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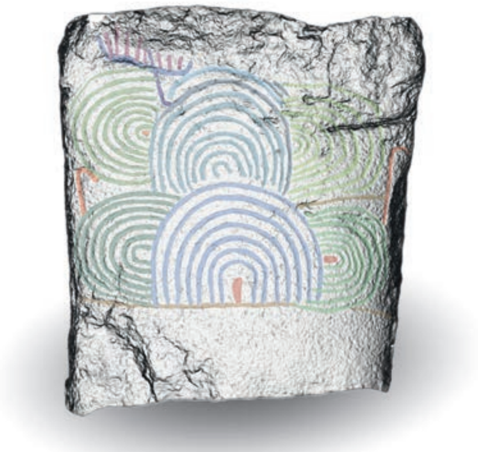

Gavrinis passage tomb

Contents

Understanding the specific nature of the East Asia Neolithic transition

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ABSTRACT – *The main subject of this article is to define the specific nature of the Palaeolithic-Neolithic transition in East Asia. A comparative analysis of regional East Asian data was run in order to achieve this. As a result, three dissimilar models of the Neolithic transition were distinguished: Meso-Neolithic, Subneolithic, and Neolithic proper. The first and last are similar to their counterparts in the western part of Eurasia, but the Subneolithic is unique for East Asia. Regarding chronology, two stages of Neolithic transition can be clearly recognized in this region. The new Subneolithic type of hunter-gatherer cultures occurred during the first stage around the Sea of Japan. At the second stage, the transition to food production started in central and north-central China. In between, there was a cultural, spatial and temporal gap splitting up the transitional process into two isolated episodes.*

KEY WORDS – *East Asia; Palaeolithic-Neolithic transition; Neolithic; Subneolithic; Meso-Neolithic; origin of pottery*

Razumevanje posebne narave prehoda v neolitik na območju Vzhodne Azije

IZVLEČEK – *V članku razpravljamo o posebni naravi prehoda med paleolitikom in neolitikom na območju Vzhodne Azije. Pri tem smo si pomagali s primerjalno analizo podatkov, pridobljenih na tem območju. Kot rezultat predstavljamo tri različne modele prehoda v neolitik: mezo-neolitik, pod-neolitik in pravi neolitik. Prvi in zadnji sta podobna procesom v zahodnem delu Evrazije, medtem ko je pod-neolitik pojav, značilen le za Vzhodno Azijo. Tukaj lahko na podlagi kronologije jasno razločimo dve stopnji prehoda v neolitik. Sprva se je nova oblika pod-neolitika oblikovala med lovci in nabiralci na območju Japonskega morja. V drugi stopnji pa se začne pridelava hrane na območju osrednje in na severnem delu osrednje Kitajske. Med obema stopnjama je kulturna, prostorska in časovna prekinitev, ki proces prehoda v neolitik deli na dva ločena pojava.*

KLJUČNE BESEDE – *Vzhodna Azija; prehod paleolitik-neolitik; pod-neolitik; mezo-neolitik; izvor lončenine*

Introduction

Recent discoveries provide increasing evidence that many human achievements, previously consid-ered to be a product of the Neolithic agrarian revolution, were made before it happened (*Barnett, Hoppes 1995; Roosevelt 1995; Close 1995; Rice 1999; Jesse 2003; Keally* et al. *2003; Kuzmin 2006; 2010; 2015; Budja 2006; 2016; Jordan, Zvelebil 2009; Huyseco* et al. *2009, Hommel 2012; Gibbs, Jordan 2013; Cohen 2013; 2017*). A huge number of studies have been made to explain the new facts and link them with the traditional point of view, and as a result a new paradigm began to take a shape in

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the literature, radically changing our understanding of the Neolithic (*Zeder 2009; 2011; Fuller* et al. *2011; Finlayson 2013; Özdoğan 2010; 2014; Uchiyama* et al. *2014; Nordqvist, Kriiska 2015; Gibbs, Jordan 2016*). Two statements constitute its core. One of them postulates the multiplicity of the Neolithic forms and their ways of evolving, whereas the second call into question the revolutionary nature of the Neolithisation, since new data indicate that this process was protracted and not as influential as previously considered.

It should be noted these new views are coming rapidly into ascendance, and are recurrently ex-pressed by different scholars and with different rationales. It seems that right now a new Neolithic concept is being formed. Accordingly, the Neolithic turns from a global phenomenon with a single set of innovations into some kind of 'patchwork' phenomenon consisting of many different regional forms. In this vision, the long polycentric process of Neolithic development substitutes the Neolithic burst in a core area with subsequent transmission of the ready-made package of Neolithic innovations beyond its borders.

It is quite understandable that the new perspectives are based to a large extent on data from East Asia, as the Neolithic transition began there with the advent of pottery and ended with the develop-ment of agriculture, while in West Asia, providing a classic case of Neolithic research, this sequence was reversed (*Björk 1998; Bar-Yozef 2011a; Kuzmin 2013; Gibbs 2015; Gibbs, Jordan 2016; Fuller, Stevens 2017*). This indicates a clear discrepancy between the eastern and western pathways of the Neolithic transition. However, does this observation cover all features separating East and West Asia? In this paper, I will attempt to summarize the data concerning this question. My analysis shows that spatio-temporal dynamics of the Neolithic transition and its regional differences also deserve our attention from this point of view.

However, before starting, some preliminary remarks have to be made with regard to the terms and approaches taken in this study. In a broad sense, the Neolithic transition means people's shift from the Palaeolithic to Neolithic way of life. But the understanding of the latter has been changing drastically in recent years. Nowadays the question of what was the endpoint of this process thus arises in almost every research lying in the scope of Neolithic studies. The traditional point of view takes agriculture as the terminus of the Neolithic transition, while another widespread position sees pottery as the endpoint. However, the concept of the multifarious Neolithic seems to infer that there is no one proper answer to this question.

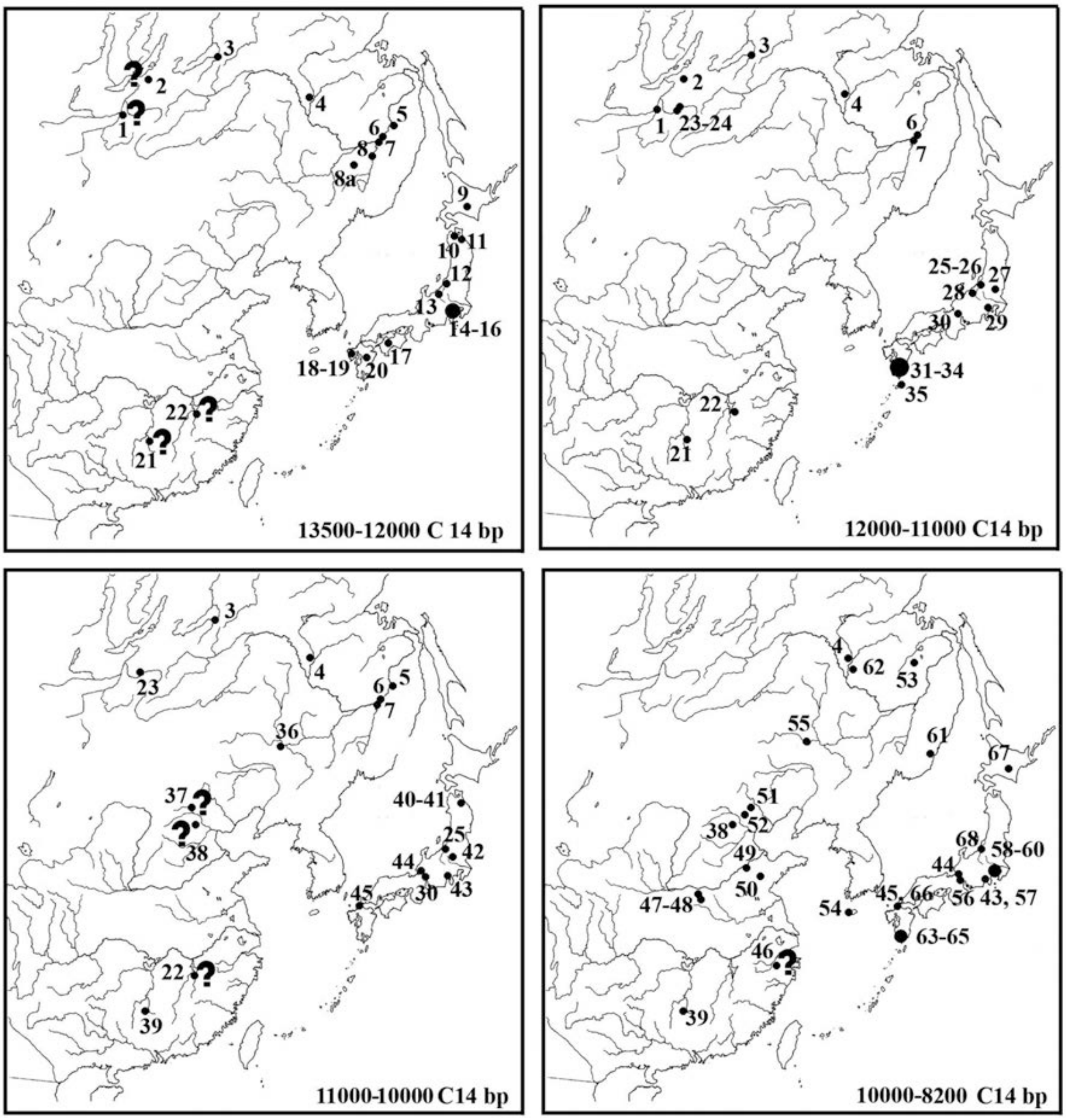
In the present study, I would prefer to avoid the generalizations that hide beneath the question above. First, in my opinion, we have to document and comprehend all possible regional variants of the Neolithic. Therefore, my task here is only to explore what is, in fact, the Neolithic transition in East Asia. However, even in this case it is necessary to define this process at least to outline the dataset relevant to this task. In this way, I propose to abide by the local schemes of interpreting the Neolithic. From this, the Neolithic transition is considered here as moving from what local researchers regard as its starting point to what they understand under the term Neolithic.

It also has to be added that East Asia is extremely extensive and diverse in both cultural and climatic terms. For this reason, in order to make out the shared features of the Neolithic transition in this vast area it is necessary first to define its regional peculiarities. My analysis shows three regional models of the Neolithic transition can be clearly recognized in East Asia: the Subneolithic in the Sea of Japan area, the Neolithic proper in central and north-central China, and the Meso-Neolithic in the Circum-Baikal region. Other territories did not generate any special forms of the Neolithic transition and might be characterized as laggards in this context (*Eerkens, Lipo 2014*).

Thus, further in this article regional data will be first presented so that they reflect a general sequence of the Neolithic transition in each of the three areas mentioned, and then an attempt to designate a region-wide scheme will be made. Finally, the assessment of this scheme will be done in comparison with the general pattern of the Neolithic transition according to its classical understanding registered in West Asia and implied the shift to farming.

Regions around the Sea of Japan

The Sea of Japan basin introduces the first model which is related to forming sedentary hunter-gatherer-fisher cultures, and therefore it can be defined as Subneolithic. A wide range of innovations emerged here during the course of the Neolithic transition. A little later, they will constitute the hallmark



1 - Ust'-Kyakhta-3; 2 - Krasnaya Gorka; 3 - Ust'Karenga; 4 - Gromatukha; 5 - Khummi; 6 - Gasya; 7 - Goncharka-1, Novotroitskoe-10, Osinovaya Rechka-10, 16; 8 - Xiaonanshan; 8a - Taoshan; 9 - Taiso-3; 10 - Oday-Yamamoto-1; 11 - Kiwada; 12 - Kubodera-Minami; 13 - Seiko-Sanso; 14 - Gotenyama; 15 - Tsukumino-Kamino-2; 16 - Manpukuji; 17 - Kamikoroiwa; 18 - Fukui; 19 - Senpukuji; 20 - Kawayo F; 21 - Yuchanyan; 22 - Xianrengdong; 23 - Studyonoe-1; 24 - Ust'-Menza-1; 25 - Unoki-Minami; 26 - Jin; 27 - Nozawa; 28 - Nakamachi; 29 - SFS; 30 - Aitani-kumahara; 31 - Tsukabaru; 32 - Sojiyama; 33 - Shikazegashira; 34 - Higashi-Kurotsuchida; 35 - Sankakuyama-1; 36 - Houtaomuga; 37 - Yujiagou; 38 - Nanzhuangtou; 39 - Zengpiyan; 40 - Kushibiki; 41 - Takihata; 42 - Saishikada-Nakajima; 43 - Kuzuharazawa-4; 44 - Torihama; 45 - Obaru D; 46 - Shangshan; 47 - Lingjing; 48 - Lijiagou; 49 - Zhangmatun; 50 - Bianbiandong; 51 - Zhuannian; 52 - Donghulin; 53 - Yamikhta; 54 - Gosanri; 55 - Shuangta; 56 - Awazu-kotoi; 57 - Ikeda B; 58 - Hanawadai; 59 - Natsusima; 60 - Musashidai; 61 - Ustinovka-3; 62 - Chernigovka-na-Zee; 63 - Kakuriyama; 64 - Nagasakohira; 65 - Kivaki; 66 - Matsukida; 67 - Taiso-6; 68 - Kurohime

Fig. 1. Spatio-temporal distribution of pottery-bearing sites during the Neolithic transition (based on ^{14}C dates run on charcoal, bone or pottery charred crust). In the Japanese archipelago only the main sites have been marked due to their immense number.

of the 'northern' Neolithic and partly of the agrarian one. Three phases can be traced in the development of this scenario of the Neolithic transition.

The first phase is marked out by the sudden emergence of just three cultures of an absolutely new type: Incipient Jomon in the Japanese archipelago, Osipovka culture in the Low Amur River, and the Gromatukha culture in the Middle Amur River (Fig. 1). Even the very first sites differed significantly from the surrounding Upper Palaeolithic ones, but over time these differences became more and more pronounced, and to the end of this phase the whole suite of Neolithic novelties was already engendered.

The data from the Japanese archipelago, which is the most studied of all three areas examined in this paper, shows in detail the course of the Neolithic transition during this phase (*Keally 1991; Kenrick 1995; Imamura 1996; Mizoguchi 2002; Sato, Tsutsumi 2002; Keally* et al. *2003; Habu 2004; Kobayashi 2004; Pearson 2006; Kanner 2009; National Museum of Japanese History 2009; Kanomata 2010; Nakazawa* et al. *2011; Sato* et al. *2011; Nishida 2002; Kudo, Kumon 2012; Craig* et al. *2013; Morisaki, Sato 2014; Seguchi 2014; Morisaki* et al. *2015; Lucquin* et al. *2016; Sato, Natsuki 2017; Morisaki, Natsuki 2017; Otsuka 2017; Ikawa-Smith 2017; Kanner, Taniguchi 2017; Morisaki* et al. *2018*).

The new type of sites came into existence on the north of the Paleo-Honshu Island just before the Bølling-Allerød warming. Soon after, the fast proliferation and at the same time enhancement of the new culture began. During this process, the highly evolved toolkit arose looking rather precocious or outpacing the time. It includes pottery, the rejection of microblade techniques in favour of a less demanding flake industry, the rejection of composite tools and shift to simple stone tools with facial secondary processing, partly polished axes and adzes, bifacial tools used as spearheads and arrowheads, new types of cutting and scraping tools, and abraders.

The appearance of this package of novelties took place against the background of changes in subsistence strategies and in a way of life as a whole, but in this field the transition did not keep up such a fast pace. At the current stage of knowledge, relocation of residential camps to the margins of rivers or lakes, reducing the dependence on stone raw materials of high quality, thickening of cultural depositions, expansion of social networks, and to some extent ascending the ritual behavior scale indicate these changes and signalize the outset of sedentarization process and moving to a broader economy.

The next set of novelties appeared a bit later during the Allerød warming on the southern part of modern Kyushu. Here, in more favourable climatic conditions, plant gathering, mainly of acorns, became a focus for local people (*Habu 2004; Shibutani 2009; 2011; Kudo 2014; 2015; Noshiro* et al. *2016*). In addition, grinding tools, storage pits, semi-subterranean dwellings, and village-like settlements occurred for the first time here (*Imamura 1996; Habu 2004; Shinto 2006; Pearson 2006; Morisaki, Sato 2014; Izuka, Izuho 2017; Morisaki* et al. *2018*).

It should be noted also that the process of Neolithisation was to a certain extent geographically uneven in the Japanese archipelago. The first Incipient Jomon sites arose on the North of Honshu, *i.e.* on the periphery of areas that were the most mastered by people developing the microblade industries. Moreover, where the microblade industries occurred earlier and evolved more than elsewhere, they persisted the longest. For example, on Hokkaido, the local people refused to adopt pottery and many other innovative changes during this phase, while on the south of Kyushu they conserved only microblade techniques. Moreover, on Hokkaido, and during this phase, the local people refused to adopt pottery and other innovative changes, while on the south of Kyushu people conserved only microblade techniques for a long term.

The archaeological data from the Amur River does not contradict these observations (*Derevyanko, Medvedev 1995; 2006; Lapshina 1999; Kuzmin 2003; 2005; Kuzmin, Shewkomud 2003; Shewkomud, Yanshina 2010a; 2010b; 2012; Yanshina 2008; 2014*). The Osipovsky sites appeared suddenly at the very outset of the Bølling-Allerød warming, and within an area which was not settled at all before. All of them were tied to the mainstream of the Amur River whose water level was 10m higher at that time than today. To the end of the development of the Osipovka culture, we can see semi-subterranean household structures (like pits with unknown purposes, postholes, fireplaces, and possibly dwellings), stationary and portable ritual objects, signs of long-term habitation (*e.g.*, palimpsests of settlement structures), and well established tool assemblages which include pottery and steady series of polished axes, bifacial spearheads and arrowheads, the new types of cutting and scraping tools, and abraders. Unfortunately, the timeline and scope of variety of the Gromatukha culture are poorly studied.

It should be added that throughout the first phase the traditional Upper Palaeolithic cultures continued to develop around of Sea of Japan, but occupying the other areas. Thus, they are known not only in Hokkaido but also in Sakhalin, Primorye, and Korea. Then over time, some of the novelties began to penetrate there, as mainly represented by arrowheads and axes (*Vasil'yevsky* et al. *1997; Kajiwara, Kononenko 1999; Cohen 2003; Vasilevsky 2008; Bae 2010; 2017; Otsuka 2017*).

The second phase (10 000–8000 ^{14}C bp) coincided with the first two or one and half millennia of the

Holocene. It started with the more or less rapid disappearance of three pioneering cultures of the previous phase, though this process was also uneven throughout the region.

On the south of the Japanese archipelago it started slightly earlier under the impact of the Younger Dryas cooling (*Nakazawa* et al. *2011; Morisaki, Natsuki 2017*). The Incipient Jomon camps totally disappeared here during this climatic event. At the same time, to the north, it seems this cooling had not such a damaging influence. On Honshu the number of sites reduced sharply but the Incipient Jomon culture survived, and on this basis the subsequent variants of Jomon culture were formed to further evolve the preceding achievements. During this phase, plant gathering and dwelling pits spread across all Paleo-Honshu while remaining rare. In addition, shell mounds and special fishing equipment (fishhooks, net weights, *etc*.) appeared for the first time at this phase, signalling the final establishment of the new subsistence strategies. However, there were no indications of the previous dynamism.

In the more northern areas, on the contrary, the Younger Dryas cooling coincided with the flourishing of the Osipovka culture occurred at the middle stage of its development. But with the onset of the Holocene, the Gromatukha and Osipovka cultures vanished, leaving no traces (*Shewkomud, Yanshina 2012.231–244*). The latest dates of the former vary within 9680±80 and 9150±80 ^{14}C bp (*Derevianko* et al. *2017*); the latest dates of the latter are 9810±80 and 9430±70 ^{14}C bp (*Fukuda* et al. *2014*) (Fig. 2). Thereafter and somewhere concurrently, a very pronounced gap in the archaeological records occurred along the Amur River and also in Sakhalin, Hokkaido, Primorye, and Korea with only a few exceptions: Ustinovka-3 in Primorye (*Garkovik 1996; Derevyanko, Tabarev 2006*), Yamikhta in the northeast part of the Amur River region (*Fukuda* et al. *2014*), and Taiso-6 in Hokkaido (*Obihiro City Board of Education 2005*). Therefore, it is not known how the subsequent events developed in this area as a whole.

The third phase (8000–5500 ^{14}C bp) comes with appearance across all the given area the fully-developed Neolithic sites or rather Subneolithic (Japan: *Habu 2004; Imamura 1996; Nishida 2002; Matsumoto* et al. *2017; Morisaki* et al. *2018*; Amur river: *Derevyanko, Medvedev 2006; Shewkomud, Kuzmin 2009; Shewkomud, Yanshina 2012.31–244*; Primorye: *Andreeva 1991; Dyakov 1992; Zhushchikhovskaya 2006; Batarshev 2009; Sakhalin: Grishchenko 2011; Vasilevsky, Shubina 2006; Kuzmin* et al. *2012*; see also *Kuzmin 2005*). These inherit the whole set of innovations developed earlier by the groups of Osipovka, Gromatukha, and Incipient Jomon cultures, but differ by the presence of a more pronounced ritual activity, including a regular burial practice, though not in all areas, as well as larger settlements with semi-subterranean dwellings. Subsistence practices become more developed and steady. According to the Japanese data, the economy acquires a complex nature, which makes it possible to efficiently exploit different seasonal resources without permanent residential movement. The shift to food production occurs here many millennia later, in each of the areas at a different time and in a different mode.

Circum-Baikal region

The Circum-Baikal region represents the second model and demonstrates one more way of forming a new type of hunter-gatherer-fisher cultures. Like in the previous case, this process can also be split into several phases. However, some general remarks have to be made before proceeding to describe them in detail.

First, the Baikal region is the only in East Asia where the presence of ceramics in the Late Pleistocene assemblages is still disputed. This greatly complicates an understanding of the general pattern of Neolithic transition in this area. It is not possible to characterize all of the controversial points of this discussion, since they can be found in various publications (*Konstantinov 1994; 2009; Razgil'deeva* et al. *2010; Vetrov 2010; Hommel 2012; Hommel* et al. *2017*).

Secondly, the Neolithic transition in the given area ran with some important differences between two opposite sides of Lake Baikal, *i.e.* Transbaikalia and Gisbaikalia. In the former, during the last millennia of the Pleistocene, the steady and continuous development of human culture is recorded up to the Holocene (*Konstantinov 1994; Buvit* et al. *2016*), whereas in the latter there was a deep recession in the development reflected in a total reduction in the number of sites up to their complete disappearance (*Berdnikova 2012*). The situation, however, changed drastically with the onset of the Holocene. ^{14}C dated sites vanished in Transbaikalia (*Konstantinov* et al. *2016*; see also *Buvit* et al. *2016*), but in contrast the powerful Mesolithic culture arose in Gisbaikalia

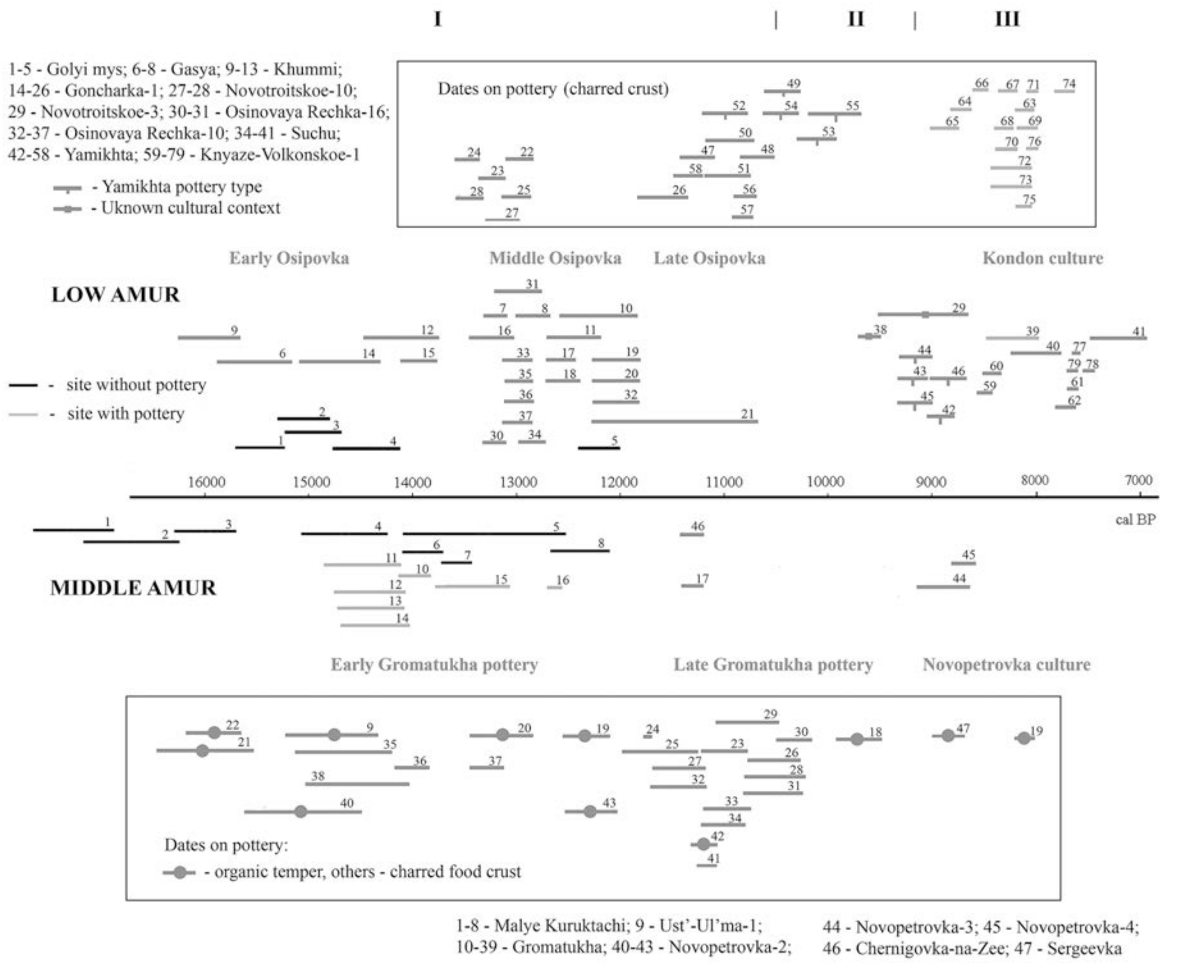


Fig. 2. Schematic representation of the Amur River radiocarbon date database referring to the Palaeolithic-Neolithic transition. Note the gap between the dates of the Gromatukha-Osipovka and the Neolithic site and differences between dates for the charcoal, organic temper, and food crust.

(*Berdnikova* et al. *2014; Losey, Nomokonova 2017*). Due to this feature, the overall picture of the Neolithic transition can be comprehended only if both sides of Lake Baikal will be taken into consideration, though the early pottery is known only in the Transbaikalia, that normally falls into the focus of East Asia Neolithic studies (Fig. 1).

Thirdly, there is increasing evidence the territory adjacent to Lake Baikal was the easternmost point of the influence of the European Upper Palaeolithic (dwelling constructions, anthropomorphous and zoomorphic figurines, burials, *etc*.). It is interesting in this context that this area, in addition, is the only in East Asia where a Mesolithic period very similar to the European one is clearly distinguished (*Kol'tsov 1989; Konstantinov 1994*). The characteristic of this period is the new type of hunter-gatherer-fisher cultures forming at the interstice between the Upper Palaeolithic and the appearance of pottery. These cultures evolved toward the Neolithic quite slowly, holding many Upper Palaeolithic traits and adapting incrementally to new environments and a more mobile way of life. Therefore, this model of the transition to the Neolithic can be labelled under the banner of Meso-Neolithic.

The first phase (12 700–10 300 ^{14}C bp) started with the appearance of pottery in Transbaikalia (*Kuzmin, Vetrov 2007; Razgil'deeva* et al. *2013; Tsydenova* et al. *2017*). It occurred in the assemblages with the microblade industries represented by two traditions based on edge-shaped and wedge-shaped microcores (*Tashak 2005; Tabarev, Gladyshev 2012; Pavlenok 2015; Tsydenova, Piezonka 2015*). The former is called Selenginskaya, and it is considered to be local in origin. The overwhelming majority of sites located in the south of Transbaikalia are attributed to this tradition, and these are concentrated within the Selenga and Chikoy river systems. The second tradition is known as Chikoiskaya, and its origins have yet to be established, with sites mainly in the north of Transbaikalia (see exception: *Moroz 2014a*).

Looking at the data as a whole, one can see in Transbaikalia a rather sharp rise in the total number of archaeological sites coinciding with this phase (*Buvit* et al. *2016.Fig. 2*). From this point of view, it looks like a single episode in the prehistory of this area. The shared trends in cultural development throughout this time also confirm this proposal, as outlined below.

Firstly, a very sophisticated house-building practice known from the earlier Upper Palaeolithic records of Circum-Baikal Asia began to decay at this stage (*Konstantinov 1994; 2001; Aseev 2003; Philatov 2016*). This tendency is clearly distinguished at the multi-layered sites of Transbaikalia, such as Studenoe-1 and Ust'-Menza-1. Here, large, steady in shape multi-fireplace structures represent the earliest of dwellings. They had a clear-cut layout and borders lined with stones. However, by around 13 000 ^{14}C bp they had already started degrading and turned into single-fireplace objects, and with each next horizon of the sites their construction elements were becoming more and more featureless. This tendency reaches its apogee in the horizons with pottery: residential structures here are distinguished solely by the concentration of finds near fireplaces. The general thinning of cultural deposits corresponds to these changes as well (*Konstantinov 1994.150*).

Secondly, some changes in the subsistence strategies also occurred at this phase. To begin with, fish bones and fishing tools appear here for the first time. Thus, fish bones are found in the Ust-Kyakhta-17, layers 2–6 (*Tashak 2005*), Oshurkovo, layer 3, Ust-Menza-1, layers 11–12, 9, Studenoe-1, layers 10–11 (*Konstantinov 1994.148*). Dace, roach, burbot, and pike were identified from bones recovered at the sites located along the Chikoi River. Bone fishhooks were found in the Ust-Kyakhta-3 site (*Aseev 2006*), Ust-Kyakhta-17, layer 3 (*Pavlenok 2015.147*), Studenoe-1, layers 10–11 (*Konstantinov 1994.80–81*). Two bone harpoons were documented as well in layer 3 of Oshurkovo (*Konstantinov 1994.149*). Interestingly, in the horizons with pottery such clear evidence of fishing has not yet been found.

Besides, some changes in the design of the composite tools appeared at this phase. In addition to large one-edged shafts for microblades, their smaller-sized variety with a double-edge came into existence, as found at Ust-Menza-1, layer 12, Studenoe-1, layer 11, Ust-Kyakhta-17, layer 3 (*Pavlenok 2015.147*). It is suggested that they were used for spears or darts (*Konstantinov 1994.184*). At the Studenoe-1, a double-edge shaft was found in the same layer with pottery (layer 9), but not in the upper horizons (*Ibid. 81–84*).

Thirdly, some changes are noted in microblade industries themselves (*Antonova 2012; 2015; Moroz 2014b*). Apart from the ongoing microblade miniaturization, the transition to raw materials of lower quality mentioned in the literature, there was also a change in microcore proportions, the improvement of microblade cutting, and the advent of points known as the Kyakhta type.

It is worth noting that all these features characterize only the sites located in the south of Transbaikalia. On these grounds, researchers combined them in the same cultural and chronological unit with an approximate age of 13–10 000 ^{14}C bp (*Moroz 2014; Pavlenok 2015*). How these observations fit the more northern sites situated in the mouth of the Karenga River remains unclear. In addition, some time seems to pass between the starting of this culture and the coming of pottery, but it is difficult to determine how protracted this timelag was (Tab. 1; *Konstantinov 1994; Kuzmin, Vetrov 2007; Razgil'deeva* et al. *2013*).

Moving people to a more mobile way of life is suggested to be a general tendency of the Neolithic transition in the Circum-Baikal area. This statement is in good correlation with some of the traits above, such as the miniaturization of microblades, simplification of house-building practices, and thinning of cultural deposits, while it does not fit well with others, such as the advent of pottery, birth of a fishing economy, and shift to a raw material of lower quality. This discrepancy stresses the complex nature of the processes happening in the given area in the course of the Neolithic transition.

The second phase started with the onset of the Holocene (10 300–7500 ^{14}C bp). Two main events designate this period. On the one hand, there is evidence signalling the crash of cultural development in Transbaikalia, which was less pronounced in its

	Ust'-Karenga-12	Ust'-Menza-1	Studenoe-1
Pre-ceramic layers	12 880±130–12 710±380	11 820±120–10 380±250	12 330±60–10 775±140
Ceramic layers	12 180±60–10 600±110	11 550±50 (food crust)	10 780±150–10 400±155

Tab. 1. Chronology of pre-ceramic and ceramic-bearing layers of the Transbaikalia Late Pleistocene sites.

very northern part (*Teten'kin 2010*) (Fig. 3). Indeed, the ^{14}C dates of this age are almost absent in the current dataset (*Konstantinov* et al. *2016*; see also *Buvit* et al. *2016*). The few exceptions represent the dates derived from unclear stratigraphic, planigraphical and cultural contexts. On the other hand, multi-layered sites, like the Transbaikalia ones of the previous phase, came into existence in the Gisbaikal (*Berdnikova* et al. *2014; Losey, Nomokonova 2017*). They are considered in the frame of the Mesolithic epoch, which means pottery completely disappeared in the Circum-Baikal region at the second phase.

The early Holocene assemblages of the Gisbaikal are typical for the classic Mesolithic epoch. The sites can be clustered into a few geographically isolated areas. Most of them concentrate on the north and south of Angara Region, and also on the west coast of Lake Baikal, by being tied to the edges of water holes. Their perfect stratigraphy allows tracing the incremental transformation of culture during this phase (*Kol'tsov 1989; Bazaliyskiy 2012; Rogovskoy, Kuznetsov 2013; Bocharova* et al. *2014; Berdnikov* et al. *2014; Berdnikov 2016; Losey, Nomokonova 2017*).

The cultural remains are mainly clustered around fireplaces, forming clear outlined spots. The dwelling-like structures are absent, but pits filled with ash and fish bones have been discovered. Hunting and fishing were the primary subsistence strategies. Faunal remains represent roe and red deer, and much more rarely elk and boar; however, the key tendency of the economic activity was the adoption of fishing. The increase in its significance is seen from the lowest to more and more upper horizons: the number of fish bones and fish tools accrue, simple fishhooks change to more effective composed tools, harpoons of a new design and weights also appear. Sturgeon, pike, burbot were the main objects of fishing. The role of seal was also growing in the course of this phase. The sites tied directly to Lake Baikal are broadly interpreted as seasonal fishers' camps.

The stone industries and tool assemblages also became more advanced, but most novelties arose only at the end of the phase. The progress in prismatic splitting and burin techniques was the principal tendency of that time, although bone and horn processing also flourished. The percentage of blade tools was high. Firstly the mid- and multi-facets burins and then their polyhedric varieties replaced the corner ones. New techniques also emerged: grinding, drilling, bifacial processing. In addition, axes and adzes, including the ones with polished working edges, arrowheads, knives, as well as various decorative pendants appeared to supplement the assemblages.

The third phase (7500 ^{14}C bp and onward) termed Neolithic in local schemes came with the advent of pottery and burials. And once again, some discrepancies between two opposite sides of Lake Baikal can be seen at this time. In Transbaikalia, this phase introduces only burial sites though with no pottery (*Lbova, Zhambaltarova 2009*). Dated habitation sites are still absent here up to approx. 5000 ^{14}C bp, and exceptions, once more, are few and obscure. (*Aseev 2003; Hommel 2012; Konstantinov* et al. *2016*). In Gisbaikal, conversely, pottery and burials penetrated gradually into local assemblages starting yet in the Mesolithic phase (*Weber 1995; Bazaliyskiy 2012; Berdnikov 2016; Berdnikov* et al. *2017*). Thus, single burials appeared at the end of the Mesolithic, while pottery-bearing sites coexisted with the aceramic ones for some time. For this reason, drawing a clear-cut border between the Mesolithic and Neolithic phases is not possible in this region. Besides, the subsistence strategies did not change significantly during Neolithic: deer, fish and seal were the staple foods at that time. The way of life also continued without pronounced changes.

The next noticeable shift in cultural development in the Circum-Baikal region occurred only much later, around 3000 ^{14}C bp. It was related to the arrival of pastoralist practices into this area and the rise the influence of nomadic culture.

Central and North-Central China

The archaeological records of China represent the third model related to the forming of agricultural communities. Since China was the only region in East Asia where the proper Neolithic formed, it has drawn the strongest attention of international scholars. As a consequence, many aspects of the Neolithic transition in China have been reappraised in recent years (*Cohen 2003; 2011; 2013; 2014; 2017; Bar-Yosef 2011a; Zhao 2011; Liu, Chen 2012; Shelach-Lavi 2015; Wagner, Tarasov 2014; Zhuang 2015; Liu X.* et al. *2009; 2015; Liu L. 2015; Lu T. 2010; 2012; Wang* et al. *2016; Lu H. 2017; Stevens, Fuller 2017; Crawford 2017; Chen, Yu 2017; He* et al. *2017*; *etc.*). And again, three phases can be seen in the course of food production forming.

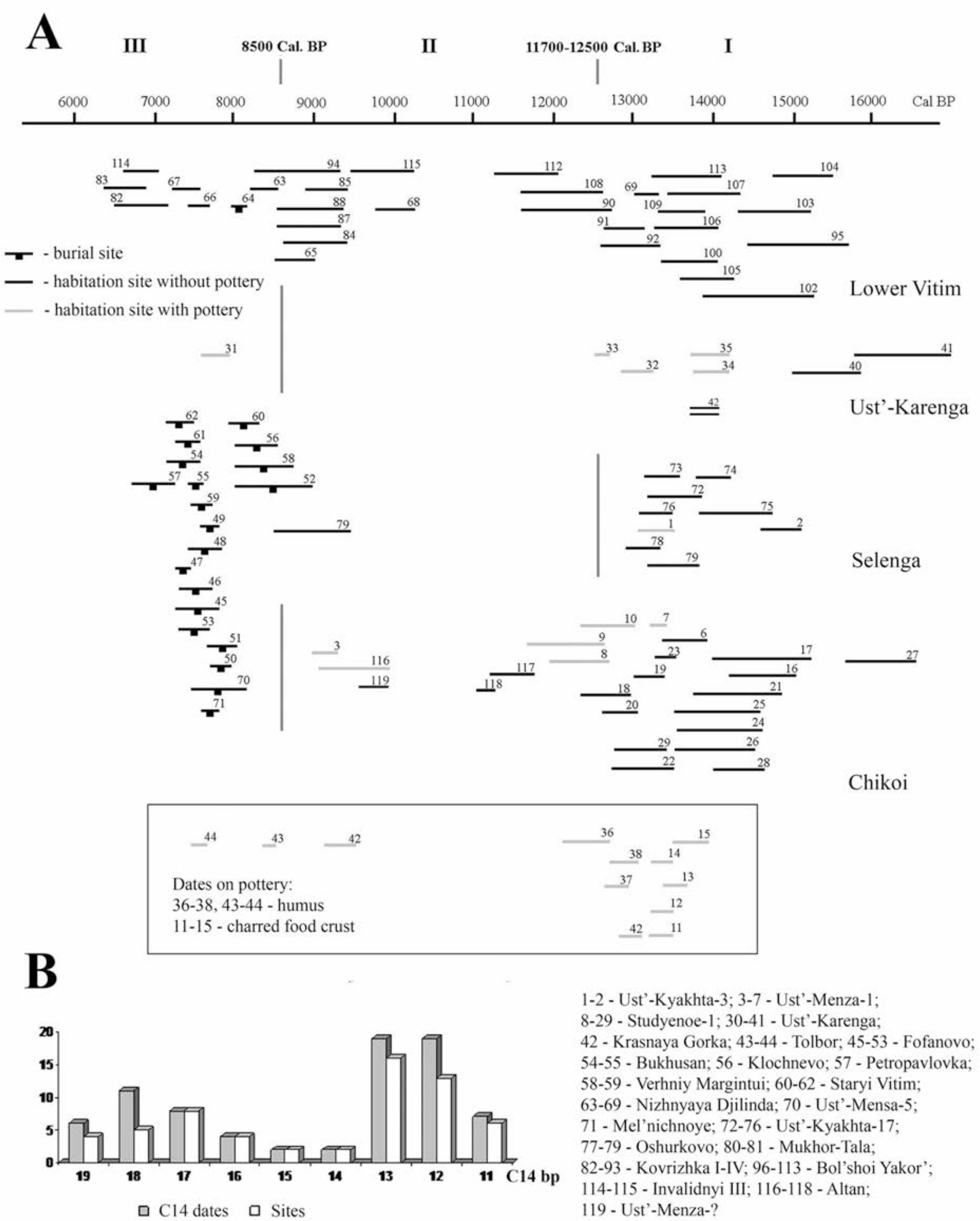


Fig. 3. Schematic representation of the Circum-Baikal radiocarbon date database referring to the Palaeolithic-Neolithic transition (A), and distribution of the number of dates under each millennium (B). Note the rise in the number of sites and dates during the 13th to 11th millennia (B) and Early Holocene gap in the records (A).

The first phase (17/11 000–8200 ^{14}C bp) is marked by the appearance of pottery and some other novelties, but this process proceeded with many differences in North and South China, and possibly asynchronously (Fig. 1).

In South China, a new cultural tradition was formed in the middle reaches of the Pearl River. People continued to dwell in caves and use pebble tools, like their Paleolithic predecessors, but pottery along with partly polished bone and shell tools, and oversized waste shells evidenced the advent of profound changes in their life. The chronology of this moment is unclear and still under discussion (*Kuzmin 2013a; 2017; Cohen 2013; Cohen* et al. *2017; Izuka 2018; Yanshina, Sobolev 2018*). The recent ^{14}C dating refers it approx. to the Last Glacial Maximum (*Boaretto* et al. *2009; Wu* et al. *2012*), whereas more conservative assessments, based chiefly on cross-cultural comparisons, point out to the Pleistocene-Holocene boundary (*MacNeish 1999; Zhao 1998; Wu* et al. *2005; Chen 1999; Chi 1999*). Later, but how much later it is unknown, isolated burials appeared there as well. Pottery has very distinctive appearances with no resemblance to any other known from that time outside of China (*Yanshina 2017*). So, it seems all the southern sites represent a homogeneous and well-clustered culture. Only a few sites are known outside it's areal, *i.e.* Xianrendong, Diaotonghuan, and Yuchanyan caves located in the juxtaposed Yangtze River basin. Interestingly, they show at the same time the most advanced assemblages: the majority of pottery, all finds of rice, and some progressive traits in stone tool manufacture were registered there.

In the North, emerging of pottery and partly polished stone axes indicates the arrival of the new phase. However, in contrast to the South, these novelties spread across a much wider area and turned to be embedded into at least two different cultural contexts.

The first and the earliest one is represented by the sites dated to the Bølling-Allerød warming and housed at the very north of Manchuria: Taoshan (*Yang* et al. *2017; Zou* et al. *2018*), Xiaonanshan (*Heilongjiang Provincial Museum 1972; Barton 2009*), Houtaomuga (*Kunikita* et al. *2017; Wang, Sebillaud 2019*). Due to their location close to the Osipovka and Gromatukha cultures, pottery and stone tools peculiarities, they have to be considered as part of the Amur River cultures increasingly focusing on fishing (*Kunikita* et al. *2013; 2017*). Thus, these sites might hardly characterize the forming of agriculture in China itself.

The second context is of greater interest from this point of view. It's related to the sites located along the eastern slope of the Loess Plateau, they are limited in number and seemingly reflect small disconnected groups of people. Grinding tools were found at all of the sites, being their only shared trait. In other respects, they were a rather heterogeneous and showed quite different assemblages with varying chronology and degree of 'neolithization'. From this perspective, three kinds of sites might be distinguished there. The earliest one, dated to the Bølling-Allerød warming like on the North of Manchuria, is represented by the Yujiagou site with only one neolithic novelty, *i.e.* pottery. Then, at the very outset of the Holocene or a bit earlier, more 'neolithisized' kind of sites appeared in the Hebei province (Nanzhuangtou, Zhuannian, Donghulin, Yujiagou) (*Liu, Chen 2012; Shelach-Lavi 2015*) and in the upper stream of Huaihe River (Lingjing, Lijiagou) (*Li* et al. *2017*). Finally, sites with assemblages similar to the early Neolithic Houli and Xinglongwa cultures arose in Shandong Province (Zhangmatun, Bianbiandong) (*Wu* et al. *2014; Sun* et al. *2014*) and in the south of Manchuria respectively (Xiaohexi culture sites) (*Wagner 2006*), being dated, however, a little before them.

Their stone assemblages keep the Upper Palaeolithic microblade industries, though at some this was already not the case. The settlement structures differing from the Palaeolithic are registered, but they have no repeated traits. It might be pits filled with ash and organics; fireplaces filled with stones or animal bones, or coal and burnt clay concentrations. Pottery at some instances looks like the ceramics of the Amur River (Yujiagou, Nanzhuangtou), but in others it shares some traits with ceramics of the Jomon culture (Lijiagou) or is featureless and therefore remains without any analogies (Lingjing, Zhuannian, Donghulin).

In general, as opposed to the South, the North sites appear to reflect a rather feeble and dissipated process. At the same time, it cannot exclude that this impression is partly the result of the information scarcity.

Changes in the subsistence strategies at this phase are the main focus of scholars, since they are looking for the roots of Chinese agriculture. In the southern part of China, these changes were nonetheless the most pronounced in the field of hunter-gatherer activities. Here, the gathering of freshwater molluscs developed and gained impetus. With regard to gathering plants, rice remains were discovered at some of the sites housed along the Yangtze River, but only very few in number (*Zhao 1998; Lu T. 2009; 2010; 2012*). In the northern part of China, conversely, plant gathering started to thrive, as can be seen from increasing number of grinding tools with starch remains of cereal, nuts, acorns and root crops, although hunting seemed to be the main activity (*Liu, Chen 2012; Yang* et al. *2012; 2014; 2015; Liu 2015; Wang* et al. *2016*). It should be stressed here in reference to the plants found at this phase in both parts of China that their position along the path between wild and domesticated forms remains an open question, but in any case, the practice of plant gathering only started to form as a regular part of the subsistence during this phase.

The second phase (8200–6000 ^{14}C bp) started with the 'sudden' appearance of early agricultural communities, first in the low and middle parts of the Yangtze River, and then in more and more northern areas up to the southern part of Manchuria. Despite the fact that their examination has been ongoing for several decades, in recent years there have been major changes in the assessments in this field. This is due to the fact that the economies of such communities have turned out to correspond to only incipient or low-level agriculture (*Smith 2001*), as indicated by a whole range of data.

Firstly, recent studies revealed that the millet and rice domestication process was only at its very starting point at this time. The earliest remains of these plants found at the sites show either evi-dence that they were at the very beginning of the transformation process, or have questionable status (*Fuller* et al. *2008a; Jones, Liu 2009; Zhao 2011; Barnes 2015; Stevens, Fuller 2017; Crawford 2017*).

Secondly, paleobotanical assemblages point to the fact that millet and rice constituted only a minor part of the people's diets, no more than 20% based on various evidence, whereas nuts, acorns and root crops dominated. Similar results follow from the isotopic studies of North China, showing no more than 20–25% of the diet was from millet (*Li, Chen 2012; Chen, Yu 2017*).

Thirdly, tool assemblages also match well with new assessments, though north and south sites differ in this regard (*Liu, Chen 2012; Chen, Yu 2017*). In North China, apart from the grinding equipment, specialized polished sickle-like knives were also used, and their proportion increased over the time. Such tools has not been registered at all in the lower part of the Yangtze River, while ordinary flint flakes which could be used as sickles are known in its middle stream. In contrast, grinding tools were absent in the middle part of the Yangtze River, but present in its lower course. It is interesting that they markedly differed from the ones being in circulation in North China. Moreover, in both rivers basins there were no special tools for soil preparation (*Fuller* et al. *2008; Makibayashi 2014*).

Fourthly, palynological data also indicate the low-productive nature of farming, albeit indirectly. According to the results of recent studies, at this stage there was no reduction in the area occupied by forests, which is usually observed under intensive agricultural management (*Ren 2007*). The content of coal and weeds remains relatively low as well.

It should be noted it is hard if not impossible to trace any dynamics in the cultural development during this phase. This is especially true when it comes to the process of agriculture evolving, as well as settlements, dwellings and other indicators of lifestyle. They remained almost unchanged throughout the phase up to the stage of the Yangshuo culture, while tool assemblages developed a bit more dynamically (*Liu, Chen 2012; Chen, Yu 2017*).

The third phase (6000–5500 ^{14}C bp and onward) comes with the appearance of much more developed cultures like the Yangshuo, Hemudu, and Daxi. Absolutely all indicators mentioned above changed drastically at this stage (see reviews in *Liu, Chen 2012; Shelach-Lavi 2015*), mirroring as well the establishment of much more intensive agriculture (*Barton 2009; Stevens, Fuller 2017*). Concurrently, there was a sharp increase in the population which is assessed based on the rise in total amount of archaeological sites, their size and the areas occupied by farmers (*Li* et al. *2009; Wu* et al. *2014; Hosner* et al. *2016; Lu* et al. *2018*). Many sources also indicate the rising complication of social life and ritual practices (*Liu 2005; Shelach-Lavi 2015*). Moreover at this phase, although with some delay in the south, we see the spreading of agriculture into new areas due to the growth of its influence and the opportunities to engage in it (*Zhang, Hung 2010; 2013; Fuller* et al. *2007.325–326*).

Such tripartition of the Neolithic transition is not something new, and the specific nature of its three consequent phases are obvious to all specialists. The major problem in this field concerns searching for the roots of Chinese agriculture. The first agricultural communities show only the incipient level of agriculture, but other constituents of the Neolithic package they possessed were already very sophisticated, although their origins still remain unclear.

Thus, the early agriculturalists of China lived in village-like settlements or in proper villages. The biggest of them included tens of dwellings, burials and hundreds of household pits; they were often organized according to a well-defined layout, had pottery kilns, and were enclosed by ditches. Their pottery was of high quality and differed much from the previous types, except that which originated in South China. Its shapes were surprisingly diversified, as they were already well adapted to special functions; their set and painted patterns was typical for farmers over all of Eurasia, but diverged significantly from the vessels of the surrounding hunter-gatherers. Advanced burial practices also appeared at this phase along with other kinds of ritual activity, while less pronounced. The cemeteries were located as a rule near the habitation sites and featured steady ceremonial traits with regard to the shape and disposition of graves, set of grave goods, body position of dead and their orientation, post-mortem manipulations, sacrificial offerings, *etc*.

Distinguishing the Neolithic transition in East and West Asia

For a start, let us look at the general timeline of the Neolithic transition in East Asia. Summing up the above data, we can get the scheme where two stages are clearly distinguished (Fig. 4). The first concerns the forming of more sophisticated and equipped cultures of hunter-gatherer-fishers. It seems this process started earlier and was more fast-paced and more innovative in the Japanese archipelago. Here, we can trace two successive phases of the transition with different suites of the novelties: the first in the north of Honshu and the second in the south of Kyushu (Fig. 4). The second stage concerned the transition to food production, and this process was explicitly concentrated in central and north-central China. Between these two stages, we can also see a cultural, spatial and temporal gap in records splitting up the Neolithic transition into two seemingly isolated episodes. This is why it is hard to conceive it as an incremental and coherent process, as we can observe in West Asia.

Next, we can see that in each of the East Asia regions considered above, the transition to the Neolithic was run according to its own distinctive scenario. In each of the regions we have an individual set of novelties which differs in each case in a special manner from the classical package formed in West Asia. However, if we take East Asia as a whole and consider what specific innovations, where and in what sequence arose during the Neolithic transition, we will see a process that differs little from that is known in the Near East. It will become obvious that the Neolithic transition in both regions had the same vector and went through the same stages: (1) the broad spectrum economy (*Binford 1968; Flannery 1969; Zeder 2012*); (2) low-level food production (*Smith 2001*); (3) the establish-ment of fully developed agriculture, *i.e.* based primarily on domesticated species (*Asouti, Fuller 2013; Stevens, Fuller 2017; Freeman* et al. *2015*).

The terms used above are based mainly on the West Asia data. Nonetheless, in East Asia researchers also use them or their equivalents widely, though predominately to interpret the Chinese materials (see, for example, the broad spectrum revolution: *Habu 2004; Lu 2006; Prendergast* et al. *2009; Elston* et al. *2011; Shelach-Lavi 2015.52–66; Morgan* et al. *2017.18*; low level production: *Crawford 2006; Barton 2009; Bettinger* et al. *2010; Liu, Chen 2012.125, 168; Shelach-Lavi 2015.149; Pan* et al. *2017.366–367*). Herewith, if the concept of low-level production seems in good correspondence with East Asia records, then this might not be so obvious with respect to the concept of a broad-spectrum revolution. This is particularly the case with regard to Japan, Far East Russia, and Transbaikalia, and special research is required to illuminate this question. In the almost complete absence of zooarchaeological and paleobotanical data

STAGE		HONSHU	SOUTHERN KYUSHU	CHINA
I	13.5-12.0 C^{14} 16300-13900 cal bp	Axe, adze Arrowheads Pottery Wetstones Polishing Bifacial tools		– – ? – – –
		12.0-11.0 C^{14} 13900-12900 cal bp	Grinding tools Start of acorn economy Village-like settlement Storage pits Pithouse	+ Plant gathering – – –
			Crush Dispersal (?)	Nanzhuangtou, Donghulin
II			8.2-6.0 (5.5) C^{14} 9200-6800(6300) cal bp	Moated settlements Burial grounds Rise of ritual practice Pottery kilns Textile Start of domestication Low-level agriculture
			6.0 (5.5)-3.0 C^{14}	Full agriculture

Fig. 4. General timeline of the Neolithic transition in East Asia.

reflecting the Terminal Pleistocene in these regions, chiefly technological changes can be used there as the marks of resource spectrum broadening or resource intensification.

Further, on the basis of these observations we can synchronize the events related to the Neolithic transition in both East and West Asia (Tab. 2).

The synchronization shows clearly that the Neolithic transition started in East Asia approximately at the same time as in West Asia, *i.e.* on the eve of the Bølling-Allerød warming, but ended much later. At the dawn of the Holocene, this lag became more noticeable. Despite the early appearance of pottery together with other innovations mentioned above, the domestication process began and ended in East Asia later, and it concerns as well a sedentary way of life, intensive agriculture, and its transmission into new areas occupied by hunter-gatherers.

What were the reasons for this lag? It appears different economic strategies underlay the Neolithic transition in West and East Asia during its first steps. The Natufian culture had a complex subsistence practice, and from the very beginning it had been distinctly specializing in harvesting plant resources (*Weiss* et al. *2004*), but in East Asia this was not the case. Here, in the first instance, a more advanced culture of hunter-gatherer-fishers was established, and only after this did cultures somewhat similar in their economy to the Natufian one appear on the south of Kyushu, but with no time to gain strength since their development was soon interrupted by the Younger Dryas cooling.

This climatic event equally affected the plant gathering in both West and East Asia (*Bar-Yosef 2011b*). In the former, it led to the decline of the Natufian culture, but at the same time to the dissemination of its main achievements. On these grounds, the PPN cultures arose soon after. In East Asia, plant gathering, which had already starting later, was interrupted, and for a much more extended time, including into the Early Holocene. It seems also that on the Japanese archipelago, given its geographical setting, the successful evolution of plant resource specialization into intensive agriculture was *a priori* impossible or at least much more difficult (*Bleed, Matsui 2010*). Perhaps due to these circumstances, in East Asia plant resources fell into the focus of subsistence practices only much later, and in a more relevant place, namely China.

The core-area displacement from the Japanese archipelago and Amur river region to China during the process of Neolithization, most likely, also influenced its pace, and this concerns not only the development of plant gathering itself. In Western Asia we can also see such a displacement, but it was accompanied by a continuity in cultural development, whereas in East Asia it coincided with a deep spatial, temporal and moreover cultural gap.

To date, no clearly expressed cultural links between China and the Japanese archipelago (or Amur River region) are yet visible in the course of Neolithization. The data on the two first Holocene millennia are not within the main research focus, and also remain too scarce. We do not know if there was a relay-like transmission of cultural baggage, or if the early agriculturalists started moving to food production based only on the achievements of their local ancestors. The latter, however, were rather moderate in comparison to those framed in the southern part of the Japanese archipelago. Nonetheless, early agricultural communities appeared to be well-formed in China, and due to the gap mentioned it is still difficult to find the origins of their high culture. This is in sharp contrast to West Asia, where we see an incremental moving to more and more sophisticated cultures.

One more feature becomes obvious when comparing the western and eastern trajectories of the Neolithic transition, and this concerns the so-called Subneolithic cultures. According to most definitions, they possess all, almost all, or some of the Neolithic novelties, except agriculture, though we do not understand the whole spectrum of their varieties. However, it appears our comparative analysis permits us to solidly differentiate them into two main kinds: Meso-Neolithic and Subneolithic. It seems they differ chiefly by the extent of sedentarization as indicated by

	West Asia	Cal bp	East Asia	Cal bp
Broad spectrum economy	Natufian	15 000–11 500	Proto-Jomon	16 000–11 500
Low level production	PPN	11 500–8200	Peiligang	8200–6800
Intensive agriculture	PN	>8200	Yangshuo	>6800

Tab. 2. Rough synchronization of the main steps of Neolithic transition in East and West Asia.

the presence/absence of village-like settlements. From this, we might see the notional sequence 'Mesolithic- Subneolithic-Neolithic' where pottery distinguishes the Mesolithic and Subneolithic, but agriculture separates the Neolithic and Subneolithic. Besides, it sounds like this partitioning is relevant not only for East Asia, but also for most of Eurasia.

In the West, both Subneolithic and Meso-Neolithic cultures become ubiquitous only after intensive agriculture develops in the Near East. Moreover, it is well known that their advent was caused by the influence of agriculturalists. Conversely, in the East, Subneolithic and Meso-Neolithic cultures arose across the whole area more or less simultaneously with the first low-level agriculture communities. This means that their forming started even earlier. In East Asia, the pioneering hunter-gatherer-fisher cultures of the first stage of the Neolithic transition engendered the whole range of Neolithic innovations, and possibly imparted them to the early agriculturalists, but not the reverse. This fact makes the Neolithic transition in East Asia unique, and not only due to the earlier appearance of pottery. It emerged together with other novelties typical for the Neolithic, Meso-Neolithic and Subneolithic cultures of all Eurasia.

Conclusions

Taking stock of all the above data and considerations, we can reach the following conclusions.

Firstly, there were three dissimilar models of the Neolithic transition in East Asia: the Meso-Neolithic in the Circum-Baikal region, the Subneolithic in the Sea of Japan area, and the Neolithic in China. They vary widely, but at the same time, have an important commonality concerning the suite of Neolithic novelties. In each region we observe their individual set, but it always remains within the frame of the classic Neolithic package. Thus, in light of this pattern, the main question is why the transition to the Neolithic was so similar in different regions.

Secondly, two stages and two centres might be clearly recognized during the Neolithic transition in East Asia. The early stage concerned the so-called broad spectrum revolution leading to the origin of more sophisticated and newly equipped hunter-gatherer-fisher cultures. This process was rather diffuse, but seems to have started earlier and was more fast-paced and more innovative in the Japanese archipelago. At the second stage, the transition to food production started in central and north-central China. There we observe further progressive development toward the Neolithic, and China clearly becomes the centre of the Neolithization process. Between the stages, there is a clear cultural, spatial and temporal gap splitting up the Neolithization process into two isolated episodes. However, a more comprehensive analysis of the records bearing on the first millennia of Holocene is needed to assess whether this gap is artificial or reflects an objective picture

Thirdly, the early emergence of pottery was not the only feature of the East Asia Neolithic transition. Most crucially, it appeared together with other novelties typical for the classic Neolithic package. Moreover, they were all embedded in a process leading to the forming of a new type of hunter-gatherer-fisher culture known in the literature as the Subneolithic. It seems the early dates of pottery acted as a red herring in Neolithic studies, hindering the understanding of this pattern. In addition, this process occurred at the end of the first stage mentioned above, *i.e.* prior to early agriculture. Further, for a long time afterward the relationships between the first agriculturalists and surrounding Subneolithic communities were not like those between the centre and periphery, and this shift happened only after several thousands of years when intensive agriculture had been established.

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Towards a prehistory of the Great Divergence: the Bronze Age roots of Japan's premodern economy

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ABSTRACT – *This essay argues that the primary socio-economic formations of premodern Japan were formed in the Bronze Age via processes of ancient globalization across Eurasia. Multi-crop cereal agriculture combining rice, millet, wheat and barley with a minor contribution from domesticated animals spread from Bronze Age Korea to Japan at the beginning of the 1st millennium BC. This agricultural system gradually expanded through the archipelago while engendering new economic niches centred on trade, raiding and specialized fishing. From the 5th century AD the horse became widely used for warfare, transport and overseas trade. While alluvial rice farming provided staple finance for the early state, it is argued here that the concept of the 'maritime mode of production' better explains economic processes in the nonstate spaces of Japan until the early 17th century. Despite this diversity in socio-economic formations, the post-Bronze Age globalization of food in Japan appears to have been delayed compared to many other regions of Eurasia and to have been less impacted by elite consumption. Further research is required to confirm this suggestion, and the essay outlines several areas where archaeological research could contribute to debates over the 'Great Divergence' and the economic development of the modern world.*

KEY WORDS – *agriculture; globalisation; mode of production; Great Divergence; Bronze Age; Japan*

K prazgodovini velikega razhajanja: izvor japonske predmoderne ekonomije v bronasti dobi

IZVLEČEK – *V prispevku razpravljamo o tem, da so se prvotne družbeno-ekonomske oblike predmoderne Japonske oblikovale v času bronaste dobe, in sicer s procesi starodobne globalizacije v Evraziji. Poljedelstvo s številnimi vrstami žit, ki vključujejo riž, proso, pšenico in ječmen, in z manjšim deležem udomačenih živali se je širilo iz bronastodobne Koreje na Japonsko na začetku 1. tisočletja pr. n. št. Takšen poljedelski sistem se je postopoma širil čez celotno otočje, kar je povzročilo nove ekonomske niše, osredotočene na trgovanje, roparske napade in specializiran ribolov. Od 5. stoletja n. št. se je razširila uporaba konjev pri vojskovanju, transportu in čezmorskem trgovanju. Medtem ko je pridelava riža na naplavinah nudila stabilno financiranje za prve države, v članku razpravljamo o tem, da lahko ekonomske procese za območja na Japonskem, ki so bila izven teh držav, do začetka 17. stoletja bolje razložimo s konceptom 'morskega načina proizvodnje'. Kljub takšni raznolikosti v družbeno-ekonomskih oblikah se zdi, da se je po-bronastodobna globalizacija v prehrani na Japonskem v primerjavi z drugimi regijami v Evraziji zgodila z zamikom in je bila pod manjšim vplivom porabe elit. To bo treba potrditi z dodatnimi raziskavami, na kar opozorimo tudi v prispevku in okvirno predstavimo, na kakšen način bi lahko arheološke raziskave prispevale k razpravam o 'velikem razhajanju' in ekonomskemu razvoju modernega sveta.*

KLJUČNE BESEDE – *poljedelstvo; globalizacija; način proizvodnje; veliko razhajanje; bronasta doba; Japonska*

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Introduction

The premodern economy of the Japanese archipelago has received considerable attention from economic historians who have attempted to explain why Japan was the first Asian country to industrialize. Many such historians have concluded that premodern Japan was characterized by relatively high living standards and economic growth until the so-called 'Great Divergence' of the early modern era (*Hanley 1983; Pomeranz 2000*). Recently, Jean-Pascal Bassino *et al.* (*2019*) found that even during the 19th century living standards and productivity in Japan remained high as compared to the rest of Asia. Despite its unquestioned importance in understanding the origins of industrialization, however, comparative research on premodern Japanese economic history has tended to emphasize shared similarities with Europe, such as markets, institutions, and the rise of capitalism. This research also relies heavily on documentary records produced by state bureaucracies. As a result, *differences* in premodern socio-economic formations between Japan and the rest of Eurasia – especially those formations which receive little attention in state records and are primarily known from archaeology-remain less well understood. Historians of Japan have long used archaeological findings in their work (*e.g.*, *Farris 1998; Wakita 2001*). However, recent years have seen significant changes in our understanding of many aspects of the archaeology of early Japan, and these changes necessitate a re-evaluation of several aspects of economic history.

This essay argues that feudal or peasant modes of production were not the only game in town in premodern Japan. In a preliminary attempt to develop a 'prehistory' of the Great Divergence, I discuss the roots and evolution of socio-economic formations in Japan from *c*. 900 BC to AD 1640 from a primarily archaeological perspective using Scott's (*2017*) ideas about post-Bronze Age resistance to alluvial states and Johan Ling *et al.*'s (*2018*) concept of the 'maritime mode of production'. The essay summarises current understandings of the relevant issues but also identifies areas where future research is required.

Bronze Age agriculture

The Neolithic Jōmon cultures of the Japanese Islands had combined hunter-gathering with the management and cultivation of several native plants, including adzuki (*Vigna angularis* var. *angularis*), soybeans (*Glycine max*) and barnyard millet (*Echinochloa esculenta*) (*Nakayama 2010; Crawford 2011; Obata 2016*). Millet farming reached southern Korea from northeast China by around 3500 BC (*Lee 2011; 2017*). Jōmon populations must have been aware of this, because one of the earliest Korean sites with evidence of millet is Tongsamdong, a site on the south coast of the peninsula long-known for remains relating to Neolithic interaction between Korea and Japan (*Sample 1974; Bausch 2017*). However, the Neolithic millet agriculture found on the Korean peninsula was not adopted in Japan, and it was not until the beginning of the 1st millennium BC when a new complex of mixed cereal agriculture spread from Bronze Age Korea to Kyushu, giving rise to the cultures of the Yayoi period (*c*. 900 BC – AD 250). This agricultural complex included rice (*Oryza sativa*), both broomcorn (*Panicum miliaceum*) and foxtail (*Setaria italica*) millet as well as wheat (*Triticum aestivum*) and barley (*Hordeum vulgare*) (*Nakayama 2010; Nasu, Momohara 2016*).

The first millennium BC agricultural expansion to Japan built on preceding Neolithic networks across the Korea Strait (*Bausch 2017*), but involved new Bronze Age globalizations. While it was earlier assumed that agriculture reached Japan from the Yangzi basin of southern China (*e.g.*, *Egami 1964*), in fact it was a combination of southern and northern Chinese farming systems, as well as West Asian crops (notably wheat and barley), which spread to the Japanese Islands (*Stevens, Fuller 2017*). The mixed nature of Japanese agriculture is clear even from mythological texts produced by the Yamato state. The *Nihon Shoki* (AD 720) describes how Ukemochi no kami, the goddess of food, transmitted a range of important foodstuffs after her death: "*On the crown of her head there had been produced the ox and the horse; on the top of her forehead there had been produced millet; over her eyebrows there had been produced the silkworm; within her eyes there had been produced panic [broomcorn millet]; in her belly there had been produced rice; in her genitals there had been produced wheat, large beans and small beans.*" (*Aston 1972.I. 32–33*).

Moreover, the Yamato state issued a number of official directives between 715 and 840 encouraging the cultivation of crops other than rice (Tab. 1).

Despite this, there is still a pervasive emphasis on rice in many archaeological writings on Japan, ultimately reflecting the way the ancient state used rice to define Japanese ethnic identity (*Batten 2003*).

Year	Decree
715	Each adult male shall additionally sow barley and millet
722	For warding off famine, plant late-ripening millet, buckwheat, barley and wheat
723	Sow and harvest barley and wheat
766	Plant barley and wheat
767	Expand the cultivation of mulberry
820	Plant barley and wheat
839	Sow buckwheat and millet
840	Cultivate dry fields. For support in bad years, plant two kinds of millet (*kibi* [broomcorn] and *takakibi* [sorghum]), barnyard grass, barley, large and small beans, and even sesame

Tab. 1. ***"*****Measures for the Increased Production of Miscellaneous Grains*****" issued by the Japanese state 715–840 (adapted from*** **Kimura 2018*****).***

Shin'ichiro Fujio (*2013*) defined the Yayoi as a culture which selected irrigated paddy-field rice cultivation as its basis of production *and* which engaged in 'Yayoi rituals' to maintain that production base. This interpretation leads Fujio to conclude that less than half of the Japanese archipelago fits his own definition. Although he presents this as a critique of a simplistic association between rice and the Yayoi, Fujio is unable to develop an alternative framework which takes full account of social and economic diversity in Bronze Age Japan, leading him to follow Tsuyoshi Fujimoto (*1988*) in positing the existence of 'blurred' or 'fuzzy' cultural zones surrounding the Yayoi. Areas of ancient Japan *with* wet rice cultivation are assumed to be the norm and are termed the 'central culture' zone by both Fujimoto (*1988*) and Fujio (*2013*).

The spread of agriculture from north Kyushu across the Japanese archipelago was not especially rapid. Some readers will note that this statement contradicts my earlier evaluations of a fast expansion (*Hudson 1990; 1999*), and a short explanation is in order. Firstly, recent radiocarbon dating puts the beginning of the Yayoi period some five centuries earlier than previously assumed (*Fujio 2011*). According to current chronologies, therefore, the Yayoi period lasts some 1200 years, a time span which is almost as long as the 1500 years of the following Kofun through early modern eras (*Kawamura 2018*). Latest estimates plot the spread of Yayoi *culture* as follows: north Kyushu by the end of the 10th century BC, Shikoku and the central Inland Sea in the 8th century, the Kinai (Osaka-Kyoto) region in the 7th, the Tōkai and Hokuriku in the 6th, and the Chōbu, Kantō and southern Tōhoku in the 3rd century BC (*Segawa 2017.19*). Rice paddy fields were constructed in Aomori in the northern Tōhoku in the 4th century BC but rice growing in this region was quickly abandoned, only to return centuries later. Agriculture did not reach the Ryukyu Islands in the south until the 10th century AD (*Takamiya* et al. *2016*). In Hokkaido, barley is known from sites of the Iron Age Okhotsk culture (*Leipe* et al. *2017*). In the 9th century, the cultivation of barley, wheat and broomcorn and foxtail millet has been confirmed from the Sapporo area (*Crawford, Yoshizaki 1986*). The medieval period saw a further expansion of crops from Honshu into Hokkaido (*Yamamoto 1996*), but a full-scale transition to agriculture across Hokkaido did not occur until the settler colonial period of the late 19th century. In some regions of Japan, agriculture seems to have spread as a package with the Bronze Age Yayoi culture. In other areas it is possible that local hunter-gatherers took up farming themselves (*Fujio 2011*), although the evidence for the latter is largely circumstantial.

The speed of agricultural colonization is, of course, relative. Compared to Japan, for example, the spread of farming across Britain and Ireland seems to have been extremely fast (*Bocquet-Appel* et al. *2012; Shennan 2018*), perhaps taking only some 300 radiocarbon years (*Whittle* et al. *2011*) despite a larger surface area (*c.* 312 773km^2 for Britain and Ireland compared to *c.* 283 542km^2 for Honshu, Kyushu and Shikoku). On the ground, settlement by farmers would have depended on local geographic conditions and, in the case of Japan, the actual areas suitable for early farming would have been extremely limited due to the mountainous topography. It has been suggested that the rapid Neolithic colonization of Britain was aided by a series of separate migrations from the continent (*Whittle* et al. *2011*). Such a scenario also seems likely for Yayoi Japan, although further research is required on specific routes. Another point is that the speed of an initial agricultural colonization needs to be balanced against evidence for later abandonment and re-introductions. In Britain, it has been proposed that cereal farming was abandoned in many areas after five centuries, only to be re-introduced in the Bronze Age (*Stevens, Fuller 2012*). With the exception of the northern Tōhoku region mentioned above, this possibility has yet to be seriously considered by Japanese archaeologists, who define Yayoi farming on the basis of its irreversibility (*Fujio 2013*). As compared to Neolithic Britain, however, the late arrival of farming in Japan probably gave it greater flexibility and resilience (*cf. Fuller, Lucas 2017*).

Domesticated animals played a relatively minor part in the initial Bronze Age expansion of agriculture to Japan. The pig was the main such animal associated with the introduction of cereal agriculture in the Yayoi period, but the status of pigs in Bronze Age Japan has been controversial (*Hongo 2017*). Some pigs were probably introduced from Korea at this time, but extensive inter-breeding with wild boar probably occurred. Pigs are also known in the Iron Age Okhotsk culture in Hokkaido (*Hudson 2004*). Domesticated chickens first appear in the Middle Yayoi (*c.* 400 BC–AD 100), but are rare until the Middle Ages. In Yayoi Japan, only some 13 chicken bones (NISP) have been discovered from seven sites (*Eda 2018*). Chickens are archaeologically more common by the early modern Tokugawa period and comprise 22% of avifauna excavated from Tokugawa sites (*Niimi 2008*). However, this figure is significantly lower than at European sites from the same time period (Tab. 2).

Horses were introduced to Japan in the late 4th or 5th centuries (*Sasaki 2018*). Cattle bones also appear from the 5th century, becoming more widespread from the 6th (*Hongo 2017*). According to the *Nihon Shoki*, an envoy from the Korean state of Paekche presented a camel, a donkey and two goats to the Japanese court in 599. Another camel was given by the state of Koguryŏ in 618, but none of these animals became common in Japan until much later, and camels were never integrated into the Japanese landscape. Goats were, however, common in Okinawa and the islands of northwest Kyushu from the medieval period (*Thiede 1998; Toizumi 2018*).

Archaeological evidence is crucial to understanding the role of domesticated animals in ancient Japan, since historical texts sometimes borrow Chinese expressions about animals. An entry in the *Nihon Shoki*, for example, describes a prosperous nation as one where "*a measure of rice was sold for one piece of silver, and horses and kine covered the moors*", but the translator of this text takes "*the whole passage to be a flight of the author's fancy, stimulated by his recollections of Chinese literature*" (*Aston 1972.I.391*). One example where texts and archaeology match well is the domestic cat. Cats are first mentioned in the diary of the late 9th-century emperor Uda, and the first archaeological evidence for this animal in Japan dates to the 10th century at the Kannonji site in Tokushima (*Yamane 2008*). Cats were initially associated with the aristocracy, and from the Kamakura period (1185–1333) were used by shrines and temples to keep rats from damaging sutras and other documents (*Yamane 2008.86*).

A scarcity of domesticated animals has been proposed as a distinctive feature of the premodern Japanese economy, most vociferously by the environmental archaeologist Yoshinori Yasuda (*2006*). While Yasuda's writings have been widely critiqued for their nationalistic interpretations of the Japanese past (*Reitan 2017*), there is a need for further empirical research on at least five issues to determine just how distinctive patterns of domesticated animal usage in premodern Japan really were: (1) historical differences between domesticated animal utilization in Japan and neighbouring areas such as Ko-

Site/location	Period	% *G. gallus domesticus*	Chicken sample size (NISP)	Source
Japan	Tokugawa (1603–1868)	22.1	1605	*Niimi 2008*
Savvatiev Monastery, Tver oblast, Russia	14–16th centuries	46.66	7	*Zinoviev 2019*
Gdansk, Poland	16–18th centuries	45	190	*Makowiecki, Gotfredsen 2002*
Middle Volga, Russia (3 sites)	16–17th centuries	50.97	236	*Galimova* et al. *2013*
St. Anne's Square, Belfast, N. Ireland	17th-early 20th centuries	56.25	18	*Fothergill 2017*
Santa Clara-a-Velha Convent, Coimbra, Portugal	17th century	>63	1462	*Moreno-Garcia, Detry 2010*
Stafford Castle, UK	19th century	70.77	491	*Thomas 2011*

Tab. 2. Percentage of* Gallus domesticus *as a total of all avian fauna from early modern Japan and Europe. Unidentified avian fauna were removed from the totals before calculating the percentages.

rea; (2) actual numbers of domesticated animals in Japan; (3) the extent to which wild animals and birds were eaten as an alternative to domesticates; (4) the role of commercialization and capitalism in promoting meat consumption; and (5) the influence of elite political controls over diet. All of these issues require evidence from zooarchaeology, which sometimes does not match that from the historical record (*Albarella 1999*).

From the Neolithic period, domesticated animals were widely adopted across Eurasia but actual patterns of utilization were variable and were influenced by regional ecological and historical conditions (*Manning* et al. *2013; Balasse* et al. *2017; Zeder 2017*). The animals that were domesticated in West Asia in the 8th millennium BC spread to Europe north of the Mediterranean through a series of cultural and biological adaptations including dairying and an increased reliance on cattle at the expense of ovicaprids (*Ethier* et al. *2017*). Pigs were also domesticated in China but spread more slowly to Northeast Asia, including Korea, the Russian Far East and Japan (*Kuzmin 1997*). Some Japanese historians such as Nakazawa (*2009*) see a major difference between domestic animal exploitation in Japan and that in China and Korea, yet Korea remains poorly understood in this respect. European historians tend to emphasize low levels of domestic animal usage across East Asia as a whole. Eric Jones (*2003*) argued that the European accumulation of capital in the form of livestock was one cause of what he called *The European Miracle*. Kenneth Pomeranz (*2000.32–35*) claims that the scarcity of domestic animals in many parts of Asia had little effect on economic development, but further research is needed to support this argument for the ancient and medieval periods.

The consumption of animals in premodern Japan must be understood in relation to questions of political control by the emperor and social elites, as well as complex histories of social taboos. It has been argued that at least until the 9th century – when Buddhist ideas gained greater influence amongst the aristocracy – abstinence from killing animals and eating meat served as a type of magico-ritual means of avoiding disasters (*Harada 1993; Nakazawa 2009*). Prohibitions against the use of certain resources were also a way by which elites could control their subjects. The late 13th century Azuma Kagami contains prohibitions against burning moorland to hunt animals and against using oil cakes to poison rivers to catch fish (*Taniguchi 2014*). Various social taboos were also associated with fish. According to the mid-18th century *Efu fūzokushi*, "*tuna, sweet potato, pumpkin, and such are exceedingly low class foods, and even commoners are ashamed to eat them openly*" (*Sakurai 2017.680*).

The presence of good pastureland in many areas of eastern Japan meant that horses were more commonly raised there than in the west of the country. This difference extended to animals used in agricultural work, with cattle being more common in most of western Japan, whereas horses were more frequently used in east Japan as well as in southern Kyushu and southern Shikoku (*Kōno 2009*). In the ancient period, horses were raised on official government ranches, but also in nonstate spaces by groups such as the Emishi of the northern Tōhoku (*Matsumoto 2018*).

The barbarian niche and the maritime mode of production

Even in Europe, premodern history has for the most part adopted a land-based perspective (*Rüdiger 2017*) and – notwithstanding the influential critiques of Amino (*2012*) and others – this remains true for Japan. In this context, the term 'land-based' may be less useful that the concept of 'nonstate spaces' developed by James Scott (*2009; 2017*). Although the term 'feudalism' is rarely used in more recent Japanese historiography, there is still an assumption that the economy centred around aristocratic landlords who obtained a surplus from dependent peasants. Chris Wickham (*2005.304*), an historian of medieval Europe, has proposed a 'peasant mode of production' for "*societies in which peasants are mostly independent producers, and the local rich and powerful are dominant only over a minority of the peasantry, or are partly direct producers themselves*". However, this concept seems difficult to apply to Japan. In an alternative approach, which would appear to be more relevant to the Japanese context, Ling *et al.* (*2018*) have proposed a 'maritime mode of production' which combined agricultural production with new maritime, warrior and trading dynamics. Although Ling and colleagues illustrate this model with Bronze and Viking Age examples from Scandinavia, they suggest that the maritime mode of production was more widespread, and briefly note comparative examples from Island Southeast Asia, Oceania, and the Northwest Coast of North America.

As in Europe, land-based power in Japan has often been contrasted with the opposing, 'dangerous' world of pirates and others who attempted to live in non-state spaces. In a much-cited work, Shōsuke Murai (*1993*) saw medieval pirate/traders as 'marginal men'. This framework derives in part from the 'agrarian fundamentalism' of Confucian thought, which was perhaps less strict in Japan than in Korea or China (*Amino 2012*), yet I believe this opposition between the land and the sea in Japanese history to be over-stated. Ling *et al.*'s (*2018*) maritime mode of production emphasizes that maritime raiding and trading could incorporate an agricultural sector owned by free farmers and chieftains.

New maritime adaptations had to some extent developed in Japan from the Late Jōmon period, before farming had been introduced from Korea, with a new emphasis on offshore resources such as tuna, marlin and sharks (*Toizumi 2008*). However, the arrival of agriculture and immigrant populations in the Yayoi transformed post-Jōmon economies in the archipelago, opening up new opportunities which – following the logic of Scott (*2017*) – might be termed the 'barbarian niche' (*Hudson in press*). In Hokkaido, Epi-Jōmon groups focused on sea bottom fish, especially Pleuronectinae and Japanese halibut (*Paralichthys olivaceus*), as well as swordfish (*Segawa 2017*). All of these were difficult and dangerous species to fish, and it can be assumed that opportunities for trade were a major stimulus. From Hokkaido down to Kyushu, abalone also became a very common trade item, a pattern that continued into the Tokugawa period. The long-distance connections between maritime-oriented populations along the coast of the Sea of Japan is shown by various categories of archaeological evidence including shell beads and rock art (*Hudson, Barnes 1991; Segawa 2017*). Certain Japanese rock and tomb art motifs from this period mirror Indo-European mythological themes connected to ships, horses and the sun (*Segawa 2017; cf. Kristiansen 2012*), and it has yet to be explained how such influences might have reached the archipelago.

The post-Jōmon 'barbarian niche' did not only involve maritime resources. As noted above, horses were also important in many 'peripheral' (meaning peripheral to the Yamato state) regions of Japan. The early 8th century gazetteer, the *Hizen no Kuni Fudoki*, mentions that maritime-based peoples in the Gotō Islands of Nagasaki raised horses and cattle (*Aoki 1997.265*). Mountain bandits were also common in many areas of the archipelago. But it was the sea-based 'pirates' and traders who developed enormous power across Japan and into the broader East Asia region (*Amino 2012; Carré 2017; Oxenboell 2005; in press; Shapinsky 2009; 2014; Smits 2018*). Medieval Japan can be characterized by processes of political decentralization and economic commercialization (*Yamamura 1990*), yet the pirates served to promote 'connectivity' (*Horden, Purcell 2000*) across the region. Forest products, including furs and timber, were important items of commerce with China and Korea, as were slaves (*Nelson 2004; Totman 2014; von Verschuer 2006*). Archaeology is crucial to our understanding of this trade. A recently published example is Deryugin's (*2018*) suggestion that petroleum for lighting was traded from northern Japan to the state of Parhae in northern Korea and the Russian Far East. As early as 668, the *Nihon Shoki* mentions that "*the province of Koshi [the modern Hokuriku region] presented to the Emperor burning earth and burning water*", items that are assumed to be coal and petroleum (*Aston 1972.II.289*).

Of course, the sea also supported state power in early Japan, but its role in this respect seems to have undergone significant changes over time. Guillaume Carré (*2017*) argues that "*the Yamato court was not particularly interested in the sea*" between the 8th and 12th centuries, although he notes that internal seaways were used to collect taxes. In earlier centuries, however, the sea had been important as a route to attempted territorial expansion through frequent attacks on the Korean peninsula, as described in the *Nihon Shoki*. The historian Gari Ledyard (*1975*) even called the early Japanese state the 'Thalassocracy of Wa', although he never published a full argument in support of this concept.

Food globalization and the economy of premodern Japan

Background remarks

The long-distance exchange of ancient foods has become an important topic of research in recent archaeology (*Boivin 2017; Boivin* et al. *2012; Liu, Jones 2014*). Research on the ancient globalization of food can provide new perspectives on the question of wealth disparities across Eurasia. Many early travellers from Europe remarked that Asian societies were characterized by profligate aristocracies who exploited poor peasants (*Jones 2003.5*). Further research is needed on how the Japanese Islands articulated with premodern processes of globalization, but it seems hard to avoid the impression that those processes were often quite delayed with respect to the rest of Eurasia. Even rice, that most symbolic of crops in Japan, reached the archipelago very late. By comparison, imported rice has been found at a number of Roman sites in Europe from at least the 1st century AD (*Reed, Leleković 2019*), a date that is not significantly different from many parts of eastern Japan. The slow rate of the globalization of food in early Japan appears to mirror that of other technologies, such as wheeled transport. The oldest wooden wheel in Europe, from the Ljubljana marshes, dates to around 3150 BC. Very sophisticated woodworking technologies were found in Neolithic and Bronze Age Japan, but the wheel and wheeled transport were probably not introduced until the middle of the 1st millennium AD. Chariots were never used in Japan, and the emperor and aristocracy do not seem to have used wheeled transport for political display until as late as the 10th century (*Nakazawa 2009.6*).

Several new crops and varieties did have a major economic impact in premodern Japan. Champa rice (*Oryza sativa indica var. spontanea* or *perennis*), introduced from south China sometime between 1100 and 1300, not only produced higher yields but was also more resistant to disease, drought and flooding (*Farris 2006.132*). Champa rice also became popular, because its taste made it less attractive to aristocratic tax demands (*Totman 2014.126*). The introduction of the pumpkin and sweet potato shows the importance of contact with the European trading nations in the late 16th and early 17th centuries, a time of considerable agricultural change in parts of Europe (*Grau-Sologestoa, Albarella 2019*). Some plants did not take off widely upon their first arrival in Japan. Cotton is said to have first been introduced to Japan in 799 by a man from Southeast Asia. In the following year, the court ordered cotton to be grown in several provinces but this was not followed, and cotton was not widely grown until it was re-introduced from Korea in the 15th century (*von Verschuer 2016.26*). DNA evidence suggests that melons (*Cucumis melo* L.), which appear to have first reached Japan at the end of the 1st millennium BC, were re-introduced on several occasions thereafter, but underwent intensified artificial selection for desired traits after around AD 1000 (*Tanaka* et al. *2016*).

One explanation for the apparently slow rate of food globalization in Japan may relate to different attitudes and ideologies of state control. Von Verschuer (*2016*) notes that until the 17th century the Japanese government hardly ever provided peasants with technical assistance or manuals on agricultural improvement, even though the large Chinese literature on such matters was known in Japan. Von Verschuer's (*2016.13*) suggested explanation that "*the Japanese mentality put zeal before technical ability*" begs the question of why the ancient and medieval state in Japan was so weak in that respect. A hypothesis for future consideration is that – from the perspective of food globalization – Japanese elites had a relatively low influence over the introduction and spread of new food items. Testing this hypothesis would provide new perspectives on the role of the profligate consumption by Asian elites proposed by Jones (*2003*) and others.

The role of commercial fisheries

The globalization of food does not just involve the transfer of exotic items, but the whole process by which new foodstuffs are incorporated into the broader social and economic structures of a particular culture. This process may have important knock-on effects on social change beyond food. As an example, in this section I briefly consider fish and fisheries.

Japanese elites enjoyed an extensive culture of banquets. The abbot of the Chōrakuji temple in modern Gunma is said to have attended more than 100 such banquets in 1565 alone (*von Verschuer 2017*). Following Buddhist precepts some of these meals were vegetarian, but Japanese elites were also major consumers of seafood in feasts and banquets. Zooarchaeological analyses from the residence of the Ōuchi family in Yamaguchi has shown that around AD 1500, as well as ducks, pheasants, sparrows, rabbits, otters, martens and badgers, a huge variety of marine and river resources was consumed, including scorpion fish (Scorpaenidae), Asian sea bass (*Lateolabrax sp.*), Carangidae mackerels, sweetfish (*Plecoglossus altivelis*), sharks, rays (Myliobatiformes), pike congers (Muraenesocidae), Serranidae sea basses and groupers, grunts (Haemulidae), surfperch (Embiotocidae), salmonids, tuna and bonito (Scombridae), sardines, carp, abalone, horned turban shell (*Turbo cornutus*) and the Asian rapa whelk (*Rapana venosa*) (*Kitajima 2014*). Elite sites of the early modern Tokugawa period are also marked by a large diversity of marine remains. For example, the Ministry of Post and Telecommunications Iikura Annex site in Tokyo, the location of Tokugawa daimyo residences of the Yonezawa and Usuki domains, produced 25 types of fish and 18 types of shellfish (*Sakurai 2017*).

The medieval expansion of offshore fishing has been seen as one important factor in the economic

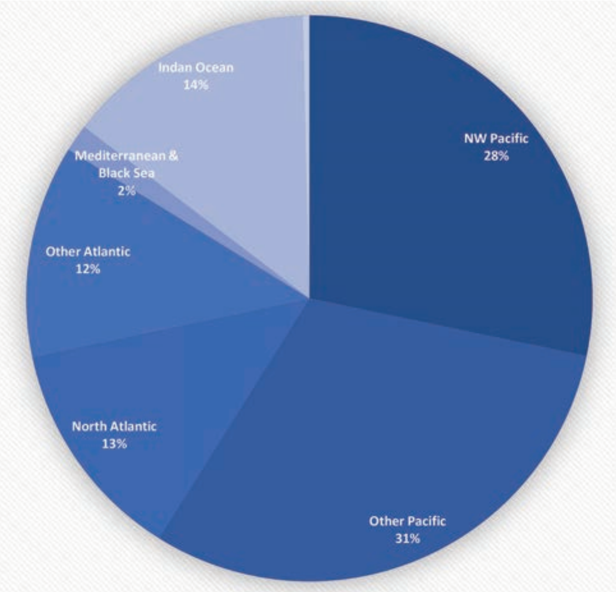

Fig. 1. Global marine fisheries capture in 2016 (based on data in FAO 2018).

rise of Europe (*Jones 2003.75*). In Asia, by contrast, Jones (*2003.167–168*) argues that the available fisheries were much less rich: "*Asians were simply not provided with as good marine fishing-grounds as the North Sea and the far side of the Atlantic offered to Europeans.*" Japan is noted as an exception to this generalization, but Jones provides no discussion of the historical role of fisheries in Japan. Based on contemporary data from the Food and Agriculture Organization of the United Nations, fisheries in the northwest Pacific accounted for 29% of global marine capture in 2016; the north Atlantic by contrast comprised only 13% (Fig. 1). Although Japan is most conveniently located to access northwest Pacific fisheries, access from China and Korea would also have been possible had such an economy developed in those countries.

Archaeology has played an important role in understanding the historical commercialization of fishing (*Pitcher, Lam 2015*). Zooarchaeological evidence shows a rapid increase in offshore catches of herring and cod in northwest Europe after around AD 1000 (*Barrett* et al. *2004; Galloway 2017*). Long-term trends in fisheries in Japan are quantitatively less well understood, but a broad outline is known from the work of Toizumi (*2008*) and others (Fig. 2). What stands out from these trends is the great variety of fishing adaptations found in Japan over time. Some of this variation no doubt reflects environmental factors and, from the medieval period, it is possible to identify the growing commercialization of fisheries, yet the overall diversity is still high.

In Europe, herring from Britain were being traded to France and Germany by at least the 12th century AD (*Barrett 2018.130*). The increasing commercialization of fisheries in Europe probably derived from a range of factors, including Christian fasting regulations, population growth and urbanism, and declining freshwater fish resources (*Hoffmann 1996; 2002; Barrett* et al. *2004*). It is presently unclear to what extent similar factors affected fisheries in Japan. Various social taboos surrounding the killing and eating of animals in Japan might be assumed to have encouraged fish consumption, but this relationship needs to be investigated using long-term zooarchaeological sequences. Jun'ya Sakurai (*2017.680*) claims that the fish most preferred by the Japanese during the medieval period was carp, whereas red

Jōmon
- Pottery used to process marine foods
- Salmon exploitation
- Large shell mounds with inshore (*e.g.*, *Acanthopagrus schlegelii* & *Lateolabrax japonicus*) and offshore (*e.g.*, *Katsuwonus pelamis*) fish in addition to shellfish
- Freshwater species exploited, especially in western Japan

Yayoi
- Big decline in shell mounds
- 'Jomon type' offshore fishing continues in NW Kyushu, Hokkaido and along Pacific coast of Tohoku
- Carp raised in rice paddy fields

Kofun-Heian
- Specialist processing of *K. pelamis*, abalone and other resources used for tax payments
- Small-scale shell middens in Kanto region
- Large *Corbicula sp.* midden at Kaminagahama (Shimane)

Medieval
- Tuna, *Scomberomorus niphonius, Coryphaena hippurus* and *Pagrus major* common at Kamakura and other urban sites
- Blood clam (*Anadara broughtonii*) middens around Osaka Bay suggest new netting techniques
- Growing commercial-isation, salmon trade in Hokkaido

Early Modern
- Heavy exploitaion of Tokyo Bay to feed Edo
- Dominance of Pagrus major in Kanto follows medieval trend, but matched by increased variety of exploited fish
- Decline in *Meretrix lusoria* and increase in *Venerupis philippinarum* and *Mactra chinensis* possibly linked with urban pollution
- Dried herring imported from Hokkaido as fertliser

Fig. 2. Major trends in Japanese fisheries exploitation from the Jōmon to early modern periods. Based on Toizumi (*2008*), Habu* et al. *(*2011*), Hudson (*1994*), Nakajima* et al. *(*2010*), Ōnishi (*2014*), and other sources.

sea bream (*Pagrus major*) became the most popular fish in the early modern era. This shift might reflect medieval over-exploitation of freshwater fish, but the Japanese fisheries record is characterized by high regional and chronological diversity and more research is needed. By the early modern Tokugawa period, however, it is known from the historical record that various fishery conservation methods had already been introduced (*Takahashi 2009*), presumably as a result of over-fishing in earlier times.

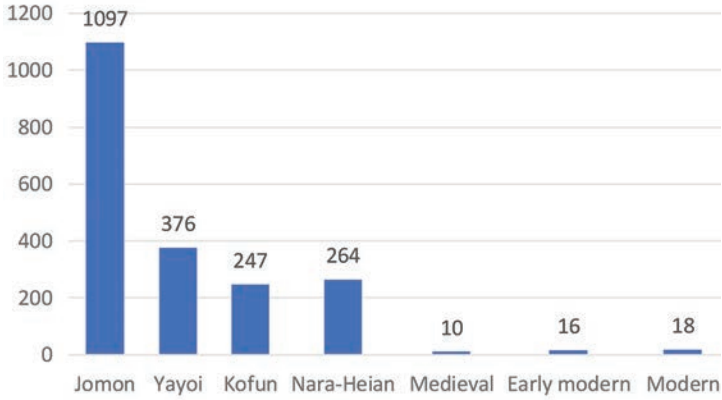

Fig. 3. Number of shell middens in Honshu, Shikoku and Kyushu from the Jōmon to medern periods. Data from Sakatsume (*1959*) and Kenmotsu (*2014*).

Figure 3 shows a decline in the number of shell middens in Japan from the Bronze Age Yayoi period. Figures for the Jōmon to Kofun periods are taken from Nakao Sakazume (*1959*). As noted by Junko Habu *et al.* (*2011*), based on more recent data actual shell midden numbers are likely to be higher, but the overall trend shown here can be assumed to reflect long-term changes in the use of marine resources. An important caveat, however, is that many Jōmon shell mounds are located on higher ground and have been less disturbed by modern coastal development.

Conclusions

The field of Japanese history is entering an exciting new phase wherein interdisciplinary and revisionist approaches are beginning to transform traditional understandings. Recent books by Takuro Segawa (*2017*) and Gregor Smits (*2018*) can be cited as examples of this trend. This exploratory essay has argued that Bronze Age globalization established mixed cereal farming in the Japanese Islands and also stimulated the formation of new, 'post-Jōmon' economies filling what I have called the 'barbarian niche'. Continuing globalization over the historic period was important, but further research is needed to explore the role of elite consumption in that process. A discussion of historic transformations in Japanese fisheries was used to illustrate this problem.

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Neolithisation process in the central Zagros: Asiab and Ganj Dareh revisited

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ABSTRACT – *In the 1960–70s, fieldwork in the central Zagros Mountains produced evidence of early Holocene Neolithic settlements in this mountainous zone along the 'Eastern wing' of the Fertile Crescent. Following a long hiatus in fieldwork, new investigations have highlighted once more the potential of the transitional Neolithic (*c. *9600–8000 BC) and early Neolithic (*c. *8000–7000 BC) sequence in this region. However, some of the pivotal sites that had originally been excavated in the 1960–70s were not published in adequate detail, leaving many questions unanswered. Recent fieldwork at Asiab and Ganj Dareh directed by the authors has sought to address the issues raised by these previously unpublished excavations. Here we summarise the results of our recent work at these two sites and discuss their implications for our understanding of neolithisation in the central Zagros.*

KEY WORDS – *Zagros; neolithisation; Asiab; Ganj Dareh; early domestication*

Proces neolitizacije v osrednjem delu Zagrosa: ponovni pregled najdišč Asiab in Ganj Dareh

IZVLEČEK – *Izkopavanja v 60. in 70. letih 20. stoletja v osrednjem delu gorovja Zagros, t.j. v goratem predelu na vzhodnem kraku rodovitnega polmeseca, so odkrila zgodnje holocenske neolitske naselbine. Po daljši prekinitvi so nove raziskave ponovno izpostavile potenciale za preučevanje obdobja prehodnega neolitika (ok. 9600–8000 pr.n.št.) in zgodnjega neolitika (ok. 8000–7000 pr.n.št.) v tej regiji. Nekatera ključna najdišča, ki so bila prvotno izkopana v 60. in 70. letih 20. stoletja, do danes še niso bila natančno objavljena, zato ostajajo številna vprašanja povezana s temi najdišči še odprta. Avtorji prispevka so želeli z novimi izkopavanji na najdiščih Asiab in Ganj Dareh pridobiti nove podatke in odgovore na nerešena vprašanja iz starejših neobjavljenih raziskav. V prispevku predstavljamo rezultate izkopavanj na obeh najdiščih in razpravljamo o njuni vlogi pri razumevanju procesa neolitizacije v osrednjem Zagrosu.*

KLJUČNE BESEDE – *Zagros; neolitizacija; Asiab; Ganj Dareh; zgodnja domestikacija*

Introduction

Recent debates concerning the development of the Neolithic in southwest Asia have centred on whether plant cultivation and associated cultural characteristics emerged rapidly first in an Upper Euphrates 'core area', and whether this process was driven by environmental, demographic, socio-economic or cultural-symbolic factors. In this regard, it is argued that the eastern wing of the Fertile Crescent, including the central Zagros, was a distinct 'eco-cultural' zone that experienced trajectories different to the western wing, despite some more or less contemporaneous evolutions that it shared with other parts of the Fertile Crescent (*e.g.*, see *Kozłowski, Aurenche 2005; Zeder 2011*). Likewise, recent research

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across southwest Asia has demonstrated the extent of the regional diversity of early cultivator-gatherer-farming societies between the 10th and 8th millennia BC (see *Arranz-Otaegui* et al. *2018; Weide* et al. *2018*). In the eastern wing, early cultivation of key founder crops has been suggested for a number of early Neolithic sites in the central Zagros (see *Riehl* et al. *2012; 2013; 2015*), as well as elsewhere outside the so-called 'Golden Triangle' of the Upper Euphrates and the Levantine corridor (see *Kozłowski, Aurenche 2005; Fuller* et al. *2011; Nesbitt 2002*), calling into question the idea of a single coherent core area of early plant cultivation. This once again highlights the importance of the Zagros region in investigating neolithisation in southwest Asia. Pioneering fieldwork in this region was directed by the late Robert Braidwood in the 1940–50s, he and his team of interdisciplinary specialists investigated early domestication and the emergence of sedentary way of life (see *Braidwood 1961; Braidwood* et al. *1961; 1983*). Unlike his work in Iraqi Kurdistan (*cf. Braidwood, Howe 1960; Braidwood* et al. *1983*) Braidwood's subsequent Iranian Prehistoric Project (IPP) was never fully published. Nevertheless, excavations at Warwasi, Asiab and Sarab laid the foundations for later fieldwork in the Iranian Zagros (Fig. 1). In 1963, Peder Mortensen located aceramic and ceramic Neolithic deposits in a deep trench at Tapeh Guran and then discovered additional Epipalaeolithic and Neolithic sites in the Huleilan Valley during a survey in 1973–74 (*Meldgaard* et al. *1963; Mortensen 1974; 2014*). At the same time, Frank Hole excavated Ali Kosh and Chogha Sefid in the Deh Luran plain (*Hole* et al. *1969; Hole 1977*). The longest fieldwork, however, was directed by Philip E. L. Smith (*1976*) who excavated a large area at Ganj Dareh during five seasons between 1965 and 1974. Levine surveyed the Mahidasht Plain in 1975 (*Levine 1976; Levine, McDonald 1977*) and made a brief sounding at Tapeh Sarab in 1976 (*McDonald 1979*). Both Smith and Mortensen investigated an area between Harsin, Bisotun and the confluence of the Qara Su and Gamasiab rivers in 1977 which was accompanied by sounding at three Neolithic sites (*Mortensen, Smith 1977; Smith, Mortensen 1980*). The latest important excavation, prior to the 1980s, was undertaken by Judith Pullar (*1990*) at Tapeh Abdul Hosein in 1978. Over the following two decades, fieldwork ceased due to regional instability. Although this first phase of fieldwork demonstrated the presence of aceramic Neolithic settlements in the central Zagros, many questions concerning their emergence and development with respect to external versus internal cultural influences, the subsistence

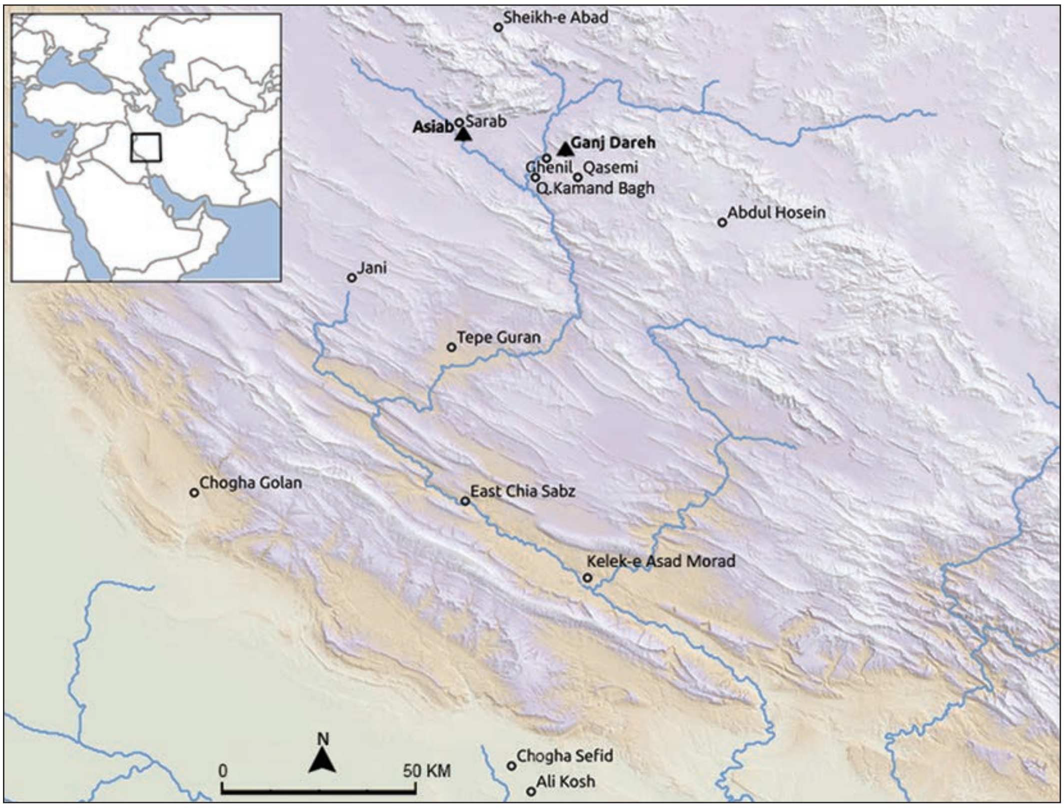

Fig. 1. Map showing the location of the most important Neolithic sites, including Asiab and Ganj Dareh, in the Central Zagros.

economy and settlement pattern, as well as the chronology, were only partially answered or not answered at all.

By the late 2000s new fieldwork projects were initiated in the central Zagros at Sheikh-e Abad (*Matthews* et al. *2013*), East Chia Sabz (*Darabi* et al. *2011; 2013*), Chogha Golan (*Conard* et al. *2013*) and Kelek-e Asad Morad (*Moradi* et al. *2016*). Based on evidence gained from these excavations, discussion on the better understanding of neolithisation in the central Zagros began to emerge (see *Darabi 2015*). Although these recent studies have produced new insights into the emergence of Neolithic economies and societies in this region, some of the previously excavated sites present us with a number of ambiguities, which we will discuss in more detail below. Moreover, most of the sites that have been investigated to date have focused on aceramic or ceramic Neolithic occupations, but very few Epipalaeolithic sites have thus far been investigated. It is for these reasons that a new project entitled "*Tracking Cultural and Environmental Change: The Epipalaeolithic and Neolithic in the Seimarreh Valley, central Zagros*" (TCEC) was initiated in 2016[1]. Following a short introduction of the aims of the new project, this article discusses the preliminary results from the project's new excavations at Asiab and Ganj Dareh, two famous sites originally excavated in the 1960–70s.

TCEC project

Despite recent efforts to investigate the onset of the Neolithic and the nature of neolithisation in the central Zagros, little is known about the preceding late Epipalaeolithic societies that occupied this region prior to the Neolithic. Although previous research had demonstrated that a number of Epipalaeolithic settlements exist in the region (*Braidwood 1960; 1961; Smith 1967; Mortensen 1993; Olszewski 1993a; 1993b*), none of these were comprehensively published, and little is known about the economy, palaeoenvironment or society of these groups. A chronological gap still exists between the late Epipalaeolithic and the early Neolithic in the central Zagros that has to yet be explained, though recent investigations at Sheikh-e Abad and Chogha Golan have pushed backed the emergence of early settlements to the 10th millennium BC (*Matthews* et al. *2013; Riehl* et al. *2013*). It is still unclear whether this gap is due to a genuine absence of late Epipalaeolithic settlement in the region because of the harsh conditions of the Younger Dryas, or if this is simply because of a lack of investigated sites. Recent work at rockshelter and cave sites in the Kermanshah area has only yielded ephemeral evidence for Epipalaeolithic occupations (Heydari-Guran, personal communication, 2017). Thus, the overall objective of the TCEC project is to obtain a better understanding of the role played by the central Zagros in the neolithisation process during the late Pleistocene and early Holocene periods (*c.* 13 500–6000 cal BC). In addition to reconnaissance surveys the project aims to re-investigate some previously excavated sites using small-scale excavations in combination with up-to-date archaeological methods (*e.g.*, high-resolution Accelerator Mass Spectrometry dating, ancient DNA analysis, micromorphology and botanical flotation) that were not available in the 1960–70s. A further goal is to reconstruct the late Pleistocene and early Holocene landscapes in the central Zagros to gain a better understanding of the impact of macro-climatic changes on late Pleistocene and early Holocene communities in the region. Furthermore, the project aims to establish a detailed chronology of the transition from the Epipalaeolithic to the Neolithic in the central Zagros where, unlike its westward neighbours, suffers from a precise chronological frame. In this respect, in the first phase of the project two previously excavated sites were revisited: Asiab and Ganj Dareh.

Asiab

Asiab was first excavated by Bruce Howe under the overall direction of Robert Braidwood in 1960 (*Braidwood 1960; 1961; Braidwood* et al. *1961*). Although Asiab is well-known there is a significant lack of secure knowledge about the site. Since there is no detailed final publication of the excavations very little information is available about the stratigraphy of the site, specific features, the material culture, fauna or botanical remains. The nature of the occupation (short-term versus long-term), the function of the circular cut in the basal layers (refuse pit versus building, see below), the date of the occupation, and the nature of the site's economy – both with respect to animals and plants – is largely based on partial, incomplete reports and little solid data.

1 In 2014, Peder Mortensen and Tobias Richter were asked by the board of the C. L. David Foundation and Collection to look into re-initiating research into the late Epipalaeolithic and early Neolithic in the central Zagros, leading on from Peder Mortensen and Philip Smith's surveys in the Harsin basin during the 1970s (*Smith, Mortensen 1980; Mortensen, Smith 1977*). Subsequently, the current joint Iranian-Danish project was set up.

Fig. 2. A general view of the Pleistocene terrace on which Asiab sits during the 2016 excavation, looking north/northeast.

Flotation for botanical remains was not carried out during the original excavations, as the technique was unknown at the time. The previous absolute dates from Asiab range from 9310–6528 cal BC (*Bangsgaard* et al. *2019*), reflecting a very long range. Given the lack of a published stratigraphic sequence there are great uncertainties over the provenience of the dated samples, in addition to issues surrounding the dating methods used and the type of sample material dated. It is due to these reasons that the TCEC project decided to return to Asiab in 2016 to relocate, re-excavate and record Bruce Howe's 1960 excavation area, and to open up a new area to obtain stratified finds and samples from the site. A particular focus was on the recovery of charred plant materials, as the original excavations did not sample for this particular material, whereas it is now of vital importance to reconstruct ancient environmental regimes and plant-based subsistence (*Darabi* et al. *2018*).

The site of Asiab is located at 1304m a. s. l. on the east side of the Qara Su river, *c.* 0.5km south of the village of Bijaneh and 0.7km from the modern outskirts of Kermanshah (Fig. 2). It is situated on a Pleistocene river terrace, which is now *c.* 5m above the current floodplain of the Qara Su River. While no plan of the excavation areas or trenches was published, Howe states in one of the only more detailed descriptions of the excavation that 130m^2 of the site were exposed in a series of smaller and larger trenches and areas (*Howe 1983*). The largest excavation area measured 6 x 8m. At the base of this main area Howe exposed one quarter of a circular feature that had been excavated into the virgin soil during the Neolithic. In the interior of this feature he discovered numerous pits and two human burials (*Howe 1983*). In this report, the stratigraphy was only described in very basic terms and Howe voiced uncertainty over the interpretation of the circular feature he had exposed, calling it either the remains of a building or a refuse pit.

In 2016, the priority was to relocate the previous main excavation area that Howe dug in 1960. Three areas were opened up: Area I on the northern part of the terrace, Area II at the western edge of the terrace and Area III in the central part of the terrace (Fig. 3). While Area I yielded no significant archaeological features, Area II was a narrow trench excavated to better understand the stratigraphy of the sediment above the conglomerate that forms the Pleistocene terrace. Area III became the main focus of our excavations. This area was laid out to measure 15 x 15m, and after removing topsoil the infilled excavation area of Bruce Howe from 1960 became visible. Following the removal of the backfill, which was dry-sieved on site, the feature previously reported by Howe was once again revealed (Fig. 4). The circular feature was associated with a number of postholes and pits that Howe seems to have excavated back in 1960. In the northeast of the Howe area excavations revealed a pit that was not excavated or simply missed during the original excavation. This pit contained skulls and mandibles of 19 wild boars, as well as a single deer antler and the cranium of an Asiatic brown bear (*Bangsgaard* et al. *2019*). The 19 boar skulls and mandibles were all aligned in an east-west orientation and tightly packed together. They were clearly placed in the pit in this fashion intentionally with convincing symbolic connotations. The pit was sealed with the spoil from its excavation and appears to have been immediately buried after the placement had been made.

A succession of two floor layers, which Howe did not report in any of the publications, were recorded in both the north and east section of the area. Their presence together with the numerous postholes clearly suggest that the circular feature is the remnant of a Neolithic building. It is important to note that both in this area, and in the newly established excavation area adjacent to it (see below), there was considerable evidence for bioturbation: vertical 'shafts' disturbing the archaeological sequence were noticeable in the sections. These shafts led into animal burrows that crisscrossed Howe's area, as well as the new excavation area. This suggests considerable disturbance in the Asiab stratigraphic sequence.

To further expose this structure, and also to recover *in situ* archaeological remains, a 5 x 5m excavation was opened next to Howe's area (Fig. 5). In this area the circular feature continued, but we were able to trace it from much higher in the sequence. The feature became visible immediately beneath the plough zone horizon. Further excavation showed that the feature was cut into the sub-soil to a depth of 1.2m, whereas in Howe's 1960 area the cut was only preserved to a height of *c.* 0.3m. This suggests that Howe did not notice the feature immediately and did not trace its contour, but truncated the upper 0.9–1m of it. Our excavation in the new area showed that the feature was infilled by a substantial midden deposit which, as previously noted, was heavily disturbed by animal burrows. These burrows continued all the way down to the floor of the structure, where we found a series of collapsed animal tunnels crisscrossing the floor of the structure. Along the edge of the sunken feature a pisé bench or wall had been built that followed the circular shape of the cut. We therefore believe that the circular cut is a 'construction cut' into which a wall made of pisé and potentially other materials had been set. Some antlers were incorporated into the pisé feature. Inside the structure we found the remnants of a mud-plaster floor, confirming the observation from the north and east sections in Howe's area. In one area a shallow depression had been shaped in the floor, painted with red pigment (presumably ochre), and a cattle horn core placed inside.

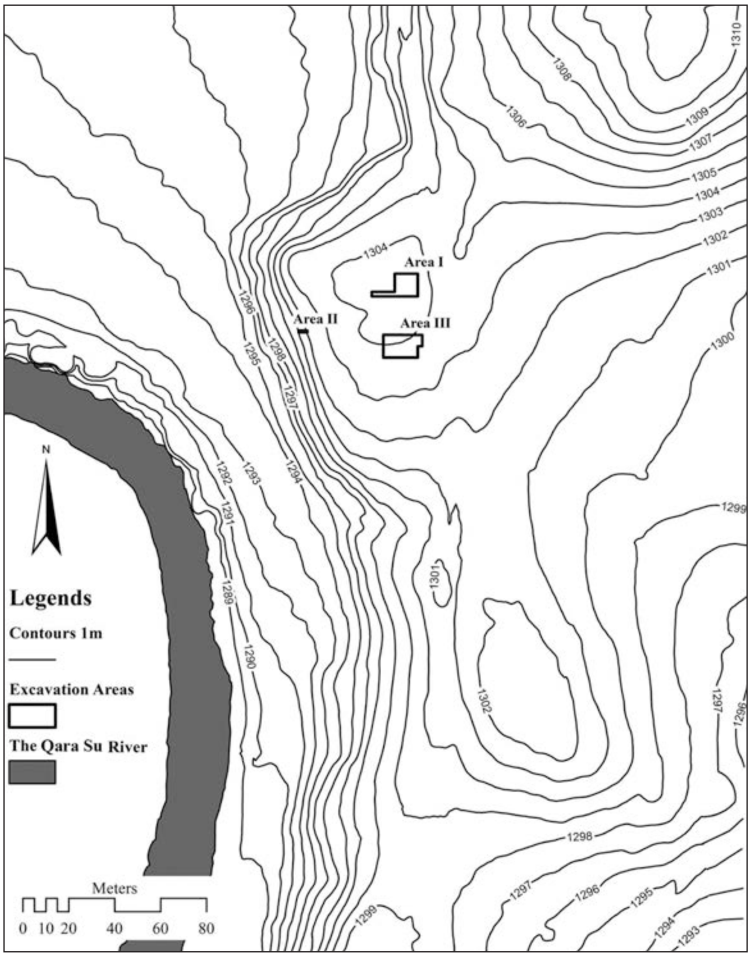

Fig. 3. Counter map of the site and the surrounding area showing the location of excavation areas in 2016.

The discovery of post- and stakeholes, as well as *in situ* floors inside the circular feature demonstrates that this was indeed a (semi)subterranean, sunken building of considerable dimensions. This building may have had a 'special' character: its considerable size measuring 10m in diameter, the pit with dozens of placed wild boar skulls, caches of antlers, as well as the single horn core placed in a plastered depression stained with ochre, all suggest that this building may have had a ceremonial, symbolic or communal function.

The lithic assemblage recovered from the excavation is quite homogenous. Cores are mostly uni-directional single platform bladelet and flake samples, with some opposed platform cores and flake cores also present. Bladelets and flakes are most common, while blades are much fewer in quantity. Amongst the retouched pieces, backed, utilized and retouched bladelets are common, as well as retouched blades. Techno-typologically, these criteria suggest that the Asiab assemblage can be grouped under the

'Pre-M'lefatian industry', a transitional lithic tradition that links the preceding Zarzian to succeeding early M'lefatian tradition.

Faunal material analysed to date provides evidence for a variation of species, including *Caprines*, boar, aurochs, rodents, hedgehog, birds, tortoise, crab and fish. At present there is no evidence of animal management (*Bansgaard* et al. *2019*), although analysis of the faunal material continues. The preliminary analyses of the plant macroremains indicates the predominance of small-seeded grasses (*Poaceae*), which are found in >90 of the samples. Medium and large-seeded grasses like wild oat, feather-grass, medusahead, and brome are also present, as well as wild barley and wheat. Amongst the wild plants there are some edible species like club-rush, along with crucifers and *polygonaceae*. Despite the presence of plants commonly considered as 'weeds of cultivated crops' there is no firm evidence for plant cultivation at the site. The wood charcoal recovered from the excavations suggests the presence of woodland-steppe vegetation with pistachio and almond.

Nine new Accelerator Mass Spectrometry dates are now available from Asiab, which allow us to evaluate some of the previous dates obtained from the site. Howe (*1983*) obtained four dates from Asiab which placed the occupation between *c*. 9300–7600 cal BC (68.2% probability). However, these dates are suspect because their proveniences are unknown, the sample material is unspecified and bulk radiocarbon dating was used. A second round of dates obtained from collagen samples of animal bones from the 1960 excavation by Melinda Zeder and Brian Hesse (*2000; Zeder 2008*) using Accelerator Mass Spectrometry dating produced dates falling between *c*. 9120–6530 cal BC (68.2% probability). Our new series of nine dates, however, produced a range falling between *c*. 9750–9300 cal BC (68.2%). All of these dates were obtained from point provenienced samples of charred plant matter that was identified to species or, if identification was not possible, only short-lived parts of plants were selected. Our new dates clearly indicate that the occupation of Asiab fell into the earliest part of the Holocene, right at the conventional start of the Neolithic era.

Ganj Dareh

Ganj Dareh is situated *c*. 8km west of the city of Harsin in the Kermanshah province, *c*. 32km east of Asiab at an altitude of 1400m a.s.l. The mound is in a small side valley where a small stream has forged a passage through the Deraz Kouh and Boreh Kouh Mountains. In fact, the valley in which the site lies is the only natural break or passage through the mountain range for several kilometres in a northwest-sout-

Fig. 4. Braidwood/Howe's trench after the removal of the fill of the original excavation, looking southeast.

Fig. 5. The newly excavated part of the large construction in which remnants of pisé wall, floor, antler and horn core are seen **in situ*****, looking south.***

heast direction. Ganj Dareh is a settlement mound that rises *c*. 6m above an alluvial floodplain situated between steeply rising limestone cliffs (Fig. 6). The availability of local chert, fresh water and fertile soil as well as suitability of the valley for hunting offered an environmental niche that seems to have been an attractive settlement location. Smith's excavations at Ganj Dareh concentrated on the central, southern and western parts of the mound, exposing approx. 21% of the site (Fig. 7). Smith sub-divided the stratigraphy of the site into five major levels: A, B, C, D and E (from top to bottom). Despite these substantial excavations, however, the results were only preliminarily and briefly published in a series of reports and articles (see *Smith 1967, 1968a-b; 1970; 1971; 1972a-b; 1972b; 1974, 1975; 1976; 1978; 1983; 1990*). Although subsequent analyses of the animal and human bones added to our knowledge in association with chronology and the issue of initial herding of goats at the site (see *Zeder 1999; Zeder, Hesse 2000; Meiklejohn* et al. *2017*) the lack of a final, comprehensive report left many questions unanswered. These include questions about the chronology of the site, the changes in architecture and evidence for plant cultivation. Therefore, the general objectives of the TCEC project were to re-investigate the chronology, questions about sedentism, goat domestication, pre-domestic cultivation, pottery emergence and delineation of the site limit (see *Darabi* et al. *2017*).

In 2017, work concentrated on an area to the north of Smith's central excavation. The section that remained from the original excavations was first cleaned and recorded. In order to study the full stratigraphic sequence of the mound a 9m long and 3m wide trench was opened, targeted over the top of the mound and the collapsed/backfilled main area of Smith's excavation. The area was labelled Area A and subdivided into A1 (top part of the trench) and A2 (lower part of the trench) (Fig. 8). The overall goal was to record the entire stratigraphic sequence in a stepped trench. In A1 our excavations targeted Smith's levels A-C, which had not been well described in the existing reports of the excavations. Our work revealed solid remains of pisé and mud-brick walls in the upper levels suggesting the presence of a number of distinct buildings. This contrasts with Smith's assessment of Levels A-C, which he described as being largely unclear. Area A2 targeted Smith's earlier levels D-E. Around two meters of archaeological deposits were excavated in this area. Most of the burned deposit between the two areas was left unexcavated until the following season in 2018. A new area (Area B) was opened to the west of the mound adjacent to the location of the so-called West Cut, where Smith had found pits that he attributed to Level E. Our aim in opening this area was to determine the chronological relationship between the pits found by Smith and the lowest phase in Area A. Excavations in Area B, which measured 2 x 2m resulted in the discovery of architectural remains that appeared to be linked, on the basis of material culture recovered, to the upper phases A-C on the mound. Moreover, in order to delineate the site, 17 test pits were dug around it. The delineation showed that the original limit of Ganj Dareh was *c*. 0.7ha, much larger than what had previously been thought, *i.e.* 1300m^2 (*cf. Smith 1972b.183; 1975. 179*).

In 2018, the unexcavated portion between Areas A1 and A2 was focused on to establish a stratigraphic link between the upper and lower sequence. The majority of the archaeological remains excavated here can be correlated with Smith's Level D. They appear to have been burned at a high temperature, which turned the deposit into a reddish-brown in colour. In fact, the burned deposit is entirely composed of building materials, including plastered floors and walls built of pisé and mud-bricks. As no

Fig. 6. Arial view of Ganj Dareh and the surrounding lime outcrops (photo by L. Ahamdzadeh).

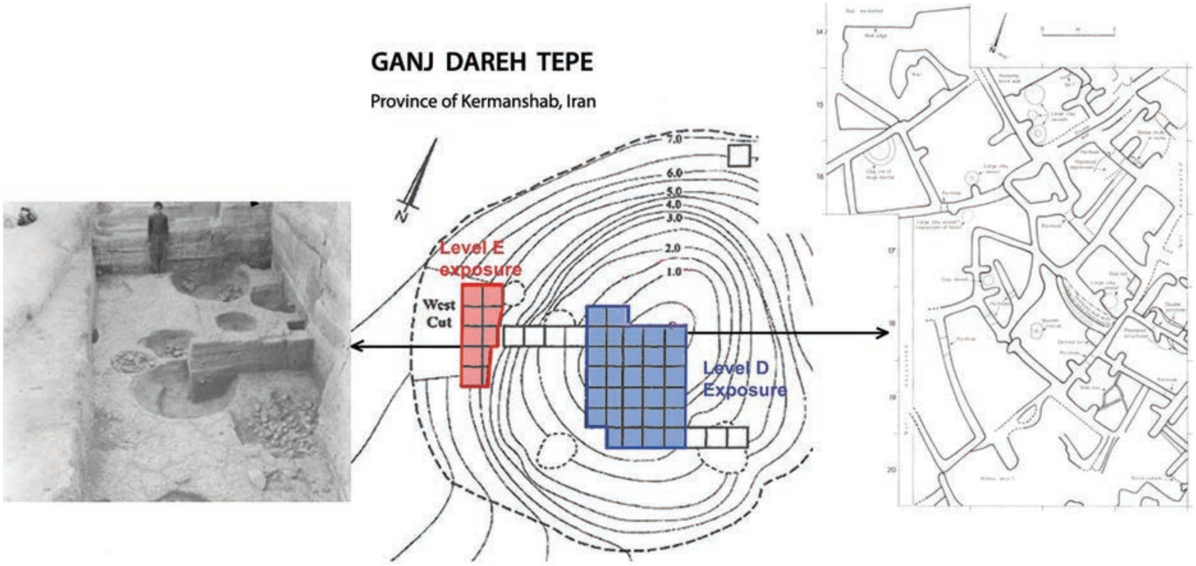

Fig. 7. Locations of the excavated areas in the 1960–70s; note the pits (level E) exposed in the west cut and plan of the buildings (Level D) in the central part of the mound (modified after* Merret 2004.178, Fig. 9/1*).

solid evidence of the Level E had been exposed in the 2017 season, a new excavation area (Area D), 4 x 4m in size, was targeted over the north edge of the 'West Cut'. In addition to relocating the eastern border of Smith's 'West Cut', we were also able to document a sequence of *in situ* archaeological deposits overlying Level E (Fig. 9). This included a series of architectural remains not previously reported by Smith. However, the most important find was the exposure of the pits excavated by Smith that he identified as Level E. Some of these pits had not been fully excavated by Smith and provided a unique opportunity to sample for finds, as well as samples for radiocarbon dating. These pits were cut into the virgin soil and it is still unclear whether they consist of the earliest remains of the site, as believed by Smith, or are associated with later levels.

The chipped stones of Ganj Dareh that were recovered from previous excavations have already been analysed (see *Nishiaki 2016; Thomalsky 2016*). Our own analysis of the material recovered in 2017 and 2018 shows that the predominant raw material used for flaking is of local origin, namely radiolarian chert, mostly of a reddish-brown colour. The industry is characterised by the predominance of nibbled tools. Subsequently, backed, retouched and notched pieces and scrapers are present. Tool production was predominantly geared towards informal tool types, with a significant presence of microlithic backed bladelet types. The Ganj Dareh lithic assemblage falls into the general Early M'lefatian Kermanshah group (*Kozłowski 1994; 1999; Nishiaki 2016*), and appears quite similar to the East Chia Sabz assemblage recently reported in detail (*Nishiaki, Darabi 2018*).

Zooarchaeological analysis shows that the mammal species were dominated by goats. Other species include wild aurochs, deer, boar, fox and hare. Work on avifaunal remains is still ongoing, but partridges are well represented (*Bansgaard, Yeomans in prep.*). Previous work on the faunal material from the original excavations at Ganj Dareh suggested that goats were managed at the site as an early stage in the aceramic Neolithic (*cf. Hesse 1978; Zeder, Hesse 2000; Zeder 2008*). The preliminary data thus far available from the recent excavations suggests that – on the basis of the mortality profile – there is a high presence of foetal or pullus age bones. This may underline the argument for early goat management. Moreover, mud-bricks with impressed hoof prints also suggest the presence of goats at the settlement during construction work, further supporting the idea of management.

The preliminary analyses of the plant macro-remains from Ganj Dareh was carried out in the latest phases: A-C (no remains from the pits have been analysed yet). In comparison to Asiab, a change is observed with the predominance of large-seeded grasses, primarily barley. However, feathergrass seem to have been consumed as well as the seeds appear fragmented. Lentils are also present, along with small-seeded legumes that could potentially constitute fodder remains. In terms of wood charcoal, woodland-steppe vegetation with pistachio and almond predominates the assemblage (*Arranz-Otaegui in prep.*).

Ganj Dareh has so far been radiocarbon dated in several stages. First, all of the dates acquired by Smith (*1990*) relied on charred plant material and range from *c.* 10 500–7000 cal BC. However, the dates are not internally consistent. Smith reported that "*the earliest level (E) has produced both the earliest and some of the youngest dates in the site*" (*Smith 1990. 324*). Other samples have also produced dates that appear to be inconsistent with their stratigraphic position. The exact provenance of many of these dates is uncertain. Furthermore, most were obtained using bulk carbon dating and in most cases the dated material was not identified prior to dating. Second, Zeder and Hesse (*2000*) obtained an additional series of 12 AMS dates taken from collagen samples of goat bones from the site ranging from *c.* 8240–7610 cal BC. These dates suggested a much shorter period of occupation for the site. They argued that the site was only occupied for a period of 100–200 years. These dates also showed no hiatus in occupation between Levels E and D. Third, Christopher Meiklejohn *et al.* (*2017*) recently obtained another five dates from collagen in human bones that fall between *c.* 8200–7750 cal BC, confirming Zeder and Hesse's chronology. The real issue for all of these dates, however, is that due to the lack of a final publication the contextual stratigraphic information is non-existent. Thus, all of the dates are somewhat suspect. This makes it vital that additional dates from secure, well-identified and recorded, stratified contexts are obtained, using the latest advanced AMS dating techniques available. We recovered a new series of samples from Areas A and B and some of the test pits dug around the site for delineation in 2017. These were recently dated at the Aarhus AMS Centre and suggest a range of dates between 8200–7600 cal BC (68.2% probability). However, this sequence of dates is not yet complete, as the portion of the stratigraphic sequence between A1 and A2 has yet to be dated, and because no dates are yet available for Area D. However, the dates do show that the occupation in Area B corresponds to Levels A-C at the top of the mound. This suggests that during this phase, between *c.* 7800–7600 cal BC, the occupation spread from the mound to the surrounding area. Further analysis of the recently recovered samples from Ganj Dareh is underway to finalise the chronological assessment of the site.

Fig. 8. A general view of Areas I and II.

Conclusions

The recent excavations at Asiab and Ganj Dareh have started to provide us with significant new insights into the transition from hunting and gathering to agriculture in the central Zagros. However, current achievements are still preliminary and require further detailed analysis. At Asiab, Bruce Howe's main trench was relocated and documented. Moreover, the new excavation area suggests that the cut was originally a circular, semi-subterranean structure that probably represent a communal building – a type of structure that is common at many other early aceramic Neolithic sites in southwest Asia. Judging from new AMS dates it can be stated that the emergence of communal buildings pre-dates the emergence of early domesticates in the eastern wing of the Fertile Crescent. As such, neolithization in the central Zagros should not entirely be limited to an investigation of early domestication and sedentary life while, despite the Levant and Anatolia, other ritual and social dimensions of the life of communities have obviously been overlooked at a regional scale. However, unlike previous views suggesting the initial management of goats at Asiab (*cf. Bökönyi 1977; Zeder*

Fig. 9. Area D after the removal of the backfill showing the* in situ *deposits, including the previously excavated pits by Smith (foreground) and the recently exposed sequence overlying a number of new pits (background).

2008) new zoo-archaeological analysis shows no evidence of animal management or domestication (*Bansgaard* et al. *2019*). Likewise, no evidence indicating cultivation of plants has yet been found. This type of subsistence strategy is consistent with other contemporaneous sites across the Zagros and Taurus arc, where the earliest settlements were still based on hunting and gathering while turning to sedentary life in the 10th millennium BC when the environment had improved after the end of the Younger Dryas. However, the nature of the transition from seasonality to sedentary life is still poorly understood in the Zagros region. Generally speaking, the new finds from Asiab are all aligned with the Transitional Neolithic period (*c*. 9600–8000 BC) during which the foundations were laid for the subsequent early Neolithic (*c*. 8000–7000 BC) in the central Zagros.

The ambiguities associated with the stratigraphy and chronology at Ganj Dareh, are now being addressed. Due to the complexity of the stratigraphic sequence, however, further radiocarbon dating and analysis of the site formation processes are needed to fully evaluate the previous phasing of Ganj Dareh's occupations. The new stratigraphic sequence will allow us to study diachronic developments in architecture, material culture and economy at the site in unprecedented detail. The middle phase of occupation in Area A, previously known as Level D, appears to have some evidence for large-scale destruction that seems to have been resulted from a massive fire. In terms of chronology, our new results show that the site was continuously under occupation for roughly 600 years (*c*. 8200–7600 BC), a duration longer than what was already suggested (*cf. Zeder, Hesse 2000; Meiklejohn* et al. *2017*). Also, delineation of the site has attested to an area larger than the previous estimation. In this regard, it seems that due to continuous occupation and deposition the site was so raised through time that its surrounding areas were finally prioritised by the latest inhabitants and then abandoned forever around the mid-8th millennium BC, a time in which the earliest occupations appeared in the lowland south-western Iran. Based on the new data, it is believed that the earliest occupants of Ganj Dareh were herding goats. This is consistent with the previous evidence (*cf. Hesse 1978; 1984; Zeder, Hesse 2000; Zeder 2008*). Although the presence of cereals is notable at the site the nature of crop domestication still needs further analysis. Ganj Dareh was already suggested to have yielded early evidence of two-row barley (*Van Zeist* et al. *1984*). The questions of barley domestication and also pre-domestic cultivation of plants, however, need to be given further attention in future. It has recently been suggested that pre-domestic cultivation did not happen across the Zagros region (see *Weide* et al. *2018*). Although this idea once again shows a tendency for the out-modelled issue of diffusion of agriculture stemming from culture-historical concepts, further data is required to investigate the mechanism of transition to early domestication at a local scale. Therefore, the transitional Neolithic sites such as Asiab, Chogha Golan and Sheikh-e Abad should attract particular attention to track synchronous cultural and environmental changes at the dawn of the Holocene era in the Zagros.

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Barcın Höyük, a seventh millennium settlement in the Eastern Marmara region of Turkey

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ABSTRACT – *Recent excavations at the site of Barcın Höyük provide a detailed view of a settlement founded and inhabited during the early stages of the Neolithic of the Marmara Region of northwestern Anatolia. The occupation history of the site complements and extends further back in time the regional sequence as it had been established for the eastern Marmara Region on the basis of excavations at nearby Menteşe, Aktopraklık and Ilıpınar, and Fikirtepe and Pendik in the Istanbul environs. The site of Barcın Höyük is therefore of critical importance for our understanding of the initial neolithisation of northwestern Anatolia. This paper summarizes some of the main findings of the Barcın Höyük excavations with regard to the Neolithic occupation phases.*

KEY WORDS – *neolithisation; spread of farming; Northwestern Anatolia; settlement; migration*

Barcın Höyük, naselbina iz 7. tisočletja v regiji Vzhodna Marmara v Turčiji

IZVLEČEK – *Na podlagi nedavnih izkopavanj na najdišču Barcın Höyük dobimo bolj natančen vpogled v naselbino, ki je bila osnovana in poseljena v času zgodnjega obdobja neolitika v regiji Marmara na območju severozahodne Anatolije. Poselitvena zgodovina tega najdišča tako dopolnjuje regionalno sekvenco, ki je bila postavljena za območje Vzhodne Marmare na podlagi izkopavanj na bližnjih najdiščih Mentessse, Aktopraklık in Ilıpınar ter na najdiščih Fikirtepe in Pendik blizu Istanbula, ter jo celo postavlja v zgodnejše obdobje kot doslej domnevano. Najdišče Barcın Höyük je tako izredno pomembno za razumevanje začetne neolitizacije severozahodne Anatolije. V članku povzemamo podatke o glavnih odkritjih pri izkopavanjih na najdišču glede na poselitvene faze, vezane na obdobje neolitika.*

KLJUČNE BESEDE – *neolitizacija; prehod na kmetovanje; severozahodna Anatolija; naselbina; preseljevanje*

Introduction

Research on the pre-Bronze Age cultures of the Marmara Region began relatively early in the history of Anatolian archaeology, and has seen concerted efforts over the last few decades to document through a number of excavations the early cultural history of the region and to build provisional neolithisation models for this region at the transition between Anatolia and Europa (Fig. 1). The excavations at Barcın Höyük have been conducted as part of this effort. Barcın Höyük was first recognized as a prehistoric site and recorded as Yenişehir II in surveys by James Mellaart and David French (*Mellaart 1955; French 1967*). Following long-term excavations during the 1980s and 1990s at the 6th millennium site of Ilıpınar (*Roodenberg 1995; Roodenberg, Thissen 2001; Roodenberg, Alpaslan Roodenberg 2008*) and

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soundings at the 7th millennium site of Menteşe (*Roodenberg 1999*), Jacob Roodenberg initiated excavations at Barcın Höyük in 2005. In 2007 the authors of this article took over responsibility and conducted nine consecutive excavation campaigns until 2015. The project has taken place under the auspices of the Netherlands Institute in Turkey, in close partnerships with colleagues at Turkish universities, in particular at Koç University, Boğaziçi University and Ege University, and in collaboration with an international team of specialist researchers. At present, the project team is preparing specialist studies and final publications.

Environmental setting

The site of Barcın Höyük is currently located among arable fields in the centre of the Yenişehir Plain. Well into the 20th century AD, the valley bottom was prone to seasonal flooding. A small lake a few kilometres to the west of the site existed until 1950, when a drainage canal was dug to drain the lake water and the surrounding swamps (*Aksoy, Özügül 2014*). Palynologists Bottema and Woldring of Groningen University cored the dried lakebed for pollen and published a vegetation sequence covering much of the early Holocene period (*Bottema, Woldring 1995; Bottema* et al. *2001*).

A small program of coring on and around the mound was carried out to reconstruct the local environmental conditions during the Neolithic. Geoarcheologists Sjoerd Kluiving, Mark Groenhuijzen and Michiel Künzel of Vrije Universiteit Amsterdam established that the first settlers selected a slight natural elevation of coarse sand at the northern edge of a lake or marsh (*Groenhuijzen* et al. *2015*). Nearby access to a wetland environment to the south of the settlement, as well as drier terrain to the north, may have been a consideration in the selection of the site location. During the centuries of Neolithic occupation, the edge of this lake or marsh appears to have withdrawn further away from the edge of the mound. Subsequent millennia indicate fluctuations in the distance of the site to nearby standing or flowing water. As the outcome of a complex history of deposition and removal of sediment, the current level of the plain 100m away from the edge of the mound at *c.* 225.20m lies 1.2m higher than the base of the mound at 224.00m.

General occupation history

The current archaeological site consists of two low mounds connected by a saddle covering an area of about 1.7ha. The smaller, western mound was not excavated. Surface collections indicate that occupation there postdates the Bronze Age. On the eastern mound, excavations concentrated on a transect running from the centre down the southern slope of the mound. Contiguous areas between 250 and $550m^2$ were exposed of each of the Neolithic occupation phases. The excavations established that, following the abandonment of the Neolithic settlement, parts of the site were intermittently reoccupied. This includes brief occupation episodes during the Middle Chalcolithic Period, the Late Chalcolithic Period (*Gerritsen* et al. *2010; Özbal* et al. *2017*), the Early Bronze Age, and the Early to Middle Bronze transition. Mound formation during these periods was limited. A last phase of use of the site occurred during the Byzantine Period, when the eastern mound was used as a burial ground (*Alpaslan Roodenberg 2009; Roodenberg 2009*).

Neolithic architecture and settlement layout

The Neolithic settlement existed continuously for approximately six centuries. Based on a combination of stratigraphic observations, building horizons, ce-

Fig. 1. Map of central and western Anatolia with the location of regions and sites mentioned in the text.

ramic developments and ^{14}C dates, this period has been subdivided into seven phases, labelled from old to young: VIe, VId1, VId2, VId3, VIc, VIb and VIa.

The architecture shows a significant degree of continuity throughout much of the occupation period, with rectangular buildings made of wood and loam. The structural timber is placed in foundation ditches for the walls and in postholes for roof bearing posts. Loam is used to fill the spaces between and around rows of wall posts in order to create closed walls. Evidence of wattling is strikingly absent, even in cases where buildings burnt down and yielded ample impressions of building wood in the burnt loam debris. Entrances are located in the long sides of the buildings. The architecture of the oldest building phase (VIe) appears to differ somewhat from the later phases, making use of heavy posts set in individual postholes rather than in foundation ditches.

In terms of settlement layout, however, the general pattern established in phase VIe was adhered to throughout the following phases until an apparent reorganization of settlement space in VIb. During the early phases, VIe and VId1 (*c*. 6600–6400 cal BC), there was a row of buildings oriented East-West, facing a large open space, that dipped into a natural depression, probably with further architecture beyond the depression to the south (Fig. 2). In the course of the early phases, the depression became filled up with midden deposits.

During the middle phases, VId2, VId3 and VIc (*c*. 6400–6200 cal BC), houses continued to be erected in the same central East-West strip, and the open space to the south continued to be used for outdoor activities, including fire pits and other installations. The courtyard was also frequently used to bury adult individuals in flexed position in simple pit graves (*Alpaslan Roodenberg* et al. *2013*). Infants tended to be buried inside or in the direct vicinity of the houses. During the middle phases, the southern part of the courtyard became built up. The architectural remains and installations in this area are less well preserved than in the central part, but appear to have been of the same rectangular type, with post-rows set in foundation ditches as elsewhere in the settlement. Similarly, there is evidence for one or multiple buildings appearing to the north of the central buildings, separated by an open space. Judging by the limited excavated area, therefore, it appears that the number of buildings in the settlement expanded during the middle phases of occupation, possibly connected to an increase in the population.

With the transition from VIc to VIb, around 6200 cal BC, new buildings appear in two of the areas that had functioned as open courtyard areas during all previous centuries of occupation. Assuming that the former courtyards had been communally used until then, this suggests a reorganization of settlement space connected to new property practices. The architecture of VIb again consists of post-row buildings, but these now stand individually rather than agglomerated, as before (*Gerritsen* et al. *2013a.Fig. 6*). They appear to have had small annexes or side rooms attached to them. Architectural remains of phase VIa are very fragmentary, and it is impossible to say to what extent the spatial layout continues the pattern established in phase VIb.

Subsistence economy

Studies of the subsistence economy are ongoing, but preliminary results of palaeobotanical and archaeo-

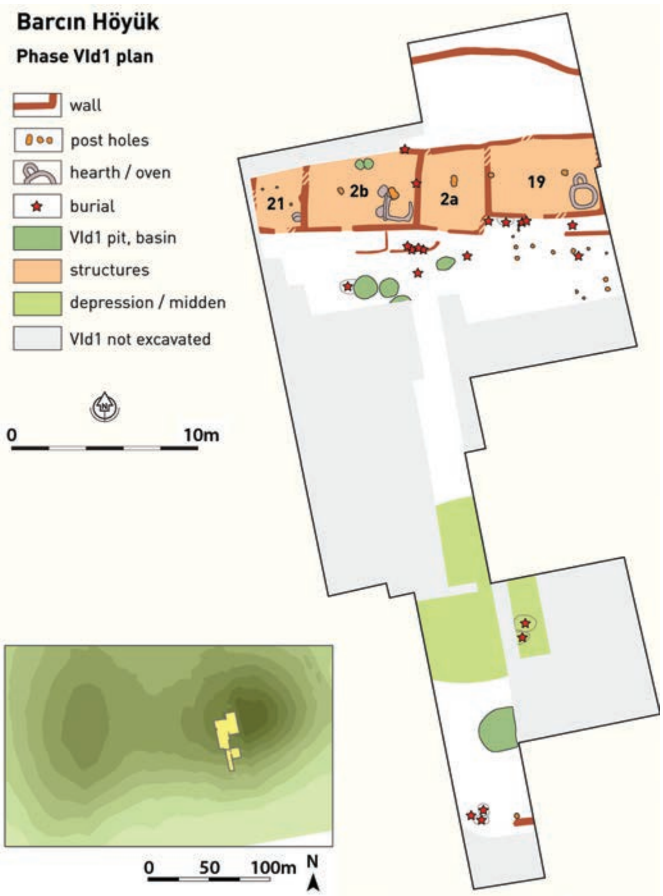

Fig. 2. Barcın Höyük; generalized overview of the excavated remains of phase VId1 (6500–6400 cal BC).

zoological analyses indicate that its main components were agriculture and animal husbandry. There appear to have been minor changes in the relative importance of specific crops and animals, but it is clear that the first settlers were farmers and that this remained the case throughout the habitation history of the settlement.

The botanical samples analysed to date number over 450 (1318 liters of soil), with an overrepresentation of samples from the early phases VIe and VId1 (*Cappers, Balci n.d.; Balcı* et al. *2019*). The samples represent a broad array of settlement contexts: indoor and outdoor surfaces and deposits, ovens, hearths and storage features, as well as pits and midden fills. With the exception of a single store of charred lentils from Structure 2a in phase VId1, crops stores were not encountered. This suggests that viewed together, the samples give a representative picture of plants that were brought to the settlement and were processed and consumed there. Cultivated plant species included a wide range of cereals (Einkorn, Emmer, Bread/Hard Wheat, hulled and naked barley) and pulses (lentil, pea, and chickpea), bitter vetch and flax. Additionally, hazelnut and blackberry count among the economic plants exploited at Barcın Höyük.

The animal economy relied largely on domesticated cattle, sheep and goat, with the first two being more frequent than the third (*Galik 2013; Würtenberger 2012*). With slight variations between the phases of the occupation history, wild animals are always a minor component of about 15%. They include fallow and roe deer, wild boar, hare, fox, birds, terrapins, small rodents, fish and molluscs. Domesticated pig is absent in the Neolithic faunal assemblages from Barcın Höyük, supporting an emerging picture of the adoption of pig husbandry in the Marmara Region not before the Early Chalcolithic period (*Arbuckle* et al. *2014.Fig. 1*).

Pottery

The ceramic assemblages of Neolithic Barcın Höyük provide a rich source to study the development of a ceramic tradition in the Eastern Marmara Region. This material has been and continues to be studied by Laurens Thissen (*Thissen* et al. *2010; Gerritsen* et al. *2013b; De Groot* et al. *2018*).

In Phase VIe, pottery was made and used in small quantities. The central area of the settlement with structures 24 and 25 yielded only a handful of sherds. The midden deposits in the depression excavated in L13 and M13 produced slightly larger numbers, mostly deriving from the upper deposits of VIe. Among these same VIe midden deposits, fire cracked stones occur in large quantities, whereas they are quite rare in levels following phase VIe. This has been interpreted as an indication that the earliest settlers relied mostly on hot-rock cooking techniques, and that subsequent generations abandoned this in favour of using cooking pots (*Gerritsen* et al. *2013a. 58; 2013b.72–73*).

The low intensity of ceramic production during phase VIe notwithstanding, the earliest settlers were accomplished potters. They made holemouth pots and bowls in schist tempered wares with burnished surfaces in light buff and greyish colours. During phase VId1, vessels walls become harder and thinner, while the repertoire of forms remains restricted. There is a switch to crushed calcite as the main tempering agent. Greatly increased quantities of sherds compared to VIe indicate a significant increase in the level of production in VId1. During subsequent phases VId2 and VId3, the range of shapes increases, with bowls and pots with light S-profiles. Surfaces tend to have pastel colours in phase VId2 and darker colours in VId3, highly burnished as before.

Ceramic traditions continue to develop during the later phases of occupation (VIc, VIb and VIa). New forms such as pots with four vertically pierced lugs or two lug handles and four-legged Fikirtepe boxes become common. There is now a greater variety in tempering additives, including quartz and sand. Dark, burnished surfaces are sometimes decorated with simple incised geometric patterns.

Overall, the ceramic assemblages of Barcın Höyük convey the development of gradual change within a consistent tradition (see Thissen in *Gerritsen* et al. *2013a; 2013b*). Changes are introduced by building on and transforming existing practices of production rather than by radical changes. Comparisons with the ceramic assemblages of other 7th millennium sites in the eastern Marmara Region are difficult to make with any precision because of the still limited extent of publication of ceramics from stratigraphic sequences. Nevertheless, it is clear that much of the ceramic sequence at Barcın Höyük predates what is termed Archaic and Classical Fikirtepe (*Özdoğan 1999; 2019.Fig. 3*). Barcın Höyük phases VIb and VIa, with their globular pots with pierced lugs and handles and Fikirtepe boxes show the best resemblances to the Fikirtepe traditions. This suggests that the Barcın Höyük ceramic sequence can be taken to represent the precursors and early stages of the Late Neolithic and Early Chalcolithic Fikirtepe tradition (Fig. 3). Beyond the eastern Marmara Region, parallels for the earliest Barcın Höyük ceramics (especially VIe) can be found at Demircihüyük (*Seeher 1987*) and Keçiçayırı (*Akyol 2018*) in nearby inland northwestern Anatolia.

Lipid residue analyses

An extensive program of lipid residue analysis on the ceramics from Barcın Höyük has been carried out under the direction of Hadi Özbal of Boğaziçi University, Istanbul. Preliminary reports have appeared (*Thissen* et al. *2010; Özbal H.* et al. *2012; 2014*) and a final publication of the results is in preparation. From over 1000 sampled sherds, lipid residues were successfully extracted and identified from 174. These represent all phases of the Neolithic occupation history and include small numbers of sherds from the brief Middle and Late Chalcolithic re-occupation phases of the site.

The analyses demonstrate that using ceramic vessels for milk processing occurred from phase VIe onwards. With minor variations between phases, the percentage of sherds with residues of milk fats is around or above 50%. These findings substantiate the suggestion made by Evershed and his team that dairying became an important element of subsistence strategies in the Marmara Region, earlier and more dominantly than in other regions of Anatolia and southeastern Europe (*Evershed* et al. *2008*). The lipid residue data from Barcın Höyük corroborate the faunal data. Aside from the milk lipids the data yielded numerous samples with ruminant adipose fats. Only small amounts of non-ruminant fats were discovered.

Lithic technologies

A large assemblage of some 17 000 pieces of flint and obsidian has been studied and is currently being prepared for publication by Ivan Gatsov and Petranka Nedelcheva (preliminary studies in *Gatsov, Nedelcheva 2009; 2016; in print; Gatsov* et al. *2012*).

Among the Barcın Höyük raw material, flint is much more common than obsidian, but during some of the occupation phases obsidian represents as much as a quarter of the assemblage. A preliminary study using pXRF points to Central Anatolia as the dominant source area for obsidian, possibly supplemented by materials acquired from Melos (*Milić 2014*) and unidentified sources (perhaps Galatian: *Bigazzi* et al. *1995; 1998.80–86*).

Based on the research conducted by Gatsov and Nedelcheva, it is clear that lithic production at Barcın Höyük connects very well with the traditions that characterize the assemblages from sites of the Fikirtepe horizon, both typologically and technologically (*Gatsov 2003; Gatsov, Nedelcheva 2009; 2016; Gatsov* et al. *2012*). Unidirectional blade cores, including bullet cores, are characteristic elements of the assemblage, as well as the blades and bladelets struck from them. Semi-circular and circular end-scrapers as well as high and macro end-scrapers are common among the tools. Sickle blades, blade perforators and drills, as well as a small number of trapezes also occur. There is evidence for pressure blade production, indirect percussion and direct percussion.

Small finds

The excavations at Barcın Höyük have yielded a large assemblage of finely made bone tools. Particularly striking are the spoons, which differ from spatulas in their pronounced distinction between the handle and spoon bowl (*Erdalkıran 2016*). Beads are made of stone and shell (*Baysal 2014*). Whereas in the earlier levels, dentalium shell beads dominate the assemblage, in the later levels turquoise coloured beads, probably made of bone, become common (*Bursalı* et al. *2017*). Baked and unbaked clay human figurines occur in small numbers, from different levels of occupation (*Gerritsen* et al. *2013a; Özbal, Gerritsen 2019.Fig. 9*).

In general, all categories of small finds, including also the ground stone tools and axes, display a development from a limited range of types, shapes and raw materials during the pioneer phases of VIe and VId1, to a much wider variety during the middle and late levels.

Human DNA studies

A total of 130 Neolithic graves were excavated at Barcın Höyük. A selection of the human skeletal remains from Barcın Höyük has been used for a series of genetic studies that focused on the grand narrative question of the nature of the expansion of farming from Anatolia and the Near East to Europe (*Mathieson* et al. *2015; Hofmanová* et al. *2016; Lazaridis* et al. *2016*). Conducted at a time when full genomic analyses from Anatolia and the Near East were only just beginning to produce results, the skeletal remains from Barcın Höyük have been instrumental in establishing an 'Anatolian Farmer' genetic profile. Comparisons with genetic profiles of European hunter-gatherers and European Neolithic farmers from Hungary, Germany and the Iberian Peninsula showed that early European farmers derived almost all of their genetic ancestry from Anatolian farmers. This has now provided a strong case for migration-based theories of the expansion of farming to Europe.

Additional studies have used the genetic data from Barcın Höyük to track the genetic histories within Anatolia and the Near East. On present evidence, it appears that people at Barcın Höyük were genetically closely related to 9th and 8th millennium groups in Central Anatolia (Boncuklu), but also that as a group they were genetically more diverse than Central Anatolian groups, perhaps incorporating a modest genetic influx from populations from or genetically similar to the Levant (*Kılınç* et al. *2016; 2017*). In the coming years new data will undoubtedly expand and refine this emerging picture of complex genetic histories.

Regional and inter-regional setting

The full-fledged farming economy of the earliest inhabitants of Barcın Höyük is the strongest indication that the settlers were newcomers to the region. Any acculturation processes of an indigenous population would be observable in the faunal and botanical assemblages, as well as in different artefact categories and architectural remains, but indications of this are absent. Given the ^{14}C dates that place the foundation of Barcın Höyük at around 6600 cal BC, it is clear that the site stands at the start of Neolithic presence in the region (Fig. 3), and therefore that the settlers at Barcın Höyük must have moved here as immigrants from outside the eastern Marmara Region (*Özbal, Gerritsen 2019*). Mainly on the basis of parallel developments in ceramic traditions, the Anatolian Corridor can be identified as the most likely route along which this population entered the region, with ancestral roots probably in western Central Anatolia and Çatalhöyük, and with intermediate sites such as Keçiçayırı and Demircihüyük as nodes in the network of the earliest pioneers that settled in the Marmara Region (Fig. 1). Whether there existed early contacts with the Lakes District, as suggested by Mehmet Özdoğan (*2019.320*), is more difficult to establish.

For the Fikirtepe Horizon, and specifically for the sites in the Istanbul environs, an indigenous component in the population has been suggested (*Karul 2017.8; Özdoğan 1999.210; 2019.320*). This idea is based on a combination of evidence for Epipalaeolithic or Mesolithic hunter-gatherer groups in the region (the Ağaçlı group) and elements in the food economy and architecture at Neolithic sites like Fikirtepe and Pendik that do not seem to have their origins in a Neolithic way of life (*Özdoğan 1999.215*). Different aspects of the idea of the Fikirtepe Horizon as a merging of indigenous and Neolithic traditions are being re-evaluated by various authors in light of new data (*Çakırlar 2013; Özbal, Gerritsen 2019*). Regardless of the nature of this cultural interaction elsewhere in the eastern Marmara Region, it is clear that hunter-gatherer influence in the Barcın Höyük community was very minimal at most, and probably completely absent.

In the course of the second half of the 7th millennium, there appears to have been an increase in the number of settlements in the eastern Marmara Region, possibly as a result of a continuing influx of people from inland Anatolia as well as from indigenous population growth over the course of several centuries. The shared material culture traditions of

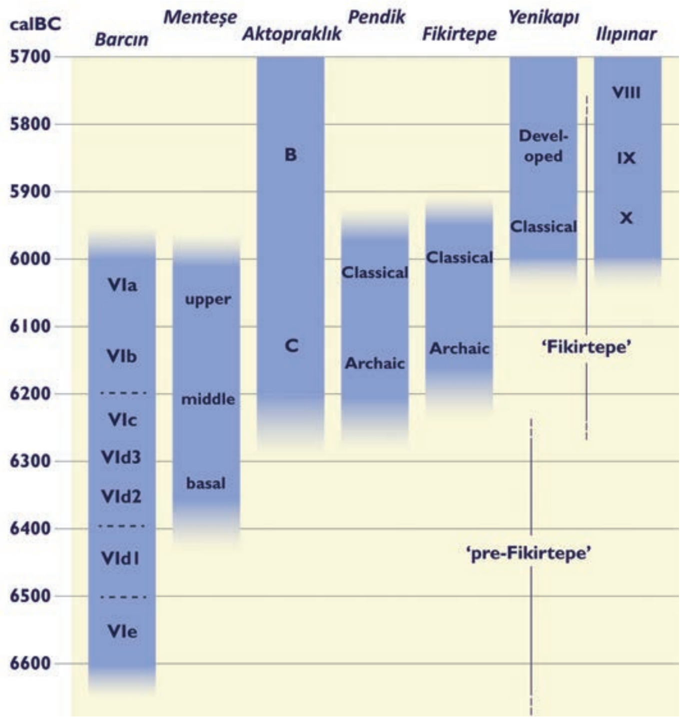

Fig. 3. Comparative periodization table of excavated sites in the eastern Marmara Region.

these settlements inhabited during the final centuries before 6000 cal BC and into the beginning of the 6th millennium cal BC have given rise to the term Fikirtepe Horizon or Fikirtepe Culture (*Özdoğan 1979; 1983; 2013; Karul 2019*). Although there remain site-specific differences and intra-regional distinctions, the later levels of Barcın Höyük, VIb and VIa, share this regional identity with other sites in the eastern Marmara Region. The long stratigraphic sequence of Barcın Höyük shows, moreover, that the genesis of the Fikirtepe Culture took place gradually over the course of several centuries.

In sharp contrast to the growing body of evidence for cultural interaction and interconnected developments within the eastern Marmara Region and with inland central-western Anatolia, we find many differences in material culture with eastern Thrace and the western Marmara Region (*Özdoğan 2019*). There appears to have been a distinct and lasting cultural boundary to the west of Istanbul. Aşağıpınar, in eastern Thrace, displays very different material culture traditions than sites that belong to the Fikirtepe Horizon, and the lithic data show this very clearly (*Gatsov* et al. *2017*). While the eastern Marmara assemblages, including Barcın Höyük described above, yielded microblade assemblages and pressure flaked bullet cores, the Thracian side of Turkey (with the exception of a few sites along the coast) have no evidence of pressure flaking (*Özdoğan 2014*). Likewise, sites like Barcın and other eastern Marmara sites have consistent access to obsidian mostly from Central Anatolia. In contrast, western Marmara lithic assemblages are characterized by Karanovo I-type blades, and obsidian is completely absent at sites like Aşağıpınar, although some coastal sites have yielded small quantities (*Özdoğan 2014.42*). Differing burial customs are another indication of this regional boundary. If we consider burials as reflective of societal beliefs then it is noteworthy that no burials have been uncovered from western Marmara sites, whereas Barcın and other sites in the eastern Marmara, including Ilıpınar, Fikirtepe, Pendik, and Yenikapı, have ample evidence for human inhumations within and near the settlements.

This final point on cultural boundaries can serve as a useful reminder of the need to maintain a critical, archaeological outlook on neolithisation processes. The new genetic paradigm that points to migration as a major mechanism in the expansion of farming (see above) leaves many archaeological questions unaddressed, questions about how and why people interacted and migrated, and about why they on occasion they also maintained cultural boundaries that prevented mobility and interaction. Both are aspects of the history of the spread of Neolithic ways of life from Anatolia to Europe.

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Long and short revolutions towards the Neolithic in western Anatolia and Aegean

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ABSTRACT – *This paper provides an overview of our current knowledge about the transformation towards the Neolithic in western Anatolia and the Aegean, and offers a narrative for their interpretation. Within the longue durée perspective of the long revolution in the Near East, the first millennia of the Holocene of the Aegean and western Anatolia are contrasted with each other. Economic strategies, environmental conditions, technologies, raw material procurement and cultural practices in the Aegean Mesolithic and the Pre-Neolithic times in western Anatolia are analysed to classify potential similarities and differences. The evidence of new cultural and symbolic practices, economies, and technologies in the seventh millennium is discussed as the paradox of a short revolution embedded in a long-term process of interaction, knowledge-transfer and adaptation, setting the scene for the Neolithic pioneers establishing a new social life.*

KEY WORDS – *Neolithic pioneers; social life; practices; technologies; western Anatolia*

Dolge in kratke revolucije k neolitiku v zahodni Anatoliji in v Egejskem morju

IZVLEČEK – *V članku predstavljamo pregled trenutnih podatkov o spremembah, ki so vodile k neolitiku na območju zahodne Anatolije in Egejskega morja, ter ponujamo pripovedi za njihovo interpretacijo. V okviru perspektive dolgoročnih zgodovinskih procesov (fr. longue durée) na Bližnjem Vzhodu, Prvo tisočletje v holocenu je v okviru perspektive dolgoročnih zgodovinskih procesov (fr. longue durée) na Bližnjem Vzhodu potekalo različno na območju Egejskega morja in v zahodni Anatoliji. Za ovrednotenje morebitnih podobnosti in razlik med mezolitikom na območju Egejskega morja in pred-neolitikom na območju zahodne Anatolije smo ovrednotili gospodarske strategije, okoljske pogoje, tehnologije, oskrbo s surovinami in kulturne običaje. V članku nadalje razpravljamo o novih kulturnih in simbolnih običajih, gospodarstvih in tehnologijah v sedmem tisočletju, ki predstavljajo paradoks kratke revolucije, ki je zakoreninjena v dolgoročnih procesih interakcije, prenosa znanj in prilagoditev, kar je omogočilo neolitskim pionirjem vzpostavitev novega družbenega življenja.*

KLJUČNE BESEDE – *neolitski pionirji; družbeno življenje; običaji; tehnologije; zahodna Anatolija*

Dedicated to Klaus Schmidt (†)
who inspired Neolithic research far beyond Anatolia

Introduction

Decades of intensive research, discoveries of new sites and an interdisciplinary approach in late Pleistocene and early Holocene archaeology are strongly linked with Gordon Childe's 'Neolithic Revolution' concept. While the revolutionary aspect of the crucial transformation process is doubtlessly evident, fundamentals other than changes in the economy have been integrated into the discussion and opened significant, new horizons (*Schmidt 2006*). Cognitive and cultural changes have been defined as pivotal

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agents of change as well. Following Trevor Watkins (*2005*) concept, the "*Neolithic Revolution can be understood as the discovery by humans of the potential of material culture for the storage and transmission of ideas and concepts, elements of symbolic reference*". This cultural and cognitive approach additionally extended the timeline by pushing the beginning of the revolution further back into the Epipaleolithic, when the transformation of new social life began in south-west Asia *c.* 23 000 years ago (*Watkins 2010; 2018*). The societies in the regions of western Anatolia and the Aegean faced these fundamental changes in a different way and later in time, but were related with the long revolution in many ways. The 'farming frontier' between central Anatolia in the 9th millennium BC and the regions further west reflects the diverse pathways towards the Neolithic, where a lag of *c.* 2000 years is evident in the current data sets (*Brami, Zanotti 2015; Brami, Horejs in press*). The mosaic-like pattern in western Anatolia and the Aegean shows the diverse trajectories in the transformation process of the Neolithisation. There are nevertheless some similarities and differences in the communities' ways of managing cultural and social life, adopting new subsistence strategies, and integrating new technologies, that allow the incorporation of the regions into a broader narrative.

Diversities in Aegean and Anatolian archaeology

The early Holocene in the Aegean and western Anatolia (modern Greece and western Turkey) is nowadays embedded in a different narrative than the core zones of the Levant and Mesopotamia. Although situated in direct proximity of central Anatolia and the eastern Mediterranean – both parts of the Neolithic core zones – the long-term transformation between 10 000 and 6000 BC in these cores is discussed differently and mostly separately. The academic segregation of east from west in discussions of the Neolithisation process, especially in Aegean archaeology, developed in the few last decades for several reasons, including the influence of post-processualist theories and the tendency towards national or regional specialization in archaeology. This decoupling process might additionally lie in the strong influence of Near Eastern and Anatolian archaeology in the early days of the spectacular discoveries of Kathleen M. Kenyon, Robert J. Braidwood, James Mellaart and other pioneers, only very simply summarized here as the concept of '*ex oriente lux*' (*Kotsakis 2008*). Since the first excavations of the oldest Neolithic settlements on the Greek mainland in the 1950s' by Demetrios Theocharis and Vladimir Milojčić (*Milojčić 1950; Theocharis 1973*), the impact of new information from the Near East on research in Greece has understandably been enormous. Not only the exchange of knowledge on a personal level, but also the terminology and cultural concept of Neolithisation as defined in the Levant were integrated into interpretations of the early Neolithic of the Greek mainland, mainly in Thessaly, and in Knossos on Crete (*Kotsakis 2008; Reingruber 2015*). While discussions about the evidence and dating of the so-called Preceramic or Aceramic phases in the early Neolithic rooted in these early days are still ongoing, the model of an Aegean Neolithic pathway that is different from the Levant is now widely accepted.

Scholars working in western Anatolia have had different conceptualizations of the long-term process of Neolithisation. The early excavations of James Mellaart in Hacılar in the 1950s (*Mellaart 1958; 1970; Brami, Heyd 2011*), followed by Refik Duru's investigations in the Lake District (recently: *Duru 2012*) and Mehmet Özdoğan's early work in the Marmara region and in Turkish Thrace were strongly influenced by the results of research in the rest of Anatolia, and frequently contextualized with the various regions of the huge landmass (*e.g., Özdoğan* et al. *2012*). The additional establishment of a Turkish-international academic community, especially since the 1970s, has also led to an intensification of western Anatolian investigations regarding prehistory, again embedded in new discoveries in central and south-east Anatolia (*e.g., Özdoğan, Başgelen 1999; Lichter 2005*). While field investigations of the early Holocene in western Turkey have increased considerably since then, with a few exceptions (*e.g.*, Franchthi Cave, Knossos, Paliambela, Youra Cave, Maroulas) fieldwork in Greece stagnated. The archaeological community working in Greece focused instead more on detail, but crucial studies on a micro-level highlight the complex trajectories and adaptation process, particularly regarding early Holocene material, involving profound social, demographic, cultural and economic changes (*e.g., Perlès 2001; 2003a; Séfériadès 2007; Kotsakis 2003; Souvatzi 2008; Trandalidou 2003; Galanidou 2011; Reingruber 2011*).

This brief overview explains the different chronological and cultural concepts as well as the diverse available data sets for the first millennia in the Holocene in Aegean Greece on the one hand, and in western Turkey on the other. The dialectic research tradition of both regions handicapped their comprehensive integration, especially with our longue durée perspective on the topic. Thanks to several new studies that overcome this artificial segregation, we are now able to combine various results and new data (*e.g., Lichter 2005; Özdoğan 2010; Perlès* et al. *2013; Guilaine 2013; Çilingiroğlu, Çakırlar 2013; Weninger* et al. *2014; Kotsakis 2014; Horejs* et al. *2015; Carter* et al. *2016; Horejs 2016; 2017; Kozłowski 2016; Çilingiroğlu 2016; Reingruber 2017; Milić 2018; Brami, Horejs in press*). The Aegean coastal zones of modern Greece and Turkey are slowly coming together again as Mesolithic-Neolithic research re-evaluates both old and new concepts about the crucial early Holocene cultural developments.

The Aegean Mesolithic: Time of foragers, fisher(wo)men and seafarers

The time between 9000 and 7000 BC in the Aegean is characterized by mobile and seasonally based foragers (recently: *Reingruber 2017*). Our current knowledge is based on about 20 known sites along the Aegean coasts and on the islands, including Crete and the southern coast of Turkey (Fig. 1).

Thanks to studies and fieldwork by various scholars, the main cultural components of the Aegean Mesolithic in the 9th and 10th millennia BC were slowly brought to light with respect to the economy, mobility, exchange, resource management, technologies and other aspects, although many questions are still open and require more primary data (*Galanidou, Perlès 2003; Galanidou 2011; Sampson 2010; 2014; Perlès* et al. *1990; Kozłowski 2016; Reingruber 2011; 2017; Carter* et al. *2016*). In summarizing the main conclusions of Mesolithic research, we are faced with the remains of mobile groups who probably based themselves in seasonal camps. The Aegean islands appear to have been visited and used seasonally but intensively by foragers and fishermen, as attested at a few sites. A multi-seasonal or even year-round occupation of island sites is attested, such as on the islands of Youra, Naxos, Ikaria, Kythnos and Crete (*Sampson* et al. *2010; Strasser* et al. *2010; Carter* et al. *2014; 2016*). We can assume the use of other islands and sites as well, which today lie below sea-level, as recognized for example at Youra (*Efstratiou 2014.79*). Currently, early island occupation around the Pleistocene-Holocene transition is attested only in the northern Aegean, as at Ouriakos on Lemnos (*Efstratiou* et al. *2014*). This picture may change, when more field data becomes available from the central and southern Aegean. The Mesolithic as currently known in the central and southern Aegean basin belongs mainly to the 9th and 8th millennia BC, also defined as the 'Aegean Mesolithic' (*Kozłowski 2016*).

A semi-sedentary lifestyle has been suggested for these societies based on the preserved architectural

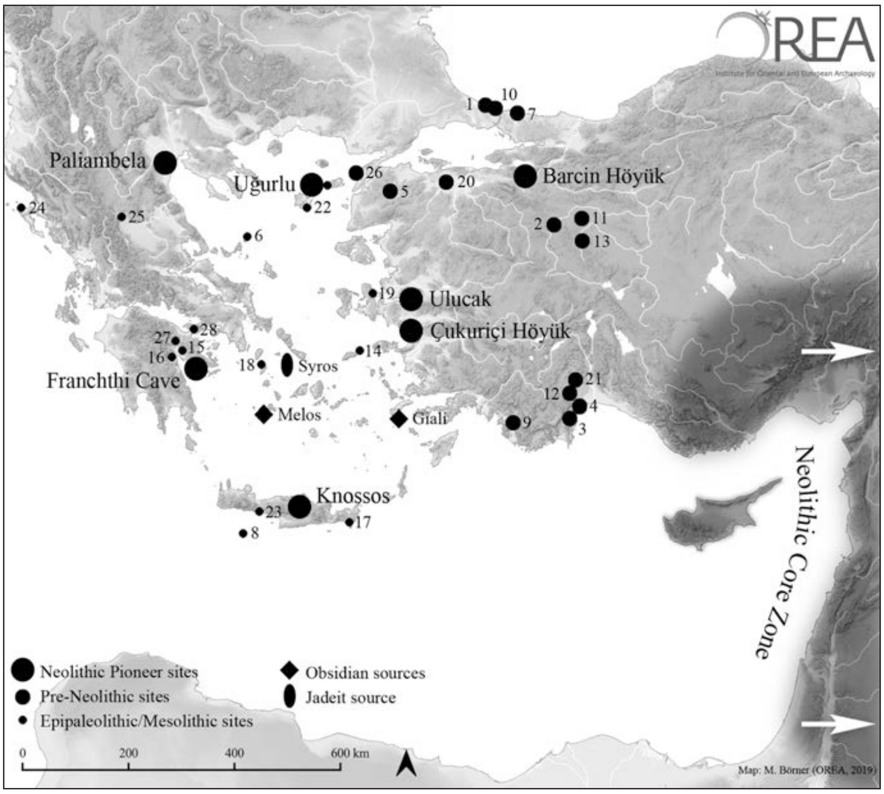

Fig. 1. The Aegean Mesolithic and western Anatolia Pre-Neolithic sites dating between 10 000 and 7000 BC and the Neolithic pioneer sites starting around 6700 BC (after* Horejs in press. Fig. 2 *with modifications). 1 Ağaclı; 2 Asarkaya; 3 Belbaşı; 4 Beldibi; 5 Çalca; 6 Cyclops Cave (Youra); 7 Domalı; 8 Gavdos; 9 Girmeler; 10 Gümüşdere; 11 Kalkanlı; 12 Karain; 13 Keçiçayırı; 14 Kerame; 15 Klissoura; 16 Koukou; 17 Livari; 18 Maroulas; 19 Mordoğan; 20 Musluçeşme, 21 Öküzini; 22 Ouriakos; 23 Plakias; 24 Sidari; 25 Theopetra; 26 Üçdutlar; 27 Uğurlu; 28 Ulbrich; 29 Zaimis (map made by M. Börner, OREA).

remains. The best example is Maroulas on Kythnos, which is dated to the first half of the 9th millennium BC. Circular and oval structures with stone pavements and enclosures, partially constructed with stone-tiles at the bottom, are reconstructed as huts with central posts and structured entrance areas (*Sampson 2010.102, Figs. 98–101*). About 27 of these dwellings represent at least a multi-seasonal occupation and are used for domestic activities (*Sampson* et al. *2010; Kozłowski 2016*). Burials underneath the stone pavements of these huts and next to it represent a group of six children and 19 adults.

The economy of the Aegean Mesolithic was based on a subsistence strategy in which foraging played an important role alongside fishing of coastal and seasonal off-shore fish, including tuna. The evidence of grinding stones at Maroulas indicates the intensive use of plant foods processed at the site. The presence of pre-/semi-domesticated or domesticated pigs and caprines at Cyclopes Cave and Maroulas in Mesolithic times, as suggested by Katerina Trantalidou (*2003; 2010*), is based on very scarce data and viewed sceptically by various scholars (*e.g., Kozłowski 2016*). Neither species is local and both have to be brought to the islands by people (*Trantalidou 2011*). If the early evidence is affirmed by additional evidence and further analyses, the introduction of domesticates into the Aegean would have taken place at about the same date as their appearance in Cyprus (*Vigne* et al. *2012; 2014*). Whatever the situation concerning the introduction of certain species, based mainly on results from Maroulas and the Cyclopes Cave (*Trandalidou 2011*), the economy of the island populations is based mainly on marine fishing and foraging, hunting birds as well as gathering snails. Finally, the lithic industry of the Aegean Mesolithic seems to be its own technological complex, based on a flake industry, with retouched flakes, splintered pieces, backed blades and microliths (*Kaczanowska, Kozłowski 2008; Kozłowski 2016*). Recent investigations on the Aegean coast of Turkey revealed the new open-air site of Mordoğan on the Karaburun Peninsula near Izmir, which shows the same kind of industry (*Çilingiroğlu* et al. *2016*). Çiler Çilingiroğlu has convincingly argued for an Aegean Mesolithic complex that includes the Anatolian coastal zone (*Çilingiroğlu 2016*), and she now offers the first evidence of a Mesolithic population in the centre of the Aegean coast of Turkey.

The evidence for intensive Mesolithic seafaring in the Aegean Sea implies highly connected mobile groups, occupying sites on the islands and partially also the shores at least multi-seasonally, partially perhaps also round-year. A network of voyaging groups is indicated by the intensively used obsidian from sources on Melos and Giali (*Ammermann 2014*) (Fig. 1). Although we have no information on their communication systems, and are far from a detailed resolution of the chronological situation of the Aegean Mesolithic, the agents of the obsidian exploration offer us a small indirect insight into these societies. The knowledge of both island sources had to be transmitted down the generations and between groups. This information had to be embedded in a whole package of nautical knowledge including the routes, navigation, winds and currents, seasonal weather conditions, landing options, available water sources, transport facilities and much more (*Broodbank 2013; Cherry* et al. *2017*). It is therefore safe to assume that these maritime societies not only developed a distinct system of mobility in their marine environment, but also established a package of nautical knowledge as a fundamental Mesolithic capability that was sustained over many generations.

These Mesolithic Aegean networks seem to come in contact with the eastern Mediterranean, at least sporadically (*e.g., Horejs* et al. *2015; Kozłowski 2016*). These contacts are indicated by some elements adopted in the Mesolithic Aegean that most probably came from Cyprus and the Levant, as recently argued by Kozłowski (*2016*). These are the circular dwellings with stone foundations and floors, burials underneath the floors and next to the dwellings, evidence of grinding stones and plant processing as well as a few stone vessel fragments. Another potential side-effect of these contacts between the Aegean Mesolithic and Cyprus is seen in some aspects of the stone industry, which is interpreted as a potential western influence on Cyprus (*Ammerman 2014; Kozłowski 2016*). It has been suggested (*Kaczanowska, Kozłowski 2014*) that the lithic assemblage of Nissi Beach, based on a pebble-flake industry and the production of certain tools such as arched-backed pieces, denticulates, and notches, may be evidence for close connections between Cyprus and the Aegean Mesolithic. The seafaring groups of the Aegean Mesolithic had certainly established maritime networks in the 9th millennium BC, which appears to coincide with the existence of the eastern Mediterranean maritime network.

We are therefore faced with an Aegean Mesolithic society organized in mobile groups and based on a foraging, fishing and hunting economy, which stands in strong contrast to the contemporaneous Pre-Pottery-Neolithic cultures of the Levant and central and southeast Anatolia. Aside from the few presumably adopted elements mentioned above, the economic, cultural and social characteristics of the PPN societies are not evident in the Aegean Mesolithic (Fig. 2). Although the mobile or semi-mobile populations of the Aegean islands and the littorals came into contact with the PPN societies of Cyprus and the Levant, the direct transfer of the classic Neolithic village society and farming economy is not recognizable in the 9th and 8th millennia BC. Neither the complex early PPN symbolism nor the practice of farming, herding and sedentary settlements is to be found in the Aegean Mesolithic. Indeed, one may wonder why and how a population with an established economic niche system founded on a maritime mobility, resource system and subsistence strategy should integrate and adopt the new Neolithic strategies into their way of life. The island environmental conditions offer the ideal world system for the Aegean Mesolithic maritime societies, and are not at all suitable for farming, herding or permanent settlement. It is therefore not surprising that the first year-round Neolithic farmers on the islands (as distinct from the mainland coasts) are a quite late phenomenon, not arriving before 6th or even 5th millennia BC. Even after the establishment of the Neolithic in the surrounding coastal zones of the Aegean in the early 7th millennia BC, the new economic system did not reach the islands immediately. Crete, as the largest Aegean island, is the only exception, where an early Neolithic economy is attested at Knossos in the early 7th millennium BC (*Douka* et al. *2017*). However, the Knossos pioneer phase did not lead to a dispersal of farming and herding communities in Crete, and it appears to have lasted for only a short time at Knossos. The Neolithic at Knossos succeeded only after a hiatus of about 1000 years, probably again related to the incoming of new people, as recently suggested by Katerina Douka *et al.* (*2017*).

If an interaction existed between the mobile maritime foragers and the Neolithic farmers in the 7th millennium BC, how it may have operated, and how long both systems might have existed in parallel, is unfortunately unknown. At least in the 9th and 8th millennia BC we are confronted with two different cultural world systems, an Aegean Mesolithic on the one hand, and a Neolithic in the 'core zones' of Southwest Asia on the other hand, with well-established and long-term seaborne contacts preparing the foundations for the later Neolithic dispersal (*Broodbank 2013; Simmons 2014; Horejs* et al. *2015; Douka* et al. *2017*).

Western Anatolia in Pre-Neolithic times

Thanks to new investigations in northern, central and southern areas of western Anatolia, the scattered data of the Pre-Neolithic is slowly coming together, although many questions remain un-answered. Based on current data, around 15 sites probably dating between 10 000 BC and the beginning of the Neolithic at around 6700 BC are spatially clustered on the coast of western Anatolia. This clustering probably reflects the regional distribution of surveys and field investigations. The higher sea level and the related geographical and climatological settings in the Younger Dryas and early Holocene revealed a closer proximity between the northeast Aegean islands of Gökçeada, Bozcaada, Lesbos, Lemnos and Samothrace, as well as to the Gallipoli Peninsula. While they were presumably still connected with the mainland in the Older Dryas about 16 000 years ago, the Pleistocene sea level rise led to the islands' setting and the increasing distance between them and the mainland (*Özbek, Erdoğu 2014*). The lithic assemblages – though still based on a few sites – show that the landscape of the Bosporus northern shore as well as the Marmara coastal zones in the south and the Gallipoli Peninsula including the island Lemnos were used in Epi-Palaeolithic and Mesolithic times (*Gatsov, Özdoğan 1994; Efstratiou* et al. *2014*). Moreover, a clear chronological distinction based on survey materials is currently not possible (*Milić 2018*); the so-called Ağaçlı Group in northwest Anatolia might represent the remains of mobile pre-Neolithic societies, while the other surveyed sites in Çanakkale and Balıkesir provinces may attest the initial movements of so-called 'forerunners' of the Neolithisation taking place in the region (*Özdoğan 2008; 2011*). The flake-based lithic industry of Üçdütlar might give us a first indicator for potential connections to the Aegean Mesolithic (see above), although they do not appear comparable based on the current state of knowledge, as summarized by the experts (*Özbek, Erdoğu 2014*).

The southwest Anatolian coastal littoral and its wider hinterland provide new evidence of semi-mobile or even permanent foragers and hunter communities in the Girmeler Cave (*Takaoğlu* et al. *2014*). Their remains of plastered floors and dwellings with hearths and pits suggest the continuous use of a site where domestic activities took place. Though based on a complete hunting and foraging economy, plant processing is indicated by grinding stones, as also known from the contemporaneous Aegean Mesolithic. The late 9th and 8th millennia BC site might represent only the tip of the iceberg of terrestrial hunter-foragers in the region. The 8th millennium BC sequences of plastered floors have been related to inner Anatolian PPN traditions, such as those best presented in Aşıklı (*Takaoğlu* et al. *2014*). As recently suggested by Çilingiroğlu (*2016*), the hunter-gatherers of Öküzini Cave probably reflect early forager-farmer interaction related to the pioneers who founded the first Neolithic farming sites in the Aegean in the period between 7000 and 6600 BC. So far, there is no evidence for the earlier adoption of domesticated crops and herded animals. As in the Aegean Mesolithic, we might imagine terrestrial hunter-foragers with probable contacts to central Anatolia on the one hand, and to the Aegean Mesolithic groups on the other hand. The southern coast of Anatolia should play a particularly crucial role in our understanding of the Neolithic dispersal, but till now early farmers and herders have not been detected, although in my view they can be expected to exist and are still awaiting discovery. The more inland sites around the Lake District (like Bademağacı and Höyücek) are not directly connected to the coast, and most probably date a few generations later than the pioneer groups coming along the southern Anatolian coast (*Clare, Weninger 2014.11*). The recently detected site with a Mesolithic flake-based lithic industry in Mordoğan on the Karaburun Peninsula mentioned above provides the first evidence for hunter-foragers on the central Aegean coast of Turkey. The first studies of the surface materials pinpoint the strong relations to the Aegean Mesolithic in a raw material and techno-typological sense (*Çilingiroğlu* et al. *2016*). Although we await future analyses of the site's chronology and economic data, evidence of hunter-foragers (and probably also fishermen) can be expected for the Izmir region as well.

How these early Holocene hunter-foragers of western Anatolia were culturally connected to the PPN farmers and herders of the 'core zone' further east remains an open question. So far, we can recognize some influences in cultural practices, such as the plastered floors in the southwest mentioned above, also interpreted as an indicator of a sedentary lifestyle. But the most essential economic foundation for sedentism – farming and herding – was not adopted by these communities for a long time. The western Anatolian hunter-foragers between 10 000 and 7000 BC apparently lack any transformation or experimental phases in their economy. The adopted social-cultural techniques, such as (wild) plant processing and the erection of dwellings, might reflect occasional contacts with the Neolithic in the east, and highlight a potential long-term connectivity in these millennia that prepares the ground for the arrival of the new social and economic strategies of the Neolithic a little after 7000 cal BC.

Similarities and differences in the early Holocene

Overall, the Aegean Mesolithic and the Pre-Neolithic western Anatolia offer a heterogeneous picture in the early Holocene, with lots of unknown aspects regarding their populations in these millennia. Nevertheless, the currently available data allows us to note some similarities and differences, which I will try to summarize without over-simplifying a complex story covering about three millennia. The main common feature is to be seen in their economic strategies, which remain connected to mobility and differ in relation to distinct environmental conditions. Together with foraging, hunting of small animals on the Aegean islands and of large mammals on the mainland in Greece and Turkey forms the economic backbone. The important role of fishing for the island economies is also attested for coastal communities, as in the fishing at Franchthi or shell collecting in Üçdütlar (*Rose 1995; Perlès 2003b; 2019; Stiner, Munro 2011; Özbek, Erdoğu 2014*). The processing of wild plants is another common economic aspect, indirectly evident by the use of grinding implements. The erection of huts and dwellings with floor-sequences indicating potential permanent or at least repeated use is known from a few sites in the vast area. Although contacts with the Neolithic economies in the eastern Mediterranean and inland Anatolia are indicated, their farming subsistence systems were not adopted either in western Anatolia or the Aegean before about 6700/6600 BC. The Aegean and western Anatolian hunter-foragers appear to have continued their long-established subsistence practices without any evidence of transformation, experimentation or adaptation to farming or herding. Finally, the almost complete lack of symbolism remains astonishing in relation to the complex symbolic systems of the neighbouring PPNs world (Fig. 2).

However, the absence of any symbolic material does not imply communities without a multifaceted system of beliefs. Rather, the lack of evidence confronts us with the problematic visibility of these aspects in early Holocene hunter-forager-fishing societies.

The differences between the regions can be recognized in the lithic technologies, raw material procurement (local versus non-local) and some cultural practices (*e.g.*, plastered floors, burials), which are expected to increase in respect of the number and types of differences with more data in the future. Finally, the concept of the Mesolithic as a culturally and chronologically defined period is widely accepted in the Aegean and on the Greek mainland, related to continental European research history (*e.g., Perlès 2019*). The western Anatolian sites are strongly connected with the Near Eastern tradition, where the Epipaleolithic before the early PPN period is a well-established cultural concept (*Watkins 2018*). The merging of both research traditions in western Turkey reflects the complexity of late Pleistocene/ early Holocene archaeology in the region. Both concepts – Epipaleolithic in the Near Eastern and Mesolithic in the Aegean case – are currently applied to western Anatolian sites. Future studies will hopefully show the expected high number of regional differences and how potential cultural varieties can be interpreted to gain a deeper insight into the populations before the fundamental change into the Neolithic way of life took place.

The abrupt arrival of the Neolithic

The Neolithic way of life appears to start abruptly in the Aegean and in western Anatolia, already fully developed in all main aspects, such as farming, herding and sedentary life (Fig. 2). A few sites around the Aegean Sea and in inland western Anatolia represent the first Neolithic farming communities, recently defined as pioneers (*Horejs* et al. *2015*): Barcın Höyük, Ulucak, Çukuriçi, Uğurlu, Knossos, Franchthi and perhaps Paliambela (Fig. 1). They all date within the timeframe of 7000 to 6600 cal BC; unfortunately a more precise date cannot be achieved due to a plateau in the current radiocarbon calibration curves. Site-based modelling revealed the most probable date for most of these sites is around 6700 cal BC (*Weninger* et al. *2014; Perlès* et al. *2013; Horejs* et al. *2015; Brami, Zanotti 2015; Maniatis 2014; Douka* et al. *2017*; for a different modelling see *Guilbeau* et al. *2019*). However, we are currently aware of only a few early Neolithic sites founded before 6600 cal BC, whereas the majority of Neolithic farming sites developed after this. The first appearance of these early farmers in diverse landscapes and environments, such as the Aegean littorals, the Gökçeada Island and the Marmara Sea in western Anatolia, as well as diverse cultural contexts, suggests different trajectories.

Archaeological Data	Pre-Pottery Neolithic (Core Zones)	Aegean Mesolithic/ Pre-Neolithic Western Anatolia	Pioneer Sites Ulucak VI & Çukuriçi XIII	Anatolian Aegean Coastal Group
	10.000 BC - 7.000 BC		6.700 BC	after 6.500 BC
House-based Community	x		x	x
Village Life	x			x
Rectangular Buildings	x		x	x
Special Cult Buildings	x			
Painted Plaster	x		x	
Plastered Floors	x	x	x	x
Domestic Animals	x		x	x
Cultivated Plants	x		x	x
Fishing, Shell-fishing	x	x	x	x
Obsidian	x	x	x	x
Exotic shells	x	x	x	x
Malachite	x		x	
Ocr/Hematite	x		x	
Native Copper	x			
Celts, Chisels etc.	x	x	x	x
Grinding Stones	x	x	x	x
Stone Vessels	x	x	x	x
Bracelets, Rings	x		x	
Fine Beads	x		x	x
Pressure Technology	x		x	x
Flake Industry	x	x	x	x
Caches of Long Pressure Blades	x			x
Seafaring	x	x	x	x
Mat, Basketry	x			x
Textile	x			x
Pigmenting	x		x	
Leopard Symbols/Bones	x			x
Animal Figurines	x			x
Steatopygic Figurines	x			x
„M" shaped Figures	x			
Skull Cult, Modelled Skulls	x			
Phallus Symbols	x			
Bucrania	x			

Fig. 2. Archaeological evidence of the PPN Core Zones, Mesolithic Aegean/ Pre-Neolithic western Anatolia, Neolithic Pioneers and the Anatolian Aegean Coastal Group (table made by F. Ostmann, OREA after* Özdoğan 2010.Tabs. 1–2*).

Although we have to take into account the likelihood of diverse processes, the abrupt appearance of farming and herding societies suggests a general pattern of Neolithic expansion, as stated often and by several scholars (*e.g., Perlès 2003a; Özdoğan 2011; 2014; Guilaine 2013; Weninger* et al. *2014; Brami, Zanotti 2015; Brami, Horejs in press*). The pioneer sites around the Aegean Sea were most probably founded by newcomers and brought the new Neolithic subsistence strategies (as well as the animals and plants) together with other social and cultural elements (Fig. 2). This pioneer phenomenon, also described as the 'maritime colonization model' (*Horejs* et al. *2015*), may over-simplify the initiation of a complex process beginning immediately after the arrival of new groups, involving interactions between the newcomers and indigenous groups, and adaptation to local environmental conditions (recently *Guilbeau* et al. *2019*). Further, the process of groups from different origins searching for new land over a period of several centuries can hardly be summarized as a singular event. This is apparent in inland Anatolia, as well as for Crete and Cyprus, where several waves of moving groups are evident (*Özdoğan 2008; Vigne* et al. *2012; Douka* et al. *2017*).

The Aegean pioneer sites show crucial economic and social aspects in common that clearly belong to the earliest Neolithic lifestyle in our region, and stand in strong contrast to the earlier Aegean Mesolithic. These new Neolithic aspects are four-tier husbandry, the planting of domestic cereals and pulses, permanent habitation in house architecture and new material-related technologies (Fig. 2; *e.g., Çilingiroğlu 2016*). The whole bundle of innovations – the 'Neolithic package' – is related to a broader package of skills and knowledge affecting all crucial aspects of individual and community life. To start with, there was a new way of life in rectangular mud-built houses, as at Çukuriçi XIII, Ulucak VI and probably also in Knossos X. As Çilingiroğlu (*2016*) has recently pointed out, the technology of lime-plastered floors is limited to Anatolian mainland sites (continuing through the later stages of the Neolithic), as seen at Çukuriçi, Ulucak, Bademağaçı and Hacılar, and is not found on the Greek mainland or on Crete. This regionally distinct phenomenon may indicate different origins; the evidence of plaster in floor-sequences at the Pre-Neolithic Girmeler Cave in southwest Anatolia (*Takaoğlu* et al. *2014*) points to the probable route along the Anatolian coast and the incorporation of the 9th and 8th millennia BC foragers into both inland Anatolian and maritime networks. Red plaster appears to be restricted to the foundation horizons of the pioneer sites, as attested in Ulucak VI and Çukuriçi XIII. The deposition of red lumps inside the Çukuriçi XIII house additionally supports the practice of using this pigmenting technology by the early settlers. As Çilingiroğlu convincingly argues, the use of red plaster found no place among the Epipalaeolithic hunter-gatherers of Southwest Asia, but is characteristic of later Pre-Pottery Neolithic settlements. The houses of the early pioneers were the centres for domestic activities, evident in food processing, storage and fire installations such as hearths. This new kind of architecture included sequences of floors, which indicate permanent occupation and periodic renewal; the material evidence shows us that these were house-based societies representing a new form of social life. The restricted extent of the excavated area of the earliest levels at almost all the pioneer sites is a limiting factor preventing any kind of population estimate; we cannot definitely describe them as early 'villages'. The concept of Neolithic villages is currently not attested before 6600–6500 BC (Fig. 2). Rather, we are probably dealing with small groups of pioneers, living together in house-related communities. While this general pattern is attested at the western Anatolian sites (Ulucak VI, Çukuriçi XIII) and probably also in early Knossos, the pioneers of the same period in the northern Aegean, evident in Paliambela, initially practiced a different settlement strategy based mainly on pit structures (*Maniatis 2014; Katsanis* et al. *2008*). The excavation analyses by Kostas Kotsakis and his team will show if these pit complexes represent local adaptations of the new social life, or served as the initial stages of a semi-mobile or permanent habitation strategy, representing another trajectory within the wider dispersal.

Subsistence strategies mark the new Neolithic economy

The pioneers' subsistence was based on a fully developed farming and herding economy with many essential details in common. It has frequently been pointed out that the four domesticates – sheep, goat, cattle and pigs – are evident in most of the pioneer sites, as for example at Franchthi, Knossos, Çukuriçi and Ulucak, and represent a series of complimentary sets of developed herding strategies (*e.g., Arbuckle* et al. *2014; Horejs* et al. *2015; Munro, Stiner 2015; Çilingiroğlu 2016*). The evidence of a comparable economy at Bademağacı and Uğurlu V dates slightly later, and is probably not related to the earliest introduction (*Clare, Weninger 2014; Atıcı* et al. *2017*). Although the wild ancestors of domesticates are evident at least as far west as the Aegean coast of Anatolia and the island of Gökçeada, the stock-keeping economy is complete and present from the beginning, with no experimental or transformation phases (*Çakırlar 2012; Galik, Horejs 2011; Horejs* et al. *2015; Galik in press*). Benjamin S. Arbuckle *et al.* (*2014*) have argued convincingly for the dispersal of the four-part herding economy along the Mediterranean coasts, bypassing central Anatolia (where cattle and pigs are not evident). The lack of domesticated pigs at the pioneer site of Barcın Höyük in northwest Anatolia and in the later dated Uğurlu V gives additional support to this model; instead, in the earliest phase of Barcın Höyük wild boar were hunted (*Arbuckle* et al. *2014; Gerritsen, Özbal 2016; Atıcı* et al. *2017*). New zooarchaeological and stable isotope data from Uğurlu V in the northeast Aegean are suggesting a founder population of the sheep and goat stock from the mainland, or at least from more arid zones than the western Anatolian coast (*Pilaar Birch* et al. *2019*). The Çukuriçi sample highlights an additional economic aspect of the stock-keeping and farming community related to maritime sources. From the founding of the site onwards fishing and diving for shells played an important role in providing nutrition (*Horejs 2012; Horejs* et al. *2015; Galik, Horejs 2011; Galik in press*). Inshore fish, such as sea bream, sea bass, groupers and bluefish, as well as pelagic fish like tuna and chondrichthyes (stingray), are evident (Fig. 3).

A variety of bivalves, like lagoon cockles, corneus wedge clams, venus shells, carpet shells, noble penshells, ark clams, bearded ark clams, mussels, oysters, spondylus, date shells and paddocks as well as a wide variety of marine gastropods are attested in the assemblage. These indicate different practices of collecting, diving and fishing with distinct equipment, experience and knowledge of seasonal conditions. The role of fishing in the former Aegean Mesolithic economies has been discussed above and is evident in fish remains (*e.g.*, Franchthi) as well as in fishing equipment, like hooks (*e.g.*, Youra). The maritime exploitation skills might indicate a knowledge transfer from or even an adaptation process of local Aegean economies by the Neolithic newcomers. They may have brought fishing expertise with them, bearing in mind the evidence in Neolithic Cyprus (*Vigne* et al. *2014*). Overall, hunting was practiced only in small amounts and herding dominates the economy in the Neolithic pioneer sites. Cultivation of crops is evident at the pioneer sites, but published data is still rather scarce and it is difficult to form a clear picture (*Çilingiroğlu* et al. *2012; Perlès* et al. *2013; Horejs* et al. *2015*). The botanical analyses of Ulucak, Franchthi and Çukuriçi reveal heterogeneous data of einkorn and emmer wheat, barley, free-threshing wheat and pulses.

New technologies and exotic items

A package of new lithic technologies and distinctive tools is attested at some of the Neolithic pioneer sites (*Milić 2018; Milić, Horejs 2017; Guilbeau* et al. *2019*). Most important is the use of pressure-flaking technology in producing chipped stone tools, mainly blades and bladelets, which is absent before 6700 BC. The flake-based industry of the Mesolithic Aegean, as well as the diverse technological industries in Pre-Neolithic western Anatolia, appear to continue, but are first supplemented and soon afterwards dominated by pressure blade making (recently *Guilbeau* et al. *2019*). Together with the adoption of a new production technique, some atypical tool types like lunates and foliate points (not known in the Mesolithic Aegean) appear in the founding phase of the pioneer site Çukuriçi Höyük XIII. The whole lithic package indicates an origin in the east Mediterranean, the Levant and north Mesopotamia, and probably represents the arrival of lithic industries from outside the region (*Perlès 2001; Horejs* et al. *2015; Milić 2018*). A few other objects in the material assemblages of the newcomers' sites around the Aegean Sea seem to incorporate narratives, materials and technologies that cannot be related to the local traditions of the Mesolithic Aegean (for earlier ornaments see *Perlès 2019*). As recently recognized by Çilingiroğlu (*2016.36*), the very few symbolic items and special objects in the early Neolithic are all por-

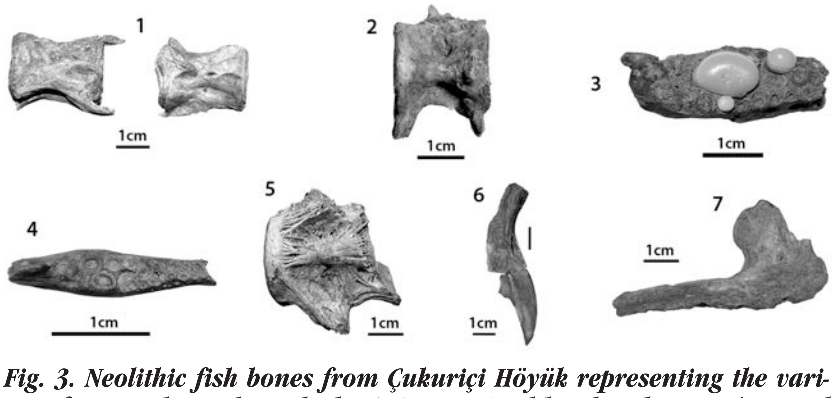

Fig. 3. Neolithic fish bones from Çukuriçi Höyük representing the variety of species hunted regularly. 1–2 tuna; 3 gilthead seabream; 4 striped seabream; 5–6 grouper; 7 bluefish (classification and photos by A. Galik, figure design by F. Ostmann/OREA).

table. The well-made stone bracelets (Çukuriçi and Knossos), a malachite bead (Çukuriçi), and pierced circular beads (Ulucak and Çukuriçi) are rare finds; they appear exotic in the Aegean and may have arrived with the newcomers, or via extensive exchange networks (*Horejs in press*).

The evidence of ceramic vessel production in the pioneers' founding phases is either very rare or completely lacking, as pointed out several times (*Perlès 2001.83; Reingruber 2015; Horejs* et al. *2015; Çilingiroğlu 2016; Douka* et al. *2017*). Pottery production does not play any role at the beginning of this process, especially in the coastal sites of the Aegean Sea, where it is totally lacking in Ulucak VI and evident only as small fragments potentially representing later intrusions in Çukuriçi XIII. The impact of ceramics appears different in Barcın Höyük, a pioneer site at the southern Marmara Sea, where pottery containers are evident from the beginning (*Gerritsen* et al. *2013; Gerritsen, Özbal 2016; de Groot* et al. *2017*). The early practice of pottery-making perhaps points to the Marmara Sea pioneers' relation to central Anatolia, where the presence of a much longer ceramic tradition has recently been argued (*Fletcher* et al. *2017*).

An overview of all the archaeological data regarding settlement and architecture, subsistence, imported raw materials, ground-stone tools, status objects, lithic technology, special crafts and symbolic representations illustrates the abrupt arrival represented by the pioneer sites of Ulucak VI and Çukuriçi XIII (Fig. 2). The integration of Mesolithic Aegean and Pre-Neolithic western Anatolian evidence into this overview clearly demonstrates that only very few aspects of the new Neolithic social life can be attested in our region before the arrival of the newcomers.

The long and short revolutions

The paradox of a short revolution within the long-term process of the Neolithisation can probably be related to the distinct cultural conditions in the Aegean Mesolithic and the Pre-Neolithic western Anatolian world(s), where the idea of a long revolution is hardly tenable on present evidence. The long-established hunter-forager-fisher communities of the early millennia of the Holocene seem to encounter the contemporary farmers and herders in inland Anatolia, as well as via maritime networks. A few cultural practices (*e.g.*, plastered floors, stone vessels) indicate potential forager-farmer interactions within terrestrial Anatolia, such as between Cappadocia and the coastal zones of southwest Turkey (Fig. 2). The implementation of (wild) plant processing with grinding stones within the subsistence strategy of those Pre-Neolithic societies probably reflects knowledge-transfer and adaptation based on these contacts via terrestrial and maritime routes. The impact of this interaction on the hunter-forager-fishers presumably included other social-cultural aspects as well, which are not visible in the archaeological record. The evidence of semi-sedentary habitation with dwellings of multi-seasonal or even permanent use might reflect a crucial shift in the cohabitation of the communities. The evidence of such dwellings and floor-sequences are usually seen as Neolithic influences (*Sampson 2010; Takaoğlu* et al. *2014; Kozłowski 2016*). Further analyses and new field data will perhaps indicate whether the adoption of a semi-sedentary lifestyle did in fact lead on to house-based communities before 7000 BC. The lack of evidence for this is not surprising in the context of the economic background, in which mobility played a crucial part, at least for the maritime communities of the Aegean. The distinctive Aegean Mesolithic system of seasonally mobile groups, using their environmental conditions in a highly specialized and sustainable way, appears unsuited to the adoption of farming and herding strategies.

The economic system of Pre-Neolithic western Anatolia differed in many aspects and could therefore more easily integrate new subsistence strategies. The founding of the first farming and herding communities on the mainland of Greece and western Turkey took place in areas well suited to agriculture, in areas generally different from the formerly used peninsulas or caves (with the exception of the Franchthi Cave, where an initial Neolithic is evident). The coastal zones of southwest Anatolia, which have been only sketchily investigated thus far, are likely to offer new data on pioneers in the future, and possibly for older occupations than those presently known. The interactions via overland and maritime routes may indicate a long-term process of communication between hunter-foragers and farmers, involving the adoption of a few cultural and subsistence practices and some related ideas, technologies and perhaps also worldviews. The suggested exploration phase by sea and land may form a crucial first stage in a longue durée process (*Özdoğan 2010; Broodbank 2013; Horejs* et al. *2015; Çilingiroğlu 2016*). The archaeologically invisible seafaring and travelling groups searching for new land and new options are hardly a singular event in time. We can envision a continuous and ongoing process of small-scale migration, which is observable at Knossos (*Douka* et al. *2017*). It is in this short revolutionary perspective that the first farming and herding communities appear after 7000 BC. This sudden appearance of more or less contemporaneous settlements is on the one hand an abrupt event occurring between 7000 and 6600 BC, which on the other hand marks the end of a long-term process of exploration, communication, knowledge-transfer and adaptation. The paradox of this 'sudden event' within the long revolution process has been argued as resulting from maritime and terrestrial colonization by Neolithic pioneers (*Broodbank 2013; Horejs* et al. *2015; Douka* et al. *2017*).

Recent genetic studies additionally support this colonization model (*Hofmanová* et al. *2016*) by demonstrating close relations between the agricultural communities in Anatolia, Greece and continental Europe with common ancestors (recently *Lazaridis* et al. *2016; Mathieson* et al. *2018*). These new genetic data convincingly demonstrate the movement of people from Anatolia into Europe during the intensification phase of the Neolithic (*Mathieson* et al. *2018*), although timespan, frequency, and not at least potential 'origins' are still matter of debate. The origins within the core zone may be several and various, differing between the regions of inland western Anatolia and the Aegean littoral. More detailed studies of the material relations of Franchthi (*Perlès 2005*) and Çukuriçi (*Horejs* et al. *2015; Milić 2018*) indicate a starting point in the eastern Mediterranean (including the Levant and north Mesopotamia), at least for those two pioneer sites. Movement of people is therefore the current best-fitting model for the Neolithisation of the Aegean and western Anatolia according to both the archaeological and DNA data in my view (for a different view s. *Guilbeau* et al. *2019*). The trigger for these developments remains an open question and our model requires further research (*Brami, Horejs in press*).

Since the first farmers and herders arrived in the region after 7000 BC, the dispersal within the Greek mainland, the Aegean littorals and within western Anatolia took place within a few generations (with the exception of Crete). The next generation of farmers extended their activity zones, cultivated various new micro-regions and were living in house-based communities embedded in village-based systems. From 6500 BC onwards, an increase in settlements seems to reflect a demographic boom (see *Shennan* et al. *2013* for the phenomenon in continental Europe). Regional groups emerged with their own identities, as the Anatolian Aegean coastal group demonstrates (*Horejs 2016*). Various settlements in this micro-region over some 500–700 years shared economic strategies, means of raw material procurement and distribution, socio-cultural practices, the style and technology of pottery production and several other material technologies. These Neolithic communities continued some traditional aspects of subsistence and sourcing, such as fishing and shellfishing and obsidian exchange, both of which originate in the Mesolithic period (Fig. 2). The established Aegean obsidian networks seem to form the basis for the succeeding raw material exchange systems of the Neolithic village-based communities. Targeted seafaring based on well-established nautical knowledge and skills was integrated into the Neolithic system, as has been recently shown for the procurement of jadeite from the island of Syros (Fig. 4), with distribution reaching Çukuriçi in the 7th millennium BC (*Sørensen* et al. *2017; Schwall* et al. *in press*).

We do not know how long the hunting-foraging-fishing seafaring societies in the Aegean Sea continued to exist alongside the farming-herding communities. The newcomers may not have immediately affected their environmental conditions and related economic and social systems. While the new Neolithic life of the Greek mainland and western Anatolia increased rapidly among the succeeding generations of farmers and herders, for at least another millennium most of the Aegean islands remained untouched by these crucial cultural, economic and social changes.

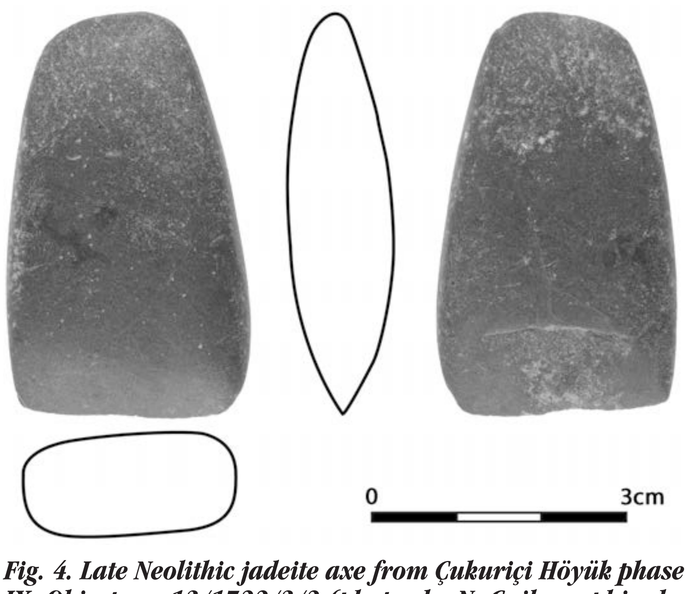

Fig. 4. Late Neolithic jadeite axe from Çukuriçi Höyük phase IX, Object no. 13/1722/3/2 (photos by N. Gail, graphics by M. Röcklinger/OREA).

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The beginning of the Neolithic on the Upper Volga (Russia)

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ABSTRACT – *The appearance of the Neolithic in the Upper Volga region is to be associated with infiltrations of notch-ware pottery-makers into the indigenous Mesolithic populations. Most likely the first vessels were imported into the region as final goods. The undistinguished differences between the Final Mesolithic and the Early Neolithic stone industries prove that this invasion was not a large-scale one. This episode should be regarded as transitional from the Mesolithic to the Neolithic (*i.e., *as part of the process of Neolithisation). The non-ornamented/notch-ware ceramics tradition first established in the local cultural environment was soon after discontinued by the appearance of the populations with multi-compound comb-ware pottery about 6500–6400 uncal BP.*

KEY WORDS – *Upper Volga region; Initial Neolithic; neolithisation; cultural genesis*

Začetek neolitika na območju zgornjega toka reke Volge (Rusija)

IZVLEČEK – *Pojav neolitika na območju zgornjega toka reke Volge povezujemo z vdiranjem nosilcev lončenine z vrezi na območje domorodnih mezolitskih populacij. Najverjetneje so prve lončene posode na območje prinesli kot končne izdelke. Glede na podobnost izdelave pozno mezolitskih in zgodnje neolitskih kamnitih orodij sklepamo, da vdor ni bil obsežen. To obdobje obravnavamo kot obdobje tranzicije med mezolitikom in neolitikom (to je del procesa neolitizacije). Neokrašena keramika in keramika z vrezi, ki so se kot prve pojavile v lokalnem kulturnem okolju, je kmalu zamenjal pojav lončenine z veliko sestavinami in okrašen z glavničenjem v času 6500 do 6400 pred sedanjostjo.*

KLJUČNE BESEDE – *območje zgornje reke Volge; začetni neolitik; neolitizacija; kulturna geneza*

Introduction

The beginning of the Neolithic in the forest zone was marked by the earliest pottery appearance in the material culture. In the Upper Volga region, which combines the territories from the Volga headwaters along with the Valdai Lakeland to the confluence of the Oka and the Volga, this event took place *c.* 7100–7000 BP (here and below all ^{14}C dates are uncalibrated BP). The initial stage of the Neolithic corresponds to the early phase of the Upper Volga archaeological culture. The latter's main feature is pottery either non-ornamented or decorated with small dots and notches (simple puncture ware) (Fig. 1). The transition from the Mesolithic to the Neolithic on the Upper Volga is currently interpreted as the Butovo Mesolithic culture (see more detail in *Kol'tsov, Zhilin 1999*) evolution into the Upper Volga Early Neolithic culture (see more detail in *Kraynov 1973; 1996; Kraynov* et al. *1973; Kraynov, Khotinskiy 1977; Kraynov, Kostyleva 1988*) with the immixture of the newcomers population skilled in making clay ware (*Kostyleva 2003.213*).

The stone assemblage of the early phase of the Upper Volga culture is characterized by finds from the sites Okayomovo 5 and 18/III, Ozerki 5/III, Belivo 2, Al'ba, Davydkovskaya, and Shadrino IV. The typical

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features are: (1) usage of flakes as main tools blanks; (2) decrease of the percentage of blades compared with the Final Mesolithic; (3) predominance of irregular blades; (4) diversity in core forms; (5) production of arrowheads and cutting tools on blades; (6) rare slotted bone tools accompanied by microblade inserts, mostly with sharpened margins or with backed edges/ends, and oblique points; (7) arrowheads with a distinct tang and willow-leaf points two-side trimmed on the tip and haft or those with edge contour retouching; (8) variously shaped scrapers which are predominant in the tools categories; (9) angle burins on breaks, predominantly made on flakes and occasionally on blades; (10) single dihedral burins and burins of other types; (11) chopping tools being manufactured by both knapping and polishing; (12) diverse knives, notch-scrapes, borers, combined tools (*Engovatova* et al. *1998.18; Kol'tsov, Zhilin 1999.82*).

Such a very general characteristic of the stone industry of the initial phase of the Neolithic of the Upper Volga, until recently, was considered sufficient. It was declared that the Butovo and the Upper-Volga culture succession was proved. The stone industry of the Final Butovo culture characterized in detail also provides a comprehensive notion about the early Upper-Volga culture assemblages (*Zhilin 1994; Kol'tsov, Zhilin 1999.82*).

The situation changed after a technological analysis revealed the variations of the early Upper-Volga non-ornamented/simple-puncture ware ceramics when compared with the later pseudo-corded ware with comb-stamped decoration of the middle and late phases of the culture (*Tsetlin 1996*). Now it has been established that the Upper-Volga potters employed a multicomponent clay with varying recipes of 'clay + chamotte + organics' and 'clay + chamotte + organics + granite grus'. Moreover, the use of chamotte is considered as a marker of the Upper Volga culture. Alexander A. Bobrinsky (*1978.71–72*) established that the appearance of multi-compound technological traditions (multicomponent temper to the clay paste) at the initial stages of pottery-making was induced by cultural mixing of the simple tradition bearers (one-component temper to the clay paste). The appearance of granite grus temper in the late stage of the Upper Volga culture is explained through contacts of the local population with the bearers of the pit-comb ware traditions. Organics as temper were used in the early Upper-Volga pottery with simple puncture or non-ornamented ware. This was accepted as the basis for distinguishing the Volga-Oka culture identified by Yuriy B. Tsetlin (*2008.37*) as an independent cultural unit preceding chronologically the Upper Volga culture.

However, the concept of the Volga-Oka culture was criticized. Elena Kostyleva *et al.* (*2002.41*) suggested: "*...for the initial stage of pottery-making, when technological practices were still evolving and were not sustainable, there is no need to associate the appearance of one or another admixture in the*

Fig. 1. The pottery either non-ornamented or decorated with small dots and notches (simple puncture ware): 1, 2 Okayomovo 18/III; 3–5 Sakhtysh IIa/IIg; 6–17 Kotchishche II; 18 Shchepochnik (photo and drawing by the author).

pottery with a foreign cultural influence. This latter is possible only in conditions of stable, long-established technological traditions. Therefore, it seems to us an inappropriate attempt ... to single out the early stage of the Upper Volga culture into a special autochthonous Volga-Oka culture ... Moreover, the proposing of a new archaeological culture requires more solid substantiation than the data on the ceramics production technology."

The last years research has confirmed the heterogeneity of the Upper Volga culture components. The technical and typological analyses of the stone industry made it possible to distinguish two qualitatively different stone inventory groups in terms of technology, each of which is accompanied by heterogeneous pottery types, according to Tsetlin. For the first and earlier industry (from 7100–7000 to 6600–6500 BP), the significant role of blades and the secondary treatment with the minimum modification of blanks are typical. This feature is clearly expressed in the shapes of arrowheads having a slightly retouched tip and haft or retouched over a contour of the blade blank covering less than 3/4 of its surface. These assemblages correspond to the 1st phase of the Upper Volga culture (the Volga-Oka culture according to Tsetlin), and are accompanied by early pottery with sparse puncture-ware ornamentation. The second group of artefacts originate from of the evolved and late Upper Volga culture sites (6600/6500–6000/5900 BP) and are characterized by the use of flakes as basic blanks, the continuous retouching of points (arrowheads, spearheads, darts) and also knives, as well as by spread of the thin-bifaces technique. It is accompanied by pottery with pseudo-corded and comb-ware ornamentations (*Tsvetkova 2012*).

The stone inventories of the reference Volga-Oka culture sites of Zales'e 1, Ust'-Valdayka, Yazykovo 1, Somino 2, Ivanovskoye III, V,and VII, Sakhtysh I, II, and VIII, Kosyachevo 1 & 2, Zav'yalka 1, Malaya Lamna 1, Strelka 1, Borinka 2, Volosovo. Korenets. Teren'kovo III. Zhabki 3. Belivo 2, and Davydkovskaya (*Tsetlin 1996*) have still not been researched. In the present study, a detailed characterization of the stone industry of the initial stage of the Neolithic of the Upper Volga is presented. On the basis of the data obtained, the validity of distinguishing the artefacts of the initial stage into a separate archaeological culture is analyzed.

Sources

Collections of stone artifacts (7521 items; Tab. 1) from nine sites were used, in which only non-decorated/simple puncture-ware ceramics were present in the Early Neolithic cultural layers. The following sites deposited in the subaqual and subaerial sediments ('on sands') have such a feature: Alekseyevskoye I, Davydkovskaya, Kotchishche I, Nilova Pustyn', Shadrino IV, and peat-bog sites of Zamostje 2/4a, Okayomovo 18/III, Sakhtysh IIa/IIr, and Stanovoye 4/II (excavation 2 of 1998), dating to 7030±100 BP (GIN-8378) (Fig. 2).

There is a widespread opinion among researchers about the admixture presence of the Final-Mesolithic artefacts in the cultural layers of these sites (*Kostyleva 2003.213*). As proof, examples for the peat-bog sites are given of the overlapping of the early Neolithic finds on the Mesolithic ones without stratification, with rare exceptions, by sterile layers. It is however practically impossible to prove the presence of such an admixture, since the differences between

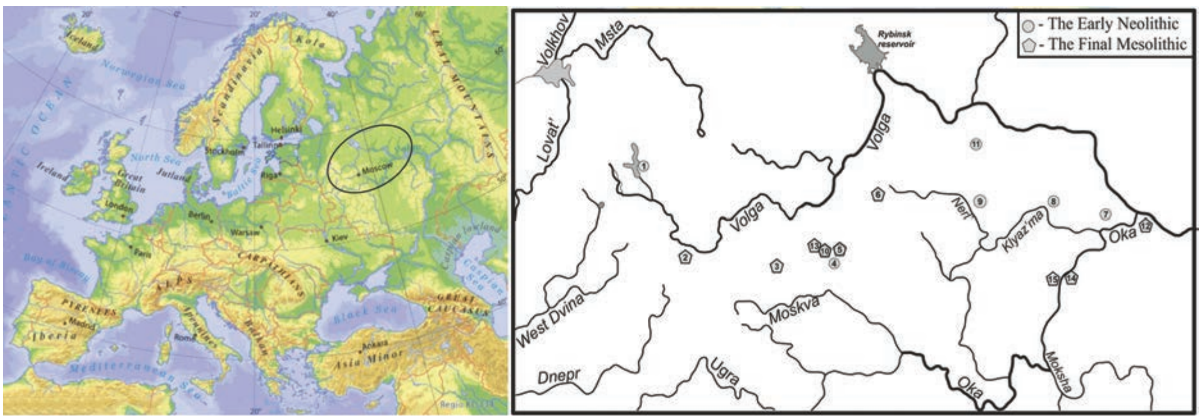


Fig. 2. The map of research area: 1 Kotchishche I, Nilova Pustyn'; 2 Ozerki 5/IV; 3 Berendeevo III; 4 Davydkovskaya; 5 Zamostje 2/upper mesolithic layer, Zamostje 2/4a; 6 Ivanovskoye VII/IIa; 7 Shadrino IV; 8 Alekseyevskoye I; 9 Sakhtysh IIa/IIg; 10 Okayomovo 4/III, 5, 18a, 18/III; 11 Stanovoye 4/II; 12 Bezvodnoye 10; 13 Nushpoly 11; 14 Novoshino; 5 Elin Bor (composed by the author).

No.	Sites	Age (BP)	Age (cal BC)	Index	Sample
1	Zamostye 2/4a	6385±150	5621–5008	SPb-719	Sherd with "retreating spatula" decor, food-crust
2	Zamostye 2/4a	6485±150	5712–5079	SPb-728	Undecorated sherd, food-crust
3	Zamostye 2/4a	6720±150	5973–5376	SPb-725	Undecorated sherd, food-crust
4	Zamostye 2/4a	6975±100	6024–5672	SPb-721	Undecorated sherd, food-crust
5	Zamostye 2/4a	7030±100	6076–5718	SPb-723	Undecorated sherd, food-crust
6	Zamostye 2/4a	7105±150	6342–5676	SPb-722	Undecorated sherd, food-crust
7	Okayomovo 18/III	6800±60	5813–5617	GIN-8416	elk skull
8	Sakhtysh IIa/IIg	6753±150	5986–5389	SPb-1453	food-crust
9	Sakhtysh IIa/IIg	6874±150	6033–5522	SPb-1450	food-crust
10	Sakhtysh IIa/IIg	6920±150	6074–5554	SPb-1451	food-crust
11	Sakhtysh IIa/IIg	7065±150	6231–5667	SPb-1448	food-crust
12	Sakhtysh IIa/IIg	7088±150	6246–5669	SPb-1449	food-crust
13	Sakhtysh IIa/IIg	7037±27	5991–5849	KIA-39309	food-crust
14	Sakhtysh IIa/IIg	7018±45	6000–5794	KIA-39308	food-crust
15	Sakhtysh IIa/IIg	6860±31	5835–5669	KIA-39301	food-crust
16	Sakhtysh IIa/IIg	6847±31	5801–5662	KIA-39300	food-crust
17	Sakhtysh IIa/IIg	7356±30	6353–6090	KIA-39310	food-crust
18	Sakhtysh IIa/IIg	7072±36	6019–5887	KIA-39311	food-crust
19	Sakhtysh IIa/IIg	6395±28	5469–5319	KIA-39312	food-crust
20	Sakhtysh IIa/IIg	6371±30	5467–5305	KIA-39313	food-crust
21	Sakhtysh IIa/IIg	6740±90	5804–5487	Ki-14556	sherd
22	Sakhtysh IIa/IIg	6690±90	5739–5478	Ki-14554	sherd
23	Sakhtysh IIa/IIg	6410±90	5544–5213	Ki-14557	sherd
24	Sakhtysh IIa/IIg	6830±40	5791–5638	GIN-12985	sherd
25	Sakhtysh IIa/IIg	6960±40	5917–5741	GIN-12986	sherd
26	Sakhtysh IIa/IIg	7220±70	6231–5986	GIN-12984	sherd
27	Stanovoe 4/II	7030±100	6076–5718	(GIN-8378)	board

Tab. 1. Radiocarbon dates for sites of the Initial Neolithic in the Upper Volga region (see* Radiouglerodnaya khronologiya 2016*).

the stone industries of the Final Mesolithic and Early Neolithic are hardly noticeable, being identified reliably only through comparative statistics of the collections. Meanwhile, finds of early pottery in the cultural layer are a convincing argument in favour of the chronological position of a site.

The artefacts

Characteristic of the initial stage of the Neolithic of the Upper Volga is the predominant use of flint of different colours and quality extracted from Carboniferous Age deposits. Among these raw materials, the light-violet staritsa flint is easily distinguishable. Its outcrops on the Volga are known in the Tver' region. Tools made from it are found at the sites of Kotchishche I, Nilova Pustyn', Okayomovo 18/III, and Shadrino IV. An insignificant percentage of artefacts from the sites under consideration are manufactured from imported material of high quality sourced from Cretaceous deposits. For instance, at the camp-site of Davydkovskaya, semitransparent light-grey and black flint with a chalk cortex was found (*Sidorov 1973*). Besides, tools made from quartzite, slate, sandstone, *etc.*, were also used.

Summarising the data on the stone industry of the initial Neolithic of the Upper Volga region, the following characteristics are worth mentioning. Most of the cores from sites of this period are made using the volumetric knapping technique (prismatic cores). The volumetric cores are represented by six broad-faced cores and twelve narrow-faced cores (Tab. 3; Fig. 3.6–7, 11–12, 15–18, 20–22, 24). Cores of a conventionally mixed type (three items; Fig. 3. 23) and amorphous cores (three items) are rather rare. Cores of irregular knapping were found in Okayomovo 18/III – two items and Davydkovskaya – one item.

The methods of producing blanks differed. The deep and uneven negatives of flaking on cores and untrimmed striking platforms of the latter indicate the use of a hard hammerstone. At the same time, faceting of striking platforms and reduction of the platform overhangs on the cores can have resulted from the use of a soft hammerstone or a punch. Some cores for microblades have an angle of flaking close to 90°, suggesting a high probability of the use of a pressure technique. The single clearly identified core (pencil-shaped) with pressure knapping comes from

Categories	Alekseevskoe 1	Davydkovskaya	Zamostje 2/4a	Kotchishche I	Nilova Pustyn’	Okayemovo 18/III	Sakhtysh IIa/IIg	Stanovoe 4/II	Shadrino IV	Total
Precores	–	3	–	–	–	1	–	–	–	**4**
Coreoutlines	2	10	1	3	–	3	–	2	3	**24**
Core-shaped chunk	6	1	4	7	1	–	5	–	3	**27**
Flakes (including framents)	133	2267	1808	1510	114	62	12	15	113	**6034**
Blades (including framents)	23	554	165	128	3	19	–	1	80	**973**
Abrasives	–	–	–	–	–	3	2	1	–	**6**
Sinkers	–	–	–	–	–	–	2	–	–	**2**
Hammerstones	–	2	–	1	–	–	4	–	–	**7**
Slate saws	1	–	–	–	–	–	1	–	–	**2**
Retouchers	–	2	–	1	–	–	–	–	–	**3**
Arrowheads (including framents)	1	3	5	5	1	3	–	–	1	**19**
Spear and darts points	–	–	1	2	–	–	–	–	–	**3**
Borers	3	5	27	6	–	2	–	–	–	**43**
Woodworking tools	4	4	3	1		1	3	2	1	**19**
preforms of woodworking tools	1	1		1	–	–	2	1	–	**6**
Burins	2	11	1	6	–	5	–	–	3	**28**
Scrapers	5	53	27	34	1	5	2	3	16	**146**
Inserts	5	4	9	–	–	2		1	6	**27**
Blades with regular retouch	3	3	24	14	–	1	–	–	10	**55**
Flakes with regular retouch	5	1	4	–	2	1	–	–	1	**14**
Combined tools	1	–	2	1	–	4	–	–	1	**9**
Undiagnostic tools	1	–	–	–	–	–	–	–	–	**1**
Fragments of tools	–	2	–	1	–	–		–	2	**5**
Blades with unregular retouch	5	1	–	1	–	1	–	1	14	**23**
Flakes with unregular retouch	1	–	–	–	–	–	4	–	31	**36**
Raw materials	1	–	–	–	–	–	3	1	–	**5**
Total	**203**	**2927**	**2081**	**1722**	**122**	**113**	**40**	**28**	**285**	**7521**

Tab. 2. Distribution of categories of stone tools at the sites of the initial Neolithic in the Upper Volga region (composed by the author).

the site Shadrino IV (Fig. 2.16). The platforms of all the prismatic cores are formed either by a single strike or show trimming negatives. The overhangs on most of the cores are not reduced. Considerable numbers of the cores are strongly exhausted.

Blades/microblades as potential blanks (with negatives of previous longitudinal removals) are mostly fragmented and have an irregular faceting of the dorsal surface (Tab. 4).

The percentage of tools made from blades varies within a broad range from 17.5% to 50% (Alekseyevskoye I: 45% of all the lithics with secondary working; Davydkovskaya: 22.6%; Zamostje 2/4a: 17.5%; Kotchishche I: 39%; Nilova Pustyn’: 25%; Okayomovo 18/III: 50%; Stanovoye 4/II: 14%; Shadrino IV: 36%). For comparison, at sites of the Final Mesolithic in the region the values of the same indicator vary from 35% to 54% (Sakhtysh 14/Ib: 35%; Okayomovo 18a: 54%; Zamostje 2: 21%; Okayomovo 4: 35%; Okayomovo 5: 53%; Ivanovskoye VII/IIa, Ivanovskoye 3: 31%) (*Tsvetkova 2012*).

Artefacts marking the Initial Neolithic – arrowheads with a distinct tang (two items; Fig. 3.46, 49) or leaf-like shape (seven items; Fig. 3.39–41, 43, 47, 48, 50) are manufactured from blades or microblades with a slight modification of the blank by means of retouching (the haft and tip treatment). The proportions of the arrowheads are either very elongated (three items) or medium sized (six items). Single arrowheads are manufactured in the same technological tradition made on flakes (Kotchishche I; Fig. 3.40) and a blade-flake (Davydkovskaya; Fig. 3.43) as blanks. The single point from Kotchishche I is the only tool of elongated proportions with contour retouching that is due to the character of the blank (flake) which required a greater modification in the manufacture of the instrument, rather than just treatment of the tip, and the haft might be considered as an individual form. The unifacial points on blades also found at excavations of the site of Kotchishche I (Fig. 3.44, 45) can be considered in a similar fashion, and such points are also known in the Final Mesolithic of the region. For example, the unifacial points come from the Early-Neolithic layer of Za-

Sites	Prismatic cores			Narrow faced cores				
Alekseyevskoye I	–	–	2	–	–	–	–	–
Davydkovskaya	–	–	–	5	–	–	2	–
Zamostje 2/4a	–	–	–	–	–	1	–	–
Kotchishche I	2	–	–	–	–	–	–	–
Okayomovo 18/III	–	–	–	1	–	–	–	–
Nilova Pustyn'	–	–	–	–	–	–	–	–
Sakhtysh IIa/IIg	–	–	–	–	–	–	–	–
Stanovoye IV	1	–	–	1	–	–	–	–
Shadrino IV	–	1	–	–	1	–	–	1
Total	**3**	**1**	**2**	**7**	**1**	**1**	**2**	**1**

Tab. 3. Types of regular cores from the Initial Neolithic sites in the Upper Volga basin (composed by the author).

mostje 2 – from that area of the settlement where defining of the initial Neolithic strata from the whole Early-Neolithic horizon was impossible. The fragment of the bifacial arrowhead tip from the site Shadrino IV, taking into account the presence of a single pit-comb ware vessel fragment, seemed to be an admixture of the Evolve Neolithic (Fig. 3.38; *Tsvetkova 2014b.48*). The bifacial point from Kotchishche I, according to the character of the secondary treatment, undoubtedly also belongs to the Evolved Neolithic. Its occurrence could be explained by the adjacent location of later settlements close to Kotchishche I.

The spear and javelins points are rare in the Initial Neolithic. Two of them are bifaces from sites Kotchishche I and Zamostje 2/4a (Fig. 3.37). The third item is one with dorsal continuous retouch and ventral semi-abrupt micro retouch covering 3/4 of the point contour, was recovered from Kotchishche I (Fig. 3.36). At the same site, a tool fragment interpreted as a point tip was encountered. By the nature of the secondary treatment, it is an admixture of the Evolved Neolithic which came from the nearby later site (see above). The other two bifaces, considering the context of their finding, belong to the Early Neolithic.

End-scarpers with a convex edge (type 1) are characteristic of the stone industry of the initial Neolithic of the Upper Volga region. The quantity of such tools made on flakes exceeds that of scrapers on blades by 2.5 times. End scrapers with a straight edge (type 2), 'nosed' scrapers (type 3) and ogival forms (type 3) are rare (Tab. 5). Despite the fact that they do not compose a significant series, they can also be fully considered as characteristic of the initial phase of the Neolithic in the Upper Volga region. Microscrapers are represented by end forms in the sites Sha-

Sites	distal frags	medial frags	proximal frags	dihedral	trihedral	tetrahedral	pentahedral	regular facetted	irregular facetted	intact	cortical	width/thickness of blades (mm)	number of blades	total number of blades in the assemblage
Alekseyevskoye I	2	18	3	6	13	4	–	8	15	–	6	7–15, 30/2–4	**23**	**205**
Davydkovskaya	+	+	+	+	+	?	?	+	+	?	?	4–10/?	**554**	**3217**
Zamostje 2/4a	14	21	16	+	+	?	?	+	+	10	?	?	**165**	**311**
Kotchishche I	+	+	+	59	61	5	3	10	118	11	14	6–29/8–11	**128**	**1721**
Okayomovo 18/III	–	2	–	3	–	–	–	1	2	1	–	12–15/ 2–5	**3**	**122**
Nilova Pustyn'	5	12	2	10	6	3	–	4	15	2	–	6–32/2–6	**19**	**113**
Sakhtysh IIa/IIg	–	–	–	–	–	–	–	–	–	–	–	–	**–**	**–**
Stanovoye IV	–	1	–	–	1	–	–	–	–	–	–	12/2	**1**	**26**
Shadrino IV	+	29	+	?	?	?	2 +	2 +	+	14		6–9, 16–17/?	**80**	**306**
Total	**21**	**83**	**21**	**78**	**81**	**12**	**5**	**25**	**150**	**41**	**20**	**–**	**973**	**6021**

Tab. 4. Techno-morphological parameters of the blades from the Initial Neolithic sites on Upper Volga (composed by the author).

drino IV and Davydkovskaya assemblages (Fig. 4.16–17, 26, 29–32). Side-scrapers are unknown among the collections from the sites under consideration (see in more detail in *Tsvetkova 2015a*). Amorphous scrapers *i.e.* tools on flakes and their fragments with irregular retouch imitating a scraper working edge constitute 1/8 of the total quantity of scrapers from the Initial Neolithic sites (Tab. 5). Thus the notion that by the beginning of the Neolithic the numbers of amorphous scrapers in the inventories of sites increases substantially seems to be incorrect (*Kol'tsov, Zhilin 1999.64; Tsvetkova 2015a.358*).

This period is characterized by angle burins bevelled on a break. There are twice as many burins on blades as burins on flakes (Tab. 6). As a rule these are tools with a single bevel. Dihedral burins and retouched ones are single. A single example of a combination burin was found (Davydkovskaya) conjoining dihedral and angle types in the same piece (Fig. 4.20). The total number of the tools made on blades and flakes is 17 and 10, respectively (see more detail in *Tsvetkova 2014a*).

Inserts are represented at sites of the Initial Neolithic by nine microblade types of the thirteen identified for the Mesolithic and Early Neolithic of the Upper Volga (Fig. 4.1–11; Tab. 7). Regression of microblade technology in the Initial Neolithic, compared with the Mesolithic, has not been observed. In the stone industry of the Early Mesolithic, the percentage of inserts varies from 1.1% to 35% among the tools with secondary treatment. In the Middle Mesolithic this characteristic ranges from 1.1% to 20%, while at sites of the Final Mesolithic it does not exceed 1.3%. Early Neolithic microblade-inserts constituted from 0.4% to 13% of such tools. These values indicate the absence of clear relationship between the age of the site and the number of inserts. It must be also taken into consideration that microblades without secondary treatment can be potential inserts (*Tsvetkova 2017*).

Insert weapons were used on the Upper Volga during the entire Mesolithic and Early Neolithic periods. Some tool types, *e.g.*, flat and needle-shaped bone points equipped with inserts, were used throughout all the considered Mesolithic-Neolithic periods. Some of them, *e.g.,* the points with a triangular tip without barbs slotted on the haft, do not constitute considerable series and each is an individual form. Thus for the initial Neolithic, five types of bone tools with slots are known, of which three (narrow flattened points, one-winged points with a barb and straight daggers) were used since the Preboreal period and one (points with a biconical head) since the beginning with the Boreal period (*Tsvetkova 2017*).

Borers are represented by tools with a distinct or casual beak. No relation between the type of the blank (blade/flake) and the form of the borers is traceable. The quantities of borers made from blades and flakes are equal. Borers with a distinct piercing tip were found at the sites of Alekseyevskoye I (one item; Fig. 3.2), Davydkovskaya (one item; Fig. 3.13), Kotchishche I (three items; Fig. 3.3, 9). The borers with an indistinct tip come from collections from Alekseyevskoye I (two items; Fig. 3.4), Davydkovskaya (four items; Fig. 3.10), Zamostje 2/4a (two items; in total, 24 borers and three drills were found in layer 4a at the settlement of Zamostje 2; since their detailed description is not reported, in the present article the statistics include only the illustrated tools from the literature (*Lozovskaya, Lozovskii 2015*; Fig. 3.14) for Kotchishche I (three items; Fig. 3.1, 8) and Okayomovo 18/III (two items; Fig. 3.5).

	blade/ flake-blade				flake												amorphous	Total
Groups	**End-scarpers**				**End-scarpers**				**circular scrapers**				**Side-scapers**					
Types	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4		
Alekseyevskoye I	1	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	**2**
Davydkovskaya	11	1	–	–	32	–	–	–	7	–	–	–	–	–	–	–	2	**53**
Kotchishche I	3	1	–	3	13	4	–	–	–	–	–	–	1	–	–	–	9	**34**
Okayomovo 18/III	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	**1**
Nilova Pustyn'	–	–	–	–	2	–	–	1	1	–	–	–	–	–	–	–	1	**5**
Sakhtysh IIa/IIg	–	–	–	–	–	–	1	–	–	1	–	–	–	–	–	–	–	**2**
Stanovoye IV	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	2	**3**
Shadrino IV	4	1	1	–	7	–	–	–	1	–	–	–	2	–	–	–	–	**16**
Total	**20**	**3**	**1**	**3**	**56**	**4**	**1**	**1**	**9**	**1**	**–**	**–**	**3**	**–**	**–**	**–**	**14**	**116**

Tab. 5. Ratio of groups and types of scrapers at the sites of the initial Neolithic of the Upper Volga region (composed by the author).

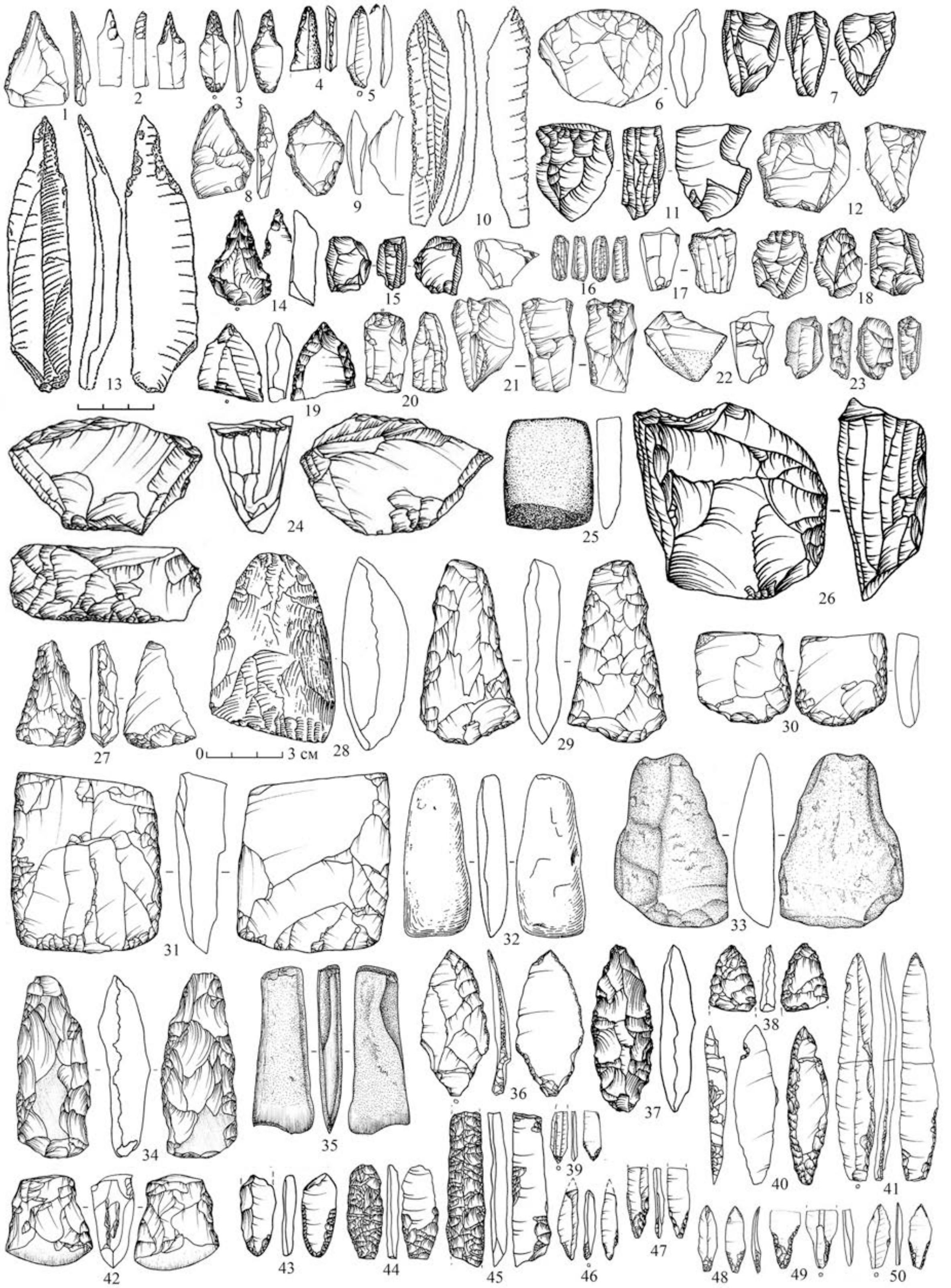


Fig. 3. The stone tools from the sites of The Initial Neolithic in The Upper Volga region: 1, 3, 6, 8, 9, 21, 24, 27, 31, 36, 40, 44, 45, 48 Kotchishche I; 2, 4, 12, 20, 29, 30, 42, 47 Alekseevskoye I (**Tsvetkova 2014b*****); 5, 39, 49, 50 Okayomovo 18/III (*****Zhilin 1997*****); 7, 10, 13, 15, 18, 26, 28, 32, 43, 46 Davydkovskaya (*****Sidorov 1973*****); 14, 19, 37 Zamostje 2/4a (*****Lozovskaya, Lozovskii 2015*****); 16, 23, 25, 38 Shadrino IV (*****Tsvetkova 2014b*****); 17, 22, 35 Stanovoye 4/II; 33, 34 Sakhtysh IIa/IIg (*****Tsvetkova 2013*****); 41 Nilova Pustyn' (*****Tsvetkova 2018*****). 1–4, 6, 8, 9, 12, 16, 17, 20–24, 27, 29–31, 33–36, 38, 40–42, 44, 45, 47, 48 drawn by the author.***

Site	on blade/on flake-blade						on flake							
	angle		dihedral	truncation	combined		angle		dihedral		truncation		combined	total
	1 bevel	2 bevels	1	1	1 bevel	2 bevels	1 bevel	2 bevels	1 bevel	2 bevels	1 bevel	2 bevels	1	1
Alekseyevskoye I	1	–	–	–	–	–	–	1	–	–	–	–	–	**2**
Davydkovskaya	3	1	–	–	–	1	3	1	2	–	–	–	1	**12**
Zamostje 2/4a	–	–	–	–	–	–	1	–	–	–	–			**1**
Kotchishche I	4	1	–	–	–	–	–	–	–	–	1	–	–	**6**
Okayomovo 18/III	–	–	–	–	–	–	–	–	–		–	–	–	**–**
Nilova Pustyn'	4	–	–	–	–	–	1	–	–	–	–	–	–	**5**
Sakhtysh IIa/IIg	–	–	–	–	–	–	–	–	–	–	–	–	–	**–**
Stanovoye IV/II	–	–	–	–	–	–	–	–	–	–	–	–	–	**–**
Shadrino IV	2	–	–	–	–	–	1 unclear						–	**3**
Total	**14**	**2**	**–**	**–**	**–**	**1**	**5**	**2**	**2**	**–**	**1**	**–**	**1**	**29**

Tab. 6. Ratio of groups and types of burins at the sites of the initial Neolithic on the Upper Volga (composed by the author).

There are five times as many axes than adzes. Trapezoid tools are the most widely distributed among both categories. Artefacts of triangular or rectangular form are found as single examples. The technology of manufacture of wood-working tools of the Early Neolithic involves the application of bifacial flaking and abrasive treatment by means of various techniques. Among the latter the 'flake-axe' technique is of note, where a large flake is used as a tool blank. The distal end of such a flake with minimal treatment would have been intended for a working edge. Such a blank had the ventral surface trimmed on the lateral sides which were first worked with transversal flaking (*Tarasov 2009.125*). Two artefacts manufactured using this technique have been encountered (Kotchishche I; Fig. 3.27, 31).

Four types woodworking tools are distinguished according to the manner of treatment: tools with bifacial treatment (Fig. 3. 28–29), tools with treatment of the dorsal surface and ventral trimming with flat retouch (Fig. 3.27, 31), axes and adzes with an bifacial treatment combined with grinding (Fig. 3.33–34, 42), and polished tools (Fig. 3.25, 32, 35; Tab. 8). The variant-forming attributes are the proportions of the tools (see more detail in *Tsvetkova 2013.205*).

Blades and flakes with regular abrupt/semi-abrupt and sharpening retouch are represented by series in various combinations: unilateral, bilateral and alternate.

Combination tools are found in the following variants: 'scraper + burin', 'burin + knife', 'burin + push-plane', and 'burin + borer' (Alekseevskoye I, Zamost'e 2/4a, Okayemovo 18/III, Kotchichshe I, Shadrino IV). In the opinion of Vladimir V. Sidorov, the so-called 'cores-burins' are typical for the Early Neolithic. In terms of their technical and morphological characteristics, these artefacts are either core-shaped pieces or strongly exhausted cores (*Tsvetkova 2014a.264*).

There are also known finds of tools used for the production of tools: abrasives (Okayamovo 18/III, Sakhtysh IIa/IIg, Stanovoye 4/II), hammerstones (Kotchishche I, Sakhtysh IIa/IIg), slate saws (Alekseevskoe I, Zamostje 2, Sakhtysh IIa/IIg), and retouchers (Davydkovskaya, Kotchishche I) (Tab. 1; see more detail in *Tsvetkova 2015b*).

Thus the stone industry of the Initial Neolithic of the Upper Volga region should be considered as based on the blade-flake blanks knapping technique.

Discussion

The characteristics of the stone industry based on the finds from the sites with exclusively unornamented/simple puncture-ware pottery make our notions about this time much more precise. Primarily this concerns the role of blade knapping in the industry of the Initial Neolithic. As already mentioned above,

Sites	Microblades						
	with marginal micro-retouch	with tiny marginal retouch	with sharpening marginal retouch	blunted marginal retouch	with retouched end transverse truncation	with retouched end oblique truncation	Total
Alekseyevskoye I	4	–	–	–	–	1	**5**
Davydkovskaya	2	–	2	–	–	–	**4**
Okayomovo 18/III			1		1		**2**
Stanovoye IV/II	1	–	–	–	–	–	**1**
Shadrino IV	2	1	1	2		–	**6**
Total	**9**	**1**	**4**	**2**	**1**	**1**	**18**

Tab. 7. Ratio of inserts types on the sites of the early Neolithic of the Upper Volga (composed by the author).

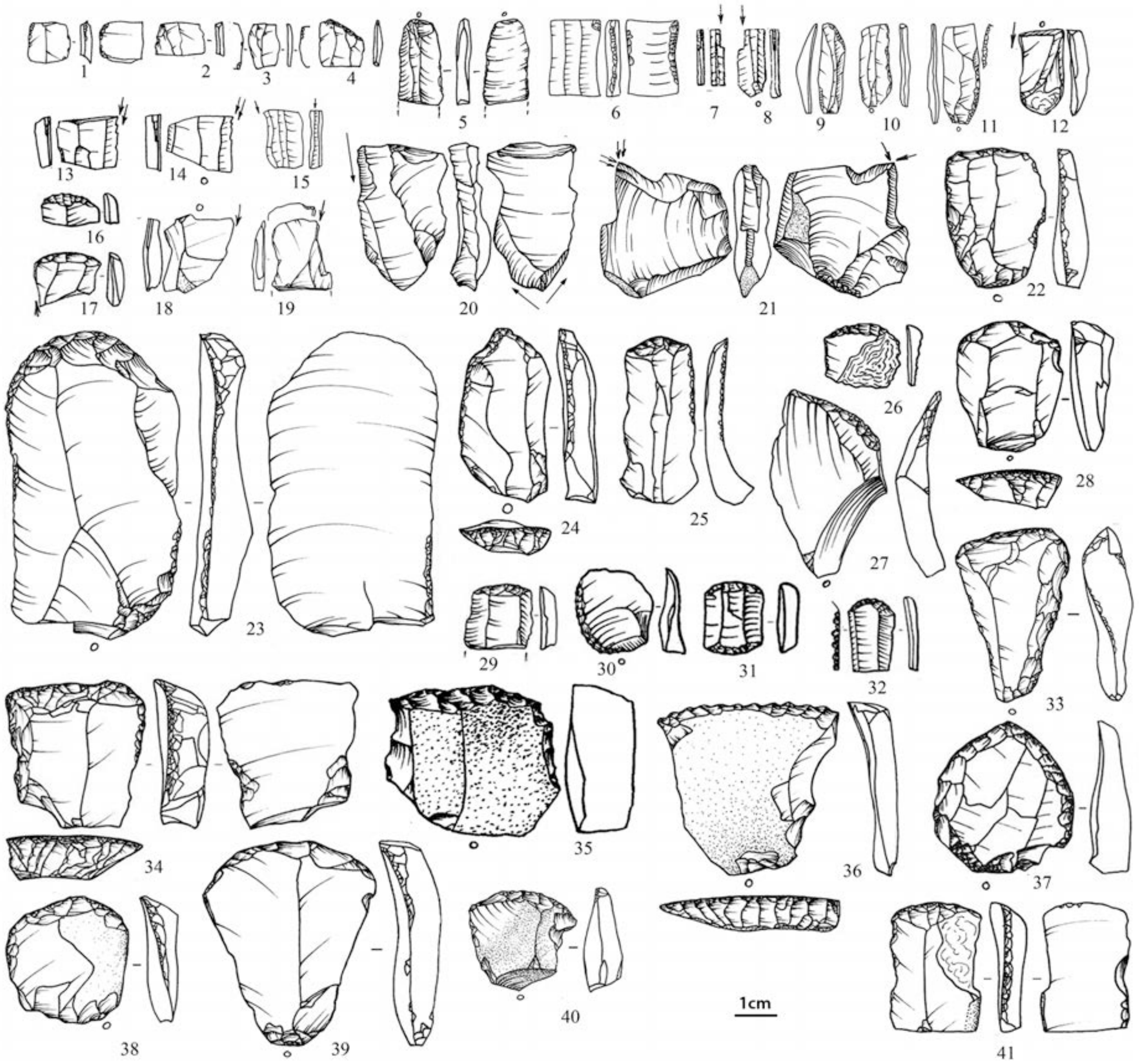
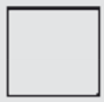
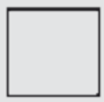


Fig. 4. The stone tools from the sites of The Initial Neolithic in The Upper Volga region: 1, 2, 4, 17 Alekseevskoye I (*Tsvetkova 2014b*); 3 Stanovoye 4/II; 5, 19, 12, 22, 24, 25, 27, 28, 33, 34, 36, 38–41 Kotchishche I; 6, 15, 20, 21, 31 Davydkovskaya (*Sidorov 1973*); 13, 14, 18, 9, 11, 37 Okayomovo 18/III (*Zhilin 1997*); 7, 8, 10, 16, 26, 29, 30, 32 Shadrino IV (*Tsvetkova 2014b*); 23 Nilova Pustyn' (*Tsvetkova 2018*); 35 Zamostje 2/4a (*Lozovskaya, Lozovskii 2015*). 1–5, 10, 12, 17, 19, 22–25, 27, 28, 29, 33, 34, 36, 38–41 drawn by the author.

researchers regard the regress in the technology of making blades and microblades as a distinctive feature of this period. Observations of the author show that the estimate of the percentage ratio of blades, microblades and products made from them, in comparison with flakes and tools on flakes, in the stone industries of the Mesolithic and Neolithic Upper Volga is rather artificial in a certain sense, and associated with incomplete and unequal sources, *i.e.* mainly of the source studies character (*Tsvetkova 2017*). Firstly, the sites differ from one another through their functional features. Indeed, they are certainly represented by hunting camps, workshops, dwelling settlements, places for butchering hunted prey, *etc*. Secondly, they differ in the duration and frequency of habitation and/or visitation episodes. Moreover, they have been studied to different extents. On the other hand, the percentage of tools on blades, the presence of cores for blades and microblades, the quantity of blades as potential blanks and the high percentage of tools on blades in collections from sites of the Early Mesolithic and Initial Neolithic convincingly suggest that the tradition of manufacturing tools on a standardized blade-blank was practised in this region for 3500 years, since the Preboreal period. Its existence was not affected in any way by differences in the quality of the raw materials used or dependence on the location of the sites in different areas of flint accessibility (*Zhilin 1998*).

The microblade technology on the Upper Volga falls out of use together with the composite armature after 6500–6400 BP. For that period, a transformation of the stone industry from blade-flake to exclusively flake is recorded, as well as the appearance of other categories of bifaces. These bifaces were produced in particular by the bifacial thinning technique (*Engovatova* et al. *1998*). In our case, we can state the successive existence in the Early Neolithic of the region of two different technological and cultural traditions for tool manufacture that are alternatives to each other. In the same period, the ornamentation of ceramic pottery also changes significantly, as comb-ware ornamentation replaces the simple-puncture elements. At present, the results of pottery technological analyses have proved that the bearers of the traditions of the Early Neolithic archaeological cultures of the central part of European Russia who manufactured ware with simple-puncture and combed ornamentation were not related (see more detail in *Smirnov 1988; Ivanishcheva 2004; Tsetlin 2007*). The abandoning of the microblade technique by people of the Upper Volga region can be more logically explained through the displacement of the population that took place 6500–6400 BP rather than through the loss of the skills of making blades.

	Groups	Types	Alekseyevskoye I	Davydkovskaya	Zamostje 2/4a	Kotchishche I	Nilova Pustyn'	Okayomovo 18/III	Sakhtysh IIa/IIg	Stanovoye IV/II	Shadrino IV	Total
Axes		Type 1	1	2	–	–	–	1	–	1	–	5
		Type 2	–	–	1	–	–	–	–	–	–	1
		Type 3	2	–	1	–	–	–	2	1	–	6
		Type 4	–	–	–	–	–	–	–	1	–	1
		Type 1	–	–	–	–	–	–	–	–	–	–
		Type 2	–	–	–	–	–	–	–	–	–	–
		Type 3	–	1	–	–	–	–	–	–	–	1
		Type 4	–	–	–	–	–	–	–	–	–	–
		Type 1	–	–	–	–	–	–	–	–	–	–
		Type 2	–	–	–	1	–	–	–	–	–	1
		Type 3	–	–	–	–	–	–	–	–	–	–
		Type 4	–	–	–	–	–	–	–	–	–	–
Adzes		Type 1	–	–	–	–	–	–	–	–	–	–
		Type 2	–	–	–	–	–	–	–	–	–	–
		Type 3	–	–	–	–	–	–	1	–	–	1
		Type 4	–	1	–	–	–	–	–	–	–	1
		Type 1	–	–	–	–	–	–	–	–	–	–
		Type 2	–	–	–	–	–	–	–	–	–	–
		Type 3	–	–	–	–	–	–	–	–	–	–
		Type 4	–	–	–	–	–	–	–	–	1	1
		Type 1	–	–	–	–	–	–	–	–	–	–
		Type 2	–	–	–	–	–	–	–	–	–	–
		Type 3	–	–	–	–	–	–	–	–	–	–
		Type 4	–	–	–	–	–	–	–	–	–	–
		Total	3	4	2	1	–	1	3	3	1	18

Tab. 8. Woodworking tools from the initial Neolithic sites the Upper Volga (composed by the author).

The identity of the stone industries of the initial Neolithic and Final Mesolithic allows us to define the details of the Neolithisation in the Upper Volga region. The phenomenon of the appearance of ceramics in the material culture of hunter-fisher-gatherers remains not completely clear. The three earliest centres of pottery-making are known in the European part of Russia. From there, the 'cultural impulses' spread to the Upper Volga region as a result of migrations of the populations. The appearance of the first ceramic vessels on the Upper Volga is associated with the advancement of the population from the southern/south-eastern regions (*Nikitin 2008; Viskalin 2015*).

The conclusions on the movements of groups of people who mastered the skills of making ceramic pottery are based on studies of the technology and ornamentation of ceramics. No detailed comparison of the Mesolithic with the Early Neolithic stone industry based on the types of tools has been so far conducted for the Volga-Oka interfluve region. It is believed that, in similar natural climatic and economic conditions, a difficulty arises in identification of cultural variations in the lithic assemblages on the Mesolithic/Neolithic turn (*Nikitin 2008.308*). Meanwhile, the necessity of such a comparison is clear since the heterogeneity in the typological composition of the Final Mesolithic and Early Neolithic tool assemblages can suggest either mass changes in the population (migrations) or one-time infiltrations (*e. g.*, marital connections or guest contacts).

The dated sites with relatively 'pure' complexes of the Final Mesolithic period on the Upper Volga include those (Tab. 9): Bezvodnoye 10, Berendeyevo 3, Zamostje 2/Upper Mesolithic layer, Ivanovskoye VII/IIa, Nushpoly 11, Ozerki 5/IV, Okayomovo 4/III, Okayomovo 5, and Okayomovo 18a (Tab. 9). Based on the results of palynologic analysis, materials from the sites Novoshino and Yelin Bor/II (*Kol'tsov, Zhilin 1999.72*), (Fig. 1) are dated to the beginning of the Atlanticum. A comparison of the types of tools typical of the final Mesolithic and early Neolithic of the region is shown in Figures 5 and 6.

No differences are traceable in the primary knapping when compared with the preceding period. Com-

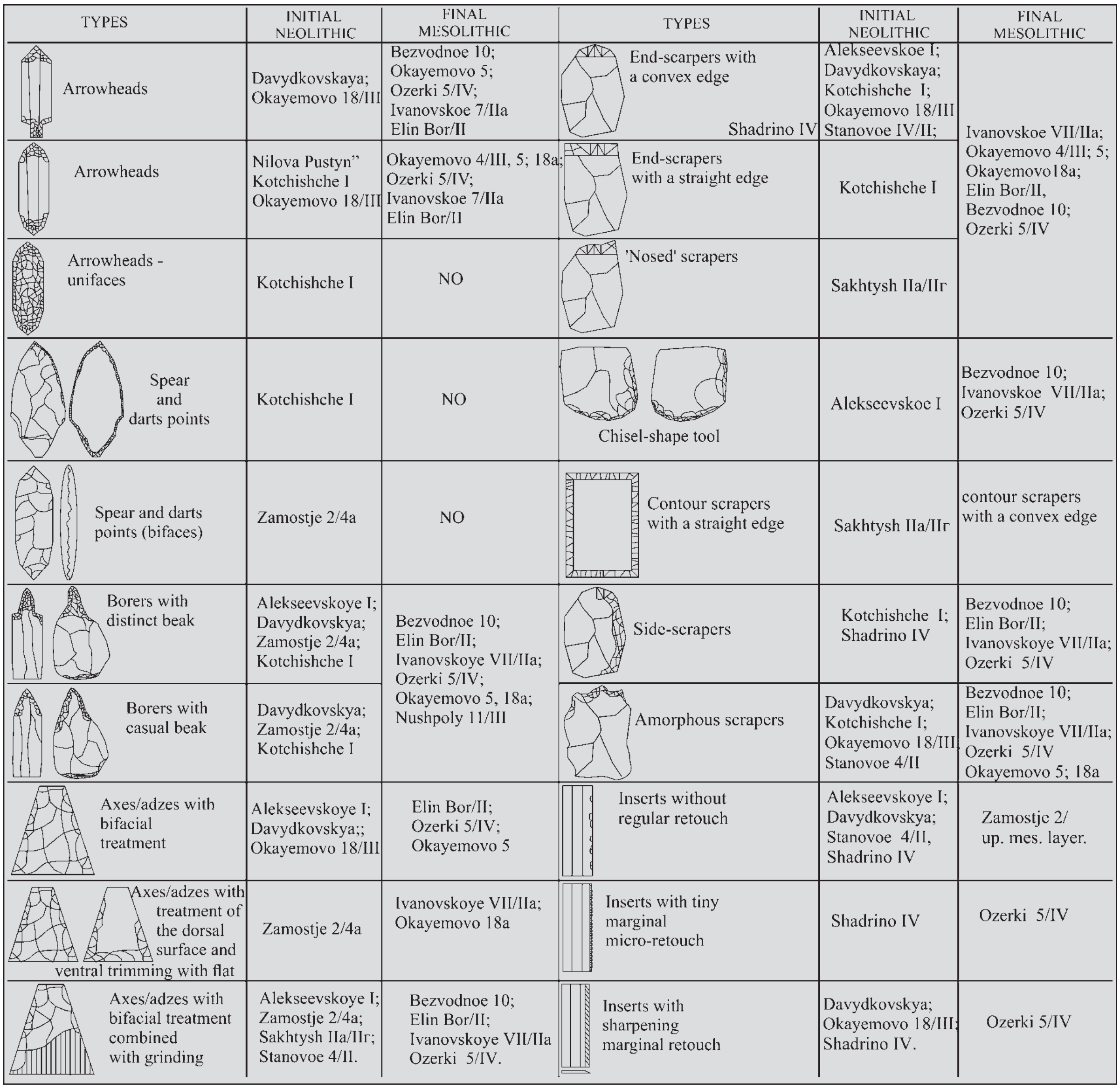
No.	Sites	Age (BP)	Age (cal BC)	Index	Sample	Source
1	Bezvodnoye 10	6920±380	6607–5191	GIN-5442	charcoal	1
2	Berendeevo 3	7770±100	6843–6436	LE-1556	wooden platform	1
3	Zamostje 2/up. mes. layer	7450±100	6467–6088	GIN–6565	peat	2
4	Zamostje 2/up. mes. layer	7200±90	6247–5892	GIN–7988	bone	2
5	Zamostje 2/up. mes. layer	7380±60	6392–6094	GIN–6565	wood	2
6	Zamostje 2/up. mes. layer	7050±60	6033–5789	GIN–10068	wood	3
7	Zamostje 2/up. mes. layer	7270±120	6406–5973	LE–9524	wood	3
8	Zamostje 2/up. mes. layer	7350±45	6274–6079	LE–10090	wood	3
9	Zamostje 2/up. mes. layer	7380±60	6392–6094	GIN-6201	wood	3
10	Zamostje 2/up. mes. layer	7400±75	6420–6095	LE–10260	wood	3
11	Zamostje 2/up. mes. layer	7440±60	6438–6214	LE–10092	wood	3
12	Zamostje 2/up. mes. layer	7450±70	6453–6211	LE–10091	wood	3
13	Zamostje 2/up. mes. layer	7460±20	6399–6327	LE–10094	wood	3
14	Zamostje 2/up. mes. layer	7100±120	6217–5743	GIN–10066	sapropel	3
15	Ivanovskoye VII/IIa	7530±150	6660–6064	GIN–9361	peat	4
16	Ivanovskoye VII/IIa	7320±190	6533–5836	GIN–9369	peat	4
17	Ivanovskoye VII/IIa	7375±170	6590–5974	LE–1261	peat	4
18	Ivanovskoye VII/IIa	7490±120	6535–6088	LE–1260	peat	4
19	Ivanovskoye VII/IIa	7520±60	6465–6248	GIN–9361	peat	4
20	Nushpoly 11	7310±40	6237–6072	GIN–6657	pole wood	5
21	Ozerki 5/IV	7410+90	6435–6084	GIN-6659	charcoal	1
22	Ozerki 5/IV	7120±50	6072–5897	GIN-7217	worked wood	6
23	Ozerki 5/IV	7190+180	6413–5737	GIN-6660	charcoal	6
24	Ozerki 5/IV	7310+120	6424–5989	GIN-7218	worked wood	6
25	Okayomovo 4/III	7490+50	6440–6246	GIN-6204	worked wood	1
26	Okayomovo 5	7910±80	7049–6629	GIN-6191	gyttja peat	1
27	Okayomovo 5	7730±60	6657–6457	GIN-6192	gyttja peat	1
28	Okayomovo 18a	7420±50	6422–6214	GIN-6656_	wooden pole	5

***Tab. 9. Radiocarbon dates for sites of the Final Meolithic in the Upper Volga region. Sources: 1* Kol'tsov, Zhilin 1999*; 2* Lozovskii 2003*; 3* Lozovskii *et al.* 2014*; 4* Zhilin *et al.* 2002*; 5* Zhilin 1997*; 6* Zhilin 2006.**

parison of the types of tools also demonstrates the absence of differences between the stone industries of the Final Mesolithic and Early Neolithic, suggesting a cultural continuity of the populations during these epochs. No new types of stone tools are known at the sites with the unornamented/simple puncture ware pottery. Vladimir M. Lozovskiy considered the appearance of the denticulate retouch as an Early Neolithic novelty (*Lozovskii, Mazurkevich 2014*). However, it is found only on the tools from Zamostje 2 in a layer containing mixed simple puncture, pseudo-corded and combed ware sherds. Such a rare use of this kind of retouching indicates that the denticulate retouching as a technique is classless for the early Neolithic of the Upper Volga basin.

The beginning of the Neolithic period on the Upper Volga is marked by the appearance of pottery at 7100–7000 BP without any transformation of the stone industry. The first pottery in combination with the blade- and flake-based industry was in use until 6500–6400 BP. It is obvious that the stone assemblage and pottery of that chronological span differ from the later Early Neolithic complexes of the Upper Volga region (phases II and III of the development of the Upper Volga culture). Tsetlin proposed a designation of *Volga-Oka archaeological culture* for the artefacts of the Initial Neolithic (*Tsetlin 1996*). However, it must be considered as a Final-Mesolithic culture, and pottery appears in its later stage. Its lower chronological limit is defined by the appearance of pottery about 7100–7000 BP, while the upper one by the appearance of the technology of making thin bifaces and the distribution of ware with pseudo-corded and combed ornamentation along with the disuse of insert weapons at about 6500–6400 BP.

In the territories adjacent to the Upper Volga region archaeologists also note the appearance of flake stone industries, points of arrows/darts and biface knives at *c.* 6500 BP, together with a synchronous spread of traditions of manufacturing comb-ware pottery made of clay mass with a complex composition (*Tsvetkova 2014c.368*). Both of the categories of sources bear a distinct typological similarity with the artefacts of the Upper Volga. An exception is the Karamyshevo culture on the Upper Don. It is characterized by a flake-based stone industry and ceramics with puncture-ware ornamentation. However the question of the type of stone industry of the Kara-



TYPES	INITIAL NEOLITHIC	FINAL MESOLITHIC	TYPES	INITIAL NEOLITHIC	FINAL MESOLITHIC
Arrowheads	Davydkovskaya; Okayemovo 18/III	Bezvodnoe 10; Okayemovo 5; Ozerki 5/IV; Ivanovskoe 7/IIa Elin Bor/II	End-scarpers with a convex edge Shadrino IV	Alekseevskoe I; Davydkovskaya; Kotchishche I; Okayemovo 18/III Stanovoe IV/II;	Ivanovskoe VII/IIa; Okayemovo 4/III; 5; Okayemovo18a; Elin Bor/II, Bezvodnoe 10; Ozerki 5/IV
Arrowheads	Nilova Pustyn'' Kotchishche I Okayemovo 18/III	Okayemovo 4/III, 5; 18a; Ozerki 5/IV; Ivanovskoe 7/IIa Elin Bor/II	End-scrapers with a straight edge	Kotchishche I	
Arrowheads - unifaces	Kotchishche I	NO	'Nosed' scrapers	Sakhtysh IIa/IIr	
Spear and darts points	Kotchishche I	NO	Chisel-shape tool	Alekseevskoe I	Bezvodnoe 10; Ivanovskoe VII/IIa; Ozerki 5/IV
Spear and darts points (bifaces)	Zamostje 2/4a	NO	Contour scrapers with a straight edge	Sakhtysh IIa/IIr	contour scrapers with a convex edge
Borers with distinct beak	Alekseevskoye I; Davydkovskya; Zamostje 2/4a; Kotchishche I	Bezvodnoe 10; Elin Bor/II; Ivanovskoye VII/IIa; Ozerki 5/IV; Okayemovo 5, 18a; Nushpoly 11/III	Side-scrapers	Kotchishche I; Shadrino IV	Bezvodnoe 10; Elin Bor/II; Ivanovskoye VII/IIa; Ozerki 5/IV
Borers with casual beak	Davydkovskya; Zamostje 2/4a; Kotchishche I		Amorphous scrapers	Davydkovskya; Kotchishche I; Okayemovo 18/III Stanovoe 4/II	Bezvodnoe 10; Elin Bor/II; Ivanovskoye VII/IIa; Ozerki 5/IV Okayemovo 5; 18a
Axes/adzes with bifacial treatment	Alekseevskoye I; Davydkovskya;; Okayemovo 18/III	Elin Bor/II; Ozerki 5/IV; Okayemovo 5	Inserts without regular retouch	Alekseevskoye I; Davydkovskya; Stanovoe 4/II, Shadrino IV	Zamostje 2/ up. mes. layer.
Axes/adzes with treatment of the dorsal surface and ventral trimming with flat	Zamostje 2/4a	Ivanovskoye VII/IIa; Okayemovo 18a	Inserts with tiny marginal micro-retouch	Shadrino IV	Ozerki 5/IV
Axes/adzes with bifacial treatment combined with grinding	Alekseevskoye I; Zamostje 2/4a; Sakhtysh IIa/IIr; Stanovoe 4/II.	Bezvodnoe 10; Elin Bor/II; Ivanovskoye VII/IIa Ozerki 5/IV.	Inserts with sharpening marginal retouch	Davydkovskya; Okayemovo 18/III; Shadrino IV.	Ozerki 5/IV

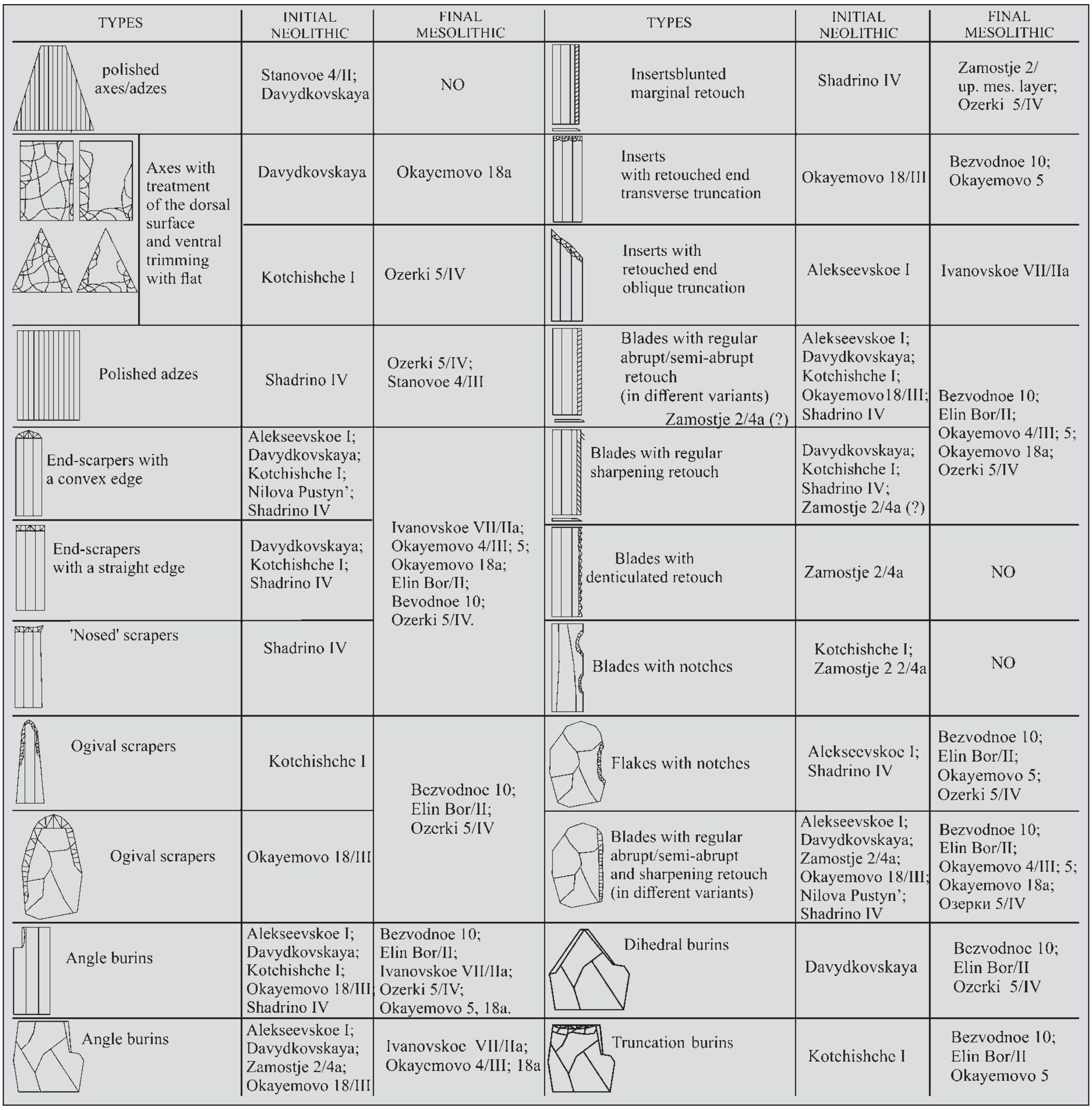
Fig. 5. Comparative characteristic of the tools types from the sites of the Early Neolithic and the Final Mesolithic (composed by the author).

myshevo archaeological culture still remains open, because of the absence of clearly stratified multi-layer sites in the upper reaches of the Don (*Tsvetkova 2011.133*).

Thus we are dealing with a situation where very similar features of the stone assemblages and pottery are encountered throughout a vast territory. Their similarity, despite belonging to different archaeological cultures, is so significant (*Nikitin 2008*) that there is no possibility to define the boundaries of their areas. Valeriy V. Nikitin characterizes the interrelations between the bearers of the initial Neolithic cultures of the forest and forest-steppe zones as kindred ones, and proposes considering archaeological cultures of the initial Neolithic in this territory as parts of a single historical and cultural unity (*Nikitin 2008.310*). While this idea seems logical and reasonable, a question arises as to the territorial boundaries of the community of the early simple puncture-ornamented ware, since it is also a marker of the initial phase of the Early Neolithic far beyond the limits of the Volga basin.

Conclusions

The transition from the Mesolithic to the Neolithic on the Upper Volga according to the results of the stone assemblage studies of the Final Mesolithic and Initial Neolithic must be associated with sporadic contacts between the autochthonous population and the bearers of the skills of manufacturing clay ware



TYPES	INITIAL NEOLITHIC	FINAL MESOLITHIC
polished axes/adzes	Stanovoe 4/II; Davydkovskaya	NO
Axes with treatment of the dorsal surface and ventral trimming with flat	Davydkovskaya	Okayemovo 18a
	Kotchishche I	Ozerki 5/IV
Polished adzes	Shadrino IV	Ozerki 5/IV; Stanovoe 4/III
End-scarpers with a convex edge	Alekseevskoe I; Davydkovskaya; Kotchishche I; Nilova Pustyn'; Shadrino IV	Ivanovskoe VII/IIa; Okayemovo 4/III; 5; Okayemovo 18a; Elin Bor/II; Bevodnoe 10; Ozerki 5/IV.
End-scrapers with a straight edge	Davydkovskaya; Kotchishche I; Shadrino IV	
'Nosed' scrapers	Shadrino IV	
Ogival scrapers	Kotchishche I	Bezvodnoe 10; Elin Bor/II; Ozerki 5/IV
Ogival scrapers	Okayemovo 18/III	
Angle burins	Alekseevskoe I; Davydkovskaya; Kotchishche I; Okayemovo 18/III; Shadrino IV	Bezvodnoe 10; Elin Bor/II; Ivanovskoe VII/IIa; Ozerki 5/IV; Okayemovo 5, 18a.
Angle burins	Alekseevskoe I; Davydkovskaya; Zamostje 2/4a; Okayemovo 18/III	Ivanovskoe VII/IIa; Okayemovo 4/III; 18a

TYPES	INITIAL NEOLITHIC	FINAL MESOLITHIC
Insertsblunted marginal retouch	Shadrino IV	Zamostje 2/ up. mes. layer; Ozerki 5/IV
Inserts with retouched end transverse truncation	Okayemovo 18/III	Bezvodnoe 10; Okayemovo 5
Inserts with retouched end oblique truncation	Alekseevskoe I	Ivanovskoe VII/IIa
Blades with regular abrupt/semi-abrupt retouch (in different variants) Zamostje 2/4a (?)	Alekseevskoe I; Davydkovskaya; Kotchishche I; Okayemovo18/III; Shadrino IV	Bezvodnoe 10; Elin Bor/II; Okayemovo 4/III; 5; Okayemovo 18a; Ozerki 5/IV
Blades with regular sharpening retouch	Davydkovskaya; Kotchishche I; Shadrino IV; Zamostje 2/4a (?)	
Blades with denticulated retouch	Zamostje 2/4a	NO
Blades with notches	Kotchishche I; Zamostje 2 2/4a	NO
Flakes with notches	Alekseevskoe I; Shadrino IV	Bezvodnoe 10; Elin Bor/II; Okayemovo 5; Ozerki 5/IV
Blades with regular abrupt/semi-abrupt and sharpening retouch (in different variants)	Alekseevskoe I; Davydkovskaya; Zamostje 2/4a; Okayemovo 18/III; Nilova Pustyn'; Shadrino IV	Bezvodnoe 10; Elin Bor/II; Okayemovo 4/III; 5; Okayemovo 18a; Озерки 5/IV
Dihedral burins	Davydkovskaya	Bezvodnoe 10; Elin Bor/II Ozerki 5/IV
Truncation burins	Kotchishche I	Bezvodnoe 10; Elin Bor/II Okayemovo 5

Fig. 6. Comparative characteristic of the tools types from the sites of the Early Neolithic and the Final Mesolithic (composed by the author).

with simple-puncture ornamentation. Most possibly, the first ware penetrated into the region ready-made, as is suggested by (1) the small number of vessels at the sites, (2) finds of flat bases of technologically completely modelled pottery uncharacteristic of the forest Neolithic, and (3) temper of coarse-sized chamotte in the earlier ware, suggesting an advanced technology of pottery-making based on the tradition of the use of 'old' ware. Since the earliest pottery appears on the Upper Volga virtually simultaneously without traces of its local manufacture, it is quite evident that it was imported. The absence of differences between the stone industries of the Final Mesolithic and Initial Neolithic on the Upper Volga demonstrates that there was no massed inflow of people to this region. Otherwise, in the stone industry of the Early Neolithic, new types of tools and, possibly, new techniques of working stone would have emerged that is not observed in reality.

Considering the cultural status of the materials of the Initial Neolithic of the Upper Volga region, it must be recognized that the Volga-Oka artefacts can neither be attributed to a particular archaeological culture nor to some conventional unit of subdivision of archaeological evidence, implying "*an aggregate of materials (complexes and separate finds) from one or, more often, many sites characterized, on the one hand, by an internal uniformity while, on the other hand, it markedly differs in its character and* *the types of artefacts represented in it from the complexes not included into it*" (*Vasil'ev* et al. *2007. 230*). The absence of assemblages of culture-defining tools among the artefacts of the Initial Neolithic of the Upper Volga region and adjoining territories, on the one hand, and, on the other, the impossibility of defining distinct borders of the areas of archaeological cultures of that period suggest a single cultural unity of the early puncture-ware pottery. This unity is characterized by a blade- and flake-based stone techno-complex as "*an aggregate of archaeological sites/groups of sites distinguishable at one level of archaeological periodization within definite space-time and environmental limits*" (*Lisitsyn 2014.91*). The archaeological cultures now known should be considered as conventional geographic subdivisions of the cultural *oecumene* of the early puncture-ware pottery, each of which possesses individual features within common technological lithic and pottery-making traditions.

Having got into the Mesolithic environment, the tradition of manufacture of early simple puncture-ware was of no long duration, being interrupted by the inflow of people possessing the skills of manufacturing pottery with comb-ware ornamentation made of clay mass with a complex composition. The episodes characterized by the appearance (7100/7000–6800 uncal BP) and distribution (6800–6400 uncal BP) of pottery with sparse simple-puncture ornamentation (*Zaretskaya, Kostyleva 2008.13*) without essential changes in the form of stone and bone artefacts can be considered as a transition period between the Mesolithic and Neolithic representing the process of Neolithisation. The transition to the Neolithic marked by a change of the economic structure, formation of a local centre of pottery-making and distribution of the technique of manufacturing thin bifaces took place later, and was related with the replacement of the population on the Upper Volga about 6500–6400 BP.

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The first *vs.* second stage of neolithisation in Polish territories (to say nothing of the third?)

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ABSTRACT – *The origins of the Neolithic in Polish territories are associated with migrations of groups of the Linear Band Pottery culture (LBK) after the mid-6th millennium BC. Communities of this culture only settled in enclaves distinguished by ecological conditions favourable to farming ('LBK neolithisation'). This situation persisted into the 5th millennium BC, when these enclaves were inhabited by post-Linear groups. This state of affairs changed from* c. *4000 BC onwards due to the formation and spectacular territorial expansion of the Funnel Beaker culture (TRB). In the territories under consideration this expansion covered the areas previously inhabited by both hunter-gatherers ('TRB neolithisation') and farmers. Some of the Late Mesolithic hunter-gatherers did not accept TRB patterns. They successfully carried on their traditional lifestyle until the Early Bronze Age although some changes in their material culture are visible (including 'ceramisation').*

KEY WORDS – *Poland; neolithisation; LBK; TRB; para-Neolithic*

Primerjava prve in druge stopnje neolitizacije na območju Poljske (da o tretji sploh ne govorimo)

IZVLEČEK – *Začetki neolitika na območju Poljske so povezani z migracijami skupin linearno trakaste kulture (LTK) v drugi polovici 6. tisočletja pr. n. št. Te skupine so se naselile v enklavah, za katere so značilne ekološke razmere ugodne za kmetijsko ('neolitizacija LTK'). Takšno stanje se je ohranilo do 5. tisočletja pr. n. št., ko so te enklave poselile po-linearne skupine. Poselitev se je bistveno spremenila šele od ok. 4000 pr. n. št. naprej z oblikovanjem in spektakularnim širjenjem nosilcev kulture lijakastih čaš. Na Poljskem je ta poselitev zajela tudi območja, ki so jih pred tem poseljevali tako lovci in nabiralci ('neolitizacija kulture lijakastih čaš') kot poljedelci. Nekatere skupine pozno mezolitskih lovcev in nabiralcev niso sprejele vzorca kulture lijakastih čaš in so uspešno ohranili svoj način življenja vse do zgodnje bronaste dobe, čeprav lahko zaznamo nekatere spremembe v njihovi materialni kulturi (tudi 'keramizacijo').*

KLJUČNE BESEDE – *Poljska; neolitizacija; linearno trakasta kultura; kultura lijakastih čaš; para-neolitik*

The present-day territory of Poland (Fig. 1) was and is situated in the borderland of different environmental (*Rdzany 2014*) but also different cultural, prehistoric, and historic formations (*Davies 2005*). In the period discussed here this resulted in different types of Neolithic culture, and different faces of neolithisation. These variants of the Neolithic and neolithisation developed in parallel for a relatively long time, coming into various interactions in the process. This situation is fairly unique for the entire European continent.

As in other parts of Central Europe, the origins of the Neolithic in the region in question are associated with the appearance of the Linear Band Pottery culture (LBK) (Fig. 2) after the mid-6th millennium

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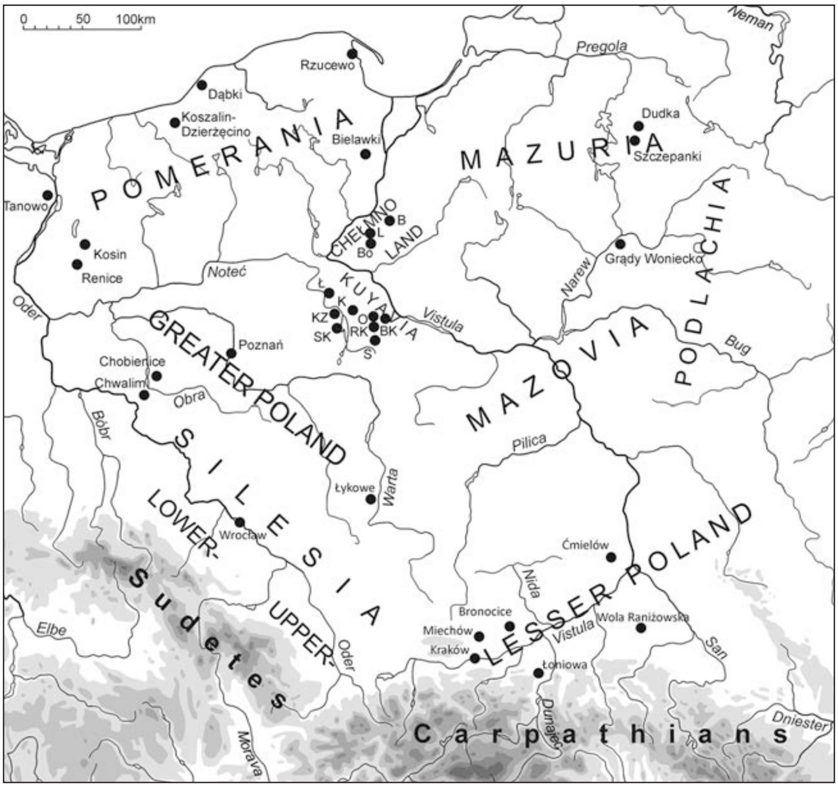


Fig. 1. The location of the study area with archaeological sites and towns mentioned in the text and figures (*B *Boguszewo,* Bo *Bocień,* BK *Brześć Kujawski,* K *Konary,* KZ *Krusza Zamkowa,* L *Lisewo,* Ł *Łącko,* O *Osłonki,* RK *Redecz Krukowy,* S *Sarnowo,* SK *Strzelce Krzyżanna).

BC (*Czekaj-Zastawny 2008; 2009; 2017; Grygiel 2004; Kulczycka-Leciejewiczowa 2000; Pyzel 2010*). We still do not have genetic data from the 'Polish' LBK. However, such data from nearby Hungary, Austria, and Germany (*Ammerman* et al. *2006; Bramanti* et al. *2009; Brandt* et al. *2015; Burger* et al. *2006; Haak* et al. *2005; 2010; 2015; Lazaridis* et al. *2014; Lipson* et al. *2017; Mathieson* et al. *2018; Szécsényi-Nagy* et al. *2015*) demonstrate genetic dissimilarities between LBK and central-European, hunter-gatherer populations and the predominance of the so-called north-western Anatolian Neolithic component among the former ones. In conjunction with distinct similarities and even uniformities in material culture between the LBK north and south of the Carpathians and Sudetes (compare, for example, *Czekaj-Zastawny 2014; 2017;* and *Pavlů, Zápotocká 2007; 2013*), this makes migrations from the south the most probable scenario of the origins of the LBK in Polish territories. On the other hand, a very modest but quite pervasive proportion of hunter-gatherer ancestry in quoted, European genetic data (*i.e.* including even the Balkan Neolithic) should be emphasized. Thus, some contacts between incoming early farmers and local hunter-gatherers had to exist, even if these were only casual sexual contacts. It is also characteristic that participation of the hunter-gatherer component is higher in Germany than in Transdanubia (*Lipson* et al. *2017*). This would mean that during the LBK spread outside the 'cradle' area, the Neolithic-Mesolithic contacts became more intense. Consequently, such a scenario can be also applied to the LBK spread in the Vistula and Oder basins.

Perhaps it is worth noting here that genetic data obtained in the 21st century have demonstrated that classical constructs – deriving inter alia from the works by Vere G. Childe (*e.g., 1929; 1947*) as well as Albert J. Ammerman and Luigi L. Cavalli-Sforza (*e.g., Ammermann, Cavalli-Sforza 1984; Cavalli-Sforza* et al. *1994*) – which presented the LBK as a continuation of the Anatolian-Balkan First Neolithic, in principle seem to be true (*cf. Hofmann 2015*). Certainly, many details of these constructs were amended or eradicated due to new data, both genetic and archaeological ones. For instance, the crystallisation processes of the LBK that took place in the north-western parts of the Carpathian Basin filtered and changed the First Temperate Neolithic (FTN) cultural pattern (*e.g., Bánffy 2004; 2006; 2019; Bickle* et al. *2013; Stadler, Kotova 2010; Whittle* et al. *2013*), regardless of how they are interpreted. However, for a follower of the allochtonic position the 'Mesolithic' hypotheses, which assumed substantial or even exclusive role of Mesolithic acculturation (*e.g., Bánffy 2004; 2006; Bánffy* et al. *2007; Bentley* et al. *2013; Mateiciucová 2008; Whittle 1996. 150–152*), currently do not seem particularly convincing. Perhaps it is characteristic that in the very recent publication by Eszter Bánffy (*2019*) the particular emphasis has been placed on transformations between Starčevo-Körös and LBK in the patterns of architecture and husbandry.

As a matter of fact, the latter hypotheses have never become fully entrenched in Central European culture-historical archaeology (*cf. Gronenborn 2007*).

Therefore, the followers of the culture-historical approach may undoubtedly take some satisfaction from the fact that its traditional analytical methods have proven to be not so completely useless after all. This does not mean that the consciously and unconsciously used paradigms of culture-historical archaeology, relevant in this context, should always be considered as true. To such paradigms belong, for example, convictions about the decisive role of migration in cultural changes and – as a consequence – the negligible participation of hunter-gatherers in neolithisation.

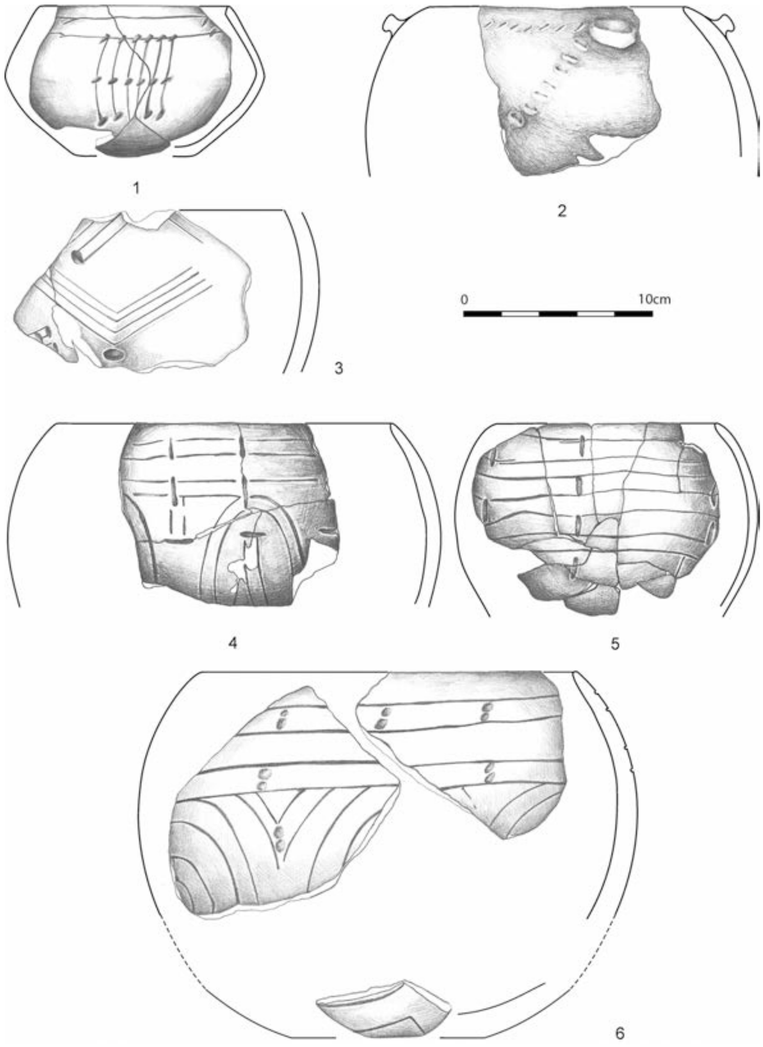


Fig. 2. Examples of the LBK pottery from site 3 in Miechów (drawn by S. Krishnevskaya; layout by U. Bąk).

In light of the currently available radiocarbon dates we can draw a picture of a very rapid initial expansion that started in western Lesser Poland and proceeded along the Vistula River to Kuyavia and Chełmno Land as well as eastward, to the upper Bug River basin (Fig. 3). In both cases this expansion basically took place in the 54th century BC. This fits very well to the scheme proposed a few years ago by Janos Jakucs *et al.* (*2016*), despite the fact that their research hardly used absolute dates of the LBK from Poland. Another axis of LBK migrations – Wrocław – Poznań – Kuyavia/Chełmno Land/Western Pomerania – started to function later. One way or another, this means that the beginnings of LBK in Polish territories, and not only here (*cf. Jakucs* et al. *2016*), should be placed later than previously believed, that is around 5400 BC at the earliest. In the cited publication the beginnings of the LBK 'formative phase' around 5500 BC, or perhaps within the 56th century BC, are referred only to Transdanubia and Lower Austria (*Jakucs* et al. *2016.323–324, 329*).

One should also raise another issue here, one not related to the territory of present-day Poland alone. When speaking of the LBK, we usually have in mind the image of a great LBK 'empire', stretching continuously from the Paris Basin to western Ukraine, and even to Moldova and the eastern part of Wallachia. This is mainly due to a map developed by Jens Lüning (*1988*), later repeatedly reproduced and used in many publications (*e.g., Bogucki, Grygiel 1993*), although this was naturally not the only cartographic depiction functioning in the literature (*e.g., Price, Bentley 2005.Fig. 3*). However, Lüning's map is a far-reaching simplification, because the real picture of LBK distribution looks quite different. Communities of that culture first and foremost settled zones with a prevalence of ecological conditions favourable to farming. As a consequence, LBK sites distinctly concentrate within enclaves ('islands') of different sizes, even very small ones. Such enclaves were separated by vast areas with either a very low density of LBK settlement or literally deprived of it (*e.g., Czekaj-Zastawny 2009; Kulczycka-Leciejewiczowa 1993*). The patchy character of the early farming spread was certainly noticed (*cf. Robb 2013. 658*), but it was reflected relatively poorly in general interpretations.

As a matter of fact, the appealing idea, one that is repeatedly presented in such general contributions,

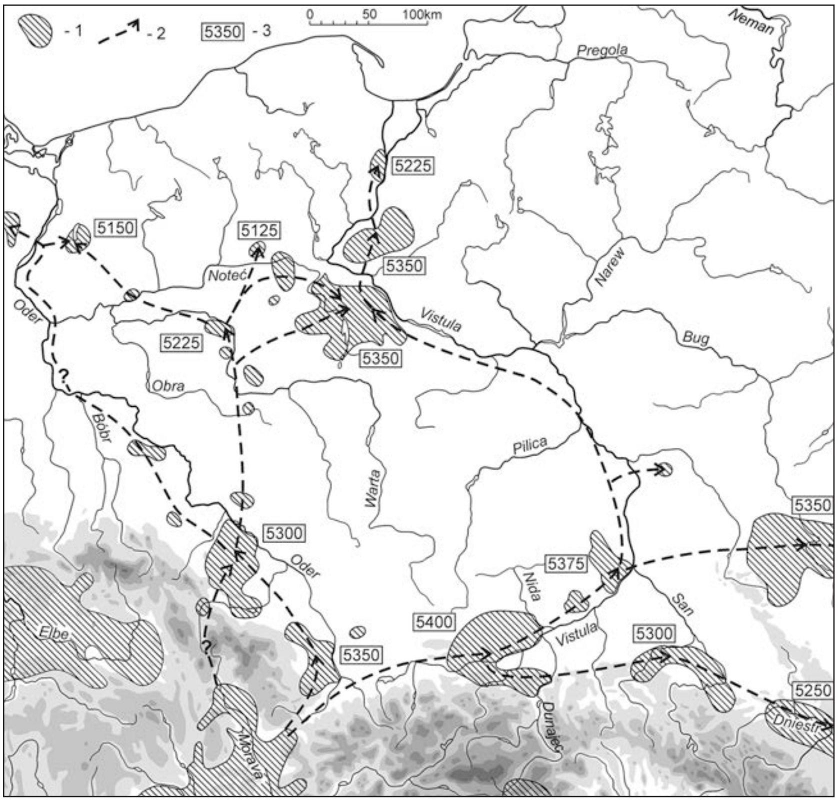


Fig. 3. The spread of the LBK in Polish territories. 1 enclaves settled by the LBK communities (in the period of greatest territorial extent,* i.e. *in the classical and late phases); 2 basic routes of migrations of the LBK groups (in the period of stabilisation they became axes of contacts between settlement enclaves); 3 averaged datings of the appearance of the LBK in a given area.

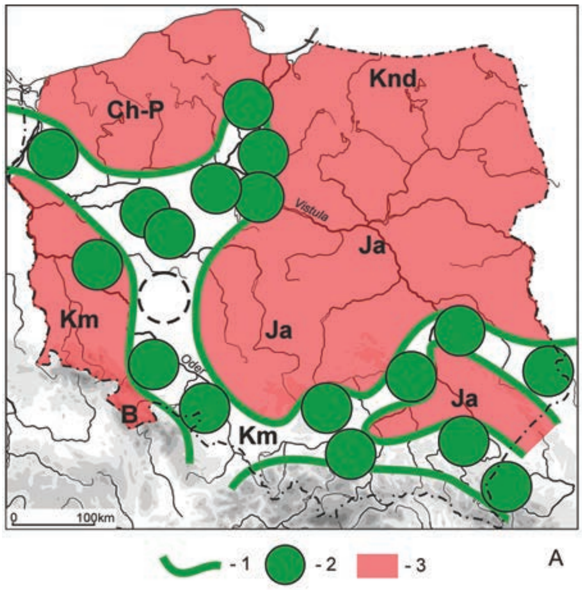
of a single, uninterrupted front between the Neolithic and Mesolithic populations running latitudinally across the whole of Central Europe (*e.g., Fernández* et al. *2014; Silva, Vander Linden 2017*) is untrue. In fact, the borderline between these two formations was incomparably longer and had a far more complex course, particularly during the peak of LBK development. The relation between these two cultural entities can also alternatively be presented as a co-existence of two communication systems (Fig. 4) (*Kozłowski, Nowak 2018a; 2018b*). On the other hand, one should emphasize that LBK communities did not cling to the most fertile soils. Recent years have produced a growing body of LBK finds from sandy soils, and not only from lowlands. Strikingly, however, these sites are always situated close to fertile soils, not further than a few kilometres away, and sometimes simply in sandy enclaves within such soils (*e.g., Pyzel 2010*).

As in other central European countries, the LBK in Poland comprises all elements of what is known as the Neolithic Package (*Czekaj-Zastawny 2017; Grygiel 2004*). It is significant (particularly from the perspective of the LBK origins) that these elements, in full suite and in evident predominance, are distinctly recordable even from the very beginning of this culture. In other words, the LBK appeared in Polish territories as a developed, operational cultural model. We can only express, one more time after many authors, our bewilderment at the far-reaching stylistic uniformity within the archaeological unit that covered vast territories of central Europe, including Poland, and some neighbouring areas. Significant similarities in terms of diet, health conditions and residence patterns have also been underlined (*e.g., Hedges* et al. *2013*). This does not mean that all LBK constituents were identical, and that there were no local specificities and outliers (*Whittle, Bickle 2013*).

It is somewhat paradoxical that in the archaeological literature the LBK constitutes perhaps the most textbook example of a Neolithic formation and Neolithic Package in central Europe, despite its early position within this period. This is perhaps best illustrated by highly typical LBK houses, commonly called longhouses (although not all of them are actually long) (Fig. 5). As a matter of fact, they are the most solid, durable, and evident house constructions throughout the whole central European Neolithic (*sensu largo*, *i.e.* including also the Eneolithic). One may wonder whether this implies some unique position of such houses in the settlement and social structures of LBK communities. Unfortunately, although these structures have been very comprehensively described and many interesting interpretations have been proposed (*e.g., Hamon* et al. *2013; Lüning 1988; Modderman 1988; Oross* et al. *2016; Pavlů 2000; Pyzel 2010; 2012; Rück 2007; 2012; Werra 2010; 2012*), one can hardly argue that this has brought us closer to any clear conclusions concerning their function or even the number of people living in such houses. The remains of perhaps more than 500 have already been uncovered in Poland. They are known from LBK settlements of different sizes and are situated in different environments. Nevertheless, one should emphasize that there are sites where remains of such houses have not been identified (Fig. 6). It is hard to solve the problem whether in all such cases these remains were destroyed by erosional processes or there existed some LBK settlements without longhouses.

Cultural and spatial arrangements typical for Polish territories during the LBK period also persisted in the 5th millennium BC. Different Neolithic groups of a post-Linear character, which traditionally have also been called Younger Danubian Communities, still concentrated within the same enclaves (*Kadrow 2017; Nowak 2009*). As in other areas previously occupied by the LBK, the uniformisation of pottery can no longer be observed (*cf. Robb 2013.665*), a phenomenon which was already detectable at the close of the LBK development[1]. In other aspects of the cultural system, however, no radical transformation can be seen. The fundamental patterns of settlement and economy seem to have remained largely unchanged. For example, situations where sites used in the LBK period were also used, albeit not necessarily uninterruptedly, by Younger Danubian communities, were commonplace (see for instance again Miechów 3 – Figs. 7, 8). Undoubtedly, some areas outside these enclaves were penetrated and even settled and exploited by Neolithic groups, like some parts of Greater Poland, eastern Pomerania or even Mazuria. However, this does not undermine the fact that until the end of the 5th millennium BC at least approx. 70% of the territory under discussion still remained beyond the extent of compact Neolithic settlement (*Kozłowski, Nowak 2018b*).

However, in the second half of the 5th millennium BC pottery appears outside the context of Younger Danubian communities. Technologically and stylistically it stands very close to east-European Neolithic units, for instance the Dnieper-Doniec or Narva cultures. We should mention here early Zedmar ceramics in the Masurian Lake District (*Kozicka 2017*),



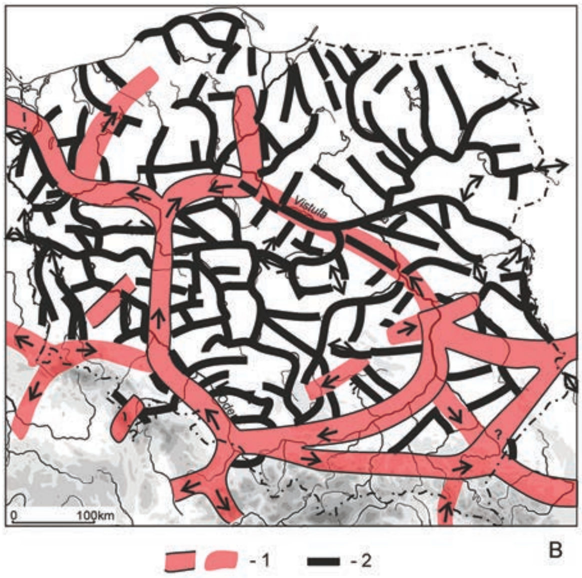


Fig. 4. Confrontation of the first farmers and the late hunter-gatherers in east-central Europe (*Kozłowski, Nowak 2018b*). A the first contact: the LBK (1–2) and the Late Mesolithic cultures (3) (B Beuronien, Km Komornica, Ch-P Chojnice-Pieńki, Ja Janisławice, Knd Kunda); B the road map of the 6th millennium BC (1 the Early Neolithic 'motorways' and delivery roads; 2 the Mesolithic paths).

1 The side effect is that a number of cultural units have been distinguished in the archaeology of Poland in the 5th millennium BC, some of which are rather poorly defined. This drives discussions on taxonomical divisions, with new propositions overlying previous ones. For example, the same archaeological phenomenon is referred to as the Brześć Kujawski group, Brześć Kujawski culture, Late Linear Band Pottery culture (phases II and III), Brześć Kujawski group of the Lengyel culture, *etc*. Since these discussions are generally carried out only in Polish-language literature, they remain largely unknown outside this milieu. As a result, archaeologists from other countries may have an impression of terminological chaos, and sometimes use some of the terms in a simply incorrect manner (*e.g.*, regarding the above-mentioned cultural unit as a late phase of LBK). Perhaps the best remedy for this situation (regardless of the general terms mentioned above, such as post-Linear or Younger Danubian Communities) is to apply the most classic approach, in which the decline of LBK is followed by the development of the Stroked Pottery culture in western Poland in the first half of the 5th millennium BC, and the so-called Lengyel-Polgár cycle/complex. The latter term covers more than a dozen smaller groups developing in the 5th and early 4th millennia BC throughout most of Poland (within the enclaves discussed in the text). The trait shared by these groups is their strong dependence on cultural patterns created in that time in the Lengyel and Tisa cultural centres.

Fig. 5. Examples of the LBK longhouses from different environmental zones. **A *upland zone (Brzezie 17;* Czekaj-Zastawny, Zastawny 2006*); B mountainous zone (Łoniowa 18;* Valde-Nowak 2009*); C lowland zone (1 Boguszewo 43a, 2 Bocień 5, 3 Lisewo 31;* Werra 2012*).***

and single vessels of the Dubičiai (Prypat'-Neman) type in north-east Poland (*Józwiak 2003; Kempisty, Sulgostowska 1991*) (Fig. 9).

As for the spread of this phenomenon, which was independent of the FTN/LBK and Cardial/Impressa neolithisations, it progressed, generally speaking, among local, hunter-gatherer populations by way of acculturation. This is also demonstrated by 'new' genetic data from the Baltic countries (*Mittnik* et al. *2018*) and slightly 'older' data, including several samples from north-east Poland (*Bramanti* et al. *2009*). Certainly, some movements of the hunter-gatherer groups cannot be ruled out.

However, it is necessary to underline that this east-European Neolithic, including the Polish sites, differs considerably from, for example, Balkan FTN or LBK or post-Linear units. In practice, it is pottery that constitutes the only element of the Neolithic Package present there (*e.g., Piezonka 2015; Rimantiene 1992; 1994*). In other words, in the eastern European literature the term 'Neolithic' has a very different meaning as compared to in the central or western European literature. Actually, we are dealing here with the incompatibility of notional apparatuses used with respect to the discussed period by different schools of research. More precisely, we are dealing with differently understood Neolithics, if we insist on using the term Neolithic at all.

To complicate the issue further, a similar phenomenon, *i.e.* the presence of pottery in the hunter-gatherer context dated to the 5th millennium BC, was recorded in the northern fringes of Poland (Fig. 10). One should mention in this context at least three sites: Tanowo (*Galiński 2016*), Dąbki (*Kabaciński* et al. *2015*), and Rzucewo (*Król 2018*). The beginnings of this phenomenon can be dated at *c.* 4800/4700 BC, at least in the case of Dąbki. The pottery in question is more or less similar to the pottery of the Ertebølle culture (EBK). Combined with the dating this is interesting, as this means that this pottery is not much later than the EBK proper (*Hartz, Lübke 2005; 2006; Hartz* et al. *2000; Terberger 2006*). We must not forget, however, that the dating of EBK and similar pottery is generally problematic due to the particularly strong impact of the marine reservoir effect. Nevertheless, it needs to be stressed that in Dąbki, Tanowo, and Rzucewo the pottery appears in the context of the local Mesolithic. In terms of the flint industry, this is not EBK but the post-Maglemose Chojnice-Pieńki culture, in its developed phase.

As regards these finds, from the eastern European perspective we could say that we are dealing here with neolithisation and the Neolithic. However, it is extremely telling that the investigators of Dąbki, Tanowo, or Rzucewo never used such terms. For them it was first and foremost an example of ceramisation of local Late Mesolithic groups. The same approach currently prevails with respect to several similar northern German sites, and actually to the entire EBK as such.

The relation between the Ertebølle pottery (*sensu largo*) and the pottery of the east-European Neolithic is another issue, and different views have been expressed in this respect (such as *Czerniak, Pyzel 2011; Dumpe* et al. *2011; Kabaciński, Terberger 2011*). These potteries are indeed similar, although no obvious intermediate link can be identified in the southern Baltic basin. Perhaps Dąbki could be such a link given the possibly early occurrence of pottery in this site. However, to discuss the issue in more detail is beyond the scope of this paper, and we only hint at a possible solution.

Contacts between farming and hunting-gathering groups seem to have been rather limited during the 5th millennium BC, similar to the situation in the second half of the 6th millennium BC. They are evidenced by single finds of pottery and stone tools belonging to older and younger 'Danubians' beyond their oecumene, including those in direct hunter-gatherer contexts (see, for example, the Neolithic pottery in Dąbki – *Czekaj-Zastawny 2015; Czekaj-Zastawny* et al. *2011; Dudka, Szczepanki-Gumiński 2011*).

Undoubtedly, it is worth paying a little more attention to some types of stone artefacts, which seem to reveal a little more about the potential Neolithic-Mesolithic relations at that time. Polished stone implements (axes and adzes) are a permanent element of the LBK cultural system, but also of the post-Linear ones (the latter fact is often forgotten). They were made mainly of Sudeten rocks, particularly amphibolites (*Cholewa 2004; Prostřednik* et al. *2005*). Sporadically, we can also find tools of this kind made of erratic rocks, which suggest that local production was rarely undertaken (*Prinke, Skoczylas 1980*). Stone tools from Sudeten rocks are widespread within the LBK and post-Linear units (*e.g., Ramminger 2009*). There had to exist an organized distribution network for them that served all clusters of 'Older' and 'Younger' Danubians, more or less distant from the Sudeten Mountains. Perhaps this system contributed to maintaining a mental and ideological commonality among these areas (the notion of an 'imagined community' proposed by Alasdair Whittle and Penny Bickle (*2013*) seems to be a good description of this phenomenon). We can suppose their non-utilitarian significance, due to their frequent presence in male graves. In this respect, let us mention the re-

Fig. 6. The LBK settlement at the multi-period site 3 in Miechów against the blurred background of features belonging to other archaeological units; the LBK features are highlighted by graphic symbols. 1 features with longer axis over 5m; 2 features with longer axis 3–5m; 3 features with longer axis 1–3m; 4 features with longer axis less than 1m; 5 extremely elongated features (mostly burials).

Fig. 7. The settlement of the Lublin-Volhynian culture (late stage of the Younger Danubian communities/Lengyel-Polgár complex) at the multi-period site 3 in Miechów against the blurred background of features belonging to other archaeological units; the Lublin-Volhynian features are highlighted by graphic symbols. 1features with longer axis over 5m; 2 features with longer axis 3–5m; 3 features with longer axis 1–3m; 4 features with longer axis less than 1m; 5 extremely elongated features.

cent, exceptionally interesting discovery of a cremation burial ground in Modlniczka 5 (*Czekaj-Zastawny, Przybyła 2012*), where stone adzes constituted the only category of grave goods (although, of course, the identification of sex was not possible there).

However, more important for us is the fact that these items are also present in areas beyond the compact range of the Linear and post-Linear settlements, stretching from the Netherlands to Pomerania and central Poland. By convention, these areas can be called a Mesolithic oecumene. The map published several times by Marek Zvelebil (*1998.Fig. 1.6; 2001.Fig. 4*) is very meaningful here, and should be supplemented for Poland with data by Kazimierz Siuchniński (*1969*), Andrzej Prinke and Janusz Skoczylas (*1980*) and Jolanta Ilkiewicz (*2005*). All these records show that numbers of finds of this kind are very high: probably hundreds, if not thousands.

The problem is that the vast majority of these finds are devoid of archaeological context, *i.e.* they were not found directly in Mesolithic sites. Danubian axes and adzes found directly in such contexts are rather rare, and are actually limited to only a few sites in northern Germany and Denmark, while in Poland only the site of Dąbki can be noted. This observation, however, confirms the supposition resulting from the cartography of 'Danubian' stone tools, which is that they in any case entered the Mesolithic environment. We can therefore hypothesize that these products were an element of Neolithic-Mesolithic interactions (mainly commercial?), which did not take into account the 'cultural' borders.

Another possible hint on Neolithic-Mesolithic contacts are Mesolithic traces in the maternal genetic pool of the Younger Danubian groups in Kuyavia (vide the sites of Osłonki, Konary, Krusza Zamkowa, Brześć Kujawski – *Juras* et al. *2017; Lorkiewicz* et al. *2015*), although, as stated in a recent study by Daniel M. Fernandes *et al.* (*2018*), the Brześć Kujawski group (excluding two outliers) is certainly composed of the same genetic component present among Anatolian and LBK Early Neolithic farmers.

Summing up the above discussion, one can conclude that, until the end of the 5th millennium BC, the cultural picture of Polish territories was shaped by three main components. First, there were enclaves settled by Older and Younger Danubian communities, which represented a complete Neolithic Package, as well as 'routes' and 'motorways' connecting them. Second, in the 5th millennium BC, most likely in its second half, the east-European Neolithic encroached from the east, while in the northern peripheries we can observe a similar process, this time according to the Ertebølle patterns. In both cases it was first and foremost the ceramisation of the local Mesolithic substratum. However, the adoption of pottery by hunter-gatherer groups was still a very local and limited phenomenon. Finally, the third component of this picture is obviously the late, non-ceramised Mesolithic communities, which in that time were still present everywhere (*Kozłowski, Nowak 2018a; 2018b; Nowak 2009*), even in the south (*Nowak* et al. *in press; Pazdur* et al. *2004*).

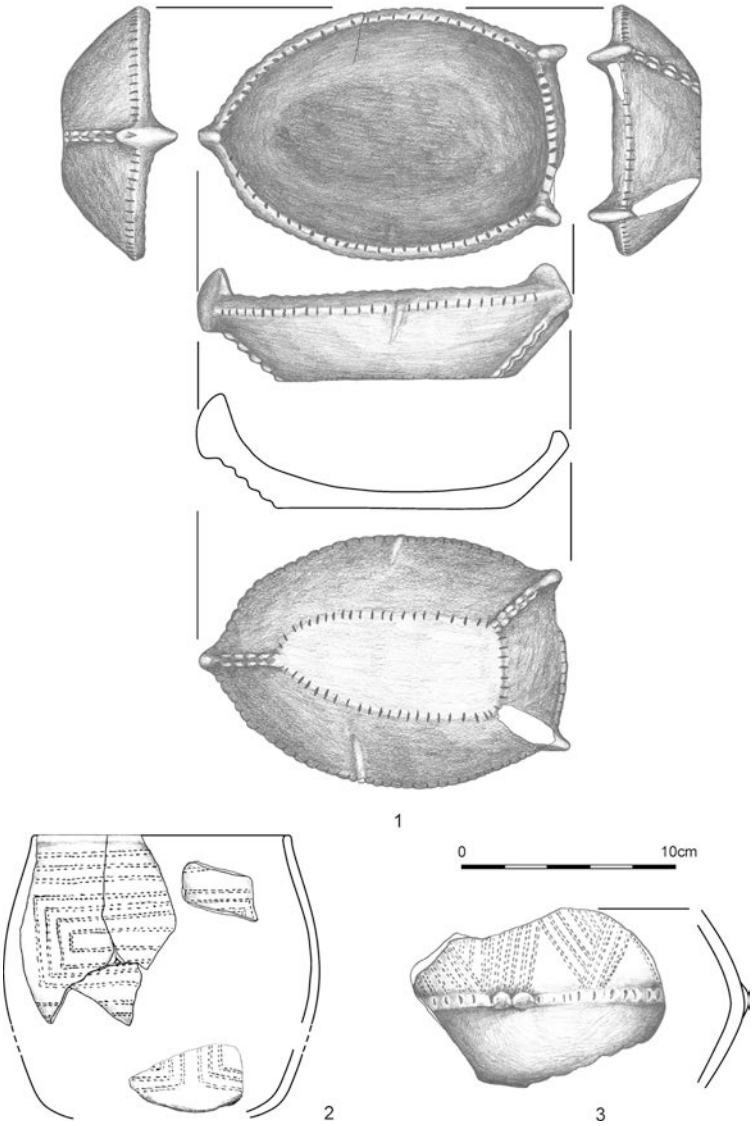


Fig. 8. Examples of pottery of the Malice culture (middle stage of the Younger Danubian communities/Lengyel-Polgár complex) from the site 3 in Miechów (drawn by S. Krishnevskaya; layout by U. Bąk).

From the late 5th millennium BC onwards, complex cultural transformations started to take place in the Vistula and Oder basins. They were associated with the spread of a new model of farming culture throughout most of the discussed part of Europe, and not only the above-mentioned fertile enclaves. This new model, known to archaeologists as the Funnel Beaker culture (TRB) (Fig. 11), actually covered a much larger area, from the Netherlands to western Ukraine, including the south-Scandinavian zone, where it marked the beginning of the Neolithic. In the Vistula and Oder basins, as in other territories within the TRB range, we can observe a phenomenon that can be called a filling-in of the landscape. A very large number of TRB sites are known, many more than those of the Danubian cultures (which in itself is puzzling), and they have been recorded in nearly all ecological zones, not only in the most fertile areas, as preferred by previous Neolithic settlement. This makes TRB the first Neolithic culture to have covered the previously not Neolithicized areas in the Vistula and Oder basins, which de facto means most of the territory of our interest. Therefore, this phenomenon, *i.e.* the spread of the 'Beaker' Neolithic to areas outside previous Neolithic (Danubian) occupation, was once called the second stage of Neolithisation (*Nowak 2001; 2009*). In the end, this process proved perhaps even more important than the first Neolithisation. One way or another the Neolithic formation eventually filled, in a relatively compact manner, the majority of the Polish territories around the mid-4th millennium BC.

As an example of this filling in of the landscape one can present the case of central Greater Poland (*Wierzbicki 2013*). There are more than 3100 TRB sites and fewer than 150 sites of LBK and Younger Danubian Neolithic in the region, with TRB sites covering this area more or less uniformly (Fig. 12).

The basic problem associated with the described process is the genesis of TRB and the mechanism of its spread. This is surely one of the most controversial issues of the central European Neolithic, and it has long been discussed and analysed (such as *Czerniak 1994; 2018; Grygiel 2016; Jażdżewski 1936; Kośko*

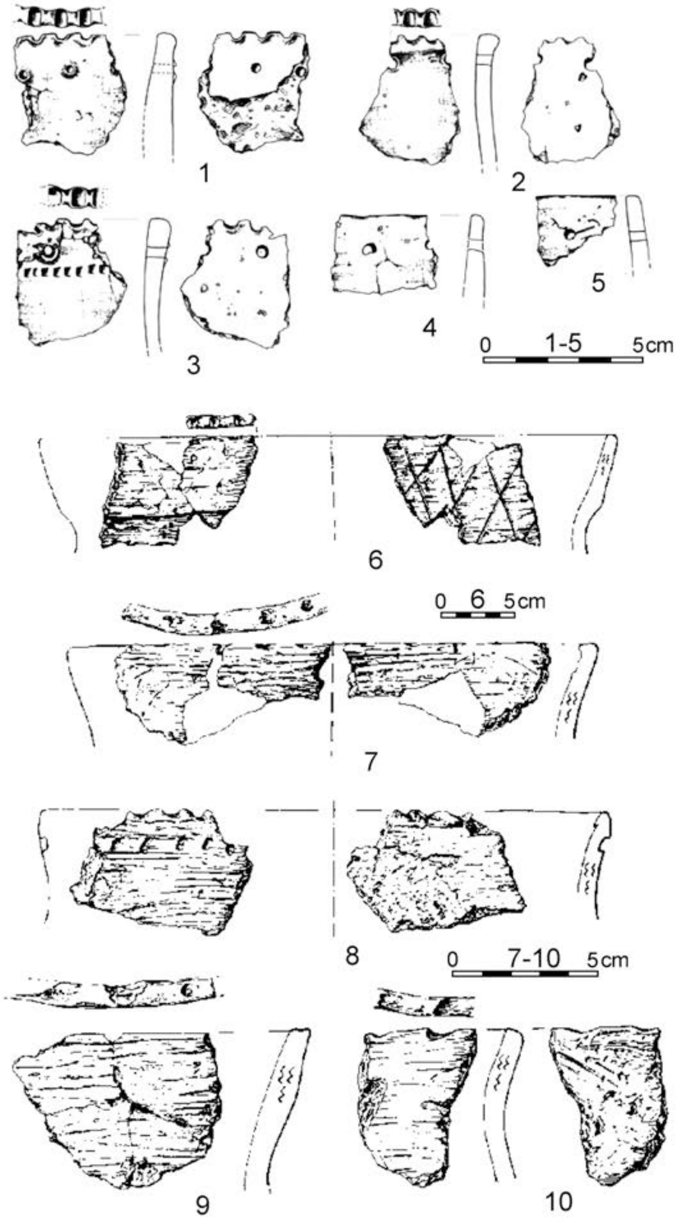


Fig. 9. Examples of the early para-Neolithic pottery. 1–5 Grądy Woniecko, stylistic group I (**Wawrusiewicz *et al.* 2017*****); 6–10 Woźna Wieś (*****Kempisty, Sulgostowska 1991*****).***

1981; Kowalczyk 1970; Kukawka 2015; Nowak 2009; 2017; Wiślański 1979a), of course not only with respect to the territory of Poland (*e.g., Fischer 2003*). Without going into details, it should be emphasised that all these discussions are somewhat flawed due to their local scales. For example, the genesis of TRB in Denmark has been analysed as if the scholars were unaware that TRB also existed outside its northern group, or outside Denmark. And likewise, discussions on the issue carried out in Poland, hardly ever reach beyond the borders of Poland, as if the archaeologists have forgotten that TRB is present also elsewhere, for example in southern Sweden, the Netherlands, or Moravia.

At present, the chronological antecedence within the whole range of TRB should formally be given to the zone of the south-western Baltic coast, since radiocarbon dates recently obtained there point to *c.* 4200–4000/3950 BC. One should mention here the sites of Wangels, Parow, Stralsund, Baabe (*Kotula* et al. *2015b*), Neustadt (*Glykou 2016*), and perhaps Lübeck-Genin (*Hartz 2015*), Flintbek 48 (*Mischka* et al. *2015*) and Hamburg-Boberg 15 (*Thielen, Ramminger 2015*) in Germany as well as – again! – Tanowo, Dąbki, and Rzucewo (*Galiński 2016; Kabaciński* et al. *2015; Król 2018*) in Poland. These sites produced remains of the early TRB, which seem to appear in the already quoted context of local hunter-gatherers that had undergone ceramisation several hundred years earlier. As mentioned above, to the east of the lower Oder River these groups, from the point of view of flint knapping, can be identified as belonging to the evolved Chojnice-Pieńki tradition, while to the west of this river they belong to the EBK tradition. Pottery revealing traits of both EBK (or rather its local derivative) and TRB, such as so-called transitional vessels from Dąbki (*Czekaj-Zastawny, Kabaciński 2015*) and Rzucewo (*Czekaj-Zastawny, Kabaciński 2018*), and perhaps some forms from Tanowo (*Galiński 2016*), is significant in this context (Fig. 13).

However, a detailed analysis of publications presenting the above-mentioned 'Polish' sites (*Kozłowski, Nowak 2018b*) shows that the absolute age determinations for the earliest TRB phases are far from unambiguous, unlike quite many of the interpretations developed on their basis. This stems from the fact that all archaeological materials in these sites are vertically, and to certain degree also horizontally, mixed. Pottery fragments described as 'of the EBK type' and 'of the TRB type' (and in Dąbki also other single sherds assigned to LBK, Stroke Band Pottery culture, Brześć Kujawski culture, and Bodrogkeresztúr culture) were found virtually together. Similarly, ^{14}C dates are also mixed (*e.g.,* the majority of ^{14}C dates in Dąbki originate from pottery), *i.e.* it is difficult to notice any arrangement consistent with the stratigraphy or depth (*e.g., Kotula* et al. *2015a.Fig. 6*). As a result, as Andreas Kotula writes in another paper from the monograph on the Dąbki site: "*[...] in most cases the excavation* *context does not contribute to the dating, and nearly all finds could potentially be of Mesolithic or Early Neolithic age*" (*Kotula 2015.177*). This conclusion should be extended to the sites of Tanowo and Rzucewo as well.

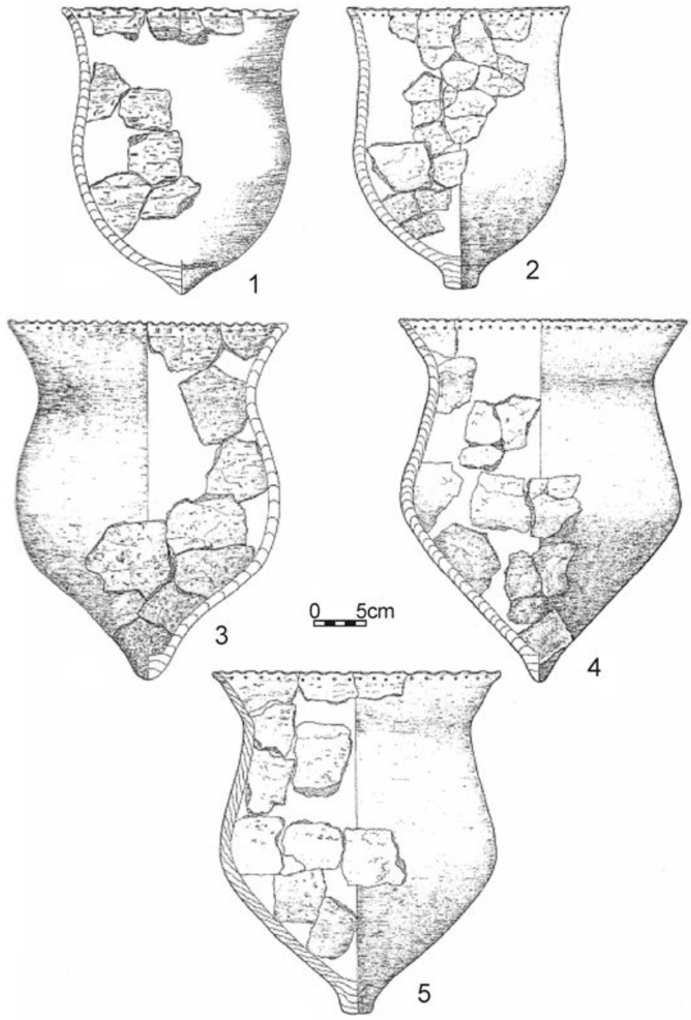


Fig. 10. Reconstructed pottery of the EBK from Tanowo (*Galiński 2016*).

Thus, one can reasonably conclude that we do not have a proper insight into the chronology of the earliest TRB occupation in these sites, as smaller or greater reservations concerning the context can be expressed with respect to all the mentioned dates, not to mention the impact of the marine reservoir effect. Therefore, it comes as no surprise that the dating of the appearance of TRB pottery to *c.* 4200–4000/3950 BC (*Galiński 2016. Tab. 3; Kotula* et al. *2015a.122–123, 133*) has been determined by the cited authors on the basis of the chronology of analogical early TRB phenomena in northern Germany, rather than on the basis of the ^{14}C dates themselves. In other words, 'Polish' dates pointing to the mentioned period have been interpreted as representing TRB rather than Late Mesolithic, because it is with this chronological horizon that the German researchers link the beginnings of TRB in northern Germany. Naturally, such a per analogiam hypothesis is fully admissible and logical. However, it needs to be emphasised that a number of other, alternative hypotheses can be formulated as well, including one positing that the dates within the 4200–4000 BC range, are actually connected still with late, ceramised Mesolithic communities, while the beginnings of TRB should be dated later, say to 4000–3800 BC or even 3800/3700 BC.

Whether our general approach to the chronology of the pottery from Dąbki, Tanowo, and Rzucewo is correct is another issue. Is this approach not overly burdened with stereotypes and habits of culture-historical classifications, which hamper the proper understanding of the analysed processes? In his analysis of the Mesolithic pottery from Dąbki, A. Kotula very strongly emphasizes that this pottery is technologically very similar to TRB pottery (*Kotula 2015.177–178*). He even concludes that "*the main distinguishing criterion between the Late Mesolithic pointed bottom pots and Early Neolithic Funnel Beaker vessels is the vessel shape, but many of the sherds have comparable technological features. For this reason it is difficult to securely attribute pieces without specific characteristics of shape or decoration to one or the other type*" (*Kotula 2015. 178*). Now, it seems clear that these sites represent some kind of an occupational, economic, social, and ideological continuum, spanning basically the 5th and early 4th millennia BC, and supplemented with pottery at least from the middle of the 5th millennium BC. The manufacture and use of this pottery is therefore also a continuum of a kind, into which we try to fit our traditional terminological bricks of EBK and TRB (to put it simply). In the case of the three sites discussed here, such 'Beaker' bricks are basically no more than certain changes in vessel shapes (but were they common?), maybe stemming from a slightly different manner of using the vessels, or some novelties in vessel decoration. The mentioned transitional pottery is particularly telling in this context (*Czekaj-Zastawny, Kabaciński 2015; 2018*). Yet, in this particular setting, these changes and no-

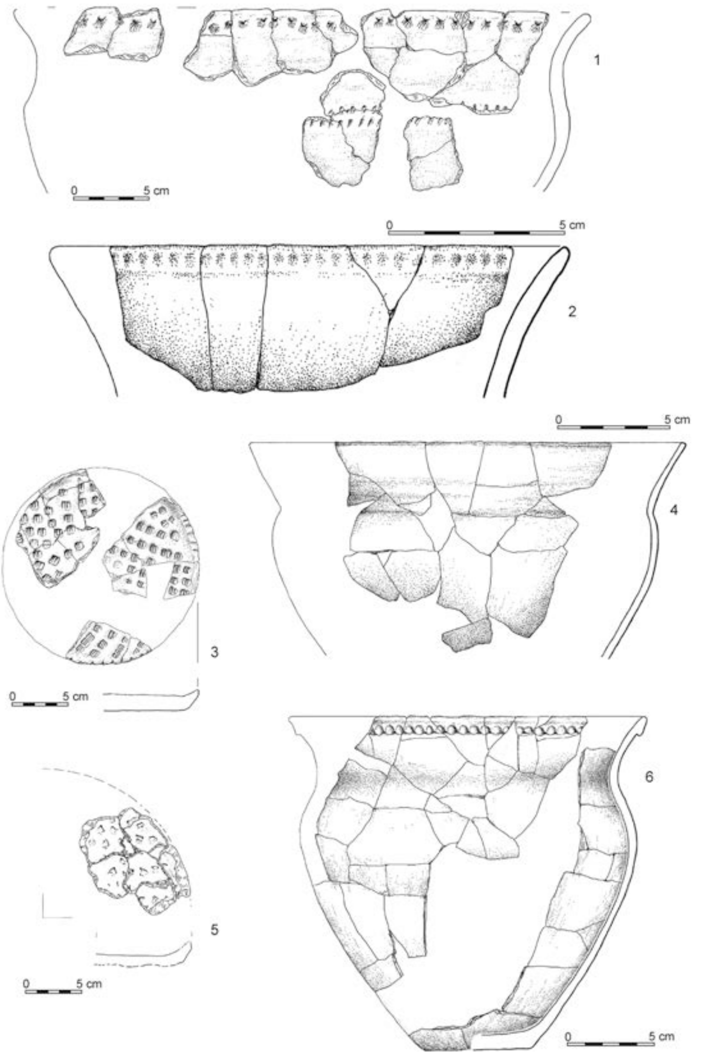


Fig. 11. Pottery of the early TRB from the site 20 in Redecz Krukowy (**Papiernik, Brzejszczak 2018*****).***

velties, which for us formally mark TRB, did not bring about any significant change. The pottery, which can formally be labelled as EBK and TRB, can be seen as certain types, variants of the same state of pottery, produced and used by hunter-gatherer communities from the south-western coasts of the Baltic Sea throughout the 5th and early 4th millennia BC. This pottery was changing gradually, with changes in manners of food preparation and consumption inspired by external influences. The changes which appear to us as 'culture-making' and therefore significant were not perceived as such by the mentioned communities.

As a result, one can express a view, which basically repeats in a more cautious manner the opinion expressed by the author in 2009 (*Nowak 2009*), that the south-west Baltic centre can likely be interpreted as the area where the original (first of all ceramic) version of the phenomenon known to us as the Funnel Beaker culture was formed, and that this took place between *c.* 4200 and 4000 BC. A correction is needed to the monograph from 2009 regarding the extent of this centre – it would stretch from Holstein to eastern Pomerania. The crystallisation of the 'Beaker' patterns would be based on a strictly local, hunter-gatherer (proto-Neolithic – see further in the text) demographic and cultural substrate.

In my opinion, one cannot subscribe to the view (*Czekaj-Zastawny, Kabaciński 2015; 2018; Czerniak 2018; Kotula* et al. *2015a*) positing that Tanowo, Dąbki, or Rzucewo are connected exclusively with the northern group, and even are of 'genetic' importance for it. This can hardly be imagined in practice for reasons of geography. If the results of processes taking place there could affect territories to the north-west, why could they not affect those to the south or south-east (see, for example, *Sørensen 2015. Fig. 11*)?

However, from what has been written here it emerges that the south-west Baltic cradle of TRB in the last two centuries of the 5th millennium BC is just one possible option. If we date the appearance of the Beaker traits in this area to a later period, *e.g.,* around 3800/3700 BC, it will turn out that the beginnings of TRB may have been earlier in the Polish Lowland, where they date to 3950/3900 BC at the earliest (*Kukawka 2015; Nowak 2017; Papiernik, Brzejszczak 2018*). In this interpretation, the TRB traits in the south-west Baltic area would originate from the south, exactly from the Polish Plain. As a reflection of the early TRB 'expansion' towards the Baltic shores one could interpret for example the site of Bielawki in eastern Pomerania (*Czerniak, Rzepecki 2016*). This hypothesis, however, creates a problem on a broader scale, as it implies that the earliest sites of the northern group, in northern Germany and Denmark, must be even later (*c.* 3700 BC?), which seems inconsistent with the current state of knowledge.

It also stands in opposition to those hypotheses and views which apparently extend the cradle of TRB to the west, even as far as the Netherlands. Within the core area defined in this way, covering a very large

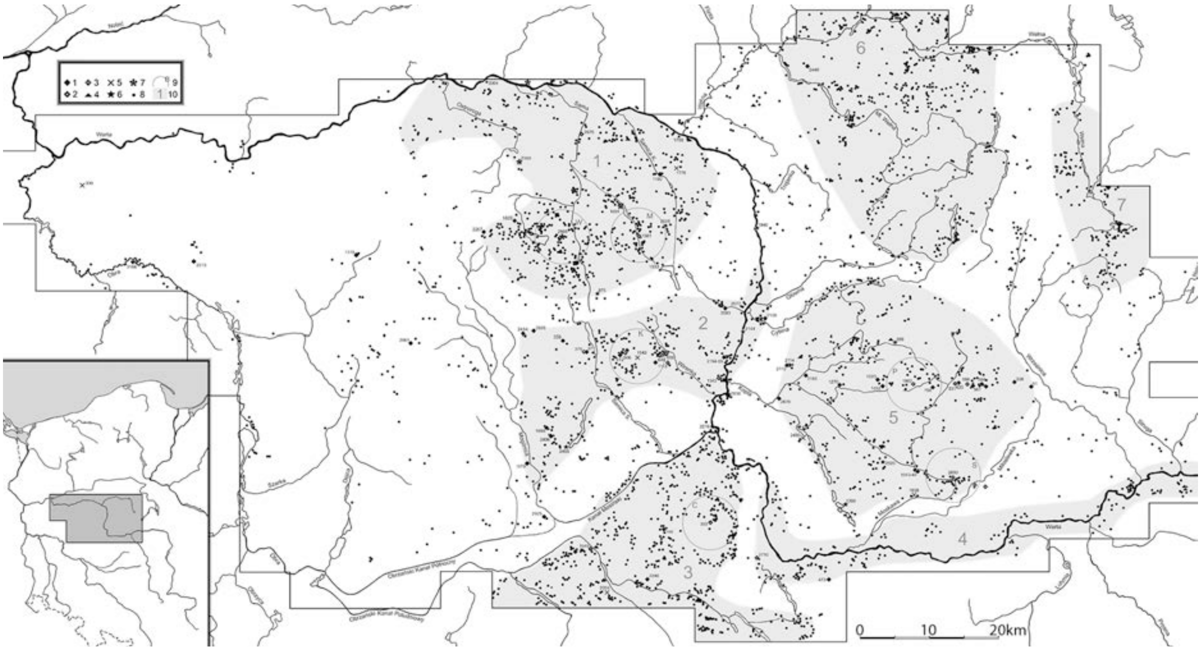


Fig. 12. The TRB sites in the middle Warta river region (**Wierzbicki 2013.Fig. 4*****). 1–3 different categories of settlements; 4 stray finds; 5 cemeteries; 6 swamp deposits; 7 copper artefacts; 8 other sites; 9 so-called sample microregions; 10 so-called anthropomezoregions.***

longitudinal span, the crystallisation of the 'Funnel Beaker' patterns is believed to have been first initiated (*c.* 4200–4100 BC) in the west, *i.e.* in the Netherlands, with ceramized Swifterbant communities as the substrate (*Raemaekers 2015; Ten Anscher 2015*). In this approach, in northern Germany these processes would be dated to *c.* 4100 BC (*Ten Anscher 2015.Fig. 15*); by implication, 'Polish' sites should be given later dates, say around 4000 BC. The transformations of local hunter-gatherers into TRB is consequently seen as resulting from influences from, and contacts with, farming communities of the already formed Neolithic (the Michelsberg in particular) (*Gron, Sørensen 2018; Sørensen 2015; Ten Anscher 2015*), which means they are similar to 'our' Pomeranian phenomena. Views are even expressed positing the presence of 'Michelsberg' settlers, as in the case of Flintbek 15 site (*Mischka* et al. *2015*), or more generally the agrarian (migration-related) and material (*e.g.*, axes with thin butts) Michelsberg impulses (*Sørensen 2015*). The hypotheses promoting this area of TRB formation corroborate (but by no means prove) the idea of a south-western Baltic cradle which extended to the coastal part of Pomerania as well.

Consequently, we are of the opinion that it is still possible to assume that the zone extending along the south-western coast of the Baltic Sea was the area in which the new cultural model was formed around 4200/4000 BC, and from this zone this model spread to remaining parts of east-central Europe. This model was comprised of such elements as: (i) a flexible farming-herding economy, easily adaptable to different environmental conditions but at the same time showing a tendency to significant transformation of these conditions in some places (*Kruk, Milisauskas 1999; Nowak 2009; Wierzbicki 2013*); (ii) a relatively stable, but at the same time flexible and environmentally universal settlement pattern (*Czerniak 1994; Dreczko 2019; Król 2017; Wierzbicki 2013*); (iii) 'Funnel Beaker' pottery; and (iv) monumental and communal burial rites (*Król 2011; Libera, Tunia 2006; Rzepecki 2011*). With time and during the TRB expansion the model was surely improved and supplemented – for example, the monumental form of the burial rite appeared with some delay in relation to the beginnings of TRB.

To some extent the spread of the 'Funnel Beaker' Neolithic attributes to the remaining part of Poland took place by means of leapfrog expansion[2] and ecological infiltration, advancing from the north-west starting from *c.* 4100/4000 BC. Yet, these processes were surely not the only ones responsible for the further spread of this cultural model throughout Po-

2 The terms and notions used in this and subsequent paragraphs have been developed by Zvelebil (*Zvelebil 2001.2*; *cf.* also *Zvelebil, Lillie 2000.62–63*).

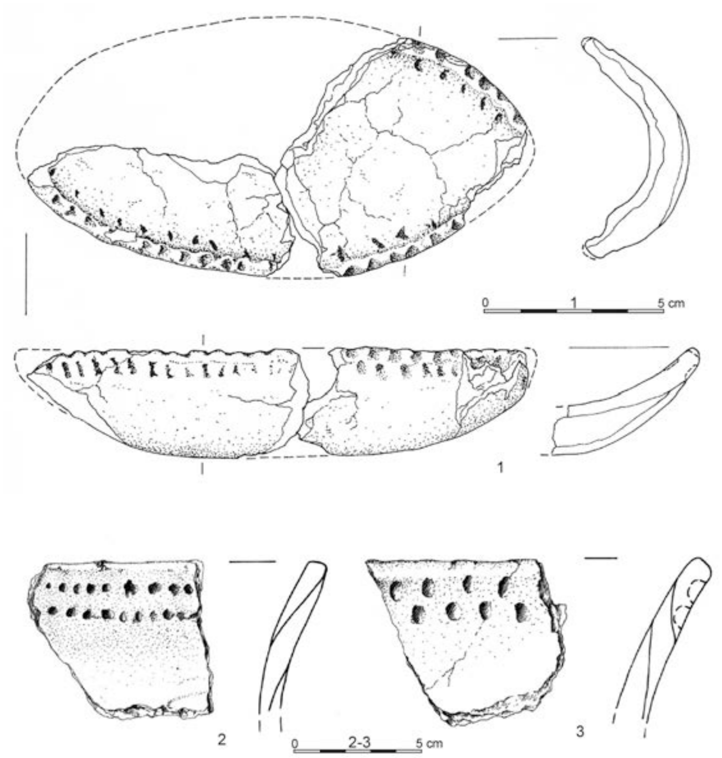


Fig. 13. Examples of so-called transitional pottery (between the EBK and TRB). 1Dąbki (**Czekaj-Zastawny *****et al.* **2013*****); 2–3 Rzucewo (*****Czekaj-Zastawny, Kabaciński 2018*****).***

land. The appeal of this model ensured its wide acceptance among populations representing various cultural milieus, both the Mesolithic and Younger Danubian groups (Fig. 14).

First of all, early TRB attributes were spread among local hunter-gatherer populations by contact and frontier mobility, and perhaps also as a result of processes resembling the domination of elites, and by *c.* 3650–3500 BC they had gained predominance among some of these populations. The process was facilitated by long lasting local co-existence of farming and hunting-gathering populations; after all, even limited contacts resulted in transmission of Neolithic ideas and patterns, and the practical knowledge they entailed.

Secondly, parallel with the processes described above, these attributes were also spread among Neolithic Lengyel-Polgár groups who sporadically infiltrated areas outside the 'old farming' enclaves; the mechanisms of the spread were the same.

In 'old farming' enclaves in the Polish Lowland the hitherto prevailing Neolithic culture was 'liquidated'. The processes responsible included migration, diffusion, and infiltration of the 'Meso/Neolithic' TRB population, but perhaps most importantly 'frontier' contacts maintained among early TRB and late Lengyel-Polgár (*cf. Lorkiewicz 2012. 45–54*). In turn, in Lesser Poland and Silesia the 'liquidation' of the previous Neolithic culture was the result of leapfrog colonisation, frontier mobility, and infiltration. These processes were completed around 3600–3500 BC.

To sum up, we can figuratively say that TRB (or TRB package) was a kind of a mantle which wrapped various groups and different cultural traditions (*cf.* also *Robb 2013.666*).

The fact that the TRB patterns also gained general acceptance among post-Linear, Neolithic groups is equally as fascinating as the TRB neolithisation of Late Mesolithic hunter-gatherers. This phenomenon is – frankly – not yet well understood and frequently neglected. This is because TRB is commonly regarded as a cultural unit par excellence of 'northern' or 'lowland' affiliation, while it actually reaches as far south as the middle Danube (near Vienna). In fact, TRB in 'southern' loess uplands reflects a blooming society or societies, as illustrated for instance by the micro region around the site of Bronocice in western Lesser Poland (*Kruk* et al. *1996*). It is quite common for many Linear and post-Linear sites there to have been occupied by TRB people as well, as was the case with site 3 in Miechów (Fig. 15). This example demonstrates, by the way, that these TRB settlements quite often seem to be larger and much more populated.

It should be emphasised that Mesolithic and Neolithic echoes are fairly well perceived in TRB flint industries (*Kozłowski, Nowak 2018a*), and that in fact there is no such thing as a specific TRB flint industry. Regional or even local groupings are characterized by their separate variants, which originate from earlier backgrounds, be it Late Mesolithic or Neolithic (*i.e.* Younger Danubian) (Fig. 16).

Unfortunately, as yet there is not much genetic data for TRB in Polish territories. In the above-quoted publication (*Fernandes* et al. *2018*) we can read, based on only three skeletons from Kuyavia, that the TRB individuals shared a genetic composition similar to that of the Brześć-Kujawski group individuals, but with a slightly higher hunter-gatherer component. This actually corroborates quite well the view positing population continuity between a local branch of the Brześć Kujawski culture and TRB. To compare, in central Germany the relation between early Neolithic and Mesolithic components seems to be at a roughly similar level (*Brandt* et al. *2015; Haak* et al. *2015*); therefore a similar interpretation can be proposed. On the other hand, Scandinavian data, admittedly again very scarce, suggests the predominance of 'southern' Neolithic genetic clusters with only some admixture of local hunter-gatherers (*Skoglund* et al. *2012; 2014*), which does not fit well with the patterns of material culture of the northern TRB.

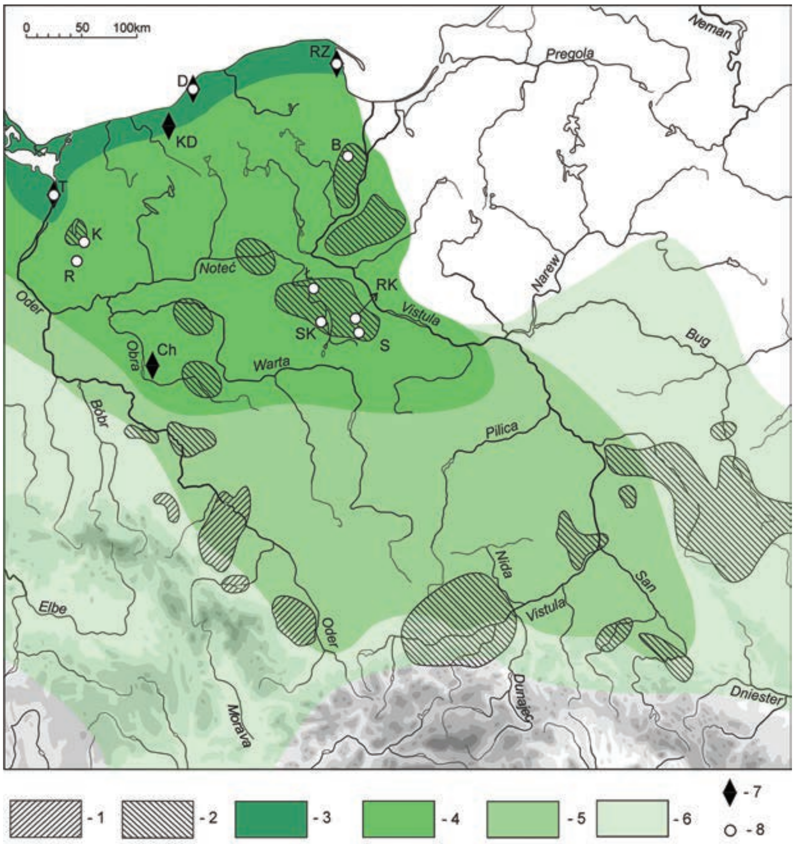


Fig. 14. The spread of the TRB in east-central Europe. 1–2 main enclaves of settlement of the late stage of the Lengyel-Polgár complex (1 Lengel branch **sensu largo***; 2 Polgár branch* **sensu largo***); 3 area of the TRB crystallisation,* **c.** *4200–4000 BC; 3–4 extent of the TRB* **c.** *4000–3900 BC; 3–5 extent of the TRB* **c.** *3800/3700 BC; 3–6 extent of the TRB after* **c.** *3700/3600 BC; 7 sites with pottery of the EBK and similar to the EBK (***T** *Tanowo 3,* **D** *Dąbki 9,* **KD** *Koszalin-Dzierżęcino,* **Ch** *Chobienice,* **RZ** *Rzucewo); 8 selected sites with early pottery of the TRB (***T** *Tanowo 3,* **K** *Kosin 6,* **R** *Renice 5–6,* **D** *Dąbki 9,* **RZ** *Rzucewo,* **B** *Bielawki 5,* **Ł** *Łącko 6,* **SK** *Strzelce Krzyżanna 56,* **RK** *Redecz Krukowy 20,* **S** *Sarnowo 1).*

The TRB does not make the end of the story. As we know, independent, non-Neolithic ceramic phenomena were already present in the area under consideration in the 5th millennium BC. But in the 4th (and actually also the 3rd) millennium BC they significantly grew in importance. This process is not particularly well-understood, and its chronology remains far from clear as well. Perhaps this is due to its 'non-Neolithic' nature – it simply does not attract sufficient attention from specialists interested in the Neolithic. The phenomenon is represented in surprisingly vast areas (Fig. 17), throughout of almost all Poland, as some works demonstrate (*Józwiak 2003; Józwiak, Domaradzka 2011; Wiślański 1979b*). In archaeological terms the sites and materials linked with this phenomenon are represented mainly by the Neman culture (Fig. 18) and locally in the Mazuria by the Zedmar culture. Sometimes this phenomenon has been symbolically denoted in Polish literature as the 'Forest Neolithic', after works by Elżbieta Kempisty (*1973; 1983*). It continued to flourish in the 3rd millennium BC as well, as can be seen, for instance, in the recently published, very important site of Grądy Woniecko (*Wawrusiewicz* et al. *2017*).

As previously mentioned, agriculture played no role among 'Forest Neolithic' communities, with pottery still remaining the only formal reference to the Neolithic (in the classical meaning). This pottery is characterized by a certain duality. On the one hand, some of it is similar to the pottery of comparable groupings in eastern Europe, but on the other hand, another part demonstrates mixed features of the 'Forest Neolithic' and local Neolithic cultures. This branch was distinguished in the early 1970s by Kempisty (*1973*) as the so-called Linin type. Interestingly, four sub-types of Linin pottery were distinguished, due to the presence of Funnel Beaker, Globular Amphorae, Corded Ware, and Early Bronze elements there (*cf.* also *Józwiak 2003*). This also demonstrates that hunter-gatherer groups still existed in the late 3rd millennium BC, and that some contacts with Middle and Late Neolithic as well as Early Bronze Age communities were maintained. This is also evidenced by imports of TRB ceramic in some

Fig. 15. The TRB settlement at the multi-period site 3 in Miechów against the blurred background of features belonging to other archaeological units; the TRB features are highlighted by graphic symbols. 1 features with longer axis over 5m; 2 features with longer axis 3–5m; 3 features with longer axis 1–3m; 4 features with longer axis less than 1m; 5 extremely elongated features (mostly burials).

'Forest Neolithic' sites (*Gumiński 2011*), as well as by the presence of 'Forest' ornaments and vessels in many TRB sites, particularly in Chełmno Land (*Adamczak* et al. *2018; Kukawka 2010*).

When considering the origins of this phenomenon (the 'second', so-called southern tradition in *Piezonka 2015.566, Fig. 13*), the above-mentioned issue of flint inventories is of utmost importance. Specifically, 'Forest Neolithic' pottery routinely co-exists with chipped lithics of the Late Mesolithic type. In the east these lithics belong to the Janisławice tradition (*e.g., Kempisty, Więckowska 1983; Wawrusiewicz* et al. *2017*), and in the west to the Komornica one (*e.g., Kabaciński 2016; cf. also Kozłowski, Nowak 2018a; 2018b*) (Fig. 19). We can assume, by the way, that such correlations have very often passed unnoticed by modern archaeologists because in the research practice this has been considered to be a result of secondary mixing, and consequently these pottery fragments and flints were regarded as separate. Very often they landed in separate sections of different regional or even archaeological museums. It turns out that, as a result of such an approach, the materials of the Neman culture in Poland are practically devoid of flint materials. In the light of current knowledge this is not possible, so the described practice was wrong. Consequently, 'Forest Neolithic' pottery should be combined with local late-Janisławice and late-Komornica flint artefacts.

In such a situation, the strict separation between the Mesolithic and 'Forest Neolithic' loses its original sense, the two being just two branches of the same phenomenon, that is to say of the hunting-gathering populations operating in the Middle Holocene forests of the Vistula and Oder basins. The patterns of ceramic production were only transmitted from the east and south-east. These patterns were at the same time adapted and changed on the spot to some extent, among other things as an effect of contacts with the said Neolithic units. The phenomenon under discussion developed from the late 5th millennium BC until the Early Bronze Age, simultaneously with agricultural groups.

Summing up, we should answer the question of whether two or perhaps three separate forms of neolithisation took place in Polish territories. At first glance, attempts to answer this question may seem a purely academic discussion, since the notions of the 'Neolithic' and 'neolithisation' are our creations. Were they in any way relevant for the populations of the time? We do not know, but it does not seem very likely. On the other hand, we know that people, even in historic times, have rarely been aware of long-lasting processes. We might ask, for example, who in the England of the late 18th century was aware they were witnessing the beginnings of the Industrial Revolution and its early impact? Therefore, I believe we are entitled to analyse and classify various forms and variants of the neolithisation processes, irrespective of whether they were noticed by the people of that time.

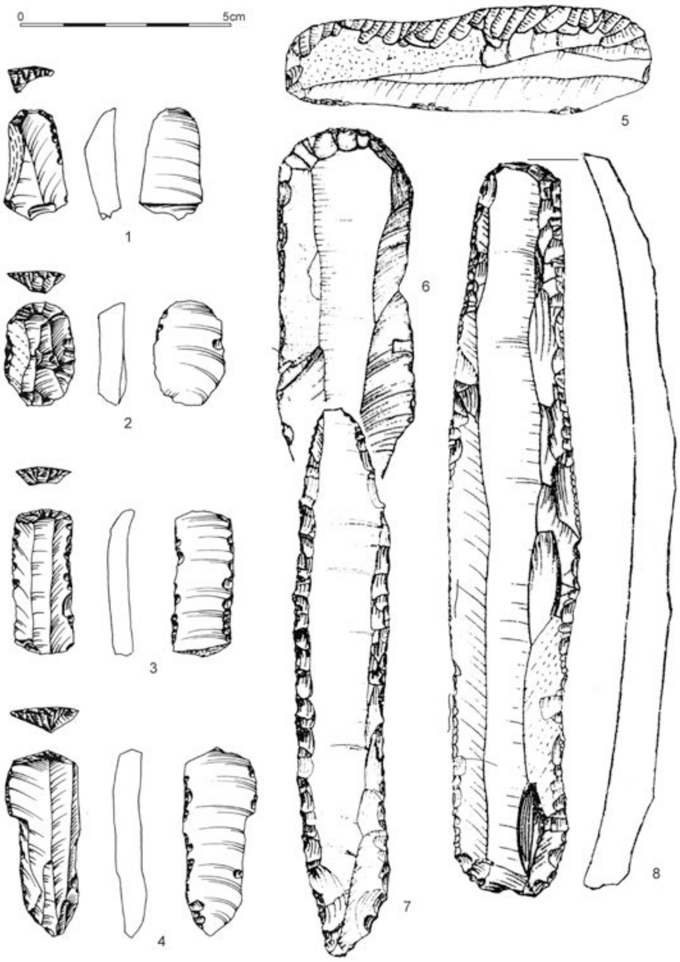


Fig. 16. Different types of chipped lithic industries of the TRB. 1–4 early, Lowland type (Redecz Krukowy 20; **Papiernik, Wicha 2018***); 5–8 upland, so-called Lesser Poland type (Ćmielów*; **Balcer 2002***).*

Thus, it seems it is justified to speak about the differences between – so to say – LBK and TRB types of neolithisation.

The LBK neolithisation is basically a migration with a ready, complete Neolithic Package, originating entirely from the outside (people, ideas, material culture). Its inherent elements are a strict ecological selection of areas for settlement, as well as settlement and economic behaviours requiring a relatively small space.

On the other hand, neolithisation of the TRB type operated on a local hunting-gathering basis, which had already been slightly ceramicised. Although very few novelties in the history of mankind were completely independent and new, in general the TRB Neolithic model should be considered as an independent product. Among others, this model consisted of: (i) flexible settlement and economic behaviours, highly adaptable to different ecological conditions, (ii) a subsistence model usually requiring large spaces, (iii) domination of agriculture, with local deviations from this rule, and (iv) great importance of sepulchral monuments acting as visible social and ideological symbols, which were organizing the space. This TRB model turned out to be so attractive that it was also taken over by the last Younger Danubian communities.

However, only some of the Late Mesolithic hunter-gatherers accepted Funnel Beaker patterns. The remainder (*c.* 30/40% – perhaps 'science fiction', but based on a numerical relation between 'Forest Neolithic' sites and Late Mesolithic and earlier TRB ones) successfully carried on a traditional subsistence lifestyle, gradually supplementing it with pottery. While this fact would suffice to include this phenomenon in the Neolithic from the eastern European archaeological perspective, it is debatable whether this can be done from the perspective of more Western archaeology. Seeking an answer to this question, it should be noted that in these communities pottery was produced and used very commonly indeed. If we consider that a prerequisite for including a given unit in the Neolithic is the presence in it of only one or several elements of the Neolithic Package on a predominant level, not necessarily including food production, and if we regard the Neolithic as a new state of mind, then these conditions are fulfilled here.

What is equally important, and fascinating, is that the communities in question never adopted or imitated to any significant extent the strictly Neolithic pottery, nor the Neolithic patterns of pottery production and ornamentation. The pottery was always produced and decorated in a separate and distinct manner. It seems like the idea of pottery production itself was borrowed from the Neolithic neighbours, while the methods of implementing this idea were

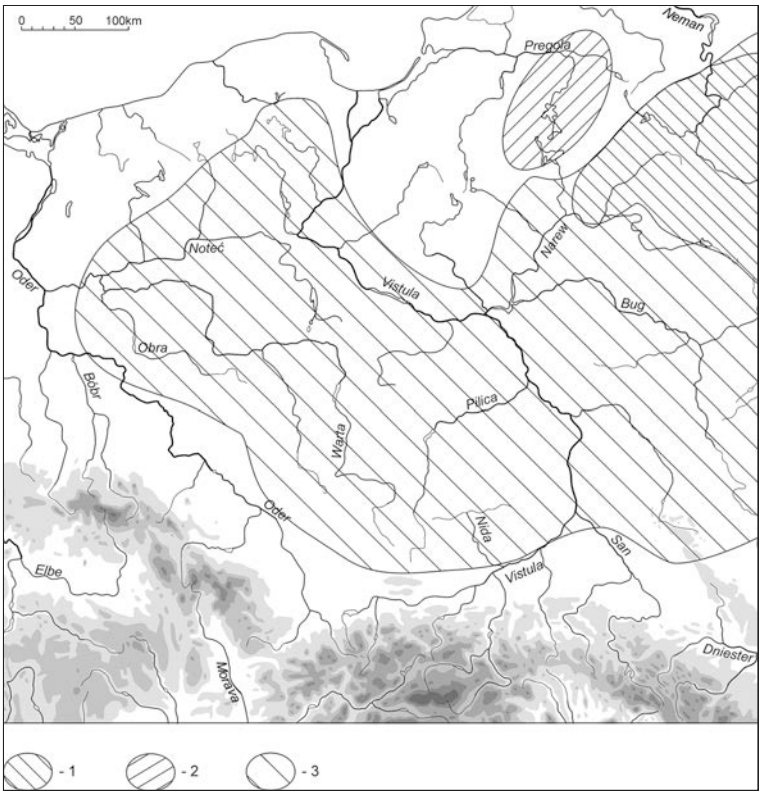


Fig. 17. The spread of the para-Neolithic in Polish territories. 1 extent of the early Neman culture in the late 5th millennium BC; 2 extent of the Zedmar culture; 1, 3 extent of the Neman culture in the 4th and 3rd millennia BC.

not. If the details of the pottery production system were borrowed from somebody at all, it was from the neighbours/kinsmen from the east, and perhaps, in the second half of the 5th millennium BC, from the north-west.

Let us also add that here and there a number of other novelties appear in these communities, *e.g.*, flint tools with surface retouching, including spear- and arrowheads, flint inserts or, in places, more frequent use of the same place for settlement. Although these are not direct determinants of the Neolithic, they demonstrate that ceramics was not the one and only thing that had changed in relation to the Mesolithic. Furthermore, as a result of more and more intensive contacts and interactions with the 'proper' Neolithic these people became well-aware that it was possible to cultivate land and raise animals, but they quite consciously did not exploit that possibility.

All these factors suggest the existence of a third, independent process, say of the east-European type of Neolithisation, which involved certain widening of the previous spectrum of material culture and the emergence of a new (in relation to the classical Mesolithic one) state of consciousness regarding their own place in the universe. Therefore, the cultural model formed as a result of this neolithisation, in the conditions of the territory under consideration in the 5th, 4th, and 3rd millennia BC, might be included in the Neolithic.

However, if we decide that the presence, and actually predominance, of a farming-herding economy is a condition necessary for labelling a prehistoric phenomenon as Neolithic, then the 'Forest Neolithic' obviously cannot be classed as such. Similarly, the processes behind its formation cannot be called neolithisation. This does not change the fact, however, that the above-described transformations in material culture and mentality were progressing at a slower or faster pace, which means that the communities undergoing these transformations can hardly be called strictly Mesolithic. In my opinion it would be justified to use the term

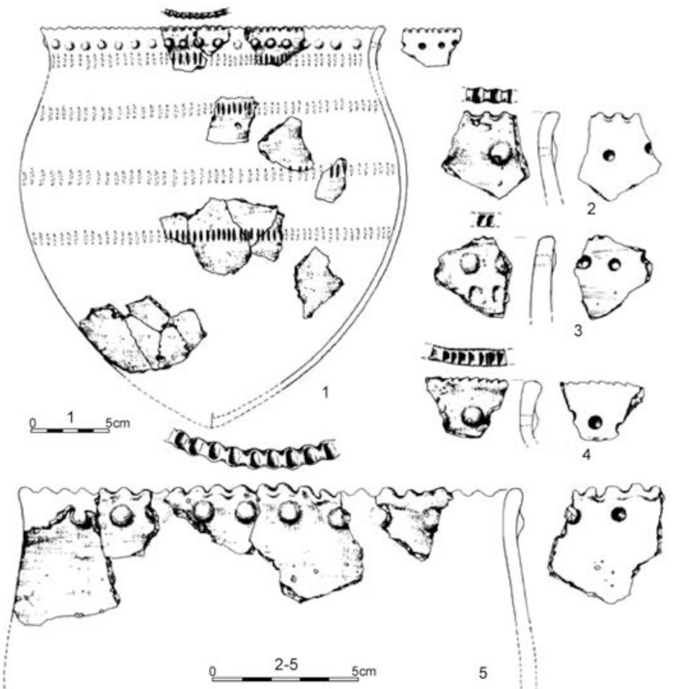


*Fig. 18. Examples of the para-Neolithic pottery (Neman culture), from the site 1 in Grądy Woniecko, stylistic group IIa (***Wawrusiewicz** *et al.* **2017.Fig. IV.8***).*

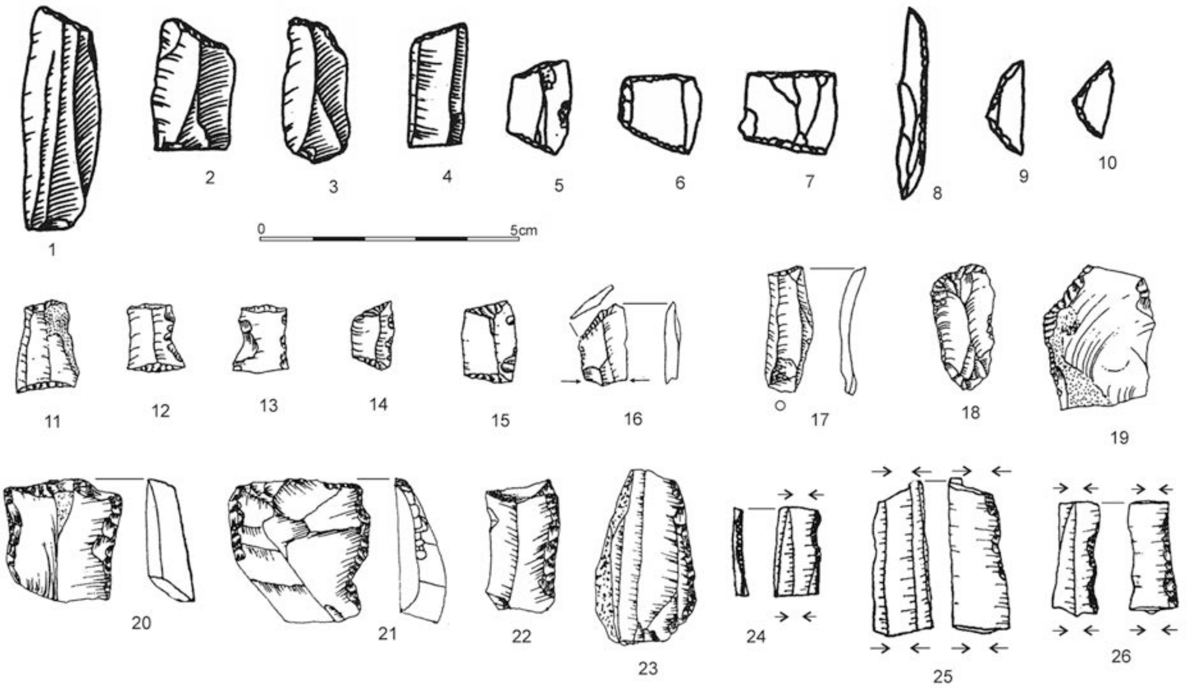


Fig. 19. Examples of chipped lithics found together with para-Neolithic pottery. 1–10 Komornica tradition (Chwalim, upper layer;* Kabaciński 2016*); 11–26 Janisławice tradition (11–19 Łykowe;* Cyrek 1990*; 20–26 Wola Ranizowska;* Mitura 1994*).

'para- Neolithic' (quite frequently used in the literature, although in different contexts and meanings), or perhaps even 'alternative Neolithic'. They describe a formation which cannot be included either in the classic Mesolithic or the classic Neolithic, one which marks an alternative trajectory of development in the age of the Neolithic and neolithisation. One should only keep in mind that the notions of 'para-' or 'alternative-' do not have a pejorative meaning here; these were not 'defective Neolithics'. These were simply phenomena different from the Neolithic and different from the Mesolithic, distinct and specific in themselves.

The term 'proto-Neolithic', on the other hand, should in my opinion be used to describe the relatively few hunter-gatherer, 'ceramicised' groups which clearly were the demographic substrate upon which Neolithic communities developed in the late 5th and 4th millennia BC. In Poland, this would be the situations recorded in Dąbki, Tanowo, and Rzucewo.

Thus, to conclude, we might state that in territories of present-day Poland groups of Neolithic farmers coexisted with Late Mesolithic/proto-Neolithic/para-Neolithic hunter-gatherers throughout the whole of the Neolithic. These two worlds coexisted in close geographical proximity, although not necessarily maintaining close contacts, until the Early Bronze Age.

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The development of Neolithic pottery technology in Eastern Jazira and the Zagros Mountains

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ABSTRACT – *The origins of pottery technology in Eastern Jazira and the Zagros Mountains can be seen as a process of several stages, from unfired clay and plaster vessels to the fully ceramic technologies of the Proto-Hassuna period. This paper reviews this process and presents a technological analysis of Proto-Hassuna ceramics to investigate the relationships between the pottery traditions at sites in Eastern Jazira and the western part of the Zagros Mountains.*

KEY WORDS – *Neolithic pottery technology; Near East; Proto-Hassuna*

Razvoj neolitske lončarske tehnologije na območju vzhodne Jazire in gorovja Zagros

IZVLEČEK – *Izvor lončarske tehnologije na območju vzhodne Jazire in gorovja Zagros lahko opazujemo kot proces, ki je potekal v nekaj stopnjah, in sicer od nežgane gline in posod iz mavca do polno razvite tehnologije keramike v obdobju Proto-Hassuna. V članku pregledamo te procese in predstavimo tehnološko analizo proto-hassunske keramike, s katero preučujemo tudi odnose med lončarskimi tradicijami na najdiščih na območju vzhodne Jazire in zahodnega dela gorovja Zagros.*

KLJUČNE BESEDE – *neolitska lončarska tehnologija; Bližnji Vzhod; Proto-Hassuna*

Introduction

The emergence of ceramics in the eastern part of Northern Mesopotamia (Jazira) and the Zagros Mountains (Northern Iraq and Western Iran) is recorded between the 8th and 7th millennia BC. However, the origins of pottery technology in this region began long before the emergence of fired vessels, and went through several stages in its development. This process can be traced at sites such as Ganj Dareh (*Smith 1974*), Ali Kosh vessels (*Hole* et al. *1969*), Tepe Guran (*Mortensen 2014*) in the valleys of the Zagros Mountains and Tell Magzalia in Eastern Jezira. For more than a millennium before the first fired vessels of the Pottery Neolithic there is clear evidence of vessels of both unfired clay and gypsum/lime plaster. The wide distribution of fired ceramics in the region occurred from the middle of 7th millennium BC in Eastern Jazira in settlements related to the Proto-Hassuna period. This paper explores the technological traditions in which these vessels were made.

The Zagros Mountains

Unfired clay vessels (the end of 9th to the 7th millennia BC)

The earliest examples of vessels in this region were found in the Zagros Mountains of Western Iran in the Ganj Dareh settlement (layers E and D). This small, but very important mound not far from Kermanshah, dates from the end of 9th to the beginning of the 8th millennia BC (*Mellaart 1975.78; Darabi 2015.P. 31; Bernbeck 2017.101*). These large

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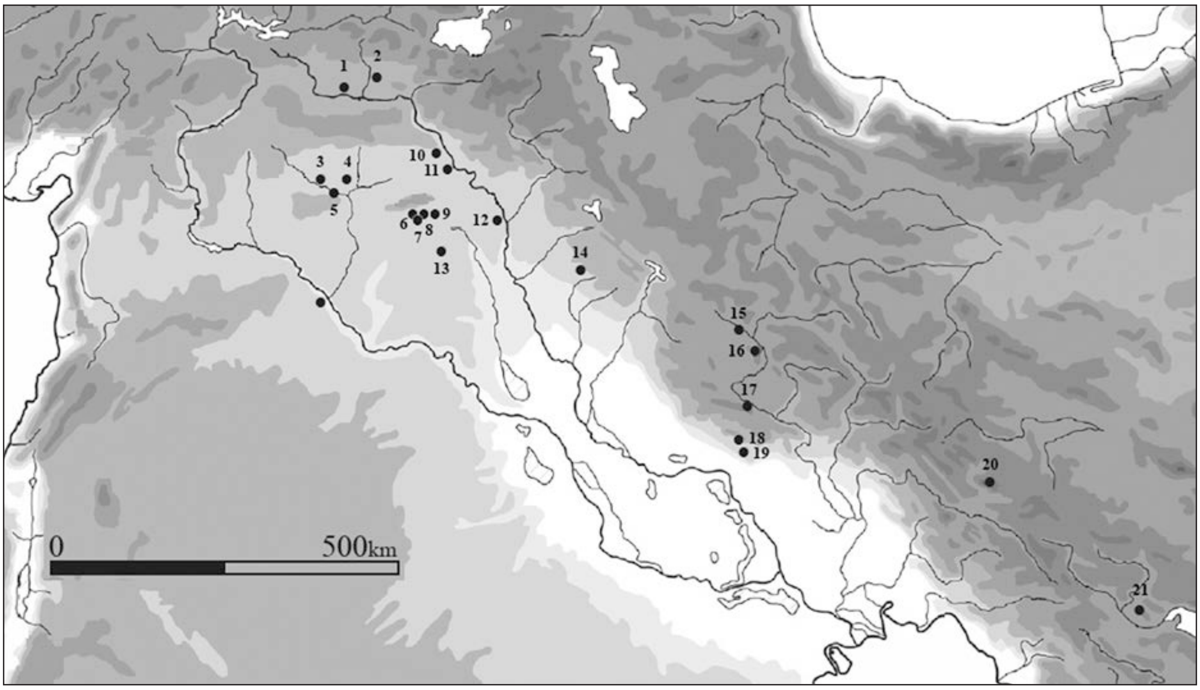

Map 1. Sites mentioned in the text: 1 Salat Cami Yani; 2 Sumaki Huyyuk; 3 Kashkashok; 4 Hazna II; 5 Seker al-Aheimar; 6 Magzalia; 7 Yarimtepe I; 8 Sotto; 9 Kultepe; 10 Ginnig; 11 Telul eth Thalathat; 12 Hassuna; 13 Umm Dabaghiyah; 14 Jarmo; 15 Sarab; 16 Ganj Dareh; 17 Guran; 18 Choga Sefid; 19 Ali Kosh; 20 Qaleh Rostam; 21 Tal-e-Mushki.

vessels (80–100cm high) of unfired clay were often built into the interior walls of the houses. Philip E. L. Smith (*1990*) describes these as either storage vessels or house construction details. One clay fragment from a small vessel with impressions was found in level E (Pre-Pottery Neolithic/PPNB) (*Smith 1974. 207*). The first fired vessels were associated with level D, but these were found only in burned houses and represented by large unfired vessels (*Smith 1974.207; 1990.332*). We have little information about the technology of unfired clay vessels, though it is known that the vessels from Ganj Dareh level D were made from 'clay with plant inclusions' (*Mellaart 1975.78*). Pamela Vandiver (*1987.16*) studied these ceramics in particular, and noted the use of slab construction.

Gypsum and lime vessels (around the turn of the 7th millennium BC)

The calcination of gypsum or limestone to produce a plastic mass with water and some admixtures represents an alternative approach to container technology. Vessels made of gypsum and calcareous clay were found in Ali Kosh settlement in Iran, where the application of slab construction and the use of wicker basket moulds, which left imprints on the surface of some gypsum and lime vessels, has been noted (*Kingery* et al. *1988.219–227; Nilhamn, Koek 2013. 292*). Such vessels were also found at the Magzalia settlement in Northern Iraq, dated to the beginning of the 7th millennium BC (*Bader 1993a.61–62*). The use of these resources was regionally variable. For example, only vessels of gypsum have been identified within the territory of Zagros (Choga Sefid and Ali Kosh settlements) (*Miyake 2016.120*).

Although the tradition of making vessels from gypsum was short-lived, during the Proto-Hassuna period, the tradition of applying lime to clay vessels remained. A similar coating both on one and on both sides of the vessel is present on containers from the Tell Sotto, Kultepe and Yarimtepe I settlements in Northern Iraq. It was also noted in the settlements of this period in Syria (*Nieuwehuyse, Dooijes 2008. 162, 169*) and on the ceramics of the Jarmo settlement (*Adams 1983.215*). The use of gypsum as a coating for baskets (for example, the settlement of Umm Dabagiya) also continued into the Proto-Hassuna period (*Kirkbride 1972.4, Pl. VI*).

The first fired vessels (around the turn of the 8th to 7th millennia BC)

There is no clear starting point for the appearance of the first fired ceramic vessels at Ganj Dareh. Possibly it happened during the formation of level D at the settlement, which dates no later than 7750 cal BC (*Bernbeck 2017.101*). Early ceramics are also recorded at Tepe Guran, Ali Kosh and Tepe Mahtaj settlements. The finds from Ali Kosh date to the last third of the 8th to 7th millennia BC (*Darabi 2012. 104*). Plant inclusions were noted in the pottery of Ali Kosh as the main temper added to these vessels (*Hole* et al. *1969.109–115*). However, the earliest ceramics on Tepe Guran (7100–6800 cal BC) contained no identifiable admixtures (*Bernbeck 2017. 101; Mellaart 1975.86*).

By the beginning of 7th millennium BC, ceramics were already widespread in the Zagros Mountains, at Tepe Guran (younger layers), Ganj Dareh (layer B), Tepe Sarab, Qaleh Rostam (phases III and II), at Tal-e-Mushki in Western Iran and at Jarmo in Eastern Iraq (*Bernbeck 2017.107–108; Braidwood, Howe 1960.38–49; Mellaart 1975.86*). Published accounts of the ceramics of Tepe Guran and Tepe Sarab note that these vessels were tempered with coarse plant inclusions. James Mellart considered it was a straw tempering (*Bernbeck 2017.101; Mellaart 1975.86–87*). Vandiver (*1987.16, 18*) noted the use of slab construction in the ceramics of Ganj Dareh level B. However, nothing is known about its fabric composition.

Jarmo pottery is divided into early and late phases. Frederick Matson (*1960.68*) studied the Jarmo ceramics in detail. The technology of pottery was similar in both phases and characterized by the presence of dung as the primary temper. Matson identified thin plant inclusions up to 5mm length and *c.* 1mm wide with longitudinal lines and round holes with grain prints in the ceramic body (*Matson 1955.355; 1960.68*). Pottery of the early phase has analogies in Tepe Guran and Tepe Sarab. Later vessels are coarser, having both organic and abundant lime mineral inclusions of large size and high frequency. According to a number of researchers, this type of vessels have close parallels in the Proto-Hassuna ceramics of Northern Mesopotamia (*Bader 1975.105–110; Adam 1983.215; Bernbeck 2017.103, 105*).

Ancient pottery of Northern Iraq

The evidence of transition from the Pre-Pottery Neolithic to the Pottery Neolithic in Northern Iraq is clear in the material from Tell Magzalia in Northern Iraq, and can be dated the beginning of the 7th millennium BC based on excavations carried out by Nikolay Bader (*1993*) in the 1970s. Large unfired storage vessels (65cm high, 45cm in diameter) were identified in the first level of the settlement (720–780cm). These vessels have a circular hole *c.* 10cm in diameter at the bottom, and the author suggested they were used for grain storage (*Bader 1989.61–62, Fig. 18.2; 1993a.12–13*). The first fired ceramics fragments were recorded at a depth of 470cm. Unfortunately, little is known about them. Moreover, large heaps of raw, unprocessed clay were found in the different levels of the tell (*Bader 1989.61, 105, Pl. 41.13, 14, 20, 21;1993a.19, Fig. 2.12; Bader, Le Mière 2013.515*).

Pottery of the Proto-Hassuna period

The wide distribution of ceramics in the Northern Mesopotamia region is associated with the Proto-Hassuna period. These have been found at Tell Sotto, Kultepe, Yarimtepe I, Umm Dabaghiyah, Tell Hassuna, Telul eth Thalathat, Ginnig, Shimshara in Northern Iraq; Tell Seker al-Aheimar, Tell Kashkashok II, Tell Hazna II, Tell Bouqras in Easten Syria; Salat Cami Yani and Sumaki Huyyuk in the headwaters of Euphrates in Turkey and a number of other sites (*Bader, Le Miere 2013.513; Le Mière 2000; Nieuwehuyse 2013.114*)[1].

There is no consensus regarding the origins of the Proto-Hassuna culture. Various features of material culture, including analogues in ceramic form and ornamentation, were associated with the Jarmo settlement (Zagross) (*Bader 1993b.48*). There is also the opinion that Proto-Hassuna ceramics originated from the ceramics of the Pre-Proto Hassuna period. This is based on the successive occurrence of pottery bearing layers from these periods at Tell Seker-al-Aheimar in Eastern Syria. Researchers note that the ceramics of Pre-Proto-Hassuna period differ from those of the Proto-Hassuna period in both forms and the presence of a large amount of exclusive mineral inclusions (*Bader, Le Mière 2013.520; Nishiaki, Le Mière 2005.67*).

Proto-Hassuna ceramics are usually defined by researchers as 'coarse ware', with red paint, slip and appliqué ornament. The technology used for making the vessels is usually described as follows.

Raw material – it is generally agreed that the material for production was clay with a small amount of mineral inclusions (calcite and sand) (*Bader* et al. *1994; Campbell, Baird 1990.70; Kirkbride 1972.8*). The *pottery paste* contains a large amount of plant

1 Tell Sotto, Kultepe (*Bader 1993*); Yarimtepe I (*Munchaev, Merpert 1993; Bashilov* et al. *1980*); Umm Dabaghiyah (*Kirkbride 1972*); Tell Hassuna (*Lloyd, Safar 1945*); Tell Ginnig (*Campbell, Baird 1990*); Tell Hazna II (*Munchaev* et al. *1993*); Tell Kashkashok II (*Matsutani 1991*); Tell Seker al-Aheimar (*Nishiaki, Le Mière 2005*).

Fig. 1. Proto-Hassuna vessels: 1 Tell Sotto, 1974, II-D-1, 220cm deep, level 3, I.2.a 491 KP-417962; 2 Tell Sotto, 1973, 10-B-1, level 5, I.2.a 636 KP-418107; 3 Yarim Tepe I, level 12, I.2.a483 KP 417954.

inclusions (Telul eth Thalathat, Tell Seker al-Aheimar, tell Sotto, Kultepe and Yarimtepe I (*Bader 1989. 218; Bader, Le Mière 2013.516, 518; Nieuwehuyse 2013.120*), which is sometimes called straw (Tell Sotto, Tell Hassuna, Tell Kaskashok II (*Bader 1989. 138; Lloyd, Safar 1945.276; Maeda 1991.20*). Vessels from Yarimtepe I, Umm Dabagiyah and Ginnig smaller plant inclusions in addition to straw (*Bashilov* et al. *1980.43–64; Campbell, Baird 1990.70; Kirkbride 1972.8*). Oliver Nieuwehuyse suggested the possible presence of dung in the Proto-Hassuna pottery paste (*Nieuwehuyse 2013.125*).

Construction – vessels were made with the coiling (*Campbell, Baird 1990.70; Kirkbride 1972.8*) or slab construction techniques (*Campbell, Baird 1990. 70*). Fuad Safar, who excavated the Tell Hassuna, suggested that the bases of large vessels with ribs were made in pits, and then built up from this (*Lloyd, Safar 1945.277*). *Surface treatment* – vessels were smoothed by grass (*Kirkbride 1972.8*), and sometimes burnished (*Campbell, Baird 1990. 70; Kirkbride 1972.8; Nieuwehuyse 2013.120*). Firing – the vessels were fired at low temperature (*Campbell, Baird 1990.70; Bashilov* et al. *1980.43–66*). During the excavations of Tell Sotto a large vessel burned in a pit was identified (*Bader 1989.140*).

Pottery of Tell Sotto and Yarim Tepe I

Technological analysis according to the method of Alexander Bobrinsky

The settlements of Yarim Tepe I and Tell Sotto were excavated by the Soviet archaeological expedition in Northern Iraq under the authotity of Rauf M. Munchayev, Nikolai Ya. Merpert and Otto N. Bader from 1969 to 1976 (*Merpert 1993; Merpert, Munchaev 1993; Bader 1993b*). Both settlements may be dated to the second half of the 7th millennium BC. Recent ^{14}C dates obtained for the Proto-Hassuna period in the lower level of the Yarim Tepe I settlement are 6220 to 6071 cal BC (7280 ± 30BP) (*Yutsis-Akimova* et al. *2018.51*).

The technology of ceramics of the Tell Sotto and Kultepe settlements was first analysed by Bobrinsky, who considered both the qualities of the raw materials and the pottery paste. As a result, several types of medium and high plasticity clays with limestone as a supplement to local clays were identified. The main additive to the clay during production was dried animal dung of goats, sheep and cows. This was identified from the remains of very small organic inclusions up to 0.5mm long and 0.1–0.2mm wide, with smooth rounded margins. The concentration of these remains and voids from them in the ceramic fabric ranged from 40 to 70% (mostly 50 to 60%) (*Bobrinsky 1989.327–334*). Bobrinsky (*2006. 415*) noted that in addition to dung, straw and hay were often added to the pottery paste. Firing is characterised by a rapid rise in temperature and short duration, which corresponds to the conditions typical of pit firing (*Bobrinsky 1989.334*).

My technological analysis of Proto-Hassuna ceramics based on materials from Yarim Tepe I (levels 12–11; fragments from 149 vessels and one whole vessel) and Tell Sotto (level 2; fragments from 40 vessels and two whole vessels[2]) found dates earlier than the Proto-Hassuna levels of Yarim Tepe I, and two whole vessels from levels 3 and 5 (Fig. 1)[3]. Microscopic[4] analysis of the surface and of cross-sections

2 Forty ceramics samples previously studied by Aleksandr Bobrinsky.

3 The ceramics collection of Yarim Tepe I and Tell Sotto is located in the Russian Institute of Archaeology. Three whole vessels stored in the Pushkin State Museum of Fine Arts in Moscow (Yarim Tepe I - I.2.a483 KP 417954; Tell Sotto - I.2.a 491 KP-417962; I.2.a 636 KP-418107).

4 Binocular microscope MBS-10, stereo microscope Carl Zeiss 2000-C and metallographic microscope Olympus MX 51.

of ceramic samples from all stages of pottery production was conducted according to the method of Bobrinsky (*1978; 1999;* see also *Tsetlin 2017*). A study of raw materials and pottery paste, methods of construction, vessel surface treatment, and firing was performed. During the study of clay selection the degree of ferrugination as well as quantity and composition of natural inclusions were determined. The organic temper was classified according to its type. The quantity and size of the mineral inclusions influences the plasticity of clay, so this was taken into account by potters when choosing clay. The methods of temper processing and temper concentration were determined. Analysis of ceramics included the re-firing of samples in a muffle furnace under identical conditions (850°C) to determine the relative degree of clay ferrugination. At this temperature clay ferrugination reaches its maximum level and does not change with an increase in the firing temperature.

Besides this, ceramics from excavations were compared with experimental samples. A series of experiments was carried out with different kinds of organic tempers containing the following plant residues: fresh grass, hay, straw, and the dung of cows, sheep and goats in different concentrations. In addition, experiments with different types of construction and surface treatment methods were performed (*Petrova 2012; 2016*).

The raw materials

The vessels from the Tell Sotto settlement were made from ferruginous clay with limestone with a small amount of rounded fine-medium sand: 0.1–0.25 and 0.25–0.5mm (for coarse vessels) and with average quantity of mineral inclusions – rounded fine and medium quartz sand (0.1–0.25 and 0.25–0.5mm), white/light grey colour in a concentration of no more than 1:5 (for thinner vessels) (*Lopatina, Kazdim 2010.47*). The vessels from Yarim tepe I – mainly from moderately ferruginous clay with the addition of limestone and an average quantity of mineral inclusions.

The pottery paste

Ceramics were divided into two groups. The first group (90% of the collection) contains pottery with a mixture of clay and dung. At Tell Sotto the concentration of the dung in ceramics ranged from 40 to 70% of all pottery paste, and at Yarim Tepe I from 20 to 40%, depending on the type of vessel. The dung is indicated with the presence of various types of very small plant residues and voids with rounded

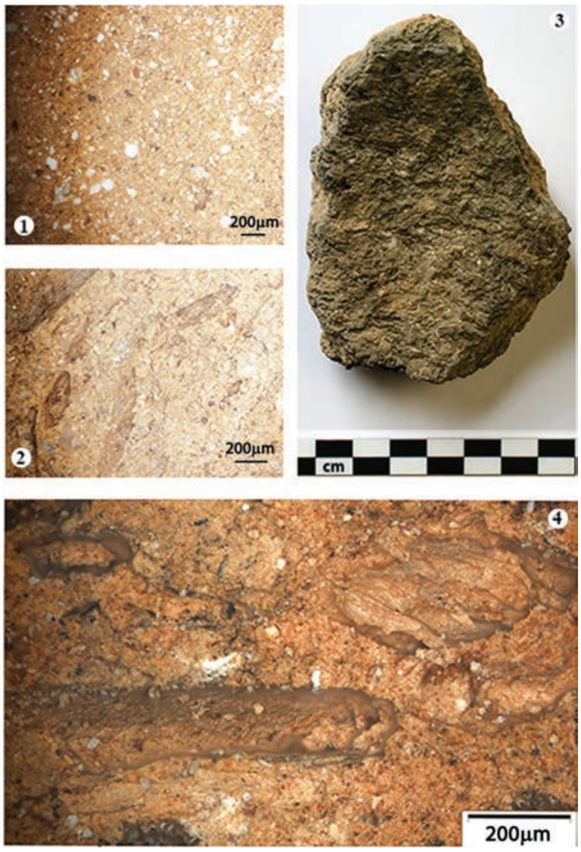

Fig. 2. The raw materials and pottery paste: 1 the Proto-Hassuna ceramics without any specially added temper; 2, 4 the presence of dung in Proto-Hassuna ceramics: Microscopic photo – very small plant residues with rounded ends and a degree of disintegration – Yarim Tepe I, pit 73 in the virgin soil, pocket 232 No. 10; Tell Sotto, 1974, Level 2; 3 the presence of dung in Proto-Hassuna ceramics: various types of very small plant residues in pottery paste in high concentration: Tell Sotto, 1974, II-B-4, Level 2, P.75, N.2.

ends and some degree of disintegration (Fig. 2.2–4). The coarser and larger vessels were made with the addition of organic inclusions in a greater concentration. The presence of larger plant residues — hay, dried or fresh grass combined with dung – was identified. The second group includes only thin-walled bowls and does not contain dung in the pottery paste, only clay without any specially added temper (Fig. 2.1).

The construction methods

Vessels built out with coils and slabs. Spiral coils were detected in from 40 to 60% of the studied vessels and were used in the construction of various vessel categories. In most cases, thick-walled (1cm or more) vessels were made of coils (Fig. 3). The coil height is from 1.5 to 3.5cm, depending on the size of the vessel. In two cases it was possible to define the diameter of the coil as 2.6–2.8cm. Sometimes the torsion introduced during the rolling of the coils can be observed within the section. A single-layer slab construction was used in both thick-walled (up to 20% of cases) and thin-walled vessels of all categories (approx. 60–70% of all cases). The slab size is approx. 1.5 x 3.5–4.5cm (Fig. 4). In some cases the vessels' external surfaces were knocked out with a flat paddle. On the inner surface of some vessels there were various static prints, probably from a model or lining (Fig. 5). The use of coils and slabs together (coils – in the lower part of the vessel, slabs – in the upper part) was detected once at the Tell Sotto settlement.

The surfaces
The surfacesof the vessels were first treated with grass, and then sometimes with leather. In many

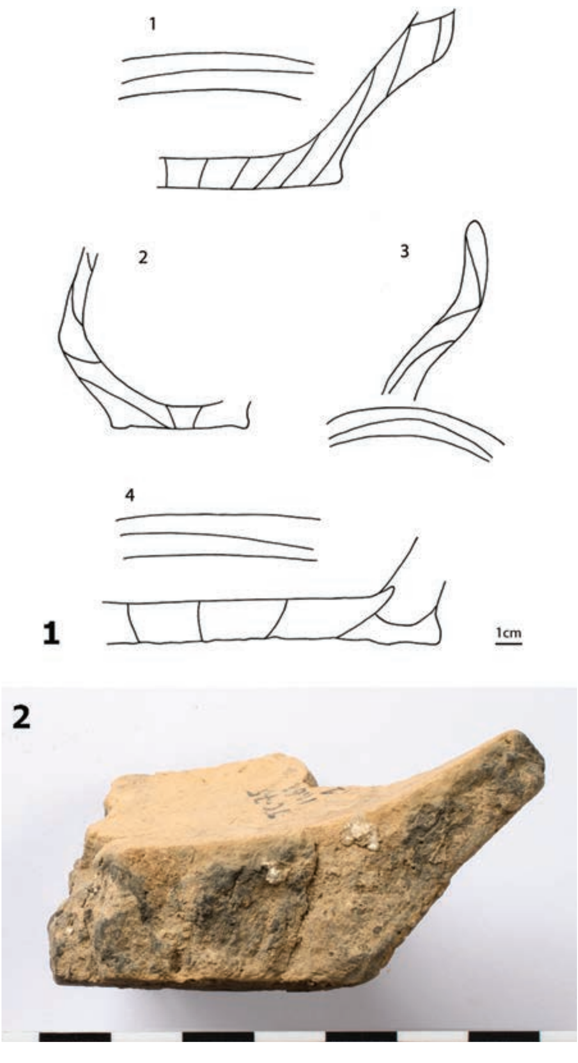

Fig. 3. The construction methods – spiral coils: 1 drawing of cross-sections of samples with spiral coils, Yarim Tepe I, level 12; 2 photo of cross-sections of samples with spiral coils. Tell Sotto, 1975, P. 62, N.1.

cases lime or plaster coating was applied. Sometimes intentional burnishing is also apparent.

Firing
The middle layer of potsherds has a light grey or slightly reddish colour. The transition between layers of potsherds with different degrees of firing of is often indistinct. These features indicate that ceramic products have reached temperatures of at least 650° with a long dwell time at the highest temperature and then a slow cooling rate. These conditions are typical of pit firing but also of simple kitchen ovens, which were found at Tell Sotto (*Bader 1989.140*).

Decoration
Various appliqué ornaments (mainly on storage vessels and pots), red paint, obtained probably on the basis of ochre, and the slip from less ferruginous clay (for decorating bowls and, more rarely, pots) were used.

Ceramics of other Proto-Hassuna sites

In addition to the samples from Yarim Tepe I and Tell Sotto, ceramics samples from Umm Dabaghiyah, Tell Hazna II, Tell Sekeral-Aheimar and Tell Kashkahok II were analysed. All of them contain dung in different concentrations depending on the type of vessel: thinner vessels (jugs and bowls), from 10–20% to 20–30%, and more coarse vessels (pots and griddles), from 30–40%.

It seems that in many cases, as mentioned above, where the authors wrote about the presence of finer inclusions than straw in the ceramics of the Proto-Hassuna, it could actually have been dung temper (*Bashilov* et al. *1980.43–64; Campbell, Baird 1990. 70; Kirkbride 1972.8*). Indeed, based on the results of ceramics technology studies (*Bobrinsky 1998. 327–334, 2006.415; Petrova 2012; 2016*), we can conclude that the presence of dung was in fact the main tradition of paste preparation for the production of early ceramics in this region. With regard to construction, two different traditions are observed: coiling and mould-based slab building (evidence of which is visible on the inner surfaces of only these vessels).

Conclusion

As a result of studying all available sources (in both the literature and directly by examining fragments of ceramics), it is possible to make a conclusion about the similarity of technological ceramic traditions between the settlements of the Proto-Hassuna period located in the eastern part of Northern Mesopotamia (Jazira) and settlements located in the western part of the Zagros Mountains. The best example is the Jarmo settlement, where both similar technological traditions (the presence of dung as temper, applying lime to clay vessels), and common features in the morphology and ornamentation of vessels are documented.

The presence of dung in Jarmo ceramics from levels situated lower than the Proto-Hassuna phase (*Matson 1955.355; 1960.68*) is evidence of the deep roots of this tradition in Zagros. The presence of plant or organic matter (probable dung temper) was commonly noted by a number of researchers at settlements in Iran and Iraq (*Bader 1989.218; Bader, Le Miere 2013.516, 518; Bashilov* et al. *1980.43–64;*

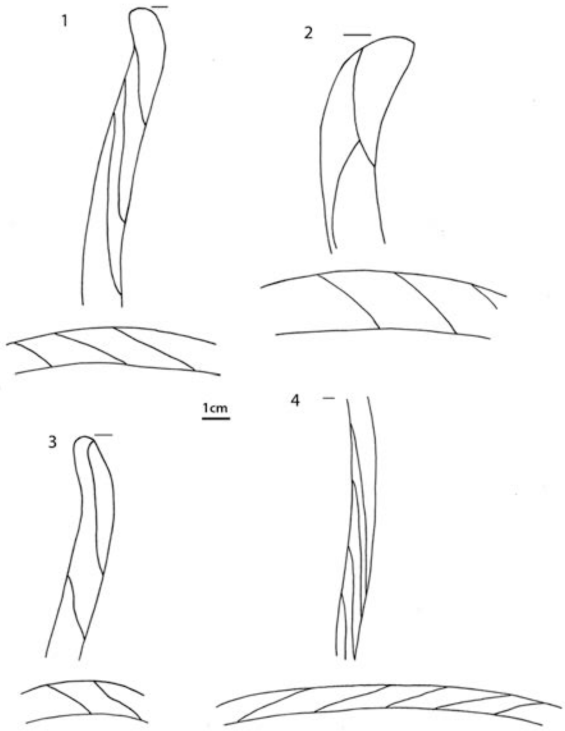

Fig. 4. The construction methods – drawing of cross-sections of samples with slabs construction.

Fig. 5. The static prints, probably from a model or lining. Tell Sotto, 1974, II-D-1, 220cm deep, level 3, N.I.2.a 491 KP 417962 (photo by D. A. Popova).

Bernbeck 2017.101; Campbell, Baird 1990.70; Kirkbride 1972.8; Lloyd, Safar 1945.276; Maeda 1991. 20; Matson 1960.68; Mellaart 1975.86–87; Nieuwehuyse 2013.125).

It is also possible that there could have been a link between the Proto-Hassuna ceramics originating from Northern Mesopotamia and the organic-tempered ceramics found at the Taurus Mountain settlements. Further studies are needed to explore this matter in detail. The link between the Proto-Hassuna ceramics and the Pre-Proto-Hassuna ceramics from the territory of Syria, however, looks doubtful, because of differences in morphology and in traditions of ceramic technology, where the exclusive use of mineral temper in high concentrations has been found (*Bader, Le Mière 2013.517*).

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The Early Neolithic pottery of Keçiçayiri and its place in the North-western Anatolian Neolithisation process

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ABSTRACT – *The region of Inner North-western Anatolia was a key node in the transmission of the Neolithic lifestyle from the Near East to Marmara, and from there to the Balkans and the rest of Europe. It formed the intersection between several important routes and trade networks, and the settlement of Keçiçayırı, the subject of this paper, had an essential role in the transfer of cultural elements during the Neolithic. The settlement is located on a natural communication route that connects the region of Emirdağ-Bolvadin with Eskişehir across the mountainous area of Phrygia, between the distribution areas of the Hacılar and Fikirtepe cultural groups. Finds from the site include both Pre-Pottery Neolithic material and Early Neolithic ceramics, and it is therefore among the earliest permanent settlements of the Eskişehir region, and contains some of the earliest evidence for the Neolithisation process. In this paper, the pottery assemblage of the Early Neolithic settlement at Keçiçayırı is discussed, and its place in the spread of Neolithisation from the Near East to North-western Anatolia is evaluated when compared to other known sites.*

KEY WORDS – *Neolithisation; Early Neolithic pottery; Anatolia; Phrygian highlands; Keçiçayırı*

Zgodnjeneolitska lončenina z najdišča Keçiçayiri in njen položaj v procesu neolitizacije severozahodne Anatolije

IZVLEČEK – *Območje notranje severozahodne Anatolije je bilo ključno presečišče prenosa neolitskega načina življenja iz Bližnjega Vzhoda na območje Marmarskega morja in naprej na Balkan in v Evropo. Tukaj je bilo pomembno sečišče med številnimi pomembnimi potmi in trgovskimi mrežami, pri čemer je imelo najdišče Keçiçayiri, ki ga obravnavamo v članku, pomembno vlogo pri prenosu kulturnih elementov v času neolitika. Naselbina se nahaja na naravni komunikacijski poti, ki povezuje regiji Emirdag-Bolvadin in Eskisehir preko goratega predela Frigije, in sicer med področjema distribucije kulturnih skupin Hacılar in Fikirtepe. Najdbe vključujejo tako material iz obdobja predkeramičnega neolitika kot keramiko iz zgodnjega neolitika, kar pomeni, da je najdišče Keçiçayiri eno najstarejših stalnih naselbin na območju Eskisehir in vključuje najstarejše dokaze o procesu neolitizacije tega prostora. V članku predstavljamo zgodnjeneolitsko lončenino iz te naselbine in njen položaj pri širitvi neolitizacije iz Bližnjega Vzhoda proti severozahodni Anatoliji, pri čemer ocenjujemo njen položaj v primerjavi z drugimi znanimi najdišči tega časa.*

KLJUČNE BESEDE – *neolitizacija; zgodnjeneolitska lončenina; Anatolija; Frigijsko višavje; Keçiçayiri*

 DOI: 10.4312/dp.46.9

Introduction

Following the end of the Last Ice Age, people in the Near East who had subsisted by hunting and foraging began a transition into a lifestyle that included permanent settlement and food production, the first step of a radical alteration that would ultimately be adopted by much of humanity. The earliest Pre-Pottery Neolithic settlements yet identified, and thus the earliest core regions for the transition into farming, are in the Zagros Mountains of modern Iran, the Levant, at Çayönü near the Taurus Mountains and on the Konya Plain in Turkey. Excavations carried out at settlements such as Can Hasan, Aşıklı Höyük and Musular indicate that the earliest areas of incipient food production outside the Fertile Crescent seem to have been in the Konya Plain and mountainous area to the east of it. Perhaps the most notable of these is Aşıklı Höyük, near Aksaray, where a few Pre-Pottery Neolithic settlement phases show an overlapping stratigraphy (*Özbaşaran, Cutting 2007.55*), but the Neolithisation process continued at such sites as Çatalhöyük, near Çumra, which shows many overlapping Early Neolithic layers. Ongoing work in the west of the Konya Plain has greatly clarified the comparative chronologies of the Early and Late Neolithic Periods (*Gérard* et al. *2002*).[1]

Recent excavations in Western Anatolia (Fig. 1) have demonstrated that this area had a role in reshaping the cultures of the Neolithic, rather than simply acting as a bridge for the transition of the Neolithic lifestyle. Mehmet Özdoğan, for example, states that the Neolithic cultures that developed in Western Anatolia and spread to the Balkans and Europe were the predecessors of the European Neolithic, and thus defines Western Anatolia as a Neolithic core region (*Özdoğan M. 2007.418*). Excavations at Bademağacı, in the Lakes District, and at Ulucak, Yeşilova and Çukuriçi, near the Aegean, show that material culture which was clearly influenced by Central Anatolian Neolithic developed differently in the south than in the north. Material from Aktopraklık, Ilıpınar, Barcın Höyük and Yenikapı are representative of the northern Fikirtepe culture and the Neolithisation of the Marmara region.

The settlement of Keçiçayırı, the subject of this paper, is situated on a natural communication route that connects Central Anatolia with Eskişehir, in the mountains of Phrygia, and the southern Marmara coastline beyond. Keçiçayırı was one of the first permanent settlements in this part of the world, and finds show that it was inhabited from the Pre-Pottery Neolithic to the Roman Period.

Brief overview of the Neolithisation of North-western Anatolia

Despite increasing research, it is clear that there is still much that is unknown about the process of Neolithisation of Western Anatolia, and there are many ways to approach it. Mehmet Özdoğan regards the process of Neolithisation in the Near East, Aegean and Balkans as a series of geographical/cultural zones (*Özdoğan M. 2014; 2016*). The earliest lie to the east of the Central Anatolian Basin, and are regarded as the regions that saw the formation and development of the Neolithic lifestyle (10 400–7200 BC): Northern Syria and the Levant (Zone A1), Northern Iraq and Western Iran (Zone A2), and South-eastern Anatolia (Zone A3). From the early 7th millennium BC, the Neolithic lifestyle began to spread rapidly, probably due to the effects of geographical, climatic, and social dynamics, and in this period many settlements were abandoned in the east while people moved west. As such, data about the next phases of the Neolithic lifestyle are encountered in the Anatolian Lakes District (Zone B1) and Aegean (Zone B2), in which the number of settlements greatly increased, and in Inner Western Anatolia (Zone C1) and to

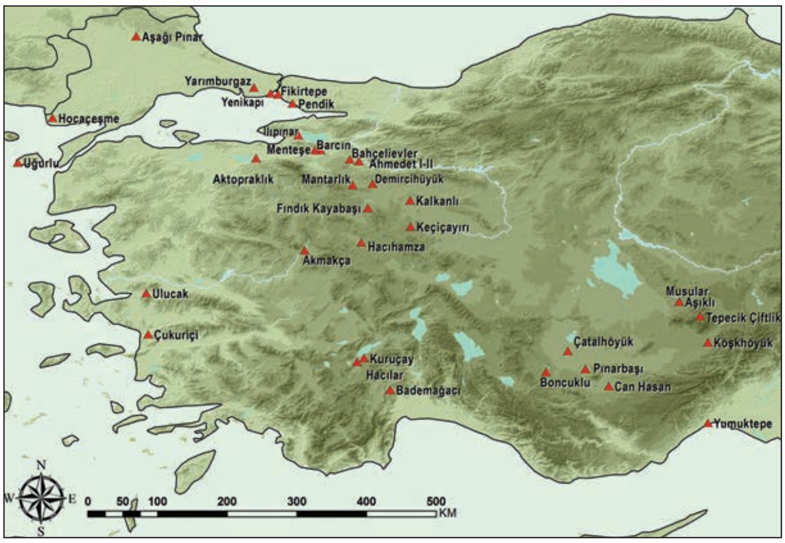


Fig. 1. Major Anatolian Neolithic sites of Western Anatolia.

1 For current ^{14}C dates see http://www.14sea.org.

the east of the Sea of Marmara (Zone C2). The trend seems to be that the Neolithic lifestyle spread along two paths from the Lakes District, with one continuing south to the Aegean coast and the other crossing the Anatolian Plateau to the Sakarya River basin (*Özdoğan M. 2014.36; 2016.54–55*).

Recent data has amply demonstrated that Neolithisation is closely connected with climatic oscillations (*Weninger* et al. *2014*). A period of rapid climate change now known as the 8.2-k event saw a period of rapid cooling that lasted up to 600 years, Phase A from 6600 to 6300 BC and Phase B from 6300 to 6000 BC. Phase A corresponds to the period when pottery was used first in the Near East and when a number of Pre-Pottery Neolithic settlements were abandoned (*Weninger* et al. *2014.13–14*). By Phase B, there were a greatly increased number of settlements in Western Anatolia (*Özdoğan, Gatsov 1998. 211*).

The earliest traces of the pre-Neolithic Period in North-western Anatolia have been discovered in the Çatalca-Kocaeli district to the north of the Sea of Marmara. These appear in sites that reflect the elements of the Ağaçlı culture, a late Mesolithic phase from the 8th millennium BC (*Özdoğan, Gatsov 1994; 1998.210, 213*). The lithic material of this phase is similar to the Neolithic examples that followed, including microlite tools created using pressure techniques reminiscent of the epigravettian tradition, and chipped stone tools with prismatic blade cores. It is probable that the lithic toolkit of the Mesolithic Ağaçlı culture was adopted by the Neolithic Fikirtepe one (*Özdoğan M. 1999.203*).

Yet evidence from settlements such as Keçiçayırı, Kalkanlı, and Asarkaya situated in the district of Eskişehir shows that some communities followed ceramic traditions that originated from Central Anatolia and used very different chipped stone tool technologies to those living further north. These tools are from contexts that date to the Pre-Pottery Neolithic, and come from a different tradition to the microlilte tools of the Ağaçlı culture of Mesolithic Period, or the Pendik and Fikirtepe cultures that followed. They are characterized by macro blades, macro perforator and chipped discs (*Özdoğan, Gatsov 1998. 213–214*). Macro blades and macro perforator are closer to the traditions seen in material from the Pre-Pottery Neolithic Period of Konya Plain. This suggests that there were connections with North-western Anatolia during the Pre-Pottery Neolithic (*Özdoğan, Gatsov 1998; Efe 2005; Efe* et al. *2012*).

The chipped stone tools known from the Pre-Pottery Neolithic of the Konya Plain seem to have been part of a long tradition, especially in the eastern parts of the plain in the district of Eskişehir. Keçiçayırı, Kalkanlı, and Asarkaya are situated at the western extremity of the culture's distribution area (*Efe 2005. 112*). These settlements, which contain the first traces of Neolithisation in the area, are located in high, somewhat mountainous areas that are more suitable to hunting and animal husbandry than to agriculture (*Özdoğan M. 1997.18*).

Traces of pottery appear for the first time in the Konya Plain during the early 7th millennium BC, in Levels XI–VIII at Çatalhöyük, which have been dated to 7000–6700/6600 BC. It is represented by straw- and grit tempered coarse ware, thick-walled simple profile bowls, and holemouth jars (*Özdöl 2006.130–153*). The earliest traces of pottery in the Lakes District are seen shortly thereafter, in the EN I/8–9 layers at Bademağacı, dated to 7050–6705 BC (*Duru 2007.349*). By the middle of the 7th millennium BC there were some innovations in the pottery tradition found in Levels VII–IV of Çatalhöyük (6700/6600–6400/6300 BC), which were a development of the earlier styles and have been defined as the 'Middle Tradition' (*Özdöl 2006.153–205*). Among these developments are the ledge-rimmed bowls, 's'-profile bowls, squat-necked pots, and pierced lugs that became distinctive elements for dating settlements in Western Anatolia. The features of the Middle Tradi-

Fig. 2. The location of Keçiçayırı.

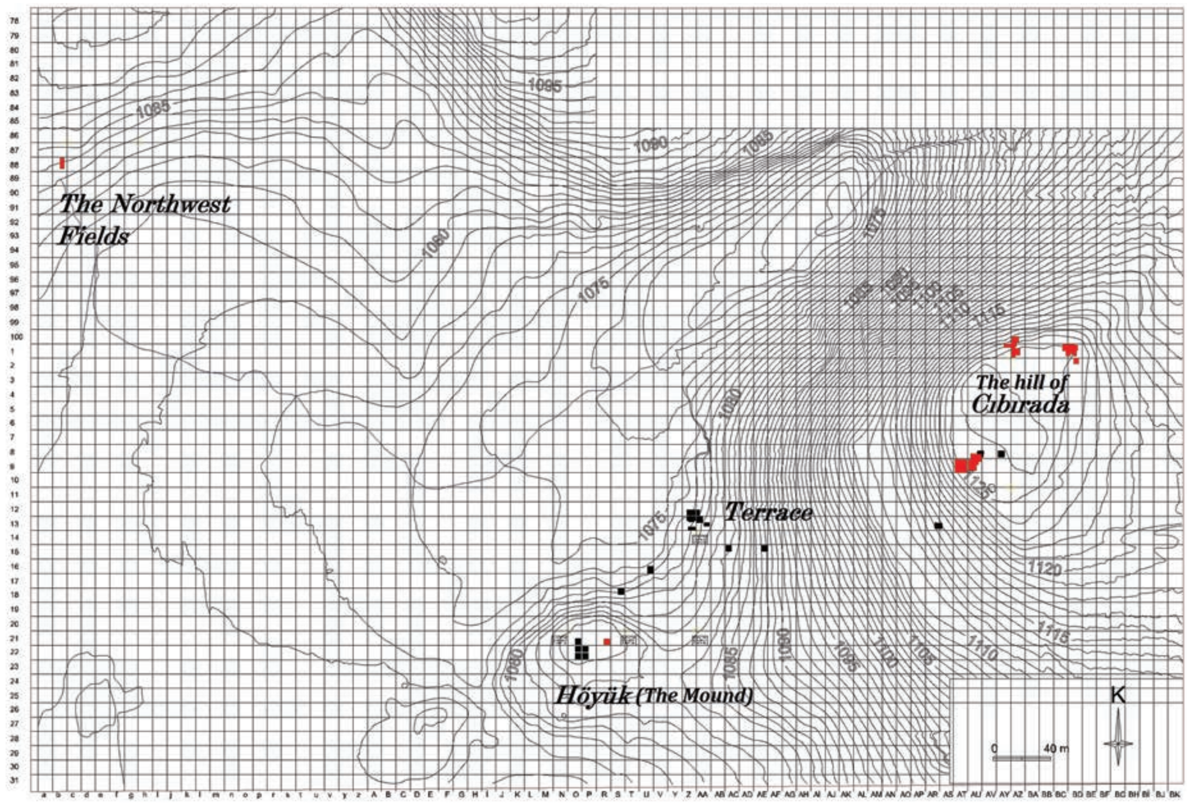


Fig. 3. Topographical plan and trenches of Keçiçayırı.

tion of the Konya Plain are found in the pottery of Inner North-western Anatolia a few centuries later.

These are the earliest ceramic forms from this region, from a period called the Initial Neolithic (*Özdogan E. 2015.51, Fig. 6; 2016.271, Fig. 2; Erdoğu* et al. *2015.34*). Radiocarbon and relative dates are consistent for the pottery of the western part of the Konya Plain and that of the Inner North-western Anatolia from Keçiçayırı and Demircihöyük, in the district of Eskişehir, and Layers VIe and VId (6570–6330 BC) at Barcın, where they have been attributed to a pre-Fikirtepe culture (*Gerritsen* et al. *2016. 200*). Holemouth jars and ledge-rim pots indicate that these ceramics originated in the tradition found earlier at Çatalhöyük. It appears to have arrived on the Aegean coast one or two centuries earlier still, having been dated at Ulucak VI to 6750–6600 BC (*Çilingiroğlu 2012.18*) and at Çukuriçi XII–XI to approx. 6772–6489 BC (*Horejs* et al. *2015.302*).

In the next phase, the settlements of Menteşe 3 Basal and Aktopraklık C were founded to the south of the Sea of Marmara, followed soon after by Fikirtepe and Pendik to its north. This phase began around 6300 BC and corresponds to the Late Neolithic layers III–O at Çatalhöyük (6400/6300–6000 BC), and has been called the 'Late Tradition' (*Özdöl Kutlu 2014*). The pottery parallels the Middle Neolithic Period in Northnorth-western Anatolia (*Özdoğan E. 2016.Fig. 2*), and retains the elements of pottery from the 'Archaic Fikirtepe culture'. These elements include 's'-profile bowls and squat-necked pots also known from the Middle Tradition of Çatalhöyük, along with rectangular or triangular cultic wares with incised decoration known as 'Fikirtepe box' forms.

The Late Neolithic phase began *c.* 6000 BC and lasted until around 5750 BC. It was in this phase that two different cultural regions coalesced in Western Anatolia: the Fikirtepe culture that extends along a region that included the eastern parts of the Sea of Marmara and the Sakarya Basin directly to the south-east, and the Hacılar culture that developed in South-western Anatolia and is characterized by a red-on-cream pottery tradition.

Fikirtepe ceramics originated in the monochrome tradition of Central Anatolia, which was found across the whole of Western Anatolia in the previous phase, but merged with local elements and developed to take on a new identity. This interpretation is based on surface surveys at the settlements of Akmakça, Fındıkkayabaşı (*Efe 1990.409*), and Hacıhamza (*Efe 1994.574*) in the western part of the Anatolian plateau, where Fikirtepe pottery, including elements such as Fikirtepe box forms, have been found together with red-on-cream wares. As such, the plain of Eskişehir, incuding Demircihöyük, seems to have been at the border between classical Fikirtepe culture and those of the Hacılar culture. Some pieces of typical Fikirtepe wares have been found in surface surveys to the north of this region, such as Ahmedet I–II (*Efe* et al. *2015.497*) and Bahçelievler (*Efe* et al. *2015.499*) in the district of Bilecik, where no traces of painted pottery have been encountered.

Periods	Northwest fields	Mound	Terrace	Cıbırada
Roman	x	x	x	–
EBA III	–	–	–	x
Late EBA II	–	–	–	x
Late Chalcolithic	–	–	x	–
Early Neolithic	x	–	–	x
Aceramic Neolithic	x	x	–	–
Upper Palaeolithic	x	–	–	–

Fig. 4. The stratigraphy of Keçiçayırı.

The location of Keçiçayırı and its excavation history

The settlement of Keçiçayırı is located in the mountainous southern part of the province of Eskişehir, in an area known as the Phrygian Highlands (Fig. 2). It lies 5km southwest of the village of Bardakçı and approx. 18km south of Seyitgazi. A stream, the Eşen, rises beside the village of Yazılıkaya and connects to the Sakarya River after passing Keçiçayırı, flowing through a somewhat rough lowland area surrounded by low mountains. Two rocky hills of Neogene chalk, named Cıbırada and Aralıkada, border the plain to the east of the Eşen. Quaternary alluviums are located in the vicinity of Cıbırada. The Keçiçayırı settlement area surrounds the western foot of this hill, and its fields lie to the northeast on the plain.

Keçiçayırı was first visited by the head of Eskişehir Museum in 1977, and was officially registered after some illegal excavations by treasure hunters had been reported to the authorities. It was then examined a few times during surface surveys undertaken by Turan Efe from 1988 to 1995, which included the provinces of Bilecik, Eskişehir and Kütahya, and some materials were collected from it (*Efe 1997. 217*). From 2006 to 2009, with permission from the General Directorate of Cultural Heritage and Museums and financial support from The Scientific and Technological Research Council of Turkey (TÜB_TAK; SOBAG Proje No 106K111), rescue excavations were carried out under the direction of the head of Eskişehir Museum and with Efe as the scientific consultant (*Efe, Türkteki 2007.75; Efe* et al. *2011; Fidan 2016; Efe, Tuna 2017; Sarı 2017*).

Stratigraphy and excavation

Excavations at Keçiçayırı were independently carried out in four different areas (Fig. 3): the Mound, the Terrace, the North-western Fields, and the Hill

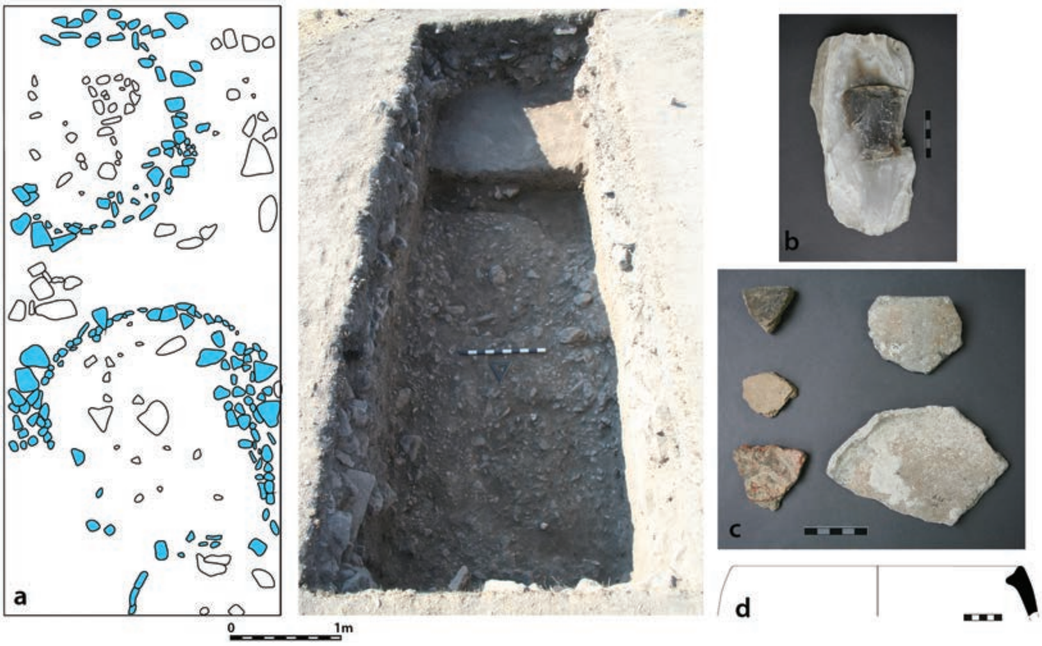


Fig. 5. The flint core dated Pre-Pottery Neolithic and Early Neolithic sherds from trenches other than the Hill of Cıbırada.

Fig. 6. Southern section of the Keçiçayırı plain, including Cıbırada and the Mound or Höyük.

of Cıbırada (*Efe* et al. *2011.10*). There was a layer of Roman period material on the surfaces of all areas other than the Hill. The excavation areas and the periods they include are shown in Figure 4.

Mound
The area named the Mound or Höyük is a natural hill, and there was only 50cm of cultural accumulation on it. Some stone artefacts that might belong to the Pre-Pottery Neolithic Period were found there, including a discoidal core and end-scrapers (*Efe* et al. *2012.229, Figs. 5–6*), along with remains from the Roman Period. Pits carved into the bedrock at the northern end of a Roman Period building were probably the remains of Pre-Pottery Neolithic Period structures that were demolished during the construction of the Roman one. Many scraps of stone and animal bones were found around these pits (*Efe* et al. *2011.11*).

Terrace
A round structure from the Roman Period was found 100m northeast of the Mound and approx. 200m southwest of the Hill of Cıbırada, and named the Terrace (*Efe* et al. *2011.12*). A sounding opened here reached the bedrock, upon which were two damaged human skeletons. Two vessels, apparently grave goods, were found along with these skeletons, and have been dated to the Late Chalcolithic Period (*Efe 2008.245*).

North-western Fields
The area called the North-western Fields lies on the plain, approx. 750–800m northwest of the Hill of Cıbırada. These fields saw extensive use during the Roman Period, but prehistoric remains were reached there in two trenches (b-88 and part of b-87). Two supeimposed prehistoric layers were found beneath the Roman ones in trench b-88. The upper layer was homogenous and dark in colour without architecture, while the one below was a pebbly layer containing some chipped stone material. Two round depressions in the pebbly layer might point to an intermediary phase (Fig. 5a). A naviform and a flake core (Fig. 5b) of the Pre-Pottery Neolithic Period are probably the most important finds from this area (*Efe* et al. *2012. Figs. 3–4*), though a few Early Neolithic sherds were also collected from the upper prehistoric layer (Fig. 5c–d), one of which had a ledge-rim and was thus typical of the period (*Efe* et al. *2011.12–13*).

The stratigraphy and Neolithic architecture of Cıbırada

The Hill of Cıbırada is situated on the eastern border of the plain, approx. 45m higher than the Mound and Terrace (Fig. 6), and the Neolithic and Early Bronze Age (EBA) stratigraphies of Keçiçayırı were obtained from this area. The main settlement at Cıbırada was an EBA fortification, approx. 120 x 100m in size, which was surrounded by a wall that was built to follow the natural contours of the hill. Pottery and other finds from the settlement show that it dates to the second half of the 3rd millennium BC (*Efe, Tuna 2017; Fidan 2016; Sarı 2017*).

Two EBA II structures, named Rooms 15 and 16, were found in squares AV-1, AY-1 and AZ-1 in the

Fig. 7. The Neolithic layer under the EBA II houses of the citadel (Room 15 and 16) situated on the Hill of Cıbırada.

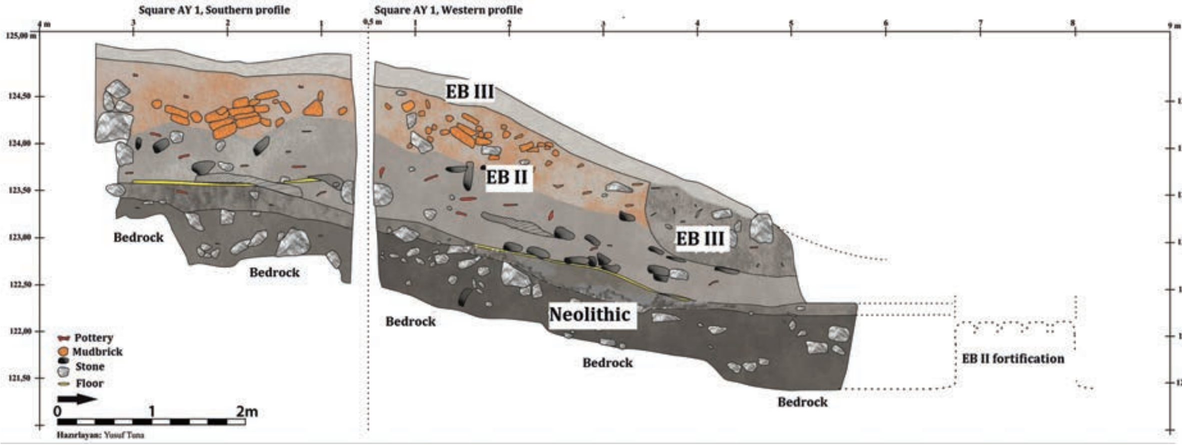


Fig. 8. The stratigrapgy of Cıbırada, Trench AY 1, western and southern profiles, Room 15.

north of the settlement (Fig. 7). They appear to have been destroyed in a fire. Beneath a thin homogeneous layer containing a mixture of EBA II and Early Neolithic material, there is a Neolithic layer on the bedrock (Fig. 8).

The structures were defined by three north-south walls, built directly onto the bedrock and following the slope of the hill, so that the northern end was approx. 50cm lower than the southern one. Overlain by these walls was the only architectural remains of the Neolithic Period to be found, a structure with a round or oval plan carved into the bedrock and approx. 60cm in depth and 5m in diameter (Fig. 9).

The majority of this structure is still beneath the EBA II walls, but part of its southern extent was revealed during excavation. It consisted of two courses of small- to medium-sized stones surrounding a pit that had been cut into the bedrock. No traces of mudbrick or post-holes were found, but the soil matrix contained pottery and many ground- and chipped stone tools were discovered lying in situ on the bedrock.

Chipped discs made from tabular flint, retouched blades, and end-scrapers were found with pottery from the Early Neolithic Period on the Hill of Cıbırada (Fig. 10). These tools were generally shaped by indirect percussion, though direct percussion was also used for flakes (*Gatsov* et al. *2016.2*). The pressure flaking which was developed from the previous Pre-Pottery Neolithic phase is used subsequently for bullet core fragments; this connects the Konya plain with Keçiçayırı and Barcın VIe–VIe/d (*Gatsov* et al. *2016.3*) and then to Aktopraklık C (*Karul 2017.66–67; Özdoğan M. 2014.42, Fig. 7*) to the south of the Sea of Marmara. The Early Neolithic pottery assemblages from Keçiçayırı, discussed in greater detail in the sections that follow, also support this opinion.

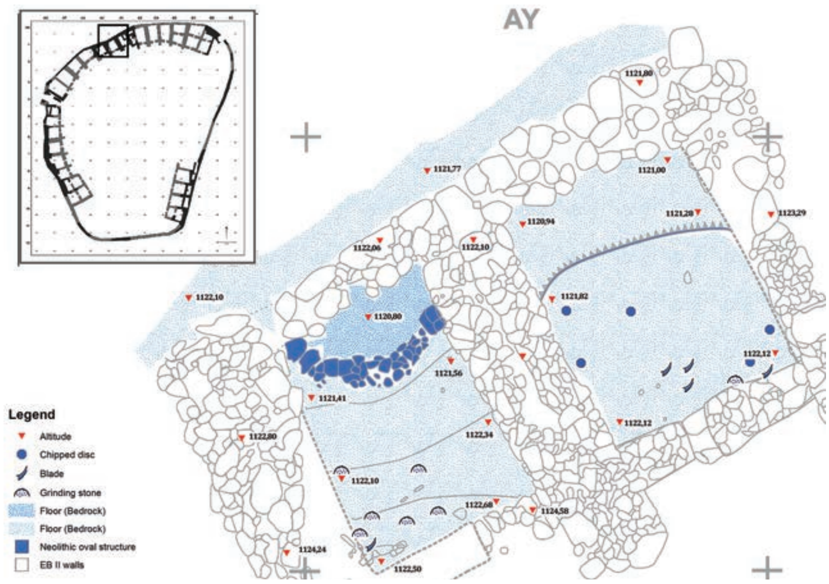


Fig. 9. Neolithic layer of Cıbırada (Rooms 15 and 16).

The Neolithic pottery of Keçiçayırı

Neolithic pottery had been found in square b-88 in the North-western Fields and in squares AV-1, AY-1, and AZ-1 on the Hill of Cıbırada. The number of pieces in North-western Fields was limited, with only eight body sherds and one ledge-rim piece that might be dated to the Neolithic Period being found in this area (Fig. 5c–d). The Hill of Cıbırada yielded a greater number, and 522 pieces dating to this period and

55 of the assemblage are diagnostic. These were found across an area of roughly 100m², in strata that were on average 60cm deep.

The ware groups

The 522 Neolithic sherds have been identified as belonging to three main ware groups: Red Slipped Wares, Dark Faced Wares, and Coarse Wares. Coarse Wares represented 60% of the pottery, and are thus the most common ware group from the settlement, though most were amorphous pieces. Dark Faced Wares were the next most common, at 35%, while Red Slipped Wares were sparsely represented, at only 5%. There is, however, a margin of error because it was not always easy to distinguish which pieces might belong to a given ware group (Fig. 11).

Red Slipped Wares

The surfaces of Red Slipped pieces were better preserved than those of the other ware groups due to their slip and burnishing. The surface colours were typically red and reddish brown, though in some pieces the colour was closer to a shade of brown. Some pieces were speckled due to secondary combustion. The paste was more readily observable than in Coarse and Dark Faced Wares, though no cores were found. Mica was commonly used as a temper, but thin or gritty straw tempers were also visible (Fig. 12a). Red Slipped ware was mainly used for simple profile bowls, 's'-profile bowls, closed vessels, and long necked pots.

Dark Faced Wares

This group was only the second most commonly represented group of Neolithic pottery, but 43 of the 55 diagnostic pieces (78%) were Dark Faced Ware. Blemishes on the surface were generally corrected by non-slipped plaster that was burnished to varying degrees. Accordingly, some pieces have smooth and bright surfaces, while others have matte surfaces that are less well-finished. A variety of dark browns were dominant among the surface colours, but there were light-brown faced pieces as well, and some had multiple colours due to secondary combustion. The paste was generally mid-brown, though some samples were beige and dark brown, while others had a grey or black core. Mica was used as a temper in almost every piece, and could be seen on the surfaces of some. Thin grit temper was used in thin-walled wares, and rough grit and some straw temper in thick-walled wares (Fig. 12b). A variety of forms were observed, including simple profile bowls, ledge-rim bowls, 's'-profile bowls, closed vessels, squat necked pots, long necked pots, and lids. Vertical handles, horizontal handles, vertical lugs and pierced lugs were seen.

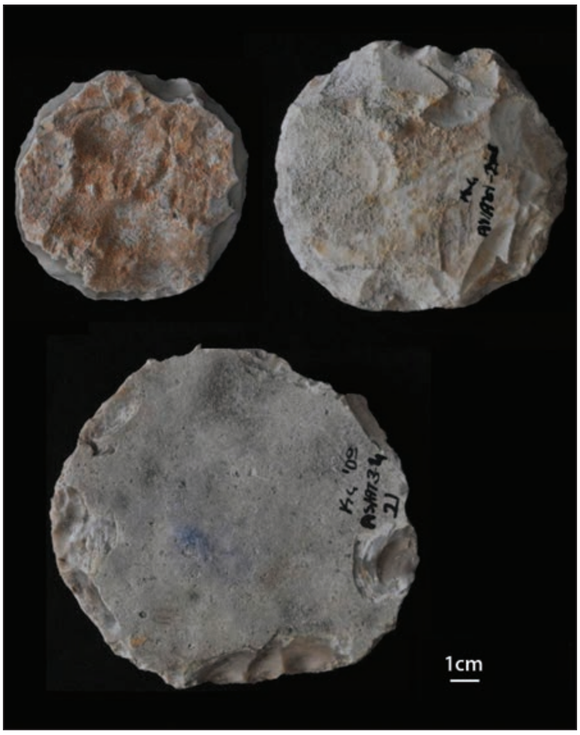


Fig. 10. Chipped-discs from Cıbırada.

Coarse Wares

The surfaces of Coarse Wares were not generally well-finished, and slip and burnish were not used on this ware group. Some 72% of these pieces were multi-coloured in grey and black due to secondary combustion, so although it is not easy to determine the original colour of this ware type it is almost certain that dark colours were dominant, albeit that some light brown/beige shades were seen. The colour of the paste also ranged from shades of light brown/beige to dark brown/black, with some samples showing light grey pastes and black cores. Rough grit, mica, and limestone were used as inclusions. Straw-based tempers were seen but were uncommon, though many samples showed straw negatives on the surface (Fig. 12c). So far as it is possible to determine, the majority of Coarse Ware pieces were storage- and kitchen wares. Almost all of the pieces found were body sherds, with only three base pieces that might be considered diagnostic.

Pottery forms

The amount of pottery obtained from the Neolithic layer is not high, and the diagnostic sample is limited. Most of the Early Neolithic pottery from Keçiçayırı can be reconstructed as bowls and jars, along with a handful of lids and handles (Fig. 13).

Bowls

As noted, most of the bowl forms at the settlement (Pl. 1.1–10) were of Dark Faced Ware, along with a few of Red Slipped Ware. They have been subdivided typologically into three groups: simple profile bowls (Fig. 13.1a), ledge-rim bowls (Fig. 13.1b), and 's'-profile bowls (Fig. 13.1c).

Simple profile bowls made up 30% of the Neolithic bowls, most of which were of Dark Faced Ware. Their profiles either show a slight outward curve or are vertical (Pl. 1.1–3). Ledge-rim bowls have a broadly similar form, but have an internal ledge around their rims, which probably allowed a lid or cover to be placed on them (Pl. 1.4–7). All of the ledge-rim bowls at Keçiçayırı were Dark Faced Ware. 'S'-profile bowls (Pl. 1.8–10) also made up 30% of the bowls at the settlement, and most were Dark Faced Ware but a few Red Slipped Ware samples were seen. The mouths and body parts of 's'-profile bowls were normally well-finished, though some were quite rough.

Jars

There were two subgroups of jar – closed jars and necked jars – the surfaces of which were generally dark and burnished. The majority of the base and body sherds from the settlement were jars. Closed jars (Fig. 13.2a) were the most common type, making up 65% of all forms of jar at the settlement. This form narrows at the mouth, which has a horizontal profile, and normally a globular body, and is one of the characteristic forms of the Neolithic Period (Pl. 1.11–13, Pl. 2.14–21). Closed jars were probably used for storage. The majority were again Dark Faced Ware, with a limited number of Red Slipped Ware examples.

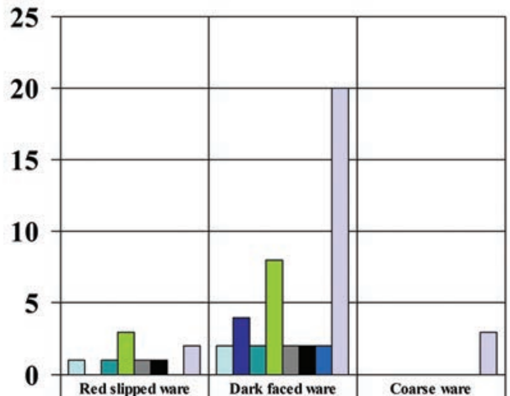
Necked jars (Fig. 13. 2b) differ from closed jars in that a neck arches upward from the body (Pl. 2.22–27). The majority of these rims were of Dark Faced Ware, with Red Slipped Ware in limited numbers. Necked jars have two subgroups according to the length of the necks: 'squat' necked jars (Fig. 13.2b1; Pl. 2.22–24) and 'long' necked jars (Fig. 13.2b; Pl. 2.25–27). Some 'long' necked jars also had vertical handles (Pl. 4.51).

Lids

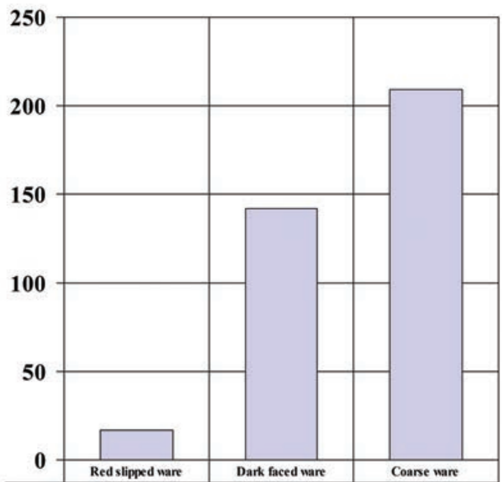
Covers or lids were probably used with ledge-rim bowls or on cooking vessels. The surfaces of the samples found at Keçiçayırı were well burnished and all of them were of Dark Faced Ware. One of was 15cm and another was 17cm in diameter. This form does not show much variety, having sharp edges and rising in the centre to form a low dome (Pl. 4.47–48).

Handles, lugs, and bases

All examples are Dark Faced Ware. Handles are vertical (Pl. 4.51) or horizontal (Pl. 4.49). Lugs are vertical (Pl. 4.50) and some of them are pierced (Pl. 4.52–54). Bases were the most common diagnostic in the sample (Fig. 11), comprising nearly half of the Dark Faced Ware and Coarse Ware, though two Red Slipped Ware base sherds have been found. All bases should be regarded as belonging to jar forms due to ware, base types, rising angles, and diameters. Some



	Red slipped ware	Dark faced ware	Coarse ware
Simple profile bowls	1	2	0
Ledge-rim bowls	0	4	0
"S" profile bowls	1	2	0
Hole-mouth jars	3	8	0
Jars with short neck	1	2	0
Jars with long neck	1	2	0
Lids	0	2	0
Flat bases	2	20	3



	Red slipped ware	Dark faced ware	Coarse ware
Amorfs	17	142	209

Fig. 11. The ratio of the ware groups.

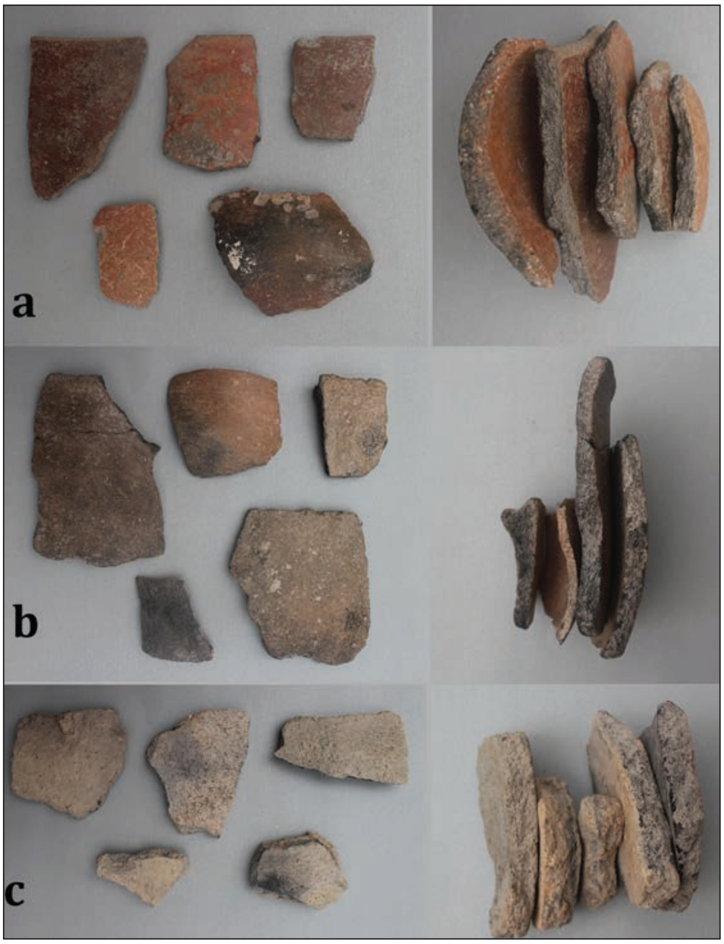


Fig. 12. Ware groups.

of the bases were very rough and thick, though there were also some that were thinner, and more care had been taken during their manufacture.

Comparisons with other sites

Although the short-term rescue excavations conducted at Keçiçayırı allowed important archaeological data to be retrieved, it was not possible to take advantage of radiocarbon dating methods to produce an absolute chronology. Comparative chronologies are possible, however, notably with Çatalhöyük, one of the starting points for Neolithisation in Western Anatolia, but also with Demircihöyük in the far west of the Plain of Eskişehir, some 90km northeast of Keçiçayırı, and with Barcın Höyük in the Plain of Yenişehir, 180km from Keçiçayırı in the same direction. The radiocarbon data taken from stratigraphic levels at Barcın Höyük is particularly significant for the chronology of Keçiçayırı.

Çatalhöyük

The pottery of Keçiçayırı can be seen as a development and variety of the pottery from levels VII–IV at Çatalhöyük, where the most common groups are straw tempered dark wares, dark faced burnished wares, and grey granular red-slipped wares (*Özdöl 2006. 154*). The dark faced wares and red slipped wares with grey scrapings on them are similar to those from Keçiçayırı both in terms of paste and surface treatment. The pottery from level III at Çatalhöyük shows that dark faced wares continue from previous levels but also see a decrease, with lighter and red surfaces taking their place (*Özdöl 2006.161*).

Vessel walls became thinner at Çatalhöyük from level VIII, and from level VII there was an increase in form types and ware groups. Closed vessels continued to develop from previous levels (*Özdöl 2016.Pl. 25*), particularly in level VI (*Özdöl 2006.Pl. 24*) where they are a good match with those from Keçiçayırı. Simple profile bowls continued into levels VII–IV, again developing from previous phases. Ledge-rim bowls appear in level VI (*Özdöl 2006.Pl. 31.2, 32.2–3, 33.3, 36.3, 37.2–3*), and are very similar to those at Keçiçayırı. Pierced lugs also appear in level VI. These forms appearing in levels VII and especially VI continued to develop through to level III, where 's'-profile and external rim bowls take the place of the closed vessels commonly seen from level XI (*Özdöl 2006.Pl. 126*).

Demircihöyük

Ware A, a mica schist tempered and red-slipped ware from Demircihöyük, is believed to correspond to levels XII–IX of Çatalhöyük, and Ware B, which has intense mica temper, grey- to greyish-beige faces, and shining surfaces due to this mica temper, corresponds to levels IX–VI. The forms represented among Ware A include ledge-rims (*Seeher 1987.Pl. 1.1–7*), closed mouths (*Seeher 1987.Pl. 1.8–9*), lids (*Seeher 1987.Pl. 1.16–19*), horizontal lugs (*Seeher 1987.Pl. 1.10*) and straight bases (*Seeher 1987.Pl. 1.11–15*). Different forms are known from Ware B at Demircihöyük, including necked pots (particularly the 'squat' necked subgroup; *Seeher 1987.Pl. 2.12, 15–18*), 'S'-profile bowls (*Seeher 1987.Pl. 3.4–5*) and pierced lugs (*Seeher 1987.Pl. 2.11*).

Barcın Höyük

Finds from phase VIe, the earliest Neolithic phase at Barcın Höyük (*c.* 6570 BC), have been compared to those from Demircihöyük Ware B and appear to predate level VI at Çatalhöyük (*Gerritsen* et al. *2013.73*). The pottery of Barcın VIe is represented by simple profile bowls and closed vessels (*Gerritsen* et al. *2013.Fig. 17.1–7*), while one of the more notable forms found in phase VIe has been identified as a prototype for Fikirtepe box forms (*Gerritsen* et al. *2013.Fig. 17.9–10*). The first ledge-rim bowls appear at the transition between phases VIe and VId, alongside profile bowls and closed vessels (*Gerritsen* et al. *2013.Fig. 18.1–5*), as do 's'-profile bowls, necked pots, and pierced lugs (*Gerritsen* et al. *2013.Fig. 18.6–15*). A painted and decorated vessel, and samples of four-footed and incrusted Fikirtepe box forms (but without white paste fill) were also among the new forms from the Barcın phase VId (*Gerritsen* et al. *2013.Fig. 19.7–8*).

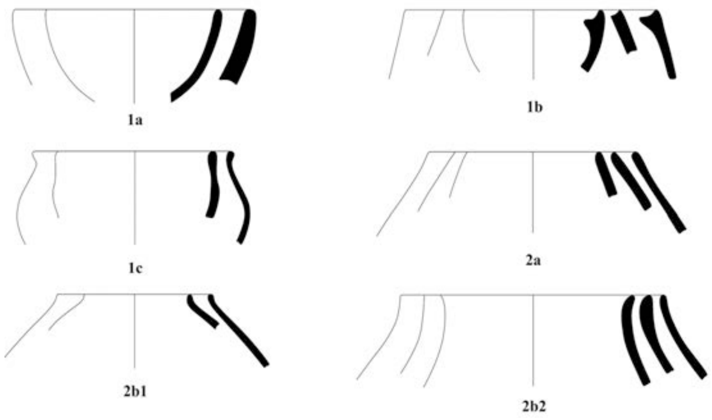


Fig. 13. The typology of the Neolithic pottery from Keçiçayırı.

Aktopraklık

Aktopraklık is located in Akçalar, 4km east of Lake Ulubat and approx. 30km from Bursa. It is situated at the western edge of a corridor running from Eskişehir to Bozüyük and Bursa that connects Central Anatolia to the northwest (*Karul 2017.81*). The earliest settlement was in Area C, and its earliest phases, which have been dated between 6380 and 6250 BC, have architecture that consists of round- or oval wattle and daub buildings with a sunken floor. The walls are sometimes supported by a line of stone from the lower end (*Karul 2017.90, Fig. 53*). Despite the fact that wattle and daub superstructure is not evidenced in Keçiçayırı, Aktopraklık is the closest parallel of oval structure carved into the bedrock found at Cıbırada of Keçiçayırı. Closed vessels, ledge-rim pots (*Avcı 2010.Pl. 18*), 's'-profile bowls, and pierced lugs (*Karul 2017.92, Fig. 56*) were also found in this phase at Aktopraklık.

Relative chronology

Light faced coarse wares were common in the earliest levels at Çatalhöyük, but disappeared at the end of level VII, after which dark faced wares became dominant. The pottery from level VI at Çatalhöyük closely resemble those at Keçiçayırı, when ledge-rim pieces, pierced lugs, and especially closed vessels and 'squat' necked pots started to appear. The earliest samples of 's'-profiles are from levels VI and III of Çatalhöyük, and became more developed in level II, and this suggests that the settlement of Keçiçayırı was roughly contemporary with levels III and II of Çatalhöyük.

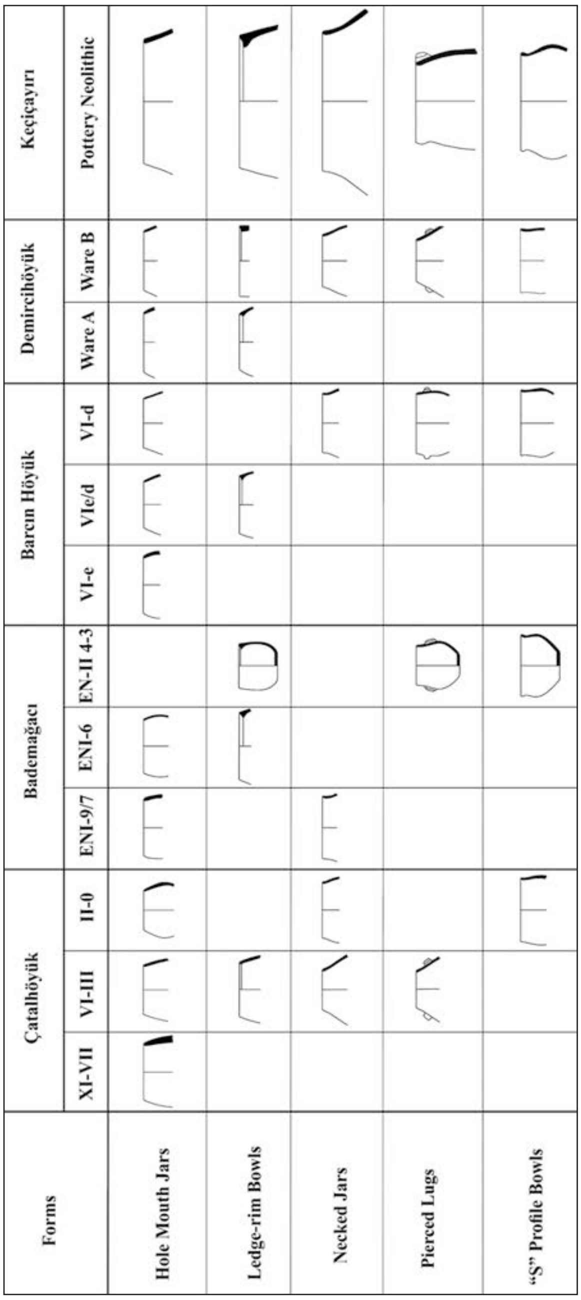


Fig. 14. Form comparison.

Wares A and B of Demircihöyük do not show many similarities with the ware types at Keçiçayırı, but almost all forms in the Demircihöyük A show parallels with those from Keçiçayırı. Most notable are the ledge-rims and closed vessels, which imply that Keçiçayırı was contemporary with the Ware A at Demircihöyük, while the existence of 's'-profiles, one of the most characteristic forms of Demircihöyük Ware B, indicates that settlement at Keçiçayırı continued into this phase.

Dates(B.C)	Çatalhöyük	Bademağacı	Barcın	Demircihöyük	Keçiçayırı
6000	0 I				
6100	II	ENII/1			
6200	III				
6300	IV	ENII/4-3	VId/c	Ware B	↑
6400	V				
6500	VI	ENI/6	VIe/d	Ware A	
6600	VII		VI-e		
6700	VIII				
6800	IX				
6900	X				
7000	XI XII	ENI/8			

Fig. 15. The suggested chronology of Keçiçayırı.

Light coloured wares dominate the earliest level of Barcın Höyük, level VIe, and these are reminiscent of the coarse wares at Keçiçayırı, albeit that the latter lacks diagnostics. Dark faced wares began to appear at the transition between phases VIe and VId at Barcın Höyük, and these show many similarities with those from Keçiçayırı. Notably, the walls of ledge-rim vessels and closed vessels from phase VId became thinner, paralleling the repertoire of ware and form at Keçiçayırı. These data suggest that Keçiçayırı was settled concurrently with Barcın Höyük phase VIe. Additionally, the 's'-profile bowls, necked pots, and pierced lugs that appeared in phase Barcın VId and continued into phase VIc show Keçiçayırı was still occupied at this time. Similar elements seen in the early stages of Aktopraklık C imply that it was also settled at this time, as do the oval structures, which further suggest cultural connections with Keçiçayırı.

Pottery of Phase VId at Barcın shows similarities with Keçiçayırı, but there are also differences. The painted and decorated sherds found here and the incrusted Fikirtepe box differ from anything found at Keçiçayırı, though a non-decorated Fikirtepe box was found at Keçiçayırı during an early surface survey (*Efe 2005.Fig. 8*). Comparative data and a suggested chronology are presented in fgures 14 and 15.

Conclusions

While the Ağaçlı culture was present on the Bosphourus and Western Black Sea coasts during the Mesolithic Period, there is no evidence for settlements to the south of the Sea of Marmara or in inland western Anatolia, where Keçiçayırı is located. As the area transitioned into the next phase, traces of Pre-Pottery Neolithic at lasting settlements – which had a longer tradition in the east of the Konya Plain – begin to appear along the natural route that connects Central Anatolia to Eskişehir and then to Southern Marmara. Keçiçayırı is one such settlement, and along with the introduction of pottery it had a different lithic tradition to that of the previous Ağaçlı culture, such as macro blades and chipped discs. Its location at the easternmost point of the corridor from the Anatolian plateau to the Sea of Marmara is consistent with its place in the Neolithisation process of North-western Anatolia.

During the first half of the 7th millennium BC, the occurrence of pottery influenced by the western part of Konya Plain appeared in this area, signifying the beginning of the Early Neolithic Period in North-western Anatolia. This early pottery seems to have spread quite rapidly, appearing within a few centuries in areas along the south-eastern coast of the Sea of Marmara, and then its northern coast. In this context, it can be shown that Keçiçayırı was settled during the period concurrent with Çatalhöyük VI–IV and with Barcın Höyük layers VIe to VId. It can therefore be dated to 6700/6600–6300 BC, after which time it was abandoned.

The results of the research outlined above are demonstrated by what might be the earliest Neolithic architecture among the highlands along this corridor, on the Hill of Cıbırada at Keçiçayırı, represented by a stone architecture with round structures dug into the bedrock. This architecture was accompanied by many grinding stones, chipped stones, and blades found in situ, as well as pottery from a monochrome tradition that included holemouth jars, simple profile bowls, ledge-rim bowls and jars, 's'-profile bowls, necked jars, pierced-lugs, and prototypes of the so-called Fikirtepe boxes. This ceramic tradition originated on the Konya Plain, and became common on the whole of Western Anatolia during the Early Neolithic, including North-western Anatolia, the Lakes District, and the Aegean Coast.

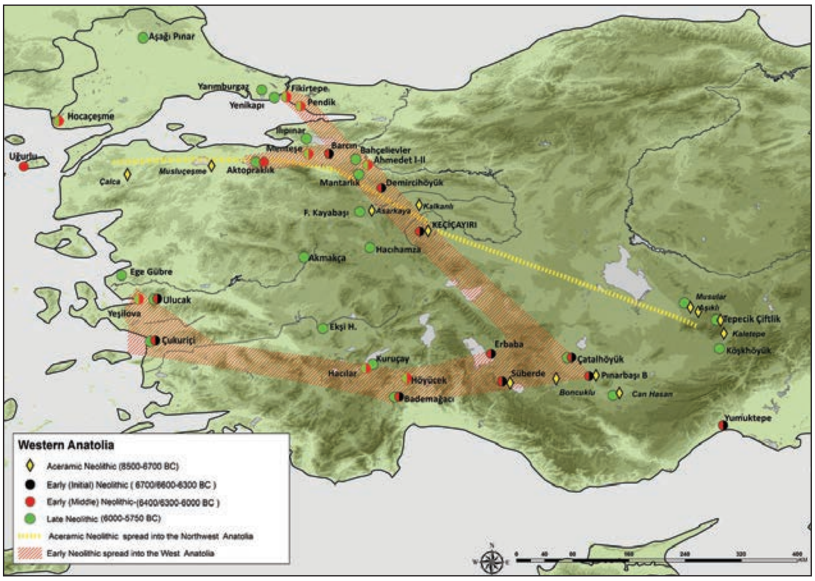


Fig. 16. The spread of the Neolithic from Central Anatolia to the Western Anatolia.

Regional differences had not yet begun to be form at this time. This process began around 6300 BC, as the Lakes District in the south began to adopt a painted pottery tradition, perhaps influenced by further away, from the Eastern Mediterranean. But there is no evidence of such an influence in North-western Anatolia, and it is here that the Early Neolithic monochrome pottery from the Konya Plain continued to develop, becoming integrated with local elements and finally transforming into Fikirtepe culture. The lack of evidence for these later cultural elements at Keçiçayırı suggests that settlement there came to an end just before these regional cultures, or the Archaic Fikirtepe culture, developed. Accordingly, it may be claimed that Keçiçayırı was settled roughly between 6600 and 6300 BC. This period corresponds to the first stage of the Neolithic expansion to the Western Anatolia. There was no longer an occupation at Keçiçayırı around 6300 to 6000 BC, but there were settlements in the northern part of the Eskişehir plain (Demircihöyük, Ahmedet I–II, Bahçelievler) and the eastern part of the Sea of Marmara, some of which (Barcın, Aktopraklık, Pendik, Fikirtepe, Yenikapı) were newly established (Fig. 16).

The settlement of Keçiçayırı shows that Neolithic communities, which were previously founded on plains and coastlines, could also be established in mountainous (but sheltered) areas. The model of settling on a hill was often preferred during the Chalcolithic Period, as settlements such as Orman Fidanlığı, Kanlıtaş and Keskaya indicate. The hill settlement at Keçiçayırı in the Early Neolithic Period shows that this tradition existed before the Chalcolithic in the region.

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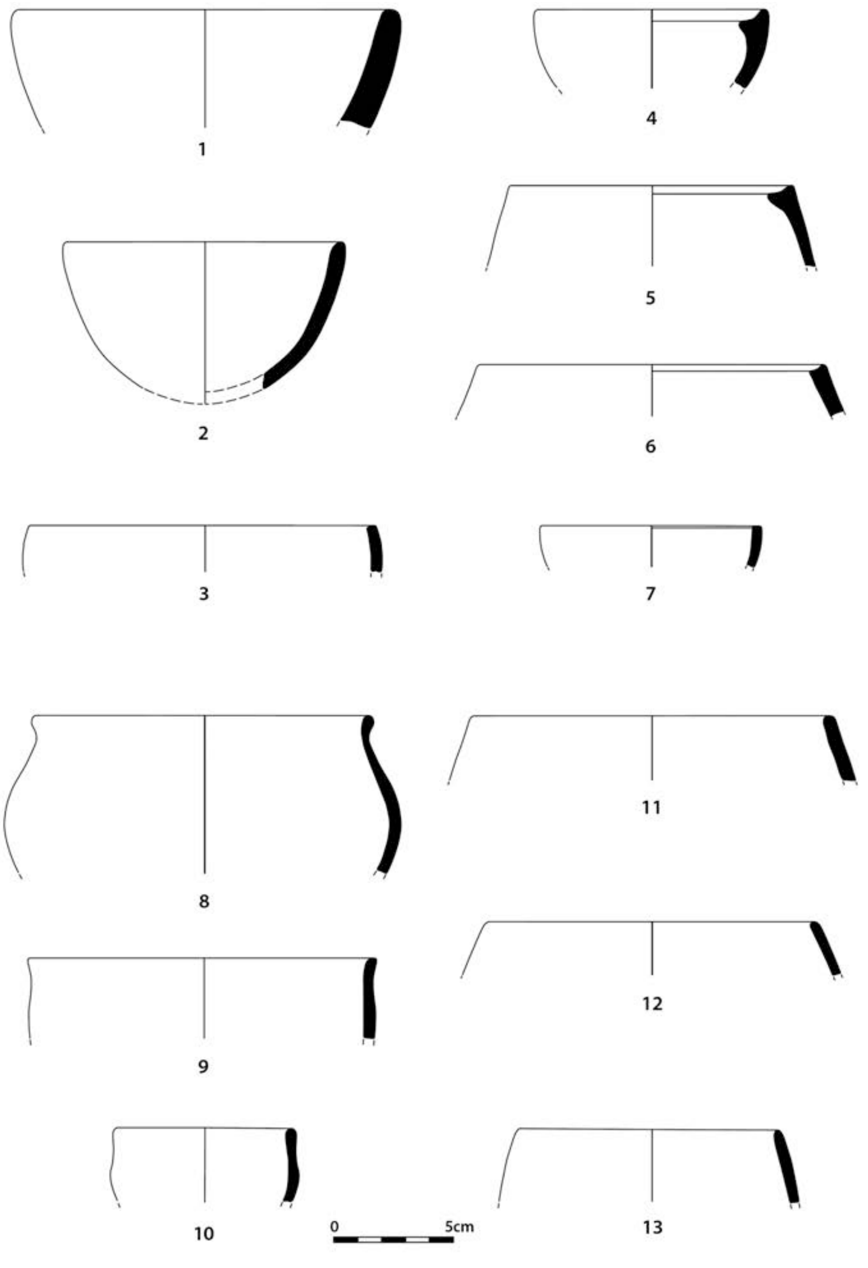
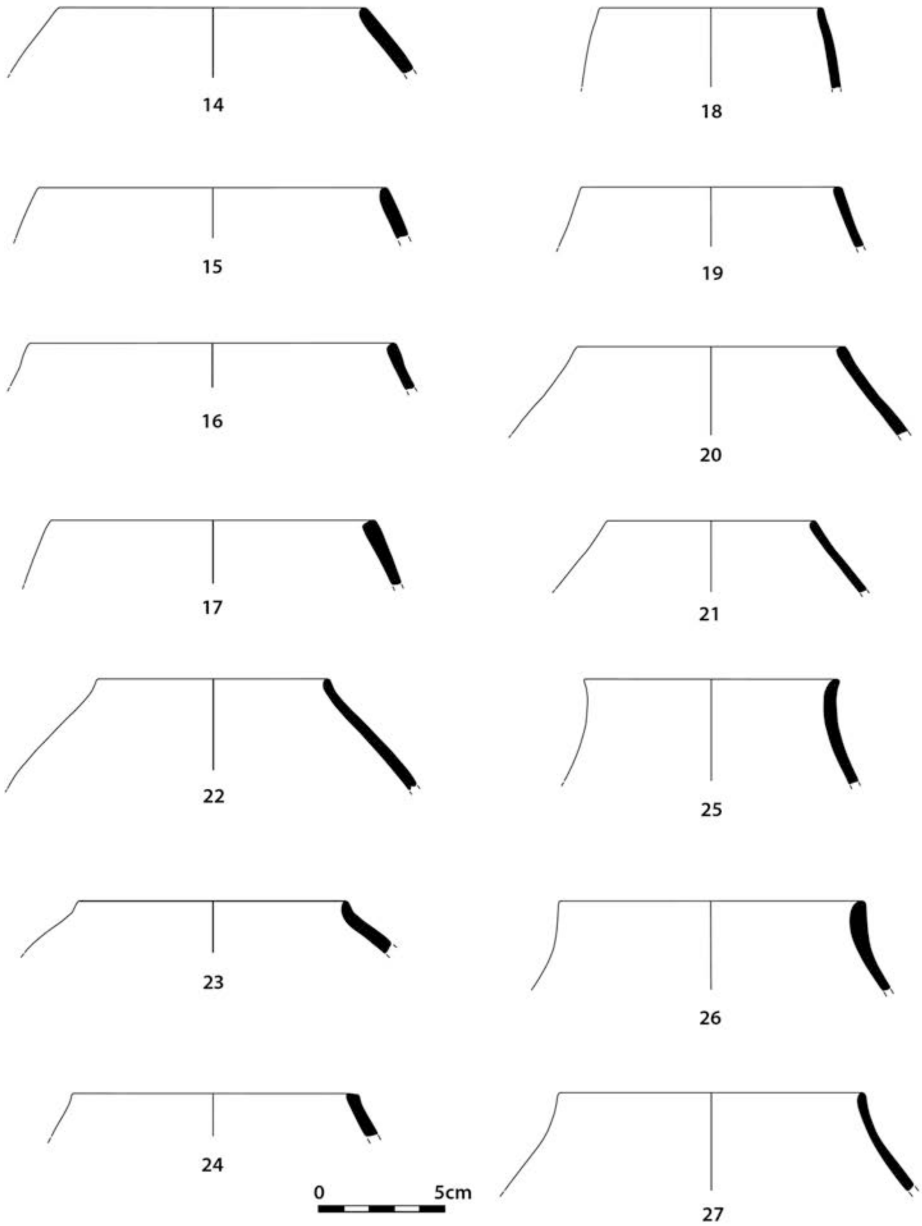
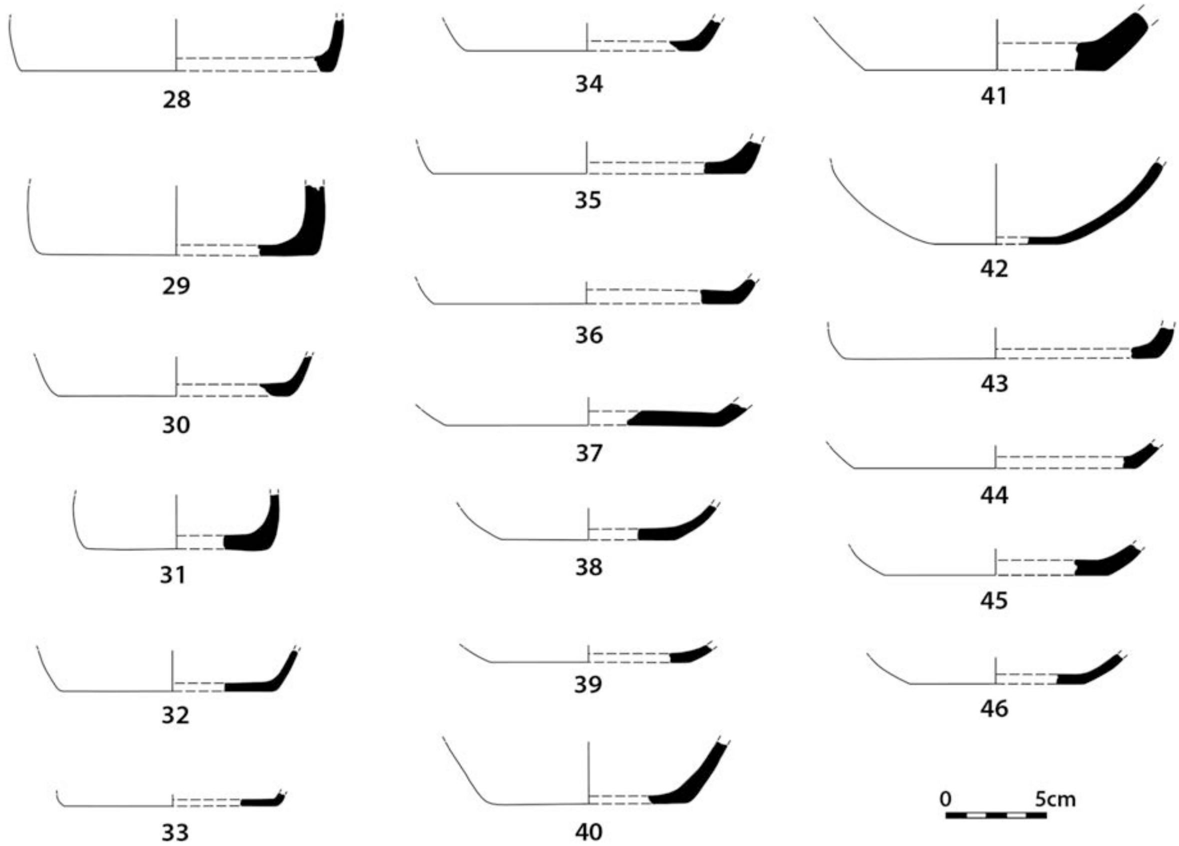


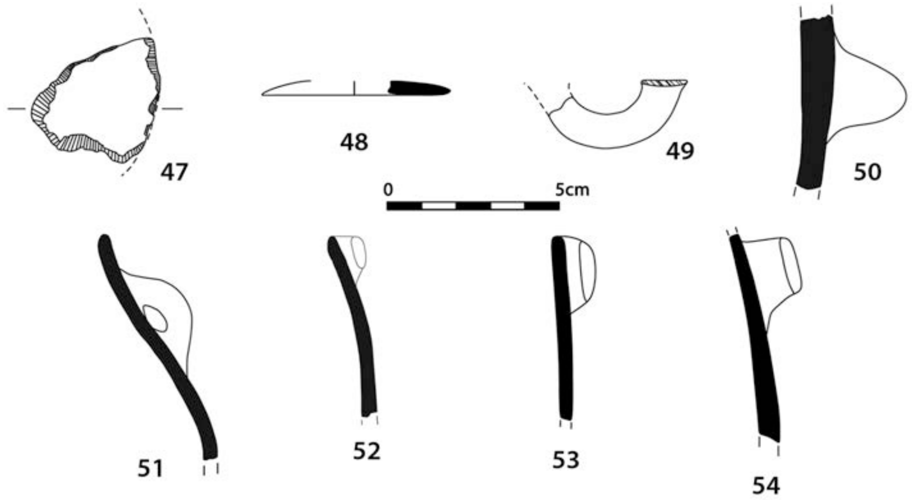
Pl. 1. 1. AY-1. 247. Simple profile bowl. Dark faced ware. Black biscuit with straw and stone inclusions. Light brown surface burnished, mottled black; 2. AY-1. 250. Simple profile bowl. Dark faced ware. Micaceous black biscuit with some small stone and straw inclusions. Light brown surface burnished; 3. AY-1. 250. Simple profile bowl. Red Slipped Ware. Micaceous light brown biscuit with small stone and chalk inclusions. Red slipped surface burnished; 4. AY-1. 198. Ledge-rim bowl. Dark Faced Ware. Micaceous light brown biscuit with small stone inclusions. Dark brown surface burnished; 5. AY-1. 260. Ledge-rim bowl. Dark Faced Ware. Micaceous black biscuit with some coarse stone inclusions. Light brown surface burnished; 6. AY/AZ-1. 280. Ledge-rim bowl. Coarse Ware. Micaceous dark brow biscuit with coarse stone and chalk inclusions. Light brown surface unburnished; 7. AY/AZ-1. 267. Ledge-rim bowl. Dark Faced Ware. Light brown surface unburnished. Brown biscuit with small stone and chalk inclusions; 8. AY/AZ-1. 291. 'S'-profile bowls. Dark Faced Ware. Light brown biscuit with straw and chalk inclusions. Reddish brown surface burnished, black mottled on the rim; 9. AY-1. 226. 'S'-profile bowls. Red Slipped Ware. Micaceous biscuit with small stone inclusions. Red slipped surface on exterior and interior; 10. AY/AZ-1. 267. 'S'-profile bowls. Dark Faced Ware. Micaceous dark brown biscuit with small stone and chalk inclusions. Black surface fine burnished; 11. AY-1. 244. Hole-mouthed jar. Dark Faced Ware. Micaceous dark brown biscuit with small stone and straw inclusions. Brown surfaces burnished; 12. AY/AZ-1. 267. Hole-mouthed jar. Coarse Ware. Dense micaceous light brown biscuit with stone inclusions. Buff surface unburnished; 13. AY/AZ-1. 278. Hole-mouthed jar. Dark Faced Ware. Micaceous brown biscuit with small stone inclusions. Light brown surface burnished.



Pl. 2. 14. AY-1. 247. Hole-mouthed jar. Dark Faced Ware. Black biscuit with small stone and scarcely straw inclusions. Brown surfaces burnished, mottled; 15. AY-1. 282. Hole-mouthed jar. Dark Faced Ware. Micaceous black biscuit with small stone inclusions. Greyish brown surface wet-smoothed; 16. AY-1. 247. Hole-mouthed jar. Dark Faced Ware. Brown biscuit with coarse stone inclusions. Brown surface wet-smoothed; 17. AY/AZ-1. 272. Hole-mouthed jar. Dark Faced Ware. Micaceous brown biscuit with coarse stone inclusions. Brown surfaces burnished, brilliant on exterior; 18. AY-1. 247. Hole-mouthed jar. Red Slipped Ware. Red slipped on both surfaces. Micaceous black biscuit with small stone and chalk inclusions; 19. AY-1. 244. Hole-mouthed jar. Red Slipped Ware. Micaceous black biscuit with small stone inclusions. Maroon slipped surface burnished; 20. AY-1. 247. Hole-mouthed jar. Red Slipped Ware. Micaceous black biscuit with small stone inclusions. Maroon slipped surface burnished; 21. AY-1. 260. Dark Faced Ware. Greyish brown surface smoothed on exterior. Micaceous black biscuit with small stone inclusions; 22. AY/AZ-1. 241. Squat-necked jar. Dark Faced Ware. Micaceous black biscuit with small stone and chalk inclusions. Dark brown surface burnished; 23. AY/AZ-1. 241. Squat-necked jar. Red Slipped Ware. Red slipped surface, mottled on rim. Black biscuit with small stone and chalk inclusions; 24. AY-1. 282. Squat-necked jar. Dark Faced Ware Greyish brown surface smoothed on exterior. Micaceous dark brown biscuit with coarse stone inclusions; 25. AY/AZ-1. 272. Necked jar. Dark Faced Ware. Micaceous blackish brown biscuit with small stone inclusions. Dark brown surface fine burnished; 26. AY-1. 226. Necked jar. Red Slipped Ware. Red slipped surface burnished. Micaceous light brown biscuit with stone inclusions; 27. AY-1. 226. Necked jar. Dark Faced Ware. Brown biscuit with small stone inclusions. Light brown surface burnished.



Pl. 3. 28. AY-1. 247. Base. Dark Faced Ware. Micaceous black biscuit with stone inclusions. Greyish brown surface wet-smoothed; 29. AY-1. 260. Base. Dark Faced Ware. Brown surface burnished on lower body. Black biscuit with stone inclusions; 30. AY/AZ-1. 278. Base. Dark Faced Ware. Light brown biscuit with stone inclusions. Light brown surface burnished on lower body; 31. AY-1. 247. Base. Dark Faced Ware. Dark brown biscuit with stone inclusions. Light brown surface burnished on lower body; 32. AV-1/2. 32. Base. Dark Faced Ware. Micaceous light brown biscuit with small stone inclusions. Light brown surface burnished on lower body; 33. AV-1/2. 32. Base. Dark Faced Ware. Dark brown biscuit with stone inclusions. Light brown surface burnished on lower body; 34. AY-1. 247. Base. Dark Faced Ware. Micaceous black biscuit with stone inclusions. Dark brown surface burnished on lower body; 35. AY/AZ-1. 291. Base. Coarse Ware. Micaceous brown biscuit with coarse stone inclusions. Light brown surface unburnished on lower body; 36. AY/AZ-1. 267. Base. Dark Faced Ware. Brown biscuit with coarse stone inclusions. Brown chalky surface; 37. AY/AZ-1. 278. Base. Dark Faced Ware. Micaceous black biscuit with stone inclusions. Brown surface burnished on lower body; 38. AY/AZ-1. 278. Base. Dark Faced Ware. Micaceous dark brown biscuit with stone inclusions. Brown surface fine burnished on lower body; 39. AY/AZ-1. 241. Base. Red Slipped Ware. Light brown biscuit with small stone inclusions. Red slipped surface burnished; 40. AY/AZ-1. 280. Base. Coarse Ware. Dark brown biscuit with coarse stone inclusions and slightly micaceous. Dark brown surface unburnished; 41. AY/AZ-1. 241. Base. Dark Faced Ware. Brown biscuit with stone inclusions and slightly micaceous. Brown surface unburnished; 42. AY-1. 228. Base. Red Slipped Ware. Light brown biscuit with small stone inclusions and slightly micaceous. Red slipped surface burnished; 43. AY/AZ-1. 267. Base. Coarse Ware. Brown biscuit with stone inclusions and slightly micaceous. Light brown surface unburnished; 44. AY-1. 250. Base. Dark Faced Ware. Micaceous brown biscuit with stone inclusions. Dark brown surface unburnished; 45. AY/AZ-1. 241. Base. Dark Faced Ware. Micaceous brown biscuit with stone inclusions. Light brown surface smoothed; 46. AY-1. 247. Base. Dark Faced Ware. Black biscuit with small stone inclusions and slightly micaceous. Blackish brown surface burnished.



Pl. 4. 47. AV-1/2. 40. Lid. Dark Faced Ware. Micaceous dark brown biscuit with stone inclusions. Brown surface smoothed; 48. AY-1. 228. Lid. Dark Faced Ware. Micaceous brown biscuit with stone inclusions. Light brown surface smoothed; 49. AY/AZ-1. 278. Horizontal handle. Dark Faced Ware. Micaceous light brown biscuit with stone inclusions. Light brown surface smoothed; 50. AY-1. 259. Horizontal lug. Dark Faced Ware. Brown biscuit slightly micaceous with stone inclusions. Light brown surface burnished, black mottled below the lug; 51. AY/AZ-1. 278. Vertical handle. Dark Faced Ware. Micaceous dark brown biscuit with small stone inclusions. Light brown surface burnished; 52. AY/AZ-1. 278. Pierced lug. Dark Faced Ware. Micaceous dark brown biscuit with small stone inclusions. Greyish brown surface burnished; 53. AY-1. 275. Pierced lug. Dark Faced Ware. Micaceous brown biscuit with small stone inclusions. Light brown surface burnished; 54. AY-1. 259. Pierced lug. Dark Faced Ware. Micaceous brown biscuit with coarse stone inclusions with a black core. Dark brown surface burnished.

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Early ceramic styles and technologies in the Aegean and the Balkans: retrospect and prospects

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ABSTRACT – *Ceramics have always played a central role in defining the Neolithic period in southeastern Europe. Early Neolithic ceramic assemblages, forming techniques, clay recipes, shapes, decoration, and vessel function have been traditionally used to establish the chronology and cultural groups of a region based on a handful of purported type-sites. This paper presents a critical review of the literature on Early Neolithic pottery in Greece, highlighting how preconceptions shaped the research and interpretation of the data of not only the ceramics themselves, but also how those interpretive conclusions were projected into other aspects of Early Neolithic life, such as the gender and status of potters and the socio-functional use of pottery. The recent reevaluation of old and new absolute dates through Bayesian analysis, statistical modelling, and stratigraphic considerations has also helped to provide a more nuanced use of relative pottery chronologies. New archaeological evidence from Northern Greece as well as reevaluations of Knossos and the Franchthi Cave are highlighted.*

KEY WORDS – *chronology; pottery; Impresso; Knossos; Franchthi; Greek Macedonia*

Zgodnji keramični stili in tehnologije na območju Egejskega morja in Balkana: pogled nazaj in naprej

IZVLEČEK – *V jugovzhodni Evropi je imela keramika pri opredeljevanju neolitika vedno osrednjo vlogo. Na podlagi podatkov, pridobljenih na maloštevilnih domnevno tipičnih najdiščih, se je v tej regiji za vzpostavljanje kronologije in kulturnih skupin tradicionalno uporabljalo zgodnje neolitske keramične zbire, tehnike oblikovanja, lončarske recepte, oblike, okras in namembnost posod. V članku ponudimo kritično presojo literature o zgodnje neolitski lončenini v Grčiji, pri čemer izpostavljamo načine, kako so pristranski pogledi oblikovali raziskave in interpretacije različne vrste podatkov, ne samo same keramike, ampak tudi kako so s takšnimi zaključki interpretirali tudi druge vidike zgodnje neolitskega življenja kot sta spol in status lončarjev ter družbeno-funkcionalna raba lončenine. Za bolj raznoliko rabo relativnih kronologij, ki temeljijo na lončenini, si lahko pomagamo predvsem z nedavno predstavljenimi novimi ovrednotenji starih in novih absolutnih datumov, ki so bili izvedeni z Bayesovo analizo, ter s statističnim modeliranjem in ovrednotenjem stratigrafije. V članku predstavljamo tudi nove arheološke podatke iz severne Grčije ter ponovno ovrednotenje podatkov iz Knossosa na Kreti in jame Franchthi na Peloponezu.*

KLJUČNE BESEDE – *kronologija; lončenina; Impresso; Knossos; Franchthi; grška Makedonija*

Introduction

The Neolithic period in Greece was traditionally believed to have begun around 7000 BC based on early absolute dates from the 1960s from a handful of sites, including Nea Nikomedia, Argissa, Sesklo, Achilleion, the Franchthi Cave, and Knossos on Crete (Fig. 1). This early date seemed to support the relative chronology and led to comparisons between the Near East, Anatolia, and southeastern Europe. It also

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paved the way for pejorative descriptions of the pottery as primitive and simple, fitting presumed evolutionary paradigms of technological development. This fact is evident in the names (Frühkeramikum, Proto-Sesklo, Vor-Sesklo) and their definitions (early pottery, early painted, developed monochrome) of the first relative chronology for the Early Neolithic period for Thessaly. These sites have served as type-sites for the Early Neolithic period in their respective regions ever since, but can no longer do so, as recent work in Northern Greece, Crete, the Cyclades, and Western Anatolia has expanded and enhanced the dataset.

Traditional chronology of the Early Neolithic period in Greece

The traditional relative chronology of Neolithic Greece was primarily created in Thessaly due to early excavation and survey work in the area, and was based on surface treatment and decoration (*Tsountas 1908; Wace, Thompson 1912*). The relative chronology for Thessaly was established by Vladimir Milojčić (*1959*) and it became canonical (*Theocharis 1973*). Scholars in Central and Southern Greece (*e.g., Weinberg 1962; 1970*) tried to correlate their ceramics to those of Thessaly as based on Milojčić's system, but did not make chronological subdivisions based on decorated ceramics. Early Neolithic Greek Macedonia was unknown in Milojčić's time.

Concerning the Early Neolithic, a tripartite system was established. It consists of the Frühkeramikum, a purely monochrome phase, the Proto-Sesklo with developed monochrome pottery and limited use of painting, and the Vor-Sesklo (Pre-Sesklo) in which painted pottery was more common than before. In this traditional scheme, the first painted pottery in Greece was conceived of as red-painted decoration, typically red or reddish or buff-coloured surfaces.

Milojčić (*1960*) later argued for the existence of a Pre-Ceramic phase in Greece of chronological significance in the Balkans based on analogy with the Pre-Pottery Neolithic (PPN) of the Near East. Late, the 'Magoulitsa sub-phase' was added at the end of Vor-Sesklo based on the finds from Otzaki Magoula (*Milojčić-von Zumbusch 1971; Müller 1988; 1994; Reingruber 2011; 2015*). The 'Magoulitsa phase or culture' was defined by the use of impressed, incised, and finger-pinched decoration, subdivided into an earlier ('barbotine') and a later ('cardium') phase (*Milojčić-von Zumbusch 1971.146–148; Reingruber* et al. *2017.41–42*). It was thought to be of Balkan influence (*Milojčić, Milojčić-von Zumbusch 1971.82ff*) and allowed for correlations between the two regions (*Milojčić 1959.10–11, 31–32*) as this type of decoration was recognized since the beginning of the 20th century as an "*independent cultural phenomenon in the northern Balkans*" (*e.g.*, 'nail-decorated horizon'; *Childe 1929.75–76, 79*; 'Na-

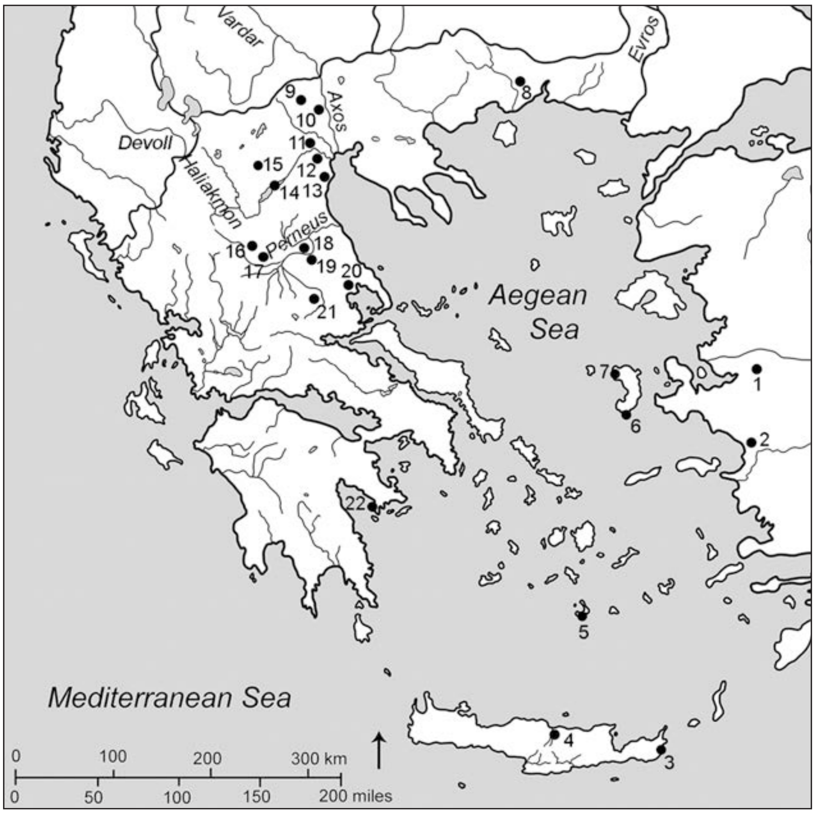

Fig. 1. Neolithic sites mentioned in the text with absolute dates within 6600–5900 cal BC. Numbers 3, 6, 7 without absolute dates. 1 Ulucak Höyük; 2 Çukuriçi Höyük; 3 Pelekita Cave, Crete; 4 Knossos, Crete; 5 Akrotiri, Santorini; 6 Ayia Gala, Chios; 7 Emporio, Chios; 8 Dikili Tash; 9 Giannitsa B; 10 Axios A; 11 Nea Nikomedia; 12 Kolindros- Paliambela; 13 Revenia-Korinos; 14 Servia-Varytimidis; 15 Mavropigi-Filotsairi; 16 Theopetra Cave; 17 Prodromos; 18 Otzaki Magoula; 19 Argissa Magoula; 20 Sesklo; 21 Achilleion; 22 Franchthi Cave.

gelgeritzte'; *Banner 1929; 1935.122–123; Raczky 2012.9*).

As the culture-history approach fell out of fashion, the tripartite chronology of Early Neolithic Thessaly was relabelled under the more neutral divisions of Early Neolithic 1, 2, and 3 (*Wijnen 1981*). Later, the 'Preceramic' was renamed 'Initial Neolithic' (*Perlès 2001.43, n. 8*). Local regional differences in ceramics also began to be considered within Thessaly, such as the disappearance of painted pottery by the end of the Proto-Sesklo phase at some sites in and directly around the plain of Larisa, like Sesklo and Argissa Magoula. Yet in the Vor-Sesklo period, painted pottery, "*at sites in or around the plain of Karditsa it does not vanish, but coexists with plastic decoration*" (*Wijnen 1981.36*).

Lastly, what is significant about the relative chronology of Greece as established by Milojčić (*1949a; 1949b; 1950/51; 1959*) is that his chronology was used as a template of cultural development for the whole of south-eastern Europe in the Neolithic (*e.g.*, Starčevo in Serbia, Körös in Hungary, Criş in Romania) despite some objections (*e.g., Nandris 1970; Schubert 1999; 2005*) (Fig. 2). For instance, by analogy with Greece, a hypothetical monochrome phase was proposed for the definition of Proto-Starčevo phase (*Srejović 1973*) and Starčevo Ia (*Lazarovici 1979*). Milojčić's four-stage relative chronology for the Neolithic period was also subsequently modified in its application in other regions (*e.g., Arandjelović-Garašanin 1954; Grbić 1957; Dimitrijević 1969; 1974; Srejović 1971; Makkay 1965; 1969; 1987*).

Aspects related to the Impresso-style

Impressed, incised, and finger-pinched decoration of the 'Magoulitsa phase' is today referred to in the literature of Neolithization of Europe under the umbrella term of 'impresso', which encompasses all types of plastic surface decoration irrespective of the fabric, vessel shape, method of surface manipulation (finger or tool), stylistic differences (dense *vs*. sparse, organized into motifs *vs*. random), or precise chronological correlations (*Vuković 2013.661–666*), and is cited as evidence of connectivity and mobility between vast geographic areas (*e.g.*, Adriatic, Balkans, Anatolia, North Africa, the Near East, and the Black Sea) (*Çilingiroğlu 2010; 2016; Gaskevych 2010; 2011; Güldoğan 2010*).

The term 'impresso' was originally used to describe pottery decorated with incisions made with pointed tools and impressions of cockle shells (formerly classed as *Cardium edulis* but now classified as *Cerastoderma edule*) in the Early Neolithic period of the Adriatic; impressions of fingernails, fingertips, and finger-pinches were rarely used in this region. Conversely, in the Balkans, cockle shells were never used for impressions (*Coleman 1992.254*); instead 'pseudo-impresso' or 'comb-impressed' was used to describe impressions and incisions made with tools or fingers (*Vuković 2013.658*). The ceramic tradition in the central Balkans also remained distinct from that of the Adriatic coastline (both style and manufacturing techniques) (*Spataro 2009*).

The subcategory of 'barbotine' (barbotin) was thought to be a chronological marker for the Early Neolithic Balkan-Anatolian complex in the Central Balkans (*e.g.*, proto-Starčevo) (*Vuković 2013.671*). Barbotine was defined as an additive decorative style in which wet clay slurry is added to create a lumpy, irregular surface, sometimes with ridges or rows in ornamental compositions (stepped, channelled, arcaded) (*Arandelović-Garašanin 1954*); pseudo-bar-

Date cal. BC	Milojčić and Milojčić-von Zumbusch 1971	Wijnen 1981	Furness 1953, Evans 1964	Mantelli 1993	Tomkins 2007, 2014	Vitelli 1993	Garašanin 1979, 1982
7000	Präkeramikum (Preceramic)	– – –	Aceramic Stratum X	Aceramic Stratum X	Inital Neolithic Stratum X	Franchthi Initial Neolithic	– – –
6500	Frühkeramikum (Early Pottery / Early Monochrome)	Early Neolithic 1 (EN 1)				Early Neolithic	Early Neolithic Balkan-Anatolian Complex
6300	Proto-Sesklo (Early Painted/ Developed Monochrome)	Early Neolithic 2 (EN 2)	Early Neolithic I-II Strata IX-I	Early Neolithic I Strata IX-V	Early Neolithic Strata IX-VII	Franchthi Ceramic Phase 1	(Proto-Starčevo-Starčevo)
6100	Magoulitsa Phase Vor-Sesklo	Early Neolithic 3 (EN 3)					Balkan-Carpathian Complex (Starčevo-Criş-Körös)
5900	Middle Neolithic	Middle Neolithic			Middle Neolithic Strata VII-VIB, P	Franchthi Ceramic Phase 2	Middle Neolithic

Fig. 2. Traditional chronology of Early Neolithic Greece, as based on Thessaly and in reference to the Balkans.

botine is defined as a slurry surface and small clay granules (*Vuković 2013.662*). Several other descriptive terms or phrase have been applied (*e.g.*, 'wheat-grain': *Dimitrijevic 1974.67; Sekereš 1974.192*; 'fir branches': *Benac 1979.380*; "*an endless flock of birds in flight*": *Vetnić 1974.130*). The distinction between 'impresso' and 'barbotine' found in the literature was believed to have chronological meaning, but this is no longer the case (*Vuković 2013.660*). Complicating the picture is the fact that the terms 'impresso' and 'barbotine' are used differently in Greece from the rest of the Balkans.

In Greece, the 'impresso' pottery associated with the 'Magoulitsa phase or culture' of the Vor-Seklo period was subdivided into an early 'barbotine' phase consisting of finger pinches and nail impressions and a later 'cardium' phase, in which tools were used to create the impressions, excluding the use of cockle shells (*Reingruber* et al. *2017.41–42*). These subphases were based on Otzaki Magoula (*Müller 1988; 1994; Reingruber 2011*) but were not grounded on stratigraphic reality (*Reingruber* et al. *2017.42*), nor does the small amount of highly curated published material add much to support to this claim (*Tsitrstoni 2009.45*).

Furthermore, the ceramic sequence of the 'Magoulitsa phase' as found at Otzaki was not confirmed at Sesklo, where painted pottery disappeared before the end of the period, when parts of the settlement were destroyed by fire (*Andreou* et al. *1996.540; Wijnen 1981.11*) and perhaps followed by a hiatus during Vor-Sesklo period (*Wijnen 1981*). It has also been suggested that the absence of the 'Magoulitsa phase' at Sesklo or other sites in eastern Thessaly is not chronological, but rather geographical, as impressed, incised, and finger-pinched pottery is documented in Thessaly both at the end of the Early Neolithic (*e.g.*, Nessonis I, Gediki, Argissa Magoula, Otzaki Magoula) and in the beginning of the Middle Neolithic (*e.g.*, Magoulitsa, Achilleion, Bardali, Koutroulou Magoula). Therefore, any distribution maps of Early Neolithic sites based on Gallis' Atlas (*Gallis 1992*) should be seriously questioned because they were constructed using relatively dated sites based on the presence or absence of monochrome, painted, or impresso decoration of surface sherds (*Reingruber 2011.297*).

A greater degree of ceramic variability is now recognized both at the intra site and regional levels (*Kotsakis 1983; 2008*) within the same chronological period (*Gallis 1987; Coleman 1992*), which suggests that comparative conclusions from excavation sequences presumed to be typical (*e.g.*, as Mottier 1981 does with Otzaki) should not be taken as representative of the wider region (*Andreou* et al. *1996.542*).

Current chronology of the Early Neolithic period in Greece

The main weakness in Milojčić's relative chronology was its complete lack of absolute dates, which were also absent from the rest of south-eastern Europe. Current absolute dates from Thessaly and Macedonia date the Early Neolithic period to *c*. 6500–5900 BC (*Reingruber* et al. *2017; Tsirtsoni 2016; Maniatis 2014; Perlès* et al. *2013; Lespez* et al. *2013; Douka* et al. *2017; Perlès 2001.109–110*), although some sites may begin as early as *c*. 6600 BC. These dates are comparable to new data from western Turkey (Anatolia).

Current absolute dating of the Pre-Ceramic phase prevents its definition of being contemporary with the PPN Pre-pottery Neolithic of the Near East of Cyprus (*Reingruber 2015.153–154*). This phase also remains to be securely documented anywhere in Greece, as its definition was primarily based on small areas of exposure in thin strata just above bedrock, or sterile soil and often with 'intrusive' sherds or other ceramic material such as figurines (*Nandris 1970.196–201; Reingruber 2008; 2011; 2015; Reingruber, Thissen 2009; Bloedow 1992–1993; Nowicki 2014.48–60*).

Similarly, neither a Pre-Ceramic nor an Early Monochrome (ger. *Frühkeramikum*) phase is found elsewhere in areas to the north (*e.g.*, Republic of Northern Macedonia: *Stojanovski* et al. *2014; Naumov 2009.4*); Albania (*e.g.*, Vlush, Konispol Cave: personal comm.; *Adoni 2018*); Bulgaria (*e.g.*, Krainitsi I, Koprivets I and Polyanitsa-platato I: *Krauß* et al. *2014.52; Stefanova 1996; Krauß 2006.161–162; 2008.119–121; 2011*); and probably Hungary and Romania (*Biagi, Spataro 2005*).

The existence of an Early Monochrome (Frühkeramikum) phase can also be questioned on the same contentious criteria as the Pre-ceramic deposits (*e.g.*, limited exposure, thin deposits, small sample). Given the supposed rarity of early painted pottery in the Vor-Sesklo phase in general, and the fact that this early painted decoration was often applied only on a small part of the vessel (*e.g.*, near rims), it cannot be convincingly argued that painted pottery was not in use. A more accurate statement would be that painted pottery was not found in the lowest levels of small horizontal exposure, often in secondary refuse pits. Yet the use of painted pottery cannot be ruled out due to these small sample sizes and contexts (*e.g.*, in pits).

Giving these individual site phases/levels chronological meaning beyond the site level by making them into regional phases of long temporal duration may be an artificial construction by modern archaeologists. For instance, Karen D. Vitelli (*1993b.46, n. 18*) has pointed out how excavation methodology affects the data; without the sherds recovered from sieving, the earliest levels at the Franchthi Cave were monochrome and the ceramic development appeared to conform to the Thessalian sequence, but when she added the sherds recovered from sieving, this development was invalidated. In contrast to the excavation procedures of the Franchthi Cave, where dry and wet sieving were employed, the material from Sesklo was not even dry sieved (*Wijnen 1981. 17*), which may have impacted its interpretation.

New evidence from Greek Macedonia

New data from Northern Greece highlights the need to carefully integrate excavation stratigraphy with ceramics and absolute dates, as well as identify regional differences with the same period. For instance at Mavropigi-Filotsairi in Western Macedonia, the excavators identified three phases belonging to the Early Neolithic period; these phases seem supported by absolute date. These phases were primarily based on the stratigraphy of a central feature of the site (the central origma), which was interpreted as a semi-subterranean house that eventually became a ground-level structure (*Karamitrou-Mentessidi* et al. *2016.51–53*).

On its own, a simple presentation of the stratigraphy and ceramics from the central origma would also appear to follow the Thessalian sequence, with the lowest levels above sterile soil devoid of ceramics but containing other cultural remains, followed by thin levels with monochrome pottery, and later levels that included painted, impressed, and incised pottery (*Bonga 2017*). Yet upon close inspection of the sherds (*e.g.*, a few joins between Phase I and the first passes of Phase II and the nature of the sherds themselves: small, abraded, reused, use of red-slip), the lack of complete vessels, and the rarity of complete profiles suggests that these pieces were discarded material that may or may not date to one temporal moment. Similar depositional practices were suggested at the Franchthi Cave, where most deposits were determined to be secondary and suggestive of periodic cleaning of areas rather than containing material from a specific activity (*Vitelli 1993b.31*).

When other deposits at Mavropigi-Filotsairi are taken into account, other complications arise. The use of red-painted pottery on a white slip made of a calcareous material, though rare, is documented in the Vor-Sesklo phase both at Paliambela (*Saridaki* et al. *2019*) and at Mavropigi-Filotsairi (*Bonga 2017.378*); this type of decoration is characteristic of the Middle Neolithic in Thessaly. The distinction between the use of painted decoration on a slip, white slip, or unburnished surface may be related to regional differences and/or chronological ones.[1] For example, white-on-red painted pottery in the traditional relative chronology was characteristic of the Middle Neolithic in Thessaly. Yet this type of decoration in the Vor-Sesklo period appears in Central Macedonia at Nea Nikomedia (*Yiouni 1996*), Axos A (*Chrysostomou 1996*), and Yiannitsa B (*Chrysostomou 1997*), together with impresso. These sites date to *c.* 6300/6200 BC (*Maniatis 2014.Fig. 2; Maniatis* et al. *2015. Fig. 4*).

White-on-red painted pottery from Mavropigi-Filotsairi was found in pit 106 and assigned to Phase II by the excavators. The precise date of the appearance of this type of pottery is unclear as the pit was used over time, but the absolute date *c.* 6200 BC based on charred seeds (OxA-31863, 6222±83 BC) may be an indicator. The central orgima in Phase II did not contain white-painted pottery. What is interesting at Mavropigi-Filotsairi is the fact that the technology (red slip, white paint) to produce white-on-red decoration was known since the Proto-Sesklo phase, as the characteristic pottery of Mavropigi-Filotsairi includes polychrome-painted pottery consisting of broad areas of motifs painted in red on a tan back-

1 Creating a distinction on the use of slips in general and as a background for painted pottery requires more investigation thanis possible based on small assemblages or applying one site (*e.g.*, Sesklo) as a paradigm, even within a region. While a limited use of slips is documented at Sesklo in all phases and areas of the settlement, slips of various composition were used at sites in the plain of Larisa (*e.g.*, Argissa, Otzaki, Soufli, and Melissochori Magoula) and slips were regularly used at Achilleion (*Dimoula 2017. 211, 213, 215*). A similar variability in the use of slips is seen in Central Macedonia at Revenia, where slips were rare while at Palaiambela slips were common, including the use of white slip (calcareous material) (*Saridaki* et al. *2019*).

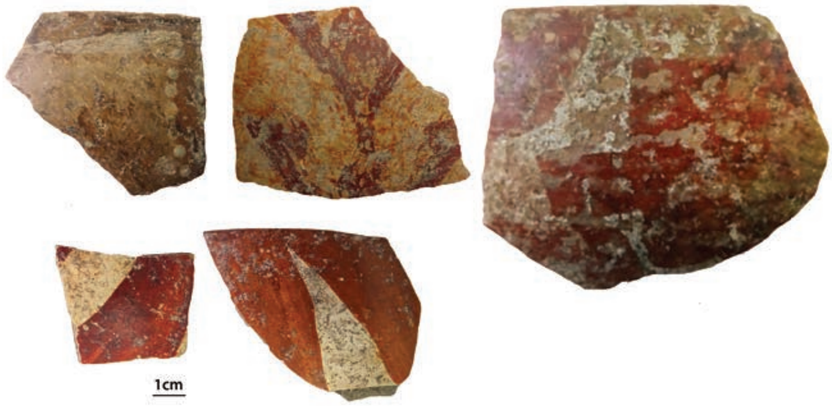

Fig. 3. Early Neolithic polychrome, white-on-red, and red-on-white painted pottery from Phase II, pit 106 at Mavropigi-Filotsairi.

ground and outlined in white paint (Fig. 3). Polychrome and red-pained pottery was preferred over white-on-red.

The impressed, incised, and finger-pinched pottery at Mavropigi-Filotsairi dates 100–200 years earlier than that of 'Magoulitsa phase' *c.* 6400/6300 BC (*e.g.*, pit A, DEM-1680; *western origma* DEM-2697/MAMS-21104; burial 3, in the *central origma*, OxA-V02365-54/S-EVA 10096). Many different types of surface treatments were used (Fig. 4) and this type of decoration was used alongside monochrome and painted pottery. Similarly, while few in number within a small area and sample size, decorated pottery consisting of both red-painted and finger-pinched decoration was documented in two pits (629, 630) with early dates at Paliambela (*Papadakou 2011; Papadakou* et al. *2015*).[2] These sites show the development of decorated pottery at some sites in Central and Macedonia does not match the traditional Thessalian sequence in terms of development or date.

Recent re-evaluations of the Franchthi Cave in the Argolid (Peloponnese)

At the Franchthi Cave, Vitelli (*1993a.37*) defined deposits below pottery-bearing levels as Ceramic Phase Zero and the Ceramic Interphase 0/1 as units in each sequence located between lower deposits that contained no pottery (FCP 0) and upper deposits that contained all of the Franchthi Ceramic Phase 1 varieties. Ceramic Phase Zero is called Initial Neolithic by other scholars who conducted secondary research, but not primary analysis of the ceramic assemblage itself (*e.g., Perlès 2001; Perlès* et al. *2013; Reingruber, Thissen 2009; 2016*).

An examination of the absolute dates and contexts from the Franchthi Cave revealed the Final Mesolithic layers (Franchthi Lithic Phase X) overlap with the dates for Initial Neolithic layers (*c.* 6700–6400 BC; *Reingruber, Thissen 2016; Perlès* et al. *2013*), and this was followed by a gap in dates of at least 500 years (up to 700 years; *Reingruber, Thissen 2009.758*) when the cave was re-occupied around or after 5900 BC based on these dates and ceramic parallels.[3] These gaps were perceptible in the ceramics, but were dismissed by Vitelli (*1993b.26*).[4]

It is also worth noting that the Franchthi Cave is perhaps better described as rock shelter or abri with a small open-air site adjacent (Paralia). It is not a dark, damp, cavernous cave like those used in later periods of the Neolithic (*e.g.*, Skoteino, Alepotrypa, Ayia Triada); nor is it an open-air settlement, and these differences of context must be taken into account. The Franchthi Cave is also located on the coast, un-

2 The interpretive situation at Palaimbela is based on absolute dates from burned animal bones (unspecified species) found in two Early Neolithic pits (629, 631) that have been interpreted as semi-subterranean pit-dwellings (*Maniatis* et al. *2015.151*). Pit 629 yielded one date (DEM-2462/MAMS-12513) of *c.* 6400–6200 BC (another date DEM-2461/MAMS-12512) is listed as coming from over rather than within the pit itself). Pit 629 was 2.48 x 2.10m in size (*Maniatis* et al. *2015.151*) and contained 8.12 kilograms of pottery, consisting of 439 sherds, only one of which was red-painted without the use of a white slip (*Papadakou 2011.93*). Pit 629 does not seem to be a totally closed deposit, however, as historical pit 606 cuts into its southern part and because the two dates (DEM-2464/MAMS-12515, DEM-2465/MAMS12516) from pit 627 antedate pit 629, even though pit 629 is depicted on the plan (*Maniatis* et al. *2015.Fig. 1; Papadakou 2011.237, Fig. 2*) as later than pit 627 (pit 627 is also cut into by historical pit 607 in the northern part). Pit 630 yielded three dates (DEM-2458/MAMS-12509, DEM-2459/MAMS12510, DEM-2460/MAMS12511) falling around 6600–6400 BC (*Maniatis* et al. *2015.Fig. 1*). The pit was approx. 1.7 x 1.07m in size and contained 1.32 kilos of pottery, consisting of 187 sherds, six of which were decorated with finger and nail pinching (*Papadakou 2011.90*).

3 Other gaps in the stratigraphy are also confirmed by the absolute dates, such as before Franchthi Ceramic Phase 4 (*c.* 5200 BC) in the beginning of the Late Neolithic (*Reingruber 2008.23, Tab. 1.6; 2017; Reingruber, Thissen 2016*).

4 Similar reevaluations of key Neolithic sites in later periods throughout Greece (*e.g.*, Skoteini, Sarakenos, Cyclops, and Franchthi Caves, Dikili Tash, Sitagroi, and Servia) have also demonstrated that previous observations about the continuity of stratigraphy and ceramics cannot be substantiated (*Coleman 2011.17–19; Coleman, Facorellis 2018; Nowicki 2014; Tsitrsoni 2016; 2017; Reingruber, Thissen 2009*).

Fig. 4. Early Neolithic impressed, incised, and finger-pinched pottery from Phase II in the central origma at Mavropigi-Filotsairi.

like most caves, and this location (also next to freshwater springs) is probably related to the function of the cave. Yet like other caves in Greece, it was never used for permanent habitation but rather for short stays for various reasons (*e.g.*, illness, ritual, herding, and refuge from inclement weather).

These facts change how Franchthi Cave was traditionally interpreted in terms not only of its date, use, and duration, but also affect the interpretation of the artefacts, such as the ceramics. For instance, it was interpreted that only a limited amount of pottery (*c*. 12 or 13 pots a year) was produced (*Vitelli 1993b.210*) by female specialists, and was thus highly valuable and used in symbolic rituals rather than for daily food-related activities (*e.g.*, storage, processing, cooking) (*Vitelli 1993a.254–255; 1999.188, 191–192, 196*). These hypotheses were turned into theory by a series of archaeometric studies of sites in Thessaly (*e.g., Wijnen 1981; Bjork 1995; Gardner 1978*) and Central Macedonia (*e.g., Yiouni 1996*), and subsequently accepted as fact (*e.g., Perlès 2009*).

Some of these statements, however, are not applicable to other sites because of the dissonance between them either due to differences in dating or type of site (cave *vs*. open air settlement). For instance, a higher rate of vessel production was proposed at Nea Nikomedia (*c*. 25 to 90 per year) using a different methodology (*Yiouni 2004.4; 1996.186*), which is more in line with the quantity of ceramic production and use at open-air Early Neolithic sites (*Yiouni 2004.10, nn. 38, 39*). Similarly, the technological simplicity (*e.g.*, use of temper, surface treatment, method of firing) of past interpretations must be questioned as new evidence from the early Middle Neolithic period (*e.g.*, Magoula Imvrou Pigadi (*Kyparissi-Apostolika 2012*), Magoula Rizava (*Krahtopoulou* et al. *2018*), and Kouphovouno (*Ballut* et al. *2017*) suggests that kiln use was well established and probably began in the Early Neolithic period.

Crete: traditional chronology and terminology

Crete is often left out discussions of Neolithic Greece in general due to its peculiar traditional chronology and terminology. The relative chronology was almost exclusively defined in a small area within the Central Court of the Palace of Minos at Knossos excavated in the late 1950s and early 1960s (*Evans 1964*), and by another team in 1997 (*Efstratiou* et al. *2013*); other areas were excavated or explored in soundings and used to fill-in or check the Central Court sequence.

The chronology of Knossos was established by Furness (*1953*) and built upon by John D. Evans (*1964*). This relative sequence used its own periodization terminology that did not match that of mainland Greece (or Anatolia), despite the existence of absolute dates from Evan's excavations since the late 1950s to help do so (nor did his subsequent experience in the Cyclades at Saliagos change his views). As a result, the levels and material labelled as Early

Neolithic in fact correspond with the Early, Middle, and Late Neolithic periods on the mainland in terms of absolute dates (*Evans 1964*). The lowest level at Knossos was labelled 'Aceramic' as a parallel to the Near East and mainland Greece. The ceramics used to create the relative chronology (*Furness 1953; Evans 1964; Tomkins 2007*) was based primarily on decorated sherds, as undiagonstic and undecorated sherds were discarded. Much of the material was also identified as secondary refuse from exterior spaces or dumped from levelling the surface of the site. The ceramics from 1997 excavation remain unpublished.

The incongruous terminology and periodization was partially rectified by Peter D. Tomkins (*2007.12; 2008*), who tried to correlate the pottery groups from Knossos "*on the basis of imports, exports, stylistic parallels and, wherever possible, radiocarbon dates to other Neolithic assemblages from elsewhere in Crete*" to be more in line with dates and assemblages from mainland Greece, the Aegean islands and the Anatolian-Aegean coast. It should be noted that Tomkins himself did not apply his chronology and phases in his doctoral dissertation (*Tomkins 2001*) or any of his publications before 2007 (*Tomkins, Day 2001; Tomkins* et al. *2004*), and that any articles that refer to these phases are outdated. Similarly, the Early Neolithic Houses of Sir Arthur Evans (*Evans 1921*) in the Central Court in fact really date to the Early Minoan period.

Furthermore, this new phasing and dating has not been universally adopted. Even as a co-editor of the volume on Neolithic Crete, which includes Tomkins' (*2008*) detailing of the historiography of ceramic studies at Knossos and the reasoning for his (*2007*) changes, few of the articles in the volume actually adopted his changes; others adhered to the old chronology (*e.g.*, *Galanidou, Manteli 2008, Strasser 2008*; and the other co-editor, *Isaakidou 2008*) or followed their own systems (*e.g., Todaro, Di Tonto 2008, Nowicki 2008*). This failure of acceptance by other scholars is perhaps in part due to the fact that Tomkins (*2007*) did not publish any new material and even reused Evan's 1964 illustrations. Lastly, some of the parallels made by Tomkins (*2007*) are not all correctly dated, a fact which he may address in the future, as indicated in a footnote in which the Neolithic phase-names are changed and/or combined, and different absolute dates given but without further explanation (*Tomkins 2018.129, n. 1*).[5]

The Early Neolithic on Crete revised: Knossos central court strata X, IX and levels 38, 39

The reevaluation of absolute dates, stratigraphy, and ceramics at Knossos mirrors that of the Franchthi Cave. First, what initially appeared to be early dates of *c*. 7000 BC for Stratum X (*Reingruber 2015.151; Reingruber, Thissen 2016b*) are likely mistaken because the first occupation of Knossos should date closer to 6610 BC (*Reingruber, Thissen 2009.758–760; Douka* et al. *2017*), which is in accordance with dates from site both the southern Aegean (*e.g.*, Franchthi, Çukuriçi Höyük, and Ulucak) and northern Greece (*e.g.*, Paliambela, Mavropigi-Filotsairi), and integrates Knossos into the earliest stage of the Early Neolithic in the wider Aegean.[6]

Second, there are neither dates for Stratum IX, which was previously believed to date to the Early Neolithic period, nor dates from the Middle Neolithic period. The next group of absolute dates from Knossos occur after 5300 BC (*Reingruber, Thissen 2016; Douka* et al. *2017.315*) "*an estimate that is not in conflict with the material culture of the surrounding areas*", in terms of shapes and ornaments, particularly the Aegean islands (*e.g.*, Tigani on Samos, Agia Gala on Chios, Akrotiri on Santorini) and western Anatolia (*Reingruber, Thissen 2009.760–761*).[7]

5 On numerous occasions Tomkins promises future clarification of such statements in publications which remain to appear, including (*2008.27*) a "*completed re-evaluation of spatial (and thus demographic) development at Knossos (*Tomkins in prep*. with no further information)*" and full publication "*of Neolithic material from the British School excavations (*e.g*., ceramics, chipped stone, ground stone axes, faunal remains)*" using with new chronology (*e.g.*, *Tomkins, in preparation* as "*Neolithic Knossos: Early, Middle and Late Ceramics and Stratigraphy*" and "*Neolithic Knossos: Final Neolithic I-IV Ceramics and Stratigraphy*"). (*Tomkins 2007.12*). A "*new typology of EN forms*" to be presented elsewhere (*Tomkins* et al. *2004.57* with no further information) and a "*new set of RC dates from Knossos in preparation (personal communication Peter Tomkins, 30 May 2015)*" (*Reingruber 2015.151*) also awaits publication.

6 The Theopetra Cave could be another similar case in which early Neolithic absolute dates are followed by a gap of occupation followed by reuse of the cave within the middle of the Early Neolithic period) and in which the Mesolithic-Neolithic is not a contiguous transition, although the cave stratigraphy is known to be disturbed by both natural and anthropogenic processes and full publication of the stratigraphy and pottery is not yet available (*Kyparissi-Apostolika 2000a; 2000b;2012; Facorellis, Maniatis 2000; Facorellis* et al. *2001*).

7 Recent re-excavation of the Pelekita Cave near Katos Zakros, Crete as also yielded similar Late Neolithic pottery, which according to Knossos would be dated to the Early and Middle Neolithic based on Tomkins' (*2007*) chronology (*Bonga 2019*).

Due to the fact that Knossos was abandoned for 1000–1500 years (*Douka* et al. *2017.317; Reingruber* et al. *2017.150; Reingruber 2015.154*), continuing to use the 7000 BC date (or limit?) for Stratum X (*e.g.*, 7000–6600 BC: *Tomkins 2007*; 7000–6500/6400 BC: *Tomkins 2014*; 7000–6500: *Tomkins 2018*; 7030–6780 BC: *Facorellis, Maniatis 2013.199*) is in error (*Reingruber, Thissen 2016*), as is maintaining that "*from the IN [Initial Neolithic] onwards habitation at Knossos seems to have been continuous and permanent*" with "*no obvious breaks in the stratigraphical and cultural sequences*" (*Tomkins 2008.21, 30; Tomkins 2007.9, 21*; following *Evans 1968.275*). Once again, "*the relative chronological system of Knossos has to be re-evaluated in a general Aegean perspective*" (*Reingruber, Thissen 2016*).

Regarding the often discussed nature of the lowest levels (Stratum X, Levels 38 and 39) at Knossos (especially *Reingruber 2011; 2015; Reingruber, Thissen 2009; 2016; Evans 1964; 1971; Efstratiou* et al. *2013; Tomkins 2007; Winder 1991; Bloedow 1991; Nowicki 2014*), it seems increasingly unlikely that these levels represent an 'Aceramic' phase, as mudbrick and ceramic figurines were found in these levels and based on analogies with sites on the mainland formerly considered to as Aceramic or Pre-ceramic pre-ceramic as based on parallels with the PPN Pre-pottery period of the Near East or Cyprus.

Conclusion

Absolute dates from Western and Central Macedonia have pushed back the beginning of 'impresso' and painted pottery. In Southern Greece new dates on old samples and the application of Bayesian statistical analysis have demonstrated the lack of Early Neolithic occupation at both the Franchthi Cave and Knossos, aside from brief visitations at the very beginning of the period. Gaps in occupation at sites are also increasingly being recognized based on these refined dates, re-examination of stratigraphy, and ceramic analysis.

Current studies of early ceramics are also beginning to overturn the old simplistic narratives of decorative and technological evolution. It is now demonstrated that early ceramics were a fully developed technology, although not standardized as in later periods of the Neolithic (*e.g., Dimoula 2017; Pentedeka, Dimoula 2009*). More complex and nuanced approaches to understanding depositional processes and cultural choice are necessary in approaching the dating and nature of Early Neolithic Greece as a socially embedded process located in a particular place and time within a certain social space (*Kotsakis 2003*).

The recent work on re-evaluating absolute dates through Bayesian statistical analysis and modelling is a useful way to move forward on refining chronologies at the region level and enables the accurate comparison of sites across wider geographical regions, within and outside of modern Greece. By focusing on smaller regions, perhaps patterns within these smaller areas can be better understood, with the individual site stratigraphy more accurately correlated with contemporaneous neighbouring sites. Of course, the excavation of broader areas of horizontal exposure of early sites and larger sample sizes are also necessary before constructing arguments or plugging-in data to fit preconceived expectations. Site and regional schemes, however, must take caution to not falsely be integrated into the wider world of Neolithic Greece (*e.g.*, Franchthi Cave) or isolated from it (*e.g.*, Knossos and Crete).

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The Kargopol type ceramics – the first pottery of the northern part of the East European Plain?

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ABSTRACT – *The small group of early ceramics was found between the 1930s and 1990s, but was previously underestimated as a source that points directly to the origins of ceramic production in the boreal forest zone* c. *5500–5000 BC. The Kargopol type ceramics demonstrate very archaic technological traits: a straight rim with round holes below the rim and clay paste with sand temper. This type of ceramics had a wide distribution and was made uniformly, at least concerning vessel capacities and basic decoration patterns, probably reflecting the birch bark vessel features. We recognize this phenomenon as key to understand how the process of ceramic production emerged in the zone of Russian boreal forest.*

KEY WORDS – *Early Neolithic; hunter-gatherer-fishers; pottery; East European Plain Northern part*

Keramika tipa Kargopol – prva lončenina na severnem delu Vzhodnoevropskega nižavja

IZVLEČEK – *Manjša skupina zgodnje keramike je bila odkrita med leti 1930 in 1990, vendar so jo v preteklosti podcenjevali kot vir podatkov, ki kaže na neposreden izvor keramične proizvodnje na območju borealnih gozdov ok. 5500–5000 pr. n. št. Keramika tipa Kargopol kaže zelo arhaične tehnološke značilnosti: raven rob ustja z okroglimi vbodi pod ustjem in lončarsko maso z dodanim peskom. Keramika tega tipa je bila razširjena na večjem območju in je izdelana enovito, vsaj kar se tiče prostornine posod in osnovnih okrasnih motivov, ki verjetno posnemajo videz posod iz brezovega lubja. Pojav te lončenine razumemo kot ključen pri razumevanju načinov, kako se je keramična proizvodnja pojavila na območju ruskih borealnih gozdov.*

KLJUČNE BESEDE – *zgodnji neolitik; lovci – nabiralci – ribiči; lončenina; severni del Vzhodnoevropskega nižavja*

Introduction

In this paper we have made an attempt to analyse a small group of Neolithic ceramics which was not the focus of previous studies in Russian papers concerning the northern part of the East European Plain, but was only sporadically mentioned. According to our new study of the morphology and technology of these type of ceramics, we assume that these materials reflect the early, initial phase of ceramic production in the vast territory stretching from the Onega Lake to the west to the Pechora River downstream to the east, thus covering a zone of around 1000km by length, which seems to be the most outstanding lenght for Russian Stone Age (Neolithic) ceramics, based on current knowledge. We are waiting to obtain the ^{14}C dating results for organic residues on the inner sides of ceramic fragments in the near future, which would allow us to check the arguments proposed in this work and provide more firm proof of our ideas.

The northern part of the East European Plain has an enormous area (nearly 1 400 000km^2), and consists

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of several large administrative units of Russian Federation (Fig. 1): the Republic of Karelia, the Murmansk, Arkhangelsk and Vologda Regions, the Republic of Komi and the Yamalo-Nenets autonomous district. Obviously, archaeological surveys have only been made locally here, and while a long series of large material collections obtained in the 20th century is available in the various capital cities' local museums, most of these have still not been fully studied. This territory was populated immediately after the end of the last glaciation (*Subetto* et al. *2002*). Most of the related sites were situated within lake depressions, and have been found to contain multi-layer settlement materials of different epochs, sometimes not clearly stratified or even totally mixed in sandy sediments. This settlement pattern is typical for the whole boreal forest zone of the East European Plain in prehistory, populated by hunter-gatherer-fishers, living in the conditions of a moderate continental climate (*Oshibkina 2003*).

Our particular interest in the Early Neolithic history of this area rose after the new ^{14}C dating results obtained for the burials at the Kubenino site (Arkhangelsk region), which were previously dated to the 4th millennium BC. However, in the course of recent collaboration with Finnish colleagues, these burials were dated to *c.* 5000 BC (*Ahola* et al. *in press*). That is why we started to ponder which types of ceramics might have existed there at such an early period, at the hypothesized border between the Final Mesolithic and Early Neolithic, the last being distinguished by the presence of pottery while the whole toolkit seemingly stayed the same (*Gerasimov, Kriiska 2018.307*).

Aleksandr Zhulnikov (Republic of Karelia, Petrozavodsk) (*pers. comm.*, March 2017) gave us the first data about the special and rare sherds of the so-called Kargopol type, and we started to explore its historiography deeper. These ceramics were first documented by Aleksandr Brussov during his excavations of the Karavaikha site (Vologda Region) in the early 1950s (*Brussov 1961*). Some other researchers have also found the same pottery fragments, but attributed them to the Bronze Age or even Iron Age (*Foss 1952; Burov 1967*). Coming after Brussov, in a series of recent studies the Kargopol type ceramics were described more accurately by their morphology and technology, but again no one declared their innovative and archaic provenance, recognizing them only as a synchronous variant of Pitted Ware or Pit-Comb Ware – the huge conglomerate of ceramic types spread along the whole territory of the East European Plain forest zone (*Lobanova 1997; Ivanischeva 2014*). Though in some studies the Kargopol type ceramics from the territory of the Republic of Komi were recognized as one of the earliest ceramic types there (*Kosinskaya 1997; Karmanov, Volokitin 2004*).

To date we have made a technological analysis of 22 ceramic fragments from the Karavaikha site, and additionally studied the morphology of *c.* 30 fragments from the same site and several neighbouring ones, which are kept in the State Historical Museum (Moscow) collections. It is still not possible to count the total number of fragments based on the literature, and instead we can only produce approximate figures. According to Nadezhda Lobanova, 400 fragments are known for the whole Karelian territory (*Lobanova 1997.86*). For each settlement, it doesn't matter in which region it was situated, the number of the Kargopol type sherds can vary from one to several dozen (*Ivanischeva 2014*). It seems that the scale of production for these vessels was much smaller than that seen with the main younger Neolithic ceramic types in Northern Russia, like the Pitted Ware, Pit-Comb and Comb-Pit Ware.

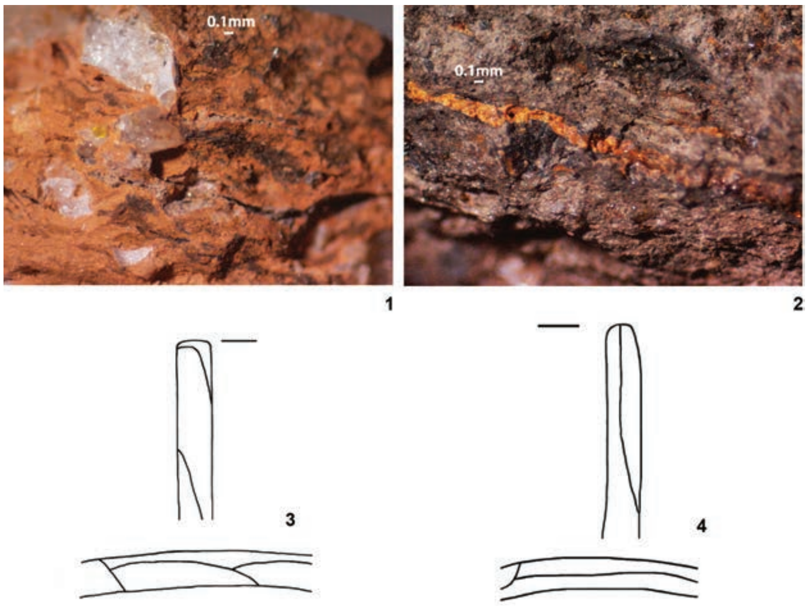

Fig. 1. Technological analysis of the Kargopol type pottery: 1 inclusions of sand (microphoto); 2 traces of organic solution (microphoto), 3 slab construction (drawing); 4 paddling (drawing) (all photos and drawings by N. Petrova).

It should be noted than no one has yet discussed whether this type of ceramics could have been the oldest pottery in the territory of the northern part of the East European Plain. The first reason why no one has discussed this is obviously the multi-layered character of this pottery's find contexts: usually it has been found mixed with younger finds of Pitted and Pit-Comb Ware, or even younger, depending on the site. Only at the Karavaikha site (Arkhangelsk region) and at the group of Karelian sites in the Vodlozero microregion, has it been possible to detect it in the lowest part of the cultural layers, but again mixed with younger ceramic types (*Brussov 1961; Kosmenko 1992.122*). Another reason is the lack of technological studies for this type of pottery: most descriptions are based on superficial inspections by researchers who are not familiar with the methodology of archaeological ceramic studies (*Kosinskaya 1997; Lobanova 1997; Ivanischeva 2014*). That is why we applied this approach here, based on methods developed in the USSR and later in Russia by Aleksandr A. Bobrinsky and Yuri B. Tsetlin (*Bobrinsky 1978; 1999; Tsetlin 2017*).

Technological analysis of the Kargopol' type pottery

After looking through the State Historical Museum collections (based on excavations by Brussov of Karavaikha and Kubenino in 1952 and 1961 and by Maria Foss of the site in the mouth of the Olga River), we obtained 22 fragments of the Kargopol type pottery for further analysis. Microscopic trasological analysis of the surface and of cross-sections of ceramic samples at all stages of pottery technology was carried out using the method devised by Bobrinsky (*Bobrinsky 1978; 1999*), with a binocular microscope MBS-10, stereo-microscope Carl Zeiss 2000-C and metallographic microscope Olympus MX 51. A study of raw materials and pottery paste, methods of construction, vessel surface treatment, and firing was performed (Fig. 1). Samples of modern clay from sites Karavaikha III and IV were taken to explore the natural mineral inclusions. These samples together with ancient ones were re-fired in a muffle furnace under identical conditions (850°C), which allowed us to determine the relative degree of clay ferrugination and detect evidence of organic solution as one of the paste components.

Vessel diameters vary from 10 to 36cm with 0.3–0.7cm thick walls, which agrees with Lobanova's measurements of Karelian fragments (*Lobanova 1997*). In four cases a crust was detected on the inner sides of four relatively large vessels, having a diameter from 23 to 35cm. All rims are straight and decorated in a particular way. It seems that the vessel bodies were not decorated at all, but in order to avoid mistakes in Early Neolithic pottery detection (as Karavaikha is in fact a multilayer site), we did not study the undecorated walls, concentrating only on rim fragments. Thus we have absolutely no relevant data on the Kargopol type vessel bottoms. Medium-ferruginous clay with the average quantity of mineral inclusions was used, with visible plant inclusions as imprints of 0.7–0.8mm in length, pointing to the use of silt clay as a raw material (*Vasilieva 2011*). The deliberately added inclusions are represented by non-rounded smooth sand (units or conglomerates) and by the organic solution of unknown origin (the amorphous or filamentary cavities) (Fig. 1.1–2). The slab construction is evident, with slabs measuring 2–3cm length; then vessels were paddled, as the slabs had a rather thin cross-section (Fig. 1.3–4). The surface treatment of the vessels was obviously made by fingers and some firm tool, probably made of bone, which made the sand particles glossy on the outer surface. The lightness of the outer layers of clay paste, detected not deeper than 1mm, could witness the short stay at the heating temperature (at least 650°C), and the sharp colour difference between outer and inner layers indicates fast cooling.

The Kargopol type of vessel decoration is simple and consists of only two motifs: a row of pierced round holes made before firing, and a row of short incisions at one or both rim edges. Pierced holes were made from the outer side at 0.3–0.9cm below the rim edge, and the spaces between them are from 0.5 to 1.6cm. Two kinds of holes were distinguished according to their diameter: small (1.5–2mm) and large (3–4mm). Short incisions, usually made on both sides of the rim edge, can be vertical or slightly inclined to the left or right. No correlation between hole sizes and incisions were detected. Such a composition is recognized as a 'proto-décor', reflecting the raw, initial stage of the potters' knowledge about methods of vessel decoration (*Tsetlin 2002*).

The pierced holes were inherent to ceramic vessels over a huge territory at the initial stage of pottery production all over the world, and researchers give different explanations of their purpose, *e.g.*, aesthetic, to hang the vessel, to attach a lid, or technological traces in the case of a wicker mould used for vessel modelling. We detected neither traces of mechanical hole damage, nor wicker mould traces, that is why we propose the following explanation of the Kargopol type vessel decoration.

Most likely an imitation of organic material containers (*e.g.*, the birch bark vessels) took place, where the edge was strengthened by sewing a narrow band over the container's edge (*Tsetlin 2002*). In collections at the State Historical Museum there is a birch bark container fragment from the Middle Trans-Urals settlement Gorbunovo, dated to the Early Bronze Age, 3rd millennium BC (*Kashina, Chairkina 2012*), where those traces of sewing are clearly visible, reminiscent of holes and incisions in the Kargopol type ceramics (Fig. 2.1–2). According to ethnographic data on traditional North Eurasian and North American communities, making birch bark items was a typical female handicraft, being technically very close to sewing. The making of birch bark containers included sewing, and those items were always among women's personal belongings even after getting married or divorced (*Chernetsov 1964; Croft, Mathewes 2013*). A number of researchers maintain that the making of hunter-gatherer pottery was a predominantly female handicraft, and we completely agree

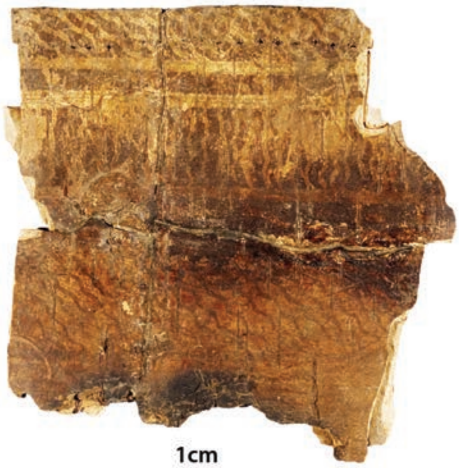

Fig. 2. The Gorbunovo peat-bog site birch bark container fragment: 1 general view; 2 enlarged rim area with traces of perforations and sewing (photos by E. Kashina).

with them (*Tsetlin 1998; Zhulnikov 2006*). Accordingly, Stone Age birch bark handicraft and pottery production were very close to each other, and both birch bark containers and the Kargopol type vessels (as we reconstruct moderate volumes for some of them) could have been simply taken from one site to another, and this is how these ceramics may have travelled considerable distances.

As a result of our study, we have some evidence that the Kargopol type ceramics could have been the earliest pottery in the territory of the northern part of the East European Plain:

❶ simple pottery paste recipes, the minimal deliberate sand admixture;

❷ simple decoration, the so-called 'proto-décor' stage.

We also have preliminary proof which enables us to speak not only of the abstract 'genetic ties' between the Kargopol type ceramics and the Sperrings, the Pitted Ware, and the Pit-Comb Ware, dispersed over the northern part of the East European Plain. We recognize the similarity of their recipes, as we concluded after analysing the narrow random series of Karavaikha site ceramic fragments which belong to all three mentioned groups. Finally, we can make an assumption that according to its technological features the Kargopol type ceramics could have been older than other ceramic types on this list, and perhaps even given rise to them.

Morphological analysis of the Kargopol type pottery

Despite the rarity of these type of ceramics, their fragmentation, and absence of clear archaeological settlement/burial contexts, it has several clear morphological traits which help to separate it from the whole ceramic assemblage at multi-layered sites: a straight rim, pierced holes in a horizontal row, and incisions along the rim edges. Observing the data concerning our museum materials, other museum collections and publications, we found multiple variations of Kargopol pottery decoration besides the basic elements of holes and incisions (for this finding we are grateful to Aleksandr Zhulnikov and Ekaterina Dubovtseva for their valuable data and photos of the Arkhangelsk and Syktyvkar museum materials).

Four variants of the Kargopol type ceramics were distinguished (Fig. 3), as follows.

● Variant 1. Vessel fragments have only the basic decoration elements – pierced holes in a horizontal row and incisions along the rim edges. This variant is widely spread over the territory of the northern part of the East European Plain, from the Onega Lake Eastern shore area to the Pechora River downstream. The amount of fragments at each site differed from one piece to several dozen (Fig. 4.1–6);

● Variant 2. Besides the basic elements, a row of shallow rounded pins was made on the rim. However, only two such fragments are known so far, at the sites Vodla V and Yavronga I (Fig. 4.7);

● Variant 3. Besides the basic elements, shallow rounded pins can also be placed between each basic hole, in a number from one to four pins. Only six such fragments are known date, from the at sites Yerpin Pudas I, Karavaikha, Vshivaya Tonya and Yavronga I (3 pieces) (Fig. 4.8–10).

● Variant 4. Besides the basic elements, multiple elements and motifs made using different kinds of stamps have also been found. This variant has been discovered at many sites over a wide area. The total number of fragments is not known, but it seems to be quite numerous, especially in the Republics of Karelia and Komi (Fig. 5.1–4).

In two cases a mixture of variants occurred: the Kubenino site fragment combined variants 3 and 4, the Yavronga I site fragment combined variants 2 and 3 (Fig. 5.5–6).

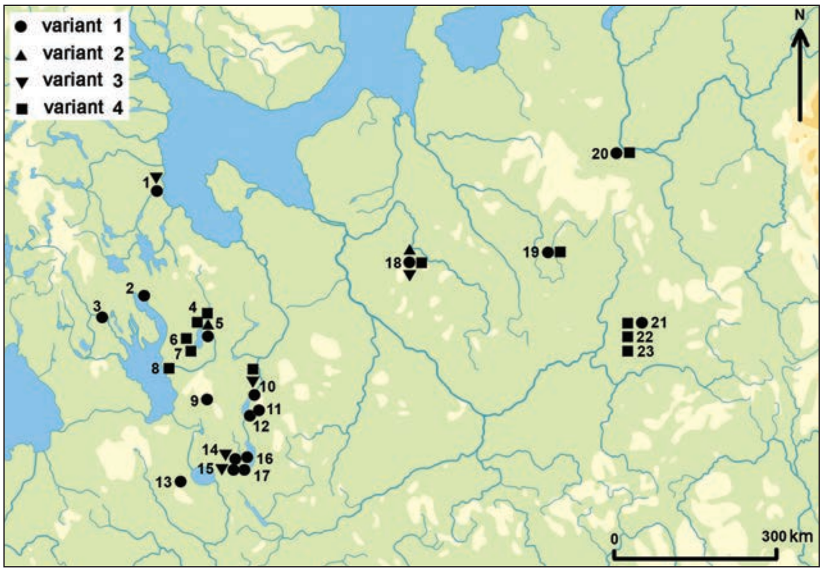

Fig. 3. Map of the Kargopol' type pottery distribution, four variants. 1 Yerpin Pudas I; 2 Voynavolok V; 3 Cheranga III; 4 Ileksa IV; 5 Vodla V; 6 Okhtoma I; 7 Somboma I; 8 Ust'-Vodla III; 9 Soydozero I; 10 Kubenino; 11 River Olga Estuary; 12 Popovo; 13 Andozero II; 14 Karavaikha; 15 Vshivaya Tonya; 16 Mys Brevenniy; 17 Modlona; 18 Yavronga I; 19 Ust'-Komys; 20 Pizhma II; 21 Vis I; 22 Vis II; 23 Vis III (map by E. Kashina).

There are also some distribution features. At the Karelian sites with the well represented variant 4 no basic variant 1 sherds were detected, according to Lobanova's data, except at only one site, Vodla V, where the variant 1 coexists with variants 2 and 4. On the other hand, at the sites to the east from the Kubenino settlement to the Pechora River basin both variants 1 and 4 coexist at all sites (*Lobanova 1997; Kosinskaya 1997.168–169*).

We still have not explored some other archaeological site collections of the huge Arkhangelsk region and the Republic of Komi, which have been mentioned in passing in the literature (*Ivanischeva 2014*). Moreover, some similar materials could be detected in the multi-layered site collections of Eastern Finland, in the Kainuu area, situated very close to the westernmost point with Kargopol type ware – at the Cheranga III site in Karelia (*Lobanova 1997.87*).

Discussion

A preliminary overview of the Kargopol type ways of distribution and change could be explained as follows: the very first vessels (variant 1) emerged in the Onega River basin area (Kubenino and the neighbouring sites). Then this tradition moved further both to the west (to Karelia) and to the east – probably up to the Pechora River basin. Later, the process of decoration complexity was triggered, causing the emergence of other variants (2 and 3) right in the initial zone. The flourishing of the most sophisticated and probably most numerous variant 4 could have appeared later, but in broader area like Karelia (west) and Komi (east). In the decoration patterns inherent to variant 4, the features of later ceramic types of the Neolithic epoch can already be observed (*Kosinskaya 1997; German 2002*).

The Kargopol type ceramics were disseminated over a surprisingly huge territory, around 1000km in length (Fig. 3). We suppose that the tradition of making this pottery moved step by step from one lake depression to another, thus forming segments not longer than 200 to 300km. The distribution of

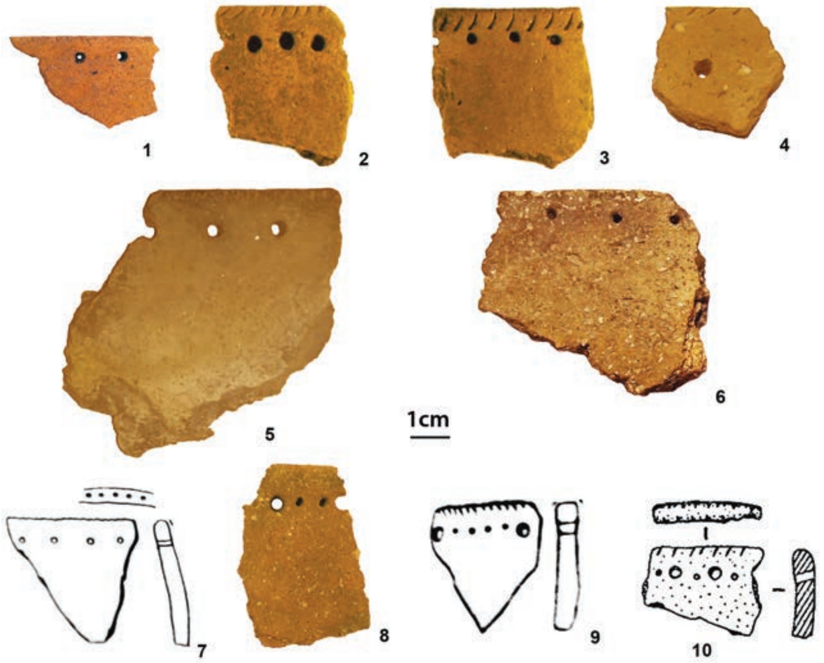

Fig. 4. The Kargopol type pottery fragments, variants 1 to 3: 1–6 variant 1; 7 variant 2; 8–10 variant 3. 1–3 Kubenino; 4 Soydozero I; 5, 6 Karavaikha; 7 Vodla V; 8 Karavaikha; 9 Yerpin Pudas I; 10 Yavronga I (photos by N. Petrova and E. Kashina, figures after **Lobanova 1997*).***

these vessels probably happened not only by matrimonial ties, but also by the vessels direct transport, as they sometimes had rather modest volumes.

The small number of finds could reflect different circumstances:

❶ the Early Neolithic communities were seemingly rather small; the moderate vessel size noted for some of the vessels, along with the known presence of food crust, point to the cooking function, but for only a small number of people, possibly members of one small family;

❷ the production of vessels was limited, probably due to their innovative character; ceramic vessels were probably recognized as a novelty by local communities within these huge territories.

The longitudinal character of the distribution of Kargopol type ceramics has also drawn our attention, being dispersed along the directions west-east/east-west, pointing at the particular marriage alliances and directions of goods exchange in the northern part of the East European Plain. It reminds us of the ways in which some other artefacts, ideas and traditions moved, *e.g.*, the Eastern Baltic amber ornaments, ceramic vessels of Comb Ware with human heads on the rim and with stamped waterfowl images turned right instead of left (*Zhulnikov 2008*; unpublished data of E. Kashina). Though these examples belong to the 4th millennium BC, together with the case of the Kargopol type vessels they seemingly represent some regularity, which still needs to be appropriately explained in future work. Another example, although not really of longitudinal character, are the rare finds of wooden skis decorated with sculptural elk heads on the front part, found at three sites of the northern part of the East European Plain (Ivanovskoye III, Veretye, and Vis I) and dated to approx. 6000–5000 BC (*Burov 1989*). The distance between sites is 500–700km as the crow flies, and the clear morphological similarity of these ski fragments points to the fact that the makers knew the exact way and manner of their production, obviously having direct contacts with each other.

Thus, the Kargopol type ceramics are a precious resource for revealing of social interactions between the inhabitants of lake depressions during the Early Neolithic. This raises some issues for future research: about the estimated level sedentarism, the population number, the directions of social connections and their probable changes in time and space.

The Kargopol type ceramics relations inside the whole East European Plain

Which places took these ceramics in the general context of the East European Early Neolithic epoch? It would be of great interest to establish the reasons and circumstances of their emergence at a particular moment and area, namely in the north of East European Plain, and their relations with previous ceramic types of neighbouring territories, primarily the southern ones. According to a handful of studies, performed at the central and southern parts of East European Plain, the earliest known ceramic vessels appeared here around 6000 BC, seemingly spreading their influence further to the north (*Zaitseva* et al. *2016*). The given millennia (6th to 5th millennia BC) are of great research interest from a different perspective, being not only the era of first appearance of ceramics and their dissemination all over the East European forest zone, but also the increase in sedentarism and associated population growth. Also, at the beginning of the 5th millennium a general change of ceramic traditions together with the replacement of blades by flakes and the use of bifacial technology in flintknapping took place. The explanation of an obvious change in lifestyles due only to Atlantic climate conditions does not seem sufficient, and these processes could have had some deeper reasons.

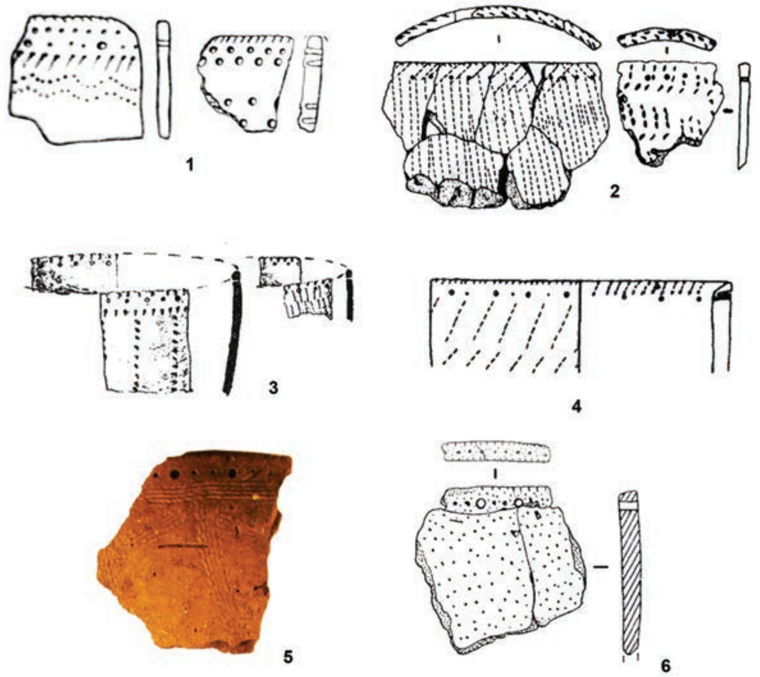

Fig. 5. The Kargopol type pottery fragments, variant 4 and variant mixings: 1–4 variant 4; 5–6 variant mixings. 1 Okhtoma I, Vodla V; 2 Vis I, 3 Ust'-Komys, 4 Pizhma II; 5 Kubenino; 6 Yavronga I (photo by A. Zhulnikov, figures after* Burov 1967; Kosinskaya 1997*).

Returning to ceramics, as a result of southern influence the so-called Verkhnevolzhskaya (or Upper Volga) ceramic type emerged and spread over a large territory in the central part of East European Plain, including the Volga-Oka interfluve and the Valdai Upland, united by the presence of fine clay paste with grog, a smooth surface and different decoration patterns, from only pierced holes under the rim to sophisticated narrow stamp compositions covering the whole surface of the vessel (*Kraynov 1996.166– 172*).

A series of recent studies focused on interpreting the new AMS dates, made on ceramic residues/food crusts, sometimes aiming to represent the most ancient appearance of ceramics at the given areas (*Zaitseva* et al. *2016*). But from our point of view, the represented data frequently lack any firm bases, such as an archaeological context and other AMS data which could help to verify the vessel crust dates. The weakest point of those studies' conclusions about the start of mass ceramic production of the Upper-Volga ceramic type around 6000 cal BC is seen when we look at the highly reliable corpus of the Finnish first ceramics dating results, which consists of a large number of crust dates, verified by the dates of associated contexts (*Nordqvist, Mökkönen 2017*). By the way, the given data fully coincide those of Karelian researchers (*Tarasov* et al. *2017*) and the main conclusion is that the first pottery, namely the Säräisniemi I and Sperrings I types, occurred in Karelia and Finland no earlier than 5000 cal BC. The question arises: how to explain such an incredibly slow movement of the initial pottery making tradition (over a period of one thousand years) from the central to northern parts of Russia (*e.g.*, from the Upper Volga to the Onega Lake area) in the conditions of a plain landscape, rich in waterways (*Gerasimov, Kriiska 2018.309*)? The simplest answer is that it is necessary to revise the whole assemblage of ^{14}C dates of the Upper Volga ceramic type: the time of its appearance and distribution was probably not earlier than mid-6th millennium BC, and then the idea of ceramic production could move quickly further to the north.

It was supposed by researchers that undecorated vessels and those with pierced holes around the rim zone were the earliest in different parts of north Eurasia (*Tsetlin 2002*), as well as at the East European Plain. The Upper Volga ceramic type vessels from the Middle Volga, Upper Volga and Tver Volga regions have a steady and universal grog admixture in their clay paste, together with a universal decoration motif – the row of pierced holes under the rim, the last feature reminiscent of the Kargopol type decoration. Were the Upper Volga ceramics a prototype for the Kargopol type? Absolutely not: a characteristic of the Kargopol type is the total absence of grog together with the presence of rim incisions, a unique and highly recognizable decoration motif along with pierced holes. According to this, we can observe no similarity between these two types of Early Neolithic ceramics. The Kargopol type recipe was obviously invented quite independently.

We present here only a simplified view of the process of the development of the first pottery from the south to the north of the East European Plain. In reality, the distribution of the very first local ceramic types could have been much more patchy and differentiated. Aside from the basic Early Neolithic types from the East European Plain, each represented by numerous ceramic fragments, there obviously existed some other variants, known from an extremely small number of sherds, dispersed very locally, which contradict some of the conclusions on the already distinguished ceramic types' basic traits. The good northern examples are those found at the borders or inside the zone of the Kargopol type distribution: the earliest Sukhona River basin ceramic type demonstrates the same pottery paste but the different decoration patterns (*Nedomolkina, Piezonka 2016*). The earliest Tudozero Lake (neighbouring the Onega Lake from the east) ceramic type demonstrates the absence of grog and a local decoration pattern (*Ivanischeva* et al. *2016*). Some earliest Komi Republic types contain grog (*Karmanov, Volokitin 2004.5*), which was supported by Dubovtseva (*pers. comm.*, October 2018). Thus, seemingly several of the earliest ceramic types existed simultaneously at different areas of the northern part of the East European Plain, and the Kargopol' type itself probably slightly overlapped the initial period of the Pitted Ware (and Pit-Comb Ware), at least in Karelia and the Onega River basin around 5200–4900 BC. Nevertheless, the Kargopol type, based on its morphological and technological characteristics, could have been the earliest in the northern regions. We will try and look into this further by performing AMS residue dating on these materials in the near future.

More illustrations can be obtained from https://www.academia.edu/37660053

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The state of Early Linear Pottery Culture research in Slovakia

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ABSTRACT – *The article focuses on the current state of research of the first Neolithic culture in Slovakia. So far around 70 sites are known from Slovakia dated to the Early Linear Pottery Culture and the Early Eastern Linear Pottery Culture. Most of the sites are known only from surface collections, and in only four cases have dwellings been documented. Settlement features/pits have been discovered at around half the sites. Finally, we know graves from only four (and possibly five) sites. In the article we deal also with the elaboration of the Early LPC/ELPC material culture. We discuss pottery from the point of view of typology and decoration and other types of findings, such as chipped stone industry, ground and polished stones, small clay artefacts, daub, animal bones* etc.*, are not omitted either. The goal is to evaluate the research possibilities of the Early LPC/ELPC in Slovakia.*

KEY WORDS – *Slovakia; Early Linear Pottery culture; settlement; material culture; current state*

Stanje raziskav zgodnje kulture linearno trakaste keramike na Slovaškem

IZVLEČEK – *V članku se osredotočava na trenutno stanje raziskav prve neolitske kulture na Slovaškem. Do danes poznamo 70 slovaških najdišč, ki datirajo v čas zgodnje kulture linearno trakaste keramike in zgodnje vzhodne kulture linearne keramike. Večina najdišč predstavlja površinske najdbe in le na štirih najdiščih so bili odkriti sledovi domovanj. Naselbinske strukture/jame so bile dokumentirane na približno polovici najdišč. Grobove poznamo iz štirih, morda petih najdišč. V članku predstavljava tudi obdelavo materialne kulture zgodnje LTK in vzhodne LTK. Lončenino predstavljava iz vidika tipologije in okrasa, pri čemer ne zanemarjava tudi druge vrste najdb, kot so kamnita orodja, polirani kamni, majhni keramični predmeti, hišni lep, živalske kosti itd. Cilj preiskave je oceniti raziskovalni potencial zgodnje LTK in vzhodne LTK na Slovaškem.*

KLJUČNE BESEDE – *Slovaška; zgodnja kultura linearno trakaste keramike; naselbina; materialna kultura; trenutno stanje*

Introduction

Linear Pottery Culture (hereinafter LPC) represents the oldest known culture of the Neolithic in the territory of Slovakia. It is the period of first Neolithic societies and a new form of cultural expression. The Neolithic in Central Europe is dated to the period between the middle of the 6th and the second half of the 5th millennia, and in many regions it is associated with first farmers. The LPC is characterized mainly by a homogenous style of pottery shapes and decoration. The region of the Middle Danube is considered to be the primary region of the LPC around 5500/5400 cal BC, when its formative phase started. Development of the LPC in the territory of Slovakia as well as in the whole of Europe can be divided – on the basis of regional differences and diversity of the terrain – into the western LPC spread in south-

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western Slovakia following from the settlement in the northern part of Transdanubia and/or in Lower Austria and the Eastern Linear Pottery culture (hereinafter ELPC) in eastern Slovakia, which is part of the Alföld Linear Pottery culture (hereinafter ALPC) formed in the Upper Tisza region in the second quarter of the 6th millennium BC.

The genesis of the Early LPC is not unambiguous. On one hand, there are opinions which see its origin under influence of the Vinča culture from the Starčevo culture primarily south of Balaton Lake in Transdanubia (*e.g.*, *Pavlů 2012.95; Bánffy 2004; Bánffy, Oross 2009.223–224, 227, Tab. I; Marton, Oross 2012.233–236*) or in the wider region of Transdanubia, western parts of Austria (primarily Lower Austria), and southwestern Slovakia (*Lenneis 2010. 190–193*). On the other hand, there is an opinion that the Early LPC started as early as the Starčevo culture in the territory north of the Starčevo settlements along the Danube as far as southwestern Slovakia, not in Transdanubia south of Balaton Lake (*Pavúk 2014.199–207, Map 3; Pavúk, Farkaš 2013*).

The greatest interest of investigators in the Early LPC/ELPC in the territory of Slovakia was in the 1970s and 1980s, and since then less and less attention has been paid to the culture, except for the Moravany site in the Eastern Slovak Lowland. In the article we thus deal with previously published information from domestic as well as foreign literature. Unprocessed and previously unpublished material or information passed orally was not included in the data. Mostly, brief reports occur in works informing the occurrence of finds during surface collections or rescue excavations. There are no summarizing publications (except for the Early ELPC site Moravany) about sites with long-term research (*e.g.*, sites Zemplínske Kopčany, Košice, Senica). The fact that most finds were obtained from multicultural sites with dominant material from other cultures is also a determining factor in identification of the Early LPC/ELPC culture. In such cases, often only a notice of occurrence of this culture is found in the literature, without any further information.

Research history

Although the period of the Late Stone Age in Slovakia first attracted attention as early as the 19th century, almost no records have been preserved from those first – often amateur – researches (for more information see, *e.g.*, *Pavúk, Šiška 1971.320*). The first systematic review of prehistoric periods including cultures from the Neolithic and Aeneolithic in Slovakia was published by Jan Eisner (*1933*) between the world wars. It presents nine sites belonging to the LPC– Gajary, Devínska Nová Ves, Čeklís, Gocnod, Hurbanovo, Zeleneč, Borovce, Stráne, and Moravany (*Eisner 1933.14–15*). Later, Vojtech Budinský-Krička (*1947*) published a work called *Slovakia in the Late Stone Age* (in Slovak: *Slovensko v mladšej dobe kamennej*), where he included Bešeňová, Blesovce, Behynce, Lúky, Gergeľová, Gocnod, Zeleneč, Gajary among LPC sites (*Budinský-Krička 1947.56*).

The new ELPC sites of Lúčky, Oreské, Kapušany, Cejkov, Michalovce, and Košice-Barca were discovered by surveys in eastern Slovakia in the 1950s (*Andel 1955.148, 150; Hájek 1957*). The first destructive research was carried out in 1951 at the site of Košice-Barca III, where a settlement of the Bükk culture (Middle Neolithic) was studied; eight features with exclusively Linear Pottery finds were also uncovered. Unfortunately, only incomplete pottery data without division by features was published from the site (*Šiška 1989.12*).

It was only after the discovery of Barca III type in eastern Slovakia that interest in study of the Alföld pottery increased, since similarities in their shapes and decorations were obvious (*Pavúk, Šiška 1971. 322*). The Linear Pottery from eastern Slovakia, which follows from the pottery of Barca III type, also corresponds with finds of the Alföld pottery. The difference in names is only due to geographical reasons (*Točík 1970.74*).

The Michalovce-Hrádok site, where seven features were studied in 1954, is important because the collection of finds comprised material from the older phase of ELPC and sherds of protolinear character and from the younger phase of ELPC (*Šiška 1989. 15*). Fragmentary material of the Early ELPC was discovered in the 1950s at the sites of Lúčky and Zemplínske Kopčany (*Pavúk, Šiška 1971.327; Vizdal, Paulík 1959*). On the basis of results of these investigations, Kopčany was indicated as a regional group within the older phase of ELPC in the Eastern Slovak Lowland (*Šiška 1989.67*).

Several new investigations were carried out in the western part of Slovakia at Early LPC sites in Hurbanovo (Pavol Čaplovič in 1956), Veľký Grob (Bohuslav Chropovský in 1986), Čachtice (Titus Kolník and Jozef Paulík in 1959) and, *e.g.*, Milanovce (Juraj Pavúk in 1961). Such research considerably extended our knowledge of the culture. The first summarizing study about the Early LPC in Slovakia or its relative chronology was elaborated by Pavúk (*1962; 1980. 11*).

In the eastern part of Slovakia, the sites of Veľké Raškovce, Hutníky, Valaliky, Komárovce, Blažice and Košice-Barca, Svetlá III (*Bánesz, Lichardus 1969.204–207*) and Čečejovce (*Šiška 1989.15*) were added to the list of the Early ELPC sites. In 1975–1976, research continued in Košice-Barca (*Budinský-Krička 1976.46–54*), Bara (*Šiška 1989.148*), Čečejovce (*Čaplovič* et al. *1978.62–70*), Veľké Trakany (*Šiška 1989.170*) as well as the rescue excavations in Žbince (*Šiška 1989.178*). The first study on ELPC was published by Karol Andel (*1955*), and then others by Jan Lichardus (*1986; 1970; 1972*) and in more detail by Stanislav Šiška (*1982; 1989*) and Marián Vizdal (1997a; 1997b).

In western Slovakia, rescue excavations were carried out in the 1970s at the sites of Krakovany (*Sedlák 1975.98*), Nevidzany (*Bátora 1976.25–26*), Čataj (*Pavúk 1976.177–182*), Blatné (*Pavúk 1978.192–195*), Komjatice (*Točík 1978.246–272*), or Cífer-Pác (*Kolník 1980a.142–155; 1980b.106–111*); they successfully enriched the previously known finds from the Early LPC.

Since 1980, destructive research continued in eastern Slovakia in the Košice basin at the sites of Čečejovce (*Šiška 1981.236–289*) and Veľké Raškovce (*Bánesz 1981.23–26*). In Malé Raškovce (*Vizdal 1988.140–141*), only a surface collection was carried out with a positive result for the Early ELPC. Rescue excavations were carried out at three new sites – Čeľovce (*Vizdal 1986.141*), Slavkovce (*Vizdal 1990. 69–170*) and Zbudza (*Vizdal 1986.237–238*). The results of the rescue excavations at Košice-Červený rak site in 1980 are important; there, protolinear pottery and the middle Neolithic Tiszadob Group pottery was identified (*Kaminská* et al. *2008.83*). Finds from the Košice, Galgovec site (*Kaminská 1998*), Slavkovce (*Vizdal 1996.187–188; Skiba* et al. *1996*), Zalužice (*Vizdal 1996.186–187*) and Ždaňa (*Béreš 1996*) were added by the end of the previous century from eastern Slovakia. Also important is the site of Slavkovce, where the presence of the oldest Neolithic population in eastern Slovakia (the Szatmár Group) was found (*Vizdal 1997a.50*).

New sites were also found in the last decades of the 20th century in western Slovakia. Surface collections and rescue excavations extended the number of known sites with the Early LPC by *e.g.*, Borovce (*Staššíková-Štukovská 1988.173–190*), Kátov (*Drahošová 1987.39–40*), Bratislava, Mlynská ulica street (*Egyházy-Jurovská, Farkaš 1987.41*), Bernolákovo (*Farkaš 1987.42*), Slovenský Grob (*Marková 1988. 89*). New finds were obtained in the districts of Trnava, Senica, Nové Zámky and Nitra, however, surface excavations or accidental finds prevailed. Several features with material were uncovered in Senec (*Farkaš 1995.5–22*) or in Mojzesovo (*Ruttkay 1997. 140*). Material of the Early LPC was first found in the southern part of central Slovakia in Tornaľa, formerly called Šafárikovo (*Kovács 1984.45*), Bátka (*Kovács 1982.165–168*) and in the central Gran (Hron) river basin in Ladomerská Vieska (*Mosný, Šiška 1997*). While the first two sites can be attributed to the ELPC, Ladomerská Vieska can be considered as the northernmost site of the Early LPC in Slovakia and classified in the Bíňa phase.

Since the turn of the century, only the site of Moravany was systematically studied in eastern Slovakia (*e.g., Kaczanowska* et al. *2003; Kalicki* et al. *2004. 95; 2005; Kozłowski* et al. *2003*). Material from the ELPC was detected as part of surveys in Kendice (*Horváthová 2017*), Zemplín (*Horváthová, Hreha 2017*) and in Veľký Šariš (*Vizdal, Derfiňák 2006*); however, most of the finds can be classified as part of the middle Neolithic Tiszadob Group.

In the western part of Slovakia, surface surveys detected new sites in Kozárovce (*Ivanič 2002.79–80*) and Choč (*Bielich 2004.34*), while accidental finds contributed to our knowledge of Borovce (*Verčík 2002.224*), Dolné Krškany (*Ruttkayová 2004.161*), and Stupava (*Farkaš 2012.7–12*). Several new features were also found in Senica-Sotina (*Farkaš 2008. 57–58*) and Hurbanovo-Bohatá (*Březinová, Pažinová 2011.100*).

Chronology of the Early LPC/ELPC in Slovakia (Table 1)

The relative chronology of the Early LPC in Slovakia is first of all defined by different features and decoration of the surface of vessels. Quality data or stratified finds have been absent for a long time. The first classification of material from the Early LPC in Slovakia was done by Pavúk (*1962*). He divided finds from the sites in western Slovakia into two stages. The first stage was further divided into two phases: Ia and Ib. The first one was characterized by the material from Milanovce and Hurbanovo, and the second phase represented transition between the sta-

BC	Eastern Slovakia			Western Slovakia	
	Eastern Slovak Lowland	Košice Basin			
5300	Early Raškovce	Tiszadob	Late ELPC	Late LPC	
	Kopčany	Barca III	Early ELPC	Post-Bíňa phase (= Milanovce phase)	Early LPC
5400	proto-Kopčany phase	Košice-Červený rak		Bíňa phase	
5500	*Moravany, Slavkovce*			Pre-Bíňa phase (=Nitra and Hurbanovo phases)	
5600					

Tab. 1. Chronological table of Early LPC/ELPC in Slovakia (remodelled after* Kalicki *et al.* 2005*).

ges (*Pavúk 1962.17*). After the source fund had been extended, two more phases were added to the division (*Pavúk 1980.8–10, 44–45*), while the author himself emphasized that the classification did not present final knowledge of the development of the Early LPC; it rather presented certain moments of development (*Pavúk 1980.47*). Typical decoration and surface texture of the pottery were taken as a basis for a four-phase division by the eponymous sites of Nitra, Hurbanovo, Bíňa and Milanovce. In general, we can say that the Early LPC pottery contained a lot of organic admixture and thick-walled material prevailed. The Hurbanovo phase was characterized by wide cannelures which occurred also on the pottery from Bíňa, while in Milanovce this element was absent. Nail scratches which were more frequent in the first three phases with dominance in Hurbanovo (nail scratches in form of a cereal ear) and in Bíňa were also absent in the Milanovce phase. The phase of Bíňa is the best researched and documented one. Its specific shape is a biconical vessel with a slightly thickened and offset rim and a distinct bend on the belly (*Pavúk 2004.16*). The thick-walled pottery contains mainly semiglobular shapes decorated mostly with wide lines and engravings. The so-called Schlickbewurf (mud slip) is mentioned as an important chronological element. The latest development phase of the Early LPC, called Milanovce, is characterized by a globular vessel without a distinct bend on the belly on which three perforated vertical handles appear. The circumferential decoration is made of a wavy, often multiple grooving and a row of shallow dimples under the rims of globular vessels is a new element (*Pavúk 2004.18*).

Currently, a three-phase division of the Early LPC is accepted in Western Slovakia (*Pavúk 2004.18; 2007; Pavúk, Farkaš 2013*). The first one is a formative phase called Pre-Bíňa (including finds from the Nitra and Hurbanovo phases). It is followed by the Bíňa phase itself with the typical biconical vessels and Schlickbewurf technique applied on thick-walled vessels. The last phase is Post-Bíňa (= Milanovce phase), which – according to Pavúk (*2018*) – starts the expansion of the LPC all over Europe.

The ELPC has been analysed in the context of the overall evaluation of the Neolithic development in Slovakia[1] (*Lichardus 1970; Pavúk, Šiška 1971; 1980*) or as primary study (monograph by *Šiška 1989*). Later the pottery of the ELPC in the Eastern Slovak Lowland (sites of Malé Raškovce, Slavkovce, Zbudza and Zalužice) was evaluated by Marián Vizdal (*1997a.43–141*), who also introduced a new scheme of the development of the ELPC in the Zemplín region and synchronized it with the development on the territory of north-eastern Hungary and Transcarpathian Ukraine. Other authors also dealt with the culture classification (*e.g., Strobel 1997*) or with selected issues of the ELPC (*Lichardus 1964; 1972; Kozłowski, Nowak 2010; Nowak* et al. *2010; Pavúk 1994; 2004; Piatničková 2010; 2015*).

The site of Košice-Červený rak, where pottery with style and technological features analogous with the Körös culture was identified, is important for the genesis of the old Neolithic in Eastern Slovakia. The site belongs to the group of the northernmost sites representing the transitory period between the Körös culture and the Early ELPC (*Kaminská* et al. *2008.90*), and the site qualifies as a representative of the Méhtelek Group in the territory of Slovakia (*Pavúk 2004.42–43*).

In the eastern territories of Slovakia the ALPC/ELPC spread to the north in its second phase. In the third and fourth phases two distinct cultural groups or units occurred, represented by the Tiszadob, Bükk and Szakálhát pottery (typical engraved ornaments), and black painted ware of the Esztár, Raškovce, Piş-

1 Earlier works dealing with the Neolithic and Aeneolithic development on the territory of present-day Slovakia originally declared that the oldest Neolithic relics in east Slovakia would be the finds from Michalovce, site 'Hradok' (features 2 and 3). Based on these, Lichardus introduced the term 'protolinear pottery' into the professional literature (*Lichardus 1970.75; 1972.1–15*).

colt and Lumea Nouă Groups (further *Piatničková 2015.161–165; Raczky, Anders 2003.156–158*).

The ELPC development begins within so called Proto-Linear Pottery stage (the site Košice-Červený rak in the Košice Basin), followed by the Early ELPC Barca III Group (south part of the Košice Basin) and Kopčany Group (Eastern Slovak Lowland) in the western Tisza region (*Šiška 1979.81–87; 1989.62–69*). After the Barca III and Kopčany Groups, the development continued with the evolution of the Tiszadob and Raškovce Groups, and subsequently to their phases representing the late and also the final stage of the ELPC (*Šiška 1989.129–135*).

The oldest Neolithic occupation on the Eastern Slovak Lowland is represented by the Proto-Kopčany phase (*Vizdal 1997a.43–71*). It is actually a transitional phase in the ELPC genesis, in which, besides the older traditions, the ceramic material is represented by elements that are typical throughout the further development, in the groups Kopčany and Raškovce. The following Kopčany Group is defined on the basis of finds from feature 9 at the eponymous site of Zemplínske Kopčany, and from other sites known at that time (*Šiška 1982.262–263; 1989.67–74*).

To other significant sites belong in the Eastern Slovak Lowland (Zemplín region) Slavkovce (Szatmár II Group) and Moravany considered as one of the earliest sites of the ELPC (*e.g., Kozłowski, Nowak 2010.73–79; Kozłowski* et al. *2003; Nowak* et al. *2010; Vizdal 1997a.50–55*, *etc*.).

To conclude this chapter, it is necessary to mention the absolute data of Early LPC/ELPC sites in Slovakia. Not only is there not enough such data, but the reliability of dating is also a problem, since mainly charcoal – not bones or cereals which could provide more reliable data – were used for radiocarbon measuring. In general, we only have information on the ELPC. Košice-Červený rak belongs to the oldest known sites indicating the transition from the Körös culture to the ELPC (*Kaminská 2008.88*). Two dates are available from the site (6190 ± 40 BP and 6520 ± 50 BP), and the second sample in particular presents 5563-5372 cal BC. Currently, the Neolithic settlement in Slavkovce is the oldest evidence of prehistoric farmers in the territory of eastern Slovakia (6630±90 BP; *Kozłowski, Nowak 2010.82*). The data obtained from Zemplínske Kopčany (*Pavúk, Šiška 1980.146*) suggested the occurrence of the Early ELPC around 5491–5297 cal BC. The latest data comes from the Moravany site (28 dates refer to ELPC; *Nowak* et al. *2010.Tab. 7; Nowak 2015.216–219, Tab. VII-1*). The highest level of probability was associated with a period of *c*. 5500–5250 BC, while the lowest was connected with *c*. 5050/5000–4700 BC. In this case the foundation of the Moravany settlement was between 5600 and 5400 BC (the fixed starting point of the settlement should be at *c*. 5500 BC) and for the end of settlement the proposed range was 5200–5150 BC (*Nowak 2015.220–228*). For example the established chronology of the first stage of ALPC, *i.e.* the Szatmár group dated to *c*. 5600 BC (*Domboróczki 2009; 2010*).

Knowledge source

The Early LPC in western Slovakia has been found at approx. 39 sites, and in central Slovakia there are three sites (two of them belong to the ELPC). The Early ELPC in Eastern Slovakia has been documented at least at 28 sites. The finds from western and central Slovakia mainly come from surface collections (60%), while other finds were at rescue excavations. In the eastern part of the country, rescue excavations were carried out at more than half of the sites, while surface collections and accidental finds appear at less than a third of sites. A systematic research in eastern Slovakia was carried out at the site of Moravany (latest *Kozłowski* et al. *2015*). In all, 70 sites with the Early LPC (ELPC) have been recorded in the territory of Slovakia (Fig. 1), occurring in 20 districts. The highest number has been recorded in the Košice District (min. 17 sites), which is followed by Michalovce District (11 sites), with both are situated in eastern Slovakia. In western Slovakia, the Early LPC is mentioned nine times in the Senec District, eight times in the Nové Zámky District and seven times in the Senica District and Nitra District. In other areas, the number decreases significantly.

The Early LPC/ELPC sites are mostly located on the Danubian and Eastern Slovak Lowlands. Settlements are situated in dry, warm climatic zones and dry chernozem soils predominate (in some areas sites are found on sandy subsoil). Overall, the most fertile sites for settlement were chosen at regular distances along larger rivers and less frequently on their tributaries, in lowlands close to water sources (*Tóth* et al. *2011.310–312*). Localization of sites does not exceed an altitude of more than 250m a.s.l. The sought natural environment was very similar in both developmental stages of the culture (Early and Late LPC), and sites were often in the same location, thus containing mixed material.

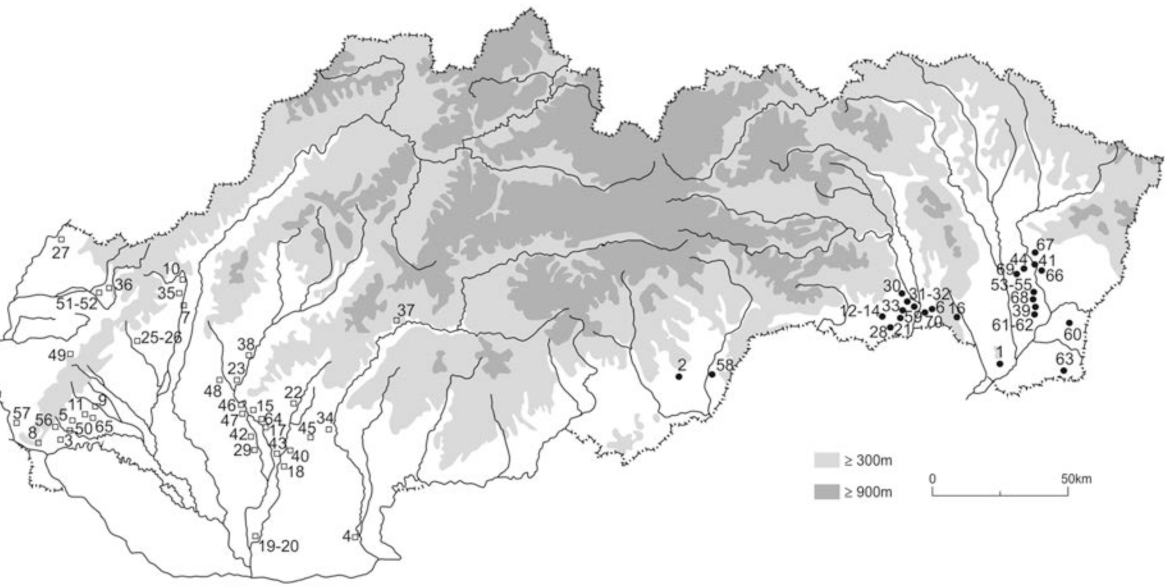

Fig. 1. Sites with finds of the Early Linear Pottery culture (squares) and Early Eastern Linear Pottery culture (circles) in Slovakia: 1 Bara; 2 Bátka; 3 Bernolákovo; 4 Bíňa; 5 Blatné (Štrky); 6 Blažice/Bohdanovce; 7 Borovce; 8 Bratislava (Mlynská ulica); 9 Cífer-Pác; 10 Čachtice; 11 Čataj; 12 Čečejovce (Gemerské); 13 Čečejovce (Balász); 14 Čečejovce (Rigó); 15 Čechynce; 16 Čeľovce; 17 Horný Vinodol; 18 Hul; 19 Hurbanovo (Bacherov majer); 20 Hurbanovo-Bohatá; 21 Hútniky; 22 Choča; 23 Jelšovce; 24–26 Kátlovce; 27 Kátov; 28 Komárovce; 29 Komjatice; 30 Košice (Galgovec); 31–32 Košice-Barca; 33 Košice-Šaca; 34 Kozárovce; 35 Krakovany; 36 Kunov; 37 Ladomerská Vieska; 38 Ludanice; 39 Malé Raškovce; 40 Maňa; 41 Milanovce (Veľký Kýr); 43 Mojzesovo; 44 Moravany (Stredné Pole); 45 Nevidzany; 46 Nitra; 47 Nitra-Dolné Krškany; 48 Nové Sady; 49 Plavecké Pohradie; 50 Senec; 51–52 Senica – Sotina; 53 Slavkovce (Hruštiny); 54 Slavkovce (Pánska Pažiť); 55 Slavkovce; 56 Slovenský Grob; 57 Stupava; 58 Tornaľa (Šafárikovo); 59 Valaliky; 60 Veľké Kapušany; 61–62 Veľké Raškovce; 63 Veľké Trakany; 64 Veľký Cetín; 65 Veľký Grob; 66 Zalužice (Malé Zalužice); 67 Zbudza; 68 Zemplínske Kopčany; 69 Žbince; 70 Žďaňa.

All documented sites of the Early LPC/ELPC in Slovakia are settlements. Burials were only documented in the western part of Slovakia in three cases, however they were polycultural sites also settled in the Late LPC and even later. A child skeleton burial was discovered in feature 114/86 in Bratislava, Mlynská ulica Street (*Egyházy-Jurovská, Farkaš 1987. 41*). Two other skeleton burials of children were documented in Čataj (*Pavúk 1976.178*) and three crouched burials are mentioned in Bíňa (*Točík 1970. 26–27*). All of them represent burials at settlements. Besides, an accidental find of a skull and several bones discovered together with typical Early LPC pottery came from a private estate in Maňa, where they were discovered by the owner during the digging of pits (*Samuel 2001.172*). It is possible that an unrecognized grave find was found in Stupava (*Farkaš 2012.7–12*), where an assemblage containing pottery (two vessels, sherds, adze, sandstone plate) was found by accident during construction work for a family house. The surface collection in Bátka in central Slovakia brought – besides fragments of the Early ELPC pottery – fragments of a human skull (*Kovács 1982.166*). The finds suggest the possible presence of burials. Nevertheless, there has been no investigation at the site so far. The research of the Early ELPC site in Zalužice in eastern Slovakia in the years 1991–1995 was enabled by low water levels in the Zemplínska Šírava water reservoir. An crouching adult individual was found at a depth of 0.55m under thick daub layer (floor?) in feature 1/91, belonging to the Kopčany Group (*Vizdal 2005. 173*).

Immovable archaeological sources in the form of dwellings, settlement features (storage or waste pits, clay pits) post-holes *etc*. from the Early LPC are rare. Complexes of features and post-holes at the Senica-Sotina site were interpreted as possible remnants of an Early LPC house oriented NNE – SSW (Fig. 2). There, a sunken outdoor oven was also documented (*Farkaš 2009.62*). A semi-sunken pithouse of a rectangular shape from the Early ELPC is mentioned from Zbudza (*Vizdal 1986.236*). Feature 3/94 (4.4m x 2.5m) with an uneven bottom (0.15–0.7m deep) and with pole pits from the site of Zalužice is also considered to be a semi-sunken pithouse (*Vizdal 1996.186–187*). Nevertheless, it is not clear in either of the features if they had a residential function. The occurrence of possible hearths is interesting as well, since there are mentions of orange soil with charcoal and traces of burning at the Early LPC site of Cífer-Pác (*Kolník 1980a.143*) and three Early ELPC sites – Moravany (*Kaminská* et al. *2004.95; Nowak 2015.45, 61, Fig. III-6*), Košice-Barca (*Bánesz, Lichardus 1969.291; Šiška 1989.153*) and Čečejovce (*Šiška 1980.205*). A separate oven situated near sunken features is also documented by destroyed earth remains at the settlement with protolinear pottery in Košice-Červený rak (*Šiška 1989.49; Kaminská* et al. *2008.83–84*).

The presence of various settlement features (only rarely characterized as storage pits or clay pits) was identified at least on half of the sites (altogether 131 features). The shapes of the features are mostly described as irregular or regularly oval, irregularly circular and trapeziums. As far as their sizes are concerned, we can see great variance. The average size of the features reached approx. 2–3 x 1–2m and they were 0.8–1m deep. The largest features within the Early ELPC include feature 3/95 from Slavkovce (length 9m, depth 1.6–2m; *Vizdal 1996.187–188*), feature 3 in Košice-Barca III (3.6 x 4.55m, depth 0.3m; *Šiška 1989.152–154*), feature 3/85 in Čeľovce (length 4.8m; depth *c.* 1m; *Vizdal 1986.243*), and feature 9 in Zemplínske Kopčany (10.4 x 2–2.5m, depth 0.6m; *Šiška 1989.172*). In Moravany there are

Fig. 2. Senica-Sotina site. Documented part of a dwelling with postholes (*C*) and surrounding features (*A *feature 2/06, *B *feature 6/06) of the Early Linear Pottery culture in Western Slovakia (modified after* Farkaš 2008.207, obr. 37.1*).

five features with exceptionally large dimensions: 1/98, 2/99, 3/01, 10/01 (with hearth), 1/06 (*Nowak* et al. *2015.43, Figs. III-3; III-4; III-5; III-6, III-7; Fig. III-8*). Their plans can roughly be described as irregular ovals or trapeziums, and their dimensions vary from 7 to 10m and from 4 to 5m along the longer and shorter axes, respectively. In cross-section, these features can be described as hollow-shaped. Their bottoms reached *c.* 0.95–1m below the ground, as much as 1.7m in the case of feature 1/06. As for the function of the features found in Moravany, the most obvious interpretations are workshops processing obsidian and other lithic raw materials. This seems particularly likely in the case of features 1/98 and 2/99 (*Nowak* et al. *2015.61*).

In the western part of the country, the largest features of the Early LPC include feature 1/86 in Bernolákovo (2.1 x 4.8m, depth 2,48m; *Farkaš 1987.42*), feature 76 in Hurbanovo-Bohatá (6 x 7m, depth 0.4–0.8m; *Březinová, Pažinová 2011.26*), feature 300 with oven in Cífer-Pác (4.2 x 2.2m, depth 0,9m; *Kolník 1980a.143*) and feature 14 in Milanovce (3.3 x 2.6m, depth 1.3m; *Pavúk 1980.27, 11*).

It is clear by the amount of finding types documented at Early LPC/ELPC sites that there was pottery – the main indicator of cultural classification – present at each of them. Chipped stone industry occurred at 21 sites, ground stones and polished products were found at 17 sites. Animal bones are reliably present at 11 sites – processed bones or bone industry were present at four sites. Miniature items are mentioned 13 times and daub is only mentioned at eight sites.

Material culture

Pottery

Recently the pottery (forms, ornamental techniques) from the Early ELPC site Moravany (*Vizdal* et al. *2015.85–92, 94–126, Tab. IV-7*) was thoroughly analysed and evaluated, while the typological development of Early ELPC pottery in the Eastern Slovak Lowland (analysed assemblages from Moravany, Malé Raškovce, Zálužice, Slavkovce, Zbudza) was also reviewed and interpreted (*Vizdal 1997a; Vizdal* et al. *2015.90–94*). It was proposed that the stylistic-typological categories such as proto-Kopčany, Kopčany, Raškovce, *etc.*, should tentatively be seen as pottery styles (fashions), they should not be automatically taken as successive phases of ELPC development in the Eastern Slovak Lowland. To the basic pottery forms of the ELPC belong: pots (barrel-shaped and conical pots), bowls (conical bowls, deep bulbous bowls, low-thick-walled bowls/pans), plates, pedestalled vessels/bowls, cups and small beakers, vessels with neck, storage vessels (*Vizdal* et al. *2015.86–88*).

The published pottery represents a collection of 474 fragments in the western part of Slovakia from approx. 40 Early LPC sites, from which we could typologically classify 181 finds. This collection was divided into seven basic vessel types (or in more detail identified sub-types). Biconical vessels (72 specimens) were the most frequent in the collection, followed by semiglobular vessels (31 specimens). The third group – globular vessels (barrel-shaped pots) – contained 28 specimens and the richly represented pottery forms also included bowls (23 specimens). Other forms were less frequent – vessels on pedestals (14 specimens), pot-like vessels (five specimens), and vessels with neck (eight specimens).

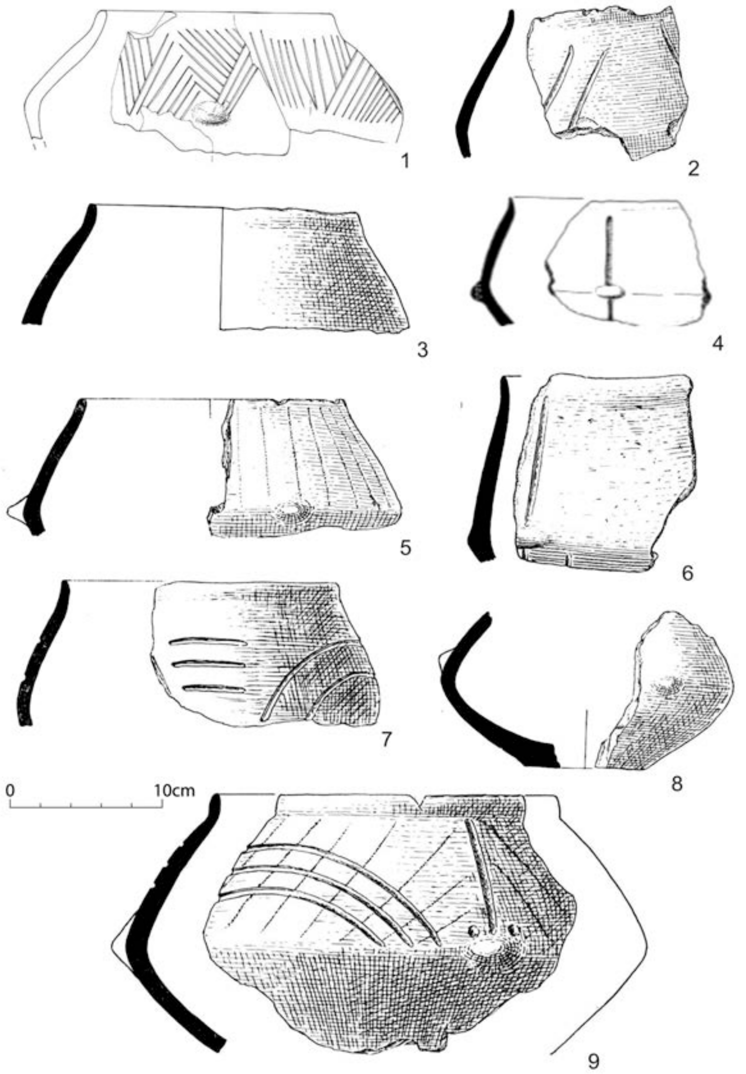

Fig. 3. Biconical vessels of the Early Linear Pottery culture in Western Slovakia. 1 Hurbanovo-Bohatá (after* Březinová, Pažinová 2011. 234, Tab. XXXII*); 2 Bíňa (after* Pavúk 1980.20, Abb. 7.12*); 3 Bíňa (after* Pavúk 1980.19, Abb. 6.4*); 4 Bernolákovo (after* Pavúk, Farkaš 2013.219, Abb. 4.7*); 5 Bíňa (after* Pavúk 1980.19, Abb. 6.1*); 6 Nitra (after* Pavúk 1980.17, Abb. 4.2*); 7 Bíňa (after* Pavúk 1980.19, Abb. 6.3*); 8 Hurbanovo (after* Pavúk 1980.36, Abb. 17.2*); 9 Bíňa (after* Pavúk 1980.19, Abb. 5.2*).

Division of the sites according to their location within Slovakia shows differences in the occurrence of the types of finds. We do not come across all types present in the western part of Slovakia at the sites in Eastern Slovakia, and vice versa. Biconical vessels (Fig. 3) are a good example; they are completely absent in Eastern Slovakia. Vessels/bowls on pedestals are recorded in the eastern as well as western part of the territory, although tall hollow pedestals are typical of the western territory. As for various bowls, their occurrence is mostly evenly distributed. Although, for example, tall bowls are more common in the Early LPC, bowls with low thick almost vertical profiles of walls (pans) and plates are recorded only in the Early ELPC. Vessels with neck and pots (semiglobular and barrel-shaped) are represented in both territories (Fig. 4).

Pottery decoration

Statistical evaluation of the share of ornamented vessels in total pottery production encounters problems posed by huge differences in its representation at particular locations and even features. This can be demonstrated by an example of sites from the Eastern Slovak Lowland. In Moravany, the share of ornamented pottery in features is less than 6%. Values higher than 25% were recorded in most of the features in Zalužice, while pottery from feature1/1988 in Malé Raškovice consisted as much as 42.9% of decorated sherds (*Vizdal 1997a; 1997b*).

For the purpose of this article we analysed in terms of decoration 873 published fragments from 53 sites (36 Early LPC sites and 17 Early ELPC sites), except from the settlement at Moravany, whose ceramic material (6705 fragments altogether, various kinds of decoration identified on the surfaces of 356 fragments – 5.3%) was recently analysed (*Vizdal* et al. *2015.113*).

Engraved decoration was applied on almost half of the analysed pottery (47%). Where the documentation of the material allowed, it was possible to also identify fine (thick and thin) engraved decoration more in detail (4%) and decoration in the form of grooving (3%). Impressed decoration included short incised lines (4%), pinching (3%), impressed dimples – finger-tipped hollows (3%), and – in two cases in the Early LPC also circular stamps.

Painted decoration was very rare and occurred exclusively in the ELPC in Eastern Slovakia. It used only black paint (5%), uniquely combined with engraved decoration (Slavkovce 0.6%; Malé Raškovce 3.97%). The diversity of ornamental motifs made by black painting or its combination with engraving is best illustrated by feature 1/1988 from Malé Raškovce, where this technique was applied on 28.93% of all the sherds – 45% within ornamented artefacts (*Vizdal 1997a*).

Appliqué (plastic) decoration in the form of knobs (breast-shaped, cylindrical, flat circular, tongue-shaped, *etc.*) which were mainly functional (of practical importance) were present on 16% of the pottery collection. Only on a small number of fragments (5%) were combinations of a knob and ornamentation in the form of thick engraving, scratches and hollows documented. Appliqué (plastic) bands (strips) and cordons were present on 3–4% of pottery. The collection also contained very rare handles.

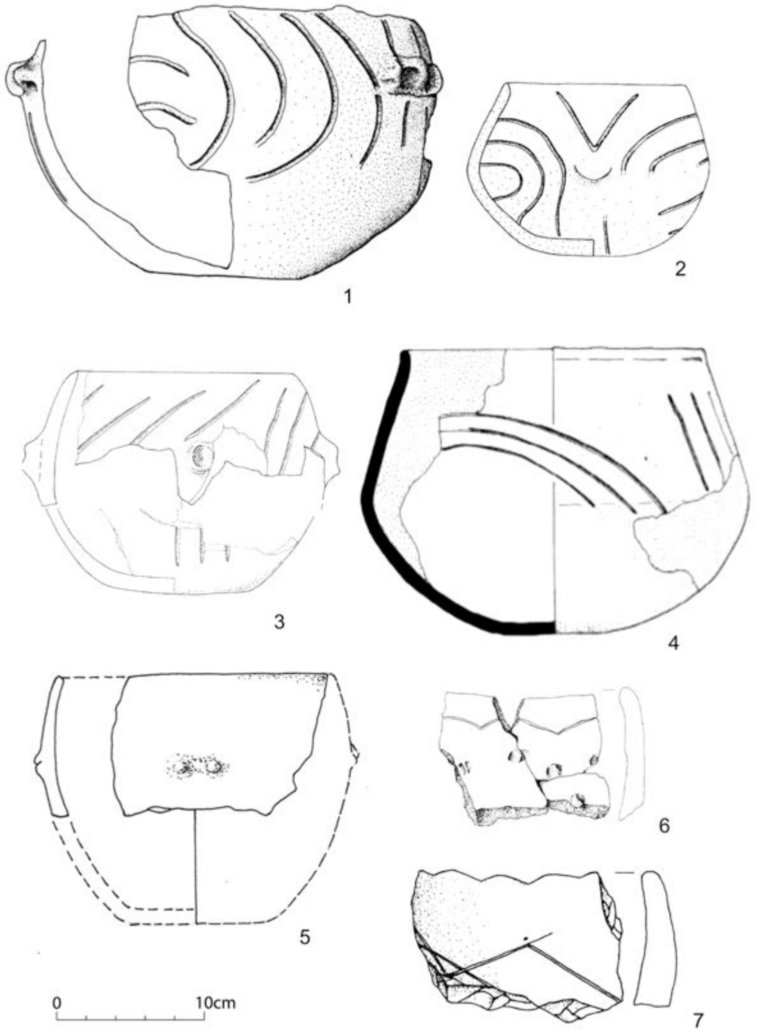

Fig. 4. Globular (barrel-shaped) vessels of the Early Linear Pottery Culture (1–4) and Early Eastern Linear Pottery Culture (5–7). 1 Maňa (after* Samuel 2001.297, obr. 104*); 2 Senica-Sotina (*Farkaš 2008.207, obr. 37.3*); 3 Hurbanovo-Bohatá (after* Březinová, Pažinová 2011.256, Tab. LIV.2*); 4 Bernolákovo (after* Pavúk, Farkaš 2013.219, Abb. 4.4*); 5 Moravany (after* Vizdal *et al.* 2015.130, Pl. IV-4.6*); 6 Zbudza (after* Vizdal 1986.342, obr. 109.2*); 7 Čeľovce (after* Vizdal 1986.361, obr. 131.2*).

Small clay artefacts (Fig. 5)

First in this category, we must mention anthropomorphic figurines, including examples applied on vessels. Their presence was recorded in the Early LPC at five sites: Čataj (*Pavúk 1970.31, Tab. VII.3a, b; 1976*), Milanovce (*Pavúk 1980.10*), Veľký Grob (*Točík 1970.31; Pavúk 1970.31, Tab. VII.2*), Veľké Trakany (*Šiška 1989. 170*), Cífer-Pác (*Kolník 1978.129, obr. 70.1; 1980a.143*). One exemplar was discovered in Central Slovakia in Tornaľa (*Kovács 1984.5–6*) as well as in the east in Košice-Barca III (*Šiška 1989.154*) and in Zemplínske Kopčany (*Šiška 1989. 174–175*). We must not forget the appliqué anthropomorphic scenes on a storage vessel from the proto-Linear site of Košice-Červený rak (*Kaminská 2008.86, Fig. 7, 8; Beljak Pažinová 2018.15*).

Other clay finds include various pendants and bracelets known from the Early ELPC. They occurred in Košice, where the inventory was complemented with clay pearls (*Kaminská 1998.94*). In Zbudza, the most notable finds are a necklace comprising 24 beads, nine tooth-shaped and four fang-shaped pendants. Fragments of bracelets discovered at this site were perforated, which suggests their possible use in a necklace (*Vizdal 1986.238*). Bracelets were recorded in Valaliky as well, where a fragment of a horn-shaped clay artefact also comes from (*Šiška 1989.168*). Besides the presence of clay rings, pendants also occur in Veľké Trakany (*Šiška 1989.170*). We can also see various types of pendants in Čeľovce (*Vizdal 1986.241*) and Zemplínske Kopčany (*Šiška 1989.174–175, Pl. 13.12*). A number of almost identical specimens of long, longitudinally drilled cylindrical pendants were found in Zalužice (*Vizdal 1997b.Pl. IV-49.6*) and Moravany (*Vizdal* et al. *2015.88*).

Types of pottery products which suggest the presence of textile production and weaver's equipment are loom weights and spindle whorls. They were found at Early ELPC sites in Košice (*Kaminská 1998.94*) and Zbudza (*Vizdal 1986.238*) and at Early LPC site in Bíňa (*Pavúk 1980.10*).

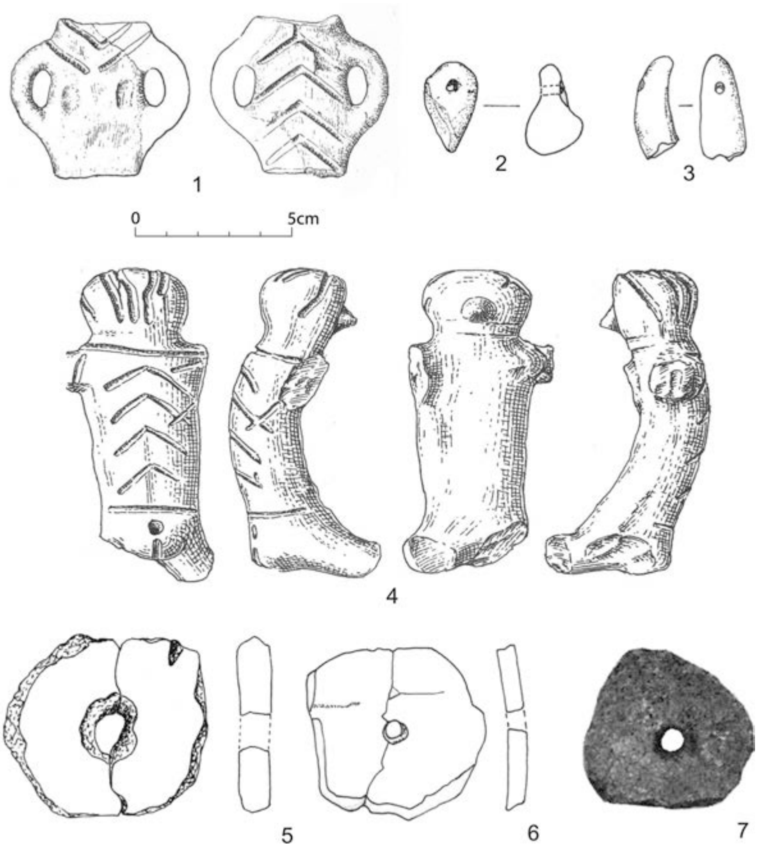

Fig. 5. Small clay artefacts. Anthropomorphic applied figurines of the Early Linear Pottery culture: 1 Cífer Pác (after* Kolník 1980b. 296, obr. 54.1*); 4 Cífer Pác (after* Kolník 1980a.337, obr. 73.1*). Pendants of the Early Eastern Linear Pottery culture: 2 Zbudza (after* Vizdal 1986.345, obr. 112.6*); 3 Moravany (after* Vizdal *et al.* 2015.140, Pl. IV-14.4*); 5 Zbudza (after* Vizdal 1986.345, obr. 112.5*); 6 Moravany (after* Vizdal *et al.* 2015.140, Pl. IV-14.13*); 7 Zemplínske Kopčany (after* Šiška 1989.Tab. 11.10*).

Chipped stone industry

This group of finds is the second most frequent group represented at the sites of the Early LPC/ELPC in Slovakia. Occurrence of these artefacts was documented in cadastral areas of 21 villages. Twelve sites were situated in the eastern part of the country, while nine come from its western part. The determining factor is that at five sites the finds come from surface collections or surveys. Data such as number, description or types of industry are not stated for almost quarter of the sites. From other sites, we only have partial information on the occurrence of a certain number of chipped industry without further data.

From the Early ELPC site Moravany a total of 5142 chipped stone artefacts have been investigated. Approximately one third of the artefacts were blades and flakes, tools were about 10%, chips between 20 and 30%, and cores were no more than 5% (*Kaczanowska* et al. *2015*). These finds were also quantitatively compared with other related sites (Slavkovce, Zbudza, Zalužice, Zemplínske Kopčany) in the vicinity (*Nowak* et al. *2010.Tabs. 1, 2*). The distinctive dominance of obsidian is clear (over 80%), followed by limnoquartzites, radiolarites and hornstone. Sites of the Early ELPC in the Eastern Slovak Lowland represent three types of quantitative structure of assemblages: Type 1 (blades with lateral retouch, retouched flakes, end-scrapers, trapezes and other microliths) – in this group belong Moravany, younger assemblages from Zalužice and Kopčany; Type 2 (retouched flakes, retouched blades, end-scrapers, trapezes and other microlithic forms) – represented by finds from Slavkovce; Type 3 (retouched blades, end-scrapers, retouched flakes, trapezes and other microlithic forms) – occurs at Zbudza and in the older phase of the settlement at Zalužice (*Kaczanowska* et al. *2015.173*). At Moravany blades with lateral retouch predominate, which is also typical for other sites of the ELPC in the Eastern Slovak Lowland (Slavkovce, Zbudza, Zalužice, Kopčany). On the other hand, in the Košice Basin at the site of Čečejovce (*Kozłowski 1989*) a somewhat higher proportion of end-scrapers than other forms with lateral retouch was registered. Interesting is the discovery of a depot of unworked obsidian concretions (34 concretions that, together, weigh 13.5kg) in feature F/1988 in the Early ELPC site Slavkovce, while the total proportion of obsidian at this site is 96.0% (*Vizdal 1990.170; Kaczanowska, Kozłowski 1997*). We should also mention the unusual discovery of a notched drill from the Čečejovce site which was found during surface collection (*Kaminská 1982. 142*). Other finds of chipped stone industry also appeared during surface collections at Early ELPC sites in Bara (*Šiška 1989*), Čel'ovce (*Vizdal 1986.241*), Košice-Galgovec (*Budinský-Krička 1976.46–54*), Košice-Barca (*Bánesz, Lichardus 1969*), Vel'ké Raškovce (*Šiška 1989; Bánesz 1981.23–26*) and Vel'ké Trakany (*Šiška 1989.170*). However, their exact number or raw material composition is not specified.

The total minimum number of chipped stone industry finds of the Early LPC in the territory of Western Slovakia is 50. Exact amount of finds is mentioned in Bernolákovo (43 specimens; *Pavúk, Farkaš 2013*), Borovce (four flakes; *Staššíková-Štukovská 1988.175*) and Senec (one blade, two flakes; *Farkaš 1995*). Certain number of chipped industry without further data comes from Bíňa (*Pavúk 1980*), Blatné (*Pavúk 1978.192; 1988.5–8*), Bratislava – Mlynská ulica Street (*Egyházy-Jurovská, Farkaš 1987.41*), Kátov (*Drahošová 1987.40*), Mojzesovo (*Ruttkay 1997.140*) and Senica-Sotina (*Farkaš 2008. 57; 2009.69*). Among raw materials, obsidian prevailed (over 80%).

Ground and polished stones/artefacts

The occurrence of ground and polished stones at Early LPC/ELPC sites is not common. Finds (5 axes, 16 hammerstones, 4 pounders, 20 grinding stones fragments, 12 plaquettes or flat stones, 19 fragments of pebbles) from the Moravany site in Eastern Slovakia have been comprehensively evaluated (*Kaczanowska* et al. *2015.175–179, Tab. V-8*). All raw materials (sandstone, chalk, quartzite, tuff, hornstone, gaize, diatomite) come from local gravels (pebbles) and/or from an area 30–50km around the Moravany site (*Kaczanowska* et al. *2015.178*).

Besides Moravany ground and polished stone artefacts were recorded in the western part of Slovakia on at least eleven sites and in the east at another five sites (Tab. 2). Most often (nine times) adzes are mentioned closely followed by axes (seven times). Less common are grinders (three pieces), grinding plates (three pieces), chip (one piece) and grinding stones (three pieces).

Except for Moravany (*Kaczanowska* et al. *2015. 190–196, Pl. V-11–V-17*) very few displayed specimens from the analysed period are known. We found only three pieces from the Čachtice site (*Kolník, Paulík 1959.96, Tab. I.1–3*) and two from Stupava (*Farkaš 2012.obr. 2: 1, 5*). Finds from Hurbanovo-Bohatá have been specified and analysed (*Březinová, Pažinová 2011.136–140*), where grinders were made from quartz fluvial pebbles, grinding plates from phillite and grinding stones from sandstone or andesit.

Osteological material and bone tools

Animal bones occurred at only two sites of the Early ELPC – Vel'ké Raškovce (five bones including a fragment of mandible; *Bánesz 1981.25*) and Moravany (small bones; *Kaminská 2003.68–69*). Within the territory of Western Slovakia (Early LPC), animal bones were present at nine sites – Senec (*Farkaš 1995.6*); Senica-Sotina (*Farkaš 2008.57*); Mojzesovo (*Ruttkay 1997.140*); Slovenský Grob (*Marková 1988.89*); Bernolákovo (*Pavúk, Farkaš 2013.218*); Čataj (*Pavúk 1976.178*); Borovce (*Staššíková-Štukovská 1988.174*); Hurbanovo-Bohatá (*Březinová, Pažinová 2011.150–151*); Bíňa (*Pavúk 1980.10*). Identified animal bones from Borovce and Hurbanovo-Bohatá point to beef cattle, swine and goat/sheep. Besides these species, game in the form of a deer bone occurred in Borovce. The rare representation of osteological material depends on the properties of soil at the sites, which influence the preservation of such material. For instance, in the Senica-Sotina site there were rather decayed and eroded bones under the related conditions, and mainly tooth enamel was detected (*Farkaš 2008.57*).

Processed animal bones occurred very rarely at the sites of the Early LPC. A bone spatula was only found in feature 3 in Hurbanovo-Bohatá, where there were three features with animal bones (*Březinová, Pažinová 2011.167, Tab. LXIX.12*). Bone tools were more frequent in Bíňa and Milanovce (*Pavúk 1980. Abb. 16; Točík 1970.31*). In Cífer-Pác a 7.5cm long perforated bear tooth was recorded in feature 300 and a bone spatula was found in feature 360 (*Kolník 1980a.145, 333, obr. 73.2, 5*).

Daub

Among the features of the Early LPC, daub was reliably detected at three sites – Hurbanovo-Bohatá (pieces of surface daub in feature 73; *Březinová, Pažinová 2011.104*), Senica-Sotina (with imprints of wattle construction, *Farkaš 2009.62*) and in Borovce (daub layer of 110 x 90 x 136cm in feature 2; *Staššíková-*

Štukovská 1988.174). Information on four small lumps of daub without specification comes from feature 1/93 in Senec (*Farkaš 1995.6*).

In the Early ELPC, a higher number of daub pieces or daub in form of layers occurred in Slavkovce (*Skiba* et al. *1996.104–105*), Čeľovce (*Vizdal 1986.241*), Košice-Barca, Svetlá III (*Bánesz, Lichardus 1969.291*) and Moravany (*Kaminská 2003.69; Nowak 2015.59–61, Fig. III-19*). On the latter site, daub appeared in a total of 16 features out of 39, while worth noting is the presence of daub lumps bearing structural imprints in features 1/98, 3/99–2000, 9/01, 4/02, and 7/01 (*Nowak* et al. *2015.61*).

Paleobotanical samples and results

In Slovakia there are only a small number of samples with finds of grown plants from the Early LPC/ELPC (for more details see *Hajnalová 2007.297; 2011.142–143; Lityńska-Zajac 1997; Lityńska-Zajac* et al. *2008; Moskal-del Hoyo* et al. *2015*). Carbonized remains come from Borovce, Moravany, Blatné and Hurbanovo-Bohatá, imprints on daub and pottery come from Nitra-Dolné Krškany, Košice-Červený rak, Moravany, Zálužice and Slavkovce. In southwestern Slovakia, we have documented einkorn wheat (*Triticum monococcum*), emmer (*Triticum dicoccum*) and spelt (*Triticum cf. spelta*). In Eastern Slovakia, barley (*Hordeum vulgare*) and pea (*Pisum sativum*) are added to the einkorn wheat and emmer. Although flax (*Linum usitassimum*) is absent among the finds, finds of spindle whorls suggest its probable production.

Discussion and conclusion

The aim of this work was to point to the condition of research into the Early LPC/ELPC in the territory of Slovakia. It was preceded by collecting and processing of sites with relevant archaeological material known from the literature. It is clear from the obtained data that the first stage of Neolithic occupation in Slovakia is not often represented. Another negative is that in most cases only brief information on the occurrence of the Early LPC/ELPC material is published without more detailed analysis, or without more specific data.

The collection of finds from the first Neolithic culture from the territory of Slovakia represents

site	cultural affiliation	research method	amounth	adze	axe	chip	grinder	grinding plate	grinding stone	source
1 Bernolákovo	Early LPC	rescue excavation	not speciefied							*Farkaš 1987.42*
2 Blatné	Early LPC	rescue excavation	not speciefied							*Pavúk 1988.6*
3 Čachtice	Early LPC	surface collection	4	2	1	1	–	–	–	*Bánesz, Lichardus 1969.96; Kolník, Paulík 1959*
4 Čečejovce	Early ELPC	rescue excavation	not specified							*Šiška 1980.206*
5 Hurbanovo-Bohatá	Early LPC	rescue excavation	?	–	–	–	1	1	1	*Březinová, Pažinová 2011.135–136*
6 Kátlovce	Early LPC	surface collection	3	2	1	–	–	–	–	*Bátora 1993.23–24*
7 Kátov	Early LPC	surface collection	2	–	2	–	–	–	–	*Drahošová 1987.40*
8 Malé Raškovce	Early ELPC	surface collection	not specified							*Vizdal 1988.141*
9 Milanovce	Early LPC	rescue excavation	not speciefied							*Točík 1970.30*
10 Mojzesovo	Early LPC	rescue excavation	not speciefied							*Ruttkay 1997.140*
11 Senica – Sotina	Early LPC	systematic research	2	1	1	–	–	–	–	*Pichlerová 1961.32; Farkaš 2008.57*
12 Slavkovce	Early ELPC	trenches	2	–	–	–	–	–	2	*Skiba* et al. *1996.104*
13 Slovensky Grob	Early LPC	surface collection	3	1	–	–	1	1	–	*Marková 1988.89*
14 Stupava	Early LPC	accidental find	2	1	–	–	–	1	–	*Farkaš 2012.9, obr. 2.1, 5*
15 Valaliky	Early ELPC	trenches	1	–	–	–	–	1	–	*Šiška 1989.168*
16 Zemplínske Kopčany	Early ELPC	rescue excavation	4	2	2	–	–	–	–	*Šiška 1989.171*

Tab. 2. Representation of the polished stone types at Early LPC/ELPC sites in Slovakia (except the Moravany site).

at least 70 sites; only a few of them have been studied by systematic or rescue excavations. Despite this, we cannot ignore the potential for investigation of this culture in the studied area.

The initial collection which we worked with is not ideal. Part of the material was obtained during surface collections and surveys. However, we must also emphasize that most sites are polycultural, with younger material prevailing. The sites of Malé Raškovce (*Vizdal 1988.140–141*), Blatné (*Pavúk 1988. 6*) and Mojzesovo (*Ruttkay 1970.140*) are good evidence of the importance of surface collections from the aspect of the investigation's further potential. Nevertheless, the number of identified features of the Early LPC/ELPC within the subsequent research was small in comparison with other periods. In the eastern part of Slovakia only three sites (Zalužice, Moravany, Zemplínske Kopčany) and in the western part five sites (Cífer-Pác, Senec-Blatné, Čataj, Senica, Hurbanovo-Bohatá) were investigated to a slightly greater extent, but even there the excavations mostly covered only a small part of the estimated total area.

The collecting and processing of the Early LPC/ELPC finds from Slovakia has resulted in a collection containing various settlement features (77%), hearths and ovens (8%), pole pits (6%), dwellings (5%), clay pits (4%) among immovable finds. As for movable finds (besides pottery which was present at all sites), chipped stone industry (39%), ground and polished stone industry (22%), and animal bones (19%) were predominant. Less than 15% of finds were small clay artefacts, daub, and bone industry.

From the material culture we first focused on pottery. The remarkable absence of biconical vessels and vessels/bowls on tall pedestals in the eastern part of the country cannot be ignored. Globular (barrel-shaped) and semiglobular vessels/pots, just like bowls, are represented in almost identical numbers in the Early LPC and ELPC collections. We must also take the following into consideration – only a small collection of Early LPC finds was used for typology and compared with recently processed Early ELPC pottery (*Vizdal 1997a; Vizdal* et al. *2015*). This corresponds with the information value of the finds presented in the article. The pottery material was not processed only on the basis of forms but also by decoration. Pottery decoration points to frequent application of mainly engraved lines on almost half of decorated fragments. Impressed decoration was less frequent (13%). Painting (black paint; combination of painting and engraved lines) had a 5% share in the collection and occurred only in the eastern part of Slovakia. Appliqué (plastic) elements such as knobs, lugs, bands, cordons had an almost 25% share. In some cases perforations on the vessel bodies also occurred.

After pottery, chipped stone industry was the second most frequently represented group of finds, with occurrence in the cadastral areas of 21 villages. As for raw materials, obsidian was most often used (with the related analyses better known from Early ELPC sites in the Eastern Slovak Lowland), while the range of finds included end-scrapers, retouched blades, flakes, cores and – rarely – lumps.

Polished stones and ground stones were mentioned rarely (only at 17 sites altogether), and their exact numbers from the sites are unknown. Mainly adzes and axes were reported. Animal bones and bone industry, like small clay artefacts, were only insignificantly represented. However, we must point to the occurrence of anthropomorphic figurines at a minimum of eight sites. Discovered pieces of daub are also reported from eight sites, but their occurrence specifically at the sites of Senica (Western Slovakia) and Moravany (Eastern Slovakia) is important. Twig impressions on daub lumps suggesting timber-framed buildings have been found at these sites.

The presence of dwellings at the Early LPC settlements in Slovakia is minimal. The low number of identified houses is undoubtedly associated with the low amount of systematic research or with the rescue excavations carried out over only small areas. Analogous sites in the neighbouring countries, *e.g.*, in Austria Brunn am Gebirge II (*Lenneis 2004; Stadler 2005*), Mold bei Horn (*Lenneis 2003; Hofmann, Lenneis 2017*), Rosenburg im Kamptal (*Lenneis 2009*), Neckenmarkt und Strögen (*Lenneis 2001*); Vedrovice-Za dvorem (*Podborský* et al. *2002*), Popůvky (*Bálek 2002*) and Brno-Ivanovice (*Čižmář 1998*) in Moravia; or Szentgyörgyvölgy-Pityerdomb (*Bánffy 2004; 2005; Bánffy, Réti 2008*) and Balatonszárszó–Kis-Erdei dülő (*Oross 2010*) in central and southern Transdanubia and Dunakeszi–Székesdülő (*Horváth 2002; 2004*) on the left bank of the Danube north from Budapest, show that detection of residential features is considerably complicated by their sparse distribution within settlements.

An important site that can bring new knowledge about the settlements of the Early LPC culture in Western Slovakia (Zahorie region) is Senica-Sotina (*hung. Szotinafalva*), where a part of a house ground plan was identified (Fig. 2; *Farkaš 2009.62*). Its dimensions and characteristics (outer pits, external hearth, orientation) are comparable to residential buildings (two houses with dimensions of 7–8.5m x 13–15m) excavated in Szentgyörgyvölgy – Pityerdomb in southern Transdanubia (*Bánffy 2004.176–177*).

Similarly, in Eastern Slovakia (*e.g.*, Zbudza: *Vizdal 1986; 1990*; Zalužice: *Vizdal 1996*; Moravany: *Nowak* et al. *2015*), features whose interpretation encourages the presence of houses were uncovered. We therefore believe that it is only a matter of time before settlements (including dwelling houses) dated to Early LPC/ELPC can also be explored to an adequate extent in Slovakia.

Finally, it is necessary to mention the potential of research in to the focal culture in the territory of central Slovakia. The Ladomerská Vieska site in the Central Gran river basin, Žiar nad Hronom District, gives the impression that even at a distance of a minimum of 50km from the centre of the Early LPC settlement in southwestern Slovakia, it is possible to trace the evidence of settlement from the beginning of the Neolithic period.

Similarly, in the eastern part of central Slovakia (the Gemer region), there are also a few surface collections (Bátka and Tornal'a sites) of the Early ELPC. It is therefore necessary to monitor the presence or absence of these early finds during future research in the central part of the country, which will clarify our knowledge about the first farmers in the territory of what is today Slovakia.

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‘Robust chronologies’ or ‘Bayesian illusion’? Some critical remarks on the use of chronological modelling

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ABSTRACT – *The explanatory power of Bayesian chronological modelling is often overestimated, leading to an uncritical belief in the reliability of each isolated model without the necessary look at archaeological connections between different models. The methodical pitfalls of this approach, especially in combination with inaccurate use of typochronological methods, are highlighted for Linear Pottery Culture (ger. Linienbandkeramik – LBK) and Middle Neolithic chronological models from Central Europe (*Jakucs *et al.* 2016; Denaire *et al.* 2017; Bánffy *et al.* 2018*). A more critical approach to Bayesian modelling, considering possible mathematical artefacts and the deficits of the actual calibration curve as well as the inherent imprecision of the used typochronological dates, seems to be required.*

KEY WORDS – *^{14}C; Bayesian modelling; Correspondence Analysis; Central Europe; Early Neolithic; chronology*

‘Robustne kronologije’ ali ‘Bayesova iluzija'? Nekaj kritičnih pripomb na uporabo kronološkega modeliranja

IZVLEČEK – *Moč, ki jo nudi Bayesovo kronološko modeliranje za razlago, je pogosto precenjena, kar vodi v nekritično zaupanje v zanesljivost vsakega posameznega modela, ne da bi se pri tem upoštevale arheološke povezave med posameznimi modeli. Metodološke zanke takšnega pristopa, predvsem ob nenatančni uporabi tipološko-kronoloških metod, se kažejo predvsem pri preučevanju kulture linearno trakaste keramike (nem. Linienbandkeramik – LBK) in kronoloških modelov za srednji neolitik v Centralni Evropi (*Jakucs *et al.* 2016; Denaire *et al.* 2017; Bánffy *et al.* 2018*). Če upoštevamo možne matematične izdelke in primanjkljaje dejanske kalibracijske krivulje kot tudi neločljivo nenatančnost uporabljenih tipološko-kronoloških datumov, lahko sklepamo, da potrebujemo bolj kritičen pristop k Bayesovemu modeliranju.*

KLJUČNE BESEDE – *^{14}C; Bayesovo modeliranje; korespondenčna analiza; Centralna Evropa; zgodnji neolitik; kronologija*

Until the 1960s, typochronology of the Early and Middle Neolithic in Central Europe was mainly based on descriptive typologies and individual judgements by expert archaeologists (*Tichý 1960; 1962; Meier-Arendt 1966*). However, standardized typologies and combinations of the types were already used during the 1930s (*Buttler, Haberey 1936*), with the method being later refined by Pieter J. R. Modderman (*1970*). Statistics-based methods using such typologies became the standard for new relative chronologies since about 1970 (*Dohrn-Ihmig 1974; Meier-Arendt 1975*). Finally, a consensus about the relative chronology of the Early and Middle Neolithic was achieved around 1990 (*Stehli 1994; Spatz 1996; Strien 2000*; all PhD theses completed 1989–1991), combining regional seriation-based chronologies, classical typological linking and sometimes additional supra-regional seriations (*Stehli, Strien 1986; Steh-*

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li 1994). This was complemented by first modelling of ^{14}C dates, mainly aiming at estimates for the absolute duration of the LBK as a whole and of the house generations of the compound model (ger. Wohnplatzmodel; *Stehli 1989*). The estimated absolute date for the LBK of the lower Rhine Valley (5300–4950 cal BC) was soon confirmed by dendrochronological dates from the Kückhoven wells (Fig. 2). Later on, other regional chronologies were added (*e.g., Lefranc 2007; Denaire 2009; Pechtl 2009*), but without great changes for the overall scheme. In the south-east, until recently chronologies relied mainly upon individual typochronological estimation (*e.g., Pavúk 1980; Čižmař 1998; 2002; Marton, Oross 2012.Fig. 10*).

While the start of the early LBK (known also as Flomborn and Notenkopf phase) somewhere around 5300 BC is widely accepted, the absolute date of the formation and expansion of the earliest LBK (eLBK) remains contested, with postulated dates up to 5700 BC, but rarely later than 5500 BC. The model of an at least partial parallelization of earliest and early LBK based mainly upon ^{14}C dates from taphonomically problematic contexts (*Stäuble 2005; Cladders, Stäuble 2003*) has not received general approval.

However, recently the previous consensus on the relative and absolute chronology of the beginning as well as the end of LBK was disturbed by the approach of formal modelling of ^{14}C dates, applying Bayesian statistics. The first attempts (*Jakucs* et al. *2016; Denaire* et al. *2017*), postulating an unexpectedly late start of the expansion of the eLBK around 5350 cal BC, and a long-lasting hiatus between the final LBK and the beginning of the Middle Neolithic, provoked concerns (*Strien 2017*). Consequently, this led to a reply in which the claims of the criticized papers were restated (*Bánffy* et al. *2018*). The problems with ^{14}C-dates on bone collagen (as discussed in *Strien 2017*) were rejected by the authors, mainly based on the conviction that ^{14}C dating is technically mature to a degree excluding major problems. This point shall be addressed below with additional evidence.

To come to an overall sound line of argument, it is helpful to briefly review some statements of Eszter Bánffy *et al.* (*2018*) concerning the alleged methodical deficits of my line of argument:

● The absolute chronology proposed by Hans-Christoph Strien (*2017*) is not "*based on informal inspection of selected radiocarbon dates*" (*Bánffy* et al. *2018.121*) nor on the "*selective use of visual inspection of radiocarbon dates*" (*Bánffy* et al. *2018.128*), but explicitly based on omitting all ^{14}C dates (*Strien 2018.17–18, 27–28*). The exclusive use of quantitatively modelled ^{14}C-data series (*e.g., Strien 1989a*) was proposed as a standard procedure long ago (*Strien 2000.70–71*).

● The succession of house generations as a base for my absolute chronology is not "*identified only by study of ceramic motifs*" (*Bánffy* et al. *2018.130*), but also by detailed studies of site-formation processes (*Strien 2018.94–95, 97–98* and further; illustrated *Strien 2014.Abb. 1–2*): "*The knowledge of the stylistic development is fundamental for this purpose, but it is supplemented by other, independent information such as the position of pits relative to houses, spatial relations between houses, and stratigraphy*" (*Strien 1989b.364–365*; own translation; in more detail and with comprehensive literature *cf. Zimmermann 2012.12–13*).

● It should be noted that using (1) the lowest existing estimate for the number of inhabitants of a house, (2) a low estimate for the mean number of houses per settlement based on a model with a low duration of houses (23–25 years), (3) only actually known settlements, and (4), a very high population growth to calculate the minimum number of immigrated people is usually termed a 'conservative estimate' and not (*Bánffy* et al. *2018.129*) 'demographic speculations'.

What should be discussed in more detail are some other points: 'robust chronologies' require dates with a statistical error as small as possible, which in ^{14}C-dating is at first hand a technical problem. However, the statistical error of a typochronological date in the case of Neolithic ceramics is mainly a function of the number of sherds found in the feature. In consequence, using Correspondence Analysis (hereafter CA) is no guarantee for a 'robust chronology' of all dated features; a critical look at dates based on small samples is necessary. In regions not reached by modern statistical methods of relative dating the uncertainties of individual typochronological judgement enlarge the potential errors considerably.

Looking first at the Transdanubian earliest LBK (eLBK), the only available CA consists of all accessible features of this phase from all over Central Europe (*Strien 2018*). The alleged earlier date of the so-called 'formative phase' compared to the Bíňa phase and the expansion horizon, which plays a central role in the argument of János Jakucs *et al.* (*2016*), is in clear contradiction to the results of this CA (Fig. 1), showing an anteriority of Bíňa, not 'formative phase' inventories. The detailed results of the CA might be questioned for edge effects (as discussed in *Strien 2018.24–25*), but an earlier start of Bíňa (Donau-eLBK) seems most probable, although a synchronous start remains possible, and the reverse sequence can be excluded[1]. These results are backed by maps (*Strien 2018.Abb. B4-B5*) showing that contemporaneity between the 'formative phase' and Bíňa phase, and even some early Moravian sites, all synchronized by CA, is geographically plausible.

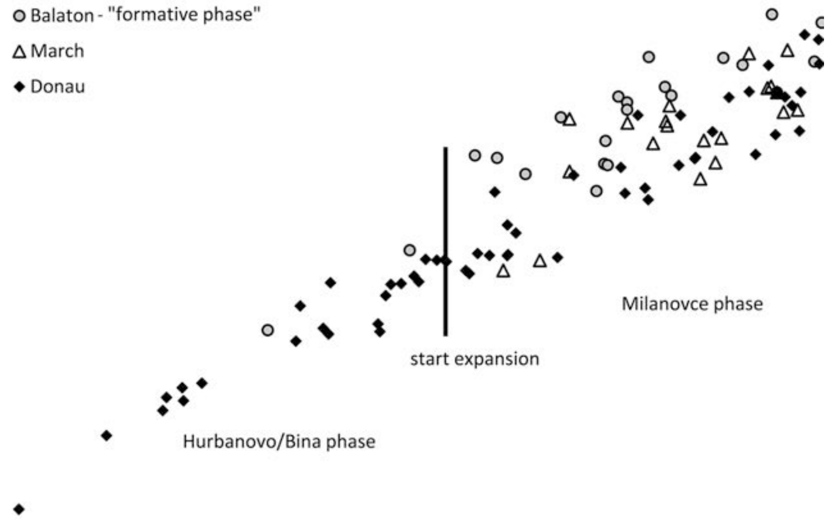

Fig. 1. Projection 1./2. EV of a CA of eLBK (after* Strien 2018*).

It remains to be noted that:

● The only argument for the anteriority of the 'formative phase' mentioned by the authors, the presence of Starčevo-like pottery at Szentgyörgyvölgy-Pityerdomb and "*the Starčevo presence in southern Trandanubia and the Balaton, ending perhaps in the 56th century*" (*Bánffy* et al. *2018.128*), is somewhat surprising since not less than five out of the 11 authors of this paper had strongly dismissed this in another paper only a few months earlier (*Jakucs* et al. *2018*): at Versend-Gilencsa Starčevo and early (not 'formative' nor earliest!) LBK were shown to have been contemporaneous in some households, following formal modelling as late as 5200 cal BC (*Jakucs* et al. *2018.112*), far beyond the suggested start of the Earliest LBK at about 5350 cal BC. It remains unexplained why Bánffy *et al.* (*2018*) nevertheless claim an end date of Starčevo anterior to the Earliest LBK and in consequence also for the 'formative phase', in straight contradiction to their own paper.

● At Szentgyörgyvölgy-Pityerdomb, the main site of the 'formative phase', *i.e.* pit 16 and together with pit 11 forming the long pit of house 1 (house numbers according to *Lüning 2016*), provided one of the earliest inventories from the site according to the CA[2]. One of the pots shows a motif composed of three lines, forming an arc standing on the carination of the biconical bowl (*Bánffy 2004.138.141, Fig. 71*). The same motif in the same position on recipients of related form is not only well known from but most typical for the Bíňa phase (*Pavúk 1980*); the technical differences (narrow, smoothed and finely incised lines instead of broad deeply incised lines) at the same time link it with early Vinča parallels (*Horváth 2006*).

After all, there is no argument left for the postulated anteriority of the so-called 'formative phase', but manifold evidence against it. Bánffy *et al.* (*2018. 128*), complain that this "*simply reduces the proposed 'formative phase' to a regional variant*" – in fact it simply is a regional variant. The term should in consequence be disregarded as misleading; the phase preceding the expansion of eLBK is constituted not only of the earliest pits of the sites in the region between western Balaton and Vienna (only the earliest part of the so-called 'formative phase'), but by all Bíňa phase sites, too.

Changing to the Alsatian chronology, Anthony Denaire *et al.* (*2017*) tend to an uncritical optimism concerning the reliability of CA dates and at the same time to a readiness to adjust them without mathematical foundation, as may be shown by some examples:

● In the case of Osthouse 227, a single pot is dated to a stylistic phase most probably (84% probability)

1 In fact, including the inventories from Brunn 2, published after finishing this paper (*Stadler, Kotova 2019*) at first sight shows a synchronisation of Brunn 2 with Biňa phase and again no anteriority.

2 I can judge the ceramic finds from Pityerdomb only from the published photographs and given descriptions. The direct access to these finds I requested for my study (*Strien 2018*) was unfortunately denied.

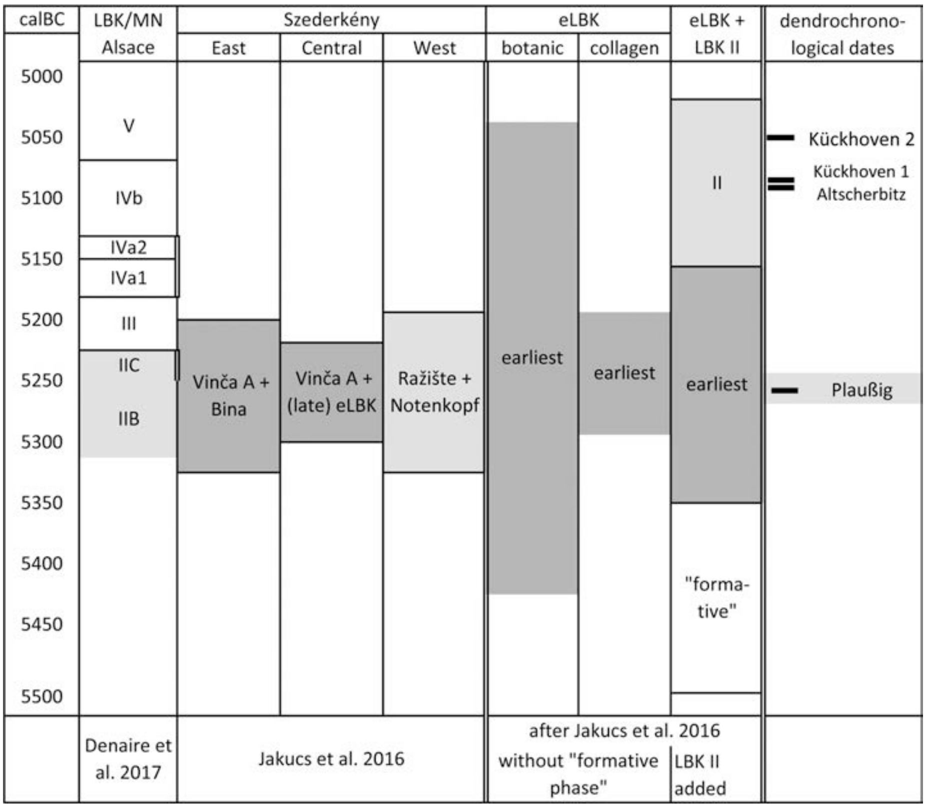

Fig. 2. Chronological table putting together different results of formal modelling (for details see text).

spanning not more than 10 years according to the formal modelling (*Denaire* et al. *2017.1106*). Dating single pots poses methodical problems like possible stylistic interdependencies of rim and body decoration (*Strien 1984.23, Abb. 11*) – the main reason why single pots should be excluded from a CA of features (*Strien 2000.46*). This weak point is combined with a second potential source of dating problems: the assumption that ceramic from graves is representative of the style in use at the time of the funeral. This assumption excludes the possibility that ceramic was produced or at least selected for funerary purposes, the decoration following rules somewhat different from those for everyday items. Indeed, there are hints in this direction at least for the Niedermerz cemetery (*Frirdich 1994.336–340*). The idea that typochronology based on such a narrow and problematic base could reach a precision in the range of one decade or less is in remarkable contrast with the negative attitude towards the much more refined identification of house generations of an estimated 25 years shown by the same authors.

● In the case of KV107 not only the small number of decorated sherds (*Denaire 2013*) poses problems, as its typochronological date had also been determined quite arbitrarily by drawing in the projection 1./2.EV of the CA diagonal phase boundaries at strange angles, changing the position of KV107 from between phases IIB and IIC to the beginning of phase III (*Denaire* et al. *2017.Fig. 5*; one may also ask why Bisch 1735 is dated to IVa1 and not to IVa2 where its position in CA fits better) – connecting chronology in this way with 1. and 2.EV of a CA at the same time is at best unusual, and would have required some solid justification.

● Another highly problematic methodical handling is shown by the last example: Talheim and the phase to which it can be dated (8A of the Württemberg chronology) had until now always been attributed to late LBK (*Strien* et al. *2014.Fig. 5; Lefranc 2007. Tab. 14; Jeunesse, Strien 2009.Fig. 1*), corresponding to phases IVa2 or IVb of the Alsatian chronology – dating it without any explanation to the final LBK[3] is not what usually is understood under the term 'robust chronology', but looks more like arbitrarily arranging the relative position to fit the ^{14}C dates to the authors' own chronological ideas.

After all, the results of CAs are treated in very different manners by Denaire *et al.* (*2017*) and Bánffy *et*

3 'Strien 9' (*Denaire* et al. *2017.1132*); phase 9 has never been found in the whole Neckar Valley; in the region Unterland/ Kraichgau, where Talheim is, even phase 8B is not attested (*Strien 2011.20*).

al. (*2018*): sometimes accepted even for statistically problematic inventories (Osthouse 227 in Alsace), sometimes 'corrected' (features KV107 and Bisch 1735 in Alsace, Talheim), sometimes completely ignored ('formative phase' of LBK) – this is far from "*using a rigorous statistical methodology*", as claimed by Bánffy *et al.* (*2018.130*), for combining ^{14}C dating and archaeological evidence.

But 'robust chronologies' require reliable ^{14}C dates, too, not changed by later alterations of the dated material. Two thirds of the paper (*Bánffy* et al. *2018. 121–128*) provide a lucid argument as to why on both methodological and technical grounds ^{14}C dates are supposedly highly reliable. In practice, things are a bit different, as some examples show. The first is the start of eLBK expansion, dated by Jakucs *et al.* (*2016*) to *c.* 5350 cal BC, and questioned by me on the grounds of contradictory ^{14}C dates. The simplest method, if my conclusions on the reliability of collagen dates were wrong, is a comparison of bone-based with charcoal-and-cereal-based formal modelling, and this was not chosen – for obvious reasons, as may be shown. As the original code has not been published, the models had to be rebuilt online (*Bronk Ramsey 2009a; 2009b*; https://c14.arch.ox.ac.uk/oxcal/OxCal.html, Version 4.3). The reconstructed model 2 produces results that are not identical but close to those of Jakucs *et al.* (*2016*) (Tab. 1). The differences may be caused by minor errors in typing and by the use of different releases of OxCal. Then the model was split in two (Appendices 1–2), one version with the collagen dates and a second one with the dates on botanical material. The result is quite clear and supports my position: using collagen, the start of the expansion phase is dated to *c.* 5290 cal BC (the absolute dates mentioned in this paper are the median values according to OxCal; Tab. 1; Fig. 2), about the same date as for the start of Flomborn in Alsace; using botanical dates, the start goes back to *c.* 5395 cal BC, with a better overall agreement for the latter.

Approaching the correct archaeological model, *i.e.* removing the 'formative phase' from the botanical dates, results in a start date for the expansion of 5425 cal BC (Fig. 2). Changing the model by putting all dates from features dated by CA to the pre-expansion horizon in a new 'formative phase' alters the results only slightly and therefore is not shown here (5290 cal BC for collagen, 5400 cal BC for cereals/charcoal), with a date for the start of the pre-expansion horizon of 5325 cal BC and 5440 calBC, respectively. Evidently, there is a difference between the collagen and botanical dates, the latter giving a date that is more plausible, although too late compared with my archaeological findings. Anyhow, it should be noticed that none of the formal models presented here is meant to present a correct alternative. They are only used to highlight the problems of the disputed models. The deficits of the calibration curve, making all actually possible models insecure, will be discussed below.

Another point is the end date for eLBK, left open by Jakucs *et al.* (*2016*) as the models produced dates in the 52nd/51st centuries cal BC. The authors bypassed the problem by claiming that "*for that, a much better data set is required*" (*Jakucs* et al. *2016.318*). It remains unexplained why the same dataset should produce robust estimates for the start, but obviously unrealistic ones for the end of eLBK. On the other hand a very simple method for estimating an end date was omitted: the ^{14}C dates from Vedrovice and Kleinhadersdorf from phase Ib were included as eLBK – why not take phase IIa from these sites plus Alsatian Phases IIb/IIc as post-eLBK? The explanation might be the unwelcome result: Using the model of Jakucs *et al.* (*2016*), as above, but excluding all eLBK dates later than 6100 BP as intrusions and including the dates of seven graves from Vedrovice and Kleinhadersdorf and 11 pits from Alsace as LBK II (Appendix 3), the new model shows low overall agreement (A = 36), mainly caused by the two earliest Alsatian dates (SUERC-46497, OxA-27805). Re-

	Jakucs et al. *2016*	reconstructed model	collagen only	botanical material only	
median probability					
start formative	*c.* 5500	5518	–	5516	–
boundary formative/earliest	*c.* 5350	5357	5291	5395	5427
end earliest		5113	5190	5052	5040
overall agreement (A)		79	63	85	104
95.4% range					
start formative	5625–5480	5590–5479	–	5610–5477	
boundary formative/earliest	5395–5320	5397–5322	5340–5231	5442–5351	5517–5348
end earliest		5164–5043	5224–5127	5152–4950	5142–4933

Tab. 1. Formal modelling of eLBK. Variants of Model 2 from* Jakucz *et al.* 2016 *(see text): own online reconstruction and separate modelling of collagen and botanical dates (dates cal BC).

moving them, the overall agreement is much better (A = 71), without changing the results (Fig. 2): the end of eLBK/ start of LBK II is dating to 5161 cal BC (95.4%: 5201–5106 cal BC), the end of LBK II to 5018 cal BC (95.4%: 5135–4948; 68.2%: 5046–4985 cal BC). In other words: the end of LBK II in this model is with a probability of more than 85% later than the second well from Kückhoven, dating to late LBK, and the start of LBK II in this model is later than the end of it in the model of Denaire *et al.* (*2017*), although 9 and 11, respectively, of the 16/18 measurements are the same. Beyond this obvious difference we need not discuss the implications of an end date of eLBK about the same time as the late LBK phase IVa1 in Alsace ('around 5160 cal BC' according to Denaire *et al.* (*2017.1106*)) to realize a contradiction between the archaeological and ^{14}C chronologies, which had been denied by Bánffy *et al.* (*2018*).

	Oxford	Poznan	SUERC
median of probability			
Start Hinkelstein	4827	4795	4764
Hi/Großgartach	4737	4740	4696
GG/Planig-Friedberg	4701	4653	4644
PF/Rössen	4651	4582	4580
Rössen/Bischheim	4563	4492	4494
End Bischheim	4195	4390	4256
95% range			
Start Hinkelstein	4990–4726	4919–4721	4901–4698
Hi/Großgartach	4785–4712	4791–4700	4729–4627
GG/Planig-Friedberg	4723–4673	4707–4582	4689–4595
PF/Rössen	4697–4589	4667–4508	4646–4526
Rössen/Bischheim	4559–4400	4570–4409	4545–4412
End Bischheim	4326–3912	4489–4246	4324–4146

Tab. 2. Laboratory differences in Alsatian Middle Neolithic models (dates cal BC). Dates from **Denaire *et al.* 2017.Tab. 2*; Oxford Hinkelstein dates from Trebur (*Spatz 1999.214*).***

The last example relates to the question of the internal chronology of Großgartach in Alsace. Here formal modelling produced a result according to which the typochronological phases could not be established as chronological units[4]. Denaire *et al.* (*2017. 1114*) concluded that "*alternative explanations have now to be found for contemporary variation*". With a bit more scepticism a possible methodological explanation can be found: running separate models with the Oxford, Poznan and SUERC dates (Bruebach-Oberbergen and BORS not included) highlights differences between laboratories (Tab. 2). The Oxford dates are nearest to the usual expectations, with boundaries between main phases 40–70 years earlier compared to SUERC dates (except the end of Bischheim), which on the other hand are the only series in accordance with the typochronology of Großgartach. The reason for the laboratory differences as well as for the lack of chronological differentiation of the Großgartach sequence might admittedly be haphazard, but problems with collagen dates cannot be excluded, which regrettably cannot be checked without ^{14}C dates from botanical material.

In addition, the SUERC dates (Appendices 4–5) demonstrate another factor, the influence of purely mathematical effects on the results, seemingly completely ignored by the authors:

● Comparing the difference between the median of the boundaries (as an estimate of phase duration), there are important differences between a model separating the Großgartach phases and the model taking Großgartach as one phase (Tab. 3; Fig. 3). The question of how fine-grained the development of ceramic styles is differentiated in the regional chronology is of greater importance for the modelled start and end dates of the typochronological units, and even more for the relation between their time spans. This may be an extreme case as the number of dates is quite low, but first experiments with other data sets showed that it is a common effect.

● Even more, sometimes the addition of more phases at the end of a sequence also influences the start date of the whole sequence (Tab. 3). The changes usually seem to be in a range that is at first sight negligible (rarely more than 40 years), but the moment the start or end of the model are inflicted by a plateau the consequences might be quite significant.

● And finally OxCal does not produce absolutely stable results: changing the input order of dates within one phase sometimes slightly changes the results.

Even without laboratory differences the three potential mathematical artefacts identified here further weaken the illusion of 'robust chronologies'.

In the light of the aforementioned problems, the series from Szederkeny should be reconsidered: here the displayed LBK finds show a clear typochronological sequence, from Bíňa in the eastern part (*Jakucs,*

4 Nevertheless Denaire *et al.* (*2017.1128*), claim: "*The radiocarbon dates are in good agreement with the sequences suggested by the seriations in both the LBK and Middle Neolithic periods*", although for the latter this obviously is not the case.

Voicsek 2015.Fig. 10, 11) to a probably late eLBK in the middle (*Jakucs* et al. *2016.Fig. 8, 8.9*) and post-eLBK in the western part (*Jakucs* et al. *2016. Fig. 9, 1.2*; even Notenkopf decoration is mentioned, *Jakucs* et al. *2016.281*). The formal modelling nevertheless shows no chronological difference (*Jakucs* et al. *2016.293–298*). This implies that three or four different typochronological or geographical units of the LBK (earliest phase – Bíňa in the eastern part, Milanovce there and/or in the central part – Notenkopf and Malo Korenovo in the western settlement), plus Vinča A and Ražište are all present at the same time within a few hundred meters, but with restricted contacts between them. Here again the Oxford dates show no sequence of the different parts, whereas modelling only SUERC and MAMS dates (Appendix 6) produces a different picture similar to that developed at Balatonszarszo (Tab. 4; Fig. 4). A sequence for the eastern-central-western part is in sufficient overall agreement with the dates (A = 73). Of course the low number of dates per part of the settlement (and as a consequence that the differences between the laboratories might as well be pure chance) excludes any definite conclusion on the contemporaneity or sequence of the three parts based exclusively on ^{14}C, as both models are in accordance with the dates. Nevertheless we should take into account problems with collagen dates, as seen for the Alsatian Middle Neolithic, possibly based on diagenetic processes and the resulting difficulties in removing later contaminations, as typochronology postulates a sequence.

The two last examples clearly reveal the major methodical deficit of the TOTL project, the refusal to date botanical material for the sake of minimizing taphonomic risks at the cost of lack of control for possible problems with collagen dates.

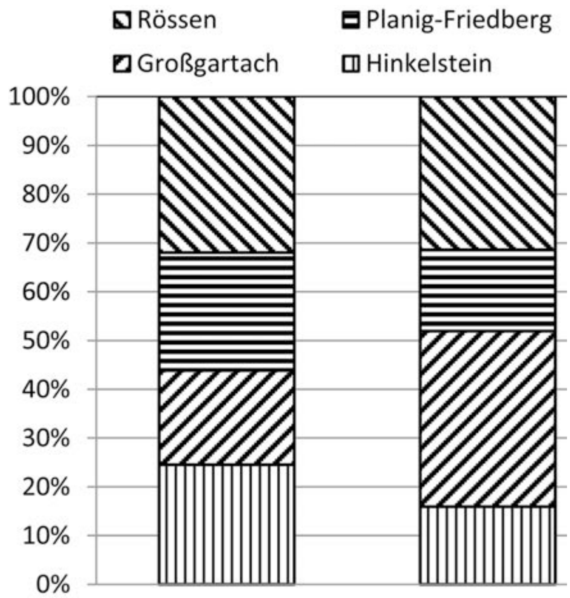

Fig. 3. Percentage of each cultural unit compared to the duration of the whole sequence Hinkelstein-Rössen (SUERC dates only), with (right column) and without (left) subdivision of Grossgartach (visualisation of Table 3, long model without Bischheim).

Given the very small number of dates the question of the start date of the Central European Middle Neolithic will not be discussed here in detail, as a handful of new dates – especially based on botanical material – from early Hinkelstein contexts might change the picture entirely. It should only be remarked, that:

● Even Bánffy *et al.* (*2018.130*) had to admit that there is at least one contact between late LBK and Hinkelstein (Köln-Lindenthal) – the overall number of contacts is irrelevant the moment this single contact is undisputed, so a contemporaneity between late LBK and Hinkelstein cannot be rebutted.

● The alleged "*evidence for contacts between users of late LBK and Hinkelstein pottery*" in the Worms region has never been shown; the cited papers and books did not present anything of this kind, only Walter Meier-Arendt (*1975*) postulates, based on merely typological arguments, a development from LBK IV (!) to Hinkelstein I, a view

	short model: Hinkelstein-Planig-Friedberg		short model: Großgartach-Bischheim		long model: Hinkelstein-Bischheim		difference highest/lowest
all dates calBC	fine-grained	coarse-grained	fine-grained	coarse-grained	fine-grained	coarse-grained	
Start Hinkelstein	4734	4752			4753	4763	29
Hi/Großgartach	4710	4696	4715	4688	4712	4697	27
Großgartach 2/3	4688		4685		4686		3
Großgartach 3/4	4670		4661		4661		9
Großgartach 4/5	4653		4639		4639		14
GG/Planig-Friedberg	4633	4655	4619	4632	4619	4645	36
PF/Rössen	4614	4611	4576	4579	4576	4580	38
Rössen/Bischheim			4495	4495	4495	4494	1
End Bischheim			4265	4252	4267	4256	15

Tab. 3. SUERC dates for Alsatian Middle Neolithic: models with different number of phases and difference fine-grained* vs. *coarse-grained typochronology. Großgartach 1: no dates.

adopted by other authors only by citing it. For the undeniable typological connections between late LBK and Hinkelstein (*Spatz 1996.474–475*) examples from Worms and its immediate surroundings are missing, they are more general late and latest Northwestern LBK – so within the same time range as the 'mixed assemblages' rejected by the authors. Even when interpreted as an evolutionary sequence instead of contacts they are no argument for a hiatus.

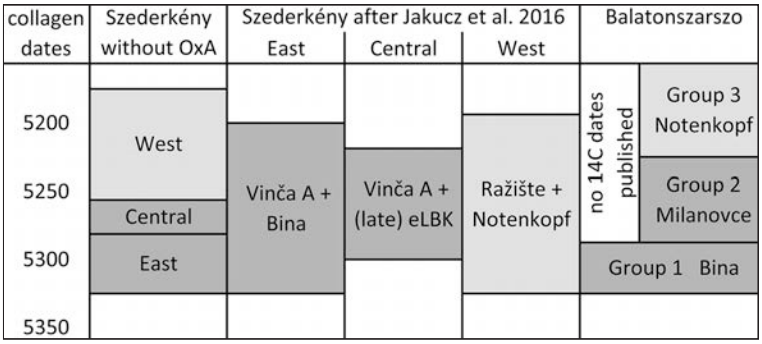

Fig. 4. Two different chronological models for Szederkény (see text; dates cal BC) and the Balatonszarszo chronology (after* Marton, Oross 2012*, ^{14}C dates from* Jakucz *et al.* 2016*).

● A phase 'VI', in any case indispensable to render possible the alleged contacts in the Worms region when postulating a hiatus between LBK V and Hinkelstein in the neighbouring regions, has never been described by any author familiar with the LBK around the estuaries of Neckar and Main[5]. The only inventories of late LBK from Worms which have been claimed to be near the beginning of Hinkelstein (*Meier-Arendt 1972*) can be dated to Phase IV (*Strien 2000.66*).

● The use of CA and more generally the typochronological approach does in no way "*tend ... to gloss over any possible disruptions or hiatuses*" (*Bánffy 2018.131*). This statement reflects an obvious misunderstanding of the two cited articles (*Shennan, Wilkinson 2001*[6]*; Pechtl 2015*), which do not suggest anything like this. In contrast, CA tends to overestimate any disruptions, as experiments with test data sets have shown (*Strien 2000.41–47*). Rapid innovations are such disruptions, causing larger distances on the 1.EV between stratigraphically immediately neighbouring units, as demonstrated at Vinča-Belo Brdo (*Schier 2001*) – a well-known effect that has served for the differentiation of stylistic phases for some decades (*e.g., Schmidgen-Hager 1993.89*), disproving speculations about "*default perspectives of slow change*". It may be remarked that a slow change from the Early to Middle Neolithic has never been discussed, although the question of how to explain the obviously rapid change between LBK and Hinkelstein has been noted (*e.g., Spatz 2003; Strien* et al. *2014.254–255*). And when typological similarities and – be it a single one – contact finds suggest it, continuity is indeed and should be the default perspective compared to a large-scale and long-time hiatus (the whole Rhine Valley and its tributaries, deserted for up to two centuries: *Denaire* et al. *2017.1132, 1136*), especially if the only argument for this hiatus is a handful of ^{14}C dates.

	m	68.3%	95.4%
Start East	5321	5335–5305	5374–5241
East/Central	5286	5309–5268	5311–5238
Central/West	5253	5272–5227	5300–5224
End West	5182	5209–5162	5217–5018

Tab. 4. Szederkèny: median and ranges of the dates (cal BC) of the boundaries between the three parts of the settlement based on SUERC and MAMS dates only.

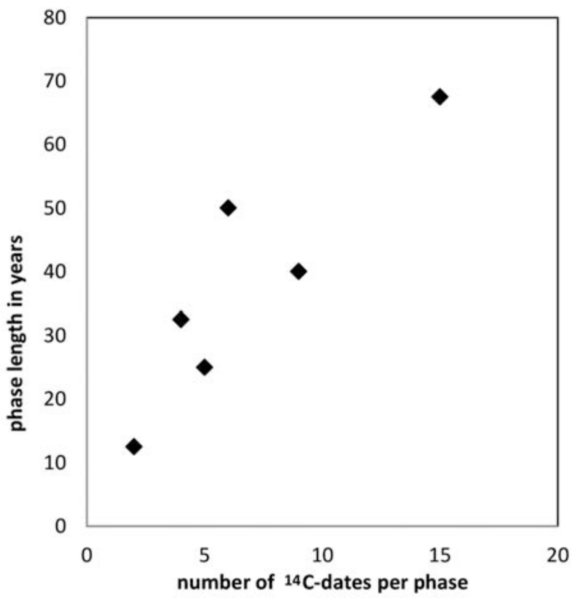

Fig. 5. Correlation between number of ^{14}C-dates per phase and phase lengths of Alsatian LBK (difference between upper and lower boundary; visualisation of Table 5).

5 Phase VI of the chronology (*Lindig 2002*) is synchronized with Phase IVb in Lower Alsace, Phase 8A/B in Württemberg (*Lefranc 2007.Tab. 14*).

6 The observed effects have recently been interpreted as indicators of social diversity (*Gronenborn* et al. *2017; 2018; Peters, Zimmermann 2017*).

A last point to be mentioned is the high degree of confidence in the actual calibration curve demonstrated by the authors. Looking at known problems, *e.g.*, inaccuracies of the calibration curve around the time of the Thera eruption (*Pearson* et al. *2018*) and within the LBK plateau (*Weninger 2019*), a more modest judgement concerning the allegedly 'robust' models would perhaps have been appropriate. The low density of measurements (IntCal13: 483 dates for the range 4050–6050 cal BC), low density of interlaboratory dating, and the extreme smoothing of the IntCal13 curve compared to IntCal98 – all well-known facts – exclude any reliable dating, especially within plateaus. In consequence the idea that the duration of the stylistic phases of Alsatian LBK, all boundaries between them laying within the plateau around the 52nd century cal BC, could be reliably estimated at the actual state is highly dubious, so doubts concerning, for example, the duration of phase IVa2 of "*only 1–15 years (95% probability)*" (*Denaire* et al. *2017.1106*), based on two (!) ^{14}C dates (plus one outlier and two old charcoal dates, another date arbitrarily put to Phase IVa1, as shown above), seem to be neither overcautious nor overcritical but self-evident, even when neglecting the fact that the stylistic phases are found by a CA with its inherent statistical dating errors, consisting of inventories from several sites and different functional and social contexts, with individual filling histories, which makes typochronological divisions at this fine-grained level highly improbable. Even more, further OxCal mathematical artefacts become visible: (1) for unknown reasons the given estimates for the duration (*e.g.*, "*probably for 5–35 years (68% probability)*" for phase IIb; *Denaire* et al. *2017.1104*) are evidently too short, even the sum of the upper boundaries of the 68%-ranges lying slightly below the estimated overall duration (Tab. 5), and (2) there is a correlation between the number of ^{14}C dates per phase and their length according to Bayesian modelling. Using the means of the modelled boundaries between phases for calculation of durations (Tab. 5) the correlation is clearly significant (Spearman's rank correlation coefficient: $r_s = 0.8857$, $n = 6$, $p = 0.01$; Fig. 5); using the above mentioned modelled phase lengths, r_s is even higher (Tab. 5). Oxcal seemingly distributes the dates more or less evenly along the plateau of the IntCal13 curve. Using even numbers of dates per phase would not cure the fault but produce equal phase lengths. A robust estimate of phase lengths in the plateau, using the IntCal13 curve, is mathematically impossible. A completely new model for settlement organisation, based on so slippery ground (*Lefranc, Denaire 2018*) will necessarily be highly speculative and no serious alternative to existing models.

stylistic phases	modelled phase length			difference	number of
	−1σ	mean	+1σ	start/end (medians)	^{14}C dates
IVb	30	50	70	67.5	15
IVa2	1	5.5	10	12.5	2
IVa1	5	15	25	32.5	4
III	15	32.5	50	40	9
IIc	1	13	25	25	5
IIb	5	20	35	50	6
sum	**57**	**136**	**215**	**227.5**	
r_s	0.8571	0.9429	0.9857	0.8857	

Tab. 5. Estimated phase lengths of the Alsatian LBK sequence (after* Denaire *et al.* 2017*), number of ^{14}C dates per phase and Spearman's rank correlation coefficient for the relation number of dates to phase length.

The models of Jakucs *et al.* (*2016*) and Denaire (*2017*), suffering from methodological deficits in the typochronologies on the one hand, and an uncritical attitude towards the reliability of ^{14}C dates and deficits of the present calibration curve as well as a lack of awareness of mathematical artefacts in Bayesian modelling on the other, are far from being 'robust chronologies', as claimed by Bánffy *et al.* (*2018*). A patchwork of contradictory chronologies for different parts of the Danubian sequence in different regions and even at single sites (as shown in Fig. 2) is no chronological model of any explanatory value. The conclusion of the authors concerning the greater effectiveness of "*our collective efforts ... if the strengths of the various approaches reviewed in this paper were to be applied more regularly and more systematically*" (*Bánffy* et al. *2018.131*) can only be underlined. Bayesian statistics will provide a highly valuable instrument for absolute chronology once the main requirements are fulfilled: a precise calibration curve, better control of factors influencing dates, better knowledge of mathematical properties – presently this instrument only produces an illusion of robustness.

Appendices 1–6 are available at
http://dx.doi.org/10.4312/dp.46.13

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New AMS dates from the Sub-Neolithic sites in the Southern Buh area (Ukraine) and problems in the Buh-Dnister Culture chronology

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ABSTRACT – *Ideas about the origin of the Buh-Dnister Culture under the influence of the Danube Early Neolithic were questioned by series of radiocarbon dates falling into the second half of the 7th millennium BC measured on bones at the Kyiv laboratory in 1998–2004. To start addressing this problem, 11 AMS dates on organic inclusions in the ceramic paste and charred residues on the surface of vessels were obtained at the Tokyo University laboratory. Apart from two heavily overestimated values, measured on samples with very low carbon content, they fall into the range of the 60th–46th century BC that correspond better to the primary views of this chronology. However, the issues of the time and direction of spreading of the first pottery in the region need further research.*

KEY WORDS – *Neolithic; Buh-Dnister culture; radiocarbon dating; pottery; stratigraphy*

Novi AMS datumi iz sub-neolitskih najdišč na območju južnega dela reke Bug (Ukrajina) in težave s kronologijo kulture Bug-Dnester

IZVLEČEK – *Zaradi vrste radiokarbonskih datumov, ki sodijo v čas druge polovice 7. tisočletja pr. n. št. in so jih izmerili na kosteh v Kijevskem laboratoriju med leti 1998 do 2004, smo podvomili v zamisli o izvoru kulture Bug – Dnester pod vplivom Donavskega zgodnjega neolitika. Da bi lahko razrešili to vprašanje, smo v univerzitetnem laboratoriju v Tokiju pridobili 11 AMS datumov iz organskih vključkov v lončarskih masah in zoglenelih organskih ostankov na površinah posod. Razen dveh izredno precenjenih vrednosti, ki smo jih izmerili na vzorcih z nizko vsebnostjo ogljika, padejo datumi v razpon od 60. do 46. stoletja pr. n. št., kar je bolj v skladu s prvotnimi stališči o tej kronologiji. Ne glede na te rezultate pa bo potrebno čas in smer širitve prve lončenine v tej regiji še dodatno preučiti.*

KLJUČNE BESEDE – *neolitik; kultura Bug – Dnester; radiokarbonsko datiranje; lončenina; stratigrafija*

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Introduction

The Neolithisation process, defined as the spread of sedentary lifestyle and farming is one of the main issues in prehistory. In Eastern Europe, a key area for its study is the basin of the Dnister[1] and Southern Buh Rivers, which flow into the Black Sea to the east of the Carpathians. There, Neolithic farming incomers from the Balkan-Danube area directly contacted with indigenous groups. The evidence of such interaction, marked in archaeological records from the local sites, became a reason for distinguishing the Buh-Dnister Culture (henceforth, BDC).

To make the timing and the route of dispersal of crops in Ukraine clear a special archaeobotanical project was carried out by a joint Japanese-Ukrainian team in 2016–2019[2]. Within its framework early published information about imprints of cultivated plants on the BDC pottery has been checked. Re-identification using a refined impression method has not found any reliable imprints of cereals and pulses (*Endo* et al. *in prep.*). This confirms that in terms of the availability model of the agricultural transition (*Zvelebil, Rowley-Conwy 1984; 1986*) the BDC bearers should likely be recognised as a community at the availability stage throughout their existence. Therefore, following some researchers (*e.g., Dergachev* et al. *1991*), it would be more correct to call the culture not Neolithic but Para-Neolithic or Sub-Neolithic. These terms have long been used by archaeologists from Poland, Finland, and the Baltic states to refer to hunting-gathering semi-mobile societies manufacturing pottery and polished stone tools. Recently, Oleksandr Gorelik asserts the need for the consistent use of such terms regarding the cultures of 7th–6th millennium BC in the southern part of Eastern Europe (*Gorelik 2019*). Thus, in the mentioned time, the 'real' Neolithic with a farming economy is represented here only by groups of incomers from the Balkans-Danube-Carpathians region, correlated with the cultures of Criş and Linear-Band Pottery, and in the 5th millennium BC the Trypillia Culture.

In the course of the project, the team was confronted with questions about the age of vessels, on the surfaces of which they were looking for the imprints. But, in the case of the BDC, it could not be answered exactly, since both its relative chronology and absolute dates have caused heated discussion during the last two decades. As an attempt to start clarifying this problem, two samples of carbonized crust and nine samples of organic inclusions in ceramic paste have been measured using the AMS method at the Radiocarbon Dating Laboratory of the University Museum of the University of Tokyo.

Overview of the BDC chronology research

The BDC area covers part of both the Southern Buh and the Dnister River basins within the forest-steppe and steppe zones in present-day Ukraine and Moldova (Fig. 1). To date, about 70 monuments of the culture are known there. Only 15 of those are in the Dnister area, the rest are in the Southern Buh area. A few characteristic BDC vessels were also found on some sites of other cultures in neighbouring regions, where they are considered as so-called 'imported' goods. According to the specifics of the material, three local variants of the culture are distinguished – in the Buh forest-steppe area, in the Buh steppe area, and the Dnister area.

Field research and source criticism

Sub-Neolithic materials were discovered for the first time in the Southern Buh area between 1928–1931. But they were not published properly and almost all were lost during World War II. The BDC was distinguished by Valentyn Danylenko during his research in the forest-steppe part of the Buh area in 1949–1961 (*Danilenko 1969.46–174*). The majority of the BDC sites situated on the Dnister riverbanks were researched by Vsevolod Markevich in the north of Moldova in the 1960s (*Markevich 1974*) and Valentin Dergachev, Olga Larina, and Klaus-Peter Wechler in the 1990s (*Larina* et al. *1997; Wechler* et al. *1998; Larina 2006*). Mykola Tovkailo has excavated several BDC sites in the Southern Buh steppe since 1980 (*Tovkajlo 1996; Tovkaylo 2005; 2010; 2014*). Leonid Zalizniak (*Zaliznyak* et al. *2013.194–257*), Dmytro Haskevych (*2006; Gaskevych, Zhuravlev 2008; Czerniak* et al. *2013*), and Dmytro Kiosak (*2016. 137–141; Kiosak, Salavert 2018.120–122*) have investigated the BDC in the Southern Buh forest-steppe in the 21st century.

1 In the article all Ukrainian geographical names and derived names of archaeological monuments and cultures are given according to their writing in Ukrainian, not the Russian commonly used earlier. The same applies to the names of researchers, except for the references. Out of a dozen ways of romanizing the Ukrainian alphabet, the standard adopted by Ukrainian government in 2010 is used here.

2 The work was supported by the Japan Grants-in-Aid for Scientific Research Program (KAKENHI Research Project 16K03166, principal investigator – Eiko Endo).

Most of the researched monuments are located in a river floodplain on the edge of periodically flooded river terraces, or just on riverbanks and islands. Often, they are near mouths of tributaries – brooks and small rivers. A lot of the sites in the Buh area are near river rapids. In those places, rivers break over the granite ridges of the Ukrainian Crystalline Massif forming canyons with steep sides. The shallow but wide and fast rivers flow on among large granite blocks and islands. Such areas are well-suited for fishing. The convenient places on the banks were settled many times. As a result, monuments with thick cultural levels, rich in finds of diverse time and cultures, arose there.

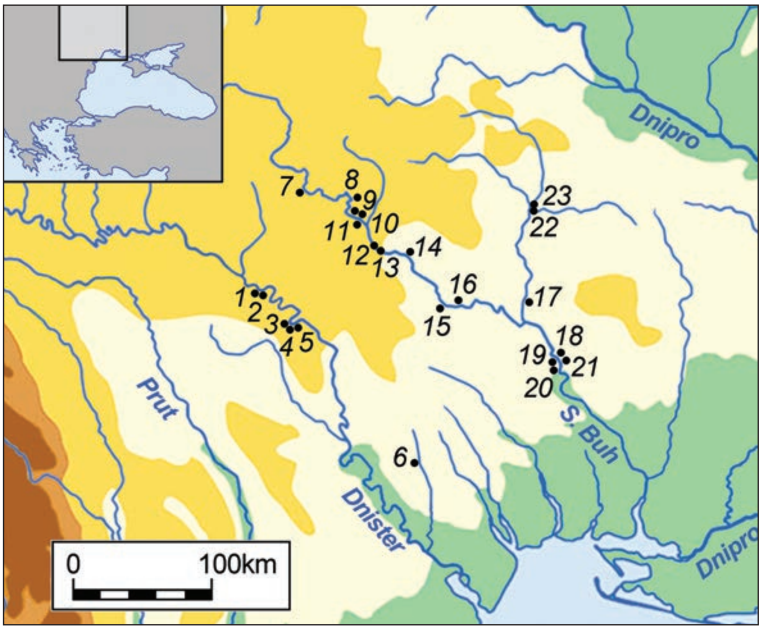

Fig. 1. Map of the ¹⁴C dated BDC sites. 1 Tătărăuca Nouă XIV; 2 Tătărăuca Nouă XV; 3 Soroca V; 4 Soroca II; 5 Soroca III; 6 Hirzhove; 7 Pechera I; 8 Ziankivtsi II; 9 Sokiltsi II; 10 Sokiltsi I; 11 Hlynske I; 12 Mytkiv Ostriv; 13 Bazkiv Ostriv; 14 Shumyliv-Cherniatka; 15 Savran; 16 Melnychna Krucha; 17 Mykolyna Broiaka; 18 Puhach II; 19 Gard III; 20 Gard; 21 Tashlyk II; 22 Dobrianka 3; 23 Dobrianka 1.

The conditions of the rapid parts of the river valleys promote the construction of hydroelectric power stations at such locations. In the BDC area, 13 stations are built on the Buh and its tributaries, and three stations on the Dnister. Constructions of several of these were preceded by archaeological explorations of the terrain before it was submerged. Danylenko's fieldwork was carried out for this reason. As a result, almost all of the important large-scale excavated BDC sites are submerged now. Moreover, many identified but not investigated settlements, as well as the territories most suitable for occupation, were submerged on both the Southern Buh and Dnister. The current excavation by Tovkailo at the site of Gard on the Southern Buh River is being done as it will be submerged in the future, too. In general, the situation reminds us of the loss of the famous original settlements and burial grounds in the Iron Gates area on the Danube, although repeated many times here.

The specificity of the rescue excavations has determined the state of archaeological records. In the Soviet Union, such field works were carried out in a hurry, obeyed the needs of construction, not science. The Soviet mentality of the administration and archaeologists was aimed at obtaining impressive quantitative rather than quality results. As such, scientists frequently preferred the excavation of monuments with the largest number of finds, not possibly more interesting archaeological contexts. Many of those sites are places of continual occupation, oversaturated with mixed materials from different periods. The aim of doing the work more cheaply and quickly uncovering a wide area often led to the excavation of settlements, where the cultural layers lay at a low depth and therefore were heavily damaged by nature and man. Some collections include finds from the surface of absolutely destroyed monuments. In contrast, sites with 'pure' cultural layers poorly loaded by finds, but well-preserved by thick sediment deposits, were investigated in a small area.

Insufficient funding and the atmosphere of haste and negligence in research often led to the involvement of unskilled personnel, non-compliance with fieldwork procedures, and a deficiency of field documentation – lack of drawings of excavations and cross-sections, plans of sites, photos, and depth measurements. Later, this was followed by the loss of a considerable portion of the finds, mainly faunal remains and pottery. The publication of the materials was also incomplete and tendentious. For many sites, no topographical plans, drawings of excavations, figures of the majority of finds, or statistics were provided. Errors and contradictions in records and the ignoring of facts not fitting the paradigms of the time are quite frequent (*Gaskevych 2013.6–9; 2015*). Moreover, archaeologists have been disregarding any critical analysis of the sources for decades and have made their conclusions based on the study of artificially sorted collections and imperfect publications.

The building of hydroelectric power stations has not only submerged many monuments but also changed the water regime of the Southern Buh and Dnister rivers with regard to their stopping spring floods, thus eroding the banks. This has led to covering of the floodplain with trees and bushes. Due to this the discovery of new sites has become more complicated. One of this article's authors has found only a few new BDC sites suitable for excavation during almost two decades of prospecting. The slow accumulation of new applicable materials makes it necessary to work with old collections of destroyed and submerged monuments, despite their imperfections. Therefore, the absolute dating of such sites is an important task for current researchers.

History of absolute dating

The radiocarbon dating of the BDC began at the end of the 1960s when four dates for two monuments located near the city of Soroca on the Dnister River were measured at the Berlin laboratory (*Quitta, Kohl 1969.250*). Twenty years later, a sample from the settlement of Puhach II was measured at the Kyiv laboratory (*Tovkajlo 1996.24*) and a sample from the Hirzhove site at the Leningrad one (*Stanko, Svezhentsev 1988.117*). In 1997–1998, Gliwice and Kiel radiocarbon laboratories provided three conventional and five AMS dates for three monuments from the territory of Moldova, respectively (*Larina* et al. *1997.109; Wechler 2001.29–30*). In 1997–2004, 30 conventional dates of the Buh area sites, investigated in the 1950–1980s, were measured at the Kyiv laboratory (*Videiko, Kovalyukh 1998; Burdo 2002; Kotova 2003.130–133, 139–140; Manko 2006.18–19*). Another 20 conventional dates measured at the Kyiv laboratory and four AMS dates obtained at the Groningen and Oxford ones in 2005–2010 are connected with the recent work at sites Dobrianka-1, Dobrianka-3 (*Zaliznyak, Manko 2004.141, 145; Biagi* et al. *2007.27; Lillie* et al. *2009.260*), Gard (*Tovkaylo 2010.214; 2014.231*), and Tashlyk II (*Fomenko* et al. *2014.Tab. 3*). More recently, two AMS dates have been measured at the Poznan laboratory on charcoal from a new excavation on the site of Melnychna Krucha (*Kiosak, Salavert 2018.122*).

At present, in sum 71 dates measured on samples from the BDC sites have been published (Tab. 1; Fig. 1). Among these, four dates of the so-called 'aceramic' sites Ziankivtsi II and Soroca II, levels 2 and 3, and the bottom level in the Gard site are confidently linked to the Mesolithic. Two other dates measured directly on the early Trypillian pottery from so-called 'syncretic' complex in Gard are confidently linked to the Eneolithic. Eight more dates turned out to be very much older or younger than expected, and are considered 'non-Neolithic' without discussion. They show real cultural stratigraphy in the sites, where finds of different periods are mixed. It should be emphasized, that all the eight were measured at European laboratories (and are almost half the dates obtained there for BDC sites) and were published by European researchers (*Wechler 2001. 29–30; Biagi* et al. *2007.27; Lillie* et al. *2009.260*). In contrast, in a large set of 51 Kyiv dates, clear 'non-Neolithic' values are not present at all. These results are never even mentioned by Ukrainian authors, which is especially suspect. It seems the problem concerning stratigraphy was either unnoticed or carefully hidden by these researchers.

Possible belonging to the BDC as such is thus supposed for only 57 dates, which may be subjected to further analysis. A high limit of the oldest date reaches the 65th century BC, and a low limit of the youngest date the 47th century BC[3]. But there is no concordance of opinion concerning the timeframe of the BDC. After the publication of a large series of Kyiv dates in 1998, the specialists divided into two opposing camps. This cleavage was deepened by new Kyiv dates over the next decade. One camp approved the dates pointing to the 60th–47th centuries BC, measured abroad and at the Kyiv laboratory before 1998. And the other thinks that the set of new Kyiv dates, measured since 1998 and pointing to the 65th–50th centuries BC is right. The terms 'old chronology' and 'new chronology' thus began to be used in publications. The reason for scepticism regarding the 'new' dates is not only their inconsistency with the time of the BDC start and end measured at the European laboratories, but their inconsistency with the relative chronology of the culture, too.

Relative chronology

The first BDC periodization was proposed by Danylenko (*1969*). He divided the culture into seven phases, grouped into three periods (Tab. 2). In constructing this scheme he relied on the specificity of the pottery, which was regarded as the main chro-

3 All ^{14}C dates in the article are calibrated using software OxCal v 4.3.2 (*Bronk Ramsey 2017*) and the IntCal13 atmospheric curve (*Reimer* et al. *2013*) and given a 95.4% confidence level (2σ).

nological marker. But his criteria for pottery grouping are often incomprehensible, since clear definitions of types were substituted for description of a few of the brightest vessels or generalized descriptions of some ceramic group from the monument that was becoming eponymous. The earliest Ziankivtsi non-pottery phase is associating with the late Mesolithic now. Two other phases, the Sokiltsi and Khmelnyk, looked somewhat unconvincing even in Danylenko opinion (*Danilenko 1969.150–151*). Soon after they were disproved by the majority of specialists (*e.g., Tringham 1971.97, 100–101; Telegin 1977.89*). Thus, somewhat schematically, the periodization scheme proposed by Danylenko consists of a sequence of four variant of pottery.

The Skybyntsi type pottery was correlated with the earliest BDC period. Typically it is made in a truncated egg-shape and decorated by parallel incised lines forming wavy bundles and meander patterns filled with incised crosshatching or stroke impressions. According to Danylenko, their common features are the use of silt paste containing organic fibres and coarse shell fragments, as well as their pointed bottoms. These were considered as evidence of their eastern, Azov-Caspian steppe origin in a time before Balkan influences had reached the region (*Danilenko 1969.150–151*).

The next period was characterized by pottery of the Pechera type. These vessels are made of ceramic paste of the same composition but have a flat base. Their relatively late age was determined by similarity to the Criş pottery from Romania, due to their globular and elongated globular shapes, surface treatments, decoration with pinches, fingernail impressions and various plastic applications as a rule combined with incised zigzag patterns. Their synchronous development was supported by discovering at sites of Pechera I, Sokiltsi VI, and Hlynske I, where a number of burnished Criş-like vessels made of fine-structure paste has been documented (*Danilenko 1969.152–153*), which are now interpreted as real Criş 'imports' (*e.g., Wechler 2001.274, 275, 278*).

According to Danylenko, the Pechera pottery was replaced by the Samchyntsi type vessels. They are characterized by a pointed or round bottom, the presence of gravel and stones in the ceramic paste, decoration by imprints of various notched and comb-like stamps, as well as the lines scratched by them. He thought that the origin of the Samchyntsi tradition was linked to the Eastern European forest zone. Its time of appearance was correlated with the 'music-note' phase of the Linear-Band Pottery Culture (henceforth, LBPC), because of the finding of numerous Samchyntsi vessels and two LBPC bowls at one depth in the Bazkiv Ostriv site (*Danilenko 1969.66, 156, 207*).

The Savran type pottery, correlated with the latest period of the BDC, was indistinctly defined by Danylenko as characterised by flat and pointed bottoms as well as "*almost unlimited domination of an impressed linear decoration*" (*Danilenko 1969. 154*). When describing finds of the Savran period, Danylenko did not mention the materials of other cultures among them. Thus, he justified their late age only by stratigraphic observations at the monuments of Bazkiv Ostiv, Mytkiv Ostriv, Sokiltsi II and Ziankivtsi II.

Later, six other periodization schemes for the whole culture or its local variants were proposed by Ruth Tringham (*1971.97*), Dmytro Telehin (*Telegin 1977. 90*), Klaus-Peter Wechler (*2001.30–31, 52–54*), Markevich (*1974.127–143*), Nadiia Kotova (*2003.30–32*), Tovkailo (*Tovkaylo 2014.235–239*), Ihor Sapozhnikov and Halina Sapozhnikova (*Sapozhnikov, Sapozhnikova 2005.92*). However, they consisted mainly of the renaming, correction and mechanical merging of Danylenko's phases and periods (Tab. 2). But they did not touch on the basic sequence of his scheme, which was agreed by all the researchers. In a maximally general view, this erupted into the common belief that the dominant type of admixture in clay divides the BDC sites in the Buh area into two groups: the earlier with numerous vessels tempered by coarse shell, and the later with isolated cases of its use or without such pottery. Ultimately it was reflected in the simple two-part periodization (*Kotova 2003.30–32*). The difference in the researchers' views is the synchronization of the neighbouring cultures with BDC pottery types, as well as indirect absolute dating of the lasts.

Indirect absolute dating of the pottery types

The analysis of publications allows us to distinguish two approaches to indirect absolute dating of the BDC pottery types. They are different by the source of the radiocarbon dates used.

The external approach leans on the pottery typology and the finds of mutually 'imported' vessels. On the basis of the latter, radiocarbon dates of corresponding neighbouring cultures are projected to the BDC sites. This method arose long ago, and was the only one possible before the beginning of the mass radiocarbon dating of BDC. Its followers synchronize the Skybyntsi and Pechera pottery with the Criş materials from Moldovian and Romanian sites, dated to the range of the 59th–54th centuries BC. Vessels of the Samchyntsi type are synchronized with LBPC sites, dated to range of 54th–50th centuries BC, and the Savran type initially with LBPC, and then with early Trypillya settlements, which start appearing *c*. the 48th century BC in Ukraine. The origin of the culture is linked by supporters with the Balkans-Danube region (*Tovkaylo 2005.44–49; 2014.235–239; Gaskevych 2007; Zaliznyak* et al. *2013.249–250*).

The internal approach leans, first of all, on the mass series of the 'new' radiocarbon dates measured on bones and projected onto certain groups of BDC pottery. But the basis of this approach is the same traditional conception about the sequence of the pottery types. Thus, its followers project the high dates of the 7th millennium BC onto the Skybyntsi and Pechera vessels, and low dates in the range the 59th–53th centuries BC onto the Samchyntsi and Savran ware. Consequently, the first two types are considered by them as preceding the Criş Culture, and the second two as synchronous with the Criş and partially LBPC (*Kotova 2003.30, 56*). In fact, these researchers have just shifted the whole traditional sequence of pottery types several centuries deeper. Logically, they and their adherents support the idea of the non-Danube origin of the culture, since the Neolithic dated to 6400 BC is not found to the west (*e.g., Reingruber 2017.93–94*).

Followers of the first approach criticized the second one because of the well-known presence of typical Pechera pottery at Criş settlements of Moldova, dated to the middle of the 6th millennium BC (*Dergachev, Larina 2015.176–180*), as well as discovering the typical LBPC pottery together with the Samchyntsi and Savran vessels on the BDC sites of Bazkiv Ostriv (*Danilenko 1969.66*), Shchurivtsi-Porih (*Gaskevych 2008b.170*), Dobrianka-3 (*Zaliznyak* et al. *2013.234*), Gard (*Tovkaylo 2014.201–202*), Tătărăuca Nouă XV (*Larina 2006*), and vice-versa, the BDC pottery on the LBPC settlements of Maynova Balka (*Larina* et al. *1999.27*), Ruseştii Noi I (*Markevich 1973.25*), and Gura Camencii VI (*Larina 1999. 104*). But these researchers could not explain the 'new' Kyiv dates pointing to the beginning of the BDC being around the middle of the 7th millennium BC, before the start of Neolithisation in the Danube-Prut region; and its ending before the beginning of the Precucuteni-Trypillya Culture. Therefore, they questioned the validity of the 'new' Kyiv dates as such. Afterwards, this distrust extended to all dates from the Kyiv laboratory, although many of them do not contradict the measurements of other laboratories and synchronization data. The situation has come to a standstill, and one way out could be an attempt to re-view the BDC periodization, as well as the direct dating of vessels of various types.

Attempts at revising the traditional views

In the early 2000s, one of this article's authors was a follower of the external approach and one of the steady critics of the 'new' Kyiv dates (*Gaskevych 2007*). But his excavation, collating of the old collections, a study of archaeological context and the typological analysis of finds have enabled him to try transforming some of the traditional views concerning the BDC to eliminate the inconsistency in its dating.

First, all of the available finds of vessel bottoms from the Southern Buh monuments were analysed (*Gaskevych 2008a*). It was established that in fact among the pottery attributed by Danylenko to the Skybyntsi type only one pot from the Bazkiv Ostriv site has a pointed bottom. It is made of paste without shells and adorned with meander decoration. It has reaffirmed the unlikely nature of chronological opposition of the Skybyntsi and flat-bottomed Pechera types (*Telegin 1977.90; Wechler 2001.52*) that allowed considering of all the vessels with coarse shell inclusions as synchronous with the Criş settlements in Moldova. On the contrary, all the Samchyntsi type vessels turned out to have pointed and round bottoms. Since analogies to these are absent in the Danube Neolithic, a question about distinguishing a specific tradition (or even culture) with a genesis different from the BDC, and an area wider than its own, was raised (*Gaskevych 2008a; 2008b; 2010; 2011*).

Second, re-excavation of two 'classical' sites on both the Buh (Pechera I) and the Dnister (Tsekynivka) was carried out (*Czerniak* et al. *2013*). The results and critical consideration of the archaeological context from old excavations testified to the poor state of cultural stratigraphy on most BDC monuments. No reliable closed contexts such as pits or semi-subterranean houses have been documented in the Southern Buh area. Vessels of different types are spaced apart planigraphically, which does not allow us to assert a sequence of their getting in sediments at some monuments, which were published as 'well-stratified' before (*Gaskevych, Kiosak 2011.202; Gaskevych 2017a.88–90*). But in most cases, they lay mixed (*Gaskevych 2013.11–13*). Consequently, the bones used for radiocarbon dating were frequently found next to the pottery of different types (*e.g., Gaskevych 2017c.200–201*).

The observation of real cultural stratigraphy has allowed us to assume that the high measurements on bones do not date the Criş-like Pechera vessels, but the round-bottomed Samchyntsi ones decorated with a comb. Since the presence of domesticates in the BDC was generally not questioned a decade ago, analogies were looked for in the southern Mediterranean. There, pottery similar to the Samchyntsi and dated before the 6th millennium BC is in the Middle East (*Balossy Restelly 2006*) and Northern Africa (*Jesse 2010*). Therefore, a hypothesis about the marine expansion of the earliest Impresso traditions to the North-Pontic region in the period preceding Balkanization was put forward. This was facilitated by the discovery of pottery with *Cardium* decoration and an admixture of the valves of brackish water ostracods *Ciprideis torosa littoralis* (Brady 1864) in the collections of some BDC monuments (*Gaskevych 2010; 2011; Tovkaylo 2012*). Consequently, it was assumed that the pointed- and round-bottomed comb decorated vessels were one of the first types of pottery in a significant part of the territory of Ukraine and became one of the main background pottery types there. In the contact zone with the western agricultural population, the traditions of Criş, Alföld, Vinča, Dudeşti cultures influenced it at different times. They determined the appearance of various local decoration styles (but not phases) such as the Skybyntsi, Pechera, Savran, and some other nameless ones.

Afterward, the almost complete absence of Southern Buh forest-steppe Mesolithic monuments has attracted attention. The only exception is the late Mesolithic level in the Ziankivtsi II site (*Danilenko 1969.90*). Its 'new' radiocarbon date points to the same range as the most ancient Kyiv dates of the BDC settlements Sokiltsi II, Bazkiv Ostriv, Mytkiv Ostriv, and Pechera I. Therefore, it was assumed that late Mesolithic finds could form palimpsests with slightly younger finds of the BDC on those and some other sites (*Gaskevych 2012; 2014.10*). A series of characteristic flint tools of the Late Mesolithic Kukrek Culture, which were discovered there earlier (*Gaskevych 2005; 2012*), support this conclusion. It logically explains the early Kyiv measurements of the BDC without a far-fetched hypothesis about the very early marine diffusion of Impresso pottery. So, the latter could start in the North-Pontic area synchronously with the Northern and Western Mediterranean in the 6th millennium BC.

Thus, the state of the majority of sources allows the creation of various explanatory models correlating different types of finds with any dates on bones and demolishing traditional views concerning the origin and development of the BDC. Under these circumstances, almost the only way one can avoid speculation and check the existing chronology and periodization as well as the suggested hypotheses is direct radiocarbon dating on pottery.

Direct radiocarbon dating on pottery

Today, the 16 conventional dates on organic inclusions in 15 pottery samples from four BDC monuments (Dobrianka-1, Dobrianka-3, Gard, Hirzhove), and two AMS dates on carbonized crust on the surface of one vessel from the Tătărăuca Nouă XV site, have been published. Of these, the last two were measured at the Kiel and 16 other at the Kyiv laboratory. Unfortunately, a detailed description of the decoration and ceramic paste composition, as well as a well-reasoned attribution to some type of pottery, is not given for all samples. The too large standard errors (±140–230 years) of some measurements seriously diminish their utility. But even these dates allow us to question the established views on the relative and, partially, absolute chronology of certain pottery types, and the BDC as a whole. In this sense the dates for the sites of Gard, Dobrianka-1 and Hirzhove are very significant.

The settlement and burial ground of Gard, located in the steppe Southern Buh region, were excavated by Tovkaylo over the last 12 years. He identified two BDC horizons, separated by a 'relatively sterile' layer on some part of the monument's area. The researcher believes that the lower horizon is characterized by the finds of 'early Neolithic' pottery of the Pechera type, which he typologically synchronizes to phases III and IV of the Criş Culture, according to its subdivision by Gheorghe Lazarovici (*1984*). But an LBPC vessel with the 'music-note' decoration was also found there. The upper horizon he characterizes by the finds of 'Late Neolithic' pottery of the Savran type, as well as of the early Trypillia pottery of the Sabatynivka II type (*Tovkaylo 2014*). Two dates of the second to third quarter of the 6th millennium BC were measured on the samples of the 'early' BDC pottery, one of which (Ki-14789) is made of paste with coarse shell fragments. The dates on three samples of the 'late Neolithic' pottery pointed to the same time range (Tab. 1). The location of the 'early' sample Ki-14790 and the 'late' one Ki-14791 in the same square and depth (*Tovkaylo 2010.Tab. 2*) also indirectly confirms at least partial synchronization of the measured vessels of the Pechera and Savran types.

The site of Dobrianka-1, located in the Sinyuha River basin between the BDC and Kyiv-Cherkasy culture areas, was investigated by Zalizniak's expedition in 2001–2006. A representative flint complex of the Mesolithic Kukrek culture and fragments of no less than 10 vessels with some characteristics of pottery from steppe BDC sites were found there. The stratigraphic position of the Sub-Neolithic materials is uncertain (*Zaliznyak* et al. *2013.195–214*). The fragments of two vessels – one with two-pronged stamp impressions and other with a pointed bottom and gridlines decoration – were measured for the dates Ki-14798: 6880±90 BP and Ki-14799: 6730±90 BP, respectively (*Manko 2013.216; 2016.271, 278*). The age of the first sample, attributed to the Samchyntsi type (*Zaliznyak* et al. *2013.214, Fig. 14.6*), turns out to be older than the Pechera and Savran type pottery from the Gard site, and the second one coincides with them in time.

The settlement of Hirzhove is located on the Kuchurgan River (left tributary of the Dnister River) in the steppe zone. It was excavated by Pavel Boriskovskiy and Volodymyr Stanko in 1961–1963. They represented the site as a classic monument of the Late Mesolithic Hrebenyky culture. But the 'Neolithic horizon' with characteristic geometric microlithics and some fragments of BDC pottery with comb impressions, which were referred by Danylenko to the Samchyntsi type, is mentioned in publications, too (*Stanko 1966; 1967*). Two 'new' Kyiv dates that fall into the last quarter of the 7th millennium BC were measured on the same potsherd in 2004 (*Manko 2006.19*). They were used as one of the rationales for the early appearance of the Samchyntsi type pottery in the region (*Gaskevych 2011.282*).

Re-publishing of the site by Vladyslav Petrenko proved the finds of all periods lay mixed at a depth up to 0.5m in the soil layer disturbed by deep ploughing. One fragment of the LBPC vessel and more than 100 potsherds of BDC pottery were attributed by Petrenko in the collection. Description and drawing of the measured sample, published for the first time, has shown that the potsherd is adorned with a double line and a parallel row of simple impressions (*Petrenko 2012.235–236, Fig. 4.1*). This decoration is not typical for the Samchyntsi style, and this rather shattered the idea about the antecedence of pottery with comb impressions in the Northern Black Sea area.

Thus, if we consider the direct dating on only more-less well-published pottery samples, the earliest is measuring on the vessel of an unattributed type from Hirzhove. Somewhat younger are the Samchyntsi vessels from Dobrianka-1. Vessels with some Criş characteristics and coarse shell fragments in the paste from Gard are, as expected, synchronous with the Criş sites of Moldova and dated back to the middle of the 6th millennium BC. The Savran pottery from Gard also points to this time.

The above dates are contrary to all periodization schemes of the BDC created over a half-century. Therefore they have been met with disapproval and been ignored by most followers of both external and internal approaches. The first justify this by scepticism about the Kyiv laboratory, where the dates were measured (*Zaliznyak* et al. *2013.249; Tovkaylo 2014*), and the second by the unreliability of the measured material (*Kotova 2015.13*). Doubts about the reliability of measurements in the Kyiv laboratory can easily be verified by dating in other laboratories, as is done later in this article. But the disadvantages of direct dating on pottery are well-known and it cannot be overcome. Therefore, possible distortions of the real age of the samples should be taken into account.

Sample description

Eleven samples – nine fragments of pottery with organic inclusions in the paste and two charred residues on the pottery surface – were selected from collections of three sites.

Shumyliv-Cherniatka

The monument is situated at 48°29'17.69"N, 29°40' 33.54"E on the high part of the floodplain on the left bank of the Southern Buh River between the villages of Shumyliv and Cherniatka (both – Bershad district, Vinnytsia region) near large rapids. It was investigated by Danylenko in 1960. The surface was heavily destroyed by the construction of a hydroelectric power station dam. According to published data, an area of more than 300m^2 has been uncovered. A few clusters of the Sub-Neolithic and early Trypillia materials lay at a depth of 0.5–0.8m in a layer of "*dense grey-green loam*" treated by the researcher as "*ancient meadow-type soil*" (*Danilenko 1969.121–125*).

According to our preliminary calculations, the collection stored in the Institute of Archaeology of NAS of Ukraine now includes 450 potsherds of roughly dozen Sub-Neolithic pots and 314 fragments of no less than 19 early Trypillian vessels, 303 knapped flints, two not flint pebbles, and two pieces of bones. Where the other 1397 intact and broken animals' bones and seven processed bones mentioned in the field documentation are stored is unknown. Perhaps they are lost.

Danylenko attributed the site to the Savran phase (*Danilenko 1969.121*).

This monument has been chosen for sampling because it allows us to check widespread views about the partial synchronism of the late BDC and early Trypillia culture (*e.g., Tringham 1971.167–168; Tovkaylo 2005.39, 40*). Second, a fragment of BDC vessel with an extremely rare carbonized crust has been found in the collection.

Two samples taken from the site collection have been measured.

Shum 1t
The sample is a fragment of a wall (field inventory No. 183, square 26G, without depth mark) of the vessel, which is represented by 128 fragments stored in the collection. The vessel was probably a pot with a cylindrical upper body of about 30cm diameter, and inverted conical bottom part. The rim is slightly everted. The lip is rounded, straight. The bottom is missing. The wall thickness is 0.6–0.8cm. The pottery paste contains a lot of sharp-cornered gravel (up to 0.6cm), sand and organic fibres as well as a little crushed shell (up to 0.6cm). The outer surface is light reddish brown, pale red, grey, very dark grey. The inner one is very dark grey, pinkish grey, light reddish brown, grey. The colour of the fractures is various, irregular. Both faces of the rim are roughly smoothed with a notched tool that left characteristic traces in many places. The body is smoothed better. No decoration is observed on the preserved part of the vessel (Fig. 2).

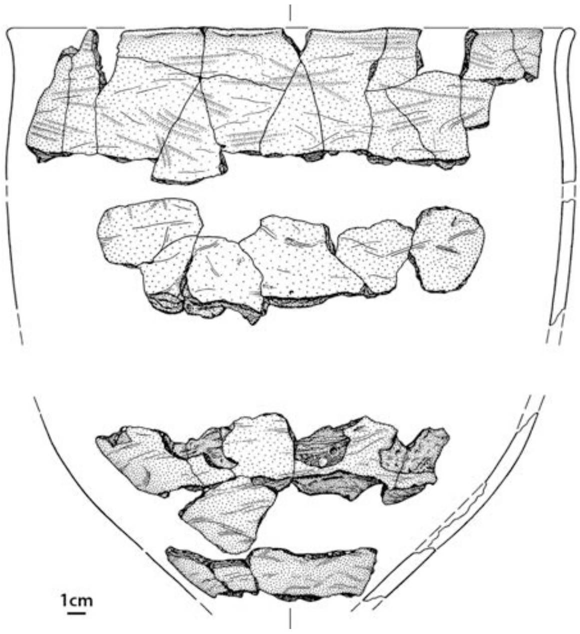

Fig. 2. Chumyliv-Cherniatka. Vessel, dated by samples Shum-1c and Shum-1t.

Shum 1c
The thin coat of charred organic residue in the form of two dark brown spots, each less 1cm^2 large, was scraped off the inner surface of the potsherd, which is the sample of Shum 1t.

Hlynske I
The site situated roughly at 48°44'27.19"N, 29°5' 14.55"E is now flooded by waters of the Ladyzhin hydropower station reservoir. Neolithic finds were collected by Pavlo Khavliuk and Danylenko on the surface of a more than 100m part of the right lower (about 3m high) terrace of the Buh River, to the south of the Hlynske village (Nemyriv district, Vinnytsia region) in 1955 and 1957. They cleaned section of steep terrace edge 35m in length in 1957. That year, two small trenches (Complex 1 on 22m^2 and Complex 2 on 6m^2) were investigated at opposite ends of the cleaned area.

All the sources about the monument are Khavliuk and Danylenko's field documentation and a very incomplete description in Danylenko's monograph (*1969. 105–107*). The collection is stored in the Institute of Archaeology of NAS of Ukraine. Its Sub-Neolithic part consists of 160 fragments of 16 vessels, 82 flint artefacts, one bone tool, and six animal bones. A comparison of the finds and field records shows the presence of almost all the pottery and flints, but most of the bones are missing.

The pottery is subdivided into three types: the Samchyntsi, Pechera, and Criş-like. The location of vessel fragments discovered on the surface was described very roughly, and the stratigraphic sequence of different type pottery from trenches has not been recorded. Thus, both Danylenko's statement that the Hlynske I is a stratified settlement with the Pechera and Samchyntsi phases of occupation (*Danilenko 1969. 107*), and the note about the site 'bottom layer' repeating by Kotova (*2002.22; 2003.30; 2015.40, 41,* *102*) are in fact unfounded. However, the absence of the Samchyntsi type pottery in the relatively well-preserved Complex 1, uncovered in a layer of yellow loam at the of depth 3.1m, was strictly ascertained (*Danilenko 1969.106; Gaskevych 2017a.107*).

Complex 1 in the monument of Hlynske I has been chosen for sampling because two vessels very similar to Criş-Körös fine pottery or even imported from the area of that culture were found there. Their shards lay around stone fireplaces close to the fragments of the Skybyntsi and Pechera type vessels (Fig. 3). This allows for checking the possible synchronism of the mentioned types of pottery.

Two sampled potsherds from the site have been measured.

Hlyn-2t
The sample is a fragment of a wall (collection inventory No. 93, field inventory No. 9, Complex 1, square 2–3/a, without depth mark) of vessel 16. There are five debris of this vessel in the collection. All were found in a compact cluster in marginal squares in the Complex 1 and the outcrop of a fluvial terrace edge. The largest fragment lay on the stone fireplace in square 1/a (Fig. 3). The vessel can be reconstructed as a biconical bowl with a pronounced body corner. The maximum diameter is 15cm; the height of the extant part is 10.5cm. The rim is vertical, slightly thinned; the lip is rounded, straight. There are remnants of a broken pedestal foot base on the bottom surface. As far back as Neolithic times fractures of the pedestal were rasped off to make the vessel steady. The wall thickness is 0.5–0.9cm. The pottery paste is soapy and flaky. It consists of clay, containing a small amount of organic matter and very fine slightly micaceous sand. The external surface was smoothed, covered in slip and burnished. But now it is eroded off in many places. Its colour is dark grey, brown, very dark greyish brown, black. The inner surface is smooth; very dark grey, black. The fractures are dark grey. Decoration – hardly observable knobs on the body corner (Fig. 4). In the late 1950s the vessel was reconstructed in an artisanal way. In this process, some part of the surface was washed off and treated with abrasive.

Hlyn-3t
The sample is a small decorated fragment of a wall (collection inventory No. 51, field inventory No. 8, Complex 1, square 4/b, without depth mark) of vessel 7. In the collection, this vessel is represented by 21 fragments. They were found within the whole area of Complex 1 as well as in the outcrop and cleaning of the terrace edge. Probably, the vessel had a cylindrical body with a maximum diameter of about 20cm. The rim is outwardly thinned and slightly inverted. The lip is rounded, straight. The bottom is missing. The wall thickness is 0.8–1.2cm. The pottery paste is well-kneaded. It contains small amounts of coarse fragments of shells (up to 1.0cm) and vegetable fibres. Both surfaces are smooth, with remains of burnishing preserved in some places. The colour is light reddish brown and pinkish grey with greyish brown spots. Fractures are black. The vessel is decorated with zones, contoured by curved both superficial impressed and deeply cut lines 0.1–0.2cm thick. The row of densely arranged pits imprinted by a tubular stamp of 0.4cm diameter is along the lines from the outside of zones. The surface within these zones is filled with a grid pattern drawn with diagonal lines of the previously mentioned nature (Fig. 5). The figure, which these zones form, cannot be recognized. Perhaps, it is irregular like on a well-known pot from the Mytkiv Ostriv site (*Danilenko 1969.Fig. 33, 34.2; Wechler 2001.Taf. 5.5*).

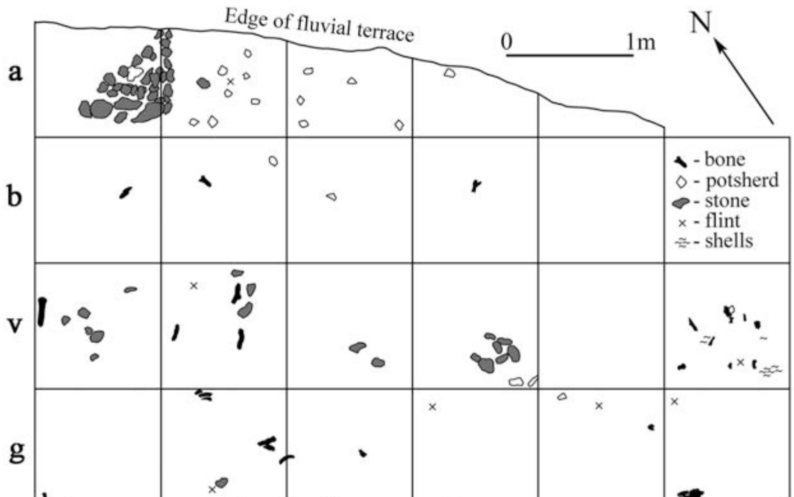

Fig. 3. Hlynske I. Plan of the Complex 1. According to Danylenko's field drawing.

Bazkiv Ostriv
The monument situated roughly at 48°33'06.72"N, 29°21'30.27"E is now submerged by waters of the Hlybochek hydropower plant reservoir. It was investigated by Danylenko on the same name is-

land to 3.5m high in the middle of a rapid part of the Southern Buh River near the village of Skybyntsi (Trostianets district, Vinnytsia region) in 1959. The site description, published by Danylenko, is very brief. The pottery of the Skybyntsi, Samchyntsi and Savran types, each associated with a distinct layer, were recorded by him there (*Danilenko 1969.62–69*). Later Kotova considered the site as the best in the BDC owing to the representativeness of its collection and accuracy of its stratigraphy, although she distinguished only two cultural layers there (*Kotova 2003.26–29*).

All available sources regarding the site have been re-analysed recently (*Gaskevych 2017c*). An area of over 300m² was investigated there during a mere 28 workdays. The Sub-Neolithic materials were found in a layer of sediment described by Danylenko as 'yellow-grey loess-silty loam'. It was of different thickness and occurred at varying depths in different parts of the monument. The excavated area of a total of 247m² was drawn on the plans including marks of 3381 finds – 1353 fragments of pottery, 487 flint artefacts, 1509 bones and bone tools, 32 shaped and not-shaped stones of not-flint rock. But today, the settlement collection stored in the Institute of Archaeology of NAS of Ukraine consists of only 1403 labelled items including 701 fragments of 90 vessels, 665 flint and three not-flint stone artefacts, 34 animal bones, bone and antler tools. Another 375 intact and broken bones of animals and fish are stored in the Palaeontology Department of the National Museum of Natural History of NAS of Ukraine. However, the lack of field labels reduces their value for analysis. The rest of the materials are considered lost.

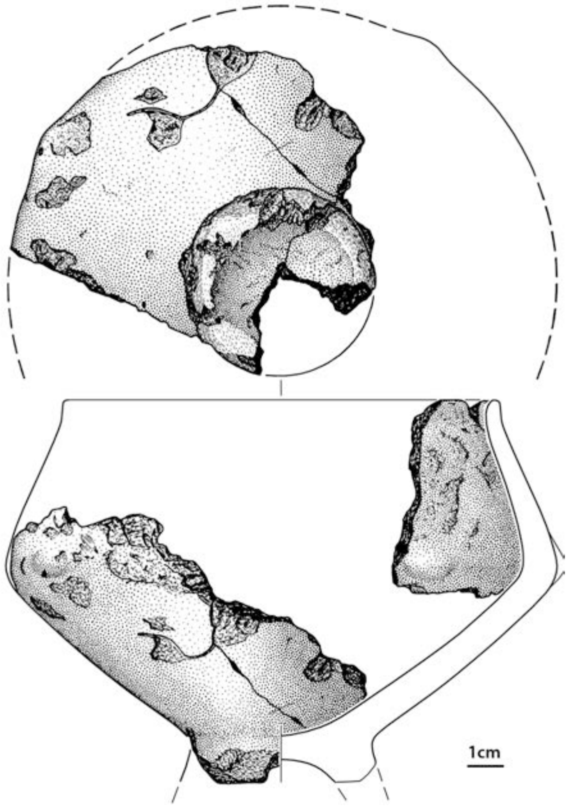

Fig. 4. Hlynske I. Vessel 16 dated by sample Hlyn-2t.

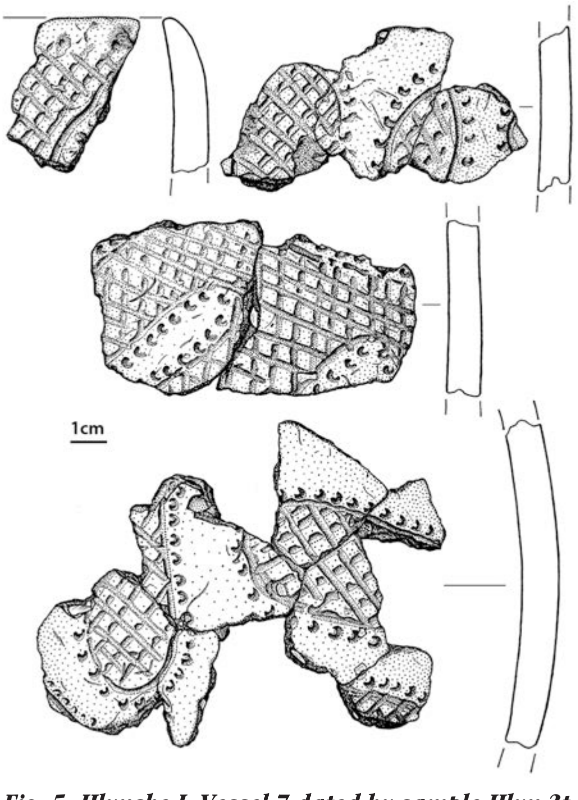

Fig. 5. Hlynske I. Vessel 7 dated by sample Hlyn-3t.

A comparison of nine stratigraphic sections of the trenches allows two important conclusions. The first – a slight declivity of the ancient surface is recorded on the settlement. The second – because of the absence of precise topographic instruments all depths were measured from the datum line, drawn on different walls of the trenches at varied absolute depths. So, nominally identical depths of finds from different parts of the site may in fact (along the absolute calculations) also be different. Thus, a vertical sequence of finds from various depths measured from only the same drawn datum line is correct.

Because of the above, the site stratigraphy has been analysed from the number of finds marked on the field drawings, for each of nine zones numbered from II to X and representing stages of increasing the excavation area (Fig. 6). A small area of each zone allows disregarding the natural declivity of the ancient surface, and the use of the same datum lines allows comparing the depths of finds more or less reliably. The number of finds from different depths shows a possible presence of three horizons of concentration increase – two with pottery (Sub-Neolithic) and one non-pottery (Mesolithic). No 'sterile' layers between them have been recorded.

The different estimated ages of the two possible ceramic layers in Bazkiv Ostriv suppose the typological difference of their pottery. The depth of only large available fragments has been taken as the criterion for linking vessels to excavation levels. This approach is based on two postulates: the position of larger potsherds in sediments is more stable; impacts of the forces which move fragments in sediments break them at the same time (*Tsetlin 1991. 27*). So, 93 potsherds larger 20cm^2 have been analysed. They represent 31 BDC, 1 LBPC, and 4 Trypillian vessels.

The analysis results have shown the arising of two recognised ceramic horizons at some zones owing to the way of recording the depth of the finds. In other zones, differences in the pottery types from both horizons are absent or not detected due to the loss of most shards. Thus, the presence of evident cultural layers mentioned by Danylenko and Kotova has not been confirmed. Instead, considerable mixing of materials, attributed by them to different periods of the culture, has been established. The recorded vertical sequence of the compact clusters of several vessel shards contradicts traditional views concerning a sequence of the BDC pottery types. It is in concordance with the organic combining of technological and decorative characteristics, traditionally attributed to the different periods, noted for some vessels (*Gaskevych 2017c.199*).

The site of Bazkiv Ostriv has been chosen for sampling because fragments of two LBPC vessels were found there. It allows checking Danylenko's views about the synchronism of the 'music-note' wares and Samchyntsi pottery (*Danilenko 1969.66, 154*). Second, a series of seven radiocarbon dates on animal bones was measured for the site at Kyiv laboratory in 1998 and 2000 (*Telegin* et al. *2000; Kotova 2002*). It allows comparing the results obtained on different materials at different laboratories.

Seven samples taken from the site collection have been measured.

Bazk-4t
The sample is a decorated fragment of a wall (without inventory No., square B'/5, depth –1.03m) of vessel 23. There are only six fragments of this vessel in the collection now. Half of them were found in square B'/5 in zone VI at a depth of 1.03m (Figs. 6, 7). But a compact cluster of 15 potshards is marked in this place and depth on the field plan. Probably the vessel was a semisphere shape. The rim of about 18cm diameter is slightly tapered. The lip is rounded, and, in some places, flattened. The bottom part is missing. The wall thickness is 0.7–0.9cm. The pottery paste contains an admixture of organic fibres, waterworn fine sand and a large amount of shell fragments (up to 0.8cm). The outer surface is well smoothed; dark reddish grey, greyish brown

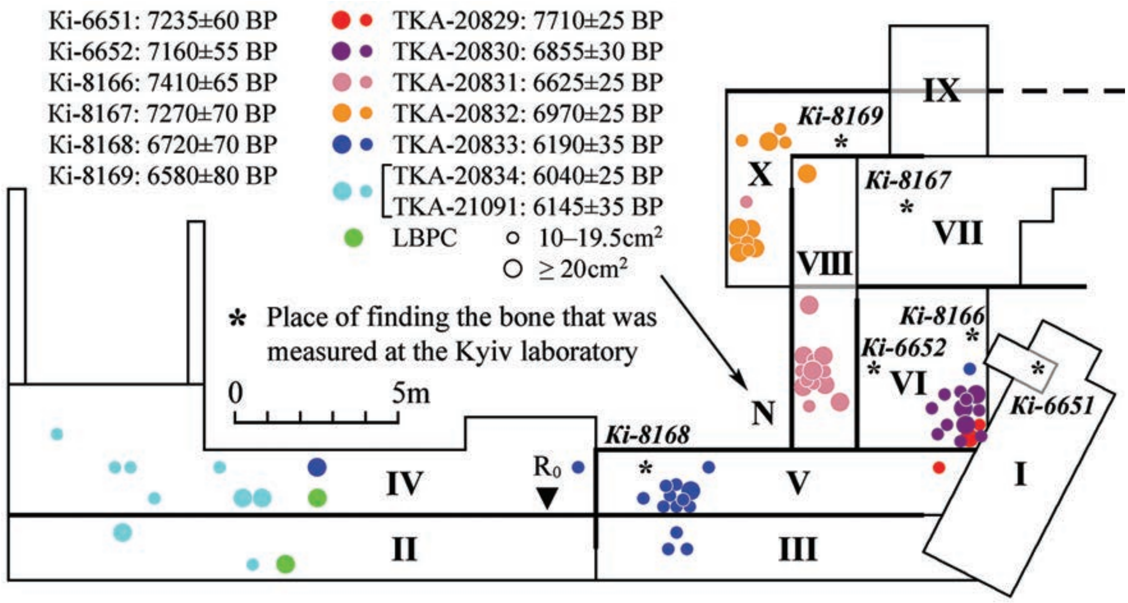

Fig. 6. Bazkiv Ostriv. Excavations scheme with margins of the zones and samples location.

and dark brown. The inner surface is well smoothed; brown, greyish brown, very dark greyish brown, pinkish grey. Fractures are black. Decoration – a solid zone filled with pinches (twin fingernail impressions) covering the whole body except the edge and the bottom part (Fig. 8).

Bazk-5t
The sample is a fragment of a wall (field inventory No. 1, square B'/6, depth 0.9m) of vessel 1. In the collection, the vessel is represented by 31 fragments found within zones I, V, VI, VII, with 16 laying in a sufficiently compact cluster in squares A'–B'/5–7 in zone VI at a depth of 0.9–0.99m (Figs. 6, 7). The vessel is reconstructed as a pot with a slightly everted rim of 22cm diameter and hemispherical low part with a maximum diameter of 22cm too. The rim is thinned. The lip is rounded, straight. The bottom is missing. The wall thickness varies from 0.6cm to 1.0cm. The pottery paste contains an abundant admixture of thin organic fibres, some quantity of the waterworn pebbles and sand as well as grog in the form of small rounded clots of unburnt white clay. The outer surface is well smoothed; very dark greyish brown, greyish brown, brown, reddish brown. The inner one is black, very dark grey, very dark greyish brown. The fractures are black. Decoration – two horizontal belts consisting of parallel rows of notched stamp impressions, separated from one another by a horizontal zigzag pattern drawn using the same comb stamp (Fig. 9). The closest analogy to this composition is a decoration of the best Samchyntsi type pot – vessel 3 from the eponymous Samchyntsi I site (*Gaskevych 2010.217, Fig. 2; 2011.Fig. 3.3*).

Bazk-6t
The sample is a decorated fragment of a wall (square Š/6, without inventory No. and a depth mark) of vessel 22. There are 20 fragments of this vessel in the collection. Most of them were found in a compact cluster in square Š/7 in zone VIII at a depth of 0.8–0.89m (Figs. 6, 7). The vessel can be reconstructed as a pot of truncated ovaloid (egg-like) shape. The maximum diameter is 19cm; the height is at least 21cm. The slightly thinned rim is inverted. The lip is flat, straight. The bottom is missing. The wall thickness is 0.6–0.9cm. The pottery paste contains an admixture of thin organic fibres, a small amount of sharp-cornered gravel and shell fragments (up to 0.7cm). The outer surface is well smoothed; reddish grey, brown, greyish brown, very dark grey. Slight burnishing (self-slip) is preserved in some places. The inner surfaces are well smoothed; very dark greyish brown, very dark grey, greyish brown. Fractures are black. Decoration – a zigzag composition covering the whole vessel except the rim edge and the bottom part. It is formed of horizontal belts filled with parallel diagonal deep incised lines less 1mm wide. Deep pits made using a ribbed-end stamp are on the lip (Fig. 10). There are imprints of elderberry (*cf. Sambucus*) seeds on the outer surface (*Endo* et al. *in prep.*).

Bazk-7t
The sample is a decorated fragment of a wall (field inventory No. 210, sq. C/14, depth 0.7m) of vessel 21. There are 19 fragments of this vessel in the collection. Most of them were found in a compact cluster in zone X at a depth of 0.9–0.99m (Figs. 6, 7).

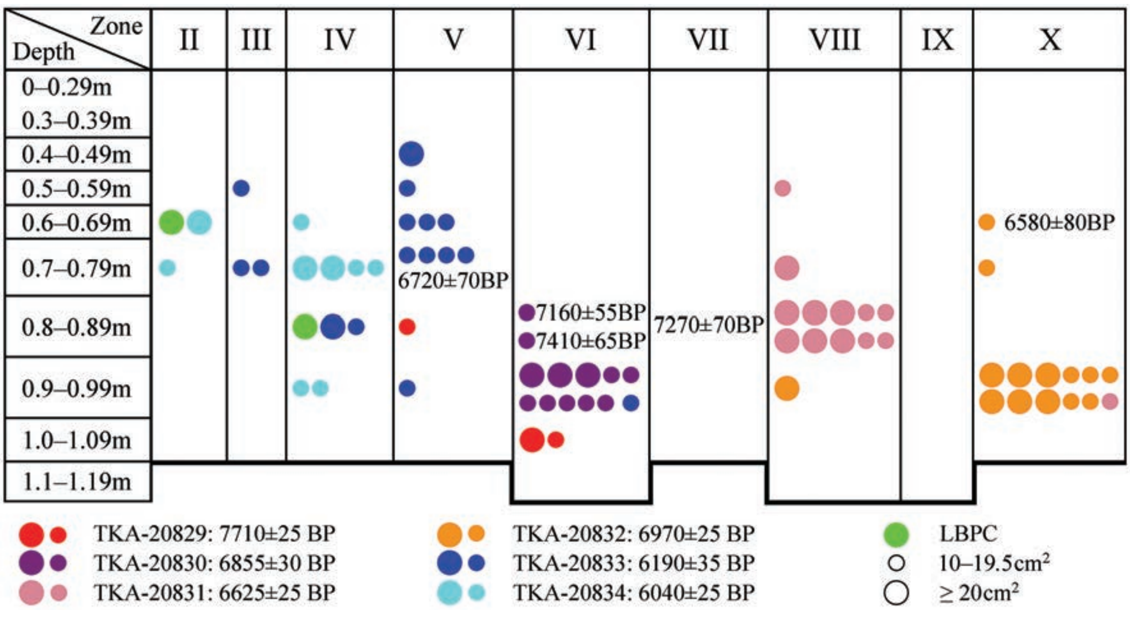

Fig. 7. Bazkiv Ostriv. Scheme of the vertical location of the sherds of dated vessels.

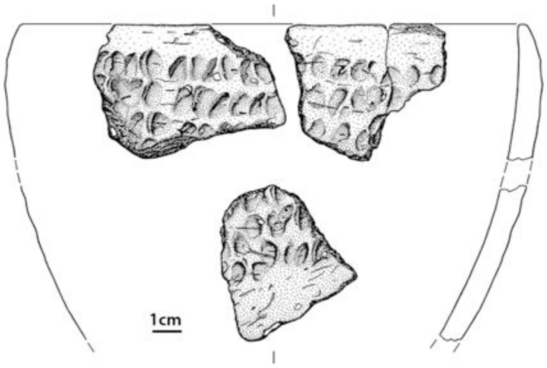

Fig. 8. Bazkiv Ostriv. Vessel 23 dated by sample Bazk-4t.

The vessel can be reconstructed as a pot with a slightly inverted rim, cylindrical upper part with a diameter of about 30cm, which is connected to the inverted conical lower part through a pronounced body corner. The lip is rounded, straight. The bottom is missing. The wall thickness is 0.8–1.0cm. The pottery paste contains an admixture of thin organic fibres, isolated waterworn pebbles, a lot of large fragments of shells (up to 0.7cm). The outer surface is slightly burnished (self-slip); pinkish grey, red, dark brown. The inner surface is well smoothed, grey. The fractures are black. Decoration – composition of vertical bundles consisting of seven parallel wavy deep incised lines 2–3mm wide. Each line begins and ends with a deep pit (Fig. 11).

Bazk-8t

The sample is a fragment of a wall (field inventory No. 6, square F/1–2, depth 0.7m) of vessel 2. In the collection, the vessel is represented by 32 fragments found within zones III, IV, V, VI. But the majority of them lay in the sufficiently compact cluster in squares U–H/1–4 in zones III and V at a depth of 0.5–0.79m (Figs. 6, 7). The vessel is reconstructed as a pot with a truncated ovaloid body of maximum diameter 22cm. The everted rim is of 19cm diameter. The lip is rounded, slightly undulate. The bottom is missing. The wall thickness is 0.6–0.8cm. The pottery paste contains a lot of sharp-cornered gravel (up to 0.6cm), sand and organic fibres as well as a little mica and small grains of red ochre. The outer surface is reddish brown, pinkish grey, greyish brown. The inner one is black, very dark grey, dark reddish grey, pinkish grey. The fractures are generally black. Both surfaces are well smoothed and slightly burnished (self-slip). Decoration – grid consisting of bundles of diagonal lines superficial incised by a notched stamp on the exterior rim face; rectangular zones filled with horizontal rows of impressions made with that stamp on the vessel body; and sparse diagonal lines drawn by the same stamp on the bottom part (Fig. 12).

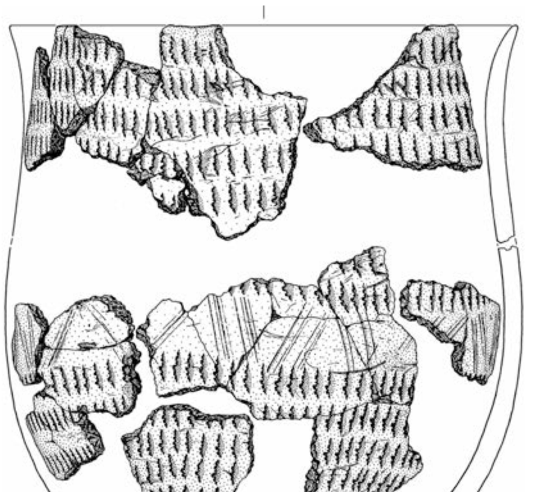

Fig. 9. Bazkiv Ostriv. Vessel 1 dated by sample Bazk-5t.

Bazk-9t

The sample is a decorated fragment of a wall (field inventory No. 38, square B/5, depth -0.65) of vessel 39. There are 12 fragments of this vessel in the collection. They were found within zones II and IV. Except for two shards, the rest lay at a depth of 0.6–0.79m (Figs. 6, 7). Only the restricted upper part of the probably truncated ovaloid vessel has been preserved. The maximum diameter is 19cm. The vertical rim is of 13cm diameter. The lip is rounded, straight. The wall thickness varies from 0.5cm to 1cm. Pottery paste is oversaturated with sharp-cornered gravel (up to 0.4cm), sand and mica. A small amount of thin organic fibres is there too. The outer surface is well smoothed; light reddish brown, greyish brown, very dark greyish brown. The inner one and fractures are black. Decoration – a diagonal grid pattern, which is on all available potsherds. It is formed of superficial incised lines of 1–2mm wide. One horizontal row of comb stamp impressions is on the thinned interior rim edge (Fig. 13).

Bazk-9c

The sample of charred organic residue in the form of a very thin black coating was scraped off the inner surface of the potsherd, which is the sample of Bazk-9t.

Method

Sample preparation for radiocarbon dating was conducted following the methods of Yoshida *et al.*

(*2004*). About several millimetres of the potsherd's surface was shaved using a grinder, and then thrown away to remove impurities on the earthen vessel. The sample of about 200–300mg was cut off by using a diamond cutter, corresponding to 0.5cm^2 of 1cm thickness. The potsherd was divided into exterior and interior surface portions and the internal black portions were subjected to a series of experiments. To remove the contaminants for ^{14}C dating, samples were subjected to acid-alkali-acid (AAA) pre-treatment at 80°C. The process was the same as that described in Kunikita *et al.* (*2007*). The rates of chemical treatment for specimens are shown in Table 3. The concentration of the alkali treatment for the potsherd (organic temper in pottery) was adjusted to prevent the specimens from being slightly coloured by it. The concentration of the alkali treatment for the charred remains on pottery was also kept to a level at which the sample did not dissolve completely. The rate of CO_2 in the refinement was kept within a range of 0.6–5.6% for a potsherd. The potsherd (organic temper in pottery) can be dated using the black-coloured inside part at 1.5–2.5% content (*Yoshida* et al. *2004*). The measurements were taken using the compact AMS of the University Museum at the University of Tokyo. The radiocarbon results were calibrated using OxCal v4.3.2 (*Bronk Ramsey 2017; Bronk Ramsey, Lee 2013*).

Results and discussion

The results of the analysis are shown in Table 4. But before using them for clarification of the issue of the timeframe of the different BDC pottery traditions a preliminary assessment of their reliability should be carried out. It consists of the mutual verification of information obtained in various ways. Therefore we will consider the question of possible distortion of the real age of the samples and compare these data with the typological characteristics of the corresponding vessels and the stratigraphic context in which they were found.

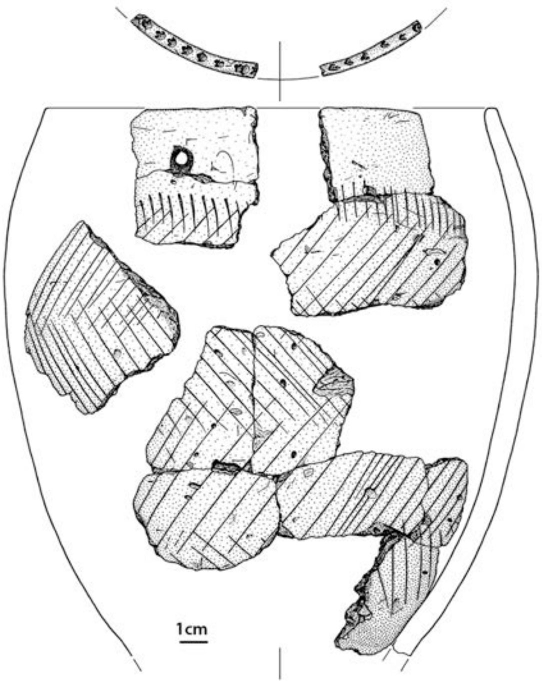

Fig. 10. Bazkiv Ostriv. Vessel 22 dated by sample Bazk-6t.

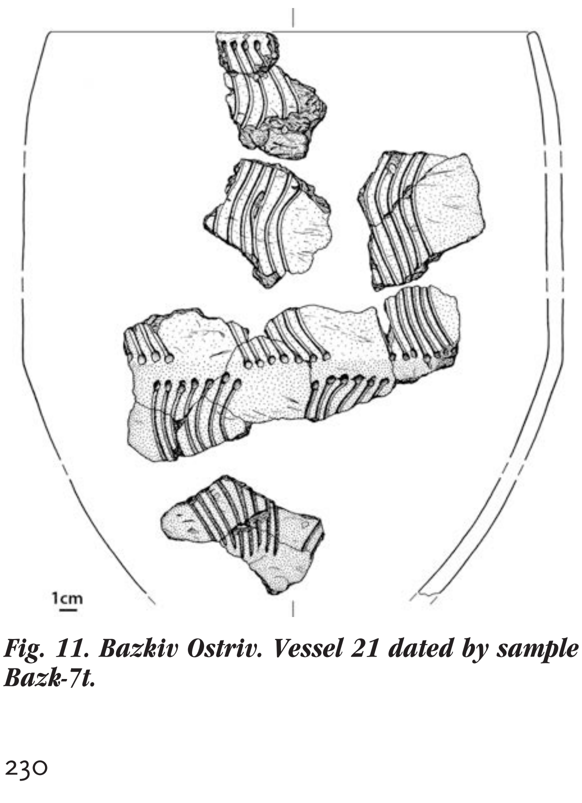

Fig. 11. Bazkiv Ostriv. Vessel 21 dated by sample Bazk-7t.

Possible distortion of true age of the samples

The origin of the carbon-containing materials in the pottery can be problematic, and it is important to verify if those materials are directly related to the archaeological context. Therefore, first, there is distinction to be made: is it indeed the direct dating of vegetable fibres, more or less contemporaneous with the production of the pot, or is it rather the carbon fraction of the sherd that has been dated? It is believed that geological signals are always difficult to separate completely from the archaeological ones, especially in those sherds that do contain not enough organic temper (*Kulkova 2014.117*). Thus, the relative carbon content in the measured samples plays a key role. A value of about 2–3% is considered as such that the effect of the 'old' carbon from clay may be ignored (*Yoshida* et al. *2004.716*).

Examining our samples from this view, only three measurements on fragments of vessel 22 (Fig. 10) and 39 (Fig. 13) from Bazkiv Ostriv as well as the

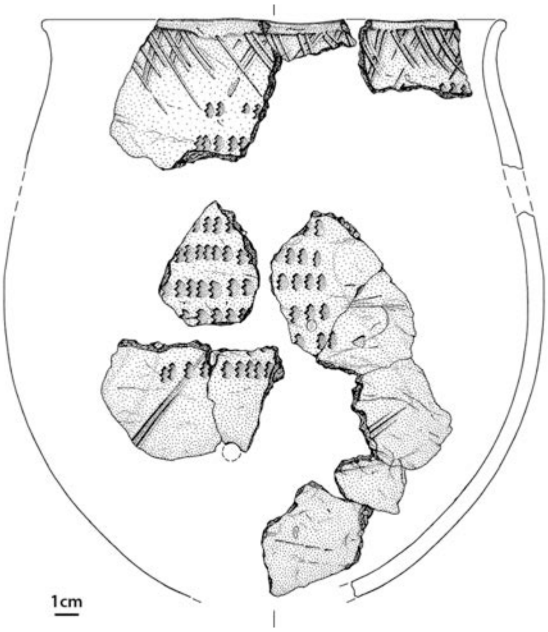

Fig. 12. Bazkiv Ostriv. Vessel 2 dated by sample Bazk-8t.

vessel from Shumyliv-Cherniatka (Fig. 2) can be recognized as the most reliable (Tab. 3; Fig. 14). The reliability of three more measurements on samples with the same CO_2 content of 1.1% is moderate. These are obtained on fragments of vessel 16 from Hlynske I (Fig. 4), vessel 1 (Fig. 9) and vessel 2 (Fig. 12) from Bazkiv Ostriv. Measurements on samples of vessel 7 from Hlynske I (Fig. 5), vessel 23 (Fig. 8), and vessel 21 (Fig. 11) from Bazkiv Ostriv with a CO_2 content of 0.6–0.7% are the least reliable. It is noteworthy that these two samples gave the most controversial dates of the first half of 7th millennium BC. Perhaps they are heavily overestimated due to the age of the geological carbon in their clay matrix.

Second, the real age of archaeological carbon, which is simultaneous with the time of manufacture and use of vessels, can be distorted by several factors (overviews: *Bonsall* et al. *2002; Philippsen 2015. 160–162*). The main one is the freshwater reservoir effect (FRE). The most important mechanism of its origin is the dissolution of carbonate minerals, due to hard water, and thus the 'hardwater effect'. From such water, dissolved inorganic carbon gets into aquatic vegetation and further along the food chain into the organisms of molluscs, fish, crawfishes, turtles and river mammals. Therefore, the inclusions of river silt, algae and mollusc shells to ceramic paste can overestimate its true age.

Today, laboratory studies on the composition of the ceramic paste of vessels from more than a dozen BDC monuments have been published. For example, according to Alexander Bobrinsky and Irina Vasilyeva's identification, all 57 vessels they studied from eight BDC sites from the forest-steppe Buh area were made of river clay. Among them, 13 vessels are from Bazkiv Ostriv, six from Hlynske I and seven from Shumyliv-Cherniatka. In describing all the samples the presence of waterworn fine sand and "*voids by the liquid organic fraction of silt*" was noted. Imprints of algae were on all samples except one. Mollusc shells were found in the paste of most vessels (*Bobrinsky, Vasilyeva 1998.216*). Frequent use of silt, as well as the presence of imprints of 'aquatic vegetation' on 86% of the pottery from the Tătărăuca Nouă XV settlement, is mentioned by Larina. She also notes an admixture of crushed shells and small river pebbles in the ceramic paste (*Larina 2006.37–38*). But linking these results with concrete vessels and even with the type of pottery is impossible, since drawings or photos of the analysed samples have not been published.

Examining our nine pottery samples according to the above criteria visible with the naked eye in the fractures of corresponding vessels, the presence of shells is noted in five cases, rounded sand (possibly taken along with river mud) – in three cases, prints of thin, twisted curly threadlike fibres (algae?) – in eight cases (Tab. 5). On this basis, the vessels with lower carbon content also look potentially the most susceptible to the FRE, which increases our doubts about the validity of very old dates, measured on their shards.

The FRE distortion of a vessel's age can arise also due to penetration of the broth of cooked aquatic flora and fauna into its pottery structure as well as due to formation of a charred crust of the food of aquatic origin on its surface. Such contamination can be detected by special lipid residue analysis. Samples of eight of the nine measured vessels have al-

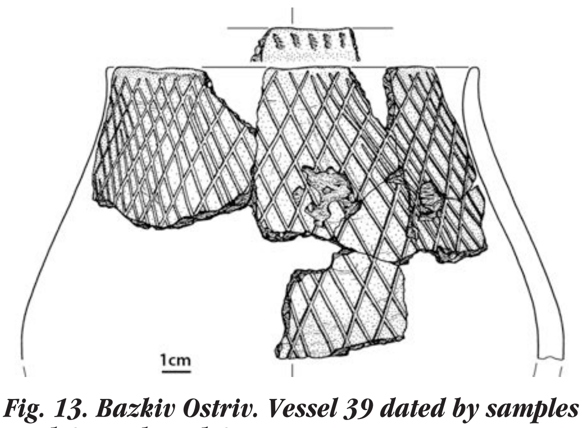

Fig. 13. Bazkiv Ostriv. Vessel 39 dated by samples Bazk-9c and Bazk-9t.

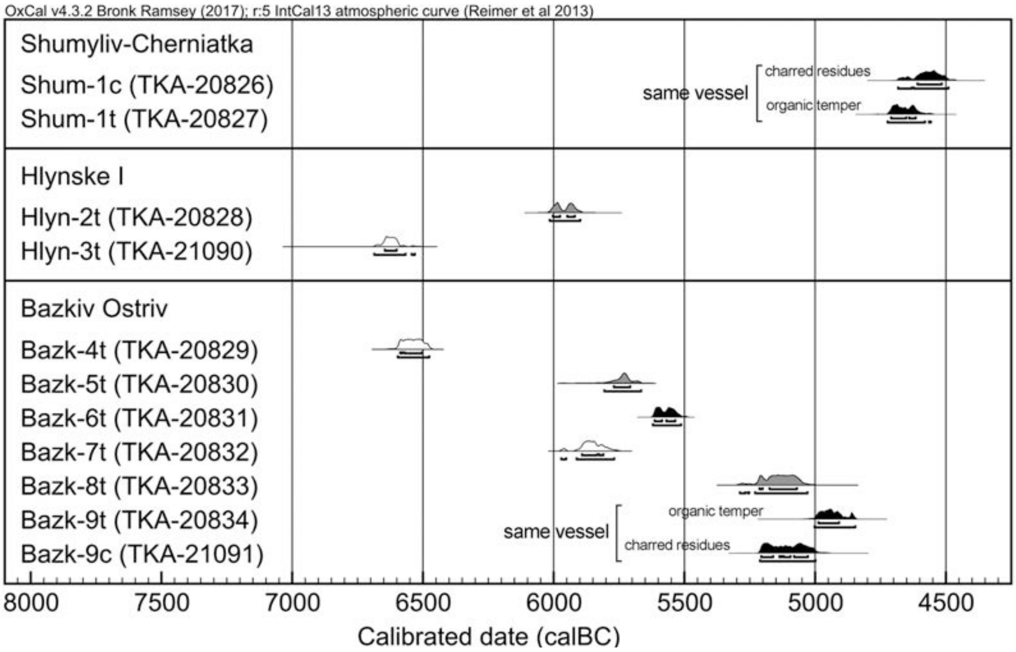

Fig. 14. Plot of the new AMS dates, measured on the samples with CO_2 content of: white 0.6–0.7%, grey 1.1%, black 2.4% and more.

ready been transferred for such research, which is carried out by an international team led by Prof. Carl Heron within the scope of the project "*The Innovation, Dispersal and Use of Ceramics in NW Eurasia*".

Also, the 'old wood' effect can arise if carbon was sorbed from the fuel during the firing process when the clay paste had not yet hardened. In a similar way, during food cooking, the soot of old trees can get into the burnt food crust, overestimating its true age.

Taking into account these factors, which make the real age of the samples seem older, each of the dates we obtained (especially on samples with low carbon content and an abundance of freshwater shells) should be considered as not a precise time period, but *terminus post quem* – the earliest possible date of the corresponding vessel.

Various contaminations may have occurred due to young carbon getting into the potsherds from the surrounding soil matrix. It can dissolve in water and percolate through sediments, accumulating in both pottery paste and carbonized crust, underestimating their true age. Thorough chemical sample preparation usually ensures the removal of humic acids from the pore structure of the ceramic matrix, as well as from food carbon deposits on ceramics (*Kulkova 2014.119*). However, in this regard, the two youngest dates for the vessel from Shumyliv-Cherniatka deserve special attention. Danilenko's words about discovering it in grey-green sediments interpreted as 'ancient meadow-type soil' are worrying, as this differs from the 'yellow-grey loess-like loams' which contained the finds in the Hlynske I and Bazkiv Ostriv. Therefore, the slight young carbon effect cannot be ruled out completely here.

Comparing the new dates with absolute chronology and archaeological context

The plot of our dates clearly shows that they group four separate clusters (Figs. 14, 15).

The first cluster is formed by two dates, falling into the second quarter of the 7th millennium BC. Today, they are the earliest for the culture as a whole, and are even somewhat earlier than the dates of the Late Mesolithic monuments of Soroca II, layer 2 and 3; Ziankivtsi II, the lower layer (Tab. 1).

The first date, TKA-21090: 7795±30 BP (6686–6532 cal BC), was measured on vessel 7 with the Skybyntsi type characteristics from the Hlynske I site (Fig. 5). Danylenko referred it to the Pechera phase of his periodization due to the finding of the Criş-like bowl there. However, the discussed date turned out to be at least 500 years older than the result of direct dating on the mentioned bowl. Thus, either we are dealing with a palimpsest, or with some distortion of the true age of the sample. The latter seems more likely because of the extremely low carbon content and abundance of shell in its pottery paste. Also, it is supported by the stratigraphic position of the few mate-

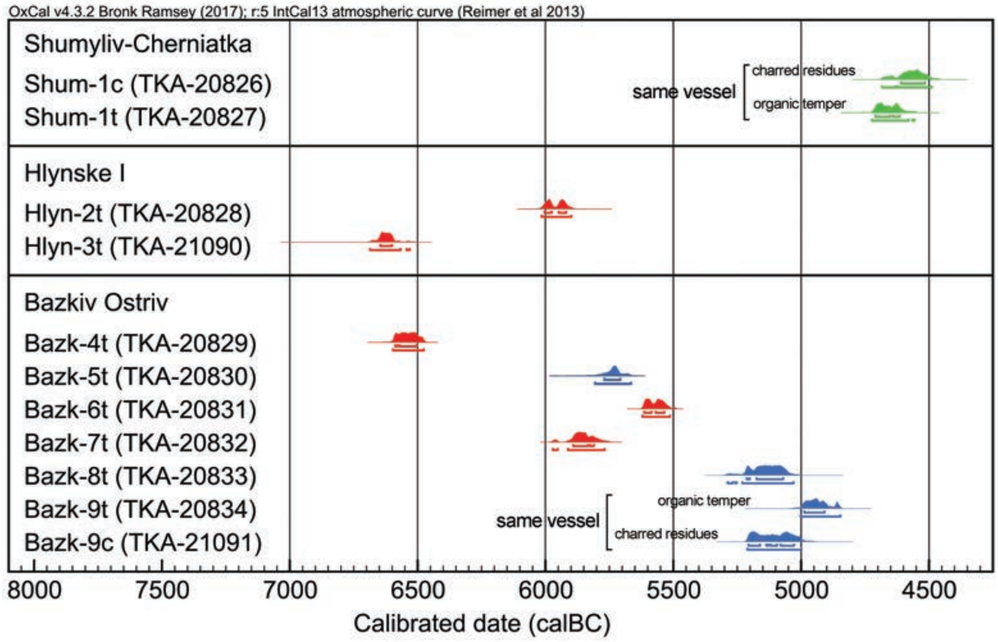

Fig. 15. Plot of the new AMS dates. Red: the Skybyntsi and Pechera type; blue: the Samchyntsi type; green: the Savran type.

rials in Complex 1, forming a cultural layer lying at a depth of more than 3m. Moreover, it is noteworthy that not one flint artefact characteristic to the local Mesolithic Kukrek culture was found there (*Gaskevych 2017a*).

Pottery contemporaneous with the date under discussion is known in Europe only in the Rakushechnyi Yar site on the Lower Don River, the Kairshak-Tenteksor group monuments near the Volga River delta, the sites of the Elshanka Culture on the Middle Volga, as well as in the Serteya sites in the basin of the upper Western Dvina River. But the style of those vessels is defined as predominantly no decorated, or decorated in a way which shows no close analogies to the ornamentation of vessel 7 from the Hlynske I (*Vybornov 2008; Mazurkevich, Dolbunova 2015*). The only archaic-looking feature that brings them together is the rows of small pits set along incised lines. However, smoothly curved meander incised compositions themselves are characteristic not of the eastern hunter-gatherers, but the Danube-Carpathians farming cultures of the linear circle dated no earlier than the middle of 6th millennium BC.

The second date, TKA-20829: 7710±25 BP (6597–6477 cal BC), was measured on vessel 23 with pinches from Bazkiv Ostriv (Fig. 8). There, it lay deeper than the other 11 dated items with known depths (Fig. 7). Since its discovery, it has been considered one of the oldest pots of the culture. But at the same time, Danylenko linked the origin of the decoration with pinches in the BDC with influence from the Criş-Körös-Starčevo area (*Danilenko 1969.68–69*). That simple pattern is known almost everywhere in the Balkans-Danube-Carpathians during all the Early Neolithic periods. In particular, vessels with pinches are in the materials of the most eastern Criş monuments located in Moldova, approx. 130km from Bazkiv Ostriv (*Dergachev, Larina 2015.Tab. 10, 32, 49, 80*). However, the age of the measured fragment turned out to be older not only than their ^{14}C dates (*Kovalenko 2017.157, 158, Tab. 1*), but all reliable dates of the Early Neolithic monuments in the whole Danube catchment (*Thissen 2009*). In areas east of the Buh, prototypes of this decoration are also not known. Therefore, such an old date should be explained either by distortion of the true age due to the extremely low carbon content and presence of shell temper, or by an unlikely direct cultural impact from the Near East, where vessels of similar shape adorned with pinches and fingertip impressions are found at some sites dated to the first half of the 7th millennium BC, for example, Tell el-Kerkh (horizon Rouj 2a-2b) in the Rouj River basin in North-Western Syria (*Tsuneki 2012.34–36*).

The next cluster is formed by four dates that point to the first half of 6th millennium BC.

The first date, TKA-20828: 7080±30 BP (6016–5899 cal BC), was measured on sherds of the possible Criş 'import' vessel 16 from Complex 1 in the Hlynske I site (Fig. 4). Its main features are the dark burnishing, carinated form, and a pedestal. Based on this, Kotova (*2015.61*) has seen analogies to it in several partially preserved bowls with a more-less pronounced body corner from the Koprivets and Blagotin site in the Balkans, dated to a slightly older time than our date shows. The bottom shape of these bowls is unknown. The closest analogies of vessel 16 in terms of technology, form, decor, and metric parameters are noted in the materials of the Körös monuments of Eastern Hungary (*Gaskevych 2008a.294; 2017a. 107*), for example, Furta-Csátó (*Makkay 1990.Pl. 3, 5; Makkay* et al. *2007.Fig. 132.7–9, Fig. 134.6*). Due to the presence of pottery with so-called 'Protovinča' traits there, they may be synchronous with the early phases of the Vinča culture, dated no earlier than 5300 BC (*Reingruber 2018.85–88*), or slightly precede them. In this case, the joint occurrence of vessels 16 and 7 (with some possible traits of the linear pottery) within Complex 1 does not cause contradictions. Therefore, in general, the discussed date may be considered overestimated due to the distortion of its true age. Based on the composition of the clay paste (Tab. 5) and the likely use as 'tableware' rather than 'kitchenware', it is least affected by FRE. On the other hand, the probable western or southwestern origin of this vessel may indicate that it was made in the limestone and chalk rich landscapes of the Moldavian and Moesian Platform, or mountain systems of the southern and western Carpathians, where the powdered carbonaceous bedrock with no radiocarbon content could get into the pottery paste directly. However, verification of these assumptions requires special in-depth analyses using natural science methods.

The second date, TKA-20832: 6970±25 BP (5972–5769 cal BC), was measured on vessel 21 with vertical incised wavy lines (Fig. 11), which was found in the western part of the Bazkiv Ostriv settlement. On zone X, its large fragments lay compactly at a depth of 0.9–0.99m corresponding to the oldest (the Skybyntsi after Danylenko) layer. The "*fragment of red deer horn*" with a younger date of 6580±80 BP (Ki-8169) was found above in this zone (Fig. 7). This is in favour of the possible reality of the discussed date, despite the extremely low carbon content and abundance of coarse shell fragments in the clay paste of the sample. A distant analogy of this pot decoration may be seen in a vessel from the 'lower Neolithic' layer in Gard, the direct dates on the pottery from which fall into the second and third quarter of the 6th millennium BC. Parallel wavy lines on the upper cylindrical part of the body of that vessel were also grouped into bundles of seven pieces each (*Tovkaylo 2014.Fig. 11.2*). But an admixture of very coarse sand and granules, not shells, is in its paste.

The third date, TKA-20830: 6855±30 BP (5807–5666 cal BC), was measured on vessel 1 with comb impressions (Fig. 9) from the northern part of Bazkiv Ostriv. There, in zone VI, its large fragments lay compactly 10cm above the large fragments of vessel 23 given one of the earliest dates. However, bone samples measured to the end of the 7th millennium BC (Ki-6652 and Ki-8166) lay 10–20cm above discussed vessel 1 (Fig. 7). Despite this, Kotova has attributed the last to the 'upper Neolithic' layer, but the dates – to the 'lower' one (*Kotova 2003.208, Fig. 42.1*). For us, this fact may be explained either by the mixture of materials of different times in that part of the monument or by significant distortion of the real age of the bones due, for example, to FRE. Anyway, this date questions the traditional synchronization of the Samchyntsi-type pottery exclusively with the post-Criş time. This is in agreement with the deep occurrence of the vessel that was found nearby shards of the Skybyntsi type pottery. The latter probably explains why such a representative well-preserved vessel has never been mentioned and published by Danylenko, the author of the BDC basic periodization.

The fourth date, TKA-20831: 6625±25 BP (5621–5514 cal BC), was measured on vessel 22 with incised linear zigzag decoration (Fig. 10) from zone VIII in Bazkiv Ostriv. There, its large fragments lay above vessel 21 with a slightly older date (Fig. 7). The pot under discussion was published by Danylenko as belonging to the Skybyntsi-type (*Danilenko 1969.70*). The motif of its decoration has analogies among the vessels from the nearest Criş monuments in Romanian Moldova (*Ursulescu 1984.Pl.15.5, 43. 25; Comşa 1991.Fig.4.3, 14, 17; Popuşoi 2005.Fig. 59.4, 72.7, 73.2, 82.8, 83.4, 83.7, 95.4, 102.5, 109.1*), and the neighbouring Republic of Moldova (*Dergachev, Larina 2015.Tab. 20.8, 50.4,11,13,14, 76.3,4*). The radiocarbon age of Trestiana, Level I (GrN-17003: 6665±45 BP) and Sacarovka 1 (including one conventional Kyiv date Ki-13899a: 6590±180 BP on organic inclusions in pottery paste) fall in the range 5840–5450 BC (*Mantu 1995.226; Kovalenko 2017. Tab. 1*) that is roughly synchronous with the date of vessel 22. In addition, the date coincides with the direct dates on pottery with the same admixture of coarse shell fragments from the Gard site (*Tovkaylo 2014.199–201*).

The third cluster is formed by three dates of the Samchyntsi-type vessels from the Bazkiv Ostriv site, falling into the end of the 6th to the beginning of 5th millennia BC.

The first date, TKA-20833: 6190±35BP (5288–5030 cal BC), was measured on potsherd of vessel 2 decorated with comb impressions (Fig. 12). Large fragments of the LBPC fine bowl were found at the same depth with a large fragment of this vessel in zone IV. The second date, TKA-20834: 6040±25 BP (5211–5000 cal BC), and the third date, TKA-21091: 6145±35 BP (5003–4847 cal BC), were measured on organic inclusions in pottery paste and charred residues on the inner surface of vessel 39 with the incised diagonal grid pattern (Fig. 13). Its large fragments were found at the same depth with large fragments of the above-mentioned LBPC bowl in zone II (Figs. 6, 7). Since all three dates concur to the time of local LBPC monuments with a 'musical note' pottery (*Sapozhnikov, Sapozhnikova 2005.91.Tab. 1; Kiosak, Salavert 2018.122*) their age can be considered true. In addition, the first date is consistent with the conclusion about the presence of painted vessels reproducing the Szakálhát culture ceramics from the Tisza River basin on the monument (*Gaskevych 2017b*).

Finally, the fourth cluster is formed by two dates, TKA-20826: 5725±30 BP (4683–4491 cal BC) and TKA-20827: 5805±25 BP (4723–4558 cal BC), measured on Savran-type vessel from Shumyliv-Cherniatka (Fig. 2). They point to the second quarter of the 5th millennium BC; those are the youngest reliable measurements for the BDC. Excavating the site Danylenko noted the occurrence of materials of both the BDC, and Trypillia A of the Sabatynivka II type at the same depth, but not mentioned their possible synchronism. However, our dates fall into the range that coincides with the generally accepted dating of the Precucuteni II – Trypillia AIII (*Mantu 1995.228; Rassamakin 2012.22–24*), and they are even much younger than the range of Kyiv dates on bones from the eponymous Sabatynivka II settlement (*Telegin* et al. *2000.66*). Thus, it confirms Tringham and Tovkaylo's views concerning the long-term synchronism of the late Buh-Dnister and early Trypillia monuments in the Buh area. With that, assuming the finds of BDC and Trypillia A form a homogeneous complex in the Shumyliv-Cherniatka (as has been asserted by Tovkaylo regarding the sites of Gard, Gard III, Puhach I, and others) seems too bold.

The issue of the BDC pottery types time frame

Summing up the assessment of the reliability of dates from both a technical point of view and their correspondence to the typology and archaeological context, it should be recognized that the most valid in our series are the five youngest dates for two vessels of the Samchyntsi type and one of the Savran type. They are obtained on samples with satisfactory carbon content. There are no (Bazkiv Ostriv) or just a small number (Shumyliv-Cherniatka) of shells in their pottery paste. Also, the dates of the Samchyntsi vessels correspond to their occurrence on the same level with the LBPC materials in Bazkiv Ostriv, and the Savran vessel – with Trypillia finds in Shumyliv-Cherniatka. Moreover, the reliability of four of them is confirmed by the coincidence of the dates measured, one on carbonized crust on the surface and the other on organic inclusions in the paste of the same vessels. So, two dates from Shumyliv-Cherniatka giving with 95% confidence level showed significant overlap in the interval of 4683–4558 cal BC. Although the overlap of the dates of vessel 39 from Bazkiv Ostriv is only three years in the range 5003–5000 cal BC, these results are very close, too. It thus seems that these dates correspond to their real age. These dates turned out to be much younger than the Kyiv dates obtained on bones from the 'upper Neolithic' layer from Bazkiv Ostriv, the 'dwelling' from the eponymous Savran site, the 'late Neolithic' or the 'Savran phase' settlements of Mykolyna Broiaka, Puhach II and Gard III. Three possible explanations can be proposed for this contradiction.

❶ A reassessment of the age of dates on bones due to the influence of FRE cannot be ruled out. Publishing a large set consisting of 33 Kyiv dates measured on bones, the researchers mentioned the species of corresponding animals in five cases only. These are two samples of the omnivorous wild boar and two samples of the horns of the herbivorous deer from Bazkiv Ostriv, as well as one sample of the herbivorous *Bos* or *Equus* from Hirzhove (Tab. 1). Thus, the most reliable Kyiv dates on bones are the last three only. Of these, two dates for Bazkiv Ostriv fall into the second and third quarters of the 6th millennium BC, and the date for Hirzhove into the second half of the 7th millennium BC. Any of the other dates on the animal bones could be measured by a sample that is the remains of a wild or domestic animal constantly or occasionally feeding on aquatic plants, animals, and mollusks. This is evidenced by the published species identification of the bones from nine Southern Buh monuments with mixed materials of different times (Bazkiv Ostriv, Mytkiv Ostriv, Mykolyna Broiaka, Puhach I, Puhach II, Gard III, Gard IV, Nova Mykolaivka-1, Dobrianka-3). In particular, a turtle, otter, beaver, bear, badger, wild boar, domestic pig, and dog are included in these lists (*Danilenko 1969.Tab. 1; Tovkaylo 2005.Tab. 6.1; Gaskevych, Zhuravlev 2008.174; Zaliznyak* et al. *2013.245*). Humans are also omnivorous mammals who eat fish. Burials associated with the BDC were found on the Southern Buh sites Samchyntsi I, Gaivoron-Polizhok (Solgutiv Ostriv), Sokiltsi VI (*Gaskevych 2015*), and Dobrianka-3 (*Zaliznyak* et al. *2013.242*). The date was measured only for the burial from Dobrianka-3. It falls into the last quarter of the 7th millennium BC (*Lillie* et al. *2009.260*). However, it cannot be ruled out that some unidentified human bones could be found on this and other sites and were ^{14}C dated. Therefore, all Kyiv dates, made on the basis of material which is referred to in publications as just 'animal bone', are generally doubtful.

❷ The uncertainty or lack of real cultural stratigraphy, as well as the mixing of materials of different times on many monuments, could lead to the erroneous correlation of the complexes of finds to the 'upper' and 'lower' layers and become the cause of the contradiction under discussion.

❸ It is possible that the real time-space of the existence of the Samchyntsi and Savran type pottery was longer than is traditionally considered. In this case, both groups of the corresponding dates may be correct, but the relative chronology that correlates such vessels with only the post-Criş time is erroneous. This explanation is also supported by our less reliable AMS date on vessel 1 from Bazkiv Ostriv (Fig. 9), as well as Kyiv dates on the pottery from Gard and Dobrianka-1.

Even more complicated is the issue of the dating of the Skybyntsi and Pechera type pottery. The date on the only Skybyntsi-type sample with satisfactory carbon content, obtained from vessel 22 in Bazkiv Ostriv (Fig. 10), points to the third quarter of the 6th millennium BC. This is entirely consistent with the dates for the Criş settlements Sacarovka 1 and Trestiana, Level I (*Mantu 1995.226; Kovalenko 2017.Tab. 1*), recognized as 'Criş IV' after the Lasarovici periodization, or phenomenon like the 'Glăvănesti culture' or 'Prut-Danube culture', after Agathe Reingruber (*2016.169; 2017.96–97*). The established synchronization does not contradict the traditional view of the dating of the beginning of the BDC and its origin under the Balkan-Carpathian influence. It also corresponds to direct Kyiv dates on the Pechera type pottery from Gard. Thus, a comparison of this vessel with the Kyiv dates of the second half of the 7th millennium BC, measured on the 'animal bones' from the 'lower layer' of the site (*Kotova 2003.27–28, 205*), seems erroneous. Perhaps this was due to the mixing of the Skybyntsi finds with unrecognized late Mesolithic materials or a distortion of the real age of bones (which were published without identification) influenced by the FRE.

Unfortunately, all the other dates for the Skybyntsi and Pechera type pottery were measured on the samples with medium or very low carbon content (Tab. 3), which undermines their reliability. Thus, for example, the strong influence of 'geological' carbon can be clearly revealed for the date of the carinated bowl with features of the Vinča traditions from Hlynske I (Fig. 4). Such influence could even more strongly change the real age of the two oldest samples with an abundance of shell in their pottery paste (Figs. 5, 8). Therefore, the chronology of the corresponding vessels should be determined taking into account typological arguments.

Today, various possible scenarios of the origin and spread of the earliest pottery in the vast territory of Eastern Europe are debated. More traditionally it is seen as a component of the cultural complex of the Middle East agricultural population who moved to the northern Balkans and south-western Carpathian basin. It is believed that such pottery is not earlier 6200 BC (*Budja 2009.126*). For more ancient ceramic production three variants are proposed. Two of them are: its independent invention by mobile and semi-mobile hunter-gatherers in many centres in Eurasia and Africa; or its spreading to local foragers from one starting point that arose in East Asia as early as the Pleistocene around 14 500 BC (overviews: *Jordan, Zvelebil 2009; Budja 2013*). The main common features of this old pottery are a pointed or conical base, the predominantly bag-like form, covering of the whole outer surface by impressed decoration or another relief-like structure (*Piezonka 2015. 286–287*). According to a recently proposed third variant, one part of the oldest East European pottery is a component of a near-eastern 'Neolithic package', which had already arrived here directly from one or more unknown sources in the first quarter of the 7th millennium BC, and the other component is the result of its further development by indigenous hunter-gatherers (*Mazurkevich, Dolbunova 2015*). An important argument for this is the predominantly flat bottom shape of the most ancient vessels in various parts of the region.

Paradoxically, among BDC pottery in the Southern Buh area 'archaic' features of the oldest forager ceramics are more typical of exclusively point- and round-bottomed vessels of the Samchyntsi type, and have given reliable direct dates of the end of 6th millennium BC. In contrast, there is only one reliable point-bottomed vessel (No. 38 from Bazkiv Ostriv) among the earlier pottery of the Skybyntsi and Pechera type. It is decorated with smoothly curved meander compositions formed by bundles of incised lines (*Danilenko 1969.Fig. 24.4,6*). This ornamental pattern has no analogies within foragers' assemblages to the north or east, but is a characteristic feature of some cultures of the linear circle, such as the Tiszadob Group and Bükk Culture in the Carpathian Basin (*e.g., Piatnicková 2015*). Perhaps it and some other peculiar forms of decoration, for example, vertical wavy lines covering the whole of a vessel's surface, appeared earlier not in the west, but just in the Southern Buh, which was proposed by Reingruber (*2018.90*). Therefore, to determine the place of origin and the distribution vector of the described traditions, reliable direct dating of the BDC pottery should be continued.

Conclusion and prospects

The set of 11 new AMS dates has given a wide scatter of their values within the entire period outlined by the previous BDC dates. Moreover, the two results of the second quarter of the 7th millennium BC are beyond it and may potentially be the oldest dates of the culture. However, analysis of the samples from the aspect of carbon content, their susceptibility to the influence of the FRE, correspondence to the stratigraphy of the sites and typology of materials detected only six more credible dates. Their order on the timeline coincides with generally accepted ideas about the sequence of existence of the different BDC pottery types. The youngest is the vessel of the Savran type from Shumyliv-Cherniatka that gave two dates, which fall into the range of 4723–4491 cal BC, when the Trypillia culture bearers already populated the region. Two vessels of the Samchyntsi type from Bazkiv Ostriv gave three dates within the range of 5288–4847 cal BC, which corresponds to their finding next to fragments of fine 'music-note' bowls of the LBPC. The vessel of the Skybyntsi type from Bazkiv Ostriv gave the oldest plausible date of 5621–5514 cal BC, which corresponds to the age of the Criş monuments in neighbouring Moldova.

From a perspective of the problem that arose two decades ago after the publication of the 'new' Kyiv dates measured on bones, the AMS Tokyo dates better correspond not to the latter, but the primary, traditional, absolute chronology of the BDC, and conventional Kyiv dates on pottery. Most likely the dates on a bone, pointing to the second half of the 7th millennium BC, are related to the Final Mesolithic finds not separated by excavators in the palimpsests of some Southern Buh settlements in the 1950s, or sampling the bones of animals, exposed to the FRE. Thus, it appears that the long-discussed problem of the BDC chronology is concerned with not only the material of samples, as is considered now, but with the interpretation of results. In quick pursuit of impressive publications, numerous radiocarbon dates were offhandedly compared with the unlikely stratigraphy of settlements, and doubtful periodization schemes created under the paradigms of stadial development more than half a century ago.

Of course, 11 new dates can by no means be sufficient for reliably dating the three corresponding sites, not to speak of a whole BDC. They can only be the beginning of a long process aimed at the creation of a model that could be advanced for future testing. In such a study, particular attention should be paid to the question of the age of pottery with the high amount of shell, given the old values, which show dates from our series. Is it a cultural trait of older pottery, where shell temper has dominated? Or is it a technical shortcoming in the dating process? Another important issue is the time of appearance of the archaic-looking point- and round-bottomed pottery of the Samchyntsi type. Is it the oldest in the region, or do the previous dates measured on such vessels convey the age of the geological component in their ceramic paste? To answer these and other questions, new direct ^{14}C dating on pottery, accompanied by its petrographical, physical and chemical studies, and in particular lipid analysis, should be conducted. Also, if possible, detailed information about the species of animals whose bones were measured at Kyiv laboratory earlier and the localization of corresponding samples in the sites should be found and published for further analysis.

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Appendix

Tab. 1. The dates measured on samples from the BDC sites.

Site	Context	Lab No	Material	^{14}C age BP	Calibrated age cal BC (2σ)	Reference
Bazkiv Ostriv	square B'/8, depth 80cm	Ki-8166	animal bone – 'bone polisher'	7410±65	6426–6100	*Kotova* 2002.103; *Gaskevych* 2017.200
Bazkiv Ostriv	square JA/12, depth 80cm	Ki-8167	animal bone – 'bone awl' (?)	7270±70	6336–6004	*Kotova* 2002.103; *Gaskevych* 2017.200
Bazkiv Ostriv	square G'/7, depth 80cm	Ki-6651	animal bone – 'boar tusk' (?)	7235±60	6224–6009	*Telegin* et al. 2000.64; *Burdo* 2002.433
Bazkiv Ostriv	depth 90cm	Ki-6696	animal bone – 'boar tusk'	7215±55	6216–6002	*Telegin* et al. 2000.64; *Burdo* 2002.432
Bazkiv Ostriv	square JU/7 depth 80cm	Ki-6652	animal bone – 'bone polisher'(?)	7160±55	6207–5912	*Telegin* et al. 2000.63, 64; *Burdo* 2002.433
Bazkiv Ostriv	square U/4	Ki-8168	animal bone – 'antler hoe'	6720±70	5736–5514	*Kotova* 2002.104; *Gaskevych* 2017.200
Bazkiv Ostriv	square Š/14, depth 60cm	Ki-8169	animal bone – 'antler'	6580±80	5644–5374	*Kotova* 2002.104; *Gaskevych* 2017.200
Dobrianka-1		Ki-14798	organic inclusions in pottery	6880±90	5978–5631	*Manko* 2013.216
Dobrianka-1		Ki-14799	organic inclusions in pottery	6730±90	5786–5485	*Manko* 2013.216
Dobrianka-1		Ki-9833	organic inclusions in pottery	6530±140	5714–5224	*Manko* 2006.17
Dobrianka-1		Ki-9834	organic inclusions in pottery	6360±150	5616–4991	*Zaliznyak, Manko* 2004.141
Dobrianka-3	trench 3, depth 1.0m	OxA-17490	animal bone (*Bos primigenius*)	9115±45	8454–8252	*Lillie* et al. 2009.260
Dobrianka-3		Ki-11105	animal bone	7400±130	6474–6016	*Zaliznyak, Manko* 2004.145
Dobrianka-3		Ki-11104	animal bone	7320±130	6441–5933	*Zaliznyak, Manko* 2004.145
Dobrianka-3	trench 3, depth 1.2m	OxA-X-2222-33	human bone	7297±39	6230–6070	*Lillie* et al. 2009.260
Dobrianka-3		Ki-11108	organic inclusions in pottery	7260±170	6452–5808	*Zaliznyak, Manko* 2004.145
Dobrianka-3		Ki-11106	organic inclusions in pottery	7070±150	6232–5668	*Zaliznyak, Manko* 2004.145
Dobrianka-3		Ki-11107	organic inclusions in pottery	7050±160	6232–5642	*Zaliznyak, Manko* 2004.145
Dobrianka-3		Ki-11103	animal bone	7030±120	6202–5670	*Zaliznyak, Manko* 2004.145
Dobrianka-3		GrA-33115	animal bone	4400±35	3308–2910	*Biagi* et al. 2007.27
Dobrianka-3		GrA-33117	animal bone	3595±35	2113–1831	*Biagi* et al. 2007.27
Gard	square IX-9, depth 1.4–1.5m	Ki-14796*	animal bone	7640±90	6655–6264	*Tovkaylo* 2010.Tab. 2
Gard	square IV-100, depth 1.4–1.5m	Ki-14797	'Early Neolithic layer' soil	6980±80	6006–5723	*Tovkaylo* 2010.Tab. 2
Gard	square IX-16, depth 1.3–1.4m	Ki-14791	organic inclusions in the 'late' BDC pottery	6710±80	5734–5489	*Tovkaylo* 2010.Tab. 2
Gard	square IX-16, depth 1.3–1.4m	Ki-14790	organic inclusions in the 'early' BDC pottery with sand and granules admixture	6630±90	5721–5385	*Tovkaylo* 2010.Tab. 2
Gard	square IX-39, depth 1.1–1.2m	Ki-14789	organic inclusions in the 'early' BDC pottery with coarse shell fragments admixture	6480±80	5612–5310	*Tovkaylo* 2010.Tab. 2

Site	Context	Lab No	Material	^{14}C age BP	Calibrated age cal BC (2σ)	Reference
Gard	square IX-29, depth 1.2–1.3m	Ki-14792	organic inclusions in the 'late' BDC pottery with *Ostracods* admixture	6520±80	5618–5338	*Tovkaylo 2010.Tab. 2*
Gard	square IV-70, depth 1.2–1.3m	Ki-14793	organic inclusions in the 'late' BDC pottery	6400±90	5546–5210	*Tovkaylo 2010.Tab. 2*
Gard	square IV-97, depth 1.2–1.3m	Ki-14794	organic inclusions in the Trypillia A pottery	6360±80	5486–5080	*Tovkaylo 2010.Tab. 2*
Gard	square IV-87, depth 1.2–1.3m	Ki-14795	organic inclusions in the Trypillia A pottery	6170±80	5312–4910	*Tovkaylo 2010.Tab. 2*
Gard III	square 8	Ki-6655	animal bone	6930±55	5976–5716	*Telegin* et al. *2000.64*
Gard III		Ki-6650	animal bone	6865±50	5875–5650	*Telegin* et al. *2000.63*
Gard III	trench 7	Ki-6687	animal bone	6640±50	5636–5486	*Telegin* et al. *2000.64*
Hirzhove	trench IV, spit 1	Ki-11240	animal bone (*Bos* or *Equus*)	7390±100	6435–6065	*Manko 2006.19*
Hirzhove	trench II, spit 1	Ki-11241	organic inclusions in pottery	7280±170	6465–5812	*Manko 2006.19*
Hirzhove	trench II, spit 1	Ki-11743**	organic inclusions in pottery	7200±220	6466–5668	*Manko 2006.19*
Hirzhove		Le-1703	animal bone	7050±60	6032–5789	*Stanko, Svezhentsev 1988.117*
Melnychna Krucha	2012, the base of stratigraphical unit 3, depth 200cm	Poz-67496	charcoal (*Angiosperm*)	7520±50	6461–6252	*Kiosak, Salavert 2018.122*
Melnychna Krucha	2012, the base of stratigraphical unit 2	Poz-67497	charcoal (*Fraxinus*)	7380±40	6380–6100	*Kiosak, Salavert 2018.122*
Mykolyna Broiaka	square 1, depth 120cm	Ki-8171	animal bone	6520±70	5618–5356	*Kotova 2002.104*
Mytkiv Ostriv	depth 125cm	Ki-6695	animal bone	7375±60	6388–6090	*Telegin* et al. *2000.64*
Pechera I		Ki-6693	animal bone	7305±50	6328–6054	*Telegin* et al. *2000.64*
Pechera I		Ki-6692	animal bone	7260±65	6240–6008	*Telegin* et al. *2000.64*
Pechera I	square Ž/7, depth 70cm	Ki-8164	animal bone	7205±70	6227–5930	*Kotova 2002.103*
Puhach II	trench 2, depth 2.5–2.6m	Ki-6656	animal bone	6895±50	5890–5674	*Telegin* et al. *2000.63*
Puhach II	square XIX-51	Ki-6657	animal bone	6810±60	5836–5622	*Telegin* et al. *2000.63*
Puhach II		Ki-6649	animal bone	6780±50	5752–5616	*Telegin* et al. *2000.63*
Puhach II		Ki-6648	animal bone	6740±65	5741–5534	*Telegin* et al. *2000.63*
Puhach II	trench 1, depth 2.8–2.9m	Ki-6679	animal bone	6560±50	5621–5390	*Telegin* et al. *2000.64*
Puhach II	trench 1, depth 2.4–2.5m	Ki-6678	animal bone	6520±60	5615–5363	*Telegin* et al. *2000.64*
Puhach II		Ki-3030	charcoal	5920±60	4962–4619	*Tovkajlo 1996.24*
Savran		Ki-6654	animal bone	6985±60	5986–5744	*Telegin* et al. *2000.64*
Savran	"dwelling" 2	Ki-6653	animal bone	6920±50	5969–5716	*Telegin* et al. *2000.64*
Sokiltsi I	Complex 1	Ki-8165	animal bone	7260±80	6350–5988	*Kotova 2002.103*
Sokiltsi II	depth 140cm	Ki-6697	animal bone	7470±60	6438–6232	*Telegin* et al. *2000.64*
Sokiltsi II	depth 120cm	Ki-6698	animal bone	7405±55	6416–6102	*Telegin* et al. *2000.64*
Soroca II	layer 3	Bln-588*	charcoal (*Fraxinus sp.*)	7515±120	6596–6099	*Quitta, Kohl, 1969.250*
Soroca II	layer 2	Bln-587*	charcoal (*Ulmus sp.*)	7420±80	6435–6097	*Quitta, Kohl, 1969.250*
Soroca II	1964, from pit within upper layer I; depth 3.3–3.5m	Bln-586	charcoal (*Fraxinus sp.*)	6830±150	5998–5491	*Quitta, Kohl, 1969.250*

Site	Context	Lab No	Material	^{14}C age BP	Calibrated age cal BC (2σ)	Reference
Soroca III		KiA-4159	horse tooth	9950±70	9758–9713	*Wechler 2001.29*
Soroca III		Gd-11297	shell	8430±90	7602–7192	*Wechler 2001.29*
Soroca III		??	??	6750±100	5840–5488	*Yanushevich 1989.609*
Soroca III		KiA-4158	deer bone	5560±60	4526–4273	*Wechler 2001.29*
Soroca V	1966, from fireplace at 2 m depth	Bln-589	charcoal (*Fraxinus sp.*)	6495±100	5631–5235	*Quitta, Kohl 1969.250*
Tashlyk II	square III-23, depth 2.34m	Ki-10789	animal bone	6160±60	5292–4948	*Fomenko* et al. *2014.Tab. 3*
Tătărăuca Nouă XIV		Gd-9697	animal bone	5370±170	4548–3796	*Wechler 2001.29*
Tătărăuca Nouă XV	square D26 "bottom" (on shell midden 10), depth 1.10m	KiA-3705b ***	food crust	6340±70	5478–5081	*Wechler 2001.30*
Tătărăuca Nouă XV	square D26 "bottom" (on shell midden 10), depth 1.10m	KiA-3705a	food crust	5960±230	5366–4362	*Wechler 2001.30*
Tătărăuca Nouă XV	square E15, depth 1.25m, within shell midden	KiA-4160	antler	5900±40	4882–4690	*Wechler 2001.30*
Tătărăuca Nouă XV		Gd-9693	animal bone	5220±70	4242–3811	*Wechler 2001.29*
Ziankivtsi II		Ki-6694*	animal bone	7540±65	6494–6244	*Telegin* et al. *2000.64*

*	– dates, which were originally linked with the Final Mesolithic (or "Pre-Pottery Neolithic") materials
**	– repeated dating of sample Ki-11241
***	– repeated dating of sample KiA-3705a
dark shading	– too high or low dates, which are considered 'non-Neolithic' without discussion

<table>
<tr><th>Autor</th><th colspan="7">Periods and phases</th></tr>
<tr><td rowspan="2">Valentyn Danylenko (1969.48, 49)</td><td colspan="3">Early</td><td colspan="2">Developed</td><td colspan="2">Late</td></tr>
<tr><td>Ziankivtsi</td><td>Skybyntsi</td><td>Sokiltsi</td><td>Pechera</td><td>Samchyntsi</td><td>Savran</td><td>Khmilnyk</td></tr>
<tr><td>Viacheslav Markevich (1974.136–141)</td><td>I</td><td colspan="2">II</td><td>III</td><td>IV</td><td>V</td><td>–</td></tr>
<tr><td>Ruth Tringham (1971.97)</td><td>–</td><td colspan="3">Early</td><td>Middle</td><td colspan="2">Late</td></tr>
<tr><td>Dmytro Telehin (1977.90)</td><td>–</td><td colspan="3">Pechera</td><td>Samchyntsi</td><td>Savran</td><td>–</td></tr>
<tr><td>Klaus-Peter Wechler (2001.30–31) – Dnister</td><td>–</td><td colspan="3">Early</td><td colspan="2">Late</td><td>–</td></tr>
<tr><td>Klaus-Peter Wechler (2001.52–54) – S. Buh</td><td>–</td><td colspan="3">Early</td><td>Middle</td><td colspan="2">Late</td></tr>
<tr><td>Nadiia Kotova (2002.19–21)</td><td>–</td><td colspan="3">Early</td><td colspan="2">Late</td><td>–</td></tr>
<tr><td>Mykola Tovkailo (2014.235–239)</td><td>Pre-Pottery</td><td colspan="3">Early</td><td>Middle</td><td colspan="2">Late</td></tr>
</table>

Tab. 2. Comparing of the BDC periodization schemes.

Sample No.	Sample weight (mg)	Residue after AAA treatment (mg)	Residue after AAA treatment (%)	Oxidation weight (mg)	CO_2 weight (mg)	CO_2 content (%)
Shum-1c	5.3	1.5	27.8	1.5	0.7	49.0
Shum-1t	188.5	93.4	49.6	66.1	2.3	3.5
Hlyn-2t	233.5	132.4	56.7	77.7	0.9	1.1
Hlyn-3t	291.2	207.1	71.1	100.0	0.6	0.6
Bazk-4t	257.5	164.5	63.9	53.0	0.4	0.7
Bazk-5t	273.9	195.0	71.2	91.8	1.0	1.1
Bazk-6t	211.6	127.9	60.4	83.7	2.0	2.4
Bazk-7t	324.4	223.3	68.8	97.6	0.7	0.7
Bazk-8t	229.0	122.1	53.3	84.7	1.0	1.1
Bazk-9c	7.8	2.6	33.0	0.8	0.2	21.3
Bazk-9t	197.1	99.6	50.5	66.2	3.7	5.6

Tab. 3. Chemical treatments of the samples.

Sample No	Vessel No	Figure	Material	^{14}C age BP (1σ)	Calibrated age cal BC (2σ)	Lab No	$\delta^{13}C$ (‰, AMS)
Shumyliv-Cherniatka							
Shum-1c	–	2	Charred residues (inner)	5725±30	4683–4491	TKA-20826	–23.6±0.2
Shum-1t	–	2	Organic inclusions in the pottery paste	5805±25	4723–4558	TKA-20827	–29.5±0.2
Hlynske I							
Hlyn-2t	16	4	Organic inclusions in the pottery paste	7080±30	6016–5899	TKA-20828	–24.2±0.3
Hlyn-3t	7	5	Organic inclusions in the pottery paste	7795±30	6686–6532	TKA-21090	–22.7±0.5
Bazkiv Ostriv							
Bazk-4t	23	8	Organic inclusions in the pottery paste	7710±25	6597–6477	TKA-20829	–25.8±0.4
Bazk-5t	1	9	Organic inclusions in the pottery paste	6855±30	5807–5666	TKA-20830	–26.4±0.5
Bazk-6t	22	10	Organic inclusions in the pottery paste	6625±25	5621–5514	TKA-20831	–28.4±0.2
Bazk-7t	21	11	Organic inclusions in the pottery paste	6970±25	5972–5769	TKA-20832	–24.8±0.3
Bazk-8t	2	12	Organic inclusions in the pottery paste	6190±35	5288–5030	TKA-20833	–24.0±0.6
Bazk-9t	39	13	Organic inclusions in the pottery paste	6040±25	5211–5000	TKA-20834	–28.2±0.3
Bazk-9c	39	13	Charred residues (inner)	6145±35	5003–4847	TKA-21091	–23.0±0.4

Tab. 4. Radiocarbon ages of the samples.

Sample No	Calibrated age cal BC (2σ)	Vessel No	Pottery type	Shell	Waterworn sand and gravel	Impressions of algae?
Shumyliv-Cherniatka						
Shum-1c	4683–4491	–	Savran	+	–	+
Shum-1t	4723–4558					
Hlynske I						
Hlyn-2t	6016–5899	16	Pechera-Kriş?	–	–	–
Hlyn-3t	6686–6532	7	Pechera-Skybyntsi?	+	–	+
Bazkiv Ostriv						
Bazk-4t	6597–6477	23	Skybyntsi	+	+	+
Bazk-5t	5807–5666	1	Samchyntsi	–	+	+
Bazk-6t	5621–5514	22	Skybyntsi	+	–	+
Bazk-7t	5972–5769	21	Skybyntsi	+	+	+
Bazk-8t	5288–5030	2	Samchyntsi	–	–	+
Bazk-9c	5003–4847	39	Samchyntsi	–	–	+
Bazk-9t	5211–5000					

Tab. 5. Admixtures of possible aquatic origin in the pottery paste of dated vessels.

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The chronology of Jäkärlä Ware – Bayesian interpretation of the old and new radiocarbon dates from Early and Middle Neolithic southwest Finland

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ABSTRACT – *The chronology of the eastern Fennoscandian Neolithic is organized with the help of pottery styles, one of which is southwestern Finnish Jäkärlä Ware. In this paper a number of new radiocarbon dates connected with Jäkärlä Ware and other relevant ceramic groups are presented and discussed. The radiocarbon dates of each group are modelled within a Bayesian chronological framework. Also, the potential reservoir effect in charred crust dates is estimated for each date based on stable carbon isotopic ratios of the crust samples and incorporated into models. Jäkärlä Ware appears to be a short-living and quite a isolated group, which had no chronological contacts with Sperrings 1–2 Wares, but with possible coexistence with Middle Neolithic Typical Comb Ware. Jäkärlä Ware is partly simultaneous with eastern Finnish asbestos-tempered Kaunissaari Ware, and forms with it a short chronological horizon in the turn of the Early and Middle Neolithic of eastern Fennoscandia.*

KEY WORDS – *Bayesian modelling; Early and Middle Neolithic; Eastern Fennoscandia; chronology; radiocarbon dates*

Kronologija posod tipa Jäkärlä – Bayesova interpretacija starih in novih radiokarbonskih datumov iz časa zgodnjega in srednjega neolitika na območju JZ Finske

IZVLEČEK – *Neolitska kronologija na območju vzhodne Fenoskandije je organizirana s pomočjo okrasov na lončenini, ene izmed njih so tudi posode tipa Jäkärlä iz območja jugo zahodne Finske. V članku predstavljamo in razpravljamo o številnih novih radiokarbonskih datumih, vezanih na te posode in druge pomembne keramične skupine. Datume vsake od predstavljenih keramičnih skupin smo modelirali z Bayesovim kronološkim okvirjem. Ocenjujemo tudi morebitne efekte rezervoarja na podlagi razmerij stabilnih izotopov ogljika pri datumih, pridobljenih iz zoglenelih organskih ostankov na keramiki, kar smo nato vključili tudi v modeliranje. Posode tipa Jäkärlä kažejo na skupnost, ki je živela izolirano in le kratko časovno obdobje ter ni imela nobenih kronoloških povezav s posodami tipa Sperrings 1-2, opažamo pa določeno sobivanje s srednje neolitskimi posodami z značilnim glavničastim okrasom. Posode tipa Jäkärlä so tudi sočasne s posodami Kaunissaari iz območja vzhodne Finske, ki imajo dodan azbest, in skupaj z njimi sestavlja kratek časovni horizont na prehodu zgodnjega v srednji neolitik na območju vzhodne Fenoskandije.*

KLJUČNE BESEDE – *Bayesovo modeliranje; zgodnji in srednji neolitik; vzhodna Fenoskandija; kronologija; radiokarbonski datumi*

 DOI: 10.4312/dp.46.15

Introduction

Jäkärlä Ware, or Jäkärlä pottery, is a special Early Neolithic group of ceramics with a distinctively south-western Finnish distribution. Traditionally, Jäkärlä Ware has been dated contemporary with the younger style of Early Comb Ware (Sperrings 2 or Ka 1:2) and the beginning of Typical Comb Ware (Ka 2) in Finland. What makes Jäkärlä Ware sites different, *e.g.,* to certain sub-groups within Sperrings 2, is the more differentiated stone tool inventory than in these groups, giving grounds to call Jäkärlä Ware sites a separate group differing from the Early Comb Ware sites.

The chronology of the Jäkärlä group has been a subject of discussion ever since the realization of its typological peculiarity among other comb ceramic groups. First, Jäkärlä Ware was interpreted as a local south-western Finnish variant of Early Comb Ware 1:2, but chronologically belonging to the time of Typical Comb Ware because Jäkärlä Ware was found together with Typical Comb Ware in the Eura Lammila site (*Europaeus-Äyräpää 1930.178–179*). In the eponymic Turku Jäkärlä site the style is succeeded by Typical Comb Ware, and Europaeus-Äyräpää saw Jäkärlä Ware as a delayed phenomenon of Ka 1:2. This was the state of art formulated in various studies between the 1910s and 1960s before the advent of radiocarbon dating (*e.g., Europaeus 1916; 1917; 1922; 1925; 1926; Europaeus-Äyräpää 1930; Riska 1945; Luho 1948; 1952; Meinander 1965; Edgren 1966*). A notion put forward especially by Tove Riska (*1945*) was that in southwestern Finland Jäkärlä ceramics replaced style Ka 2:1 of Typical Comb Ware, rather rare in SW Finland, and was thus succeeded by style Ka 2:2 of Typical Comb Ware.

The first radiocarbon dates of charcoal samples from the Jäkärlä Ware sites were produced at the advent of the methodology in Finland from Sauvo Nummenharju (six pcs) and Eura (Honkilahti) Kolmhaara (five pcs). The Nummenharju datings spanned from 6000 to 5000 BP, two Kolmhaara dates were from *c.* 5450–5400 BP, and the others clearly dating to a later period. Carl F. Meinander, who published the dates, used the median value for Nummenharju, 5625 BP, as a date for Jäkärlä group (*Meinander 1971*).

The next set of radiocarbon dates from the Jäkärlä context were derived only twenty years later. Seven charcoal samples were dated in 1990 after a small-scale text excavation on the Jäkärlä site Nöjis in Dragsfjärd (now Kemiönsaari). Curiously enough, these dates are generally younger than the ones from Nummenharju and spanning over 600 radiocarbon years, the median value being 4710 BP (*e.g., Asplund 1995*).

In 1969, Ari Siiriäinen dated the Jäkärlä group according to shoreline chronology into the periods of Ka 1:2 and Ka 2:1. The dating was not unambiguous, but nevertheless it showed that Jäkärlä Ware would belong to the end period of the Ka 1:2 rather than to its beginning (*Siiriäinen 1969.65–66*). Later, Siiriäinen pointed out that the radiocarbon dates from Nummenharju are generally too old for the shoreline chronology, showing that the younger limit of the dates is of the age expected while the older limit is at least 500 years more than expected (*Siiriäinen 1973.11*). In the chronological diagram, Jäkärlä Ware remained an entity without a beginning or an end (*Siiriäinen 1973.18*). The strong discrepancy between the radiocarbon dates and the shoreline position of the Nummenharju site has been pointed out more recently (*Tiitinen 2011.60*). In several studies, the problems with the geological shoreline curves for the Southwest Finland have also been put forth (*Lehtonen 2005; Asplund 2006; Tiitinen 2011*).

The chronological position and the development succession of the Jäkärlä ceramics have been discussed most extensively by Henrik Asplund (*e.g., 1990; 1995; 1997; 1998*). He maintains the validity of Nummenharju and Nöjis radiocarbon dates, building a line of succession between Ka 1:1 and Pyheensilta Ware, via Jäkärlä Ware. Pyheensilta Ware is a Late Neolithic ceramic group with some common traits and technology with Jäkärlä Ware. Moreover, the connection between Jäkärlä Ware and Uskela Ware (style Ka 3:1 of Late Comb Ware) was proposed earlier (*Vikkula 1981.65–67*).

With this background of mixed cultural connections and long time span of *c.* 1500 years, it is obvious that the dating and also the cultural position of the Jäkärlä Ware is far from clear. In this paper an attempt to give this group a solid chronological background is made and some notes on the cultural affiliations of the group are also presented. The new radiocarbon dates from short-lived materials combined with those from other sources provide us with the possibility to examine the shoreline chronology once more. In this paper the phase chronology of Jäkärlä Ware is established with a Bayesian approach built in the Oxcal calibration programme (*Bronk Ramsey*

2009a) that allows for coherent testable quantitative estimates for timing of cultural phases. This same approach is used for other ceramic/cultural groups in the typo-chronological environment in the Early and Middle Neolithic southwestern Finland. Essential ceramic groups in this connection are Sperrings 1 and 2 (Early Comb Ware 1 and 2), Typical Comb Ware and Late Comb Ware.

Early and Middle Neolithic ceramic types in Eastern Fennoscandia

The earliest Neolithic ceramics in southwestern Finland are called Sperrings Ware or Early Comb Ware. Its origins lie in the Comb-stamp decorated ceramic traditions developed in the northern taiga zone of Eurasia, first appearing *c.* 6000–5500 cal BC in the north-eastern part of European Russia (*Karmanov* et al. *2014*), with possible predecessors even further east (*Vybornov* et al. *2014; Kosinskaya 2014*). Sperrings Ware has its ceramic roots in the Upper-Volga area, where it developed and from where it spread to north-western Russia and Finland (*Piezonka 2015; Nordqvist 2018*). The earlier Sperrings 1 Ware tradition continued in the later Sperrings 2 Ware, which was however limited mainly to Finland, and not to Karelia, where Pit-Comb Ware prevailed after Sperrings 1 ceramics (*Nordqvist, Mökkönen 2016*). In southwestern Finland the succession of ceramic types and/or cultures continued with Typical Comb Ware and Late Comb Ware, of which Late Comb Ware is a markedly southern/western coast type, while several ceramic types after Typical Comb Ware appeared inland (*e.g., Carpelan 1979; Vikkula 1981; Nordqvist 2018*).

Some of the prominent sites of the Sperrings 1 Ware (Early Comb Ware 1 or Ka 1:1, Fig. 1a) are known in Southwest Finland, *e.g.*, Kokemäki Kraviojankangas site in Satakunta. It seems that Sperrings 1 Ware does not have chronologically much in common with the Jäkärlä Ware, even though the earliest dates from Sauvo Nummenharju site would fit into this period (*e.g., Pesonen* et al. *2012*). In contrast, Sperrings 2 Ware (Early Comb Ware 2 or Ka 1:2, Fig. 1.b-c) has often been considered as a contemporary phenomenon with the Jäkärlä Ware and these both as later developments following Sperrings 1 Ware. Within this sequence of events, Typical Comb Ware was thought as an interference disturbing the development. However, the people producing Typical Comb Ware and Jäkärlä Ware were speculated to have lived together in the same area for some time (*e.g., Meinander 1965; Edgren 1966; Asplund 1995; 1998*). This situation of cultural melange makes it interesting to try to find out the chronological niches of these other ceramic groups in southwest Finland during the time.

Sperrings 1 Ware was the earliest type of ceramic in southern Finland, and it spread all the way to southern Lapland and Russian Karelia. Sperrings 1 Ware is roughly contemporaneous with the northern Säräisniemi 1 Ware. These two ceramic styles also have a common distribution in northern Ostrobothnia, southern Lapland and Russian Karelia (*e.g., Piezonka 2015*). In an earlier study (*Pesonen* et al. *2012*) the chronological boundaries for Sperrings 1 ceramics were defined for the northern and southern part of the eastern Fennoscandia separately. In the southern part of the distribution area Sperrings 1 Ware was dated *c.* 5145–4400 cal BC with the continuation of Sperrings 2 Ware *c.* 4400–4175 cal BC.

Typical Comb Ware (Ka 2; Fig. 1h) succeeded earlier ceramic types in many areas, and did not spread any further north than Sperrings Ware did. Among other things, the more or less common distribution has led to the assumption that there was a continuum from Sperrings to Typical Comb Ware, even though the central cultural attributes within these two ceramic carrying traditions differ a lot. For example, the use of semi-subterranean houses, richly furnished graves and contacts to the amber and flint areas are almost extinct within Sperrings Ware while they are common in Typical Comb Ware sites (*e.g., Meinander 1984; Carpelan 1999; Pesonen 2002; Nordqvist, Mökkönen 2015; Mökkönen, Nordqvist 2016*).

Late Comb Ware was the third stage in the Äyräpää's succession of comb ceramics. It was first defined as a 'degenerated style' of Typical Comb Ware (*Europaeus-Äyräpää 1930.183*). Later on, this pejorative denomination was largely rejected and the role of Late Comb Ware and its connections realized (*e.g., Vikkula 1981*). In particular, a possible stylistic and chronological connection between Jäkärlä and Late Comb Ware has been suggested (*e.g., Asplund 1995; 1998*).

Jäkärlä Ware and its setting in southwestern Finland

Jäkärlä Ware characteristics

Jäkärlä ceramics, *i.e.* Jäkärlä Ware of the Jäkärlä group, was defined according to ceramics analysed from 22 settlement sites known by 1965 (*Edgren 1966*). The ceramics are the most important factor

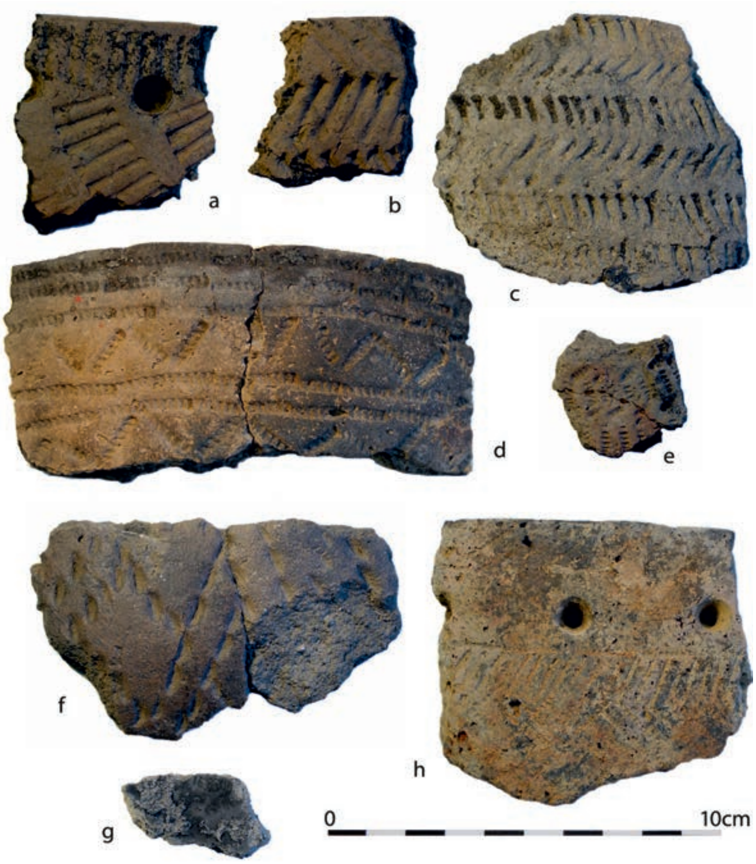

Fig. 1. Examples of radiocarbon dated ceramics in this study. **a** ***Sperrings 1 Ware, Porvoo Böle (KM 17074:724, Hela-3177, 5884±43 BP);*** **b** ***Sperrings 2 Ware, Raasepori Timmerkärr (KM 31635:210, Hela-3170, 5614±41 BP;*** **c** ***Sperrings 2 Ware, Espoo Kläppkärr (KM 31107:399, Hela-3173, 5439±43 BP);*** **d** ***Jäkärlä Ware, Espoo Mynt (KM 13594:392, Hela-3166, 5210±40 BP);*** **e** ***Jäkärlä Ware, Turku Jäkärlä (KM 8063:107, Hela-3169, 5119±42 BP);*** **f** ***Jäkärlä Ware, Lieto Kukkarkoski II (KM 16879:161, Hela-3176, 5130±40 BP, MRE corrected 5096±43 BP);*** **g** ***inner surface of Jäkärlä Ware, Lieto Merola (KM 16879:28, Hela-3172, 5002±40 BP, MRE corrected 4992±40 BP); and*** **h** ***Typical Comb Ware, Nousiainen Kukonharja 2 (KM 38207:21, Hela- 3178, 4829±40 BP, MRE corrected 4560± 137 BP).***

that constitutes the Jäkärlä group, as no other artefact group or solid structure is present in all sites.

The diatom poor clay used in Jäkärlä ceramics is of glacial origin. Such clay deposits are available in the surroundings of many Jäkärlä sites. Jäkärlä ceramic sherds are often very porous, which points to the use of organic substances in tempering. These materials have obviously been dissolved during the taphonomic process in the ground. In some sherds, however, survived pieces of Cardium-shells have been detected among temper material. The firing of Jäkärlä pots presumably happened at a relatively low temperature as the sherds are often grey. Sometimes the surface of the wall has been split away, and this indicates the use of an extra clay slip on the surface (*Edgren 1966.107–109*). The technological choices are different from the other Early Neolithic potteries, where, for example, Sperrings 1–2 pots are often tempered with rock minerals.

The forms of the vessels follow the standard comb ceramic forms, where the most common type is a round-bottomed, unprofiled large jar. Sometimes the rim-part is bent a little inwards. A few occurrences of flat-bottomed jars exist, and some small, low bowl-like vessels and miniature vessels also occur (*Edgren 1966.109; 1983*).

The decoration of Jäkärlä pots covers the whole vessel body, but the rim top decoration occurs very rarely. This is also a common trait in Sperrings 1–2 Wares and Säräisniemi 1 Ware of northern Finland, while in other later or contemporary ceramics Early Asbestos Ware and Typical Comb Ware rim top decoration is dominant. The most common decoration stamps are comb stamps, twisted cord stamps, tube stamps and oval or grain-shaped stamps (*e.g.,* Fig. 1.d-f). The comb stamps are most common, and they are usually oval-shaped and relatively wide. The decoration is overall horizontal (*Edgren 1966.110–111*).

The most distinct peculiarities of Jäkärlä Ware compared to roughly contemporaneous and geographically overlapping ceramic styles (Typical Comb Ware, Sperrings Ware 1–2) are the organic temper material, poorly fired clay (grey in colour), the use of broad and oval comb stamps, and the absence of pit stamps and the rim top decoration. These features make it possible to distinguish Jäkärlä Ware from other ceramic styles in the find material.

However, the typological difference between Jäkärlä Ware and Sperrings 2 Ware is sometimes very difficult to decipher. The use of organic temper is not a rare occurrence in Sperrings 2 Ware, either. Sometimes, only the decoration with broad and oval stamps in Jäkärlä Ware separates it from Sperrings

2 Ware, which is usually decorated with long comb stamps or lines (*Rankama 1982*).

The geographical distribution and natural environment of Jäkärlä Ware sites

Judging by its distribution, Jäkärlä ceramics are a characteristically southwestern Finnish phenomenon. Of the *c.* 50 sites,[1] a vast majority are situated in the southwestern provinces of Varsinais-Suomi and Satakunta (Fig. 2). A number of sites are also spread along the southern coast of Uusimaa and Kymenlaakso, and the most eastern site is situated in Virolahti, near the Russian border. There are two sites on the Åland Islands and a few sites in the provinces of South and North Ostrobothnia, the northernmost site lies in Kalajoki, in North Ostrobothnia. Due to the rebounding of the earth's crust after the Ice Age, the sites are today in the inland, but all the evidence points to the fact that they were without exception once maritime and coastal sites.

In the Middle Holocene, during the Jäkärlä period, the climate was optimal and this contributed to increased productivity and greater availability of natural resources. The forests were composed mainly of pine and broad-leaved trees, with water chestnut thriving in small ponds, *etc*. (*e.g., Tallavaara 2015. 48–49; Tallavaara, Seppä 2012*). The Jäkärlä sites were situated at the coast, near to both maritime and terrestrial resources (*e.g., Tiitinen 2011*). The lipid analyses conducted recently on Jäkärlä ceramics also show the use of both resources (*Papakosta, Pesonen 2019; Pääkkönen* et al. *2016*).

The Jäkärlä pottery was obviously used for cooking both terrestrial and aquatic products. So far there have been no osteological analyses connected directly with Jäkärlä Ware. In the eponymous Turku Jäkärlä site, seal and fish dominate, but the osteologial material is limited and the context is mixed (*Pääkkönen* et al. *2016.70*). The aquatic/maritime orientation of the Jäkärlä group and its ceramics must be kept in mind. The radiocarbon dates conducted on the Jäkärlä pottery food crust are thus vulnerable to the marine reservoir effect (see later).

Pure contexts of Jäkärlä Ware are rare. For a long time only the Sauvo Nummenharju site was known, but later other sites with only Jäkärlä ceramics were discovered, *e.g.*, Kemiönsaari Nöjis (*Asplund 1990; 1995*). But from the chronological point of view, the mixed sites also tell stories. In Finnish coastal conditions, the mixing of chronologically different cultural items principally happens only during a fairly limited time period, when the shoreline was still close enough to the settlement site. The mixing thus gives a chronological hint for the dating of Jäkärlä Ware. Of the *c.* 50 sites with Jäkärlä ceramics, two are mixed with Sperrings 1 Ware, ten with Sperrings 2 Ware and 20 with Typical Comb Ware. Late Comb Ware (aka. Uskela ceramics) occurs in eight sites together with Jäkärlä Ware, Corded Ware at 11 sites and Pyheensilta Ware at six sites. Bronze Age and Iron Age ceramics are also featured in some sites. It thus seems that Jäkärlä Ware would have a common geographical contact mainly with Sperrings 2 Ware and Typical Comb Ware.

Material and methods

Radiocarbon dating procedures

For this paper, 18 samples from charred crust of ceramics and burnt bone were radiocarbon dated (eight samples of Jäkärlä Ware, two samples of Sperrings 1 Ware, four samples of Sperrings 2 Ware and four samples of Typical Comb Ware). The chemical pretreatment protocol for the charred crust samples followed an acid-alkali-acid (AAA) treatment (*Taylor, Bar-Yosef 2014.93*). The protocol for burnt bones was according to Dorien Lanting *et al.* (*2001*). The pre-treated samples were converted to CO_2 either by combusting (charred crusts) or acid release (burnt bones) after which the CO_2 samples were converted to graphite targets (*Slota* et al. *1986*) by chemical reduction. The AMS radiocarbon measurements were carried out by the Uppsala Tandem Laboratory (*Possnert 1984*) on these graphite targets. All conversions to calendar years were performed using the Oxcal software (*Bronk-Ramsey 2009a*) and with the Intcal13 radiocarbon calibration curve (*Reimer* et al. *2013*).

The data selection

Additional radiocarbon dates were gathered from the database collected during the Argeopop-project (*Pesonen, Sundell 2011*) and most of these have already been published in several papers (*e.g., Pesonen* et al. *2012; Oinonen* et al. *2014*). The original dates are reproduced in Appendices (1–2). Even though Jäkärlä Ware is the focus of this paper, it is necessary to also deal with the other ceramic groups relevant in this connection, which are Sperrings 1 Ware, Sperrings 2 Ware, Typical Comb Ware and Late Comb Ware. The Sperrings 1–2 and Late Comb

1 The exact number of sites is not fixed, as the identification of Jäkärlä Ware in some sites remains uncertain.

Ware dates are so far so few that only Typical Comb Ware could be studied separately for southwestern Finland, with regard to the main distribution area of Jäkärlä Ware. Sperrings 1–2 Wares and Late Comb Ware were studied for the whole area of Finland.

There are currently 69 radiocarbon dates available from sites where Jäkärlä Ware has also been discovered (Appendix 1 at http://dx.doi.org/10.4312/dp.46.15). Inevitably, many of these sites are multiperiodic, and thus a large proportion of the radiocarbon dates lack a proper context. Altogether 31 dates from 11 archaeological sites were deduced to be in close contact with the Jäkärlä pottery ('class 2' dates; see later). Of these, ten dates are charred crust from the pottery surface, one is a burnt bone date, one is

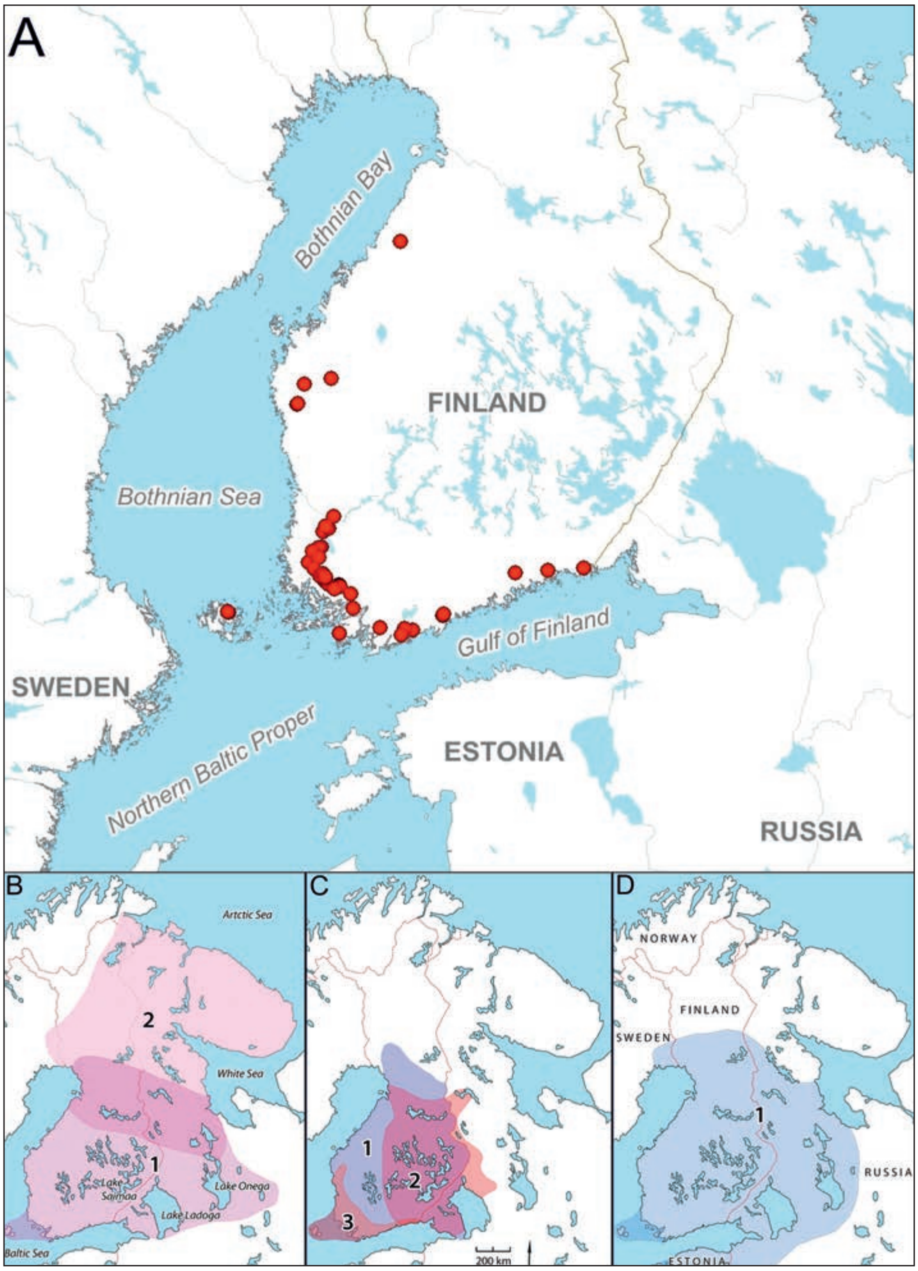

Fig. 2. Early and Middle Neolithic ceramics in Finland. **A** ***The distribution of Jäkärlä Ware in the former coast of the Baltic Sea. The list of sites is in Appendix 3 at http://dx.doi.org/10.4312/dp.46.15;*** **B** ***The first half of the Early Neolithic. 1 Sperrings 1 Ware; 2 Säräisniemi 1 Ware;*** **C** ***The second half of Early Neolithic. 1 Sperrings 2 Ware; 2 Asbestos-tempered Sperrings 2 and Kaunissaari Wares; 3 Jäkärlä Ware;*** **D** ***Early Middle Neolithic. 1 Typical Comb Ware. The distribution of the Late Comb Ware (Uskela Ware) coincides roughly with that of Jäkärlä Ware, though several variants of Late Comb Ware are present also in the Finnish inland and Baltic States (*****e.g.*****, Nordqvist 2018). Maps*** **B-D** ***from*** **Nordqvist, Mökkönen 2017**, ***published with a permission from the authors. Original design of maps*** **B-D** ***by Kerkko Nordqvist, modified by Petro Pesonen.***

a charred nut date and the rest are traditional charcoal dates. Most of the charred crust dates and the single burnt bone dating were performed for this paper, with the exception of one crust date from the Turku Jäkärlä site (*Pääkkönen* et al. *2016*) and two crust dates from the Nousiainen Kukonharju 2 site made earlier (unpublished).[2] Most of the charcoal dates have already been published (*Meinander 1971; Asplund 1995*), but one date from the Turku Jäkärlä site has been published only in the date list and in the related open-access database (*Junno* et al. *2015*). Three dates from the Nousiainen Rauanniittu site and three dates from the Eura Kolmhaara site have not been published before.[3]

For the other periods similar screening of dates was applied, even though it is sometimes difficult for the samples from multiperiod sites. For the Sperrings 1 and 2 Wares, those dates sampled from gyttja layers or having unknown origin were left out altogether. The same applies in principle also to the Typical and Late Comb Ware dates.

Because the charcoal dates typically have much larger error margins and also because of potential error sources in the samples themselves, the calibration runs were performed for each period also just on charred crust and birch bark dates. Luckily, the corpus of crust and birch bark tar dates has gradually grown, so these kind of general, phasewise dating schemes are now possible to make. Altogether 350 dates were applied in this study (Jäkärlä dates included in the count), and of these 152 are charred crust and birch bark tar dates (see Appendix 2 at http://dx.doi.org/10.4312/dp.46.15). As for the Jäkärlä dates, most of these have also been published earlier in various papers and in the open-access database (www.oasisnorth.org/14carhu), but some are published for the first time in this paper with the permission of the original samplers.

Radiocarbon dates in Jäkärlä Ware context

Charcoal dates from Jäkärlä sites have a wide chronological variation spanning from 5990±180 BP (Hel-48) to 4490±120 BP (Hel-2816), while more reliable charred crust dates show a much shorter timeslice for the ceramics from 5230±41 BP (Hela-2660) to 5055±41 BP (Hela-3076). One charred crust date (7450±49 BP; Hela-3075) is over 2000 radiocarbon years older than the other crust dates and 2400 radiocarbon years older than the other charred crust dating from the same site (5055±41 BP; Hela-3076). It turned out, however, that there was probably some glue or conservation liquid in the dated sherd (glued together from two pieces), which may have contaminated the result as the glue was probably made of fossil (*i.e.* old radiocarbon-free) material, and was thus likely resistant against the chemical pretreatment. When calibrated, the mean result is 6325±55 cal BC,[4] which is more than 1000 years older than any ceramic date from Finland and neighbouring areas. This date is thus rejected as potentially contaminated. The other charred crust dates seem to be reliable as far as it is possible to judge from the successful analysis procedure and results.

The charcoal datings of Jäkärlä Ware are problematic, as 1500 radiocarbon years for an otherwise very local and even an 'introvert' cultural feature seems to be an unexpectedly long time period. In the following, the reliability of the each charcoal series is discussed.

According to shoreline chronology, the older end of the Sauvo Nummenharju dating series seem in particular to be anomalously old (*Siiriäinen 1973.11*). Siiriäinen observed, that "*it may be a question of the excessive dispersion which has been generally observed in datings obtained from the hearth charcoal of settlements*" (*Siiriäinen 1973.11* with references). Nummenharju remains an enigmatic site, as the context of the samples seems to be fairly good. One further reason to suspect the charcoal dates of the site is however a new burnt bone result from the area (Hela-3165; 4926±35), which is *c.* 100 radiocarbon years younger than any of the charcoal dates from the site and it obviously fits fairly well also in the shoreline chronology (*cf. Tiitinen 2011*). However, the $\delta^{13}C$-value of the burnt bone is considerably higher than any other values in the data set, –12.7 ‰. This resembles a highly marine value, and probably shows the conservation of the marine signal in the sample despite the burning process (see discussion on the burnt bone dates below).

In contrast, the dating series from the Kemiönsaari Nöjis site is from the lower end of the whole sequence, with a span of *c.* 600 radiocarbon years.

2 The dates from Nousiainen Kukonharju 2 were initiated by Simo Vanhatalo, Finnish Heritage Agency (*Vanhatalo 2010*).

3 The dates from Nousiainen Rauanniittu were initiated by Simo Vanhatalo (*Vanhatalo 1991*), and the dating from Eura Kolmhaara by Päivi Kankkunen, of the Finnish Heritage Agency (*Kankkunen 2005*).

4 In this paper, all calibrations are made with Oxcal v. 4 or later (*Bronk Ramsey 2009a*) and the atmospheric data is from Reimer *et al.* (*2013*).

	charred crust	birch bark tar	black paint	chewing resin	burnt bone	charred nut shell	charcoal	wood	altogether
Sperrings 1	35	5	1		8		33		82
Sperrings 2	18						8		26
Jäkärlä (class 1 and 2)	10				1	1	19		31
Typical Comb Ware	24	48		13	12	2	84	5	188
Late Comb Ware	9	3			1	2	8		23
altogether	**96**	**56**	**1**	**13**	**22**	**5**	**152**	**5**	**350**

Tab. 1. The radiocarbon dates and sample material in each ceramic group.

There is no clear information how the Nöjis dates were obtained, but by the nature of the excavation (test pitting) it is reasonable to suspect they are charcoal pieces collected from the cultural layer, which are not very reliable in normal circumstances as they may as well derive from forest fires and the like. However, most of the Nöjis datings are in fairly good accordance with the shoreline chronology.

One of the oldest datings in the Jäkärlä series is a charcoal dating from the Eura Kolmhaara site (5850± 90; Hel-4612). There are many other dates, but they are usually thought to belong to the Typical Comb Ware phase of the site. However, it is noteworthy, that there are also two quite early Typical Comb Ware context dates which were also dated in the same era as the above-mentioned Sauvo Nummenharju dates (Hel-39, 5430±160 BP and Hel-20, 5410± 150 BP). These are 250 radiocarbon years older than the oldest charred crust Typical Comb Ware date from Kolmhaara (Hela-362; 5155±60 BP), which itself is almost 400 radiocarbon years older than two AMS-dates from charcoal and charred nut from the site (Hela-651, 4775±65 BP and Hela-650, 4710± 55 BP), which are from the Munasaari part of the site, interpreted primarily as a Jäkärlä group part in the Kolmhaara site. There thus seems to be a pattern which gives older dates for those radiocarbon dates conducted in the early years of radiocarbon dating in Finland, but also a pattern which gives old dates for the charcoal samples in the region in general when using the conventional dating method. It is however obvious that, judging from the Kolmhaara dates alone, the Jäkärlä and Typical Comb Ware are contemporaneous phenomena. According to the excavation report, the above-mentioned old date Hel-4612 is from a fireplace stratigraphically below the other fireplaces in the site, which were dated to the Jäkärlä period (*Kankkunen 2005*) giving grounds for rejecting this date from the Jäkärlä context. The other two dates (Hela-650 and Hela-651) are from the same excavation and are interpreted to derive from a Jäkärlä context. However, these two dates are considerably younger than the other dates of the site and other dates with Jäkärlä contexts elsewhere. Thus a doubt arises as to whether they truly represent Jäkärlä Ware.

The Nousiainen Rauanniittu site might be a pure Jäkärlä group site, or at least no other ceramic types have been found in the site so far. The site was test excavated in 1988 (*Vanhatalo 1991*). The excavation is well documented and the radiocarbon dates seem to be from reliable contexts in the fireplaces. The importance of the site is further attested by the presence of a potential pithouse in the site, which is unique if truly assigned to the Jäkärlä group. Apart from two charred crust dates, one charcoal date from the Turku Jäkärlä site also exists. This was collected in 1985, but on the basis of the excavation report alone (*Salo, Laukkanen 1986*) the context of the date is impossible to define, so this date is eventually rejected.

After such scrutiny only 15 dates were thought reliable enough, and most probably connected with the Jäkärlä Ware (class 1 dates). However, it is useful to make runs also with all 31 dates (class 2 dates) in order to see how great an effect the new dates really have on the dating of the whole cultural group.

Radiocarbon dates in Sperrings 1–2 Ware, Typical Comb Ware and Late Comb Ware contexts

Sperrings 1 and 2 Wares are also present in the Karelian Republic and Leningrad oblast in Russia (*German 2009; Nordqvist, Mökkönen 2016*). A number of radiocarbon dates also derive from this region and these were used in this study too. Altogether 82 radiocarbon dates are from the Sperrings 1 context and 26 from the Sperrings 2 context. Five Sperrings 1 Ware dates and six Sperrings 2 Ware dates are published for the first time in this study, and six of these samples were dated by the authors for this work. The seven oldest radiocarbon dates are from Sperrings 1 contexts in the Karelian Republic and Leningrad oblast, and six of these are from charcoal samples and one from a burnt bone sample (*e.g., Piezonka 2008; German 2009; Nordqvist, Mökkönen 2016*). The burnt bone from Sulgu 2 site is the oldest of all, 6670±35 BP (KIA-35900), but it may well derive from settlement use in Mesolithic times (*Piezonka 2008*). The oldest context date from Finland is from a burnt bone sample in the Erolanniemi site in Kontiolahti, eastern Finland, 6267±44 BP (Hela-2557), and the oldest charred crust date is from the Uja III site in the Karelian Republic, Russia, dated to 6225±40 BP (GrA-63566; *Nordqvist, Mökkönen 2016*).

The contact period between Sperrings 1 and 2 Wares has previously been studied with the help of Bayesian modelling with a two-phase model, and the boundary between successive phases was estimated to be *c.* 4400 cal BC (*Pesonen* et al. *2012*). There is a group of radiocarbon dates younger than this limit in the Sperrings 1 context, and a number of dates older than this in the Sperrings 2 context. The youngest date within the Sperrings 1 context is from the Haasiinniemi site in Lieksa, eastern Finland, dated to 5240±110 BP (Hel-3574), and oldest date within the Sperrings 2 context is from the Kivimäki site in Pielavesi, central Finland, dated to 5680±40 BP (GrA-62077). Thus major overlap may occur for several reasons: 1) a true, slow shift of styles, 2) problems in defining the ceramic styles, and 3) problems in specifying the context of the sample.

Sperrings 2 dates are not as numerous as Sperrings 1, but there are now enough of them to form a picture of its chronological framework. The youngest Sperrings 2 dates are clearly overlapping with the Typical Comb Ware dates, but it is noteworthy that none of the direct datings (charred crust and birch bark tar) overlap, as the youngest Sperrings 2 charred crust is from the Summassaari Uimaranta site in central Finland and dated to 5335±45 BP (Hela-642), while the oldest Typical Comb Ware charred crust is from the Törmävaara site in northern Finland and dated to 5160±100 BP (Hela-78).

Typical Comb Ware is present in great numbers also in northwest Russia, the Baltic states and to some extent also in Sweden. Accordingly, a number of radiocarbon dates exist also from these regions, but for the purpose of this study only some samples from Leningrad oblast and the Karelian Republic were taken along in the study, as there are many Typical Comb Ware contexts and direct dates from Finland and a few more would not add much to the corpus. As already noted, a number of early Typical Comb Ware contexts dates are available, with the earliest example from the Autioniemi site in Hankasalmi and dated to 5500±170 BP (Hel-30). It was noted already at the end of the 1990s that the early dates derived from charcoal are in strong conflict with the birch bark tar and the charred crust dates (*Pesonen 1999*), and this remains the case. The earliest set of Typical Comb Ware context dates are likely outliers.

The youngest Typical Comb Ware date is from a multiperiod site of Naarajärvi in Pieksämäki, central Finland, dated to 4200±190 BP (Hel-1926), and there are a number of other dates almost as young as this. There is again a strong overlap between Typical Comb Ware and Late Comb Ware dates, as the oldest Late Comb Ware date from the Maarinkunnas site in Vantaa, southern Finland, is 4940±70 BP (Hela-259). The overlap is significant and really comprises the younger part of the whole Typical Comb Ware sequence of dates. The problems in direct seriation of these two ceramic types have already been noted (*Leskinen 2003; Räihälä 1996*). This overlap may have similar causes as the overlap between Sperrings 1 and 2 dates. Late Comb Ware is here understood predominantly as Uskela Ware (as defined by *Vikkula 1981*), because the late forms of Comb Ware and their connection with the other Middle Neolithic ceramic types (*e.g.,* Kierikki, Zalavruga, Orovnavolok and Voynavolok Wares) are not fully understood and studied in the Finnish assemblages (*Mökkönen, Nordqvist 2018*). The distribution of Late Comb Ware (of the Uskela-type) is extended to the Karelian Isthmus (*Kholkina 2018*), but obviously it is mainly a coastal type with other ceramic types dominating in inland Finland during the Late Middle Neolithic. The youngest Late Comb Ware context date is from the Ostrobothnia, Bläckisåsen site in Kokkola, and dated to 4200±60 BP (Su-1568), *i.e.* to the same time as the youngest Typical Comb Ware context date from Naarajärvi in Pieksämäki (see above).

Reservoir effect and other potential error sources

There are many potential error sources affecting the radiocarbon dating results. Besides the obvious potential error sources in sampling, which indeed is one of the most crucial points in the radiocarbon dating procedure, some other error sources in the dated material itself are also a risk. One of the most challenging ones is the so-called reservoir effect. Radiocarbon dating is based on comparison of the measured radiocarbon content of a sample to the known past atmospheric radiocarbon contents. If all the carbon in aquatic environments would be based on just dissolved atmospheric carbon dioxide into water, the radiocarbon content of the aquatic and atmospheric carbon would resemble each other. However, aquatic organisms, marine in particular, contain typically less radiocarbon compared to contemporaneously-living terrestrial organisms due to old dissolved organic carbon in water, to the slower aquatic carbon cycle and to dissolved inorganic carbon from limestone bedrocks. These result in older values for the dates than expected if aquatic carbon is involved.

The amount of marine reservoir effect (MRE) within the Baltic Sea varies according to the assumed geographical origin of carbon from *c.* 400 radiocarbon years at the Danish Straits to *c.* 25–50 radiocarbon years at the bottom of the Bothnian Bay (*Lougheed* et al. *2013*). In the marine conditions of the northern Baltic Sea (between 59° and 66°N latitude), the current average value of the MRE is estimated as 231±113 radiocarbon years (N = 8, CHRONO Marine database, http://calib.org/marine/; Appendix 4 at http://dx.doi.org/10.4312/dp.46.15).[5] One possibility to estimate this systematic offset is to make a correction based on the stable isotope signals ($\delta^{13}C$ and $\delta^{15}N$) in the dated material. The isotopic ratios reflect the marine or terrestrial origin of the food ingredients present in the crust sample, and it is possible to scale down the maximal reservoir effect in each sample based on this data (*Pesonen* et al. *2012; Oinonen* et al. *2013a*).

The $\delta^{13}C$ values of the eight Jäkärlä charred crust dates vary between –27.1 and –19.5‰.[6] These values are in line with the other charred crust values obtained in Finland (*Pesonen* et al. *2012.665*). Generally, the average value for terrestrial samples in the food residue is about –26‰ (*Fischer, Heinemeier 2003.460–461; Pesonen* et al. *2012*). As the Jäkärlä sites have been considered to situate at the marine shoreline, it is assumed that aquatic influence is essentially also marine, and thus any potential freshwater influence would be minimal. Four of the charred crust dates have values over –26‰, but only the samples from the Nousiainen Kukonharju 2 site have a clear marine signature (–19.5 and –20.8‰) and the potential of the reservoir effect must thus be considered. Interestingly, another one of these Kukonharju 2 dates is the oldest crust date of Jäkärlä Ware. The reservoir effect correction with the procedure explained in Pesonen *et al.* (*2012*) has been applied, and corrected values for the four Jäkärlä crust dates used in the model runs.

To perform comparable chronological analysis to our previous work, Pesonen *et al.* (*2012*), we have adopted $\delta^{13}C$ = –19.3 ± 2.0‰ as the 100% marine isotopic signature. The isotopic baseline values for the Bothnian Sea and Bothnian Bay are different for marine animals on both sides of the Quark (a strait between Bothnian Bay and Bothnian Sea). This means that for correction of the reservoir effect, in addition to the different maximal MRE, different isotopic values should also be used for maximal 100% marine share in the correction procedure for different parts of the Baltic Sea. Obviously, these would slightly affect the outcome of the reservoir correction procedure. The maximally terrestrial $\delta^{13}C$ value (–26 ± 1‰) is based on measurements on terrestrial material and is robust (*e.g., Fischer, Heinemeier 2003; Pesonen* et al. *2012.665–666*). A sensitivity analysis has been made by assuming a $\delta^{13}C$ value of –15.9 ± 2.0‰ as representing the 100% marine content in the crust. The value is derived from an open access database (www.oasisnorth.org/diana; *Etu-Sihvola* et al. *2019*). The isotopic signature for the flesh of the marine animals was deduced as $\delta^{13}C$ = –15.9 ± 1.8‰ for the areas south of the Quark (lat. 56–63°N) based on bone collagen data and by assuming a collagen – flesh isotopic offset of –1‰ (*Fernandes 2016*). The results of the sensitivity analysis show only minor effects in the modelled boundary values. The maximum effect observed is 95 years for the start boundary of the Late Comb Ware crust and birch bark tar dates, obviously caused by several very high marine signals in crust samples. This makes the individual corrected dates and corresponding model result slightly younger when the alternative 100% marine isotopic value is adopted. For all the other boundaries, the changes due to this alternative selection were within the original uncertainty estimates. Although an extensive pairwise marine terrestrial sample comparison approach could also cross check our results in the future (*e.g., Edinborough* et al. *2016*), this is well beyond the scope of the present study. In the meantime, we conclude that the modelling results, except for Late Comb Ware, are not significantly affected by the assumed isotopic signature for a 100% marine crust. We also note that this kind of approach is crucial to improving the analysis procedure.

5 In Pesonen *et al.* (*2012*) the MRE was defined as 279±77 years according to values then available from the whole Baltic Sea basin. Now it was possible to choose only the eight northernmost datapoints that better refer to Finnish conditions, thanks to new measurements by Lougheed *et al.* (*2013*). The Northern Baltic Sea data is from studies by Olsson (*1980*) and Lougheed *et al.* (*2013*).

6 Here, the rejected date (Hela-3075) is not considered. The $\delta^{13}C$-isotope value of Ua-46150 (Turku Jäkärlä; *Pääkkönen et al. 2016*) has not been reported.

Although bone is prone to a confounding reservoir effect through the food chain, there is a strong possibility that burnt (or cremated) bone dates actually represent the age of the wood burned in the pyre (*Hüls* et al. *2010; Van Strydonck* et al. *2010; Olsen* et al. *2012*). In fact, the original study by Lanting (*2001*) compared burnt bone dates to charcoal dates from the same contexts. If the carbon of the inorganic component of burnt bones is replaced by charcoal carbon, then the radiocarbon measurements of the samples would still be coeval. Thus, burnt bone dates should have the same potential errors as traditional charcoal dates, which in principle should not carry any other error sources except the possible old wood effect. At the same time, the replacement of the animal carbon signal by the wood carbon signal would eliminate the possible reservoir effect in the burnt bone dates. No burnt bone radiocarbon dates have thus been corrected for the reservoir effect in this paper.

Bayesian modelling of the archaeological dates

Bayesian modelling of radiocarbon dates was pioneered in Britain during the 1990s and 2000s (*e.g., Buck* et al. *1991; Bayliss 2009; 2015; Bronk Ramsey 2009a*) and in Scandinavia (*e.g., Edinborough 2009*), and modelling of a series of dates has become a standard procedure in many archaeological projects. Such modelling, with archaeological *a priori* considerations on the order, is especially useful in stratigraphic contexts (*e.g., Oinonen* et al. *2013b*). Archaeological phases, technological traits, fashions and 'cultures' can be understood as stratigraphic units as well, and these phases and the underlying assumptions can be scrutinized and tested with new Bayesian approaches (*e.g., Edinborough* et al. *2015*). This was also the presupposition in several earlier works, where Säräisniemi 1, Sperrings 1–2, Early Asbestos Ware and Typical Comb Ware phases were discussed and the dates of these modelled (*Pesonen* et al. *2012; Oinonen* et al. *2014*). Moreover, analysing dates within a consistent Bayesian framework allows for building comparable time spectra of archaeological events, such as the beginnings and ends of cultural phases, and to study their temporal relations.

In the earlier studies, the models were created with Oxcal software (*Bronk Ramsey 2009a*), which has extensive built-in capabilities for creating and running models with different parameters. Oxcal is the most widely used programme for Bayesian modelling in archaeology (*Bayliss 2015*). The current online version Oxcal 4.3 was selected for this study, and a simple model with end and start boundaries (Boundary-command in Oxcal language) was used for each ceramic phase (*cf. Edinborough 2009*). Outlier analysis (*Bronk Ramsey 2009b*) was employed in the early stages of the project to recognize those outliers which were not obvious even from the start.[7] Eventually only one date, Hela-3075 (see above), was hand-picked and removed from the models.

Results

The results of the runs are presented in Table 2 and Figures 3–4. With the Jäkärlä Ware, the 15 samples classified as class 1 were treated first and they gave mean value limits for Jäkärlä Ware from 4055±50 cal BC (start) to 3550±65 cal BC (end). With all 31 dates (class 2), the time scale is considerably broader, *c.* 4700–3350 cal BC. Here the Sauvo Nummenharju dates and the earliest Eura Kolmhaara dates are the ones pulling the start boundary earlier. The Nummenharju dates are certainly problematic, as the oldest date is *c.* 4900 cal BC (Hel 48; 5990±180 BP), when the water level of the Baltic Sea was still several meters above the site (*e.g., Siiriäinen 1973; Eronen* et al. *2001.28 Fig. 7; Hatakka, Glückert 2000*). The lower end of Jäkärlä model is dictated by two earlier mentioned dates from the Eura Kolmhaara Munasaari site, obtained in the 2005 excavation (Hela-650 and Hela-651). The reservoir correction of the four 'marine' charred crust dates does not change the model results much. First of all, the amount is small, and even though single dates may contain even 200 years individual MRE correction, their effect on the model result depends on their temporal position within the phase. Moreover, by having larger uncertainties the corrected dates result in wider and more evenly spread calendar-year probability distributions.

The Jäkärlä run was also performed for the charred crust datings only (with the anomalous Mynämäki Aisti crust date Hela-3075 left out), and these mean values give 4035±40 cal BC to 3885±55 cal BC. With the reservoir correction the values are almost same, only the end date going a little later, 3830±80 cal BC. These values are very interesting and are discussed below. This is perhaps the 'safest' core phase

7 There are a number of radiocarbon dates from Typical Comb Ware sites, that probably reflect later occupation phases at the site. These dates are not used in the runs, nor are they presented in Appendix 2 at http://dx.doi.org/10.4312/dp.46.15

dating for the Jäkärlä ceramics sequence, *i.e.* **4030–3830 cal BC**.

A similar procedure was also performed for the other Early and Early Middle Neolithic ceramic groups in Finland. In recent years, new radiocarbon dates have been accumulated and the situation has greatly improved, especially in the case of Sperrings 1 and 2 ceramics, while the already large amount of Typical Comb Ware dates has been growing even more extensive. Only Late Comb Ware does not have so many new dates.

The Sperrings 1 phase dating has a significant difference when one uses the whole dataset with context dates compared to charred crust and birch bark tar dates. The mean boundaries for the whole dataset with MRE correction from 5560±40 to 4170±45 cal BC, while crust and birch bark dates give from 5155±50 to 4335±50 cal BC. A number of Sperrings 1 charcoal dates from northwest Russia skew the start boundary to Mesolithic times, while a group of charcoal dates from Finnish sites are younger than the youngest Sperrings 1 crust date from the Timmerkärr site in Raasepori, southern Finland (Hela-3175, 5451±44 BP). Ten of the charred crust dates show marine inference by their carbon stable isotope values and were corrected accordingly. On the basis of the charred crust and birch bark tar dates, we give Sperrings 1 a phase dating of *c.* **5155–4335 cal BC**.

With Sperrings 2 dates the basis for the analysis is not so strong, only 27 dates are connected with the style in Finland and Karelian Isthmus. However, in this case, accounting for the small number of context dates, there is no great discrepancy between the dates from whole dataset and crust and birch bark tar dates. The run with all dates gives us mean value boundaries (with reservoir correction of five charred crust dates) of 4525±40 and 4050±110 cal BC, while the crust and birch bark tar run results in 4510±40 to 4225±50 cal BC. The latter, fairly concise and short phase, is based on 19 dates, which gives the dating of the phase *c.* **4510–4225 cal BC**.

The Typical Comb Ware run is based on total of 183 radiocarbon dates, mostly from Finland, but some also from northwest Russia. The large corpus gives more reliability to the model, where the whole dataset with reservoir correction gives mean values between 3920±30 and 3345±45 cal BC, while 70 dates on crust and birch bark tar values are 3800±25 to 3545±30 cal BC. As there are so many radiocarbon dates connected with Typical Comb Ware, it was possible to also make a test run for the Southwest Finnish Typical Comb Ware separately.[8] The results give a slightly shorter phase to the whole dataset, 3900±60 to 3445±85 cal BC, but a slightly longer phase for crust and birch bark tar, 3840±90 to 3440±105 cal BC. While the southwest Finnish Typical Comb Ware consists of only 10 crust and birch bark tar dates, the values from the whole distribution area are considered as the dating for the whole phase, *i.e.* **3800–3545 cal BC**. However, it is interesting to note that the Southwest Finnish dates in particular raise the possibility for an overlap between Typical Comb Ware and Jäkärlä Ware. Within Typical Comb Ware, 16 charred crust dates were corrected for the reservoir effect.

Late Comb Ware dates are from the coastal area of Finland and six stable carbon isotope values in the crust reflect the marine components in it, and thus a need for the reservoir estimate in the dates. This is shown in the results of the runs, where in the crust and birch bark tar runs the difference between uncorrected and corrected dates is almost 200 years in the start boundary mean values. This emphasizes the importance of marine resources within the Late Comb Ware culture. With reservoir corrected dates, the result of the runs for the whole dataset is 3660±75 to 2940±125 cal BC and for crust and birch bark tar dates the values are 3540±95 to 3195±100 cal BC. The dating for Late Comb Ware in Finland and the Karelian Isthmus would be *c.* **3540–3195 cal BC**. Taking into account the sensitivity analysis with an alternative 100% marine limit, the span of Late Comb Ware would be *c.* 3635–3165 cal BC.

The results clearly show that the large range especially in charcoal dates distorts the chronological picture, and that the dates from the charred crust or birch bark tar in the surface of the ceramic itself form a much more concise and coherent sequence. The application of the reservoir effect correction changes the date limits to some extent, but rarely more than some tens of years. The greatest difference seems to be for Late Comb Ware, where the beginning of the use of this type of ceramic is almost 200 years younger with the correction applied than it would be without it. The indicated marine orientation in the use of Late Comb Ware pots is an interesting observation and calls for studies into the ecological strategies adopted during this stage.

8 Southwest Finland comprising in this case three counties: Uusimaa, Finland Proper and Satakunta.

	Without reservoir correction, mean value (calBC)	Without reservoir correction, 68% HPD region (calBC)	Without reservoir correction, 95% HPD region (calBC)	With reservoir correction, mean value (calBC)	With reservoir correction, 68% HPD region (calBC)	With reservoir correction,95% HPD region (calBC)	
Jäkärlä class 1	4070±50	4090–4020	4180–3995	4055±50	4080–4000	4160–3980	
dates (n = 15)	3550±60	3620–3525	3635–3425	3550±65	3620–3525	3635–3420	
Jäkärlä class 2	4700±105	4780–4575	4910–4500	4700±110	4780–4575	4915–4505	*
dates (n = 30)	3355±105	3475–3285	3550–3135	3350±110	3475–3280	3550–3120	
Jäkärlä only crust	4035±40	4055–3990	4105–3975	**4030±50**	4050–3980	4120–3960	**
(n = 9)	3885±55	3945–3870	3955–3770	**3830±80**	3930–3790	3950–3675	
Sperrings 1 /	5555±40	5590–5515	5620–5490	5560±40	5595–5515	5630–5490	
Ka 1:1 all (n = 82)	4175±45	4243–4155	4325–4080	4170±45	4225–4150	4235–4075	
Sperrings 1 / Ka 1:1	5160±50	5195–5095	5260–5070	**5155±50**	5190–5095	5250–5070	
crust and bbt (n=40)	4340±50	4425–4295	4435–4255	**4335±50**	4405–4285	4435–4255	
Sperrings 2 /	4525±35	4550–4485	4460–4525	4525±40	4550–4485	4605–4460	
Ka 1:2 all (n = 26)	4075±110	4215–3915	4225–3865	4050±110	4205–3900	4220–3855	
Sperrings 2 / Ka 1:2	4510±35	4540–4475	4556–4420	**4510±40**	4540–4475	4600–4415	
crust and bbt (n=18)	4240±40	4290–4210	4353–4101	**4225±50**	4290–4200	4310–4125	
TCW all (n = 188)	3930±30	3950–3905	3970–3880	3920±30	3950–3895	3965–xxxx	
	3335±20	3345–3325	3355–3310	3345±45	3350–3320	3475–3300	
TCW crust and birch	3825±25	3840–3800	3885–3780	**3800±25**	3825–3780	3840–xxxx	
bark tar (n = 72)	3550±30	3580–3525	3600–3500	**3545±30**	3585–3530	xxxx–3495	
TCW SW Finland all	3900±50	3950–3845	3990–3810	3900±60	3970–3840	4005–3780	
(n = 34)	3530±60	3605–3500	3620–3420	3445±85	3535–3375	3600–3285	
TCW SW Finland	3920±75	3970–3830	4075–3800	**3840±90**	3890–3730	4000–xxxx	
crust and bbt (n = 10)	3560±65	3635–3530	3655–3420	**3440±105**	3565–3365	xxxx–3260	
Late CW all (n = 23)	3735±70	3785–3660	3890–3595	3660±75	3720–3580	3825–xxxx	
	2905±115	3065–2780	3250–2675	2940±125	3080–2805	3235–2730	
Late CW crust and	3710±85	3795–3640	3875–3540	**3540±95**	3630–3395	3715–3380	
bbt (n = 12)	3140±100	3275–3060	3325–2950	**3195±100**	3325–3140	3340–3000	

* Hela-3075 left out; ** Hela-3075 left out

Tab. 2. The resulting table of the analysis. The models used are so-called single-phase models (see* Pesonen *et al.* 2012.Tab. 2*). The first and last values in the given cell are the start boundary and the end boundary, respectively, while xxxx denotes that the boundary could not be solved. In the analysis, OxCal 4.2 was used (*Bronk Ramsey 2009a*), with the calibration curve IntCal 13 (*Reimer *et al.* 2013*). Those values marked in bold are used for the further analysis and describing the most probable boundaries for the use-period of given ceramic types. TCW = Typical Comb Ware; CW = Comb Ware.

In summary, our radiocarbon results provide a significantly more robust chronological framework for the Early and Middle Neolithic ceramic groups in Finland and Eastern Fennoscandia, because of the new charred crust and birch bark tar measurements.

Discussion

Shoreline dating of Jäkärlä Ware and related ceramics

The shoreline chronology of the Baltic Sea is based on observations on shore formations and pollen and the diatom stratigraphy of bogs. For the absolute chronology, radiocarbon dates of several lake isolation horizons have been used. For southwest Finland, the basic work was accomplished in 1976 by Gunnar Glückert. New material and dates were presented by Matti Eronen *et al.* (*2001*) and Lassi Hatakka and Gunnart Glückert (*2000*). The last mentioned study shows the calibrated shore diagrams for five separate areas in southwest Finland. These diagrams have aroused some concern among archaeologists who feel that calibrated shore diagrams give too old dates for the shorebound archaeological sites, especially Stone Age settlement sites (*Lehtonen 2005; Asplund 2006; Tiitinen 2011*).

Henrik Asplund has illustrated the problem by tentatively re-calibrating the old isolation radiocarbon dates presented by Glückert (*1976*). This shoreline diagram fits much better with the radiocarbon date from the Turku Jäkärlä site and the Typical Comb Ware (Ka 2) and Earlier Late Comb Ware (Ka 3:1/ Uskela Ware) occupation zone levels at the same site than with the diagram presented by Hatakka and Glückert (*2000*) (*Asplund 2006.5, Fig. 2*).

One problem in testing the shoreline diagrams has been the lack of reliable archaeological radiocarbon dates that could be used to correlate the diagrams (*Asplund 2006.4*). In the present paper a number of new radiocarbon dates are from the Turku region, the area covered in Asplund's paper, thus giving a possibility to evaluate the shoreline diagrams once more.

The diagram was reproduced from Asplund's paper (*2006.5, Fig. 2*).[9] The radiocarbon dates of Jäkärlä, Typical Comb Ware (Ka 2) and Late Comb Ware (Ka 3) were calibrated and their mean value was plotted on the diagram, which shows both the calibrated old curve with error margins (68.2%) by Glückert (*1976*) and the new calibrated curve by Hatakka and Glückert (*2000*). It is obvious that the radiocarbon dates settle better with the old curve than the new curve (Fig. 5). The height difference between the lower limits of the sites and the mean curve of the Glückert (*1976*) varies between 0 and 5.5m, while the same variation between the lower limits and the curve by Hatakka and Glückert (*2000*) is *c.* 1.5–10m.[10] On the basis of the new radiocarbon dates, it seems that the curve presented by Glückert (*1976*) is a better fit with the archaeological material. New datings from the other sites and the calibration and re-evaluation of the new isolation dates in Eronen *et al.* (*2001*) and Hatakka and Glückert (*2000*) would probably further improve the shoreline diagrams in Southwestern Finland.

Jäkärlä Ware among the Early and Middle Neolithic ceramic traditions in eastern Fennoscandia

The new date ranges give a chance to further discuss the cultural succession between ceramic assemblages, cultures or even populations (*cf.* Figs. 3–4). According to the new results, the transformation of Sperrings 1 to Sperrings 2 happened between *c.* 4500–4300 cal BC. In the earlier work, by assuming phase independence, the end of Sperrings 1 was dated to 4360±60 cal BC and the beginning of Sperrings 2 to 4365±95 cal BC (*Pesonen* et al. *2012*), but new dates favour an earlier beginning for Sperrings 2 (especially the Pielavesi Kivimäki site (*Nordqvist, Mökkönen 2016*)).[11] The Bayesian model takes account of the new dates in a reasonable way. While the new dates push the end of Sperrings 1 to an even younger direction, until 4335±50 cal BC, and the beginning of Sperrings 2 to 4510±40 cal BC, a direct succession from Sperrings 1 to Sperrings 2 does not seem probable anymore (*cf. Pesonen* et al. *2012*) as the two ceramic styles clearly overlap chronologically. Still, we would suggest a closer style analysis of these ceramics and see whether all the style determinations are still valid and in line with each

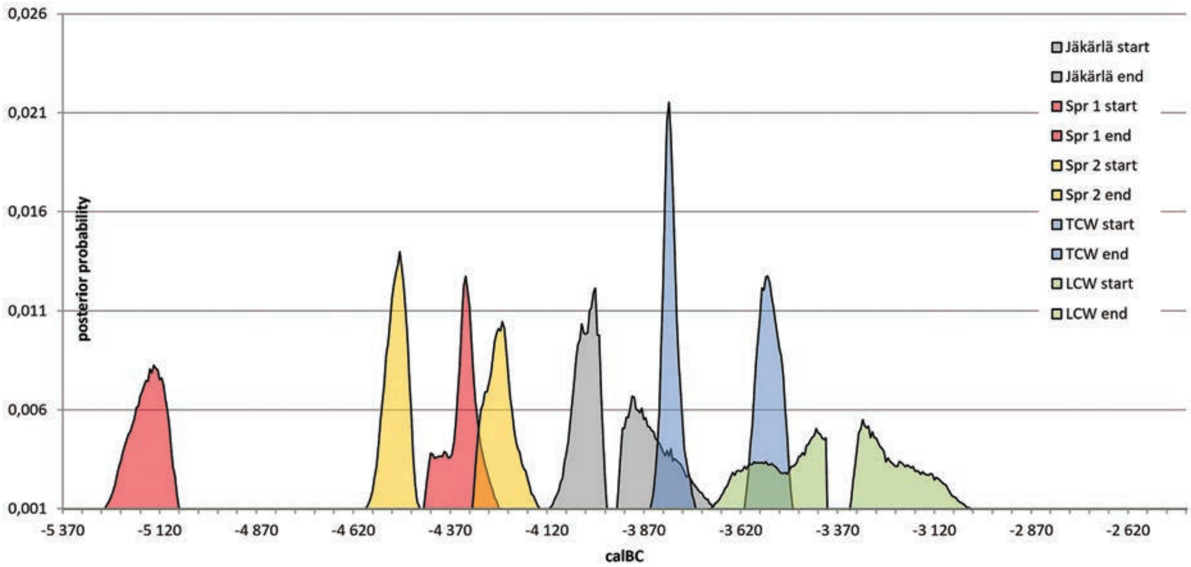

Fig. 3. The posterior probability distributions for the start and end boundaries of each ceramic group. The distributions are from the Bayesian model runs with crust and birch bark tar datings with reservoir correction applied (Tab. 2).

9 The original calibrations were kindly given for the author's use by Henrik Asplund, which is acknowledged.

10 The definition of the lower limit of the site is often based on the very superficial notion in the Register of the Ancient Monuments and in some cases in the literature. The limit cannot thus be taken as an accurate measurement.

11 The model in Pesonen *et al.* (*2012*) was created two-ways: as a single-phase model and as a two-phase model. The referred dates are single-phase model (independent) boundaries.

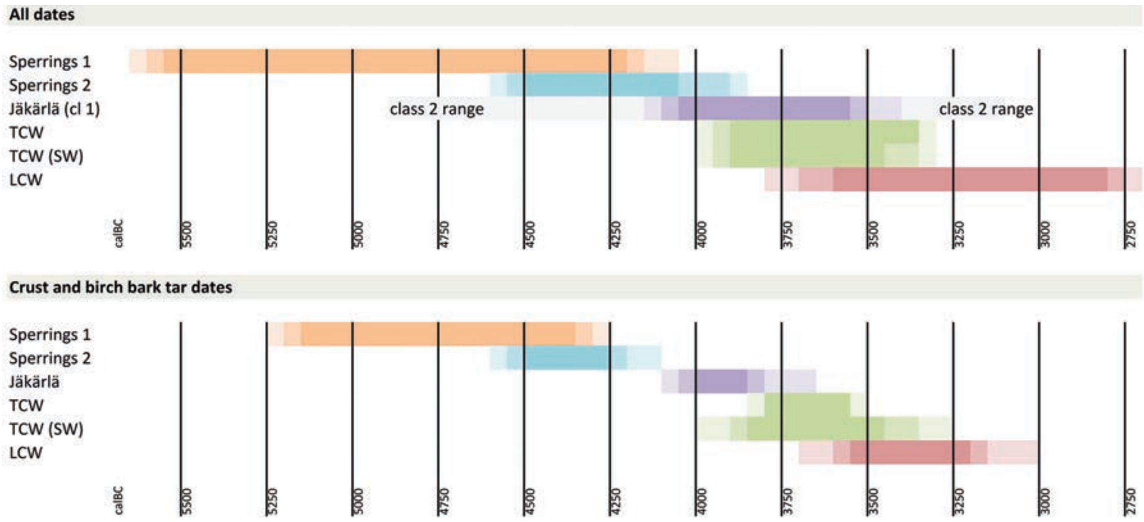

Fig. 4. The date ranges for the studied ceramic types. The shading implies 95%, 68% HPD region and mean values for the model runs with reservoir correction applied. TCW = Typical Comb Ware, LCW = Late Comb Ware.

other. Further dates would further illuminate the overlapping period between Sperrings 1 and 2 Wares.

Perhaps the most interesting result is the time-gap between the end of Sperrings 2 Ware and the beginning of Jäkärlä Ware. According to Jäkärlä Ware crust dates (and also class 1 dates), Jäkärlä Ware starts 4030±50 cal BC while Sperrings 2 Ware ends 4225±50 cal BC. This implies that a connection between Sperrings Ware and Jäkärlä Ware is not plausible (*cf.* Figs. 3–4) undermining the old idea of Jäkärlä Ware being a subgroup of Sperrings 2 Ware. However, a new question arises: where does the Jäkärlä Ware come from?

The end of Jäkärlä Ware is dated according to crust dates to 3830±80 cal BC, but with the other (class 2) dates counted in, to a much later time, until 3350±110 cal BC. According to shoreline chronology, the shorter chronology is more suitable for Jäkärlä Ware. Furthermore, there are in practice only the two Eura Kolmhaara dates (Hela-650 and Hela-651) and the set of Kemiönsaari Nöjis dates, which pull the range too young for the end boundary.

Typical Comb Ware has a lot of dates, and correspondingly the Bayesian model gives quite sharp boundaries for this tradition. There is no big difference in the beginning of Typical Comb Ware in any of the model alternatives. The boundaries given by charred crust and birch bark tar dates from the whole country confirm that Typical Comb Ware starts *c.* 3800 cal BC. It is interesting that the end of Jäkärlä Ware and the beginning of Typical Comb Ware actually overlap, and this indicates their partial contemporaneity. This observation allows for a question as to whether these two ceramic groups are also archaeologically connected in time and space. One key site in this potential connection is Aisti in Mynämäki, which has yielded crust dates for both Jäkärlä Ware and Typical Comb Ware. Jäkärlä sherd was dated 5055±41 BP (Hela-3076) and Typical Comb Ware sherd 5071±42 BP (Hela-3077). However, after reservoir correction the latter is slightly younger, 5006±53 BP. As the individual calendar-year probability distributions overlap, ceramics have possibly been used contemporaneously at the same site. Another interesting site is Kukonharju 2 in Nousianen, with two crust dates from Jäkärlä of 5230±41 BP (Hela-2660) and 5177±37 BP (Hela-2661), and one crust date from Typical Comb Ware of 4829±40 BP (Hela-3178). The Jäkärlä dates are much younger when corrected, 5051±97 BP and 4953±116 BP, respectively, but the Typical Comb Ware date goes even younger to 4560±137 BP. So, at this site, the pattern seems to be quite clear and no contemporaneity is observed. These are the only two sites where both Jäkärlä Ware and Typical Comb Ware charred crust or birch bark tar dates are available.

The beginning of Late Comb Ware is fairly concise regardless of dating material, though the crust and birch bark tar set gives a *c.* 100 years younger start for the style, *c.* 3540 cal BC. The most interesting thing is that the end of Typical Comb Ware (according to crust and birch bark tar dates) is put at almost exactly the same date. This suggests these two ceramic groups follow each other chronologically. The RE correction especially affects the Late Comb Ware dates. Without correction, the beginning of Late Comb Ware would be almost 200 years older. The apparent chronological overlap of Typical and Late

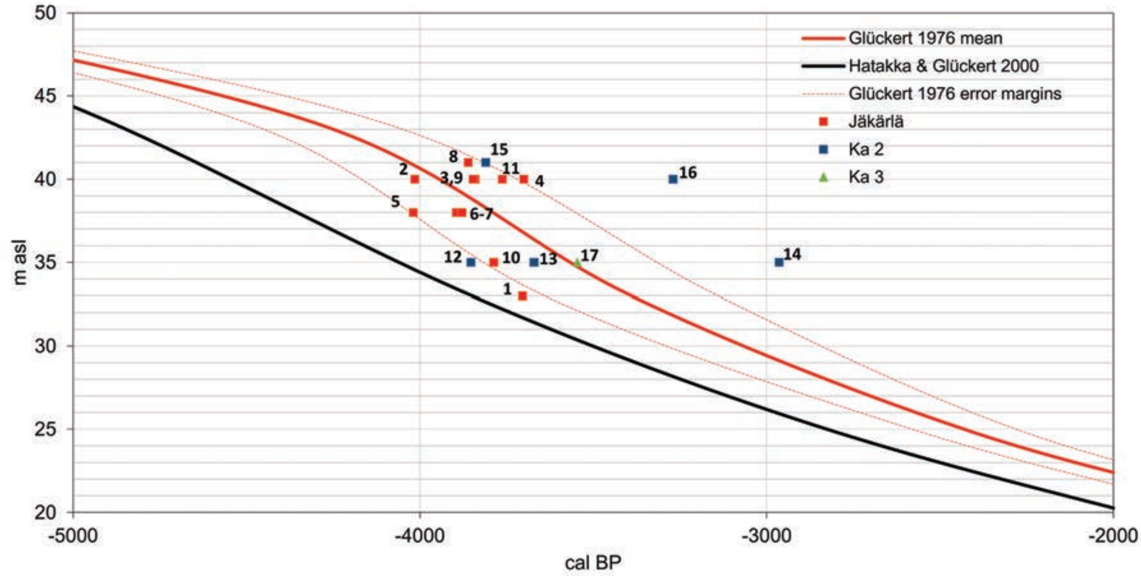

Fig. 5. The shoreline diagrams by Glückert (1976) and Hatakka and Glückert (2000) with radiocarbon dates and elevation of sites in Turku region. The radiocarbon dates with calibrated mean values: Jäkärlä dates – 1 Sauvo Nummenharju, Hela-3165 (4926±35 BP, 3704±30 cal BC); 2 Nousiainen Rauanniittu, Hel-2662 (5190±110 BP, 4015±143 cal BC); 3 Nousiainen Rauanniittu, Hel-2664 (5040±110 BP, 3841±118 cal BC); 4 Nousiainen Rauanniittu Hel-2663 (4900±110 BP, 3700±134 cal BC); 5 Turku Jäkärlä, Ua-46150 (5195±56 BP, 4019±86 cal BC); 6 Turku Jäkärlä, Hela-3169 (5119±42 BP, 3895±62 cal BC); 7 Lieto Kukkarkoski II, Hela-3176 (5130±40 BP, reservoir corrected 5096±43 BP, 3879±56 cal BC); 8 Mynämäki Aisti, Hela-3076 (5055±41 BP, 3861±59 cal BC); 9 Nousiainen Kukonharja 2, Hela-2660 (5230±41 BP, reservoir corrected 5051±97 BP, 3847±105 cal BC); 10 Lieto Merola, Hela-3172 (5002±40 BP, reservoir corrected 4992±40 BP, 3787±72 cal BC); 11 Nousiainen Kukonharja 2, Hela-2661 (5177±37 BP, reservoir corrected 4953±116 BP, 3762±110 cal BC); Typical Comb Ware dates – 12 Lieto Kukkarkoski I, Hela-118 (5060±65 BP, 3853±75 cal BC); 13 Lieto Kukkarkoski I, Hel-832 (4880±150 BP, 3671±180 cal BC); 14 Lieto Kukkarkoski I, Hel-831 (4310±170 BP, 2964±249 cal BC); 15 Mynämäki Aisti, Hela-3077 (5071±42 BP, reservoir corrected 5006±53 BP, 3810±78 cal BC); 16 Nousiainen Kukonharja 2, Hela-3178 (4829±40 BP, reservoir corrected 4560±137 BP, 3270±189 cal BC); and Late Comb Ware date – 17 Nousiainen Kuuvanvuori, Hela-979 (4775±55 BP, 3546±76 cal BC).

Comb Ware is a problem recognized in earlier publications (*e.g., Leskinen 2003; Leskinen, Pesonen 2008; Räihälä 1996*) but understandable in the light of reservoir effect, which particularly affects the oldest Late Comb Ware dates from the sites Maarinkunnas in Vantaa and Kuuvanvuori in Nousiainen. This corresponds well with the lipid and isotope studies performed for Typical and Late Comb Ware pots showing substantial use of marine food (*Leskinen 2003; Pesonen, Leskinen 2009; Cramp* et al. *2014*) which agrees with the high $\delta^{13}C$ – values in the food crusts of these items.

Conclusions

Our new dates and their modelling inside a Bayesian framework give a clear and concise picture of the chronological position of southwestern Finnish Jäkärlä Ware. The use period of this ceramic type is dated to *c.* 4030–3830 cal BC, which is a considerably shorter period than previous radiocarbon dates have lead us to think. According to this study the model dating of Sperrings 1 Ware is *c.* 5155–4335 cal BC and Sperrings 2 Ware 4510–4225 cal BC. These figures are fairly consistent with earlier studies (*Pesonen* et al. *2012; Nordqvist, Mökkönen 2017*), and would imply an overlap period between Sperrings 1 and 2 ceramics. However, there is no overlap whatsoever between the periods of Sperrings 2 and Jäkärlä Wares. The dating of Typical Comb Ware was already fixed in earlier studies (*Pesonen 1999; 2004; Oinonen* et al. *2014*), and now the borders are only closing in so that the Typical Comb Ware begins *c.* 3800 cal BC and ends soon after, *c.* 3545 cal BC. According to the data in this study, the production of Late Comb Ware begins right after Typical Comb Ware and lasts until *c.* 3195 cal BC.

Several consequences on the chronological succession of ceramic types follow from the results. First, Jäkärlä pottery is chronologically (and spatially) a limited phenomenon, which does not seem to have roots in Sperrings (Ka 1:1 or Ka 1:2) pottery, which must be sought elsewhere. So far, there are no paragons for Jäkärlä Ware. Secondly, Jäkärlä pottery may have existed contemporaneously with Typical Comb Ware, but the scenario is still not clear with regard to these two styles. Most likely Jäkärlä pottery and its users were there sometime together with Typical Comb Ware, before the Jäkärlä tradition finally ceased. The situation may have been somewhat similar to the circumstances in eastern Finland and between Early Asbestos Ware and Typical Comb Ware (*cf. Oinonen* et al. *2014*). Thirdly, we find it very unlikely that Jäkärlä pottery and Late Comb Ware (or any other Middle or Late Neolithic pottery type) would have any chronological contacts with each other. The few dates pointing to the late existence of Jäkärlä pottery are from Nöjis and Kolmhaara sites, but they are both controversial and unfit for the shoreline chronology as well.

The new chronology for the Jäkärlä Ware also implies that the sometimes postulated (*e.g., Pesonen 1996; 2001*) connection between eastern Finnish Early Asbestos Ware and Jäkärlä Ware is difficult to understand. Early Asbestos Ware was produced between *c.* 4670–3845 cal BC (*Oinonen* et al. *2014*), *i.e.* starting long before Jäkärlä Ware and coming to end along with the appearance of Typical Comb Ware. According to the new interpretation the term 'Early Asbestos Ware' should be rejected, and the terms 'asbestos-tempered Sperrings 2 Ware' and 'Kaunissaari Ware' should probably be used instead (*Nordqvist 2018*). This division carries chronological significance. Although not yet studied, it is possible that Kaunissaari-type Early Asbestos Ware is younger than asbestos-tempered Sperrings 2 Ware, and indeed may overlap chronologically with Jäkärlä Ware. A geographical gap still separates two ceramic traditions, but the possible connection is worthy of further investigation, and may reveal a hitherto unknown typo-chronological period that exists between Sperrings 1–2 Wares and Typical Comb Ware.

The Appendices 1–4 are available at
http://dx.doi.org/10.4312/dp.46.15

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Neolithic and Copper Age settlement dynamics in the Western Carpathian Basin and Eastern Alps

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ABSTRACT – *The paper tackles the spatio-temporal patterns of Neolithic and Copper Age settlement dynamics in the Western Carpathian Basin and Eastern Alps with spatially explicit use of radiocarbon dates. It focuses on the spatial process of spread, movement, aggregation and segregation in the time frame between 8500 and 5000 cal BP. The distribution of Neolithic and Copper Age sites in the study area is clustered and patchy. The first Neolithic settlements appear as isolated islands or enclaves which then slowly expand to fill neighbouring regions. After 6300 cal BP the study area experienced a significant reduction in the extent of settlement systems, associated with the Late Neolithic to Copper Age transition.*

KEY WORDS – *Neolithic; Copper Age; Carpathian Basin; East Alps; settlement patterns; radiocarbon dating; demography; modelling*

Neolitske in bakrenodobne poselitvene dinamike v zahodni Panonski nižini in vzhodnih Alpah

IZVLEČEK – *Članek se posveča prostorsko-časovnim vzorcem neolitske in bakrenodobne poselitve zahodne Panonske nižine in vzhodnih Alp s pomočjo prostorsko eksplicitne rabe radiokarbonskih datumov. Analizira prostorske procese širjenja, gibanja, združevanja in razdruževanja v časovnem loku med 8000 in 5000 pred sedanjostjo. Neolitska in bakrenodobna najdišč se pojavljajo v neenakomernih skupkih. Prve neolitska poselitev se pojavi v obliki izoliranih otokov ali enklav, ki se počasi širijo v okolico. Po 6300 pred sedanjostjo lahko zaznamo upad poselitve, ki ga povezujemo s prehodom iz poznega neolitika v bakreno dobo.*

KLJUČNE BESEDE – *neolitik; bakrena doba; Panonska nižina; vzhodne Alpe; poselitveni vzorci; radiokarbonsko datiranje; demografija; modeliranje*

Introduction

What we call the Neolithic is shorthand for several historical processes on different time and spatial scales. Nevertheless, the Neolithic is not just a construct, it is real and has some kind of downward causality on all the historical processes that make it. The historical processes behind the Neolithic are a result of the formation and development of a relatively stable and resilient assemblage of human-material relationships which develops in an increasingly structured, organized and consistent social world (*Robb 2013*). The Neolithic assemblage originated in the Near East, where by 9500 cal BP people had domesticated all the major crops and animals. They started to make and use new things, including pottery, figurines, polished stone axes and houses, begun to live in villages and practice new rituals.

What is a proper scale to study the Neolithic? Behind the long-term directionality and near irreversibility of the process is the great local variability seen in

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the archaeological record across Europe. On the broad scale, we can see a process of the movement of groups of people and new material assemblage from the southeast towards northwest over a span of several millennia, which resulted in a uniform and coherent thing we call the Neolithic (*Robb 2013; 2014*).

By about 9000 cal BP this assemblage had spread to south-eastern Europe. The Neolithic assemblage spread rapidly from the Aegean through the Balkans, along the northern coast of the Mediterranean, and across the Northern European Plain. The spread in other areas was slower. There are regions which did not become Neolithic for up to a millennium after their initial contact with farmers.

The spread of the Neolithic assemblage was first estimated to be around 1 kilometre per year, covering the distance between the Levant and Scotland in about 3000 years (*Ammerman, Cavali-Sforza 1984*). More recent research has refined this picture substantially (*e.g., Gkiasta* et al. *2004; Bocquet-Appel* et al. *2009; Fort 2015*). Recent research has also demonstrated that this was not a uniform, 'wave of advance'. Most archaeologically demonstrable movements of people seem to be leap-frog migrations in which small groups leave their community to establish enclave settlements in suitable environments. This is best seen in percolation of the LBK settlements in the river valleys of Central and Western Europe and the spread of Impressa settlements over the Mediterranean.

With the recent development of AMS dating and accumulation of data, it is possible to access the dynamics of spread in much finer temporal and spatial resolutions. A large quantity of AMS radiocarbon data – each individually dating a single event of the end metabolism of an organism – transforms into a new quality, allowing us to glimpse larger spatial and temporal patterns. This radiocarbon 'Big Data' allows us to approach the Neolithic as a set of local historical trajectories, each with its own speed, tempo and rhythm. It enables us to change the narrative of gradually spreading Neolithic assemblage to a series of regional or local responses and actions behind the larger process. In this way, the Neolithic becomes less a uniform process, driven by a single, perhaps evolutionary principle (*Shennan 2018*), but instead a true historical development. The Neolithic also gains temporal depth. Instead of a narrative of the spread of a formed Neolithic assemblage, we can begin to appreciate the complexity of social processes and transformations in the established Neolithic societies (*Hofmann, Gleser 2019*).

The aim of the paper is to approach the process of Neolithic and Copper Age settlement of the Western Carpathian Basin and Eastern Alps based on the available radiocarbon data. It applies spatially explicit use of radiocarbon dates to understand spatiotemporal trends. We are interested in the spatial process of the spread, movement, aggregation and segregation in the time frame between 8500 and 5000 cal BP.

The settlement dynamics proxies that revealed these processes' dynamics are based on the temporal frequencies of radiocarbon-dated archaeological sites, which are represented as summed probability densities (SPDs). The underlying assumption is that the number and distribution of radiocarbon dates in time and space indicate the existence of settlement systems and reflect demography, as more people and more settlements result in more activity and more radiocarbon dates.

This is an explorative study. Its goal and focus are to identify large spatio-temporal patterns in the process of Neolithic settlement in the area around the Eastern Alps and not to test mono-causal explanations for dynamic processes of cultural change. In this way, it is an open-ended study without definite explanations.

Materials, methods and assumptions

The study area covers around 170 000km^2 and encompasses the western part of the Danube watershed above the Danube – Sava confluence. This includes the western part of the Carpathian basin, Eastern Alps and north-eastern section of the Dinaric Alps.

The study area was divided into grid cells over which we summarized spatial variables. Hexagon cell shapes were chosen as regular hexagons are the closest shape to a circle that can be used in a tessellation. Hexagons have reduced edge effects and have identical neighbouring cells, each sharing one of the six equal length sides. Furthermore, the distance between centres is the same for all the neighbours.

A database of 141 sites with available absolute dates from the Neolithic and Copper Age was compiled for the study area. The observed mean distance between sites is around 11km, while the expected mean distance is around 20km, indicating the clustered distribution of dated sites. This also dictated the spatial resolution of the study. Grid cell diameter was chosen to be 25km, with each grid cell covering approx. 520km². In this way, the diameter of grid cell is aproximately a double mean distance between sites.

The study area is covered with 320 grid cells. Due to the highly clustered distribution, only 77 grid cells are occupied with sites, forming several distinctive clusters. Most of the grid cells are occupied with only one site (43 grid cells, with a median one site per grid and a third quartile of two sites per grid cell), with the densest grid cell occupied by nine sites.

At this resolution, we assume that each grid cell represents the area of a regional settlement system (*Kowalewski 2016*) or settlement cluster (*Parkinson 2002.397–398*). A regional settlement system is defined here as interacting interdependent groups of people. It contains several (or several tens of) settlements and communities, tied manly with an exchange of various kinds into "*regionally-integrated social networks*" (*Parkinson 2002.395*)

A database of 815 radiocarbon dates from Neolithic and Copper Age contexts between around 8000 and 5000 cal BP was compiled for all sites in the study area. Neolithic and Copper Age contexts were defined on their material assemblage (presence of houses, pottery, domestic animals, and plants); pragmatically this means that they were already assigned to one of the regional Neolithic or Copper Age cultures (LBK, Starčevo, Lengyel, *etc.*) by the authors of the original publications. In order to uphold the quality of the database, all problematic dates (dates that seem too early or too late for a given context) and dates with standard deviations greater than 100 years were discarded, resulting in 750 dates being used in the analysis (see Appendix at http://dx.doi.org/10.4312/dp.46.16).

The settlement proxies used in the study are based on the temporal frequencies of radiocarbon-dated archaeological sites, which are represented as summed probability densities (SPDs). This proxy assumes that the temporal frequencies of dates in a given site indicate relative human population size and density of occupation at the site. The SPDs are mainly used

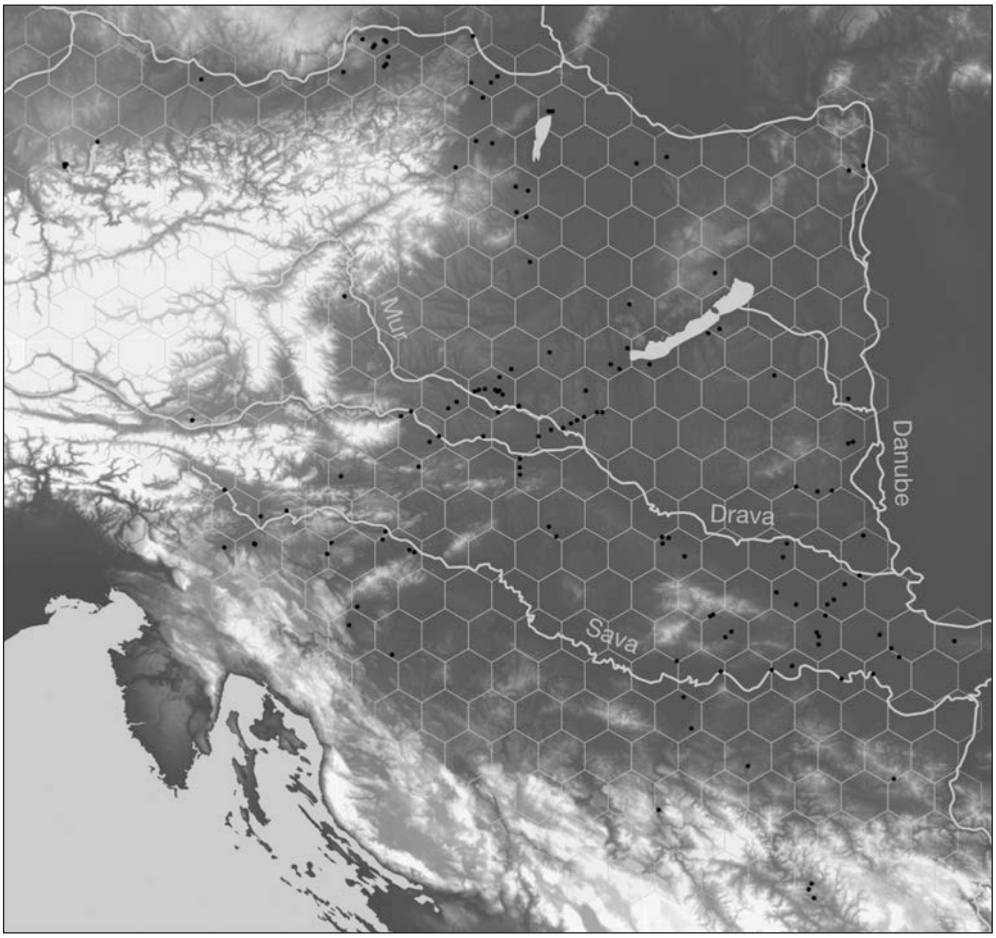

Fig. 1. Study area with sites and grid used in the study.

in demographic studies, while here they are used in a slightly more general way as indicators of grid cell occupation and therefore the existence of regional settlement system in a grid cell.

There are several potential issues associated with the use of summed probability densities, which are summarized by Alan N. Williams (*2012*), mainly being problems of sample size, intra-site sampling, taphonomic loss and calibration effects.

Two fundamental assumptions of the method are that the radiocarbon dates used in these analyses are associated with occupation events; and that the number of dates from a region represents the occupation events in the region. The first assumption is based on the logic of the selection of archaeological samples for dating. The second assumption is not necessarily true, as radiocarbon samples are not collected randomly between and within sites, and the process is heavily biased by sampling intensity and history of research. The collection of radiocarbon dates is always driven by specific research interests, and consequently the number of dates coming from different phases on the same site may often be a consequence of the research questions being asked.

However, this bias is to some degree offset by aggregation of data. The working assumption of summed probability analysis is that a sufficiently large regional sample of radiocarbon dates will counteract any problems at the site level, and that multiple small non-systematic samples from a large assemblage of sites constitute a quasi-random sample of regional trends in occupation (*Williams 2012.580*).

In order to address this bias, the radiocarbon dates are binned (or aggregated) within grid cells. Radiocarbon dates are first binned into grid cell phases and then sorted in decreasing order within each grid cell phase (*Shennan* et al. *2013; Timpson* et al. *2014*). The dates within a given grid cell phase were further subdivided into bins if the difference between two adjacent dates was greater 200 radiocarbon years. The dates are first calibrated and summed within bins, with a bin sum normalized to the area of 1, and the resulting bin sums are then summed and normalized to produce the final SPD curve for a

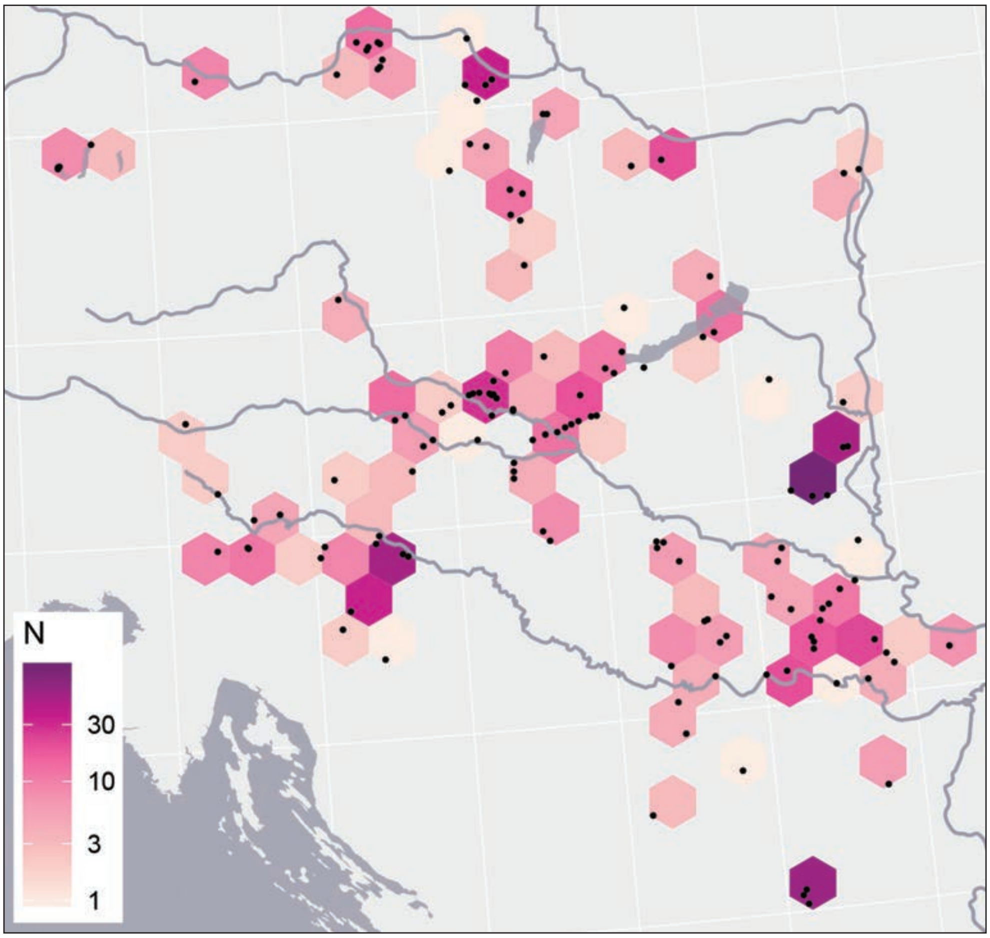

Fig. 2. A number of radiocarbon dates per grid cell. Values are log10 scaled.

grid cell. This procedure controls for research bias when it comes to the frequency of samples per site or site phase, but it does not control for the bias stemming from the different regional histories of research.

All analysis was performed in an R statistical environment (*R Core Team 2018*), using the rcarbon package for radiocarbon calibration (using the IntCal13 radiocarbon curve; *Reimer* et al. *2013*) and SPD analysis (*Bevan 2018*) and sp package for spatial analysis (*Bivand* et al. *2013*).

For each grid cell, a normalized summed calibrated radiocarbon probability distribution was calculated. The number of radiocarbon dates varies from one per grid cell (9 grid cells) to 88 radiocarbon dates per grid cell with a median value of four dates per grid and third quartile at eleven dates per grid cell.

The ranges were calculated on the basis of the highest probability density and are the shortest ranges that include 95% of the probability in the probability density function.

The lower 95% range endpoint date was taken as the start of the Neolithic at a particular grid cell. This was then used to estimate the spread of the Neolithic across the study area using kriging interpolation (see *Brami, Zanotti 2015*).

Kriging is a two-stage geostatistical method which begins with analysis of the gathered data to establish the predictability of values from place to place. This results in a graph known as a semivariogram which models the difference between a value at one location and the value at another location according to the distance and direction between them (*Chilés, Delfiner 2012.147–150*). Based upon these, it estimates values at those locations which have not been sampled. The technique uses a weighted average of neighbouring samples to estimate the unknown value at a given location. Weights are optimised using the semivariogram model, the location of the samples and all the relevant inter-relationships between known and unknown values. The technique can also asses the uncertainty of the predictions.

Kriging data in our study consists of grid cell centroids with the date for a beginning of the Neolithic occupation, calculated using the procedure described above. Grid cells with only one radiocarbon date were excluded from the interpolation. The result of kriging is an interpolated surface with values for the earliest estimated date of Neolithic settlement with a spatial resolution of 12.5km.

This data was used to compute the direction and speed of the spread of the Neolithic. The aspect and slope for 12.5km large grid cell were computed on a smoothed surface. The slope is in this study is defined as the rate of change between adjacent cells, expressed as the time to traverse from each cell to its neighbours, while aspect is defined as the direction of maximum slope from each cell to each of its neighbours. Slope and aspect were visualized as a vector field, with the size of each vector indicating the speed and direction of spread.

SPDs were also used for crude demographic estimation, which is the most common use of summed calibrated radiocarbon probability distributions. In most of the palaeodemographic sites in studies, SPDs are summed together to an empirical SPD that is treated as a proxy for demographic dynamics. Therefore, it is a number of sites and extents of activity at a particular site that provide a proxy for demographic growth. Empirical SPDs are compared to theoretical growth curves to test the statistical significance of the empirical SPD curve (*Shennan 2009; Porčić* et al. *2016; Blagojević* et al. *2017*).

In this study the normalized SPDs for each grid cell are summed together. SPDs were thus aggregated or binned over grid cells. This approach offsets bias in the selection of regional research histories. Thus, a grid cell with one site has the same weight as a grid cell with many sites, as we assume that the difference in a number of sites is a direct result of sampling bias. The assumption is that each grid cell (and therefore local settlement system) has the same maximum population (which is of course not necessarily true). In this way, SPDs provide only a dynamic component, an indication of a change in settlement intensity over the grid cell, while the number of grid cells provides the main proxy into overall demographic dynamics.

Although this is an explorative study, we compared the empirical SPD curve against the theoretical null model of population growth. The null model assumes that the underlying population was stationary. Statistically significant positive local deviations from the null model (peaks) occur between 6860 and 6180 cal BP, while significant negative local deviations (dips) appear at 8000–7630 cal BP, 5880–5730 cal BP, 5450–5390 cal BP and 5350–5260 cal BP.

We also the compared empirical SPD curve for the study area with the SPD created from the subset of dates from the SE Alps area. The idea was to evaluate regional variations in settlement trends (see *Timpson* et al. *2015; Crema* et al. *2016*), and to test whether differences between curves are statistically significant, possibly indicating different settlement trends in the SE Alps area. We found significant positive local deviations (higher settlement intensity in the SE Alps area) at 6390–5940 cal BP, 5880–5780 cal BP and 5600–5390 cal BP and significant negative local deviation (lower settlement intensity in SE Alps) at 7810–6850 cal BP.

Another similar, even simpler graph is the number of grid cells occupied at a particular time. This estimate gives the extent of the settlement system and can provide insight into the spatial dynamics in terms of the expansion and contraction of regional settlement systems. It was constructed by counting grid cells where there is an indication of occupation (with 95% probability) for every century, and summarized in a graph.

Results

The patchy distribution of occupied grid cells reflects the uneven density of Neolithic sites in the study area (Figs. 2–3). Grid cells are agglomerated into several contiguous clusters, two in Slavonia, a large one stretching across the SE Alps, across Western and Central Transdanubia, and a third in the Vienna basin. There are also some curious gaps, an especially large one in the Alps, but also smaller gaps in the middle reach of the Sava (Posavina) and Drava rivers (Podravina), parts of Southern and Central Transdanubia and Styrian basin.

This is probably a result of research bias, as most of the new dates are from recent research, especially in relation to the Slovenian and Hungarian motorway construction programme. However, it also reflects a deeper pattern, as Neolithic sites seem to avoid hilly and mountainous terrain.

When we plot each grid cell with the dates of earliest occupation (Fig. 3) it can be noted that the ear-

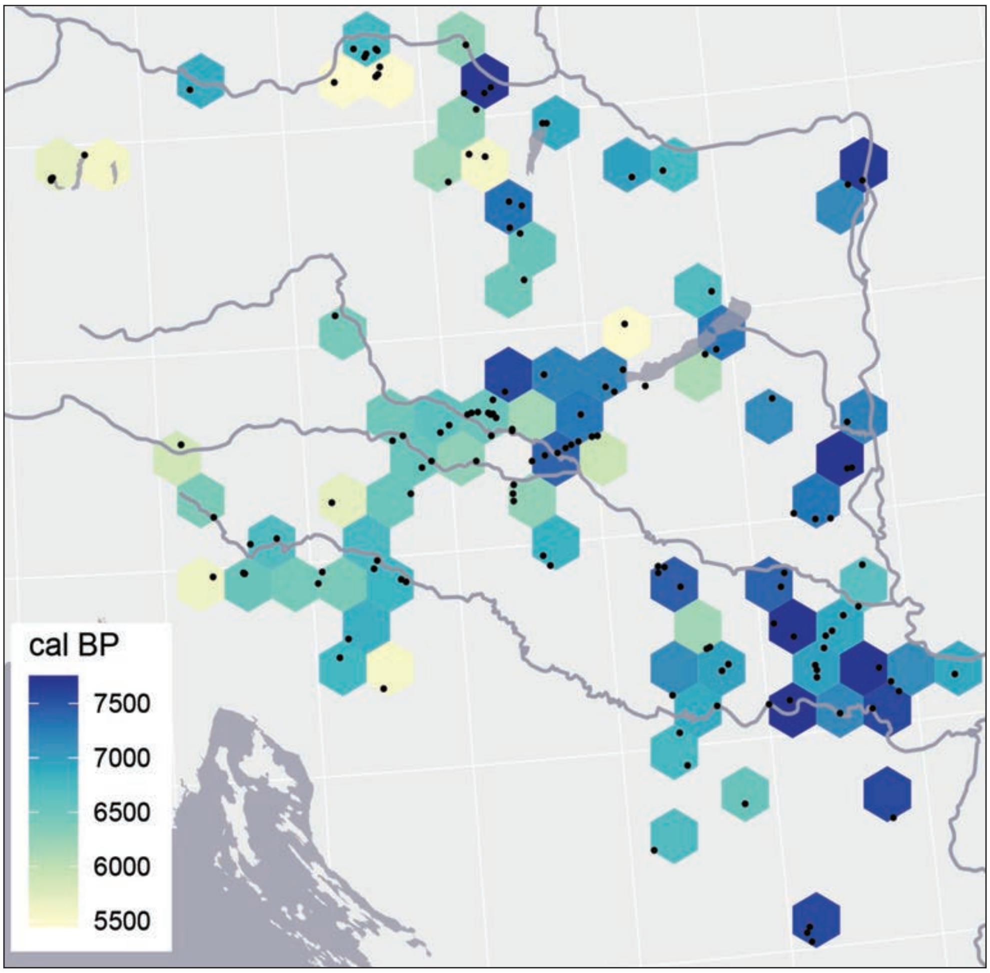

Fig. 3. The earliest appearance of the Neolithic settlement in a grid cell.

liest grid cells are concentrated in the SE edge of the study area (mainly Slavonia around 8000 cal BP), but isolated grids cells with very early dates are spread all over the study area. It seems that within 500 years after the first appearance of the Neolithic in Slavonia, Neolithic sites can be found all over the study area, except the Alps. Thus we have the earliest appearance of Neolithic settlements after 8040 cal BP in Slavonia (Sopot: *Krznarić Škrivanko 2011*), then after 7830 cal BP in the Vienna basin (Brunn am Gebirge: *Stadler, Kotova 2010*), after 7780 cal BP in the Budapest area, and after 7590 cal BP in western Transdanubia, at the edge of the SE Alps (Szentgyörgy-Pityerdomb: *Bánffy 2004*). There seem to be two possible corridors of expansion from the Slavonian core area, one along the Danube and the other on along Drava River and then along the eastern edge of the Alps.

The first Neolithic thus appears as isolated islands or enclaves of Neolithic settlements which then slowly expand to fill neighbouring regions. However, there are some areas, especially the SE Alps west of the Mur River, which are consistently settled much later than their neighbours.

The spatio-temporal pattern of the 2000-year long process of the formation of Neolithic settlement systems in the study area is clearly visible on the map of the estimated age of the arrival of the Neolithic (Fig. 4).

The core area for the spread of the Neolithic is that between the Sava and Drava. From the origin in Slavonia, the Neolithic expands in two prongs, one along the Danube and the other along the Drava, Mur and eastern foothills of the Alps. This expansion is in the form of several very early enclaves with a much earlier appearance of the Neolithic than the surrounding areas, such as those enclaves along the Danube, Vienna basin and Western Transdanubia. Those enclaves are limited one or two grid cells, and might in some cases reflect the research bias. What we see is a very crude remnant of a string of small communities stretching along expansion corridors.

There are also some backwater areas with much later Neolithic occupation. The most prominent being the area of the Alps and the smaller area around Balaton lake. While those small backwater areas are most probably the result of research bias, the Alps area

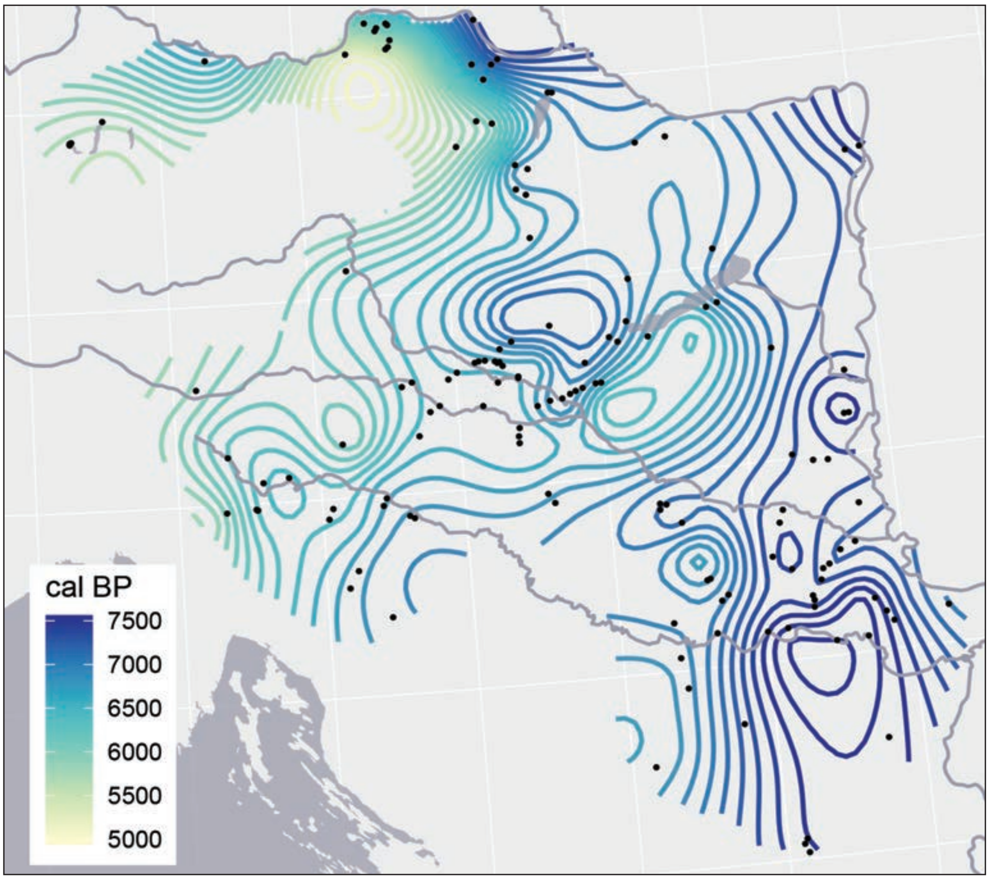

Fig. 4. Isochrone map of the estimated age of the beginning of the Neolithic, result of a kriging interpolation. The contour interval is 100 years.

does not seem to be an artefact. A large number of dates from the SE Alps indicate the relatively late arrival of the Neolithic with rapid expansion along river valleys.

Dense isochrones indicate the existence of a stationary border, most prominently on the edges of Carpathian Basin and the Alps, along the lower course of the Mur river, where the Neolithic expansion toward the west halted for almost 500 years with a stationary border, and more than 1000 years with a stationary border on the western edge of the Vienna basin toward the Alps.

The distance and shape between isochrones encode the rhythm, tempo and direction of the process, which can more clearly be visualized as a vector field (Fig. 5). The overall speed of the process seems to be quite rapid. The study area was crossed in a direction from SE to NW in around 200 years, as the 370km distance between Sopot in Slavonia and Brunn am Gebirge in the Vienna basin was covered in a span of around 210 years, which gives an average speed of Neolithic expansion of about 1.7km per year. Thus is a speed of enclave colonization over the study area that reflects the high mobility of early Neolithic communities.

The local speed of expansion was estimated to be from 0.025 to around 5km per year, with the median speed around 0.15km per year. The local speeds estimated in this study indicate other processes, a relatively slow expansion around core regions and enclaves that filled the landscape.

The estimated speed of expansion is the highest in the areas of no data, such as the Alps and middle reach of the Sava, where it slows down when encounters Alpine foothills, once it reaches the area where we have more data. This points to significant gaps in the data.

The general direction of expansion is mostly from the core areas and enclaves toward surrounding regions. Even so, it looks that the main direction of spread is from SE to NE.

Although the spatial resolution is quite low, it seems that the main corridors of expansion are the river valleys of Danube, Drava, and the Sava.

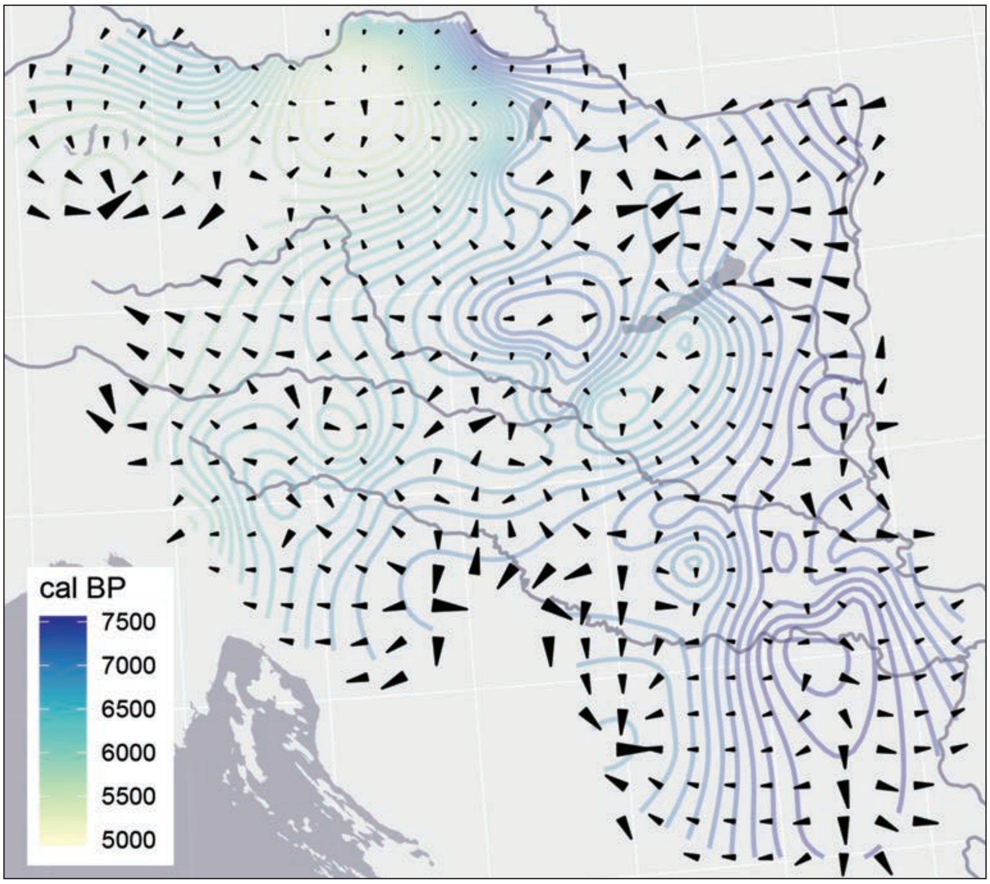

Fig. 5. Direction and speed of the spread of the Neolithic, based on the estimated age of the beginning of the Neolithic (Fig. 4) visualized as a vector field.

Expansion along the Mur and Drava Rivers slows down until an over 500-year long standstill of the stationary border when settlements reach the foothills of the Alps. However, after the border was breached it expands very rapidly into the hilly fringe of SE Alps. This expansion happens at roughly the same time as the expansion of the Neolithic along the Sava River into the SE Alps, and might be a part of the same process.

Based on the analysed data we can identify at least two processes behind the pattern. The first is the establishment of enclaves which happened in the first 500 years and then spread relatively slowly from there. In some areas, especially on the western fringe of the Carpathian Basin, we can observe the formation of a stationary border for almost 500 to 1000 years, followed by quick spread into the Alpine foothills.

The general SPD curve constructed from the SPD curves for each grid cell thus reflects the settlement and demographic dynamics in the study area (Fig. 6). The curve shows a rapid increase from 8000 to 7500 cal BP with another push after 7000 cal BP when the curve reaches a peak at around 6300 cal BP. After 6500 and especially after 6000 there is a pronounced dip in the curve, with small increase and local peak just before 5500 cal BP followed by a slow decrease until the end of time frame. Main peak and dips are statistically significant.

This curve might overrepresent the earliest dates due to the research bias, as research strategy is usually focused mainly on the oldest and the earliest dates and contexts. Nevertheless, the SPD curve reflects some trends, the most interesting being the rapid decline after 6300 cal BP. The fast rise and peak are consistent with the Neolithic demographic transition model (*Bocquet-Appel 2011*), which postulates fast growth at the border, followed by a drop a few centuries layer. The same pattern is found in other regions all over Europe (*Shennan* et al. *2013*).

More interesting are regional differences in the process.

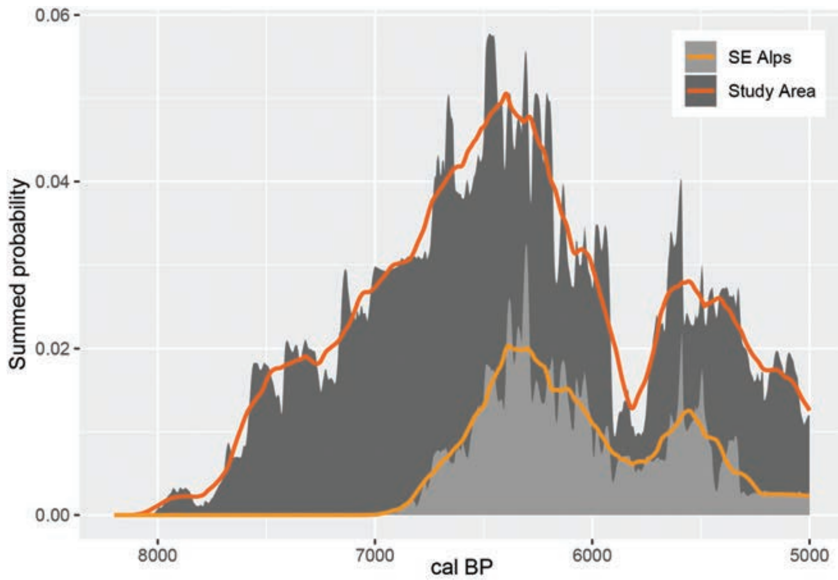

Fig. 6. SPD curve based on the Neolithic dates from the study area (dark) and a subset of dates from the SE Alps (light) and 200-year rolling means (oranges).

The curve for the SE Alps rises rapidly just after 7000 cal BP. Most of the growth in the study area between 7000 and 6300 cal BP can be attributed to the expansion and growth in the SE Alps area in this period. There is also proportionally less decline than elsewhere after 6300 cal BP, where especially after 6000 cal BP the SE Alps contribute most of the value to the overall curve. Those differences from the study area are statistically significant

Another estimate shows the number of occupied grid cells at 100-year intervals (Fig. 6). This is a similar although simplified estimate of the extent of Neolithic settlement in the study area. The curve shows a steady increase in the number of occupied grid cells starts around 8000 cal BP and reaches a peak around 6500 cal BP. After 6300 cal BP, beginning of the Copper Age in the study area, the curve experiences fast decline with some fluctuations after 6000 cal BP. Overall it seems that the extent of the Copper Age settlement systems is approximately half that of the maximum extent of Neolithic settlement around 6500 cal BP in the study area.

In contrast to the study area, the SE Alps experiences different dynamics. Fast expansion into the SE Alps starts just after 7000 cal BP and reaches a peak at around 6500 cal BP, like the curve for the overall study area. It looks as if the main contribution to the overall extent of settlement after 7000 cal BP can be attributed to the expansion into the SE Alps. When, after 6500 cal BP the curve experiences a notable and rapid drop, the reduction in the SE Alps is not as significant as in the overall study area. After the drop stabilises at around 6000 cal BP, the SE Alpine area contributes a large number of grid cells to the overall study area, as up to half of the grid cells in the study come from the area of the SE Alps.

This might be exacerbated by the research bias, as this is the period of the appearance of Neolithic in Slovenia, where a lot of dating effort was focused. The Late Neolithic has received much less focus elsewhere. However, even considering this research bias, the area of the SE Alps experiences different dynamics than the rest of the study area.

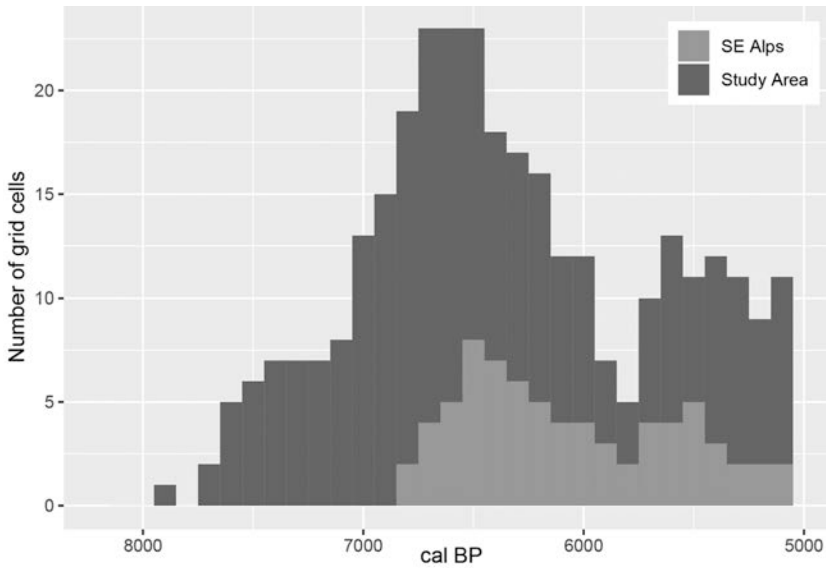

Fig. 7. Number of occupied grid cells by century from the study area (dark) and SE Alps (light).

The spatial pattern of this process is clearly shown in a sequence of settled grid cell maps at 500-year intervals (Fig. 7). Neolithic settlement starts as sparse isolated grid cells in Slavonia, along the Danube, Bosnia and at the eastern edge of the Alps. Between 7000 and 6500 cal BP we can observe a process of expansion around already established grid cells. The first clusters of grid cells are formed in Slavonia, in the area between the Sava and Drava and at the eastern edge of the Alps, between the rivers Balaton and Mur.

The time slice between 7000 and 6500 cal BP is marked by expansion into the SE Alps, with a further process of expansion in other areas. This is also the period where we can observe the abandonment of the first grid cells. This process continues after 6000 cal BP, with continuous expansion into the SE Alps and extensive abandonment of grid cells in the lower reaches of the Sava, Drava and Danube. The general decline in the settled grid cell density continues toward 5000 cal BP.

Discussion

Alasdair Whittle in his discussion of long-term and large-scale processes suggests three interweaved processes behind the formation of European Neolithic settlement patterns. There is the first phase of primary agricultural colonization, followed by the second phase of internal infilling and continued external expansion, followed in turn by the final phase of 'packing' (*Whittle 1987.34*).

The picture painted here is a bit more intricate. Complex spatio-temporal processes can be decomposed into three basic processes, spread, then movement, and aggregation or segregation (*O'Sullivan, Perry 2013*). Although the present study observes these processes at a very low spatial and temporal resolution it is still possible to appreciate the complexity and identify the main components. The spread processes include growth, diffusion and percolation, and they all refer to the expansion of a common boundary or fronts of a phenomenon, such as the expansion of a gas into a vacuum, forest fire or spread of animal species in a new environment (*O'Sullivan, Perry 2013.133–168*). Movement refers to the spread of individual entities, and can be seen as the secession of shifts which relocate an entity (single molecule of gas, fire, or individual animal or human) from one location to another. These walks can be random (as in case of isolated gas molecules) or, more often, influenced by the environment or other entities (*O'Sullivan, Perry 2013.97–131*). Aggregation and segregation are two facets of the same process, driven by a tendency of similar elements to group together in space or dissimilar elements to separate in space (*O'Sullivan, Perry 2013.57–95*).

The process of the formation of Neolithic settlement systems in the study area was not a swift, uniform transition that established stable Neolithic settlement system in the course of a few centuries. It was not an even diffusion of Neolithic settlements, filling the landscape of the study area. Instead, as already argued by Marek Zvelebil (*2001.1*), it was a complex interaction of several processes with their own dynamics and time depth, which included both movement and contact, combining in a very complex and long historical trajectory, embedded in the existing social and historical conditions. In this sense, the social context of the agricultural transition in the study area had structure and agency. The formation of Neolithic settlement systems in the study area lasted several millennia and included lives over tens of generations. The process was probably experienced more as continuity than one of disjuncture and change (*Hofmann, Gleser 2019*).

The spread of Neolithic settlements was part of a wider phenomenon, the Neolithisation of Europe. However, the spread of specific material assemblage associated with Neolithic was not uniform. Instead, the edge of the process observed in a study area has a ragged, swirly, pixelated border (*Robb 2014.33*). The Neolithic material assemblage percolated along different paths, with the establishment of pioneer communities at the front. The discontinuous spread and establishment of enclaves point to the key role of movement and personal and group mobility in the process. Spread involved the movement of small groups or even individuals (see *Zvelebil 2001.2A*). These movements usually do not have a single origin point, creating a perplexing pattern of "*migrations without a homeland*" (*Robb 2014.658–659*). What drives such groups onward is poorly known (but see *Hofmann 2016*). Movement seems to follow the natural corridors in a landscape, especially river valleys. Here, the Danube, Sava, Drava, and Mur seem to be main lines along which Neolithic communities moved forward. Rapid enclave movements tend to halt when they encounter either different environments (Alpine foothills) or dense forager settlements (possibly Alpine foothills and the Balaton Area; see *Bánffy 2006.130–136*). The resulting frontiers lasted a long time, and may include the movement of individuals, families or small groups of people across the border.

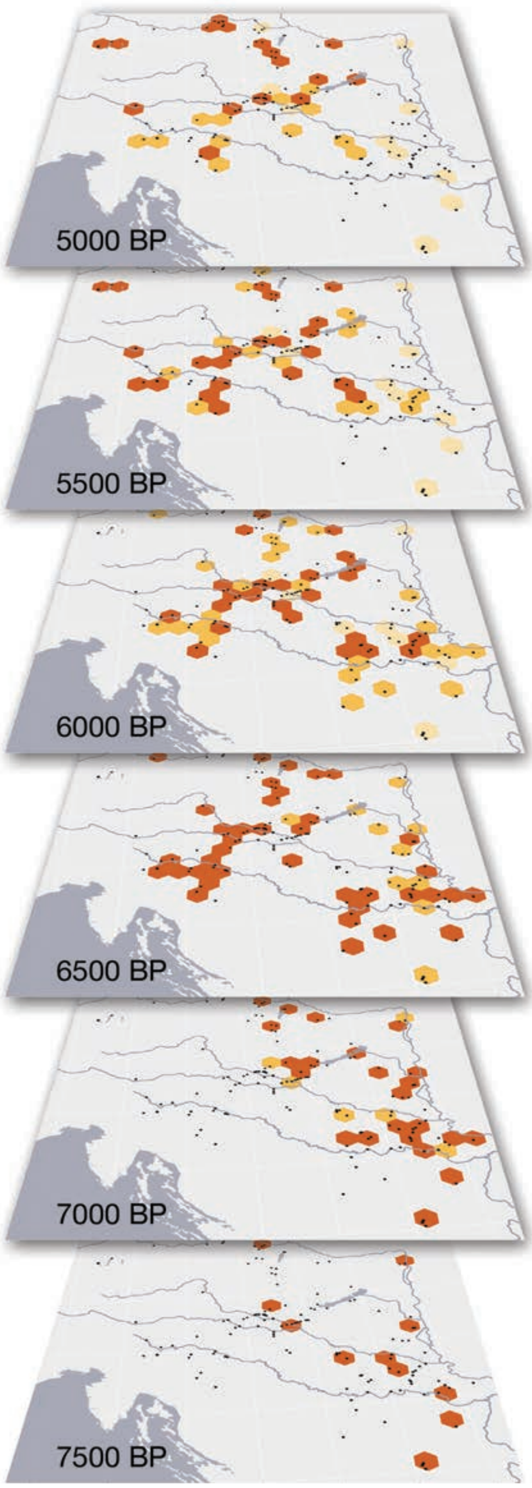

Fig. 8. The extent of Neolithic and Copper Age settlement systems in the study area in 500-year time slices. Dark grid cells indicate occupation while light indicates abandoned grid cells.

The third process is the aggregation or segregation of Neolithic settlements, which created a patchy landscape of a structured, organized and consistent Neolithic social world surrounded by untamed, wild landscape. There are two general factors behind the process, one is the environment while the other is demographic and social. Initial enclave colonization targeted specific environmental niches. After the formation of initial or core settlements, a gradual process of aggregation continues as a slow infill of the landscape around initial settlements, creating Sidelungskammern of Neolithic settlements. The movement of people and things between settlements and patches connected them in the social landscape, prone to shifting patterns of interaction and integration. There are several centripetal and centrifugal forces leading to either integration or fissioning of groups. These changes are reflected in a settlement pattern and may be a driving force behind other processes, such as movement and spread.

The dynamics of the Neolithic spread and the movement of individuals and small groups were determined to an extent by social processes in already settled regions. This is especially pronounced in the case of the secondary expansion of Neolithic settlement systems into the SE Alps.

Around 6700 cal BP there is a pronounced change in the settlement systems in the Balkans with the appearance of stratified tell sites, large nucleated settlements and large cemetery grounds (*Hofmann, Gleser 2019.24–29*). In the study area, this process is very well documented with the dynamics in Alsónyék-Bátaszék in south-west Hungary, where the settlement that formed in the Starčevo phase experiences sudden large-scale expansion around 6800 cal BP with the erection of settlement with 122 houses and cemetery with around 2300 graves. It is just one of several substantial Lengyel culture sites in the neighbourhood which include both cemeteries and settlements. Alsónyék-Bátaszék became a large aggregation of people, with a population that suddenly increased almost fifty-fold. This aggregation stayed in place for only one generation, followed by an equally fast dispersal (*Osztás* et al. *2012; 2013; 2016*).

This process coincides with the Neolithic expansion into the SE Alps, especially the area of modern Slovenia, which started after 7000 BP. It is marked by a relatively fast expansion along the Sava River, establishment of settlements in the river valleys and plains. This is followed by the expansion along Drava and Mur river valleys into the Alps. This process of expansion into the Alpine river valleys continues for almost 500 years. The same pattern of breach of long-standing frontiers is also visible elsewhere in the study area.

A resurgence of Mesolithic ancestry in the Late Neolithic has already been noted all over Europe, although in some places this process was limited. Genetic signatures associated with European hunter-gatherers (mitochondrial U-haplotypes) reappear in central Europe during the 7th and 6th millennium BP (*Haak* et al. *2015; Bollongino 2013; Fu* et al. *2016; Lipson* et al. *2017*). The possible origins of this resurgence are currently not yet clear, however, it might be associated with the expansion of Neolithic communities into previously marginal areas, new contacts with Mesolithic hunter-gatherer communities that could have been accompanied by increased genetic exchange with more central areas.

On the other hand, it seems that by around 6600 cal BP, tell and nucleated sites which previously characterized most of the Carpathian Basin were suddenly abandoned. The transition from Late Neolithic to Copper Age is marked by a change from nucleated to a dispersed settlement pattern. In the whole Carpathian Basin previously nucleated sites were replaced by smaller, flat settlements, largely characterized by shallow single-layer occupation deposits, along with a change from intramural burials to large extramural cemeteries (*Parkinson 2002.391–394; Borić 2015.157*). This seems to be a wider process that occurred almost simultaneously over the study area.

This process of segregation can be detected all over the study area. Initial Neolithic settlements in Lahinja river valley and Krupsko polje in Bela Krajina, Slovenia targeted fertile soils and were established soon after 7000 cal BP. In the mid-6th millennium BP there is an expansion from core areas into the drier Karst hinterland, with new sites that were occupied less intensively and for shorter periods and the formation of enclosed upland sites (*Budja 1995; Mason 1995*). However, initial settlements, such as Moverna vas, were not abandoned.

The pattern of smaller dispersed settlements in the Early Copper Age, despite possible research biases regarding the visibility of small dispersed sites, could suggest a drop in population levels, even if the number of individual sites increases. However, the demographic decline did not affect all areas equally, but is much more pronounced in core areas of Slavonia, while newly settled areas peripheral areas seem to experience much less severe declines.

Attempts to explain these discontinuities by simple boom-boost cycles of population dynamics (caused by climate change which affected subsistence practices, ultimately lowering reproductive success; *Shennan 2009; 2013; 2018*) seem overly simplistic and theoretically impoverished. If the Neolithic was a historical process (in contrast to an evolutionary episode) the explanations must take into account the nature of social interaction and the way it is stabilized by the use of durable material resources and symbols. Material resources fix the way individuals interact, behave and move, and dictate new skills, habits and actions. They impose new physical techniques, training and disciplines, making individuals become productive members of a specific assemblage.

The spatial segregation processes that mark the transition from Late Neolithic to Copper are obviously connected to increased residential mobility, as reflected in the dispersed settlement pattern and occupation of new areas with newly founded settlements. It is difficult to identify the mechanisms behind the centrifugal forces which caused the segregation of previously dependent and closely-knit communities at a larger regional level (*Borić 2015.189–193*).

It might be the result of a restructuring of a Neolithic assemblage which becomes destabilized with the introduction of new components such as copper metallurgy and the growing importance of domestic cattle and pastoral economy (*Orton 2012*). After all, assemblages are precarious composite entities that just about hold together because all their parts happen to be in the right places, doing the right things to achieve this. Adding and swapping new elements in an assemblage can cause non-linear transitions to occur (*DeLanda 2006.10–11*).

Conclusion

The paper approached large spatio-temporal trends in the formation and change of regional settlement systems in the Western part of the Carpathian Basin area around the Eastern Alps in the Neolithic and Copper Age. We were interested in the spatial processes of spread, movement, aggregation and segregation in the time frame between 8500 and 5000 cal BP.

The distribution of Neolithic and Copper Age sites in the study area is clustered and patchy. The first Neolithic thus appears as isolated islands or enclaves of Neolithic settlements which then slowly expand to fill neighbouring regions.

The core area for the spread of the Neolithic is that between the Sava and Drava. From the origin in Slavonia, the Neolithic expands in two prongs, one along the Danube and the other along the Drava, Mur and eastern foothills of the Alps. This expansion is in the form of several enclaves with much earlier appearance of the Neolithic than surrounding areas, such as ones along the Danube, Vienna basin and Western Transdanubia.

There are also some backwater areas with much later Neolithic settlement. The most prominent being the area of the Eastern Alps. We identified the existence of stationary borders, most prominently on the edges of Carpathian basin and the Alps, along the lower course of the Mur River, where the Neolithic expansion toward the west halted for almost 500 years.

However, once the border was breached it expands very rapidly into the hilly fringe of SE Alps. Fast expansion into SE Alps starts just after 7000 cal BP and reaches a peak at around 6500 cal BP, which is also the period of the maximum extent of Neolithic settlement systems in the study area.

After 6300 cal BP study area experiences a significant reduction in the extent of settlement systems, associated with the Late Neolithic to Copper Age transition. This was a significant decrease in the extent of settlements system, but not all areas were affected to the same extent.

Appendix is available at
http://dx.doi.org/10.4312/dp.46.16

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Quantifying prehistoric physiological stress using the TCA method: preliminary results from the Central Balkans

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ABSTRACT – *The Neolithic way of life was accompanied by an increase in various forms of physiological stress (*e.g. *disease, malnutrition). Here we use the method of tooth cementum annulation (TCA) analysis in order to detect physiological stress that is probably related to calcium metabolism. The TCA method is applied to a sample of teeth from three Mesolithic and five Neolithic individuals from the Central Balkans. The average number of physiological stress episodes is higher in the Neolithic group – but the statistical significance of this result cannot be evaluated due to the small sample size, therefore these results should be taken as preliminary.*

KEY WORDS – *stress-layers; tooth cementum annulation (TCA); Mesolithic; Neolithic; Central Balkans*

Kvantificiranje fiziološkega stresa v prazgodovini s pomočjo metode anulacije zobnega cementa (TCA): preliminarni rezultati iz osrednjega Balkana

IZVLEČEK – *Življenje v neolitiku je spremljal porast različnih oblik fiziološkega stresa (npr. bolezni, podhranjenost). Predstavljamo uporabo analitske metode anulacije zobnega cementa (TCA), s katero lahko odkrivamo fiziološki stres, ki je verjetno povezan s presnovo kalcija. Metodo smo uporabili pri analizah vzorcev treh mezolitskih in petih neolitskih posameznikov iz osrednjega Balkana. Povprečno število fizioloških epizodnih stresov je v neolitski skupini večje – vendar zaradi majhnega števila vzorcev tega rezultata statistično ne moremo ovrednotiti in ga predstavljamo kot preliminarnega.*

KLJUČNE BESEDE – *plasti-stresov; metoda anulacije zobnega cementa (angl. TCA); mezolitik; neolitik; osrednji Balkan*

Introduction

One of the major events in human prehistory was the transition from hunter-gatherer lifestyle to agricultural food production in the Holocene, which significantly influenced the way of life in this era. This transition was followed by the beginning of a fully sedentary way of living, the cultivation of domestic plants and breeding of animals. Many scholars have hypothesized that these changes had a dramatic impact on population size and structure, resulting in a significant increase of the world population, the demographic process known as the Neolithic demographic transition (*Bocquet-Appel 2008; 2011*).

Moreover, with an increase in population size an overall decline in health has also been documented worldwide (*Cohen, Armelagos 1984; Cohen, Crane-Kramer 2007*). Usually named among the main causes of this decline are changes in diet, a limited food

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range, and the low level of food quality (*Cohen 2008*). Besides changes in diet, an increase in fertility with narrow birth spacing, increased sedentism and life in villages close to domestic animals, resulted in poor hygienic conditions and higher rates of zoonotic disease (*Bocquet-Appel 2008; Stock, Pinhasi 2011*).

Studies across Europe based on human skeletal remains document a general decline in health status (*Jarošova, Dočkalova 2008; Wittwer-Backofen, Tomo 2008; Papathanasiou 2011; Stock, Pinhasi 2011; Ash* et al. *2016; Jovanović 2017*). These show that around 50% of the individuals examined had some kind of growth disruption as a consequence of the new lifestyle in the Neolithic period, while in the Mesolithic only 20% of individuals were affected by growth risk factors during childhood (*Jarošova, Dočkalova 2008; Wittwer-Backofen, Tomo 2008; Papathanasiou 2011*). A recent study with a focus on the diet and health of Mesolithic-Neolithic inhabitants of the central Balkan region also showed that Early Neolithic people had limited nutritional resources and a greater prevalence of various dental and skeletal pathological conditions, as well as growth disturbances (*Jovanović 2017*). Stable isotope values show that, at the beginning of the 7th millennium, hunter-fisher-gatherers from the central Balkans, mainly dependent on aquatic resources, increased their consumption of terrestrial resources (*Bonsall* et al. *1997; Grupe* et al. *2003; Borić* et al. *2004; Nehlich* et al. *2010; de Becdelievre* et al. *2015; Jovanović 2017*). At the same time, the frequency of caries increased, possibly due to a diet rich in carbohydrates (*Turner 1979; Powell 1979; Larsen, Griffin 1991; Larsen 1995*). Furthermore, analysis of micro-plant fossils (starch grains) found in dental calculus lends weight to the argument that Neolithic people in the Central Balkans started to consume more terrestrial resources, and probably significant amounts of carbohydrates (*Jovanović 2017*). This dietary shift and poor hygienic conditions in the Neolithic Central Balkans resulted in the higher incidence of non-specific stress markers such as enamel hypoplasia, cribra orbitalia, and porotic hyperostosis (*Jovanović 2017*).

In this paper, we address the aspects of the Mesolithic-Neolithic transition related to health by looking at the changes caused by physiological stress at the microscopic level. We apply the method of tooth cementum annulation analysis to a sample of Mesolithic and Neolithic individuals from the Central Balkans. We expect the frequency of variation in the cementum layers as indicators of physiological stress to be higher in the Neolithic than in the Mesolithic sample, as predicted by theory and previous empirical studies.

Archaeological context

Mesolithic and Early Neolithic sites have been discovered on the territory of the Central Balkans (Fig. 1). One of the key areas is the Danube Gorges, where a series of settlements yielded well-preserved archaeological remains which document the chronological continuity of occupation along the Danube River from the Mesolithic to the Neolithic (10 000–5500 cal BC) (*Radovanović 1996; Roksandić 2000; Borić 1999; 2002a; 2002b; Borić, Miracle 2004; Borić, Stefanović 2004; Borić, Dimitrijević 2009*).

The Mesolithic-Neolithic sequence in the Danube Gorges is characterized by a specific material culture, including complex settlement architecture (trapezoidal buildings), sculpted sandstone boulders, and specific mortuary rites (*Srejović 1972; Radovanović 1996; Jovanović 2008; Borić 2011; 2016*). Archaeological excavations of these sites uncovered more than 500 human skeletons (*Roksandić 2000; Borić* et al. *2004; Stefanović in press*).

The inhabitants of these sites were semi-sedentary hunter-fisher gatherers, who settled in the vicinity of natural whirlpools which provided good hunting and fishing spots (*Borić 2002; Živaljević 2012*). During the Mesolithic and transitional Mesolithic-Neolithic phases the economy was mainly based on aquatic resources (*Clason 1980; Bartosiewicz* et al. *1995; 2001; 2008; Dinu 2010; Borić 2011; Dimitrijević* et al. *2016*) and wild game (*Bökönyi 1972; 1978; Dimitrijević 2000; 2008*). In the Early Neolithic (post *c*. 5900 cal BC) domesticated animals (cattle, ovicaprid, pig) started to appear (*Borić, Dimitrijević 2007*). In addition, in the Neolithic period people included more plants in their diet, possibly cereals (*Filipović* et al. *2017*). The only domesticated animal that appeared before the Neolithic is the dog, locally domesticated during the Mesolithic (*Bökönyi 1978; Dimitrijević, Vuković 2015*).

During the Neolithic phase, hunter-fisher-gatherer communities in the Danube Gorges began to have intensive contacts with first farmers in the region (*Borić 2002; Borić, Dimitrijević 2007; Borić, Price 2013*). The beginning of the sixth millennium BC in the western central Balkan region is associated with the Early Neolithic Starčevo culture (6200–5200 cal BC) (*Whittle* et al. *2002*). Aquatic resources and wild game still played a significant role in the diet of Neolithic inhabitants of the Danube Gorges, as indicated by stable isotope and archaeozoological analyses (*Borić* et al. *2004; Borić, Dimitrijević 2006; Borić 2008; 2011*). Animal husbandry and stock-breeding played a major role in subsistence, but wild game remains (red deer, roe deer, wild boar, and aurochs) were also found (*Bökönyi 1974; 1984; 1988; Clason 1980; Vörös 1980; Greenfield 1993; Blažić 1985; 1992; 2005; Arnold, Greenfield 2006*). Cultivated cereals (such as wheat and barley) and pulses (lentils, peas), were also identified at some Early Neolithic sites (*Filipović, Obradović 2013*). Although there is a large number of excavated sites, burials are very rare (*Borić 2014*). They are mostly found as single inhumations in a flexed position, located within the settlement.

Tooth cementum

Tooth cementum has a principal function of anchoring the tooth in the jaw, attaching the fibre of the periodontal membrane to the tooth root surface (*Condon* et al. *1986; Liebermann 1994*). Tooth cementum surrounds the dentine and forms in annual layers, with the first deposited layer defining the cemento-dentine junction. The cementum extends from the enamel-dentine junction to the apex of the root, varying from a thin layer close to the tooth crown up to 0.5mm thickness at the apex at older age (*Schröder 2000*).

Incremental bands, annual layers, or cementum growth layers (*Klevezal', Myrick 1984*) are rhythmic depositions of the tooth cementum. They consist of alternating dark and bright lines, differing in mineralization as seen under transmitting light microscopy (*Wittwer-Backofen 2012*). These depositions are seasonal, and are visible in a broad variety of mammalian species (*Grue, Jansen 1976, 1979; Lieberman 1993, 1994; Grupe* et al. *2012*). In humans, structured appositional growth of the tooth cementum can be seen in the acellular extrinsic fibre cementum concentrated in the middle third section of the root (*Wittwer-Backofen 2012*).

Compared to morphological traits correlated to age, the advantage of this method is the often better preservation of teeth compared to bones. Tooth cementum is less vulnerable to decomposition processes than osteological remains (*Grupe* et al. *2012*). For adults, this age estimation method resulted in more precise ages than estimates based on standard macroscopic indicators of age (*Grosskopf 1990; Wittwer-Backofen* et al. *2004; Naji* et al. *2016*). An individual's chronological age is estimated by adding the average age of tooth root formation by tooth type and sex to the mean number of counted incremental layers, or by applying a mathematical algorithm which comes close to this procedure (*Wittwer-Backofen* et al. *2004; Grupe* et al. *2012; Gupta* et al. *2014*). Under optimal conditions, TCA provides a highly precise age at death estimate with an error margin of ±2.5 years (*Wittwer-Backofen* et al. *2004*), or additionally a determination of the season of death (*Klevezal', Shishlina 2001; Wedel 2007*).

Due to its strict appositional growth, the acellular extrinsic fibre cementum is a valuable tool for the reconstruction of certain life-history parameters (*Kagerer, Grupe 2001*). More specifically, TCA layers differ from each other in width and appearance, and it is assumed that these irregularities are formed as a response to life-events of physiological stress related to the sensitive calcium metabolism.

Further clinical studies into the origin of these patterns showed that surgery performed on the spine and/or bones, and other orthopaedic interventions, renal disease, tuberculosis, and pregnancies leave a visible mark in the tooth cementum (*Kagerer 2000; Kagerer, Grupe 2001; Caplazi 2004*), suggesting that stress layers could be interpreted as reflecting specific life-events. However, diabetes, thyroid disorders, metabolic bone diseases such as osteoporosis, malnutrition, rachitis, periodontal disease, or leprosy do not leave visible traits in the dental cementum (*Kagerer 2000; Kagerer, Grupe 2001; Bertrand* et al. *2016; Broucker* et al. *2016*). Another study on captive great apes showed that extreme weather leaves marks, too (*Cipriano 2002*). This was explained by the lack of sunlight, caused during a long cold winter, leading to reduced vitamin D levels. What all these occurrences have in common is their impact on the calcium metabolism. Conditions such as kidney diseases and traumas mobilize calcium in the body and influence the concentration of available calcium (*Kagerer, Grupe 2001*). Pregnancy and lactation are processes that are energetically costly (*Medill* et al. *2010*), and these physiological demands as well as increased hormone activity also cause alterations in the cementum layers. An increased thickness of cementum layers is also connected with weaning or menarche, as well as with dry and rainy seasons in baboons (*Dirks* et al. *2002*). Even in periods of extreme calcium demand, such as pregnancy or lactation, the growth process of the incremental layers is not interrupted, leading to the fact that the number of AEFC layers is closely correlated to chronological age and does not depend on major life events or living conditions. Correlation of stress markers and pregnancies has been documented in humans (*Kagerer, Grupe 2001; Künzie, Wittwer-Backofen 2008*). During pregnancies, due to low levels of metabolically available calcium, the cementum layers are still produced but appear differently mineralized, broader, and with higher or lower translucency than other layers (*Kagerer, Grupe 2001*). Peter Kagerer and Gisela Grupe (*2001.79*) showed that in all cases of pregnant women the "*translucent layers corresponded exactly with the age when the female had been pregnant, interbirth intervals were maintained and exactly datable*". Besides humans, these changes in cementum have been detected in polar bears (*Medill* et al. *2010*), dolphins (genus Stenella) (*Klevezal', Myrick 1984*), great apes (*Cipriano 2002*) and black bears (*Carrel 1994*).

These layers are described as "*hypomineralized incremental lines*", "*conspicuous incremental lines*" or "*broad and translucent layers*" (*Kagerer, Grupe 2001*), "*irregularities in terms of hypomineralized bands*", and "*influence on the quality of incremental lines*", and "*stress-related variation in line quality*" (*Cipriano 2002*). As these lines do refer to a certain stress-related life-events, in this study they will be referred to as stress layers. However, despite the vast evidence of the occurrence of cementum layers that correspond to life-events, a standardized methodological approach for the determination of such stress layers is not available yet.

The variation of these layers involves two features: (1) disparities in width of the layers, with stress events supposed to result in broader layers, and (2) difference of optical appearance under transmitting light microscopy, with a greater contrast between dark and bright lines, *i.e.* the stress-related layers are broader and appear darker. To count the pairs of light and dark lines that represent one year in age determination, we use the dark lines as markers as they are easier to determine visually. The first line, the eruption line, is also a dark one.

When it comes to the darker appearance of the layers, there are no strict criteria for the definition of a layer being darker or lighter, whereas the width of the respective cementum layer can be evaluated by measurements. It thus rather depends on the subjective impression of the observer. This leads to highly subjective determinations of potential stress layers. Galina A. Klevezal' and Albert C. Myrick (*1984. 104*) described in their research the dentine of toothed whales and dolphins that consist of numerous layers having different optical densities. The variations in optical appearance are described as subjective: "*DSLs (deep stained layers) in males were subtly different in character from those observed in females. Nevertheless, clear distinctions between DSLs in males and in females were difficult to describe, and we have here used the same definition for both sexes.*" In their study the presence of 'doubtful' layers is noted, emphasizing that the criterion for that description is subjective (*Klevezal', Myrick 1984*).

As an indicator for a determination of a stress layer the presence and visibility of striking incremental layers through all sections of the same tooth (*Kagerer, Grupe 2001*) is suggested.

Materials, methods and results

Sample description

Eight archaeological specimens (currently investigated at the Laboratory for Bioarchaeology, Department of Archaeology, Faculty of Philosophy, University of Belgrade) from the Mesolithic and Neolithic periods were analysed for tooth cementum stress layers (Tab. 1). All samples are from individuals without visible traumata and from secure archaeological contexts. They originate from excavated archaeological sites that have clear prehistoric contexts (Fig. 1). For some directly dated individuals a radiocarbon date is available, whereas others are assigned to a period (Mesolithic or Neolithic) based on the dating of the entire site and the burial position. In the Danube Gorges, Mesolithic individuals are buried in supine position, whereas Neolithic individuals are buried in flexed position lying on their sides (*Borić 2011*). As a preparatory first step, all samples were photographed, 3D scanned, and a cast was made of each tooth before the sample preparation took place.

TCA sample preparation

Only single-rooted teeth were investigated. The general protocol for the preparation of samples was based on the work of Ursula Wittwer-Backofen (2012). Teeth were embedded into Biodur epoxy resin (Biodur E12 resin with hardener E1 in the ratio 100:28) and the middle third of the tooth was cut cross-sectionally with a slice thickness of 80μm using a Leica 1600 rotating diamond microtome. This resulted in 7 to 17 sections per tooth. Each section was observed visually and individually by

Archaeological site	Grave	Sex	Tooth (FDI)	Macroscopic age estimate	TCA age estimate	Period	Absolute date 95% CI (reference)
Vlasac	38	Female	42	30–59	70 ± 2.5	Mesolithic	7514–7351 cal BC (this study)
Vlasac	24	Male	21	25–29	44 ± 2.5	Mesolithic	6640–6220 cal BC (*Borić 2011*)
Padina	18b	Female	35	>30	65 ± 2.5	Mesolithic	9115–8555 cal BC (*Mathieson* et al. *2018*)
Vinča–Belo brdo	VII	Female	43	15–18	23 ± 2.5	Neolithic	5565–5470 cal BC (*Tasić* et al. *2015*)
Lepenski Vir	66	Male	22	25–30	34 ± 2.5	Neolithic	5995–5848 cal BC (this study)
Lepenski Vir	8	Female	44	30–49	36 ± 2.5	Neolithic	5990–5790 cal BC (*Bonsall* et al. *2015*)
Ajmana	11	Female	41	>30	60 ± 2.5	Neolithic	/
Lepenski Vir	9	Female	13	>15	55 ± 2.5	Neolithic	5980–5740 cal BC (*Bonsall* et al. *2015*)

Tab. 1. Samples analysed for tooth cementum stress layers (where no date for the specific individual was available field was marked with "/", this individual was assigned to a period according to burial position and the dating of the site).

the first author using the transmission light microscope Leica DM RXA 2 with magnifications of 20x and 40x. Photographs of all regions of interest were taken using a digital tubus camera Leica DC 250 and saved in a database. Each pair of light and dark cementum layers was counted for the age at death estimation (SFig. 1–SFig. 8 at http://dx.doi.org/10.4312/dp.46.17). Three sections from each tooth were selected for stress layer evaluation. The average number of layers was calculated by averaging the number of layers counted covering all sections (total number of sections for each tooth). One representative photo from each section was analysed. Age at death is calculated by adding the sex-specific average age of tooth root eruption for the respective tooth type, as noted in Peter Adler (1967), to the average number of cementum layers counted on all sections.

Methods for stress layer determination

We used two different methods for the determination of stress layers according to their width and colour of appearance. Both methods are based on the assumption that cementum layers influenced by physiological stress show a significantly broader extension compared to regular cementum layers. The verification and counting of stress layers was a blind procedure in the sense that the researcher making the count did not know which particular tooth was being analysed. This measure was taken in order to avoid preconceptions about the sex and the period that the samples come from (Neolithic or Mesolithic), and to avoid these expectations influencing the results.

Method 1 consists of measuring each pair of dark and bright layers (Fig. 2) by using the Leica software Image measurement tool. The detailed measurements (*i.e.* the thickness of the pair of lines) were taken from three selected sections of the same tooth. For each section the average width of layers and the corresponding standard deviation was calculated. All layers with values greater than the average +1 standard deviation value were defined as stress layers. This method indicated stress layers based on their differing width, independent of their visual appearance or observer determination.

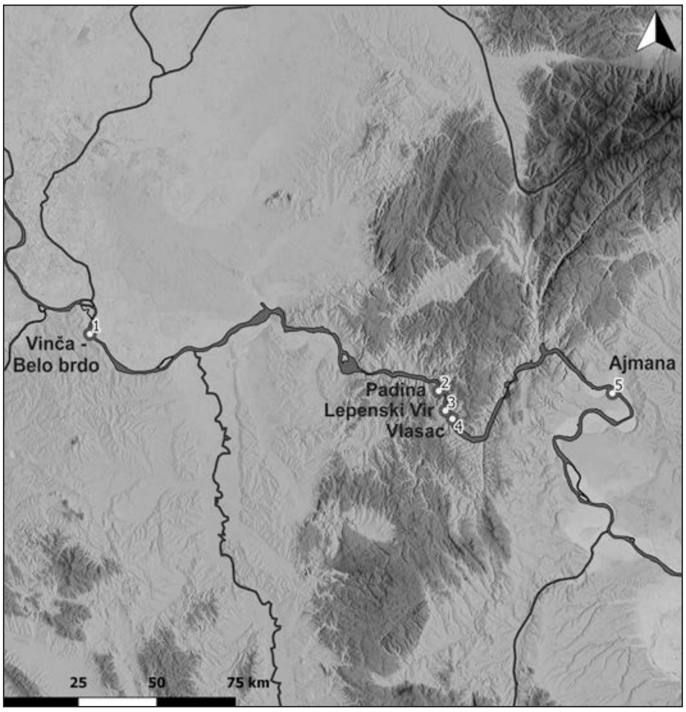

Fig. 1. Map of the research area with sites from which the samples in this study originate

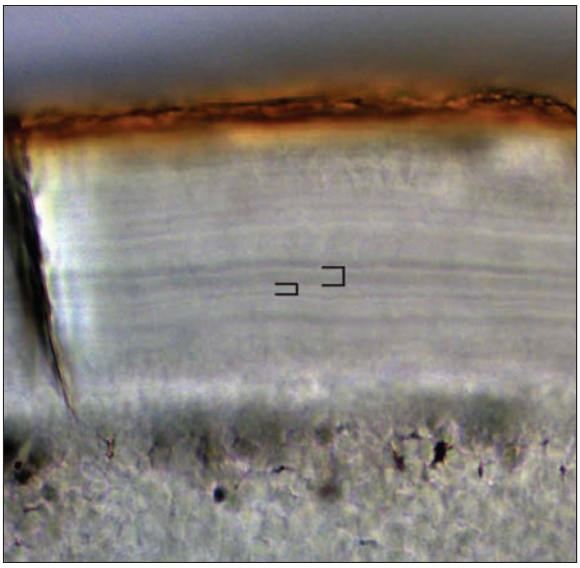

Fig. 2. The tooth cementum band under the microscope. The identification and measurement of a tooth cementum layer is illustrated.

Method 2 is based on calculating the average thickness of the incremental layers by measuring the thickness of the whole cement band at four different areas of a section. This procedure was done on three sections from the same tooth. The average value of the thickness of the band was divided by the number of layers counted from the specific section. Stress layers were determined visually by the observer, selecting layers that appeared wider and darker. Only these pre-determined layers were measured, and if their thickness was greater than the average incremental layer thickness, it was described as a stress layer. This method relies on the observer's pre-selection of stress layers.

In order to compare the results yielded by the different methods we compared the number of stress layers determined by each of the two approaches and counted the number of matches. Matching layers are those classified as stress layers by both methods applied to the same section and position in the cementum band. The percentage of matching stress layers for each section is presented in Table 2. As the match between the number and position of stress layers identified is very high (see the Results section) it was decided to use only the first method, as it is more objective (in that it does not involve the subjective pre-selection of layers).

Verifying and counting stress layers

After identification of the stress layers for each section and each tooth, the next step was the verification of the appearance of cementum stress layers on an individual level. A stress layer was considered as verified on an individual level if it appeared in the same position on at least two out of three sections of one tooth. Therefore, the total number of stress layers per individual (each individual is represented by a single tooth) is the total number of verified stress layers. In order to compare the positions of stress layers from different sections (which have different cementum band widths) the following procedure is applied (see Figure 3 for the illustration of the procedure):

❶ The sections are represented visually – each counted cementum layer is represented by a rectangle, stress layers marked in green.

❷ In order to make the sections of different widths comparable, they are stretched to same length.

❸ In order for a stress layer to be verified and counted, there have to be at least two layers at the same relative position (*i.e.* there is at least some overlap between the layers). The cementum band thickness profiles for each individual are shown in the Supplementary Material (SFig. 9–SFig. 16 at http://dx.doi.org/10.4312/dp.46.17). The evaluation of stress layers per individual was made according to this procedure, as shown in Figure 3.

Calculation of individual burden of stress

Cementum layer anomalies are indicators of stress burden, and the number of verified stress layers needs to be statistically corrected for the total number of TCA layers. This is done in order to account for the differences in age between individuals (as older individuals had more chance to experience stress). It is implemented by dividing the number of verified stress layers by the individual total number of TCA layers. Strictly speaking this is not an age correction, as the eruption time for different teeth may differ, therefore the differences in the total number of layers may not directly reflect differences in age, but for practical purposes it is equivalent to age correction given that differences in tooth eruption times are a few years at most. The resulting value can be interpreted as a number of verified stress layers per year of life covering the period after the specific tooth erupted.

Results

The stress layers are present in all individuals investigated in this study, with the number varying between two and 11 per person. The number of stress layers identified per person is consistent over all sections and between the methods. The results of the comparison of the two methods are presented in Table 2. The percentage of matching layers varies between 67 and 100 percent, with the mean value of 93.6 percent. In 64 percent of cases (sections) there is a full match between the layers identified as stress layers by both methods.

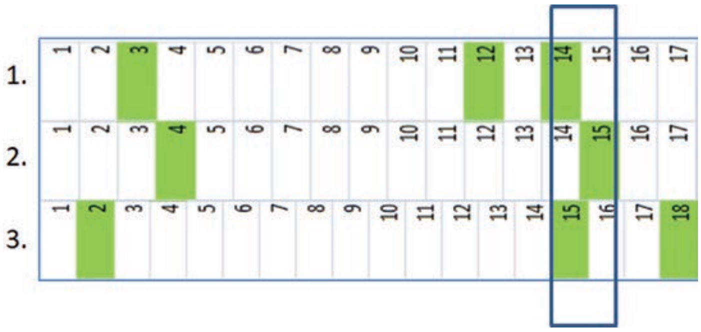

Fig. 3. Illustration of the stress layer verification: different rows represent different sections of the same tooth; stress layers (determined either by Method 1 or Method 2) in each section are marked in green; despite the fact that more than one stress layer is identified in each section individually (green rectangles), there is only one verified stress layer for this tooth, as only two layers from sections 2 and 3 overlap (the verified stress layer is marked).

The results show that both methods of stress layer identification yielded identical or very similar results in the majority of cases. However, it should be emphasized that this convergence refers only to the two specific protocols for classifying cementum layers as stress layers – it should not be interpreted as a measure of the absolute validity of any of the methods in terms of discriminating between the real stress layers and those not affected. The latter can only be achieved by a clinical study where the medical history of an individual is known.

The number of verified stress layers is correlated with the total number of TCA layers ($r = 0.675$, $p = 0.033$, see Fig. 4) which is not surprising given that, whatever the etiology of stress layers is, longer lifespan means more opportunity for stress layers to occur. The values of the number of verified stress layers per year of life (after tooth eruption) for each individual are presented in Table 3. The range of values is between 0.04 and 0.13 for the Mesolithic group, and between 0.08 and 0.15 for the Neolithic group. The average values of the number of verified stress layers corrected for the total number of verified stress layers (number of verified stress layers per year of life after tooth eruption) are 0.085 and 0.1 for the Mesolithic and the Neolithic groups, respectively. Therefore, the average number of verified stress layers per year of life after tooth eruption is higher in the Neolithic than in the Mesolithic, but there is a substantial degree of overlap (Fig. 5). No statistical tests are performed as the sample size and power of the test are too low for meaningful analysis, therefore we only report trends.

Individual	Section Nr.	Method 1, Nr. of stress layers	Method 2, Nr. of stress layers	Nr. of matching layers	Percent matching
Vlasac 38	1	7	8	7	87.5
Vlasac 38	2	6	7	6	85.71
Vlasac 38	3	9	9	9	100
Vlasac 24	1	4	4	4	100
Vlasac 24	2	4	4	4	100
Vlasac 24	3	6	6	6	100
Padina 18b	1	6	6	6	100
Padina 18b	2	3	3	3	100
Padina 18b	3	4	4	4	100
Vinča VII	1	3	3	3	100
Vinča VII	2	2	2	2	100
Vinča VII	3	2	2	2	100
Vinča VII	4	2	3	2	66.67
Lepenski Vir 66	1	6	7	6	85.71
Lepenski Vir 66	2	4	5	4	80
Lepenski Vir 66	3	4	5	4	80
Lepenski Vir 8	1	4	4	4	100
Lepenski Vir 8	2	5	5	5	100
Lepenski Vir 8	3	5	6	5	83.33
Ajmana 11	1	10	10	10	100
Ajmana 11	2	5	5	5	100
Ajmana 11	3	11	11	11	100
Lepenski Vir 9	1	9	9	9	100
Lepenski Vir 9	2	7	6	5	83.33
Lepenski Vir 9	3	7	8	7	87.5

Tab. 2. Comparison of the two methods for the identification of cementum band stress layers.

Discussion and conclusion

In this study, we explored the tooth cementum stress layers from the perspective of the differences in health and general stress between the Mesolithic and

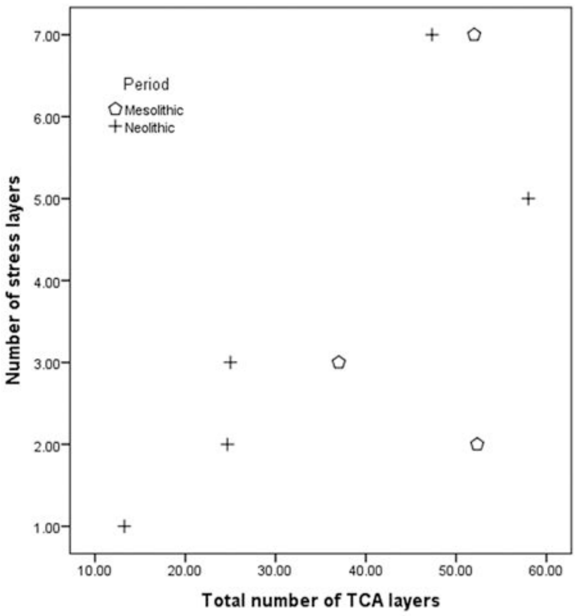

Fig. 4. Total number of TCA layers* vs. *number of verified stress layers.

Neolithic populations. As expected, the number of stress layers when corrected for the total number of TCA layers is higher in the Neolithic group than in the Mesolithic group, but the statistical significance of this trend cannot be evaluated due to low sample size.

The results are also consistent with the picture of the Neolithic Demographic Transition formulated by Jean-Pierre Bocquet-Appel (*2008; 2011*), if some of the detected stress layers are induced by pregnancies.

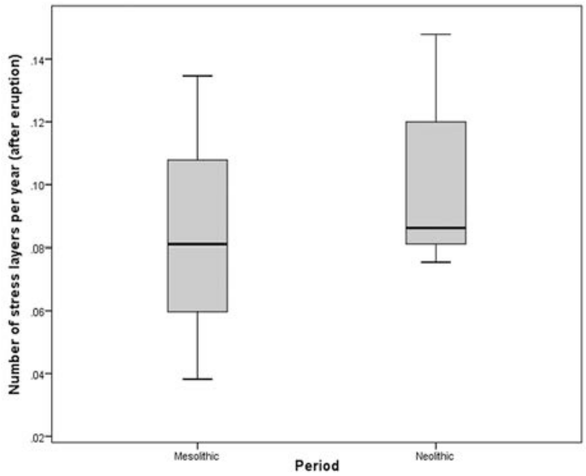

Fig. 5. Boxplot showing the distribution of the number of verified stress layers per year by chronological phases.

They might suggest both increased fertility, as the major driving force for Neolithic population growth, and increased burden of disease, as demonstrated by Ursula Wittwer-Backofen and Nicolas Tomo (*2008*). This would imply that TCA-based analysis of physiological stress can make a substantial contribution to the field of paleodemography. As teeth are among the most durable elements of the skeleton, in terms of resistance to decay and preservation, the analysis of TCA stress layers can be used in situations when the application of macroscopic methods of recording physiological stress is precluded due to missing bones. Moreover, some conditions detectable with macroscopic methods, such as hypoplasia, occur early in life, usually prior to permanent teeth eruption, whereas stress episodes that should theoretically be reflected in the cementum bands could occur later in life. To further support these first observations, a larger sample size will be evaluated in the next step in order to confirm or refute our preliminary results concerning the differences between the Mesolithic and the Neolithic populations with a statistically relevant sample.

Archaeological site	Grave	Sex	Period	Total number of verified stress layers	Number of stress layers per year
Vlasac	38	Female	Mesolithic	7	0.13
Vlasac	24	Male	Mesolithic	3	0.08
Padina	18b	Female	Mesolithic	2	0.04
Vinča–Belo brdo	VII	Female	Neolithic	1	0.08
Lepenski Vir	66	Male	Neolithic	2	0.08
Lepenski Vir	8	Female	Neolithic	3	0.12
Ajmana	11	Female	Neolithic	5	0.09
Lepenski Vir	9	Female	Neolithic	7	0.15

Tab. 3. Number of verified stress layers per year of life (after tooth eruption) for each individual.

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Obsidian provenance studies in the far eastern and north-eastern regions of Russia and exchange networks in the prehistory of Northeast Asia: a review

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ABSTRACT – *This overview is based on the results of 25+ years of provenance studies to identify the sources of high-quality volcanic glass (obsidian) in prehistoric cultural complexes of the far eastern and northeastern regions of Russia (Maritime Province, the Amur River basin, Sakhalin Island, the Kurile Islands, Kamchatka Peninsula, Chukotka region, the Kolyma River basin, and the High Arctic), as well as in adjacent parts of Northeast Asia (Hokkaido Island, the Korean Peninsula, and Manchuria). The extended networks of obsidian exchange in antiquity are reconstructed for the southern Russian Far East and Northeastern Siberia. A possible mechanism of long-distance obsidian exchange/trade in Northeastern Siberia is suggested.*

KEY WORDS – *obsidian; provenance study; prehistoric exchange; far eastern Russia; Northeastern Siberia*

Študije provenience obsidiana na območju ruskega Daljnega Vzhoda in v severovzhodni Rusiji ter mreže menjav v prazgodovini v severovzhodni Aziji: pregled

IZVLEČEK – *Pričujoča presoja je osnovana na rezultatih več kot 25 let študij provenience pri iskanju izvorov visoko kakovostnega vulkanskega stekla (obsidiana) v prazgodovinskih kulturnih kompleksih na ruskem Daljnem Vzhodu in v regijah severovzhodne Rusije (obmorske province, območje reke Amur, otok Sahalin, Kurilsko otočje, polotok Kamčatka, območje Čukotka, območje reke Kolime in Arktično višavje) kot tudi v sosednjih delih severovzhodne Azije (otok Hokkaido, Korejski polotok in Mančurija). Za območji južnega dela ruskega Daljnega Vzhoda in severovzhodno Sibirijo smo že rekonstruirali razširjeno mrežo menjave obsidiana v preteklosti. Predlagamo pa možne mehanizme menjav/trgovine z obsidianom na daljše razdalje na območju severovzhodne Sibirije.*

KLJUČNE BESEDE – *obsidian; provenienca; prazgodovinska menjava; ruski Daljni Vzhod; severovzhodna Sibirija*

Introduction

Research on the provenance of artefacts made of waterless volcanic glass (obsidian) began at the modern methodological level in the 1960s, first in the Mediterranean (*Cann, Renfrew 1964*) and afterwards in the Americas, Europe, East Africa, Oceania, and East and Southeast Asia (see bibliographies: *Skinner, Tremaine 1993; Pollmann 1999*). The success of obsidian source studies in the 1970s to 2010s, following the pioneering works of the 1960s, was due to the fact that almost every source of obsidian has a unique 'geochemical portrait (signature)' (*i.e.* the content of several chemical elements) which can be determined using analytical methods (*Williams-Thorpe 1995; Glascock* et al. *1998; Shackley 2005;*

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Carter 2014). The establishment of primary sources for obsidian artefacts is very important for understanding the patterns of ancient migrations and contacts.

Obsidian is quite common in the far eastern and northeastern regions of Russia, in the prehistoric assemblages of Kamchatka Peninsula, Chukotka region, Primorye (Maritime) Province, Sakhalin Island, and Kurile Islands (*Kuzmin 2010; 2014; Grebennikov* et al. *2018*). In other parts of eastern Russia – the Amur River basin, northern coast of the Sea of Okhotsk, the basins of the Kolyma and Indigirka rivers, and the High Arctic (*Kuzmin 2014; Pitulko* et al. *2019*) – obsidian tools are also present but are not numerous. Actual studies of archaeological obsidian in these regions only began in the early 1990s (*Glascock* et al. *1996; Shackley* et al. *1996*), even though in eastern Russia the presence of such artefacts has been known since the end of the nineteenth century (*Kuzmin 2014.144*). In this overview, brief information on the current state-of-the-art in obsidian provenance research in eastern Russia is presented, based on the latest summaries (*Kuzmin 2010; 2011; 2012; 2014; 2017; 2019*).

Methodology of obsidian provenance research and the materials used

Since the 1960s (*Cann, Renfrew 1964; Parks, Tieh 1966; Griffin* et al. *1969*), the identification of obsidian sources for archaeological materials has been conducted by comparing the geochemical composition (mainly of trace elements – U, Th, Ta, Hf, Lu, Yb, Dy, Tb, Eu, Sm, Nd, and some others) of obsidian from primary sources and archaeological assemblages (see *Glascock* et al. *1998; Shackley 2005*). One of the most important conditions for the interpretation of geochemical data is the use of uniform analytical standards, although this is not always the case; therefore, data from different laboratories often cannot be compared (see review: *Suda* et al. *2018a*). In our case studies described here, all measurements for eastern Russia were performed in one laboratory, the Research Reactor Center of the University of Missouri (Columbia, MO, USA) (*Glascock* et al. *2007*), using the same methodology (*Glascock* et al. *1998*). This makes it possible to conduct a direct comparison of the results obtained for both primary ('geological') locales of obsidian and artefacts.

Two main analytical techniques for the geochemical analysis of obsidian in eastern Russia were used by our informal Russian-US group: (1) Neutron Activation Analysis (NAA); and (2) X-ray Fluorescence (XRF). Full descriptions of these methods were given previously (*Kuzmin, Glascock 2014; Kuzmin* et al. *2002a; 2008; Glascock* et al. *2011; Grebennikov* et al. *2018*), and here I refer to these publications for more details. As for the research strategy employed by our group since 1992, we initially identified, using XRF and NAA, the geochemical groups for a few dozen obsidian artefacts from Primorye Province and the Amur River basin. This made it possible to find out about the number of primary obsidian sources which were exploited (*Glascock* et al. *1996; Shackley* et al. *1996*). Afterwards, all major primary sources of obsidian in these regions were examined by NAA (*Kuzmin* et al. *2002a; Popov* et al. *2005; Glascock* et al. *2011; Kuzmin* et al. *2013*). First, the full version of NAA, which allows the determination of 28 elements with high precision (one part-per-million, or 10^{-4}%), was used. When the 'geochemical signatures' of the main sources were established, it was possible to use the abridged version of NAA (with measurement of the content of 7–12 elements) for the examination of artefacts only, due to the relatively high cost of the full NAA and its destructive nature (samples become radioactive and need to be utilised as low-level nuclear waste).

Other analytical methods used by different groups of South Korean, Australian and US scholars in eastern Russia and adjacent Northeast Asia were Proton-Induced X-ray Emission (PIXE) and Proton-Induced Gamma-ray Emission (PIGME) (*Kim* et al. *2007; Doelman* et al. *2008*); portable XRF and a laser ablation version of the Inductively Coupled Plasma – Mass Spectrometry (LA–ICP–MS) (*Phillips 2010*); and a Prompt Gamma Activation Analysis (PGAA) (*Jwa* et al. *2018*).

As a result of the comparison based on established statistical procedures (*Glascock* et al. *1998*), common geochemical groups for sources and archaeological samples were identified (*Kuzmin, Glascock 2014*). This made it possible to determine with a high degree of reliability from where the ancient people acquired obsidian. This information constitutes a solid basis for the reconstruction of the procurement and exchange of raw materials in the prehistoric cultural complexes of the entire Northeast Asia.

Various groups of scientists up to early 2019 have analysed about 3110 samples of obsidian from far eastern and northeastern Russia, as well as from adjacent parts of Northeast Asia – the Korean Peninsula, Northeast China (Manchuria), and Hokkaido Island (Tab. 1) (see *Kuzmin, Popov 2000; Popov* et al. *2005; Kim* et al. *2007; Doelman* et al. *2008; 2012; 2014; Phillips 2010; Jia* et al. *2010; 2013; Kuzmin 2014; Kuzmin, Glascock 2014; Kim 2014; Lee, Kim 2015; Lynch* et al. *2016, 2018; Kuzmin* et al. *2018; Grebennikov* et al. *2018; Chang, Kim 2018; Pitulko* et al. *2019*). Due to the plethora of information on obsidian geochemistry for the Honshu and Kyushu islands of Japan, available mostly in Japanese only (*Sugihara 2014*), these regions are excluded from this overview; some English summaries have recently been published and can serve as primary data (see *Tsutsumi 2010; Obata* et al. *2010; Ikeya 2014; 2015; Sato, Yakushige 2014; Shiba 2014; Shimada 2014; Shimada* et al. *2017; Suda* et al. *2018b*).

Results and discussion

Sources of obsidian in Primorye Province

In the southern part of Primorye Province, the main primary source of obsidian (more precisely, waterless volcanic glass) is the Shkotovo (Basaltic) Plateau (Tab. 1, Fig. 1). High quality volcanic glass is associated here with basic rocks (basalts and andesite-basalts), unlike the majority of sources in Northeast Asia which are part of acidic rocks (mainly rhyolites) in volcanic arc positions (*Kuzmin* et al. *2013; Wada* et al. *2014*). Although basaltic glasses have been known in Primorye for a long time (*Petrov, Zamurueva 1960*), their detailed study only began in the 1990s (*Kuzmin* et al. *2002a*). During the eruption of molten basalt, pillow lavas were formed at the contact of the hot basalt mass and cold water or solid surface. Due to rapid cooling of the lava, spherical ('pillow-shaped') bodies with a diameter of 1–5m were created (*Doelman* et al. *2012*). The surface layer of pillow lava consists of volcanic glass. Obsidian on the Shkotovo Plateau is present in the form of hyaloclastites, a material formed during the fragmentation of the glassy outer part of pillow lava blocks. Welded crusts with volcanic glass are also known in this region; they are relatively thin (up to 0.3–0.5m) horizons of non-crystallised glass at the contact of the lava flow and the underlying surface.

Another primary source of volcanic glass of acidic (rhyolite) composition is located in the basin of the Gladkaya River in the extreme southwestern part of Primorye (*Kuzmin* et al. *2002a*), but it was not widely exploited in prehistory (*Kuzmin 2014; Doelman* et al. *2014*).

Obsidian source on the Korean Peninsula

As far as we know today, the single primary obsidian source in Korea of alkaline composition is situated near the modern Paektusan Volcano (*Popov* et al. *in press*). It was originally recognised by Kuzmin *et al.* (*2002a*) and Vladimir K. Popov *et al.* (*2005*), but for a long time our knowledge was based exclusively on archaeological materials (*i.e.* obsidian artefacts). Only a handful of 'geological' samples with unknown exact location – somewhere within the northern part of Korea, called today the Democratic People's Republic of Korea, or North Korea – were analysed in the early-mid 2010s (*Kim 2014.169; Yi, Jwa, 2016; Jwa* et al. *2018; Popov* et al. *in press*).

Regions	Geological samples	Archaeological samples	Main obsidian sources*
Primorye (Maritime) Province	102	390	BP, PA
Amur River basin	12	39	OP, BP, SH-OK
Sakhalin Island	–	206	SH-OK, AK
Kamchatka Peninsula	63	444	KAM-01 – KAM-15
Kurile Islands	–	773	SH-OK, KAM-01, KAM-02, KAM-04, KAM-05, KAM-07
Chukotka	37	216	LK, KAM-01, KAM-03, KAM-08, VAK
Siberian Arctic (Zhokhov I.)	–	14	LK
Manchuria (Northeast China)	–	533	PA, BP
Korean Peninsula	14	211	PA, KO
Hokkaido Island	53	–	SH-OK, AK, TM
Number of samples	**281**	**2826**	**3107****

* BP Basaltic Plateau; PA Paektusan Volcano region; OP Obluchie Plateau; SH-OK Shirataki and Oketo; AK Akaigawa; KAM-01 – KAM-15 various Kamchatkan sources (see for details: *Grebennikov, Kuzmin 2017*); LK Lake Krasnoe; VAK Vakarevo type; KO Koshidake; TM Tokachi-Mitsumata.
** Total number of obsidian samples analysed for this overview (see text for references).

Tab. 1. Number of samples analysed for each region of Northeast Asia (1992–2019), and major obsidian sources used in prehistory.

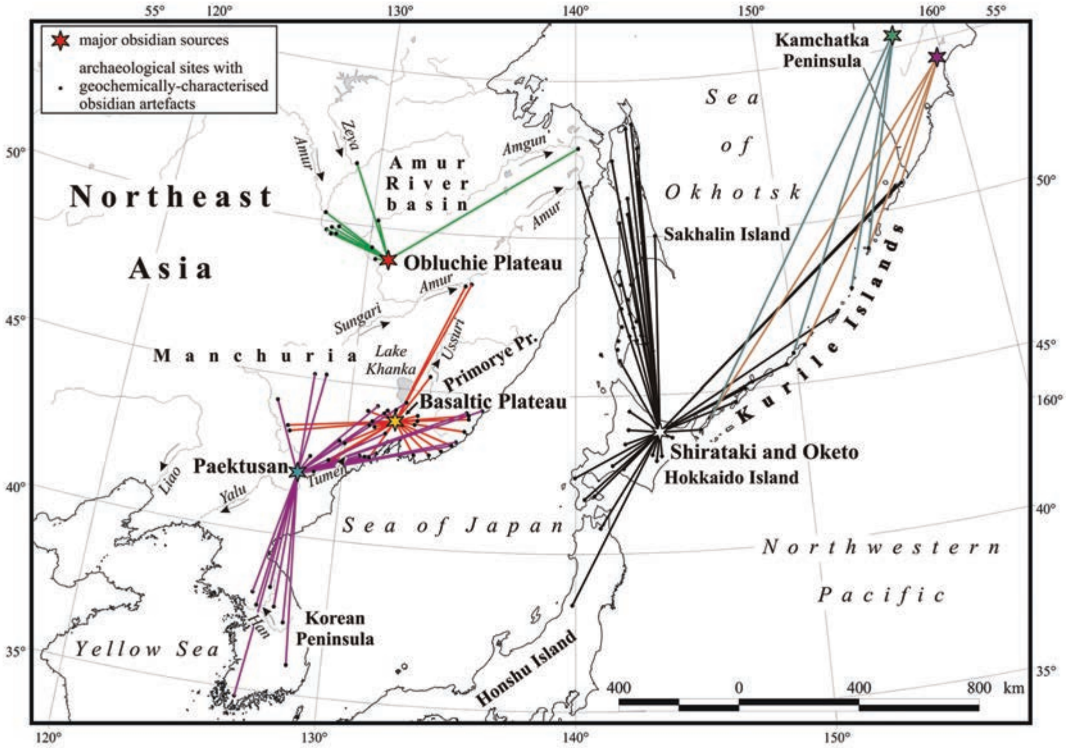

Fig. 1. Prehistoric obsidian exchange/trade networks in the southern Russian Far East and neighbouring Northeast Asia (after* Kuzmin 2017*, modified).

Nevertheless, all these data testify in favour of a single geochemical group which reflects the 'geochemical signature' of a primary source. Based on comprehensive analysis of all available evidence, it is concluded that the primary obsidian locale previously named 'Paektusan' or PNK1 is situated somewhere south of the Paektusan Volcano (Fig. 1). It is hoped that in the near future it will be possible to pinpoint the exact position of this important source in the logistically difficult region of North Korea.

Sources of obsidian in the Amur River basin

The major primary source of volcanic glass in the Amur River basin is known from the Obluchie Plateau, where it is confined to basaltic hyaloclastites (*Glascock* et al. *2011*) (Tab. 1; Fig. 1); its geological position is similar to the Shkotovo Plateau. There are also data about the existence of another kind of basaltic obsidian in this region, but the exact location of its source is still unknown. In the meantime, we called it 'Samarga' (*Kuzmin 2014.Fig. 6.1*), and suggest that it is situated in the Samarga River basin, the northern part of Primorye Province (*Kuzmin* et al. *2002a; Glascock* et al. *2011*).

Sources of obsidian on Hokkaido Island

Our informal Russian-US-Japanese group conducted NAA analyses of four major obsidian sources on Hokkaido Island – Shirataki (with two sub-sources), Oketo (with two sub-sources), Akaigawa, and Tokachi-Mitsumata (*Kuzmin* et al. *2002b; 2013; Kuzmin, Glascock 2007*). Other primary obsidian locales from Hokkaido (around 17 in number), consisting of *c.* 17–20 geochemical groups, were investigated by Keiji Wada *et al.* (*2014*) and Jeffrey R. Ferguson *et al.* (*2014*). All these sources are situated in a volcanic arc setting (*Wakita 2013; Wada* et al. *2014*).

Sources of obsidian on Kamchatka Peninsula

The Kamchatka Peninsula of eastern Russia is one of the few regions in the world with a high concentration of obsidian sources, along with the Japanese Islands (*Kannari* et al. *2014.Fig. 4.2*) and Mesoamerica (*Glascock* et al. *1998; 2010*). Today, at least 30 to 40 locales of acidic volcanic glass (associated with rhyolites and rhyodacites) are known in Kamchatka (*Grebennikov, Kuzmin 2017; Grebennikov* et al. *2010*). They are genetically related to the volcanism of the subduction zone of the Kurile-Kamchatkan arc (see *Khain 1994*). The major problem in the geological investigations of this region is its remoteness, and the logistical aspect of fieldwork is difficult and costly.

Currently, our Russian-US group has determined the geochemical composition of only 16 primary sources of Kamchatkan obsidian (*Grebennikov, Kuzmin 2017*). This is due to the difficulty of carrying out fieldwork in the Sredinny Range which is devoid of roads and settlements (*Grebennikov* et al. *2010. 90*). Sources are usually lava flows, extrusive (embedded in other rocks) bodies and pyroclastic flows. Of the 30 to 40 primary locales, 14 sources were actively used in prehistory.

Obsidian source in the Chukotka region (Northeastern Siberia)

It has been known for a long time that an obsidian source exists on Lake Krasnoe (with krasnoe meaning 'red') in the lower reaches of the Anadyr River (*Nasedkin 1983*) (Fig. 2), but more precise information about it was non-existent before our fieldwork in 2009. As a result of a survey and study of obsidian and other rocks on the shore and around Lake Krasnoe, we were able to obtain reliable data on the geology and geochemistry of this source (*Popov* et al. *2017; Grebennikov* et al. *2018*). Obsidian in Chukotka is part of the rhyolites of the West Koryak volcanic belt, and it can be found as pebbles and small boulders on the eastern shore of the lake; the primary source is perhaps currently under water (*Grebennikov* et al. *2018.609*).

Prehistoric obsidian exchange networks in the far eastern and northeastern regions of Russia

One of the main tasks of studying obsidian for archaeological purposes is to establish the patterns of its acquisition from primary sources, which allows reliable reconstructions of obsidian exchange networks, as well as human contacts and migrations in prehistory (*Williams-Thorpe 1995;* see also *Kuzmin 2012; 2015; 2017*). Currently, the existence of several large-scale exchange systems has been established (using obsidian as a commodity) for the southern part of the Russian Far East and adjacent regions, and for Northeastern Siberia (Figs. 1–2). Obsidian in these regions was most intensively exploited in the Stone Age – the Upper Palaeolithic (*c.* 25 000–12 000 years ago) and the Neolithic (*c.* 12 000–3000 years ago) (*Kuzmin 2011; 2015*). In the Bronze and Early Iron ages (*c.* 3000–1500 years ago), the value of obsidian as a raw material almost vanished, with the exception of Kamchatka and the Siberian Arctic, where the ancient populations continued to use it until the arrival of Russian settlers in the 17th–18th centuries AD, who introduced metals.

Three obsidian exchange networks have been reconstructed in the mainland Russian Far East (Fig. 1; Tab. 1), centred around the sources of the Shkotovo and Obluchie plateaus, and the Paektusan Volcano. While obsidian from the Shkotovo Plateau and the Paektusan sources is widely distributed in the region, including Primorye, the Korean Peninsula, Manchuria, and the Amur River basin, the Obluchie Plateau supplied only the Amur River basin. The distances from the sources to the utilisation sites in Primorye and the Amur River basin range from a few kilometres to 660–700km in a straight line, and for the Paektusan obsidian network it is even further, up to 800km (Fig. 1). The extensive exchange of obsidian centred around the Paektusan source was initially established by our group in the early 2000s (*Kuzmin* et al. *2002a*); subsequent studies confirmed this conclusion (*Doelman* et al. *2008; 2012*).

In insular Russian Far East – Sakhalin Island and the Kurile Islands – the main sources of obsidian were Shirataki and Oketo locales on Hokkaido Island (Fig. 1). Obsidian from the Shirataki source was also detected on the mainland (lower reaches of the Amur River), and it was brought there *c.* 8000 years ago (*Glascock* et al. *2011*). The distance from the Hokkaido sources to the utilisation sites in some cases exceeds 1000km in a straight line. For the Kurile Islands, the use of obsidian from several Kamchatkan sources has been established (Fig. 1), with distances of up to 1400–1500km as the crow flies. These obsidian exchange networks are an example of the super-long transport of raw materials, and their existence would be impossible without the use of watercraft from *c.* 10 000 years ago onwards (*Kuzmin 2016; 2017*).

Based on current knowledge on obsidian sourcing in insular Northeast Asia, one can confidently say that obsidian from sources in the Japanese Islands almost never reached the mainland part of the region, except the lower Amur River basin (*Kuzmin* et al. *2013*) and the southernmost part of the Korean Peninsula (*Kim 2014; Kim* et al. *2007; Lee, Kim 2015*). As for the latter, the main supplier of obsidian was the Koshidake source in northern Kyushu Island; it was also transported to the Ryukyu Archipelago in later prehistory (*Obata* et al. *2010; Kuzmin 2010.Fig. 8.8*). The use of watercraft for the creation of this network since the Upper Palaeolithic is evident, because even during the Last Glacial Maximum, *c.* 27 000–23 000 years ago, the Korea (Tsushima) Strait between the Korean Peninsula and Kyushu Island existed, with *c.* 20km width (*Kuzmin 2017.Fig. 4*).

Research conducted on the Kamchatka Peninsula by our group allowed us to reconstruct several obsidian exchange networks, with distances from sources to utilisation sites up to 600–650km in a straight line.

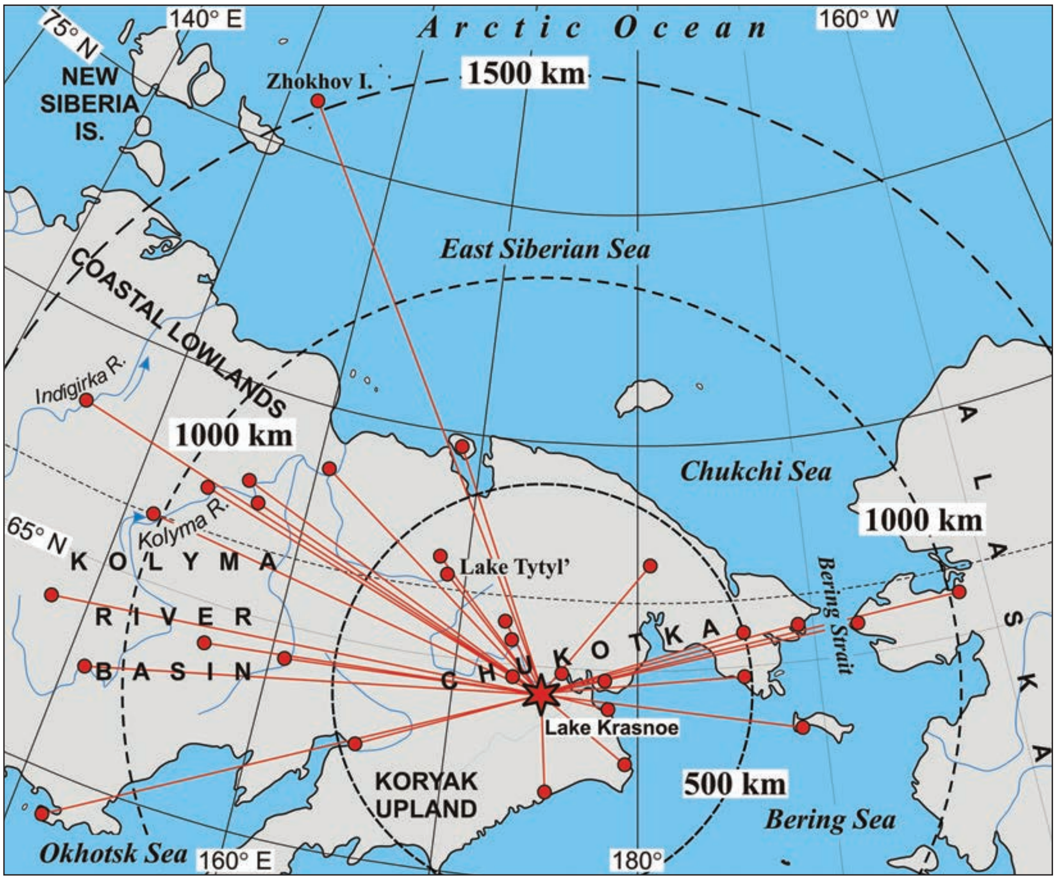

Fig. 2. Distribution of obsidian of the Lake Krasnoe source in Northeastern Siberia and Alaska (modified from* Kuzmin 2019 *and* Pitulko *et al.* 2019*). Red circles are sites with geochemically-characterised obsidian artefacts belonging to the Lake Krasnoe source.

The study of the obsidian sources in Kamchatka is still in its initial stage, primarily due to the high cost of fieldwork in the more remote parts of the peninsula where the majority of sources are located. Currently, on the basis of general geological and geochemical data, the most promising areas that require research have been identified (*Grebennikov, Kuzmin 2017*).

Northeastern Siberia (Chukotka and adjacent areas) is a relatively new territory for the study of obsidian sources at the modern methodological level. According to the results of geochemical analyses of *c.* 220 artefacts from the Chukotka region, a single source of obsidian was found, at Lake Krasnoe (*Grebennikov* et al. *2018*). The raw materials from this locale spread beyond Chukotka – to the Koryak Uplands, the basin of the Kolyma River, and Alaska (*Grebennikov* et al. *2018; Kuzmin* et al. *2018; Rasic 2016*) (Fig. 2). The distance from the source to the utilisation sites in some cases exceeds 1000km in a straight line.

The latest data from this region were obtained for the Zhokhov site in the High Arctic (76°N latitude). Here 79 obsidian artefacts were found in the Mesolithic cultural layer, dated to *c.* 8900–8600 years ago (*Pitulko, Pavlova 2016*). A provenance study of 14 artefacts showed that the raw material of all of them originated from the Lake Krasnoe source (*Pitulko* et al. *2019*). The straight distance between site and the source is *c.* 1500km; considering the coastline of the Arctic Ocean at the time of human occupation, it would be *c.* 2000km (Fig. 2; *Pitulko* et al. *2019. Fig. 7*). The obsidian from the Zhokhov site along with other archaeological localities in Northeastern Siberia (*Kuzmin* et al. *2018*) is evidence of the super-long-distance transport of raw material. It also shows that the size of the human interaction sphere in the Mesolithic of the Siberian Arctic was very large, up to *c.* 4 000 000km² (*Pitulko* et al. *2019*).

An important feature of obsidian exploitation by ancient humans in the eastern regions of Russia is the use of this raw material from several sources at a given site from the same cultural component; such cases have been repeatedly noted in Kamchatka, Primorye, Sakhalin Island and the Kurile Islands (*Kuzmin 2014*). The clearest example in this respect is the multilayered Ushki site cluster in Kamchatka (*Kuzmin* et al. *2008*). In the Late Pleistocene Layer 7 (dated to *c.* 12 600–17 400 years ago), seven sources of obsidian were identified. In the Final Pleistocene Layer 6 (dated to *c.* 11 900–12 900 years ago), the use of obsidian from four primary sources was detected. In the Holocene strata 5–1 (dated to *c.* 300–10 100 years ago), obsidian from one to six sources was determined. The distance from the site to the sources of obsidian is *c.* 140–260km in a straight line, and the sources are *c.* 250–500km apart. This complex strategy in the acquisition of valuable raw material in the harsh sub-Arctic environment, revealed after obsidian provenance research done by our group (see *Kuzmin* et al. *2008; Grebennikov, Kuzmin 2017; Grebennikov* et al. *2010*), represents a striking pattern of human adaptation to the natural environment in northeastern Russia in the late Upper Palaeolithic, Mesolithic and Neolithic.

One of the most important aspects in the study of the acquisition and use of archaeological obsidian is the mechanism for acquiring raw material from remote sources. In the southern Russian Far East, the travel distance of obsidian pebbles transported by rivers is up to 30–50km downstream from the source (*Pantukhina 2007*). Because today the presence of long-distance movement of obsidian, which greatly exceeds the range of obsidian transport by natural agents, is well-established (Figs. 1–2; Tab. 1), the issues related to exchange of this high-quality raw material are of great significance. Studies done in the Mediterranean and Near East in the 1960s (*Renfrew 1975*) allowed the creation of the 'down-the-line' concept of prehistoric trade/exchange. The main components of this concept are: (1) a *supply zone*, with a radius of up to 300km from the centre where the utilisation site is located, with the share of obsidian in the composition of the raw materials up to 80%; and (2) a *contact zone* beyond the supply zone, inhabitants of which could not easily visit the sources of obsidian due to the large distance to them, and they exchanged (traded) obsidian with people of the supply zone; the share of obsidian ranges from 30–40% to 0.1%.

In many cases established by our group for eastern Russia, the archaeological obsidians are separated from the primary sources by distances greater than *c.* 300km (Figs. 1–2), and this is evidence of well-developed exchange/trade networks, especially in Northeastern Siberia where the raw material from an obsidian source of Lake Krasnoe was spread in an enormously large area, with straight distances between end points up to *c.* 2000–2250km (Fig. 2). This kind of obsidian spread across an enormously large region can be called 'super-long-distance' exchange. It would be impossible to maintain the acquisition of obsidian from so remote a source without primitive trade and/or exchange, as is also evident in some other parts of Asia (*Campbell, Healey 2018*) and other continents (*Haines, Glascock 2013*).

The reconstruction of exchange/trade networks requires a detailed study of the petrographic composition of stone artefacts, and technical and technological investigation of obsidian products (tools, along with flakes and other sub-products), in order to understand the nature of raw materials brought to utilisation sites – in the form of either angular blocks, cores or finished products. Using the Zhokhov site (Mesolithic, *c.* 8900–8600 years ago) as a case study, one can conclude that obsidian was used for making microblades (*Pitulko* et al. *2019*). No obsidian cores were found, although it seems that microblade manufacture occurred at the site. Therefore, obsidian appeared at the Zhokhov site in a semi-ready form (cores and blades). Other rocks from the Zhokhov site, including local flint and sandstone, and 'exotic' chalcedony, were also used as raw materials for the manufacture of microblades by pressure flaking (*Pitulko* et al. *2012*). The technological analysis of the lithics concluded that the raw material was not in the form of blocks, but prepared cores and large blades were transported to the site. This is true in terms of both local and 'exotic' rocks (*Pitulko* et al. *2012. 240*).

Some information on the distribution of obsidian artefacts and their typological characteristics exists for other parts of Northeastern Siberia (Fig. 2). At archaeological sites in the lower Kolyma River course dated to the Neolithic (*c.* 7000–3000 years ago), the main obsidian artefacts are blades and their fragments, flakes, insets, and arrowheads, while a few obsidian prismatic cores were also recovered (*Kuzmin* et al. *2018*). It seems that obsidian was brought to the lower Kolyma River region from far away in the form of cores, and blade-making was performed locally. The high value of obsidian as an 'exotic' raw material forced prehistoric people to use cores to complete exhaustion. Several sites with obsidian were excavated at the Lake Tytyl' cluster in western Chukotka (*Kiryak 2010*), and they belong to the Mesolithic (*c.* 11 200 years ago) and Neolithic (*c.* 4800 years ago). Some of the artefacts (the exact number is unknown, but it is relatively small), especially points, are made of obsidian. It was suggested that this area may have served as a 'hub' for the exchange of obsidian between the source in eastern Chukotka and the Kolyma River basin and territories west of the Kolyma River (*Pitulko* et al. *2019*) (see Fig. 2). Because in the Kolyma River and Lake Tytyl' regions obsidian was traded as an 'exotic' raw material with populations near the source located at Lake Krasnoe (*Grebennikov* et al. *2018; Kuzmin* et al. *2018*) – at least *c.* 400–800 km away in a straight line – the exchange of it was carried out as prepared cores and tools rather than unworked pieces.

As far as I know, similar work has not yet been carried out in far eastern Russia. Some of the steps taken in this direction for the southern Russian Far East and Manchuria (see *Doelman* et al. *2008; 2012; 2014*) are still at a very preliminary stage.

Conclusions

Over the last 25+ years, significant progress has been achieved in obsidian provenance research in eastern Russia. The main networks of prehistoric exchange / trade of obsidian were reconstructed in the continental and insular parts of the southern Russian Far East; more work is underway in the northern part of the Russian Far East (Kamchatka Peninsula) and in Northeastern Siberia.

However, several issues still remain unresolved. The lack of standardisation for geochemical analyses conducted by different researchers has often made it impossible to compare the results obtained. To overcome this problem, a parallel analysis of obsidian source samples from Hokkaido Island was conducted in several laboratories, followed by interpretation of the results and determination of the optimal analytical strategy (*Suda* et al. *2018a*). The Kamchatka Peninsula remains the least studied region in eastern Russia in terms of the provenance of archaeological obsidian; the exact positions of seven sources used in prehistory are currently unknown (*Grebennikov, Kuzmin 2017*). The question of the mechanism of obsidian exchange between the populations near the sources and those who lived at a considerable distance from the primary obsidian locales requires in-depth study.

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Real and ideal European maritime transfers along the Atlantic coast during the Neolithic

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ABSTRACT – *The history of research on the Neolithic of the Atlantic façade shows how speculation about prehistoric mobility, especially across the sea, is mainly based on three types of archaeological evidence: megalithic monuments, rare stones, and pottery decoration. With the aim of approaching the issue from other perspectives, we have focused on the Morbihan area, a focal point of the European Neolithic during the mid-5th millennium BC. The analysis of this area has allowed us to grasp which objects, ideas and beliefs may have been desired, adopted and imitated at the time. We shall begin with an architectural concept, the standing stone. These were sometimes engraved with signs that can be directly compared between Brittany, Galicia (NW Spain) and Portugal, but for which there are no intermediate parallels in other areas of the French or Spanish coast. The unique accumulation and transformation of polished blades made of Alpine rocks and found inside tombs or in other sort of depositions in the Carnac region allowed us to establish a second link with Galicia and the Atlantic coast of the Iberian Peninsula, where certain types of the axes were imitated using a set of different rocks (sillimanite, amphibolite). Finally, the variscites and turquoises from different Spanish regions were used for the manufacture of beads and pendants at the Carnacean tombs, without it being possible – once again – to retrieve similar objects in the intermediate areas. The mastery of direct Atlantic sea routes is posed as an explanation for this geographical distribution. But, beyond the information drawn from specific artefacts – whose presence/absence should not be used in excess as an argument to endorse or underrate such movements across the ocean – we will return to a more poetic and universal phenomenon: the spell of the sea. Therefore, we will focus on the depictions of boats on the stelae of Morbihan to open such a debate.*

KEY WORDS – *Neolithic; maritime transfers; jade; Callaïs; symbolic representations*

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Resničen in idealen evropski morski transfer ob Atlantski obali v neolitiku

IZVLEČEK – *Zgodovina raziskav obdobja neolitika ob Atlantski obali kaže na to, da so domneve o premikih ljudi v prazgodovini, predvsem premiki po morju, osnovani predvsem na treh vrstah arheoloških podatkov: na megalitskih spomenikih, na redkih kamninah in na okrasu na lončenini. V članku se bomo te teme lotili iz drugega vidika, in sicer se bomo osredotočili na območje departmaja Morbihan, ki je bil v središču dogajanja v evropskem neolitiku v sredini 5. tisočletja pr. n. št. Z analizo tega območja lažje razumemo, katere objekte, ideje in verovanja so v tem obdobju ljudje najbolj pogosto želeli, posvojili in posnemali. Začeli bomo z arhitekturnim konceptom, menhirji/stoječimi kamni. Takšni kamni imajo občasno gravure z znaki, ki jih lahko neposredno vežemo na območje Bretanje, Galicije (SZ Španija) in Portugalske, medtem ko nimajo primerjav v vmesnih območjih ob francoski in španski obali. Enkraten zbir in preoblikovanje glajenih rezil, izdelanih na kamninah iz Alp, ki so bila odkrita v grobnicah ali drugih depozicijah na območju Carnaca, predstavlja drugo povezavo z območjem Galicije in Atlantsko obalo na Iberskem polotoku, kjer so bili najdeni posnetki nekaterih tipov sekir, izdelani iz različnih kamnin (silimanit, amfibolit). Tudi jagode in obeski, najdeni v grobnicah v Carnacu v Bretanju, so bili izdelani iz mineralov variscita in turkiza, ki izvirata iz španskih regij, medtem ko takšni predmeti – ponovno – na vmesnih območjih niso bili odkriti. Takšna geografska porazdelitev se razlaga z obvladovanjem neposrednih morskih poti po Atlantiku v prazgodovini. Kljub informacijam, ki jih dobimo s takšnimi posebnimi najdbami – katerih prisotnost/odsotnost naj ne bi preveč pogosto uporabljali kot argument v podporo ali podcenjevanje takšnih premikov po oceanu – se bomo vrnili na bolj poetičen in univerzalen fenomen: čarobnost morja. Pri tem se bomo osredotočili in razpravljali predvsem na upodobitve ladij na stelah, najdenih na območju departmaja Morbihan.*

KLJUČNE BESEDE – *neolitik; morski transfer; žad; Callaïs; simbolne upodobitve*

Foreword. A comparison.

In order to properly deal with the request made by the organizers of a recent seminar in Sweden (Göteborg, June 8–10, 2018), namely, the issue of long distance contacts along the Atlantic façade of Europe in the second half of the 5th millennium BC, a simple comparison of objects, materials and representations was conducted based on three types of data:

- First, on the circulation of rare materials, such as specific rocks with an Iberian origin (variscite/turquoise, probably sillimanite) used for the manufacture of tools and ornaments, in parallel with the phenomenon of the terrestrial distribution of axes and rings made of Alpine rocks;
- Second, through the analysis of ceramic production, technical features and specific decoration patterns, seemingly shared between distant areas;
- Third, based on a specific type of architectural structure (the standing stone) and of different signs engraved on its surface, whose shared characteristics in different European lands cannot be easily conceived without a direct relationship.

Such a comparative exercise, and the role attributed to the ocean, connects with a tradition of research that goes back to the first descriptions of the megalithic monuments of Brittany. Thus, in the year 1760, the Comte de Caylus concluded – while observing the distribution of the Breton megaliths along the sea coast – that they had their origin in people coming by boat from Northern Europe through coastal journeys. Later, Joseph Déchelette (*1908.626*) evoked 'unnamed seafarers' to explain both the Atlantic diffusion of megaliths and that of the Neolithic idols coming from the Mediterranean through the Gadès pass. This author was followed – among others – by Thomas William Mansell De Guérin (*1920*), who interpreted the settlement of the Channel Islands as the result of diffusion of people from South Brittany, as seen in the related ceramics, jadeite and fibrolite axes, together with the worship of a female divinity. This was before Daryll Forde suggested, in 1930, the existence of these terrestrial and maritime movements – especially from Galicia and Portugal – based on the megaliths in 'tholos', the 'callaïs' and the axes made of 'green rocks' (Fig. 1). Less boldly, Vere Gordon Childe (*1942*) and Glyn Daniel (*1941*) considered that Carnac and Spain were connected only through inland routes, while traveling by sea across the Mediterranean posed no conceptual problems for these authors.

Our exercise will, therefore, be conducted on part of the Atlantic coast of Europe. Since this synthesis will be anchored in the 5th millennium BC, the references will not focus on Ireland, Scotland, England and Wales (for such possibilities from northern France, see *Sheridan, Pailler 2011*). The starting point will be the Carnac area, in the southern coast of Brittany, a region chosen due to its complexity, since it was the most dynamic centre in Western France for several centuries. A node that, regardless of the quantitative and qualitative scale of our observation, can only be defined as truly exceptional. The data, as we will see, cannot be interpreted without considering the hypothesis of maritime movements, and the control of such routes as a source of wealth. This possibility of seafaring over long distances will ultimately be tested by accounting for the power of the imaginary carried by the Ocean.

Objects-signs, weapons and adornments

Considering yet again the sites of Morbihan that provided particularly unique objects, these are located in a quite small geographical area, barely 100km^2 around the protected bay of Quiberon, the real Morbihan (in Breton: the 'small sea').

The Carnacean tumuli

There are, in this region of Western France, more than one hundred earthen mounds (circular or elongated) containing individual (*e.g.,* Bovelann 2) or multiple burials (*e.g.,* Mané Lud central) dug into pits or arranged in stone or wood cists. The dimensions of these mounds vary between 5m in diameter and 180m long, and a maximum height (currently) ranging from 50cm to 3m. Among such monuments, three stand out for their isolation in the landscape, gigantic proportions and for the quantity and quality of the objects made of jade and callaïs they contained. These funerary spaces have no structured access and preserved the remains of only one individual. The volumes of their tumuli are extraordinary: Saint-Michel in Carnac (35 000m^3), Tumiac in Arzon (16 000m^3) and Mané er Hroëck in Locmariaquer (14 600m^3); while their maximum height rises between 10 and 15m above the ground (*Cassen* et al. *2011*). The current state of knowledge suggests Mané er Hroëck was the oldest of the three, followed by Tumiac and – finally – Saint-Michel. The last two have radiocarbon dates available (about 4500 cal BC), obtained from diverse samples and by different researchers (*Cassen* et al. *2012; 2019; Pétrequin* et al. *2012a; Schulz Paulsson* et al. *2019*).

Jade polished blades and their imitations

At the origin of the term 'Neolithic', enunciated by John Lubbock in 1865, the jade polished blades of Morbihan were the objects used to illustrate the con-

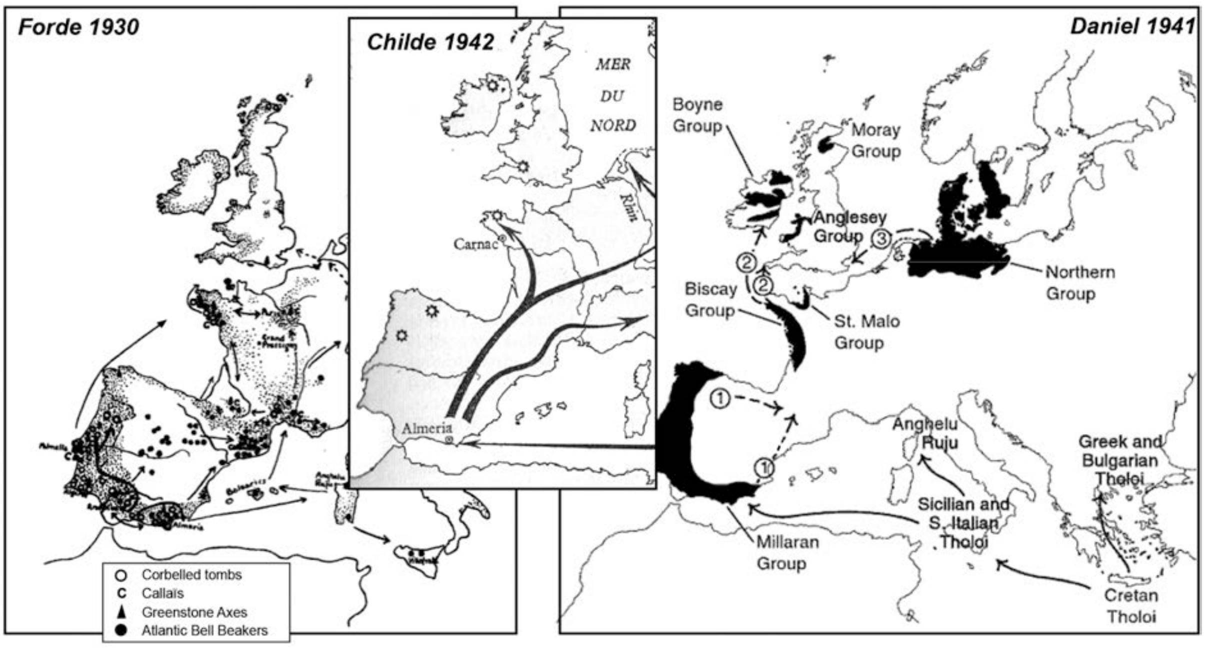

Fig. 1. Terrestrial and maritime diffusion of megalithic tombs, 'green stone' axes and 'callaïs', after* Forde 1930*; terrestrial diffusion of megaliths and metallurgy after* Childe 1942 *(French edition 1961), and after* Daniel 1941 *(CAD by S. Cassen).

cept of 'new stone', specifically those of the Larguéven hoard and the tumulus of Tumiac, discovered in 1808 and 1853. The recent study of such magnificent objects has shown that the geological origin of the rocks used for making them (jadeitite, eclogite, omphacitite) was mainly located on the Italian side of the Alps. Their distribution is widespread across Western Europe, with extensions towards the Black Sea and another dynamic focus existing at the time, centred on Varna (Bulgaria) (*Pétrequin* et al. *2012c*). A maritime 'trade' is the obvious explanation for the transfer of these polished blades from the continent to the British Isles (*Piggott 1953*), while river navigation probably sped their dissemination on the mainland (*Camps 1976*).

In order to illustrate this phenomenon, both in its deep insertion in the material culture of the Carnac region and in its impact at a European scale, we shall turn to a very specific type of axe found both in the Carnacean tumuli and in the local contemporary hoards: the butt-perforated Tumiac type. This is a Morbihan invention, a local transformation – by repolishing – of a ground blade transferred from the Alpine regions. One of these Tumiac axes has been found in the Iberian Peninsula, in Vilapedre, Galicia (NW Spain) (Fig. 2; *Fábregas* et al. *2012*). It is an object clearly made of jadeitite that travelled from Brittany after its repolishing (being, therefore, a secondary transfer). Most interestingly, there are no known intermediate finds along the northern coast of Spain.

The Tumiac axes were reproduced, in their general lines, in northwestern Spain and Portugal, resulting in the so-called Cangas type axes (Fig. 2). The Cangas are triangular, very elongated and occasionally fusiform axes; as in the original model, their butt is always perforated. The raw materials used were mainly sillimanite and amphibolite (*Pétrequin* et al. *2012b*). Their manufacture and dissemination dates back to the transition between the 5th and 4th millennia BC. This phenomenon of imitation is also visible in other areas of Europe, as in the case of the Zug blades, mainly made of serpentinite, whose presence underlines the penetrating force of the objects-symbols from Morbihan in areas such as Switzerland.

Surprisingly, we have identified a typical Cangas axe in Brittany that deserves further investigation after its original publication (*Le Guern 2011*). Found in Rest Louët, south of the town of Plévin (Finistère) in the 1980s, its raw material was initially identified as fibrolite, probably due to its fibrous appearance (Fig. 3). Revisited in 2014 by one of the current authors (YP), nephrite was considered the most probable raw material. This new examination allowed us to verify that despite the extensive alteration of the material the surfaces still had mirror polished areas. The perforation is biconical; part of the edge and the end of the heel have been broken since the discovery of the artefact, but the restoration conducted by the owner took into account the original morphology (L = 20.4cm; W = 4.21cm; T = 1.45cm; diameter of the perforation on the upper face). After a new macroscopic examination in 2018, nephrite was also discarded as the raw material for the axe, and Pierre Pétrequin pointed out the possibility of the rock being made of amphibolite. Due to the impossibility of carrying out a spectroradiometric ana-

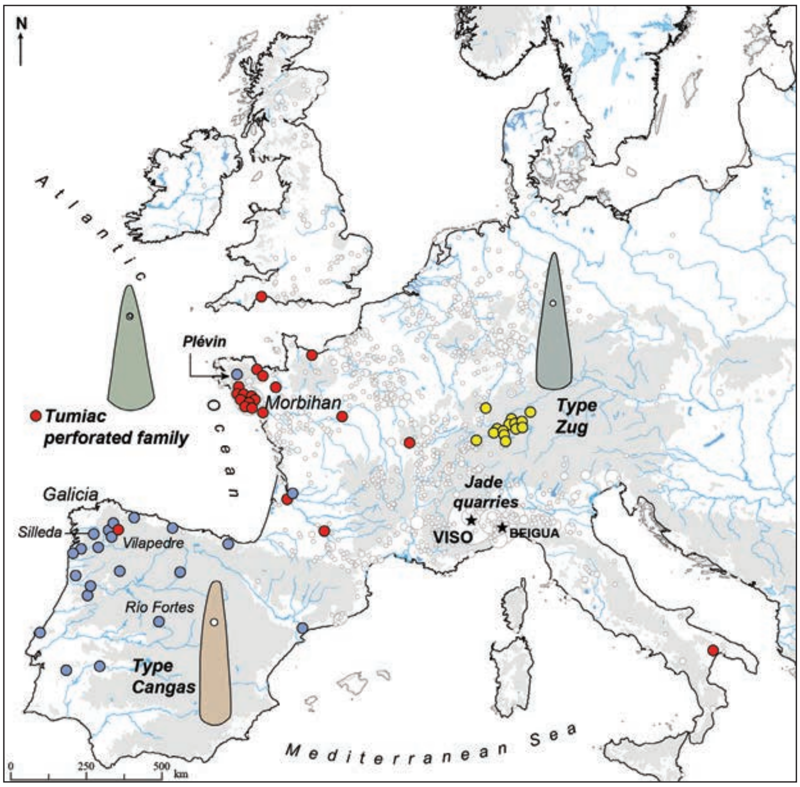

Fig. 2. Distribution of the axes of the Tumiac perforated family made on Alpine jades, compared to the Zug type and the Cangas type; localization of the axe of Plévin (after* Pétrequin *et al.* 2012, *and* Fábregas Valcarce *et al.* 2012, supplemented*).

lysis (the owner not allowing the movement of the piece), a series of pXRF analyses were therefore conducted on the surface of the axe. At the same time and for comparison purposes, measurements were taken on the nephrite ring of Languidic (Morbihan) that is in the museum of Carnac (Fig. 4). This bracelet was considered for a long time to be made of serpentinite, but it turned out to be a piece of retromorphosed nephrite, similar to that of the Valais sources (*Pétrequin* et al. *2015*). In the absence of reliable references for Europe, the issue of nephrite is difficult to address; still, after the analyses had been conducted, the idea of nephrite as the raw material was discarded for the Rest Louët Cangas-style axe. The pXRF results (Si = 25.80; Mg = 13.24; Ca = 8.30; Fe = 3.02; Al = 0.41) are compatible with those of a calcium amphibole.

Unfortunately, the geological origin of that piece cannot be ascertained for now, since the sources are quite diverse in Western Europe. However, in order to find similarities with the Plévin axe, we must turn to the Iberian Peninsula. The Spanish objects chosen for comparison (Fig. 3) came from Río Fortes – made of sillimanite – and Silleda – made of actinolite (part of the calcium amphibole group). The latter is not a perforated blade, but its appearance is quite similar to that of the axe found in Brittany. Regardless of the raw material, the axe from Plévin obviously contributes to the open discussion regarding the transfer of objects during the Neolithic, particularly along this plausible maritime route between Galicia and southern Brittany. The location of this object, still unique in Western France, is not trivial either, since it is at almost the exact meeting point of the departments of Finistère, Côtes-d'Armor and Morbihan, this is – therefore – one of those important topographical points in connection with the sharing of waters, which are known as neuralgic places in the landscape, subject to all kinds of dangers and therefore requiring protective object (*Cassen 2014*). This apparently 'terrestrial' location of the Plévin axe must therefore be reviewed in the light of these natural outlets in the English Channel and Atlantic.

Variscite and turquoise beads and pendants

These semi-precious rocks are, of course, one of the emblematic materials among the Carnacean grave goods, such as those from Mané er Hroëck, which contains the largest number of pearls and pendants and the biggest average weight per object for the mid-5th millennium BC in Western Europe. The presence of variscite in France is attested from the beginning of the 5th millennium BC, but only in two tombs: Les Monts, in Plichancourt (Marne; *Querré* et al. *2008*) and Lazzaro, in Colombelles (Calvados; *Billard* et al. *2014*), both dating back to the latest Linear Pottery (Fig. 5; *Cassen* et al. *2019*). These two pendants have an Andalusian origin (Encinasola, Huelva). Far fewer pearls and pendants are found from the more recent Castellic phase, and – of course – only a small number of tombs from the beginning of the 4th millennium BC still contain some of these items, especially in Poitou-Charentes, except for pendants.

To determine the origin of these objects, whose alleged source had been considered to be near Nantes (Loire-Atlantique), a series of analyses (PIXE, using the accelerator belonging to the Louvre Museum) were conducted on several hundred pearls and pendants (*Querré* et al. *2008*). For comparison purposes and with the aim of developing a reference system, natural samples from French and European occurrences were analysed under the same conditions. The conclusions reached (*Querré* et al. *2019*) are the following:

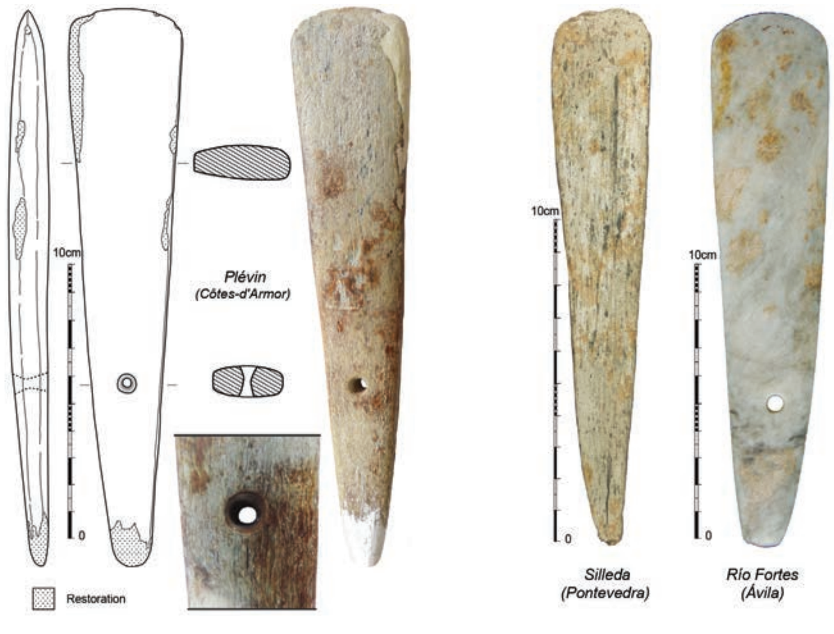

Fig. 3. Comparisons between the polished axe from Plévin (Côtes-d'Armor; drawing E. Roy, photographs B. Schulz Paulsson) and the axes from Silleda (Pontevedra) and Rio Fortes (Ávila), after* Fábregas Valcarce *et al.* 2012 *(CAD by S. Cassen).

- None of the beads came from variscite sources known in France;
- Every piece found in Armorica came from Iberian sources, but not from the classic and expected one (Can Tintorer, in Catalonia), but in the earlier periods from those of Encinasola, in Andalusia, 1600km from Morbihan, or from Palazuelo de las Cuevas, in Zamora province.

Ceramic signs

The Castellic pottery (*L'Helgouac'h 1971*) is distributed across the South Armorica area and recalls the monumental contexts described above. Approximately 50 domestic and funerary sites make up a collection otherwise little analysed during the 20th century, given the impossibility of reconstituting vessels like those from the passage graves that were (and remain) the main source of information about the Neolithic (from 1890 to 1990). The excavation of the Lannec er Gadouer mound (*Boujot, Cassen 2000*) and the works on the set of stelae close to the Grand Menhir (*Cassen* et al. *2009*) helped to narrow the chronological range of Castellic's two phases (4600–4300 and 4300–4000 BC).

Taking into account the secondary transfers originating from the Morbihan area detected when analysing some objects-symbols (weapons and adornments), the next logical step is to focus on the pottery. This is considered to evolve more quickly (in terms of both morphology and decorative patterns), while seldom moving across long distances. However, the ceramics in the Channel Islands seem to be directly related to the Morbihan tradition, using specific decorative techniques (including the common use of seashells of *Gibbula magus* and *Mytilus edulis* on the carenes and necks of the vessels – *Cassen, François 2009*). This relative similitude suggests a remote relation probably based on seafaring. The existence of maritime connections on the grounds of similar pottery traditions was also suggested by Childe (*1932*), who noted the relationship of the interlocking arches obtained by grooving among the vessels of the tomb of Mané Hui (Carnac) and those from Beacharra in Scotland, or in the funerary monument of Fontenay-le-Marmion (Calvados). We must bear in mind, however, that other approaches put forward by this author are today considered without foundation. Most researchers discredited this diffusionist model and justly criticize such decontextualized comparisons of ceramic traditions, especially dubious when associated with ideological proposals (*Bailloud 1975*).

Turning to southwestern Europe, other ceramic signs lend support to our case. A vessel found in the tomb of Dombate in Cabana de Bergantiños (Spain – *Bello Diéguez 1997*) poses another interesting question. Originally classified as a Bell Beaker by the excavators, it was subsequently linked to the early Neolithic assemblages of the Paris Basin (*Suárez Otero 1997.492*). In fact, both parallels were established without conducting the relevant comparisons with the records of these two chronological horizons (*Cassen* et al. *2012*). Several arguments favour a Castellic model for this pot: a carinated shape, a concave

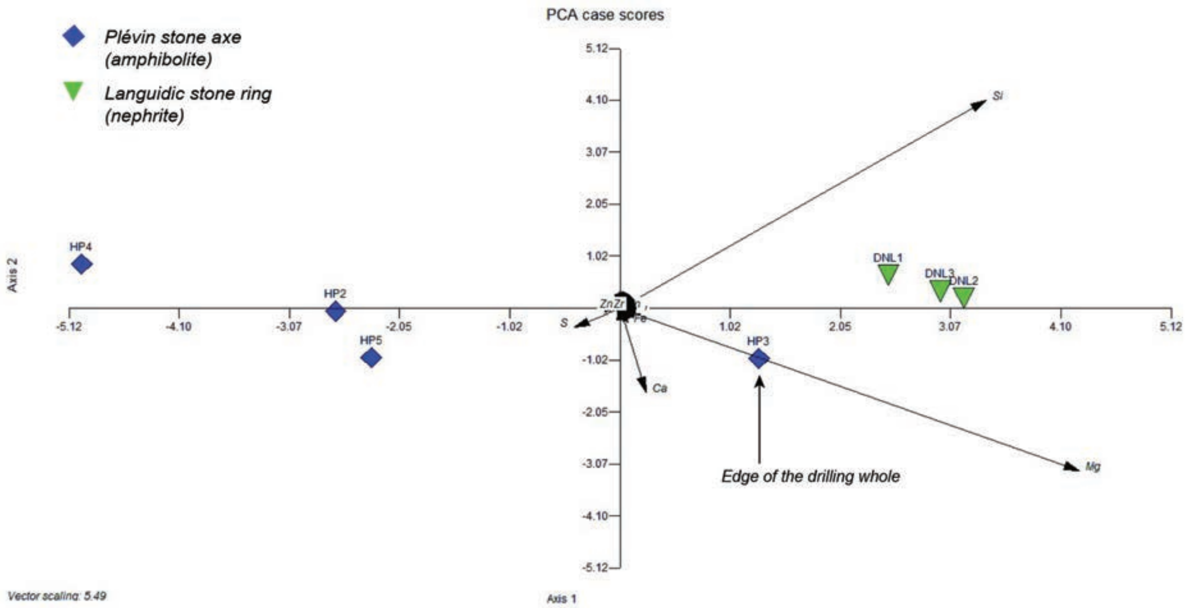

Fig. 4. Principle component analysis of the elemental composition of the Plévin axe (Côtes-d'Armor, France) compared to the nephrite reference material based on PXRF measurements.

neck and the carination itself marked by horizontal lines made of punctuations done by using the apex of *Hinia reticulata*, one of the two types of shell used at Lannec er Gadouer, the Table des Marchands and Er Grah, just to confine ourselves to recently studied Castellic assemblages in Morbihan. This vessel goes back to the first stage of Dombate's funerary architectural design, going back at least to 3800 BC, according to the ^{14}C dates. Whatever the status of this vessel (transfer, imitation, reinterpretation), it offers additional evidence of direct relationships with Morbihan that the engravings on the slabs of Dombate definitely confirm.

But before approaching the representations on monoliths, we must stress the existence of decorative motifs in pottery that could support our investigation of maritime relations. Three sites in Brittany will be compared: two of them provided vessels with a similar morphology and decoration, the third offers a graphic equivalent, but this time engraved on the wall of a burial chamber.

Carn and Guennoc Islands (Finistère, France)

Carn Island is famous for preserving a Neolithic cairn covering three fairly well-preserved burial chambers dating back to the early 4th millennium BC (*Giot 1987*). In the central tomb, a thin-walled vessel is decorated with a 'moustache' that has been interpreted merely as a handle. We propose to compare this 'crescent' shape to a similar figure recently discovered on another island in this same geographical area, Île Guennoc, which is equally famous for preserving several cairns and chambers of remarkable height. From the fifteen or so known chambers, only one engraving – heavily eroded – has been located at the chamber B of cairn II, seemingly representing a quadrangular pattern and, above all, a meander carved beside a large sign – a portion of a disc – that we relate to the 'crescent' shapes interpreted as 'unmanned boats' (*Cassen 2007*).

With the aim of ensuring these analogies, we will focus on another vessel discovered in the South-Armorican coastline. In Kervihan (Saint-Pierre-Quiberon),

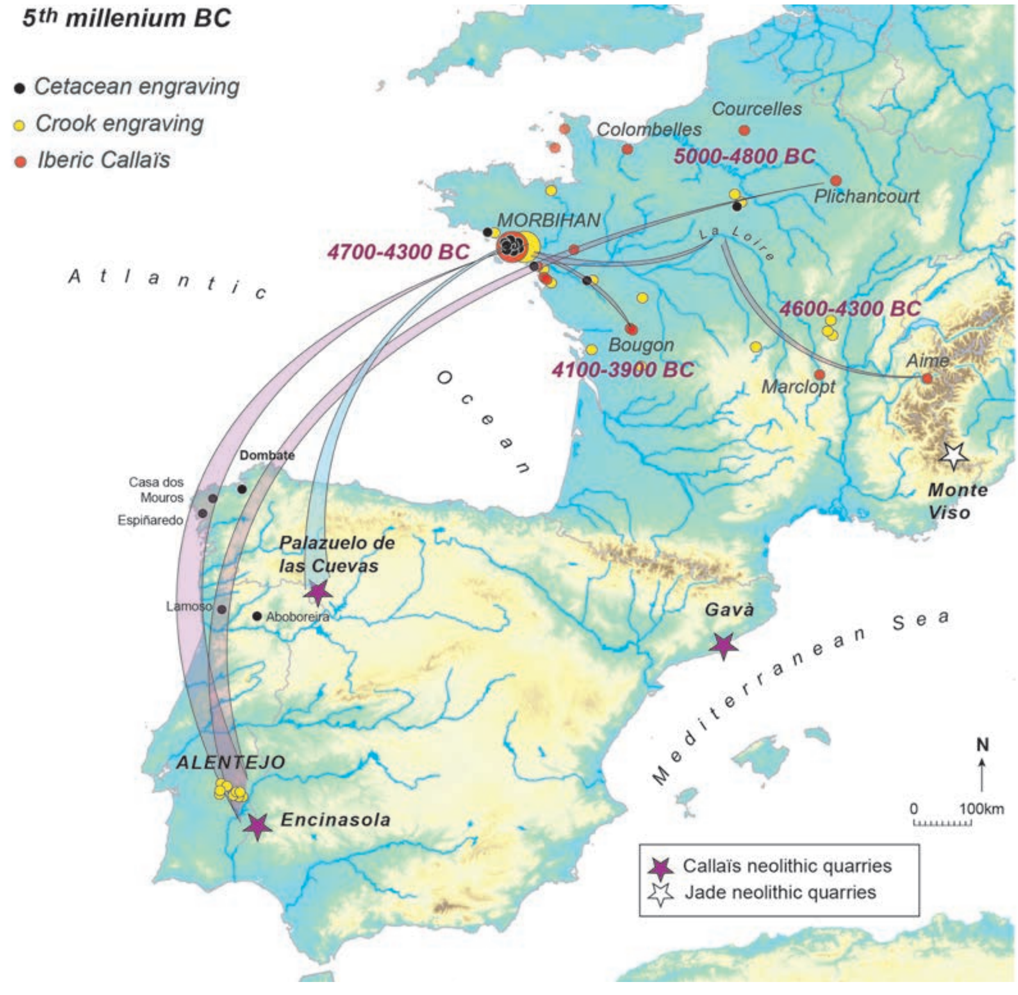

Fig. 5. Origins of the Callaïs in Neolithic tombs and depositions of northern France; Western-European distribution of the 'crook' and 'cetacean' signs (after* Cassen, Vaquero Lastres 2000; Cassen *et al.* 2019*).

5km southwest of Carnac, 200m from the sea and exactly on the watershed divide between the Atlantic side to the west and the Bay of Quiberon to the east, a set of about forty stelae was still standing around 1868, before farmers destroyed most of them. In 1888, only three of them remained intact, including a 6m long example (*Lavenot 1888*). While digging at the foot of one of these, Abbé Collet discovered a vessel (*Closmadeuc 1868*), and we are reproducing his drawing here for the first time (Fig. 6; Vannes Museum, ref. IM0418). A decoration of wavy lines, a typical Castellic technique, can be identified in three successive execution phases: (1) a first wave sign was drawn on the neck, above the maximum diameter underlined by a large groove; (2) two curved lines are subsequently incised, joined by their ends in order to form a portion of a disc, or 'crescent'; (3) a second wavy sign was then superimposed, offset with the previous one. There is no doubt that this 'crescent' motif is autonomous, not simply a rough assembly of lines. We believe this portion of disk to be the representation of an unmanned boat. Thus, the image in high relief from Carn island is represented here in a carved-out version. In spite of such a technical difference, the existence of a same intention of representation in two distinct ceramic traditions of the late 5th and early 4th millennia and echoed by the figures engraved on stelae, seems a plausible conclusion.

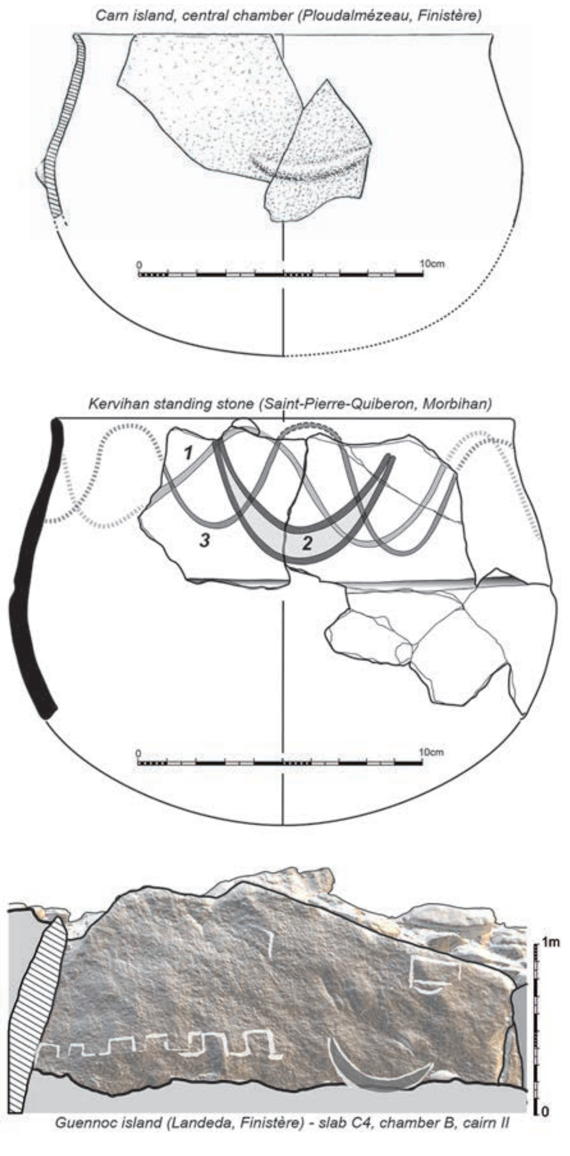

Fig. 6. The 'crescent' sign on Middle Neolithic ceramics from coastal Brittany: Carn island, central chamber (Ploudalmézeau, Finistère; after* Giot 1987*), Kervihan standing stones row (Saint- Pierre-Quiberon, Morbihan – Vannes Museum n°418), Guennoc island, slab C4, chamber B, cairn II (Landeda, Finistère) (CAD by S. Cassen).

Stelae and symbolic representations

Another dimension of the proposed problem can be addressed through the analysis of the standing stones. As it is well known, assembled in straight or curvilinear lines, many of these structures are located in close contact with Carnacean tumuli, as in Mané er Hroëck, or keeping a more distant relationship, as in Mont Saint-Michel and Tumiac. Of course, the spatial juxtaposition of these exceptional monumentalities is part of the process of distinction and unproductive expenditure that is specific to this part of the Brittany coast in the mid-5th millennium BC.

In addition to this architectural dimension, we must take also into consideration the issue of the engraved symbolic representations. This part of the phenomenon has long remained difficult to tackle due to the reuse of stelae in the passage graves of the early 4th millennium BC. Let us therefore continue our comparison based on these iconographic programs, essentially chosen because of the similarities found between Morbihan and the western areas of the Iberian Peninsula.

Materials

A detour in Morbihan, focused not on the signs but on the material used, is essential before considering the 'technical' possibility of these long-distance contacts. Thus, the orthogneiss – a coarse-grained granite – employed as raw material for the largest stelae of Arzon, Crac'h, Saint-Philibert and Locmariaquer (*Querré* et al. *2006; Bonniol, Cassen 2009*) has its closest source at the Rhuys peninsula (Pen Castel). The challenge posed by the majority of the blocks is not the distance covered during their transportation (5 or 10km as the crow flies is not an exceptional distance among European megaliths) but the weight transported, as in the case of the 330t of the Grand Menhir. In addition, there are the deep rias with strong tidal currents that had to be crossed.

The feat is even more obvious in the case of the Runélo stela, weighing between 27 and 29t, transported to the summit of Belle-Ile-en-Mer, 60km as the crow flies from its geological source, and at least 40km offshore. Like the Grand Menhir, such a displacement cannot be conceived by simply resorting to dugout canoes, even if these were juxtaposed, as pointed out by Le Roux (*1997*). We thus must suggest that these populations must have mastered relatively complex naval techniques (*e.g.,* sewn panel boats) in order to carry such a heavy cargo during open sea navigation (*Cassen* et al. *2016*).

The depictions

The image, nowadays as in the past, if it is 'thought', is not and cannot be reduced to the sole function of being an illustration. We therefore consider the image as an instrument of investigation, and – consequently – as a tool for producing knowledge of reality (*Péquignot 2006.48*). Among the European inventory of the least ambiguous motifs, seven types of engravings present on monoliths will be used to enrich our comparison.

The 'crook'/a throwing stick

This sign is the most frequent within the Armorican corpus, and it is very often associated with the depiction of hafted polished blades.

With the possible exception of reused slabs in the Bronze Age burial mounds of Old Parks, Kirkoswald (Cumbria), which would require a new survey in order to confirm the similarity of their crooks with the models in Western France (*Beckensall 1999.135*), this sign is known only on the stelae located in the Algarve and Alentejo regions, in Portugal (*Calado 1997; Gonçalves 1999; Gomes 2011*). The relationship with the Armorican specimens was suggested early on (*Siret 1920*). In this sense, a similar positioning of the instrument on the surface of the monoliths can be noted in both regions (Fig. 7). As in Brittany, the sign described in Portugal should be understood as a throwing stick and not as the shepherd's peaceful instrument.

The 'square'/the representation of a space

This sign, present on the Armorican stelae as well as on the orthostats of passage graves, was usually depicted as though 'leaning' (with respect to a horizontal axis parallel to the ground), creating an undeniably dynamic effect, often under the noticeable action of a mobile neighbouring sign (crook, croissant-boat).

The most obvious analogies lead us once again to the Alentejo (Fig. 7), where the usual tendency towards anthropomorphism lends it the function of a 'nose' (*Gomes 1997a*). The representation of a space seems to be a more likely hypothesis, no matter for the moment whether it is a territory, an island, a parcel or a dwelling.

The 'crescent'/an unmanned boat

Often assimilated to bovine horns by Breton archaeologists, we have compared this sign to what Gustave de Closmadeuc called the 'pectiniform' in 1873. Adrien de Mortillet interpreted such pectiniform as a 'boat with crew' in 1894. We therefore bring these two graphic forms close together simply due to the fact that they share the sign of the boat according to two quite distinct, even opposite, regimes of representations in the universal history of human societies (*Cassen 2007*): on the one hand a boat with crew, with a figure systematically dominating the

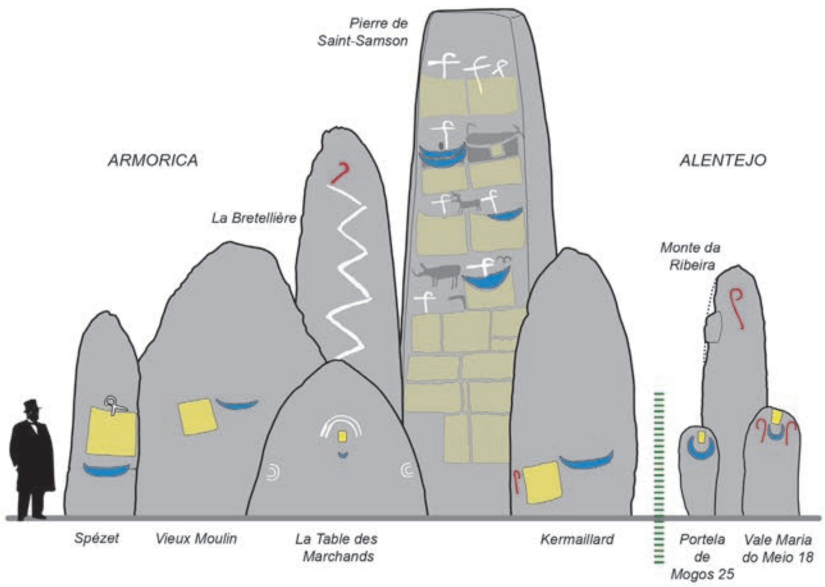

Fig. 7. Comparisons of some signs engraved on the stelae of the 5th millennium BC in Morbihan (France) and Alentejo (Portugal) (after* Cassen 2007; Gomes 2010; Cassen *et al.* 2017*).

others; on the other, a boat without oars or crew. We argue that the truncated disc represented in some Alentejo steles is equivalent to an unmanned boat, all the more so since its association with the quadrangular sign, as well as with the crook sign, reinforces the connection, going well beyond the formal similarities of simple geometric arrangements.

The 'axe plough'/a sperm whale

The 'axe plough' is a major sign within the Armorican megalithic art corpus. Its different graphic units have been deconstructed in order to understand and place them better within a process of recognition that takes into consideration the space occupied by the sign, its structural relationship with neighbouring signs and the geographical and archaeological context of the findings (*Cassen,Vaquero Lastres 2000; Whittle 2000*). Not simply a cetacean, but a sperm whale may be precisely identified.

In order to ensure the archaeological coherence of this hypothesis, we have tried to find a similar dynamic line in the European record, and it was towards Galicia and northern Portugal that the best connections appeared, through a sign called 'The Thing' (*Shee Twohig 1981*). The already mentioned passage grave of Dombate is of great interest in this respect, as it reproduces several components of the Morbihan model: (1) superimposition, around 3800 BC, of a passage grave over an earlier mound surrounding a tomb without permanent access; (2) reuse of stelae as slabs; (3) stelae depicting a group of cetaceans (Fig. 8).

The bow

Until now, the depiction of this throwing weapon was confined to the Armorican peninsula and the Channel Islands (Guernsey), always inside passage graves and twice in a clearly secondary position (Ile Longue, Le Déhus). The painted representation in the Juncais passage grave (Portugal), where a hunting scene with an archer was depicted, is of uncertain date (*Shee Twohig 1981*) and we will wait until it is better established.

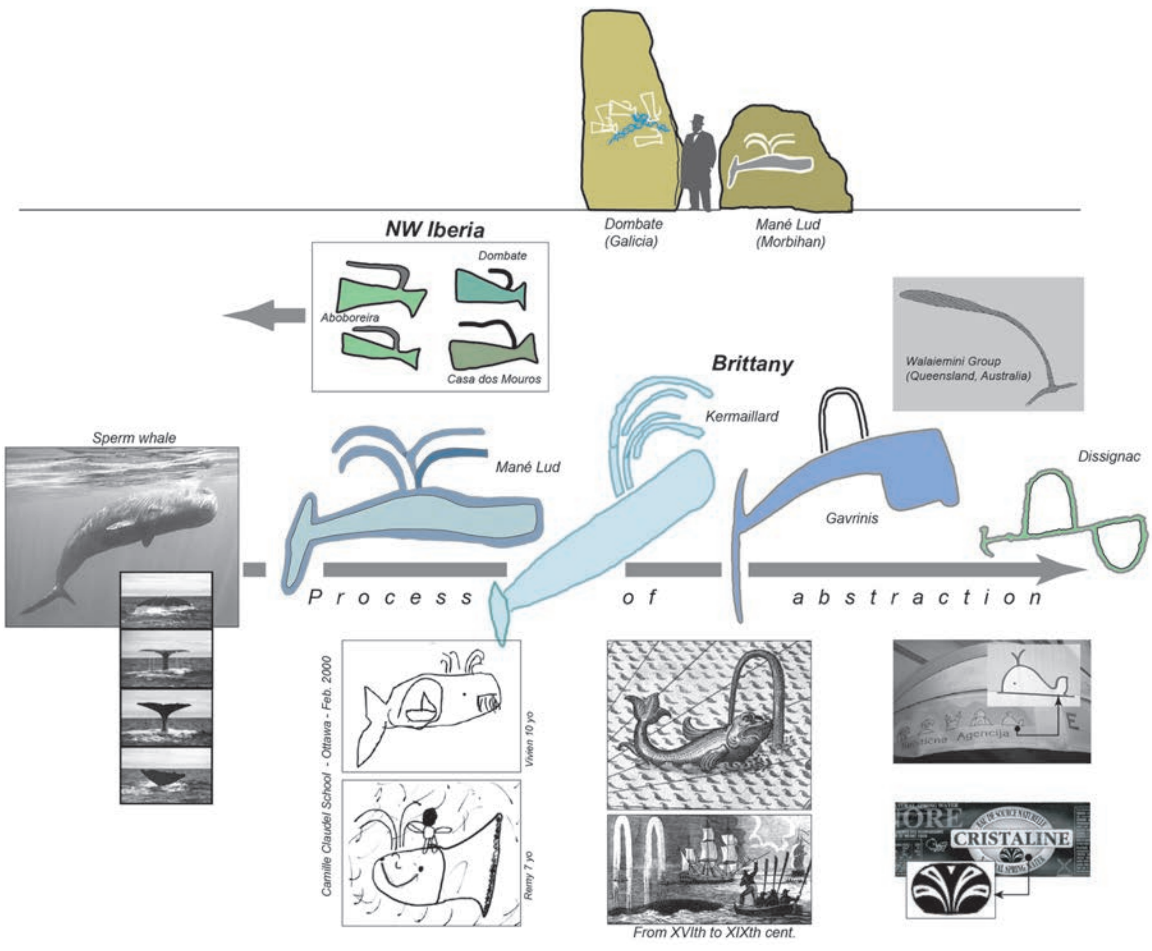

Fig. 8. Variations and diversity of cetacean engravings (sperm whales) on re-used stelae in the passage tombs of north-western Iberia and Western France. Comparisons of some significant graphic units in the current world of the representations (after* Cassen, Vaquero Lastres 2000; Cassen 2007*).

However, the careful survey of monolith Nº 10 of Vale Maria do Meio (Alentejo) has allowed us to identify a bow for the first time, an object similar to those existing in the Armorican repertoire (*Cassen* et al. *2015*). Not only its design matches exactly that of the l'Ile Longue in Morbihan (Fig. 9), but the direct association with the 'crook' and 'square' signs in the same composition (*Calado 2004*) follows a pattern similar to that found on orthostat 13 of Mané Kerioned B, in Carnac.

The 'mother goddess'/a phallus
Very few standing stones in Brittany offer a naturally phallic aspect (Barnenez H, Kermaillard), and none do so explicitly during the 5th millennium BC, *i.e.* carved with realistic anatomical details. The only possible exception is a monolith with a decorated end, discovered in the extension of the Early Neolithic house of Le Haut Mée (*Cassen* et al. *1998*). In contrast, the engraving usually known as 'shield divinity', 'mother goddess', *etc.*, considered to be a female being since the 19th century (*Gimbutas 1989. 247; Briard 1991.184; Le Roux, Lecerf 2003.26; Mohen 2009.101, 137; Sergent 2011.35*), sometimes an indeterminate entity between female and male (*L'Helgouac'h 1991.543*), will be reinterpreted as a phallic form, much more consistent with the original architectural context and in accordance with the structural analysis associating the other signs (*Cassen 2000*).

The standing stone, explicitly shaped for phallic representation (glans, meatus), is present in Galicia (Gargantáns), but even more visible in southern Portugal (*Gomes 1997; 2011*) and may be dated back to the 5th millennium BC despite the uncertainty of their stratigraphic contexts (*Calado* et al. *2003*). Wavy lines, interpreted as snakes, are frequently reproduced vertically along the length of the penis.

The snake
Without always achieving the degree of fidelity to the true animal that we recognize in Gavrinis or Manio 2 in Morbihan, the Portuguese snakes engraved on stelae (*Gomes 1994; Bueno Ramirez, Balbín Behrmann 1995*) are indeed an additional element to be added to the semiotic comparison. We would like to extend the analogy to all those regions along the European Atlantic coast where it is present, Galicia as well as the areas around the Irish Sea, but because of its banality and geometric simplification, which may lead to confusion with the representation of water, we will not dwell on this topic here.

Summing up, several of the essential signs of the Morbihan corpus of megalithic art dated back to the first half and mid-5th millennium BC are also identified in Galicia and Portugal, not in isolation and on the basis of vague similarities but within relations of opposition and complementarity shared between these regions, excluding – in the present state of knowledge – the other sectors of the Spanish (Asturias, Cantabria, Basque Country) and French (Aquitaine, Charente) coasts.

The charm of the sea
Through weapons and ornaments diverted from their function, then through pottery decorations and symbolic representations on standing stones, several combined arguments contribute to establish a direct, verifiable relationship between Morbihan and the westernmost Atlantic coast of the Iberian Peninsula from the mid-5th millennium BC. So far, no comparable intermediate parallels are known on the coasts of the Gulf of Biscay. Therefore, since the existence of coastal navigation has been clearly accepted in those areas (*Callaghan, Scarre 2009; Fábregas* et al. *2012; Philippe 2018*), we must also consider, as a matter of principle, that maritime relations, even those exceptional and more or less di-

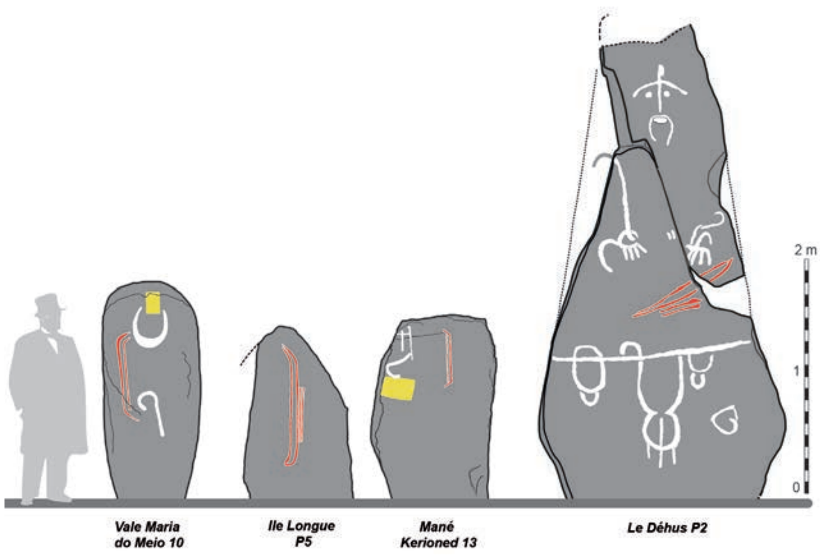

Fig. 9. Similar representations of a bow on Neolithic stelae of Alentejo (Portugal), Morbihan (France) and Anglo-Norman islands (the UK) (after* Cassen *et al.* 2015*).

rect, took place between these regions in the Neolithic. Although still hypothetical at that time, the existence of a direct route between Cape Ortegal and Southern Brittany is referred to by classical authors (*Strabo I. 4. 5* and *Tacitus in Agricola 10 and 11*). The 'Arimaspea', a poem written around the 7th or 6th century BC, or the Phoenician sailors leaving Cadiz/Tartessos at the beginning of the 1st millennium BC, are also testimonies in favour of these Atlantic voyages to Northern Europe (*Plumet 2004*). In other words, this direct route (depending on the seasons), accepted for the Late Bronze and the Iron Age, implies an older human experience.

In this respect, Galicia probably played an important role as a crossroads of communication routes from the interior (towards the variscite mines of the Zamora region, sillimanite from the mountains north of Madrid), or by coast from Andalusia (variscite mines of Encinasola) via Portugal and the key region of Evora. In Galicia, the funerary mounds of Forno dos Mouros, Chousa Nova and Illade 0 are worth mentioning for three main reasons: they are not passage graves; they contained variscite ornaments, a jadeite pendant, polished axes made on sillimanite, and – lastly – a long, polished adze planted vertically; while being dated back to the 4500–4300, 4300–4200 and 4300–4000 BC, respectively (*Mañana Borrazás 2005; Domínguez-Bella, Bóveda 2011; Vaquero Lastres 1999*).

This link between Southern Armorica and Galicia is visible, from an archaeological point of view, two or three centuries after a relationship can be indirectly guessed. Such phenomenon of delayed chronology could of course be repeated in the British Isles and Ireland. The fragment of a perforated schist bracelet found at Peak Camp (*Darvill* et al. *2011*), only 10km from the Severn Estuary facing the Irish Sea, clearly refers to an ornament specific of the Early Neolithic period in northwestern France. It alone testifies to this palimpsest that is so difficult to decipher (of course, the similar 'pendentifs arciformes' of the Paris basin are late Neolithic).

The reader may therefore understand that the quest for the physical object, or for the appropriate and accurate archaeometric measurement, is not enough to construct a historical scenario. And, if crossing the English Channel or the Irish Sea did not pose any problems in the 4th millennium BC (*Garrow, Sturt 2011*), why couldn't it be the same during the 5th? Let us return to this possibility.

"Océan. Tas de pierres"

In his posthumous writings, dated between 1816 and 1883 and gathered under this poetic title, Victor Hugo stated that the greatest realities, the most complex, the true, the only ones perhaps, are logically those which are always and perpetually pre-

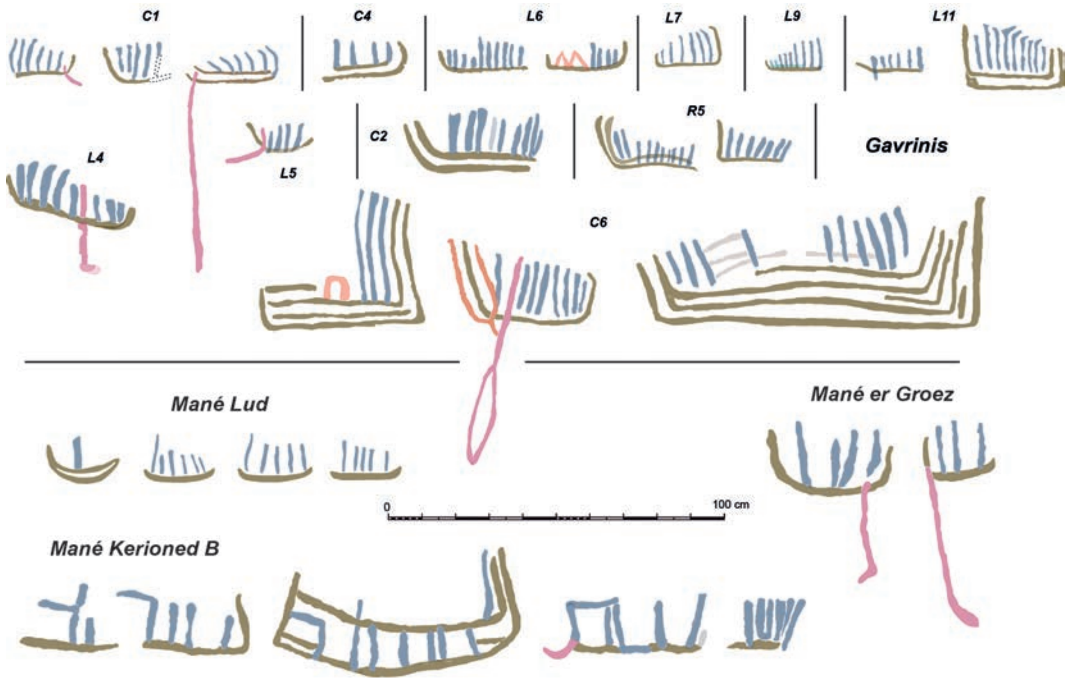

Fig. 10. Representations of boats with crew on the orthostats of the passage tombs of Gavrinis (Larmor-Baden), Mané Lud (Locmariaquer), Mané er Groez and Mané Kerioned (Carnac) (after* Cassen 2007; Cassen *et al.* 2017; Cassen *et al.* 2018, supplemented*).

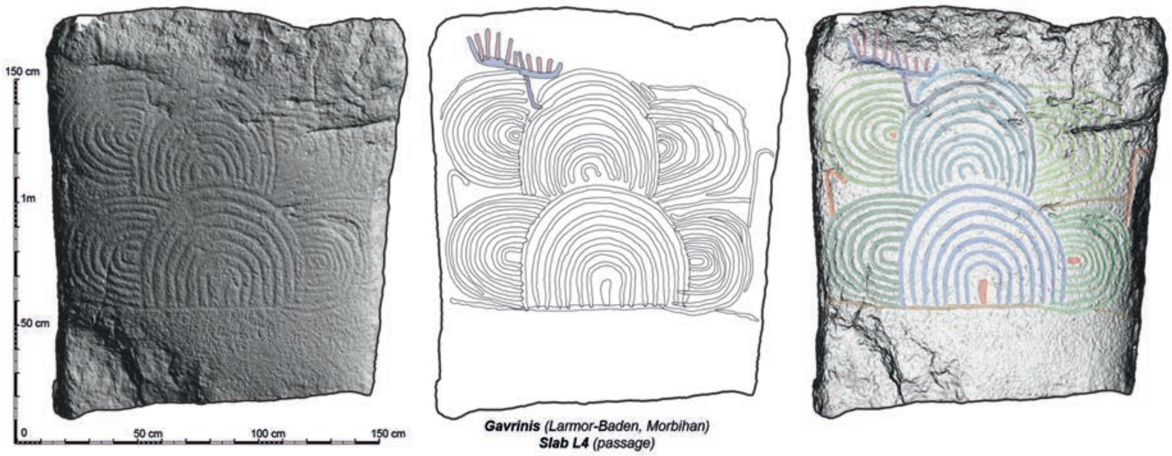

Fig. 11. Inscription of the 'boat with crew' pattern in the ornamentation of an orthostat in the Gavrinis passage tomb (Larmor-Baden, Brittany, France) (CAD and 3D model by S. Cassen, V. Grimaud).

sent, "*there is no real thing but the ideal*" (*Hugo 1942.193*).

We have previously pointed out how the transport of huge blocks raises the question of what kind of boats may have moved them at sea. Could the depictions of boats in Morbihan help us to conceive these trips? Let us recall the example of the orthostats of some Morbihan passage graves that preserve such symbolic figures (Fig. 10). It would be misguided to attempt to discover here the technical details of naval architecture ensuring the movement on the high seas, even if steering oars seem well represented. On the other hand, the depiction of a boat with crew and a steering oar, as if caught in a whirlwind (Fig. 11) present in the slab L4 of Gavrinis (Larmor-Baden), can – in turn – influence the interpretation of these concentric arcs that, by intuition, we had linked to the representation of water.

Beside this 'crewed' version, we have previously proposed that the 'crescent' depicted on several stelae in Morbihan could be interpreted as an unmanned boat. The latter interpretation – with or without standing humans in its interior – is present in both the Celtic mythology of Western Europe and in the Breton legends. Opposing life with death, it is crucial to think about the fundamental reasons for going to sea, real or ideal. In this respect, we must recall the text of Procope written in the 6th century: "*The fishermen and other inhabitants of Gaul who are in front of the island of Brittany are responsible for passing through it the souls of the dead, and for this reason exempt from taxation*" (The War of

Fig. 12. Comparison between the naviform plan of the Neolithic tumulus and tomb of Porz Poulhan (Plouhinec, France; photos S. Cassen) and the probable Viking tomb of Ales Stenar (Kćseberga, Sweden; photos D. Bengtsson and B. A. Lundberg/Kulturmiljöbild, Riksantikvarieämbetet) (CAD by S. Cassen).

the Goths 1, IV, c. 20). It is therefore likely that the funeral journey must have been a part of the world of representations of the Neolithic societies in Western Europe. In this respect, it is significant to point out that the 'naviform' plan of the burial mound surrounding certain tombs at the end of the 4th millennium BC in Brittany is closely correlated with such a belief system. The Viking tombs in Sweden (ship settings), from the 6th century onwards, were built following a similar solution (Fig. 12).

Whether the journey is by river or sea, there is little doubt that the long-distance acquisition of socially valued goods may have granted a form of social prestige in compensation for the dangers involved in the journey. But we may also miss the essential, *i.e.* the charm of the sea, if we were to remain in search of a solely economic interest. The utility of sailing on the ocean is not clear enough to force prehistoric man to dig a canoe out of a tree trunk, to stretch animal skins on a pole frame, or to tie wooden boards together. No utility can legitimize the immense risk of entering the sea in order to approach another land for the first time. To engage in navigation, you need a powerful interest. However, the real powerful interests are the chimerical ones, the interests that we dream about, not those that we calculate. These are the fabulous interests. And what could be more fabulous than to experience the end of a life, to go and to explore the end of a world? ... Because the first sailor was the first living man who was as brave as a dead man (*Bachelard 1942*), and is not the hero of the sea also a hero of death?

It is often said that death is a journey and travel is a form of death ... "*To leave is to die a little*", says the French proverb. To die is really to leave, and one can only leave well, courageously, clearly, by following the course of the water, the current of the broad river joining the River of the Dead. Only this kind of death is fabulous, only this departure is an adventure. If for the unconscious, a dead person is really an absent person, only the navigator of death is a dead man who can be dreamed of indefinitely.

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Use-wear experimental studies for differentiating flint tools processing bamboo from wood

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ABSTRACT – *Bamboo is widespread in south China and is one of the major organic resources in daily use through history due to its similar potential use value as wood. Due to the unfavourable preservation conditions and taphonomic alteration, the rare discovery of well-preserved organic remains from Palaeolithic sites means there is a lack of direct studies on the technology and behaviour of early prehistoric humans. Use-wear analysis has been proved as a reliable method to detect evidence left by working wood and bamboo on stone artefacts. This study aims to provide an experimental reference of use-wear features and patterns to identify and interpret the exploration of bamboo and wood resources in prehistory. In this experiment, 12 flint flakes were selected for processing bamboo stems and pine branches with working motions of whittling, sawing, and chopping. The results show that the use-wear features, including edge scarring, edge rounding, and polish, of bamboo-working and wood-working are distinctive. Edge scarring is closely related to the working motion, and moderate bright to very bright polish is a significant feature associated with bamboo-working. It is possible to distinguish wear traces caused by bamboo-working from those by wood-processing through a combination of low-power and high-power techniques under a 3D digital microscope.*

KEY WORDS – *use-wear analysis; experimental study; flints; bamboo-working; wood-working*

Poskusne študije sledov uporabe za razločevanje kamnitih orodij, uporabljenih za obdelavo bambusa, od tistih, za obdelavo lesa

IZVLEČEK – *Bambus je široko razširjen na jugu Kitajske in je eden od poglavitnih organskih virov, ki je podobno kot les v dnevni rabi skozi celotno zgodovino. Zaradi neugodnih pogojev v depoziciji in tafonomskih sprememb so dobro ohranjeni organski ostanki na paleolitskih najdiščih redki, kar pomeni, da imamo na voljo malo neposrednih študij o tehnologiji in obnašanju zgodnjih ljudi. Analiza sledov uporabe na kamnitih orodjih se je izkazala za zanesljivo metodo pri prepoznavanju dokazov o obdelavi lesa in bambusa. V pričujoči študiji predstavljamo referenčne podatke, pridobljene s poskusi, o značilnih sledovih in vzorcih uporabe na orodjih, da bi lahko prepoznali in razlagali uporabo bambusa in lesa kot vira surovin v prazgodovini. Pri poskusu smo izbrali 12 kamnitih odbitkov za obdelavo bambusovih debla in vej, pri čemer smo orodje uporabljali za rezanje, žaganje in sekanje. Rezultati kažejo, da lahko jasno razločimo sledove uporabe, ki vključujejo poškodbe na robu, nastanek zaobljenega roba in poliranje površine, pri delu z bambusom, od tistih, nastalih pri delu z lesom. Poškodbe na robu orodij so tesno povezane z delovnimi gibi, medtem ko lahko srednje do zelo svetla polirana območja povezujemo z obdelavo bambusa. Ugotavljamo, da lahko na podlagi kombinacije različnih tehnik, ki jih opazujemo pod 3D digitalnim mikroskopom, jasno razločimo, ali je bilo kamnito orodje uporabljeno pri delu s bambusom ali lesom.*

KLJUČNE BESEDE – *analiza sledov uporabe; poskusne študije; kamnita orodja; obdelava bambusa; obdelava lesa*

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Introduction

Early in 1958, Grahame Clark mentioned Stanley R. Mitchell's (*1949*) ethnological observation of Australian aborigines and pointed out that the most important use of stone tools is most likely the making of wooden weapons and utensils. Archaeologists have discovered, though rare, a few preserved wooden implements from Palaeolithic sites, as far back as the Gesher Benot Ya'aqov assemblage with a date of 780 000 BP (*Belitzky* et al. *1991; Goren-Inbar* et al. *1992*) as well as at the Schöningen site (*Thieme 1997; Schoch* et al. *2015*) and Lehringen site (*Marshack 1998*) in Germany. Three pieces of pencil-shaped pointed wooden objects with smooth surfaces and longitudinal scars were uncovered from the Ohalo II site in Israel. The excavators speculated these were flaked and shaved by some sharp knives (*Nadel* et al. *2006*). Richard W. Yerkes *et al.* (*2012*) claimed that light stone tools might be used to plane, shave and clean branches rather than heavier tasks like felling trees or splitting large logs.

Stone tools are generally regarded as the best evidence of human technology in prehistory. The discoveries mentioned above have proved that implements and objects made of wooden or organic materials might have long coexisted with, or been even earlier than, stone tools as the main tools in prehistory. Due to the unfavourable preservation conditions and taphonomic alteration, well-preserved organic remains are rarely uncovered in Palaeolithic sites, resulting in a lack of direct studies on the technology and behaviour of early prehistoric humans. A functional study might thus be a good complementary path to understand this kind of information through use-wear and residue analyses.

Use-wear analysis, which refers to the study of wear traces on the edges and/or surfaces of archaeological artefacts caused by use (*e.g., Odell 2004; Fullagar, Matherson 2013*), is considered as one of the keys to the functional interpretation of archaeological records (*Sterud 1978*). Various working tasks and contact materials of the archaeological tools, as well as the economic, social and cultural implications for human behaviour, can be recognized based on the results of such analysis, and many use-wear studies have successfully identified use-traces in relation to wood-working on stone artefacts from Palaeolithic sites (*Keeley 1980; Odell 1996; Chen* et al. *2002; 2014; Lemorini* et al. *2014; Liu, Chen 2016*).

Bamboo is widespread in South Asia, Southeast Asia, and East Asia. Though classified into the grass family *Poaceae*, bamboo stems are usually woody and hollow and are light and durable, with a great potential for production and utilization in daily life. Some scholars have proposed a 'bamboo hypothesis' to explain the lithic industry in Prehistoric Southeast Asia, proposing that stone tools might coexist with light organic materials like bamboo (*Solheim 1972; Pope 1989; Reynolds 2007*). A few micro-wear studies showed evidence related to plant material processing, which is widely interpreted as a result of bamboo-working (*Teodosio 2006; Pawlik 2010; Xhauflair, Pawlik 2010*).

In ancient China bamboo had notable economic and cultural significance. According to ethnoecological data, bamboo stems have been used as important raw materials for numerous functions such as building houses and making crafts over a long period of time (*e.g., Wang* et al. *1990; Liao 1996*). The earliest archaeological evidence of bamboo objects in China to date was uncovered from the Qianshanyang Neolithic site, dating back to 4700 years ago, including bamboo pieces and implements such as bamboo mats (*Zhejiang 1960; 2010*).

Hermine Xhauflair *et al.* (*2016*) conducted a series of replicated experiments particularly adapted to the specific lithic materials and vegetation of Southeast Asia. They aimed to provide a reference for identifying bamboo-working traces on archaeological stone tools, but the characteristics and pattern of use-wear relevant to bamboo-working are not clear yet, especially in Chinese archaeological studies. This is probably due to the inadequate experimental interpretative criteria concerning various working tasks on bamboo. More importantly, it is difficult to distinguish bamboo-working traces from those caused by wood or other hard organic materials (*Mijares 2001; Blench 2013*).

The development of use-wear analysis is not only characterized by establishing a reference collection, but also by the effort of those who try to improve the accuracy in the identification and recording of wear traces. Low-power and high-power are two traditional approaches of use-wear analysis. The low-power method (5–100x), using a stereomicroscope, focuses on the identification and interpretation of the edge scarring and edge rounding as indicators of working activities and contact materials if possible (*e.g., Tringham* et al. *1974; Odell 1977*). The high-power or microscopic method (100–1000x), using a metallurgical microscope or scan electronic microscope, allows distinguishing and classifying different types of materials, in more detailed but limited areas, with the emphasis on the observation of polish and striations (*e.g., Keeley 1980; Vaughan 1985*). These two approaches are complementary, and each of them has strengths and limitations (*Odell 2001*).

During the last decades, researchers have gradually attempted to use both techniques to improve the methodology of use-wear analysis (*e.g., Grace 1996; Lombard 2005; Van Gijn 2010; Macdonald 2013*). A stereomicroscope is used to examine and ascertain the relationship between the distribution of wear traces on the overall tool, and an incident light microscope is mainly for the identification of the function. The combination of both magnifications allows a more comprehensive analysis. However, how to integrate those two techniques in a more effective way is still under exploration.

Controlled experiment is considered crucial to improve the standardization of use-wear analysis and the rationality of functional interpretation. This study carried out a set of experiments to better understand the use-wear resulting from bamboo-working, attempting to distinguish it from that by wood-working. Employing a 3D digital microscope, we wish to provide a set of experimental criteria of use-wear features and patterns for identifying, in a more practical way, possible organic resources exploration and interpreting the functions of stone tools in prehistory.

Experimental program

This study is first aimed at understanding the use-wear features and patterns on flint artefacts resulting from bamboo-working under a 3D ultra-depth microscope, and secondly to differentiate the bamboo-working use-wear from the wood-working use-wear.

Experimental aim and design

As defined by George H. Odell (*1981*), whittling/shaving is a motion transversal to the working edge at an acute angle, whereas cutting/sawing is a motion longitudinal to the working edge in a position approximately perpendicular to the contact materials. Wood whittling/shaving often results in contiguous feather-terminated scars mainly on one side, which sometimes have a conchoidal shape (*Hou 1992*). Wood cutting/sawing usually produces large and medium longitudinal scars directionally on both surfaces of a tool (*Chen* et al. *2008*), and the working edge displays regular denticulation.

Twelve flakes with unretouched edges were selected as specimens in this experimental program (Fig. 1). The raw material of the specimens is flint collected from Danjiang River (Henan Province) in the central part of China. Among these specimens, two smaller flakes with sharp straight edges were used for whittling, and those flakes with larger edge angles for chopping. The flakes for sawing have relatively long and sharp edges that are straight or almost straight.

Bamboo and pine branches were chosen as the contact materials, as these are readily available in most parts of southern China. Considering the possible working tasks performed on bamboo and wood in the prehistoric period, three working motions were determined: chopping, sawing and whittling. To have

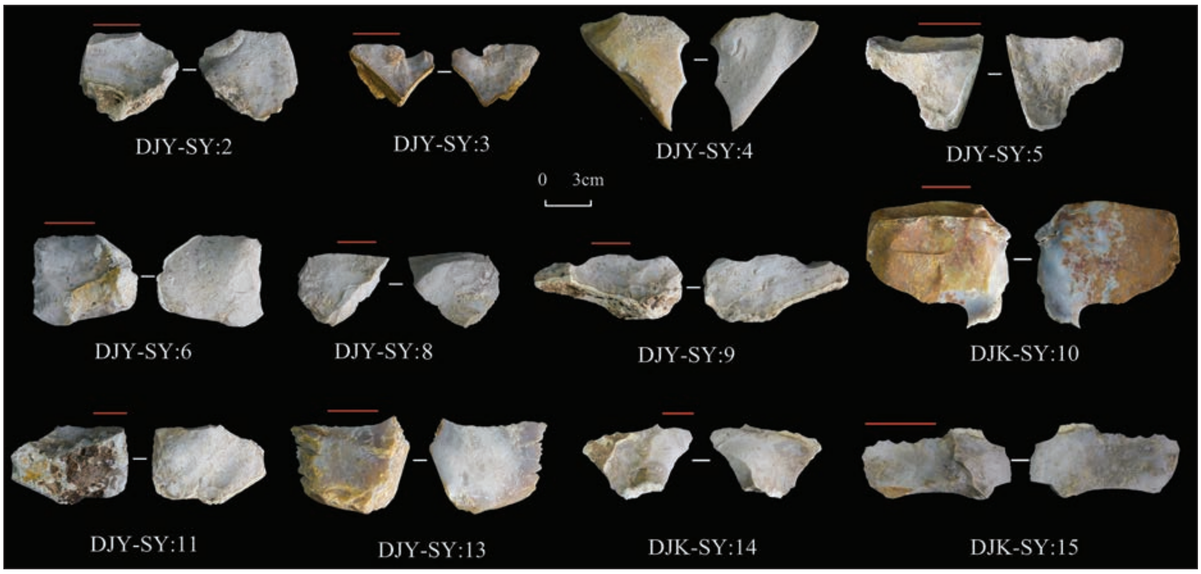

Fig. 1. Specimens in this experiment (used edge and location indicated by red line).

a better understanding of the formation of wear traces during usage, we also conducted multi-stage experiments (*Odell* et al. *1980; Chen* et al. *2013*) for every specimen. The duration of each experiment, the total time cost for processing the material with each specimen, was 30 minutes.

A group of students was invited to participate in the experiments in the laboratory. Given the detailed plan of the experimental program, they were shown how to perform the working tasks prior to the beginning of the experiments, and throughout the process their operations were closely monitored. One goal of our experiments is to understand the correlation between wear traces and contact materials and working motions, thus possible variables which would affect the wear traces were strictly controlled: every specimen had to be operated by a certain experimenter with the same supposed working motion and direction and with a steady force.

Analytical protocol

Two types of microscopes were employed in this experiment. The primary examination of specimens was carried out with a Nikon SMZ800 stereomicroscope with magnifications ranging from 10x to 63x, which allowed us to identify the overall distribution of the edge scarring, edge rounding and sometimes polish across the employable edge. All the experimental specimens were then observed and photographed under a 3D digital microscope Keyence VHX-5000 with magnifications between 20x and 200x. This is an optical microscope with the function of live depth composition, which integrates observation, image capture, and measurement capabilities, enabling detection of wear traces in a wider area with higher magnification at the same time. Compared to the approach of integrating two different kinds of microscopes, the automatic scanning and image stitching capacity of this equipment helps ease the workload considerably.

The recording criteria of use-wear patterns in this study consist of micro-fractural scarring, edge rounding, polish and striations. Scarring is documented and analysed by size (*Chen 2011*), termination (*Ho Ho Committee 1979*), distribution pattern (*Zhang* et al. *2010*) and location. Edge rounding, an indicator of the presence of abrasion, is divided into light, medium and heavy according to the extent of wear (*Odell 1996*). Polish is described mainly by brightness, the texture of the surface and the presence or absence of certain topographic features (*Keeley 1980*). Striations are often seen as linear traces indicating possible motions and directions of tool use. The presence of striations varies, and experimental specimens do not exhibit them in most cases (*Lombard 2005*).

Full-scale cleaning is necessary for each specimen after each periodic experimental operation and before observation under the microscope. The experimenter must wear powder-free gloves while handling the specimens during the whole experiment to avoid any possible contamination. First, each specimen was immersed in a warm detergent solution for 10–20 minutes. Then, JP-010T Sonic Cleanser was used to make each specimen sink in an ultrasonic bath of clean water for 10–20 minutes. The next step is cleaning each piece with an alcohol solution to remove finger grease. Finally, the specimens were placed in an ultrasonic tank with clean water for another 10–20 minutes and left to dry in the air. The residue that remained on several specimens after processing wood was difficult to remove, and thus additional cleaning was conducted before the final step, and this was immersion in warm NaOH (20–30%) for 10–20 minutes. According to Lawrence Keeley (*1980*), experimental tools are not required to remove the mineral deposits, and thus the 10% HCl solution was not used in our experiments. It is worth noting that special care must be taken to protect the employable edge of the specimen from contacting with the ultrasonic tank during the cleaning process.

Experimental procedure

The basic information of the specimens was documented in detail, including: (1) morphological features, technological characteristics, morphometric parameters and raw material colours of the experimental specimens; (2) working motions; (3) conditions of contact materials; and (4) the gender and grip strength of the operators.

Macroscopic photos were taken to record the original state of each specimen. Microscopic photos of the selected working edges before use were taken in several main magnifications of 20x, 50x or 100x, 200x. Meanwhile, the overall shapes of specimens were sketched to mark the employable locations.

The whole process of every task was divided into six 5-min sections to ensure the working efficiency of each operator. Details concerning operation times, processing efficiency and alteration of the employable edges, modification of the contact materials were recorded during each interval. Based on this information, each specimen was assigned to be observed under the microscope after every 15 minutes to record the wear traces.

After cleaning, each specimen was examined under the stereomicroscope (Nikon SMZ800), and then under the 3D digital microscope (Keyence VHX-5000) from low to high magnifications, in order to compare the results with their former conditions and be photographed. The characteristics of scarring, edge rounding, polish and striations were also described.

Results

A total of twelve specimens developed wear traces after use, and the results of microscopic observation are presented in the following (Tab. 1).

Use-wear resulting from bamboo-working
Sawing bamboo
Three specimens were selected for sawing bamboo stems and show recognizable use-wear after 30 minutes of use (Fig. 2.a1, a2, b1, b2). The medium and small scars, associated with a few large ones, distribute continuously along the edge bifacially. Most are oblique to the transversal axis of the edge, showing feathered and snapped terminations. Some rolled-over scars (*Odell 1996; Chen* et al. *2008*), which refer to the scars observed on dorsal or ventral surfaces, initiate from the opposite surface. The edge for sawing dry bamboo exhibits relatively more scars than the one for sawing fresh bamboo stems.

The moderate to highly bright polish is observed on both surfaces, mainly displaying on the elevated parts of the edge. Some polish links together as small zones. The most developed and extensive polish, characterized as very bright and smooth, was discovered on the flakes for sawing fresh bamboo. In such cases, the well-linked polish extends over the bulged parts of the edge and less bright polish is present inside some scars. Heavy rounding was observed on the employable edges of these three specimens. Except for some short striations parallel to the working edge found occasionally on the specimen for sawing fresh bamboo stems, no apparent striations were recognized.

Chopping bamboo
Two specimens were selected for chopping bamboo stems over 30 minutes. The use-wear is described as follows, including resulting from chopping dry and fresh bamboo stems (Fig. 2.c1, c2, d1, d2).

Stepped scars mainly of medium and large size distribute unevenly either on the dorsal or ventral surfaces, a few are overlapped. Small feathered scars scatter along the very edge.

Heavy rounding developed on both surfaces, which makes the edge ridge become dull. The specimen for chopping fresh bamboo displays bright polish in a relatively limited area. The polish seems not well-linked but forms a domed shape, and most scatters near the small scars. No apparent striations were identified.

Whittling fresh bamboo
Specimen No. DJK-SY:3 was used for whittling fresh bamboo stems over 30 minutes. Small and medium feathered scars are continuously distributed mainly on the dorsal surface – the non-contact surface – of the working edge. Several scars are oblique to the transversal axis of the edge. Inside the large and intrusive feathered and hinged scars, small feathered scars were observed. There are also a few medium stepped scars with rolled-over appearance. The overall margin of the contact edge appears denticulated. The employable edge on the non-contact surface shows light and medium rounding, with heavier rounding on the elevated part. Polish and striations were not recognized (Fig. 2.e1, e2).

Use-wear resulting from wood-working
Sawing wood
After 30 minutes of use, use-wear was observed on the three experimental specimens for sawing pine (Fig. 3.a1, a2, b1, b2). Both surfaces of the employable edge are dominated by feathered and snapped

Specimen No.	Contact material	Working motion	Duration (min)	Action (strikes)
DJK-SY:2	Dry bamboo stem	sawing	30	3357
DJK-SY:6	Dry bamboo stem	chopping	30	2515
DJK-SY:3	Fresh bamboo stem	whittling	30	1695
DJK-SY:4	Fresh bamboo stem	sawing	30	2249
DJK-SY:5	Fresh bamboo stem	sawing	30	3013
DJK-SY:13	Fresh bamboo stem	chopping	30	2549
DJK-SY:14	Dry pine branch	whittling	30	2129
DJK-SY:9	Dry pine branch	sawing	30	2789
DJK-SY:8	Dry pine branch	chopping	30	2651
DJK-SY:10	Fresh pine branch	sawing	30	2253
DJK-SY:15	Fresh pine branch	sawing	30	2948
DJK-SY:11	Fresh pine branch	chopping	30	2586

Tab. 1. Basic information of the experiments undertaken.

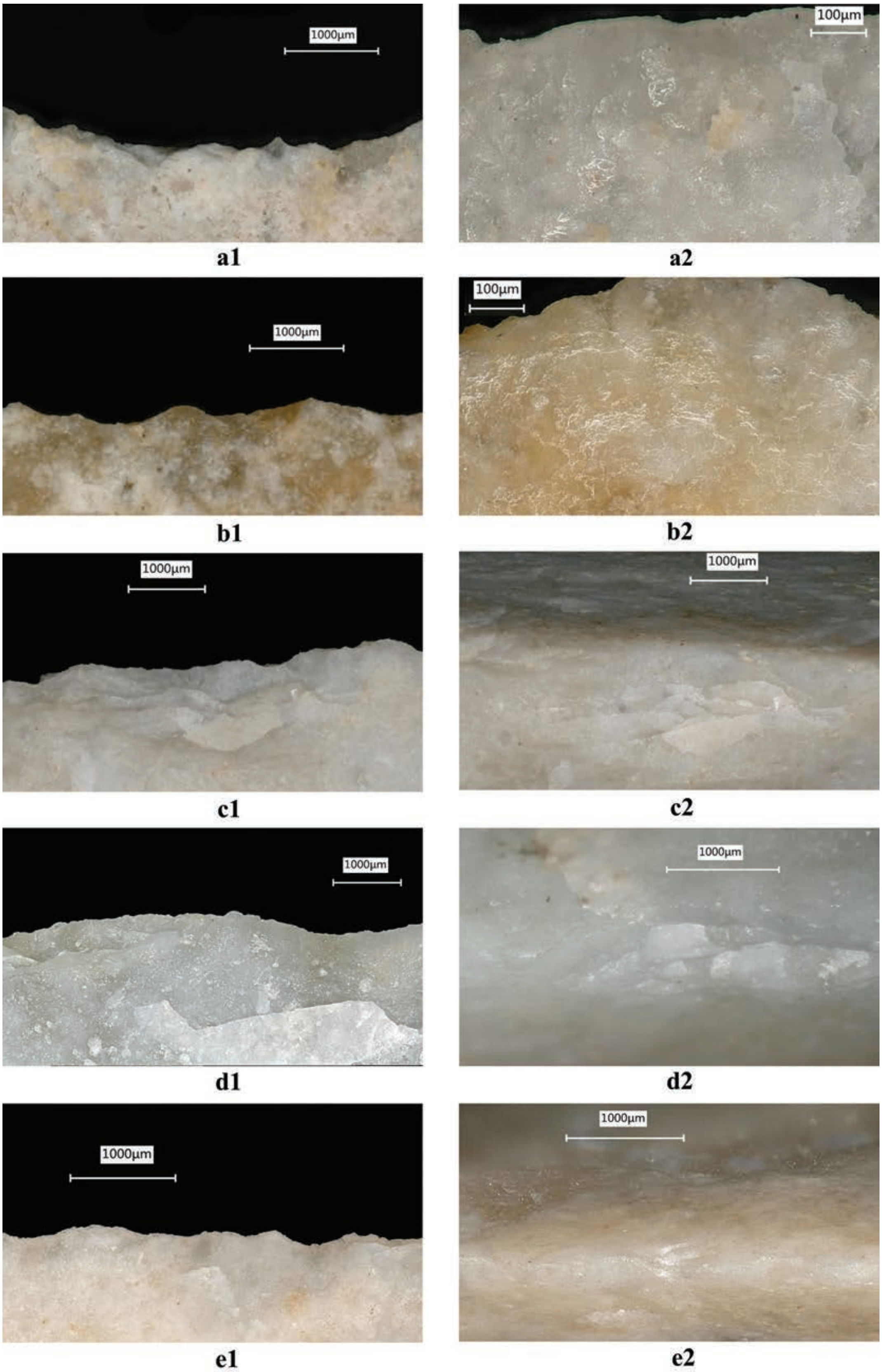

Fig. 2. Use-wear resulting from bamboo-working. a1 ***sawing dry bamboo (No. DJK-SY:2), scarring D40x;*** a2 ***polish, 30min, V400x;*** b1 ***sawing fresh bamboo (No. DJK-SY:4), scarring D40x;*** b2 ***polish, 30min D400x;*** c1 ***chopping dry bamboo (No. DJK-SY:6), scarring D30x;*** c2 ***rounding, 30min, R30x;*** d1 ***chopping fresh bamboo (No. DJK-SY:13), scarring V30x;*** d2 ***rounding, 30min, R50x;*** e1 ***whittling fresh bamboo (No. DJK-SY:3), scarring D40x;*** e2 ***rounding, 30min, R50x.***

scars in large, medium and small sizes. A few large scars occur in rolled-over appearance. The small scars distribute more closely to the edge margin. Some unevenly distributed scars in association with hinged terminations were also found on the specimen used for sawing dry pine. For the specimen sawing fresh pine, scars with occasional stepped terminations are distributed continuously.

The specimen for sawing dry pine (No. DJK-SY:9) shows heavy rounding, while the one for sawing fresh pine (No. DJK-SY:10) presents medium rounding. Moderate bright to bright polish was observed on both surfaces of the edge, of which some developed polishes with the occurrence of short lines. More developed polish appears on the specimen for sawing fresh pine, and very bright and smooth polish is only observed on the elevated part of the edge. In this case, no obvious striations were observed.

Chopping wood

The specimens No. DJK-SY:8 and No. DJK-SY:11 were used for experimentally chopping dry and fresh pine branches for about 30 minutes (Fig. 3.c1, c2, d1, d2).

Small feathered scars, and medium scars with stepped and snapped terminations, distribute unevenly on these two specimens. Scars on the specimen for chopping dry pine are mainly on the dorsal surface, while several notches of different sizes distribute on the ventral surface.

Both specimens exhibit medium and heavy rounding on the used edges, and the specimen for chopping fresh pine shows heavier rounding. Moderate bright and dull polish were identified on both specimens, with few striations.

Whittling dry wood

One flake (No. DJK-SY:14) was used for whittling dry pine for around 30 minutes and presents obvious use-wear (Fig. 3.e1, e2).

Scars were mainly observed on the non-contact side of the working edge, the dorsal surface, and these are medium and small scars with feathered and stepped terminations in relatively continuous distribution with few overlapping. There are also several hinged scars scattering along the dorsal side. The overall shape of the edge margin of the ventral contact surface appears denticulated.

Most part of the working edge shows medium rounding, while the elevated part of edge ridge displays heavy rounding. Only the contact surface of the working edge presents moderate bright and rough polish. Striations were not identified.

Discussion

The experimental results suggest that wear traces caused by bamboo-working and wood-working are distinctive. According to multi-stage experiments, the formation of scarring and polish appears differently. For the working motions of sawing and chopping, most scars were produced within the first 15 minutes, allowing the easy identification of working tasks. In the latter 15-min stage, only some small feathered scars were produced along the edge margin. On the other hand, the polish becomes more and more developed over the whole 30 minutes.

Use-wear features and patterns of bamboo-working

The bamboo-working experiments by Armand S. B. Mijares (*2001*), as well as Xhauflair and his colleagues (*2016*), show that medium to very large microfractural scarring, mainly in stepped terminations, would occur; the polish created by bamboo-working is well-developed, which is smooth and bright, very domed and often well-linked; and numerous brushstroke striations were also produced, though not on every specimen.

According to our results from the bamboo-working experiments, besides the stepped scars, feathered and snapped scars were also recognized on every specimen. The small scars in feathered termination tend to distribute continuously along the edge margin. The features of scarring are complex, which might be affected by working motions. Continuously distributed scars often occur during whittling and sawing, while uneven and overlapped scars appear with chopping. Rolled-over scars (*Odell 1996; Chen* et al. *2008*), also described as hinged cross-section scars (*Xhauflair* et al. *2016*), appear frequently. Processing dry bamboo stem tends to produce hinged-terminated scars. Medium to heavy rounding usually occurs on the edges of tools used for bamboo-working.

Moderate to very bright polish is a significant feature of use-wear in connection with bamboo-working (Fig. 4). The extent of polish expands when it is well-developed; the polish on the elevated part of the edge appears linked together, but the linkage of polish caused by chopping is much poorer. Polish produced by processing fresh bamboo is generally

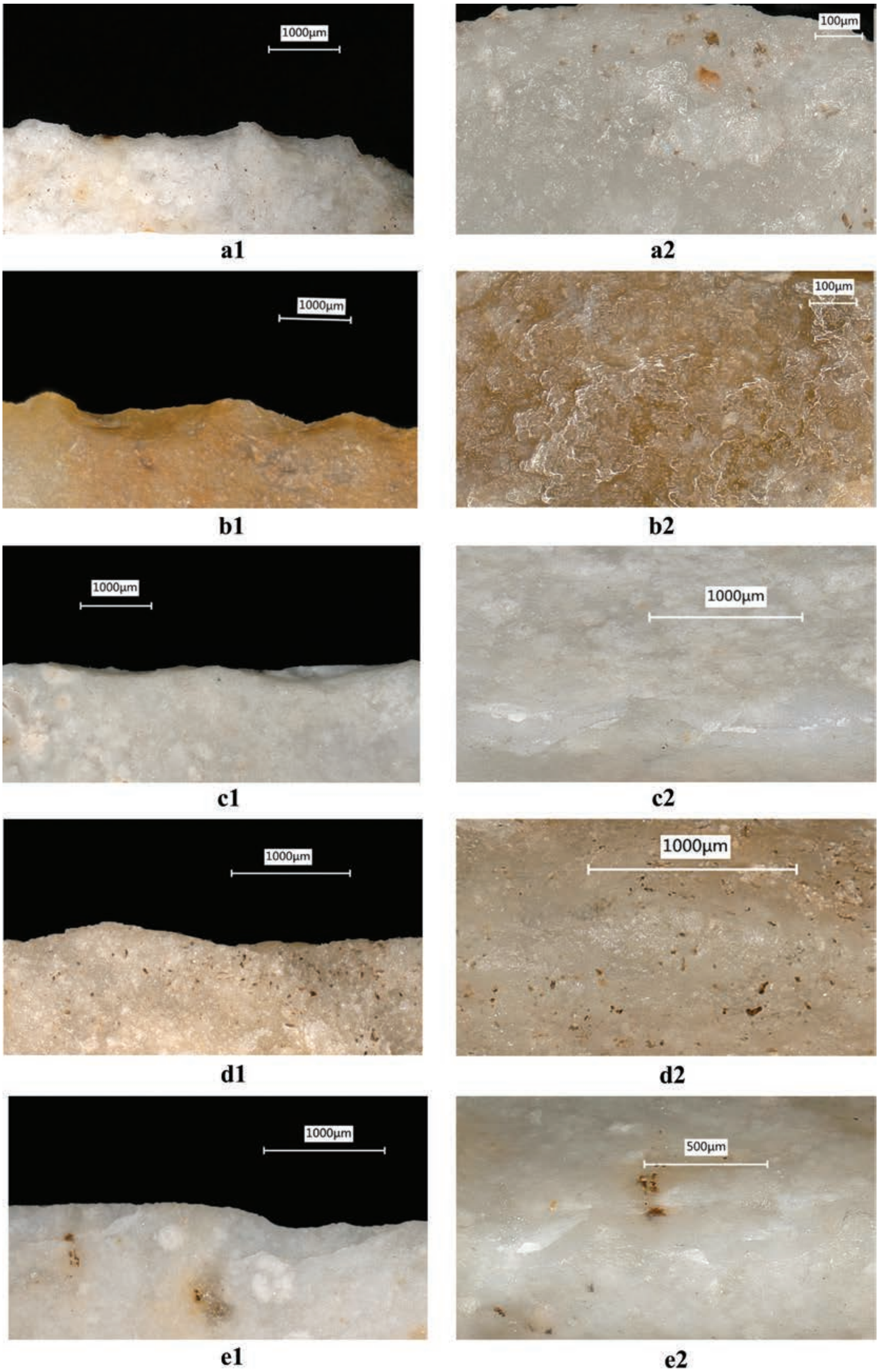

Fig. 3. Use-wear resulting from wood-working. a1 ***sawing dry pine (No. DJK-SY:9), scarring V30x;*** a2 ***polish, 30min, V400x;*** b1 ***sawing fresh pine (No. DJK-SY:10), scarring V30x;*** b2 ***polish, 30min D400x;*** c1 ***chopping dry pine (No. DJK-SY:8), scarring D30x;*** c2 ***rounding, 30min, R50x;*** d1 ***chopping fresh pine (No. DJK-SY:11), scarring D50x;*** d2 ***rounding, 30min, R60x;*** e1 ***whittling dry wood (No. DJK-SY:14), scarring;*** e2 ***rounding, 30min, R100x.***

more developed than that by dry bamboo, but an exception is found on one specimen for sawing fresh bamboo, which develops polish less bright than that resulting from sawing dry bamboo. Based on the dynamic observation of the multi-stage experiments, it can be suggested that the development of use-wear is more probably affected by working intensity.

No apparent striations were observed under the optical microscope in our experiment. The development and appearance of the striations might be influenced by various factors, which needs to be further explored in the future.

Use-wear features and patterns of wood-working

Many experimental and archaeological studies have been conducted to explore the characteristics of wood-working traces. It is summarized that the use-wear resulting from working on woody materials of medium hardness mainly consists of two categories: first, the more common smooth, bright and domed polish with occasional flat striations (*Shea 1992; Yerkes* et al. *2003; 2012*); second, the continuous distribution of shallow feathered scars of large and/or medium size, and especially with the typical marks of rolled-over shaped scars along the working edges (see *Chen* et al. *2008.Fig. 3.8; Odell 1981; 1996; Shen 2001*).

Comparison of use-wear patterns between bamboo-working and wood-working

Our experiments show that there are some similarities and differences between the use-wear resulting from bamboo-working and wood-working on flints (Fig. 5).

Rolled-over scars are commonly produced by processing both bamboo and wood, and are indicative of working with other woody materials, as suggested in previous experiments (*e.g., Odell 1996; Shen 2001; Chen* et al. *2008*). The characteristics of micro-fractural scarring, especially its distribution patterns, are in close relation to the working motion. The patterns of scars caused by whittling and sawing these two materials are similar. More differences can be observed on the specimens for chopping activity: bamboo-chopping tends to produce more scars with stepped termination and overlapped distribution, while scars produced by chopping wood are relatively smaller, presenting some medium and small notches on the edge ridge. Hinged scars often exist in association with processing dry wood and bamboo.

It has been demonstrated by a large number of experiments that a distinctive polish can be formed by different types of wood and various working motions. Usually bright or very bright with a smooth texture, the surface of the polish is rarely flat but appears to have a fluted or domed morphology (*e.g., Keeley 1980; Shen 2001; Wang 2008*). Similar features correspond to the polish produced on specimens for bamboo-sawing and bamboo-chopping. More similarities exist on the edge rounding, which is characterized by medium and heavy rounding.

In addition, rough and moderate bright polish was observed in the wood-working experiments. However, under approximately the same conditions the range and distribution of polish resulting from bamboo-working are more extensive and well-linked. In the sawing task, bamboo polish tends to link together and seems like a net in a zone, but wood polish tends to form numerous short lines. Bamboo polish is brighter than wood polish caused by chopping. Generally, soft and fresh wood or bamboo produces

Fig. 4. Polish resulting from different bamboo-working activities: a ***sawing fresh bamboo (No. DJK-SY:4), 30min, D400x;*** b ***sawing fresh bamboo (No. DJK-SY:5), 30min, D400x;*** c ***sawing dry bamboo (No. DJK-SY:2), 30min, V400x;*** d ***chopping fresh bamboo (No. DJK-SY:13), 30min, V400x.***

more polish on the tool surface than hard and dry wood or bamboo after the same use duration (also see *Keeley 1980; Vaughan 1985*).

Conclusion

The experiments and results described above indicate that the features and patterns of microfractural scarring, edge rounding and polish caused by bamboo-working and wood-working could be identified under the 3D digital microscope.

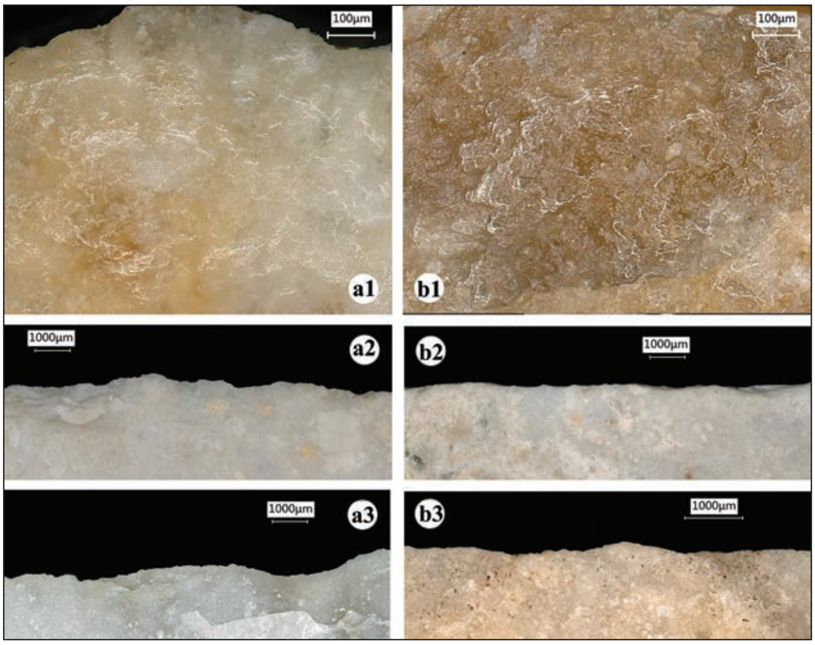

Fig. 5. Comparison between the use-wear resulting from bamboo-working and wood-working. **a1** ***sawing fresh bamboo (No. DJK-SY:4), 30min, well-linked brighter polish, D400x;*** **a2** ***chopping dry bamboo (No. DJK-SY:6), stepped and overlapped scarring, 30min, D30x;*** **a3** ***chopping fresh bamboo (No. DJK-SY:13), 30min, stepped scarring, V30x;*** **b1** ***sawing fresh pine (No. DJK-SY:10), 30min, bright polish, D400x;*** **b2** ***chopping dry pine (No. DJK- SY:8), 30min, scarring, D30x;*** **b3** ***chopping fresh pine (No. DJK-SY:11), 30min, scarring, D50x.***

Based on our experiment and other similar studies, it is demonstrated that more similarities exist between the use-wear resulting from bamboo-working and wood-working on flints, including the pattern and distribution of scarring, as well as edge rounding. The distinction and connection to working motions appear stronger than that to the contact materials. The characteristics of scarring can be used to understand the movement of tools, the brightness, morphology, and distribution of polish are also useful to identify the specific working motion.

Notably, there are a few differences allowing us to distinguish the use-wear caused by bamboo-working from that by wood-working, which should be considered in terms of a set of features rather than a single element. The most obvious distinction is that more stepped and overlapped scars and brighter polish are produced by bamboo-working than wood-working. Moreover, the range and distribution of polish resulting from bamboo-working are more extensive and well-linked. In the case of sawing activity, bamboo polish tends to link together and seems like a net in a zone, but wood polish tends to form numerous short lines. Although the resulting bamboo-working polish seems like that from reed processing (see *Vaughan 1985; Jensen 1994*), it is distinguishable when the light edge rounding and small feathered scarring are taken into consideration.

It is worth noting that striations are often seen as linear indicators of working motion in the high-power analysis. However, our experimental results show that the distribution of scarring and polish is closely related to the specific movement of the tools, which could be used to infer the working motion. The absence of striations on most specimens might be attributed to the raw material or other factors.

This study also proves that the optical 3D digital microscope used in this work has great potential to conduct integrative use-wear analysis. The capabilities of live depth composition and advanced imaging enable observation and documentation of wear traces and their formation with more details and in more extensive areas on tools. The presentation and description of traces can be more readily perceived and easily understood, which could be helpful for analysing a large sample of stone tools. Since numerous variables might influence the development of use-wear, more experiments and use-wear analyses on archaeological stone tools are needed in the future.

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The meaning of projectile points in the Late Neolithic of the Northern Levant. A case study from the settlement of Shir, Syria

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ABSTRACT – *Our contribution explores the possibilities of inferring the functions of Late Neolithic projectile points from the settlement of Shir, Syria. Use-wear and metrical values are applied to differentiate between arrowheads, darts and thrusting spears, followed by a discussion of hints for use for hunting or as weapons for interpersonal conflict. Weapons get larger and more visible exactly in the moment when hunting declines as a basis for subsistence. This economical transformation would have produced considerable change for individuals who previously defined themselves as hunters. The social practice of hunting may (at least partially) have been substituted by prowess in interpersonal conflict.*

KEY WORDS – *Neolithic; Near East; projectile points; Shir; warfare*

Pomen projektilov v času poznega neolitika v severnem Levantu. Študijski primer iz najdišča Shir v Siriji

IZVLEČEK – *V prispevku raziskujemo možnosti, kako sklepamo o namenu pozno neolitskih projektilov iz najdišča Shir v Siriji. Za razlikovanje med puščičnimi konicami, puščicami in sulicami smo uporabili analizo sledov uporabe in metrične podatke, vse to pa nadgradili z razpravo o sledovih uporabe pri lovu ali kot orožje pri medosebnih spopadih. Orožje postane namreč večje in bolj opazno ravno v trenutku, ko se zmanjša vloga lova kot osnovnega sredstva za preživetje. Takšna gospodarska preobrazba bi pomenila znatno spremembo za posameznike, ki so se pred tem identificirali predvsem kot lovci. Družben običaj lova bi lahko bil (vsaj deloma) nadomeščen s spretnostjo v medosebnih spopadih.*

KLJUČNE BESEDE – *neolitik; Bližnji Vzhod; projektili; Shir; vojskovanje*

Introduction

Conflict and warfare studies have constituted important research focusses within archaeology in recent years (*Guilaine, Zammit 2005; Livingstone Smith 2009; Martin, Frayer 1997; Meller, Schefzik 2015; Thorpe 2005*). The origin and genesis of interpersonal conflicts, war, their forms and probable causes, and their traces in the archaeological record are much debated also for the Near Eastern Neolithic (*Clare 2010; Müller-Neuhof 2005; 2014a; 2014b*). Site structures, the existence of fortifications or of defensive buildings, phenomena of site abandonment, spatial analysis of site distribution and evidence for trauma in bones are among the proposed archaeological markers for conflict (*Ferguson 2013; Glencross, Boz 2014; Müller-Neuhof 2005.129–163; Müller-Neuhof 2014a*). Based on these finds or on ethnographic analogies, generalized as well as small-scale conflicts with mostly economic causes were proposed for this epoch and region (*Clare 2010; Müller-Neuhof 2014a*).

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Weapons as a conflict marker were taken into consideration to a lesser degree. This is partly due to the difficult differentiation between weapons used for conflict and those used for hunting (with the exception of maceheads, for which an use in hunting would be less likely) – in an epoch in which hunting still represents a major basis of subsistence (*Müller-Neuhof 2014a-b; Scheibner 2016*). This is particularly the case for the Early Neolithic (Pre-Pottery Neolithic (PPN), 9600–7000 BC) of the Levant. A stronger possibility of linking weapons and conflict seems to exist only toward the end of the Neolithic, in the Late PPNB and Early Pottery Neolithic (PN) (*c.* 7500 to 6000/5600 BC) (*Hours* et al. *1994*). A supra-regional, general change of the subsistence basis takes place during that period, marked by the declining importance of hunting (and therefore of the use of weapons in this scope) and the completion of the domestication processes both of animals and plants (*Abbo* et al. *2017; Asouti, Fuller 2013; Vigne 2015*), the extended cultivation of plants, animal husbandry and the exploitation of milk (*Evershed* et al. *2008; Russell 2010; Scheibner 2016.110–125, 210–218, with bibliography*), the invention of pottery (*Nieuwenhuyse 2009; Nieuwenhuyse* et al. *2010*) and the spread of food storage (*Bartl 2004*). Archaeozoological records show a decline in the number of bones of wild animals in the finds along with a simultaneous rise in the number of bones of domesticated animals (*Scheibner 2016.235, Fig. 4.47–48*).

It is not entirely clear how demography and settlements evolved at the end of the PPNB in the Northern Levant, and most probably major regional differences in their development have to be assumed. Some reconstruction models include a reduction of settlement sizes and densities in the Late Neolithic (*Bocquet-Appel, Bar-Yosef 2008*). Furthermore, regionalization and an interruption of the long-distance trade networks of the PPNB (*Asouti 2006*) have been postulated (*e.g., Watkins 2008*). Severe climate change (the 8.2k-event: *Verheyden* et al. *2008; Weninger* et al. *2005*) was also suggested, followed by the development and spread of pastoralism as a subsistence strategy (*e.g., Russell 2010*). Climate change and subsequent lack of resources are assumed to have caused social stress, resulting in supra-regional, 'politically' motivated inter-group conflicts and large-scale migrations through Anatolia, to the West (*Clare* et al. *2008; Clare, Weninger 2016*).

The most representative weapons in Neolithic assemblages, including the Late Neolithic, are 'projectile points', *i.e.* pointed weapons, which have been addressed as arrows, darts and spears; sling stones are also numerous (*Borrell, Štefanisko 2016; Gopher 1994; Korfmann 1972; Müller-Neuhof 2005.167–207; Rosenberg 2009; Shea 2006; 2013.238–249*). The notion of 'projectile points' comprises triangular to biconical pieces of flint, usually between 2 to 10cm long and less than 3cm wide (*Shea 2013.238*). The development of the shapes of projectile points from the Epipaleolithic to the Late Neolithic in the Levant does not seem to follow one common, supra-regional line; major differences between the Southern and the Northern Levant were noticed (*Shea 2013.238–249*). These include discrepancies in shapes, which could have a functional or stylistic meaning (*Gopher 1994.22*), and a disparity in their sizes, with north Levantine points being generally larger (*Borrell, Štefanisko 2016.138*). Elongated points were usually associated with the Middle PPNB (*Borrell, Štefanisko 2016* with further reading), while for the PN a reduction in length was postulated (*Shea 2013.248–249*), following a short-time growth in the Late PPNB (*Cauvin 1978*). Regional and chronological variability and changes in the shapes of the projectile points have been explained either by major changes in hunting techniques, implying morphological and technological transformations, by shifts in weapon technologies and functions – or simply by stylistic reasons (*Gopher 1994.22; Müller-Neuhof 2005.177–181*). It has also been stressed that some objects, addressed as 'projectile points', were in fact used for different tasks based on their shapes (*Astruc, Russell 2013.338; Müller Neuhof 2014b with bibliography*) and use-wear analyses seem to confirm this hypothesis in some cases (*Coşkunsu, Lemorini 2001*). Multifunctionality (weapon-tools or tool-weapons: see *Chapman 1999*) is very likely, and exclusions of functions cannot be made easily through functional macro- and microscopic analyses of use-wear. These analyses reflect often only the last steps in the biography of an object. Previous analytical approaches focused on typological distinctions and metrical analysis. The latter were used to differentiate between different weapon categories like arrows, darts and spears by way of comparing the dimensions of archaeological finds to ethnographic data (*Hughes 1998; Shea 2006; Shott 1997; Sisk, Shea 2011; Thomas 1978*).

The present study aims to decipher possible functions and social roles of projectile points from the Late Neolithic site of Shir, Syria. The site is particularly suitable for this analysis due to its long stratigraphical and chronological sequence and a high quantity of projectile points. Also projectile points made from bone, which seem to be very rare, constitute an important part of the analysis.

The Neolithic settlement of Shir

Shir is located *c.* 12km northwest of the city of Hama on a 30m high, natural terrace above the Orontes tributary Sarut. The site, with an overall size of 4ha, was discovered in 2005 during the Orontes survey conducted by the Damascus Branch of the German Archaeological Institute under the direction of Karin Bartl in cooperation with the Syrian Department of Antiquities. Excavations were undertaken in three areas of the site between 2006 and 2010, accumulating to a total of $2350m^2$ excavated (*Bartl* et al. *2008; 2009; 2012; Nieuwenhuyse 2009; Rokitta-Krumnow 2012*). Settlement activities date exclusively to the 7th millennium BC. An earlier settlement phase was excavated in the southern area (7000 to 6600 BC), a later phase in the central and northern areas (6600 to 6200/6100 BC). As far as could be reconstructed from the excavations and the geophysical prospections, Shir represents a typical Late Neolithic village from the Northern Levant with several clusters of houses. The site's special importance arises from an exceptionally long settlement history of nearly 800 years, covering the Late Neolithic period, its very well preserved stratigraphy, the very early occurrence of pottery on site (dark faced burnished ware and later coarse ware: *Nieuwenhuyse 2009*), and evidence for significant changes in architecture with the appearance of large, specialized buildings for storage (*Bartl 2014; 2017; Dietrich in prep.; Dietrich, Lelek Tvetmarken 2015*).

The Southern Area was excavated most extensively. Here, six subsequent layers were noticed, ranging from the early to middle 7th millennium. The earlier layers (I-III) are mainly characterized by single-room buildings, sometimes with annexes and much of the daily activities going on outside the houses. The later layers (IV-VI) yielded multi-room buildings with inner courtyards (*Bartl 2017; Pfeiffer in print*).

The functional interpretation of projectile points

More than 190 projectile points have been found in this area. Most of them were made of flint. Only 48 items are fully preserved of the total number of 172 flint points. Most of the broken pieces show signs of impact, *e.g.*, burin-like blows, hinting at an interpretation as projectile points and not as awls or drills. The types are dominated by large 'Amuq-1 and 'Amuq-2 points followed by Ugarit and Byblos points; one Bouqras point and three Levallois points complete the assemblage (*Rokitta-Krumnow 2012*) (Fig. 1). The persistence of PPN lithic reduction techniques in the PN period is noticeable, and, for example, naviform core-and-blade technology producing long bidirectional blades is present at all stages of occupation (*Rokitta-Krumnow 2011*). Projectiles of flint show a high variability in size and weight (Fig. 2), ranging from 3.3g to 26.4g weight and 4.2cm to 11.8cm size.

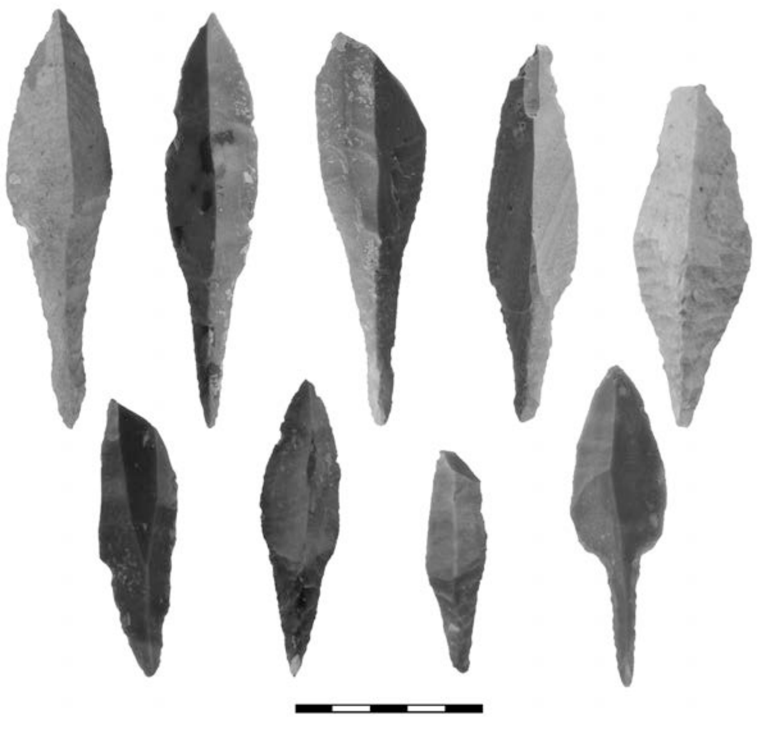

Fig. 1. Flint projectile points from the Neolithic settlement of Shir (© German Archaeological Institute, photos by K. Bartl, T. Urban).

Projectile points made from bone are generally rare in Neolithic assemblages, or they have not been recognized as such so far. Experimental studies as well as ethnographic examples have pointed out the high effectivity of bone projectiles (*Letourneux, Pétillon 2008; Waguespack* et al. *2009*), which lends some probability to the latter explanation. At Shir, fifteen bone projectile points were identified, and an additional twelve objects may possibly be addressed as such. Osseous points imitate the lithic projectiles in shape (Fig. 3). Use-wear traces like broken tips hint at their use as projectiles. This specific use-wear was also ob-

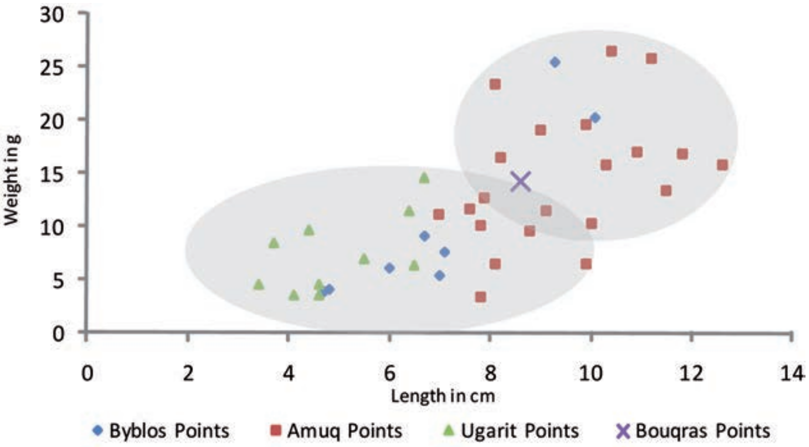

Fig. 2. Size and weight of flint projectile points from the Neolithic settlement of Shir (chart by D. Rokitta-Krumnow).

scopic analyses. Microscopic examination was planned but then not possible because of the political situation in Syria. Also, as mentioned above, observable traces often only reflect the last of a long series of uses of any given tool. However, the great quantity of other pointed osseous tools used as drills in Shir and a certain standardization of their forms may constitute arguments to exclude the differently shaped lithic and aerodynamic bone points from this category.

served with objects classified as awls based on their shapes, but is not typical for that category of tools. Other traces of use-wear include splinters on one end and to a lesser extent fissures along the shaft. Bone projectile points have relatively symmetrical shapes and are well-balanced through their wide blade with pointed ends. Hence, the shape displays aerodynamic characteristics. This is not the case with objects classified as awls, so we consider this specific shape as being diagnostic for an interpretation as projectile points. Typical awls in Shir have tubular shafts, made from an entire or half hollow long bone with one pointed end. It is however difficult to differentiate between fragmented projectile points and awl fragments. It is therefore assumed that among the objects classified as awls several projectile points are hidden. This is again tentative evidence for the original number of bone projectile points being higher.

We are aware that our identification of the tools' functions as projectile points is based on shapes and macroscopic use-wear analysis and is missing micro-

As mentioned above, size and weight have been used as indicators to distinguish between different kinds of projectile points. In some mechanical calculations, mass is an important parameter for the distinction between arrowhead and spear (*Borrell, Štefanisko 2016; Sisk, Shea 2011*). These calculations are based on the assumption that, in the case of a bow and arrow, there is a firm relationship between the arrow shaft, the arrowhead, and the bow. Accordingly, the arrowhead should not exceed 12% of the total weight of the arrow shaft (*Beckhoff 1966*) in order to hit the target. Korfmann (*1972.33–35*) confirmed these estimates by applying a relation of 1:7 between arrow and arrowhead. There is also a firm relationship between a bow and the weight of an arrow, with the consequence that the weight of an arrowhead can be estimated, too. The most practical weight for an arrowhead is estimated at *c.* 8g, although this applies only to modern-day bows with complex designs. A weight up to 5g may be estimated for prehistoric arrowheads; ethnographic studies and calculations have affirmed such approximations (*Bretzke* et al. *2006; Cattelain 1997*). This value will also be applied in the following discussion.

Fig. 3. Bone (left) and flint (right) projectile points from the Neolithic settlement of Shir (© German Archaeological Institute, photos by K. Bartl, T. Urban).

As for projectiles catapulted with spear-throwers, ethnographic studies and experiments on weights define an ideal weight-range between 9g and 70g (*Bretzke* et al. *2006; Hughes 1998*). By adding feathers, the weight of a dart can be reduced (*Hughes 1998*).

Following these schemes for interpreting projectile weights, a total of 21 points made from bone and 45 from stone from Shir were analysed (Figs. 4 and 5). Despite the small numerical basis, an interesting picture emerged about the development of the projectile points. It can be recognized that in the early Layers III and IV as well as in Layer V the weights noticeably locate within the lower (especially bone projectile points) as well as median zones, that is, within the range of possible arrowheads and darts for spear-throwers. The weight values for spear-throwers increase already in Layer Vb and even more so in Layer VI (Fig. 4).

In order to clarify this picture, reference was also made to size parameters in the analysis. Various studies on projectiles do not pay sole regard to the length, but far more to the surface area of the cross-section. This 'area' is referred to as the 'tip cross-sectional surface' (TCSA), a parameter which basically links size and shape of the projectile with the behaviour at the moment of its penetration into animal or human tissue, and the thus expended energy (*Borrell, Štefanisko 2016; Sisk, Shea 2011; Hughes 1998; Shea 2006; Thomas 1978*). The TCSA value is calculated with the formula 0.5 x maximum width x thickness. Points with a low value are smaller, thinner and penetrate tissue more quickly. A higher value, on the other hand, is indicative of wider and thicker points. Based on ethnographic metric data from North America and Australia (*Borrell, Štefanisko 2016.140, Tab. 1; Bretzke* et al. *2006.70; Shott 1997; Thomas 1978*), TCSA values between 13 and 53 for arrows and 20 and 174, *e.g.*, an average between 57 and 103 for darts can be expected (*Borrell, Štefanisko 2016.140, Tab. 1*). Values for thrusting spears range between 79 and 257 (*Bretzke* et al. *2006.70; Shea 2006*) and between 7 and 222 for experimentally produced spears (*Borrell, Štefanisko 2016.Tab. 1*). Cycles of recycling and reshaping could not be taken into consideration in the present analysis.

The development of TCSA-values for Shir results in a pattern similar to that of the development of weights (Fig. 5). Smaller, thinner projectiles that would usually be used as arrowheads and spear-thrower darts appear mainly in Layers III-IV and less so in Layer V, while larger, wider projectiles are represented predominantly in Layer VI.

Prestige weapons in a changing world

One possible way of interpreting this result based on the above mentioned weight differences among the darts with and without feathers is to view the lighter, smaller projectiles in the early layers as arrowheads and feathered spear-thrower darts, and the heavier ones in Layer VI and the later settlement as spear-thrower darts without feathers or as spearheads. They are already present in the early layers, albeit only in small numbers, but markedly increase in Layer VI. According to Shea's experiments, the values shown in Figures 3 and 4 (11g or 79mm) may represent the lower boundary of the value zone for thrusting spears (*Bretzke* et al. *2006.70; Shea 2006*), while by contrast throwing spears may weigh less (*Bretzke* et al. *2006.73*). These considerations lead to two more interpretational possibilities:

❶ During the periods of the earlier layers at Shir (III–IV, partly V), arrowheads, darts and feathered darts were produced. Thrusting spears were either rarely made, or made from perishable material, such as wood.

❷ During the periods corresponding to the later layers, especially Layer VI, arrowheads declined, while darts and/or throwing spears continued to be utilized. A change in the basic procurement of raw materials cannot be assumed, as the often-employed flint was locally available. This 'enlargement' of spears could therefore signal an increased utilization of thrusting spears. Thrusting spears can be used both as short-range as well as long-range weapons. If the coeval development of daggers and maceheads – appearing only in the later layers (Fig. 6) – is considered, which served primarily as short-range weapons and probably had social implications, being used as prestige-weapons (*Müller-Neuhof 2005.196*), then the development of large projectile points, possibly for spears, may be linked to this process.

Surprisingly, this development is opposed to the general development of other formal lithic tools, which decrease in size (*Rokitta-Krumnow 2011*) (Fig. 7). Apparently, the projectile points seem to have played an important role in the community, since their development follows the opposite direction. Comparisons to other sites in the Northern Levant with several occupational phases show a general development toward longer points at the End of the Early PN (*Rokitta-Krumnow 2011.222, Fig. 12*; Mezraa Teleilat: *Coşkunsu 2007*; Tell el-Kerkh: *Arimura 2004*; Ain el-Kerkh: *Arimura 2007*; Tell Halula: *Borrell 2006*). This is accompanied by a loss of formal tools in favour of ad-hoc and expedient tools (*Rokitta-Krumnow 2011.290*).

How can we interpret the possible appearance of large, probably prestige weapons in Shir? The deve-

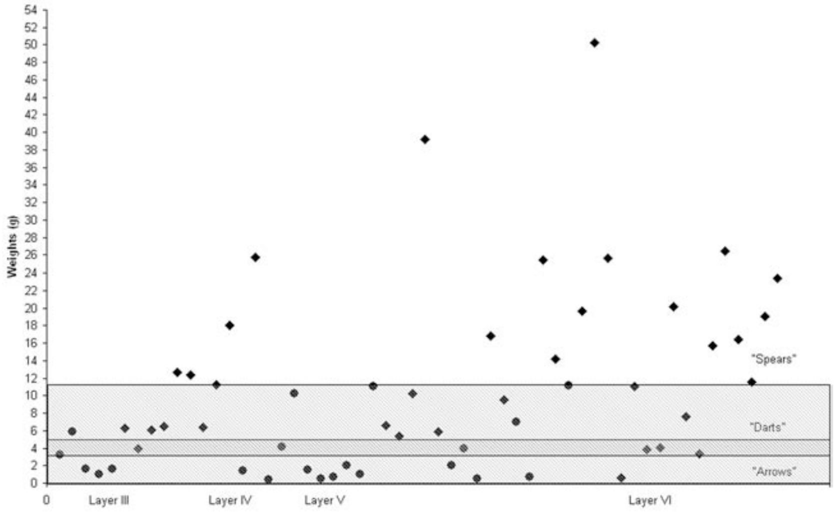

Fig. 4. Weight of projectile points from the Neolithic settlement of Shir (© German Archaeological Institute, chart by L. Dietrich).

lopment of larger projectile points in the Late PPNB in the Northern Levant has been linked with the (possible ritual) hunting of larger animals like aurochs (*Cauvin 1978*). Deposits of auroch bones in archaeological finds seem to confirm the special significance of the hunting and consumption of these animals in social activities like feasting (*Pöllath* et al. *2018; Russell, Martin 2005; Russell* et al. *2009*). The archaeozoological analyses from Shir are still in progress, but some deposits of aurochs bones were observed.

However, as a general trend a reduction in the percentage of hunted animals is noticeable between the Early and the Late Neolithic in the Levant (*Scheibner 2016.235–237, Fig. 4.47; 4.48*). Bones of domesticated animals constitute about 70% of the assemblages in the Late Neolithic, and hint at a maximum use of domestic animals in this time and a decrease of the contribution of wild animals to the food spectrum. Also, a constant reduction of game size from the Upper Palaeolithic to Late Neolithic is noticeable (*Scheibner 2016.212–217*). This general development apparently does not coincide with the development of the length of arrowheads and spears. The most characteristic weapon and one of the most characteristic objects of the Early Neolithic (PPNB) are large tanged points made on bidirectional blades (*Abbès 2003; Borrell, Štefanisko 2016*), used for middle-sized game, while for example during the Natufian small lithic-tipped projectiles coincide with large game in archaeozoological assemblages (*Bocquentin, Bar-Yosef 2004; Yeshurun, Yaroshevich 2014*). Thus, there is no simple correlation between small projectile points and small animals on one side, and large projectile points and large animals on the other. Additionally, assuming that the large points actually represent darts and/or spears, then their exclusive use for subsistence hunting would signify a lower range in variation and a lesser ability to adapt hunting techniques than with the combined utilization of spears/sling shots and the bow and arrow, as the latter are far more versatile and possess several technical advantages (*Churchill 1993; Whittaker 2013*). Taking the association of larger projectile points with other weapons in the later layers from Shir into account, a more complex significance is proposed, centring on representation within (ritual) hunting and interpersonal conflict.

In the numerous murals at the contemporary settlement of Çatalhöyük, Anatolia, wild animals and hunting scenes predominate (*Hodder 2006.195–204*). Depictions at Çatalhöyük show large dangerous animals surrounded by small hunters, who attack them with different kinds of weapons (bows

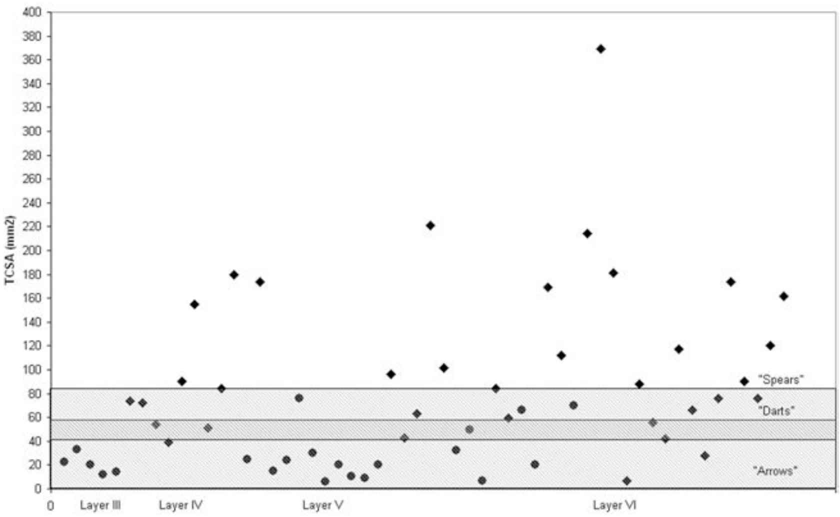

Fig. 5. TCSA values for projectile points from the Neolithic settlement of Shir (© German Archaeological Institute, chart by L. Dietrich).

and possibly bolas are visible, spears and other projectile weapons like boomerangs are also present: *Hodder 2006.197, Fig. 84, 94, Fig. 38*). Such scenes have occasionally been interpreted as attempts to transfer the strength of the large dangerous animals to human beings (*Hodder 2006.197–198; Lewis-Williams 2004*), or from a perspective of ritually acquiring hunting skills (*Hodder 2006.197, Fig. 84*), as a successful hunt not only would have an important symbolic meaning but would also bear the bonus for individuals or even dominant groups of gaining social prestige (*Hodder 2006.203–204*). The weapons depicted at Çatalhöyük (*Hodder 2006.94, Fig. 38*) are clearly recognizable, as the individuals are habitually shown with their hands raised and their weapons aiming at the animals. Such representations denote a conscious manner of depicting the action as the main subject. Along the same lines, it is likewise conceivable that at Shir weapons were made larger in order to render them more visible. Symbolically, an amplification of human strength in battle with wild animals or human opponents would thus be achieved through an enlargement of the size of the weapons. The later projectile points from Shir would consequently not only reveal specific activities, but also specific groups of agents, with regard to age/stage of initiation, gender, clan, *etc*. (*Carter 2011*).

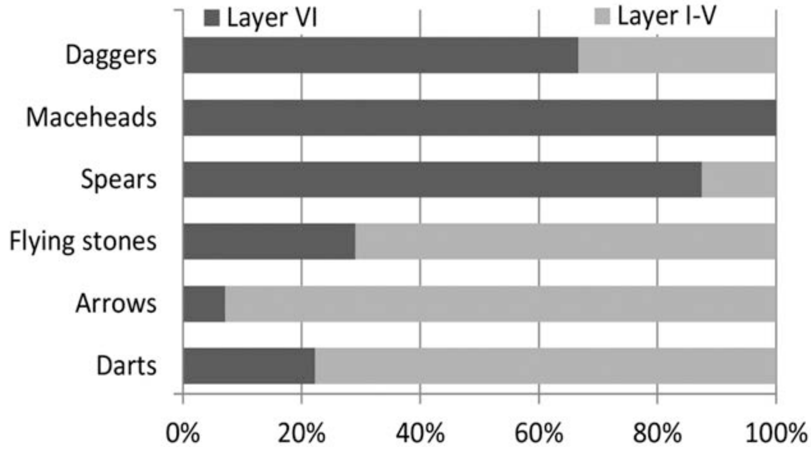

Fig. 6. Stratigraphical distribution of daggers, maceheads and projectile points at the Neolithic settlement of Shir (© German Archaeological Institute, chart by L. Dietrich).

Armed conflict between human beings is not directly archaeologically attested at Shir (for example through burnt layers, fortified complexes, large depots of sling stones). However, conflict and demonstrations of power by small groups or individuals can be assumed for the period in question on a supra-regional echelon (*Clare 2010; Clare* et al. *2008*).

To sum up, at the end of the PPNB and Early PN in the Northern Levant, large visible weapons appear. This phenomenon could have a connection to hunting, but it appears exactly at the moment when hunting declines as a basis for subsistence. This transformation would have produced considerable change regarding the social roles of individuals, who previously defined themselves as hunters. It seems possible that the social practice of hunting was (at least partially) substituted by prowess in interpersonal conflict as a means to perpetuate and reinforce identities in this situation of change, or transform aspects of them into a new one, that of the warrior, defending the new settlements and their agriculturally used hinterlands. Symbolically charged weapons of impressive size could have played a significant role here. Large-scale conflict on a supra-regional level does not need to be proposed or proven for this scenario, rather an interpretation of the use of these weapons especially for conflict on the local level within smaller groups seems probable. These conflicts might be individually motivated and may have had a denotation in the individual development of a single person, generating social status and (new) social identities.

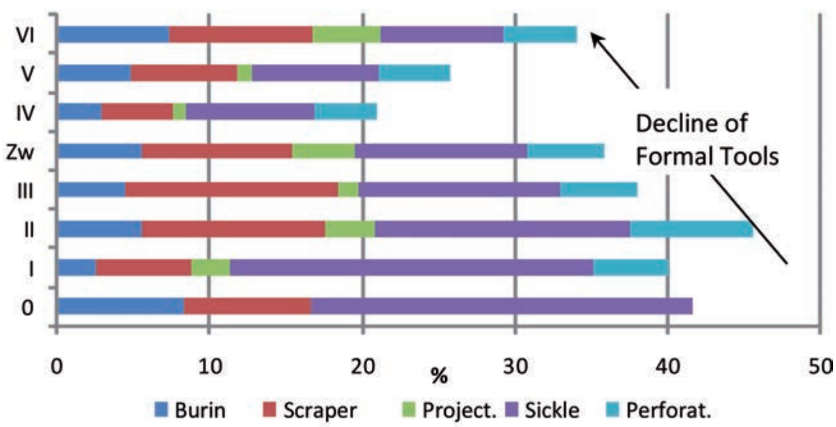

Fig. 7. Chronological development of percentage of formal tools at the Neolithic settlement of Shir (chart by D. Rokitta-Krumnow).

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Impressed Ware blade production of Northern Dalmatia (Eastern Adriatic, Croatia) in the context of Neolithisation

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ABSTRACT – *The lithic assemblages from the principal early Neolithic sites in Northern Dalmatia have been analysed with respect to the technological aspects and principles of* schéma *and* chaîne opératoire, débitage *economy and raw material economy. Northern Dalmatia, the most fertile region of the Eastern Adriatic, hosts the most important Neolithic open-air sites. Early Neolithic is associated with the Impressed Ware culture and dates back to* c. *6000–5400 cal BC. The Early Neolithic lithic assemblages are characterized by the pressure blade production techniques on high-quality Gargano cherts reflecting important socio-economic and technical mutations that are specific to the Neolithic. Moreover, the almost exclusive reliance on these exogenous cherts emphasizes the social aspects of such networks and reinforces the idea of cultural uniformity of Dalmatian and Apulian Impressed Ware.*

KEY WORDS – *lithic technology; Neolithisation; Dalmatia; Adriatic; Impressed ware; pressure flaking; Castelnovian*

Izdelava klin tipa Impresso v severni Dalmaciji (Vzhodni Jadran, Hrvaška) v kontekstu neolitizacije

IZVLEČEK – *Analizirali smo zbire kamnitih orodij iz najpomembnejših zgodnje neolitskih najdišč v severni Dalmaciji, pri čemer smo upoštevali predvsem tehnološke aspekte in principa* schéma *in* chaîne opératoire, *ekonomijo kamnitega odpada in ekonomijo surovin. Najpomembnejša neolitska najdišča na prostem so locirana v Severni Dalmaciji, ki je najbolj rodovitna regija na Vzhodnem Jadranu. Zgodnji neolitik tukaj povezujemo s kulturo Impresso, ki datira v čas ok. 6000 do 5400 pr. n. št. Zgodnje neolitski zbiri kamnitih orodij so vezani na tehnologijo izdelave klin izdelanih iz visoko kakovostnih rožencev, ki prihajajo iz polotoka Gargano v Italiji, kar odseva pomembne družbeno-ekonomske in tehnične spremembe, ki so specifične za obdobje neolitika. Poleg tega uporaba roženca, ki prihaja skoraj izključno iz drugih pokrajin, poudarja družbene vidike takšnih mrež in krepi idejo o kulturni enotnosti v dalmatinski in apulski kulturi Imresso.*

KLJUČNE BESEDE – *tehnologija izdelave kamnitih orodij; neolitizacija; Dalmacija; Jadran; izdelki tipa Impresso; tehnika lomljenja pod pritiskom; kultura Castelnovian*

Introduction

In the context of European Prehistory, studies of the lithic industries of the Early Neolithic period in Dalmatia have long been neglected or have been limited to typological aspects (*Čečuk 1974; 1976; Müller 1994; Bass 1998*). Regarding Northern Dalmatia, only one study, that from the open-air site Crno Vrilo, has been published in detail, but again mostly focusing on typological observations (*Korona 2009*). More detailed data is available from Southern Dalmatian cave sites, but the assemblages are small and/or from insecure contexts (*Perhoč, Altherr 2011; Forenbaher, Perhoč 2015; 2017; Šošić Klindžić* et al. *2015*). Recently, Zlatko Perhoč and Stašo Forenbaher opened new areas of research that consider the

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typo-technological aspects together with the raw material economy and modalities of distribution (*Forenbaher, Perhoč 2015; 2017*).

However, synthesis work on the Early Neolithic assemblages combining both techno-typological aspects (concepts of *schéma opératoire* and *chaîne opératoire*) and the *débitage* economy with raw material economy is still lacking.

Lithic assemblages reflect the intentions of prehistoric knappers and the procedures they performed in their project realization, *i.e.* the choice of raw materials, methods and techniques employed, *etc*. While in some Mesolithic societies (*i.e.* the Early Mesolithic of the Balkans) their conceptual and operative schemes often depend on techno-environmental factors, with the Neolithic the socio-cultural aspects of lithic productions are emphasized (*cf. Inizan* et al. *1999; Perlès 2009*).

Therefore, the study of the Early Neolithic chipped stone assemblages not only informs us of the techno-economical needs of the first farmers, but illustrates their social and ideological choices and relations. The strategies of the lithic production can reveal the contacts and interactions between the groups and their social and symbolic conceptions, but can also represent the routes and mechanisms of Neolithisation (*Perlès 2009; Forenbaher, Perhoč 2017*).

Moreover, in the context of Neolithisation, the study of chipped stone industries is essential to our understanding of the Mesolithic/Neolithic transition. In contrast to pottery, lithic production is an industry that the last hunter-gatherers and first farmers have in common. It consequently appears the most suitable production to evidence plausible generic links between those two types of societies. Did the first farming communities use the same methods and techniques in their lithic production as the last hunter-gatherers? Do the general *schémas opératoires* differ from Neolithic to Mesolithic sites? Are there notable differences in strategies of raw material procurement from a diachronical perspective?

In the literature dealing with the Mesolithic/Neolithic transition in the Eastern Adriatic, chipped stone industries have served either as evidence of cultural continuity (*J. K. Kozłowski 1982; S. Kozłowski 2009; Marijanović 2007; 2009; Korona 2009*) or for cultural rupture (*Müller 1994*). Typology was the only basis for such claims, while the hypothesis for 'continuity' was mostly founded on Montenegrin cave assemblages (Crvena Stijena, Odmut) (*Benac 1955; Marković 1985; J. K. Kozłowski 1982; S. Kozłowski 2009; Marijanović 2009*). Obviously, however, the uncertain stratigraphic contexts of the Montenegrin assemblages cannot be used as one reference database for the whole Eastern Adriatic.

In general, lithic assemblages from Dalmatia reflect the complex strategies of lithic production as seen in the complex economy of raw material and a certain degree of techno-economic specialisation (*Forenbaher, Perhoč 2017; Mazzucco* et al. *2018; Podrug* et al. *in press a; in press b; Kačar 2019*). This paper aims to examine the strategies of blade production

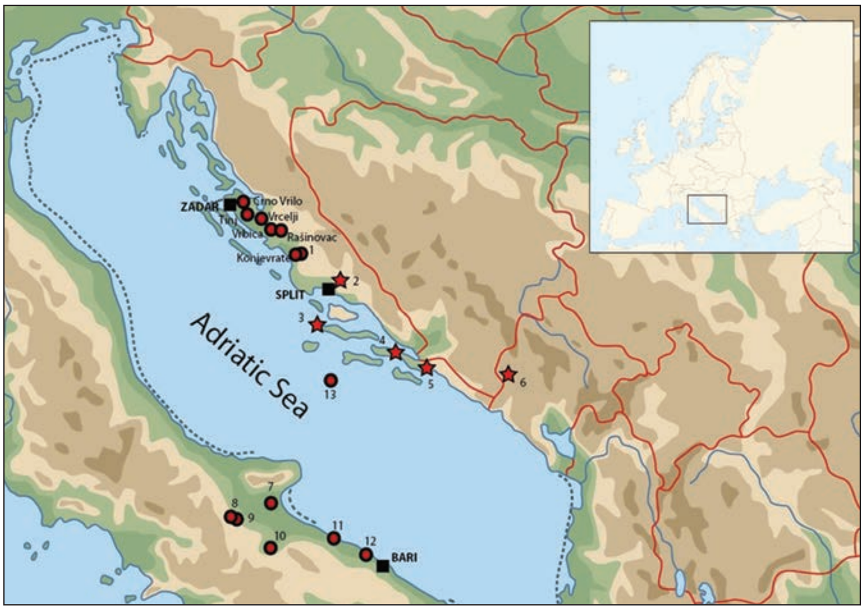

Fig. 1. Map of the main Dalmatian and Apulian impressed ware sites and the other sites mentioned in text. Framed: study area. Dotted lines: the hypothesized position of coastline during the 6th millennium BC (based on bathymetric charts and the presumption that the sea level was −10 to −15m lower than today (**cf. Surić 2006; Fontana *et al.* 2014*****). Dots: open-air sites, stars: caves. 1 Pokrovnik, 2 Zemunica, 3 Vela spila, 4 Nakovana, 5 Gudnja, 6 Crvena Stijena, 7 Coppa Nevigata, 8 Rippa Tetta, 9 Masseria Giufredda, 10 Rendina, 11 Pulo di Molfetta, 12 Scamuso, 13 Sušac (background map designed by F. Tessier).***

in order to investigate its techno-economic and social aspects. As such it attempts to shed some new light on Neolithisation in the region.

Materials and methods

This study is based on Neolithic lithic assemblages from some main Impressed-ware sites in the Šibenik and Zadar regions (Northern Dalmatia): Rašinovac, Vrbica, Konjevrate, Crno Vrilo, Tinj and Polje Niže Vrcelja (Fig. 1). All the sites are open-air settlements, but the degree of research differs among them, as well as excavation strategies and methods employed. Konjevrate, Vrbica and Polje Niže Vrcelja were part of rescue excavations where large surfaces were open: *c.* 487m^2 in Polje Niže Vrcelja, *c.* 160m^2 in Konjevrate and *c.* 50m^2 in Vrbica (*Brusić 1995; Menđušić 1998; Podrug 2013; Horvat 2015*). Systematic excavations were carried on Crno Vrilo, where a total of 550m^2 excavated area has yielded the remains of a Neolithic village with rectangular houses (*Marijanović 2009*).

Trial excavations were conducted in Tinj and Rašinovac (*Chapman* et al. *1996; Podrug* et al. *in press a*). In the latter only a small surface was open (4m^2).

Except Vrbica, which lacks the organic material, all the sites were radiocarbon dated (Tab. 1).

All ^{14}C dates mentioned in text have been recalibrated in OxCal v4.3 (*Bronk Ramsey 2009*) and Int Cal13 (*Reimer* et al. *2013*). However, some dates and namely those obtained for Tinj should be dismissed, as they show high standard deviation. Radiocarbon chronology ranges from the very beginning of 6th millennium calBC to the *c.* 5400 calBC. The earliest dates, around 6000/5900 cal BC, have been obtained from Rašinovac in Šibenik county. Crno Vrilo and Konjevrate can be placed roughly between 5800 and 5500 cal BC. The youngest dates are obtained from Polje Niže Vrcelja, placing its occupation to the very end of the impressed-ware phase, *c.* 5500–5400 cal BC. Despite the lack of ^{14}C dates for the Vrbica assemblage, the presence of one bifacial retouched point, typical for the Danilo phase and Danilo-like sickle insert (*Mazzucco* et al. *2018*), might suggest its affiliation with the later phase of Impressed ware culture.

Following this, it should be noted that the majority of Early Neolithic material studied in this work belongs to the later phase of Impressed ware (from *c.* 5800 cal BC), while only one assemblage (Rašinovac) can be dated to the very beginning of the Neolithic in the Adriatic region (*c.* 6000 cal BC) (*Forenbaher* et al. *2013; Forenbaher, Miracle 2014; McClure* et al. *2014; Podrug* et al. *in press*).

However, the Rašinovac assemblage doesn't show any significant difference from the technological and petrological points of view with other, younger assemblages. Moreover, according to available published data, as well as from the author's personal observations, the Early Neolithic assemblages of Southern Dalmatia, dated between *c.* 6000 to 5500 cal BC, are probably characterized by the same *schéma opératoire*, *i.e.* the same technology and raw material economy (*Bass 1998; Marijanović 2005; Forenbaher, Kaiser 2008; Forenbaher, Perhoč 2015; 2017; Drnić* et al. *2018; Mazzucco* et al. *2018*).

Thus, although this paper deals with the Early Neolithic lithic production of Northern Dalmatia, broader conclusions can be drawn that will concern the whole of Dalmatia.

The question of the origin of the Neolithic chert industries and its place within the discussion of Neolithisation is limited, since the Late Mesolithic sites are absent from the region. The only site in Dalmatia where Late Mesolithic occupation is clearly attested is Vela Spila on the island of Korčula, but the small quantities of collected lithic material do not allow any techno-typological and cultural attribution (*Čečuk, Radić 2005; Vukosavljević 2012*). However, when discussing the relevance of lithic studies in the Neolithisation process, in order to compare the Impressed ware industries with the previous periods, we refer to the Castelnovian lithic production strategies of adjacent regions (*Collina 2009; Binder* et al. *2012; Ferrari 2011; Kačar 2019*). The Castelnovian techno-complex developed during the 7th millennium BC and characterizes the Late Mesolithic lithic assemblages of the central-western Mediterranean, but is absent from Croatia and Greece (*Kozłowski 2009; Marchand, Perrin 2017*). While its absence from Greece can be interpreted by the early presence of Neolithic colons in this region (from *c.* 6700 cal BC), its absence from the Croatian littoral (both Dalmatia and Istria) is curious because analogous industries have been found in the neighbouring regions (Italian and Slovenian Karst, Po valley, Montenegro) (*Biagi 2003; Turk 2000; Mihailović 2009; Kozłowski 2009; Ferrari 2011; Kaczanowska, Kozłowski 2017; Kačar 2019*). We therefore think that the absence of Castelnovian finds along the Croatian coast is due to a lack of research and preservation

Site	Location	County	Stratigraphic Unit	Analysis	Laboratory Nr	BP		cal BC 2 sigma		Material	Comment	Reference
Crno Vrilo	Zekić, Ninski Draševac	Zadar County	B/IX/ 1 (upper part)	^{14}C	Z-3399	7560	120	6651	6207	animal bone	not reliable	*Marijanović* 2009
Crno Vrilo	Zekić, Ninski Draševac	Zadar County	A/IA/sterile (lower part)	^{14}C	Z-3398	6400	110	5563	5205	animal bone	not reliable	*Marijanović* 2009
Crno Vrilo	Zekić, Ninski Draševac	Zadar County	A/IA/1 (upper part)	AMS	Beta-222405	6500	60	5561	5338	bone collagen	too young?	*Marijanović* 2009
Crno Vrilo	Zekić, Ninski Draševac	Zadar County	A/1A/ sterile (lower part)	AMS	Beta-222406	6820	50	5803	5629	bone collagen		*Marijanović* 2009
Crno Vrilo	Zekić, Ninski Draševac	Zadar County	A/1A/ sterile (lower part)	AMS	Poz-18395	6900	40	5881	5716	bone collagen		*Marijanović* 2009
Crno Vrilo	Zekić, Ninski Draševac	Zadar County	A/1A/1 (upper part)	AMS	Poz-18393	6925	35	5886	5731	bone collagen	questionable	*Marijanović* 2009
Tinj	Tinj, Benkovac	Zadar County	I (pit 1)	^{14}C	GrN-15236	6980	160	6126	5619		high standard deviation	*Chapman* et al. 1991
Tinj	Tinj, Benkovac	Zadar County	I (pit 2)	^{14}C	GrN-15237	6670	260	6081	5046		high standard deviation	*Chapman* et al. 1991
Tinj	Tinj, Benkovac	Zadar County	I (pit 3)	^{14}C	GrN-15238	6280	210	5624	4770		high standard deviation	*Chapman* et al. 1991
Polje niže Vrcelja	Vrcelji, Benkovac	Zadar County	trench 1, upper part	^{14}C	Beta-293840	6520	40	5559	5461	charcoral		*Horvat* 2015
Polje niže Vrcelja	Vrcelji, Benkovac	Zadar County	lower part	^{14}C	Beta-293835	6480	50	5529	5331	animal bone		*Horvat* 2015
Rašinovac	Piramatovci, Bribir	Šibenik-Knin County	SU 3 (upper part)	AMS	PSU-5612, UCIAMS-127394	7060	25	6001	5895	bone *bos taurus*		*McClure* et al. 2014
Rašinovac	Piramatovci, Bribir	Šibenik-Knin County	SU 3 (lower part)	AMS	PSU-6492, UCIAMS-158546	7065	25	6004	5898	bone *capra*		*Podrug* et al. *in press a*
Konjevrate	Konjevrate, Šibenik	Šibenik-Knin County	trench I, arbitrary layer 1	AMS	PSU-5291, UCIAMS-116203	6655	25	5630	5537	bone *ovis aries*		*McClure* et al. 2014
Konjevrate	Konjevrate, Šibenik	Šibenik-Knin County	trench I, arbitrary layer 3	AMS	PSU-5557, UCIAMS-119838	6175	30	5218	5038	bone *ovis aries*	too late for Impressed ware	*McClure* et al. 2014
Konjevrate	Konjevrate, Šibenik	Šibenik-Knin County	trench III/ arbitrary layer 4	AMS	PSUAMS-1431	6985	30	5980	5778	bone *bos taurus*		*McClure* et al. 2018b
Konjevrate	Konjevrate, Šibenik	Šibenik-Knin County	bb/ arbitrary layer 8	AMS	PSUAMS-1432	6950	45	5974	5733	mamal bone		*McClure* et al. 2018b
Konjevrate	Konjevrate, Šibenik	Šibenik-Knin County	bb/ arbitrary layer 7	AMS	PSUAMS-1433	7000	30	5984	5806	bone *Capra hircus*		*McClure* et al. 2018b

Tab. 1. Radiocarbon dates associated with Early Neolithic assemblages of Northern Dalmatia.

factors (the sites could have been submerged due to the Holocene sea-level rise or buried under alluvial deposits).

Lithic analyses have been carried out according to the concepts of *chaîne* and *schéma opératoire*, *débitage* economy and raw material economy (*Leroi-Gourhan 1965; Pelegrin 1988; Inizian 1980; Perlès 1980; 1990; 1991; Inizan* et al. *1999; Soressi, Geneste 2011*). When describing stone tools, the typology established by Didier Binder and further developed by Thomas Perrin is generally used, but in its simplified form (*Binder 1987; Perrin* et al. *2017*). Although the raw material was examined macroscopically by the author according to the protocol established by Bressy in 2003, we are here largely relying on the published and unpublished work of Perhoč (*Perhoč 2009ab; Perhoč, Altherr 2011; Forenbaher, Perhoč 2015; 2017; Vukosavljević* et al. *2014; Vukosavljević, Perhoč 2017; Vujević* et al. *2017; Perhoč, Ruka 2017*). However, as his petrographic analysis on the assemblages mentioned in this article is still in progress, the results presented here should be considered preliminary. Our data will soon be correlated for a final publication, and here I take the opportunity to thank Perhoč for allowing me use some of his preliminary results.

Northern Dalmatia – geographic framework and subsistence strategies

Northern Dalmatia, as a central part of the Eastern Adriatic region, includes Zadar and Šibenik-Knin county, and spreads roughly from the southern edge of the Velebit mountain to the north to Krka River to the south. In the west, the region includes the Adriatic Sea and the Dalmatian islands (from Pag to Zlarin) and, on the east, it spreads to the Dinara mountains which constitute the natural border between Croatia and Bosnia. Unlike the Italian coastline, which is low and accessible, the Croatian coast is well indented and high (the Dinaric mountain range falls abruptly towards the coast, except for few narrow coastal plains). The relief of Northern Dalmatia is, compared to other parts of the region, less pronounced and characterized by the relative richness of the plains, in particular Ravni Kotari and *poljes* around Šibenik.

Almost all known Dalmatian open-air sites are situated here, on the fertile soils and always close to water sources (Fig. 2).

The region seems to have been rather densely populated during the Early Neolithic, with at least 20 open air-sites identified, the occupational sequence of 11 of which was confirmed by excavations (*Horvat 2017; Podrug* et al. *in press a*).

There is still one obvious lack of data to inventory the zooarchaeological and archeobotanical record of the Early Neolithic in Northern Dalmatia, although in the present state of research, analysis broadly shows that the economy of the early Neolithic population was dominated by ovicaprines for a combined milk-meat husbandry strategy, and that agriculture is based on emmer, einkorn and barley (*Radović 2011; Reed 2015; McClure* et al. *2018a*).

According to the faunal record, it seems that hunting and fishing played only a marginal role, although lithic kits might indicate this practice, notably with the presence of hunting equipment like trapeze arrowheads. However, trapeze arrowheads could have also been used in warfare or for some other purposes. The paucity of fishing equipment could be explained by the distance of the sites from the larger waterbodies, as well as by the perishability of the osseous material, but it can also reflect cultural choices. In this regard, it is worth mentioning the results from the stable isotope analyses conducted recently on Early Neolithic humans from Zemunica cave (near Split in Southern Dalmatia), which show that the diet of these individuals was completely terrestrial, consisting mainly of domesticated animals (*Guiry* et al. *2017*).

Fig. 2. Piramatovac valley viewed from the southeast with position of Vrbica site (encircled). Photo by Emil Podrug.

The Neolithisation of the Eastern Adriatic

The Neolithisation of the Eastern Adriatic region begins at the onset of the 6th millennium and it is associated with the Impressed ware culture. During period, the same culture, with some regional differences in ceramic production which evolved over time, spread on the Italian shore of the Adriatic.

The earliest Neolithic sites of Northern Dalmatia are dated from the beginning of 6th millennium. They are thus contemporary with the oldest Neolithic occupations of the Eastern Adriatic. In the light of new radiocarbon dates, Stašo Forenbaher and Preston Miracle (*2014*) recently revisited their former model of Neolithisation (*Forenbaher, Miracle 2005; 2006*) arguing that some interactions between local foragers and newcomer farmers (whose presence seems only evidenced in caves) took place all over the Adriatic coast during the beginning of 6th millennium and that the real colonization (settlement foundation) occurred about 150 year later (*c.* 5900–5800 cal BC), moving progressively from the south to the north.

Recent field research conducted in Northern Dalmatia slightly modified this model. The early dates for open-air sites like Rašinovac and Pokrovnik appear to corroborate the simultaneity of cave and open-air settlements (*Müller 1994; McClure* et al. *2014*), and challenge the proposed anteriority of cave sites over open-air sites (*Batović 1979; Forenbaher, Miracle 2014; Forenbaher, Perhoč 2017.202*). The distinction between cave and open-air sites is purely functional (*McClure* et al. *2014.1036*), whereas only the latter can precisely reflect the Neolithic way of life (*Guilaine 2005.60*).

Still, the majority of the open-air sites do not belong to the earliest phase of the Neolithic occupation, but are dated a few centuries later, between 5800 to 5400 cal BC.

Moreover, Forenbaher and Miracle reopened the question of the possible west-east direction of colonization (from Apulia to Dalmatia), since the radiocarbon dates obtained for South Italian villages are somewhat older than the Dalmatian ones (*Müller 1994.259; Forenbaher, Miracle 2014.238, Forenbaher, Perhoč 2015.66; 2017.202–204*). However, as already mentioned, the new dates obtained from Pokrovnik and Rašinovac place the foundation of those villages at the beginning of 6th millennium, which sets them as contemporaneous to the South Italian sites. It must be noted that those 'early' dates from Apulia (*cf.* Rendina, Masseria Giufreda and Pulo di Molfetta), are problematic, as they show large standard deviations and/or are coming from insecure or later contexts (*Guilaine* et al. *2003.372; Radina 2007; Collina 2009.52,57; Guilbeau 2010.71*). Moreover, all the recently obtained radiocarbon dates from the earliest Neolithic occupations of Apulia are still slightly younger then the Dalmatian ones (*Binder* et al. *2017*).

Thus, if one relies on firm data, the reliable current radiocarbon dates suggest a temporal priority to the Eastern Adriatic open-air sites.

However, considering the latest discoveries in the strategies of raw material procurement, pointing to sources on the Gargano promontory, the possibility of Apulian influences in the Neolithisation process in Dalmatia should not be rejected (*Forenbaher, Perhoč 2015; 2017; Podrug* et al. *in press a*).

Nevertheless, while the richness of Neolithic sites confirms that that colonization played a major role in establishing a Neolithic way of life, evidence for the presence of last hunter-fisher-gatherers in the Eastern Adriatic is still pretty scarce. In the literature, the open-air site of Lokve is sometimes referred to as Castelnovian (*Komšo 2007.66; Mihailović 2009.103; Kaczanowska, Kozłowski 2017.203*). However, the related material collected from unsecure contexts (see *Komšo 2009.292*) displays important heterogeneity in the both raw material economy and typo-technology (*Kačar 2019*).

As already mentioned, thus far, Castelnovian is absent from Dalmatia. Further research is needed in order to demonstrate whether this outlines an historical reality or if this situation is related to some other factors, such as, for example, some shift in the settlement pattern and/or loss of the sites by marine transgression, lack of research, and so on.

Lithic production strategies in the Early Neolithic of South-eastern Europe and the Central Mediterranean

'Prismatic blade technology' or 'long blade technology' is often considered to be a part of the so called 'Neolithic package', and thus one of the elements that transmits from the Near East to Europe.

Without going into further discussion about the concept of this 'package' and its content, one cannot but notice the sudden presence of long blades in Neolithic contexts all over South-eastern Europe.

In order to obtain blade blanks two main knapping techniques are generally used during the European Neolithic: indirect percussion and pressure flaking.

The technique of pressure flaking consists of applying great force on one precise point on the platform in order to obtain blades or bladelets. Indirect percussion involves the application of an intermediary tool, called a 'punch', which can be made of wood, antler or bone (*Inizan* et al. *1999.32*).

The main advantage of pressure flaking and indirect percussion over direct percussion is greater productivity and profitability. They both allow a Prehistoric knapper to maximize their production since they will obtain a considerable number of blades from a single block.

The identification of the two techniques is possible due to experimental work by several archaeologists, like François Bordes, Don Crabtree, Jacques Texier, and Jacques Pelegrin. There are some general morphological criteria that individualized the two techniques (*cf. Inizan* et al. *1999; Pelegrin 2012*). Thus, the pressure technique is identified by the regularity and standardization of blade products. This regularity is due to the immobilization of the core and the pressure force that is continuous and intense. Hence, a straight profile, parallel edges and ridges and a constant thickness characterize the blades. On the other hand, blades obtained by indirect percussion are in general larger, but less standardized and characterized by a curved profile. However, as archaeological and experimental examples show, blades obtained by indirect percussion can also be very regular, whereas the pressure flaked blades could show high variation in regularity. Besides, one must bear in mind that experimentation conducted with pressure flaking is much better documented than experimentation on indirect percussion.

Although the concept of pressure flaking was known since the Upper Palaeolithic, the two techniques were widely used in blade production since the Late Mesolithic (*Binder, Perlès 1990; Inizan* et al. *1999*). Pressure flaking was widespread during the Late Mesolithic Castelnovian culture in the Mediterranean (*Binder 1987; 2010*). The closest Castelnovian industries to the region, those from Montenegro, are also characterized by pressure flaking (*Kačar 2019*). During the Neolithic, this technique is also common all over the Mediterranean (*Binder 1987; 2007; 2010; Perlès 1990; 2001; Horejs* et al. *2015*) and at least in some parts of South-eastern Europe like Bosnia and Serbia (*I. Jovanović pers. comm.*).

The indirect percussion or 'punch' technique is present during the Late Mesolithic in Southern and Northern Europe (*Allard 2007.219; Perrin 2009. 518; Ferrari 2011*), but it seems marginal in the Castelnovian of Montenegro (*Kačar 2019*). During the Neolithic, it became the common technique for blade production in different regions of Europe. Indirect percussion is well attested in the Early Neolithic Starčevo-Körös culture (*Mateiciucová 2007.701; Šošić-Klindžić, Karavanić 2004.26; Karavanić* et al. *2010.15*; pers. comm. J. Pelegrin and I. Jovanović, personal observations). In the Early Neolithic of Bulgaria (Karanovo I-II), it is a common technique for obtaining long blades (*Gurova 2014*). However, this technique was not exclusive for producing long and large blanks, since the Starčevo-Körös assemblages are characterized by bladelets (*Mateiciucová 2007; Šošić-Klindžić, Karavanić 2004; Karavanić* et al. *2010*; personal observations). Large butts, sometimes concave, pronounced bulbs together with a certain irregularity of blanks, point rather to the use of indirect percussion.

As demonstrated above, the archaeological evidence shows that the use of so-called complex *débitage* techniques (pressure and indirect percussion) is not a Neolithic novelty, but appears from the Late Mesolithic. However, the almost systematic use of exogenous rocks in this production, as recorded in some parts of the South-eastern Europe, is an element specific to the Neolithic.

The exploitation of exogenous raw materials certainly began in the Mesolithic (or in the final Palaeolithic), as evidenced, for example, by the Melian obsidian which circulates in the Aegean, but unlike the Neolithic, the production on these exogenous rocks does not differ from that of local rocks, since they are both characterized by an simple technical investment (for an expedient production of flakes, see *Perlès 1990; 1991; 2009*).

In Central and Western Europe, so-called 'Carpathian' obsidian and Wommerssom quartzite also appear to circulate over a larger area before the Neolithic (*Mateiciucová 2007; Kozłowski 2009*).

Nevertheless, as claimed by Catherine Perlès (*2009. 558*), "*[...] there is no economy of raw materials,* *in the sense of a differential exploitation*". These exogenous rocks have therefore been exploited in the same way as the local raw material. Conversely, from the Neolithic, a more 'complex' raw material economy is implemented, and this change in the exploitation strategies of raw materials is linked to social or economic factors (*Perlès 1990; 1991; 2009. 558–563*).

From the very beginning of the Neolithic (*c.* 6700–6000 cal BC), several raw material distribution networks were operating in the Central Mediterranean and the Balkans (Fig. 3).

Those networks differ according to the extension of the network concerned, *i.e.* according to the distribution area: some may be considered local and/or regional (for example the 'Marche' cherts or the Northern Bosnian rocks, 'chocolate flints' from Northern Greece, Mont Lessini cherts), and others interregional (obsidian from Melos and Lipari, Gargano cherts). Nevertheless, at this stage, the characterization of these networks is limited and requires more in-depth regional studies. Moreover, the size of the territory alone is not sufficient to distinguish a regional network from an inter-regional one, but other factors, such as geographical constraints, must be taken into account (for example, 'Carpathian' obsidian circulates over an territory of significant size, but geographically this is the relatively easily crossed Pannonian Basin). In Figure 3 we have tried to trace these networks, which in our opinion can indicate not only the contacts between distinct geographical groups, but could also illustrate the routes and directions of Neolithization.

In some cases these exogenous rocks of regional/interregional origin ('Silex blond' from Greece, 'Balkan flint'/'white-spotted flint' in the Central Balkans and Gargano cherts in Southern Italy and Dalmatia) have been exploited in a different way than local cherts, indicating a complex form of techno-economic production (*Perlès 1990; 2009; Collina 2009; Guilbeau 2010; Forenbaher, Perhoč 2015; Guilbeau, Perlès 2016; Gurova* et al. *2016; Kačar 2019*).

Gargano cherts – an important element of Southern Italian and Dalmatian Impressed Ware culture

Recent research has shown that artefacts made from Gargano cherts are recorded at many Early Neolithic sites of Southern Italy (namely from the Northern Apulian Tavoliere region, as well as from Northern Basilicata and Eastern Calabria) and Dalmatia, evidencing that those important source deposits have been used since the very beginning of the Neolithic, from *c.* 6000 cal BC (*Collina 2009; 2015; Guilbeau 2011; 2012; Forenbaher, Perhoč 2015; 2017; Tarantini 2016; Mazzucco* et al. *2018; Kačar 2019*).

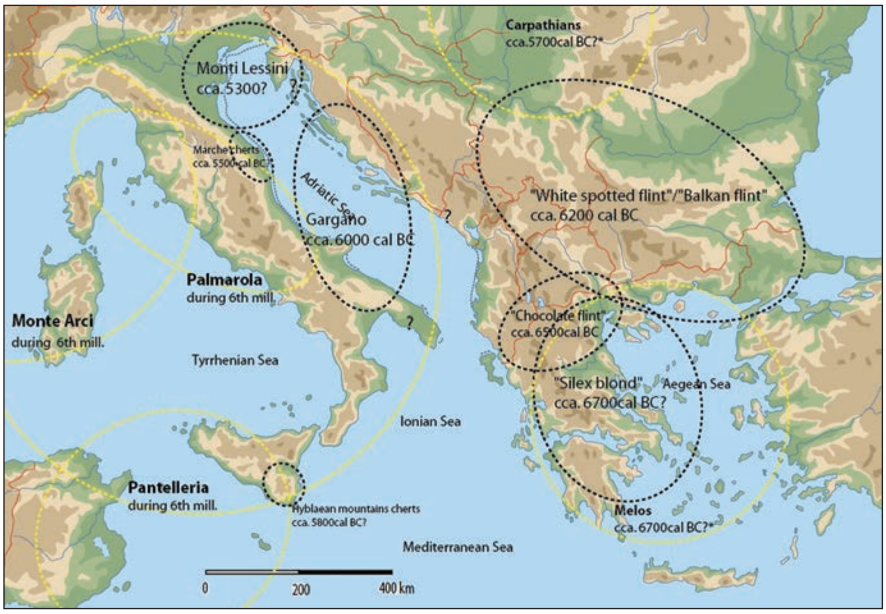

Fig. 3. Illustration of known raw material distribution networks in the Central Mediterranean and the Balkans, during the Early/Middle Neolithic, between* c. *6700 and 5000 cal BC (the displayed dates indicate the beginning of distribution in the Neolithic). Dotted lines: maximum extension of the network in the Early Neolithic (light dotted lines with titles in bold represent obsidian distribution networks). A question mark (?) indicates the presence of high quality chert of unknown, but probable exogenous origin. An asterisk (*) indicate the existence of pre-Neolithic networks (according to* Perlès 1987; 1990; 2004; 2009; Komšo 2006; Mateiciucová 2007; Kaczanowska, Kozłowski 2008; Collina 2009; Guilbeau 2010, 2011; Guilbeau, Erdoğu 2011; Šošić-Klindžić 2011; Reingruber 2011; Gurova 2012,2014; Gurova *et al.* 2016; Conati Barbaro *et al.* 2014; Freund 2014; 2018; Šarić 2014; Forenbaher, Perhoč 2015,2017; Kozlowski, Kaczanowska 2015; Tykot 2014; Dogiama 2018; Starnini *et al.* 2018; Podrug *et al.* in press a*; background map by F. Tessier).

The Gargano promontory, covering an area of about 2000km^2, is situated on the western shore of Adriatic in the vicinity of the Tavoliere plain, where one of the earliest Neolithic sites in Italy were documented.

A large network of at least twenty mining sites have been discovered, mostly located on the north-eastern part of the Gargano promontory (between Vieste and Peschici), whose exploitation was dated from the Early Neolithic to the Early Bronze Age, *c.* 6000–2000 cal BC (*Di Lernia* et al. *1995; Galiberti 2005; Tarantini, Galiberti 2011; Tarantini* et al. *2016*). Three geological Gargano formations were exploited by prehistoric miners: the Maiolica, Scaglia and Peschici formations (*Tarantini* et al. *2017*). In this region homogenous cherts are abundant, and occur either as large lenticular nodules (Peschici Nummulite platform) or in the form of spherical and irregular nodules (Maiolica and Scaglia) (for details see *Tarantini* et al. *2017*).

The Defensola site, situated on the Gargano promontory, is considered to be the oldest mine in Europe. Radiocarbon dates indicate that this underground mine was used at least from c. 5800–5700 cal BC (*Di Lernia* et al. *1995.126–130; Guilbeau 2010.51; Tarantini* et al. *2017.253*) and many Impressa sherds have been collected from here.

With regard to the current state of research, there is no evidence pointing to the complex exploitation of such cherts (from the primary sources requiring mining activities) during the Mesolithic.

The organisation of lithic blade production in Neolithic Northern Dalmatia

The organisation of lithic production, reflected in the prehistoric knapper's intentions, implies the concept of *schéma* and *chaîne opératoire* as well as the concepts of raw-material economy and *débitage* economy, and thus examines the lithic artefacts, from their extraction to final consumption (*Leroi-Gourhan 1965; Inizan 1980; Perlès 1980; 1990; Soressi, Geneste 2011*).

Raw material procurement

Due to the pioneering work of Perhoč, systematic geoarchaeological and petrographic investigations of chert outcrops and artefacts were initiated in the region (*Perhoč 2009ab; Perhoč, Altherr 2011; Forenbaher, Perhoč 2015, 2017; Vukosavljević* et al. *2014; Vukosavljević, Perhoč 2017; Vujević* et al. *2017*).

According to recent research, during the Neolithic the Gargano cherts (and specifically the Maiolica-type cherts of Upper Jurassic–Lower Cretaceous age) were almost exclusively used in the production of blades (*Forenbaher, Perhoč 2015; 2017.193; Mazzucco* et al. *2018; Podrug* et al. *in press a; in press b; Kačar 2019; pers.com. Z. Perhoč*).

Nevertheless, detailed petrographic characterisation and source identification are often problematic, since a thick white patina covers the majority of artefacts (*Forenbaher, Perhoč 2015; 2017; Podrug* et al. *in press a; in press b; Kačar 2019*). However, that is not the case for the artefacts from Crno Vrilo, as their primary appearance has stayed unchanged. This assemblage shows an important variability in the colour and structure of this Upper Cretaceous chert that might indicate different sources of procurement within the Gargano area, although these claims need to be confirmed by more detailed petrographic analysis.

It is important to note that, despite the existence of the seemingly well-organized network of Gargano chert distribution, the Lipari obsidian does not reach the Dalmatian shore before the Middle Neolithic Danilo culture (*Tykot 2015; Podrug* et al. *in press b*).

Besides this exogenous chert, the local Dalmatian cherts are also represented but in smaller quantities and almost exclusively evidenced by flakes and debris. The site of Konjevrate seems to be an exception, since local cherts prevail in the assemblage, but its stratigraphy was recently revisited confirming the pre-Neolithic attribution of these industries (*Podrug, Kačar in press*).

Lithic blade production

From the very beginning of the Neolithic period in the Eastern Adriatic, the lithic production was orientated towards blade production (*Müller 1994; Forenbaher, Perhoč 2015; 2017; Mazzuco* et al. *2018; Podrug* et al. *in press a*).

The regularity of the blade edges and ridges and constant thickness indicate the use of pressure flaking. According to the lithic assemblages under study here, an average prismatic blade would have been around 14.6mm wide and about 3.8mm thick, and its average length around 48.4 ±22.3mm (Tab. 4). Figure 4 indicates that the *débitage* aimed to produce bladelets and blades between 10 and 16mm wide.

Based on his experiments, Pelegrin has defined several pressure flaking processes related to the width of the blade blanks (*Pelegrin 1988; 2012.468*). The wider the blade is, the stronger must be the pressure exerted to detach the blade. Thus different tools were used in order to develop pressure of different intensities, with each tool corresponding to a certain 'mode' (for details see *Pelegrin 1988; 2012.468*).

Most (60%) of the Early Neolithic blades from our assemblages evidence the use of a long crutch used in a standing position (mode 4, according to Pelegrin), as their width is between 12 and 16mm – and several pieces reach almost 20mm in width (Fig. 4). The best examples of large blades come from Crno Vrilo, where a few blades of impressive dimensions are preserved. The longest complete example measures 156mm (*Korona 2009.154*). Along with these specimens there are dozens of pieces whose width exceeds 20mm (Fig. 4). According to Pelegrin's experiments, these specimens could not be detached by abdominal pressure alone (mode 4), since the long crutch used in the standing position cannot provide the necessary pressure.

According to traditional experiments, those blades could have been made by indirect percussion or by a more complex pressure mode (mode 5, according to Pelegrin), which consists of the use of a lever device. However, recently, Heredia managed to obtain, in a non-systematic way and with certain difficulties, a few of larger blades (up to 28mm) by abdominal pressure alone, using the crutch with a copper tip in the standing position (mode 4, according to Pelegrin; https://www.youtube.com/watch?v=5kvgaEH-Ll0).

While pressure flaking characterizes the Dalmatian blade production, the use of indirect percussion is harder to demonstrate. However, we think that for some specimens, and especially those detached in order to repair the knapping surface (Pl. 2.1–4), the use of indirect percussion cannot be ruled out. On the other hand, the regularity and straightness of some blanks and their constant thickness point instead to the use of lever pressure (mode 5, according to Pelegrin; Pl. 1.1,2,4). The use of lever pressure is usually suggested for the production from later periods, for example, the Chalcolithic big blades from Karanovo V-VI (*Manolakakis 1994*). However, such broad blanks are reported since the Early Neolithic in Southern Italy (*Guilbeau 2011; Collina 2015*) and in Greece (*Perlès 1990; Guilbeau, Perlès 2016*).

Although the blade cores are absent from the assemblages, the morphology of the blade blanks can indicate their form. They were of cylindrical or subconical shapes and *débitage* was always unipolar. The proximal parts of the blades (butts) indicate that the preparation of the striking platform was not systematic (butts are mostly plain and compose 45% of the assemblage, followed by linear with 25%), but the overhangs were carefully removed.

Except in Crno Vrilo, lithic finds are scarcely represented in the Dalmatian Early Neolithic assemblages, making the reconstruction of *schéma* and *chaines opératoire* somewhat difficult. However, it seems that the Dalmatian assemblages display always partial *chaînes opératoires*, *i.e.* some technical stages are always missing. Indeed, as already mentioned, the blade cores are always absent while the scarcity of cortical pieces, especially the large and thick ones pointing to decortication, trimming and shaping of the cores, implies that the first stages of reduction occurred somewhere else.

Nevertheless, in the assemblages we studied, at least for some sites, there are some elements pointing to the possibility of *in situ* production. The presence of flakes, cortical flakes and debris, and specifically of technological pieces as core tablets, crested blades, overshot blades and core renewal flakes and blades, could indicate the local production of blades (Tab. 2).

The presence of flakes (especially those bearing laminar negatives on the dorsal side) indicates *in situ* production, but one must keep in mind that pressure flaking produces few flakes. In this, the flakes are usually produced during the first stages of *chaîne opératoire*, *i.e.* core preparation, while small corrections of *débitage* surface/striking platform are most often realized by detachments of thin laminar flakes or small bladelets (Pl. 1.15). The presence, although rare (only 13 pieces from Crno Vrilo assemblage) of flakes bearing laminar negatives on the dorsal side, but which seem not to have been detached in order to rejuvenate the core, might indicate that, after blade production, the exploitation of the cores continues in order to obtain flakes. These flakes, as well as those made of local cherts, could suggest an *ad hoc* or expedient production, with the expedient products being those that "*have been manufactured, used, and discarded over a relatively short time period*" (*Binford 1977*). If this was a case, we can consider that the Early Neolithic people from Dalmatia were acquiring (more or less prepared) cores, and not exclusively finished semi-products. We have noted at least three flake cores on Gargano chert (Tab. 2; Pl. 1.16).

However, we cannot conclude that all the blades were produced *in situ*. While this may be suggested for blades obtained by abdominal pressure flaking (mode 4), for large blades (≥20 mm), and especially if we consider that they were produced by lever pressure, the introduction as finished semi-products could not be ruled out. Following criteria established by Perlès (*1990.27; 2001.208*) the lever pressured blades suggest high technological investment and obvious socio-economical specialization. Those blades must have been produced by specialized, well-trained knappers possessing the necessary equipment and who invested time in order to obtain the important knowledge and know-how needed for mastering the

Site	Category	Superior chert Gargano	Mediocre local chert	Thermally altered	Patinated/indeterm./other	Total Blanc
Tinj-Podlivade	Blades	16		2		18
	Cortical blades	4				4
	Core renewal blades	4				4
	Flakes	35	1	4		40
	Cortical flakes	4				4
	Core renewal flakes	4				4
	Cores					
	Debris	21	2	3		26
	Small flakes (≥1cm)	1				1
	Tested blocs					
	Total	**89**	**3**	**9**		**101**
Rašinovac	Blades	11		1	1	13
	Burin spalls	1				1
	Core renewal blades	1				1
	Flakes	12	12	1	2	27
	Cortical flakes		4		2	6
	Core renewal flakes	3			1	4
	Cores		1			1
	Debris	5	10		2	17
	Small flakes (≥1cm)					
	Tested blocs					
	Total	**33**	**27**	**2**	**8**	**70**
Vrbica	Blades	40				40
	Cortical blades	9				9
	Core renewal blades	4			1	5
	Flakes	24			3	27
	Cortical flakes	3			1	4
	Core renewal flakes	6				6
	Core	1	1			2
	Debris	2	3		1	6
	Small flakes (≥1cm)					
	Tested blocs					
	Total	**89**	**4**		**6**	**99**

Site	Category	Superior chert Gargano	Mediocre local chert	Thermally altered	Patinated/indeterm./other	Total Blanc
Polje niže Vrcelja	Blades	10		2	9	21
	Cortical blades	1			2	3
	Core renewal blades	3			1	4
	Burin spalls				1	1
	Flakes	30		7	15	52
	Cortical flakes	4			4	8
	Core renewal flakes	10			7	17
	Core	1				1
	Debris	25		5	20	50
	Chips	1	1		3	5
	Tested blocs	1	2			3
	Total	**86**	**3**	**14**	**62**	**165**
Crno Vrilo Sector A	Blades	200		29	26	255
	Cortical blades	14		1	2	17
	Core renewal blades	10		2	3	15
	Burin spalls	21			1	22
	Flakes	405	82	79	48	614
	Cortical flakes	47	21	9	6	83
	Core renewal flakes	135		23	7	165
	tablet	9	2	1		12
	Core	1	10	1		12
	Debris	96	25	38	21	180
	Small flakes (≥1cm)	32			4	36
	Tested blocs		1			1
	Total	**970**	**141**	**183**	**118**	**1412**
Konjevrate 88–90 campaign	Blades	12	34		2	48
	Cortical blades	1	6			7
	Core renewal blades	3	13		1	17
	Burin spalls		3			3
	Flakes	24	228	11	44	307
	Cortical flakes	3	74	4	9	90
	Core renewal flakes	8	66	3	7	84
	Cores and fragments	1	67		4	72
	– of which for blades		18			
	Debris and natural pieces	2	155	7	16	180
	Small flakes (≥1cm)					
	Tested blocs		5			5
	Total	**54**	**651**	**25**	**83**	**813**

Tab. 2. Lithic assemblage breakdown by main raw material groups and technological categories (simplified). The group 'patinated, indeterminate, other' clusters the raw materials which could not be identified due to heavy patina or raw material types for which only a few pieces have been found. For this paper different types of local/regional cherts from Konjevrate were regrouped together as 'local cherts' since, according to new excavations, these industries are pre-Neolithic. The technical group 'core-renewal flakes' clusters flakes testifying to blade débitage (elements of reparations and flakes with blade's negatives).

core preparation as the technologically most demanding part of the *chaîne opératoire*.

But is it possible to demonstrate that one population of blades (and namely the 'large' ones) were introduced as finished semi-products while others were produced *in situ*?

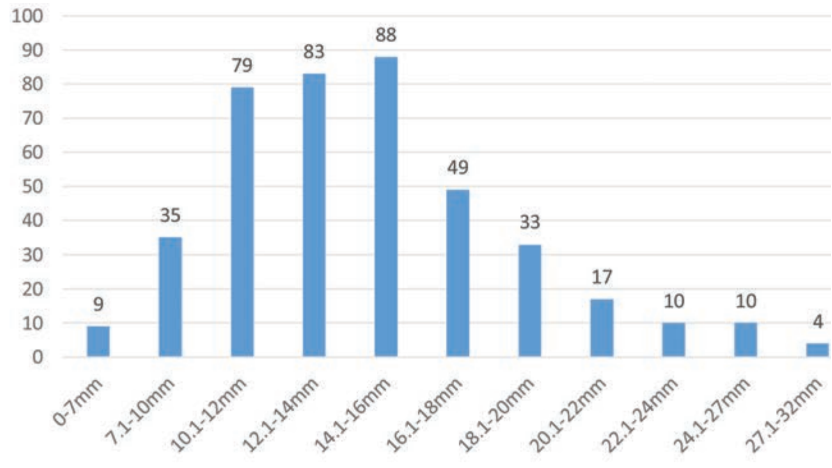

Fig. 4. Distribution of the impressed ware blades according to their width (Rašinovac, Vrbica, Polje niže Vrcelja, Tinj-Podlivade, Crno Vrilo, Konjevrate). Only blades on supposed Gargano cherts were counted.

For example, in the Crno Vrilo assemblage cortical and core-renewal blades, *i.e.* pieces that might indicate *in situ* production, are represented with 32 pieces, whereas the width of eight specimens exceeds 20mm (Fig. 5). Two different hypothesis can be proposed to explain the presence of those specimens. According to the first, the production occurred *in situ* and those specimens point to the beginning of blade *débitage* or to the core renewal (technical pieces). The second hypothesis implies that the production occurred somewhere else (and not on the site) and that the blades that we consider today as 'technical' were also circulating as finished products. This was sometimes observed in other Neolithic contexts, like in the Chasséen of Southern France. Here the regular presence of core renewal blades suggests that the robustness of blanks is sought more than their regularity (*Léa 2004.135, 147, 164, 169*). Besides, in the Crno Vrilo assemblage six specimens that refer either to cortical or core renewal blades (including two 'larges' ones) are retouched and/or glossy, while seven others (including two 'larges' ones) have very worn edges, probably indicating their use. Moreover, use-wear analysis of the harvesting techniques on the Dalmatian impressed ware assemblages has shown that the different types of blades and bladelets (central, cortical and technical) have been intentionally segmented for use as sickle elements (*Mazzucco* et al. *2018*).

On the other hand, and since we consider that for some technical pieces the use of indirect percussion cannot be ruled out, it is possible that some large blades were produced *in situ* while others (made by lever pressure flaking) could have been introduced as finished semi-products. Future research is needed to clarify the matter.

Tools

With the introduction of farming, the technical needs of prehistoric societies changed, as witnessed in the lithic tool assemblages. The lithic *débitage* was now orientated towards blade production in order to obtain long, regular and thin blanks that can could hafted onto the wooden or bone handles as sickle implements. The traces of use and the dullness of once sharp edges indicate that the majority of blades were used blank. The intensive use of blank blades in various activities could produce non-intentional retouch. For that reason, exhaustive typological analyses of Neolithic lithic assemblages are not necessary, but a combined typo-functional approach is needed.

Impressed ware assemblages from Northern Dalmatia indicate that the tools are mostly made on blades (Tab. 3). In most cases (46%) the retouches were not carefully made and the majority of tools can be regrouped as 'pieces with irregular removals'. Other tool groups can be divided as follows: blades with continuous semi-abrupt retouches (11%), blades and bladelets with abrupt retouches (less frequent 6%), drills and 'becs' (pointed blades with abrupt and semi-abrupt retouches: 7%), truncations (2%), bitruncations and geometrical trapezes (6%, almost exclusively symmetrical, with no use of the microburin technique), and burins and burin spalls (almost only evidenced in the Crno Vrilo assemblage, where it represents 19% of all tools). Glossy blades are well represented in almost all assemblages (33% of all tools). In Crno Vrilo, for example, 21% of all blades from sector A are characterized by a so-called 'sickle-gloss', although their presumed function is yet to be characterized.

The notched blades, the typical tools of Castelnovian assemblages, with notches resulting from a voluntary retouch (*Gassin* et al. *2013*), are almost completely absent from Early Neolithic lithic assemblages. On the other hand, the production of trapezes continued during the impressed ware phase, and these bitruncated blade fragments are represented with at least 14 pieces (Tab. 3). However, the Castelnovian trapezes are usually made with the microburin technique and are symmetrical, whereas the Early Neolithic ones do not use this technique and are less standardized as they generally come in various forms and shapes.

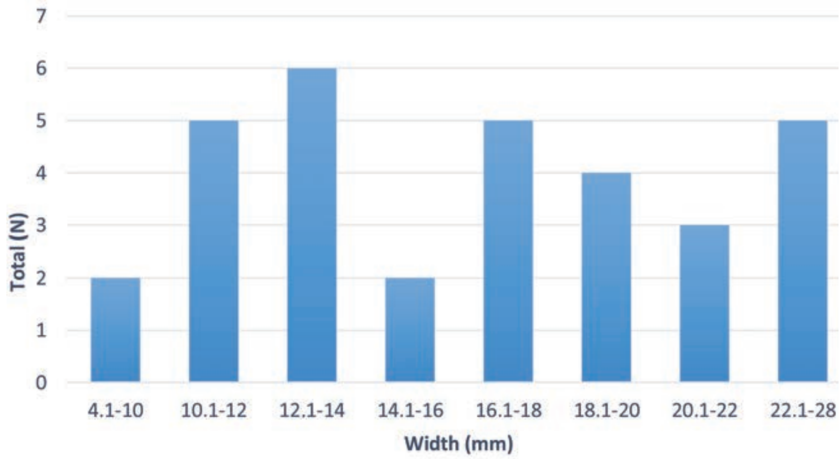

Fig. 5. Cortical and technical blades from Crno Vrilo: frequency of blade widths.

Tools made on flakes will not be discussed here, but it can be stated that flake assemblages consist mainly of expedient tools characterized by retouched flakes, scrapers and splintered pieces.

Early Neolithic lithic production and its relevance to the Neolithisation of the Eastern Adriatic

From the very beginning of the Neolithic period in both Dalmatia and Apulia, the blade production is characterized by pressure flaking on Gargano cherts (*Collina 2009; 2015; Guilbeau 2010; 2011; Forenbaher, Perhoč 2015; 2017; Mazzucco* et al. *2018; Podrug* et al. *in press a; Kačar 2019*).

Indirect percussion seems to be used to a much lesser extent and perhaps mainly for repairing the knapping surface or detaching the blades, which would have been too difficult to detach by pressure (*Collina 2009; 2015; Kačar 2019*).

As we have seen, both techniques are known from the Late Mesolithic, but the Early Neolithic lithic production is characterized by more complex procurement strategies, as evidenced in the development of sophisticated raw material economy (*Binder 1987; Perlès 1990; 1991; 2009; Allard 2007.219; Perrin 2009: 518; Perrin, Binder 2014; Kačar 2019*).

There is no evidences of complex mining during the Mesolithic, neither on the Italian nor Croatian sides of the Adriatic. It is true that the Mesolithic sites and specifically those belonging to its late phase are rather scarce in the Adriatic region, but even where the Castelnovian is surely attested (Uzzo, Latronico, Edera, Crvena Stijena, Odmut) there are no indications of complex strategies involving interregional networks of raw material procurement (*Collina 2009; Mihailović 2009; Kačar 2019*). Instead, the production of blade blanks relies on local sources of procurement, such as pebbles of small to medium size.

The dominance of Gargano cherts in Dalmatia and Apulia assemblages reinforces the idea of cultural unity under the (Italo-Dalmatian) impressed ware

	Crno Vrilo	Rašinovac	Vrbica	Tinj	Vrcelji	Konjevrate Gargano	Konjevrate other	TOTAL	%
Pieces with irregular removals	72	4	12	5	3	4	3	103	46
Notched pieces	4		1					5	2,2
Pieces with abrupt retouch	8	2				1	2	13	5,8
Pieces with semi-abrupt retouch	13		2		3	1	6	25	11,2
Borers and drills	14	1						15	6,7
Truncations	4	1						5	2,3
Bitruncations	8	1		4	1			14	6,3
Burins and burin spalls	29	1			2		3	35	15,6
Scrapers	3		3				3	9	4
Total tools on blades	155	10	18	9	9	6	17	224	100
of which glossy blades	61	1	6	2	2	1		73	32,5

Tab. 3. Tools on blades: typological breakdown.

			Lenght (mm)	Width (mm)	Thickness (mm)
Early Neolithic Impressed Ware	Rašinovac	no.	1	14	14
		Minimum	37,6	7,1	1,6
		Maximum	37,6	24,5	5,9
		Average	37,6	13,3	3,6
		SD		4,6	1,1
	Vrbica	no.	6	54	54
		Minimum	31,9	6	1,7
		Maximum	71,8	24,3	10,6
		Average	55	15,2	4,3
		SD	17,4	3,7	1,9
	Crno Vrilo (Sector A)	no.	33	280	287
		Minimum	28,8	4,1	0,9
		Maximum	132,5	27,8	8,5
		Average	50,9	14,1	3,7
		SD	21,5	5,1	1,3
	Tinj-Podlivade	no.	2	26	26
		Minimum	9,1	4,1	2,3
		Maximum	84,6	31,5	7
		Average	46,9	16,8	4,1
		SD	53,4	6,1	1,4
	Polje niže Vrcelja	no.	7	28	28
		Minimum	17,3	5,5	1,8
		Maximum	50,3	19,3	8,6
		Average	34,2	12,8	3,7
		SD	10,7	3,3	1,7
	Konjevrate (campaign 1988-1990)	no.	1	15	15
		Minimum	36,4	6,9	1,6
		Maximum	36,4	26,3	8,3
		Average	36,4	14	4
		SD		4,2	1,9
	All sites	no.	50	417	424
		Minimum	9,1	4,1	0,9
		Maximum	132,5	31,5	10,6
		Average	48,4	14,6	3,8
		SD	22,3	4,6	1,4

Tab. 4. Blades and bladelets metric data. The length was measured only for complete specimens.

ceramic style. The Gargano network spread over South Italy and Dalmatia at the same time, and since the very start of the 6th millennium BC (*Collina 2009; 2015; Guilbeau 2010; 2011; Forenbaher, Perhoč 2015; 2017*).

This date points to the very beginning of the Neolithisation of the whole Adriatic region. The presence of Gargano cherts in Eastern Adriatic assemblages raises many questions, especially why and how this raw material arrived in Dalmatia. Was it necessary because of the lack of good quality raw material or the lack of (locational) knowledge? Or was it a choice due to the social and/or symbolic value of exogenous material?

First of all, according to Perhoč's research there are no comparable (by quality and nodule size) cherts in the Dalmatia, nor in the adjacent regions (*Perhoč 2009ab; Perhoč, Altherr 2011; Forenbaher, Perhoč 2015; 2017.205; Vukosavljević* et al. *2014; Vukosavljević, Perhoč 2017; Vujević* et al. *2017; Podrug* et al. *in press a; in press b*)[1]. This implies that Gargano cherts were a rare good. In this sense, the preference for Gargano cherts in Dalmatia can be interpreted by a relative poverty of raw material suitable for complex pressure flaking (*Forenbaher, Perhoč 2017.204–205; Mazzucco* et al. *2018; Kačar 2019*). However, this does not imply that the Gargano chert distribution has only an economic (utilitarian) role and thus the social aspects of such networks cannot be neglected (*Perlès 1990; 2001; 2007; 2009; Forenbaher, Perhoč 2017.206; Kačar 2019*). On the contrary, the hypothesis of a cultural choice, revealing a social rather than a techical logic (*Perlès 2009*), must be privileged. Or, as Forenbaher and Perhoč recently concluded "*Perhaps the true value and purpose of the trans-Adriatic exchange of Gargano cherts was to maintain social networks that linked the small farming communities scattered around the Adriatic shores and islands*" (*Forenbaher, Perhoč 2017.206*).

According to the same authors, the existence of a Gargano network of distribution from the very beginning of the 6th millennium might hint to the West-East direction of Neolithisation (from Apulia to Dalmatia), supporting the hypothesis that migration played an important role in spread of farming (*Forenbaher, Perhoč 2017.204*).

In this sense the domination of Gargano cherts in the southern Dalmatia as documented in Nakovana cave was interpreted as indicating that the early Neolithic occupants of the cave were recent arrivals, not yet possessing the necessary locational knowledge (*Forenbaher, Perhoč 2015.66; 2017.204*).

However, although these claims sound plausible, one should keep in mind that reliable current radiocarbon dates show no temporal priority of Italian sites and that many data points are probably lost due to the Holocene sea-level rise.

1 However, according to Perhoč's publication (*2009b.48, Fig. 2*), one can note the existance of good-quality chert of non-negligible size (*c.* 10cm) in southern Dalmatia (Stračinčica, Vela Luka, Korčula).

In order to understand the nature of social interactions between western and eastern shores of Adriatic which might illustrate the alternative routes of Neolithisation, it is necessary to see in which form Gargano cherts arrived in Dalmatia (as finished semi-products or as blade cores) and how they were distributed (by direct or indirect procurement?).

Unfortunately, we have seen that, according the current state of research, it is not clear in which form Gargano cherts reach Dalmatia. However, unlike Forenbaher and Perhoč (*2015; 2017*), who concluded that the Gargano blades arrived as finished semi-products, we think that the presence of some elements pointing to blade production *in situ* might also indicate the acquisition of cores, *i.e.* blade blanks were not exclusively imported.

This implies that the *chaines opératoires* of the Dalmatian and South Italian assemblages do not differ substantially, since the Gargano cherts were introduced into the Italian sites as partially worked blocs/ cores in the initial phase or finished blanks, and never as raw materials (*Collina 2009; Guilbeau 2010; 2011*).

It can thus be presumed that the first phases of reduction (decortication and trimming) were conducted near or inside the mines (*Di Lerna* et al. *1995; Tarantini* et al. *2016*). The shaped blocs, or even more or less finished cores, could then be distributed over the land and sea. This preparation would facilitate transportation (since the merchandise would have been less heavy) and at the same time ensure the quality of the blocs (*cf. Perlès 1990.27*).

But how were the cherts further distributed? As already mentioned, all the southern Italian assemblages that have been studied with regard to the raw material economy, and even those situated closest to the Gargano mines (Ripa Tetta) or closest to the littoral (Scamuso), lack any evidence of primal reduction (*Collina 2009; 2015*). Following this and taking into account the important presence of Gargano artefacts at the Crno Vrilo site, a simple down-the-line distribution (*Renfrew 1984*) should be ruled out.

Besides, the long-distance procurement that requires navigation skills and some complex logistical organisation provides more supports for the idea of trade than direct acquisition (*Perlès 1990.17–23; 1992. 116*).

It is therefore reasonable to assume that the Gargano mines were held and exploited by a limited group of specialist who controlled the chert distribution as well (*Tarantini* et al. *2016*).

If the chert was distributed in the form of more and less prepared cores, then this implies that the most demanding part of the *débitage* (core preparation) occurred out of the consumer sites. The consumer sites would then receive prepared cores and only needed to detach the blades. This final task – blade detaching – is actually the easiest part of pressure flaking *débitage* (*Binder, Perlès 1990.266; Perlès 2007.57; Abbès 2013*).

However, we cannot exclude the possibility of intermediary site(s) where the blades were produced for trade. One part of Gargano artefacts was probably circulated as finished products and the lever pressured blades could have been traded this way (*Collina 2009; 2015; Forenbaher, Perhoč 2015; 2017; Mazzucco* et al. *2018; Kačar 2019*). Those sites could have been located on the coast and thus today would be submerged.

The blades manufactured with lever pressure seem to be present in Dalmatia since the very beginning of the Neolithic. They are reported at the oldest levels of Pokrovnik, dated to *c*. 6000 cal BC (*Mazzuco* et al. *2018*). The technique of lever pressure is undoubtedly a Neolithic innovation: it is recorded in a few Neolithic contexts, but never earlier (*Pelegrin 2006; Guilbeau, Perlès 2016.3*).

To sum up, although the size and the means of the Gargano chert distribution network and its relevance to the Neolithisation dispersion routes have yet to be solved, it is clear that this complex economy of raw material reflects social choices that are specific to the Neolithic.

Moreover, even though the pressure blade flaking technology emerged in the Balkans during the 7th millennium, as witnessed in the Montenegrin Late Mesolithic Castelnovian industries (with the blank size pointing to the use of a short crutch, mode 3, according to *Pelegrin 1988; 2012*), at the onset of Neolithic period more complex modes (modes 4 and 5 according to *Pelegrin 1988; 2012*) of pressure flaking were developed in connection with a new inter-regional procurement network centred in the Gargano area. It thus seems that we may be dealing with two distant phenomena of probably different origins. The origin of Castelnovian pressure blade production might be in North Africa (*Marchand, Perrin 2017*), whereas impressed ware pressure blade production is closely connected to processes of Neolithisation. The latter shows great connections with Italian impressed ware industries and Greek Early Neolithic industries, both in complex raw material procurement strategies and production techniques, and might thus originate from the Near-East (Turkey or Levant) (*Perlès 1990; 2001; Binder 2007; Guilbeau 2010; 2011; 2017; Guilbeau, Perlès 2016; Horejs* et al. *2015*). In other words, the Early Neolithic blade production of Dalmatian impressed ware should be considered as integral part of the Neolithic package, showing no connections to the Castelnovian or any other Mesolithic lithic traditions.

Conclusion

Interactions between the eastern and western shores of the Adriatic seemed to have maintained the Neolithisation process in this part of Mediterranean: the importation of Gargano cherts in Dalmatian lithic assemblages parallels the expansion of the Impressed ware culture and the new type of economy, based on subsistence production. The beginning of the Neolithic period in Dalmatia is thus characterized by profound economic, technical, social and cultural changes that also affected lithic assemblages, since the earliest impressed ware lithic production shows no links to the previous periods.

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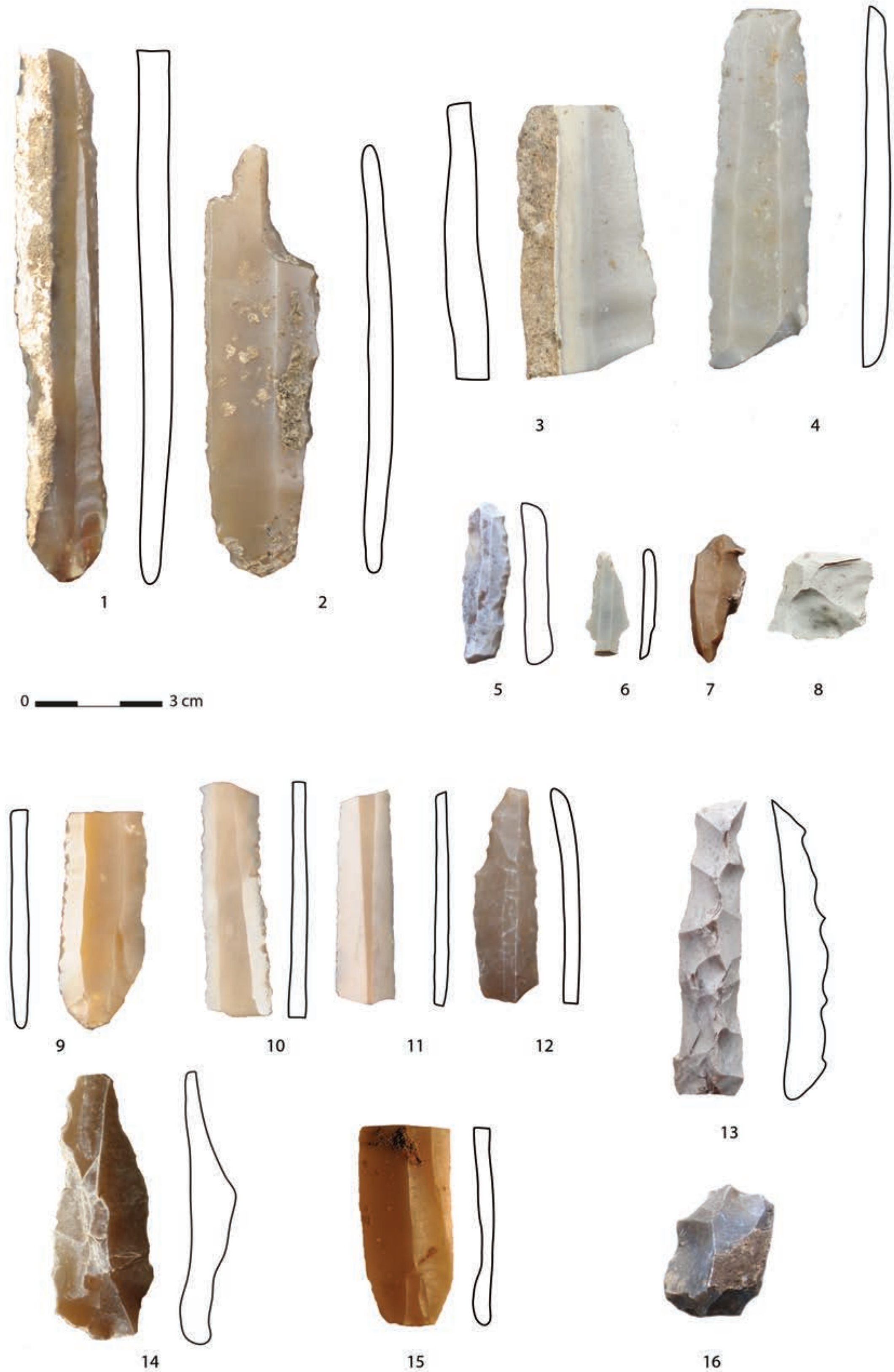
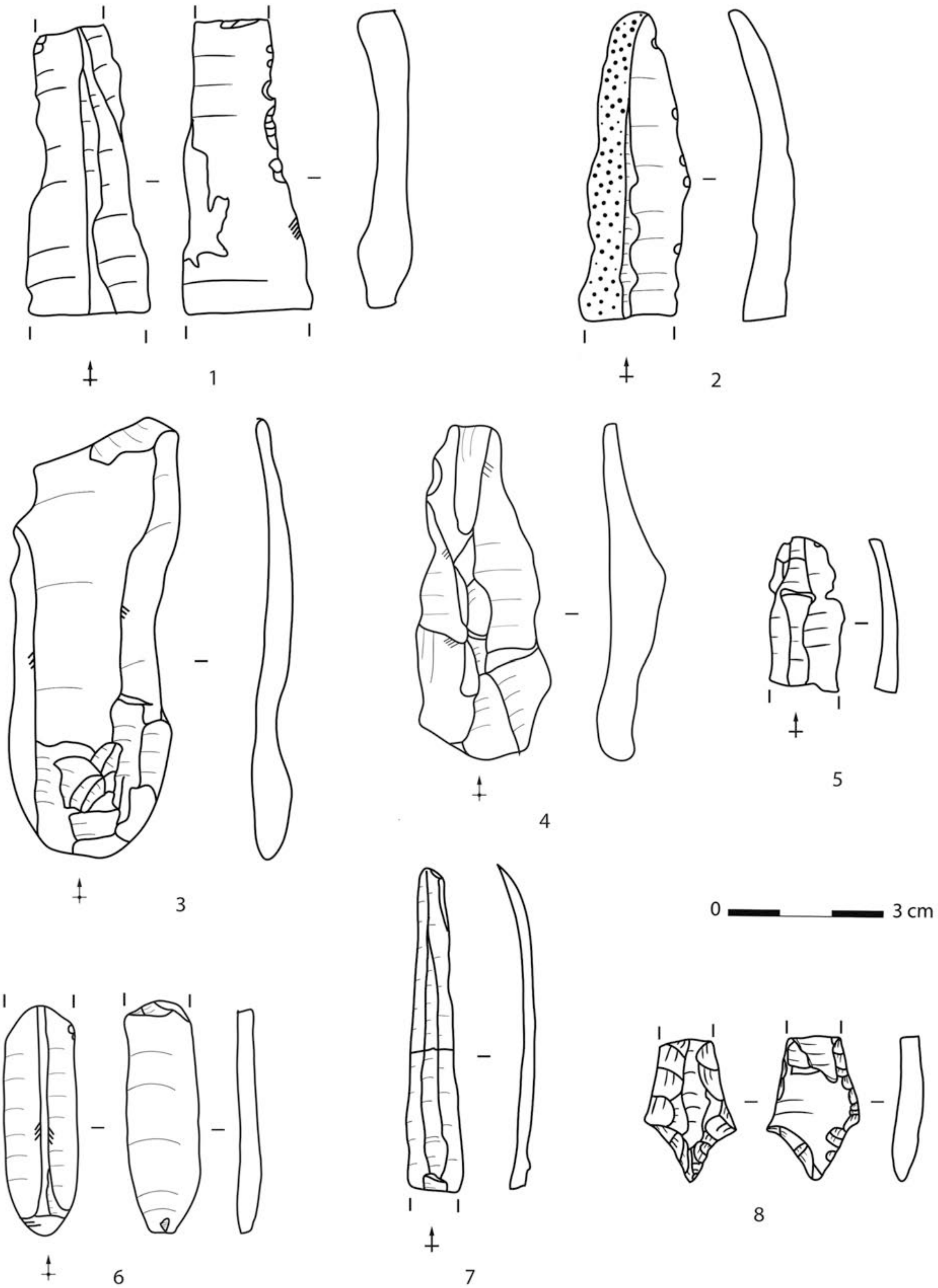


Pl. 1. Early Neolithic lithic assemblages from Northern Dalmatia. 1–4, 9–11,15 Crno Vrilo: lever pressured blades (1–2 and possibly 3–4) and pressure flaked blades, mode 4 (9–12, 15); 5, 6, 8 Rašinovac blades and core renewal flake (core tablet); 7, 13 Vrbica: core renewal flake (core fragment) and crested blade; 12, 14 Konjevrate: blade and crested blade; 16. Vrbica flake core. N. 1, 2, 5 and 12 are retouched (1 notched bladed, 2 burin, 5 blade with abrupt retouch, and 12 borer) and 9–11 are glossy. All artefacts are on presumed Gargano flint.



Pl. 2. Early Neolithic blades from Northern Dalmatia. Blades testifying to core renewal (1, 3, 4, 5) and cortical blade (2); 1– 4 (1, 2 Vrbica; 3 Tinj; 4 Konjevrate) are probably made by indirect percussion and 5 (Rašinovac) probably by direct percussion. Pressure flaked blades: 6 Konjevrate and 7 Polje Niže Vrcelja. Pressure flaked bifacial point from Vrbica (8). All artefacts are on presumed Gargano flint.

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New interdisciplinary research on Neolithic-Eneolithic sites in the Low Volga River region

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ABSTRACT – *The Neolithic and Eneolithic sites in the Low Volga River region have been poorly investigated in comparison with other territories due to a small number of excavated sites. On the Algay site and the Oroshaemoe I settlement there is evidence of the earliest appearance of Neolithic pottery and the first sign of domestication in the Eneolithic period within the Volgo-Ural territory. Archaeological, lithological, grain-size analyses, mineralogical-geochemical methods and radiocarbon dating of cultural deposits have been applied to reconstruct the palaeoenvironment in the Holocene in this area. The results show that the landscape-climatic conditions in the steppe area of the Lower Volga basin strongly affected the development and adaptation of ancient societies.*

KEY WORDS – *Neolithic; domestication; Eneolithic; Low Volga River region; geochemical indication; Holocene climate; steppe*

Nove interdisciplinarne raziskave neolitskih in eneolitskih najdišč na območju Spodnje Volge

IZVLEČEK – *Neolitska in eneolitska najdišča na območju Spodnje Volge so bila v preteklosti zaradi maloštevilnih izkopavanj slabše raziskana v primerjavi z drugimi regijami. Na najdiščih Algay in Oroshaemoe I smo odkrili najstarejši pojav neolitske lončenine in prve znake domestikacije v obdobju eneolitika na območju Volge in Urala. Za rekonstruiranje holocenskega paleookolja na tem območju smo uporabili arheološke, litološke metode, analize velikosti zrn, mineraloško-geokemične metode in radiokarbonsko datiranje kulturnih ostalin. Rezultati kažejo, da so okoljski in klimatski pogoji na območju stepe ob Spodnji Volgi močno vplivali na razvoj in prilagoditve preteklih družb.*

KLJUČNE BESEDE – *neolitik; domestikacija; eneolitik; območje Spodnje Volge; geokemične indikacije; klima v holocenu; stepa*

Introduction

The Low Volga River region borders Middle Asia and Caucuses, where the ceramic manufacture and producing economy appeared very early on. The steppe Povolzhie connects the steppe-forest and forest zones as far as the Don River region and Ural. Therefore the study of archaeological sites on the territory of the Low Volga River region is important. Besides, the Neolithic and Eneolithic sites in the Povolzhie region have been poorly investigated in comparison with other territories (*Yudin 2004; 2012*). As a result of this the distinctive features of human development in this territory are still under discussion. There is only some information available about palaeogeography during the Holocene in this region (*Spiridonova, Aleshinskaya 1999*). In this context an interdisciplinary approach to the study of these

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sites is needed. Some processes in the development of ancient societies were connected with palaeoclimatic changes during the Holocene (*Budja 2015; Kulkova 2007*), and these changes were significant in the steppe zone.

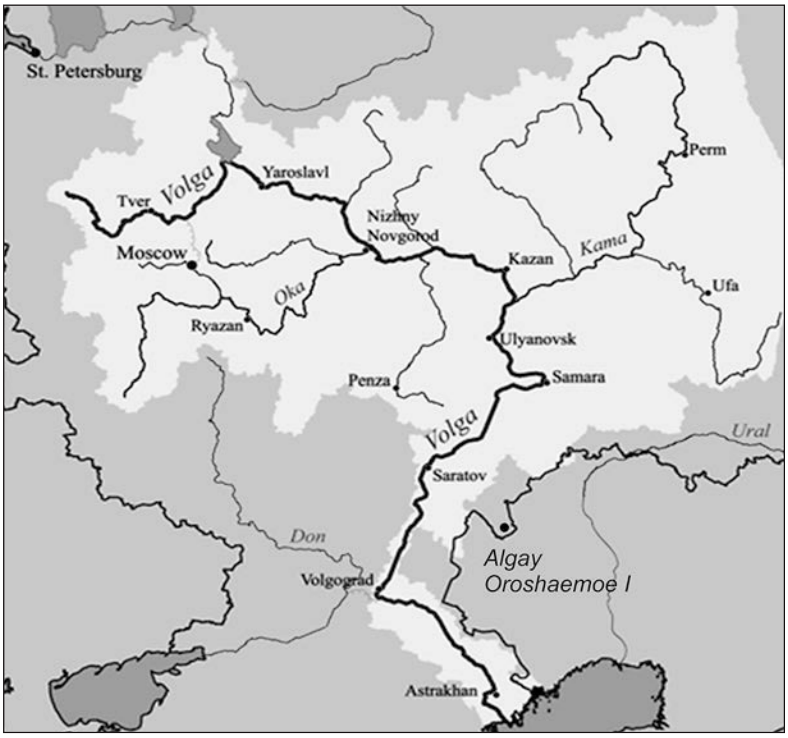

Fig. 1 The map of Algay and Oroshaemoe I sites location.

The Algay site and the Oroshaemoe settlement located in the Alexandrovsky district of Saratovskaya oblast', on the right bank of Bolshoy Uzen' River are currently being excavated (Fig. 1), and from 2014–2018 the multidisciplinary investigations were conducted on these sites (*Vybornov* et al. *2015a; 2015b; 2016a; 2016b; 2017a; 2017b; 2018a; 2018b; 2018c*). The Oroshaemoe site has a special emphasis in the whole archaeological context, as here well-defined layers of archaeological and lithological stratigraphic succession were documented. The cultural layers with Neolithic and Eneolithic finds are divided by sterile horizons (Fig. 2).

On the Algay site and the Oroshaemoe I settlement there is evidence of the earliest appearance of Neolithic pottery and the first sign of domestication in the Eneolithic period on the Volgo-Ural territory (*Vybornov* et al. *2016a*). It is thus interesting to consider the climatic conditions in these periods.

Materials and methods

On both sites complex, detailed investigations of lithological and cultural deposits from the cross-sections were carried out. Archaeological, lithological, grain-size analyses, mineralogical-geochemical methods and radiocarbon dating (Tab. 1) were applied for deposit investigations. The lithology of deposits is presented in Figures 3 and 4. Samples for analysis were taken from each 5cm cross-section.

The chemical composition of loess loam deposits from cross-sections on the Algay and Oroshaemoe I sites was determined by XRF-WD analysis using the Spectroscan Max equipment. Probing was carried out with a fine-grained fraction of <0.25mm which was ground in an agate mortar into powder state. The tablets for XRF analysis were pressed by means of a hydraulic press using boric acid.

The data on the chemical composition (Tabs. 2 and 4) was calculated by means of the principle component method for determination of landscape-climatic factors that influenced the sedimentation. The key concept of factor analysis is that multiple observed variables have similar patterns of responses, because they are all associated with a latent variable. The number of principal components was determined according to how complex our model will be. The factor corresponding to the largest eigenvalue (7.143237 and 7.833615 for Algay and Oroshaemoe, respectively) accounts for approx. 28.57% and 31.33% (Tabs. 3 and 5) of the total variance. The second factor corresponding to the second eigenvalue (4.909768 and 5.180147) accounts for approx. 19.64% and 20.72% of the total variance, and so on. When analysing correlation matrices, the sum of the eigenvalues is equal to the number of (active) variables from which the factors were extracted (computed).

We used two main factors of the four that were calculated for determination of sedimentation characteristics for both sites:

- FI (CaO, Sr/Al_2O_3,SiO_2, MnO, Fe_2O_3) shows the antagonism between elements of the carbonate group (CaO, Sr) and the group of aluminosilicate minerals (clay minerals, quartz) and iron, manganese oxides (Al_2O_3,SiO_2, MnO, Fe_2O_3). The positive factor loading corresponds to carbonate precipitation that occurred in the period of arid conditions, while the clay minerals and iron-manganese oxides with negative loading are formed in humid climatic conditions (*Kulkova 2012*). The first factor characterizes the change in relative precipitation. The positive loading of this factor describes the dry climatic conditions and the negative loading indicates wet conditions (Figs. 3–4). This interpretation is confirmed by other geochemical indicators connected with the relative humidity, like the Chemical Index Alteration (CIA = $Al_2O_3/(Al_2O_3 + CaO + Na_2O + K_2O)$ (*Nesbitt, Young 1982*) and the CaO/MgO ratio. The index of CIA shows the alteration of aluminosilicate minerals as a result of weathering. The CaO/MgO ratio indicates increasing of CaO *vs* MgO in the carbonate component in the periods of prevailing dry conditions.

● FII (P_2O_5, Zn, MgO/TiO_2, La, Zr) shows the antagonism between elements of biogenic processes (P_2O_5, Zn, MgO) and heavy, accessory minerals (TiO_2, La, Zr). This factor is connected with the relative temperature changes. The biogenic complexes are formed in the loam loess deposits together with organics during warm periods, and the accumulation of heavy minerals connects with a coarse grain sediment fraction accumulating during cold conditions. So, the positive loading of the second factor indicates the warm conditions and the negative loading is the cold conditions. Besides, the relative temperature variations are marked by the distribution of zirconium (Zr) in the deposits of cross-sections and the distribution of titanium modules (TiO_2/Al_2O_3) (*Yudovich, Kertis 2000*). The high titanium content in this case indicates the accumulation of heavy titanium minerals in the psammitic fraction, while the increasing alumina component is characteristic of the pelitic fraction. The alumina enrichment of the pelitic fraction as a rule is formed in the conditions of intense chemical weathering with a warm and humid climate.

For assessment of an ancient anthropogenic impact the indicator of $P_2O_{5antr} = P_2O_5/(P_2O_5 + Na_2O)$ (*Kulkova 2012*) was used. Increases in this indicator are correlated with the cultural horizons and remains of bones and ceramics (Figs. 3–4). It is worth noting that geochemical markers allow us to correlate climatic episodes with anthropogenic activity very precisely. This is important for reconstruction of the environment and human migration.

Fig. 2. The cross-section with cultural layers (dark colour) at the Oroshaemoe I settlement.

The radiocarbon dates were obtained on different organic materials from various cultural layers. The results are presented in the Table 1. Chronological phases for the different cultural traditions on the Algay site were calculated by means of Bayesian statistics with the help of OxCal 4.2 (*Bronk Ramsey 2009*) (Fig. 5).

Results

The archaeological characteristics of the Algay and Oroshaemoe I sites

The Oroshaemoe I site

The upper cultural layer on the Oroshaemoe I site comprises ceramics and stone tools, which have ana-

Site	^{14}C date (BP)	Lab index	Calendar age 2σ (cal BC)	Material
Algay	5875±60	SPb_1968	4571–4558	animal bone
Algay	6245± 32	AAR 21891	5309–5076	food crusts
Algay	6284±100	SPb-2038	5472–5018	animal bone
Algay	6318±33	AAR–21892	5361–5221	animal bone
Algay	6490±40	Poz-76004	5527–5367	charcoal
Algay	6479±70	SPb_1477	5560–5316	animal bone
Algay	6360±250	SPb_1411	5742–4723	charcoal
Algay	6605±32	AAR-21893	5617–5487	charcoal
Algay	6577±80	SPb_1478	5641–5374	animal bone
Algay	6654±80	SPb_1509	5708–5479	animal bone
Algay	6820±80	SPb_1510	5889–5614	animal bone
Algay	6800 ±40	Poz-65198	5741–5631	food crusts
Algay	7284±80	SPb_2144	6271–6008	humic acids
Oroshaemoe I	5806±26	UGAMS-23059	4724–4557	animal bone
Oroshaemoe I	5934±100	SPb_2091	5060–4547	animal bone
Oroshaemoe I	7010±110	SPb_2143	6072–5674	charcoal
Oroshaemoe I	7245±60	SPb_2141	6227–6015	charcoal

Tab. 1. Radiocarbon dates on organics from the cultural layers of the Algay and Oroshaemoe I sites.

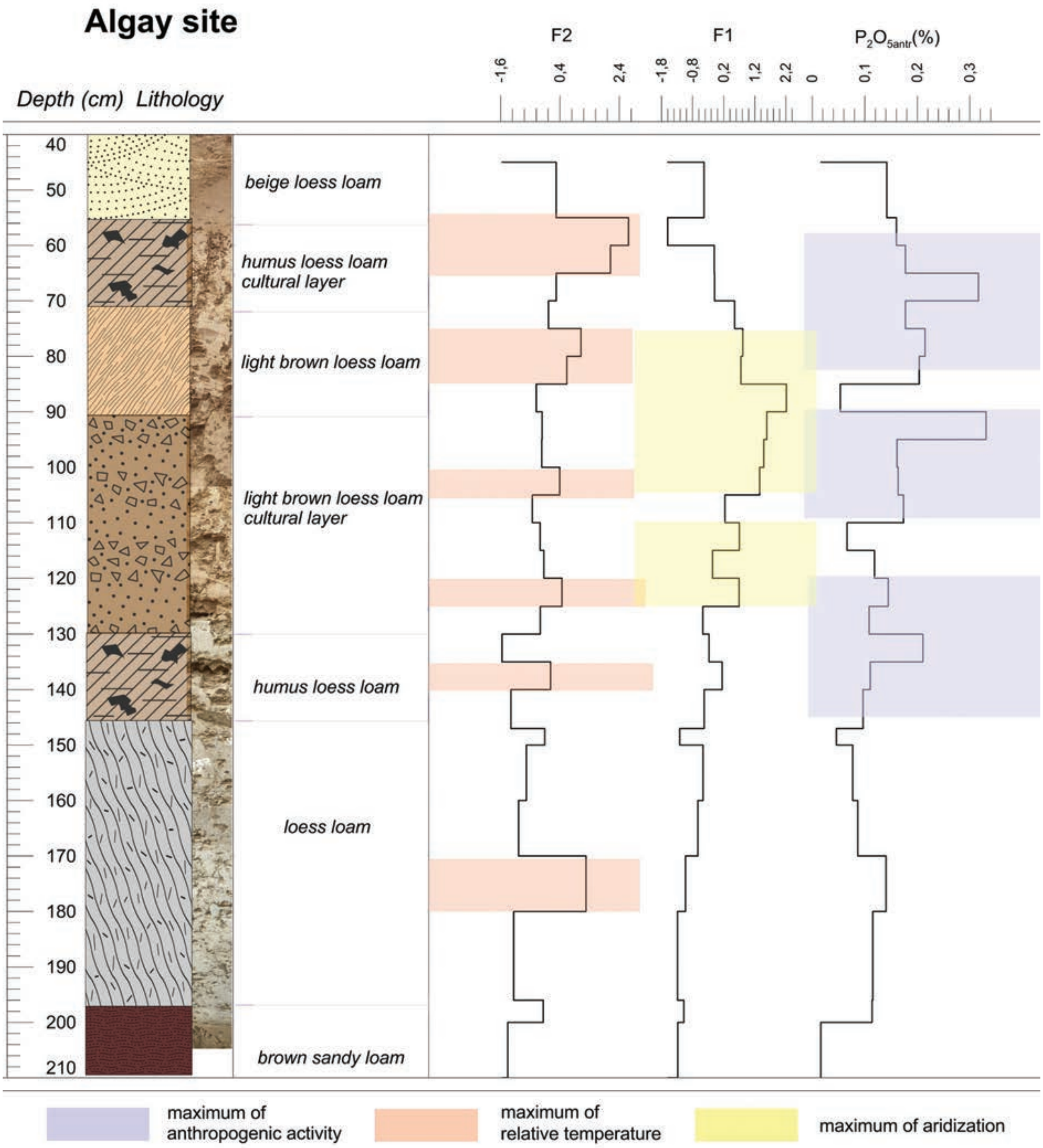

Fig. 3 Lithology and stratigraphy of a cross-section at the Algay site with geochemical indicators of the palaeoenvironment.

logies with materials of the Khvalynskaya Eneolithic culture (*Vybornov 2010; Vybornov* et al. *2015b; Yudin 2012*). This is supported by the radiocarbon dates of *c.* 4725 cal BC obtained on the kulan (*Equus hemionus*; Asian wild ass) bones from this layer. The development of Khvalynskaya culture corresponds to this time. This layer and the next bottom cultural layer are separated by a sterile horizon without any finds.

The next cultural horizon belongs to the Cis-Caspian culture (*Yudin 2012; Vybornov* et al. *2015a; 2015b*). Ceramics were made of fat silt clay tempered with crushed shells of freshwater molluscs. Vessels have flat bottoms and the upper part of the corollas has a thick edge. The decoration consists of a combination of comb-stamp prints with incised lines (Fig. 6). Stone tools were made of quartzite. The massive stone blanks were produced by the technique of reinforced extraction. Stone tools are presented by different types of scrapers, knifes, perforators and arrow points in the shape of fish (Fig. 7). Taking into account the radiocarbon age of the cultural layer, the forming of this horizon lasted about 200 years.

The radiocarbon dates of the artefacts from this layer lie in the interval of *c*. 5000–4700 cal BC (Tab. 1). The bones of domestic sheep and goat were also found in this horizon, while below this layer a sterile horizon without finds was registered.

One more cultural horizon was recovered below the sterile layer. This cultural layer comprises artefacts similar to those of the Orlovskaya Neolithic culture (*Yudin 2004*). The clay wares have the same shape as the pottery of the Cis-Caspian culture. As a rule they are flat-bottom vessels with thickening on the inner part of the corolla which has a decoration. The ornamental compositions are presented by horizontal and inclined incised rows of lines and pins, as well as horizontal zigzags (Fig. 8). The stone tools were made of grey and black flint. The tools were produced from plates and flakes. In the stone tool collection there are scrapers of different types, points and geometric microliths (Fig. 8). The time of the appearance of the carriers of these cultural traditions is *c*. 6200–5900 cal BC (Tab. 1). This is the first stage of the Orlovskaya culture and the appearance of pottery in this region.

	Factor-1	Factor-2	Factor-3	Factor-4
TiO_2	–0.525397	–0.374604	0.638549	0.012623
V	0.143179	0.103815	0.606115	–0.507017
Cr	–0.675516	–0.304983	–0.174911	–0.206581
MnO	–0.792146	–0.216703	0.180964	–0.104813
Fetot	–0.713308	0.253115	0.545018	–0.014104
Co	0.090292	–0.539679	0.511056	0.312753
Ni	–0.502823	0.325697	0.692857	0.010736
Cu	–0.184474	–0.300061	0.791513	–0.315741
Zn	–0.097698	0.801005	0.361113	0.221405
Sr	0.646855	–0.416596	0.365335	–0.031197
Pb	–0.234403	0.650516	–0.177654	–0.464782
CaO	0.832749	–0.113885	0.214682	–0.079583
Al_2O_3	–0.826869	0.370054	–0.021148	–0.017131
SiO_2	–0.815570	–0.166060	–0.474301	–0.027936
P_2O_5	0.429003	0.782884	0.137864	0.210849
K_2O	–0.492875	0.595141	–0.096002	0.439756
MgO	0.042608	0.686980	0.484446	0.147126
Rb	–0.714046	0.238823	–0.010265	0.343295
Ba	–0.462564	0.227406	–0.066073	–0.371593
La	–0.434701	–0.489385	–0.207699	0.198198
Y	–0.696520	–0.231848	0.140597	0.029511
Zr	–0.471691	–0.228049	–0.302956	0.105400
Nb	0.450337	0.265520	0.085704	0.559210
Na2O	0.419005	0.413458	–0.182563	–0.469158
As	0.078930	–0.718983	0.288837	0.280350
Expl.Var	7.143237	4.909768	3.616330	1.960236
Prp.Totl	0.285729	0.196391	0.144653	0.078409

Tab. 2. Algay site. Factor loadings (unrotated) extraction: principal components.

The Algay site

The archaeological materials that have been found on the Algay site give additional information with regard to the Oroshaemoe I site about the development of people at this place. In the lower cultural layer on the Algay site, straight wall wares with flat bottoms were found. They are ornamented by pins in a triangular manner with incised lines and notches. The compositions are presented by horizontal rows and zigzags (Fig. 9). The flint tools include plates and flakes. Scrapers of different types, points, geometric microliths and segments with geluanian retouching are most common (Fig. 9). One of main types of retouching is the geluanian retouching. This type includes the sharpening of microliths and segments from two sides. The chronological period of this cultural era is from 5900 to 5700 cal BC (*Vybornov* et al. *2017a; 2017b; Yudin* et al. *2016*). Thereby this is the later stage of the Orlovskaya cultural development in comparison with the lower layer on the Oroshaemoe I site.

	Eigenvalue	% Total-variance	Cumulative-Eigenvalue	Cumulative %
1	7.143237	28.57295	7.14324	28.57295
2	4.909768	19.63907	12.05300	48.21202
3	3.616330	14.46532	15.66934	62.67734
4	1.960236	7.84095	17.62957	70.51829

Tab. 3. Algay site. Eigenvalues extraction: principal components.

In the upper of this horizon there is a thin sterile layer and the next cultural layer also contains artefacts of the Orlovskaya culture, although the finds have some differences from the Orlovskaya bottom layer. Especially ceramics vessels show significant differences. On the inner part of the corolla there is a thickening with oval-shaped impressed decoration. This complex decorative composition on the ware walls was first observed in the Orlovskaya cultural tradition (Fig. 10). The stone industry forms from this layer have substantially changed, and microliths with a trapezium shape and dorsal retouching were found (Fig. 10). Several radiocarbon dates were obtained for this cultural layer, and they are in the interval from 5500 to 5300 cal BC (Tab. 1). A thin sterile interlayer separates the cultural layer of later stage of the Orlovskaya culture from the next Cis-Caspian culture. Ceramics and tools made of quartzite were discovered in the Cis-Caspian culture layer dated to 4800–4700 cal BC (Tab. 1).

The reconstruction of palaeoclimatic conditions during the Holocene

The Oroshaemoe I site
At the depth of 280–265cm loess loam with carbonate inclusions was discovered (Fig. 4). The sedimentation at the depth of 270–260cm was during the ending of a cold and dry event and the transition to moderately humid and warm conditions. In Figure 4 there is a trend from negative to positive for F2 and the transition from positive to negative for F1. These climatic conditions occurred about *c.* 6000 cal BC. The first evidence of carriers of the Orlovskaya culture are around this time.

At the depth of 265–243cm grey-beige loess loam is recorded. The radiocarbon age of this horizon is *c.* 5900–5600 cal BC. High anthropogenic activity was registered in this layer. The occupation of the site by carriers of the Orlovskaya cultural traditions begins exactly in this period.

Loess loam with a beige colour with carbonate inclusions is deposited at a depth of 243–150cm. In this

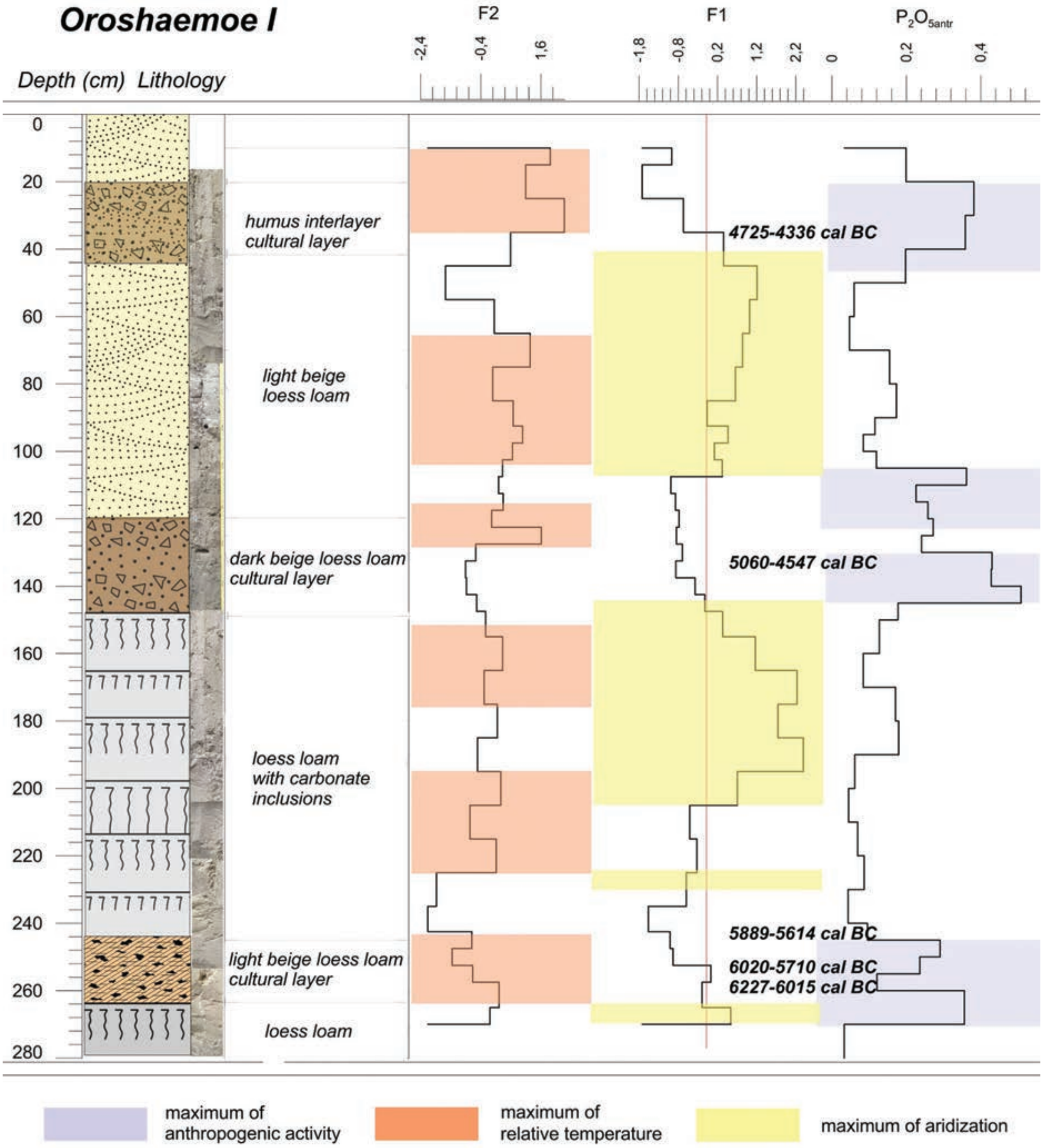

Fig. 4 Lithology and stratigraphy of a cross-section at the Oroshaemoe 1 settlement with geochemical indicators of the palaeoenvironment.

horizon low anthropogenic impact was registered. The maximum period of aridization and warm climatic conditions are marked on the basis of the geochemical indicators in these deposits. Especially strong arid conditions with carbonate formation are registered at the depth of 200–150cm on the basis of the F1 positive results. This episode coincides to *c.* 5050 cal BC.

The dark-beige loess loam is recorded at the depth of 150–120cm. The climatic conditions at the beginning of this sedimentation period were cold and humid, and both F1 and F2 are negative. At the end of this period of sedimentation there is a transition to the humid and warm conditions. This is registered on the basis of the positive value of F2. The anthropogenic activity is high. The artefacts of the Cis-Caspian culture are dated to *c.* 5000–4700 cal BC. The climatic Holocene maximum probably correlates with this period.

The next event of maximum aridization and high temperatures was recorded in the deposits of the light-beige loess loam at the depth of 100–70cm. Again, the high positive values of F1 and F2 show this. This was short-term episode with rapid sedimentation, and the level of anthropogenic activity was low.

	Factor-1	Factor-2	Factor-3	Factor-4
TiO_2	–0.778071	–0.361129	–0.046335	–0.048206
V	–0.413724	–0.233325	0.514376	0.104239
Cr	–0.375471	–0.393625	0.157189	0.188755
MnO	–0.928402	–0.022105	–0.150060	0.141842
Fetot	–0.911664	–0.360517	–0.028562	–0.110745
Co	–0.238642	–0.718360	–0.251143	0.372272
Ni	–0.789704	0.018054	0.142277	–0.461662
Cu	–0.402804	–0.755680	–0.302772	0.081161
Zn	–0.860105	0.350439	–0.110814	–0.099737
Sr	0.289314	–0.746120	–0.332121	–0.312762
Pb	–0.102168	0.045123	–0.848618	–0.219134
CaO	0.720024	–0.320048	0.156392	–0.436712
Al_2O_3	–0.791232	0.499724	0.011110	–0.269376
SiO_2	–0.206384	0.867991	–0.036818	0.084382
P_2O_5	–0.465666	0.755840	–0.048370	–0.039471
K_2O	–0.624663	0.654979	0.141454	0.221338
MgO	–0.187295	–0.076565	–0.223522	–0.843921
Rb	–0.857427	–0.348934	–0.156778	0.004863
Ba	–0.454333	–0.279516	0.534705	0.042600
La	–0.346207	–0.292131	0.469610	–0.048956
Y	–0.801067	–0.202919	–0.102270	–0.002583
Zr	0.018071	0.502598	–0.242704	0.337912
Nb	0.001422	–0.079008	–0.722107	0.192327
Na_2O	0.116133	0.305007	0.232280	–0.639645
As	–0.008519	–0.388506	0.572406	0.066714
Expl.Var	7.833615	5.180147	2.934171	2.197460
Prp.Totl	0.313345	0.207206	0.117367	0.087898

Tab. 4. Oroshaemoe site. Factor loadings (unrotated) extraction: principal components.

The transition from a dry to humid climatic period is marked in the deposits at the depth of 65–40cm. The F1 values show a trend from positive to negative.

The upper layer (45–20cm) is presented by the humus interlayer in the deposits of loess loam which were sedimented during warm and humid conditions. The F1 values are negative while those for F2 are positive. The anthropogenic activity rises again. The radiocarbon age of organic artefacts from this layer is 4700–4336 cal BC. This was the period of the development of the Khvalynskaya Eneolithic culture.

The Algay site

In the bottom part of the cross-section (210–196cm) on the Algay site (Fig. 3) there is brown sandy loam. The climatic conditions were at this time moderately wet. The values of F1 and F2 are close to zero.

The formation of grey loess loam on the depth of 196–147cm was during a moderately humid and warm climate with a short-term episode of cooling. The warm episode is registered at the depth of 180–170cm on the basis of increasing F2 values. The anthropogenic loading is low.

At the depth of 147–130cm humified loess loam with artefacts from the Orlovskaya culture was deposited. On the basis of geochemistry this layer is characterized by high anthropogenic loading. The climatic conditions are recorded as humid and warm (negative F1 and positive F2). The radiocarbon dates for this layer lie in the interval of 5800–5650 cal BC. In Figure 3 the Bayesian model of the distribution of the radiocarbon dates for this site is presented. It should be noted that several groupings of dates are divided by lacunae. The first lacuna falls on the radiocarbon 'plateau' of 5656–5566 cal BC. This episode correlates with the period of temperature de-

	Eigenvalue	% Total-variance	Cumulative-Eigenvalue	Cumulative %
1	7.833615	31.33446	7.83362	31.33446
2	5.180147	20.72059	13.01376	52.05505
3	2.934171	11.73669	15.94793	63.79173
4	2.197460	8.78984	18.14539	72.58157

Tab. 5. Oroshaemoe site. Eigenvalues extraction: principal components.

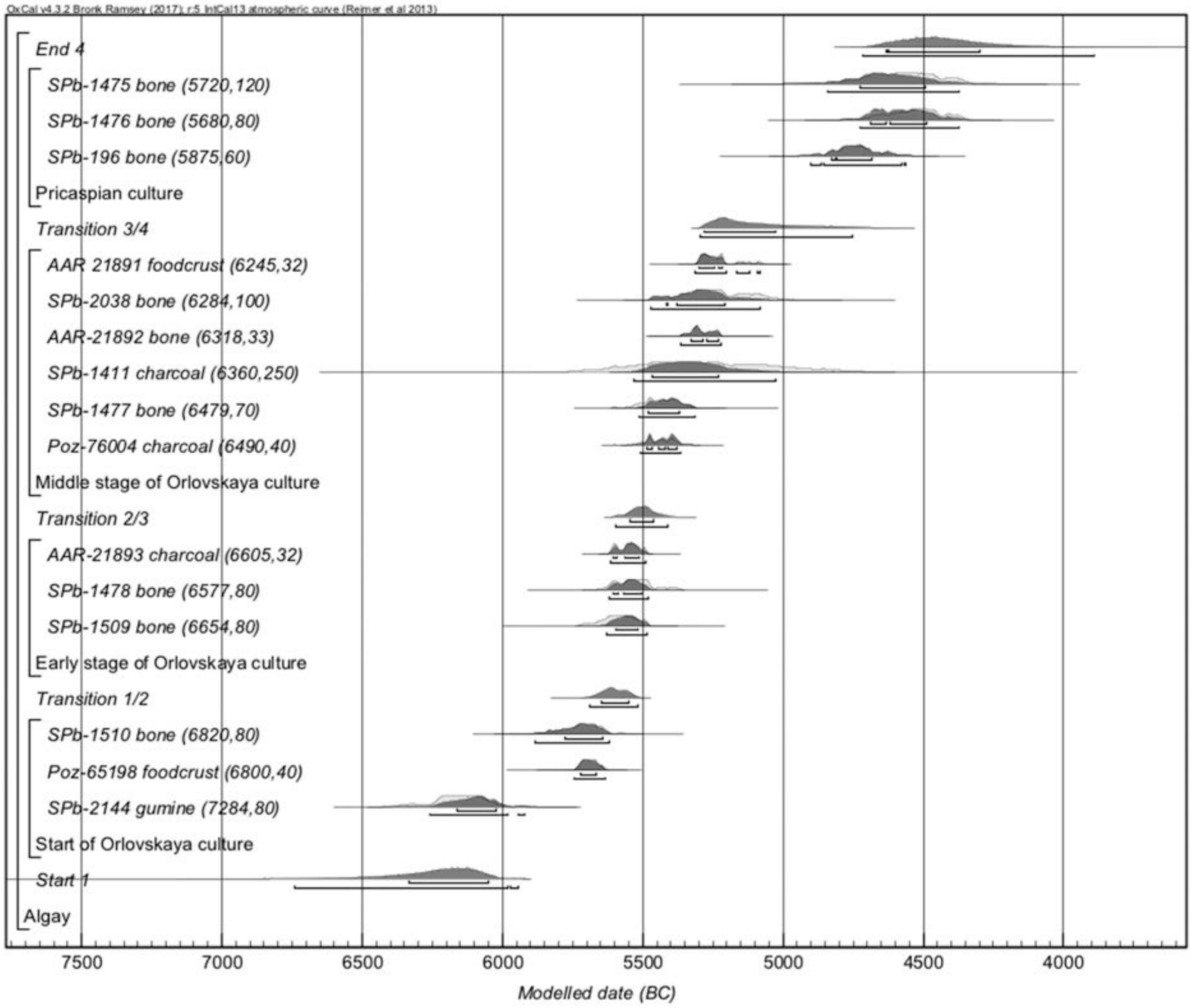

Fig. 5. Chronological phases for the different cultural traditions at the Algay site.

creasing and aridization that is registered by the geochemical indicators in deposits at the depth of 127–132cm. These conditions are supported by the negative values of F1 and F2.

At the depth of 130–90cm light brown loess loam was sedimented. The climatic conditions in this period were warm with a trend to aridization. There are high, positive values of F1. High levels of higher anthropogenic activity are revealed at the depth of 130–120cm. The radiocarbon dates on artefacts from this layer are from 5600 to 5470 cal BC.

Decreasing anthropogenic activity was registered at the depth of 120–113cm. This period corresponds with cooling and dry climatic conditions according to the negative values of F2 and high positive values of F1. The radiocarbon 'plateau' of 5470–5400 cal BC correlates to the climatic deterioration.

The next peak of anthropogenic activity is recorded at the depth of 110–90cm. This coincides with the cultural layer dated to 5350–5120 cal BC. Increasing temperature and humidity occurred in the period of sedimentation at the depth of 100–105cm. This episode is marked by positive values of F2 and a transition from negative to positive values of F1. The deposits at the depth of 100–90cm were formed in moderately cold conditions with increasing aridity (high positive values of F1) during 5120–5050 cal BC. This interval also falls on the radiocarbon 'plateau'.

The maximum of aridization and high temperatures occurred according to geochemical data in the period of light beige loam forming at the depth of 85–75cm. This is marked by high positive values of both F1 and F2. Low anthropogenic activity was revealed in this layer, and this episode can be dated to around 5050–4900 cal BC.

The next period of high anthropogenic activity concerns 4900–4366 cal BC, and this is recorded in the deposits at the depth of 80–55cm. This stage is characterized by a humid and cold climate (negative values for both F1 and F2), but at the end there is marked the transition to humid and warm conditions (positive values of F2).

Discussion

The local features of the Oroshaeomoe I site located on the riverbank were more favourable for certain types of household activities during humid periods. This place was protected from winds and therefore the local humidity was higher than on the Algay site. At Algay, situated in an elevated place, a low rate of sedimentation was recorded in the periods of aridization. The intensive rate of weathering in this area resulted in the lower accumulation of deposits. Conversely, at the Oroshaemoe I site the thickness of deposits is greater, especially for sedimentation during arid periods.

According to Nataliya S. Bolikhovskaya (*2011*) the Early stage of the Atlantic period about *c.* 7000–6600 BC in the Low Povolzhie region is similar to the humid stage of the Middle Subboreal warming. The transgressive stage of the New-Caspian basin is registered about 7000 BC. The elevation of the water level in this period was 16–20m. Around 6600–6400 BC a short period of aridization occurred and cold climatic conditions were recorded. In this period the decreasing of broadleaf forest and the spreading of non-turfed areas has been found (*Bolikhovskaya 2011*). The climatic deterioration was also chronicled *c.* 6200–6000 BC in the forest areas of the steppe zones of Eastern Europe (*Spiridonova, Aleshinskaya 1999*). After this event the climate became more favourable, but generally it was dry conditions.

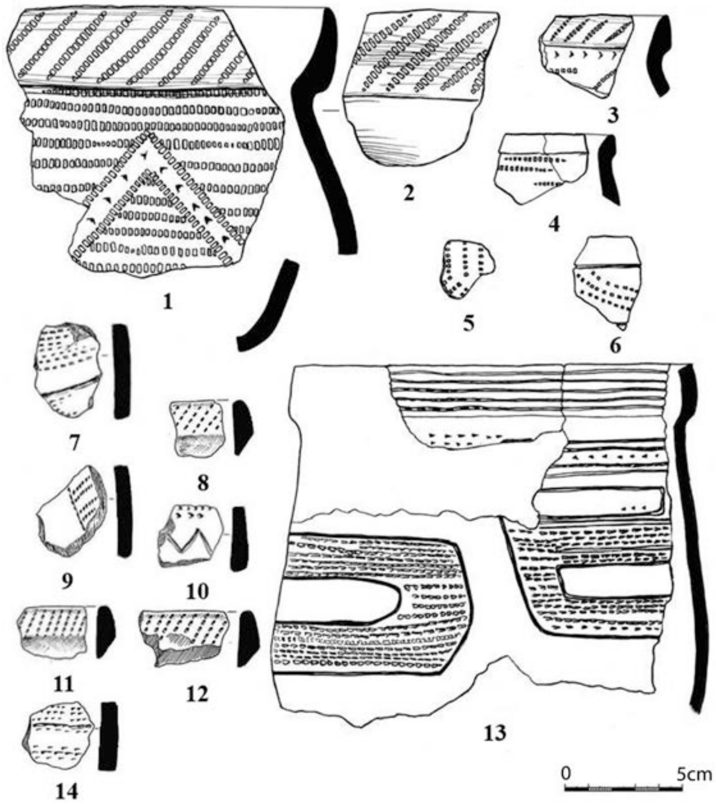

Fig. 6. Pottery of the Cis-Caspian culture from the Oroshaemoe I settlement.

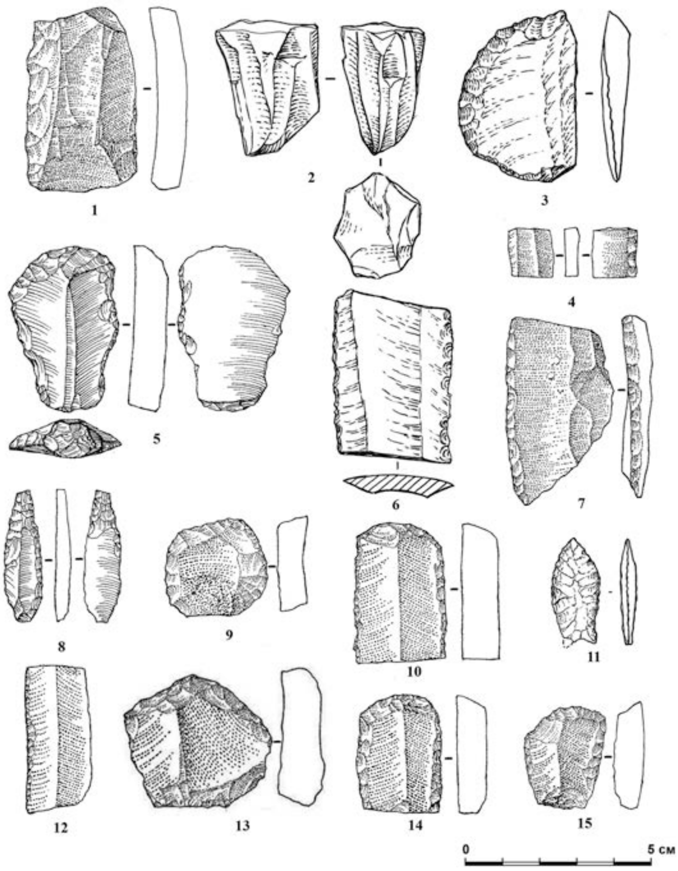

Fig. 7. Stone tools from the Oroshaemoe I settlement.

According to the geochemical indicators, in the area of the Algay and Oroshaemoe sites the climate around *c.* 6000 cal BC was humid and warm. The anthropogenic impact on the Algay site was in this period low, in contrast to the Oroshemoe site where the first evidence of a people was found. Based on the archaeological data, in this period the carriers of the Orlovskaya Neolithic culture appeared in this region. The climatic

Fig. 8. Pottery and stone tools of the Orlovskaya culture from the Oroshaemoe I settlement.

conditions in this time were favourable. The period of *c*. 6400–5100 BC, according to pollen analysis provided by Bolikhovskaya (*2011*), is characterized as warm and moderately dry in the Low Volga region. At *c.* 6200–3580 BC the rate of alluvium accumulation in the floodplains of small rivers of the Kalachskaya hilltop decreased (*Sicheva 1999*). The regressive phase of the New-Caspian basin around *c*. 5900–5200 BC was at an altitude of –28m. Open areas and a diversity of grass types and broad-leaved forests (linden, elm, beech, alder) were spreading. Cereals and grass prevailed. According to E. A. Spiridonova (*1991*), at 5500–5200 BC in the northern part of the central part of Eastern Europe the forest area prevailed, and in the southern part the steppe zones were spreading.

At the Algay site, according to geochemical markers, the beginning of aridization appeared during *c*. 5656–5566 cal BC. Some increase in humidity is registered about 5350–5120 cal BC (Fig. 3). An increase in anthropogenic activity was also noted in this period. The maximum of aridization was recorded in the deposits dated to 5050–4900 cal BC on the Algay site. These layers did not contain any cultural finds and the anthropogenic impact is low according to geochemical indicators.

According to Natalia P. Gerasimenko (*1997*), the climatic Holocene optimum in the steppe zone was registered during 5500–4500 BC. Bolikhovskaya (*2011*), on the other hand, suggests that the climatic optimum was 5100–4000 BC. The transgression in the New-Caspian basin increased to reach 18–28m in *c*. 5060–3980 BC.

We register the transition to warm and humid conditions at *c*. 5060–4547 cal BC. These conditions probably correlate with the Holocene climatic maximum in the steppe zone. The high anthropogenic activity in the deposits corresponds to this time. The artefacts of the Cis-Caspian archaeological culture were found in this layer.

Strong aridization occurred around 4700–4500 cal BC, based on the geochemical indicators. According to Bolikhovskaya (*2011*),

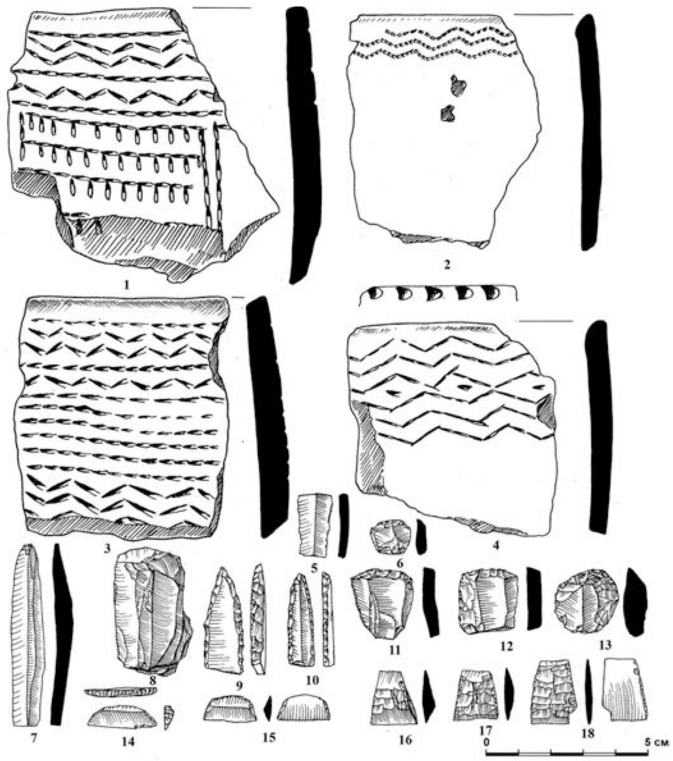

Fig. 9. Pottery and stone tools from the bottom layer of the Algay site.

the aridization of the steppe was registered at *c*. 4500–4400 BC, and this was the main factor in rapid decrease of the Caspian water level. After the climatic aridization at the Oroshaemoe site the transition to more favourable conditions resulted in the appearance of people from the Khvalynskaya Eneolithic culture at 4725–4336 cal BC.

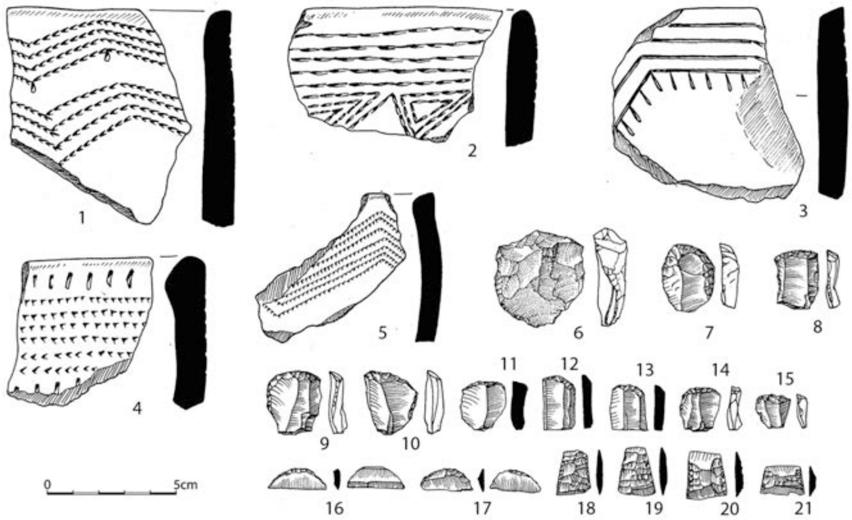

Fig. 10 Pottery and stone tools from the upper layer of the Algay site.

Conclusion

The landscape-climatic conditions in the steppe area of the Lower Volga basin strongly impacted the development of ancient societies. In this paper we considered the adaptation of people in the past to environmental conditions in this region.

The first evidence of the Orlovskaya Neolithic culture is around 6200 cal BC. In this period there was the transition to moderately humid and warm conditions that lasted till *c*. 6000 cal BC. A sterile horizon without artefacts was sedimented at *c*. 6000–5900 cal BC in the period with the maximum of aridization.

The second stage of Orlovskaya culture development was registered at 5800–5500 cal BC on the Algay site. In this period the climate was humid and warm. The decrease in anthropogenic activity correlates with cold and dry conditions at 5660–5560 cal BC. In the later stage of the Orlovskaya culture (5300–5200 cal BC) the climate was more humid and warmer, and there were significant changes in the material culture of this stage. The influence of carriers with new cultural traditions in this period is probably reflected in these changes.

The next event of maximum aridization correlates with sterile horizons on both sites at *c*. 5100–4900 cal BC when the people abandoned this territory.

The new stage of anthropogenic activity is presented at Oroshaemoe the most clearly. This is the appearance of the Cis-Caspian culture (4900–4800 cal BC), the first with domestic animals.

The humid and warm conditions changed within a short period (around 100 years) due to aridization, and this caused the forming of a sterile layer. The development of the Khvalynskaya Eneolithic culture is dated to 4700–4400 cal BC.

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The Early Eneolithic burial ground at Ekaterinovsky Cape in the forest-steppe Volga region

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ABSTRACT – *The Ekaterinovsky Cape burial ground is located on the territory of the Samara region of Russia on the left bank of the River Volga. The excavation of the burial ground was carried out in 2013–2018. During this time we studied 100 graves, including sacrificial sites with ceramics of collar type and sacrificial complexes. Most of the skeletons were in an extended position on their backs. There are some skeletons on their backs with legs bent at the knees, secondary burials and separate burials of skulls. Ochre was used. The inventory included beads made from shells, stone products, animal teeth, bones and horns. There we distinguished graves with stone sceptres and zoomorphic rods made from the horn. The burial ground belongs to the Samara culture and dates from the second half of the 6th millennium BC.*

KEY WORDS – *Early Eneolithic; Samara culture; Ekaterinovsky cape burial ground*

Zgodnje eneolitsko grobišče na rtu Ekaterinovski na območju gozdne stepe ob Volgi

IZVLEČEK – *Grobišče na rtu Ekaterinovski se nahaja na območju samarske regije v Rusiji na levi strani reke Volge. Izkopavanje grobišča smo izvedli med leti 2013 in 2018. Odkrili smo 100 grobov, vključno s prostori žrtvenih obredov s keramiko z ovratniki in žrtvenimi kompleksi. Večina skeletov je bila v iztegnjenem položaju na hrbtu. Nekaj skeletov je položenih na hrbet s skrčenimi nogami, nekaj je tudi sekundarnih pokopov in ločenih pokopov lobanj. Tudi okra je bila uporabljena. Med najdbami so jagode, izdelane iz školjk, kamniti izdelki, živalski zobje, kosti in rogovi. Prepoznali smo tudi pokope s kamnitimi sceptri in zoomorfnimi palicami iz roževine. Grobišče sodi v kulturo Samara in datira v drugo polovico 6. tisočletja pr. n. št.*

KLJUČNE BESEDE – *zgodnji eneolitik; kultura Samara; grobišče rt Ekaterinovski*

Introduction

The Ekaterinovsky Cape burial ground is located on the territory of the Samara region of the Russian Federation on the left bank of the Volga River (Fig. 1). The burial ground is located near the village Ekaterinovka and occupies the northern edge of a small elevation in the middle part of the cape, which is formed by a sharp bend of the Bezenchuk River (Fig. 2).

The burial ground was opened in 2013 by Anna Kochkina and Dmitry Stashenkov (*Kochkina 2015. 495–496*). Further excavations lasting from 2013–2018 were carried out by an expedition of the Samara Regional History Museum and Samara State University of Social Sciences and Education under the guidance of the authors of the article. The total area

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of the excavation was 318m². There were 101 graves that we studied, only one grave (No. 12) relates to a later time. The burial ground contains valuable materials with regard to burial rites and inventory, anthropological and genetic composition of the buried people, emergence of cattle breeding in the Volga region, social relations and chronology of the late Neolithic and Eneolithic. Many artefacts from the inventory of graves are unique and are of great importance for the analysis of primitive art and religion. In this article we present new materials and research results of this burial ground.

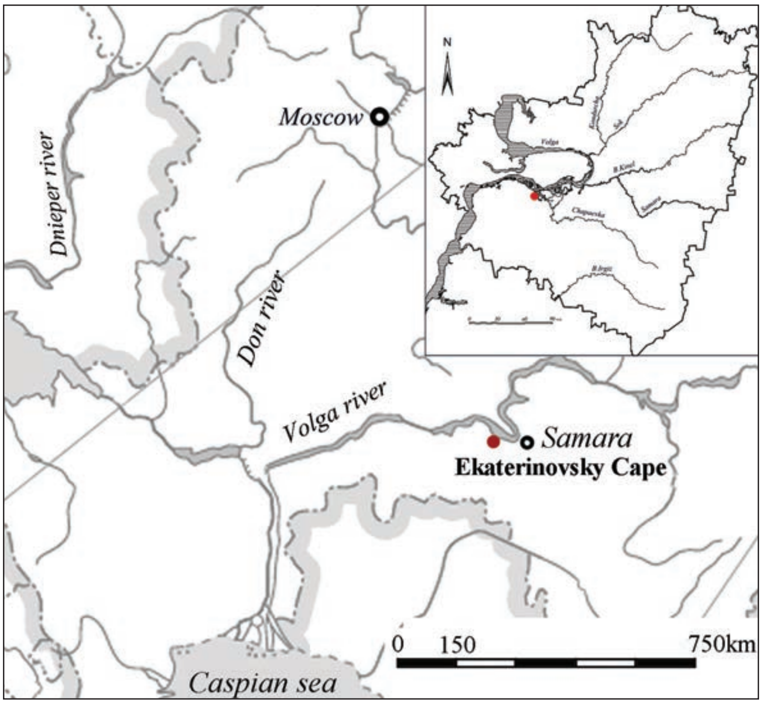

Fig. 1. Map of the location of the Ekaterinovsky Cape burial ground.

The stratigraphy

Stratigraphy and description of layers: 1) turf up to 10cm; 2) a layer of activity from the last century up to 40cm; 3) black dense loam, up to 40cm; 4) brown-grey dense loam, up to 25cm; 5) brown continental clay (Fig. 3). The graves are in the bottom of the layer of brown-grey loam and in the upper part of the continental clay. Both layers are disturbed by shrew-mice. The northern part of the burial ground was destroyed during road reconstruction works. In this part the depth of graves was 5–20cm from the surface, in the central, southern and western parts it increased to 50–80cm, and in the east it reached 120cm. The filling of the grave pits, as a rule, did not stand out against the background of the surrounding soil. Sometimes a darker spot of filling was recorded in the place of the burial pit, but it usually did not coincide with its edges. Ochre was a good marker of graves or sacrificial sites. The ochre-coloured soil or clusters of ochre grains indicated a burial pit or sacrificial site. The degree of colouring of skeletons with ochre is different. Graves with 'rich' and numerous inventories were plentifully covered with ochre. Often there were only single spots or grains of ochre in the graves. The pit of grave 31 was localized by spots of red ochre and darker filling. Due to the bright colour of the soil grave 79 was revealed (Fig. 4). Among the graves located on the periphery of the burial ground, ochre is less common and in smaller quantities. In some graves ochre was not used at all.

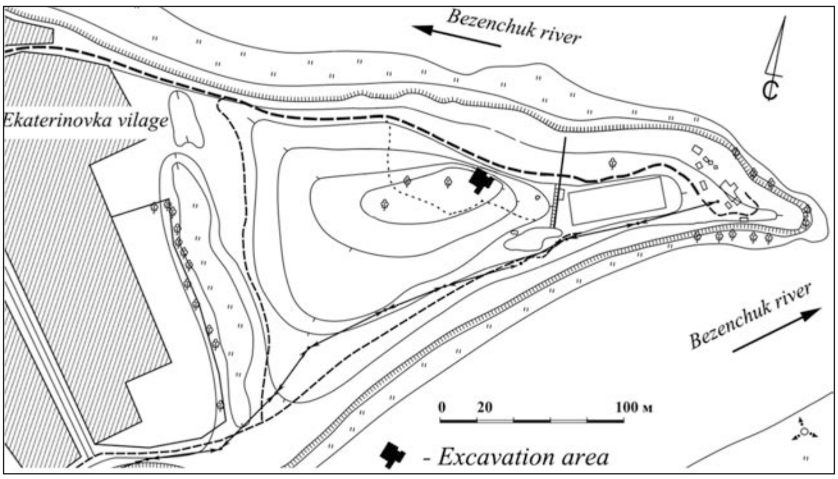

Fig. 2. Plan of the Ekaterinovsky Cape burial ground.

The funeral rites

As a rule, the graves are individual (Fig. 5), but some paired ones were also found, for example, 70–71 (Fig. 6). Sometimes the placement of graves is in several layers. For example, three graves (63, 64, 68) were located one above the other in three layers. Some cases of partial overlapping of one skeleton by another have also been recorded; *e.g.,* part of grave 31 is covered by grave 20 located above it (Fig. 7).

These observations provide us an opportunity to clarify the sequence of formation of the burial ground. There are groups of compactly located graves with equally oriented skeletons. Often such groups form rows that are not very even and differ in the number of graves (Fig. 7). Cases of early grave infringement are rare. It can be assumed that the graves were designated by some signs. However, no traces of gravestones were found. Some of the graves, mainly in the central and eastern parts of the burial ground, do not form rows. They are represented by whole skeletons and their fragments, as well as only by the skulls.

Fig. 3. The excavation profile along the N-S line.

The position of the skeletons provides a basis for the selection of ritual groups. It should be noted that in the destroyed graves it is not always possible to trace the positions of skeletons. However, skeletons extended on their backs dominate the burial ground. Arms are usually extended along the skeleton, while hands are located near the pelvic bones or lie on the pelvic bones. They constitute the first group (Fig. 8). The sculls of skeletons are oriented to the south-east, east, northeast, and sometimes to the north.

The second group of skeletons is characterized by crouched position on the back with the knees raised. This group is smaller and not so uniform. The position of skeletons from graves 85 and 86 shows that they were located on their backs with legs bent at the knees. The heads were on a small earthen 'pillow' or were resting on the edge of the pit. For the skeleton of grave 81, the bones of the legs are slightly bent. The skeleton from grave 90 with a stone cross-shaped sceptre is assigned to this group in the half-sitting position. The skeleton from grave 23 was in a crouched position with a blockage on its right side (Fig. 8). The skeleton from the half-ruined grave 52 is also included in this group, because of a stone bracelet located on the humerus (Fig. 9.1). Bracelets worn on the hands of the buried were found in the Nalchik grave (*Kruglov 1941. Figs. 33–34*). The same bracelets was found from the I Khvalynsky burial ground (*Agapov* et al. *1990. 106, Fig. 10.6*), the destroyed Ivanovsky burial ground (*Morgunova 1979.17, Fig. 3.23–30*), grave in Krivoluchye (*Vasiliev 1981.106.1–2*), which contained a sceptre similar to those of the Hvalynskaya culture. The reasons for the differences in the positions of skeletons are yet to be clarified, but the signs are characteristic of burial rituals from the Khvalynsko-Srednestnogovskoe time. The graves of the second group are noted in the central and eastern parts of the burial ground.

Fig. 4. Grave 79.

Despite the differences in the positions of the buried in the first and second groups in the Ekaterinovsky Cape burial ground, and some differences in the grave inventory, they are not entirely dissimilar to each other. There are cases when the skeletons of the first group were touched, but not destroyed, when arranging the graves of the second group. For example, the crouched skeleton from grave 23 is close to the graves 24 and 25 (Fig. 8). So, the time difference between the construction of the graves of the first and second groups cannot be significant. It is thus impossible to exclude the possibility that these graves can belong to the same time period. The depth of the graves, the absence of a noticeable filling of the burial pit, the condition of the bones and the inventory are the same. For example, the cross-shaped sceptre from the half-head grave 90 is typologically close to the cross-shaped sceptre from grave 45. The shell bead from the crouched grave 23 is not very different from similar beads from extended graves. Products made of tubular bones were found in the graves of both groups.

Fig. 5. Grave 73.

Fig. 6. Double grave 70–71.

It is more difficult to assign separate burials of skulls to one of these groups, which, as a rule, are not accompanied by inventory. Such burials may include one skull, two, or three.

Such graves are mainly localized in the central and eastern parts of the burial ground. The secondary burial ceremony was clearly manifested in grave 79, which consisted of compactly folded bones from two men and a woman covered with red ochre (Fig. 4). The grave was accompanied by a stone discoid sceptre (Fig. 9.2).

The burial ground contains mostly adult male and female graves, with few children. The anthropological study of skeletons is complicated by the poor preservation of bones and is not completed. However, for the most significant graves such definitions were made (*Khokhlov 2018.78*). For grave 45 a graphic reconstruction of the skull was performed (*Korolev* et al. *2018.299*).

The funeral inventory

The distribution of inventory in graves is uneven. There is a large group of graves without inventory, and as a rule they are not ochre coloured or are only slightly coloured. Such graves were located throughout the burial ground. More than half of the graves are with inventory, and they are often painted with ochre.

According to the total number of items found in the graves, beads made from Unio shells are the most numerous. These are disc-shaped with a hole in the centre and their size is 0.6–0.9cm. Beads were found in men's, women's and children's graves. In some graves, small beads were preserved *in situ*; judging by their location, they were sewn onto clothing. Sometimes in the graves there was one bead each, in others several dozen; for example, grave 49 had 27 beads, grave 40 had 261 beads, while grave 31 had more than a thousand beads (Fig. 10.1). Other items found in the graves are: pendants (Fig. 10.2), pierced seashells (Fig. 10.4–5), and beads made of brown and green stones (Fig. 10.3). Beads in graves are less common than adzes.

Graves with stone adzes are the most numerous in the burial ground. In one grave there can be up to four adzes. These are made of flint limestone, flint, and stones of green colour (Fig. 11) their size is from 5 to 19cm in length. As a rule, adzes have a polished surface and are well sharpened, but there are also ones processed only with chips. Many adzes were

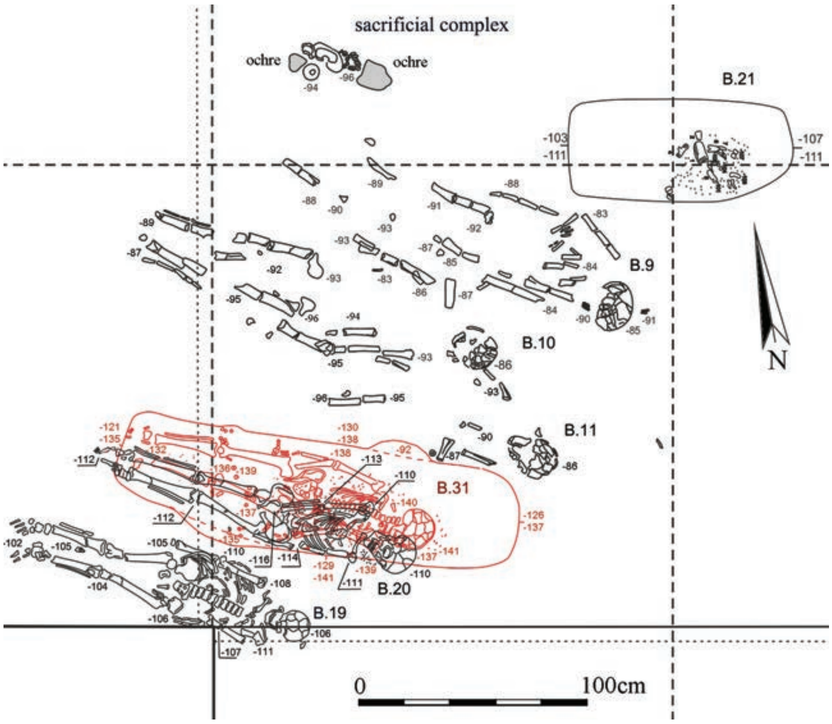

Fig. 7. The plan of graves 9–11, 19–21, 31 and the sacrificial complex.

broken during the commission of the burial rite, as represented by debris. Often they were broken by a strong strike. Fragments of broken adzes were found in the graves and cultural layer. Such actions are associated with the rite of spoilage of things recorded in the burial grounds of the Mariupol time at Sjezzhee (*Vasiliev, Matveeva 1979.152*) and Lipoviy gully (*Vasiliev 1985.11–12*). Adzes are in the inventory of both private and extraordinary graves. Knife-shaped plates of flint and quartzite are from 0.6 to 3.5cm in width and up to 18cm in length. Plates with and without retouching were found in graves, both with ordinary and with 'prestigious' inventory (Fig. 12). Stone sceptres and rods made from horn were found in the graves with knives 45 and 46 (Fig. 13.2; 14). Stone products include small rings. They are often represented by fragments, but there are also whole copies (Fig. 13.1). There are single small pendants made of stone. In one case, a stone slab with an abrasive surface was found in grave 16.

Products from boar tusks are quite numerous. These include large plaques of canines with and without holes at the ends, with ornament. A large group consists of plaques from the canine of a boar with cuts along the edges, holes and a protrusion (Figs. 15.1; 16.3). There are adornments of marmot teeth, which, apparently, were sewn onto clothing (Fig. 15.6–11). Marten fangs usually have cuttings on the root on one or two sides, but there are examples with holes and there are fangs without treatment (Fig. 15.2–5). Beaver's cutters often have transverse cuts near the ends. In the graves there are various products made of animal bones: plates with protrusions and holes, fragments of zoomorphic figures, rings of tubular bones, tubes (Fig. 15.12), daggers, pendants and large plates of horns. In the extraordinary grave 17 a hollow object carved from a horn was found, in which there were three wedge-shaped objects also made of a horn. This grave included a horn staff in the form of an elk's head, a large plate with holes from a boar's tusk, small bone plates and beads from shells. The large tusk of a boar with holes at its ends was located on the vertebrae of the deceased. Wands from the horn in the form of heads of birds, elks, and other animals, the form of which is difficult to determine, are of great interest. In grave 45 there were bones of a sacrificial domesticated animal, a young goat (*Korolev* et al. *2018.297*). Bones of a

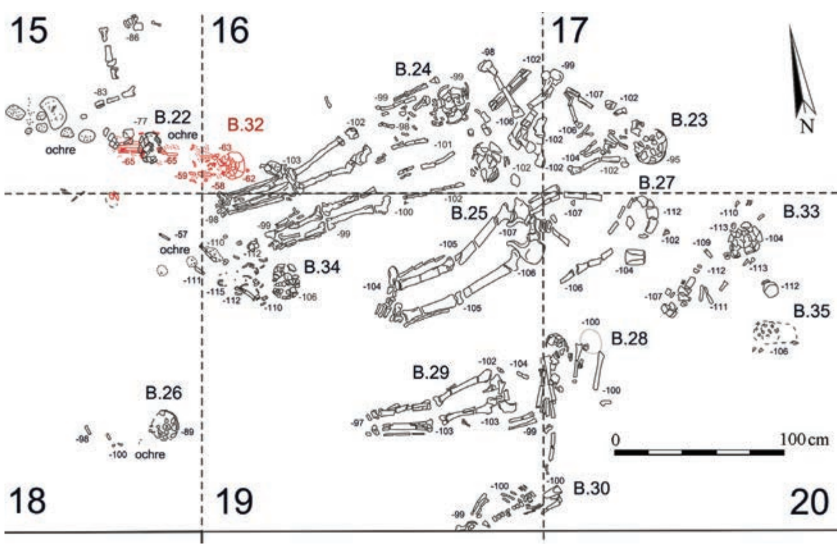

Fig. 8. The plan of graves 22–30, 32–35.

Fig. 9. Stone ring-bracelet from grave 52 and a stone pommel mace from grave 79.

sheep and a horse were found in the cultural layer and in some graves. It is difficult to prove their direct connection to the graves, since the bones of animals could enter the filling of the pits from the cultural layer. The problem of horse domestication in the Eneolithic remains unresolved (*Anthony 2007; Kosintsev, Kuznetsov 2013.405–408*). Therefore, the question of whether horse bones found in a burial ground belong to domesticated animals or not remains open. According to the presence of 'prestigious' items and the amount of inventory in the burial ground, extraordinary graves were identified in the first group. Distinctive features are stone tops of sceptres, zoomorphic tops of wands from elk horn and other individual items.

In total, 15 stone sceptres were found in graves 18, 40, 45, 46, 52, 69, 71, 76, 79, 90, and 93 (Fig. 13.2). In grave 45, three stone sceptres were found, *i.e.* a zoomorphic, cruciform, round-flattened and a rod of horn in the form of a bird's head. Also two sceptres were found aside from the graves as part of the sacrificial complexes. Zoomorphic wands or pommel hammers from horn were found in graves 19, 40, 45, and 46 (Fig. 14). Another such wand was found in the sacrificial complex near grave 76 (Fig. 16.1). Some of these products are poorly preserved, such as those from grave 55, and it is possible that there were more zoomorphic products. In some cases, the reason for determining the originality of the grave was either the rarity or high number of items found there. For example, in grave 9 there was a bone dagger, marten teeth, and a beaver's cutter. Grave 31 was made in a deep hole and contained a record number of shell beads, as well as pendants, bone rings and incisors of the marmot. In grave 41, polished rings of tubular bones, flint adzes, shell beads, and incisors of the marmot were found. In grave 74 there were two large horn plates on pelvic bones.

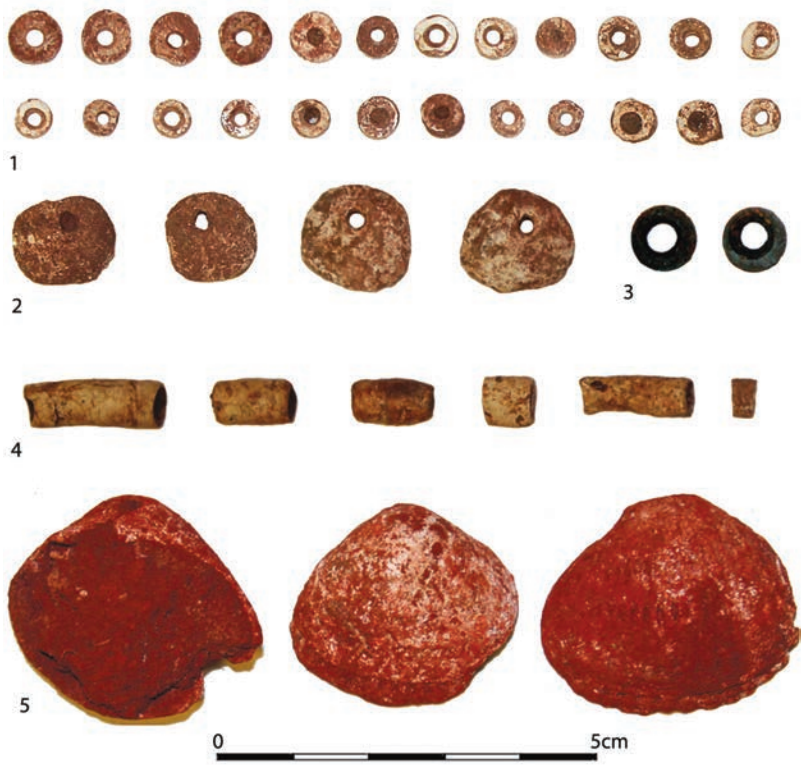

Fig. 10. Grave 31. 1–2, 4–5 decorations of shells; 3 stone beads from the cultural layer. 1,3 beads; 2,5 pendants; 4 tubules.

An important feature of the Ekaterinovsky Cape burial ground is the sacrificial sites and complexes, and these often contained ochre-coloured ceramics. The vessels were used for funeral feasts, they were exhibited in specially organized places near the graves, and often overlapped them. Places of increased concentration of ceramics were noted along the territory of the burial ground from east to west. The dishes were made of clay with an admixture of a crushed shell (*Vasilyeva 2019.33–46*). The vessels had corolla with a specific thickening on the outer side – the 'collar' and the bottom of a rounded and flattened shape. The ornament is mainly made with comb and rope stamps; there are small holes and drawn lines (Fig. 17).

Sacrificial complexes do not include human bones and are usually located near the graves. They differ

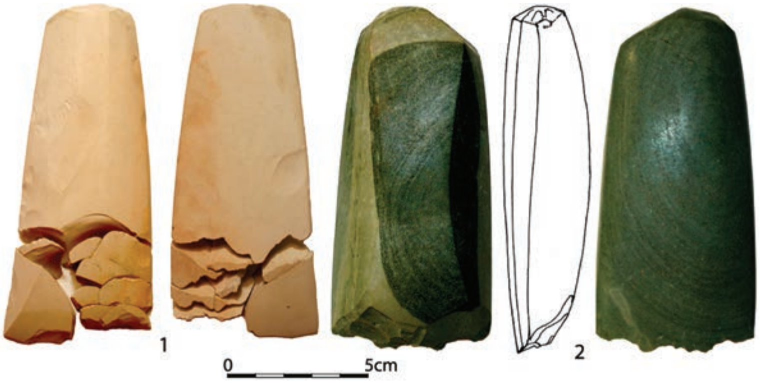

Fig. 11. Adzes. 1 grave 70; 2 grave 73.

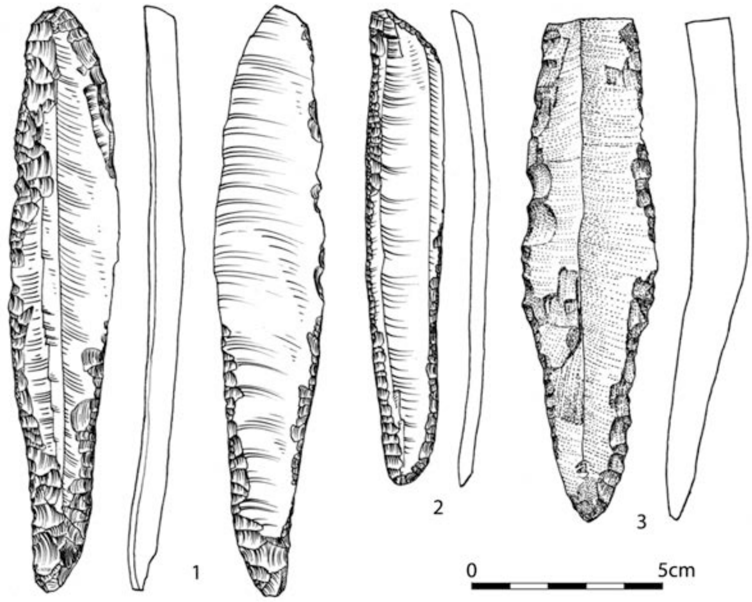

Fig. 12. Grave 46. 1–2 flint knives; 3 quartzite knife.

in the composition of their inventory, and sometimes contain items similar to those found in graves or include a set of original items. For example, in the square of 5 was found a number of things including pieces of broken stone scepter and beads made of shells. The complex, found in square 48, consisted of a large, zoomorphic hammerhead from horn, a fragment of a second blade, a bone wedge, beaver incisors, and shell beads. These complexes are fully consistent with the sets of things from graves 40 and 45. The complex of things found in square 74 includes two flint tips of darts with a notched base and knife-like plate-inserts. The tips are typologically close to the blanks of the tips from grave 86 of the second group, with these things being found together for the first time. Analysing the sacrificial complexes it is necessary to mention that in grave 45, besides the sacrificial animal, the bones of the legs of other individuals were also found.

Cultural affiliation, analogies and chronology

The cultural affiliation of the burial ground is determined by the combination of signs of the grave. First of all we should mention that the first group of graves is of the Mariupolsky type, and this provides a reasonable basis for considering the framework of the Samara culture. The Neolithic or Eneolithic epoch is complicated. It has been found that there are no metal products for the early pastoralists of the Pricaspian, Samara and Khvalynsky, which is associated with the beginning of the Eneolithic in the Lower and Middle Volga. The materials found in the Ekaterinovsky Cape burial ground are similar to those studied in the Volga region in Sjezzhee (*Vasiliev, Matveeva 1979*). The main features of the burial rite (spine-stretched position, ochre, orientation in the eastern sector), the inventory (plates from boar's

Fig. 13. 1 Stone ring, grave 58; 2 stone pommel sceptre, grave 46.

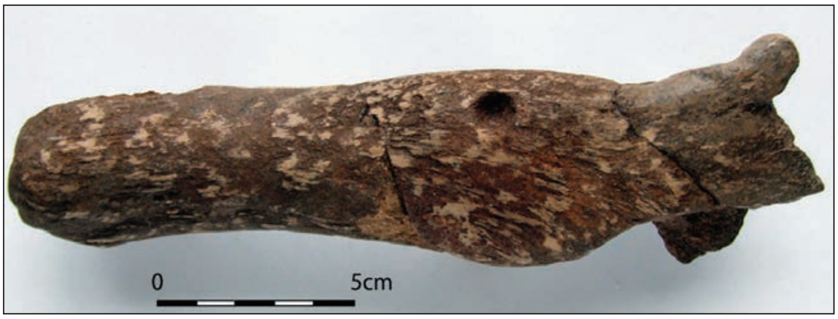

Fig. 14. Grave 46. A horn sceptre.

rial ground more similar to the graves at Krivoluchje (*Vasiliev 1981.106*).

The operation time of the burial ground is pre-determined by close analogies and dates obtained from the bones of skeletons and fragments of ceramics. The date DeA-8214 6442±34 BP (5470–5380 cal BC at 1σ) was obtained from a human tooth. This corresponds to the date obtained from fragments of ceramics from the sacrificial site of the burial ground (*Korolev* et al. *2019 29*), and is close to the date of the human bone from grave 45 (*Korolev* et al. *2018.300*). The dates obtained have a relatively narrow chronological range of approx. 5480–5219 cal BC. The dates obtained on human bones from the Ekaterinovsky Cape burial ground are similar to those for burial grounds at Vasilyevka 5, Nikolskoe, and Yasynuvatka (*Kotova 2018.57–60*). The main characteristics of the funeral rite and inventory also have the closest analogies with the materials of stage 1B and the second stage of the Azov-Dnieper culture (*Kotova 2002.25*). But for a number of samples from human bones in the burial grounds of the Azov-Dnieper culture a reservoir effect is established, which can reach 400–500 years (*Kotova 2018.58*). Therefore, before making

canine teeth, pendants made from animal teeth, bone products, shell and stone beads, knife-shaped plates, and in some cases sceptres) bring together the Ekaterinovsky Cape burial ground with the Mariupol (*Makarenko 1933*), Yasinovatsky (*Telegin 1991*), and Nikolsky burial grounds of Dnieper region (*Telegin 1961.20–26*). The second group of graves are more similar to Murzikhinsky burial ground (half-sitting burial in a pose, stone rings, leaf-shaped tips; *Chizhevsky 2008.367–371*) and I and II Khvalynsky burial ground (crouched on the back of the burial, ochre, sceptres with side ledges, stone bracelets, plates from boar's tusk, shell beads, tips with a truncated base, bone rings and tubules, knife-like plates of flint, small adzes; *Agapov* et al. *1990*). Boar tusk pectoral, a bracelet ring are similar to the Nalchik burial ground (*Kruglov* et al. *1941*). Stone bracelets, shell beads, lines, and pendants make the bu-

Fig. 15. 1 The product from the tusk of a wild boar, grave 50; 2–5 decoration of tusks, martens, grave 70; 6–8 incisors of the marmot, grave 70; 9–11 grave 31; 12 bone tube, grave 70; 13–15 beads from tubular bone, grave 31.

Fig. 16. Sacrificial complex: 1 Rod-hammer, 2 bone wedge. Grave 21: 3 boar's tusk plaque.

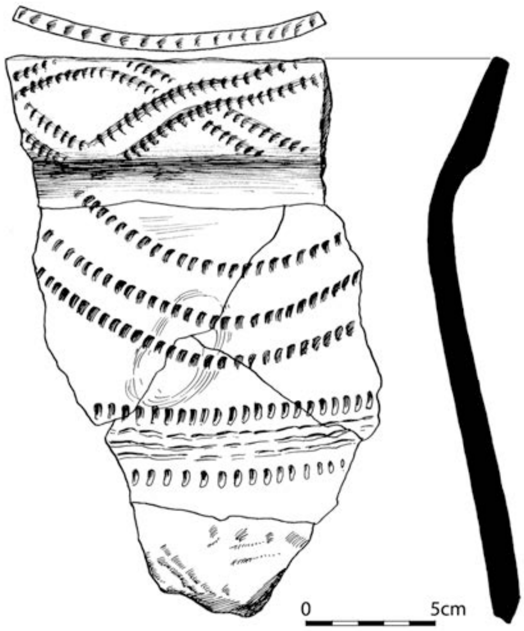

Fig. 17. Ceramics from a sacrificial place.

any final conclusions it is necessary to find out the presence of a reservoir effect in the human bones found in the Ekaterinovsky Cape burial ground.

Conclusion

It should be emphasized that the significance of the Ekaterinovsky Cape burial ground is determined by a number of circumstances. A large number of graves and numerous funeral goods are a representative basis for analysis and analogies. Characteristic features of the funeral rite and inventory give grounds for its inclusion in the burial grounds of the Mariupol historical and cultural region. In the spatial aspect, the contacts of the population of the steppe Volga region with those of the Azov region and the Dnieper in the late Neolithic and early Eneolithic became clearer. The presence in the materials of the burial ground of crouched burials allowed us to combine the materials of the earlier period of the S'ezzhinsky type and the later Khvalynsky. This is an important chronological aspect of the study of this burial ground. The chronology of the burial ground is determined by the first radiocarbon dates, which allow it to be synchronized with stage 1B and the second stage of the Azov-Dnieper culture.

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Personal adornments from the Eneolithic necropolis of Chirnogi-Şuviţa Iorgulescu (Romania): a picture of symbolism in prehistoric communities

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ABSTRACT – *The Necropolis of Chirnogi – Şuviţa Iorgulescu (Călăraşi county) was located on the high terrace of the Danube and was investigated by Done Şerbănescu (in 1989) by means of the archaeological excavations carried out for the construction of the Danube-Bucharest Channel. For this study, we analysed the archaeological assemblage preserved in the Museum of Gumelniţa civilization from Oltenita (Călăraşi county) coming from 10 graves, out of a total of 58, which are attributed to the Gumelniţa culture (the second half of the 5th millennium BC). The personal adornments are mainly bracelets made of* Spondylus *valve (16 specimens) which appear in most of the graves, along with an equal number of perforated plates made of* Sus scrofa *canine, this time the pieces being grouped into two graves. The funeral inventory is complemented by small cylindrical, tubular or biconvex beads, made of various raw materials:* Spondylus *valve, bone, malachite, cooper and green slate. At the technical level, attention is drawn towards the technological transformation scheme of the raw material, which is extremely uniform for the two main categories of ornaments. Also, the analysed pieces showed different degrees of use-wear, demonstrating on the one hand that they were worn before the deposition in graves, and on the other that the accumulation of these items took place over time.*

KEY WORDS – *Gumelniţa culture; raw materials; technological transformation schemes; use-wear marks*

Osebni okras na eneolitskem grobišču Chirnogi-Şuviţa Iorgulescu (Romunija): podoba simbolizma v prazgodovinskih skupnostih

IZVLEČEK – *Grobišče Chirnogi-Şuviţa Iorgulescu (okraj Călăraşi, Romunija) se nahaja na visoki terasi nad Donavo in ga je izkopaval Done Şerbănescu (leta 1989) v okviru raziskav ob izkopu kanala Donava – Bukarešta. Za ta prispevek smo analizirali arheološki zbir, ki je shranjen v Muzeju civilizacije Gumelniţa v Olteniti (okraj Călăraşi), in ga sestavljajo najdbe iz 10 grobov od skupno 58, ki so pripisani kulturi Gumelniţa (druga polovica 5. tisočletja pr. n. št.). Osebni okras sestavljajo predvsem zapestnice, izdelane iz zaklopk Spondylusa (16 primerkov), ki so navzoče v večini grobov skupaj z enakim številom preluknjanih ploščic, izdelanih iz kaninov divje svinje, v tem primeru so najdbe združene v dveh grobovih. Grobni inventar dopolnjujejo majhne cilindrične, valjaste ali bikonveksne jagode, izdelane iz različnih surovin: zaklopk Spondylusa, kosti, malahita, bakra ali zelenega skrilavca. Iz vidika izdelave se posvečamo shemi tehnološkega preoblikovanja surovin, ki deluje zelo poenoteno pri obeh glavnih kategorijah okrasa. Predmeti, ki smo jih analizirali, kažejo tudi različne stopnje sledov uporabe, kar po eni strani kaže na njihovo uporabo preden so bili odloženi v grob in po drugi strani kaže na zbiranje teh predmetov skozi čas.*

KLJUČNE BESEDE – *kultura Gumelniţa; surovine; shema tehnološkega preoblikovanja; sledovi uporabe*

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Introduction

For traditional societies personal adornments have many connotations: they play a central role in the affirmation of identity and represent a visual landmark of belonging to a community, social class, sex or age group (*e.g., Preston-Whyte 1994; Sciama, Eicher 1998; Trubitt 2003; Siklosi 2004; Vanhaeren 2005; etc.*). So, according to the context, they can display for each owner a different message. Generally, the need for individualization in comparison to the others seems to prevail, and this translates into the use of exotic raw materials brought from long distances or of local raw materials that were difficult to obtain, or which did not have a certain significance in dietary habits. Given this multitude of meanings, special emphasis has been laid on the remarkable importance of such ornaments in the reconstruction of social structures within prehistoric communities, the identification of geographic boundaries and, implicitly, the exchange system practiced in these ancient societies (*e.g., Newell* et al. *1990; Taborin 1993; Séfèriadès 1996; Trubitt 2003; Vanhaeren, d'Errico 2006; Szabó* et al. *2007; Rigaud 2011; Rigaud* et al. *2015*). Equally, their study also offers information regarding the technical and economic aspects specific to a human group. The economic aspects introduce into the discussion issues concerning the means of acquiring the raw materials, while the technical ones have to do with the identification of the processing marks and their integration in the operational sequence.

Starting from these general considerations about the nature of the information which the study of personal adornments can offer us, the aim of this paper is to evaluate the artefacts discovered in the graves attributed to the Gumelniţa culture (in the second half of the 5th millennium BC), from the necropolis of Chirnogi-Şuviţa Iorgulescu. For this study, we analysed the archaeological assemblage preserved in the Museum of Gumelniţa civilization from Olteniţa (Călăraşi county) coming from 10 graves out of a total of 58 from this period (*Şerbănescu 1996; 2008*). We have adopted the following goals: determining the sources of raw material acquisition (local and exotic), drawing the technological transformation schemes of the raw materials and the identification of use-wear marks which would indicate the use of artefacts prior to the depositing as funeral inventory.

The methodology used in this study relied on macroscopic and microscopic analysis of the technological and use-wear marks found on the archaeological items. The personal ornaments were microscopically examined using a Keyence VHX-600 digital microscope, with magnifications ranging from 30x to 150x, while the images were taken using a microscope digital camera. The analytical criteria for the technological and functional interpretations were established by referring to recent publications on the use of personal ornaments in prehistoric contexts (*e.g., Bonnardin 2009; Rigaud 2011; 2013; Cristiani, Borić 2012; Vanhaeren* et al. *2013; Cristiani* et al. *2014; Tata* et al. *2014; Rigaud* et al. *2015; Langley, O'Connor 2016; Clark* et al. *2018; Guzzo Falci* et al. *2018*).

Archaeological background

The necropolis of Chirnogi-Şuviţa Iorgulescu (Fig. 1) was placed on the high terrace of the Danube River in south-east Romania, north of the Balkan Peninsula. It is situated in the vicinity of the multilayered settlement of Căscioarele and several Neolithic necropolises around Chirnogi area. Based on the archaeological features uncovered within the necropolis of Chirnogi, it was determined as belonging to the Eneolithic Gumelniţa culture (in the second half

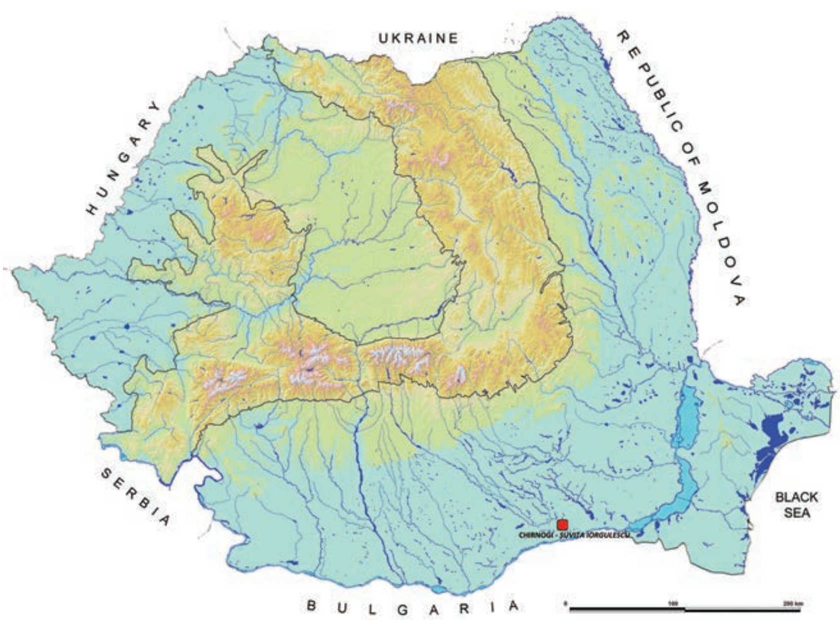

Fig. 1. Location of the Chirnogi-Şuviţa Iorgulescu necropolis.

of 5th millennium BC), part of the Kojadermen-Gumelniţa-Karanovo VI culture (*Şerbănescu 1996; 2008*).

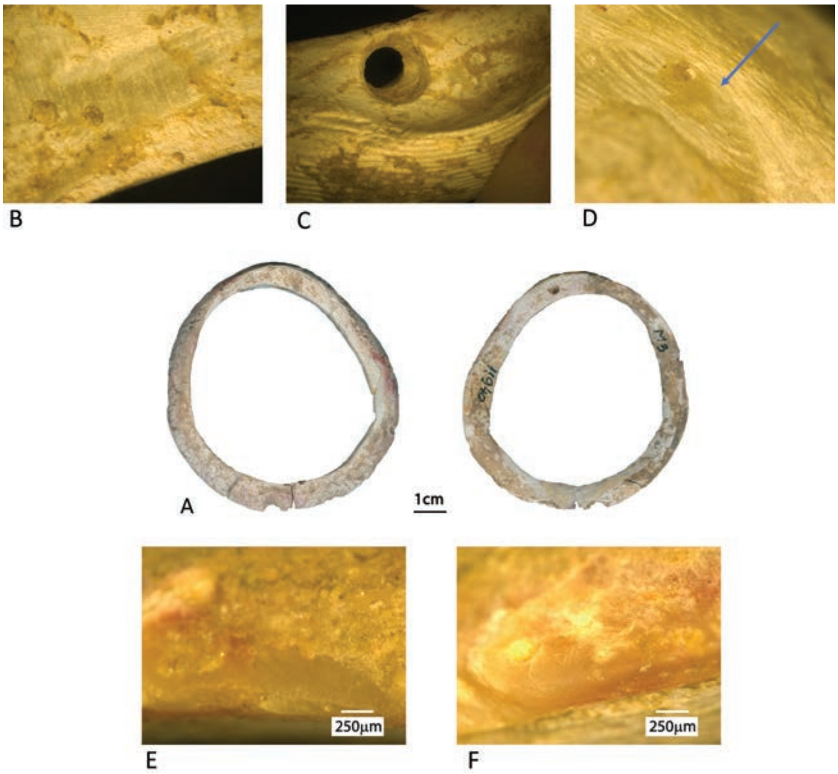

Fig. 2. **A Spondylus** ***bracelet (grave no. 3);*** **B** ***abrasion marks;*** **C** ***perforation detail;*** **D** ***use-wear depression;*** **E, F** ***use-wear marks.***

It was discovered by Barbu Ionescu in 1961 when excavations of terraces were carried out in the area. He made the first archaeological surveys and found a grave in a crouched position. Done Şerbănescu undertook rescue archaeological excavations in 1989 on the occasion of the excavations carried out for the construction of the Danube-Bucharest Channel (*Bălteanu, Cantemir 1991*).

As a result of these, 74 graves from various historical periods have been discovered. Most of the graves belonged to the Gumelniţa culture, 58 graves, with three graves from post-Neolithic periods, while for 13 graves the funeral inventory was missing and could not be attributed to a historical period (*Şerbănescu 1996*).

According to the anthropological data (*Bălteanu, Cantemir 1992*), 62 skeletons were discovered in the Chirnogi-Şuviţa Iorgulescu necropolis, with these from 36 men and 13 women, with 13 of indeterminate sex. Most were mature people (37 skeletons), followed by young adults (20–30 years, 11 skeletons), with children and adolescents being represented by 10 skeletons. The bodies were buried in a crouched position, predominantly oriented towards ESE. The graves were oval-shaped and irregular, their depth, compared to the current level, being –0.10/–1.00m.

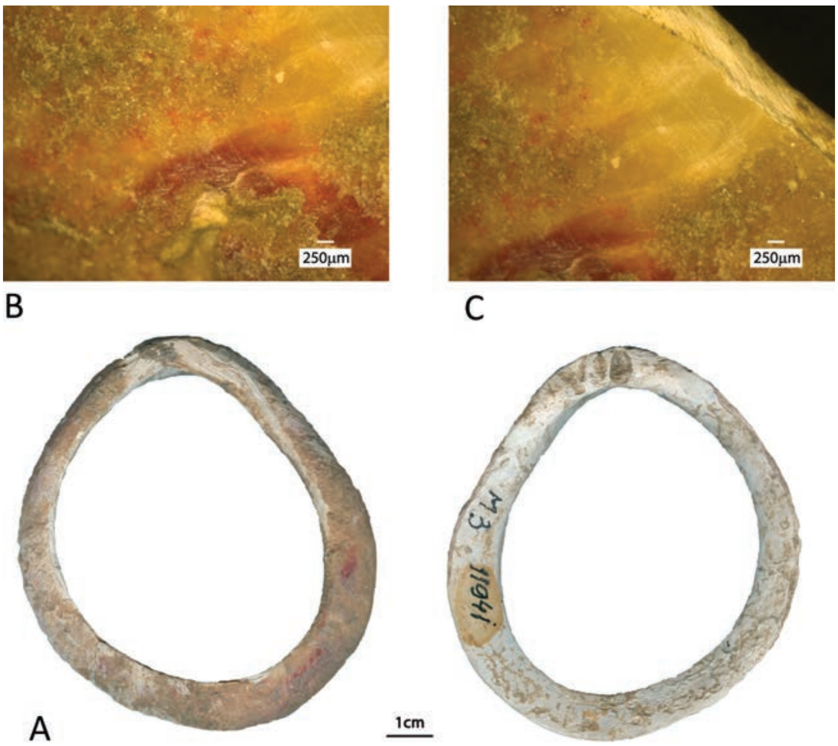

Fig. 3. **A Spondylus** ***bracelet (grave no. 3);*** **B, C** ***abrasion marks.***

Although there are two anthropological studies (*Bălteanu, Cantemir 1991; 1992*), no archaeological data has been published to allow the correlation of the skeletons with the various funerary inventories. Thus, at this point, we know from what graves come the adornments but cannot asso-

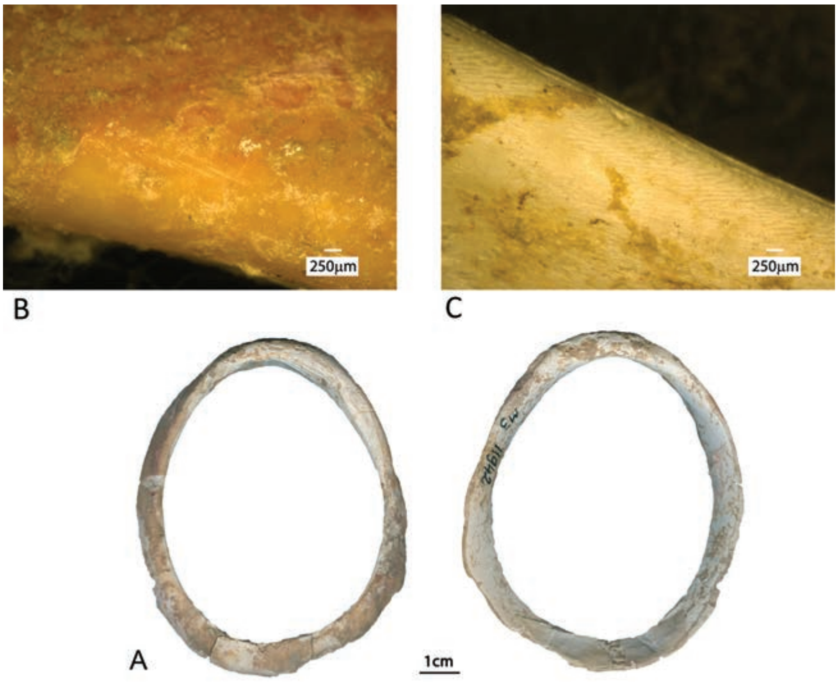

Fig. 4. **A Spondylus** ***bracelet (grave no. 3);*** **B** ***abrasion marks;*** **C** ***use-wear marks.***

ciate them with a skeleton. We also do not have data on their position in the graves or in relation to the skeleton, or if the graves contained other offerings. Consequently, we cannot make any considerations about the eventual distribution of ornaments by age or gender.

Funeral inventory

Grave no. 3 contains four bracelets made of *Spondylus* valve as funeral inventory. The first bracelet (Fig. 2A) is complete, medium preserved on its surface. The natural edge of the valve was retained and removed from the convex area by abrasion. The external surface of the bracelet was also adjusted by abrasion (Fig. 2B). This side still preserves small red spots, but much of the exterior layer was removed by the shaping procedure. The same procedure was also applied to the internal side, at the level of the cardinal plateau, in order to completely eliminate the cardinal teeth and pits and to confer the rectangular section of the piece. The bracelet presents a perforation at the level of the pits (Fig. 2C) which ensures the catching of a thread, so a small use-wear depression has been formed towards the end (Fig. 2D). The wall of the hole and the internal side are strongly smoothed and the surface is fine to the touch – probably due to use-wear/friction (Fig. 2E-F). The outer diameter of the piece is 70mm and the inner diameter is 53.8mm.

The second bracelet (Fig. 3A) is not so well preserved, having side deposits that almost entirely cover the natural red colour on its exterior. The valve modification procedure is similar to the previous piece, only not so rigorous, in the sense that it still bears traces of cardinal pits and teeth. In spite of the surface deposits, we identified marks specific to the shaping operation on the exterior side, very visible compared to other specimens (Fig. 3B-C). Nevertheless, we were not able to identify any use-wear marks of this piece under the microscope. The outside diameter is 66.2mm and the inside diameter is 47 mm.

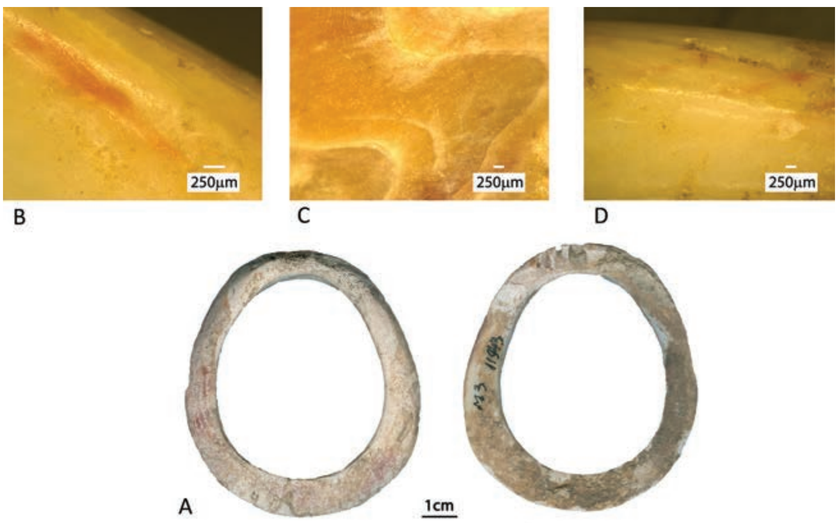

Fig. 5. **A Spondylus** ***bracelet (grave no. 3);*** **B, C** ***abrasion marks;*** **D** ***use-wear marks.***

Similarly to the first item, the third one (Fig. 4A) was rigorously abraded (Fig. 4B), eliminating the total cardinal plateau as well as the red exterior layer. The bracelet is degraded, with deposits on the external face, so we could not identify any use-wear marks

(Fig. 4C). Morphometric data are as follows: an outer diameter of 64mm, and inner diameter of 52mm.

The last item (Fig. 5A) is well preserved, allowing data to be obtained on the presence of use-wear. In this case, a portion of the cardinal plateau is still present on the internal side. The exterior side was also carefully shaped (Fig. 5 B-C), but an oval, not rectangular section was created, like in the other examples described above. Even though the internal side has significant deposits, in small areas we were able to identify use-wear marks (Fig. 5D), probably resulting from the skin/clothes friction process. The outer morphometry of the piece is 65.6mm and the inner one is 46mm.

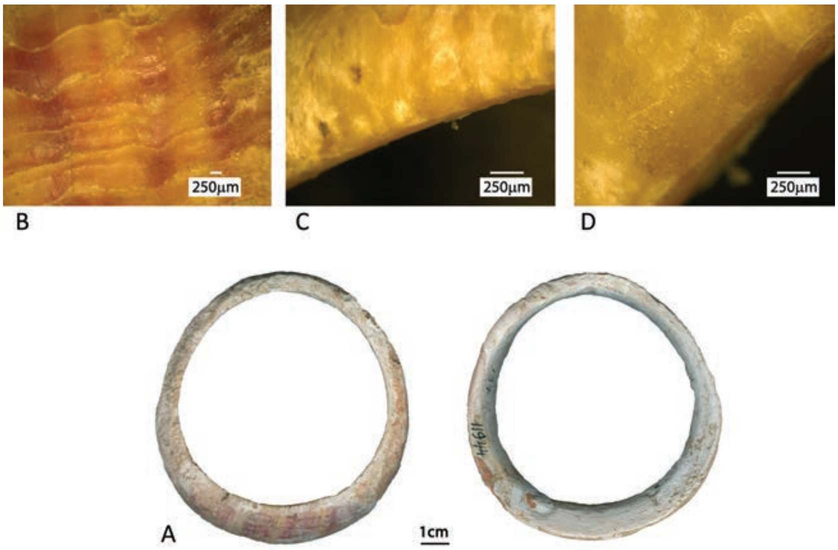

Fig. 6.* A Spondylus *bracelet (grave no. 7);* B *abrasion marks;* C, D *use-wear marks.

Grave no. 7 contained a single bracelet (Fig. 6A), similar to those found in the *grave no. 3*. The item is complete, very well preserved, without significant deposits on the surface. There is an identical technological procedure with regard to the raw material transformation, after which the piece acquired an oval section at the ventral level and a rectangular section at the umbo area. The external side retains areas of red colour with a special aesthetic impact (Fig. 6B). Both the perforation wall and the internal side have a regular fine surface with a macroscopic polish (Fig. 6C-D), indicating the piece was worn before becoming a funeral inventory. The outer diameter of the bracelet is 84mm and the inside diameter is 65.2mm.

The grave inventory is completed with 30 beads (Fig. 7A), of which: 20 are cylindrical, nine biconvex and one tubular. The morphological differences are mainly given by the shaping procedure which created the rectilinear or convex sides. All items have a circular perforation in the centre. We could not identify debitage marks for any of the specimens, due to subsequent technological interventions. From the raw material block, a blank which was perforated by bifacial rotation was obtained (Fig. 7B, E, H, K). In a second stage, the surface was shaped by abrasion (Fig. 7C, F, I, L) to give the pieces their circular shape. The beads show use-wear marks, which confirms they were worn. The perforations have small depressions,

No.	Raw material	Diameter (mm)	Thickness (mm)	Perforation diameter (mm)
1	*Spondylus*	7.80	5.75	3.17
2	*Spondylus*	7.58	4.72	3.02
3	*Spondylus*	5.52	2.65	2.40
4	*Spondylus*	4.80	2.95	2.38
5	*Spondylus*	4.12	2.03	1.92
6	*Spondylus*	4.84	3.58	2.20
7	*Spondylus*	4.32	5.78	2.44
8	*Spondylus*	5.12	3.95	2.06
9	*Spondylus*	3.97	2.42	1.52
10	*Spondylus*	4.54	1.76	1.88
11	Bone	4.20	1.98	2.04
12	Bone	5.40	3.20	2.48
13	Bone	5.20	2.90	2.16
14	Bone	5.80	2.30	2.20
15	Malachite	5.16	2.72	1.54
16	Malachite	4.26	1.62	1.48
17	Malachite	4.38	1.92	1.28
18	Malachite	3.90	1.74	1.56
19	Malachite	4.10	2.23	2.04
20	Malachite	4.64	1.56	2.25
21	Green slate	5.52	2.88	2.46
22	Green slate	5.06	2.50	2.24
23	Green slate	6.65	2.94	2.45
24	Green slate	4.52	2.48	2.20
25	Green slate	4.49	1.42	2.17
26	Green slate	5.25	3.09	1.90
27	Green slate	4.53	1.94	2.16
28	Green slate	5.59	2.76	2.24
29	Green slate	3.96	1.80	1.83
30	Green slate	5	2.48	2.23

Tab. 1. Sizes of the beads discovered in grave no. 7.

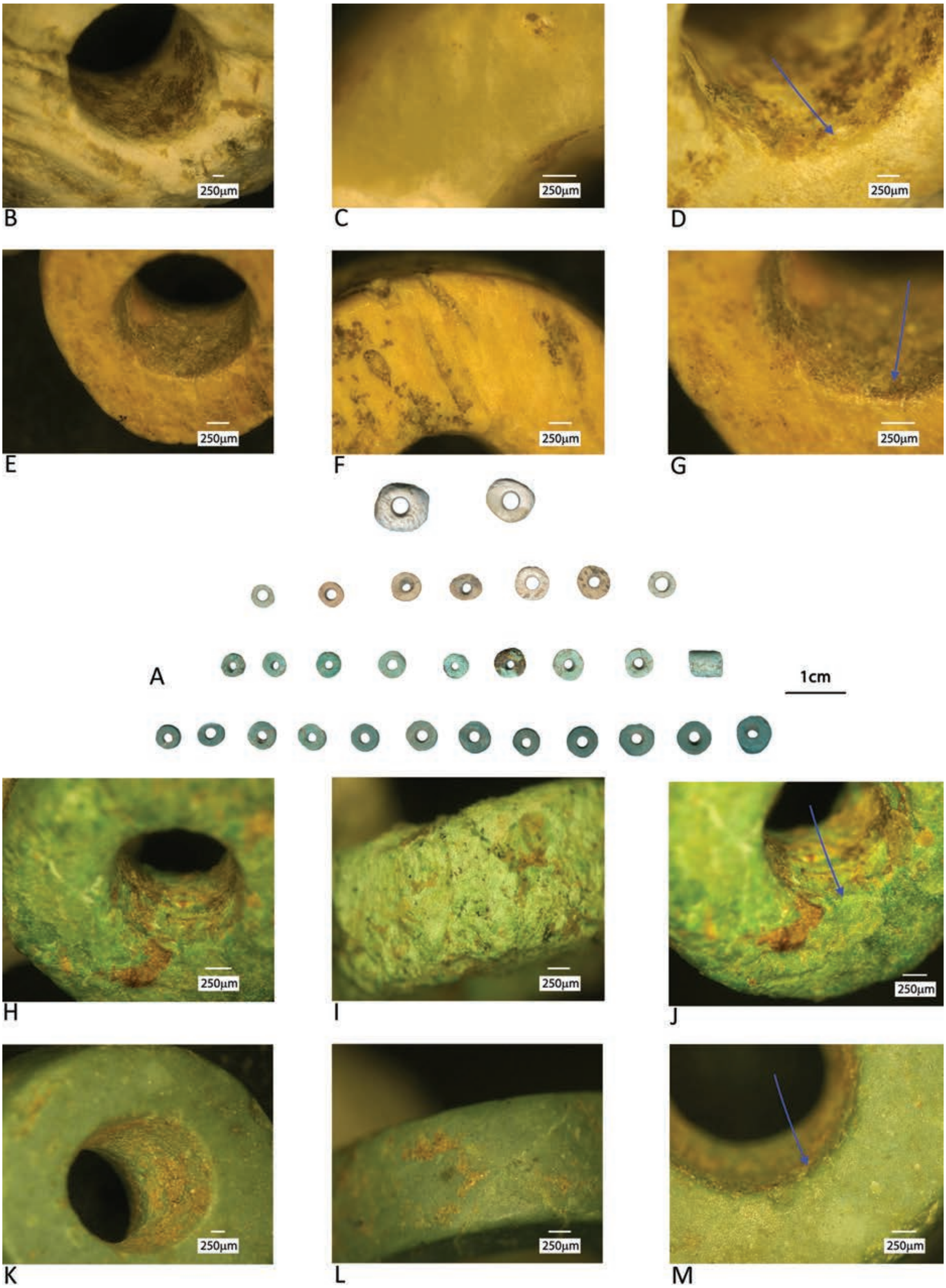

Fig. 7. A ***beads made of various raw materials;*** B, E, H, K ***perforation details;*** C, F, I, L ***abrasion marks;*** D, G, J, M ***use-wear depressions at perforations level.***

characterized by a wall deformation, the disappearance of rotation scratches and a macroscopic polish (Fig. 7D, G, J, M). This type of use-wear appeared as a result of placing several pieces on a thread in the form of necklaces or bracelets. The morphometric data are presented in the Table 1.

Grave no. 15 is similar to no. 3, having four bracelets made of *Spondylus* valve, of which there are two full pieces and two fractured ones. The technological transformation scheme of the valve is identical, except the method of shaping at the umbo level, which determined an oval (two items) or rectangular (two items) section. One of the pieces is very well preserved (Fig. 8A-B), with a use-wear area on the internal wall characterized by macroscopic polish and perpendicular fine scratches (Fig. 8C-D), also indicating in this case the previous use of the bracelet before its deposition as a funeral item. The dimensions of the items are as follows: 1. outer diameter 73mm, inner diameter 56mm; 2. outer diameter 73mm, inner diameter 58mm; 3. outer diameter 68.5mm, inner diameter 56mm; 4. outer diameter 78mm; inner diameter 63.59mm.

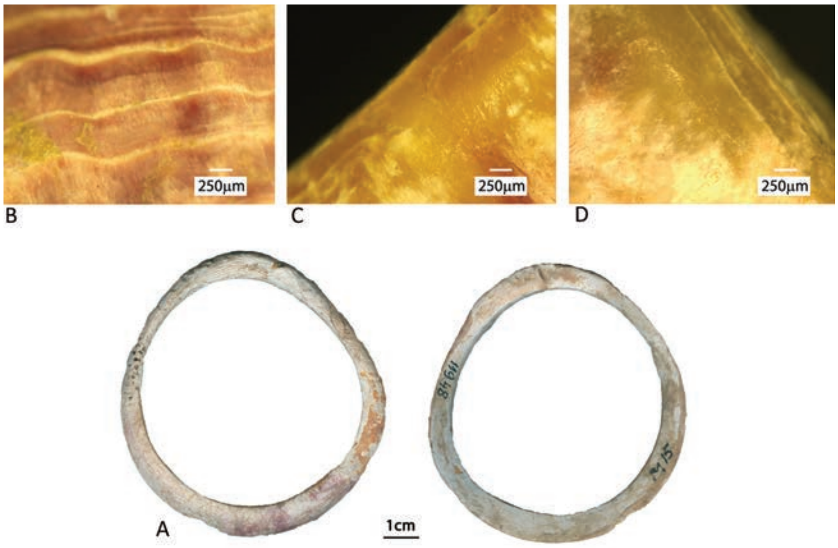

Fig. 8. **A Spondylus** ***bracelet (grave no. 15);*** **B** ***abrasion marks;*** **C, D** ***use-wear marks.***

Two bracelets made of *Spondylus* valve were inventoried in *grave no. 16*. The surface of the first item is rather damaged. As a result of abrasion, the piece has a rectangular section at the umbo level. The outside diameter of the piece is 86mm and the inner diameter 63mm. The second bracelet (Fig. 9A) is exceptionally well preserved and has, in addition, a more intense abrasion (Fig. 9B), the wall being very thin with a circular section. The use-wear of the piece is advanced, with macroscopic polish on the inner wall and the internal side (Fig. 9C-D). The outside diameter of the piece is 79mm and the inner diameter is 66mm.

Grave no. 17 contained a single bracelet from the *Spondylus* valve (Fig. 10A). It is intact and differs from the previously described specimens given the obvious preservation of a part of the cardinal plateau, which creates a special morphology. Being that well preserved, we could identify on its external side scratches resulting from the abrasion procedure (Fig. 10B). The use-wear is characterized by an intense polish and scratches perpendicular to the hole bracelet (Fig. 10C-D). The outside diameter is 77mm and the inner diameter 63.5mm.

The funeral inventory is much more complex in the case of this grave, being composed of nine perforated plates made of *Sus scrofa* canines (Fig. 11). Unfortunately, the whole assemblage has a relatively degraded surface and, moreover, the pieces were co-

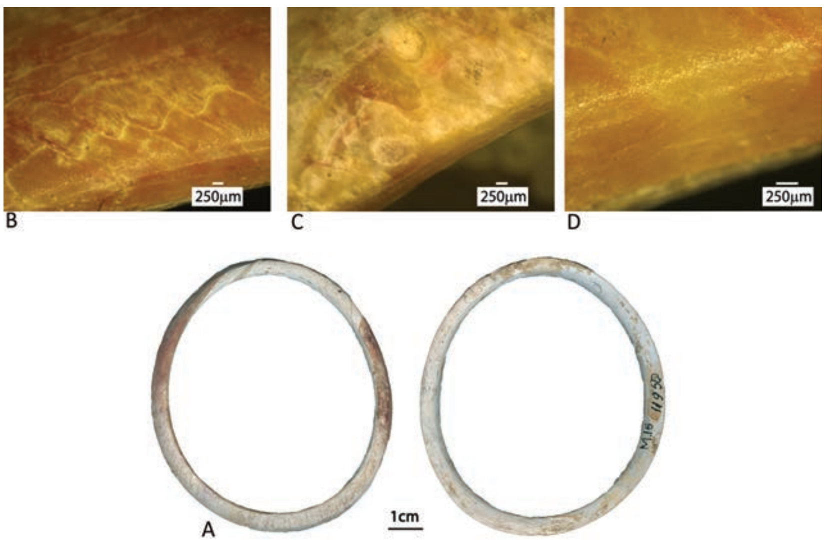

Fig. 9. **A Spondylus** ***bracelet (grave no. 16);*** **B** ***abrasion marks;*** **C, D** ***use-wear marks.***

No. of piece	Length (mm)	Medium width (mm)	Thickness (mm)	Medium diameter of perforation (mm)
1	49	8.6	3.8	4
2	48.2	13.2	3.6	4
3	50.8	14	4.6	4.8
4	51	9.6	4.3	3.8
5	61	14	5.2	4.8
6	55	15	5	4.5
7	47	13	4	4.3
8	46	18.2	4	5.2
9	45.3	17	4.6	4.4

Tab. 2. Dimensions of perforated plates made of* Sus scrofa *canines found in grave no. 17.

vered with a layer of varnish which, in some cases, cracked away from the tooth's enamel through dehydration. However, the detailed analysis allowed us to reconstitute the technological transformation schemes of the raw material as well as the gripping system of the pieces. Two of the specimens have a triangular morphology (Fig. 11A, C). The other seven plates (Fig. 11B, D-I) have a quasi-rectangular morphology, a convex-concave section with biconcave edges. Regardless of morphology, the same procedures were used to obtain the finished items. The tooth was cut longitudinally and the scraping did not help us identify the procedures due to the shape of debitage edges, overlaid with abrasion (Fig. 12A-B). Transversally, the segmentation at both ends was achieved by sawing. The procedure is illustrated by several marks left at the periphery of the segmentation plane (Fig. 12C-D), which was then abraded. The internal side of the plates has been adjusted by abrasion (Fig. 12E-F). Three or four perforations – on each item – were made by bifacial rotation (Fig. 12G-H).

It was not possible to identify the use-wear marks due to the fact that the pieces were covered with varnish. It has become obvious that the only element of use-wear identification consists in changes of the initial volume comprising small depressions at the perforation level, identified on the internal side in the area between the perforations associated with the disappearance of rotation scratches (Fig. 12I-K). On the external side, the use-wear resides in the formation of a small flattened facet associated on some specimens (probably with an advanced use-wear) with the appearance of a small depression (Fig. 12L). The use-wear details show us the individual sewing of the perforated plates. Morphometric data are as follows (Tab. 2).

A *Spondylus* bracelet was discovered in *grave no. 36*, unfortunately fractured and poorly preserved. The natural shape has been preserved and has been removed from the convex side through an identical procedure to the one showed for the bracelets described above. The outer diameter is 88mm and the inner diameter is 76mm. The same raw material was also used to make two tubular beads (Fig. 13A). They have a circular section and parallel rectilinear sides. We could not identify marks of the debitage operation because of the technological interventions during the shaping operation. In addition, the items have a degraded surface (Fig. 13B). The perforation was made by bifacial rotation. The rotation scratches are difficult to identify within the perforation (Fig. 13C). The morphology of the extremities is generally strongly rounded with the appearance of a small concavity (Fig. 13D). We assume this area was affect-

No. of piece	Length (mm)	Medium width (mm)	Thickness (mm)	Medium diameter of perforation (mm)
1	44	13	4	4,8
2	53	17,5	4	4,5
3	54	16	3,8	4,5
4	50	15,6	3,5	4,2
5	64,4	17,6	4,5	4,8
6	54	15,6	4	4
7	50	17	4	4m5

Tab. 3. Dimensions of perforated plates made of* Sus scrofa *canines found in grave no. 36.

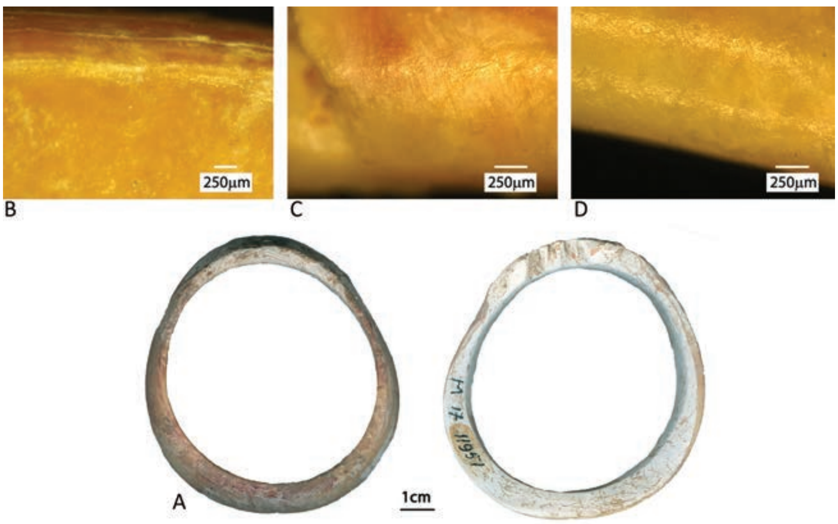

Fig. 10.* A Spondylus *bracelet (grave no. 17); B abrasion marks; C, D. use-wear marks.

ed by use-wear. Morphometric data for the two beads are as follows: 1. length 21.6mm, diameter 5.5mm, perforation diameter 3.7mm; 2. length 16mm, diameter 5.5mm, perforation diameter 3.5mm.

Fig. 11. Perforated plates made of* Sus scrofa *canines (grave no. 17).

Seven perforated plates made of *Sus scrofa* canines were also discovered in this grave (Fig. 14). The pieces have an approximately rectangular morphology, a convex-concave section and biconcave edges. A longitudinal bipartition of the tooth was applied in order to obtain the blank. We were not able to identify the debitage procedures due to the shaping of the edges by abrasion (Fig. 15A-B). The interior side was also cleaned through abrasion (four pieces) (Fig. 15C), longitudinal scraping (1 piece) (Fig. 15D) or combining both techniques (two pieces). Segmentation was performed by sawing (Fig. 15E) which was then overlaid with abrasion (Fig. 15F). At the corners, four perforations were made by bifacial rotation. Unlike the items from the previous grave, where the use-wear was quite unitary for all the specimens, in this case we deal with different degrees of use-wear. Thus, we have specimens for which the perforations preserve the rotation scratches with no depression development in the peripheral area, the use-wear being absent (Fig. 15G-I). There are also items where the wear depression starts to form (Fig. 15J) or items characterized by the development of depressions (both on the internal and external sides) (Fig. 15K-L), which illustrate long-term use. The gripping system is identical to the perforated plates from *grave no. 17*, which means individual sewing.

Grave no.	Raw material	Typological category	Number of pieces
M3	*Spondylus*	bracelet	4
M7	*Spondylus*	bracelet	1
		tubular bead	1
		biconvex bead	2
		cylindrical bead	7
	bone	cylindrical bead	4
	malachite	biconvex bead	6
	green slate	cylindrical bead	9
		biconvex bead	1
M15	*Spondylus*	bracelet	4
M16	*Spondylus*	bracelet	2
M17	*Spondylus*	bracelet	1
	Sus scrofa tooth	perforated plate	9
M36	*Spondylus*	bracelet	1
		tubular bead	2
	Sus scrofa tooth	perforated plate	7
	copper	circular bead	2
M64	*Spondylus*	bracelet	2
M68	copper	circular bead	1
M69	*Spondylus*	bracelet	1
M71	copper	circular bead	1

Tab. 4. The funeral inventory according to the grave number.

From the same grave, there are two circular beads made of copper foil (Fig. 13E). The overlapping area of the foil edges is still visible (Fig. 13F-G). Even on this type of objects a deformation of the initial volume can be identified, as a result of their use. Thus, at one of the specimens the perforation is deformed, with the appearance of a small concavity (Fig. 13H), while the end has a smoothed aspect, most likely resulting from the friction and pressure of the thread. The dimensions of the items are as follows: 1. length 7.8mm, diameter 6.4mm, inner diameter 4.3mm; 2. length 4.4mm, diameter 4.1mm, and inner diameter 1.9mm.

Grave no. 64 contains two thin *Spondylus* valve bracelets, unfortunately quite degraded in the surface, so technological and use-wear marks are difficult to be identified. However, the same method of abrasion appears clearly on both sides, with the elimination of the cardinal plateau, the pieces gaining a circular section. We were able to detect the morphometric data for one piece: outer diameter 76mm and inner diameter 51mm, the other being fractured.

In *grave no. 68* a single personal adornment was identified, a circular bead of copper foil. A small concavity on the extremity resulting from the use-wear of the piece is visible. Its diameter is 8.8mm, the thickness of 7.3mm, and the inner diameter of 5.7mm.

Grave no. 69 containes a *Spondylus* bracelet (Fig. 16A), very well preserved. An abrasion was applied to the entire surface (Fig. 16B-C), eliminating most of the cardinal plateau (Fig. 16D). The item has a rectangular section at this level. On the internal side and on the walls of the opening the surface is smoothed. This procedure is marked by a powerful macroscopic polish and fine scratches (Fig. 16E-G). The outer diameter is 82mm and the inner diameter is 62.5mm.

Finally, in *grave no. 71* a circular copper bead was discovered (Fig. 17A-C), unfortunately fractured. Its

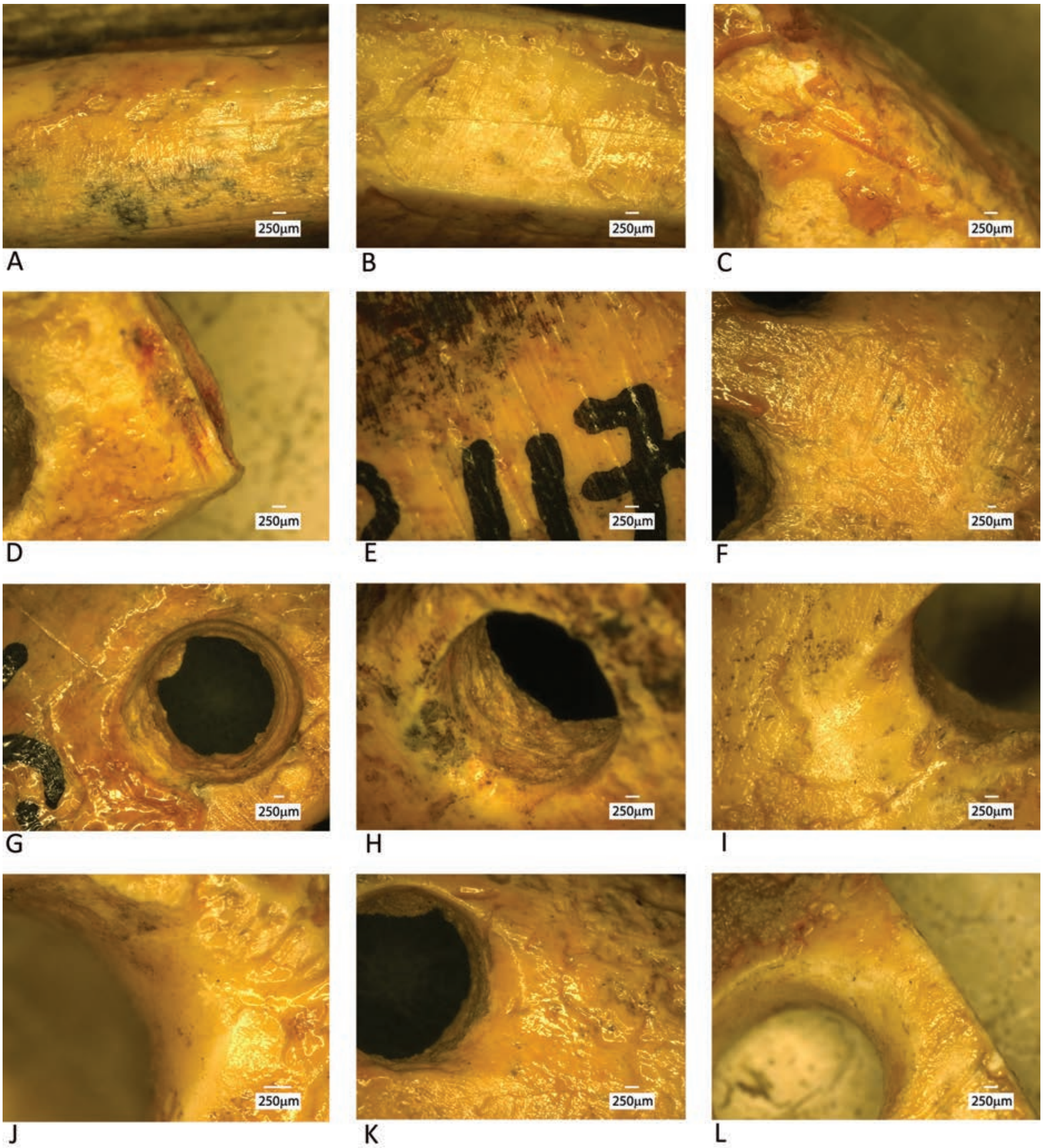

Fig. 12. **A, B *shaping of the debitage edges;* C, D *sawing marks;* E, F *abrasion marks;* G, H *perforation details;* I, J, K, L *use-wear deformation at perforations level.***

dimensions are: 9mm diameter, 6.8mm length, and 6mm inner diameter.

Discussion

Spondylus valve was mainly processed into bracelets (16 items). We assume this type of adornment has a significant value since a whole valve was used for a single bracelet, in contrast to the small beads – several pieces of this type being produced from a single valve. The study of these items (regardless of their place of occurrence) proves a special unity of the technological transformational scheme, illustrating a true 'fashion' with regard to thin bracelets. Moreover, the existence of this fashion is confirmed by the presence of at least one bracelet in almost each grave.

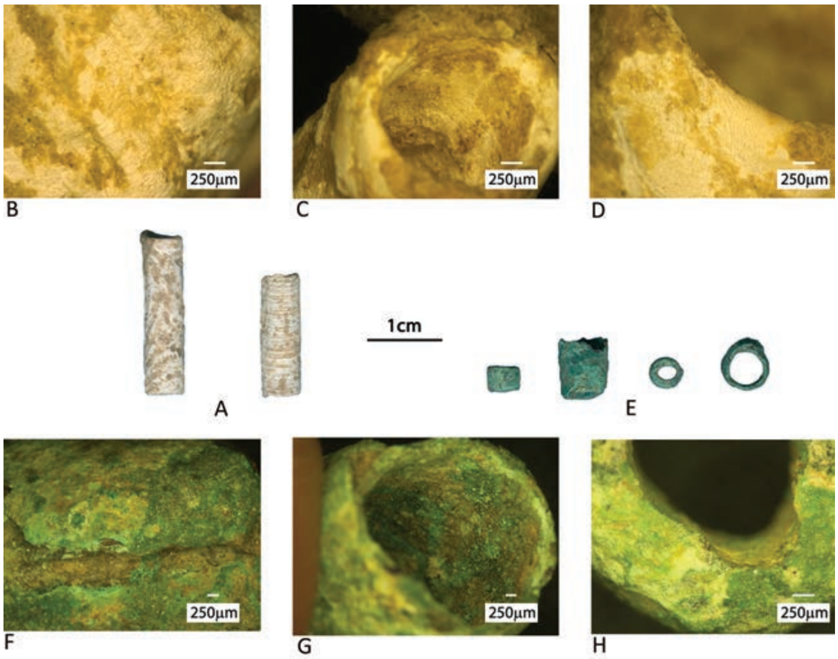

Fig. 13. **A Spondylus** ***tubular beads (grave no. 36);*** **B** ***surface detail;*** **C** ***perforation detail;*** **D** ***use-wear concavity;*** **E** ***beads made of copper foil (grave no. 36);*** **F** ***overlapping area of the foil edges;*** **G** ***perforation detail;*** **H** ***deformation of perforation.***

The two valves composing the mollusc are different in shape and thickness (*Borrello, Micheli 2004*). The left valve (the upper one) is quite fine, more rounded, shaped like a lid, having small ears on each side of the ligament and a relief of prominent thorns all over its surface. On the right valve (the lower one), which is longer and thicker, concentric lamellas are developed in relief. These different morphological aspects have generated constraints and determined the selection in order to create a certain type of object. Thus, for the bracelets discovered in the necropolis of Chirnogi, only the left valve could be used to obtain bracelets with a round morphology, while for making beads it seems the right valve has been used (*Tsuneki 1989*).

A method of processing through abrasion was applied to all specimens. On the external side, the median area of the valve was removed. The valve was also abraded on the internal side in order to remove the cardinal plateau. The scratches specific to the shaping procedure are difficult to identify due to the valve structure and various forms of surface damage. Specimens with a better preserved exterior have a

Fig. 14. Perforated plates made of **Sus scrofa** ***canines (grave no. 36).***

fine area to touch, with a macroscopic polish on the internal side.

The issue regarding the origin of this mollusc species has not yet been resolved. Michel L. Séfèriadès (*1996; 2000; 2010*) and Paul Halstead (*1993*) thus consider they are of Mediterranean origin, denying the existence of this species in the Black Sea. In contrast, Henrietta Todorova (*2002*) speaks about the possibility of a Black Sea origin. A practice often encountered with a series of prehistoric communities is that of using fossil species as well, yet the differentiation between the living valves and the fossil ones can only be made using isotopic analyses (*Shakelton, Renfrew 1970; Shakelton, Elderfield 1990; Vanhaeren* et al. *2004*). The studies carried out so far (*Bajnóczi* et al. *2013*) indicate that, at the level of the European Neolithic, the used blanks were bivalves coming from the Mediterranean Sea and not from fossil deposits or from the Black Sea.

Another specific element to the Chirnogi community is the perforated plates of *Sus scrofa* canine. Again, it draws our attention to the technological scheme

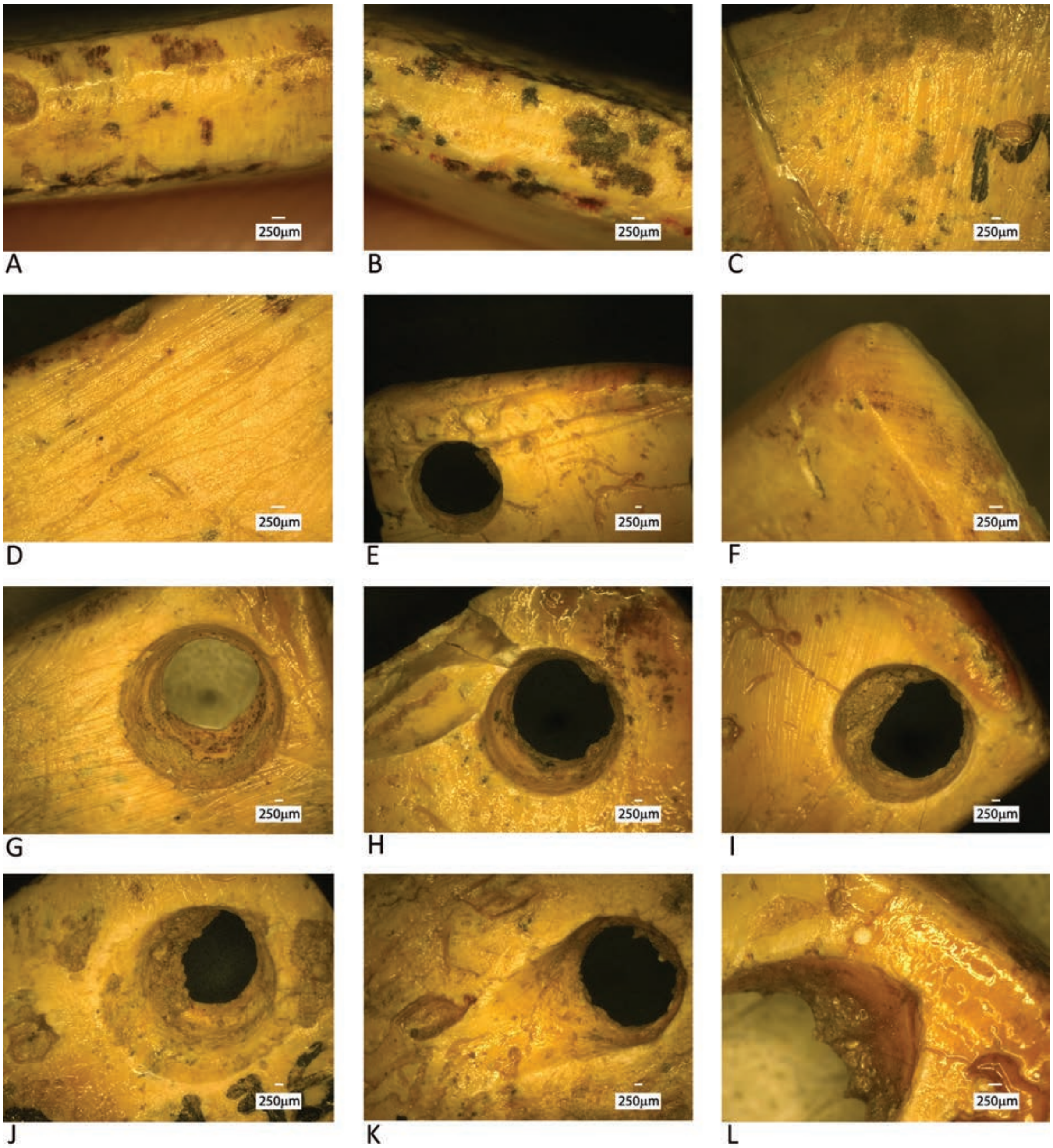

Fig. 15. **A, B** ***shaping of the debitage edges;*** **C, D** ***shaping or the interior side;*** **E** ***sawing marks;*** **F** ***abrasion marks;*** **G, H, I, J** ***perforation details;*** **K, L** ***use-wear deformation at perforations level.***

of raw material transformation, which proves to be extremely unitary. A bipartite debitage method was used, combined with a segmentation debitage. If in the first case we could not determine the techniques, in the case of segmentation the sawing technique was used. The surface modification procedures were abrasion and scraping combined on certain items, while the only volume modification procedure was the perforation with a single technological variant: the bifacial rotation. We have identified marks that show these pieces have been worn in the form of *appliqués* sewn to the garments, before being deposited in the graves. However, the degree of use-wear is variable among items, indicating the pieces were sewn at different time intervals.

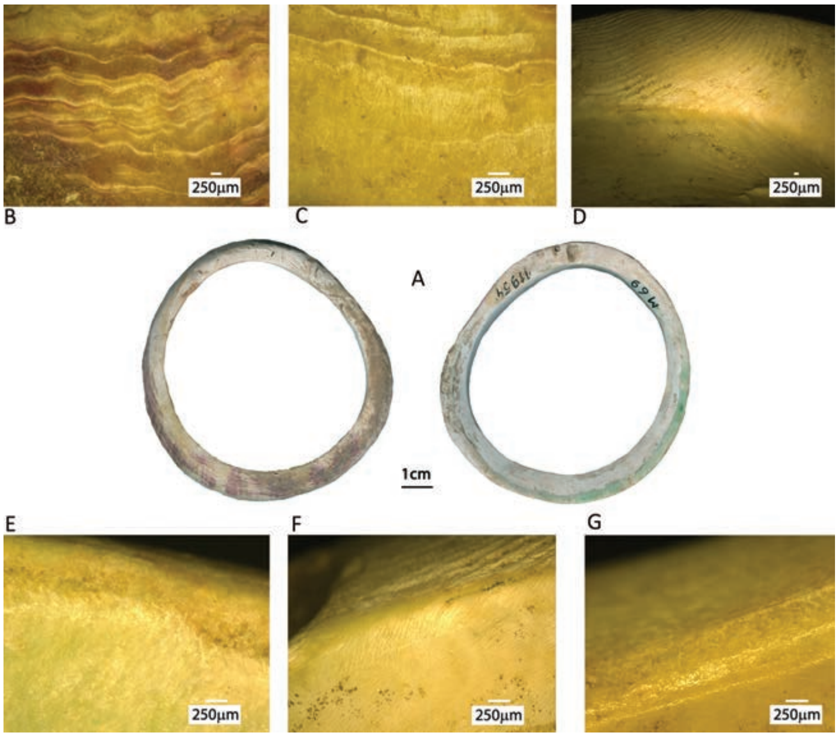

Fig. 16. **A Spondylus *bracelet (grave no. 69);* B, C, D *abrasion marks;* E, F, G *use-wear marks.***

The small beads of various raw materials also illustrate similar procedures applied mainly in the shaping operation, with the execution of a bifacial rotation perforation and a fine abrasion to give the piece the desired shape. These beads were clearly worn, showing small depressions at the periphery of the perforation resulting from the gripping system. The pieces were placed on a thread in the form of necklaces.

The identification of the sources for the raw material used to create adornments is crucial because, maybe more than any other artefact category, an adornment may provide indicators in connection to the limits within which the human groups moved or in connection to their exchange networks. Being exclusively pieces from the funeral inventory, they had reached the finishing stage of their processing. Thus, in the case of plates of *Sus scrofa* canines or beads of lithic materials, bone and copper, we cannot say whether they were made by the local community or if they reached it through exchanges. Only in the case of the *Spondylus* valve can we assume this is an import. The variables which can be invoked are those of a direct import of raw material or of the already finished pieces and, at the same time, of direct exchange or movement from group to group (*kula*-like exchanges, as those from Polynesia). The archaeological evidence supports the existence of specialized centres in the processing of *Spondylus* valves, especially on the actual territory of Greece, Montenegro, Albania and Croatia (*Séfèriadès 2010*). For other territories, the rarity and importance of this valve obligated the communities to recycle the raw material in the situation of the fragmentation of the pieces – see the case of Hârşo-

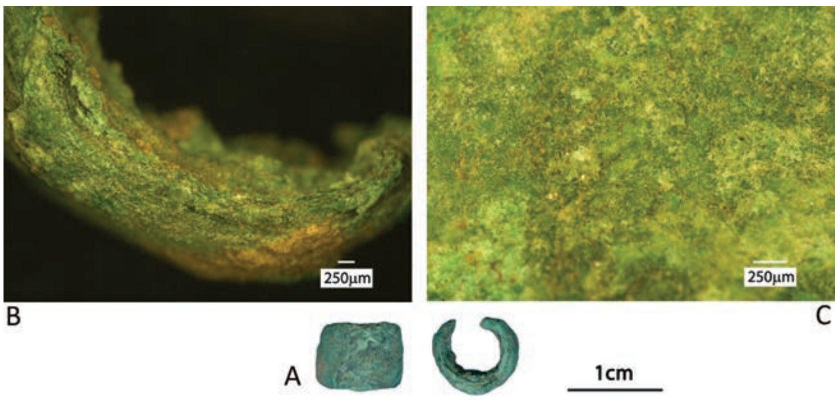

Fig. 17. **A *copper bead (grave no. 71);* B, C *surface details.***

va (Romania) (*Galbenu 1963*) or Omurtag (Bulgaria) (*Gaydarska* et al. *2004*). Moreover, the probable difficulty in procuring this raw material forced the Chirnogi community to imitate the ornaments of this raw material in bone, as we have seen in grave no. 7. The situation is not unique, as it is also identified in the necropolis of Sultana-Malu Roşu (*Lazăr* et al. *2009*).

Following this analysis, it is clear that the assemblage has an advanced degree of use-wear, demonstrating that the artefacts were worn before their deposition in graves. The existence of use-wear marks on the specimens identified in prehistoric graves was also recorded in other studies (*e.g., Beldiman* et al. *2008; Polloni 2008; Bonnardin 2009; Mărgărit, Vintilă 2015; Lazăr* et al. *2018, etc.*) and it seems to be a common practice, so we cannot assume these kinds of ornaments were created for the unique purpose of being deposited in graves. Another important observation related to the studied archaeological assemblage is the variable degree of use-wear of items from the same archaeological context, *i.e.* the boar tooth perforated plates found in two graves. As we have already pointed out, the plates in *grave no. 7* have an advanced and quite unitary wear, while in *grave no. 36* the degree of use-wear varies between items, demonstrating their accumulation over the years.

This study provides us with a picture of the symbolism in the human community at Chirnogi from the second half of the 5th millennium BC, for which two types of personal adornments – the thin bracelets of *Spondylus* valve and the perforated plates of the *Scrofa scrofa* canine – seem to have been 'prestige goods' whose symbolism continued beyond the death of the person.

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New Uruk finds in NW Iran: Hasanlu VIII-VII and no Kura-Araxes culture evidence in southern parts of Lake Urmia

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ABSTRACT – *During 2007 archaeological survey of Little Zab River in Sardasht district in northwest Iran, six typical Uruk (Uruk-related) sites were brought to light. One of the important ones is Tepe Badamyar Rabat, with typical Bevelled Rim Bowls pottery that is considered as the first evidence of Uruk materials in northwest Iran. In addition to Rabat, the Uruk materials found in Tepe Baghi, Tepe Waliv, Tepe Molla Yousef, Tepe Lavin and Tepe Goman provide an opportunity for studying the one millennium gap between Hasanlu VIIIA (Pisdeli) and VIIC (Kura-Araxes) in the southern parts of Lake Urmia, which is seen as a key unknown period in the archaeology of NW Iran. The Uruk evidence found in the mentioned sites mainly belongs to the Middle and Late Uruk periods (3600/3500–3100 BC).*

KEY WORDS – *Little Zab River; Uruk, Hasanlu VIIIA (Pisdeli)/VIIC (Kura-Araxes); NW Iran; borderland*

Nove najdbe obdobja Uruk v SZ Iranu: Hasanlu VIII-VII in odsotnost dokazov o kulturi Kura-Araxes v južnih predelih jezera Urmia

IZVLEČEK – *Pri arheološkem pregledu na območju reke Malo Zab v okraju Sardasht v severozahodnem Iranu so leta 2007 odkrili šest tipičnih najdišč obdobja Uruk (oz. z Urukom povezanih najdišč). Izmed teh je najbolj pomembno najdišče Tepe Badamyar Rabat, kjer so odkrili lončene sklede s poševnim robom, ki so pomembna značilnost materiala obdobja Uruk v severozahodnem Iranu. Pomemben je tudi vpogled v najdbe obdobja Uruk z drugih najdišč Tepe Baghi, Tepe Walvin, Tepe Molla Yousef, Tepe Lavin in Tepe Goman; le-te namreč omogočajo raziskave tisočletne prekinitve med fazama Hasanlu VIIIA (Pisdeli) in VIIC (Kura-Araxes) na južnem delu jezera Urmia, ki je ključna neznanka pri preučevanju arheologije SZ Irana. Najdbe obdobja Uruk na teh najdiščih lahko datiramo v fazi srednjega do poznega obdobja Uruk (3600/3500–3100 BC).*

KLJUČNE BESEDE – *reka Mali Zab; Uruk; Hasanlu VIIIA (Pisdeli)/VIIC (Kura-Araxes); SZ Iran; obmejno območje*

 DOI: 10.4312/dp.46.26

Introduction

The transition process between the Late Chalcolithic and Early Bronze Age (Kura-Araxes phenomena) is one of the least known, yet most important eras in the ancient history and chronological table of NW Iran. Previous studies in NW Iran demonstrated that the 4th millennium BC (mid-4th to end of 3rd millennium BC) remains among the least understood periods of development in the prehistory of the region.

According to the Hasanlu chronological sequence, the period between Hasanlu VIIIA (called as Pisdeli) and VIIC (EBA synchronic with Kura-Araxes culture) spans one thousand years, but the existence of only two periods (Pisdeli and Kura-Araxes) during this time raises some questions, because, based on recent excavations, four different periods and phases (LC1-3 and Kura-Araxes I) have been brought to light during Hasanlu VIIIA and VIIC (*Maziar 2010; Abedi* et al. *2014; 2015; Abedi, Omrani 2015; Abedi 2017*). This chronological problem is considered as one of the largest gaps in our understanding of the developmental sequence of NW Iran (*Voigt, Dyson 1992; Danti* et al. *2004; Helwing 2004*). In northern parts of the Lake Urmia and especially in the Middle Araxes Basin, this chronological issue has been clarified and resolved due to absolute ^{14}C radiocarbon dating of Kul Tepe Jolfa and Dava Göz Khoy for this time span (*Abedi* et al. *2014; Abedi, Omrani 2015*). Also according to new research in the eastern and western parts of Lake Urmia, the new chronology can be applied for this interval in these regions. One of the most obscure parts of NW Iran during Hasanlu VIIIA (Pisdeli) and VIIC (EBA) is the southern parts of Lake Urmia, with a millennium long (*c.* 4000/3900–3000 BC) gap in our understanding (*Voigt, Dyson 1992*). Several questions can be raised about this problem. First, were the southern plains of Lake Urmia during this time completely abandoned and vacant? If not, which cultures existed in this part of NW Iran? What was the nature of these cultures and what was their relationship with the Kura-Araxes and Uruk tribes? These were the questions raised by Michael Danti *et al.* (*2014*) after analysis of Hasanlu materials when identifying the transition from the Late Chalolithic to EBA.

These findings not only established a good opportunity for revising the NW Iran chronological table, but also a good basis for studying the inter-regional relationships of NW Iranian communities with southern and northern Mesopotamian societies during the 4th millennium BC. This article aims to introduce several newly found and typical Uruk sites in the southern part of the Lake Urmia, with detailed emphasis on new pottery, lithic and special finds at Tepe Badamyar Rabat. The present paper also aims to expose the position of Uruk phenomena in NW Iran chronological framework and the interregional relationships with adjacent areas.

The present study seeks to answer the questions raised above and aims to address the presence of Uruk (-related) culture in NW Iran, a topic that has not been addressed in any of archaeological research on this area. This research will introduce the typical Uruk-related site of Badamyar with its typical pottery items of Bevelled Rim Bowls (hereafter BRBs), and will also introduce all of the surveyed Uruk-related sites in NW Iran, and especially those in the Little Zab River basin, while the importance and distribution map of the region will discussed.

Archaeological background of southern Lake Urmia

The first archaeological studies in the southern parts of the Lake Urmia were started in 1936 by Sir Aurel Stein, with a survey and six days of excavation at Tepe Dinkhah, where he found eastern Khabur items which were comparable with Hasanlu VI, and he systematically surveyed the Hasan-Ali Tepe in the connection road of Ushnaviyeh to Naghadeh, finding special Bronze Age painted ware (*Steint 1940*). His archaeological activities continued at Geoy Tepe Urmia. The first scientific archaeological studies concerning the EBA period in NW Iran began with the works of Frank Earp in 1903, who opened four Bronze Age tombs (*Crawford 1975*), and continued with the work of Theodore Bortun Brown in 1948 who spent six weeks excavating in eight separate trenches (*Brown 1951*). In 1949 Carleton Coon conducted a Palaeolithic cave survey in NW Iran, and started his excavation at Temtemeh cave at the Nazloo Chay River Basin close to Esmail Agha village (*Coon 1951*). Excavations continued at other sites, such as Hasanlu (*Dyson 1965; 1968; 1972; 1976; Dyson, Muscarella 1989*) in the southern Lake Urmia region, directed by Robert Dyson, Hajji Firuz (*Voigt 1983*), Dalma (*Hamlin 1975*) and Pisdeli (*Dyson, Young 1960*). Studies subsequent to these early excavations led to identification of the Late Neolithic period in Hajji Firuz (6th millennium BC), previously regarded as belonging to the cultural horizon of Hassuna in Mesopotamia (*Voigt 1983*). Research in the region was continued by Ralph S. Solecki in 1969 (*Solecki 1969*) and then by Regnar

Kearton (*1969*), introducing around 300 archaeological sites from the prehistoric to Islamic periods. During 1971 a new survey was begun by Stuart Swiny (*1975*), who started from NW Iran and moved to the central Zagros, introducing 93 sites. The survey of NW Iran was continued by Wolfram Kleiss and Stephan Kroll, especially around Ushnaviyeh-Naqadeh, Piranshahr-Sardasht and Mahabad-Miandoab (*Kroll 1994; 2004; 2005*). After the Iranian Revolution several different projects were carried out in the region. In 2008 an archaeological survey was conducted by Ali Binandeh along the Little Zab River Basin and Simineh Rud revealed the settlement patterns of the region during the Neolithic to the Islamic eras (*Binandeh* et al. *2012*). The excavation at Tepe Lavin should be considered one of the important excavation projects in the Piranshahr region (*Binandeh* et al. *2012*). The excavations in dam archaeological projects such as Sardasht (*Fallahian, Nozhati 2016*) Silveh (*Abedi 2017a*) and Kanisib should also be considered important scientific projects for better understanding of the archaeology of the region from the Neolithic to the Islamic eras. However, the earliest and closest survey in the Sardasht region (where the research data come from) was launched at Tepe Rabat, and this revealed the best Manaeean evidence in NW Iran (*Kargar, Binandeh 2009; Heidari 2006*). During the second season of excavation at Tepe Rabat, the archaeological mission conducted a survey around the Rabat area, and they found the first evidence of BRBs and 17 archaeological sites (*Heidari 2006*). In 2007 a survey was also carried out to assess the settlement pattern of the region along Little Zab River, with 34 archaeological sites found during two seasons and six of these containing Uruk-related materials (*Heidari 2007*). The rescue project of the Sardasht Dam reported by Fallahian introduced five archaeological excavation sites, all of which are located on the banks of the Little Zab River. Both Tepe Baghi (*Fallahian, Nozhati 2016*) and Tepe Mollawosu (*Binandeh 2016*) were found to have Uruk-related materials during this project.

Tepe Badamyar Rabat, the Uruk-related site in NW Iran

Rabat is a city in the central district of Sardasht county, the west Azerbaijan province of Iran. In Rabat there are five archaeological sites numbered as 1, 2, 3, 4, and 5. Site number 4, which is called as Tepe Badamyar Rabat (45°32'13"E; 36°12'32"N; 1141m asl; Figs. 1–3) is located exactly 800m northeast of the city of Rabat. Tepe Badamyar Rabat is a single period Uruk-related site about 1ha in extent and is situated on the slope of a natural mound. The site

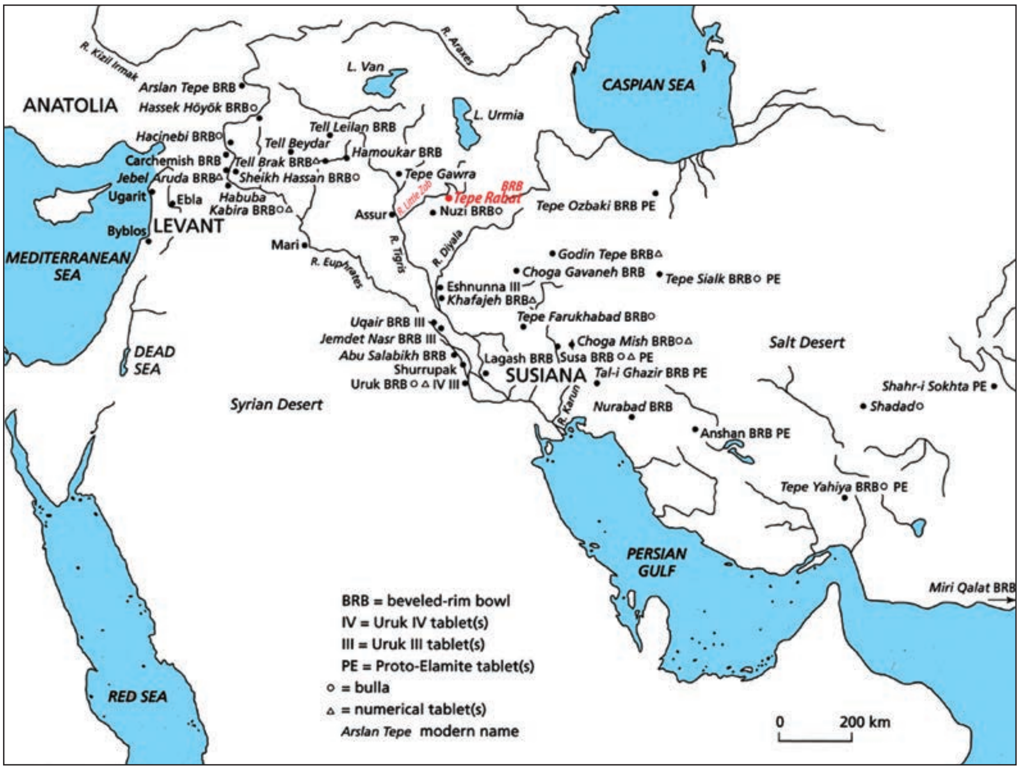

Fig. 1. Location map of Tepe Badamyar Rabat Sardasht and distribution map of Uruk and Proto-Elamite sites in Iran and Western Asia (after* van de Mieroop 2004.36, Map 2.2*).

was originally discovered by an expedition to the Sardasht in western Azerbaijan province in 2006 and 2007 under the supervision of Reza Heidari (*Heidari 2006; 2007*), and was later reported by Ali Binandeh (*2016*) and R. Heidari and Reyhaneh Afifi (*2011*). They introduced Badamyar Rabat as a 4th millennium Uruk or Uruk-related site with typical BRBs. Afterwards, during a Little Zab River basin survey, Binandeh reported Badamyar as one of the typical Uruk sites in NW Iran and the Little Zab River basin (*Binandeh 2016*).

A recent survey carried out by the authors (*Heidari 2006; 2007; Heidari, Afifi 2011*) provided the opportunity for a detailed study of the site. Tepe Badamyar Rabat is a single period Uruk (-related) site with typical BRB pottery as a unique index for the comparative dating of the site to the Uruk period. As this site is a single period one it thus gives an opportunity for focusing on the data as derived from a single period (Figs. 2–3).

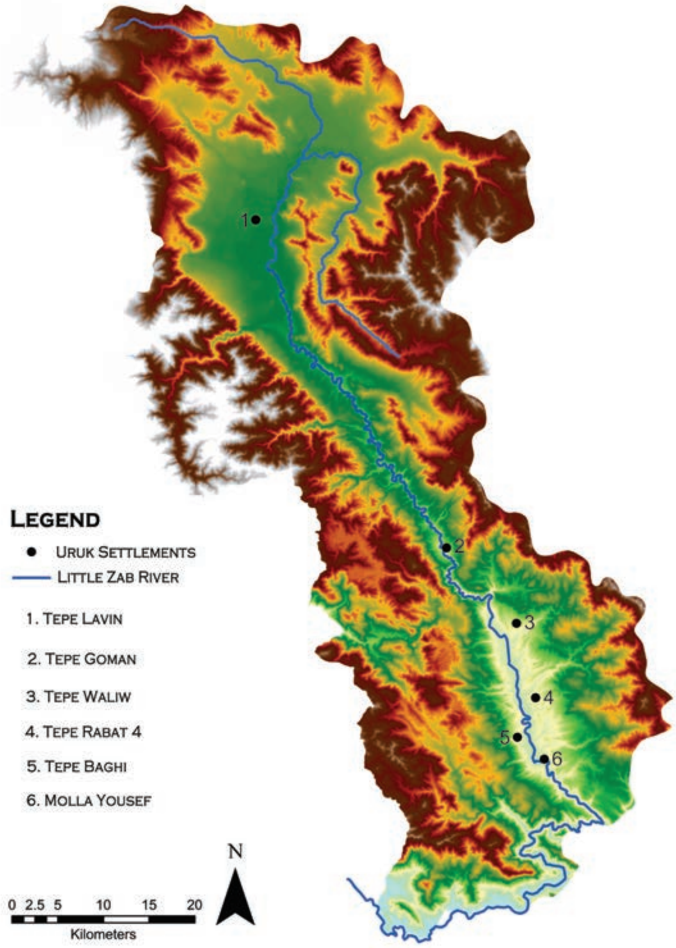

Fig. 2. Distribution map of Uruk (related) sites with BRBs in Little Zab River, NW Iran.

Uruk and Uruk-related evidence in Little Zab Basin, NW Iran

The Little (or Lower) Zab River, along with the Great (or Upper) Zab, constitute two major branches of the Tigris River. Little Zab originates from highlands of Piranshahr county in NW Iran and runs in the NW-SE direction, joining the Tigris just south of Al Zab in the Kurdistan region of Iraq. The river is approx. 400km (250mi) long and drains an area of *c.* 22 000km^2 (8500sq mi). This river is permanent and its water is drinkable (*Khezri 2000.130*). Despite the importance of this river in the formation of various archaeological settlements, and its mentions in Mesopotamian texts, only one important research-based archaeological survey has been done here (*Binandeh* et al. *2012; Binandeh 2016*). Evidence of Uruk materials in the Sardasht region has been reported from Tepe Baghi, Tepe Waliw, Tepe Molla Yousef and Tepe Badamyar Rabat (*Heidari 2006; 2007; Heidari, Afifi 2011*). Binandeh also reported on Uruk materials in Tepe Lavin (*Noberi* et al. *2012*), and introduced Tepe Gooman as another Uruk-related site during a Little Zab River survey (*Binandeh* et al. *2012; Binandeh 2016*) (Fig. 2).

The Uruk-related materials of Tepe Badamyar Rabat Sardasht

During 2006 and 2007 a surface survey was conducted (*Heidari 2006; 2007; Heidari, Afifi 2011*)

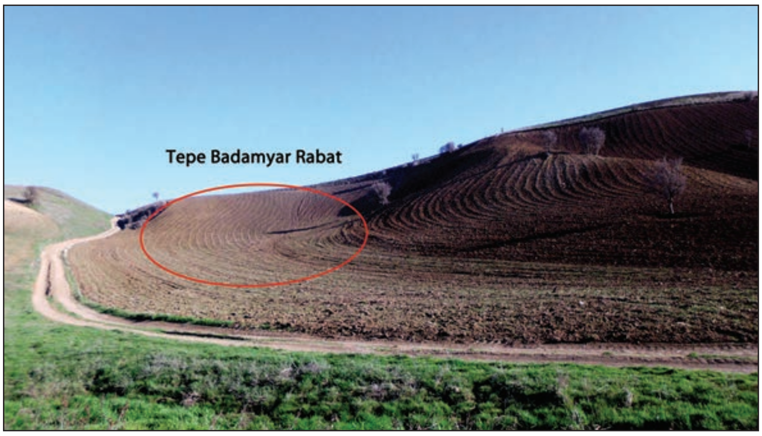

Fig. 3. Uruk-related site of Tepe Badamyar Rabat (view from NW).

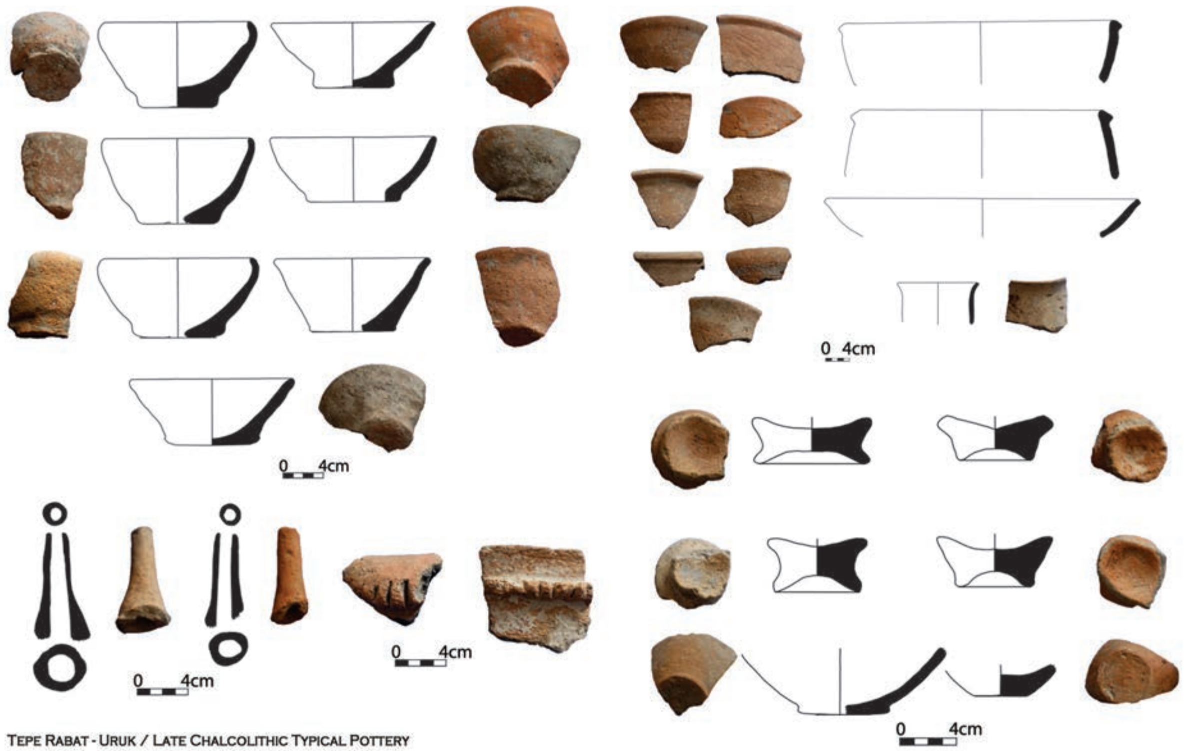

Fig. 4. Late Chalcolithic/Uruk pottery assemblage of Tepe Badamyar Rabat.

at the site to better understand the cultural materials and periodization of the site using the available evidence. In this regard typical materials have been found, among which Bevelled Rim Bowls (BRBs) could be considered as an important indicator of the relative chronology of the assemblages, attributing them to the famous Uruk period. Details of the findings will discussed below, and these are mostly pottery, lithic artefacts and small items such as ornamental lithic beads.

Pottery assemblage of Tepe Badamyar Rabat

During the 2006 and 2007 survey, a total of 350 potsherds were collected and sampled from the Uruk period in Tepe Badamyar Rabat. The great majority of the pottery is handmade (97%). The fabric is characterised by mixed chaff and grit (331 = 85.5%) temper; in chaff-tempered cases, the chaff is fine to medium, which invariably produces a chaff-faced effect. Most of the pottery sherds are under-fired (84%), which indicates a lack of control of the heating of the kiln. The pottery is mostly orange coloured (5YR-7/8) (88%), while the colours of the monochrome ware range from orange and brown, to buff (12%). The section can be monochrome and show a grey core. Most of the potsherds are simple and undecorated, and in only two samples decoration is incised under the rim.

The majority of the samples are typical rim and floor sherds. Mostly the forms of rims are simple, but there are also different styles, with everted, inverted and vertical types of rim used during pottery production. Two different forms of footed and round and flat-based pottery (jars, bowls) are evident in the assemblages. Footed jars and bowls are predominant in the pottery assemblages. Spouted vessels could be considered as important part of the ceramic findings. Three broad shape and form categories can be distinguished from the Uruk Period at the site: bowls, pots and jars. Small bowls and jar are most numerous in all strata, and there are also large storage jars (Fig. 4). What is most important in the pottery assemblage is the existence of 20 typical BRBs (Fig. 5). These all are handmade, coarse in treatment, underfired with mixed inclusion temper. These BRBs have a close similarity with the Late Uruk Godin VI-V materials (*Young 1969; Gopnik, Rothman 2011*). BRBs were reported by Heidari (*2006; 2007; Heidari, Afifi 2011*) for the first time in NW Iran during the Little Zab River survey. Later, Uruk materials were found in another survey at Little Zab River (*Binandeh* et al. *2012*) and Tepe Lavin Piranshahr (*Noberi* et al. *2012*).

Lithic artefacts of Tepe Badamyar Rabat

During the 2006 and 2007 survey of the site, 32 lithic artefacts were collected in addition to pottery

(Fig. 6). The lithic assemblages contained blades, micro-blades, flakes, and cores. Almost all the lithic findings of the Uruk period in Tepe Badamyar are made of chert, though there are four obsidian pieces in the assemblage. In most archaeological sites of south of Lake Urmia, obsidian has been reported as an item imported from the north (Armenia) and northwest (eastern Turkey), as reported in Tepe Lavin Piranshahr (*Noberi* et al. *2012*).

Small finds

According to the survey it seems that only a small part of the site can be interpreted as a cemetery located at the slope of the mound. Surface of the site has been gradually washed away because of rain and annual flooding, and nowadays the site is also disrupted as ploughing agricultural land causes the dispersion of bones, beads and pottery. In the cemetery part of the site a lot of human and animal bones are visible. A detailed survey of this part revealed six ornamental stone beads (Fig. 7).

Discussion

A social, political, technical and economic revolutions caused many changes in southern Mesopotamia (now southern Iraq) and Southwest Iran at the turn of the 4th and 3rd millennia BC. This period is marked by the appearance of the city, the state and writing, making the transition between these two millennia a pivotal period in evolutionary thinking, and in that between prehistory and history.

The end of the 4th millennium BC in SW Iran is thus characterized by the emergence of state and writing, a period which was the outcome of the 'Proto-Urban Revolution' and the result of a long process beginning from the 5th millennium. The term 'Proto-Elamite' originally referred to a script system, different from the Mesopotamian one, at the end of the 4th millennium. It is currently used to describe a period, a 'culture' and a 'civilization'. Based on the Uruk model and its proto-urban expansion from south Mesopotamia (4th millennium BC), the term has also been used to refer to a parallel phenomenon in Iran between 3300/3100 and 2800/2600 BC. These two phenomena (Uruk and Proto-Elamite) are clearly different in terms of chronology, material culture, script, and artistic originality. Nevertheless they are undoubtedly connected. New discoveries and studies have lead several scholars to a deconstruction of the Proto-Elamite phenomenon, whose terminology was used to define a theoretical generalization of the 'Urban Revolution' over a large area and during a short time period. This idea suggests a significant change in Iranian society, which is supported by the archaeological evidence (*Naccaro 2017*).

The Uruk culture from 4100 to 3200 BC spread from southern Mesopotamia and appeared along the Tigris and Euphrates in Syria, and distributed up to the

Fig. 5. Uruk-related Bevelled Rim Bowls pottery of Tepe Badamyar Rabat.

Fig. 6. Lithic artefacts of Tepe Badamyar Rabat with four obsidian artefacts.

west and southwest of Iran. Beside the whole material cultural, the Uruk phenomena is especially known for BRBs (*Wright, Johnson 1975; Oates 1985; Millard 1988*). Roughly 75% of all ceramics found with Uruk culture sites are BRBs, so two major aspects make them historically significant to archaeologists. First, they are one of the earliest signs of mass production of a single product in history. Second, their suspected use as a form of payment to workers is another historic milestone, because there is no evidence of rationed payments before these (*Millard 1988; Potts 2009*).

BRBs are small, undecorated, mass-produced clay bowls most common in the 4th millennium BC. They constitute roughly three quarters of all ceramics found in Uruk culture sites, and are therefore a unique and reliable indicator of the presence of the Uruk culture in ancient Mesopotamia. BRBs originated in the city state of Uruk in the mid-4th millennium BC. As the Uruk culture expanded so did the production and use of these bowls. Although BRBs are considered a characteristic Mesopotamian ceramic *leitfossil* of the mid- to late-4th millennium BC, the first BRBs ever reported were actually discovered in Iran, at Susa, during the seasons of 1897/98 and 1898/99 (*de Morgan 1900.Figs. 91, 118, 121*). In the winter of 1902/3 at least one complete BRB, later displayed in the Louvre, was recovered by Gautier and Lampre at Tepe Musiyan (*Burton Brown 1946.36*). The first BRBs in Mesopotamia were found at Tell Abu Shahrein (ancient Eridu) in 1918 (*Campbell Thompson 1920.Figs. 3.4, 4.10*), then six BRBs were found at Jamdat Nasr (*Mackay 1931.Pl. 67.22–23*). According to Marc Van De Mieroop (*2004*) and Daniel Potts (*2009*), "*Examples have been excavated in the Zagros Mountains (*e.g.*, Godin Tepe, Choga Gavaneh), in northern (*e.g.*, Tepe, Ozbeki, Tepe Sialk), central (*e.g.*, Tepe Yahiya), and southern Iran (*e.g.*, Nurabad). They were even found on the modern coast of Pakistan near the Gulf of Oman (Miri Qalat)*" (Fig. 1).

During the Late Chalolictich 1–3 (*c.* 4500–3700 BC) the most northern, western and southern parts of the Lake Urima region had a close relationship with northern Mesopotamian societies. Shortly after LC3 (around 4000 BC) this connection pattern disappeared and most of the southern parts of the Lake Urmia were abandoned and vacated. During the mid-4th millennium BC a new connection was established between the western parts of Lake Urmia Late Chalcolithic societies and Eastern Anatolia (*Voigt 1989. 286*). At the end of the Pisdeli period (*c.* 4000 BC), the Ushnu-Solduz valley was abandoned by sedentary farmers for some time. In the Urmia plain there is also a chronological gap between the sites. Pottery evidence shows that during the second half of the

Fig. 7. Lithic ornament beads of Tepe Badamyar Rabat.

4th millennium BC, the northern Mesopotamian related material can be divided into three major zones.[1] As Danti *et al.* (*2004*), as well as Mary M. Voigt (*1989*), suggest, the Ushnu-Solduz valley acts as a border zone between different forms of socio-economic organization from south and north Mesopotamia and the Kura-Araxes culture of the northern parts. It seems clear that the important strategic location of this region that it can be considered as an important border zone. As already mentioned, there is a huge gap in our understanding of the area from the south of the Lake Urima region, and especially Ushnu-Solduz, during Hasanlu VIIIA (Pisdeli) and VIIC (Kura-Araxes).

North-western Iran, and especially the southern parts where we know how it fits into the Hasanlu sequence, has strong Mesopotamian ties interspersed with episodes of northern, southern and eastern connection (*Danti* et al. *2004; Levine 1977; Dyson 1969*). The distribution of related settlements within the Urmia basin suggests that Ushnu-Solduz was in some periods an important boundary area, a point of contact and sometimes conflict. In times of conflict the valley may have served as a buffer zone, its settlements abandoned and the countryside empty or used by nomadic herders (*Danti* et al. *2004.584*). New Uruk findings in Sardasht and the Little Zab River basin demonstrate that the huge gap between Hasanlu VIIIA and VIIC could be the result of inaccurate and incomprehensive surveys in the whole of this region.

Conclusion

The Uruk phenomena is one of the well-known cultural periods in Mesopotamia, southwest and western Iran, but to date has not been reported in north-western Iran. A new survey in the Little Zab River basin and especially in Tepe Badamyar Rabat, which is probable single period site with typical BRBs in this region, has raised the importance of this phenomena in north-western Iran. According to the chronology of pottery material, it seems clear that the assemblage should be dated to the second half of the 4th millennium BC, and it shows close tie with the same material that has been found in western Iran, especially from Godin VI and V. BRBs help to date the assemblage to the Middle or Late Uruk period, although we need more detailed excavation to better understand the site chronology and sequence.

The discovery of Uruk finds in NW Iran has presented a new research site that can help to overcome the current chronological ambiguities, although many of the issues may remain impossible to clarify. New archaeological evidence from Rabat and other Uruk-related sites in the Little Zab River basin will definitely change researchers' attitudes toward this large chronological gap between Hasanlu VIIIA and VIIC, and it is likely that, with further research, more details and new finds (*e.g.*, the Uruk culture) will emerge in the south Lake Urmia, which is often considered one of the most important archaeological and chronological ambiguities in this area and in northern Mesopotamia in general. The present study was able to clarify some of the potential trade-economic communications in the 4th millennium BC between the northwest of Iran, northern Mesopotamia and Eastern Anatolian communities, and it is hoped that with further excavation at this site the cultures of the area will be better identified and described. Based on discussion outlined above, the rich agricultural intermountain area as well as strategic location of the Ushnu-Solduz valley were, most likely, one of the main factors why this place was the boundary between the political and economic institutions of Mesopotamia and north-west Iran. Tepe Gawra shares numerous elements of material culture with the north-western Iran highland region; at the same time, the Gawra ceramic assemblage is surprisingly distinct from those of the surrounding Uruk/Jemdet Nasr settlements. One plausible interpretation of Gawra is that it was a trading centre linking the Anatolian/Azerbaijani zone with Mesopotamia during the 4th millennium BC. Finally, the emergence of the Kura-Aras culture in the northwest of Iran and the Caucasus on the one hand, and the east of Anatolia on the other, created another border area between the land south of Lake Urmia, and especially the plains of Ushu-Solduz and the northern parts of Lake Urmia. This new findings suggests the coexistence of the Kura-Araxian in the north and the Uruk in the south.

1 One zone, centred in the intermontane valleys of western Azerbaijan and eastern Anatolia, can be defined on the basis of monochrome painted pottery and distinctive moulded ceramics. The second zone, lying primarily in the lowlands and foothills to the south, has been defined based on well-known Uruk (and perhaps Jemdet Nasr) ceramic types. A third zone, located in the central Zagros mountains, can be tentatively defined based on the occurrence of ceramics best known as the Godin VI assemblage, found at sites from Luristan to eastern Azerbaijan (*Voigt 1989.287*).

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Probable evidence of a Middle Palaeolithic site in the northern parts of the Susiana Plain, Khuzestan, Iran

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ABSTRACT – *There is a considerable body of studies regarding the activities of the Pleistocene human population in the Zagros and Alborz regions of Iran, as well as significant progress in the Palaeolithic studies in other regions, such as the foothills, plains and deserts' margins. However, some of these peripheral regions and foothills are still neglected, and the information about the Palaeolithic period in these areas is limited. Khuzestan province, especially its northern regions, is one of these unstudied regions, yet the limited information about this region seems very interesting. Khervali, located on the western foothills of the Zagros Mountains and on the northern heights of Susa, nearby the western bank of the Karkheh River, is one of the few Palaeolithic sites identified in recent years. The site was identified in 2012 and was systemically surveyed. Due to the extension of the site and the distribution of the artefacts, sampling all the site was not feasible, therefore, four sections of the site were chosen for taking the samples and a total of 330 stone artefacts were collected. The results of the techno-typology analyses, as well as the frequency of the flakes, the Levallois samples and different types of scrapers, revealed that the artefacts date to the middle Palaeolithic period, with considerable access to the local raw materials.*

KEY WORDS – *Khervali; Middle Palaeolithic; north of Susiana Plain; conglomerate formation; accessibility; raw material*

Verjeten dokaz o srednje paleolitskem najdišču v severnem delu ravnine Susiana, Kuzestan, Iran

IZVLEČEK – *Številne študije se ukvarjajo z vprašanjem aktivnosti ljudi v času paleolitika v gorovju Zagros in regiji Alborz v Iranu, velik pa je tudi napredek pri paleolitskih študijah na drugih območjih kot so predgorja, ravnine in obronki puščav. Ne glede na to še vedno ostajajo obrobna območja in predgorja, ki so manj raziskana in imamo o njih le malo podatkov iz časa paleolitika. Takšno območje je tudi severni del Kuzestana, čeprav so ti podatki zelo zanimivi. Eno redkih prepoznanih paleolitskih najdišč je Kervali, ki se nahaja v zahodnem predgorju Zagrosa in na severnih višavjih Suse. Najdišče je bilo odkrito in sistematično raziskano leta 2012. Je zelo veliko in ima veliko površinskih artefaktov, kar pomeni, da ni bilo moč izvesti vzorčenja na celotni površini, ampak smo le-to razdelili na štiri dele in pobrali 330 kamnitih artefaktov. Na podlagi rezultatov tehnološko-tipološke analize, pogostnosti kamnitih odlomkov, vzorcev orodij, izdelanih z Levallois tehniko in različnih praskal, smo lahko najdbe datirali v čas srednjega paleolitika in sklepamo, da so imeli takratni ljudje dober dostop do lokalnih surovin.*

KLJUČNE BESEDE – *Kervali; srednji paleolitik; severni del ravnine Susiana; formacija konglomerata; dostopnost; surovina*

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Introduction

Despite one century of studies of the Palaeolithic period in Iran, there are still many regions which have remained less known compared to the Zagros and Alborz mountainous areas. Khuzestan province is one of these unknown areas, specially its northern and north-western regions, with the exception of the Pabdeh cave excavation (*Girshman 1949; 1951; 1993.10*). There have been several reports about the Palaeolithic finds in recent years (*Dinarvand* et al. *2012; Dinarvand, Mehranpour 2015; Ahmadzadeh Shouhani 2014; Sheykh no date; Alipour 2012; 2014; Alipour, Nadali Kahish 2014*), although most of the archaeological research in southwestern Iran and Khuzestan province is focused on the more recent prehistoric and historical periods, and only few archaeological studies are dedicated to the Palaeolithic. As a result, our knowledge about the Palaeolithic period compared to the more recent periods of this region is incomplete, while Palaeolithic studies of areas such as Zagros and Albourz tend to be more advanced compared to those of Khuzestan province.

An archaeological survey was conducted in 2012 by Loqman Ahmadzadeh Shouhani (*Ahmadzadeh Shouhani 2014*), on the western bank of Karkheh River (the city of Susa) with the aim of identifying and registering archaeological sites in the area. The survey produced 72 new sites that were identified and recorded. One of the identified sites was a valley known as 'Khervali' with a considerable distribution of stone artefacts, which makes it the first and only known Palaeolithic site on the western side of Karkheh River and also one of the few Palaeolithic sites of the northern Susiana plain (Fig. 1).

Regarding the lack of information about the Palaeolithic period of this region and the location of this site between the western foothills of Zagros and the plains, this site can be a major source of information about the Palaeolithic period of this region.

Palaeolithic research background in the Khuzestan Province

Despite Palaeolithic studies starting in Iran more than a century ago by De-Morgan in the north of the territory (*Vahdati Nasab 2011*) there is little information about the Palaeolithic of the Iranian Plateau, and until the past few decades Palaeolithic studies in Iran were focused on the Alborz and Zagros mountainous areas. The Iranian plateau has many geomorphological variations, and the foothills, the margins of the plains and the deserts, in addition to the mountainous areas, have high value in terms of archaeological remains and studies, as suggested by the results of recent Palaeolithic studies (*Vahdati Nasab* et al. *2009; 2010; 2013; Vahdati Nasab, Hashemi 2016; Darabi* et al. *2012; Biglari* et al. *2000; 2009; Alibaigi* et al. *2010; Shidrang 2009; Conard* et al. *2009; Heydari Guran, Ghasidian 2011; Heydari Guran* et al. *2009; 2015; Bahramiyan, Ahmadzadeh Shouhani 2016; Zeynivand 2017; Biglari 2004a; 2004b; Biglari, Shidrang 2016*).

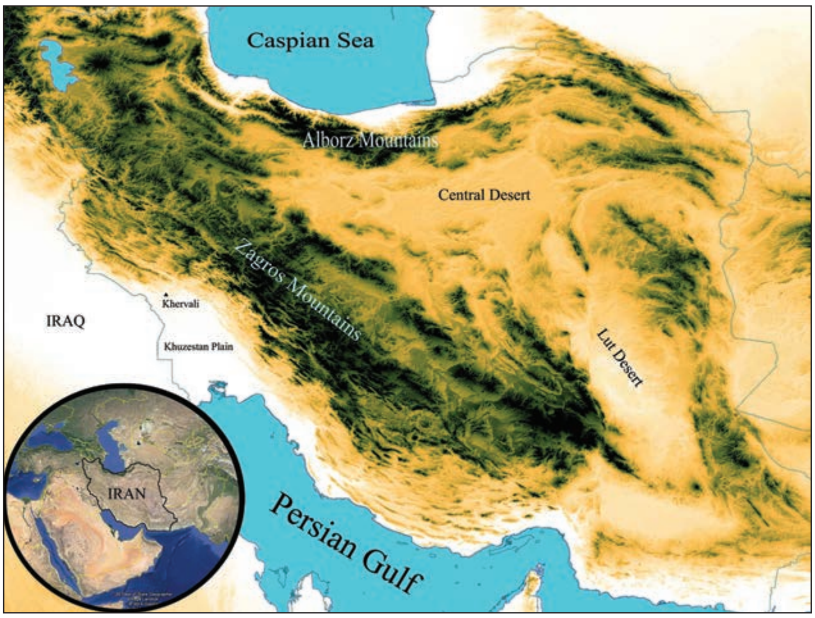

Fig. 1. Map showing the geographic location of Khervali site in the northern Khuzestan Plain.

Unfortunately, Palaeolithic studies have not been the priority of archaeological research in Khuzestan province, and few studies have been conducted in this regard. This is despite the location of this region on the west of Zagros mountains and the accessibility of environmental resources such as permanent rivers, plains, mountainous regions, hills and foothills, all of which can be considered as significant factors in attracting Pleistocene human populations.

Roman Girshman conducted the Early Palaeolithic studies in Khuzestan in Pebdeh cave, located in the Lali region (northern Khuzestan), and he discovered several simple stone artefacts (*Girshman 1949; 1951; 1993.10.465, Fig. 1*). The next major study was conducted by Henry T. Wright (*1979*) in the north-eastern region of Khuzestan, in Gol and Iveh plains, as part of the rescue project of the archeological sites behind the Shahid Abbadpour (formerly Reza Shah) dam. As a result of his study a number of Palaeolithic and also more recent prehistoric and historical periods were discovered.

In 2004, a survey in Izeh was conducted by Cyrus Barfi and a rock shelter near the Eshkaft-e Kulfarah was identified with the same name and a total of 27 stone artefacts from The upper Palaeolithic and Epipalaeolithic were discovered (*Barfi 2010*). During the follow-up surveys conducted by Mozhgan Jayez in 2007 (*Jayez 2007*), the Izeh region was surveyed once again for Palaeolithic remains, and 54 sites including caves and rock shelters with stone artefacts dating back to the Epipalaeolithic and Early Neolithic were discovered, and their distribution patterns studied (*Niknami* et al. *2009; Niknami, Jayez 2008*). Jayez conducted another archaeological survey in 2008 on the Pion plain, located in the northwest of the Izeh plain, in order to identify and register all of the archaeological sites, and as the result she identified 19 sites from the upper Palaeolithic to Epipalaeolithic period (*Jayez* et al. *2012; 2013*).

The northern and north-western regions of Khuzestan province (*e.g.*, northern piedmonts of the cities of Susa and Dezful) have attracted some Palaeolithic researchers in recent years, which has resulted in the identification of many Palaeolithic sites and remains. In 2008, Mohammad Sheyk conducted the first survey with the aim of identifying and studying the Palaeolithic settlement patterns on the eastern banks of Karkheh River, and he discovered 5300 stone artefacts from different Palaeolithic periods (*Sheykh, publication year is not available; Vahdati Nasab, pers. comm.*), which revealed the significance of the region during this time. The results of the previous Palaeolithic studies in northern Khuzestan (north of the Susiana plain) also show the importance of this less known region in this period. Another survey was conducted in 2010 by Yusef Dinarvand on the eastern banks of the Dez River, on the northern heights of Dezful, in the Shahyun region, and two lower and middle Palaeolithic sites, with stone artefacts such as cores, flakes, denticulate and Levallois pieces being discovered (*Dinarvand* et al. *2012; Dinarvand, Mehranpour 2015*).

Despite the recent Palaeolithic surveys and excavations in Khuzestan plain, there are still many unknown and unstudied regions in the area that need to be examined, such as the western banks of the Karkheh River. In the intense study project of "*The archaeological study of the western banks of Karkheh River*" conducted by Loqhman Ahmadzadeh Shouhani in 2012, a number of artefacts and archaeological sites from the Palaeolithic, Chalcolithic and other recent periods were discovered (*Ahmadzadeh Shouhani 2014*). Of all the 72 identified sites, only the site at the Khervali Valley was attributed to the Palaeolithic period, due to the considerable distribution of stone artefacts. This valley is located to the north of the city of Susa and on the west of the Karkheh regulatory dam, which is the main subject of the present paper.

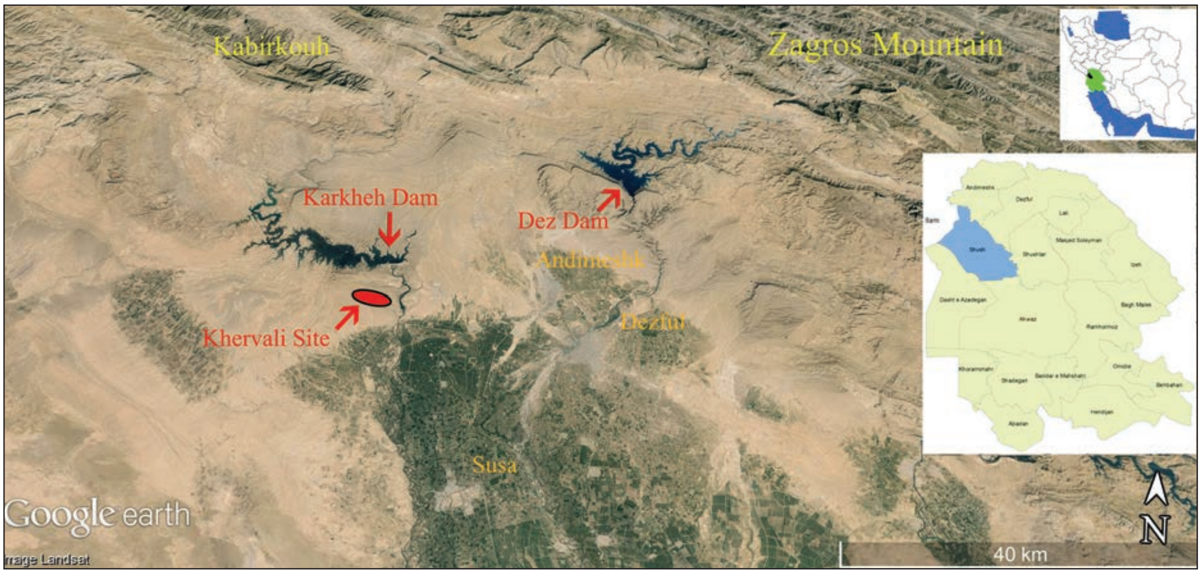

Fig. 2. The geographical position of the Khervali site in the Northern Susiana Plain.

Alireza Sardari Zarchi also conducted another archaeological survey in October 2012, in the cities of Masjed Soleiman and Andika located in north-eastern Khuzestan province. This survey was part of the project of the archaeological map of Iran and resulted in discovering several Middle and Upper Palaeolithic and Epipalaeolithic sites (*Sardari Zarchi 2013.68–86; 2014*). Mehdi Alipour conducted another survey in 2013, with the objective of identifying and studying the settlement patterns of the Palaeolithic period in northern Khuzestan, Sardasht district, and on the north-eastern Dezful (*Alipour 2012*). He decided to conduct his survey in circular areas of 200m diameter and managed to discover 1450 stone artefacts from 55 areas, and further studies showed the utilization of the Levallois technique in their production, dated back to the Middle Palaeolithic.

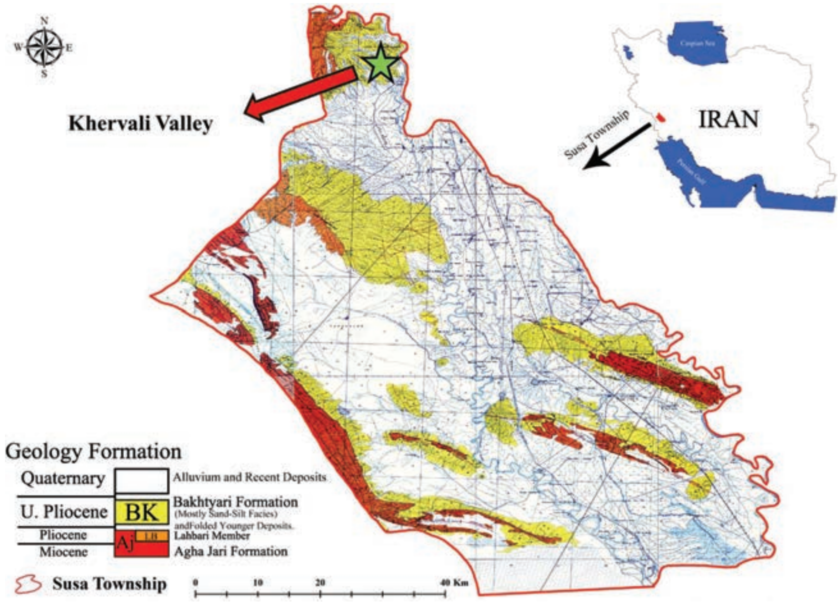

Fig. 3. Geological map of the city of Susa; the yellow part is the Bakhtyari Conglomerate Formation (BK).

As mentioned above, the western bank of Karkheh River (in Susiana plain) is less known than the eastern bank of the river, and the few archaeological studies which have been conducted on this area are mostly focused on the more recent prehistoric and historical periods (*e.g., Mecquenem 1943.141, Fig. 106; Adams 1962; Wenke 1975–76.13–221*), the only study with relevant finds to the Palaeolithic period was conducted by Ahmadzadeh Shouhani, which resulted in the identification of the Khervali site and its Palaeolithic artefacts.

The geographical location of Khervali

The Khervali site with the geographical coordinates of N: 32°25'49.5529", E: 48°07'33.6804", and the dimensions of 2320x630m is located 130 to 160m a.s.l. The site is situated to the north of the city of Susa, on the way of the connecting road between Andimeshk to Deh Luran, after the Naderi Bridge and 950m from the western gate of the regulatory dam of Karkheh River (Fig. 2). The site is an open valley in terms of topographical characteristics and has a relatively flat surface with a slight north-western – south-eastern slope that forms several hills which are known as Khervali hills based on the geological maps of Iranian Oil Company (*Iranian Oil Operating Companies DEZFUL 1967*).

Based on the geological evidence, the high elevation of the site has preserved it from the sedimentation processes of the Khuzestan plain and sedimentary deposits of the Holocene period. Besides, the site is formed on the Bakhtyari Conglomerate Formation (Fig. 3), covered in round pieces of sandstone and chert stones. A seasonal river originates from the northern heights of the valley and flows through the centre of the site and finally joins the Karkheh River. The construction of the asphalt road at the middle of the valley in order to access the Karkheh dam and also the construction of a military barracks in the southern parts, as well as the extensive excavation operations by the dam's construction machinery, have done irreversible damage and destroyed the major sections of the site (Fig. 4).

The survey methodology and the results

The process of mapping and preparing a cross-sector plan of the site with mapping cameras was not possible due to the size of the site as well as the previously mentioned damage and destruction, with a lack of time also being an issue. Therefore, after an intensive and overall survey on the site and studying the concentration and distribution of the artefacts, four different sections were chosen for further studies and sampling. The selected sections were higher than the dried bed of the river and they were consequently preserved from the natural sedimentation processes or human construction on the site. A circle with a diameter of 20m was designated as the boundary of each section, their coordinates were registered via GPS devices and they were named Locus 1, 3, 4 and 5[1]. The sampling was done by four different people in order to avoid personal bias or preconception in choosing the artefacts. Finally, a total number of 330 stone artefacts, including cores, core fragments, blank debitages, tools and debris were collected from the four selected sections (locus). Table 1 shows the number and the percentages of the collected artefacts.

Typology	Number	%
Core/Core Frag.	155	46.97
Debitage	73	22.12
Tools	76	23.03
Debris	26	7.88
Total	**330**	**100**

Tab. 1. Number and percent of Khervali artefacts.

Palaeolithic artefacts

As indicated in Table 1, among the 155 pieces of cores and core fragments, 37 pieces are the core, and 20 pieces are the core/chopper[2], which are mainly made of rubble, and based on their frequency are divided into the three groups of flake cores (53 pieces), blade cores (two pieces) and bladelet cores (two pieces) that have been reduced by unidirectional and irregular techniques (Figs. 7–8). The abundance of fragment cores (98 pieces) among the assemblage was an interesting point in the artefacts of the site, which indicated that the core reduction and tool making process had been done on the site (*Shen 1997.11*).

Another 76 pieces of tools (23.03% of the collected artefacts) included retouched pieces, notch/denticulate and some kinds of the scraper (Déjéte, single side scraper, heavy duty scraper and transverses) (Fig. 5). The flake tools, with a total number of 73, or 96.05% of the tools, are the most abundant blank types of the collection, and then the two blades (2.63%), and one bladelet (1.32%), are the next most frequent collected tools. The limited number of the blades and bladelets is relevant to the rare frequency of blade cores (3.51%) and bladelet cores (3.51%) on the site (Fig. 6).

Besides the tools collected from the site that are produced by flaking techniques from the core, a total of 73 blank debitages were also collected among the artefacts, and 71 pieces of these (97.26% of the collected blank debitages) were produced by flaking techniques (except for several cases of the Lovallois technique) and two pieces (2.74%) were produced by a blade removing technique from the core, and had been made with a similar technique to that seen with other tools and cores (*Fig. 6*).

Relative chronology of Khervali

Based on the collected artefacts, and the lack of lower Palaeolithic indicating elements such as the Acheulean hand-axes or bifaces and picks, with the exception of existing core choppers and cores, and the abundant evidence of using the flaking and Lovallois techniques, as well as the frequency of scrappers and notch/denticulate in the collected items, and also the lack of upper Palaeolithic elements such as

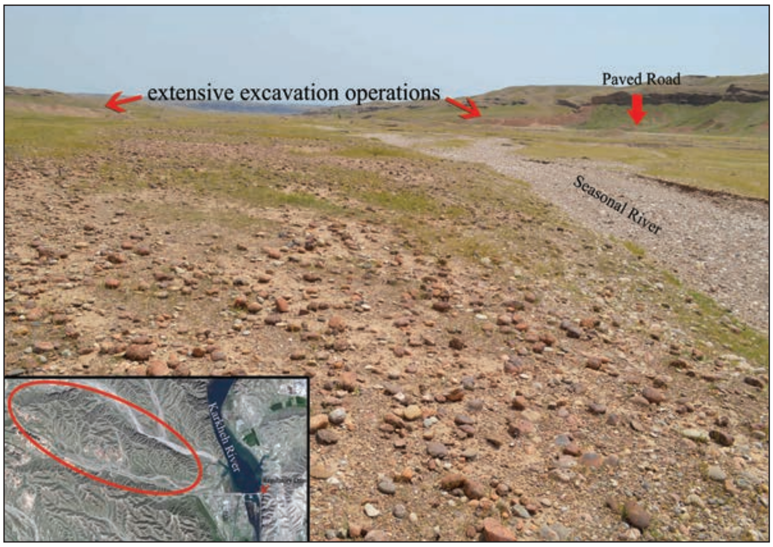

Fig. 4. Location of the Khervali Valley near the Karkheh River (left bottom), and a view of the middle part of the Khervali Valley (conglomerate landscape).

1 The section of Locus 2 is attributed to a collection of artefacts scattered on the dried river bed which passes through the Khervali Valley. Regarding the unsystematic nature of the survey and sampling, this collection was not mixed with other systematically collected artefacts.

2 Since the choppers are one of the major forms of cores (*Shea 2013.50*), the choppers are categorized as cores in the collected artefacts of this site.

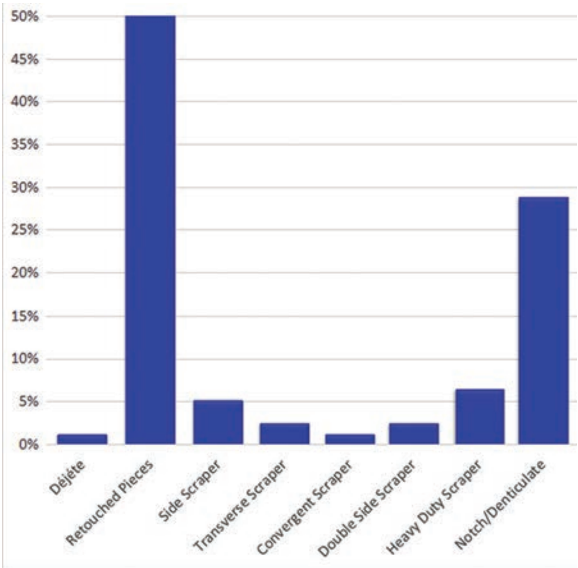

Fig. 5. Typology of the Khervali stone tools.

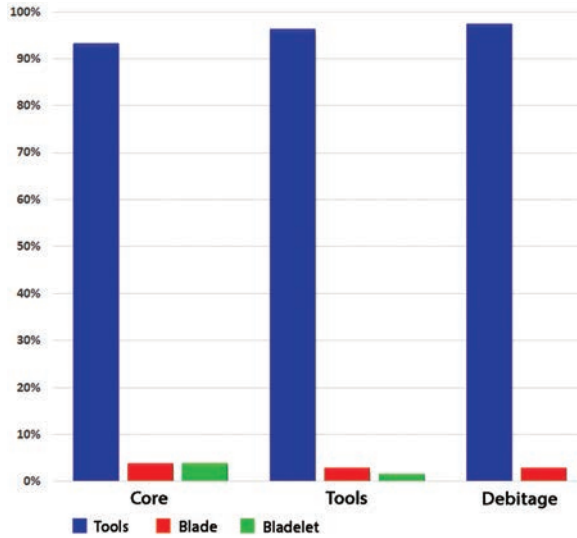

Fig. 6. The used techniques for core reduction and knapping in the Khervali site.

end scrapers, burin, high amount of retouched blades and Dufour[3] (*Olszewski, Dibble 2006.367*), we believe that this site dates back to the middle Palaeolithic.

The raw material resources

The accessibility of the raw material resources was one of the key factors in choosing the location of prehistoric settlements (*Heydari 2004*). Therefore, studying the material and structure of the raw materials (stone) utilized to produce the tools and artefacts in the site, as well as the geological features of each region, play major roles in finding out where the resources originated and also speculating about the exploitation methods in the prehistoric sites, specially Palaeolithic ones. Examining the collected stone artefacts in the present study revealed that the raw materials utilized in the Khervali Valley are mostly flint (pieces of chert, Jasper, Opal) and rarely river rubble like sandstone or quartz. Most of the artefacts are made of light brown or crimson flints, and in some cases green and red or grey and cream ones. These are the main lithological features of the Bakhtyari Conglomerate Formation[4], dating back to the Cretaceous, Eocene and Oligocene geological peri-

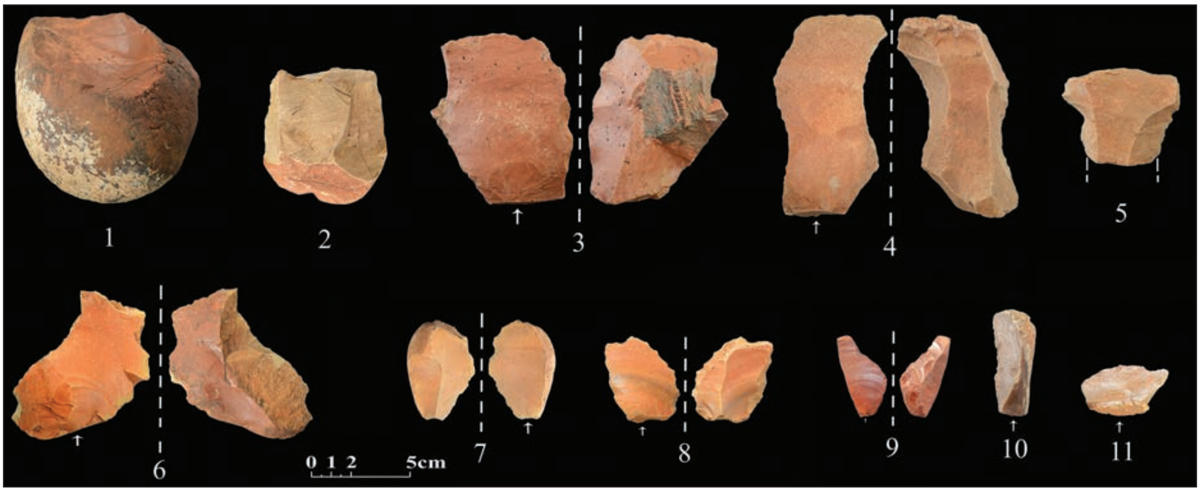

Fig. 7. Some of the collected artefacts from the Khervali site: 1 core/chopper; 2 flake core; 3 heavy duty scraper; 4–5 Levallois flake; 6–7 denticulate flake; 8 scraper with heavy retouch; 9 déjéte; 10 single-sided scraper; 11 transverse scraper.

3 It should be mentioned that the existence of blades and bladelets is not very surprising in the lower and middle Paleolithic periods (*Wojtczak 2014.27–33*).

4 This formation is named after the Bakhtyari tribe and is characterized by alluvial-foothill sediments derived from altitude erosion, including conglomerates and calcareous sandstones.

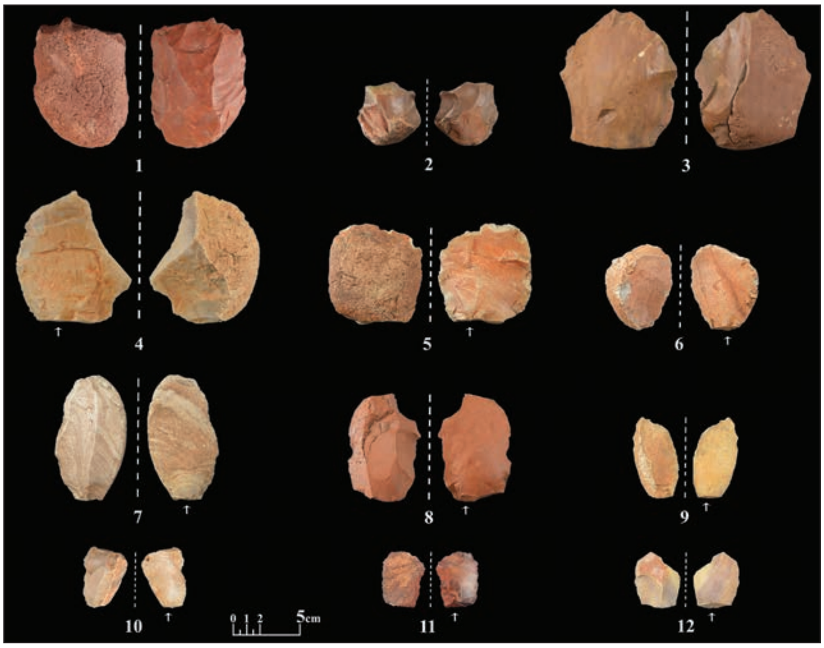

Fig. 8. Some of the collected artefacts from the Khervali site: 1 blade/bladelet core; 2 multidirectional bladelet core; 3 heavy duty scraper; 4, 5 and 12 cortical debitage; 6, 7, 9, 10, 11 retouched piece; 8 denticulate.

ods (*Darvishzadeh 1991.660*), and their outcrops have been reported in the western Zogros mountains and the northern regions of Khuzestan, particularly in the northern parts of Susiana (*Dinarvand, Mehranpour 2015; Bahramiyan, Ahmadzadeh Shouhani 2016*), Deh Luran (*Zeynivand 2017*) and Mehran plains (*Darabi* et al. *2012*). Besides the results of the precise typo-technological analyses on the stone artefacts of the Khervali site, which revealed the existence of a workshop with great accessibility to the raw materials (*Bahramiyan 2015*), this site is also located on the Bakhtyari Conglomerate Formation (Fig. 3), which obviously demonstrates the direct access of the settlers to the raw material resources needed to produce their artefacts.

Conclusion

Despite one century of Palaeolithic studies in Iran, Khuzestan province is one of the regions that have remained in darkness, compared to more studied regions such as Zagros and Alborz. Khuzestan province in general, and its northern region (Susiana plain) in particular have in Iranian archaeological studies a major role, although Palaeolithic in the region, unlike the more recent periods, is not well studied. The little knowledge we have comes from recent studies, yet the results are very interesting and there are many reports about sites from different Palaeolithic periods, in Susiana plain and its northern regions such as the heights between the Susiana plain and western foothills of Zagros. The main points about these sites is their location nearby permanent and seasonal water resources, and on the Bakhtyari Conglomerate Formation in this interstitial area, which shows the relation between these sites and the accessibility to raw material sources, which could be reached often and easily in order to support tool-making activities. The recently discovered site of Kherveli is one of the rare identified Palaeolithic sites in the northern Susiana plain with two main features: its exceptional geographical location between the Zagros mountains and the lowlands of Khuzestan, an interstitial area whose Palaeolithic history is still unknown; second, the direct and definite relation of the location of the site with the accessibility to the raw materials on the Bakhtyari Conglomerate Formation, with its high density of raw materials. Therefore, it seems that more specialized and focused studies in these areas with the aim of the identification of Palaeolithic sites and analysing their settlement patterns from a wider perspective (the highlands and the plains) can result in significant finds on how the Pleistocene human populations distributed and adapted to their environment, as well as the patterns utilized in manufacturing stone artefacts, exploiting raw materials and the probable role of the location of the sites between the mountains and the plains.

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