Dynamics of ecosystems and land use in the Dnieper left-bank forest-steppe for the last two thousand years: Kurilovka 2 case study

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Abstract. The paper presents the first results of comprehensive studies of the multi-layered settlement Kurilovka 2 (Kursk region, Russia). It is located on a remnant of a low terrace above the floodplain of the Sudzha River (tributary of the Psel River – tributary of the Dnieper). The site contains archaeological materials of two main periods: proto- and early Slavonic (2nd – 8th centuries) and the Modern Period (end of the 17th – 20th century). The main attention is paid to the results of archaeological, pedological, palynological, phytolith, anthracological study of the soil profile/archaeological pit 10/2016, located within the boundaries of the habitation zone. The data obtained allow us to reconstruct the history of the site development and dynamics of the site-encasing ecosystems over the past two thousand years. The area was initially forested and cleared for shifting agriculture, probably by the proto- and early Slavonic population. At the end of the 1st millennium AD the settlement was abandoned. The site was reforested and cleared again in the Modern Period. Now the arable land is not farmed, the site is covered with the herbaceous vegetation.

1. Introduction
The study of natural-anthropogenic landscapes is an actively developing scientific field based on a multidisciplinary approach, which combines the analysis of material culture and the reconstruction of nature conditions and human-environmental interaction. Unfortunately, this approach is so far realizing unevenly. So, for the eastern Slavs in the initial stages of their history, comprehensive studies aimed at creating a holistic picture of the development of the material culture of the population and the dynamics of the natural environment were not widely and systematically carried out. Publications in this field are few; they focus mainly on the study of agriculture [1 – 3] and are often speculative in nature. Most of them are based on scattered information about finds of agricultural tools and definitions of grains of cultivated plants in archaeological sites. It is noted a shortage of concrete paleo-soil and spore-pollen data [4].

Kursk region is one of the few territories of modern Russia where archaeological sites correlated with the proto- and early Slavs are known [5, 6], and where we can study the Slavonic cultural traditions starting from the early stages of their development. However, the data generalization and creation of integrated reconstructions is complicated by the limited information on the dynamics of...
natural environment in the forest-steppe zone, within which the Kursk region is located. Study of the vegetation history is an important part of such reconstructions. Unfortunately special researches [7 – 9] are not numerous due to the lack of representative sedimentation archives reflecting the regional situation more than the local one.

The materials presented in this paper allow us to consider for a specific example some aspects of the human-environmental interaction in the Dnieper left-bank region (the western part of the East European forest-steppe) in the Late Holocene, over the past two millennia. They were obtained during the comprehensive studies of the multi-layer settlement Kurilovka 2 in the south-west of the Kursk region. The main attention will be paid to the results of archaeological, pedological, palynological, phytolith, anthracological study of the soil profile/archaeological pit 10/2016, located within the boundaries of the habitation site. The specific questions that can be considered on the base of these data are reconstruction of changes in the structure of the soil cover, determination of the vegetation dynamics in the study area, and identification of the nature of land use characteristic for the local population, firstly for the bearers of the proto- and early Slavonic traditions. To assess the degree of anthropogenic impact on the natural environment outside the boundaries of the archaeological site, we compared the data obtained in the pit 10/2016 with published results of study of the off-site "Sudzha" palynological core [10].

2. Study object
The multi-layer habitation site Kurilovka 2 is located 150 meters from the village Kurilovka (Sudzha district, Kursk region, Russia; on the border with the Sumy region of Ukraine) (figure 1a). The study area is situated at the lower reaches of the Sudzha River which is the right tributary of the Psel River – the left tributary of the Dnieper River. It lies within the forest-steppe zone, in the western part of the Central Russian Upland considerable dissected by gullies, ravines, and river valleys. Zonal (automorphic) soils here are typical Chernozems. Watersheds are composed mainly of chalk deposits, clays, and loess-like loams [11, 12].

![Figure 1](image1.png)

**Figure 1.** Location of the Kurilovka 2 settlement (A) and soil profiles / archaeological pits of the catena 4 (B).

The Sudzha River in its lower reaches has a vast floodplain with a relatively flat surface, which is swamped in places, and abounds with tributaries, oxbows, and lakes. There are convex features within the floodplain that are remnants of an ancient terrace, positioned at various heights above the water level. There are one to two terraces on the gently sloping left bank. The right, steep bank is cut into a bedrock and heavily riddled with ravines and gullies.
The Kurilovka 2 site is located on the remnant of a low terrace (one of the first terrace levels above the floodplain) at the right bank of the present riverbed of the Sudzha River, at its confluence with the Psel River (figure 1b). The remnant has a subtriangular shape, its maximum dimensions are 180×210 m, the height above water is 3–4.5 m, and the total area is about 2.5 hectares. The site is located on the “island”: a convex part of the terrain, bordered to the east and northeast by the Sudzha floodplain, is limited by a water channel on the west and northwest; to the south lies lowland connected to the low floodplain of the Psel River. During the seasonal inundation all these areas surrounding the site become flooded. The surface of the remnant is uneven. The highest part is located on the southeast, close to the mouth of Sudzha; the terrain descends to the north and northwest. The difference in altitude is about 1.5 m. Slopes of the remnant are covered with shrubs and trees, the top is covered with the herbaceous vegetation, mainly with grasses. Currently the area is used for haying.

The site is a part of an archaeological complex at the village Kurilovka. It was discovered in 2012, has been explored since 2015 [13, 14]. The occupational layer contains materials from the Neolithic to the Contemporary Period, but the active human development of this area took place in two main chronological periods. The first refers to the end of the 2nd – 8th century. The archaeological material of this period belongs to three cultures: Kiev (the end of the 3rd – the 1st half of the 5th century), Kolochin (the 2nd half of the 5th – the 3rd quarter of the 7th century) and Volynstsevo (Sakhnovka stage) (the end of the 7th – 8th century). The first is considered proto-Slavonic by the majority of scholars, the second and the third correlate with one of the groups of the Eastern Slavs in the early stages of their development [4, 15]. The second stage of the active development of the site covers the period from the end of the 17th to the second half of the 20th century. Its beginning was connected with the entry of the Dnieper Left Bank region into the Moscow state and the foundation of the fortress of Sudzha in the lower reaches of the Sudzha River [16].

3. Materials and methods
A set of archaeological and paleoecological studies was carried out in order to reconstruct the human-environmental interaction. Particularly, a series of profiles of soil and alluvial sediments both within the boundaries of the site and in the adjacent areas were examined. They were oriented into several catenae along the main directions of the slopes of the remnant. Catena 4 (2016) provided the most interesting data, characterizing the main part of the top of the remnant. It consists of six profiles (5/16–10/16) that are oriented along the south-southeast – north-northwest line, from the highest part of the study area down the slope to the channel that delimits the remnant on the west and northwest (figure 1b). Its total length is about 100 m. The reference profile for the catena 4 became profile 10/16 located on the low northern part of the remnant inside the archaeological site.

All soil profiles were studied as archaeological pits. The archaeological investigations were based on the traditional stratigraphic method [17] which allows researchers to establish the sequence of occurrence of layers and findings. The comparative-typological and chronological analyses were used for ethno-cultural attribution and dating of the archaeological material [18, 19].

The pedological and paleopedological research was based on the morphogenetic analysis of soil profiles and surface deposits. It was carried out within catenae, which allowed us to recreate the spatial distribution of different soil types and anthropogenic deposits [20, 21]. The soil taxonomic identification was based on the Russian and international classifications [22, 23].

The changes in plant communities were reconstructed using pollen and phytolith analyses. Pollen from 13 samples from the occupational layer in the profile 10/16 (column length 95 cm) was extracted using a heavy liquid (CdI₂+KI). For the determination of pollen concentration, Lycopodium tablets were added at the beginning of the preparation [24]. Due to the very low pollen concentrations all pollen grains and spores extracted from a 10-gram sample were counted. Percentage of taxa was calculated in the samples that contained at least 150 grains. Calculation of percentages was based on the total sum of terrestrial pollen and spores. In addition to pollen, we documented the presence of panicoid phytoliths indicative of cultivated cereals.
The composition of macrofossils and botanical identifications of charcoal was carried out for one sample from the lower part of the occupational layer in the profile 10/16 (depth 65–75 cm). A 4.5-kg soil sample was air-dried and wet-sieved through a 1-mm sieve following the method described in previous publication [25]. All macrofossils and microartifacts were manually picked from the >1mm fraction. Components indicative of the forest, grassland/pasture and settlement stages in the site were described in this fraction (part 4.3).

The proportion of bark in the charcoal assemblage was calculated as an important diagnostic feature differentiating the fires that affect trees from those burning fuel on the ground [26]. Tree bark is easily charcoalified during forest fires, contributing a large proportion of soil charcoal assemblages (up to 90% during ground fires), whereas land clearance fires turn the majority of bark fragments into ash due to the higher ashing coefficient/combustibility of bark compared to the trunk wood.

Concentration of charcoal was calculated as the number of charred fragments per gram of soil and per gram of >1mm fraction. Botanical identification of charcoal was carried out in 60 fragments following published manuals [27, 28].

Chronology of materials was established by archaeological dating. In addition, four radiocarbon dates were obtained for the profile 10/16. ^14C-dating of three samples was carried out at the Laboratory of Radiocarbon Dating and Electronic Microscopy, IG RAS (IGAN 6005-6007). Humic acids were used as the dating fraction, that was separated by alkaline extraction according to the standard methodology used in the laboratory [29]. One AMS-date for a single fragment of oak charcoal was obtained at the Canadian Centre for Accelerator Mass Spectrometry of the University of Ottawa (UOC-6415). The dates were calibrated in CALIB 7.1 program.

4. Results
4.1. Soil data
The overall thickness of the soil and anthropogenic deposits recorded in the catena 4 is 110–120 cm (excluding the calcareous horizon). The most complete set of horizons is observed in the profile 10/16: AO-IAp-IBAE-IAEB-IIApyr(1)-IIAbB-IIApyr(2)-IIIAEBt-IIIBht-IIIBt-IVBk (table 1) (figure 2). This profile was selected for further analyses.

The upper 70 cm of the soil profile are dark-colored due to humification. However, the darkest layer is bedded at a depth of 40 to 67 cm, marking a buried paleosol. It consists of the dark-colored humified part and AEBt horizon of a lighter color: the soil morphology typical for the dark-gray forest soil (Phaeozem Argillic). The upper part of the profile (to a depth of 75–80 cm) contains artifacts indicating that both the humus and eluviated horizons of the original soil have been transformed here into an occupational layer.

Major changes in texture within the soil profile correspond with four depositional stages.

IV. Calcareous Bk horizon is developed on periglacial (Pleistocene) loess deposits.
III. The loess unit is superposed by a more clayey deposit that served as a parent material for the formation of a Bht and Bt horizons of a paleosol.
II. The clayey loam grades into a loam with a higher proportion of sand. This deposit served as a parent material for the formation of Aypr(1), AbB, Aypr(2), and AEBt horizons of the paleosol. The dark-colored stratum is divided into three subhorizons with different degrees of humification and eluviation. Its upper (Aypr(1), 40–45 cm) and lower (Aypr(2), 60–67 cm) parts are dark-grey due to the abundance of charcoal; boundaries of these two subhorizons are scalloped with aggregations of insect constructions, in-filled with the material of the subhorizons. Oval to round dots and finger-like tunnels, up to 1.5 cm in diameter, are similar to the constructions of sweat bees described in association with swidden layers [26]. The two subhorizons are divided by the material of lighter coloration with signs of eluviation (bleached sand particles). It appears that the dark-colored stratum consists of two buried surfaces divided by the destratified deposit of eluviated material.
Table 1. Stratigraphy of soils and deposits in the profile 10/16.

| Layer, soil | Horizon | Thickness, cm | Morphological characteristics |
|-------------|---------|---------------|------------------------------|
| 1. *Anthrosol* *Mollic Anthric* | AO      | 0–6           | Medium-gray sandy loam, crumb to granular structure, numerous fine roots. |
|             | IAp     | 6–26          | Medium-gray sandy loam, firm, crumb to-granular structure, fragments of chalk and pottery, numerous fine roots. Lower boundary even, distinct transition in density. |
|             | IBAE/AEB| 26–40         | Brownish medium-gray, sandy loam, loose, with off-white skeletons. The white hue is more noticeable in the lower part of the layer (AEB, 37–45 cm), in the upper part (BAE, 26–37 cm) the skeletons are less noticeable. Lower boundary even, abrupt, distinct transition in color and density. |
| 2. *Anthrosol 2 on phaeozem* | IIAPyr(1)| 40–45         | Dark gray loam, powdery, granular structure, loose, abundant charcoal. Lower boundary is even, with traces of insect constructions, 1–1.5 cm in diameter. |
|             | IIAbB   | 45–60         | Dark gray loam, homogeneous, skeletons, lower boundary gradual. |
|             | IIAPyr(2)| 60–67         | Dark gray loam, powdery, loose, abundant charcoal. Lower boundary is even, with traces of insect constructions. |
|             | IIIAEBt | 67–80         | Brownish-gray loam, homogeneous, skeletons and thin humus-clay cutans. |
|             | IVBht   | 80–100        | Gray-brown clay loam, fine subangular blocky structure, humus-clay cutans. |
|             | IVBt    | 100–122       | Brown clay loam, subangular blocky structure, humus-clay cutans, non-calcareous. |
| 3. *Loess*  | VBl     | 122–132       | Buff-colored silt loam, porous, calcareous. |

The surface of the paleosol is buried under a sandy loam deposit; the contact between the units I and II is abrupt. Both the covering deposit AEB/BAE and the plough layer in its upper part contain numerous fragments of pottery and bones, the occupational layer disturbed by tillage. Sod is accumulated atop the abandoned plough layer. The change in texture is associated with the influx of sand due to the periodic flooding of the remnant slopes and, possibly, lateral transfer and redistribution of sand during tillage and movement of people and their herds. The surface soil is Agrozem (*Anthrosol*).

Summarizing, we can conclude that in the profile 10/16 the original dark-gray forest soil (*Phaeozem Argillic*) was anthropogenically transformed and buried under the occupational layers. The upper part of the occupational layer (40 cm) was disturbed by tillage, whereas the lower part (40–75(80) cm) appears to be bedded *in situ*. Signs of eluviation that was presumably associated the site abandonment and its reforestation were recorded in two layers: the deposit AbB dividing the pyrogenic surfaces Apyr(1) and Apyr(2) (“pre-tillage” occupational layer) and the deposit BAE/AEB dividing the buried paleosol and the plough.
4.2. Pollen data
Preliminary results of the palynological study of the profile 10/16 have been published [10]. Here we present the augmented data obtained by analyzing the additional volume of the samples.

In all 13 samples there were great amounts of microscopic charcoal and charred phytoliths. However, quantities of pollen were sufficient for percentage calculation in only 6 of them (figure 3).

Figure 2. Kurilovka 2. Soil profile 10/16. 1 – sod, 2 – sandy loam, 3 – loam, 4 – clay loam, 5 – loess (silt loam).

Figure 3. Pollen diagram of the profile 10/16.

Three groups of pollen spectra were clearly distinguished. In the lower part of the occupational layer, at depths of 65–70 and 70–75 cm, the pollen of trees amounts to 20–45%. These are only deciduous species: birch (Betula) (up to 30%), alder (Alnus), linden (Tilia), oak (Quercus). Among the herbaceous plants, wormwood (Artemisia) (up to 25%) and other Compositae (up to 18%) are prevalent; there are also Apiaceae, Onagraceae (Chamaenerion), Chenopodiaceae, Fabaceae,
Filipendula and others. In general, such spectra (pollen of deciduous trees and steppe grasses) are characteristic of soils of the forest-steppe zone. Some signs of the agricultural use are recorded in the studied samples: pollen of cultivated cereals as well as panicoid forms of phytolites.

In the middle part of the profile (the upper part of the “pre-tillage” occupational layer), at a depth of 40–50(55) cm, a limited number of taxa were represented in the spectra due to the low concentration of pollen. Among the trees, there is still a relatively large proportion of birch (Betula) and alder (Alnus), but here pine (Pinus) is present. Both wild and cultivated grasses (Poaceae, Cerealia) are abundant among the herbaceous plants along with weeds. Solitary phytolites of panicoids are found.

In the samples from the soil (0–5 cm) and the upper part of the former plough layer (10–15 cm), the pollen of tree species amounts to about 40%, and it is almost exclusively pine (Pinus) (35–40%). Among the herbaceous plants, wild and cultivated grasses (Poaceae, Cerealia) predominate, contributing together up to 25% of the total spectrum. In addition, weeds such as Asteraceae, Cichorioideae, wormwood, Chenopodiaceae, Fabaceae, and knotgrass (Polygonum aviculare) are recorded. Such pollen spectra are characteristic of an open habitat occupied by grass communities with participation of ruderal plants, on soil enriched with manure [30].

4.3. Macrofossil data

Wet sieving of the 4.5-kg soil sample yielded 270g of >1mm fraction. In total, 432 charcoal fragments were recovered from the sample; the charcoal concentration being approximately 1 fragment per 10g of air-dried soil, or 2 fragments per gram of the >1mm fraction. Other components of the large fraction contributed 108 fragments (~20% of all macroremains) (table 2) (figure 4).

| Table 2. Composition of >1 mm soil fraction. |
|---------------------------------------------|
| plants, charred | seeds, not charred | bones and teeth of fosso- rials | food remains | arti- facts | rocks |
|-----------------|-------------------|--------------------------|-------------|----------|-------|
| fungal sclerotia | 9                 | 212                      | 104         | 4        | 16    |
| wood            | 87                | 7                        | 2           | 32       | 34    |
| bark            | 1                  | 2                         | 1           | 4        | 8    |
| prickly shrubs  |                   |                           |             |          | 20    |
| charred grasses |                   |                           |             |          |       |
| vitrified charcoal |               |                           |             |          |       |
| Chenopodium     |                   |                           |             |          |       |
| other           |                   |                           |             |          |       |
| charred wood, taxa |                 |                           |             |          |       |
| Alnus           | 1                 | 3                        | 54          | 1        | 1     |
| Betula          |                   |                           |             |          |       |
| Quercus         |                   |                           |             |          |       |
| Tilia           |                   |                           |             |          |       |
| Pinus           |                   |                           |             |          |       |
| #of fragments   | 1                  | 3                        | 54          | 1        | 1     |
| %               | 1.6                | 5                        | 90          | 1.6      | 1.6   |

The charcoal assemblage is dominated by oak (90%); other taxa are birch (5%), alder (1.6%), linden (1.6%), and pine (1.6%). A proportion of oak charcoal fragments (18%) had one to several narrow annual rings. The regular occurrence of narrowed annual rings is indicative of recurring conditions unfavorable for the tree growth, such as droughts, outbreaks of forest pests, or periodic flooding of the sites where the oak trees were growing. The last factor is consistent with the floodplain setting of the settlement.
Figure 4. Components of >1 mm soil fraction, associated with different ecosystems/stages of land use. The forest stage (I): a) charred fungal sclerotia, b) isometric charcoal fragments with a proportion of charred bark, c) *Betula* charcoal, d) *Pinus* charcoal; e, f) *Quercus* charcoal. The grassland/pasture stage (II): g) *Chenopodium* seeds, h) bones and teeth of grassland fossorials, i) charred shoots of prickly plants, j) charred hollow stems of grasses. The settlement stage (III): k) charred grain of millet, l) fish scales and bones, m) rounded fragments of pottery, n) calcined and weathered bone fragments.

Charcoal fragments were isometric, with the upper quartile size 4 mm; surface of fragments is mud-coated. Bark fragments constituted ~24% of the charcoal assemblage. Other components of >1 mm soil fraction included charred and re-burned shoots of prickly shrubs, charred grasses, *Chenopodium/Athriplex* seeds, eroded fragments of charred grains of millet (*Panicum*) and wheat (*Triticum*), charred fungal sclerotia (*Cenococcum* sp.), fish scales, fragments of processed bones (middens), teeth and bones of fossorial mammals, small fragments of hand-made pottery, and chert debitage. Such diverse composition that includes components originated from forest (sclerotia, charcoal), grassland (teeth and bones of fossorials; charred shoots of grasses and prickly shrubs), and finds related to human activity (charred millet grains, processed bones and pottery) indicates that these heterogenous materials were mixed by pedoturbation. Per cent of fragments associated with the forest, grassland, and settlement stages are ~77, 11, and 12 correspondingly. It allows us to conclude that the layer is associated with the forest stage (post-fire deforestation), whereas fragments associated with the grassland and settlement stages were probably redeposited from other layers. Redeposition due to
bioturbation could be expected, as bones of fossorials were found in the layer in large numbers (as numerous as bones from middens).

4.4. Archaeological data

The thickness of the occupational layer revealed in the profile/archeological pit 10/16 is 75–80 cm. Its upper part, to a depth of 25–40 cm, is damaged by long-term plowing. The lower part, at a depth of 40–80 cm, is bedded in situ but it is disturbed by numerous burrows of digging animals.

The archeological collection obtained in the pit 10/16 (figure 5) includes 94 fragments of pottery, which belongs to two groups: hand-made vessels (84 fr.) and wheel vessels (10 fr.). 7 pieces of wheel vessels date from the Modern Period, the late 17th – 19th century; 3 fragments belong to early medieval amphorae. The hand-made pottery refers to the so-called early Slavonic type, characteristic for the Kiev, Kolochin, and Volynetsvo (Sakhnovka stage) cultures (end of the 2nd – 8th century). In addition, 32 pieces of animal bones and teeth, 34 pieces of burnt clay, 1 piece of ceramic slag and 3 pieces of tile were found in the pit 10/16.

Figure 5. Archeological collection obtained in the pit 10/16: 1–11, 13 – hand-made pottery, 12 – ceramic slag, 14, 15, 26 – fragments of amphorae, 16–21, 24 – wheel pottery of the Modern Period, 22, 23, 25 – fragments of tile, 27–34 – animal bones and teeth.

All artefacts of the Modern Period come from the upper part of the occupational layer, from the depth of 0–26 cm from the modern surface. Most of the material was deposited in the middle part of
the in-fill of the pit, at the depth of 30–60 cm; moreover, here the size of artefacts was the largest. The lower part of the occupational stratum (60–75(80) cm) contained only fragments of hand-made early Slavonic vessels.

4.5. Radiocarbon data

Four radiocarbon dates were obtained for the soil and anthropogenic deposits of the profile 10/16 (table 3). The first sample was taken from the soil horizon Bht bedded at the base of the profile under the occupational layer. Its date (4710±80 BP) falls within the Subboreal period. The dates 710±60 and 770±60 BP obtained for the soil horizons IIAb and IIAPyr(1) respectively (the upper part of the “pre-tillage” occupational layer), are indistinguishable within one sigma interval. Finally, a single fragment of oak charcoal from the basal part of the occupational layer yielded the date 163±22 BP. It cannot be reliably calibrated due to its multiple intercepts with the calibration curve: the mean probability of the fire event being 18th century.

Table 3. Radiocarbon dates for the profile 10/16.

| №   | Lab code    | Depth, cm | Dated material | \(^{14}\text{C} \) yr age BP | Cal BC/AD, 68% (1 sigma) | Cal BC/AD, Median Probability |
|-----|-------------|-----------|----------------|---------------------------|--------------------------|-------------------------------|
| 1   | IGAN-6005   | 80–85     | Humic acids    | 4710±80                   | BC 3630-3580; 3534-3494  |                                |
|     |             |           |                |                           | 3467-3375                | BC 3496                       |
| 2   | IGAN-6006   | 50–55     | Humic acids    | 710±60                    | AD 1252-1310             | 1286                          |
|     |             |           |                |                           | 1360-1387                |                               |
| 3   | IGAN-6007   | 40–45     | Humic acids    | 770±60                    | AD 1210-1285             | 1242                          |
|     |             |           |                |                           | 1733-1779                |                               |
| 4   | UOC-6415    | 65–75     | Oak charcoal   | 163±22                    | AD 1671-1684             | 1765                          |
|     |             |           |                |                           | 1799-1807                |                               |
|     |             |           |                |                           | 1928-1942                |                               |

5. Discussion

The presented data allow us to reconstruct the development of the local landscape as follows.

At the beginning of the late Holocene, the study area has been covered with deciduous vegetation. This assumption was confirmed by several proxies. Dark gray soils (Phaeozems) were documented in the lower part of the profile 10/16; this soil is formed under the broad-leaved forest. Presence of charred Cenococcum sclerotia in the samples from the base of the occupational layer indicated that the low part of the remnant was initially forested, therefore the establishment of the habitation site was preceded by deforestation. The existence of broad-leaved forest with the predominance of oak in the flood plain of the Sudzha River is supported by the published pollen data from the core “Sudzha” located 120 m from the border of the site [10].

The presence of oak in the forest cover and its utilization by the local population were confirmed by the results of the pedoanthracological analysis. The low part of in situ occupational layer contained a high concentration of charcoal, predominantly of oak (~90% of fragments). The commonality of narrowed annual rings may be caused by trees growing in the periodically-inundated flood plain, in the site vicinity. A \(^{14}\text{C} \) date we obtained (table 3) shows that oak was growing in the microregion until ~mid-18th century.

Soil pollen spectra contained oak pollen only at the initial stage of the site utilization (the lowermost part of the occupational layer); here oak and linden pollen contributed a considerable proportion of the arboreal pollen. Later, oak had disappeared from the soil pollen spectra whereas linden reappeared in the last centuries. The oak decline coincided with the increase in pine pollen.
The shape, size, and coating of charcoal fragments from the basal part of the occupational layer as well as a comparatively low proportion of bark in the charcoal assemblage indicate that deforestation of the site has been caused by the clearance for agriculture rather than wildfire [23] though a proportion of charcoal could be brought to the site as firewood by the inhabitants of the settlement. The morphology of the low (Apyr(2)) and the upper (Apyr(1)) pyrogenic layers are consistent with descriptions of swidden layers in thickness (~7 cm), color (dark-gray), and the boundaries (numerous constructions of sweat bees) [26]. The utilization of the study area for agriculture at the early stage of its development is also evidenced by the millet and wheat grains found among the macrofossils. Such assumption is further supported by the finds of millet phytoliths, and pollen of cultivated cereals in the basal layer of the occupational stratum.

Soil pollen spectra should be interpreted with caution due to the poor preservation of pollen in the soil and possible effects of bioturbation. However, we think that soil pollen provides important site-oriented paleoecological information, especially in the floodplain [31]. Peaks in pollen concentrations in II Apyr(2)/III AEBt and II Apyr(1)/II AbB horizons and a drastic difference in the composition of pollen spectra here and in the upper strata confirm that these pyrogenic horizons are, indeed, buried surfaces [32]. Moreover, above-mentioned difference indicates that the original stratification was not overwritten by bioturbation in the low part of the soil profile. In this case, pollen spectra from the soil layers rapidly buried under anthropogenic deposits reliably reflect pre-settlement vegetation cover. Soil pollen spectra obtained from the site are dominated by birch, whereas published spectra from the swamp are dominated by oak [10], indicating that the site hosted secondary forests. Spectra with the high proportion of birch pollen combined with anthropochores and cereals, and charred phytoliths of cereals and millet are typical for the forest soils affected by slash-and-burn cultivation [26]. Similar pollen spectra were described in medieval swidden layers in other regions – the Dnieper River valley [33, 34], the Middle Volga region [35, 36].

In addition to the cultivation of crops, dwellings and utility pits were constructed and other human activities were carried out in the lower parts of the remnant. Teeth and bones of fossorial mammals along with charred shoots of grasses and prickly shrubs among macrofossils reflect the stage of an open area – grassland/pasture – in the site. Unfortunately, we could not so far clarify the time of these activities using radiocarbon analysis. The date 4710±80 BP was obtained for the soil horizon under the occupational layer. It reflects the certain stage of surface formation, and not the beginning of anthropogenic development of the site. The fragment of oak charcoal from the basal part of the occupational stratum yielded the date 163±22 BP. It was inverted due to bioturbation and evidently not related to the swidden layer. However, any date obtained on a single charcoal fragment provides a valid fire date, regardless of inversions, and in our case it indicates that the site was cleared from the oak forest/grove one more time, most probably in 18th century.

It seems that in our case the traditional archaeological dating provided a more reliable information on the beginning of site utilization. Only finds of the early Slavonic time were documented in situ in the swidden layer Apyr(2) and underlying horizon III AEBt, and no artifacts were recorded below. That allows us to consider that the initial land clearing of the site was either associated with the Early Slavs, or closely preceded the establishment of the early Slavonic settlement. Definitely, more radiocarbon dates are needed to clarify the site chronology.

Pollen spectra of the off-site sediment core “Sudzha” recorded the first anthropogenic signals in the 1st half of the 1st millennium AD, which corresponded to the beginning of the early Slavonic period of the development of the territory, but these signals were still insignificant [10]. Probably, we can talk about the local impact of the early Slavonic population on the natural environment, which practically did not go beyond the boundaries of the settlement.

At the end of the 1st millennium AD the settlement was abandoned. The site was reforested and cleared again during the second phase of its utilization. Between the two stages, the processes of textural differentiation of the anthropogenic deposits (Anthrosol) were resumed and a texturally-differentiated soil was formed.
The upper part of the “pre-tillage” occupational layer was radiocarbon dated by 13th century AD, and these data are hard to interpret as dates obtained for humic acids could often be rejuvenated. However, a peak of Cerealia (cereals) pollen was recorded in the neighboring swamp in the layer dated by 13th century [10]. One more 14C date obtained on charcoal from another profile was associated with the deforestation event that also took place in 13th century (data is being prepared for publication). It is possible that the territory was cleared for agriculture again in 13th century, already after the abandonment of the early Slavonic settlement, and the artifacts were redeposited in the upper part of the occupational layer (Apyr(1), BAE, AEB) due to tillage. Several archaeological sites of 13th century are known within 5 km from Kurilovka 2 [6], and a single pectoral cross dated to the late 12th – 13th century was found in the site.

According to the archaeological finds, a new stage in the development of the site began in the late 17th – 18th century and continued until the 2nd half of the 20th century. Judging by pedological and palynological data, characteristic features of this stage are deforestation, intensive plowing with use of efficient agricultural tools, cultivation of a certain set of crops (mainly cereals). A total deforestation and large-scale plowing are recorded not only on the territory of the site, but also in the Sudzha region, and in the central part of the forest-steppe zone of the East European Plain in general [37]. Now the agricultural land on the remnant is not farmed, and the meadow has formed in place of the former field.

6. Conclusions
It appears that the data presented allows us to reconstruct the history of the site Kurilovka 2 development and dynamics of the site-encasing ecosystems over the past two thousand years. It is obvious that the territory was initially forested, but we don’t know how many times it was cleared from trees. It can be assumed that deforestation took place here at least three times: in the early Slavonic period, in 13th century, and later in 17th to 20th century.

The area was initially cleared for shifting agriculture, probably by the proto- and early Slavonic population. Formation of the occupational layer and presence of archaeological features that contained artefacts of the 2nd – 3rd centuries, indicate that the habitation zone spread to the study part of the remnant as early as in the first period of its active development. We can also assume that after the abandonment of the habitation site the area was remained treeless for the period of time that was sufficient for migration of grassland fossorials.

The second active stage of land development falls on the end of the 17th – the 2nd half of the 20th century. Complete deforestation and heavy ploughing led to a noticeable change in the ecosystems in the Kurilovka 2 settlement area. The abandonment of the arable land occurred in the last 20–30 years. To date the site is covered with the herbaceous vegetation.

The paper presents the first results of a comprehensive study of the Kurilovka 2 settlement. We consider these results confirm the perspectives of an integrated archaeological, paleosoiil, palynological approach to the study of archaeological sites including sites with unstratified occupational layer. Research will be continued.

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References
[1] Goryunov E A 1981 Early Stages of the Slavs History of the Dnieper Left Bank Region (Leningrad: Nauka) pp 34–35 (in Russian)
[2] Terpilovskij R V 2004 Slavs in the Dnieper Region in the First Half of the First Millennium AD (Lublin: Wydawnictwo UMCS) pp 73–77 (in Russian)
[3] Gorbanenko S A and Pashkevich G O 2010 Agriculture of the Ancient Slavs (end of the 1st...
Millennium BC – 1st millennium AD (Kiev: Akademperiodika) (in Ukrainian)

[4] Gorbanenko S A 2016 Agriculture of the Kolochin culture population Early Medieval Antiquities of the Forest Zone of Eastern Europe (V — VII centuries) (Early Slavic World 17) Eds A M Oblomskiy and I V Islanov (Moscow: IA RAS) pp 114–135 (in Russian)

[5] Kashkin A V 1998 Archaeological Map of Russia The Kursk Region Part 1 (Moscow: IA RAS) (in Russian)

[6] Kashkin AV 2000 Archaeological Map of Russia The Kursk Region Part 2 (Moscow: IA RAS) (in Russian)

[7] Shumilovskikh L S, Novenko E Y and Giesecke T 2017 Long-term dynamics of the East European forest-steppe ecotone J Veget Sci 29 416–426

[8] Novenko E Y, Eremeeva A P and Chepurnaya A A 2014 Reconstruction of Holocene vegetation, tree cover dynamics and human disturbances in central European Russia, using pollen and satellite data sets Vegat Hist Archaeobot 23 109–119

[9] Novenko E Y, Tsyganov A N, Volkova E M, Babeshko K V, Lavrentiev N V, Payne R J and Mazey Y A 2015 The Holocene paleoenvironmental history of central European Russia reconstructed from pollen, plant macrofossil, and testate amoeba analyses of the Kluvkova peatland, Tula region Quat Res 83 459–468

[10] Shumilovskikh L S, Rodinkova V E, Rodionova A, Troshina A, Ershova E, Novenko E, Zazovskaya E, Sycheva S A, Kiselev D I, Schlütz F and Schneeweiß J 2019 Insights in the late Holocene vegetation history of the East European forest-steppe: case study Sudzha (Kursk region, Russia) Vegat Hist Archaeobot 28 513–528

[11] Kabanov R V (ed) 1997 Geography of the Kursk Region (Kursk) (in Russian)

[12] Velichko A A (ed) 1997 Loess-soil Formation of the East European Plain Paleogeography and Stratigraphy (Moscow: IG RAN) (in Russian)

[13] Rodinkova V E 2018 Field studies in the settlement of Kurilovka 2 in 2015–2016 Archaeological Discoveries 2016 (Moscow: IA RAS) pp 150–153 (in Russian)

[14] Rodinkova V E 2018 Comprehensive research of sites near the village of Kurilovka Archaeological Research in the Central Chernozem Region 2017 (Lipetsk, Voronezh: Novyi vzglyad) pp 88–90 (in Russian)

[15] Oblomskiy A M 2016 The Kolochin culture Early Medieval Antiquities of the Forest Zone of Eastern Europe (V — VII centuries) (Early Slavic World 17) (Moscow: IA RAS) pp 10–114 (in Russian)

[16] Babin I P 2015 The history of founding of the Sudzha city Sudzha and its inhabitants in the domestic and foreign history and culture (Kursk: Kursk University) pp 90–107 (in Russian)

[17] Avdusin D A 1980 Field Archeology of the USSR (Moscow: High School Press) (in Russian)

[18] Klejn L S 1982 Archaeological typology (BAR International series 153) (Oxford)

[19] Yanin V L (ed) 2006 Archeology (Moscow: Moscow State University Press) (in Russian)

[20] Sycheva S A, Leonova N B, Aleksandrovska A L, Vodyanitsky Yu N, Golyeva A A, Zazovskaya E P, Karfu A A, Kazdym A A, Kovalyukh N N, Kurochkin E N, Markova A K, Nikolaev N I, Pustovoitov K E, Ryskov Y G, Sedov S N, Skripkin V V, Skripnikova M I, Sychevskaia E K, Chepalyga A L and Chichagova O A 2004 Natural-scientific Methods for Studying the Cultural Layers of Ancient Settlements (Moscow: National Information Agency Priroda Press) (in Russian)

[21] Ponomarenko E V, Ponomarenko D S, Stashenkov D A and Kochkina A F 2015 Approaches to the reconstruction of dynamic of the territory occupation according to the soil signs The Volga River region Archeology 1(11) 126–160 (in Russian)

[22] National Atlas of Soils of the Russian Federation (https://soilatlas.ru/) (in Russian)

[23] World Reference Base for Soil Resources 2018 (Moscow: FAO and Moscow State University Press)

[24] Stockmarr J 1971 Tablets with spores used in absolute pollen analysis Pollen et Spores 13 pp 615–621
[25] Ponomarenko E 2017 Methods of study of soil charcoal assemblages Proc. of the III All-Russian Scientific Conference “History, Methodology and Sociology of Soil Science”, Pushchino, November 15–17, 2017 (Pushchino) pp 319–321 (in Russian)
[26] Ponomarenko E, Ershova E, Tomson P and Bakumenko V 2019 A multi-proxy analysis of sandy soils in historical slash-and-burn sites: Karula case study Quaternary International 516 190–206
[27] Vernet J L, Ogereau P, Figueral J, Machado Y C and Uzquiano P 2001 Guide d’identification des Charbons de Bois Prehistoriques du Sud-Ouest de l’Europe (Paris: CNRS)
[28] Benkova V E and Schweingruber F H 2004 Anatomy of Russian Woods: an Atlas for the Identification of Trees, Shrubs, Dwarf Shrubs and Woody Lianas from Russia (Bern)
[29] Zazovskaya E, Shishkov V, Dolgikh A and Alexndrovskiy A 2016 Organic Matter of Cultural Layers as a Material for Radiocarbon Dating Radiocarbon 59 (6) 1931-1944
[30] Moe D 1983 Palynology of sheep’s faeces: relationship between pollen content, diet and local pollen rain Grana 22 105–113
[31] Ershova E G 2019 Spore-pollen analysis of floodplain deposits: problems and opportunities Archeology of the Floodplain: Relief, Paleo-environment, History of Settlement (Moscow: IA RAS) pp 46–51 (in Russian)
[32] Dimbleby G W 1985 The Palynology of Archaeological Sites (London: Academic Press)
[33] Ershova E G and Krenke N A 2017 Archaeological-palinological studies at Sobornaya gora in Smolensk Russian archaeology 1 87–95 (in Russian)
[34] Zozulya S S 2018 Research in the Dnieper Kurgan group of the Gnezdovsky archaeological complex in 2010–2012 Gnezdovsky archaeological complex. Mat and res 1 (Moscow: State Historical Museum) pp 181–210 (in Russian)
[35] Aleshinskaya A S, Spiridonova E A and Kochanova M D 2018 The natural environment of the surroundings of the Bolgar hillfort (on the materials of palynological studies of the cultural layer of the CLXXIX excavation site) Archeology of the Eurasian steppes 5 pp 74–80 (in Russian)
[36] Vyazov L A, Ershova E G, Gajewski K, Ponomarenko E V, Blinnikov M S and Sitdikov A G 2019 Demographic changes, trade routes, and the formation of anthropogenic landscapes in the Middle Volga region in the past 2500 years Socio-Environmental Dynamics Along the Historic Silk Road Eds L Yang and H-D Bork (Springer International Publishing) pp 411–452
[37] Khotinsky N A 1993 Anthropogenic changes in the landscapes of the Russian Plain during the Holocene Grana Suppl. 2 70–74