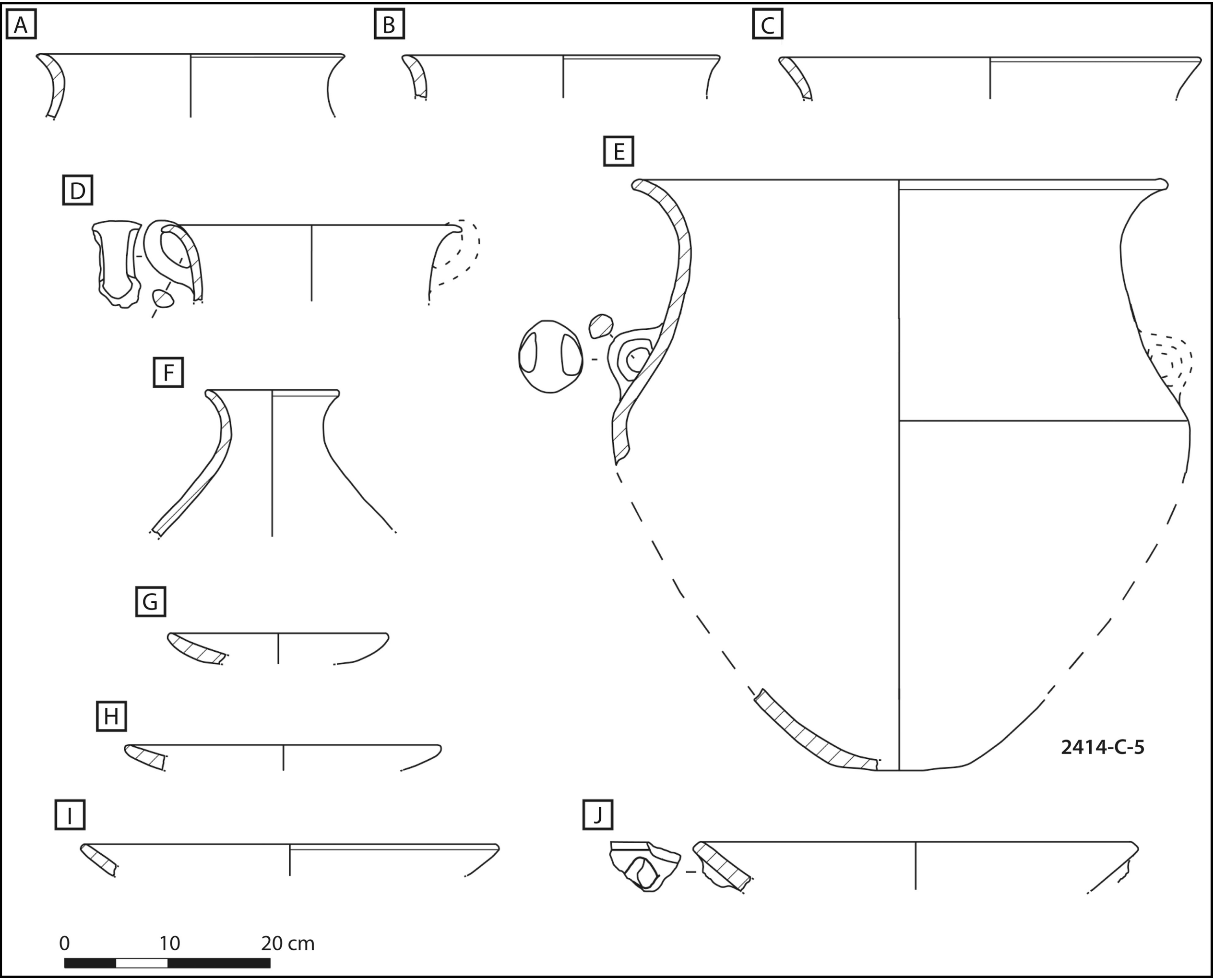

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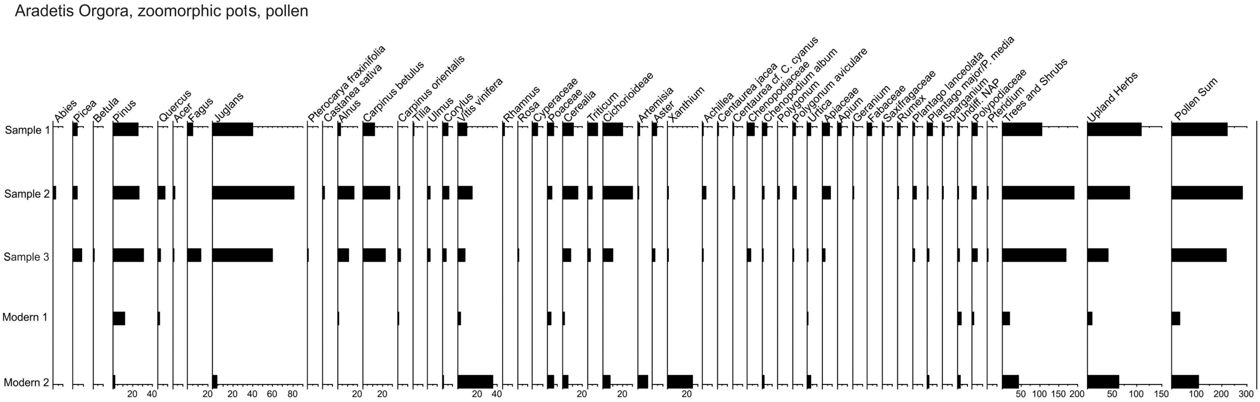

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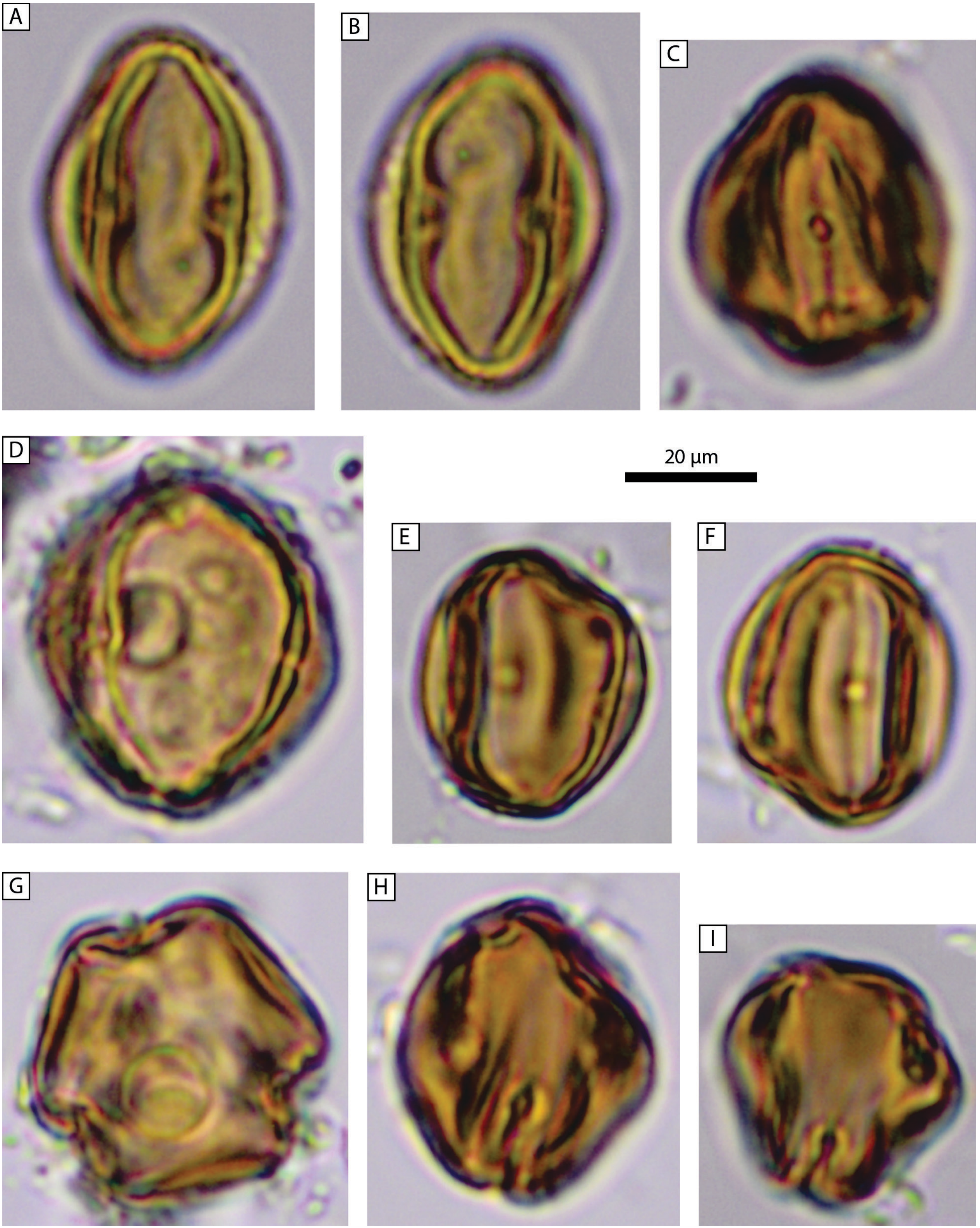
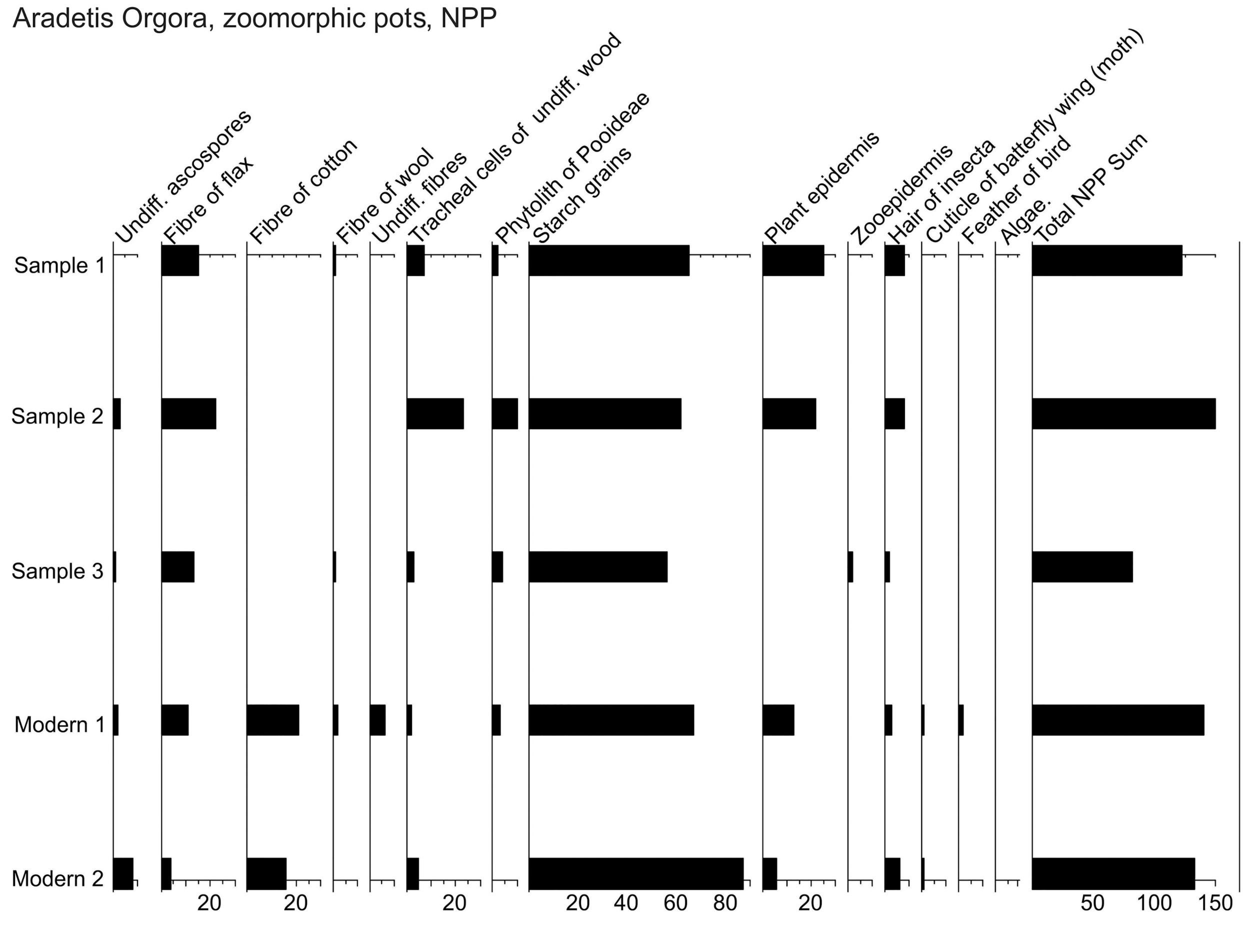
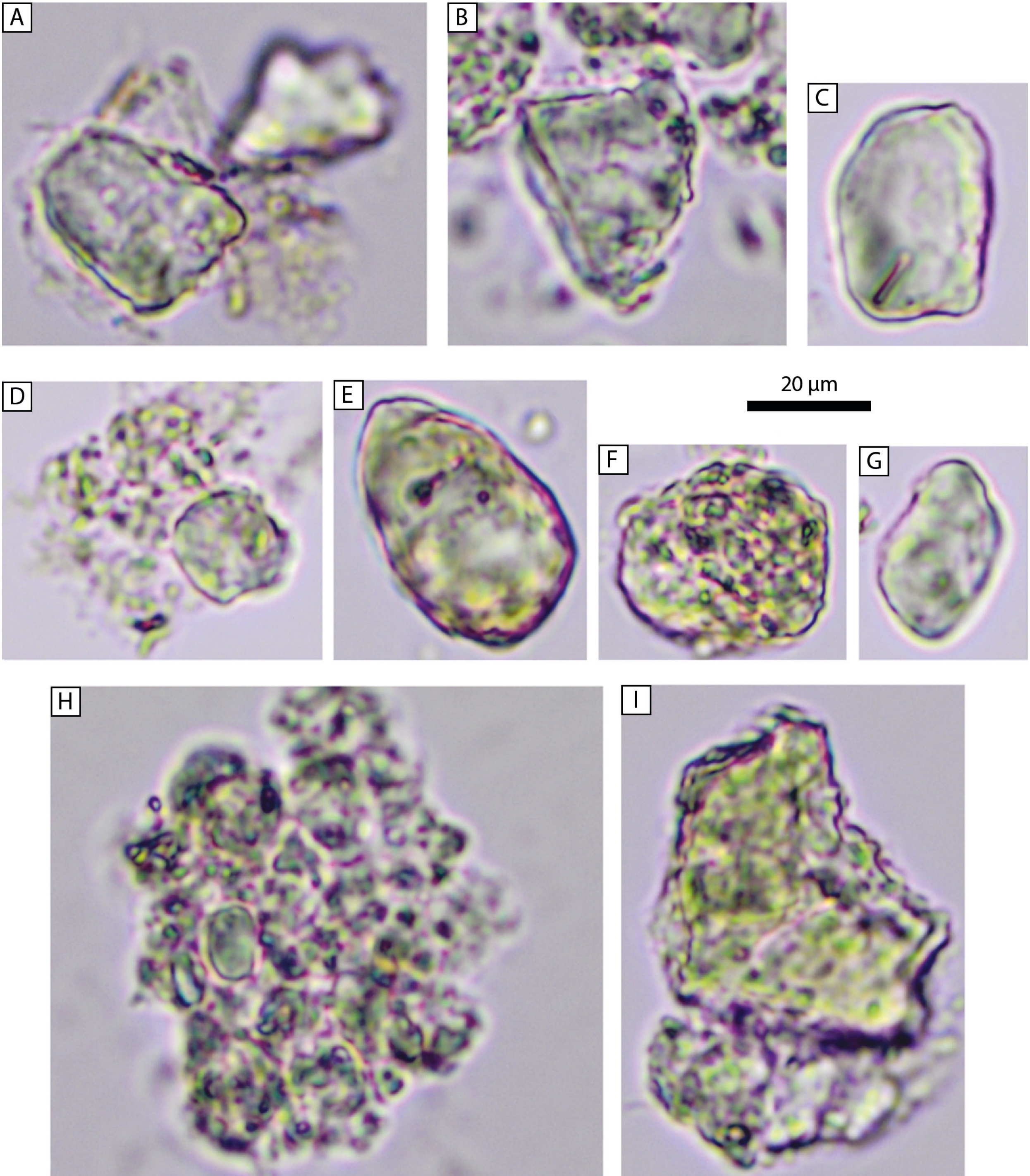


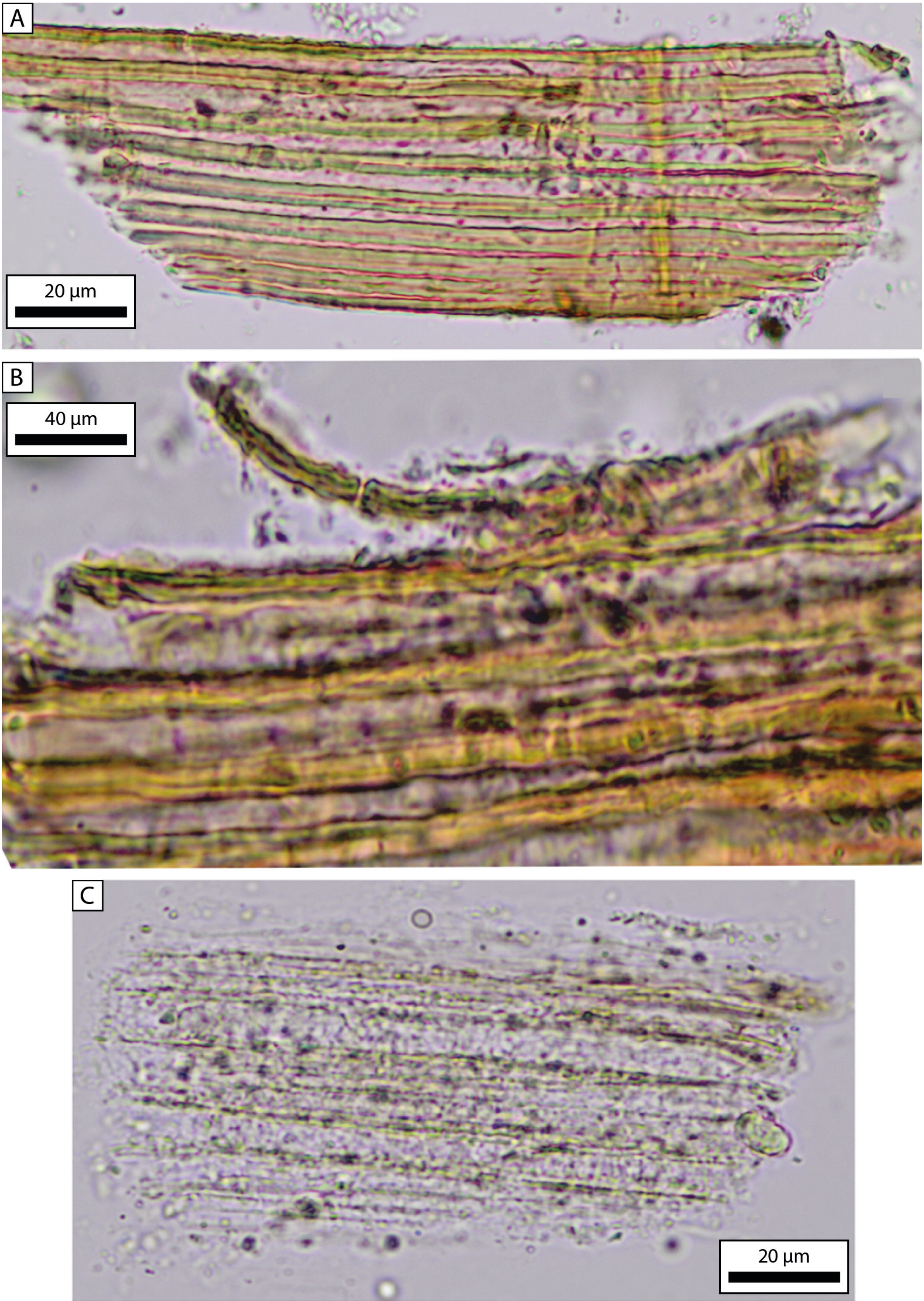
Rova_08_Grayscale



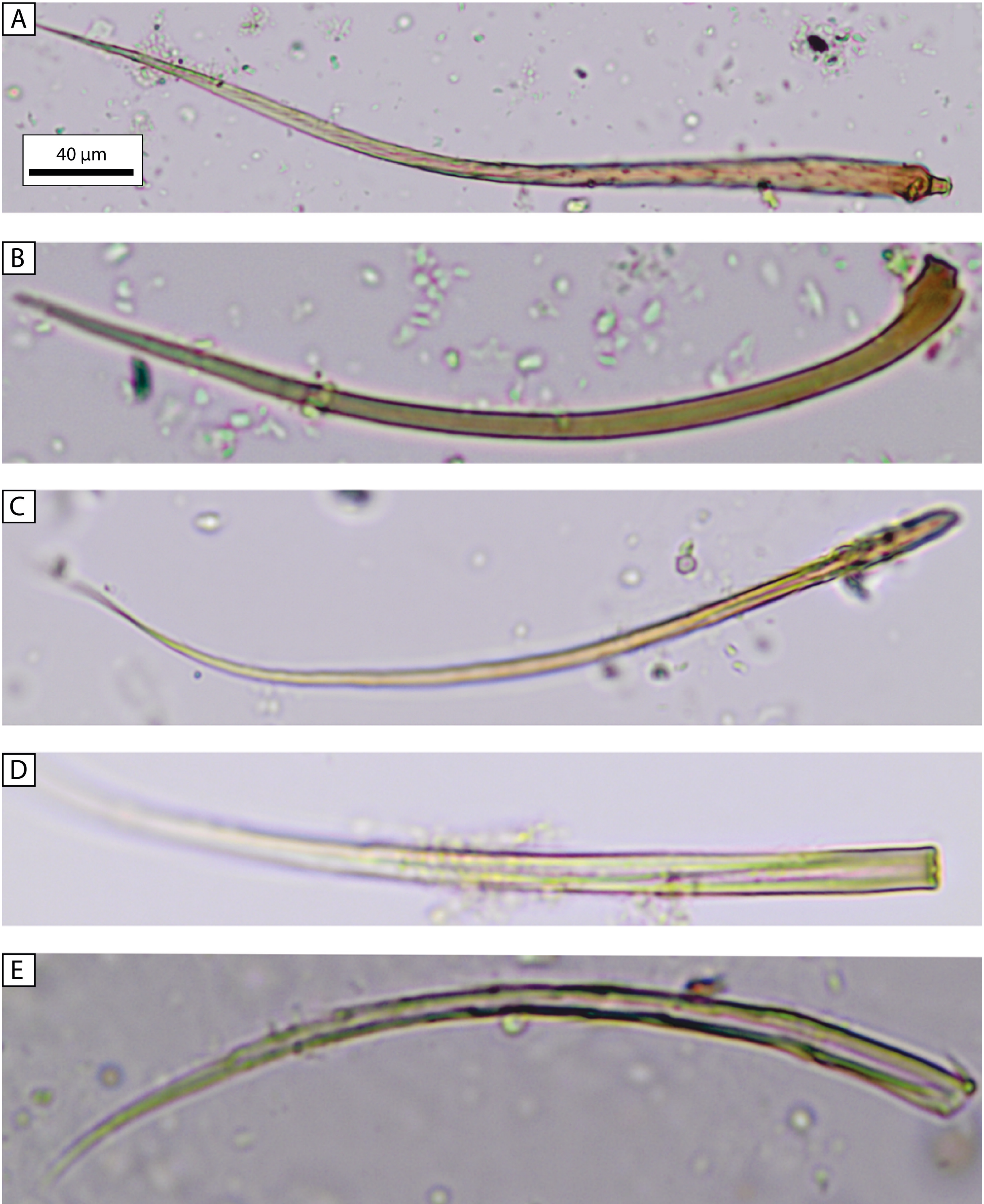
Rova_09_CMYK

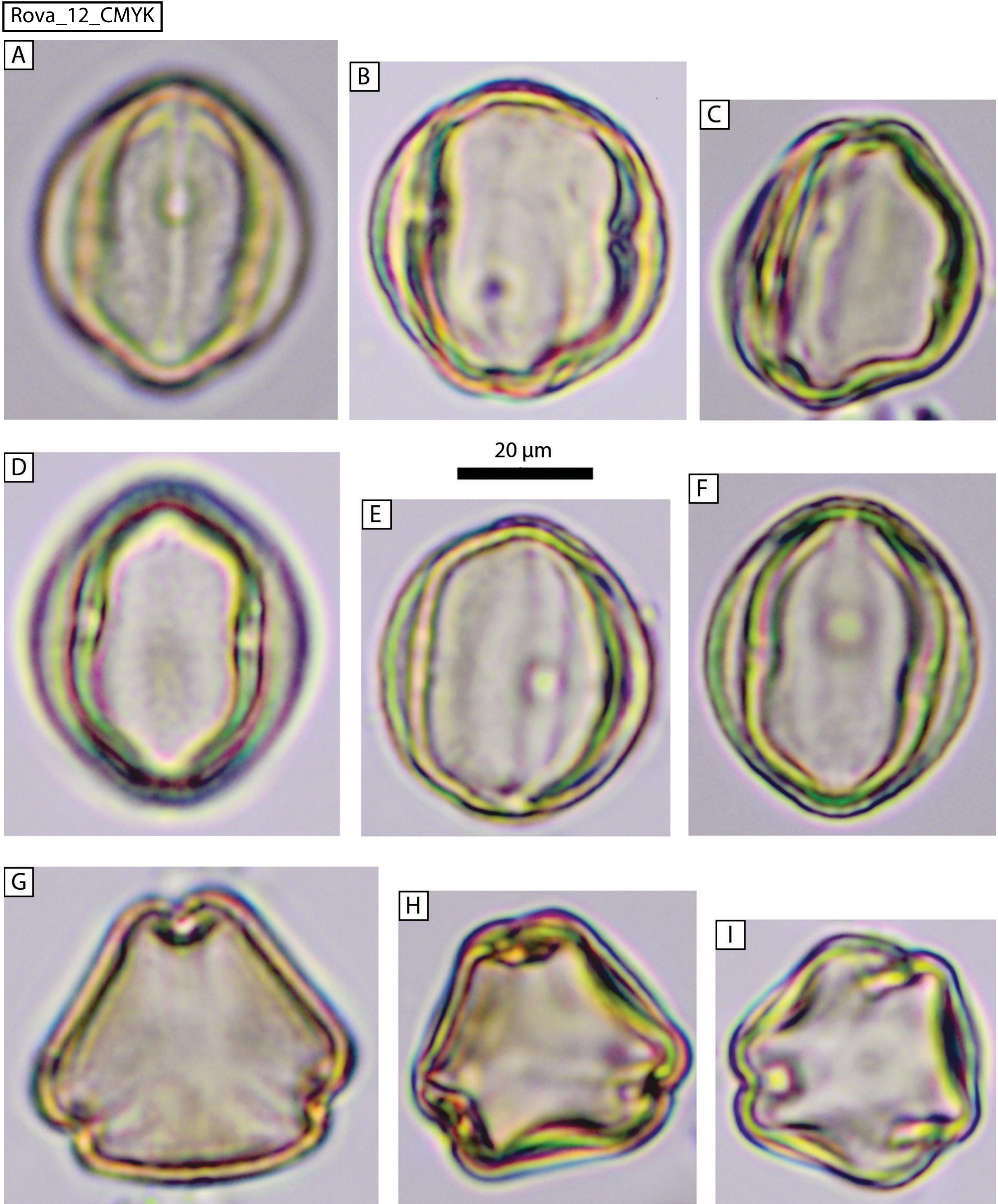


Rova_10_CMYK

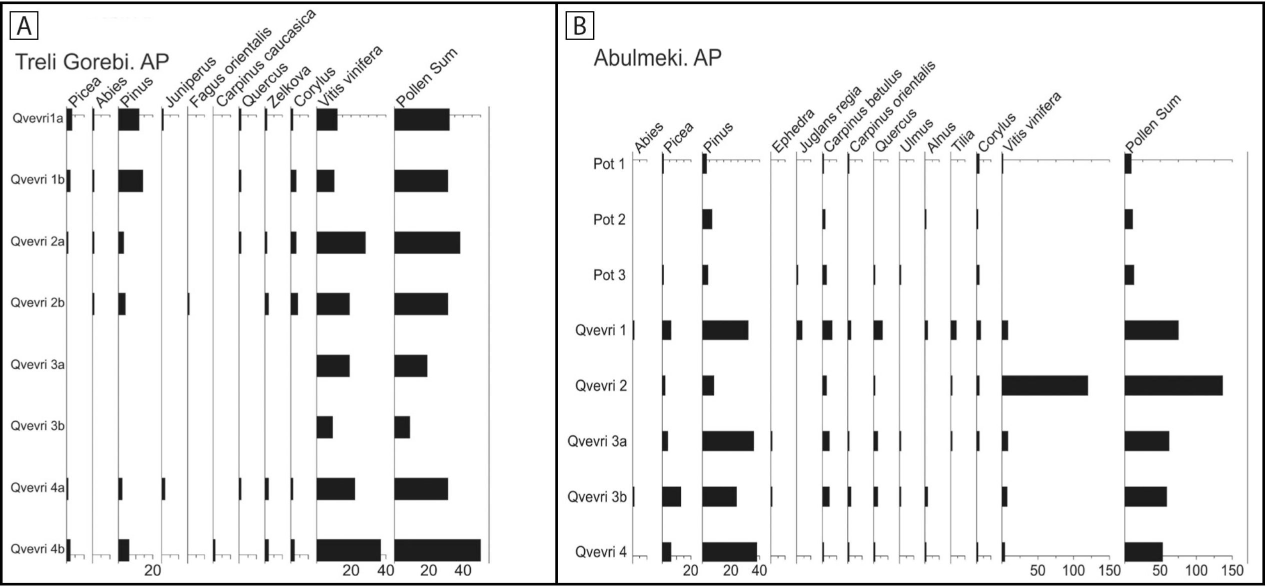


Rova_11_CMYK

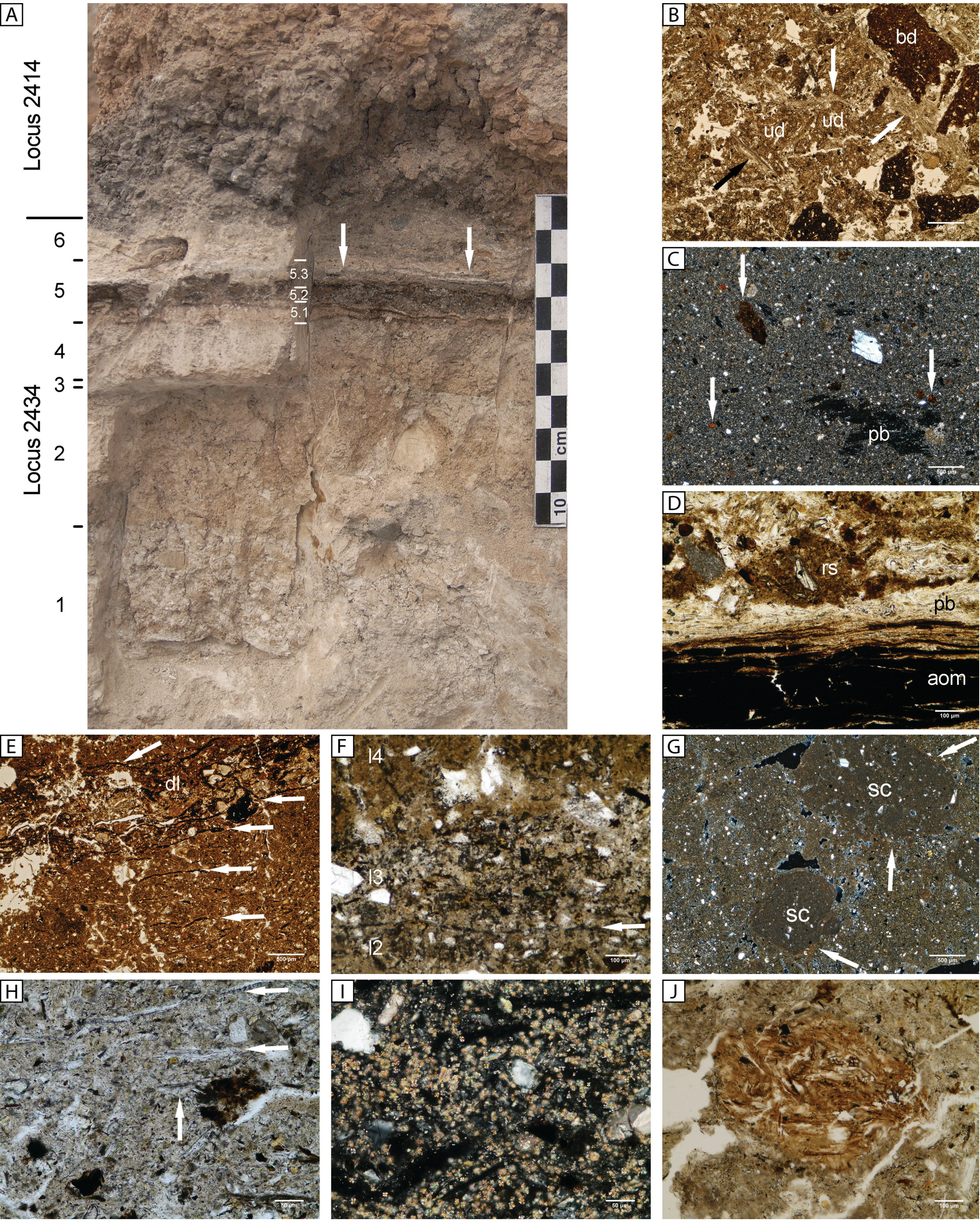



Rova_12_CMYK
A
B
C
D
20 µm
E
F
G
H
I

Rova_13_Grayscale



Rova_14_CMYK


A
Locus 2414
6
5
4
3
2
1
Locus 2434
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

Rova_15_CMYK