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FROM BONE FISHHOOKS TO FISHING TECHNIQUES: THE EXAMPLE OF ZAMOSTJE 2 (MESOLITHIC AND NEOLITHIC OF THE CENTRAL RUSSIAN PLAIN)

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Abstract: *Fishing played a fundamental role in the subsistence economy of the Mesolithic and Neolithic inhabitants of Zamostje 2, a site located on the Russian plain (Sergiev Possad, Moscow). The abundant ichtiofaunal remains and the tools found at the site (harpoons, needle nets, weight nets, fishhooks and scaling knives) corroborate this importance. In this article, we focus on the consumption of fishhooks through an analysis of the usewear observed on their surfaces. We compare the usewear observed on the archaeological fishhooks with that seen on experimental fishhooks used to capture fish species. We show how some attributes (disposition, quantity and hardness of the fish teeth) influence the nature of the usewear, especially the striations, formed on the surfaces of the fishhooks.*

Keywords: *Bone fishhooks, Experimentation, Usewear analysis, Russian Mesolithic and Neolithic*

Résumé: *La pêche semble tenir une place primordiale dans l'économie de subsistance des communautés mésolithiques et néolithiques du site de Zamostje 2 localisé dans la plaine centrale russe (Sergiev Possad, Moscou). C'est en tous les cas, ce que laissent entrevoir les quantités astronomiques des restes ichtyologiques ainsi que les divers équipements associés aux activités halieutiques (nasses, poids de filets, harpons, hameçons, couteaux à écailler, etc.) retrouvés sur le site. Dans ce travail, nous nous concentrerons plus particulièrement sur les hameçons en os et présenterons une grille de lecture, établie sur la base d'un référentiel expérimental, permettant de distinguer et de préciser leur mode de fonctionnement.*

Mots-clés: *Hameçons en os, Expérimentation, Tracéologie, Mésolithique et Néolithique russe*

1. INTRODUCTION

The site of Zamostje 2 is located in the Dubna Valley, 110 km to the north-east of Moscow (Fig. 1, Lozovski 2003). This river bank site was discovered in 1987 by Siderov and was excavated under the direction of V.M. Losovski from 1989-1991 and 1995-2000, and then by O.V. Lozovskaya from 2010-2011. Its long chronological sequence extends from the 6th to the 5th millennia BC, from the Late Mesolithic to the Early Neolithic. A large quantity of fish remains (scales, vertebrae, teeth, mandibles, etc.) were recovered in the occupation levels. According to some estimations, the ichtiological remains represent 64% of all the fauna consumed (Chaix 2003). An analysis of the ichtiological remains collected in a sondage at Zamostje 2 resulted in the identification of eleven species (versus the twenty currently present in the Dubna watercourses), five of which were present in both the Mesolithic and Neolithic occupations (*Exos Lucius*, *Perca fluviatilis*, *Rutilus rutilus*, *Carassius carassius*, and *Leuciscus idus*). The other taxa, such as *Silurus glanis* and *Sander lucioperca*, appear more sporadically within the sequence (Radu & Desse-Berset 2012). The ichtiological remains are not the only ones associated with halieutic activities and the consumption of fishing products at Zamostje 2. For example, a functional

Figure 1 – Location of the site of Zamostje 2

analysis of long knives made from elk ribs show that they were used to scale and clean fish, as well as to remove filets that could have been consumed immediately after cooking or preserved by drying or smoking (Clemente *et al.* 2002, Clemente Conte and Gyria 2003). A coprolite analysis shows that the fish were ingested when only slightly cooked or raw (Lozovski 1996). Finally, a large number of the tools and instruments found at Zamostje could have been more or less directly associated with halieutic activities and indicate the existence of varied fishing strategies: net (float weights, net needles), wooden fish traps, harpoons and fishhooks. In this paper, we focus on this last category, "fishhooks".

2. STUDY COLLECTION AND METHODS

Between 1989 and 2011, forty-seven bone "fishhooks" were identified at Zamostje 2 (fig. 2). Among these "fishhooks", two typological groups can be distinguished. Hook-shaped pieces (fig. 2, n° 1 to 18 and n° 26 to 30) and others with a flat section said to be shaped like a "willow leaf" (fig. 2, n° 19 to 25). The technological and functional analysis that we present here is limited to the first typological category, the hook-shaped pieces. It is composed of twenty-seven specimens, most of which originate from the level attributed to the Early Neolithic (Верхневолжская культура or the Upper Volga culture). Several sub-groups can be distinguished according to the general form and dimensions of the objects (Lozovski and Lozovskaya 2010). These sub-groups are fishhooks with a curved hook (Fig. 2, n° 3 and 4) or a straight hook (fig. 2, n° 5 to 10), and small (Fig. 2, n° 18) or large fishhooks (Fig. 2, n° 26). The attachment system also varies: straight shank (Fig. 2, n° 11), shouldered shank (Fig. 2, n° 27), eyed shank (Fig. 2, n° 12). With the exception of the "fishhooks" with a straight hook, which do not appear until the Early Neolithic, it is difficult to give a typo-chronological attribution to all the other types since they are present in both the Mesolithic and Neolithic.

The hook-shaped "fishhooks" were carefully made using a *chaîne opératoire* that appears to have remained the same throughout the chronological sequence considered, based on the technical pieces. These are transformed objects whose anatomical origin is most often impossible to determine. The shaping traces made by scraping cover the pieces and mask the debitage stigmata, which could thus be reconstructed based only on analysis of the manufacturing by-products. Two debitage by-products thus appear to indicate that the preforms were extracted by grooving bone plaques. We also find traces associated with this technique on the initial roughouts and the pieces representing "mistakes". The objects discarded in the process of manufacturing show that once the preform was extracted, a perforated eye was realized and the shank was regularized by scraping until the debitage traces were erased. The regularity of their walls and striations indicate that the circular eyes were realized by pressure/rotation, probably using a bow-drill tipped with a lithic point. These eyes were initiated on one or both of the faces. The enlargement of the eye, regularization of the curvature, formation of a barb and the preparation of the attachment system all appear to have been realized during the last stages of the manufacturing process.

While the technical aspects of these objects are relatively well understood, this is far from true for their function. This is because the functional interpretation of these pieces has until now been based only on morphological analogies with modern or sub-modern fishhooks and the specific archaeological context of Zamostje 2. Other uses are possible however, such as hooks for the suspension of various objects. Only a global analysis of their usewear, consisting of all the macroscopic (deformation of volumes) and microscopic (modification of the surfaces) traces resulting from the use of these objects can permit such a functional distinction (Semenov 1964, Christidou 1999, Maigrot 2003 and 2005, Van Gjin 2006, Clemente *et al.* 2002).

3. EXPERIMENTAL REFERENCE BASE

We created an experimental reference base specific to bone fishhooks. Several specimens were manufactured and used to line fish of four different fish types: sheatfish, perch, pikeperch and trout (Fig. 3, n° 1). All of the experimental fishhooks were subject to usewear analysis after their first capture. The entire collection was analyzed at different scales: the naked eye, binocular magnifier and with a metallographic microscope at magnifications of 50x, 100x and 200x.

The first macroscopic observations show that the usewear is extremely localized. On all of the experimental fishhooks, it is located on the outer edge of the first third of the shank, where the longitudinal striations associated with their shaping by scraping have been partly replaced by a polished surface (Fig. 3, n° 3). Everywhere else, the

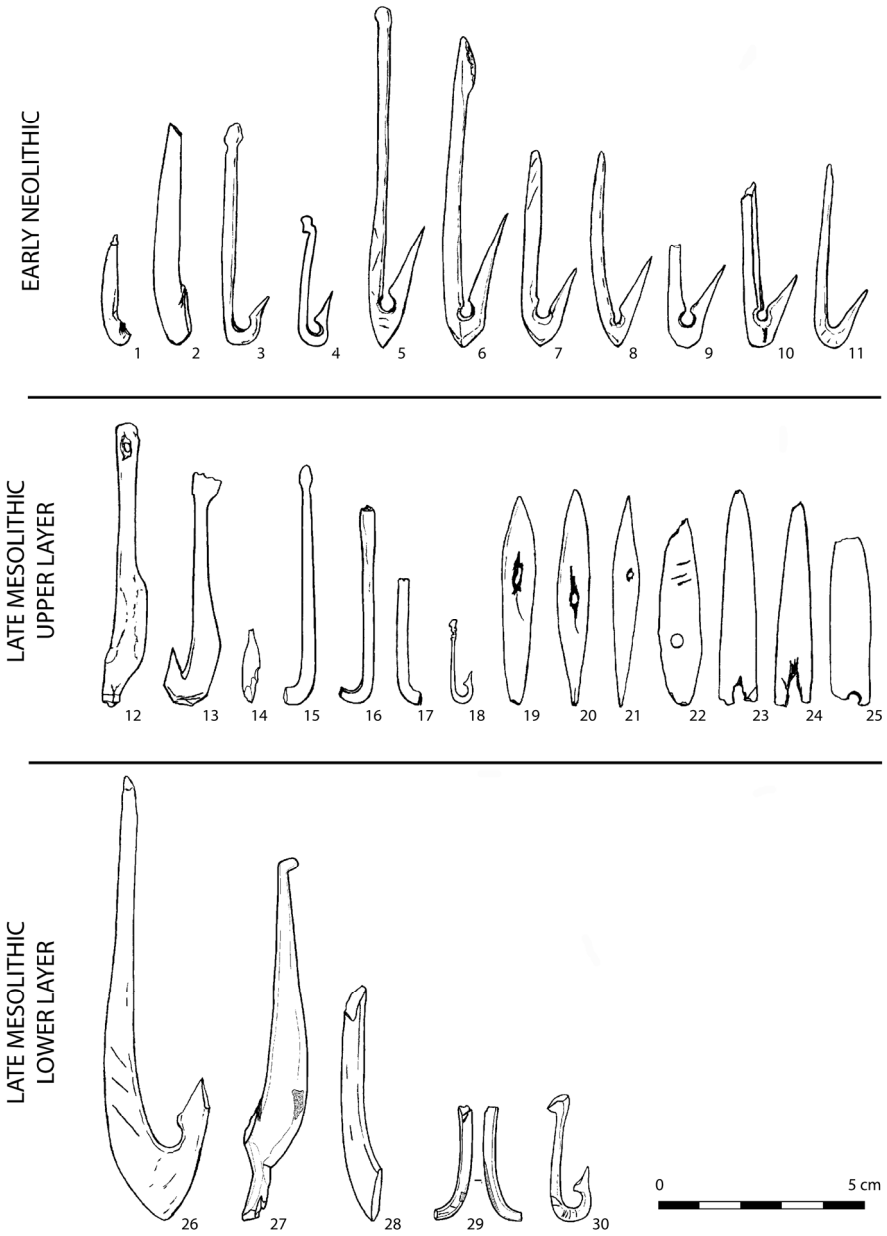

Figure 2 – Fishhooks found during the excavations at Zamostje (1989 and 1998 seasons). Drawings: Olga Lozovskaya

traces associated with the manufacturing of the experimental pieces are very clear. The location of the usewear on fishhooks is clearly different from that observed on other types of hooks (for attachment or suspension), which in the latter case mainly concerns the point and the inside of the eye, whose walls are often smoothed. In the case of fishhooks, when there is smoothing, it is visible only with a binocular magnifier and concerns only the angular parts composed by the extremity of the point and the edge of the eye. The distinction between these two types of usewear is thus very clear and can be realized by observation with the naked eye or through low magnification.

When observed at a low magnification (50x), the usewear on the outer edge of the first third of the shank of the fishhooks is characterized by transverse striations, which are more or less numerous, continuous and intertwined. In association with sheatfish or trout fishing, these striations are thin and superficial. The traces associated with pikeperch and perch fishing, on the other hand, are composed of linear depressions that are more numerous, but especially wide, and even macroscopic for pikeperch (Fig. 3, n° 3). When magnified at 200x, the surface appears irregular and displays a more or less intrusive polish. The high points of the micro-relief are slightly eroded, with a rounded profile and sometimes grainy appearance. The transverse striations have slightly eroded edges, a “U” shaped section and a rough bottom, except in association with sheatfish and trout fishing, when the bottom appears to be coalescent (Fig. 3, n° 4 to 7). After the first third of the shank, the shaping traces are fresh and perfectly visible. At 200x, they display a very slight smoothing of the elevations, whose profile is curved.

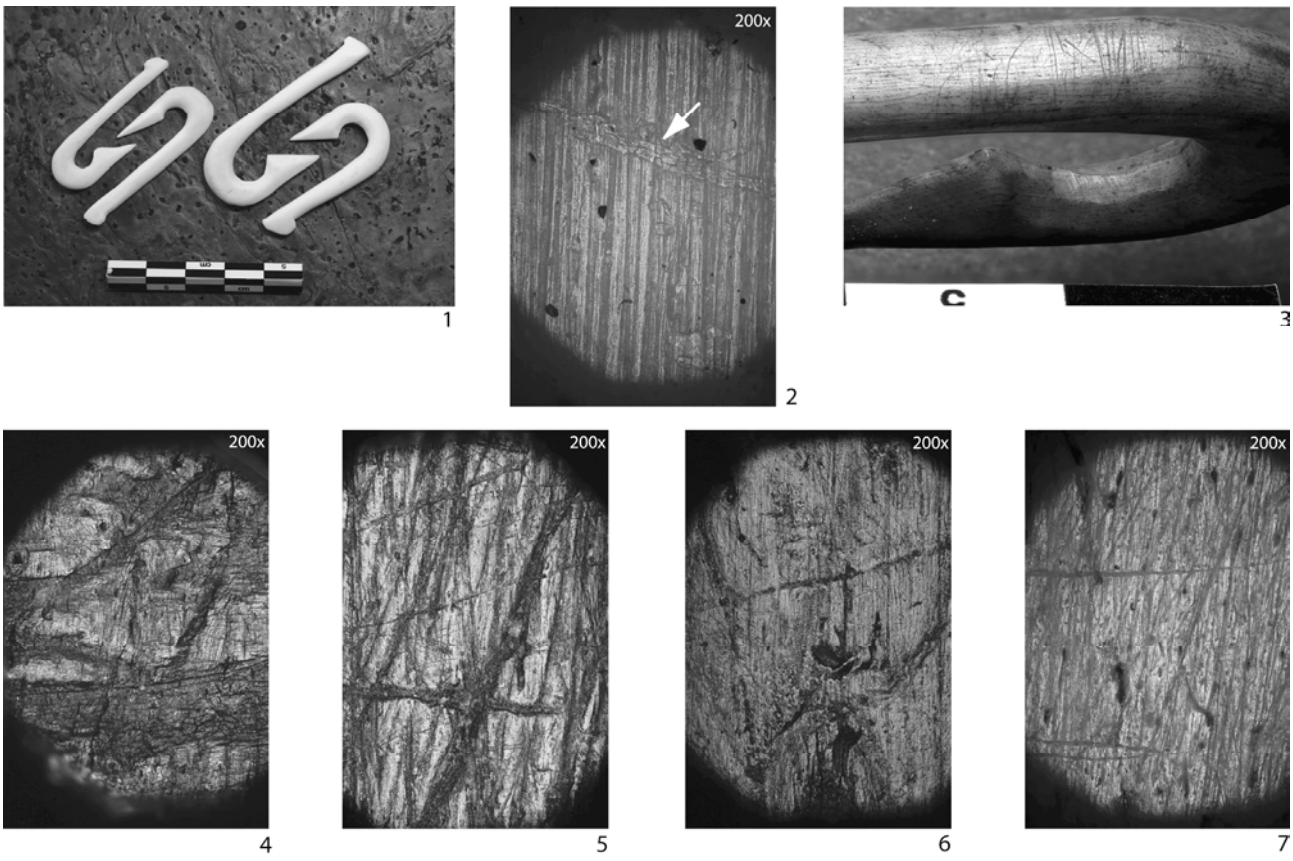

Figure 3 – Experimental references – 1) examples of experimental fishhooks. 2) Close-up of the microscopic traces observed on the ligature zone. 3) macroscopic traces visible on outer edge of the first third of the shank of an experimental fishhook used to capture a pikeperch. 4) microscopic traces on outer edge of the first third of the shank of an experimental fishhook used to capture a pikeperch. 5) outer edge of the shank of a fishhook used to capture a perch. 6) outer edge of the shank of a fishhook used to capture a sheatfish. 7) outer edge of the shank of a fishhook used to capture a trout. Photo: Evgeny Gyria (1 & 3) and Yolaine Maigrot (2 & 4 to 7)

Traces associated with the attachment of the fishhooks are rare and often very light. Only two experimental fishhooks display usewear associated with the string used to attach them. These take the form of wide clusters with a coalescent bottom, which follow the original micro-relief, in this case corresponding to the shaping traces (Fig. 3, n° 2).

In summary, the usewear observed on fishhooks is composed of traces that are mostly located on the outer edge of the shank, consisting of a light polish associated with transversal striations. Our first experiments indicate that these striations are produced directly by the teeth of the fish, which would partly explain the morphometric variations observed on different fishhooks.

Pikeperch have four large canines that could have created the macro-striations observed on the experimental fishhooks used to capture them (Fig. 3, n° 4). The mouths of sheatfish are lined with a multitude of minuscule teeth that that produce much more superficial traces on the shanks, which could explain the thin striations (Fig. 3, n° 6).

Following these first experimental tests, it appears that it is possible to distinguish fish types based on the traces left by their teeth on the fishhooks. While in some cases the distinction is clear (e.g. sheatfish *versus* pikeperch), in others it is less obvious (e.g. sheatfish *versus* trout). Nonetheless, these experiments, currently limited to four taxa, should be multiplied and extended to other species in order to further refine the criteria of distinction.

4. USEWEAR ANALYSIS OF THE "FISHHOOKS" OF ZAMOSTJE 2

All of the pieces in the Zamostje 2 assemblage were studied macroscopically, while only some were studied microscopically due to the varied states of their surfaces.

As we have seen, the technological traces are relatively clear on all the pieces in this assemblage, at least those linked to the last manufacturing stages. Only the zone roughly corresponding to the first third or first half of the shank of the fishhooks appears more or less polished and, in some cases short transversal striations are present on the outer edge. The extremity of the barbs and the edge of the eyes are sometimes lightly smoothed. In these terms the distribution of traces observed on the archaeological objects corresponds to that observed on the experimental fishhooks. It is thus probable that the Mesolithic and

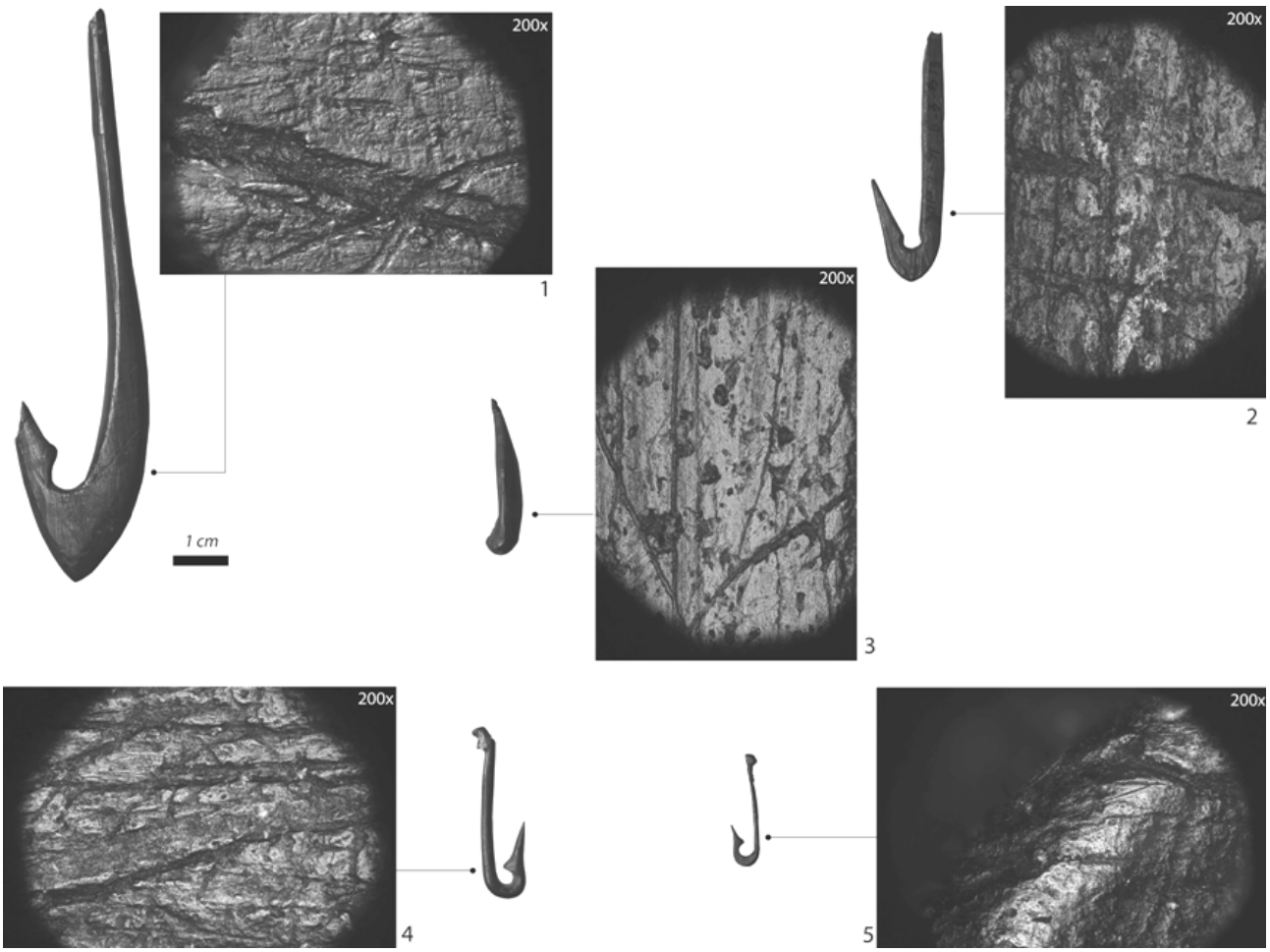

Figure 4 – Close-up of the microscopic traces observed on the outer edge of the fishhooks of Zamostje 2. Photos: Yolaine Maigrot

Neolithic hooks were used for fishing. Meanwhile, the Zamostje 2 assemblage includes many fragmented pieces (Fig. 2, n°1 and 2, n° 12 and 17). Most of the fractures, which affect more than half of the fishhooks, are located in the zone of the bend. However, none of our experimental pieces were broken during use; it is possible that our fishhooks, which were subject to the force of only one fish capture each time, may not have resisted the multiple mechanical forces associated with repeated fishing incidents.

Based on the experimental results, the most valid functional indicators are located on the first third of the outer edge of the shank, and we will thus focus on this zone. At low magnifications, groups displaying similar usewear traces appear to be visible among the archaeological objects. Some pieces display short and very thin transversal striations, and others wider striations. These observations are conformed at a high magnification (200x) and permit us to distinguish at least three groups. The first includes only the fishhooks with a straight hook. Their relatively long shank displays very wide striations visible with the naked eye. These are transversal and have a rough bottom (Fig. 4, n° 1 and 2). In comparison to our experimental reference base, these traces are similar to those associated with the fishing of pikeperch. The second group includes the small curved fishhooks. The usewear on their shank is characterized by more or less numerous transversal striations with a rough bottom, which are similar to the teeth marks produced by perch (Fig. 4, n° 4 and 5). The third group includes fishhooks of diverse sizes, but which have in common a relatively short shank with a rather massive and circular section. The striations present on these pieces are more superficial and have a coalescent bottom, similar to those produced by sheatfish or trout fishing (Fig. 4, n° 3).

5. DISCUSSION

This analysis indicates that there is a strong relationship between the morphology of the archaeological fishhooks and their usewear patterns. Is it possible to interpret this correlation in terms of the ways in which the fishhooks were used? We know that for modern fishermen, each type of prey corresponds to a specific type of line and hook. The preliminary results obtained for the Zamostje assemblage appear to follow this pattern and to indicate that the strategies were already known and practiced in the Mesolithic. But in what manner? If we attempt to compare our usewear data with the ichtiological spectrum of Zamostje 2, we are rapidly confronted with the limits

of our experiments, in which only four fish species among the identified archaeological taxa were tested. The straight fishhooks in the Neolithic levels were thus associated with usewear patterns similar to those obtained through the experimental fishing of pikeperch. However, all the pikeperch bones found at Zamostje were contained in the levels exclusively attributed to the Mesolithic (Radu and Desse-Berset 2012). The Neolithic levels, on the other hand, contain numerous remains of pike or another predator with formidable teeth that could produce deep traces on the fishhook shanks.

This first usewear analysis of bone fishhooks has permitted us to propose an initial set of criteria for the study of their use traces. The unexpected though promising results incite us to continue in this direction and to conduct more experiments in order to refine the functional interpretations proposed for this type of object. This experimental analysis must integrate new parameters, such as the size and force of the fish. It must also include other species, and should be extended to other typological categories, such as the so-called "willow leaf" fishhooks and harpoons. Through such work, we will be able to shed new light on fishing strategies and evaluate the role of these activities in the economy of the Mesolithic and Neolithic communities of the Russian plain.

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