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ГЕОМОРФОЛОГИЧЕСКИЕ УСЛОВИЯ ФОРМИРОВАНИЯ РАННЕСРЕДНЕВЕКОВЫХ ПОСЕЛЕНИЙ В ДНЕПРО-ДВИНСКОМ РЕГИОНЕ, СЕВЕРО-ЗАПАД ЕВРОПЕЙСКОЙ РОССИИ

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Наиболее активные изменения рельефа на Северо-Западе европейской части России в последние тысячелетия происходили в связи с геоморфологической деятельностью рек. Реконструкция этих изменений имеет большое значение для изучения археологических памятников позднего голоцена, многие из которых располагаются на дне речных долин. Выполненные исследования на двух ключевых объектах – Шниткино (долина р. Торопы, бассейн р. Западная Двина) и Гнездово (долина верхнего Днепра) – помогли установить облик локального рельефа в раннем средневековье. Было изучено геолого-геоморфологическое строение участков долин, выполнено радиоуглеродное датирование отложений. Изученные раннесредневековые поселения были основаны на берегах озер нестаричного типа, достаточно многочисленных в речных долинах Днепро-Двинского региона. Механизм образования озер различался в связи с различиями в послеледниковой истории речных долин: в ледниковой зоне это могли быть остаточные озера, ведущие начало от более крупных послеледниковых озер (озеро Шниткино в долине р. Торопы), за пределами границы последнего оледенения – озера, связанные с деятельностью рек (озера Камыши и Бездонка в долине верхнего Днепра). Установлено, что в период средневекового климатического оптимума (VIII–XII вв.) высота паводков и половодий была ниже, чем сейчас, что позволило заселить поймы рек, обычно затапливаемые половодьем. Реконструирована динамика речных долин в позднем голоцене. В развитии речных долин в целом преобладали процессы аккумуляции. Аккумуляция наносов на речных поймах прерывалась при снижении высоты паводков, как во время средневекового потепления климата, и возобновлялась при изменениях гидрологического режима в сторону роста паводков (Малый ледниковый период XIV–XIX вв.).

Ключевые слова: геоархеология, голоцен, палеогеография, путь “из варяг в греки”, речные торговые пути

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1. INTRODUCTION

Archaeologists have an abiding interest in the interaction between man and the natural environment. It is always important to know how people used river and lake shorelines, whether there was any craftworks or shipbuilding activity and what human impact on the shoreline was. These questions are particularly worthy for settlements of medieval times. In this regard, many significant investigations on the reconstruction of river/lake events within medieval sites were carried out by geomorphologists and geologists. For example, the survey of the Rhone river near the medieval bridge at Avignon by integrating sedimentological and stratigraphic evidence with geophysical surveys and dating (Ghilardi et al., 2015). The bridge burial relates to the stages of the Little Ice Age which are characterized by repeated floods and high sedimentation rates in the Lower Rhone River. Another great example – the study of the Staraya Ladoga site near the Ladoga Lake (Shitov et al., 2004). It was concluded that the Volkhov river level was 2–3 m higher than the present one during the Early Middle Ages and, possibly, till the XIV–XV centuries.

There are many medieval archaeological sites in Northwestern European Russia, which paleoenvironmental conditions are unknown or poorly understood. The role of a natural driver in historical events and economics of ancient people remains undefined. The current study is focused on two medieval settlements – Shnitkino (Western Dvina or Daugava river basin) and Gnezdovo (Dnieper river basin). Those sites functioned during the Rus state formation period, IX–

XI centuries. Moreover, Shnitkino and Gnezdovo were placed along the ancient trade route called “The Dnieper trade route” (“From Varangian to Greek route”). Our goal is to find out what the terrain was like when medieval people settled at sites along that route in the Dnieper-Dvina region and what the dynamics of inhabited lacustrine and fluvial landforms were in the Holocene.

Gnezdovo is a broadly known archaeological complex. There are abundant materials published by previous researchers, especially on geomorphological conditions of the archaeological complex (Murasheva, et al., 2009) Dnieper river dynamics (Sidorchuk et al., 2011; Panin et al., 2014), geophysics (Bricheva et al., 2020) and other paleoenvironmental studies (Bronnikova et al., 2018). In this article we present a brief overview of that archaeological complex and geomorphological reconstructions of its surroundings.

We concentrate more carefully on the landscapes of Shnitkino archaeological site. Since 2015 ongoing archaeological investigation of Shnitkino has brought limited insight into the paleoenvironmental settings of the site. Nonetheless, a prospect of a multi-disciplinary approach is encouraging to supplement the fundamentals of geomorphology, paleogeography and geoarchaeology simultaneously. We expect our results to be useful for understanding the hydrological response on the Holocene climate changes, notably on the Medieval warming (VIII–X centuries) and Little Ice Age (XVII–XIX centuries). According to the paleoenvironmental reconstruction based on pollen data, mean temperatures in the East European plane were 1.5–2° higher during Medieval warming (Eremeev, Dzjuba, 2010; Klimanov et al., 1995). Simultaneously, the precipitation amount dropped (Klimanov et al., 1995). In such conditions, river levels decreased in flood and low water, which affected both the alluvium deposition and human settlement patterns within river valleys (Panin, Nefedov, 2010).

2. REGIONAL SETTING AND KEY OBJECTS

The studied region is located in northwestern European Russia. It includes the upper reaches of the Dnieper and Western Dvina (Daugava) rivers and spans part of Valdai and Smolensk-Moscow Uplands and Western Dvina Lowland (fig. 1).

The area belongs to the temperate climate zone, the Atlantic-continental European region. Climatic conditions are determined by the transit of Atlantic air, which is transformed here from maritime to continental (Bozhilina et al., 2007). The climate is moderately warm and moderately humid. Vegetation varies from southern taiga with pine and broad-leaved spruce forests to coniferous-broadleaved forests with a large contribution of birch and aspen forests (Atlas Kalininskoy’..., 1964; Atlas Smolenskoy’..., 1964).

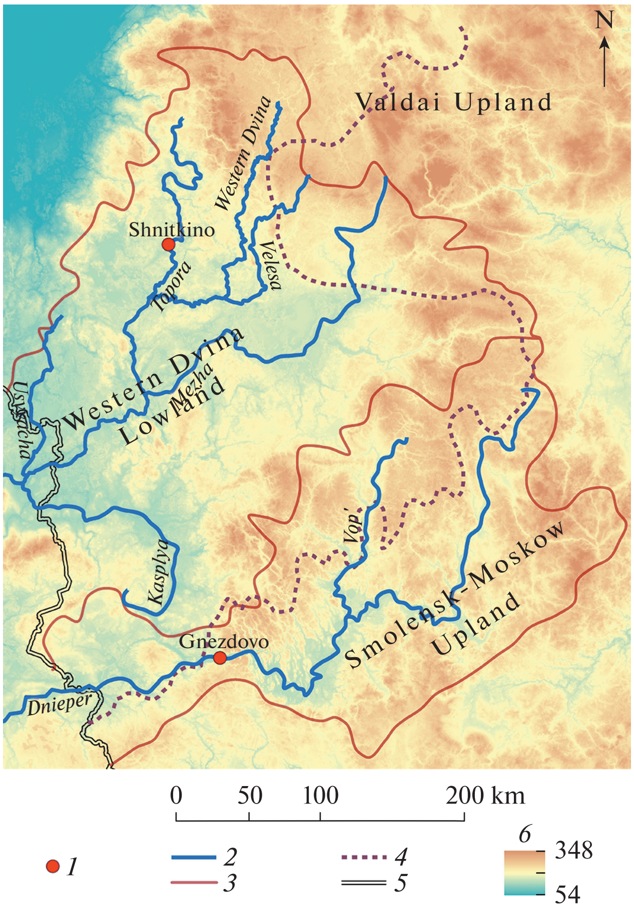

Fig. 1. Map of the Dvina-Dnieper region. *1* – key sites; *2* – main rivers; *3* – drainage basins boundary; *4* – Valdai (Weichselian) glaciation limit; *5* – Russian Federation boundary; *6* – elevation, m above mean see level. Hypsometry is given according to SRTM, the boundary of the maximum Valdai glaciation limit is given according to (Gosudarstvennaya geologicheskaya..., 2011, 2012).

Рис. 1. Карта Днепро-Двинского региона. *1* – ключевые объекты; *2* – основные реки; *3* – границы речных бассейнов; *4* – граница максимального распространения валдайского оледенения; *5* – граница России с Белоруссией; *6* – высота местности, м над уровнем моря. Гипсометрия по SRTM, граница максимального распространения валдайского оледенения по (Gosudarstvennaya geologicheskaya..., 2011, 2012).

Most of the territory is covered by quaternary deposits of different genesis. The bedrocks are sparsely found within the deepest parts of river valleys. One of the significant geological features of the studied region is the last glaciation (Valdai, Weichselian) extent limit (fig. 1). It separates landscapes of different ages and morphology. Glacial and fluvioglacial landscapes, mostly accumulative and poorly reworked by denudation, predominate on the territory of the Valdai glaciation. Another feature of that region is numerous lakes and glacial meltwater valleys, often occupied by modern rivers. Otherwise, glacial and fluvioglacial landscapes of the Moscow (Saalian) glaciation and subsequently subjected to significant erosional reworking are typical of the area outside of the last glacial zone. The river network is denser here and river valleys have more terraces and gentler streambed inclines (Geomorfologicheskoye rayonirovaniye..., 1980).

Two key sites are situated by the opposite sites regarding the Valdai glaciation limit. Both of the sites are placed within river valleys.

Gnezdovo archaeological complex is located 14 km west of the city of Smolensk, in Smolensk Oblast. The site is considered to be the largest mounds cluster in Europe (Pushkina et al., 2010). There are also several strongholds and unfortified settlements here (Arkheologicheskaya karta..., 1997). The Dnieper Kurgan Group (DKG) – one of the mound clusters on the right bank of Dnieper – was investigated in detail. It is located on a flat river terrace and its slope. There are three different-age generations of floodplain adjacent to the terrace (fig. 2, b).

Another important area within Gnezdovo archaeological complex is a Central Settlement (CS), which is located 1 km upstream from the DKG (fig. 2, a). Most of the previous investigations were held in this particular area.

Shnitkino site is located in the Tver Oblast. The main settlement of the site is placed on the left bank of the Shnitkino Lake, which the Toropa River flows through (fig. 3, a). Toropa river is the right tributary of Western Dvina. The paleoenvironmental changes of the studied area were strongly controlled by the development of the river-lake system (Shasherina, Stefutin, 2021). Nowadays the Shnitkino settlement is located almost entirely within the lake terrace and its slope, but some evidence of the cultural layer points to the lower level of the modern lake floodplain. The surroundings of the river-lake valley are the Late Pleistocene glacial and glaciofluvial landscape: hilly plains with kames, swampy depressions and a meltwater channel.

Evidence of crafts (blacksmithing and jewelry) and trade of IX–X c. within the Shnitkino site already exist, but no clear signs of shipping have been found yet (Stefutin, 2017).

3. METHODS AND MATERIALS

3.1. Fieldwork. During fieldworks on Shnitkino sites we used a number of techniques those included:

describing the topography of a nearby landscape and mapping within a radius of 2 km around the site;

coring with an Eijkelkamp manual auger with a sampler 3 cm in diameter and 0.5 m in length (up to a depth of 7.5 m) and mechanical auger with screw sampler 1 m in length (up to a depth of 19 m);

trenching.

We fixed the positions of excavations with a handle-GPS Garmin, photographed and depicted stratigraphic horizons including a cultural layer where present.

24 cores are grouped within different geomorphological positions on the left bank of the Toropa-Shnitkino reservoir system (fig. 3, a–c). We investigated alluvial sediments of the river floodplain and cultural layer, sediments of the Shnitkino Lake bank near the archaeological excavations. Moreover, we acquired the lake bottom cores from a special wooden-styrofoam raft accommodating 4–5 people. As the lake is shallow enough (0.8–2 m) it was cored by the Eijkelkamp manual auger. The first meter of bottom sediment was poorly consolidated, so the core was slightly disturbed during transition through a waterbody. These did not happen with deeper samples.

A trench, 2 × 8 m in area and 1–3 m in depth, was excavated near archaeological excavations for detailed observation of cultural layer configuration at the terrace footslope. A pit, 2 × 2 m in area and 3 m in depth, was dug within an alluvial fan of a small gully cutting the terrace slope.

We retrieved samples for AMS radiocarbon dating as a reliable technique for investigating Holocene and Late Pleistocene deposits and archaeological artifacts (Panin, 2014). Two samples were taken from the pit – wooden tool and pine cone – and one sample from the core TB-18 (poorly decomposed wood residue in laminated overbank deposit).

3.2. Processing of field data. Using obtained stratigraphic and topographic field data we built 3 cross-sections (fig. 4–6). Then we proceeded from distinguishing lithological beds to assigning them to genetic units. We used textures and structures as lead genetic indicators rather than color as in our case it reflected no initial sedimentary conditions but an aquifer level. Boundaries between stratigraphic units were drawn on a genetic basis. All boundaries laying under a depth of 5 m are uncertain because the frequency of mechanical coring (core spacing) is not enough.

Section 1 demonstrates floodplain structure reaching 200 m in length and 12 m in depth – from 2 m above the river edge down to 10 m below.

Sections 2 and 3 illustrate the lake terrace structure, the swampy lake floodplain, the bottom of the lake and the cultural layer position within natural deposits. Section 2 is 210 m long and reaches 19 m in depth – from 4 m above the river edge to 15 m below. Section 3 partly repeats section 2 showing a small slope gully and its alluvial fan on the floodplain surface. The section is 70 m long and 6 m deep – from 3 m above the river edge to 3 m below.

3.3. Dating. Radiocarbon dates were obtained in the Laboratory for radiocarbon dating and electron microscopy, Institute of Geography RAS. Calibration was performed in the OxCal 4.2 program (Bronk Ramsey, 2009) using the IntCal13 calibration curve (Reimer et al., 2016). The dating was previously published by authors in (Shasherina, Stefutin, 2021).

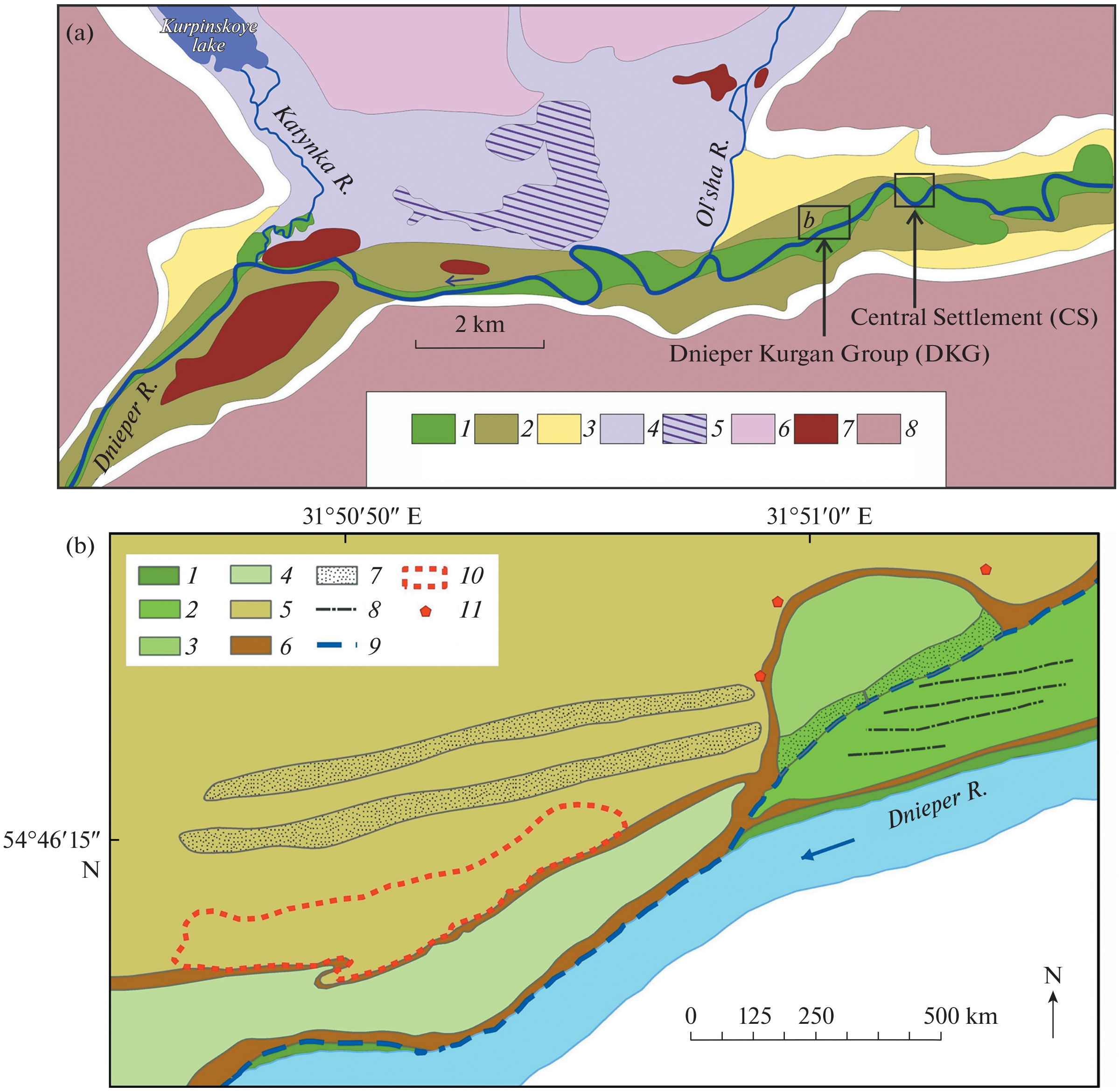

Fig. 2. (a) – Geomorphological map of the upper Dnieper valley: *1* – 5–9 m floodplain terrace (Q4); terraces: *2* – 10–13 m (Late Glacial – Early Holocene); *3* – 13–15 m (MIS 3–4); *4* – alluvial valley bottoms reworked by glaciofluvial processes (LGM); *5* – glaciofluvial ridges (eskers), LGM; *6* – morain terrain of the Late Valdaian glaciation (MIS 2); *7* – erosion remnants composed of glacial tills of different ages; *8* – partly reworked morain/glaciofluvial terrain of the Moscovian glaciation (MIS 6). From (Panin et al., 2014) with supplements. (b) – Geomorphological map of the right bank of Dnieper at the Dnieper Kurgan Group: *1* – low floodplain, *2* – 4–6 m floodplain (300–200 BP), *3* – 4–5 m floodplain (2.5–2 ka BP), *4* – 8–9 m floodplain (11–8 ka BP), *5* – terrace, *6* – erosional slopes, *7* – levees, *8* – floodplain ridges, *9* – the right bank of Dnieper river in IX–XI c. AD, *10* – the main mounds area, *11* – separate mounds. Based on geomorphological survey. Note: elevation of river terrace are related to the Dnieper valley and expressed in meters above the river at the typical low-water stage.

Рис. 2. (а) – Геоморфологическая карта участка Верхнего Днепра. *1* – 5–9 м пойма (Q4); террасы: *2* – 10–13 м (позднеледниково-раннеголоценовая), *3* – 13–15 м (МИС 4–3); *4* – аллювиальная равнина, переработанная флювиогляциальными потоками (LGM); *5* – озы (LGM); *6* – моренная равнина валдайского оледенения (МИС 2); *7* – эрозионные моренные останцы различного возраста; *8* – вторичная моренная/водноледниковая равнина московского оледенения (МИС 6). По (Panin et al., 2014) с дополнениями. (b) – Рельеф правобережья Днепра в районе Днепровской курганной группы. *1* – низкая пойма, *2* – 4–6 м пойма (300–200 BP), *3* – 4–5 м пойма (2.5–2 ka BP), *4* – 8–9 м пойма (11–8 ka BP), *5* – надпойменная терраса, *6* – эрозионные склоны, *7* – прирусловые валы, *8* – оси пойменных грив, *9* – правый берег Днепра в IX–XI вв. н. э., *10* – область расположения курганов, *11* – отдельные курганы. Карта построена на основе геоморфологической съемки. *Примечание:* высоты пойм и террас даны относительно среднего уровня воды в межень.

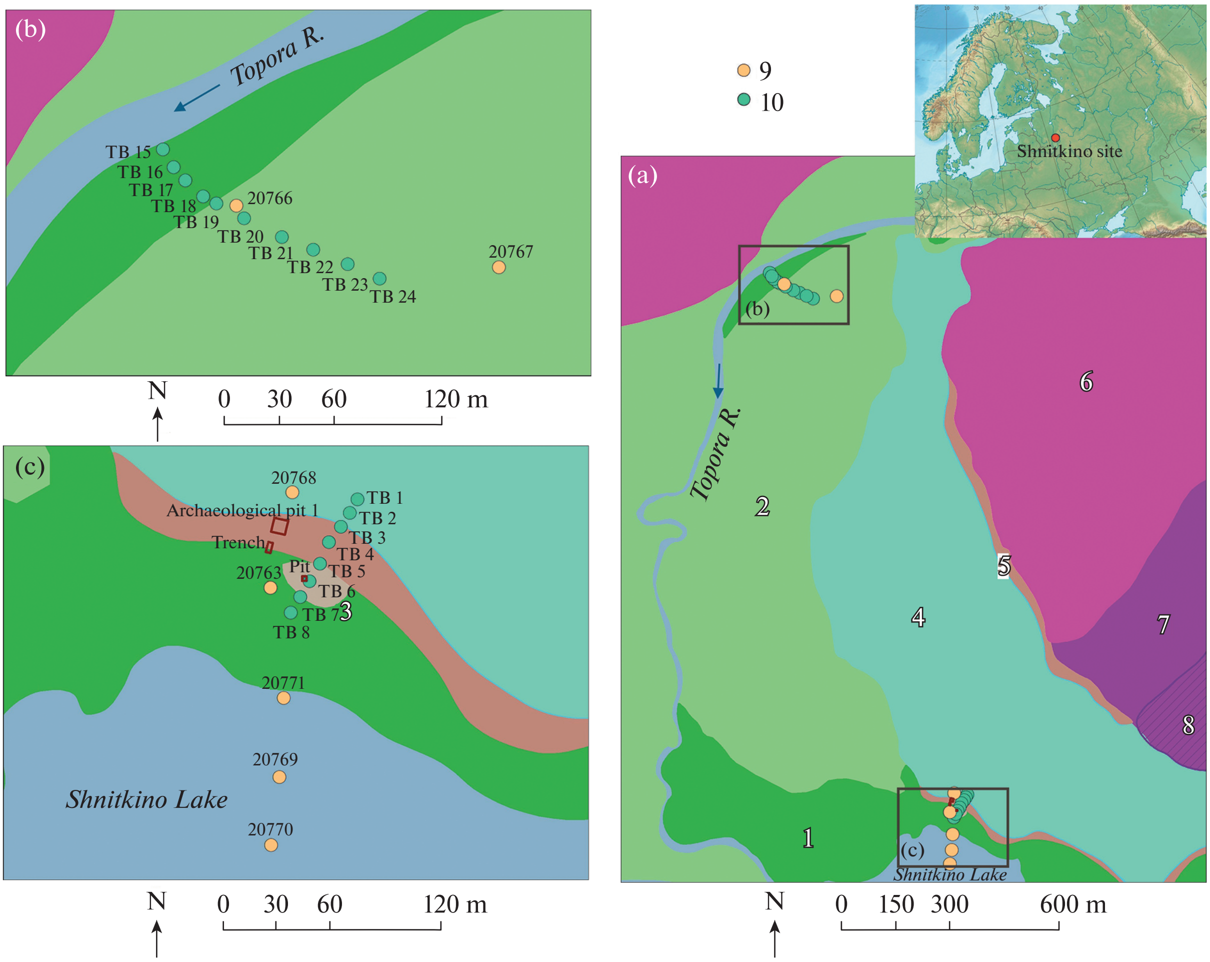

Fig. 3. Landscape within the Shnitkino key site. (a) — tudied area, (b) — cross-section 1, (c) — cross-sections 2 and 3; TB-1–8, 15–24 and 20796-71 mark manual cores, 20763, 20766-67 mark mechanical cores. *Landforms*: 1 — swampy/low floodplain, 2 — high floodplain, 3 — alluvial fan, 4 — lake terrace, 5 — slopes, 6 — hilly glacial plain, 7 — hilly glaciofluvial plane with kames and swampy depressions, 8 — meltwater channel. *Drilling*: 9 — mechanical, 10 — manual. Based on own geomorphological survey and (Gosudarstvennaya geologicheskaya..., 1976).

Рис. 3. Геоморфологическая карта окрестностей Шниткино. (a) — изучаемая территория; (b) — положение профиля 1; (c) — положение профилей 2 и 3; ТБ — точки бурения и их номера: 1–8, 15–24 и 20796-71 точки ручного бурения; 20763,20766-67 точки механического бурения. *Формы рельефа*: 1 — заболоченная/низкая пойма, 2 — высокая пойма, 3 — конус выноса МЭФ, 4 — озерная терраса, 5 — склоны, выражающиеся в масштабе, 6 — холмистая моренная равнина, 7 — холмистая водно-ледниковая равнина с камами и заболоченными депрессиями, 8 — ложбина стока талых ледниковых вод. *Бурение*: 9 — механическое, 10 — ручное. Карта построена на основе геоморфологической съемки и данных (Gosudarstvennaya geologicheskaya..., 1976).

3.4. Employed materials. We used geological survey report of Toropetskaya field party with a core database, a geological map of 1:200000 scale and supplementary geological description (Tretyakov et al., 1967; State geological..., 2020), satellite images (open source Google, Yandex) for identifying some territories up and downstream the river valley that could be analogs of the studied area. Archaeological Map of Russia (Arheologicheskaya karta..., 2007) was employed in order to obtain the distribution of medieval settlements within the Toropa River basin.

Current unpublished archaeological materials — description of the archaeological pit No. 1 — were also applied to supplement cross-sections with the cultural layer trace.

4. RESULTS

4.1. Shnitkino. The modern landscape, its lithological structure and dynamics. As already mentioned, the Shnitkino settlement is located within the lake terrace and its slope (fig. 3, a, c). That terrace is 3–4 m in height above the river edge and is being observed only on the left bank of the lake. The terrace surface is flat and its slope is poorly reworked by erosion. Only one small gully is cutting the terrace slope. The terrace sediments are fine and coarse sands and silt. In the geological survey report (Tretyakov et al., 1967) these de-

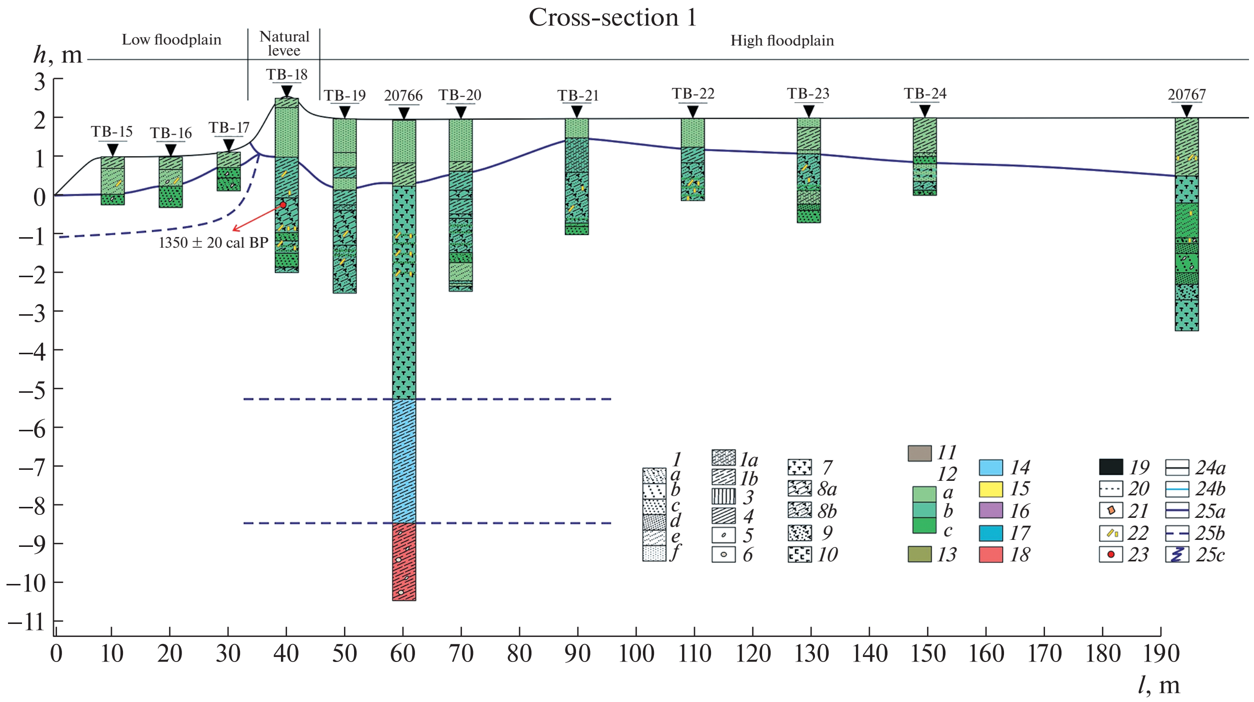

Fig. 4. Toropa river valley cross-section 1. *Texture: 1* – sand (*a* – diamicton, *b* – very coarse, *c* – coarse, *d* – medium, *e* – fine, *f* – very fine); *2a* – sandy loam; *2b* – clayey loam; *3* – silt; 4 – clay; *5* – gravel; *6* – pebble; *7* – peat; *8* – peat (*a* – sandy loam, *b* – clayey loam); *9* – sand; *10* – gyttja. *Genesis and age of deposits: 11* – alluvial fan Q4; *12* – alluvium Q4 (*a* – overbank, *b* – swampy overbank, *c* – channel); *13* – marsh Q4; *14* – lacustrine Q4; *15* – colluvium Q4; *16* – glaciofluvial MIS 2; *17* – limnoglacial MIS 2; *18* – till of the Valdai glaciation. *Other designations: 19* – cultural layer of the IX–XI c.; *20* – presumed boundaries of the cultural layer of the IX–XI c.; *21* – archaeological artifacts of the IX–XI c.; *22* – plant remains; *23* – dates ^{14}C, cal. years BP; *24* – topography of (*a* – landscape, *b* – lake bottom); *25* – boundaries (*a* – precise, *b* – imprecise, *c* – facial).

Рис. 4. Геолого-геоморфологический профиль 1 через долину р. Торопа. *Состав отложений: 1* – песок (*а* – разнозернистый, *b* – грубозернистый, *c* – крупнозернистый, *d* – среднезернистый, *e* – мелкозернистый, *f* – тонкозернистый); *2a* – супесь; *2b* – суглинок; *3* – алеврит; *4* – глина; *5* – гравий; *6* – галька; *7* – торф; *8* – оторфованный(ая) (*a* – суглинок, *b* – супесь); *9* – оторфованный песок; *10* – сапропель. *Генезис и возраст отложений*: *11* – пролювий Q4; *12* – фации аллювия Q4 (*a* – пойменная, *b* – пойменных водоемов, *c* – русловая); *13* – болотные Q4; *14* – озерные Q4; *15* – коллювий Q4; *16* – флювиогляциальные МИС 2; *17* – лимногляциальных МИС 2; *18* – морена валдайского оледенения. *Прочие обозначения*: *19* – культурный слой IX–XI вв.; *20* – предположительные границы культурного слоя IX–XI вв.; *21* – археологические артефакты IX–XI вв.; *22* – растительные остатки; *23* – даты ^{14}С, кал. лет; *24* – профиль (*a* – рельефа суши, *b* – рельефа дна озера); *25* – границы (*a* – точная, *b* – предполагаемая, *c* – фациального перехода).

posits and the terrace itself are claimed to have formed in the Late Pleistocene by lacustrine sedimentation.

The floodplain has two levels (high and low floodplain), both flooded during high water in spring. The high floodplain is 2 m above the river edge and has a natural levee (fig. 4). The low floodplain is 0.5–1 m in height and represents a point bar that is already covered with grass. The high floodplain has the following structure. The upper sedimentary unit was represented by laminated fine sand or silt and the underlying unit 3–4 m thick consisted of sandy organic sediments (overbank facies). Glaucous laminated loam lies below associated with lacustrine facies. In the core 20766 we reached the basal sandy loam with gravel that is presumably till (fig. 4), however, we cannot argue confidently on its origin. In the downstream part of the valley, floodplain levels merge into the Shnitkino Lake swampy floodplain. That swampy floodplain is composed mainly of peat with sandy interlayers, which may reflect reworked terrace deposits (fig. 5). These beds are underlain by silt similar to the lacustrine sediments found within the core 20766 at the same depth. The alluvial fan and slope sediments – unsorted sands – cover peat at the junction of the floodplain and terrace (fig. 5, 6).

Based on the described floodplain structure we have noticed the pattern: alluvial facies alter from organic clay formed in a waterlogged condition to sandy loam, silt and even fine-grained sand. Moreover, there are no erosive boundaries observed within the sedimentary sequences. Such features indicate a continuous accumulation in the valley presumably during the Holocene. There is one date in the TB-18 proving the Late Holocene floodplain formation (table 1).

The lake bottom is composed of sapropel and underlying loam of lacustrine facies (fig. 5). In some places, sapropel lies under alluvial deposits of the Toropa River (core 20771), especially where the river branches and flows into the lake.

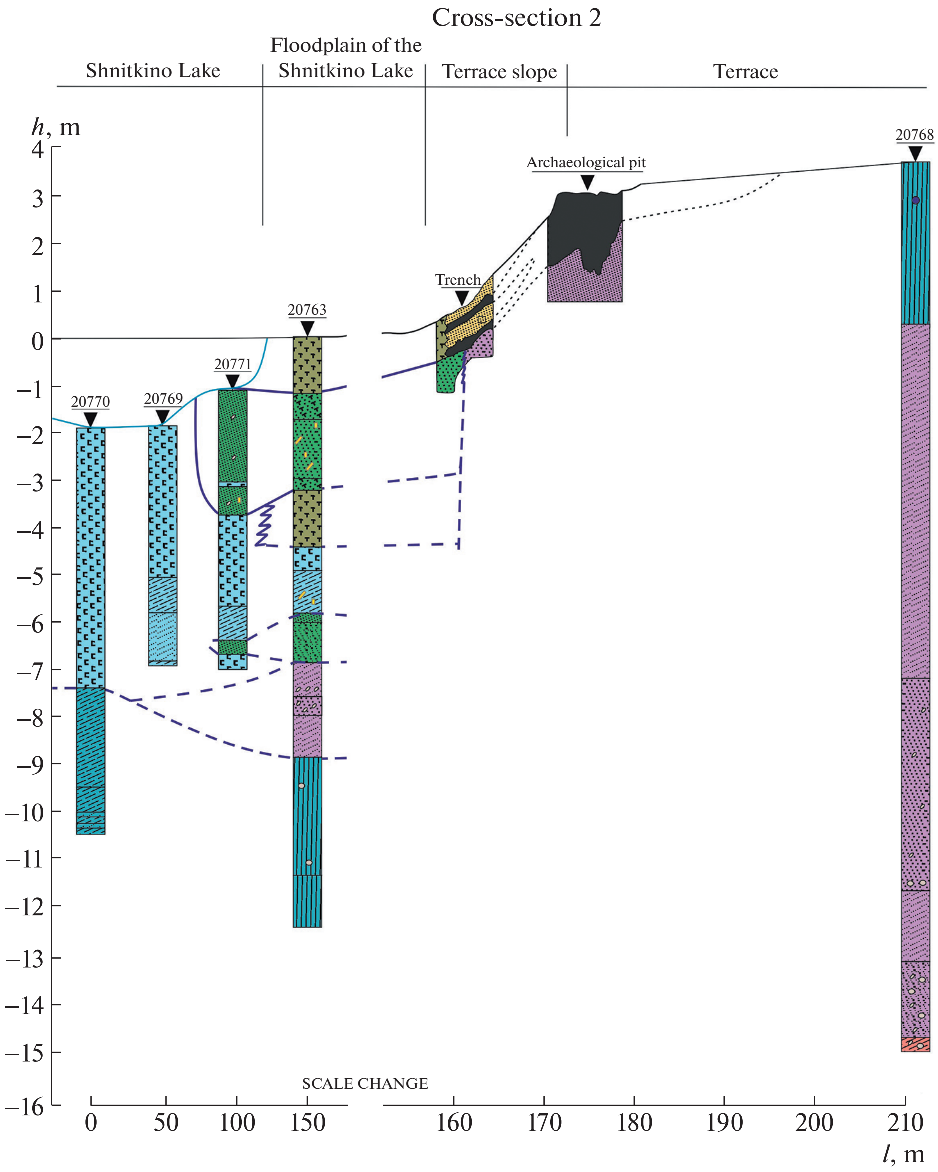

Fig. 5. Toropa river valley cross-section 2. See fig. 4 for legend.
Рис. 5. Геолого-геоморфологический профиль 2 через долину р. Торопа. Усл. обозначения см. рис. 4.

In some sections, the cultural layer is clearly traced (fig. 5): it is found above the terrace sands and within the floodplain peat where it is laterally replaced by peat with cultural remains (ceramics, wooden tools). It indicates synchronous accumulation of peat and cultural layer otherwise cultural remains could not land in peat. Slope masses and alluvial fan buried the cultural layer so it is well-preserved for investigations.

Obtained dates from peat with cultural remains and underlying sand confirm the early medieval age of archeological findings (table 1).

Table 1. Radiocarbon dates from the Shnitkino site
Таблица 1. Радиоуглеродные даты по археологическому памятнику Шниткино

Lab. No.	Excavation name	Depth, m	Material	^{14}C age BP(1σ)	Age, calBP(2σ)
IGANams6623	TB-18	2.9	wood	1465 ± 20	1310–1390
IGANams6627	Pit	1.3	wood	1135 ± 20	1015–1095
IGANams6626	Pit	2.1	pine cone	2960 ± 80	2985–3145

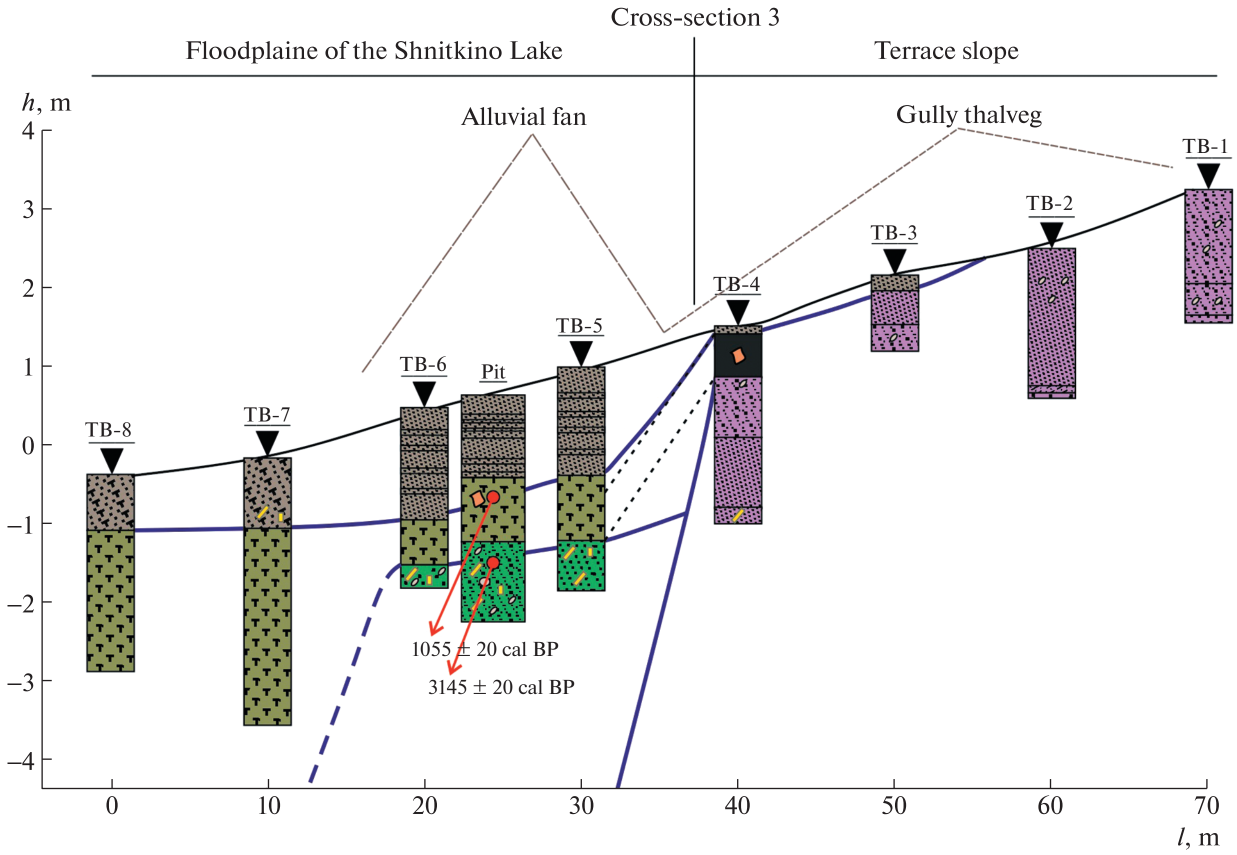

Fig. 6. Toropa river valley cross-section 3. See fig. 4 for legend.

Рис. 6. Геолого-геоморфологический профиль 3 через долину р. Торопа. Усл. обозначения см. рис. 4.

The small gully was formed later than the settlement, probably after it became abandoned because alluvial fan deposits overlap peat with cultural remains and do not contain any artifacts (fig. 6).

4.2. Interpretation of Shnitkino stratigraphic sections. The described landscape structure is not typical for most of the last glaciation zone. Local small rivers usually have relatively narrow valleys with one or two floodplain levels and sometimes one terrace (in most cases erosional). Downcutting trend within river valleys is more likely than accumulative (Panin, 2015). The mean width of the Toropa valley is 100–150 m whereas near the Shnitkino confluence it reaches 1 km. Some analogs have been found in the Toropa Valley 50 km upstream where the river successively flows through the Yassy, Kudinskoe and Solomennoe lakes and the valley becomes wider than usual.

We did not expect an accumulative trend in the river-lake system located in the last glaciation zone. There must be some local paleoenvironmental explanation because we do not observe the same sedimentation features upstream or downstream the river valley. Two possible reasons are: 1) the inheritance of a Pleistocene depression and 2) local damming of the lake at least since the onset of the Holocene.

As for the paleotopography of the Shnitkino Lake bank, there is no clear difference from the modern one. The cultural layer configuration and tilt indicate a slightly steeper slope, which was not disturbed by the river or wave erosion during or after the cultural layer formation (fig. 5). The main processes of slope transformation are downslope soil washout and plowing of the upper part of the slope (creating a plow shaft). We expected one of the Toropa braids to come close to the bank and rework the terrace slope during medieval times, but that could have happened only prior to the swampy floodplain started forming.

4.3. Gnezdovo. The modern and past landscapes. Based on the previous research (Bronnikova et al., 2018) we have correlated the studied landforms on DKG (fig. 2, b) with the landforms of CS on the principal of the same morphology and height above mean river water level (table 2). They are ranged according to the age derived from OSL and radiocarbon dating of deposits which build up landscape within CS territory. Not only floodplain and terrace, but the erosion pit and levee have analogs. Such comparison gives us an opportunity to estimate the age of the landforms only by geomorphic features.

Table 2. The comparison of Dnieper Kurgan group (DKG) and Central Settlement (CS) landforms (Bronnikova et al., 2018)

Таблица 2. Рельеф долины Днепра по результатам изучения геолого-геоморфологического строения участков Днепровской курганной группы и Центрального селища (Bronnikova et al., 2018)

Time of occurence	Landforms within DKG, height	Landforms within CS, height
Late Pleistocene – Early Holocene	Terrace, 10–11 m	Terrace T0, 10–11 m
Early Holocene – Middle Holocene	Floodplain, 8–9 m	Floodplain Fp2, 3–9 m
Late Holocene: early Subatlantic	Erosion pit 3.55 m	Erosion depressions of lakes Kamyshi and Bezdonka, 3–9 m
Late Holocene: late Subatlantic	Floodplain 3.5–6 m and a levee on its northern side	Levee L, floodplain Fp1, 7–9.5 m

The construction of mounds, as well as settlements, is confined on the constantly flooded terraces. The mounds of DKG descend along the cape-like ledge of the terrace to a height 9 m above the river – this is the mark of the maximum floods height in IX–XI centuries. It is already known that the early medieval cultural layer at the CS, lying below 7 m above river level, is interbedded with alluvium. This indicates that the maximum height of the Dnieper level rise in the Middle Ages was lower than the modern one (Bronnikova et al., 2018).

According to the data obtained, the 4–6 m floodplain did not exist in middle age. In the structure of the highest Early Holocene floodplain, a paleosol dating back to the period of 2400–610 years ago is described (Shasherina et al., 2020). This means that during this period the floodplain was extremely rarely flooded. The channel of the Dnieper in the Early Medieval time was located no closer than 100–200 m south of the 10–11 m terrace edge (fig. 2, b). Opposite the mound complex, the channel has not changed its position, upstream it slowly receded to the left (to the south), forming a gentle bend, observed in the modern channel contour (fig. 2, b).

The cultural layer within the DKG, in contrast to the CS, was not found. Except for mounds, there are no other signs of medieval people's activity in the area of DKG. The highest early Holocene floodplain was not frequently flooded, but also not settled by people. The early Holocene floodplain was probably too wet/bogged, which could be caused by groundwater discharge in the terrace ledge. In addition, the width of the floodplain is on average 100 m, while the width of the floodplain of the same age within the CS area is 300 m. It is possible that the width of the floodplain, and especially its non-bogged part, determines the conditions for a permanent settlement.

5. DISCUSSION AND CONCLUSIONS

5.1. Paleogeomorphological conditions of the Shnitkino site. Inhabitants of Shnitkino lived on the bank of the lake Shnitkino which was steeper than nowadays. Such a location is typical for early medieval settlements because terraces were not flooded. As for the studied terrace, during the Late Holocene it was close enough to the water and undisturbed by river or wave erosion. People settled here while the lake-river system development that is proved by the facial replacement of the cultural layer by lake peat saturated with archaeological material (fig. 5). The water level might be as low as the cultural layer discovered in the trench (fig. 5) and, possibly, the lake was deeper than now. An accumulation in the river-lake system during Little Ice Age caused the bottom and water levels uplifting.

The low flooding regime during the Early Medieval ages is confirmed by bioanalysis and soil micromorphology of the floodplain peat near the settlement (Karpova et al., 2020). The peat layer with cultural remains is confirmed to be waterlogged, weakly flowing, undisturbed, and shows signs of soil-forming processes. Uninterrupted peat accumulation in the whole sediment pack occurred in subaquatic or wetland conditions.

The modern condition of the bank makes it possible to launch small floating craft, like a boat or kayak, into the water. Based on our initial reconstruction, the bank of the Shnitkino Lake could have been used as a harbor for drakkars seasonally (during a flood) or in certain high-water periods.

5.2. Paleogeomorphological conditions of the Gnezdovo site. In the inhabited part of the Dnieper valley, people used the intra-floodplain lake basins for activities related to navigation and crafts. Vessels could enter Lake Bezdonka as an inner harbor, where they could be repaired or protected from being damaged by ice drift (Bronnikova et al., 2018). Lake Kamyshi, most likely, was used as a source of water for high-temperature industries located on its shore (Pushkina et al., 2010). The heyday of the settlements of the archaeological complex fell in the second half of the 10th century, at the sametime the growth of the mound areas is also noted (Pushkina et al., 2010). The decline of Gnezdov happened between the XIII and XIV centuries, and sometime after that, the frequency and height of floods sharply increased on the Dnieper, causing the accumulation of alluvium to resumed in previously unflooded areas of the floodplain.

5.3. Geomorphological factor of valley settlement formation. Contrasting variations of river regime over the Holocene reported from different river basins in the Central and Northern East European Plain (Golosov, Panin, 2005; Sidorchuk et al., 2008; Sidorchuk et al., 2012; Syrovatko et al., 2019) must have influenced the human occupation of river valleys. Climatic spatial and temporal patterns of prehistoric and Medieval settlements across the northwestern Russia have been established for the upper reaches of the Western Dvina and Volga (Panin, Nefedov, 2010): the climatically controlled shifts of low-water periods by high-water periods were accompanied by people moving to higher valley levels. During the Medieval warming the flooding activity of rivers decreased, allowing people to settle floodplains, which now are flooded or swampy.

In the case of large rivers such as the Western Dvina or Dnieper, the floodplain terraces, especially the Late Pleistocene-Holocene terrace, and the high floodplains are the most convenient locations for settlement in the Early Middle Ages. This is confirmed by the analysis of the locations of settlements described in the Archaeological Map of Russia of Smolensk and Tver Oblasts (Arheologicheskaya karta..., 1997; Arheologicheskaya karta..., 2007).

In the upper Dnieper valley, Early Medieval settlements are located on the floodplains close to the channel and on high floodplains that were not flooded during Medieval warming. Sites on the Dnieper banks are found at minimum heights of up to 6–7 m above the water level – now flooded areas. In the valleys of tributaries, settlements are located closer to the channels (up to 2 m above the mouths of small streams), as well as on the banks of lakes.

In areas covered by the last glaciation, the river network, especially the smaller watercourses are unable to accommodate settlements in their narrow valleys, and more sites are found in the interfluves. The Toropa River basin contains 78 Early Medieval settlement sites. Only 6% of these are located on the floodplains, 78% on lake terraces and 16% on the interfluves. This means that high terraces were a priority when choosing a settlement position in the Early Middle Ages. Such terraces were adjacent to large lakes rich in water and biological resources. In the Early Medieval (as at present), they were not flooded during the high water phases, which is confirmed by the reconstructions of changes in the level regime of the rivers and lakes in the upper reaches of the Western Dvina according to archaeological and geomorphological data (Panin, Nefedov, 2010) and our own material – the alluvium does not overlay lake terraces even in the valley sections with accumulative dynamics.

Thus, despite the absence of fluvial terraces in small river valleys, people found places for settlement on terraces of lacustrine or glacial nature (glaciofluvial, kame).

Three conclusions can be summarized from the study of the two key sites.

1. The foundation of Medieval settlements in the river valleys of the Dvina-Dnieper region was linked with the areas where lakes were formed. The mechanism for the formation of lakes differed due to the differences in the post-glacial history of the river valleys; in the glacial area they could be residual lakes left over from larger post-glacial lakes (lake Shnitkino), in the nonglacial area – associated with floodplain and channel restructuring (lakes Kamyshi and Bezdonka).

2. During the Medieval warming of the Holocene period, flooding activity of rivers decreased, which allowed people to inhabit floodplains in the Dvina-Dnieper region.

3. In the Late Holocene, the development of river valleys was dominated by accumulation processes. Accumulation within river channels was uninterrupted, while within floodplains was fluctuating according to flood height changes (e.g. during the Medieval warming). It resulted in some inhabited areas becoming buried under alluvial (in Gnezdovo) or lacustrine-mire, slopewash (in Shnitkino) sediments after the Early Medieval ages.

Geomorphological Settings of the Early Medieval Settlements Within River Valleys in the Dnieper-Dvina Region, Northwestern European Russia

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The most active relief changes in the Northwest of European Russia during the last millennia were due to the geomorphological activity of rivers. Reconstruction of these changes is of great importance for the studies of the Late Holocene archaeological sites, many of which are located in the bottoms of river valleys. The studies performed at two key sites – Shnitkino (Toropa River valley, Western Dvina River basin) and Gnezdovo (upper Dnieper valley) – allowed to reconstruct the appearance of local landscapes in the Early Middle Ages. The geological and geomorphological structure of the valley sections was studied, and radiocarbon dating of the deposits was performed. The studied Early Medieval settlements were founded on the shores of lakes of non-oxbow type, quite numerous in the river valleys of the Dnieper-Dvina region. The mechanism of lake formation differed due to differences in the post-glacial history of the river valleys: in the glacial zone these could be residual lakes originating from larger post-glacial lakes (lake Shnitkino in the Toropa river valley), outside the boundary of the last glaciation – lakes associated with river activity (lakes Kamyshi and Bezdonka in the upper Dnieper valley). It has been found that during the Medieval Climate Warming (VIII–XII centuries) the magnitude of floods was lower than now, which allowed the settling of floodplains of rivers normally inundated by spring floods. The dynamics of river valleys in the Late Holocene was reconstructed. The development of river valleys was generally dominated by accumulation processes. Sediment accumulation on the river floodplains was interrupted when flood levels decreased, as during the Medieval Climate Warming, and resumed when the hydrological regime changed towards an increase in floods (the Little Ice Age in the 14th–19th centuries).

Keywords: Dnieper-Dvina trade route, geoarchaeology, Holocene, paleogeography, trade routes

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