Paleoenvironment of the medieval settlement Hodosivka-Roslavske (11/12-14th cent. AD, Ukraine):
the first comprehensive bioarchaeological investigation of the East Slavic village

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ABSTRACT

Informative and representative bioarchaeological data were obtained using screen-washing and flotation at the late-medieval Hodosivka-Roslavske settlement (near Kyiv, Ukraine) in 2015. Material under study included carbonated macroremains of cultivated plants (rye, millet, barley, emmer wheat, pea), wild grass (brome), weeds (cleaver), nutshell, charcoal samples (belonging to pine, oak, maple, ash, poplar/aspen, alder, willow, rowan), as well as fish bones and scales (representing eight species, including perch, pike, catfish, etc.), bones of anuran amphibians (toads and frogs), reptiles (sand lizard, grass snake), birds (garganey/Eurasian teal, marsh tit), and teeth of small mammals (both insectivorous and rodents). These findings have significantly deepened our knowledge of the paleoecology of the Hodosivka-Roslavske settlement from the 11/12-14th centuries AD. The use of screen-washing and flotation provides an opportunity to obtain a large amount of comprehensive information about the environment of this archaeological monument.

Key words: Hodosivka-Roslavske settlement, Middle Ages, charcoal, paleoethnobotany, archaeozoology, environment.

1. Introduction

The period between the 10th and 13th centuries AD was significant in East Slavic history. States and military-political unions of East Slavs during that time played an important role in not only Eastern Europe, but also abroad (Davies, 1996). There are numerous studies concerning the East Slavs (e.g., crafts, graffiti, burials, etc.). However, the environmental studies of East Slavic settlements are still fragmented and often dedicated to specific research topics (vegetation, fishes, birds, mammals). It is almost impossible to compare obtained results of palaeoenvironmental analysis because of significant longitudinal remoteness of the described sites (from 48.0° N to 58.5° N). More or less complex research was done only on Novgorod, which is located in the north of the Slavic Lands (Brisbane, Makarov, Nosov, 2012). There are no comprehensive environmental studies even on Kyiv, which was a major political, commercial and cultural centre for the East Slavs, as well as one of the biggest cities in medieval Europe (Hohenberg, 2004). The eleventh-thirteenth centuries are remarkable not only because it was the heyday for Kievan Rus, but also it was the time when livestock breeding began to prevail over hunting in this region (Brjuzgina (Umanskaja), 1975). Moreover, it was a period of global warming in the Northern Hemisphere (Mann, 2002). The study of environmental conditions of the medieval Kyiv and its outskirts is complicated by the fact that during that time it was an important point of the famous Trade Route from the Varangians to the Greeks, so some animals and plants could be transported there from remote regions. Archaeological excavations near Kyiv are usually carried out in Vyshgorod (elite satellite medieval city) or on the territory of monasteries. That is why we chose to study a small village which has been located in close vicinity to Kyiv, but which had not great economic, cultural or defensive value. The results of such research can not only expand the characteristics of this monument, but also help to restore the environment near the medieval Kyiv and outside of its stockade. The main source of such information is derived from bioarchaeological data obtained using screen-washing of soil samples from the cultural layer.

The aim of this study is to present the results of investigation of numerous small biological remains obtained using screen-washing and flotation during excavations of the Hodosivka-Roslavske settlement in 2015, and to reconstruct its paleoenvironment with the additional information.

2. Information about the site

The late-medieval settlement Hodosivka-Roslavske was discovered in 2007, and since it has been under continuous study by the North Archaeological Expedition (NAE) of the Institute of Archaeology (National Academy of Sciences of Ukraine) led by I.A. Gotun. The site (50°16' N, 30°32' E) is located on a small hill in the southern suburbs of Kyiv, Ukraine (Fig. 1), in the

floodplain of the Dnieper River. The hill is covered by trees and shrubs and surrounded by meadows and swamps. This monument is dated to the Old Rus and Mongolian-Lithuanian periods (11/12-14th centuries AD), however it also contains some Neolithic artifacts, layers of Bronze Age and early Iron Age date, as well as findings dated to the I kya AD. A substantial amount of material on the specifics of South Rus village has been obtained during the excavations of this settlement (e.g., Gotun, 2009). In 2015, archaeological studies of the Hodosivka-Roslavske settlement were continued by the NAE IA NAS of Ukraine. The main purpose of these studies was to improve the information content using screen-washing and flotation of the cultural layer for further sampling of small biological remains.

As it was shown earlier (Gotun, 2008; Gotun, Suhonos, Kazymir, 2009; Gotun, Kazymir, 2010), the cultural layer of the settlement is characterized by a high level of material and spiritual culture. Some of these items (e.g., armament, soldier and battle horse munition, jewelry, amber, glass bracelets, etc.) were considered as unique to urban populations in traditional historiography. In various areas of economic activity, the site represents a type of settlement having a multistructural and highly developed economy and high level of welfare. It is essential that, in addition to things characterizing the features of livelihood in the settlement, significant data were also obtained on the specific interaction between its inhabitants and environment.

Some archaeozoological materials from this settlement were published previously (Taykova, 2009), others await lab processing. Thus, O.P. Zhuravlev and O.P. Senyuk (pers. comm.) have identified seven species of domestic and fourteen species of wild mammals, eight fish species, one reptile species, and one mollusk species in the collection created in 2007-2011. Additional bone remains collected in 2008-2012 were identified by A.V. Mishta as belonging to two species of rodents (A.V. Mishta, pers. comm.). Taykova (2008) identified 17 species of birds, including poultry (domestic chicken) in materials from 2007-2010. There are nine species of bony fishes in materials from the settlement, as it has been stated by E.Yu. Yanish (unpublished). G.O. Pashkevich noted indentations of five species of crops on fragments of ceramics and pieces of coating collected in 2007-2008 (Pashkevich, unpublished). Another two species were identified by S.A. Gorbanenko on fragments of pottery collected in 2011 (Gorbanenko, unpublished).

3. Material and methods

Charcoal samples, grains of cereals, leguminous plants and wild grass, numerous remains of vertebrate animals (total of 440 specimens, including 346 diagnostic) from the medieval Hodosivka-Roslavske settlement (11/12-14th centuries AD) were analysed and described here for the first time. This material was obtained mainly using screen-washing (mesh size – 1 mm) and

flotation during excavations under the guidance of I.A. Gotun in 2015. Sampling was made from a previously identified cultural layer. The settlement is characterized by the presence of a single cultural layer; samples were taken at depth of about 0.5-0.7 m; accidental invasion of remains to the layer were excluded. We affirm that all material can be dated to the 11/12-14th cent. AD. The total amount of the processed (washed) material is about 150 litres.

Paleoethnobotanical materials (grains) were identified by morphological characters with an aid of Leica/Wild M3Z stereomicroscope (magnification of single specimens was up to $\times 10$). Analysis of charcoal is based on wood anatomy, which remains perfectly preserved after carbonization. Woods were identified through comparison of their microstructure on transversal, radial and tangential sections with those in extant species (see Sukachev, 1940; Gammerman et al., 1946; Vihrov, 1959). Although examined animal bones are associated with the cultural layer, and belonged to species living at that time (or somewhat later) near the settlement. The osteological material has recently deposited in the Department of Paleontology, National Museum of Natural History (NMNHU-P), National Academy of Sciences of Ukraine (Kyiv, Ukraine). Species identification and anatomical determination of fish, bird and mammal remains were carried out using the comparative osteological collection in the NMNHU-P. Remains of amphibians and reptiles were identified using the comparative collection in the Department of Historical Geology and Paleontology, Voronezh State University (Voronezh, Russian Federation), based on diagnostic characters specified in special literature (Szyndlar, 1984; Ratnikov, 1994, 2001, 2012). The fish systematics in this paper follows Nelson (2006), amphibians – Frost (2016), reptiles – Uetz, Hošek (2016), birds – Lepage (2016), mammals – after Wilson, Reeder (2005). Ecological analysis of the identified animal taxa is based on ecotopic preferences of recent analogues (Bannikov et al., 1977; Ananieva et al., 1998; Orlova, Semenov, 1999; Davydenko, 2007; Pisanets, 2007; Movchan, 2011; Kuzmin, 2012). Abbreviations used: MNI – minimum number of individuals; NISP – number of identifiable specimens. Number of individuals was the highest number of bones of either left or right side of the body.

4. Results

4.1. Plant macros

Remains of plant grains from the Hodosivka-Roslavske settlement belonged to representatives of two groups: cultural plants (cereals and leguminous), wild grass and weeds (Table 1). The first group includes at least five species, among them remains of rye *Secale cereale* are the most numerous (seven grains). Millet *Panicum miliaceum* is the second most abundant species in the locality and represented by four grains. Other species (barley *Hordeum vulgare*, emmer wheat *Triticum dicoccum*, and pea *Pisum sativum*) are recorded each by one specimen. One grain in the

processed material is identified only to Cerealia. Diversity of wild grass and weeds is significantly lower, however the half of all grains belongs to this group. Thirteen of them were identified as cleaver *Galium aparine*, and one as brome *Bromus* sp. One nutshell fragment of *Corylus* sp. was found.

4.2. Charcoal

Twenty-four fine charcoal samples were obtained from the ancient Rus cultural layer using flotation. The following wood species were identified (Table 1): pine *Pinus sylvestris* (7 samples), oak *Quercus* sp. (4), maple *Acer* sp. (2), ash *Fraxinus* sp. (1), poplar / aspen *Populus* sp. (1), alder *Alnus* sp. (1), willow *Salix* sp. (1), rowan *Sorbus* sp. (1), and unidentified deciduous tree (6 samples). Only ripe wood (i.e., obtained from tree trunk) is represented among the analyzed samples. Charcoal belongs to indigenous wood species which are characteristic for mixed and deciduous forests. It indicates the composition of native vegetation near the settlement. The small amount of charcoal and its detection in the cultural layer (i.e., out of context allowing further historical reconstruction), does not allow its accurate interpretation.

4.3. Animal remains

For this study, 110 fish bones and 384 complete or broken scales were processed. The vast majority of them (n=311) were identified to the species level, another 46 remains (including one centrum, two fin rays and 43 scales) – to family level (Cyprinidae); however, 27 fish bones (e.g., fragments of centra, ribs, etc.) are not diagnostic and remain undetermined (Table 2). Eight species and genera representing four families (Cyprinidae, Siluridae, Esocidae, and Percidae) were recognized (Table 2). Most of the remains were those of perch *Perca fluviatilis* (NISP=234) and pike *Esox lucius* (NISP=34). Catfish *Silurus glanis* is the third most abundant species (NISP=11). Some other species (e.g., bream *Abramis brama* and crucian carp *Carassius carassius*) were of minor importance (NISP=3). At the same time, ide *Idus idus*, roach *Rutilus rutilus*, common rudd *Scardinius erythrophthalmus* are each recorded by two bones. It is not possible to determine the systematic affiliation of some remains; therefore, they are described as Teleostei indet.

Remains of amphibians were not numerous in the osteological collection from the Hodosivka-Roslavske settlement; however, the vast majority of them were identified to species or at least to genus level (Table 2). Four species of anuran amphibians (toads and frogs) were distinguished: common spadefoot *Pelobates fuscus* (NISP=4), European toad *Bufo bufo* (NISP=1), moor frog *Rana arvalis* (NISP=4), and brown frog *Rana* sp., represented by two sacral vertebrae (Table 4). There is one additional tibia belonging to some true frog (Ranidae gen. et sp. indet.).

Reptiles are represented by a handful number of osteological remains. One maxilla and one dentary belong to sand lizard *Lacerta agilis*, one abdominal vertebra – to grass snake *Natrix natrix*.

Species richness of birds in materials from the Hodosivka-Roslavske settlement is also poor. Remains of only two species were identified. Garganey / Eurasian teal *Anas querquedula / crecca* is represented by its one radius, whereas marsh tit *Parus palustris* was identified by one tibiotarsus. The proximal parts of both bones are broken. The small number of bird remains does not allow interpreting the habitat near the settlement, so they should be considered along with other taxa.

The species composition of mammals from the Hodosivka-Roslavske settlement is rather interesting: only bones of insectivorous mammals (shrews) and rodents were found there. They are represented by complete mandibles, isolated molar teeth and incisors. Six species of small mammals were identified (Table 2). All of them are more or less similar in NISP (1-7) and MNI (1-2). The most numerous remains belong to the European water vole *Arvicola amphibius* (NISP=7) and tundra vole *Microtus oeconomus* (NISP=5). The bank vole *Myodes glareolus*, harvest mouse *Micromys minutus* and common shrew *Sorex araneus* are less abundant (NISP=2), and wood mouse *Apodemus sylvaticus* is represented by only one molar (Table 2). Ten incisors belong to rodents, but they could not be identified (as with ten other fragments of small bones).

5. Discussion

The combined analysis of agrobotanical characteristics of identified cultural plants (Lysov, 1961, 1968; Degtyarev, 1981; Smirnov, Sosnihina, 1984) helps us to understand in detail the paleoecological situation near the Hodosivka-Roslavske settlement. All of the obtained cereals are unpretentious to soil fertility and grow well in temperate climate of the forest-steppe zone of Ukraine. Differences in their growth lie in the technical possibilities of cultivation. Barley, emmer wheat and millet are among the oldest cultivated plants in the territory of Southeastern Europe (Yanushevich, 1976, 1986; Pashkevich, 1991, 1991a) due to their tolerance to various natural factors and to cultivation. In contrast, the yield capacity of rye (which is the most numerous in our materials) depends on the cultivation technique. An increased proportion of rye in crops is considered as an indicator of agriculture improvement (Lange, 1975; Yazhdzhevsky, 1988). This thesis is widely confirmed in paleoethnobotanical materials of different archaeological cultures (Gorbanenko, Pashkevich, 2010; Gorbanenko, 2014, 2014a, 2014b). The existence of plow and plow-type tools in Kievan Rus has been confirmed earlier by researchers (Dovzhenok, 1961; Krasnov, 1987). The plow is also mentioned in chronicle sources (see, for example, Povest'..., 1950). Iron tools for plowing, harvesting, millstones for crop processing found during excavations in the Hodosivka-Roslavske settlement (Gotun, Suhonos, Kazymir, 2013; Gotun et al., 2013) are

direct confirmation of local agriculture. The importance of pea is difficult to estimate because we don't know whether this plant was cultivated. However, agrobotanical characteristics of the pea are essential conditions in using of crop rotation in the Ukrainian Polesie.

It is known that the range of crops grown during the Middle Ages in the region under study was much broader. The list of cereals consists of wheat, rye, barley, millet, oats; leguminous plants are represented by pea, lentil, vetch (see Pashkevich, 1991, 1991a, 1992; Gorbanenko, Pashkevich, 2010; Gorbanenko, 2016 for details). Cleaver is an annual plant, which is common throughout Ukraine and prefers grassland areas (Veselovsky et al., 1988). The presence of this anthropochorous weed may indicate human habitation near the river's floodplain. Brome indicates winter and spring crops with a high degree of probability. The finding of nutshell is evidence for existence of deciduous or mixed forests near the settlement (hazel is undergrowth in such forests). Besides, this finding is an important evidence of the phenomenon of gathering. It is safe to say that the use of hazel was common in the steppe and forest zones from the Scythian times to the Middle Ages.

Anthracological materials (charcoal mixture of pine and oak) similar to those of the Hodosivka-Roslavske settlement were obtained during excavations in the historical part of Kyiv (Upper City, Podil, 10-15 km northwards) as well as in the Ancient Rus settlement Sophiiv's'ka Borshchagivka and dated to the 10-13th cent. AD (Sergeyeva, 2016). Thus, it is safe to say that the Hodosivka-Roslavske settlement was surrounded by mixed forests of oak and pine formations.

Archaeozoological data support the view that the ecological characteristics of some species does not change through time (Lebedev, 1960; Gal, 2005). Knowing the ecological preferences of extant animals, it is possible to reconstruct the biological character of the past environments. The fish species composition of the Hodosivka-Roslavske settlement characterises a reservoir with varied habitats. The abundance of perch, presence of roach, rudd, bream and crucian carp indicates overgrown river sections with sandy bottom and slow flow (Movchan, 2011). Numerous remains of pike suggest a shallow, moderately productive and vegetated water course (Harvey, 2009). The European catfish indicates the presence of deep sloughs and backwaters (Kottelat, Freyhof, 2007). Some parts of the river were slow-flowing, sparsely vegetated and muddy, as indicated by the presence of ide (Movchan, 2011). Those species lived in a small tributary of the Dnieper River.

The data on fish bones and fishing gear are important sources of information on the role of fishery in the livelihood of the East Slavs in their medieval settlements in Ukraine. Remains of the ide, roach, rudd, bream, crucian carp, catfish, pike, perch and some other freshwater fish species are listed by Lebedev (1960) among materials from the excavations of the Trubchevske gorodyshe (10-12th cent. AD), Shestovitsy near Chernihiv (10-11th cent. AD), Vshchizh (12-13th cent. AD), Lypynske gorodyshe (11-13th cent. AD), as well as East Slavic settlement (8-13th cent. AD) near

Poltava. Numerous fish bones were found during the excavations of the medieval (8-13th cent. AD) Donetske gorodyshe (Kharkiv region, Ukraine). According to Shramko and Tsepkin (1963) and Zhiteneva (1964), they represented the sterlet *Acipenser ruthenus*, Russian sturgeon *Acipenser gueldenstaedtii*, stellate sturgeon *Acipenser stellatus*, European chub *Squalius cephalus*, ide, common roach, Pontic roach *Rutilus frisii*, rudd, common bream, blue bream *Ballerus ballerus*, European asp *Aspius aspius*, common carp *Cyprinus carpio*, crucian carp, tench *Tinca tinca*, catfish, pike, perch and zander *Sander lucioperca*. Kuza (1970) provided information on the presence of the common bream, pike, perch, zander in the Bystrynske, Borshevske and Novotroitske settlements, dated to the 6-12th centuries AD. It is known that fishery was essential for the East Slavs.

The information about the habitats of amphibians and reptiles can complete our knowledge about the natural environment near the Hodosivka-Roslavske settlement during the 11/12-14th centuries. Representatives of five families were identified in the herpetofauna of this locality, which suggests quite favorable conditions for them. Typical forms of closed (*Bufo bufo*), or open habitats (*Lacerta agilis*) are presented there. Moor frog has a wide range of habitats, while the spadefoot and grass snake are intrazonal species. The proportion of these animals shows the forest-steppe environment. Climatic conditions suitable for all reptile species from the settlement are the following: minimum daily temperature during the active period was at least +12°C, water temperature at which their reproduction is possible – +8°C, with the next heating above +15°C; duration of the warm period – at least four months. Comparative data about the finds of remains of amphibians and reptiles from the medieval settlements of that time in the studied region are recently absent.

The Hodosivka-Roslavske settlement in the 11/12-14th centuries AD was located near a small water body with slow-flowing water and overgrown vegetation (e.g., *Phragmites*, *Glyceria*, *Typha*). Such thickets are inhabited by garganey (this is preferred habitat for dabbling ducks). Garganey remains are common in Ancient Rus settlements of the 11/12-14th centuries. They are found in osteological materials from the settlements along the Dnieper River (e.g., St. Sophia Cathedral, St. Michael Monastery in Kyiv), Vyshgorod, Igren-8, in both southern (Maskovychi, Korolenko) and northern areas of mixed forests (Novgorod, Pekunovo), as well as in the steppe zone (Donetske gorodyshe) (Gorobets, 2015; Gorobets, Kovalchuk, 2017). The marsh tit usually lives in floodplain forests.

The systematic composition of small mammals from the Hodosivka-Roslavske settlement also reflects the existence of wet meadows and riverine habitats. For example, the European water vole lives around rivers, streams and marshes in the lowlands (Harrison, Bates, 1991). Wet meadows, bogs, fens, riverbanks and flooded banks are all important habitats for the tundra vole (Tast, 1982; van Apeldoorn, 1999). The presence of *Clethrionomys* indicates forested areas with shrubs. The

harvest mouse is typically found in fields of cereal crops, in reed beds, clearings and edges of humid forest (Aplin et al., 2008). Wood mice inhabit forests and grasslands (Schlitter et al., 2008). Typical representatives of open habitats are completely absent among the mammals from the Hodosivka-Roslavske settlement. It can be assumed that the climate at that time was mild, mesophilic. There are no any available comparative data about the finds of remains of insectivorous mammals and rodents from the medieval settlements of that time in the studied region.

6. Conclusions

The forest near the Hodosivka-Roslavske settlement in the 11/12-14th centuries AD consisted of coniferous and deciduous trees, which are typical for the modern Polesie boundary of Eastern Europe. Analysis of plant macros suggests the presence of complex agricultural activities such as crop rotation and the use of winter and spring crops. Most of the identified animal species may indicate the high humidity level and the presence of a small river with slow flow and overgrown banks. At the same time there were open areas (grassland) near the settlement. The average temperature at that time does not drop below +12°C at least four months during the year.

We conclude that the use of screen-washing and flotation provides an excellent opportunity to obtain a large amount of comprehensive information about the environment, climate, flora and fauna of any archaeological monument. These data are often omitted during ‘classic’ excavations. This is especially important because a comprehensive study of an archaeological monument usually involves its complete physical destruction. We believe that these methods are very promising and can successfully supplement the study of archaeological objects in a wide range of time and space.

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Figure 1. Location of the Hodosivka-Roslavske settlement: 1 – on the map of Ukraine; 2 – Kyiv region; floodplain area of the Dnieper River near Hodosivka village; 3 – outskirts of the settlement on Schubert's three verst military-topographical map of 1846-1863, fragments of 22nd and 23rd sheets (source: <http://www.etomesto.ru/shubert/>); 4 – satellite image of the Hodosivka village (part) and the settlement under study (source: <http://www.earth.google.com/>). Location of the settlement is indicated by asterisk (1–3) and arrow (1, 4).

Table 1. General list of identified plant macros and charcoal from the Hodosivka-Roslavske settlement.

Table 2. General list of identified animals from the Hodosivka-Roslavske settlement.

Table 3. Anatomical distribution of examined fish remains.

Table 4. Anatomical distribution of examined amphibian remains.

Table 1

General list of identified plant macros and charcoal from the Hodosivka-Roslavske settlement

Species	NISP	%
Plant macros (achenes)	29	100
Rye – <i>Secale cereale</i> Linnaeus, 1753	7	24.15
Millet – <i>Panicum miliaceum</i> Linnaeus, 1753	4	13.8
Barley – <i>Hordeum vulgare</i> Linnaeus, 1753	1	3.45
Emmer wheat – <i>Triticum dicoccon</i> Linnaeus, 1753	1	3.45
Undetermined cereal – Cerealina	1	3.45
Pea – <i>Pisum sativum</i> Linnaeus, 1753	1	3.45
Cleaver – <i>Galium aparine</i> Linnaeus, 1753	13	44.8
Brome – <i>Bromus</i> sp.	1	3.45
Wood (charcoal samples)	24	100
Pine – <i>Pinus sylvestris</i> Linnaeus, 1753	7	29.1
Rovan – <i>Sorbus</i> sp.	1	4.2
Oak – <i>Quercus</i> sp.	4	16.6
Alder – <i>Alnus</i> sp.	1	4.2
Poplar / aspen – <i>Populus</i> sp.	1	4.2
Willow – <i>Salix</i> sp.	1	4.2
Maple – <i>Acer</i> sp.	2	8.3
Ash – <i>Fraxinus</i> sp.	1	4.2
Undetermined deciduous tree	6	25.0
Wood (nutshell)	1	100
Hazel – <i>Corylus</i> sp.	1	100

Table 2

General list of identified animals from the Hodosivka-Roslavske settlement

Species	NISP	%
Ray-finned fishes (Actinopterygii)	384	100
Ide – <i>Idus idus</i> (Linnaeus, 1758)	2	0.5
Roach – <i>Rutilus rutilus</i> (Linnaeus, 1758)	2	0.5
Common rudd – <i>Scardinius erythrophthalmus</i> (Linnaeus, 1758)	2	0.5
Bream – <i>Abramis brama</i> (Linnaeus, 1758)	3	0.8
Crucian carp – <i>Carassius carassius</i> (Linnaeus, 1758)	3	0.8
Undetermined carp fishes – Cyprinidae gen. et sp. indet.	46	12.0
European catfish – <i>Silurus glanis</i> Linnaeus, 1758	11	2.9
Northern pike – <i>Esox lucius</i> Linnaeus, 1758	34	8.9
European perch – <i>Perca fluviatilis</i> Linnaeus, 1758	254	66.1
Undetermined bony fishes – Teleostei indet.	27	7.0
Amphibians (Amphibia)	12	100
Common spadefoot – <i>Pelobates fuscus</i> (Laurenti, 1768)	4	33.3
European toad – <i>Bufo bufo</i> (Linnaeus, 1758)	1	8.3
Moor frog – <i>Rana arvalis</i> Nilsson, 1842	4	33.3
Brown frog – <i>Rana</i> sp.	2	16.8
Undetermined true frogs – Ranidae gen. et sp. indet.	1	8.3
Reptiles (Reptilia)	3	100
Sand lizard – <i>Lacerta agilis</i> Linnaeus, 1758	2	66.7
Grass snake – <i>Natrix natrix</i> (Linnaeus, 1758)	1	33.3
Birds (Aves)	2	100
Garganey / Eurasian teal – <i>Anas querquedula</i> / <i>crecca</i>	1	50
Marsh tit – <i>Parus palustris</i> Linnaeus, 1758	1	50
Mammals (Mammalia)	39	100
Common shrew – <i>Sorex araneus</i> Linnaeus, 1758	2	5.1
Harvest mouse – <i>Micromys minutus</i> (Pallas, 1771)	2	5.1
Wood mouse – <i>Apodemus sylvaticus</i> (Linnaeus, 1758)	1	2.6

Bank vole – <i>Myodes glareolus</i> (Schreber, 1780)	2	5.1
European water vole – <i>Arvicola amphibius</i> (L., 1758)	7	17.9
Tundra vole – <i>Microtus oeconomus</i> (Pallas, 1776)	5	12.8
Undetermined rodents – Rodentia indet.	10	25.7
Undetermined mammals – Mammalia indet.	10	25.7

Table 3

Anatomical distribution of examined fish remains

Species	NIS P	Pr e m ax illa	Pa lat ine	Ar tic ular	De nt ary	Ja w tee th	Ce rat oh yal	Pr eo pe rc ular	O pe rc ular	Ph ar yn ge al bone	Fi n ra ys	Ve rte brae	Ri bs	Sca les
<i>Idus idus</i>	2	–	–	–	–	–	–	–	1	1	–	–	–	–
<i>Rutilus rutilus</i>	2	–	–	–	1	–	–	–	–	1	–	–	–	–
<i>Scardinius erythrophthalmus</i>	2	–	–	–	1	–	1	–	–	–	–	–	–	–
<i>Abramis brama</i>	3	–	–	1	–	–	1	–	–	1	–	–	–	–
<i>Carassius carassius</i>	3	–	–	–	–	–	–	–	1	2	–	–	–	–
Cyprinidae gen. et sp. indet.	46	–	–	–	–	–	–	–	–	–	2	1	–	43
<i>Silurus glanis</i>	11	1	–	–	4	–	–	–	–	–	–	6	–	–
<i>Esox lucius</i>	34	–	4	1	–	3	–	–	–	–	–	23	–	3
<i>Perca fluviatilis</i>	254	–	–	–	–	–	–	2	–	–	–	24	–	228
Teleostei indet.	27	–	–	–	–	–	–	–	–	–	4	5	11	7
Total number of specimens	384	1	4	2	6	3	2	2	2	5	6	59	11	281

Table 4

Anatomical distribution of examined amphibian remains

Species	NISP	Sphen- ethmoid	Humerus	Scapula	Ilium	Tibia	Vertebrae
<i>Pelobates fuscus</i>	4	2	—	—	—	—	2
<i>Bufo bufo</i>	1	—	—	—	—	—	1
<i>Rana arvalis</i>	4	—	1	1	1	—	1
<i>Rana</i> sp.	2	—	—	—	—	—	2
Ranidae gen. et sp. indet.	1	—	—	—	—	1	—
Total number	12	2	1	1	1	1	6