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PALEOECOLOGICAL DESCRIPTION OF KONSULIVKA HILLFORT AND ITS ENVIRONMENT

In the article, the first results of paleopedological, palynological and archaeological research of the Konsulivka hillfort of the 1st century BC — 2nd century AD, located on the right bank of the Dnipro River, near Respublikanets village, Beryslav district, Kherson Oblast, are presented. According to the data of interdisciplinary research, the characteristics of the ancient soil are given, and conclusions are drawn about the peculiarities of vegetation development in the area of the Konsulivka hillfort at the turn of the era.

K e y w o r d s: Steppe region, Dnipro River lower region, ancient Greek period, geoarchaeological research, paleopedological research, palynological data, pasture digression.

The Konsulivka hillfort is one of 14 hillforts and one settlement (archaeological sites of national significance) of the late Hellenistic period that emerged on both banks of the Dnipro River in the area from the beginning of the repids in the north to the beginning of the Dnipro-Buh estuary in the south (fig. 1). The first information about these sites appeared in the second half of the 19th century (Чирков 1867, с. 546-550). The first scientific description of the Lower Dnipro settlements was created by the Founder and Director of the Kherson Regional Museum (Гошкевич 1913, с. 118-133). Later, excavations of some of the settlements and cemeteries had begun (Ebert 1913, S. 80-148.; Schliz 1913, S. 148-157; Фабриціус 1930, с. 30-31). Particular interest in the settlements of the Lower Dnipro region arose in preparation for the construction of the Kakhovka Reservoir. Explorations and excavations of some of them were carried out by the staff of the Institute of Archaeology of the Academy of Sciences of the Ukrainian SSR under the direction of A. V. Dobrovolskyi. The results of the shores study of the future reservoir were published in the 1960s (Добровольський 1960, с. 141-166; Виєзжев 1960, с. 166-175; Шапошнікова 1960, с. 176-180; Бреде 1960, с. 191-204; Ветштейн 1960, с. 204-210; Вязьмітіна 1962, с. 14-21). The condition of the monuments had been monitored by the staff of the Kherson Regional Museum (Абікулова 1994, с. 78-84).

The settlements were located on the high slopes of the right bank of the Dnipro and the rocky outcrops of the left bank that looked like fortresses with walls and towers built on defensive ramparts. One of these fortresses was the Konsulivka hillfort, located on the northern outskirts of Respublikanets village, Beryslav region, Kherson Oblast. The site has been investigated by the Ukrainian-Polish Expedition of the Institute of Archaeology of the National Academy of Sciences of Ukraine (headed by DSc. N. O. Gavryliuk), the Faculty of Archaeology of the University of Warsaw (headed by DSc. M. Matera) and the National Reserve "Khortytsia". The expedition has been working at the site since 2014 and the results of archaeological research are regularly published (e.g. Matera, Nykonenko, Gavrylyuk, Lech 2022, p. 612-633).

It has been established that the Konsulivka hillfort consists of two parts: the Citadel, with an area of 0.25 hectares, and the Great Fortress, with an area of 3.5 hectares (Никоненко 2015, с. 95). Both parts are surrounded by stone walls with fortified

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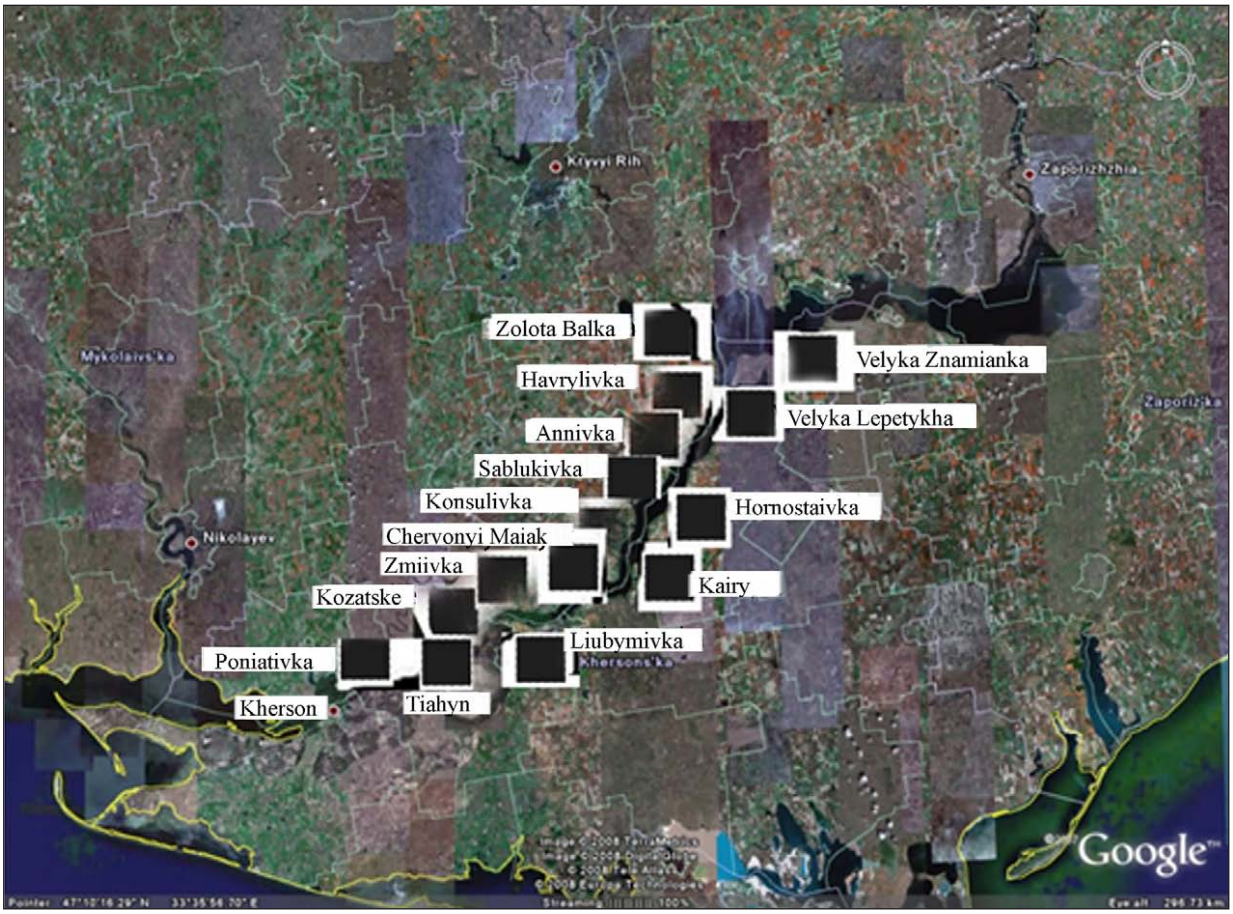

Fig. 1. Hillforts of the 2nd century BC — 2nd century AD, located on the banks of the Dnipro River before the formation of the Kakhovka Reservoir

towers without interior space. The fortress walls of both the main part of the settlement and its citadel are double-faced structures with a rubble filling consisting of medium and small stones mixed together with clay.

In September 2021, excavations were carried out in the north-western corner of the Great Fortress of the Konsulivka hillfort (fig. 2). The remains of a stone defensive wall about 2 m wide were found, which was severely damaged by modern household works. A corner entrance to the settlement was also discovered. The entrance is flanked by a stone wall, preserved in four to five layers of bedding made of roughly processed blocks of Sarmatian shell limestone, which was quarried nearby from the Dnipro terrace deposits. The height of the structure is about 1 m. In addition to the wall, the entrance was flanked by a stone tower without an interior space measuring from 3.30 m to about 4 m. This part of the fortification was built on a rampart surrounded by a moat approximately 2.50 m deep. The material from the structures is common for such monuments, which allows dating the site to the 1st century BC — 2nd century AD (Гаврилюк та ін. 2023, с. 271).

Earlier it was suggested that the purpose of the construction of the Lower Dnipro hillforts on the turn of the era and their fortification with powerful stone walls was to defend the waterway from Olbia to the northern regions of the Northern Black Sea area, inhabited by the settled population (Гаврилюк, 2013, p. 581). That is, the reason for the emergence of these fortresses was strategic, economic and connected with trade. It is not difficult to assume that, in addition to trade relations, the inhabitants of these settlements had to provide themselves with everything they needed, that is, to engage in agriculture in the form that was possible in those paleogeographical conditions. The study of these conditions at the Konsulivka hillfort has begun in the 2021 season. The paleopedological research was conducted by DSc. Zh. M. Matviishyna. During the study of soils, five samples were taken for spore-pollen analysis, which with further research was conducted by DSc. O. A. Si-

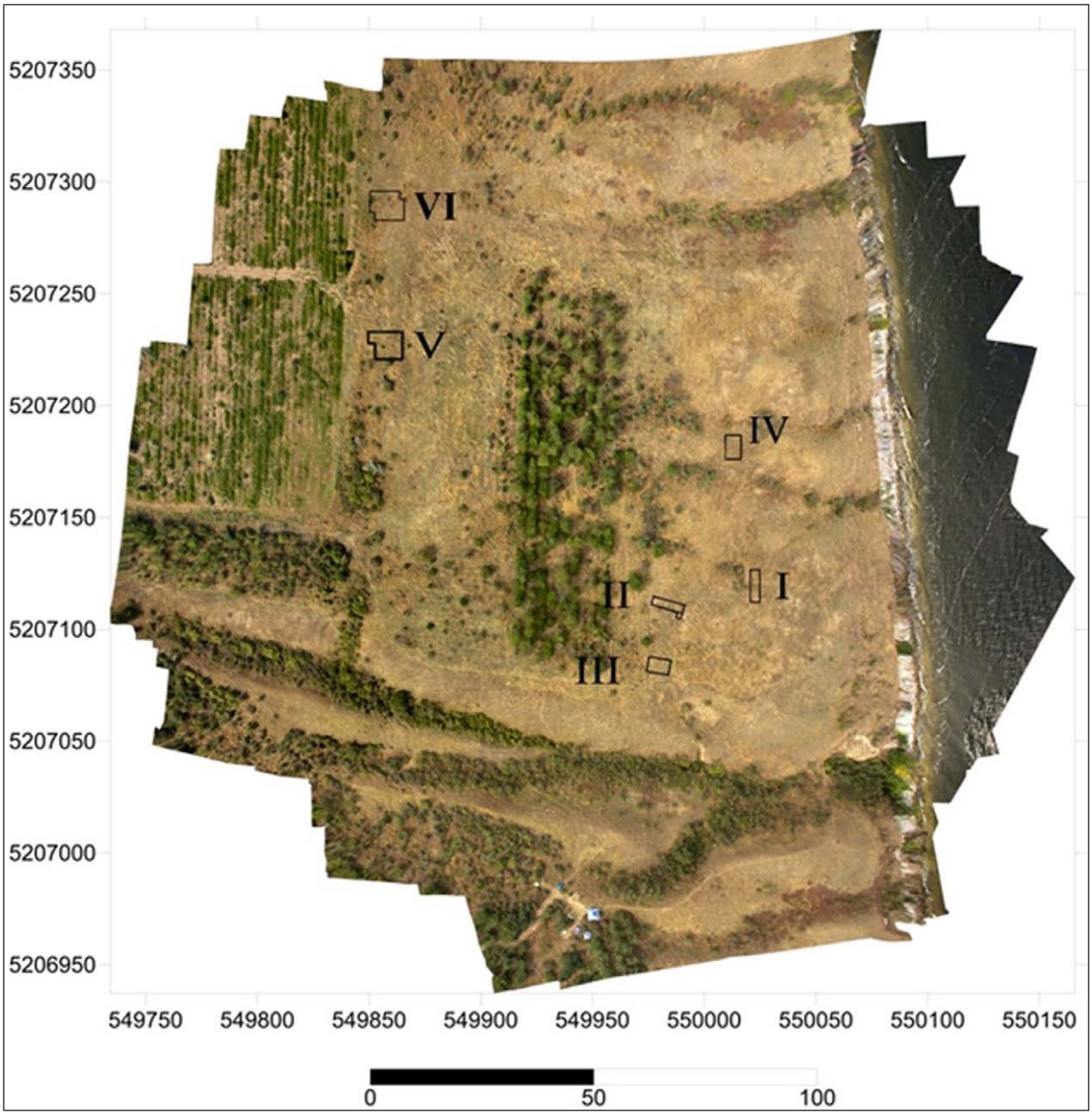

Fig. 2. General view of the Konsulivka hillfort (with the localisation of excavation sites)

renko[1]. The results are published here for the first time.

The purpose of this paper is to present the first results of geoarchaeological research (paleopedological, palynological and archaeological) in a complex and to show the prospects of such work on archaeological sites not only of the Holocene in general, but also of ancient Greek period.

Results of Paleopedological Observations

Due to the active development of the study of Holocene soils, it is possible to identify not only the intensity, but also the direction of natural processes in certain segments of the Holocene history. Not the least role in this regard was played by the scheme of stages of nature's development in the Holocene developed by M. F. Veklich (Веклич

[1] Palynological research by O. A. Sirenko was carried out in the course of the Grant of the Croatian Geological Survey and the Croatian Geological Institute: «Analysis of Neogene and Quaternary Floras of Both Croatia and Ukraine». The authors are sincerely grateful to the Director of the Croatian Geological Institute, Dr. Slobodan Miko, as well as to all the staff of the Geology Department of the Institute (Zavod za Geologiju) for their comprehensive support and assistance in conducting the research.

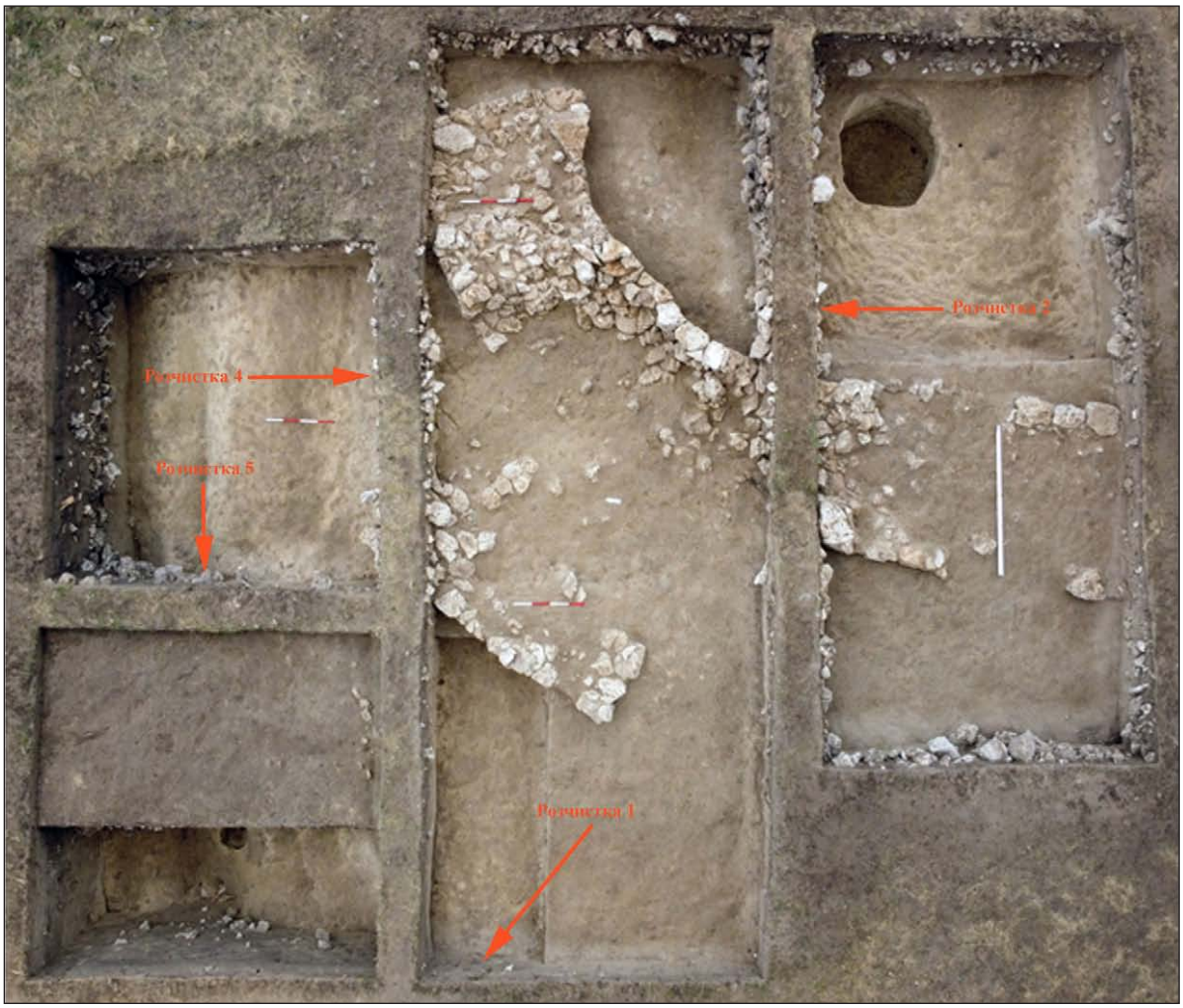

Fig. 3. Excavation site no. VI with marked places of paleopedological clearings

1987). A comprehensive study of archaeological complexes makes it possible to more accurately recreate the conditions of formation and evolution of the ancient population. In the study of the soils of the Konsulivka hillfort and its surroundings, we use the methods developed by M. F. Veklich and his followers (Веклич и др. 1979; Пархоменко, 2015, с. 16-21).

The paleopedological study of the Konsulivka hillfort was aimed at reconstructing the natural environment of the settlement's existence. The soils were studied in five clearings carried out mainly within excavation site no. VI (fig. 3). The results of the soils study in the brightest in colour two clearings no. 3 and no. 4 are presented in this paper. To distinguish paleopedological clearings from archaeological excavations we use precisely the term "clearings."

The clearing no. 3 with background soils was located 100 m west from the excavation site in a ploughed field behind a road. The level of the modern surface is 1.5 m higher than the main excavation, the relief is a gentle slope of a high terrace with a slope of 2—3 %. The type of soil is defined as a southern meadow loamy chernozem formed on loess. However, a more detailed dissection reveals two stages of soil formation, which are separated by a clear carbonate illuvium with white stars and powdery carbonates: modern surface soil and ancient soil. The level of carbonate illuvium and small limestone fragments correlates with the level of the ditch overlap with limestone blocks from the clearing no. 4, but here the body of the rampart is absent and therefore this layer directly overlies the ancient soil (fig. 4)

The clearing no. 4 with the soils of the section of the protective shaft was made in unit no. 2 on its highest part. Three levels of vertical sections are presented here: 1) the upper

Fig. 4. Clearing no. 3 (background)

level — a section of the rampart; 2) the lower level — a section of the ditch and soils in it; 3) a transition zone with a slope to the trench, where Buh River loess deposits are represented — the soil-forming material of the ancient soil. From the modern day surface, modern soil formed on the embankment and ancient soil of the 1st century BC — 2nd century AD, as well as loess rocks underlying it, can be observed. The rampart is covered by flat large blocks of Sarmatian limestone in the interval of 0.0—0.2 m from above; below are layers of modern soil formed on the embankment material; 0.0—0.8 m below the modern soil, ancient soil formed on loess (0.8—1.5 m) is clearly distinguished (fig. 5). The following layers and genetic horizons of soils were traced in the top-down clearance.

The Modern Soil of the Embankment

Hdk — 0.0—0.1 m — brownish-grey to dark gray, lumpy-dusty, light loam, loose, crumbly, transition and boundary almost horizontal.

Hk — 0.1—0.27 m — a layer with a large number of flatly placed stones 0.15—0.20 m in size of shelly Sarmatian limestone. The horizon is brownish-grey to dark grey, loose, but denser than in the overlying horizon, humified, with plant roots, lumpy-grained, with molehills of 5—6 cm in diameter with grey filling; large fragments of ceramics are found, the transition and boundary are gradual in colour and much less present in the context of large limestone blocks.

Hpk — 0.27—0.4 m — pale grey, loose when wet, somewhat compacted when dry, with a clear lumpy-grained structure, dusty light loam, includes some small fragments of limestone, with grass roots, many mole holes of 5—7 cm in diameter with material from both the horizon described and other layers. One mole hole is a habitable chamber up to 20 cm in diameter; the transition is gradual, recorded by lightened coloration.

Phk — 0.4—0.63 m — greyish-brownish-pale, well-structured, lumpy-grained, loose dusty light loam. It includes small fragments of limestone, with humus stains on grass roots, with a large number of mole holes with material from this horizon, as well as humus and Pk (grey and fawn); the transition is gradual, recorded by lightened colour.

Pk — 0.63—0.8 m — light greyish-pale, dirty, lumpy, crumbly loess-like loam, dusty, with carbonates in the form of small white specks and floury isolations. This layer contains a large number of limestone fragments of 0.1—0.15 cm in size, but with no large blocks, as in the above horizons. The transition and the boundary are almost horizontal and are marked by a distinct darkening colour. The following genetic horizons can be traced from the top to the bottom.

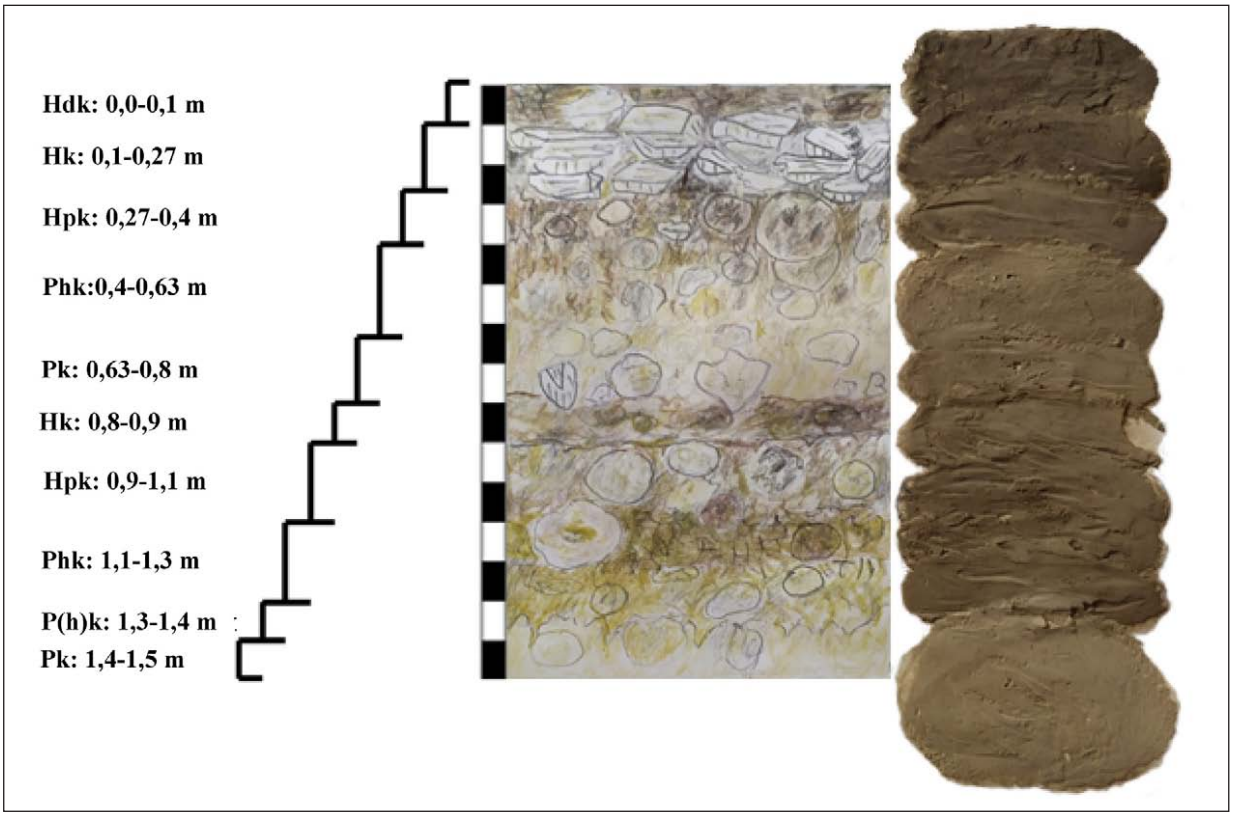

Fig. 5. Clearing no. 4

Ancient Soil of the 1st Century BC — 2nd Century AD

Hk — 0.8—0.9 m — pale light grey, weakly compacted, with a flake-lumpy structure, heterogeneously coloured with lighter spots. It has many powdery areas; $CaCO_3$ is present both inherent to this horizon and of diagenetic origin, and there are many powdery $CaCO_3$ isolations. The mole holes of 3—15 cm in diameter are filled with material from the same horizon, as well as from lower and higher layers, the transition and boundary are gradual and are recorded by slight lightening of colour.

Hpk — 0.9—1.1 m — yellowish-light grey, looser than the described above, lumpy-crumbly, dusty light loam. Mealy carbonates seep in here, and there are many burrows of various sizes, from 5 to 15 cm in diameter, filled with both dark and light (loess) material, which is the evidence of extensive activity of terrestrial animals. The transition and the boundary are gradual and recorded by some greyer and browner shades of the material colour and its greater density.

Phk — 1.1—1.3 m — yellowish pale-brown, weakly compacted lamellar-lumpy light dusty loam, mass cemented with carbonates, boils with HCL, many mole hills with dark grey, brown and pale colour, the transition and boundary are gradual and are recorded by the lightening of the colour. The stratum contains a mole-housing chamber and isolated limestone boulders. The transition and boundary are gradual and are identified by the lightening of the colour.

P(h)k — 1.3—1.4 m — brownish pile-like loess-like material, loose, crumbly, dusty light loam with a large number of molehills, impregnated with carbonates, transition and boundary are clear, and are recorded by colour lightening.

Pk — 1.4—1.5 m — beech (bg) loess — whitish-paler, light, uniformly coloured, but with a large number of mole hills, carbonate-impregnated powdery dusty light loam. Up the slope to the trench with a grade of about 20°, a vertical section of up to 2.20 m shows a whitish-palmy loess, which is the soil-forming rock for the antique soil.

Thus, in the clearing no. 4, the ancient soil was preserved. Unlike the surface soil, it is characterised by a lower humus content, although soil-accumulative processes prevailed at that time, but it was formed in a shorter time and is more evenly humified. The soil has a well-defined Pk (already in the bg loess), but at a shallower depth than the modern soil. The peculiar-

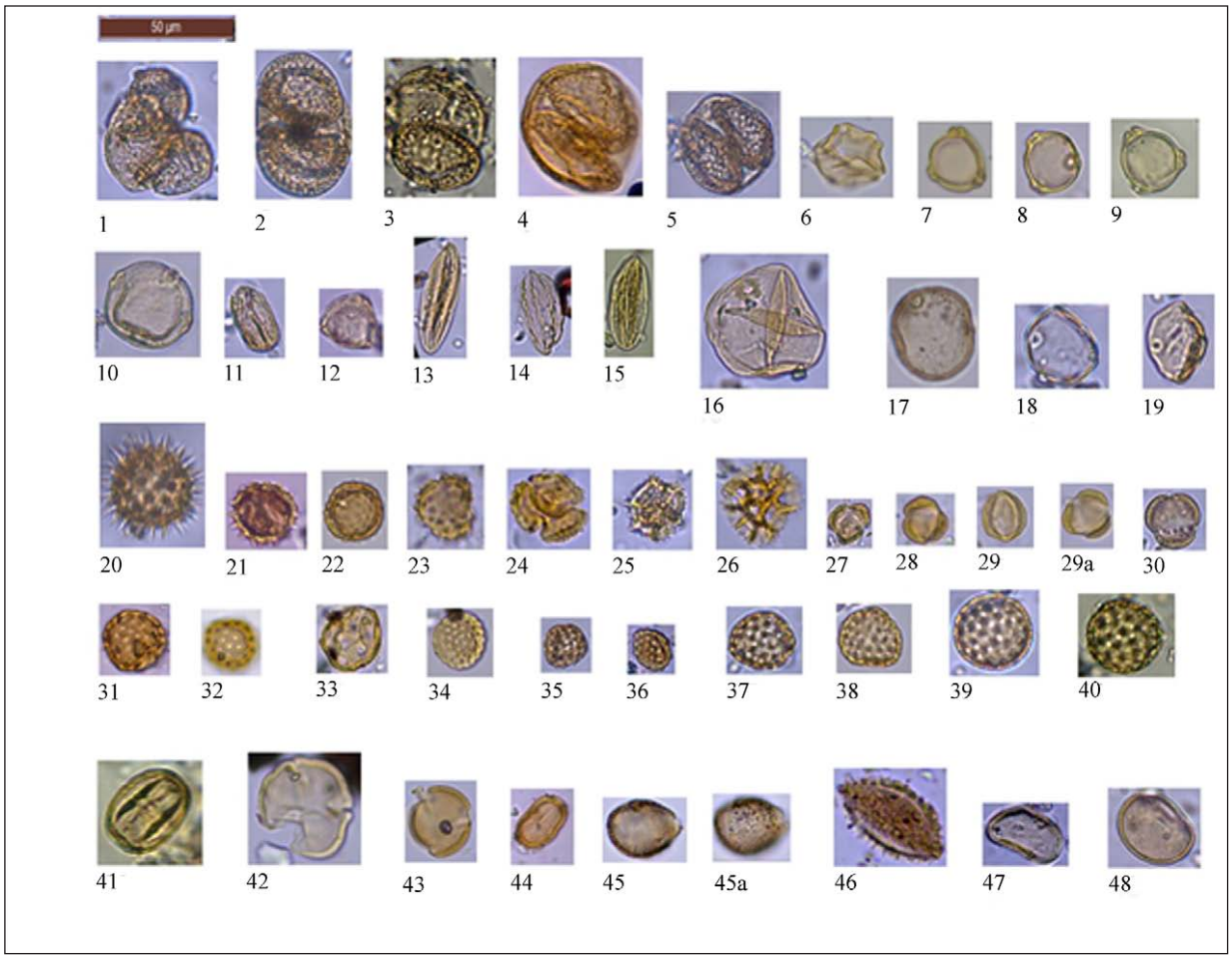

Fig. 6. Pollen and spores from Holocene sediments of the Konsulivka hillfort: *1—5* — *Pinus* spp.subg. *Diploxylon* Koehne; *6* — *Alnus* sp.; *7—9* — *Betula* spp.; *10* — *Carpinus* cf. *betulus* L.; *11* — *Quercus* cf. *robur* L.; *12* — *Corylus* cf. *avellana* L.; *13—15* — *Ephedra* spp.; *16* — *Cerealia* (Poaceae); *17—19* — Poaceae; *20—24* — Asteraceae; *25—26* — Cichoriaceae; *27—30* — *Artemisia* spp.; *31—40* — Chenopodiaceae; *41* — Polygonaceae; *42* — *Linum* cf. *usitatissimum* L. (Linaceae); *43* — Lamiaceae; *44* — Fabaceae; *45—45a* — *Typha* sp.; *46* — Nupharaceae; *47—48* — Polypodiaceae

ity of the ancient soil is the presence of a slightly denser brownish-palace horizon cemented by karst at the base, and it is possible that the soil was originally formed as forest, and then during the main time the conditions changed to dry steppe. The ancient soil is close to the chestnut soils of modern Ukraine, but differs from the modern background soil in its shorter profile (its thickness is 0.7 m, and the modern background soil is 1.0 m), it is secondarily carbonised due to the leaching of carbonates from the surface soil and the strata beneath it. The ancient soil corresponds to drier soil formation conditions (southern variations of dry steppe).

Results of Palynological Observations In the clearing no. 4, five samples of K-30/21, K-31/21, K-32/21, K-33/21, K-34/21, K-35/21, K-36/21 were taken from the ancient soil (table 1).

The maceration of the samples was carried out in the laboratory of primary processing of the Croatian Geological Institute with the assistance of Dragica Kovačić. The analytical work and photographs of palynomorphs were performed using a Leica MC190 HD camera connected to the Leica LAS EZ software, which was kindly provided to us by Dr. Koraljka Bakrač.

Maceration was carried out according to the methodology that was chosen at the previous stage of experimental research on the study of sandy rocks and included the following steps: treatment of 100 grams of rock in 40 % HF decantation with distilled water-treatment with 18% HCl (seven minutes of boiling in a glass beaker on a tile) — decantation with distilled water-treatment with 10 % KOH (seven minutes of boiling in a glass beaker on a plate) — decantation with distilled water-treatment of the precipitate

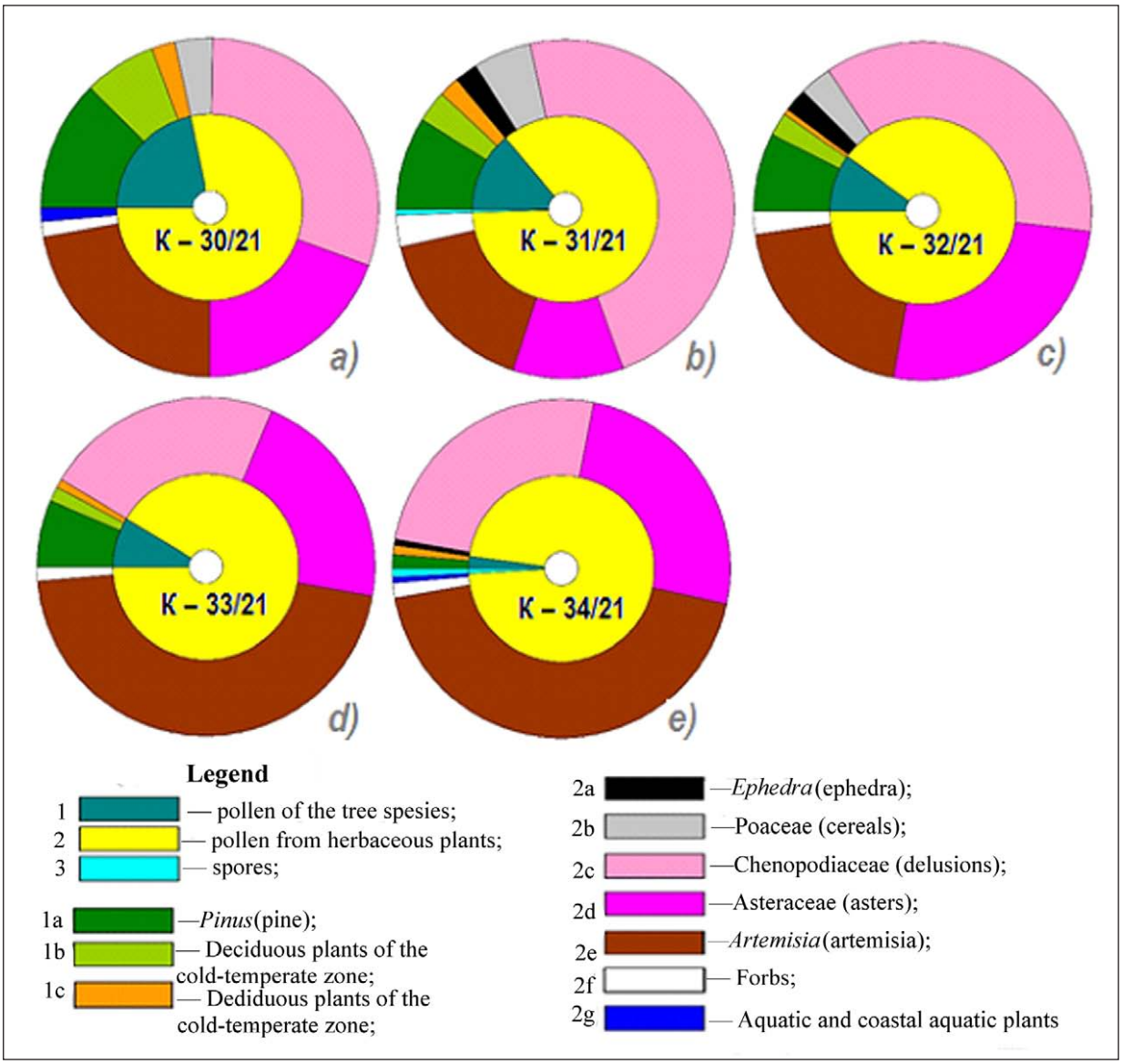

Fig. 7. Spore-pollen spectra from *Holocene* soils and sediments of cultural layers from the ancient site of Konsulivka hillfort: *a—e* — codes and results of samples analysis K-30/21, K-34/21

with HCl (rocks poured overnight without boiling) — decantation with distilled water — two-step separation in heavy liquid ZnCl.

We obtained a sufficient amount of pollen and spores to quantify the taxa in the spore-pollen spectrum. For each sample, five to eight preparations were studied. From 135 to 162 pollen grains and spores were counted from the macerates of each sample. When calculating the percentage of palynomorphs, the sum of all pollen grains and spores identified, excluding algae, was taken as 100 %. The content of each taxon was calculated from this amount. Pollen and spores were identified according to the Engler classification system.

The Main Results of Palynological Studies. (fig. 6) The spore-pollen spectra of samples nos. 30—31 are similar in composition and dominant pollen of herbaceous plants. A distinctive feature of these spectra is the highest content of woody pollen in the spectra (21.6—13.8 %), as well as its taxonomic diversity. The highest content of wood pollen was recorded in the spectrum of sample no. 31. Pollen of *Pinus* sp. subg *Diploxylon Koehne* dominates in the spectra (12.6—9 %). Deciduous plants of the temperate zone are represented by *Betula spp.* pollen (6.8—2.4 %), and single pollen grains of *Alnus* sp. (0.6%). The group of deciduous plants of the temperate zone is represented

by *Quercus* cf. *robur* L. (0.6 %), C*arpinus* cf. *betulus* L., *Carpinus* sp. (1.5—0.6 %), *Corylus* cf. *avellana* L., *Corylus* sp. (0.7—0.6 %). Shrubs are represented by *Ephedra* sp. pollen (2.4 %). The study of the macerate of the sample no. 31 revealed one Juglans pollen grain without obvious signs of redeposition.

At this stage of the research, we did not include it in the spore-pollen spectrum, but we consider it necessary to note the fact of its discovery. Pollen from herbaceous plants makes up to 78.4—85.6 %. This group is dominated by pollen of Chenopodiaceae (30.3—47.7 %). The pollen grains of *Artemisia* spp. act as a subdominant (22.3—16.5 %), somewhat less pollen of Asteraceae, including Chichoriaceae (19.3—10.5 % in total). The spectra of these samples are also distinguished by the highest amount of Poaceae pollen (3.7—5.5 %), as well as its most Single pollen of Fabaceae, Lamiaceae, and Polygonaceae was also traced in the spectra. The group of aquatic and coastal plants is represented by the pollen of *Typha* sp. Single spores belong to Polypodiaceae. Freshwater algae are also found.

The spectrum of the sample no. 32 differs from the above-described ones by a further decrease in the amount of tree pollen (up to 10.3 %), as well as a decrease in their taxonomic diversity. In addition to *Pinus sp*. subg *Diploxylon kohene* (7.4 %), which dominates in this group, *Betula* spp. pollen (2.2 %) and one *Quercus* pollen grain were identified. The pollen of *Ephedra* sp. is 2.2 %.

Compared to the previous spectra, the dominant group of herbaceous plants (89.7 %) has not changed — Chenopodiaceae (36.4 %). Among the subdominants, the second place belongs to Asteraceae pollen (26 %), slightly less to *Artemisia* spp. pollen (20 %). Single pollen grains of other herbaceous plants belong to Fabaceae and Polygonaceae. Spores were absent. Freshwater algae were noted.

The spectra of the samples nos. 33 and 34 differ from the previous ones in the impoverished taxonomic composition of both woody and herbaceous pollen, as well as in the change of dominants among herbaceous pollen.

Wood pollen makes up to 8.6—2.8 %. The smallest amount of it was recorded in the spectrum of the sample no. 34. Among this group, the pollen of *Pinus* sp. subg *Diploxylon kohene* dominates (6.5—1.4 %). It is worth noting the very poor preservation of pollen from the macerate of the sample no. 33. Pollen of *Betula* spp. is included in the spectrum of only the sample no. 33 (1.4 %). Single pollen grains of *Quercus* cf *robur* L. were also recorded.

Pollen of herbaceous plants makes up to 91.4—97.2 %. In contrast to the previous spectra, pollen of *Artemisia* spp. dominates in this group (45—44 %). Pollens of Chenopodiaceae (22.9—25.2 %) and Asteraceae (21.4—25.2 %) are in approximately equal proportions. Pollen of Poaceae was not recorded. Single pollen grains of Euphorbiaceae, *Linum* cf. *usitatissimum* L. (Linaceae) and Lamiaceae were identified. The group of aquatic and coastal-arid plants is represented by a single pollen of Nupharaceae. The spore (spectrum of the sam-

Table 1. **Results of palynological, paleopedological and archaeological research from the clearing no. 4 of the unit no. 2.0.08**

Code of the palynological samples	Names of the soil	Paleopedological stratigraphy	Archaeological stratigraphy
	(Hk, Phk)	III period — 0,1—0,63 m	I — 0,32—0,81 m
		II period — 0,63—1,1 m	III — 0,29—0,81—1,40 m
K – 30/21	H_k	0,8—0,9 m	
K – 31/21	Hpk	0,9—1,1 m	
K – 32/21	Phk	1,1—1,2 m	
		I period — 1,1—1,5 m	IV — 0,46—1,46
K – 33/21	Phk	1,3—1,4 m	
K – 34/21	Pk — (bg?)	1,4—1,5 m	

ple no. 34) belongs to Polypodiaceae. Freshwater algae were also noted.

The materials at our disposal at this stage of research make it possible to reconstruct the composition of the vegetation cover during soil formation.

The analysis of the established spore-pollen spectra, as well as the cyclograms of the ecological structure of spore-pollen spectra (fig. 7), indicates that steppe landscapes dominated within the study area during soil formation. The appearance of pollen of hygrophytes and freshwater algae in the specified territory may indicate the existence of nearby freshwater reservoirs, or that the territory was periodically flooded by river waters. At the same time, the vegetation of the periods of formation of individual horizons of the studied ancient soil was probably somewhat different.

The vegetation of the time of sediment formation in the 1.5—1.4 m interval was the most depleted (fig. 7). Perhaps at this time, only herbaceous coenoses dominated, the main component of which was various *Artemisia. C*henopodiaceae and Asteraceae were subdominant. The steppe communities also included representatives of the Euphorbiaceae family and the *Linum* genus *(Linaceae)*. Tree species were probably not part of the vegetation at all. This is evidenced by the amount of tree pollen (2.8 %) and its belonging to plants of the genera *Pinus* and *Quercus*. This pollen can be transported by wind over long distances. The plant communities of the time of sediment formation in the interval of 1.4—1.3 m was also characterised by a small diversity. The composition of herbaceous communities of this time was almost identical to the previous interval. The nature of the dominants also did not change (fig. 7).

Subsequently, the dominants of herbaceous communities changed (fig.7). In particular, during the formation of sediments of the 1.2—1.1 m interval, various Chenopodiaceae had become the main component of herbaceous communities, with Asteraceae and Artemisia acting as subdominants. Since pollen of woody plants played an insignificant role in the spectra (10.3 %), it could be considered an invasive species.

At the same time, given the clear trend of increasing the number and taxonomic diversity of tree pollen from spectra from the lower soil layers to those from the upper ones, we consider it legitimate to assume the existence of separate tree communities with pine, birch and oak along the river terraces. The number of these communities increased from the time of formation of the Phk horizon to the time of formation of the Hk horizon (fig. 3). In particular, during the formation of the Hpk and Hk horizons (samples nos. 31, 30) within the study area, there were separate small woody communities on lowered relief elements, which, in addition to *Pinus* and *Betula*, included *Alnus*, *Carpinus, Quercus,* and *Corylus*.

The herbaceous communities, in addition to the dominant Chenopodiaceae, consisted of Asteraceae and *Artemisia* with minor participation of forbs. Regarding Poaceae pollen, numerous studies by palynologists have established that the participation of Poaceae pollen in subfossil spore-pollen complexes of the steppe zone is underestimated compared to their participation in the modern vegetation cover (Зубець 1971; Безусько Л. Г., Мосякін, Безусько А. Г. 2011). Taking into account these data, Poaceae are included in the dominant complex if their content in the subphosphorus complex was greater than or equal to 5 %. Therefore, we can include Poaceae only in the dominant vegetation complex of the time of the Hpk horizon formation. The presence of *Triticum* sp. (wheat) in the spectrum may be an evidence of the development of agriculture within the area under study. During the formation of the Phk and Hk horizons, the herbaceous communities probably included only single Poaceae, and during the formation of sediments at depths of 1.4—1.3 m and 1.5—1.4 m, Poaceae were not included in the vegetation at all.

Since *Ephedra* pollen is not recorded in all spectra and accounts for less than 10% (according to: Безусько Л. Г., Мосякін, Безусько А. Г. 2011), it cannot be included in the dominant complexes. It is likely that single *Ephedra* were part of the steppe cenoses at the time of formation of the Hpk, Phk and Pk horizons. According to L. G. Bezusko, A. G. Bezusko, and S. L. Mosiakin, a direct correlation between the participation of *Ephedra* in modern cenoses and the content of its pollen in subfossil spore-pollen spectra was traced.

Results of archaeological research

Three archaeological stratigraphic layers were traced in the clearing no. 4 (Гаврилюк та ін. 2023, с. 272). They correlate well with the paleopedological ones (table 1).

Layer I is a modern, doubly dense, heterogeneous, mixed layer of light grey to grey-brown colour with a large number of small and medium-sized stones. According to the data from the clearing no. 4, this layer correlates with the Hdk layer. On the southern side of unit no. 2, it was traced to a depth of 0.32 m from the modern surface. The layer contained modern debris along with archaeological material. The archaeological material was dominated by fragments of handmade pottery (fig. 8, 1—2), which accounted for 52.7 % of the total material. The second place was occupied by fragments of ceramic containers, which accounted for 36.3 %. Among them were fragments of light-coloured amphorae, probably of Heraclean production. The layer also contains single fragments of orange and pink clay amphorae, as well as Aegean Pseudo-Koan containers. Fragments of the walls of amphorae from unidentified production centers were also found in this layer. Tableware from layer I is represented by fragments of grey clay pottery. Its percentage share was 9.1 %. Among the individual finds we can note a ceramic cork (fig. 8, 3), stone items: fishing weights (fig. 8, 4—5) a fragment of a grain grinder, and a fragment of a reused funerary slab. Traces of gradual natural destruction of the stone defenses (archaeological period III) show the cessation of life at the site. The nature of the destructive processes indicates that this occurred rather slowly, and in the comparison with other hillforts of this type (for example, Annivka hillfort). Single archaeological finds and the absence of traces of fires may indicate that the inhabitants of the Konsulivka hillfort left it with everything they needed and the defensive structures were destroyed without human intervention.

Layer I overlapped the underlying **layer III**. **Layer II** was not observed in the clearing no. 4. The depth of layer III in the southern side of unit no. 2 ranged from 0.29 to 0.81 m from the modern surface. This is a dense, heterogeneous layer of fine-grained silt loam, grey-brown to yellowish-brown in colour with single small stones, inclusions of fine-grained limestone, mainland loess washes, molehill, ceramics and animal bones. In unit no. 2, layer III laid directly on the escarpment of a defensive ditch dug in the mainland loess. Only in the southern part of the units it overlapped with layer no. IV. In unit no. 2, the mainland was at a level of sparse of 1.40 m (in the south-western part of the unit) and — 3.58 m (in the north-eastern part of the unit). The archaeological material in the layer is sparse. It is dominated by fragments of handmade pottery (fig. 8, 6—7), which account for 39.2 % of the total number of finds of 31.4 % of the found material layer was made up of clay coating fragments. The third place was occupied by fragments of amphorae containers, which accounted for 26.6 % of the total number of finds. This group was dominated by fragments of light- and orange-fired amphorae. Single fragments of pink-clay and pseudo-Kos-amphorae with double-barrelled handles were also found in the layer (fig. 8, 8). Tableware is represented by a single fragment of a grey clay vessel wall. Its percentage participation reached only 2 % of the total archaeological material from the layer III. Palynological samples K-32/21, K-31/21, and K-30/21 come from this archaeological layer (archaeological period II), which characterises the subsequent xerophitysation of vegetation. The basis of bog cenoses were wormwood plants (*Artemisia* sp.). However, unlike the previous period, their percentage is much lower — up to 22.3 %). Asteraceae, together with Chichoriaceae and Poaceae (cereals, mint) and even spelt (*Triticum* sp.) pollen, make up a significant share. The vegetation of the second period is characterised by the presence of *Ephedra* sp. pollen, which is an indicator of a dry warm period. A certain amount of tree pollen is recorded in this layer (fig. 7).

The analysis of the vegetation reconstructed on the basis of palynological studies shows the presence in the natural environment of the Konsulivka hillfort of pasture digression signs, which in the previous period, namely in the 3rd century BC, had the character of a zonal phenomenon. As it turned out, grass biocenoses in the environment of Konsulivka hillfort (layer IV, this part had not been inhabited yet) and their composition still largely contains pasture weeds, the share of which in the vegetation composition corresponds to two stages of pasture digression inherent in modern pastures of the steppe zone of south-eastern Ukraine (Шевчук 2006, с. 187). Particular attention should be paid to the family Chenopodiaceae. Ven. *(quinoa)*, the genera *Ephedra* (ephedra) and *Artemisia* (wormwood), which are undoubtedly indicators of the spread of sod-grass and wormwood-grass steppes (Безусько, Мосякін, Цимбалюк 2003, с. 393-395). Most authors associate the change of the herbaceous plant group to another not only with natural, but primarily with anthropogenic influence (e.g., Артющенко 1982, с. 6-130), which is recorded in this part of the settlement with the appearance of signs of its settlement — an increase in the number of archaeological finds.

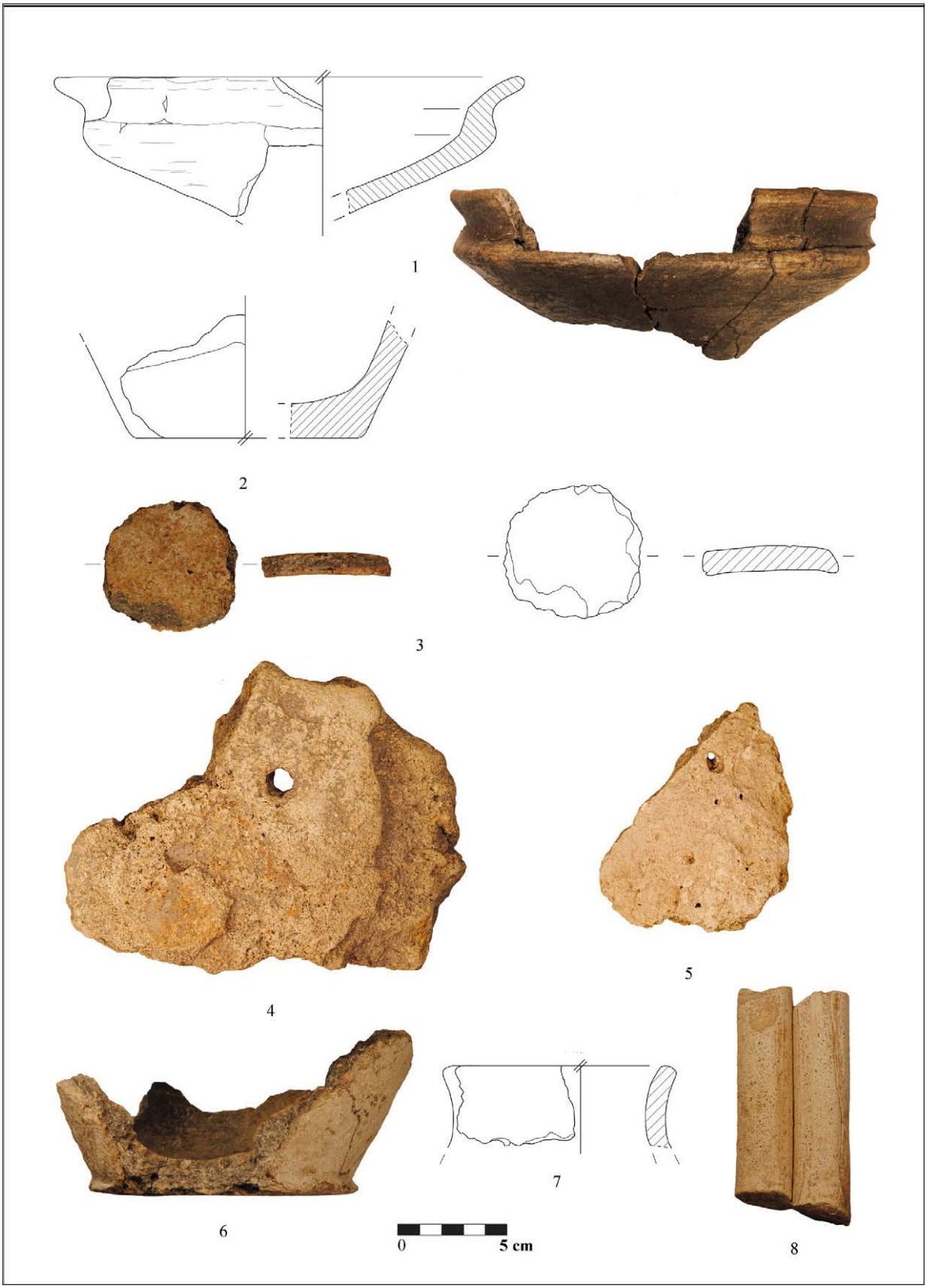

Fig. 8. Archaeological finds from excavation site no. VI — from ancient soil

The correlation of the results of paleopedological and palynological studies with the archaeological materials of the Konsulivka settlement allowed stating that according to paleopedological data, for the first time in the archaeology of antiquity, a preserved "ancient" soil was described at the Konsulivka hillfort which is reliably dated by the archaeological material of the 1st century BC — 2nd century AD. Unlike the surface soil, it is characterised by a lower humus content, and was formed in a shorter time and is more evenly humified. The peculiarity of the ancient soil is the presence of a cemented karst formation and a more compacted brownish-palustrine horizon at the base. The ancient soil is close to the chestnut soils of modern Ukraine, but differs from the modern background soil by a shorter profile and secondary to carbonation.

The analysis of the vegetation composition obtained as a result of palynological research allows us to identify some features of cattle breeding as one of the main branches of the economy of the Lower Dnipro population at the turn of the era. Together with agriculture, the organisation of which had many similarities with the ancient system of farming, cattle breeding remained the basis of the economy of the population of this region (Гаврилюк 2013, с. 567-568).

If we pay attention to the methods of cattle breeding and compare the composition of the herd of the previous Classical period with the herd of the inhabitants of the Lower Dnipro settlements of the 1st century BC — 2nd century AD, we will notice that in the post-Scythian period in the Lower Dnipro the amount of cattle bones decreases (from 24 to 32 % of bones from kitchen remains) against 50 % in the Middle Scythian period. The number of sheep-goat bones remains unchanged. It is known that sheep farming is especially in demand in times of crisis. In addition, the role of pigs in the herds of the inhabitants of the Lower Dnipro settlements is noticeably increasing: the share of pig bones in the kitchen remains is 16—32 %, while in the Middle Scythian period they only start to appear (Журавльов 1995, p. 134). The composition of the herds belonging to the inhabitants of the Lower Dnipro settlements indicates a decrease in the mobility of herds. It seems that stall-based cattle breeding with homestead grazing was concentrated in the suburbs (examples are Annivka or Havrylivka hillforts). The same system could have been in place at the Konsulivka hillfort.

Palynological studies of samples from the two periods of the mentioned hillfort contain information about the vegetation synchronous with the emergence of the settlement and the beginning of the economic use of its environment. In other words, they make it possible to determine some features of economic activity, primarily the use of pastures and the presence of certain signs of pasture deterioration due to unregulated usage.

The evidence of environmental degradation due to pastoral digression in the area of the Konsulivka hillfort is the presence of saiga bones in the archaeozoological spectra of wild animals — indicators of digression (Журавльов 1995, с. 34). The main food of these animals is pasture weeds (Динесман 1982, с. 13). This assumption is supported by the methods of cattle breeding (Гаврилюк 2013, с. 567-568), as well as the composition of the herd in the households of the population of the Lower Dnipro settlements (Цалкин 1966, с. 80-116), which was dominated by sheep and horses that trampled on pastures intensively. It is impossible to speak about the scale of digressive phenomena based on the materials of one settlement, but the fact of this phenomenon should be recorded.

Similar studies conducted at the modern scientific level on archaeological sites synchronous to the Konsulivka hillfort and located on the territory of the Eurasian steppe belt (e.g. Демкин 1997, с. 210; Иванов, Демкин 1999, с. 106-1136; Лисецкий 2008, с. 913-927; 2015, с. 94-99) indicate the instability of the steppe agrocenosis and their tendency to develop pasture digression.

Conclusions

According to paleopedological data, for the first time in the archaeology of antiquity, preserved "ancient" soil has been described at the Konsulivka hillfort, which, according to archaeological material, is reliably dated to the 1st century BC — 2nd century AD. Unlike the surface soil, it is characterised by a lower humus content, a shorter time formation, and that it is more evenly humified. The ancient soil is similar to the chestnut soils of modern Ukraine.

The ancient soil corresponds to drier soil formation conditions (southern variations of the dry steppe). According to climatologists, who believe that climate change could have been regional in nature, the territory of the Lower Dnipro region could have been part of the Roman climatic optimum zone, i.e., a short period of the sub-Atlantic period, covering the time frame

from 250 BC to 400 AD (Patterson et al. 2010, p. 530-610).

Paleopedological studies have confirmed that the Konsulivka hillfort is a multi-layered monument, as evidenced by the stratigraphy of all excavations at the site, including excavation site no. VI. Thus, a comprehensive interdisciplinary study made it possible to clearly distinguish three periods in the history of the hillfort.

According to the palynological analysis, the composition of the vegetation cover (about 40 names) of pastures and meadows that ensured the development of cattle breeding in the economy of the inhabitants of Konsulivka hillfort was reconstructed. Changes in the condition of pastures during the existence of the hillfort were traced. The beginning of the deterioration of the biocenosis as a result of anthropogenic intervention was recorded.

The conclusions presented here relate to the natural environment of only one of the 15 settlement groups of the Lower Dnipro region, the study of which is of particular importance in the current conditions of total destruction of archaeological sites in the Dnipro River region after the explosion of the Kakhovka Hydroelectric Power Station.

Our work is only the first step in the study of the Lower Dnipro hillforts in their natural environment. The conducted comprehensive interdisciplinary research has shown the prospects of the proposed new direction of studying the settlement structures of antiquity.

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ПАЛЕОЕКОЛОГІЧНА ХАРАКТЕРИСТИКА КОНСУЛІВСЬКОГО ГОРОДИЩА ТА ЙОГО ОТОЧЕННЯ

Представлено результати палеопедологічних, палінологічних та археологічних досліджень Консулівського городища, розташованого на правому березі Дніпра біля с. Республіканець Бериславського р-ну Херсонської обл. Геоархеологічні дослідження на пам'ятках Нижнього Подніпров'я здійснено вперше.

Мета цієї роботи представити перші результати геоархеологічних досліджень (палеопедологічних, палінологічних та археологічних) у комплексі; показати перспективність таких робіт на античних пам'ятках.

У вересні 2021 р. проводилися розкопки північно-західного кута великої фортеці Консулівського городища. Виявлено залишки кам'яної оборонної стіни близько та кутовий в'їзд на городище. Здійснено п'ять палеопедологічних розчисток на городищі та за його межами.

Виявлено законсервованим античний грунт, що датується I ст. до н.е. — II ст. н.е. і характеризується меншим вмістом гумусу, має гарно виражений Pk. Особливістю античного ґрунту є наявність ущільненішого буро-пальового горизонту в основі. Він близький до каштанових ґрунтів сучасної України. Палепедологічними дослідженнями підтверджено, що культурний шар городища складається з трьох прошарків, тобто Консулівське городище є багатошаровою пам'яткою, про що свідчить і археологічна стратиграфія.

Палінологічні дослідження зразків містять інформацію про рослинність, синхронну виникненню городища та початку господарського використання його довкілля. Зміна рослинної групи на іншу пов'язується не тільки з природним, але з антропогенним впливом.

Отже, комплексний аналіз довкілля підтвердив багатошаровий характер культурного шару городища. Аналіз рослинності свідчить про наявність у природному оточенні Консулівського городища ознак пасовищної дигресії. Перші міждисциплінарні дослідження на Консулівському городищі показали перспективність таких робіт на археологічних пам'ятках античності.

К л ю ч о в і с л о в а: степовий регіон, Нижнє Подніпров'я, давньогрецький період, геоархеологічні дослідження, палеопедологічні дослідження, палінологічні дані.

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