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The Craft of the Rural Blacksmiths in Ancient Rus'

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Keywords

Archaeometallography[1], Ancient Rus', rural settlements, blacksmithing, advanced technologies

Abstract

This article discusses the role of rural blacksmithing in the economic structure of a feudal state. The study is based on the metallographic analysis of a large number of iron objects taken from archaeological sites of Ancient Rus'. It can be summarized that rural blacksmithing craft was a much more complex phenomenon than previously believed. The authors have come to the conclusion that the rural blacksmithing was an important component of the production sphere of Ancient Rus' and had a significant contribution to the feudal economies.

Introduction

The craft production, along with the products of the agrarian sector, was a significant element of the economy of feudal states. First and foremost, this applies to ferrous metallurgy and metalworking, which provided tools for other craftsmen.

The major part of the population of the feudal state, as we know, was rural. Given this fact, it is impossible to obtain a full picture of the production culture without studying the role of rural crafts. By the term "production culture" we mean the complex, multifaceted phenomenon associated with the provision of basic needs of society.

This research topic poses a number of problems. First, it is necessary to generalize the currently available analytical data on rural blacksmithing. Until recently, rural blacksmithing was considered to have been more conservative than urban blacksmithing. However, the works of recent years (Zavyalov and Terekhova, 2020; 2021a) have shown that rural blacksmiths used complex technologies in their work (cementation of the blade, welding). It is necessary to find out how urban crafts influenced rural blacksmiths. Of great interest to the topic under consideration are the interactions between rural centers that produced metal and urban blacksmith centers that consumed this metal. Finally, another issue within the framework of the problem is the impact of external negative factors on the rural blacksmith's craft (such as, for example, the Tatar-Mongolian yoke).

It is important to note that targeted research in this area is scarce. However, primarily we should mention the fundamental work by the outstanding Czech historian of metallurgy R. Pleiner (2006) "Iron in Archaeology. Early European Blacksmiths". In this monograph, one can find a separate paragraph devoted entirely to the subject of medieval rural forges. The material presented represents all known archaeological evidence to date for rural European forges from the 6th to 13th centuries. This review also includes information about Viking workshops in Greenland and Newfoundland. Based on the analysis of all of the collected material, Pleiner (2006, p.169) concluded that "smithies in villages not only maintained and repaired iron objects necessary for rural everyday life and work, but some of them also produced various kinds of artefacts on their own". Unfortunately, the archaeometallographic data on items from rural settlements was not taken into account in Pleiner's work.

In the context of our topic articles by E. Blakelock and J. McDonnell, which were published in the 2000s, are of great interest (Blakelock and McDonnell, 2007; 2011; Blakelock, 2016). They present the results of the analysis of 79 knives from urban and rural settlements in early medieval England. The analytical data that were obtained enabled the authors to conclude that during the period under consideration knife production technology saw significant advancements. However, the level of

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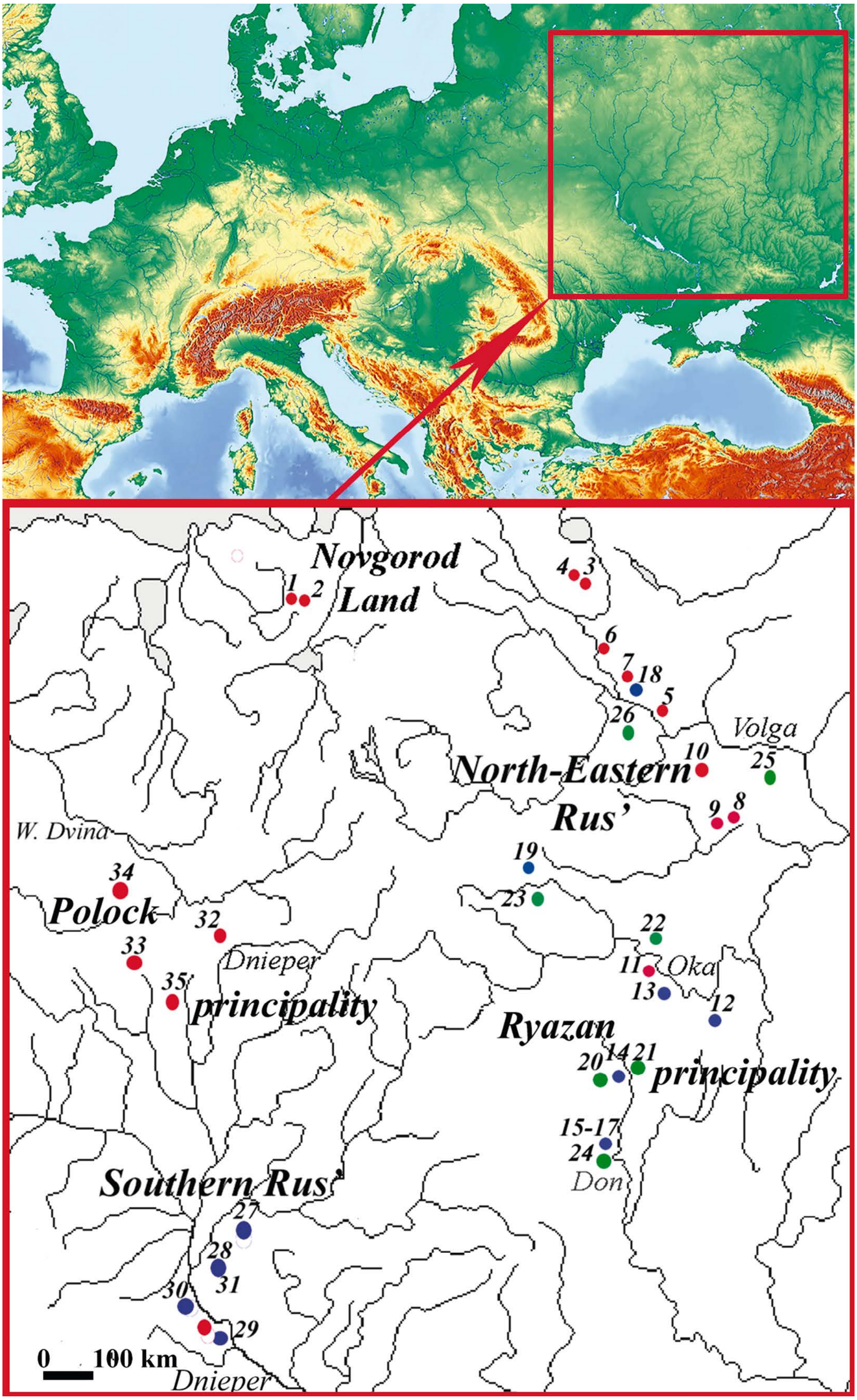

Figure 1. Location map of settlements, archaeometallographic analyses of blacksmithing products analysed in the article. Settlements of the 10th-12th c. (red dots): 1 - Udray; 2 - Peredolsky pogost; 3 - Lukovets; 4 - Krivets; 5 - Teleshovo; 6 - Andryushino-Irma; 7 - Minino 5; 8 - Vasilkovskoe; 9 - Gnezdilovo; 10 - Vvedenskoye; 11 - Sosnovka IV; 31 – Buchak; 32 – Lukoml; 33 – Menka; 34 – Postavy; 35 – Glivin; Settlements of the 12th-13th c. (blue dots): 12 - Istye 2; 13 - Durakovo; 14 - Kulikovka 4; 15 - Kazinka; 16 - Zamyatino 10; 17 - Krutogorye; 18 - Minino 4; 19 - Stepanovo 2; 27 - Avtunichi; 28 - Leskovoe; 29 - Grigorovka; 30 - Revutovo. Settlements of the 13th-15th c. (dark green dots): 20 - Gryaznovo 2; 21 - Buchalki; 22 - Nastasino; 23 - Myakinino II; 24 - Kamennoe; 25 - Teterinskoe; 26 - Troickoe. Drawing: V.I. Zavyalov.

development of the craft also depended on the status of the settlement (Blakelock and McDonnell, 2007; 2011; Blakelock, 2016). In particular, this was revealed through the study of knives from urbanized centres, where weldon technology prevailed. In contrast, the tools from rural burial sites were mainly made through simpler technological schemes.

Of particular interest is the work by D. García (2016. p.87), who carried out a comprehensive study (including an analysis of archaeological and written sources) of medieval rural blacksmithing in the Basque Country (Northwestern Spain). The researcher concluded that iron products were manufactured by using complex technologies (cementation of the blade and welding of phosphorous iron and steel). He emphasizes that the quality of medieval artefacts was not inferior but even superior to the tools of ancient times.

In the studies by B.A. Kolchin (1953) significant attention was paid to the question of rural blacksmithing in Ancient Rus'. Applying the method of archaeometallography, the researcher obtained comparative technological characteristics of products from urban and rural centres (Kolchin, 1953, p.192). For the first time the archaeometallographic analyses allowed for demonstrating the specialized and technologically complex nature of urban blacksmithing craft and the simpler nature of rural production.

New information on the topic under consideration, namely manufacturing techniques of various iron products, emerged during recent decades due to large-scale excavations of rural settlements from the area of Ancient Rus'. This allowed for conducting archaeometallographic studies of a large series of iron artefacts from the settlements.

Currently our analytical base contains about 2000 metallographic analyses of different iron objects (knives, sickles, axes, arrowheads etc.) from more than 25 rural settlements (Figure 1). Table 1 shows the distribution of items by region and chronological period. As can be seen from the data, the analytical material is unevenly distributed across the area. This is largely because until recently the subject of rural blacksmithing in Ancient Rus' was not in the focus of research. The article is devoted to iron products from rural sites. The results of analyses from cities are given as a comparison. A detailed comparison of both urban and rural materials is beyond the scope of the question under discussion.

The work by G.A. Voznesenskaya (2003), who studied the rural blacksmith craft of Southern Rus', was based on the analysis of more than 300 iron items. The author concluded that until the mid-12th c. there were no technological differences between the production of rural and urban blacksmiths: the main method of producing iron objects from cities and villages was forging from ferritic iron and heterogeneously carburized steel; three-fold welding and welding-on technologies were rarely used. Only since the 12th c. conservatism in manufacturing techniques starts being pronounced in rural blacksmithing, as opposed to the more innovative craft of urbanized settlements (Voznesens'ka, 2003, p.105). Unfortunately, the work of Voznesenskaya covers only the period up to the mid-13th c., which does not allow us to trace the dynamics of the development of Southern Rus' rural craft into the following centuries.

Table 1. The portion of archaeometallographically investigated items from rural sites of Ancient Rus'.

Region	Date	Sample quantity (in brackets knives quantity)
Ryazan principality	IX-XIII c.	262 (214)
	XIV-XVI c.	85 (66)
Chernigov principality (Southern Rus')	X-XIII c.	176 (?)
Kiev principality (Southern Rus')	XI-XII c.	160 (?)
North-Eastern Rus'	X-XIII c.	873 (624)
	XIV-XVI c.	174 (139)
Novgorod land	IX-XIII c.	61 (45)
Polock principality	IX-XIII c.	73 (63)
Total	IX-XIII c.	**1605**
	XIV-XVI c.	**259**

At present, analytical data for the items from rural sites have been published. This includes: the Novgorod Region (Nosov and Rozanova, 1989), the Moscow Region (Rozanova and Terekhova, 2009a; 2009b; Zavyalov, 2009; 2021; Zavyalov and Rozanova, 2009), North-Eastern Rus' (Zavyalov, Rozanova and Terekhova, 2012; Shcherbakov, 2018), the Ryazan and Polotsk principalities (Gurin, 1987; Zavyalov and Terekhova, 2013). All of these data requires generalization and comprehensive analysis.

Method

The traditional archaeological approach to the study of metal artefacts has some limitations. It does not allow for revealing the information about the techniques of their manufacturing, i.e. about the knowledge and skills of the craftsman and, ultimately, about the crafts production of a given society. The introduction of metallographic methods in archaeology permitted to obtain such information. The basis of the archaeometallographic method is the identification of the process used for the object's manufacturing, which shows the nature of the raw material used and the sequence of technical operations. The generalization of the results of the conducted research allows for creating a historical and a technological concept that sheds light on socio-economic questions. This way, metal artefacts become a full-fledged historical source. In this regard, items from the sites of Ancient Rus' (Kolchin, 1953; 1959) have demonstrated a significant potential of the method of archaeological metallography.

A standard procedure was used for the archaeometallographic analysis. The examined samples were cut out from the cutting edges of knives or from other functional parts of the objects. The samples were then mounted into Wood' alloy (Sn-12.5 %, Pb-25 %, Cd-12.5 %, Bi-0 %), grinded and then polished with chromium oxide. The microstructures of iron objects were determined with an MMR-2R optical microscope at magnifications of 150x and 490x, after etching the polished sample with Nital reagent (3 % solution of HNO_3 in ethyl alcohol). The size of the grains was evaluated according the Russian state standard (GOST R ISO 643-2011)[3]. Microhardness was measured on PMT-3 microhardness machine with a diamond pyramidal indenter with 100 g load. The measurement of the hardness of ferrite grains was used to identify objects with a high content of phosphorus[2], as was shown by J. Piaskowski (1959; 1989), Ä. Thiele and J. Hosek (2015, p.122), M.F. Gurin (Pobal and Guryn, 1975), L.S. Rozanova (Nosov and Rozanova 1989) and others.

Analytical results

Most of the analytical data on the manufacturing technology of iron objects from rural sites of Ancient Rus' was published (Gurin, 1987; Nosov and Rozanova, 1989; Shcherbakov, 2018; Zavyalov and Terekhova, 2013; 2019; 2021a, b; Zavyalov, Rozanova and Terekhova, 2012). Here we present the final table summarizing the distribution of technological schemes used for the manufacturing of knives from different regions of Ancient Rus' (Table 2).

Objects forged from raw metallurgical materials such as ferritic iron and heterogeneously carburized steel dominate most iron collections from rural sites. Among the forged artifacts there is a group of items (mainly knives) forged from iron with a high content of phosphorus[3]. There are no specific patterns in the occurrence of such tools: they can be found at the settlements of all regions of Ancient Rus' along with the items forged from ferritic iron.

Heterogeneously carburized steel was more often used by rural blacksmiths (Figure 2). This type of raw material was mainly used for the manufacturing of tools. Among items forged from heterogeneously carburized steel, tools constitute 74 % and among items made of soft iron - only 54 %. However, among knives, the share of items made of ferritic iron and heterogeneously carburized steel is less. It ranges from 33 % in the Polotsk principality to 52% in Southern Rus'. More than half of the heterogeneously carburized steel items were heat treated (mostly quenched).

Rural craftsmen also used billets produced from pass-through cementation steel[4] (Figure 3). About 8 % of all of the artefacts that were studied were forged from

Table 2. The portion of technological schemes used in the manufacture of knives from different region of Ancient Rus' (in %).

Region	Technological scheme					
	Ferritic iron	Heterogeneously carburized steel	Pass-through cementation	Cementation at the blade	Three-fold welding	Welding-on
North-Eastern Rus'	20	24	6	5	25	20
Southern Rus'	24	28	14	12	9	13
Novgorod Land	21	35	-	-	35	9
Ryazan principality	12	37	11	12	7	21
Polock principality	9	24	13	16	20	18

Keys: ferritic iron – knives forged from iron billet; heterogeneously carburized steel – knives forged from heterogeneously carburized steel; pass-through cementation – knives forged from spetial produced (cemented) steel; cementation at the blade – knives in the production of which the cementation of the blade was used; three-fold welding – knives welded from three strips: two iron and steel; welding-on – knives with welding steel edge.

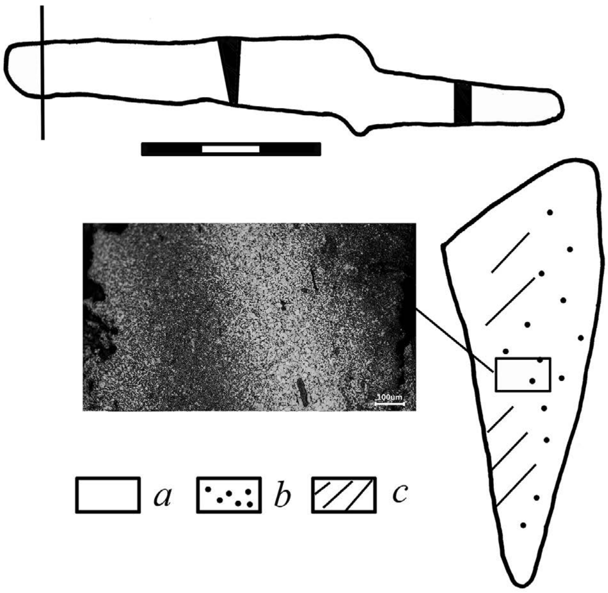

Figure 2. Technological scheme and photo of the microstructure of a knife from Stepanovo 2 (sample no. 11663), which was forged from heterogeneously carburized steel. Symbols Figures 2-6: a - ferrite; b – ferrite and perlite; c - heat-treated steel (martensite). Drawing and photo: V.I. Zavyalov.

such steel. In addition to single household items, this group of products includes tools (knives, sickles, axes, scissors, awls, etc.). The common technique for improving the working properties of the tool was cementation of the blade. This technique allowed for carburizing the working surface or the entire surface of the object to increase the hardness of the metal (Figure 4). Cementation is achieved by placing the iron piece into a carbon-enriched environment and heating it up to a temperature at which carbon diffuses into the metal (Makienko, 1973, p.81; Gulyaev, 1986, p.289). In practice, a clay crucible could be used in which the iron item and a solid carbonaceous matter (charcoal, bones, etc.) are placed. If local carburizing (for example, only the blade) was required, part of the item was isolated from the carbon-containing environment by using a clay coating. This technological process is quite fully described by the medieval authors (Theophilus, Al-Biruni, Biringuccio; see: Kolchin, 1953, p.52). Cementation takes place at a temperature of about 900-950°C which has to be maintained for a long period at which the carburization to a depth of only 0.1-0.12 mm takes at least one hour (Gulyaev, 1986, p.289). In this regard, the method of cementation was not widely used by the blacksmiths of urbanized centres of Ancient Rus'. In Novgorod only 2 % cemented products were recorded, in Pskov 1.3 %, in Beloozero 6 % and in Staraya Ryazan 5 %. In contrast, in rural centres, items with cemented blades constitute 12-15 % (Zavyalov, Rozanova and Terekhova, 2007; 2012; Zavyalov and Terekhova, 2013).

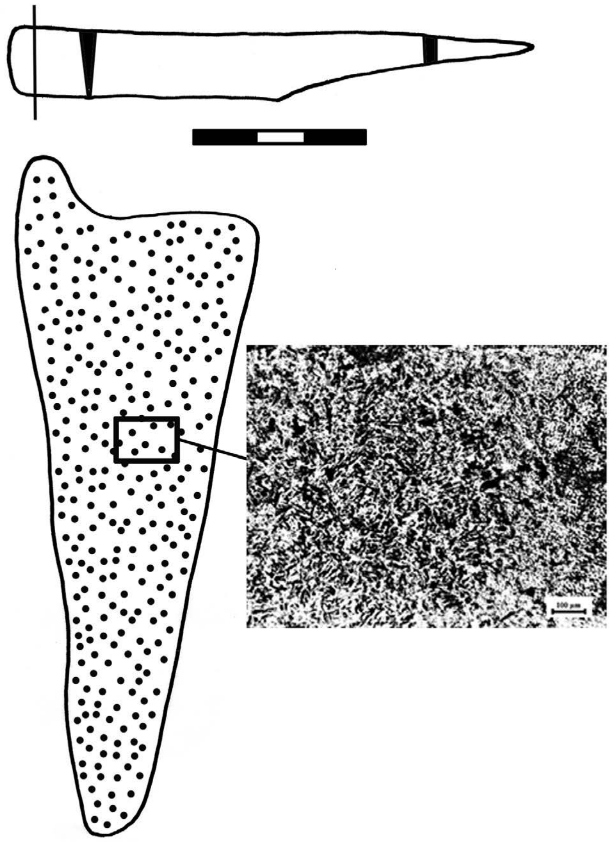

Figure 3. Technological scheme and photo of the microstructure of a knife from Sosnovka IV (sample no. 12051), which was forged from steel produced by pass-through cementation. Drawing and photo: V.I. Zavyalov.

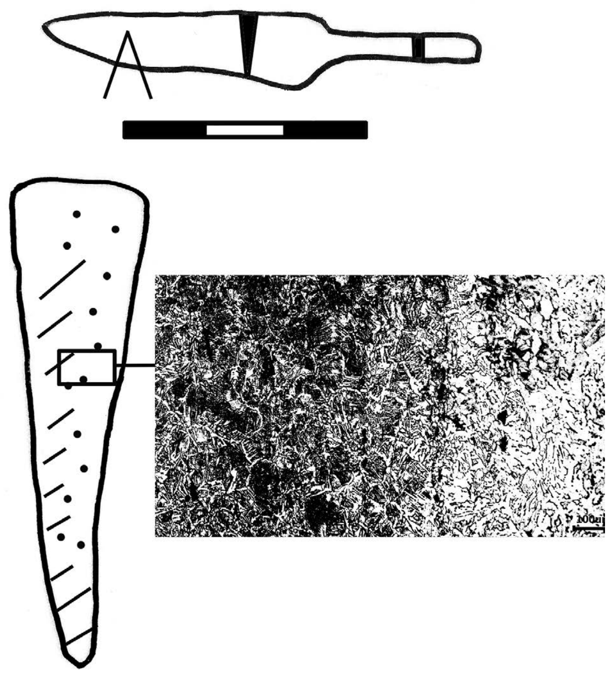

Figure 4. Technological scheme and photo of the microstructure of a knife from Istye 2 (sample no. 12191) with carburization at the blade: technological scheme and photo of the microstructure. Drawing and photo: V.I. Zavyalov.

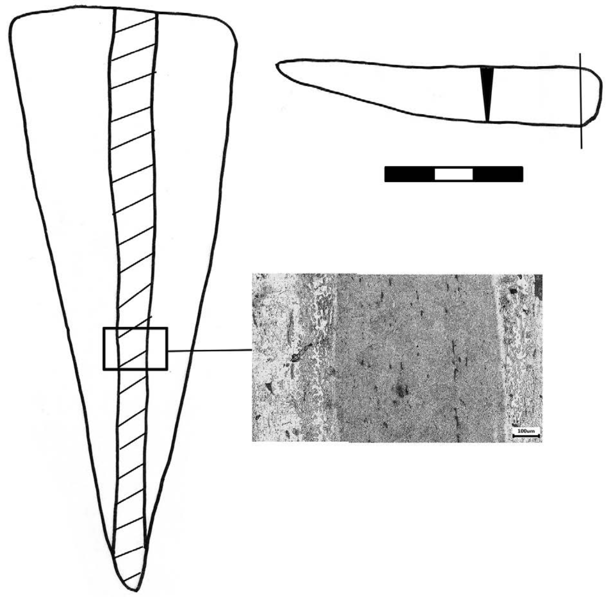

Figure 5. Technological scheme and photo of the microstructure of a knife from Sosnovka IV (sample no 11612), which was made according to the scheme of a threefold welding. Drawing and photo: V.I. Zavyalov.

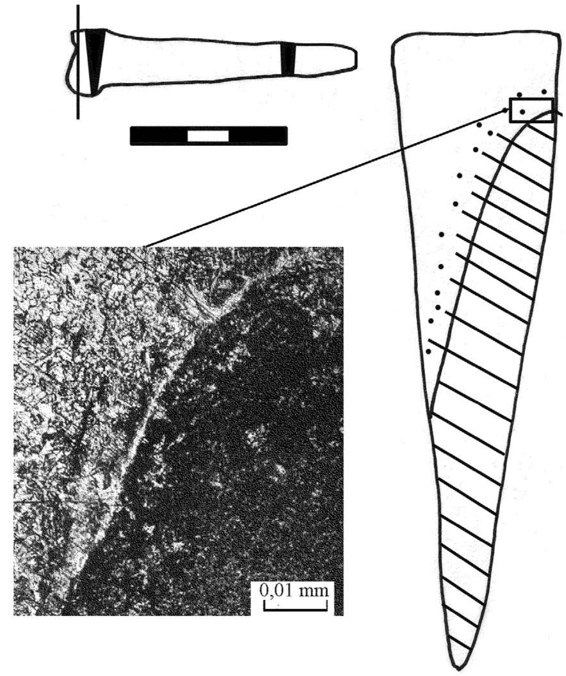

Figure 6. Technological scheme and photo of the microstructure of a knife from Istye 2 (sample no. 12174), which was made according to the scheme of welding-on. Drawing and photo: V.I. Zavyalov.

In the process of manufacturing, craftsmen needed to combine materials of different quality and different properties with one object (for example, iron and high-carbon steel). This technology achieved by forge welding, provided the blade with hardness, but did not make the product excessively brittle due to the presence of iron base. The complexity of technological welding lies in the temperature difference between the welding of iron and that of steel, and in determining the suitable temperature for welding by the blacksmith according to the colour of the heated metal. With archaeological material the quality of the forge-welding can serve as a quality indicator of the skills of the craftsman who made the object.

The complex schemes associated with technological welding include a three-fold welding (Figure 5). The technology of three-fold welding involves welding a workpiece of three strips: steel in the centre and two iron strips along the blades. According to Kolchin, from a technical point of view, this is the most expedient technology during the production of blades and one, which gave the tool its highest viscosity, elasticity and a high level of hardness in the hardened steel blade (Kolchin, 1953, p.75).

Based on the archaeometallographic analysis of a large series of iron products from the sites of Ancient Rus', we concluded that the technology of three-fold welding had no roots in the iron- working traditions of the Eastern European peoples, and its spread was in fact associated with the activation of the Varangian trade routes to the Greeks and the Arabs. This technology became the basis for the emerging craft of urbanized centres of Ancient Rus' during the 10th-11th c. knives with three-layer blades made up to more than 90 % of all tools in Novgorod (Zavyalov and Terekhova, 2021b, Fig.3) and about half of all tools in cities such as Pskov, Rostov, Suzdal and Ryazan. Examples of similar products are also common at rural sites (Zavyalov, Rozanova and Terekhova, 2012).

The study of a large series of archaeometallographic analyses has enabled us to distinguish the existence of two different technological production types of the three-fold welding scheme. One is the so-called "classical" (Northern European) technique which corresponds to a distinctive knife shape (Group IV in Minasyan, 1980, p.72) that consists of a standard combination of phosphoric iron and high-carbon steel. The second type allows for a deviation from a standard by including into the package either non-phosphoric iron or heterogeneously carburized steel (Zavyalov, Rozanova and Terekhova, 2012, pp.37-53). This variant is the so-called "Eastern European" technique, which reflects the development of innovative technologies by local blacksmiths. In some settlements in North-Eastern Rus' and Ryzan principality (Ves' 5, Krivets, Sosnovka IV), knives with three-layer blades dominate this category of tools (Zavyalov and Terekhova, 2013; Shcherbakov, 2018).

Another group of the complex technological schemes includes welding-on technologies. Eastern Slavic blacksmiths started to use them even before the end of the 1st millennium AD. Welding-on, in contrast to three-fold welding, represents a fundamentally different constructive approach. According to this scheme, the steel blade of the artefact is superimposed on the iron base. However, in contrast to the three-fold scheme, it does not pass along the blade but obliquely overlaps the blade (Figure 6).

The origins of the welding-on technology among the East Slavic tribes can be traced back to the crafts traditions of the West Slavic world. During the 7th-9th c. the welding-on technology was used for the items from the Great Moravia and Slavic sites between the Vistula and Oder rivers (Pleiner, 1967, p.93; Piaskowski, 1974, pp.83-94). In the last quarter of the 1st millennium AD single items made by using weld-on technology also appeared at the East Slavic sites (Voznesenskaya, 1978, p.64; Rozanova, et al., 2008, p.41). Gradually, the welding technology becomes a typical feature of the Slavic production tradition.

Archaeometallographic data indicate that in the 9th-10th c. the appearance of the innovative technology of three-fold welding did not replace the traditional technology of welding-on at the Slavic sites. This can be explained by certain advantages of welding-on over three-fold welding, among others the limited use of steel and the fact of its versatility, that is, the possibility of using it for various categories of tools and weapons. It is also possible that the technology was preserved because of blacksmithing traditions.

At most rural sites welded-on blades constitute up to a third of the tools among the studied items (Istye 2, Kulikovka-4, Avtunichi) and in some cases up to half (Ves' 5, Gnezdilovo, Vvedenskoye, Krivets) (Shcherbakov, 2018; Voznesens'ka, 2003; Zavyalov and Terekhova, 2013; Zavyalov and Rozanova, Terekhova, 2012). Of course, not all of these artefacts were the products of rural artisans. Some of them came from the crafts production centres of urbanized settlements. However, there is reason to believe that rural blacksmiths were also able to make tools with welded-on blades. On the other hand, if such artefacts were imported from the cities, we can assume that the rural population had sufficient resources to purchase these expensive items.

The final operation to provide the blade of the tool with maximum hardness was heat treatment. Ancient Rus' blacksmiths used various types of heat treatment: quenching (on martensite), quenching followed by tempering, and soft quenching (on sorbite). The portion of heat- treated products at rural sites can be estimated as 50 %. However, among the tools, the portion of these items is higher. To sum it up out of all tools, more than 60 % of knives, 67 % of axes and more than 70 % of scythes were heat-treated (Zavyalov and Terekhova, 2021a, b).

Discussion

To objectification and comprehensive analysis of various analytical data allow for answering a range of fundamental questions concerning the rural blacksmith craft.

Of course, not all artefacts found in settlement are the products of local blacksmiths. Only the presence of remains of metallurgical production can safely indicate that some of the iron items were produced on site. In this regard, the most difficult question to be answered is about the local or imported nature of products found at these sites. This question can be explored by help of an example of the distribution of manufactured products using complex technologies at rural sites. Direct contact of the local craftsmen with the carriers of innovative technology is an indispensable condition for the local production of such artifacts. One example of such contact is materials found at the settlements of Udrai and Peredolsky Pogost (Novgorod Land). Three-fold welding knives make a significant portion of tools found at these sites. Moreover, they were made according to the Northern European technological variant (Zavyalov, Rozanova and Terekhova, 2012, pp.239-242). Evidence of contacts between the local population and the bearers of Northern European production traditions are clearly attested from the presence of artefacts of Scandinavian origin among the materials from Udrai and Peredolsky Pogost (beads, bronze ornaments, arrowheads) (Platonova, Zheglova and Lesman, 2007). Among them there were knives produced according to the Northern European technological variant. Beyond that, the presence of three-layer objects made according to the Eastern European variant was also recorded at the settlements. This reflects attempts by local craftsmen to produce innovative technologies or to reproduce these high-quality products by making use of local resources.

In the absence of evidence of remains from blacksmithing (iron-working) on site, it would be safe to consider all items made by advanced technique to be imports. A similar situation is illustrated by the materials from the settlement of Sosnovka IV (dated the turn of the 9th-10th c. – mid.-12th c.), located in the middle course of the Oka River. Among the items found at this settlement, the absolute majority of blacksmithing tools were produced via a three- layered scheme corresponding to the North European variant. Furthermore, the

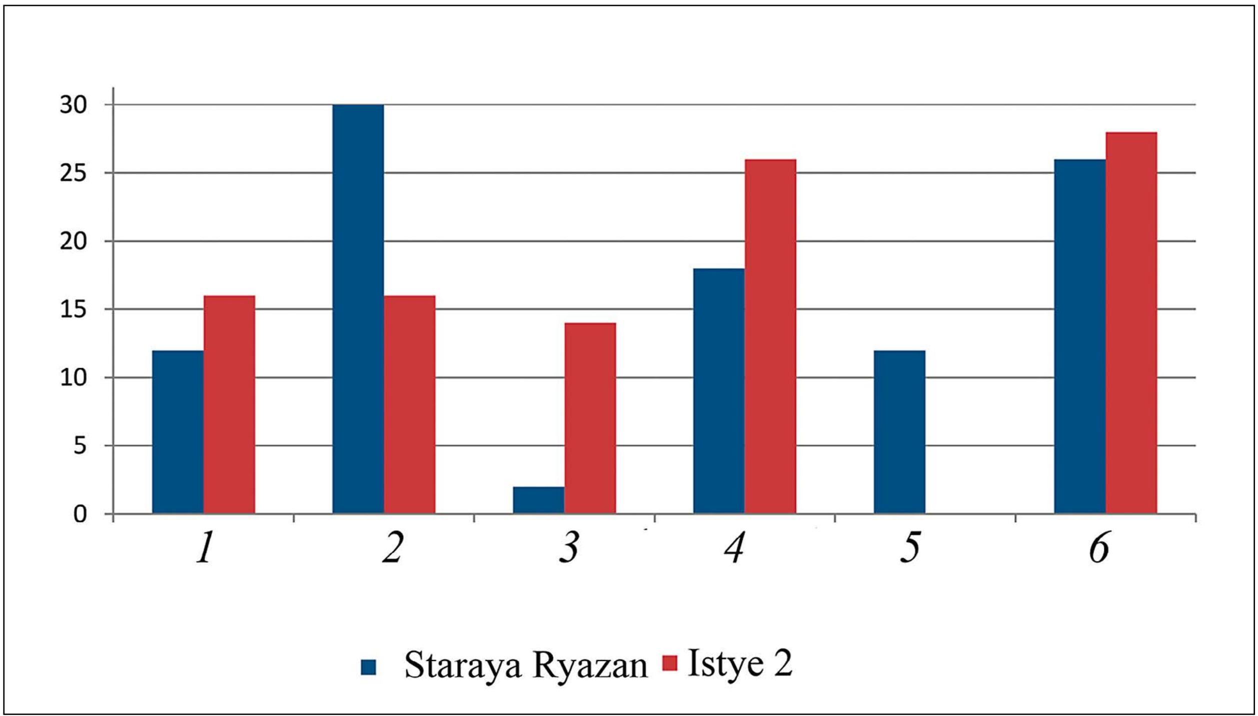

Figure 7. The ratio (in %) of technological schemes for the manufacture of knives from Staraya Ryazan (the principality capital) and Istye 2 (the rural settlement): 1 - ferritic iron; 2 - heterogeneously carburized steel; 3 - steel produced by pass-through cementation; 4 - cementation at the blade; 5 - three-fold welding; 6 - welding-on. Graph: V.I. Zavyalov.

remains of ironworking products were not found at the site, despite the many years of excavations. This directly indicates the import of knives produced by three-folded welding from more developed crafts centres (Zavyalov and Terekhova, 2013, pp.70-75).

However, the ability of rural craftsmen to produce artefacts using advanced technique is convincingly proven by the finds of semi-finished items forged by making use of welding-on technology. Semi-finished items based on this technology were found at the settlements of Gryaznovo 4 (Ryazan principality) (Zavyalov, Rozanova and Terekhova, 2007, pp.116-117), Ves' 5, Vishenki 3 (North-Eastern Rus') (Shcherbakov, 2013).

Particular attention was paid to the assessment of the ratio of different technological schemes used for the production of iron objects at urbanized and rural centres. The results of this analysis reflect certain traditions of the blacksmithing craft.

As an example, we consider objects from Staraya Ryazan (the capital of the Ryazan principality) and the rural settlement of Istye 2, a metallurgical complex that supplied raw iron to capital blacksmiths. Both sites are represented by comparable analytical data: 59 knives were examined from Staraya Ryazan, and 45 from Istye 2. All artefacts were found in archaeological strata dating from the second half of the 12th - the first half of the 13th c. The comparison that was carried out demonstrated significant differences in the distribution of technological schemes (Figure 7). Thus, whereas the assemblage from Staraya Ryazan is characterized by the predominance of artefacts forged from heterogeneously carburized steel (30 % of all studied tools), at Istye 2 such objects constitute only 16 %.

The relatively high percentage of materials and items from Istiye 2 that were forged entirely from steel produced by pass-through cementation (14 %) is worth noticing, while at Staraya Ryazan such objects are rare.

The common use of steel produced by pass-through cementation in the rural metallurgical centres raises the question of its production. In our opinion, the rural metallurgists produced such raw materials. This was due to the close proximity of fuel supplies and the lower risk of fires in rural settlements than in relatively densely populated urbanized centres. In the centres, which produced carburized steel by pass-through cementation, this raw material was cheaper and could be used directly for the production of entirely steel tools.

One of the methods to improve the working properties of tools was cementation at the blade. The more common use of this technique at Istye 2 (26 % versus 18 % at Staraya Ryazan) indicates a specialization of Istye 2 on the production of such items. This is in line with the fact that the cementation of the blade is a typical feature of rural blacksmiths (Zavyalov and Terekhova, 2021a, b).

Advanced technologies attested at Staraya Ryazan include three-fold welding and welding-on of steel blades onto ferritic iron bases, while three-layer items were not found among the materials from Istye 2. The only type of items at Istye 2 made by appliying advanced technologies is welded-on blades.

Thus, a comparative analysis of the ratio of technological schemes at two sites demonstrates clear differences. This, in turn, indicates that the iron items from the settlement of Istiye 2 were mainly produced locally.

Studying the history of the rural blacksmithing craft, one has to reflect on the vector of their development, and in particular on the extent to which the technological advancements reflect the dynamics of the development of urbanized craft. Thanks to the works by Kolchin we now know that in the history of the development of the urbanized blacksmithing craft in Ancient Rus' several chronological stages can be distinguished, based on the prevalence of certain technological schemes. Until the mid-12th c. a characteristic feature of the ironworking of urban craft centres was the prevalence of the technology of three-fold welding, and since the mid-12th c. the technology of welding-on has started to dominate the production of blades (Kolchin, 1959, pp.53-54; Zavyalov and Terekhova, 2017, p.138).

To date the collected analytical data enables us to compare the dynamics of the development of crafts production in urbanized and rural centres. This is most clearly reflected by the iron items used at the rural sites in the Beloozero region (North-Eastern Rus') (Zavyalov, Rozanova and Terekhova, 2012, p.181). The archaeometallographic data obtained from the study of the products found at 9th-11th c. sites in this region (Krutik, Nikolskoe VI) demonstrates the common use of the three-fold welding technology (among which the Northern European variant predominates). In settlements with the 10th-12th c. cultural layers (Lukovets, Minino 5, Krivets, Andryushino-Irma, Teleshovo) there occur both finds of three-layered tools and tools with welded-on blades. In collections from the sites, characterized by the presence of both early Russian layers (i.e., before 13th c.), and the layers dated to the 13th-14th c. (Nefedovo, Minino on Kubensky Lake, Oktyabrsky Most, etc.), welded-on blades dominate other welding types (Zavyalov, Rozanova and Terekhova, 2012, pp.180-182). For example, at settlement with a relatively narrow timespan (12th-13th c.), Minino 4 located on the river the Bolshoy Yug, knives with welded-on blades are predominant, while knives with three-layer blades exclusively represent the Eastern European version of the technology.

These observations are also confirmed by the study of materials from settlements of the 10th-12th c. located on the Oka and the Upper Don (Zavyalov and Terekhova, 2013, pp.70, 88). At the settlement of Sosnovka IV (late 9th - early 12th c.) eleven three-layered tools and only one knife with a welded-on blade were found. In contrast, at the 12th-13th c. sites (Istye 2, Durakovo, Kulikovka 4, Zamyatino-10) items with welded-on blades prevail among other welding types. This indicates that iron-working production at rural sites developed simultaneously with the progress of the urbanized crafts.

One of the questions in the study of the history of craft production concerns the preservation of production traditions during periods of decline. It is known that such a period in the history of Ancient Rus' was the Tatar-Mongol Yoke (mid-13th - end of the 15th c.). By an example of the blacksmithing craft we address this question in relation to both cities that were subject to raiding and the cities that escaped this fate. Based on the archaeometallographic analysis of items from urbanised centres of Ancient Rus', it was established that the blacksmithing craft did not undergo negative changes under the Tatar-Mongol Yoke during the 13th-15th c. This is especially proven by the fact that the advanced technological scheme continued to be used. The products with welded-on blades did not disappear during the Golden Horde period. Rather the opposite was observed: the portion of these items increased significantly. (Zavyalov, Rozanova and Terekhova, 2007, pp.128, 156).

As part of the present work we had the opportunity to address this problem by an example of materials from rural sites. That was undertaken through the comparative analysis of the archaeometallographic data of blacksmithing products found at the settlement of Kulikovo Pole (Tula region), where the iron production remains both from the pre-Mongolian (12th - first half of the 13th c., Kulikovka 4) and the Golden Horde (14th c., Gryaznovo 4, Buchalki) periods were archaeologically recorded. The results have led to the conclusion that there were no significant changes of ironworking techniques throughout both chronological periods. During both periods, complex welding schemes played a significant role as a blacksmithing tradition. The technique of welding-on prevailed during the Golden Horde period, which is, however, consistent with the general dynamics of the development of ironworking in Ancient Rus' (Zavyalov, Rozanova and Terekhova, 2007, p.124).

Conclusions

Thus it can be stated, based on summarizing the data presented in this article, that rural craft production was a much more complex phenomenon than it was previously believed. The rural craftsmen did not only supply raw materials to urbanised centres and produced technologically simple items but also adopted and implemented technological innovations. Although the development of blacksmithing and the emergence of new technological standards was advanced by craftsmen from the urbanized centres, the village blacksmiths were also able to produce quality blacksmithing items. Thus, the rural iron-working craft was an important component of the production culture of Ancient Rus', making a significant contribution to the economy of the feudal system.

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Notes

1 The term *archeometallography* has already entered the scientific literature (see: Zavyalov, Rozanova and Terekhova, 2012; Shcherbakov, 2018; Zavyalov and Terekhova, 2013; 2021b). The need for its introduction is as follows: the fundamental difference between technical and archaeological metallography is that in the former case (technical metallography), the ultimate goal is to determine the compliance of the physical and chemical properties of the product with the given parameters of its production. In the latter case (archaeological metallography), the task is exactly the opposite: determining the main parameters for manufacturing an artifact based on the technical characteristics of the finished product.

2 Standard of the Russian Federation.

3 Phosphoric iron was determined based on the ferrite grain size (coarse grain), the presence of ghost structure and the high microhardness of the ferrite (above 206 HV0,1).

4 These billets were worked similarly to the surface cementation, but required longer heating of the iron object in a crucible so that the cementation could pass through the whole body of the object, as opposed to "cementation of the blade".

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