Estonian Journal of Archaeology, 2015, **19**, 2, 83–109 doi: 10.3176/arch.2015.2.01

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SPATIAL SEPARATION BETWEEN MANUFACTURING AND CONSUMPTION OF STONE AXES AS AN EVIDENCE OF CRAFT SPECIALIZATION IN PREHISTORIC RUSSIAN KARELIA

Axes and adzes made of local greenstones are very common for archaeological sites in Russian Karelia since the initial inhabiting of this territory. Nevertheless, several traits of the industry that is characteristic for sites with Asbestos Ware (ca 3500–1500 cal BC) make it quite different from earlier traditions. This industry is distinguished by a selective choice of raw material of very high quality (mostly metatuff), the most sophisticated technology that had ever been used for making stone axes in prehistoric Karelia, the highest recorded degree of morphological standardization. What is especially important, assemblages from settlement sites with housepits testify that the production of chopping implements did not take place in these sites, because corresponding debitage is almost lacking. Workshop sites for making these tools are known at the moment only in one area on the western coast of Onega Lake. Dozens of workshops are characterized by the presence of waste products from all stages of the reduction process, and some of them reveal evidence of production en masse. These facts allow speaking about craft specialization, i.e. making of tools by relatively closed social group and their distribution within the rest of the society, as well as neighbouring and distant societies, through exchange networks.

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Introduction. Chopping tools of the Russian Karelian type

Cultural context

The article is devoted to discussion of some issues associated with the industry of wood-chopping tools (axes, adzes, gouges) of the so-called Russian Karelian or Eastern Karelian type. It is argued here that peculiarities of this industry testify to the existence of craft specialization, and the main emphasis is placed on spatial separation between production and consumption areas, i.e. zones with and without evidences of manufacturing activities.

The industry is characteristic for the sites with different varieties of Asbestos Ware, which are dated to the period from ca 3500 cal BC to ca 1500 cal BC based on the available radiocarbon dates, though the final phase of this cultural group is not completely clear due to the lack of sources (Zhul´nikov 1999, 76 f.; Kosmenko 2003; Zhulnikov et al. 2012). This period is labelled as Eneolithic in the Karelian research tradition due to the presence of tiny pieces of native copper in some assemblages. In neighbouring Finland, where synchronous sites belonged to generally the same cultural tradition, it is not separated from the Neolithic (see Nordqvist & Herva 2013). It should be also noted that this type of chopping tools and its specific technology were not unique to Karelia. Very similar industry based on flint and silicified limestone was also characteristic, at least, for Volosovo culture sites in the Upper Volga region (Tarasov & Kostyleva 2015). However, as the latter industry has not been properly studied so far, it will not be discussed here, and the name of the Russian Karelian type is used in this article only for tools made of rocks available in the Lake Onega area.

The subsistence system in both Finland and Karelia was still largely based on hunting and gathering with a great deal of exploitation of aquatic resources (Savvateev & Vereshchagin 1978; Kotivuori 1993; Halen 1994, 164; Pesonen 1996, 112; Ukkonen 1996, 78; Koivunen 1997, 50; Karjalainen 1999, 186; Katiskoski 2002, 194; Leskinen 2002, 168; Pesonen 2006, 204; Mökkönen 2011, 37), although there is indirect evidence of small-scale agriculture, quite numerous at the moment but still very controversial (Mökkönen 2011; Lahtinen & Rowley-Conwy 2013). Despite the hunter-gatherer's economy, we can suspect remarkable degree of sedentism based on the spread of long-term semi-subterranean dwellings, exceeding 50 m^2 and in some cases even 100 m^2 (Zhul´nikov 2003, 126 f.; Mökkönen 2011, 29–65). The period of demographic growth followed by a new decline can be suggested for the period ca 6000–4000 cal. BP (ca 4000–2000 cal. BC) in Finland based on the distribution of available radiocarbon dates (Tallavaara et al. 2010). This result, at least, can be mentioned in the context of this discussion, though the use of the radiocarbon record as a proxy for studying ancient demography can be subjected to reasonable criticism (for discussion see Mökkönen 2014; Tallavaara et al. 2014). Radiocarbon record in the neighboring Karelia is too small and not sufficient for similar study.

The presence of large houses and active participation in long-distance exchange gave reasons to some researchers to propose considerable degree of cultural and social complexity (Tarasov 2006; Costopoulos et al. 2012 and references cited). As we know from ethnography and ethnoarchaeology, social complexity can appear among hunter-gatherer populations in certain circumstances. Some of these populations, labelled as complex hunter-gatherers, have been reported from Northern America, especially the north-west coast. They are characterized by a remarkable level of formal hierarchy with leaders inheriting their positions, the presence of lineages of differential status and in some cases even slaves. Resource storage, i.e. accumulation of surplus, active trade, development of elaborate technologies and "representational arts" belong to the set of phenomena that

can be observed within such societies (Lyapunova 1972; Brown & Price 1985; Arnold 1993; Max Friesen 1999; 2007). If similar phenomena were developing in Karelia, which we can suspect even if not completely prove at the moment, an appearance of some sort of craft specialization is not very surprising.

Previous research

Studies devoted to the industry of the Russian Karelian type, which provide data in support of the social complexity hypothesis, began more than 100 years ago. The tools of the Russian Karelian (or Eastern Karelian) type, which are distinguished by their high quality and strict geometrical shape with trapezoid or oval cross-section (Fig. 1: 1–2) have been under the attention of mostly Finnish and Karelian researchers already since the 2nd half of the 19th century. Due to investigations by Finnish archaeologists J. R. Aspelin, L. V. Pääkkönen, J. Ailio, A. Äyräpää this type was recognized as a specific Karelian feature, which, though, spread far away from Karelia. Finnish researchers located the production centre on the western coast of Onega Lake in the outfall of Shuya River (Fig. 2) and discovered that some products from this centre were transported to distant areas, mainly to Finland and Estonia (Äyräpää 1944; Heikkurinen 1980; Nordquist & Seitsonen 2008; Kriiska et al. 2013). Russian archaeologists of the Soviet period who studied Karelia were more or less aware about the interpretation of these materials proposed by their Finnish colleagues, though in Russia it was not universally accepted (Bryusov 1947; 1952, 103 ff.; Foss 1952, 196; Klark 1953, 246 f.; Filatova 1971; Gurina 1974).

In the 1980s and 1990s, A. M. Zhul´nikov (1999) studied in Karelia a row of sites that according to Karelian periodization of prehistory can be dated to the Eneolithic. Pottery found from these sites is characterized by the use of organic material and asbestos for tempering (Asbestos Ware). It became clear that the tools of Russian Karelian type are very common among the finds gathered from these sites, at the same time they are missing in the sites of other archaeological cultures in Karelia (Tarasov 2008).

In the period following the Second World War Karelian archaeologists did not pay much attention to the outfall of Shuya River and the workshops located there were not even surveyed. Sporadic fieldworks resumed only in the 1980s, while regular investigations, mostly surveying and collection of loose finds, started in the 1990s. In 2000, first excavations of a workshop site in this area – Fofanovo XIV – were conducted by A. M. Zhulnikov. The results of excavations were partially published (Tarasov 2003). In 2010–2013 small-scale excavations were performed in some other sites (Figs 2, 3), which will be discussed here.

Mapping of the finds of the Russian Karelian type was resumed in 2008 when archaeological collections in Estonia were studied (Kriiska et al. 2013). The work continued in 2009 in Latvia (Kriiska & Tarasov 2011). Since then, collections of

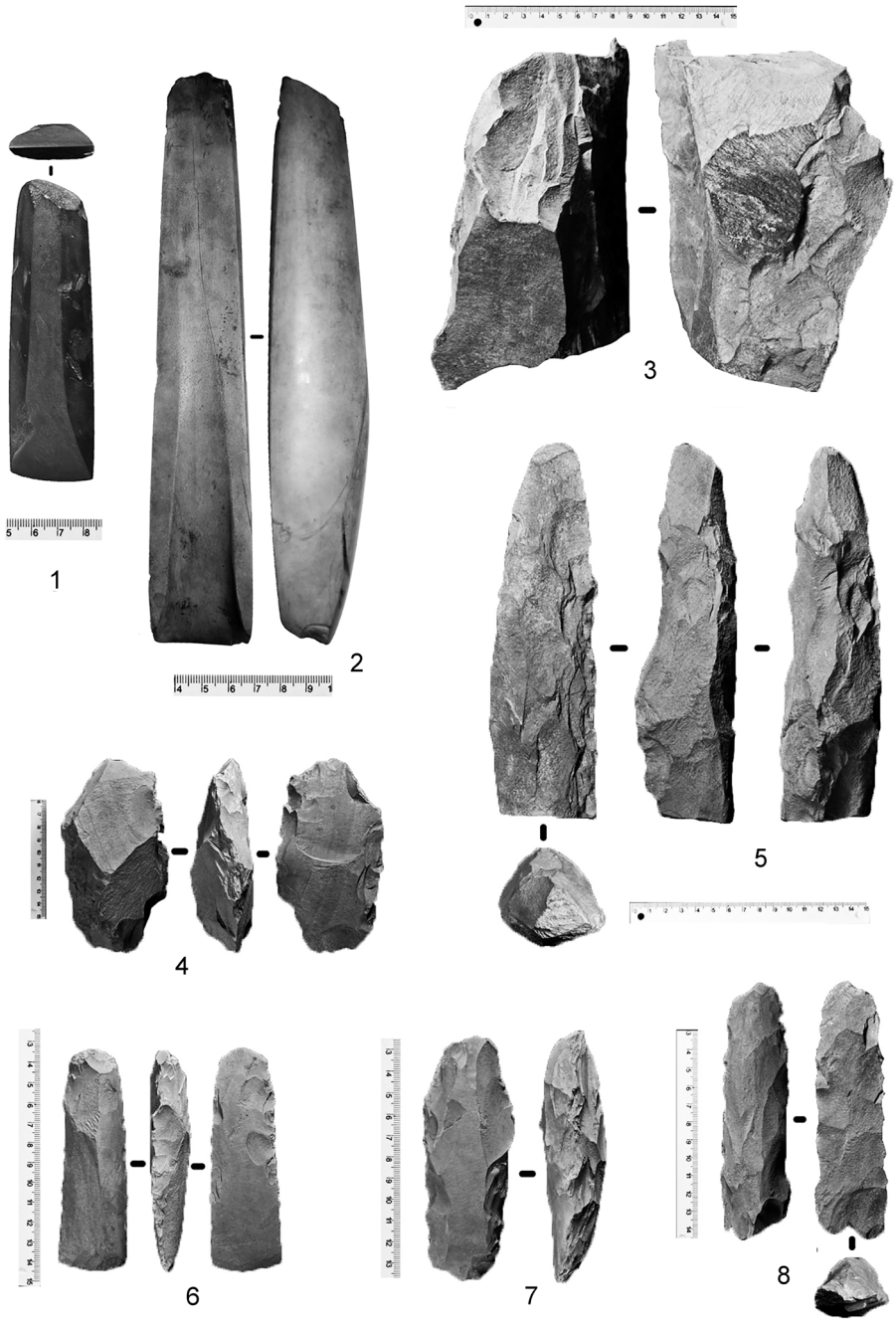

Fig. 1. Typical tools of the Russian Karelian type and their preforms (metatuff). 1 adze, 2 gouge, 3 1st stage preform, 4–5, 7 2nd stage preforms, 8 3d stage preform, 6 4th stage preform (1, 3–8 Karelia, Fofanovo XIII workshop site, preserved in ILLH KRC of RAS, Petrozavodsk, 2 Estonia, Aesoo, stray find, preserved at the Institute of History in Tallinn). Photo by Alexey Tarasov and Aivar Kriiska.

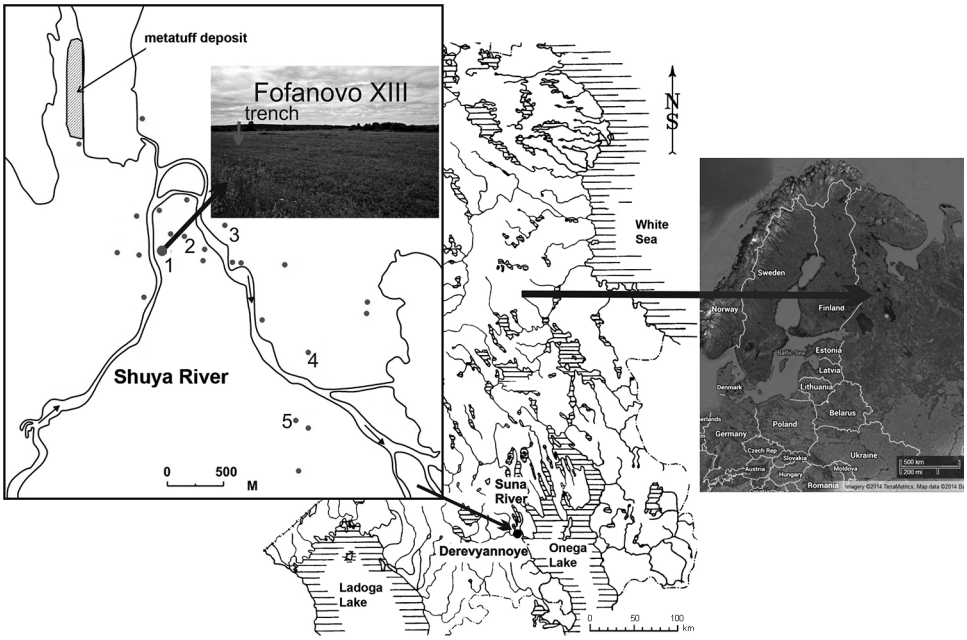

Fig. 2. Location of workshop sites for making metatuff chopping tools of the Russian Karelian type on the western coast of Onega Lake.

a number of museums in Karelia and other regions in Russia, and collections of the National Board of Antiquities (Museovirasto) in Helsinki were studied as well. At the moment, the database contains descriptions of 3466 objects, including tools of this type and their fragments along with preforms.

The raw material for making artefacts of the Russian Karelian type was identified in the 2nd decade of the 20th century by the Finnish geologist E. Mäkinen. The researcher completed the petrographical analysis, which indicated that the majority of these wood-chopping tools have been produced of tuff, which is exposed on the north-western shore of Lake Onega, but has been carried more south from the lake by continental glacier (Äyräpää 1944). The colour of this sort of rock is green or grey (or something in between), and it can be observed that colour shades of a given piece may somewhat change due to the extent of moisture in the rock or lighting conditions. Due to its colour and slaty cleavage the material has been erroneously named the green slate of Aunus, Olonetz, Äänisjärvi or Onega in archaeological literature (e.g. Tallgren 1922, 67; Äyräpää 1944; Heikkurinen 1980, 5). Petrographic investigation resumed in 2009, when the analysis of the finds from Estonian territory was conducted. The study confirmed that the majority of the analysed sampling was made of metatuff that is absent in Estonia but is fully analogous to the material of samples from the western coast of Onega Lake (Tarasov et al. 2010).

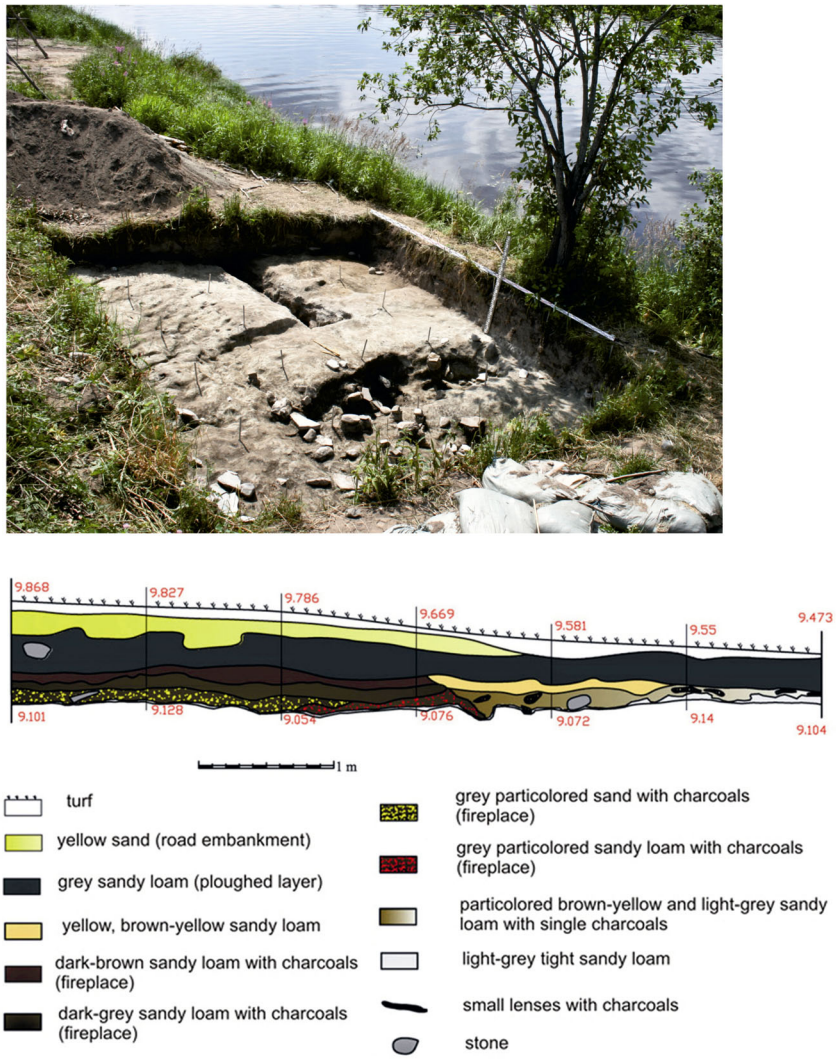

Fig. 3. Trench on the workshop site Fofanovo XIII. Bottom of the cultural layer (north-east view) and eastern profile.

Why should we suspect craft specialization? The main traits of the industry

Defining ancient craft specialization

Ancient craft specialization, including specialization in lithic production, has been discussed in numerous publications. Lithic craft specialization has been reported from different parts of the Old and New World (Shafer & Hester 1986; 1991; Torrence 1986, 139–163; Pelegrin 1990; Roux 1990; Costin 1991; Cobb

1993; Johnson 1996; Petrequin et al. 1998; Apel 2001; Bayman & Nakamura 2001; Schortman & Urban 2004; Whittaker et al. 2009; Barzilai 2010, 151 ff.; Kolesnik 2012; Nicolas & Guéret 2014 and others). Specialization in lithic industry has been also described in ethnoarchaeological studies from contemporary New Guinea (Petrequin et al. 1998; Hampton 1999, 226 ff.; Stout 2002).

It should be emphasized here that craft specialization is not a uniform entity, but rather a multidimensional phenomenon, which has different degrees and forms (Costin 1991; Cobb 1993). Craftsmen can be independent "entrepreneurs" or subordinated to elites or state institutions, work and live in separate locations or close to the rest of the society, individually or within craftsmen groups of different sizes, devote their full time to one specific activity or engage in this activity only for a certain period in their annual cycle (Costin 1991 and references cited). Due to its complex nature, quite a number of definitions and typologies of this phenomenon have been proposed. We can hardly expect that anyone of them will be accepted by all researchers.

In my own opinion, there are three key components in distinguishing specialized production from an ordinary production. The first one has to do with its customers. In the case of craft production items are made with the primary intention to be delivered to consumers that do not take part in the manufacturing, i.e. not for manufacturers themselves and their households. This feature necessarily implies some sort of surplus production. The second has to do with regularity and repetitiveness of such interactions, that is, they should be organized systematically at the level of individuals and society as a whole. Finally, technology or some critical components of technology should be inaccessible for the consumers, and thus for the majority of the population involved in the interaction process. This inaccessibility may result from the lack of proper personal characteristics, lack of time for developing skills, distance from the source of raw materials or socially imposed restrictions. All other characteristics define *types* of specialization, but for making the decision concerning the *presence* of specialized production these three features should be enough.

Because of the complex nature of this phenomenon and the nature of "silent" archaeological sources in far too many cases our attempts to distinguish and describe craft specialization will remain debatable. Alternative interpretations of archaeological record have been suggested even for the most obvious cases of Maya lithic workshops with innumerable production debris (Mallory 1986; Shafer & Hester 1986). However, researchers have outlined basic traits visible in the archaeological record, which can testify its presence at least with some degree of probability. Workshop sites or areas with unusually high density of production debris and specific tools used in production, distinct territorial separation between production areas and areas where the products were used, especially if these areas are located at big distances from each other, distribution of particular artefact types, standardization, great skill, technological efficiency can be listed among them (Pelegrin 1990; Roux 1990; Costin 1991).

All of them are not unequivocal, because it is hardly possible to estimate precisely the border value after which an ordinary production turns into a specialized one. In order to make a sound conclusion we need to consider a unique combination of traits of any specific industry and contexts in which it operated.

There is nothing exceptional in the presence of specialized lithic production as such, and searching for it in the archaeological record is not an odd idea. However, in our case the society hosting probable craftsmen was a hunter-gatherer one, and this trait distinguishes it from all other cases of lithic craft specialization that can be found in archaeological literature. Hunter-gatherers, even complex hunter-gatherers, have their limit of complexity and population size. In this aspect they are inferior to farmers and pastoralists. Nevertheless, ethnoarchaeological evidence provides examples of craft specialization even in "small-scale societies", i.e. societies not exceeding several thousand people and lacking centralized political systems. In Melanesia development of craft specialization in the form of part-time household industry and subsistence intensification was inspired by the "feasting economy" requiring accumulation of great volumes of different resources for organization of communal feasts (Spielmann 2002).

Industry of Russian Karelian tools. Quality of the raw material

Karelia, which is located in the Baltic Shield, has numerous deposits of different sorts of greenstones suitable for production of chopping implements, which are usually referred to as "slates" in the Karelian research tradition. These rocks can differ considerably in their quality, especially hardness. According to the available data, the majority of the Russian Karelian type of tools were made of slightly metamorphosed volcanic tuff from the western coast of Onega Lake. Different varieties of tuffs from this area are characterized by high volume of SiO_2 (Kairyak 1973, 92 ff.) which makes them as hard as flint and quite suitable for knapping, though still very tough and hard to work with.

Comparative study of the hardness of chopping tools from Karelian sites with "pure" (or single-period) complexes dated to the Neolithic–Early Metal Period has shown that inhabitants of Eneolithic sites with Asbestos Ware, except the latest ones, regularly chose the hardest material (i.e. metatufff) for their chopping tools (i.e. the Russian Karelian tools). In earlier periods this is not the case, and the hardest varieties do not constitute a stable majority of the samplings (Tarasov 2004). In my interpretation, this means that the Eneolithic population, which used Asbestos Ware, regularly refused to exploit more easily accessible sources of lesser quality. Harder and less accessible metatuff was preferred even in sites located at big distances from the area with deposits of this rock despite the costs of its procuring.

Morphological standardization

The same sampling of chopping tools from Karelian sites with pure complexes, most of which are located on the shores of Onega Lake, was used for assessing the degree of morphological standardization. Two variables were taken into account: a shape of the cross-section and a shape of the outline (Fig. 4). Again, chopping tools accompanying Asbestos Ware demonstrate the highest recorded degree. Most of them have trapezoid cross-section, which sometimes turns into triangular at the butt. Other variants include half-oval section, especially characteristic for gouges, and, in very rare cases, parallelogram cross-section. The latter has never been recorded among gouges, but otherwise the function of tools of this shape does not seem to differ from adzes and axes with trapezoid cross-sections.

The outline of the majority of these tools is very similar to a trapeze as well, though the widest part is not at the very edge, but at some distance from it, not exceeding 1/4 of the total length.

Of course, these tools were not cast or produced with the aid of any other technology that allows full replicating of a chosen pattern. Due to the nature of knapping technology and constraints imposed by the tough raw material we cannot find even two items that are exact copies of each other. I also realize that my evaluation of tools' shapes contains quite a lot of subjectivity. However, I believe that any other researcher after studying a big series of these tools will come to conclusion that in the case of Russian Karelian implements we see clear intention of manufacturers to follow a unified morphological standard and care about a strict shape and symmetry, while in earlier samplings it was not the case. Or, at least, it was not at the same high degree.

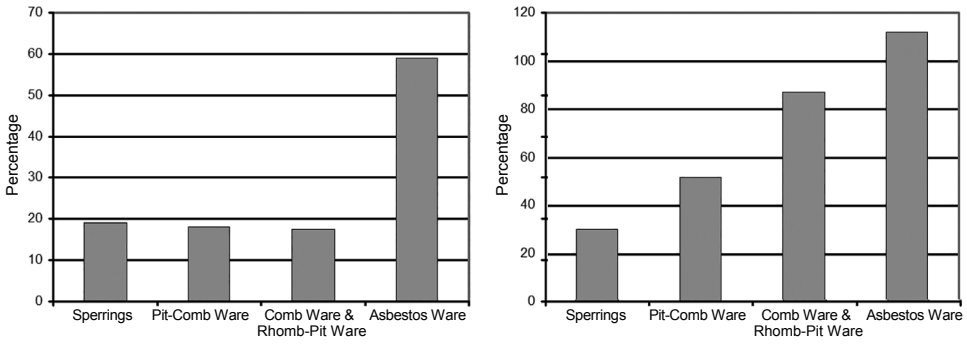

Fig. 4. Morphological standardization of chopping tools. To the left – percentage of the most common combination of outline and cross-section shapes of wood-chopping tools in the total amount of other combinations (taken as 100%) recorded among complete tools in assemblages of Neolithic – Eneolithic periods in Karelia. To the right – percentage of the most common shape of cross-section in the total amount of other recorded shapes of cross-sections (taken as 100%) in assemblages of Neolithic – Eneolithic periods in Karelia. The most common combination in the assemblages with Asbestos Ware is trapezoid cross-section and trapezoid outline, the most common shape of the cross-section is trapezoid.

Technology: complexity, skill and efficiency

A strict geometric shape with trapezoid, half-oval or, in rare cases, parallelogram cross-section was definitely an important feature for the ancient manufacturers and can be regarded as a real value.

Achieving a strict shape just by knapping was accomplished with the use of indirect percussion with antler punches, which provides a very high degree of controlling placement of blows as well as a possibility to concentrate the full strength of a blow in the proper direction. Indirect percussion was used similarly to the technology of making 4-sided axes (Fig. 5) that are characteristic for a number of European cultures, especially the Funnel Beaker (Hansen & Madsen

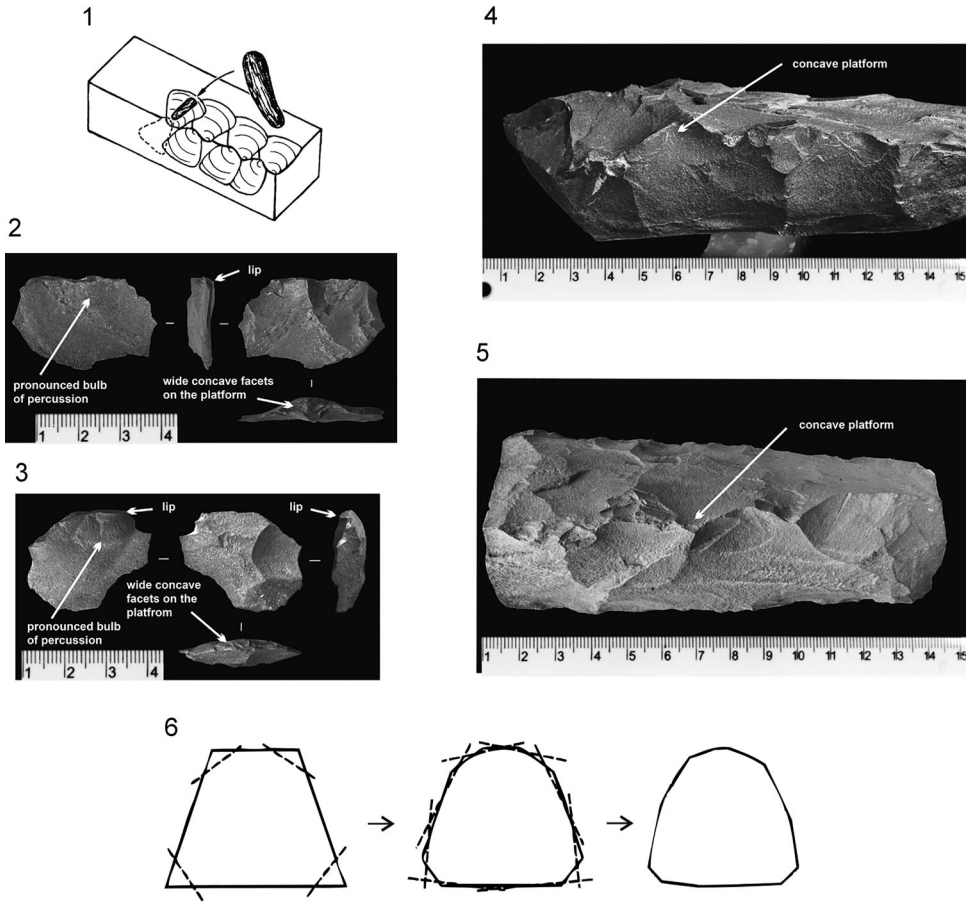

Fig. 5. Technology of Russian Karelian tools. Punch technique and features of debitage resulting from its use. 1 the method of using punch technique, 2 an experimental flake, 3 a flake from Fofanovo XIII assemblage, 4 an experimental preform, 5 a preform from Fofanovo XIII assemblage, 6 multifaceted grinding (sequence of changing the shape of the cross-section of a tool). 2–5 metatuff.

1983; Madsen 1984), but in the Russian Karelian industry masters achieved with the aid of this technique trapezoid cross-section (Figs 5, 6).

Determining the knapping technique in far too many cases is not unequivocal. However, indirect percussion can be quite safely recognized if we see concave platforms (Pelegrin 2004). Any direct percussors would not be able to reach the platform and would be stopped by the ridges surrounding it, thus spoiling the impulse. Excavations in Fofanovo XIII provided also a number of fragments of antlers. The state of preservation is poor and use-wear study is not possible, but interpreting them as punches seems most probable. The reduction sequence can be divided into several stages, namely, I discern 3 stages of knapping that are followed by the stage of grinding (Fig. 6).

This knapping technology was the most complex among all other technological variants of producing chopping tools in ancient Karelia (see, for example,

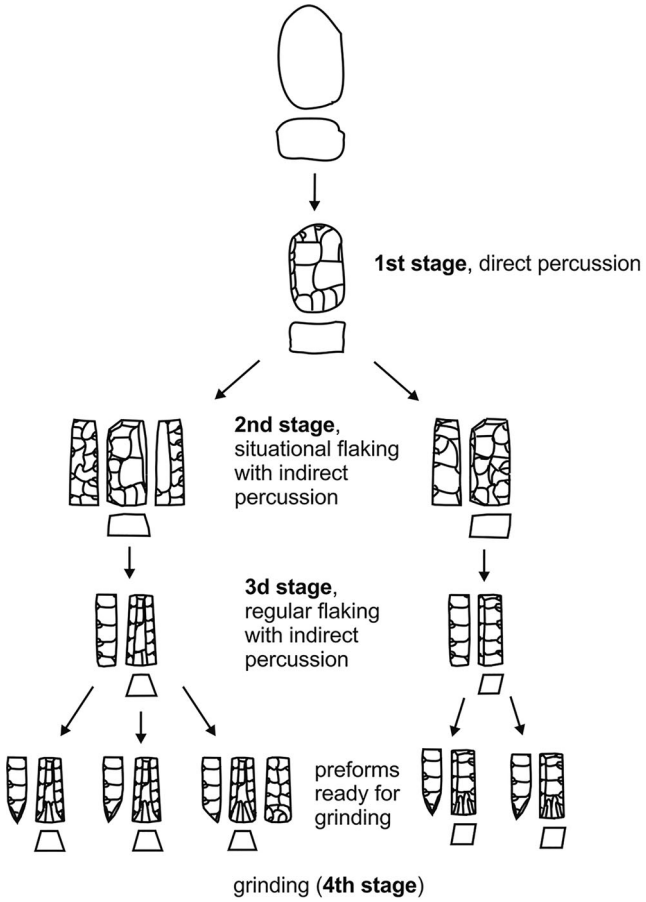

Fig. 6. Technology of Russian Karelian tools, simplified reduction sequence.

Tarasov 2009; 2011c). Moreover, it required a kit of knapping instruments, which had to be carefully prepared and kept in proper condition. Of course, it can be questioned whether the technology was complex enough to exclude any possibility that it was practiced by nearly everyone in the society. However, as it required spending some time for acquiring even the basic skills, while making an axe could have been accomplished with much simpler approaches and relatively fast, it is more likely that this complicated technology was practiced by people deliberately devoting big portion of their time to this activity. It is interesting to note that in some parts of New Guinea, where basic skills of knapping and grinding were possessed by everyone among adult males, stone axes made by ordinary people with the aid of a simple technology with hammerstones and extensive grinding were never used for long distance exchange. To the contrary, pieces of higher quality manufactured with soft hammers were produced by knapping specialists, and these items were involved in the exchange interactions (Petrequin et al. 1998).

Even average tools of Russian Karelian type have high quality and are perfectly polished. At the same time, their sizes differ considerably, and the majority is not very big, though usually bigger than 100 mm. However, there are examples of exceptionally long tools, close to 400 mm (Laaksonen et al. 1984, 38), and a representative series of implements exceeding 200 mm (Fig. 1: 2). Exceptionally long specimens that were made with the same complex technology and are of superior quality indicate that some of the masters had the possibility to develop skills requiring years of hard training.

The technology can be considered efficient as it allowed making items with a strict geometrical shape out of a hard material just by knapping, and abrasive techniques were needed only to smooth the surface and create glassy shine (polish). Making similar items of the same material just by grinding would have required much higher time consumption. However, this efficiency is evident only if we need items of high quality and have a proper skill. With simpler methods we can produce an axe even faster, but we will not be able to reach this state of quality and morphological standardization.

Another aspect of efficiency has to do with the mode of grinding. Instead of pulling wide surfaces against a grinding slab, the masters used another technique, which can be defined as “multifaceted grinding”. The finished items after the use of this technique have numerous narrow longitudinally oriented facets besides four main faces of the tool, i.e. each main face is divided into a number of smaller narrow facets attached to each other by obtuse angles. We do not fully understand how this was achieved. But it is evident that grinding started with leveling one of longitudinal ridges of the preform, and after a while two other smaller ridges were created (Fig. 5: 6). The work switched to one of these ridges creating two new ones, and so on. We have not tested this technique in experiments so far, but it seems that in this way the grinding process should proceed faster.

Production vs. consumption. Studying workshops and the distribution of products

Workshops on the western coast of Onega Lake

At the moment, workshop sites and knapping floors have been found only on the western coast of Onega Lake. We have plenty of evidence of concentration of production activities related to the Russian Karelian industry in the outfall of Shuya River (Fig. 2). Quite numerous sites have been already identified here and each year we find new ones. Moreover, even between these sites single flakes can be found while walking in the fields, and in fact the whole micro-region can be regarded as a mega-workshop with zones of higher densities of diagnostic debris. The outfall of Shuya River can be considered as the primary production centre and we do not know any other such centre for making Russian Karelian tools in Karelia and elsewhere.

Mostly, the workshops were identified by collecting stray finds in the fields (it is an agricultural area) and by materials from test pits. Only in five sites excavated area exceeded 1 m^2: Fofanovo XIV, Fofanovo XIII, Shuya XXI, Shuya XXV, Nizovie I (Table 1). It should be noted that Fofanovo XIV, where the excavated area was the biggest, the excavations were carried out with shovels and without sieving of the removed soil, and because of this the statistics about the number of finds is not fully reliable.

In 2010–2011, excavations were carried out in one of the workshop sites – Fofanovo XIII (Tarasov 2011b; 2011c). Cultural layer of ca 0.5–0.9 m of depth was excavated in 30 m^2 (Figs 2, 3). Excavations provided an extremely large artefact assemblage, consisting of more than 350 000 finds. The assemblage is very rich and diverse. Besides production waste from making chopping tools it includes waste materials from making of bifacial projectile points and polished slate points, as well as ceramics, amber pendants, pieces of native copper, unburnt bones (mostly fish bones), etc. However, the absolute majority is built up by the waste flakes from making adzes, axes and gouges.

Table 1. The number of finds from excavated workshop sites on the western coast of Onega Lake

Site	Fofanovo XIV	Fofanovo XIII	Shuya XXI	Shuya XXV	Nizovie I	Derevyannoye XVIII
Total area, m^2	3 500	40 000	6 500	1 200	4 700	3 500
Excavated area, m^2	400	30	6	6	6	18
Finds, total	9 917	355 321	610	1 183	2 885	12 120
Chopping tool preforms	43	684	0	3	21	4
Waste flakes from making chopping tools	9 487	296 829	402	1 059	2 467	11 876

The site provided numerous samples for radiocarbon dating. 5 dates have been prepared so far (Table 2). The time span outlined by these dates is too long and does not correspond to the radiocarbon-based chronology of the varieties of Asbestos Ware that were found in the excavated area, namely Vojnavolok and Orovnavolok according to the typology developed by A. M. Zhul´nikov (1999). Over 40 radiocarbon dates from sites with these varieties in Finland and Karelia place the time span of their existence between ca 4800–3900 BP (3600–2600 cal. BC), which is much less than the diapason of the charcoal dates from Fofanovo XIII (Zhulnikov et al. 2012 and references cited). Moreover, typological analysis indicates that the ceramic assemblage represents a transitional phase from the Vojnavolok to the Orovnavolok type. This transitional phase could hardly have taken more than 200–300 years (Zhul´nikov & Tarasov 2014). The only one AMS date made of charred crust on ceramics fits quite well into the expected time period, even if it might be slightly older due to the "reservoir effect" (Zhulnikov et al. 2012). As the charcoal samples from an open context are vulnerable to contamination by organic substances in the soil, it is more likely that the dates obtained from them deviate substantially from the real period of the site's occupation. The old-wood effect and non-anthropogenic origin of the chosen samples cannot be ruled out either. At the moment, the most likely dating can be proposed at around 3000 cal. BC, but we need more dates, especially ceramic crust dates to prove this. Duration of occupation cannot be estimated based on the available radiocarbon dates.

The three remaining sites – Shuya XXI, Shuya XXV and Nizovie I are not that impressive as Fofanovo XIII, but the amount of finds is still quite substantial for just 6 m^2 that were opened there (Table 1).

Waste flakes assemblage from Fofanovo XIII was compared against an experimental assemblage which was obtained due to a set of controlled replication experiments. This comparison showed that debitage from all stages of reduction process was present within the excavated area (see Tarasov & Stafeev 2014 for discussion), and this means that all reduction stages were performed here, which

Table 2. Radiocarbon dates from Fofanovo XIII workshop site. (Atmospheric data from Reimer et al. (2004); OxCal v3.10 Bronk Ramsey (2005))

Laboratory index	Date (BP ± 1σ)	Calibrated date 2 σ (BC)	δ 13C	Material
Hela-2812	4454 ± 42 BP	3340–2935 BC (95.4%)	–27.5‰	Charred crust
SPb-781	3288 ± 70 BP	1740–1420 BC (95.4%)	–25‰	Charcoal
SPb-782	3158 ± 80 BP	1630–1250 BC (94.1%) 1240–1210 BC (1.3%)	–25‰	Charcoal
SPb-783	5150 ± 80 BP	4250–3700 BC (95.4%)	–25‰	Charcoal
SPb-784	5220 ± 80 BP	4260–3910 BC (88.6%) 3880–3800 BC (7.8%)	–25‰	Charcoal

is also supported by the presence of preforms that were abandoned at all stages (Fig. 1: 3–8). The presence of grinding slabs and partly ground preforms also indicates that grinding was conducted here as well.

Experimental data were used as the basement for estimating the amount of finished tools that could have been produced within the excavated area. According to our estimation, this number, most likely, is between 500–1000, and possibly even exceeds 1000 (Tarasov & Stafeev 2014). If in just 30 m^2 ancient masters produced several hundred tools, we can expect that the whole scale of production in this workshop was dozens of thousands or even hundreds of thousands of complete implements. At the moment we cannot reliably estimate the duration of the use of the site, and it is still possible that it lasted for several hundred years. Nevertheless, axes and other chopping tools, which are quite massive, made of a tough material with considerable effort, perfectly polished, are not designed for very short period of use and can last for a considerable time, probably even exceeding one year. Therefore, even if not more than several hundreds of finished products were produced annually in just one site, it can be qualified as an evidence of specialized "mass-production", i.e. production greatly exceeding the needs of the manufacturers.

The scale of production in Fofanovo XIII workshop is unprecedented for Karelian archaeology and we do not know any other workshop whose cultural layer is similarly densely packed by production debitage (see, for example, Pesonen 1982; 1984; Tarasov et al. 2007; Tarasov 2011a). At the same time, other workshop sites from the outfall of Shuya River that have been excavated so far also contain much smaller amount of waste than Fofanovo XIII. However, they are concentrated in a very compact area, ca 2×2 km, and such a concentration of workshops is itself a unique phenomenon for the Karelian archaeology.

Another knapping floor with diagnostic debitage of the technology of making Russian Karelian tools was excavated in 2013 at 40 km to the south from the outfall of Shuya River in the vicinity of Derevyannoye village on the coast of Onega Lake (Fig. 2). The site is called Derevyannoye XVIII, and, unlike in Shuya centre, this workshop is located close to contemporary sites with semi-subterranean dwellings, which were found one year before (Zhul′nikov 2013). No house depressions have been discovered in the outfall of Shuya River so far.

18 m^2 that were excavated in Derevyannoye XVIII provided over 12 000 finds, mostly metatuff waste flakes (Table 1). Spatial analysis of the artefact distribution showed that this concentration of production debitage was formed during one relatively short episode. The analysis of the debitage, especially the study of the distribution of size classes of flakes in this assemblage, testifies that, most likely, only the last stage of the reduction process was taking place here (Table 3), but not the full cycle of production as in Fofanovo XIII. Consequently, it means that at least some unfinished preforms were transported from the main production area to other sites, quite distanced from the outfall of Shuya River.

Table 3. Average and median values of flake sizes from an experimental sampling and collections from excavations of Fofanovo XIII and Derevyannoye XVIII

Sampling	Variable	Experiment		Fofanovo XIII	Derevyannoye XVIII
		all flakes	3rd stage flakes		
All flakes	Length, average	12.16	10.51	20.88	9.24
	Length, median	8.52	8.06	17.84	7.4
Flakes >15 mm	Length, average	26.09	23.5	26.38	21.7
	Length, median	22.31	20.96	22.84	19.53

The last micro-region that must be mentioned here is the lower reaches of Suna River to the north from Shuya, also on the western coast of Onega Lake (Fig. 2). Among several dozens of sites that have been found here up to date none can be interpreted as a workshop site. Some of them contain Eneolithic materials including the Russian Karelian type tools and preforms. Preforms from this area belong to the last stages of the reduction process. But in one site, namely Suna III excavated in the 1940s (Bryusov 1952, 98), preforms outnumber finished tools: 35 to 14 in the collection from this site which is preserved in the State Historical Museum in Moscow. Waste flakes were not very numerous, and they are not available at the moment. Even this site cannot be interpreted as a lithic workshop. But we cannot fully exclude the possibility that there are some small workshops for making metatuff chopping tools somewhere in the vicinity, possibly with debitage from the full cycle of production, which have not yet been found. However, it is still more likely that the preforms were brought to Suna sites from the workshops in the outfall of Shuya River.

Distribution of the Russian Karelian tools and their preforms

Mapping of finds of the Russian Karelian type for the first time was done by A. Äyräpää (1944). The map prepared by this researcher included only complete tools and showed their distribution in Karelia, namely in the area to the east from Onega Lake and around Ladoga Lake, only as an area with high density of such finds, without specifying find spots and the actual amount of tools originating from these spots. The majority of complete tools that we can study at the moment is still constituted by the stray finds collected by Finnish enthusiasts before World War II, especially by L. V. Pääkkönen (1898). However, the following years of investigations brought many finds from settlements and the investigations in the outfall of Shuya River during the last twenty years also provided plenty of preforms.

At the moment we still cannot trace distribution of these tools from Karelia to the farthest point of occurrence even in one single direction. Therefore, the following discussion is restricted only to the territory of the present-day Republic of Karelia of the Russian Federation and some areas that are closest to it. For this

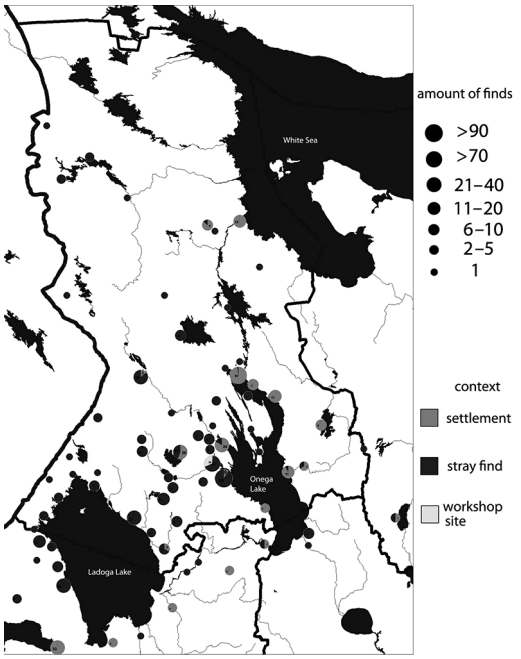

Fig. 7. Distribution map of the Russian Karelian tools.

area we can be sure that over 90% of finds have been already included in the data base. The total amount of the Russian Karelian tools and preforms that were used is 1989.

The findspots are mapped as diagrams showing the number of finds that originate from certain localities which correspond to the XIX – beginning of the XX century parishes (Figs 7–9). They are also segregated according to the type of context: settlement sites, workshop sites and stray finds. Hoards and graves are not distinguished as separate contexts. Only in one case the context can be interpreted as a hoard. An adze accompanied by a spearhead of flint and a stone pick-axe was found on the shore of a very small island in one of the lakes in central Karelia (Zhul´nikov 2005, 84 f.). Three items were laying close to each other among pebbles. Even after a very thorough survey no archaeological sites were found on this island. This single case is included in the stray find sampling. Only one grave that can be dated to the period under consideration has been investigated in Karelia so far in Zalavruga II settlement site in lower reaches of Vyg River close to the south-western coast of the White Sea (Savvateev 1977, 187 ff.). Russian Karelian tools (and any other chopping tools) were absent among its inventory.

The majority of stray finds may, in fact, originate from settlement sites; finds from Shuya parish – also from workshops. Most of them were bought from local peasants in the XIX – the beginning of the XX century and lack proper documentation. It is evident from descriptions of circumstances of their discovery that in some cases they really could not have been connected to any settlement site, for

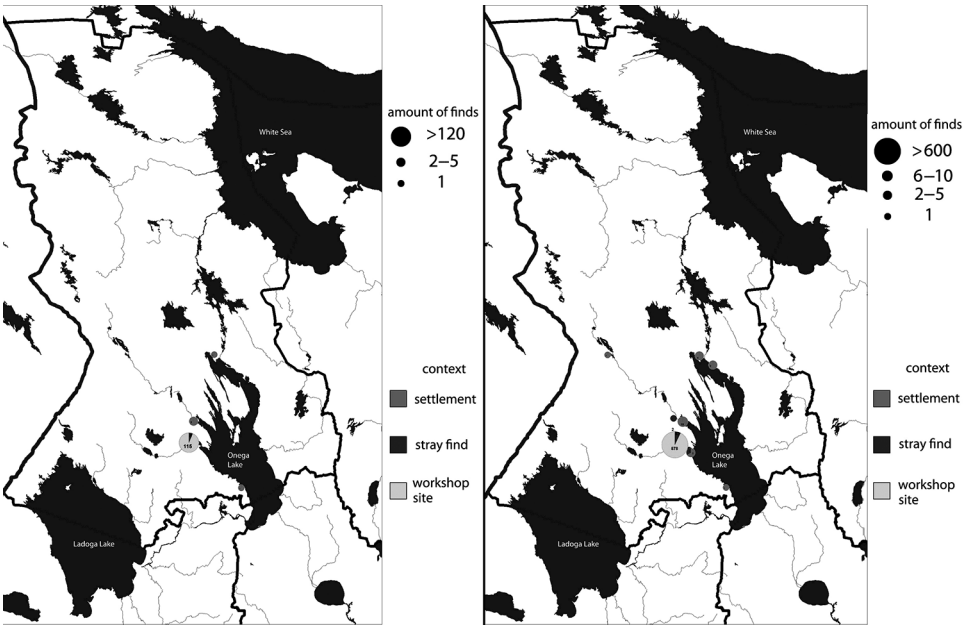

Fig. 8. Distribution map of the 1st (left) and 2nd (right) stage preforms of the Russian Karelian tools.

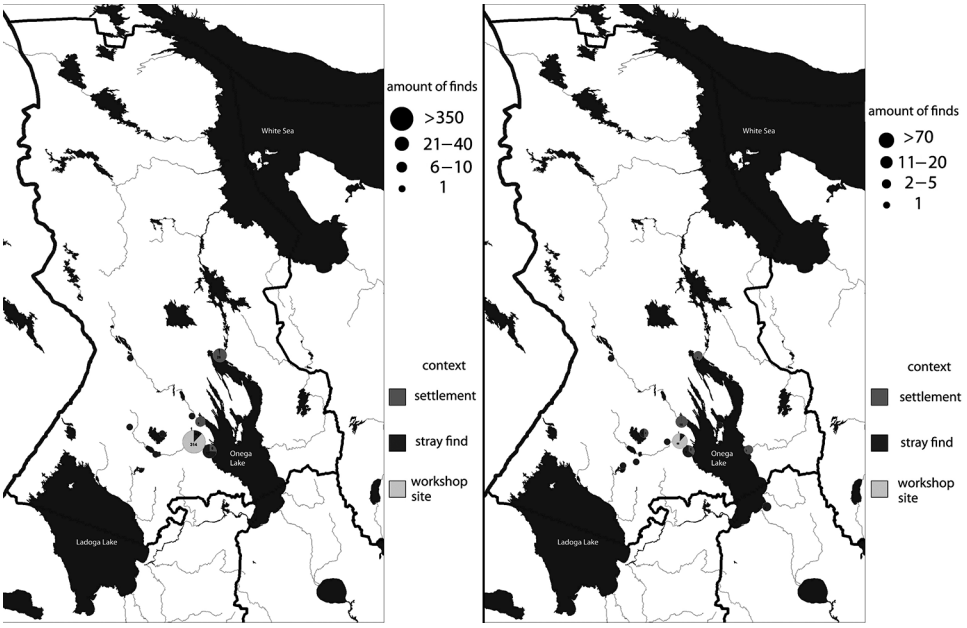

Fig. 9. Distribution map of the 3d (left) and 4th (right) stage preforms of the Russian Karelian tools.

example, items that were found in lakes and rivers while gathering iron ore or fishing. But in the majority of cases estimating precise context is not possible.

Complete tools are well represented in all major water bodies and systems in southern Karelia and are quite evenly distributed (Fig. 7). Their amount drops substantially at the distance of about 300–400 km as the crow flies from the production centre. Only on the coast of Onega Lake we have a series of excavated dwelling sites with "pure", i.e. single-period sites with Asbestos Ware (10 sites). On the basis of these assemblages we can estimate the proportion of the Russian Karelian tools among other variants of chopping tools in the dwelling sites from this period. The tools produced by the technology characteristic for this type with the aid of indirect percussion constitute 70% of the wood-chopping implements from these sites (Tarasov 2008). Of these 16% can be described as bifaces with one face more convex than the other. Such bifacial axes and adzes were also produced in the Shuya workshops, but in lesser quantities and, most likely, in situations when full implementation of the Russian Karelian technology was problematic (Tarasov 2003). But it should be mentioned that the bifacial variant is not dated strictly to the Eneolithic with Asbestos Ware and is present in earlier sites as well. To sum up, the Russian Karelian tools constitute the absolute majority of chopping implements on the sites with Asbestos Ware in the Onega Lake basin.

Unlike complete tools, preforms of the Russian Karelian chopping tools are concentrated in the outfall of Shuya River. 1st stage preforms have been distinguished only among materials from the outfall of Shuya River with just a couple of exceptions. 2nd stage preforms are only slightly more common outside of the production centre (Fig. 8). 3d and 4th stage preforms are quite common in dwelling sites, mostly on the coast of Onega Lake (Fig. 9). However, ca 80% of them still originate from the Shuya workshops. Those that were found elsewhere originate only from Onega Lake basin and do not spread further than 150 km as the crow flies from the production centre.

Discussion

On the basis of the distribution maps and studies of production sites I would like to propose several zones with differing activities. This division is still preliminary and may be changed after completing the data set of finds from territories adjacent to the present-day Karelia.

The first zone is the outfall of Shuya River which can be described as a production centre with evidence of the full cycle of production. Moreover, there are strong, even if not fully unequivocal, reasons to speak about mass production, or surplus production in some places. From this area we do not know any dwelling sites with semi-subterranean dwellings, at least we have not identified any so far. Therefore people probably did not organize their living here all-year round, and we deal with some sort of seasonal activities. Procuring raw material and making these axes and adzes may not have been the only reason for coming here, but it was definitely one of the main reasons.

The second probable zone lies close to the first one and to the north from it, including the lower reaches of Suna River. I distinguish it mainly because the deposits of metatuff should be found here as well, though the procurement sites still await proper investigation. It is possible that a full cycle of production was taking place here as well, as evidenced by the site Suna III discussed above. At the same time, mass production was not characteristic for this area, because otherwise, I believe, it would have been already noticed.

The third zone includes the Onega Lake basin. It is a consumer zone. Evidence of a full cycle of production is absent everywhere except the Shuya production centre. Nevertheless, occasional finishing of half-made items was taking place here as well, as evidenced by the presence of preforms belonging to the last stages of manufacturing and materials from the knapping floor in Derevyannoye XVIII site. This situation testifies, first, that masters were definitely present here and lived at least in some of the dwelling sites in the Onega Lake basin. Second, this fact can be hypothesized as an evidence of direct interaction between manufacturers and consumers. Third, comparison with the Scandinavian flint daggers industry studied by Jan Apel (2001) provides interesting themes for speculations. In this industry the last stages of the reduction process were often carried out within ordinary settlement sites, and not in separate areas, as the earlier stages. In Apel's view, this gave the masters the possibility to demonstrate their excellent skill ("gestures"), which could not have been reached by their fellows who did not belong to the masters "corporation", and gain big respect (Apel 2001, 327).

The fourth zone starts at ca 150 and spreads to ca 400 km from the production centre. The majority of finds were found in the south-western direction, but this difference probably depends on the state of the investigation. Compared with the Onega Lake region, relatively few sites have been investigated in the northern part of Karelia so far. At the same time, there is an obvious difference between find contexts in the Ladoga Lake region and the northern part of the fourth zone which is close to the White Sea. Ladoga Lake surroundings were also sparsely investigated in the second half of the XX century, and even less than northern Karelia. But this region, which was a densely inhabited agricultural land prior to the Second World War, provided many stray finds. The few northern sites investigated by excavations, however, provided a remarkable number of tools too (Fig. 7).

It is also a consumer zone and, unlike the previous one, it does not contain any signs of production of the Russian Karelian tools. It is not possible to estimate the proportion of these tools in the assemblages because of the lack of good series of excavated single-period sites. A very interesting site Ochta I in St. Petersburg that was recently extensively investigated and provided quite many implements is also a palimpsest (Tarasov & Gusentsova 2012). We can just notice that complete tools are quite numerous here and in some places remarkable series of them were found. An occasional direct interaction could probably have taken place in the fourth zone as well, but definitely without the settling of masters.

The fifth zone spreads far beyond the limits of the maps presented here and begins at ca 400 km from the production centre, where we can observe an abrupt

drop in the number of finds. Mapping work for this zone has not yet been completed. As a preliminary interpretation, it can be proposed that only down-the-line exchange without direct interaction between manufacturers and consumers was taking place here.

After the analysis that has been presented in the article it can be argued that, at least in the Onega Lake basin, the requirements for wood-chopping tools were satisfied by production in one small centre on the western coast of this large lake, which was located close to the metatuff deposits. The exploitation of locally available raw materials was taking place to a minimal extent. Therefore, we can speak about the spatial separation between the production and consumption of chopping tools during the Eneolithic on the sites with Asbestos Ware. And this is especially important because pieces of different raw materials suitable for making axes and adzes can be easily found all over the southern part of Karelia.

This separation required quite a developed logistic organization. Furthermore, it made participation of all adult males (let alone other members of communities) in this production practically impossible. Therefore, we have serious reasons to suspect craft specialization in one or another form. Defining this form is out of the scope of the present article, but it is obvious that it must have been one of the simplest forms and implied only part-time activity. Workshop sites in the outfall of Shuya River contained (to a much lesser extent) also waste from processing other materials, including asbestos and native copper – this aspect has not been discussed here, but it should be also mentioned. Probably, this group of masters was specializing in searching for, procuring and processing at least the most valuable local mineral resources in general, but the most strong arguments in favour of the specialization hypothesis can be drawn from the studies of the chopping tools industry.

At the moment we do not have similar arguments for speaking about craft specialization earlier than in the sites with Asbestos Ware. But we cannot fully rule out the possibility that an even simpler form of specialization, leaving much less discernible traces in archaeological record, was present in Karelia in earlier periods as well. Earlier industries still need more thorough investigation. After the Eneolithic period we can be sure that specialization did not exist at least in the industry of chopping tools, because they almost disappear from the assemblages. Moreover, we cannot be sure that specialization remained at the last stage of Karelian Eneolithic when the Asbestos Ware of Palajguba type prevailed (mostly due to lack of sources), though Russian-Karelian tools can still be found in the assemblages from this period. The question about the causes of the decline of this tradition remains open.

Finally, I would like to emphasize, even if it was not really discussed here, that local exchange network of the Onega Lake basin, in which Russian Karelian tools definitely played a very important role, functioned as a node in the larger network of exchange of valuable “exotic” objects in the Eastern European forest zone (Kriiska et al. 2013).

Acknowledgements

I would like to express my gratitude to Alexander Zhulnikov from the Petrozavodsk State University and prof. Aivar Kriiska from the University of Tartu for long-term support of these investigations, my Finnish colleagues Kerkko Nordquist, Christian Carpelan, Pirjo Uino for their kind assistance during my visits to Helsinki and interesting discussions as well as to the staff of the Finnish National Board of Antiquities, especially Päivi Pykälä-Aho and Leena Ruonavaara, Dmitry Gerasimov from Kunstkamera museum and Andrey Mazurkevich from the Hermitage Museum in Saint Petersburg, Ekaterina Kashina and Elmira Ibragimova from the State Historical Museum in Moscow, Irina Stepanova from the National Museum of the Republic of Karelia for the great help which they provided when I was studying the collections preserved in these museums, Tatiana Gusentsova from Saint Petersburg for the possibility to study materials from her excavations in Saint Petersburg (Ochta I site) and in southern Ladoga Lake region. The paper was prepared with the support of the project "The role of material culture in the Neolithization of north-eastern Europe – Studies in the use and manipulation of raw materials in Lake Saimaa, Karelia and northern Ostrobothnia c. 6000–1000 cal. BC" funded by the Academy of Finland and based in the University of Oulu (Finland) and the project "Lake Onega and its watershed: geological history, anthropogenic transformation and current state" funded by the Russian Scientific Fund (grant 14-17-00766).

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KIVIKIRVESTE TOOTMISE JA KASUTAMISE RUUMILINE ERALDUMINE KÄSITÖÖ SPETSIALISEERUMISE TÕENDINA ENEOLIITIKUMIS VENE KARJALAS

Resümee

On käsitletud mõningaid aspekte, mis on seotud nn Vene-Karjala (Ida-Karjala) tüüpi trapetsikujuliste ja poolovaalse läbilõikega raieriistade (kirved, talvad, peitlid) tööstusega. Nimetatud tööstus on iseloomulik eneoliitilistele asbestkeraamikaga (umbes 3500–1500 kal eKr) muististele. Kohalikest rohekividest kirved ja talvad on väga tavalised arheoloogilistes muististes Vene Karjalas alates selle piirkonna

esmaasustusest. Siiski on Vene-Karjala tüüpi esemete eneoliitilise tööstuse mitmed jooned varasematest traditsioonidest küllalt erinevad. Eneoliitilist tööstust eristavad väga kõrge kvaliteediga toormaterjal (peamiselt metatuff), kõrgetasemeline tehnoloogia, mida pole enne eneoliitikumi kivikirveste tegemiseks Karjalas kasutatud, ja kõrgeim tolle ajani dokumenteeritud morfoloogilise standardisatsiooni tase.

Vene-Karjala tüüpi raieriistade tootmiskeskuse lokaliseeris 20. sajandi keskel A. Äyräpää Äänisjärve läänerannikul Šuja jõe suudmealal. Praeguseks on selles piirkonnas leitud kümneid Vene-Karjala tüüpi raieriistade töökodasid, mille mõne kaevamise tulemused on esitatud ka käesolevas artiklis. Töökojad sisaldavad töötlemisjääke kõikidest tootmisprotsessi etappidest. Siiani on kõige huvitavam uuritud muistis Fofanovo XIII, kus vaid 30 kaevatud ruutmeetrilt saadi rohkem kui 350 000 leidu. Peamiselt on tegu Vene-Karjala tüüpi tööriistade valmistamise tootmisjääkidega, mis tõestab nende massilist tootmist kohal. Töökodasid, kust oleks teada kogu tootmistsükkel, ei tunta kusagil mujal peale Šuja jõe suudmeala, ehkki võib oletada, et sellised töökojad asusid ka Šuja suudmest põhja pool, kust on teada looduslikud metatufi ladestused. Äänisjärve regiooni majaasemetega asulakohtadest saadud leiumaterjal ei sisalda töötlemisjääke, mis viitab sellele, et raieriistade tootmist neis muististes ei toimunud.

Praegust Karjala ala ja sellega liituvaid piirkondi hõlmavad levikukaardid näitavad selgelt, et kuigi seda tüüpi valmisesemeid leitakse paljudest muististest, eriti Karjala lõunaosast, on nende toorikud väljaspool Äänisjärve läänekaldal paiknenud tootmiskeskust pea olematud. Mõned toorikud, eriti töötlemisprotsessi lõppstaadiumis olevad, on siiski leitud Äänisjärve nõos paiknevatest muististest. Kaevamised umbes 40 km Šuja jõe suudmest lõunas, Derevjannoje XVIII töötlemiskohas, mille lähedal asuvad ka majaasemetega asulakohad, näitasid, et vahel võidi töötlemisprotsessi viimased etapid läbi viia asulakohtade läheduses. Tulemusena võib arvata, et meistrid, kes tõenäoliselt hooajati külastasid Šuja suudmealas paiknevaid töökodasid, elasid Äänisjärve nõo asulakohtades. Neis asulates oli võimalik otsene suhtlus Vene-Karjala tüüpi esemete tootjate ja tarbijate vahel. Ühtki toorikut ei ole siiani leitud kaugemalt kui linnulennul 150 km kaugusel Šuja tootmiskeskusest, ehkki valmisesemeid leitakse paljudest muististest ja piirkondadest ka kaugemalt isegi seeriatena, tõestades seega, et esemed jõudsid sinna vahetuse teel. Üksikuid Vene-Karjala tüüpi esemete leide ja isegi väiksemaid seeriaid on leitud lausa väga suurte vahemaade tagant, näiteks Soomest, Baltimaadest ning Kesk- ja Loode-Venemaalt.

Kõik need faktid lubavad rääkida käsitöö spetsialiseerumisest, st esemete tootmisest võrdlemisi suletud sotsiaalse rühma poolt ja nende levitamisest ülejäänud kogukonnale, aga ka naabruses elavatele ning kaugematele kogukondadele vahetusvõrgustike kaudu.