



Pollen and non-pollen palynomorphs in organic residue from the hoard of ancient Vani (western Georgia)

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ABSTRACT

An investigation of pollen and non-pollen palynomorphs in the organic material in bronze objects found in Vani provides evidence that, in the first half of the first century BC, the climate of the area was cooler and much more humid than nowadays. The local population was engaged in cattle-breeding and agriculture, and both viticulture and horticulture were also well developed. The analysis of the contents of an oil lamp showed that the lamp was in use for a long time and was filled with flax oil. Large pieces of beeswax found in the hoard provide evidence of the existence of local bronze-casting industry. The palynological studies of the recent and fossil soil of Vani have shown that only in soil spectra large quantities of spores of various fungi were found, which distinguishes them from the domestic dust spectra. On the basis of this argument it was established that most part of the studied fossil material is not contaminated by the soil where the hoard of bronze objects was buried.

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1. Introduction

The ancient settlement of Vani is a unique archaeological site in western Georgia (Figs. 1 and 2) occupied from the 8th to the 1st centuries BC (Lordkipanidze, 1979, 1996; Kacharava and Kvirkvelia, 2008a,b,c,d). The first systematic excavations and investigations were carried out from 1947 to 1966 under the direction of N. Khoshtaria. From 1966 to 2002, the excavations were guided by O. Lordkipanidze and then by D. Kacharava. Over this period, the archaeological studies have revealed defensive walls with gates and towers, secret tunnels, various workshops, sanctuaries, temples, altars, treasure, burials, etc. (Lordkipanidze, 1991a, 1991b, 1995, 2002). Vani yielded a very rich and diverse collection of artefacts, including ceramic vessels, bronze, silver and gold ornaments and vessels of precious metals. Great attention was paid to the analysis of the various categories of archaeological material, e.g. Colchian ceramics, jewelry and Greek imports of the 6th–4th centuries BC, providing extraordinary insights into Colchian industries and relations between Colchis and the Ancient World. The findings in Vani are of special importance for studies of social structure and

stratification in the Colchian society. In short, the material from ancient Vani is the most important source of information on the history of ancient Colchis. The most unique and beautiful gold ornaments from Vani were exhibited in the leading museums of Europe and America from 2007 to 2009.

In August 2007, a hoard of bronze and iron objects was discovered in Vani (Fig. 3). The hoard was placed in a rectangular pit cut into rocky ground on the lower terrace of the site. It comprised two candelabra, dozens of spearheads, unidentified objects made of iron, four stands, four lamps, an incense-burner made of bronze. The artefacts are thought to date to the late Hellenistic period while they seem to be deposited in the mid-1st century BC, after destruction of the city (Akhvlediani, 2008; Akhvlediani et al., 2010; Kalandadze et al., 2011).

2. Study area description

Ancient Vani is situated in southern Imereti (western Georgia), approximately 40 km south-west of Kutaisi (Fig. 1). The relief is hilly and the maximum altitude of Mt Mtkhelovani, south of Vani, is 895 m a.s.l. The hills of southern Imereti, as a whole, vary within 200–600 m and 1000 m and form the piedmonts of the Ajaro-Imeretian Range. The Vani site itself is entirely situated on a hill with an altitude of 200 m. The area of the site is 12 ha. From the south it is surrounded by the relatively deep valley of the river Sakvabia, and from the west it is adjoined by the steep precipice of

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Fig. 1. Map of Georgia and site location.

the Kaprania stream. Both waterways are tributaries of the river Rioni, which is the central water artery of Colchis. The ancient terraces of Rioni are sharply defined. Geologically, the area of Vani is predominantly Tertiary, with Oligocene and Neogene layers composed of clays, marls, sandstones, conglomerates, etc. (Maruashvili, 1973).

According to the data of meteorological stations at Didi Vani and Kveda Dimi, the climate here is drier than in the more western part of Colchis, especially in the warm season (Maruashvili, 1970; Lominadze and Chirakadze, 1971). Annual precipitation in the eastern part of the study region reaches no more than 1200 mm, whereas to the west this index is 1600 mm and higher. Mean annual temperature in the lower areas is 14 °C, and 11–12 °C at higher altitudes. The average July temperature in Vani is 23 °C, and 2–4 °C in January (Maruashvili, 1970; Lominadze and Chirakadze, 1971). The hydrological network is rather well developed. Many small and larger rivers originate in the mountains of the Ajaro-Imeretian Range, including the Sulori, Kumuri, Khanistsqali and Sakreula.

The vegetation in the Vani environs is entirely secondary. In southern Imereti the high population density both nowadays and in historic times caused widespread deforestation. Unlike the Ajaro-Gurian piedmont, in Imereti the process of forest renewal was stalled by dry summer conditions (Maruashvili, 1970). The forests

around Vani are fragmented and consist mostly of hornbeam. There are mixed forests of *Carpinus*, *Quercus*, *Pinus*, *Acer*, *Fraxinus* and other species. *Zelkova carpinifolia* occurs solitarily. In the undergrowth, *Laurocerasus officinalis* and *Rhamnus imeretina* are predominant (Ketskhoveli, 1959; Nakhutsrishvili, 1999). The undergrowth is not distinguished by diversity observed in the piedmonts of the northern part of Imereti nor in the Ajaro-Gurian piedmont belt. This is a result of the area's climatic seasonality. The main crop grown in the farms around Vani is maize. Horticulture and viticulture are also developed.

3. Material and methods

In summer of 2007, during the excavation of the bronze hoard in Vani, 22 samples (50–60 gr each) were taken for palynological analysis. Some samples of the ware content were selected during restoration works. Altogether 18 samples with sufficient number of palynomorphs (on average, 350–450 palynomorphs) were suitable for analysis. Samples of modern soil and moss were also collected near the study site to enable comparison of the ancient material with contemporary conditions at Vani. For the purposes of experimental archaeology, organic remains from a modern lamp and domestic dust from a dwelling were analyzed. For each sample, the material was first boiled in a 10% KOH solution, centrifuged in a cadmium heavy liquid and finally acetolysis was performed using standard methods. Plotting of the palynological data was carried out using PSIMPOLL software (Bennett, 2005). During the investigation, 30 arboreal pollen taxa, 50 non-arboreal taxa and 28 types of non-pollen fossils were identified.

4. Results

4.1. Incense-burner adorned with three representations of an elephant head (inventory No. 07:1-07/323)

Sample No. 1 is a black organic deposit from the incense-burner decorated with three elephant heads (Fig. 4). The sample was scraped from the very bottom of the censer. Its palynological

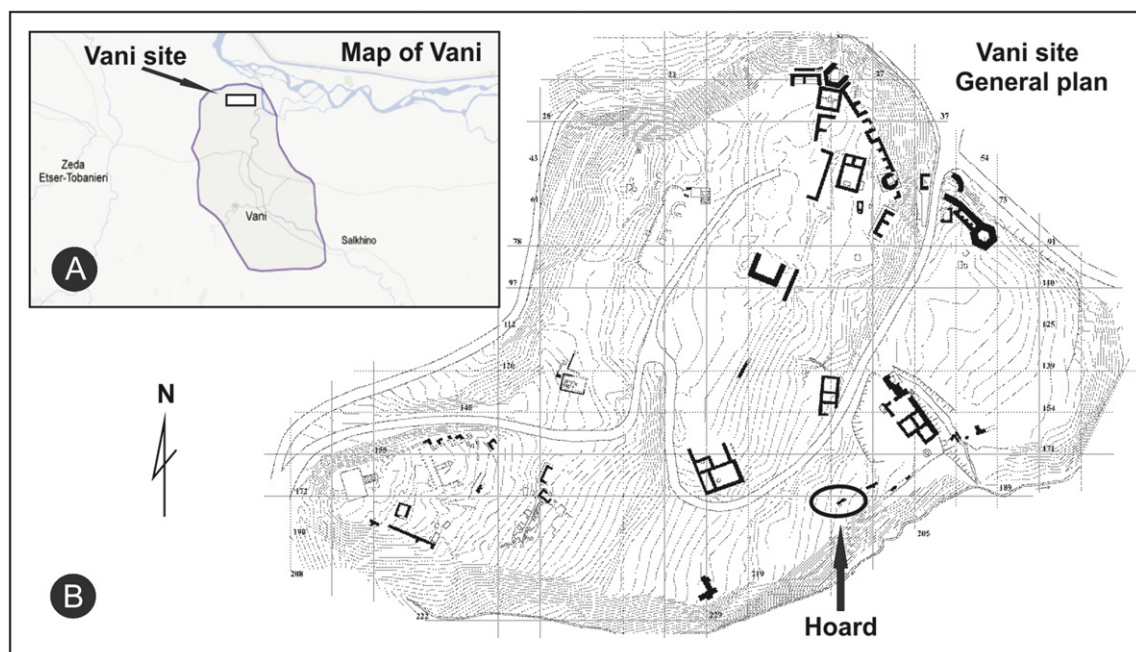


Fig. 2. Schematic map of Vani with the Vani site location (A) and plan of hoard location (B).



Fig. 3. General view of the hoard (photo G. Salniker).

content was extremely rich: 673 palynomorphs were counted, among which alder pollen and tracheal cells of various kinds of wood prevailed. Besides *Alnus* that accounts for nearly 70% of the pollen spectrum, there occur substantial quantities of *Corylus* and *Pinus* pollen (Fig. 5). *Ulmus* and *Carpinus* pollen were found in equal quantities. *Picea*, *Betula*, *Juglans*, *Quercus*, *Salix*, *Zelkova* occurred in single pollen grains. Shrub pollen included grains of *Laurocerasus* and cultural forms of *Rosaceae*. *Vitis vinifera* pollen was also found. Poaceae was the most prevalent pollen type amongst the herbaceous taxa (Fig. 6). Pollen grains of *Cerealia* also occur, and wheat pollen could be identified to the genus. *Plantago*, which is a weed of yards and ruderal habitats, is the second dominant. Among ruderal components (i.e. growing near dwellings), *Urtica*, *Achillea*, *Xanthium*, *Artemisia*, *Cichorioideae*, etc., are observed. Pollen grains indicative of cultivation and vegetable gardens occur in single grains: *Polygonum* and *Chenopodiaceae*. Fern spores including many spores of *Pteridium aquilinum* were also found.

As mentioned above, non-pollen fossils were predominantly tracheal cells of wood, including pine. The spectrum is also distinguished by large numbers of fungal spores, especially of coprophilous species such as the dung fungi *Sordaria*, *Podospora*, *Sporormiella*, *Chaetomium* and *Neurospora* (Fig. 7). The latter can grow both on dung and on wood carbonized after fire (van Geel,



Fig. 4. Incense-burner decorated with three elephant heads (photo G. Salniker).

1998; van Geel and Aptroot, 2006; van Geel et al., 2011). Textile fibres of flax and cotton were found, dyed blue and dark blue were also observed. Green algae *Spirogyra* zygospores were found. Zoological material included *Acari* remains (Kvavadze et al., 2008; Kvavadze and Kakhiani, 2010; Kvavadze and Shatberashvili, 2010).

4.2. Three nozzled lamp decorated with four figures of Eroses (inventory No. 07:1-07/327)

Sample No. 2. The lamp is decorated with bronze figures of Eroses and the lamp itself is made of bronze (Fig. 8). A dark-coloured deposit of organic material was taken from the central part of the lamp base. The spore-pollen spectra differ from those of sample No. 1 in the high quantity of *Pinus*, which is the second dominant after *Alnus*. Pollen grains of *Corylus* are found in lower quantities (Fig. 5), while *Picea* is more abundant. Broad-leaved species are represented only by *Fraxinus* and *Carpinus caucasica*. The lamp sample also contained two *Hedera* pollen grains and one *Olea* grain. Among herbaceous species, spores of forest ferns were predominant: *P. aquilinum*, *Ophioglossum vulgatum* and *Pteris cretica*. Cyperaceae pollen was also observed. Poaceae and *Cerealia* occur in rather substantial quantities. Among field and vegetable garden weeds, *Polygonum persicaria* pollen was found. Small quantities of ruderal elements, were identified. Apiaceae, Boraginaceae, Brassicaceae, *Aster* and *Artemisia* were found only as single grains.

Non-pollen fossils are represented by abundance of flax fibres, 82 in number. Cotton fibres are found in significantly lower quantities. Wool fibres are observed solitarily. Dyed fibres occur in small quantities, including blue flax and red wool fibres. There are large quantities of tracheal cells of pine wood. Many remains of green algae were found. Poaceae phytoliths occur in rather significant quantities. Fungal spores are found in low quantities and dung fungal spores were not found at all. Low amounts of insect remains were recorded.

Sample No. 3 was taken from the statuette of Eros decorating the lamp. The sample was soil adhered to the legs of the statuette. In the pollen spectrum, a predominance of *Alnus* and *Corylus* pollen is characteristic of the group of arboreal species. Among coniferous species, pollen of *Pinus* and *Abies* was found. *Ulmus* and *Tilia* pollen were the main broad-leaved constituents. *Carpinus*, *Quercus* and *Juglans* pollen grains occur in low quantities and single grains of *Pterocarya*, *Carpinus orientalis*, *Salix* and *Vitis vinifera* were observed. Among shrubs, besides *Corylus*, *Ilex*, *Rhododendron*, *Sambucus* were found. Poaceae pollen is the predominant herbaceous species. Boraginaceae, Caryophyllaceae, Apiaceae, *Aster* pollen occurred. Among weeds growing near dwellings, *Plantago*, *Achillea*, *P. aquilinum* are recorded. Spores of forest ferns were found. Non-palynological micro remains are characterised by abundance of spores of various kinds of fungi. Spores of *Sordaria* and *Chaetomii* fungi were found. There are many tracheal cells of pine wood and of other species, as well as algal remains. Zoological material is infrequent and represented by single micro remains (claws) of *Acari*. It should be noted that the studied sample contains many green fibres of flax (Fig. 9). The quantity of cotton textile fibres is low.

4.3. Lamp with an incense-burner adorned with representation of vine leaves and grapes (inventory No. 07:1-07/325)

Sample No. 4 is a porous brownish organic material with soil taken from the lamp decorated with vine leaves (Fig. 10). In palynological terms, sample No. 4 has several similarities with sample No. 1. *Alnus* pollen is most abundant, followed by *Corylus* and then *Pinus*. *Picea* pollen occurs in small quantities. Among broad-leaved species, *Carpinus caucasica*, *Tilia*, *Zelkova*, *Ulmus* and *Castanea* pollen is observed. Single pollen grains of *Ostrya*, *Olea*, *Vitis vinifera* and *Rhododendron* were found.

Vani, ancient hoard AP

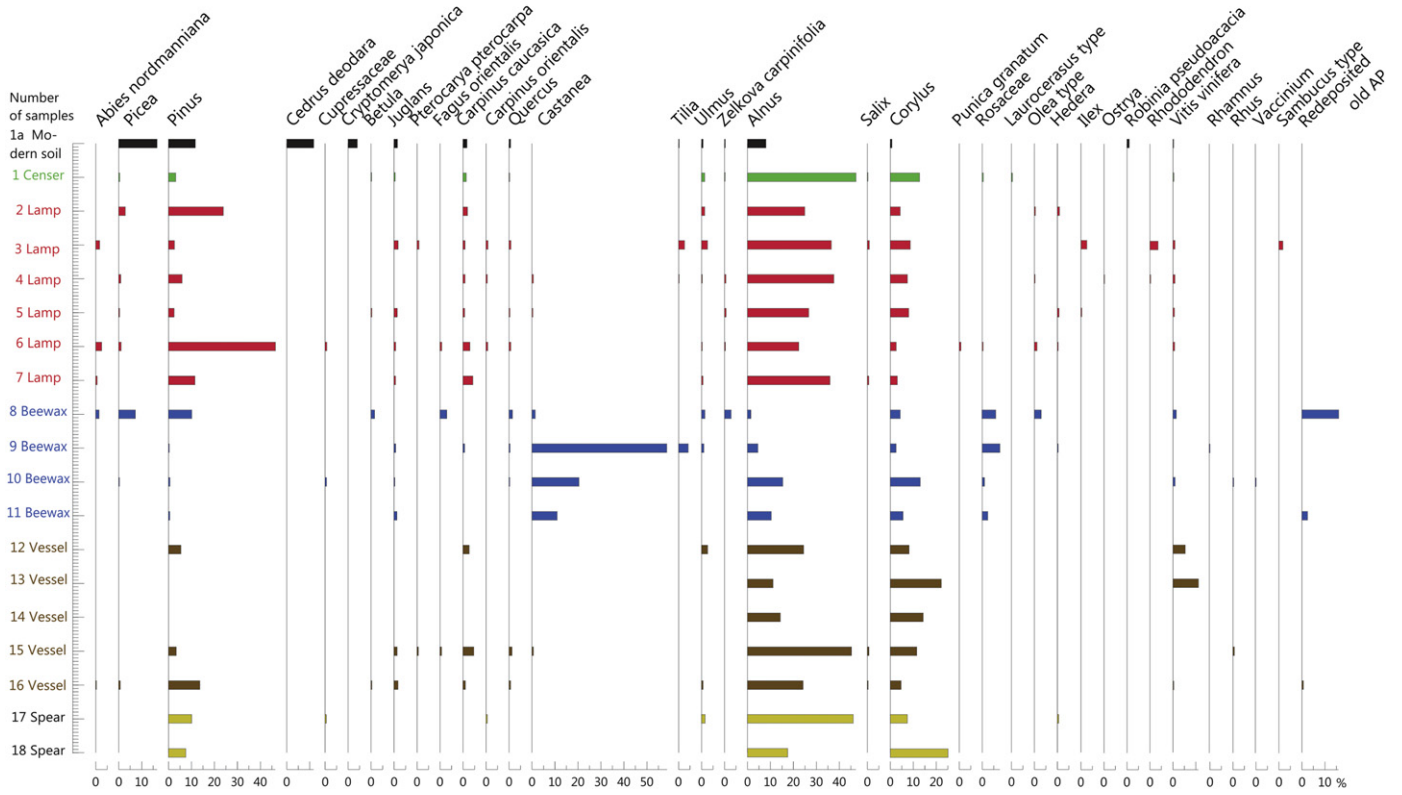


Fig. 5. Arboreal pollen diagram of organic remains from Vani bronze hoard.

Pollen of herbaceous species includes large quantities of Poaceae, but Cerealia pollen is also occur. *Triticum*, *Hordeum*, *Avena* pollen was identified up to genus. There are many weeds that accompany human habitation. They include *Plantago major/minor*, *Plantago lanceolata*, *Urtica*, *Xanthium*, *Achillea*, Cichorioideae,

Artemisia annua, etc. Spores of such ferns as *Ophioglossum*, *P. aquilinum*, *Pteris cretica* and Polypodiaceae undiff. were also found.

In the group of non-pollen fossils there are many tracheal cells of various kinds of wood, including pine. Flax fibres are second most abundant, but cotton fibres, some of them colored, occur only

Vani, ancient hoard NAP

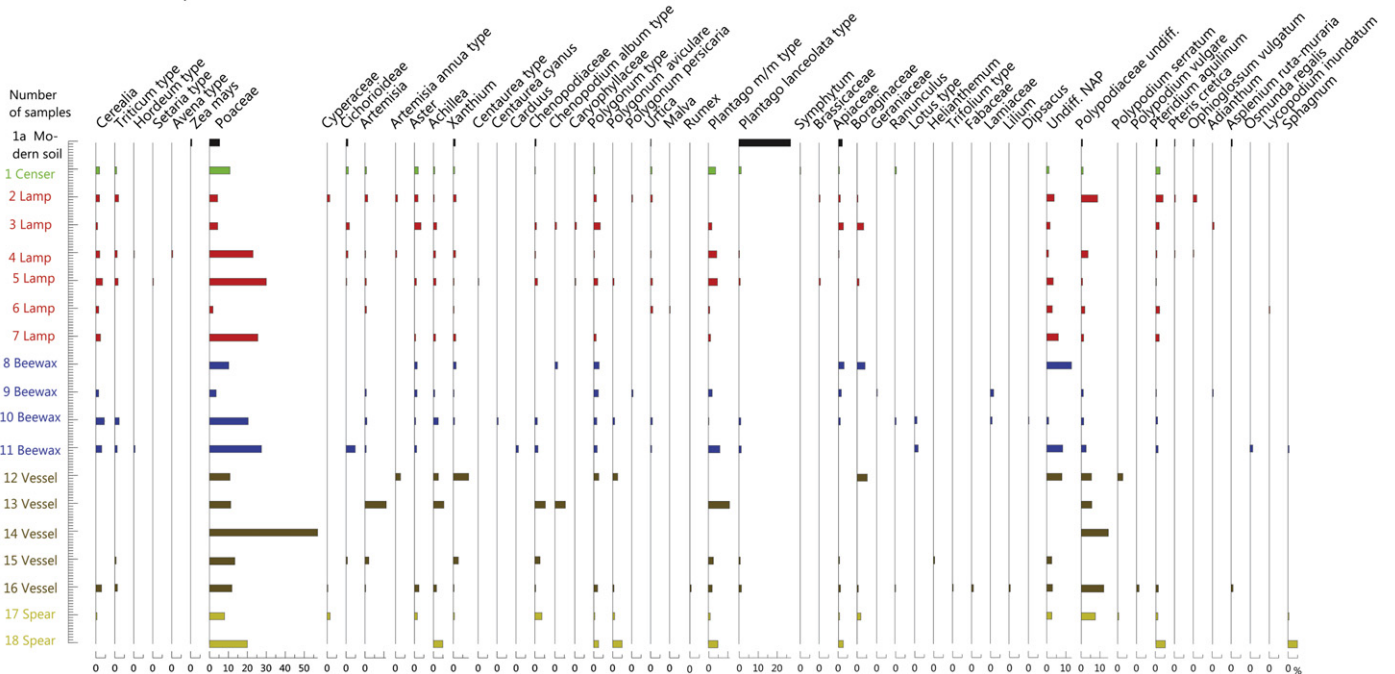


Fig. 6. Non Arboreal pollen diagram of organic remains from Vani bronze hoard.

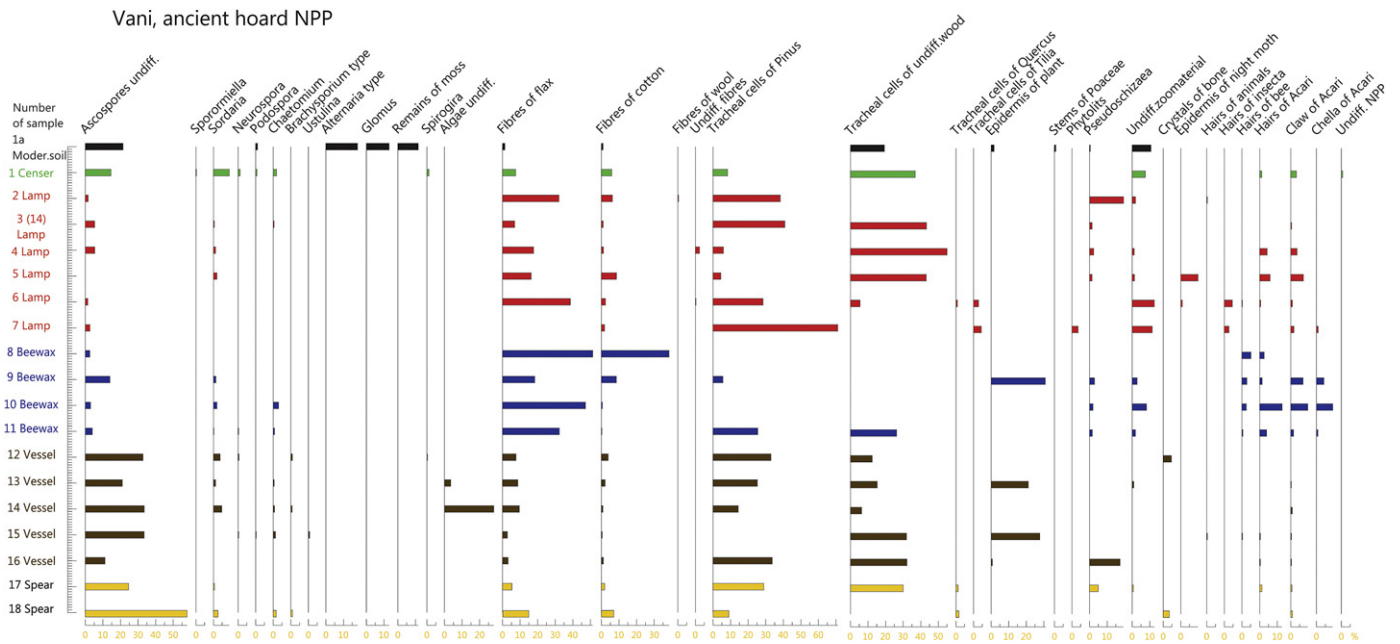


Fig. 7. Non Pollen Palynomorphs diagram of organic remains from Vani bronze hoard.

in low quantities (Fig. 11). Spores of dung fungus *Sordaria* occur in low quantities and remains of green algae were found. Zoological material is mostly represented by *Acari* hairs and claws.

Sample No. 5 was taken from the wall of the same lamp, under the porous part of the organic material. The pollen spectrum, as a whole, has the same features as sample 4; however, the complex of the group of arboreal species is richer here. Pollen of *Betula*, *Quercus*, *Ilex*, *Hedera* and *Juglans* absent in sample No. 4, was found in sample No. 5. *Sample No. 5* contains higher quantities of wheat pollen. One pollen grain of *Setaria* was found. Weeds of Cerealia fields are better represented, i.e. *Polygonum aviculare*, *Centaurea* and *Polygonum* type. However, the studied sample contains much lower quantities of forest ferns. As for non-pollen fossils, it should be mentioned that only sample No. 5 contained large quantities of moth remains found, mostly setae and epidermis. Similar remains were found during the investigation of modern organic remains of lamps.

Sample No. 6 was taken from the lamp bottom during the final restoration of the lamp decorated with vine leaves. The palynological spectrum differs strongly from the two spectra of the lamp

content considered above. Among arboreal species, coniferous taxa prevail, especially *Pinus*, which makes up about half of all the pollen counted. *Abies* and *Picea* are also abundant. Among broad-leaved species, *Carpinus* is predominant. *Quercus*, *Ulmus*, *Juglans regia*, *Olea europaea* and *Zelkova* pollen is encountered in small quantities. This sample was the only one to include pollen of *Fagus orientalis* and *Punica*. *Corylus*, *Hedera*, *Vitis vinifera* comprise the shrub and liana taxa. Among herbaceous species, spores of forest ferns are prevalent. A single *Lycopodium inundatum*-type spore was also found. Poaceae pollen is relatively infrequent, though Cerealia pollen still occurs. Pollen of plants growing near dwellings, along roads and in ruderal habitats is recorded, including *Plantago major/minor*, *Xanthium*, *Urtica*, *Malva* and *Artemisia*. A number of specific features are observed in the group of non-pollen remains. Most common are tracheal cells of wood followed by flax fibres. The third place in predominance is occupied by insect remains: moths, mites and others including bee hairs. Fungal spores occur sporadically.

Sample No. 7 consists of organic remains were scraped from the outside walls, and especially from the concave lamp base during its final restoration. In the pollen spectrum, like sample No. 4, *Alnus* pollen is predominant, but *Corylus* pollen is scarce. Instead, *Pinus* and *Carpinus* follow alder as second and third dominants. *Abies*, *Ulmus*, *Salix* and *Juglans* pollen was found in low quantities. Poaceae is predominant among herbaceous taxa. Cerealia occurred in single grains that could not be identified up to the genus level because of their poor preservation. The content of forest ferns is rather significant, for example, *P. aquilinum*. Weeds accompanying human dwellings, *Plantago major/minor*, *Xanthium* and *Achillea* are observed as well. Tracheal cells of pine wood comprise most of the non-pollen remains, but also micro remains of other kinds of wood occur. Zoological material is present in rather large quantities. Whole mites and their claws and setae were found. Among the fibres only two cotton fibres were found.

4.4. Ancient beeswax from a bronze basin (inventory No. 07: 1-07/315)

Two pieces of wax were found in a large bronze basin overturned on its stand. During excavation, the wax melted onto the



Fig. 8. Bronze lamp with Erotes (photo G. Salniker).

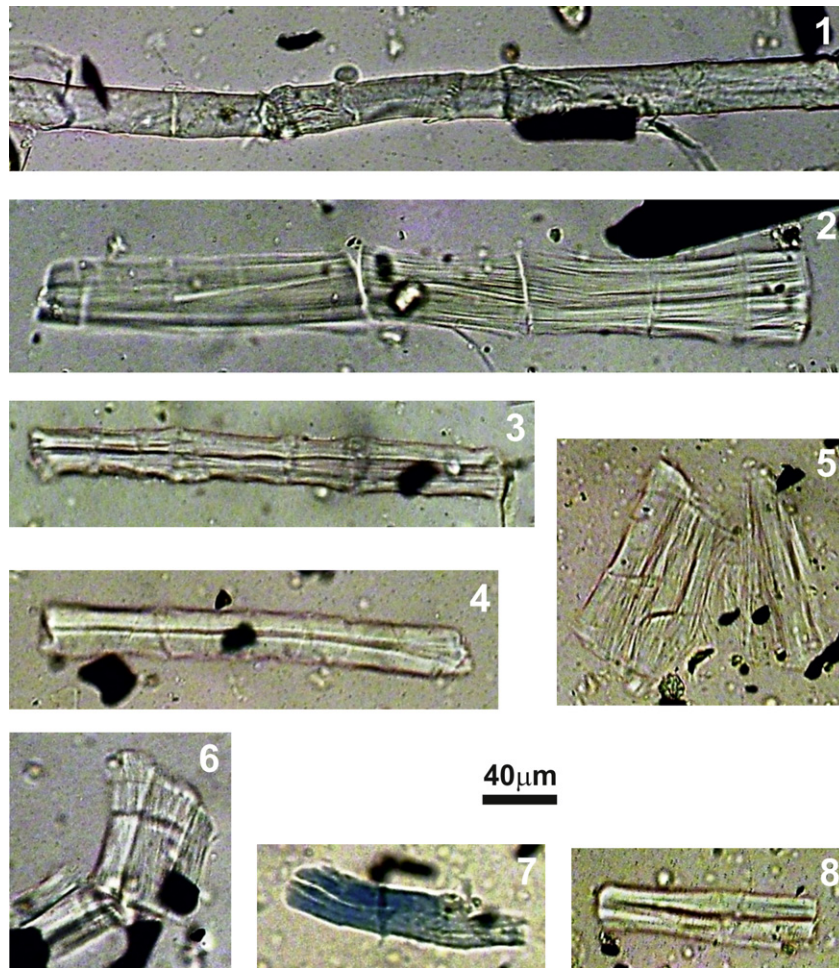


Fig. 9. The flax (*Linum*) fibres from bronze lamp with Erotes.

stand under the basin and was found in this position (Fig. 12). In some places the softened wax hung over the stand and probably trickled down into the soil, as seen in Fig. 13. The wax was generally white and its weight totaled 420 g. In places the wax was mixed with brownish organic remains and soil. Four samples from different parts of the wax were taken and studied.



Fig. 10. Bronze lamp with vine leaves (photo G. Salniker).

Sample No. 8 is pure yellowish-white wax of 20 g taken from the first piece. Altogether, 107 palynomorphs of rather pale color were found in the sample. Darker, secondary pollen comprising Tertiary elements such as *Podocarpus*, *Dacrydium*, *Cedrus*, Taxodiaceae, etc. was also found. The composition of the primary spectrum is dominated by honey plants (Rosaceae, Apiaceae, Boraginaceae, Poaceae, *Castanea*), whose pollen grains are very well preserved. In the group of non-pollen fossils textile fibres of flax and cotton are predominant. Among these, green and turquoise fibres are observed. Bee hairs and the remains of mites were also found (Fig. 14).

Sample No. 9 consists of brownish organic remains mixed with soil that occur in wax melted from the second piece. The wax fraction is higher than that of the brown organic remains. The weight of the analyzed sample was 40 g. The pollen spectrum, similar to the wax sample considered above, also consists essentially of honey plant pollen, but here the pollen concentration is higher than in sample No. 8. Among arboreal species *Castanea* pollen is the first and Rosaceae is the second dominant (Fig. 5). *Tilia* pollen was found in large quantities. Coniferous pollen is almost absent and among shrubs pollen of *Hedera* and *Rhamnus* that also are honey plants is recorded. The group of herbaceous pollen contains almost all components that are favored by bees: *Polygonum*, Apiaceae, Lamiaceae, Poaceae, *Plantago*, *Aster*, and clumps of Rosaceae pollen (Fig. 6). Flax fibres are the predominant non-pollen fossils. Cotton fibres also occur in significant quantities, some of them stained blue. Micro remains of mites are also found in

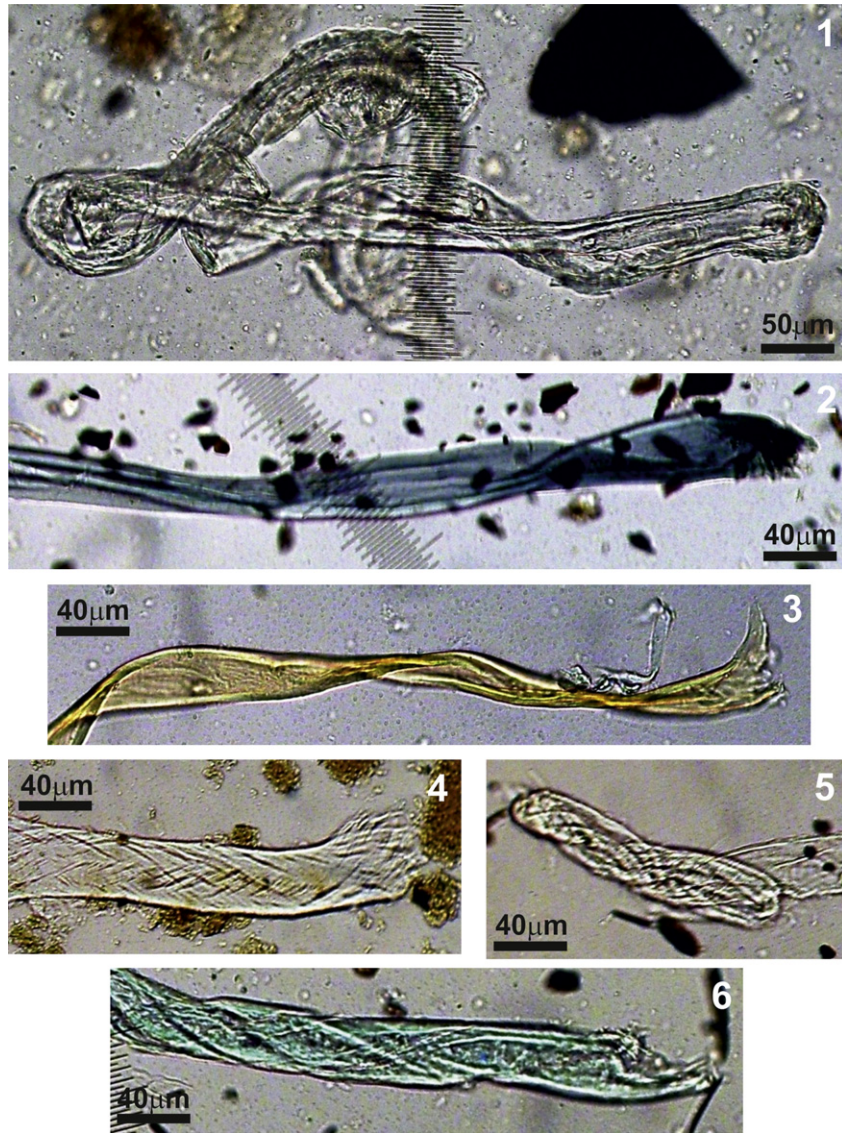


Fig. 11. The cotton (*Gossipium*) fibres from bronze lamp with vine leaves.



Fig. 12. Ancient beeswax from a bronze basin (photo G. Salniker).



Fig. 13. The beeswax over the stand (photo G. Salniker).

small amounts. In general, fungal spores including dung fungus *Sordaria*, are less common in this sample. Tracheal cells of pine wood are found in single grains. Here, as in sample No. 9, hairs of bee were revealed (Fig. 7).

Sample No. 10. This sample, as a whole, consists of soil and brown organic material adhered to the wax. The amount of wax is lower compared to the brown organics. The pollen concentration is high: 513 palynomorphs were counted. The group of arboreal pollen contains large quantities of *Castanea sativa*; the second place in predominance is occupied by *Alnus* and the third place by *Corylus*. *Poaceae* is the dominant herbaceous pollen type and Cerealia, especially wheat, is abundant. Field weeds, including *Centaurea cyanus*, *P. aviculare* and *Polygonum* that are at the same time honey plants, were found (Fig. 6). Pollen of honey plants such as Apiaceae, Fabaceae, *Plantago*, *Achillea*, *Lotus*, *Aster* and *Dipsacus* occurs in significant quantities. Redeposited Tertiary pollen of *Tsuga*, Cupressaceae, Taxodiaceae is also observed in this sample. It differs from the pollen of the primary complex by its intense, dark color. Flax fibres dominate the non-pollen remains, which some green fibres. Only one cotton fibre was observed. *Acari* remains are the

next most abundant microfossil. Bee hairs were also found, along with small quantities of *Chaetomium*, *Sordaria* fungal spores and some ascospores which could not be identified to the genus.

Sample No. 11. Like sample No. 10, this sample is a mixture of organic remains and soil stuck to the wax but taken from another part of the wax piece. In general, the pollen spectrum is the same as in the previous sample. Dominants in arboreal pollen are *Castanea*, *Alnus* and *Corylus*. In the group of herbaceous pollen *Poaceae* is predominant and many various honey herbs were found. Among Pteridophyta species there occur *P. aquilinum*, Polypodiaceae undiff., *Osmunda regalis*. In the group of non-pollen remains there are many fibres: 122 specimen in total. The role of mite remains is rather significant and bee hairs are also observed.

4.5. Bronze stand composed of fluted column erected on rectangular stand (inventory No. 07:1-07/319)

The stand is rather large and has a rectangular shape. It was located in the eastern part of the pit. Four samples were taken from the stand. **Sample No. 12** was soil adhered to the inside wall of the

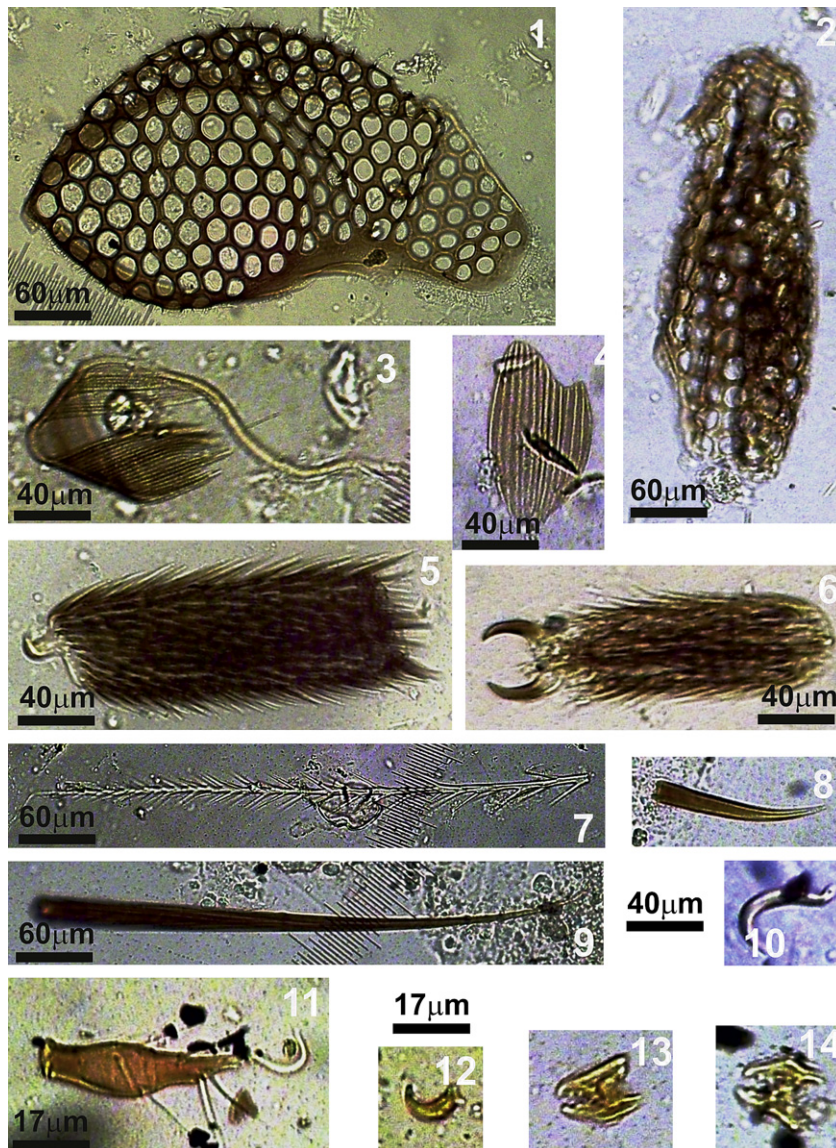


Fig. 14. Insects remains from ancient lamp: 1, 2 – eyes of insect; 3, 4 – scales of moth (butterfly); 5, 6 – legs of insect. Insect remains from beeswax: 7, 8, 9 – hairs of bee; 10 – claw of bee; 11 – tarsus and tibia of Oribatei; 12 – claw of Oribatei; 13, 14 – chela of Oribatei.

narrow part of the stand (Fig. 3). There is not much pollen in the sample, but plenty of non-pollen fossils. *Alnus* and *Corylus* are the arboreal dominants. The content of *Pinus* pollen is low. *Ulmus* and *Carpinus* occur in single grains. *Vitis vinifera* pollen occurs. In herbaceous pollen, Poaceae is predominant. There are many weeds, such as *Xanthium*, *Polygonum* type, *P. aviculare*, *Achillea*, *A. annua* type, found as single grains. Spores of forest ferns, including *Polypodium serratum*, were found. Among non-pollen fossils tracheal cells of pine wood and other species are predominant. Ascospore Type 18 is the second dominant. Spores of coprophilous fungi occur, including *Sordaria*, *Chaetomium* and *Neurospora*. Spores of the *Brachysporium* fungus (Type 360), which grows on the remains of wood, were observed (van Geel, 1998). The content of flax fibres is higher than cotton and both green and grey fibres were found. Remains of algae *Spirogyra* occurred and, in addition, some bone salt crystals were found (Kvavadze, 2008; Kvavadze et al., 2011a,b).

Sample No. 13 was taken from the wall of the middle part of the stand. Generally the pollen spectrum, presents the same characteristics as sample No. 12. The content of pollen is low, but there are many non-pollen micro remains. In the group of arboreal species, *Corylus*, *Vitis vinifera* and *Alnus* pollen was found. Among herbs pollen grains of Poaceae are recorded. Pollen of *Artemisia*, *Achillea*, Chenopodiaceae and *Chenopodium album* type is found; in Georgia the latter is a typical vineyard weed.

Among non-pollen fossils, tracheal cells of wood and spores of fungus Type 18 are predominant. Spores of *Sordaria*, *Chaetomium* fungi are found. Algal remains are found in rather large quantities. The amount of flax fibres, including dyed (green) fibres, is also significant. Cotton fibres are not numerous, but coloured fibres of rose and grey were observed.

Sample No. 14 was taken from the stand base. The pollen content is very low. Only 139 palynomorphs were counted. Among arboreal species, single grains of *Alnus* and *Corylus* were found. Herbaceous species are represented by Poaceae pollen and spores of forest ferns. However, the complex of non-pollen fossils is very rich. There are many tracheal cells of pine wood. Also fungal spores are abundant, for example *Chaetomium* and *Sordaria*. Algal remains are well represented. Flax fibres are rather numerous, including green-dyed fibres, but cotton fibres were not found at all.

4.6. Bronze basin (inventory No. 07:1-07/315)

Sample No. 15 was taken under a large overturned bronze basin in the south-western part of the pit where, as was later discovered, there were pieces of wax. The sample was taken precisely in the place where a wax piece hung from the stand (Fig. 3). The palynological analysis showed rather a rich spectrum where a total of 445 palynomorphs were counted. *Alnus* is again the dominant arboreal taxon, followed by hazel (Fig. 5). The content of pine pollen is rather significant. Pollen of broad-leaved species is mainly *Carpinus*, with some quantity of *Quercus*, *Castanea*, *Fagus*, *Pterocarya* and *Juglans*. Pollen grains of *Salix* and *Rhus* were found. Herbaceous species are represented by abundance of Poaceae. Wheat occurs in single pollen grains. *Plantago*, *Xanthium*, Chenopodiaceae, *Artemisia* pollen is abundant. Pollen of such honey plants as *Helianthemum*, *Apiaceae*, and Cichorioideae was observed. The presence of bee hairs in the sample indicates that wax formed part of its composition. The spectrum contains many spores of various fungi and tracheal cells of wood, which is typical for soil spectra. Spores of *Ustilina*, *Podospora*, *Neurospora* and *Chaetomium* fungi were found. Flax and cotton fibres were also observed, with predominance of flax fibres. Animal hair and mite (*Acari*) remains were observed, along with plant epidermal cells.

Sample No. 16 was taken on a dark spot of organic material and soil between the outer base of the basin (vessel No. 1) and the

fragment of the candelabrum in the south-western part of the pit. In sample No. 16, 589 palynomorphs were counted. Both the pollen and non-pollen remains are represented abundantly. Among arboreal species *Alnus* pollen is predominant. *Pinus* is the second dominant, followed by *Corylus* (Fig. 5). There occur *Abies* and *Picea* pollen. Secondary (redeposited) pollen of the Taxodiaceae family was also found.

Betula pollen, usually a high mountain element, is observed in this sample. Broad-leaved species are represented by pollen grains of *Carpinus*, *Quercus*, *Ulmus* and *Juglans regia*. Among shrubs, besides *Corylus*, pollen grains of *Salix* and *Vitis vinifera* are observed. Herbaceous species are also well represented, with predominance of spores of forest ferns and Poaceae. Within the Cerealia type there is a considerable amount of wheat pollen (Fig. 6). Field, orchard and garden weeds were found, but their content is rather low. Much higher is the content of pollen of a group of weeds growing near human dwellings – *Plantago lanceolata*, *Plantago m/m* type, *Rumex*, *Trifolium*, *Xanthium*, *Achillea*, *Artemisia*, and Chenopodiaceae. Interestingly, this sample contained pollen of honey plants and especially of those whose pollen is not usually preserved in soil, e.g. *Lilium* (Fig. 6).

Among Pteridophyta species, only *Asplenium ruta-muraria* and *Polypodium vulgare* were found in this sample. Spores of *P. aquilinum*, which usually grows in forest glades and clearings, were counted. Many fern spores devoid of perisporium were recorded.

In the group of non-pollen fossils, the majority are tracheal cells of wood, including pine. Significant amounts of spores of various fungi are observed. Remains of algae are found, as well as flax and cotton fibres with predominance of flax. Micro remains of *Acari* are observed in low quantities (Fig. 7).

4.7. The spearhead location (inventory No. 07:1-07/338-352)

Two samples, No. 17 and 18 were taken from two places of accumulation of spearheads (Fig. 3). They are a mixture of organic material, metal rust and soil. The pollen spectrum of sample No. 17 is very rich in all of its components. *Alnus* is once again the predominant arboreal taxon *Pinus* is the second and *Corylus* is the third dominant. Pollen of Cupressaceae, *Carpinus orientalis*, *Ulmus*, *Hedera* is observed. Poaceae is again the predominant non-arboreal taxon. Cyperaceae, Boraginaceae and Asteraceae pollen was found. Cerealia occurs in single pollen grains. Field and vegetable garden weeds are found in small quantities. The content of ruderal elements is higher. There are many spores of forest ferns and moss spores. The complex of non-pollen fossils consists mostly of tracheal cells of various kinds of wood, including pine. There are many spores of various fungi. And *Pseudoschizaea* algae zygospores are well represented (Fig. 15). Green algae *Pseudoschizaea* is representative of Zygnemataceae family and *Circulitosporite* genus and synonym of *Circuliosporites parvus* (De Jersey, 1962; Krutzsch and Pacltova, 1990). *Pseudoschizaea* grow at the edge of stream and in the ponds (Medianik et al., 2008). The amount of flax fibres is higher than that of cotton and includes some green flax fibres. The zoological material is not very rich – only micro remains of *Acari* mites were observed.

Sample No. 18. Generally, the pollen spectrum of this sample is similar to that of sample No. 17. However, the pollen content here is rather low. *Corylus* prevails in the group of arboreal pollen. There are also many *Alnus* pollen grains. *Pinus* is represented in significantly lower quantities. Among herbaceous species Poaceae pollen is predominant, but Cerealia was not found at all. *Polygonum*, *P. aviculare*, *Plantago m/m*, *Achillea* and *Apiaceae* are observed in single grains. *P. aquilinum* and *Sphagnum* spores occur as well. The content of non-pollen fossils is much higher. Spores of various fungi are predominant and spores of *Brachysporium*, *Chaetomium*

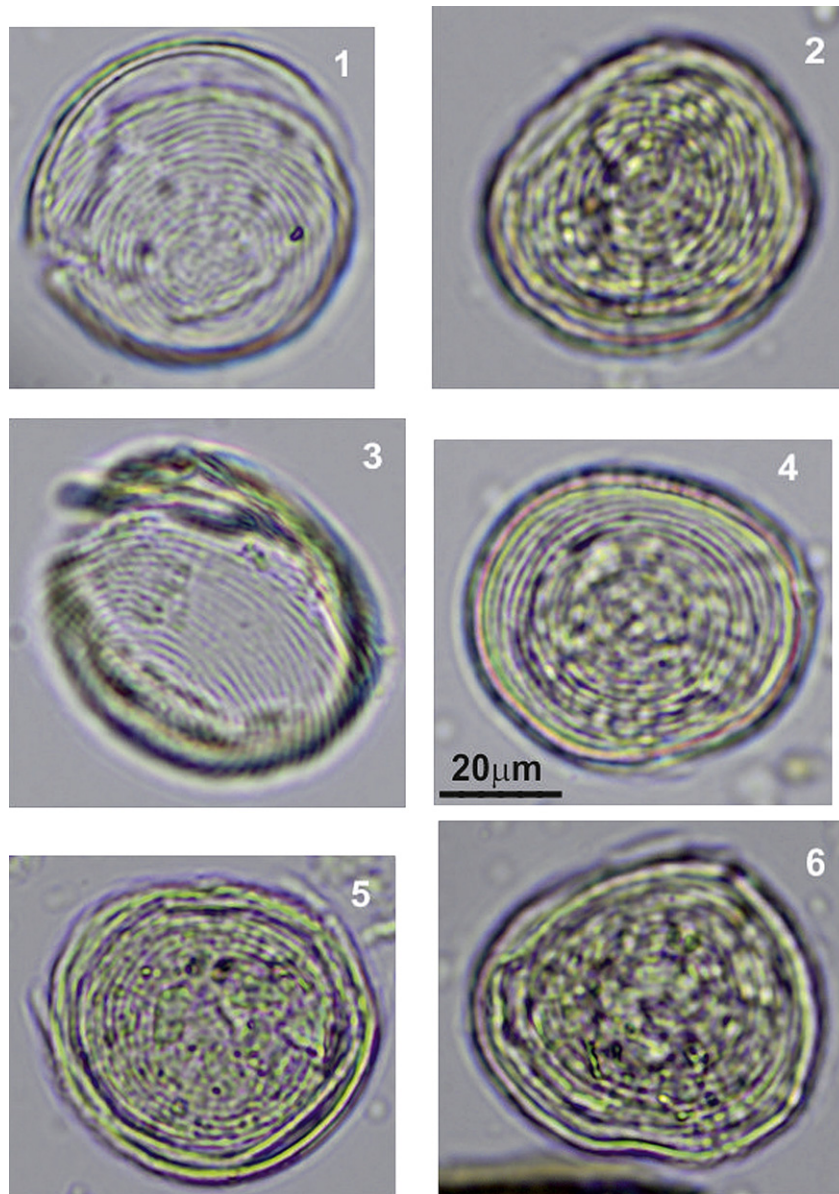


Fig. 15. Zygospores of green algae *Pseudoschizaea* (representative of Zygnemataceae family and *Circuitosporite* genus) from spear location (sample No. 17).

and *Sordaria* were identified. Tracheal cells of pine wood are observed in significant quantities. The content of flax fibres is higher, whereas cotton fibres were found in lower quantities. There are many green-dyed fibres and occasional grey cotton fibres. Also bone salt crystals (Fig. 16) and mite remains were found.

Besides the samples from the hoard itself, the samples from the bottom soil layers from the walls of the bore hole where the hoard was buried were studied by the pollen method. In the samples, there were almost no plant pollen and spores. Only isolated pollen grains of pine and alder were found. However, the spectra contained many spores of different fungi.

4.8. Pollen spectra of recent soil from Vani, human dwelling and modern lamp

Samples No.1 (=No.1a) and No.2 represent modern soil taken in a yard near the excavations. In these environs, besides gardens and vegetable gardens, big part of the landscape is occupied by maize crops. In artificial plantations there grow *Cedrus deodara*,

Picea obovata, *Cryptomeria japonica*, *Robinia pseudoacacia*, with introduced during the last two centuries. Among local plants, in the yards of piple grow *Pinus pithyusa*, *Tilia caucasica*, *Z. carpinifolia*, *Juglans regia*.

The palynomorphs concentration in the studied samples is not very high but the local vegetation is rather well represented. Among arboreal species, *Pinus*, *Cedrus* and *Picea* pollen is predominant (Fig. 17). *Cryptomeria* pollen is recorded in quite large quantities. *Alnus* pollen is numerous, representing trees that usually grows along river banks and in the gorges. *Quercus*, *Carpinus* and *Ulmus* pollen were found as well. These plants grow in the foothills of the Ajara-Imereti ridge. The spectrum contains pollen of *Juglans regia*, *Corylus*, *Vitis vinifera*, *Robinia pseudoacacia*, *Tilia* and *Zelkova* that all were spread in the gardens. The spectrum of herbaceous species is dominated by *Plantago lanceolata* and, slightly less abundant, Poaceae, including pollen of maize that grows nearby human dwellings. Further ruderal species are: *Urtica*, *Xanthium* and Cichorioideae, all growing in the yard. There are also many spores of *P. aquilinum*, which is a ruderal plant as well. Among other ferns, *Asplenium*,

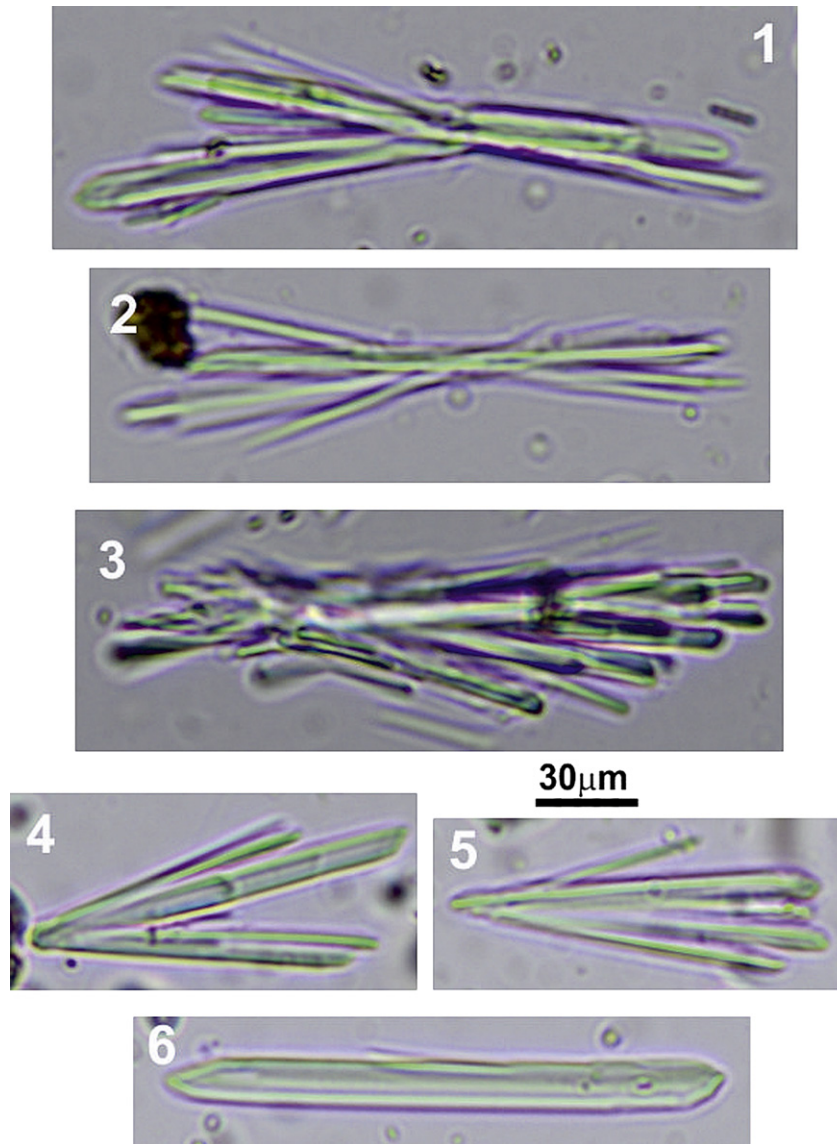


Fig. 16. Bone salt crystals from spear location (sample No. 18).

Ophioglossum vulgatum, *Pteris cretica* and perisporium-free Polypodiaceae occur. The modern complex of non-pollen palynomorphs differs strongly from the fossil spectrum. Here fungal spores are predominant, especially of *Glomus* and *Alternaria*. There are also many spores of *Tetraploa* (Fig. 18) and other non-identified fungi. Spores of coprophilous fungus *Podospora* that most often grows on cow dung were also found (Van Leeuwen, 2006). There is also *Sordaria* fungus. Beside fungal spores tracheal cells of wood are second abundant, but pine wood cells were not found. Furthermore, micro remains of mites and insects are relatively well represented. Poaceae epidermis, moss remains and stem residues were also observed as well as single micro remains of the green algae *Pseudoschizaea*. Textile fibers were found in very small quantities. In two soil samples altogether 8 flax and 9 cotton fibers including dyed ones were found. They might have got into the yard soil during linen drying, cleaning or airing of clothes.

Sample No. 3 represents domestic dust from a Vani dweller's room accumulated on the wooden floor in autumn, 2010. One-week dust was taken for analysis. The pollen analysis showed that the quantity of pollen grains was not large, since their accumulation took place in a short period of time and in a closed space.

On one glass slide with altogether 90 pollen grains brought in by wind were counted. The list of the identified plants involves 22 taxa. This is mostly the pollen of those herbaceous species that grow in the yards (Fig. 17). Poaceae is essentially predominant, including some *Triticum* pollen that might have got on the floor by flour sieving. Ruderal plants growing in the yard are also well represented with *Plantago*, *Polygonum*, *Xanthium*, *Artemisia*, etc. (Fig. 17). In the spectrum, spores of wood ferns were found as well as pollen grains of arboreal species. Here *Alnus* pollen is predominant, but also pollen grains of *Pinus*, *Cedrus*, *Carpinus*, *Quercus*, *C. sativa*, *Tilia*, *Zelkova*, *Corylus* and *Hedera* that grow rather far and were transported from a distance by wind were found (Kvavadze, 1983; Schneider, 1984; Stuchlik and Kvavadze, 1987; Kvavadze and Efremov, 1995; Kvavadze and Stuchlik, 1990, 2002; Kvavadze et al., 2009).

The quantity of non-pollen remains is much higher and amounts to 189. In this group, carbonized cells of wood probably left, by the stove fire are predominant. In the room there is a wood stove for cooking and heating. In the pollen spectrum there occur many microscopic remains of insects and arthropoda that settle in human dwellings (Figs. 18 and 19). These are, for example, moth, spider,

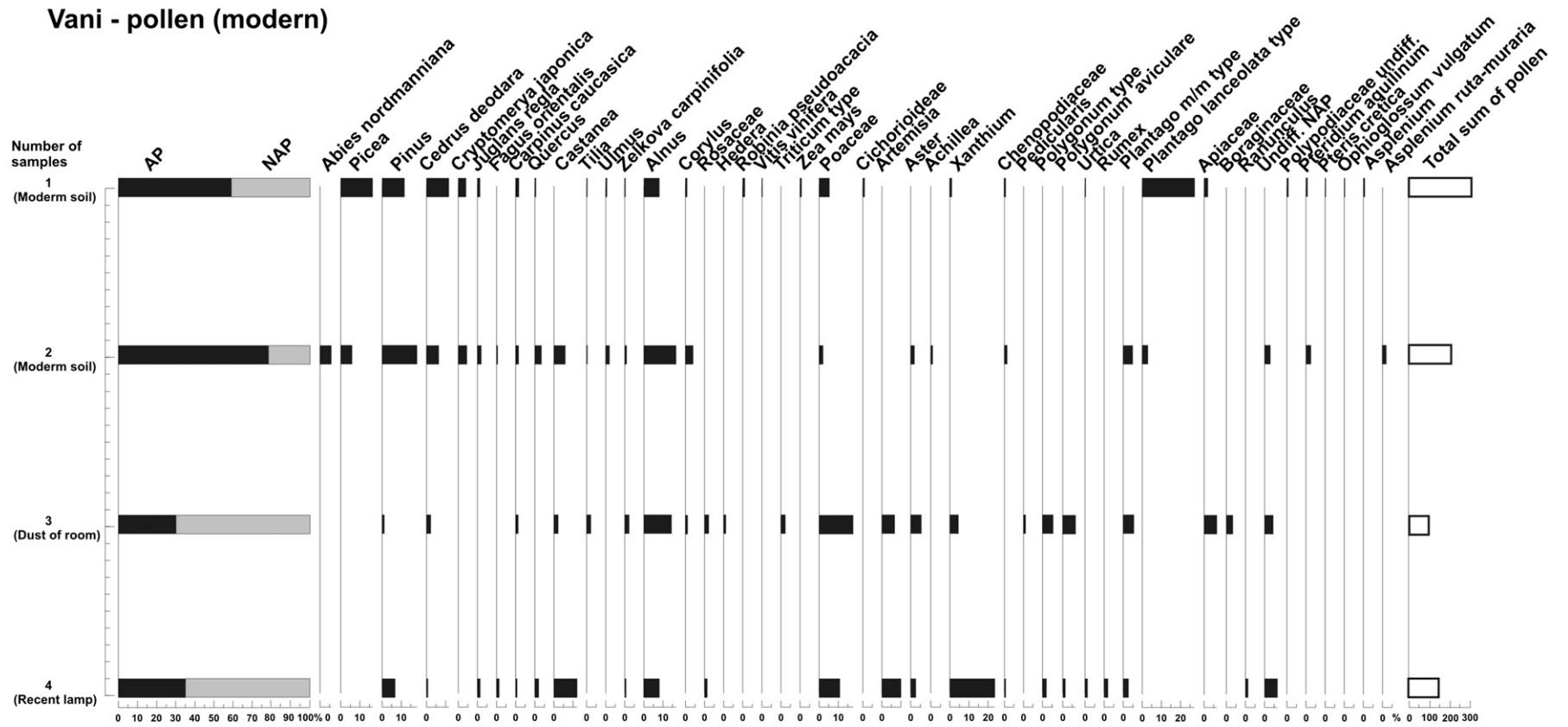


Fig. 17. Pollen diagram of modern soil, human dwelling dust and organic remains from modern lamp.

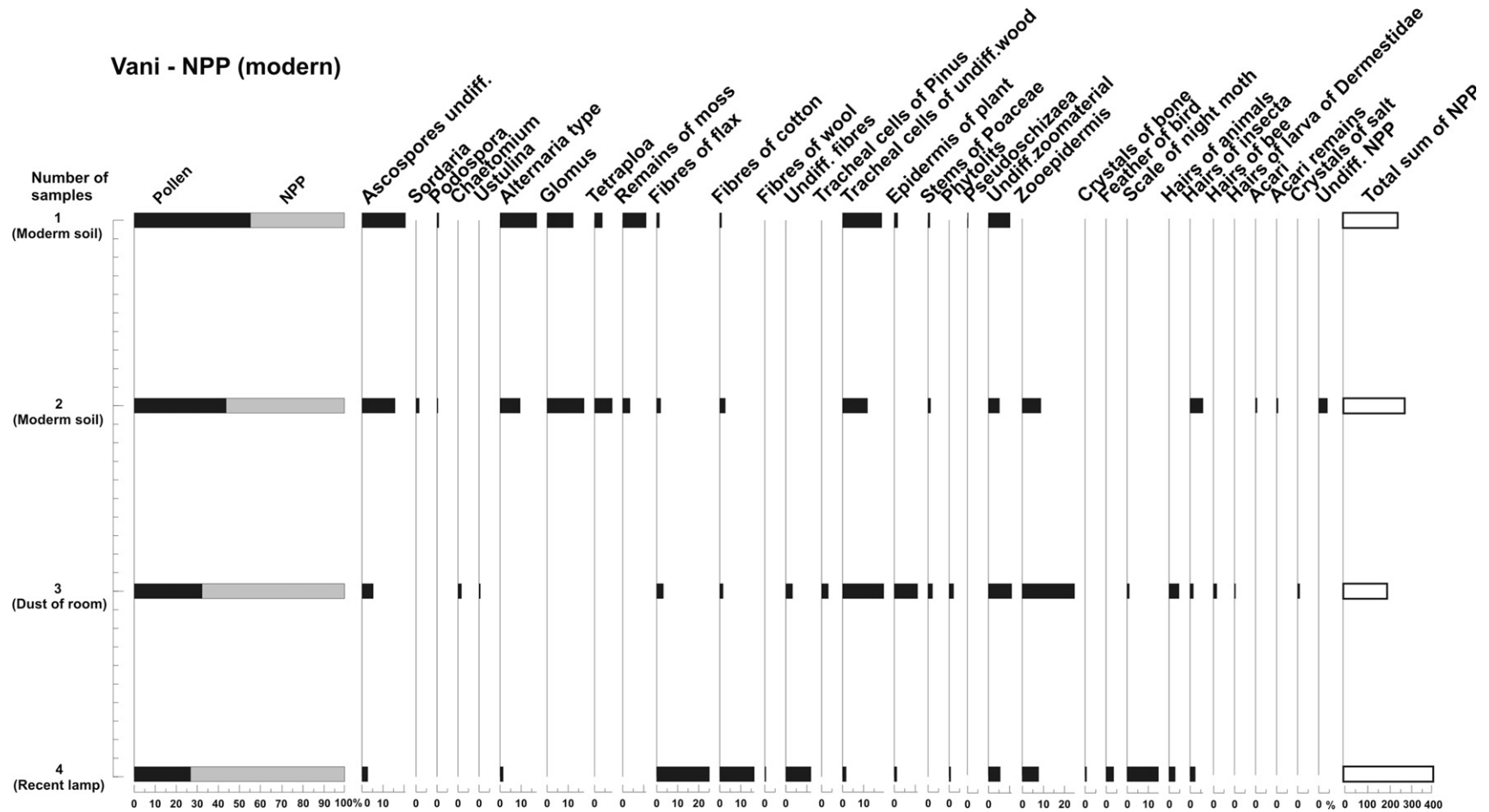


Fig. 18. Non pollen palynomorph diagram of modern soil, human dwelling dust and organic remains from modern lamp.

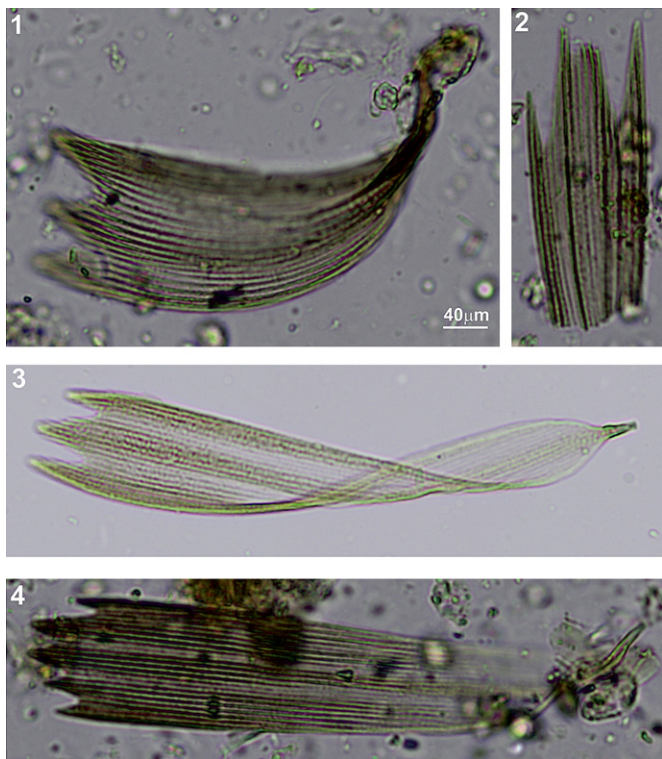


Fig. 19. Insects remains from modern lamp: 1–4 – wing scales of moth (butterfly).

dermestid beetle. Animal hairs that might belong to a cat that had lived in the living-room were found. In the spectrum, salt crystals were also revealed. Flax, cotton and unidentified textile fibers, including dyed ones, were observed. Fungal spores occur in small quantities including *Chaetomium* and *Ustilina*. The former appears in the phytogenous textile, the latter grows on trunks and might have got there with firewood.

Sample No. 4 represents pollen taken from the modern chandelier shades hanging from the ceiling of a Vani dweller's house and the dry remains of insects contained there. The shades had not been cleaned for three months, therefore here, more pollen grains were accumulated than in the floor. On one glass slide 149 pollen grains and spores belonging to 22 plants were counted. In this pollen spectrum, pollen of herbaceous species is predominant and its quantity almost doubles the arboreal pollen. There are many pollen grains of *Xanthium* that grows in the yard and along the roadsides. Other ruderal species are: *Artemisia*, *Chenopodiaceae*, *Urtica*, *Polygonum* and *Rumex*. Here no spores of wood ferns were recorded, but there are large amounts of arboreal pollen. *Castanea* pollen is predominant and there are large quantities of *Alnus* and *Pinus* pollen. *Quercus*, *Fagus*, *Carpinus*, *Cedrus*, *Juglans*, *Zelkova* and *Corylus* pollen grains were found. Among non-pollen specimen, textile fibers are predominant. There are many blue flax fibers, since here counter planes were made of blue flax textile. Cotton fibers including those dyed in different colors are also well represented, whereas unidentified textile fibers occur in lower quantities (Fig. 18). Moreover, in the pollen spectrum of the modern chandelier shade, zoological material is very important. These are mostly moth wing scales (Fig. 19) and claws, but also rather large amounts of insect setae and bird feather remains, animal hairs and other zoological material. Tracheal cells of pine wood were found and *Alternaria* fungus spores are also present.

Sample No. 5 represents the domestic dust accumulated for one month (March, 2008) in two-room flat in Tbilisi where two persons

and a dog are living. The sample was taken from the floor and from different objects. The palynological spectrum of the modern domestic dust appeared to be rich and rather large quantities of palynomorphs were counted. In the studied spectrum *Euphorbia* that grows in the flat and flowers precisely in March is predominant. However, there are large quantities of *Artemisia* and *Poaceae* pollen. *Xanthium*, *Cichorioideae*, *Achillea*, *Brassicaceae*, *P. aviculare*, *Plantago m/m*, *Plantago lanceolata*, *Chenopodiaceae* pollen grains were not numerous. *Aster*, *Sparganium*, *Triticum* were found in single grains. Generally, the studied pollen spectrum well represents the ruderal taxa growing nearby. Also arboreal taxa, pollen of *Pinus* growing near the dwelling were found as well as *Carpinus caucasica*, *Carpinus orientalis*, *Corylus*, *Quercus* and *Alnus* transported here from distant woods by the wind.

Among non-pollen remains numerous textile fibers and animal (dog) hairs were found. Cotton fibers are predominant. Flax fibers occur in relatively low amounts, whereas silk fibers were found only occasionally, which in deed reflects the real situation.

Sample No. 6 was taken in the Tbilisi two-room flat where floor dust was studied (Sample No. 5). Sample No. 6 represents the dust taken in March 2008 from the shades of a modern chandelier that is hanging on the ceiling and had not been cleaned for three months. The form of the chandelier shades is open and in the warm season, when lighted, it attracts a huge number of insects. On collision with the red-hot lamp the insects die, therefore their quantity here is very large. Here, in the pollen spectrum we find *Pinus*, *Juniperus*, *Juglans*, *Carpinus orientalis*, *Alnus*, *Xanthium*, *Saxifragaceae*, *Apium*, *Trifolium*, *Medicago*, *Chenopodiaceae*-s pollen occur in small quantities.

In the non-pollen group, zoological material is predominant. These are moth scales, setae and epidermis of insects that fly to the lamp light. It should be mentioned that the morphological structure of insects appeared to be similar to the material taken from the ancient candelabrum (Fig. 14). In the group of non-pollen remains the second place is occupied by textile fibres. Cotton dominated, but flax fibres are not numerous. In the spectrum, fungal spores, including *Alternaria* spores, are observed. Birds' feathers that might derive from the pillows kept in the room are well represented.

Thus, the analysis of the studied material shows that the pollen spectra of the soil, domestic dust and chandelier organic material are strongly different. In the modern soil spectrum there is much more arboreal pollen, and above all, fungal spores with *Glomus* and *Tetraploa* as the first dominant in the non-pollen group. At the same time, in soil the quantity of textile fibers is low.

In the room pollen spectrum carbonized cells of wood left by burnt firewood are predominant. The second place is occupied by remains of those insects and arthropoda that settle in human dwellings and fly to the light (moth, spider, dermestids, etc.). Here, textile fibers that are the microscopic remains of man's clothing and other textile objects are well represented.

In the pollen spectrum of the modern chandelier, textile fibers are also numerous, but it differs from the floor dust spectrum by large quantities of moth scales and insect setae and claws. Feather remains are also abundant. *Alternaria* fungus spores in the chandelier spectrum seem to be left by insects flying to the light as it is known that some insects (Coleoptera) use *Alternaria* fungi as food (Barjadze et al., 2009).

5. Discussion of results

The peculiarities of the pollen spectra of modern soil and domestic dust from human dwellings showed that their spectra are drastically different. In the soils of Vani like other populated places of Colchis (Kvavadze et al., 2011a,b) there are many spores of various fungi. In the soil non-pollen palynomorphs ascospores are the

first dominant. An important feature is also that the soil spectra contain small quantities of textile fibers. On the contrary, in the domestic dust from human dwelling the content of fungi spores is rather low, but here are large quantities of textile fibers (Fig. 18). Hence, we can suggest that most of the studied fossil material is not contaminated by the soil where the hoard of bronze objects was buried. Mixed with soil is mainly the material of the rectangular stand. These are samples № 12, 13, 14, 15 the spectra of which contain very high amounts of fungal spores (Fig. 7). Sample № 18 taken in the place of accumulation of spearheads is a scrape of rust mixed with earth and is also contaminated by soil. Almost clean is the material taken from lamps, wax and a big copper.

Archaeological material is rarely rich in well-preserved pollen. However, the special character of the material from the Vani bronze hoard has conserved fossils from a great variety of plants and animals. Lamp oil, incense resin and beeswax are all media favorable to the preservation of palynomorphs. Because of this good preservation, it is possible to make a direct comparison between the ancient and recent pollen spectra, shedding light on the palaeoecology, economics, and way of life and traditions of the Vani population in the first half of the first century BC.

As a whole, in the fossil material from Vani, 34 taxa of arboreal and 53 taxa of herbaceous pollen and spores were identified. In the NPP group 34 palynomorphs containing spores of various fungi, algae remains, tracheal cells of wood with many cells of pine were found. The fossil spectra are characterized by abundance of textile fibers where flax is predominant. Zoological material is also represented in substantial quantities. There can be no doubt that the studied spectra of the lamp, wax and copper material are rich, not contaminated and therefore is suitable for reconstruction of environmental conditions in the Vani environs at the beginning of the 1st century BC. The fact that the fossil spectra contain a lot of *Pinus* pollen and tracheal cells of pine wood as well as rather large quantities of *Abies* and *Picea* indicates that in the adjacent mountains the belt of coniferous species was much lower than nowadays. Our argument is also supported by the presence of birch pollen in the lamps and wax. In the Caucasus, birch is a high-mountain element and grows only in the upper forest limit. Neither the modern spectra nor the domestic dust of Vani contain birch pollen. As for large quantities of coniferous species in the modern soil spectra, this is, as mentioned above, the result of artificial plantations of *Picea*, *Cedrus*, *Pinus* and *Cryptomeria* in the yard. The climate of Vani in the first half of the first century BC was probably not only cool, but also more humid than nowadays. The presence of the remains of green algae *Spirogyra* and *Pseudoschizaea* in the lamps and on other objects can be explained by the fact that prior to burial they had been kept in a very damp, may be swamp, place. According to archaeologists, the hoard was re-buried (Akhvlediani et al., 2010). Probably, precisely due to swamping, the initial burial was re-buried in the better, more safe and dry place. The presence of the remains of green algae *Spirogyra* and *Pseudoschizaea* in the lamps and on other objects can be explained by the fact that prior to burial they had been kept in a very damp, may be swamp, place. According to archaeologists, the hoard was re-buried (Akhvlediani et al., 2010). Probably, precisely due to swamping, the initial burial was re-buried in the better, more safe and dry place. *Pseudoschizaea* are almost absent in the recent spectra. The presence of spores of such hygrophilous plants as *O. regalis Adiantum*, *Polypodium serratum* also point to humid conditions. In the recent spectra of Vani spores of the mentioned ferns were not found at all. Other moisture loving plants include, *Hedera*, *Rhododendron*, *Ilex*. They are well represented in fossil spectra, but absent in recent soil spectra. Cool and humid climatic conditions were revealed when studying the archaeological material of the Esheri settlement in the layers dated to 2100 BP (the 1st cent. BC)

(Rukhadze et al., 1988) also occupied in western Georgia. The existence of cooler conditions at that time in the western part of Georgia is observed almost on all pollen diagrams of lacustrine-bog and alluvial sediments (Kvavadze, 1982; Connor et al., 2007; Connor and Kvavadze, 2008; de Klerk et al., 2009; Connor, 2011; Shatilova et al., 2011).

It is precisely the cool and humid climate that favored the development of agriculture. The presence of Cerealia pollen in most spectra points to developed grain-growing. *Triticum*, *Hordeum*, *Setaria* and *Avena* were sown. Horticulture was also well developed and *Corylus*, *Juglans*, *Rosaceae* and *Olea europea* were cultivated. Viticulture was also present, which is indicated by frequent occurrence of *Vitis vinifera* pollen in many spectra. Though no pollen of common flax was found in pollen spectra, the significant presence of its fibres in all samples suggests that flax-growing was widely spread in ancient Vani, as described in historical sources (Lordkipanidze, 1979). Pollen of weeds growing on pastures and dung fungi spores provides evidence for developed livestock breeding.

The high pollen content in organic remains from the incense-burner (sample 1), where the highest number of palynomorphs was counted, can be attributed to the fact that it had an especially favorable medium for pollen conservation. This medium, besides bronze itself, could be the resin that is usually put into censers of large temples. Ancient resin contains plenty of pollen and is distinguished by perfect preservation, as is noted by Muller (2004). He studied the resin found on planks and beams of a shipwreck found in the eastern part of the Mediterranean and dated to the Hellenistic period. Besides pine, which prevails in the pollen spectrum, *Populus*, *Fraxinus*, *Platanus* pollen were also observed (Muller, 2004). Pollen, characterized by poor preservation was found in resin of Roman jar and in resin from an Egyptian coffin of the 2nd cent. BC (Arobba, 1976; Marriotti Lyppi and Mercuri, 1992) and in a Medieval Period wax candle from Georgia (Bitadze et al., 2011; Kvavadze et al., 2011a,b). In small globules of wax of Renaissance epoch beeswax statue pollen of *Trifolium*, *Onobrychis*, *Cytisus*, *Anchusa*, *Centaurea* was observed (Furness, 1994). Usually, these taxa are poorly preserved and are not frequently encountered in archaeopalynological material.

In the spectra from the Vani incense-burner, pollen of *Z. carpinifolia*, *Salix*, *Laurocerasus* was preserved. In Georgia, pollen grains of these taxa are poorly preserved in soil (Stuchlik and Kvavadze, 1987, 1993; Kvavadze, 1993; Kvavadze and Connor, 2005).

The presence of large quantities of various dung fungi in the pollen spectrum of the organic material from the incense-burner could be explained by the use of dung as a fuel. Naturally, coal, whose micro remains are well represented in the spectrum, was also put into the incense-burner, but carbonized dung might also have been used. Even today, dung bricks are successfully used as fuel in the mountains of Georgia and Armenia where there is neither forest nor gas available for cooking and heating.

The material from the lamps allows us to conclude that they had been used in different buildings, as indicated by the different character of their pollen spectra. For example, in the lamp with Eroses (sample 2), there are many spores of forest ferns and other elements of the forest and its undergrowth (*Hedera*, *Rhododendron*), which means that the lamp was housed very close to the forest. The lamp with vine leaves, on the other hand, had been kept in a house surrounded by cereal crops, gardens and pastures, as indicated by the large amount of cereal pollen and other anthropogenic indicators. The high content of *Vitis vinifera* pollen in the spectrum is also observed. The high proportions of *Plantago* pollen are characteristic of open pastures.

The investigation of the remains of the organic material in the lamp decorated with vine leaves showed that it had been in use for

a long time. The deepest layer of the organic material reflects quite different ecological conditions compared to the two overlying layers. During the early stages of the lamp's use, the climate was even cooler than in the succeeding periods. This is indicated by large quantities of coniferous species and especially of spruce and fir. Only on the very bottom, and only in this lamp, pollen of beech that also grows in the high mountain vegetation belts was found.

The question arises, what fabric was used to make the wick and what fuel was poured into lamps at that time. According to our investigation, a large amount of cotton fibres was found in the lamp base. Therefore, it can be supposed that the wick was made of cotton. Good absorption of cotton fibres is well known. It should be mentioned that in the last century, during wars and economic crises, kerosene lamps were widely used in Georgia. The wick was always made of cotton.

The high content of flax fibres in the samples from the lamp base might suggest that they arrived there together with oil pressed from flax. Flax fibres consist of numerous microscopic segments and during pressing they are easily broken along the lines of these segments. For example, in the vessels from the ancient settlement Esheri, flax seeds were accompanied by dust from various kinds of organic remains (Rukhadze et al., 1988; Kvavadze and Rukhadze, 1989). Later, a palynological analysis of this organic material was made, showing the presence of flax fibres. The fact that in the ancient period in Colchis flax-growing was well developed is proven not only by historical data, but also by palaeoethnobotanical material (Rukhadze et al., 1988; Bokeria et al., 2009, 2010; Kvavadze et al., 2010).

Beeswax and its palynological analysis showed that wax was in use and was poured into clay moulds for casting bronze and other metal articles. For this reason, the wax contained old pollen which was incorporated into the hot wax solution from Tertiary clay. Pollen spectra demonstrate this process clearly. The fact that wax pieces were hidden with such beautiful and precious lamps and other unique objects also indicates that, at that time, wax was an important product and was highly valued. According to Strabo, the Greek geographer, in the first century BC in Colchis, wax was produced in substantial quantities (Strabo, *Geogr.*, XI, 2, 17). Large quantities of flax and cotton fibres suggest that wax was carefully wrapped in fabric. The large basin (vessel No.1) contained pieces of wax (and from the outside base of which a palynological analysis was made – sample No. 16) which might have been used for casting. In the sample investigated, besides a pollen complex typical for wax, redeposited Tertiary pollen was found. This could have been incorporated only with the clay used for moulds. The process of making clay moulds probably took place in a foundry. During the excavations of ancient Vani, a workshop for casting of bronze statues was discovered (Gigolashvili et al., 2008).

Numerous textile micro remains suggest that the population of Vani used flax fabric extensively. Cotton articles were less common. The existence of wool fabric was also recorded. Among colored fabrics, the population of ancient Vani at that time gave preference to blue, green and turquoise colors. Red, yellow, brown and black fibers were less frequent. At that time the dyeing means might have been phylogenous and therefore stable. The fibers not only preserved their color, but also stood treatment with acids and alkalis used in the palynological laboratory. Earlier, we have carried out an experiment and established that modern different-color fibers dyed with a high-quality dye do not change their color when treated by palynological methods (Kvavadze et al., 2010; Bitadze et al., 2011).

The character of pollen spectrum of the organic material suggests that the first group (sample 17) and the second group of spearheads (sample 18) were kept in different buildings. The first building was nearer to the flood forest and the yard of the second building was an open place. The pollen spectra of sample 17 (the

first group of spearheads) show that the nearby flood forest consisted mostly of *Alnus*. It was admixed with *Ulmus* and *Carpinus orientalis*. In the undergrowth there grew *Corylus* and *Hedera*. Under the forest canopy, Poaceae, Cyperaceae, Polypodiaceae and *Sphagnum* were well represented. It might have been a swamp forest as indicated by substantial participation of remains of green algae *Pseudoschizaea* in the spectrum. Palynomorphs found here in large quantities might have been preserved due to the spearhead rust salts. Textile fibres found in samples No. 17 and 18 might have arrived there either with dust from the room where they were kept, or the spearheads were placed into textile sacks during the burial.

6. Conclusion

The simultaneous study of pollen and non-pollen fossils of organic remains from the bronze hoard in ancient Vani allowed the environmental conditions of that time to be reconstructed, based on the ecological preferences of the numerous taxa (121) identified.

The climatic conditions in Vani in the first half of the 1st century BC differed substantially from the present conditions. Mean annual, and especially summer temperatures, were somewhat lower than nowadays, therefore summer here was not particularly hot. Precipitation was much higher than today, so summer was not as dry as nowadays. It was this mild, humid climate that favored the successful development of agriculture in ancient Vani. Grain-growing, flax-growing, horticulture and viticulture were well developed.

In the landscapes of the Vani environs, besides fields, gardens and pastures, there were extensive forest stands. Along with flood-plain alder forests, hornbeam, elm and pine forests were widespread. At higher elevations, mountain coniferous forests of spruce and fir were distributed. The lower limit of the beech and coniferous forest belt in the mountains of the Ajaro-Imeretian Range was lower than it is today. Subalpine birch woodland also descended to a lower altitude.

The pollen spectra of lamps and other objects showed that they were kept in different buildings. Some of them were situated near the river bank and others near the forest. Some of the houses were situated near fields and gardens. Big pieces of wax admixed with clay indicate the development of metallurgy and, in particular, bronze casting.

Numerous textile micro remains suggest that the population of Vani used flax fabric extensively. Cotton articles were less common. The existence of wool fabric was also established. Among coloured fabrics, the population of ancient Vani at that time gave preference to blue, green and turquoise colors. Red, yellow, brown and black fibers were less frequent.

The fuel for ancient lamps from Vani might have been flax oil. For the wick, cotton fibres were used. The layers of organic material revealed in the lamp decorated with vine leaves and pollen spectra different for each layer may point to a very long history of use for the lamp. The lamps, for the whole time of their use, were kept in Vani, as indicated by the constant presence of typical Colchis elements of flora in the pollen spectra. The oil, like the incense, was also of local origin.

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We dedicate this paper to the memory of Dr. Nino Mchedlishvili, who passed away on 7 May 2011. Her contributions to palynology and palaeoecology will always be remembered. We have lost not

only a good scientist, but also a very dear friend, who always helped us in our research.

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