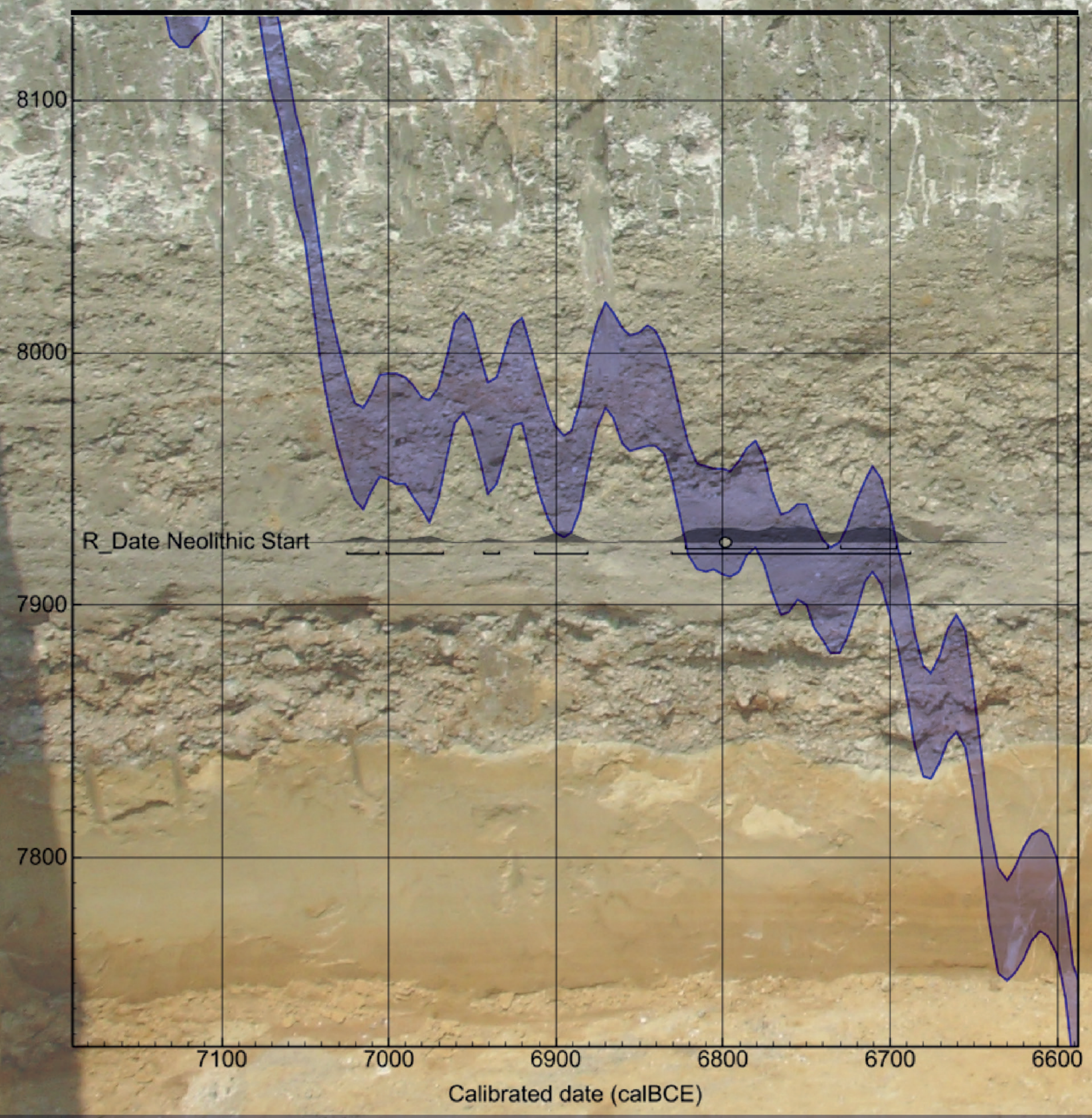

RELATIVELY ABSOLUTE

Relative and Absolute Chronologies in the Neolithic of Southeast Europe

Edited by Miroslav Marić, Jelena Bulatović and Nemanja Marković

Beograd
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Contents

Introduction

It is probably best assumed that the passage of time has been an important part of human reality for as long as humanity has existed. The notion of time, although likely not understood and measured by early hominids as it is today, was a self-evident fact of the cycles of life that each of us undertakes, from the moment of birth to the day of death. It became even more important to understand and measure when humans first attempted to understand their environment, to put it under their control. Perhaps at first, it was enough to realise when it was a period of cold or hot weather, a time of bounty and scarcity but as the complexity of human livelihood began to emerge with the onset of the Neolithic, the concept of time must have started to matter even more. Time, an intangible concept that cannot be rewound, renewed or traded, is an intricate part of daily lives governing our actions and cycles. The realisation that we can measure and organise it in the order of the occurrence of events to establish its flow was as important to the humans of the past as much as the concept of growing your own food resources and living in organised societies settled in specific environments. Certain authors (Aveni 1989) argue that the perception of time is inborn to living beings, evidenced through behaviours regulated by circadian cycles, but the measurement of time is surely a cultural product. Mankind, most likely even before the time of the Homo Sapiens, must have been aware of the biological time, evidenced in the individual phases of life that each living being goes through from birth to death. But the motion beyond that realisation, one that would cause the development of the concept of physical time; the time that exists as an external, measurable entity, must have demanded more than the inborn quality.

The measurement of time must have started very early in human prehistory, but the perishable character of material evidence from the human past partially prohibits us from discovering the point when it occurred. Additionally, even if material evidence is to be found, would we be able to, from our perspective, understand its character of timekeeping with certainty? If we were to argue the measurement of time came about in the Palaeolithic, then the material evidence is very limited due to, ironically, the sheer amount of time that has passed since. Perhaps then, it is possible to proxy search for other probable indicators of the existence of time as a concept among the current hunter-gatherer tribes that still occupy secluded parts of Earth today, avoiding contact with contemporary human societies of the 21st century? Certain studies (Sinha et al. 2011) have indicated that hunter-gatherer tribes in Amazon lack the linguistic structure that relates time and space or even lack words for time or terms associated with measuring time, like month or year. This, however, does not prevent them from talking about events and their sequence of occurrence, but it illustrates that, for them, the concept of time does not exist independently of events. Is it then prudent to assume that the Palaeolithic hunter-gatherers must have had the notion of seasonal cycles, possibly to keep track of which food sources to look for when, but surely not had them organised in calendars, rather as a series of interconnected and overlapping events related to certain natural phenomena (e.g. climatic cycles)? Would it be far-fetched to suspect that these Palaeolithic societies did not count the cycles of time but rather related them to events easily identifiable and transferable by the collective memory? This concept seems logical from the aspect of the short time scale that the hunter-gatherers were living on, based on recurring seasonal changes. It would also imply that their time was highly dependent on narratives passed down from generation to generation.

If no evidence of quantitative timekeeping can be found in the Paleolithic, can it then be identified in the Neolithic? Sedentary life and plant cultivation go hand in hand with the concept of longer annual or perennial cycles based on prolonged planning, food production, and harvesting management. While hunter-gatherers were influenced by individual seasons of climatic changes, Neolithic farmers would need to rely on at least annual cycles to know the adequate periods for sowing, cultivation and harvesting. It is safe to assume that these annual cycles would have already been known from the repetitive cyclical motions playing out above our heads – the astronomical cycles of constellations and the Sun and the Moon. The nature of these measurements is still unclear in the Neolithic period, as a key ingredient, writing, was still missing, depriving us of material evidence. Undoubtedly, the astronomical cycles have had an important role in the development of time measurement and the emergence of codified calendars, the basis for the earliest known systems of time measurement that would appear in the later periods.

Thus, moving to the earliest material evidence for timekeeping records may be pertinent, which originates in the Sumerian and Dynastic Egyptian periods (Greengus 1987; Polcaro 2013) from about 2200 BCE. However, it should be assumed that there would have been even older records since the writing system predates these earliest chronological records by almost a millennium. The Sumerian calendars were lunisolar, based on 12 lunar months, subdivided into seasons and organised around natural cycles like day (the regular rising and setting of the Sun), lunar month (the transition of the Moon through its cycle of phases) and solar cycle (the change rising and setting positions of the Sun throughout its annual cycle), while the Egyptian was solar based. The historical stage for chronology was thus set, driven by the need of emerging complex societies to record their time for posterity. Another side effect of the timekeeping was the creation of dynastic histories, the first relative chronological system known, albeit envisaged as a justification for the immense power vested in rulers rather than as a recording of the passage of time. Thus, a twofold split in chronology appeared, with shorter scaled civil time recording short-term astronomical cycles and regulating civil life, while historical time dealt solely with larger time scales that spanned periods from the current rulers back to the mythical, often divine, ancestors. The historical time was often referred to as sacred time, which must always be cyclical time as its existence made the present time (Eliade 1959). These cyclic events in which sacred times recreated the rituals originating from past sacred events from the long-gone periods often resulted in the creation of great years, truly long cycles which would often span multi millennia that were to repeat themselves over and over again.

The development of the concept of time did not end there. The cyclic time of the Bronze Age middle eastern societies began to be replaced by the notion of linear time, irreversible and not traced back to prior events in the Early Iron Age. This notion is deeply connected with the appearance of Judaism and monotheistic concepts of the Universe, which has its creation, lasting period and ending point (Goldberg 2000). Ancient Greek philosophers also tried to grasp the nature of time and the concept of chronology, introducing infinite time into the matter. The Sophist philosopher Antiphon claimed that time is not a reality, but a concept or a measure (Dunn 1996), while Parmenides saw it as an illusion because change is impossible and illusory (Hoy 1994). Somewhat later, Plato, in his Timaeus, stated that the time was created by the Creator and identified it with the period of motion of the heavenly bodies, of which he specially commented on the so-called Great Year, a complete cycle of the equinoxes around the ecliptic; effectively the return of the planets and the "fixed stars" to their original relative positions, a process that takes about 25,800 years (Plato 2001). This notion, derived from ancient astronomical observations of the movement of stars and constellations in the night sky, contributed further to the notion of linear time that early Christian authors will additionally advance in their attempts to synchronise and record the timeline of early Christianity.

In his Confessiones, St. Augustine noted that the world was neither timeless and eternal nor created at a certain point in the time series, but that the world and time were created together and also stated, "There are three times; a present of things past, a present of things present, and a present of things future" (Augustine 1992, XI:26). For Augustine, time is God's creature and God is the beginning and the end. This position reflects Neo-Platonism with an added splash of Aristotelian time as a linear stream, flowing from a beginning towards an end. This idea of linear time would not change much in the Early Medieval period. However, the theological view of time considers time to be of the material world only and that time ceases to exist in the immaterial after-world when they give way to eternity. Thus, time is an imperfect reflection of the heavenly life that awaits the worthy in this transitory world. Life on this Earth is time-bound and limited, while heavenly life is timeless and everlasting.

On the opposite end of the spectrum, in the Mediaeval period, earthly time is still a flow of moments, measured in terms of cyclical movements of the celestial bodies and the rhythm of nature (Polcaro 2013, 5). Timekeeping became very important, especially when serving religious needs, like Epiphany, Christmas, Annunciation and others. These calculatory problems occupied early Christianity, and many computations were made in attempts to fix the dates of these major events until finally, a Benedictine monk Bede Venerabilis published his study De temporum ratione in 725 AD. With the advent of the developed and Late Medieval period and the resurrection of town life that sprang around fortified castles of nobility, a new concept of time started to appear, centred primarily on acquiring economic and social wealth and prestige. The prohibition of usury, which forbade Christians from making money out of money loans and credits with interest, started giving way to money lending, which required exact determination of the lending period dependent on the universal measurement of time. By the late 14th century, even time itself became viewed as a commodity that could be parcelled out and measured on an even scale. The invention of mechanical devices for time measurements – mechanical clocks enabled this organisation of daily life by the clock. In the Renaissance, the concept of time as a precious good became an everyday topic for intellectual elites like Michel de Montaigne or Giordano Bruno (Ashcroft 2018).

The rise of science in the Modern period, starting from the late 15th century, brought about changes in paradigms in many aspects of life, often breaking away from well-established traditions. The concept of time was not left unchanged either in this process. Examining the material or physical world led scientists like Galileo to state that an objective reality exists with its intrinsic properties, independent and distinct from the individual perceiving it (Galilei 2017). Galileo, one of the greatest minds of his period, considered time and motion to be two of these properties. However, another, perhaps the best-known scientist of the period, Isaac Newton, was credited with the introduction of absolute time alongside concepts like absolute space and absolute motion. In his Philosophiae Naturalis Principia Mathematica, Newton states: "Absolute, true, and mathematical time, of itself, and from its own nature, flows equably without relation to anything external, and by another name is called duration: relative, apparent, and common time, is some sensible and external (whether accurate or unequable) measure of duration by the means of motion, which is commonly used instead of true time; such as an hour, a day, a month, a year" (Newton 1687).

However, Newton's view of the time was not the only one in existence and was furthermore soundly opposed by another prominent intellectual figure of the period, Gottfried Leibniz, who considered that space and time are for him purely relative "an order of coexistence, as time is an order of successions. For space denotes, in terms of possibility, an order of things that exist at the same time, considered as existing together, without entering into their particular manners of existing" (Leibniz's third letter to Clarke – February 25, 1716).

These views on space and time gave birth to the absolute concept of time (Newton) and a relational one (Leibniz) based on different logical priorities of space and time concerning objects and material processes. The key question and difference lie in the dilemma of whether the existence of space and time allows the existence of objects or does the existence of objects creates space and time. Despite all advancement over the century, it is just these views that, to this day, govern, more or less, the Western concept of time, which also lies at the heart of the archaeological notion of time.

In its earliest periods, modern archaeology heavily relied on the concept of relative chronologies, particularly when dealing with recorded histories of human societies being studied. It is of no surprise because no way of establishing absolute age existed in that period. The interest in the ancient Middle East and Graeco-Roman periods heavily relied on epigraphic sources listing periods, rulers and important events. However, the oldest known archaeological chronology developed was the one of a Danish archaeologist C.J. Thomsen, curator of the National Museum of Denmark, who divided the prehistoric period into the Stone, Bronze, and Iron ages (the scheme was published in 1836 in his book Ledetraad til nordisk Oldkyndighed). By the end of the 19th century and the beginning of the 20th, relative chronologies were an everyday item in the archaeological kit (e.g., Petrie 1899; Reinecke 1899, 1902), helping establish the relative age of finds and sites throughout the world.

Relative chronology remained a principal archaeological tool for chronological placement of material cultures until the mid-20th century when Willard Libby proposed an innovative method applicable to organic materials which enabled absolute dating of finds based on the measure of decay of carbon-14, an unstable isotope of carbon. This method brought back the absolute time scale to archaeology in a revolutionary manner, making possible more precise historical and prehistoric chronologies across the periods. Libby, a professor of chemistry at the University of Chicago, realised that carbon-14, an isotope abundant in the atmosphere, is embedded into the organic living matter during its life cycle through respiration, food and liquid consumption and that its accumulation ceases with the death of the organic. He proposed that if one could establish the amount of carbon-14 in an object, one could estimate that object's age using the half-life of the unstable carbon-14 isotope, i.e., the rate of decay of the original isotope quantity to half of the starting value. For this method to work, Libby assumed that the concentration of carbon-14 has been constant for thousands of years and that the isotope moves readily through the atmosphere, biosphere, oceans and other bodies of water in a known process as the carbon cycle. The first factor was later proven to be generally true, but for the second, Libby had to calculate a ratio of carbon-14 atoms per every carbon atom on Earth, which appeared to be one carbon 14 atom per every 1012 carbon atoms. Following this, he calculated the mixing of carbons across different reservoirs resulting in a prediction of carbon-14 distribution across features of the carbon cycle. Further research by Libby and others established its half-life as 5,568 years (later revised to 5,730 ± 40 years), providing another essential factor in Libby's concept. In 1949 Libby and Arnold published their results (Libby and Arnold 1949), proving the success of the method and paving the way for its introduction into the world of archaeological chronologies.

Libby's discovery helped resolve multiple issues in the sphere of anthropology and archaeology, including the notion that civilisation originated in Europe and diffused outwards into the rest of the world. By dating man-made artefacts from Europe, the Americas, Asia, Africa and Oceania, archaeologists could establish that civilisations developed in multiple independent sites across the globe. Spending less time trying to determine artefact ages, archaeologists could now ask more searching questions about the evolution of human societies and behaviour in prehistory.

Radiocarbon dating in Southeast Europe made its maiden steps in the 1960s and continued in the early 1970s, with first data published from sites like Starčevo, Karanovo, Sesklo, Vinča and others (Kohl and Quitta 1966; Lawn 1973; Nandris 1968; Vogel and Waterbolk 1963) illustrating the importance of Southeast Europe as a prominent corridor for the introduction of the Neolithic way of life into Europe. Since then, the amount of radiocarbon measurements has increased immensely, creating new insight into the dynamics of the emergence and development of the Neolithization of Europe. Old schematics of parallel relative chronologies of material cultures in the region became infused with absolute dates from many sites in the region, creating a detailed narrative of events that would shape the identity of Europe's earliest farmers spanning over two thousand years.

To this great narrative of the Neolithic period and its chronology, we contribute and dedicate our volume in the hope that new generations of researchers will find it useful for research and the creation of new questions and topics that still exist out there and are waiting to be explored and placed in the ever-growing mosaic of knowledge that archaeologists build in an attempt to understand our past and origins better.

The Editors

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5.

Chronology, economy, and technology of the Late Neolithic site of Jablanica (central Serbia)

Selena Vitezović, Nemanja Marković, Jelena Bulatović, Velibor Katić, and Miroslav Marić

Abstract Various socio-economic changes, including the introduction of metallurgy, mark the long duration of the Vinča culture. For detailed studies of the transformations of the Vinča societies, analyses of subsistence and economy must also be placed on the chronological line. The small-sized excavations carried out in 2018 at the Late Neolithic site of Jablanica (*c.* 5000–4700 BC) in central Serbia provided a faunal assemblage that enabled analyses of animal exploitation patterns, bone technology and also provided the samples for radiocarbon dating. The faunal remains show the predominance of domestic species, especially cattle. The site also yielded approximately 90 artefacts produced from bone and antler, including finished objects, preforms and manufacturing debris. Predominant raw materials were bones, mainly long bones, metapodials and ribs, followed by red deer antlers. Also, one artefact from *Spondylus* shell was found. Awls were the most frequent techno-type, and the typological repertoire also included other pointed tools, scrapers and other tools. Several preforms (mainly awls) and manufacture debris provided evidence of a working area or workshop within the settlement. Absolute dates showed that the beginning of the Late Neolithic occupation at the site of Jablanica could be equated with the relative depths of 4.5 meters at the type site of Vinča – Belo Brdo, or the late Vinča Pločnik I (Vinča C) period, while the radiocarbon dates associated with the end of the Late Neolithic occupation of the site can be correlated to layers between 4.0 and 3.5 meters at the type site of Vinča, i.e., the Vinča Pločnik IIa.

Keywords: Late Neolithic, Vinča culture, faunal analyses, bone technology, radiocarbon dates

Introduction

The 5th millennium BC in the central Balkan area is marked by the Vinča culture complex phenomenon, widespread in present-day Serbia and parts of Croatia, Romania, Montenegro, and Bosnia and Herzegovina (Garašanin 1979). Over this long period, diverse socio-economic changes occurred, including the introduction of copper metallurgy and related changes in the economy and technology. Temporal changes within the Vinča culture were mainly studied from the viewpoint of the modifications in the material culture, particularly stylistic ones, while the transformations in economy and technology were less explored. Studies of subsistence, economy and technology from individual sites must be accompanied by detailed studies of absolute chronology for a broader, comprehensive approach to socio-economic changes that took place in the 5th millennium BC. The faunal assemblage from the site of Jablanica enabled comparative, comprehensive studies of subsistence patterns, bone technology, and absolute dates.

Archaeological background

The archaeological site of Jablanica is situated in the village of Međulužje, near Mladenovac, approximately 50 km from Belgrade. The prehistoric settlement was located on a trapezoid-shaped plateau on the western bank of the Jablanica stream, and its estimated area is over 50 ha (Figure 1a). It was first discovered in 1899, and the first excavations were carried out already in 1900 by Miloje M. Vasić. These results were published in 1901 and 1902 (Reinach 1901; Wassits 1902). The excavations covered the surface of 64 m^2 and revealed a large prehistoric settlement of the Vinča culture complex. These research activities represent, in fact, the first systematic archaeological excavations of some prehistoric settlements in Serbia with up-to-date archaeological standards.

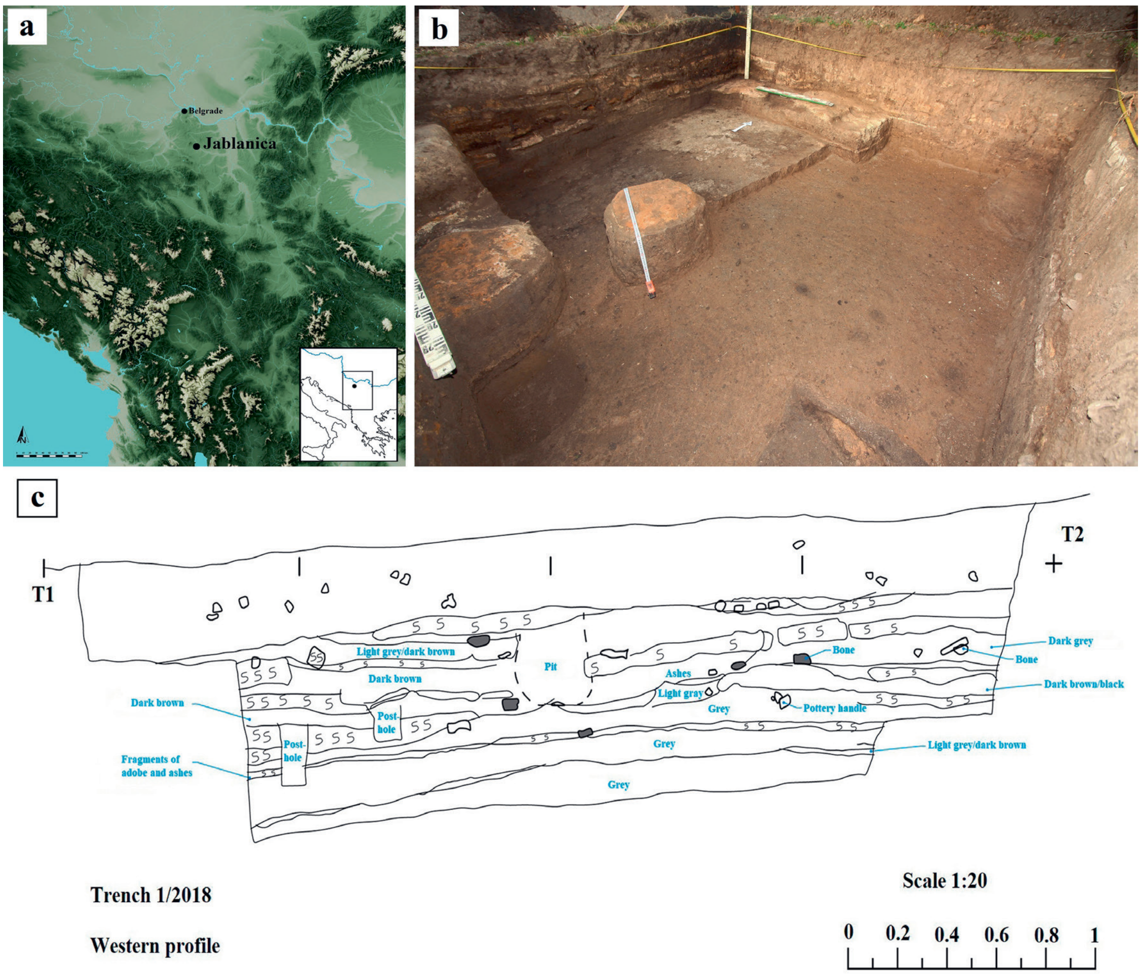

Figure 1. *Jablanica: a. position of the Late Neolithic site; b. Trench 1, view from the south-eastern corner; c. western profile of Trench 1*

The research was carried out again in 1996 by the Institute for heritage protection of the city of Belgrade, encompassing one trench with dimensions of 4 x 4 m. To the north from the central part of the site, divided by the valley of a small seasonal stream, another site was discovered, labelled Jablanica II. It was registered in 1986 during an archaeological field survey performed by the Museum of Mladenovac (part of the Belgrade City Museum) (Katić 1989, 2003). This part of the prehistoric settlement was located on a small river terrace, covering an area of approximately 0.60 ha. The Međulug plateau is situated above it and to the northwest, while there is a slight depression on the eastern side, probably created by water. Small-scale rescue excavations were carried out in 2018 by the Museum of Mladenovac. One trench, 4 x 4 m, located in the central part of the terrace, was excavated with the primary goal of defining the vertical stratigraphy of the site and determining the degree of damage caused by agricultural works (Figure 1b). The excavation methodology did not include sieving, and the excavation spits were grouped into habitation horizons.

The cultural layer from the trench from 2018 was 1.10 m thick, and the stratigraphic sequence consisted of five habitation horizons. The earliest habitation horizon comprises a part of the floor from grey clay and a horseshoe-shaped hearth outside the house. Several post holes were noted, usually grouped, thus suggesting the presence of some above-ground structures, such as shelters above the hearths. Post holes were also discovered in the later phases, but it was impossible to connect them with the reinforcement elements of the walls of any structure. Structures from the third and the fourth habitation horizons are placed right on top of each other, as suggested by the findings of large amounts of clay mass and ashes. Two circular structures were noted: red, burnt soil and a hole in the centre. Agricultural works partly destroyed the final habitation horizon, and only the northern part of a larger structure was noted, with preserved width of up to 1.5 m (Figure 1c).

These excavations revealed a large Vinča culture settlement with rich portable findings – ceramic vessels, anthropomorphic and zoomorphic figurines, altars, ground and chipped stone tools, as well as the faunal remains and the bone objects.

Radiocarbon dating

Samples from Trench 1 were selected for radiocarbon dating, carried out as part of the project "*Regional Absolute Chronologies of the Late Neolithic in Serbia"*, funded by the Science Fund of the Republic of Serbia.

The chosen trench, albeit relatively small and located towards the outskirts of the Late Neolithic settlement on the site, yielded an abundance of ceramic finds and animal remains, making it a perfect candidate for estimating a chronological sequence of the site in this part. It was also the only trench on the site to be excavated with careful methodology and good documentation. While the stratigraphy of the site overall may be thicker and consist of long-lasting evidence of occupation in other parts, the fact that the only other excavations on the site were undertaken over a hundred years ago (Vassits 1902) prevents us from radiocarbon dating this collection as we lack documentation and organic material for samples.

In total, 10 bone samples were sent for AMS dating at the Debrecen HEKAL MICADAS type Accelerator Mass Spectrometer. The samples were pre-treated by ultrasonification in distilled water, treated with the ABA method (Molnar et al., 2013), followed by gelatinisation and ultra-filtration (Brown et al., 1988), and then freeze-dried and combusted. Finally, they were graphitised and dated by Accelerator Mass Spectrometry (Kromer et al., 2013). The samples chosen were solely animal bones, as no short-lived macrobotanical samples were available to choose from, as no wet or dry sieving was implemented during excavations. The Bayesian modelling was undertaken in OxCal v4.4 program (Bronk Ramsey, 2010, 1995), and the models described are defined by OxCal CQL2 keywords and the brackets seen on the left edge of model figures. Calibrated radiocarbon dates are given in grey outlines, with posterior density estimates created by Bayesian modelling in solid dark grey.

The model was constructed using Bayesian statistics, which provide a probabilistic method for estimating absolute dates of past events. Bayes' theorem in archaeology enables archaeologists to analyse collected data from the field in the context of prior beliefs (or existing archaeological knowledge and experience) to create new understanding through the incorporation of existing knowledge and new data to create posterior beliefs that become future prior beliefs and inform new data and its interpretation in cyclic repeats. Simplified, this means that radiocarbon dates are definite specific information on a certain problem (chronology) and substantially affect the output of the chronological model. Then, informative beliefs, such as stratigraphic evidence collected by an archaeologist during excavations, provide the relationship between two (or more) radiocarbon samples obtained from the examined site. Informative beliefs can also be different, like the seriation of certain artefact categories of similar. Short-lived organic samples are preferred to provide age proximity between radiocarbon samples, thus narrowing the posterior likelihoods of individual samples. In our example, relative stratigraphy of the trench, devised by its excavator, was used to provide informative beliefs.

Figure 2. *Bayesian chronological model of Jablanica Trench 1*

Using the stratigraphic sequence of Trench 1 in Jablanica recorded during the excavations in 2018, the constructed Bayesian chronological model presented us with a very strong agreement (Amodel: 131), with only two samples (DeA-30121 and DeA-31044) displaying a strong indication of being residual bone (Figure 2). Modelled start of the occupation of the part of the settlement in Trench 1 (Figure 3) can be dated as 4815–4711 cal BC (95% prob.), possibly 4793–4756 cal BC (43.3% prob.) or 4737–4717 cal BC (25% prob.). The chronological sequence of events unfolding in the trench appears to have been very short. The oldest phase, spit 5 appears to last anywhere between 0 and 25 years (95% prob.), possibly just between 0 and 9 years (68% prob.). Similar can be said for other spits as well, since they all appear to cover archaeological accumulations that mainly lasted between 0 and 25–30 years (95% prob.), possibly 0–8 or 9 years (68% prob.). The end of the Late Neolithic occupation in the trench can be estimated to 4776–4634 cal BC (95.4% prob.), possibly 4723–4671 cal BC (68% prob.), which indicates a short occupation span of 0 to 177 years (95.4% prob.), possibly just between 0 and 71 years (68% prob.), which is indeed a short timeframe for the Late Neolithic occupation, comparable to three generation spans (Figure 4, 5). To summarise, the beginning of the Late Neolithic occupation in Trench 1 at the site of Jablanica can be equated with the relative depths of 4.5 meters at the type site of Belo Brdo or the late Vinča Pločnik I (Vinča C) period, while the radiocarbon dates associated with the end of the Late Neolithic occupation of the site can be correlated to layers between 4.0 and 3.5 meters at the type site of Vinča (Tasić et al. 2015: Tab. 5), i.e., the Vinča Pločnik IIa (Vinča D1) period (Tasić et al. 2015: Tab. 8).

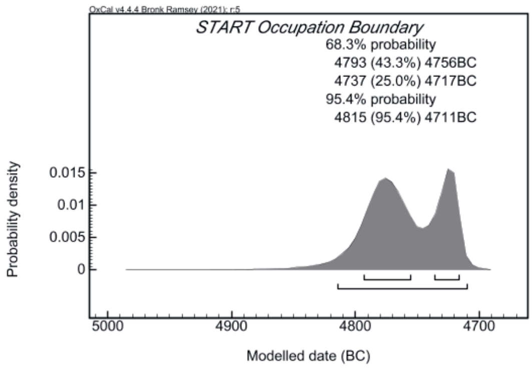

Figure 3. *Modelled Late Neolithic Start of occupation of Jablanica, derived from Bayesian model from Figure 1*

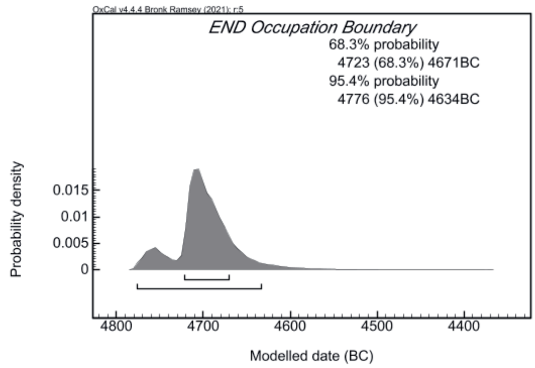

Figure 4. *Modelled Late Neolithic End of occupation of Jablanica, derived from Bayesian model from Figure 1*

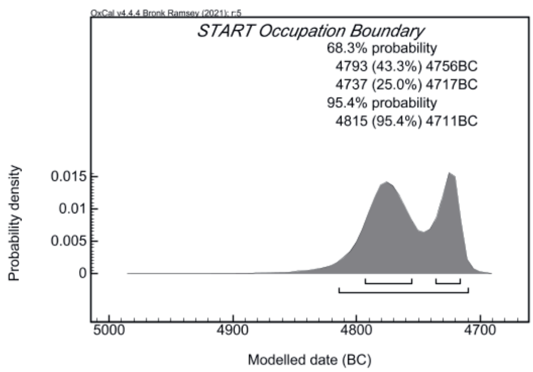

Figure 5. *Modelled span of the duration of the Late Neolithic settlement of Jablanica, based on data from Trench 1*

Faunal assemblage

The animal remains from Trench 1 found during archaeological excavations at the site of Jablanica in the 2018 campaign were hand-recovered from five Late Neolithic habitation horizons. Taxonomic determination was carried out using the comparative collection of the Laboratory for Bioarchaeology at the Faculty of Philosophy in Belgrade. Also, guides of morphological criteria and comparative anatomy were used (Boessneck et al. 1964; Boessneck 1969; Schmid 1972; Payne 1985; Prummel and Frisch 1986; Prummel 1988; Helmer and Rocheteau 1994; Halstead et al. 2002; Zeder and Lapham 2010; Zeder and Pilaar 2010). The distinction between wild and domestic pig species was derived from the correlation of metric data. The metric analysis was carried out following the metric standards of Driesch 1976. Quantification was performed according to the number of identified specimens (NISP).

The Jablanica faunal assemblage consists of the remains of mammals, birds, amphibians, fish, and molluscs (Table 1). The assemblage comprises 4,146 specimens. Out of the total number of specimens, 739 (19%) could be identified to a species or to a genus level. The relative distribution of domestic animal remains (83%) outnumbers the wild (17%). The most frequent domestic species was cattle (54.5%), followed by a domestic pig (17%) and caprines (9.5%). The dog remains were represented by 2%. The most frequently hunted species was a red deer (7%), followed by a hare (4%), roe deer (3%) and wild boar (2.5%).

Common name	Latin name	NISP	% NISP
Domestic cattle	*Bos taurus*	402	54.5
Domestic pig	*Sus domesticus*	128	17
Wild boar	*Sus scrofa*	19	2.5
Pig (indet.)	*Sus* sp.	2	0.5
Sheep or goat	*Ovis/Capra*	70	9.5
Dog	*Canis familiaris*	16	2
Red deer	*Cervus elaphus*	51	7
Roe deer	*Capreolus capreolus*	20	3
Hare	*Lepus europaeus*	31	4
Total identified		**739**	**100**
Large mammals		2946	
Medium mammals		398	
Small mammals		4	
Micromammals		1	
Birds	Aves	10	
Amphibians	Amphibia	1	
Fish	Pisces	1	
Snails	Gastropoda	14	
Bivalves	Bivalvia	32	
Total unidentified		3407	
TOTAL		4146	

Table 1. *Distribution of taxa at Jablanica, as Number of Identified Specimens (NISP)*

Anatomical region	Element	Cattle	Pig	Caprines	Red deer	Roe deer
Head	Cornus	3			18	2
	Cranium	9	11			
	Praemaxilla	1	2	1		
	Maxilla	5	7	1	1	
	Mandibula	30	23	9	2	1
	Dentes	33	10	3	2	
	Hyoid	1		1		
	Head total:	**82**	**53**	**15**	**23**	**3**
Axial	Vertebrae	9	2			
	Pelvis	14	3	3	1	
	Axial total	**23**	**5**	**3**	**1**	**0**
Upper limb parts	Scapula	6	9	4		
	Humerus	22	8	2	2	3
	Femur	10	4	1		
	Upper limbs parts total:	**38**	**21**	**10**	**2**	**3**
Lower limb parts	Radius	18	6	8	2	2
	Ulna	6	8	3	1	1
	Tibia	18	15	11	1	1
	Fibula		1			
	Carpalia	16			1	
	Tarsalia	58	2	2	6	
	Metapodium	46	9	17	10	10
	Sesamoideum	14				
	Lower limbs parts total	**176**	**41**	**41**	**21**	**14**
Phalanx	**Phalanx I-III**	**82**	**8**	**4**	**4**	**0**
	TOTAL:	**401**	**128**	**70**	**51**	**20**

Table 2. *Distribution of skeletal elements of the main domesticated and wild species*

The distribution of skeletal elements of cattle, pigs, caprines, red deer, and roe deer are provided in Table 2. The animal remains are grouped into five anatomical regions: head, axial, upper limb parts, lower limb parts, and phalanges. Skeletal elements of analysed species from all anatomical regions are present in the faunal assemblage, although their frequency varies from species to species. In the case of almost all species, the most frequent skeletal elements are from the lower parts of the limbs – metapodials, followed by head and upper limb parts, except for cattle. In the case of cattle, after the elements of the lower parts of the limbs, elements of the head and phalanges are equally represented. In the case of red deer, over 78% of head elements are antlers. Considering that they are fragments of beams and tines, it is difficult to distinguish whether the antlers originate from hunted animals or part of them are shed antlers collected in the surrounding area of the settlement. Rib fragments are also represented in the assemblage. Out of the total number of large mammal remains, ribs comprise 2%, while only three specimens (0.5%) originate from medium size mammals. Based on the distribution of skeletal elements, i.e. presence of bones from all anatomical regions, it can be concluded that whole domestic and wild animals were brought to the Jablanica settlement and further processed for food and raw materials.

Although the animal remains from the Late Neolithic Jablanica are well-preserved without pronounced weathering marks, they are highly fragmented. Whole skeletal elements constitute 3% of the total faunal assemblage. Butchery marks were revealed on the bones of cattle, pigs, and caprines and comprised 1% of the specimens in total. Traces of burning were found on 25.5% of animal remains. Most burnt specimens are carbonised or calcined, indicating the post-consumption treatment, such as managing midden areas. Gnawing marks are found on 4.5% of the specimens, indicating that dogs or even pigs had occasional access to animal bones. Taphonomic characteristics of the faunal assemblage from Jablanica, particularly the high percentage of carbonised and calcined specimens, indicate the possible existence of the organisation and management of midden areas in the settlement (Table 3).

Modifications	**n**	**% n**
Butchery	42	1
Gnawing	187	4.5
Burning	1057	25.5
Worked bones	90	2.2

Table 3. *Distribution of bone modifications in total faunal assemblage (n = 4146)*

In total, 90 (2.2%) animal remains had manufacturing and use-wear traces.

Animal husbandry in large communally oriented settlements from the first half of the fifth millennium BC in the central part of present-day Serbia, i.e., in the vicinity of Jablanica, was based on breeding large herds of cattle – e.g., Vinča – Belo Brdo (Bulatović 2018), Grabovac – Đurića Vinogradi (Bulatović and Spasić 2019), Stubline (Gillis et al. 2020), Selevac (Legge 1990), and Drenovac (Dimitrijević 2020). The relative distribution of different mammal species indicates that the most important economic species in the Late Neolithic settlement of Jablanica was domestic cattle. In light of that, the Jablanica settlement fits into the regional economic pattern. In some other large Late Vinča settlements, where animal husbandry was mainly based on herding domestic cattle, hunting played a less significant role in the economy (e.g., Pločnik) (Bulatović and Orton 2021). With 17% of the Jablanica faunal assemblage and species diversity, the hunting activity in this Late Neolithic settlement corresponds to the regional trend.

Bone tool assemblage

The bone tool assemblage consists of 90 artefacts. Some of them were recognised during excavations, while most were singled out during the faunal analysis. Artefacts were analysed from the technological viewpoint, meaning that the raw material selection, manufacturing techniques, morphology and use-wear traces were considered. Artefacts were analysed with low magnification (up to 20x), and the use-wear traces are poorly preserved in general since most artefacts had surfaces damaged by weathering, erosion, and carbonate crusts, and also, numerous items were carbonised from exposure to fire. The interpretation of the manufacturing and use-wear traces follow published criteria (Campana 1989; Christidou 1999; 2001; Christidou and Legrand 2005; Legrand and Sidéra 2006; Legrand 2007; 2008; Newcomer 1974; Patou-Mathis ed. 2002; Peltier 1986; Ramseyer ed. 2004; Sidéra 2005: Semenov 1976), while the typological classification is based on the morphology of the working end and possible function, the one already developed for the prehistoric assemblages in South-eastern Europe (Vitezović 2007; 2011; 2016) (see also Vitezović 2016 and references therein for details on the methodological procedures).

Raw materials used were predominantly bones, mainly metapodial bones and ribs. Also, several astragali were found, as well as one phalanx. Bones were from both large and medium-sized ruminants – cattle, red deer and sheep/goats. Red deer antlers were used to a lesser extent, and it was impossible to determine whether they were collected or obtained from hunted animals. Just one artefact from *Spondylus* shell was discovered. Artefacts from teeth were not noted.

Figure 6. *Complete and fragmented awls produced from small ruminant metapodial bones*

Pointed tools. Tools with a pointed end were the most frequent, particularly medium-sized pointed tools – awls. Two subtypes were noted, awls produced from long bones and awls made from ribs. Awls from long bones were all made from longitudinally split metapodial bones from small ruminants (Figure 6). Bones were split along their natural sulcus by grooving and cutting with a chipped stone tool and finalised by burnishing with an abrasive stone tool (for a detailed reconstruction of this technique, see Sidéra 2005). Two completely preserved awls have segments of proximal epiphysis preserved at the base, and several fragmented awls with the distal epiphysis are preserved. These awls were generally intensively used, often heavily fragmented, and when visible, use-wear traces consist of polished, shiny surfaces resulting from contact with soft, organic materials (Christidou and Legrand 2005; Legrand 2007; 2008; Peltier 1986). Awls produced by using the same technique (grooving, splitting, burnishing) from the same raw material and with the same morphological traits are among the most common tool types in other Vinča culture bone assemblages – they are encountered, among others, at Vinča – Belo Brdo (Bačkalov 1979; Srejović, Jovanović 1959: 182), Selevac (Russell 1990: 524), Drenovac (Vitezović 2007), Pločnik (Vitezović 2021a: 43–51, Figure 17, 18, 19; 2021b), etc. They are common on other Late Neolithic sites in Europe as well – e.g., in Greece (Stratouli 1998: taf. 25/1), in Hungary (Tóth 2013: 329–331), in Switzerland (Deshler-Erb et al. 2002: 342, abb. 507/1, 2, 4, 6), etc.

Awls made from ribs were produced from longitudinally split ribs, also finalised by burnishing with an abrasive stone. Only two are somewhat better preserved, while the majority are heavily fragmented – only the tips are preserved (Figure 7). They were also intensively used, and use-wear traces consist of polished, shiny surfaces, and smoothed, abraded spongy tissue on the inner side. A significant ratio of completely worn and broken tools suggests they were already disposed of, i.e., that the excavated area encompassed a rubbish pit.

Figure 7. *Awls made from ribs – fragments of distal segments*

Rib awls were also a widespread techno-type in the Vinča culture, known from, among others, Vinča – Belo Brdo (Bačkalov 1979; Srejović, Jovanović 1959: 182), Selevac (Russell 1990: 524), Drenovac (Vitezović 2007: 138–140), Pločnik (Vitezović 2021a: 51–54; Figure 25, 26, 27), and many more.

Several heavy points were found. They are mainly fragmented, but three of them are completely preserved. Two are produced from metapodial bones, one from red deer and the other from cattle (Figure 8). They were made using the same technique as awls – bones were longitudinally split by grooving with a chipped stone tool and finalised by burnishing and polishing. The point from the red deer bone has the distal epiphysis preserved as the base, while the point from cattle bone has the proximal epiphysis. Their distal ends are thicker, more massive points used for working on more resilient materials, such as wood, etc. Similar heavy points may be found at other Vinča culture sites – for example, Pločnik (Vitezović 2021a: 54–57, Figure 28).

Figure 8. *Heavy points produced from large ruminant metapodial bones*

One complete and one fragmented heavy point were made from unsplit ribs; ribs were divided into segments by transversal cutting and sawing, and then the side edges were cut with a chipped stone tool and burnished. Thus obtained blanks, with both bone plates of the ribs preserved, were further modified by burnishing into massive pointed tools. In order to obtain finer tools, such as awls, ribs were usually split longitudinally into two halves (two bone plates) and then shaped by burnishing – as frequently noted on this and other Vinča culture sites (e.g., Vitezović 2007; 2021a; see also Christidou 1999; 2001 for the reconstruction of this technique), but in this case, the artisan decided to make tools that are thicker and more resilient.

Fine pointed tools – needles – are not frequent; one almost complete small pointed tool made from a segment from a split rib was found, and also, few of the fragmented items were most likely needles.

Figure 9. *Fragmented tool from red deer antler, probably large cutting tool*

Figure 10. *Spatula-chisel made from rib*

Cutting tools. Two fragmented antler tools were probably axes or adzes. Only the basal part is preserved for the first one, a segment from the beam just below the crown (Figure 9). Traces of crown tines being removed may be noted, and a broken perforation is produced by cutting with a chipped stone tool. The other artefact is also a beam with crown tines removed, and the distal part is missing, but perhaps it was modified into a cutting edge. Similar axes/adzes are also known from other Vinča culture settlements, including Vinča – Belo Brdo (Srejović, Jovanović 1959).

Burnishing tools. Two scrapers made from ribs were found; they were made from unsplit segments of ribs and have a rounded working edge, worn from use. Also, one complete tool was found, a spatula-chisel made from the rib (Figure 10). The rib was split, and the tool was made from one bone plate. The tool has an irregular triangular shape; the basal end is small, while the distal end is wider. The working edge is slightly rounded, almost straight, sharp and worn from use. The spongy tissue is intensively worn, while the upper surface shows strong polish from use. Diverse types and subtypes of burnishing tools made from ribs are also frequent at other Vinča culture sites – for example, Selevac (Russell 1990: 532), or Pločnik (Vitezović 2021a: 61–63; Figure 39), to mention just a few.

Percussion tools. Three antler tines were modified into small percussion tools (Figure 11). They have traces of cutting at the basal part – the antler was thinned by the gradual removal of pieces of cortex by a chipped stone tool, and when the spongy tissue was reached, it was carefully cut through. The natural tip of the tine was also modified by cutting small pieces of the antler (whittling) to produce a small circular or elliptical working surface. The traces of use are not well preserved, but it may be noted that the distal ends are heavily worn, with lines and shallow grooves from use. They were probably used on different materials – for woodworking, food preparation, etc. On one of them, there are possible traces of being used as a retouching tool – dense, grouped short, deep grooves and incisions (see Patou-Mathis ed. 2002). Small punching tools made from antlers are also known, among others, at Drenovac (Vitezović 2007: 152).

Objects of special use. One fragmented large long bone, without preserved traces of manufacture but with intensive traces of use on its outer surface (intensive polish, worn surfaces, dense lines and striations), may have been some sort of a handle.

Five astragali with traces of use were noted, two with broken perforations. The use-wear traces are located on condyli – they are flattened and worn, and also some smoothing on the lower part may be observed on some of them. Perforations, R=5 mm, made by drilling, were positioned in the upper part. The function of these items is still a matter of debate (see Vitezović 2021a: 73–77 for an extensive overview), but their traces of use suggest they were most likely used on soft, organic materials, such as leather, hide, plant fibres, and the existence of perforation may point to their use as loom weights.

Several rib segments were also noted without preserved traces of manufacture but with intensive traces of use. Use-wear consists of worn surfaces, intensively polished, and irregular lines and striations. They were most likely used as some sort of supporter or working surfaces. Similar items were noted on other Vinča culture sites, such as Drenovac (Vitezović 2007), and for those found at Selevac, an interpretation as thong stretchers was offered (Russell 1990: 533). The examples from Jablanica were probably used for different purposes (for different raw materials), including possible thong stretchers.

Ornaments. Only one ornament was found, a fragmented bracelet from *Spondylus* shell (Figure 12). Ornaments made from marine molluscs were noted in other Vinča culture settlements – they were most frequent at the eponymous site of Vinča – Belo Brdo (Dimitrijević and Tripković 2002; 2006), but were also noted, for example, at Selevac (Russell 1990), Vitkovo (Vitezović 2013), Pločnik (Vitezović 2021a; 2021b), and many more (see also Vitezović, Antonović 2020). This find from Jablanica contributes to the map of their distribution and the reconstruction of trade routes.

Incomplete items. Besides several artefacts that are too fragmented to be identified typologically, three fragments of metapodial bones with just traces of manufacture were also noted. These bones were split longitudinally, and traces of a groove produced by a chipped stone tool are clearly visible. Traces of later stages of manufacture (namely, burnishing) and use-wear traces are missing, showing that these items are manufacture debris – and, as these are proximal fragments of metapodial bones, they were most likely discarded and only the distal portions were used for tool production.

Figure 11. *Small punching tool from red deer antler tine*

Figure 12. *Fragmented Spondylus bracelet*

Concluding remarks

The site of Jablanica was a large Vinča culture settlement, which flourished between 5000 and 4700 BC. The excavations at one trench in 2018 revealed five habitation horizons, and the radiocarbon dates enabled detailed information regarding the duration and their absolute dates. The beginning of the occupation by the Vinča culture communities can be equated with the relative depths of 4.5 meters at the type site of Belo Brdo or the late Vinča Pločnik I (Vinča C) period, while the radiocarbon dates associated with the end of the Late Neolithic occupation of the site can be correlated to layers between 4.0 and 3.5 meters at the site of Vinča – Belo Brdo.

The subsistence was based on domestic animals, and the most important economic species was domestic cattle, while hunting red deer, hare, roe deer, and wild boar played a minor role. Bones from domestic animals and occasional bones from wild species were also used to produce everyday tools, mainly pointed and burnishing tools, used for processing organic materials, such as leather, hide, plant fibres, and to a lesser extent, for woodworking. Antlers were not frequent, and it cannot be determined whether they were collected from hunted animals. Manufacturing techniques are those frequently used at other Vinča culture settlements, and the typological repertoire includes tools frequently encountered at other sites – awls from metapodial bones, awls from ribs, burnishing tools from ribs, used astragali, etc. The relatively limited repertoire (for example, small amounts of cutting and burnishing tools and the absence of large percussion tools) is due to the limited excavated area. The single find of an ornament from a mollusc shell shows that the communities at Jablanica also participated in supraregional trade and exchange networks.

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