Dating the Early Neolithic in Pelagonia: closing a chronological gap in Balkan prehistory

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ABSTRACT - *Since Gordon V. Childe first discussed the diffusion of culture from the Near East into Europe 100 years ago, various models for the advance of the Neolithic way of life have been proposed. Chronology has played an important role in this, but not all regions were included in the narratives due to a lack of data. Recent investigations in the border area between North Macedonia and Greece, namely in Pelagonia, have provided reliable new radiocarbon sequences, in total 42 new radiocarbon dates, that will contribute to the discussion on the Neolithic chronology of the Balkans.*

KEY WORDS – *Early Neolithic; Pelagonia, geographical region of Macedonia; absolute chronology; Neolithization process*

Datiranje zgodnjega neolitika Pelagonije: zapolnitev kronološke vrzeli v balkanski prazgodovini

IZVLEČEK – *Potem ko je Gordon V. Childe pred 100 leti prvič predstavil širjenje kulture z Bližnjega vzhoda v Evropo, so nastali različni modeli napredovanja neolitskega načina življenja. Kronologija je imela pri tem pomembno vlogo, vendar zaradi pomanjkljivih podatkov v zgodbe niso bile vključene vse regije. Nedavne raziskave v Pelagoniji, na mejnem območju med Severno Makedonijo in Grčijo, so prinesle nova in zanesljiva radiokarbonska zaporedja; skupaj 42 novih radiokarbonskih datumov, ki bodo vključeni v razprave o neolitski kronologiji Balkana.*

KLJUČNE BESEDE – *zgodnji neolitik; Pelagonija, geografska regija Makedonija; absolutna kronologija; proces neolitizacije*

Introduction

With the beginning of modern archaeological research, attempts were made to provide chronological frameworks for the different periods under investigation. As the discipline was evolving, a variety of methods were proposed for measuring time in the distant past. Before the mid-20th century most approaches were based on comparisons of stratigraphically secured finds that made it possible to elaborate on relative chronological schemes, but more exact determinations became possible with the development of radiocarbon dating in the late 1940s. Both approaches have been accepted and criticized, allowing archaeologists to favour the one that better supported their views on temporality.

Balkan archaeology is no exception in this regard, and numerous attempts have been made to determine both the beginning and end of the Neolithic Age, with the

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definition of the establishment of the first agricultural societies before their transformation into metallurgical communities remaining an ongoing process (*Childe 1929; Garašanin 1951; Gavela 1963; Benac 1979; Parzinger 1993; Todorova, Vaisov 1993; Sanev 1994; Korkuti 1995; Reingruber 2020*). Some authors have favoured relative chronologies based mainly on pottery and criticized the shortcomings of radiocarbon dating (*Milojčić 1949; Nikolov 1989*), while others, especially after the turn of the millennium, have emphasized the advantages of absolute dates and have been more cautious with direct material analogies (*Thissen 2000; Reingruber, Thissen 2005; Naumov 2009; Bulatović et al. 2018; Porčić 2023*). Nevertheless, nearly all archaeologists aiming to determine the timeframe of the Early Neolithic (EN) have attempted to provide elaborate perspectives on the dissemination of innovations from the Near East to Europe, reflecting in particular on the intermediary regions of the Aegean and the Balkans.

Given the influential relative chronology of the Balkans kans (*e.g., Milojčić 1949*), some archaeologists adjusted their own appraisals of the evidence based on this. Indeed, it has often seemed unthinkable to argue against such a chronology, leading to the situation in which authoritative *dicta* were followed and reinforced, as was the case with the so-called Preceramic Period in some countries (*Reingruber 2008.85–93*). On the other hand, language and national borders have often impeded productive communication among archaeologists, and the political situation of the 20th century, with Europe divided by an 'Iron Curtain', only exacerbated this.

These persistent, rigid approaches to archaeology were overcome not only with the political changes that occurred after 1989, but also with the broad acceptance of radiocarbon analysis. Although the first challenges to the relative chronological systems in the Balkans go back to the early 1970s when Colin Renfrew presented his new chronological insights based on the stratigraphy from Sitagroi with a sequence of 26 radiocarbon dates (*Renfrew 1971*), it took two decades until John Coleman gathered and analysed all the radiocarbon dates available at that time (*Coleman 1992*). The dissertation of Laurens Thissen (*2000*) set new standards with regard to the comprehension of the connectivity between Southeast Europe and Anatolia in light of the absolute chronology, and the online project CANeW (the precursor of 14SEA) in particular has led to the more widespread application of chronologies based on radiocarbon dates. As such, an absolute chronology has slowly been adopted and adapted, but even more than 20 years later some adjustments are still necessary (*Reingruber 2020.17*).

In the past, radiocarbon dates were either dismissed and ignored, or were accepted at face value with the expectation that they reflect a prehistoric 'reality'. Similarly, the quality of the dates is not sufficiently discussed, and one can observe a tendency to give credence to single dates, even with high standard deviations. This has led to a lopsided assessment of when and where the EN started in the Balkans. Sometimes, the properties of the calibration curve are not considered, especially the long-lasting plateaus resulting from the many wiggles (particularly that of the 7th millennium BC). This has led and still leads to a disproportionate emphasis on the oldest possible date instead of a more objective discussion of the dates in question. One must further acknowledge some inconsistencies in the interpretation of radiocarbon dates resulting from largely neglecting the origin of samples, natural effects on them, warnings by laboratories (*e.g.,* too little collagen in the samples, $\delta^{13}C$ effects, N:C-ratios, *etc.*). Moreover, the small number of dates inevitably cause biased interpretations. Despite some significant contributions to a better understanding of Neolithic chronology in the Balkans, regions with few and inconsistent radiocarbon dates were missing from broad chronological overviews. Such gaps in our knowledge have been detrimental to a better understanding of the advance of the Neolithic way of life.

Therefore, this paper will be an attempt to incorporate a missing region into the absolute chronological maps of the Neolithic Balkans. Our major focus will be on the new dates obtained from recent excavations and/or re-investigations of tell sites in Pelagonia (North Macedonia). We will provide more accurate information from the recent processing of the available data and present modelled sequences with the help of Bayesian statistics. As the research at some of the EN sites in this area is ongoing and the number of samples is still limited, we would like to stress that our models are provisional.

Neolithic in Pelagonia

Pelagonia is an elongated basin about 80km long and 20km wide that straddles the border area between North Macedonia and Greece (Fig. 1). Mountains with peaks as high as 2500m surround it, such as Dautica, Babuna, and Buševa in the north, Baba and Neredska in the west, Selečka and Niđe in the east, whereas the Varnoundas and Voras enclose the southern part. Surrounded by these mountains is a flatland at 600–700m above sea level. The fertile alluvial sediments of the flatlands are remnants of the Neogene lake that was naturally drained by the river Crna Reka and its tributaries that discharge into the river Vardar/Axios and from there into the Aegean Sea. As a result, a series of wetlands were created, particularly in the seasons of river floods, which were artificially drained during the melioration processes in the 1950s (*Arsovski 1997; Trifunovski 1998; Dumurdzanov* et al. *2004; Mirčovski* et al. *2015; Puteska* et al. *2015*). The existence of such wetlands in prehistory and particularly in the Neolithic period is confirmed by geoarchaeological research, while wetlands are also mentioned in some of the Medieval sources (*Kitanoski* et al. *1980; Chausidis 2003; Naumov 2020; Naumov* et al. *2021*).

The wetlands and alluvial soils of Pelagonia may have been an essential incentive for farming societies to settle here around 6000 BC. It was a wide-spread procedure in the Neolithic to establish and then continuously inhabit a site, resulting in tells several metres high. Besides Pelagonia, this practice is also present in other regions of the Balkan Peninsula, as well as in the Anatolian highlands and beyond (*Gallis 1992; Commenge 2009; Rosenstock 2009; Fouache* et al. *2010; Alexakis* et al. *2011; Ghilardi* et al. *2012; Lespez* et al. *2014; Ayala* et al. *2017; Naumov 2018*). Pelagonia can be considered an adequate setting for agricultural communities with access to a variety of resources around and in the wetlands (*e.g.,* fertile soils for cultivation, clay for constructions and pottery production, water animals and fruits) that enabled the ongoing occupation of tells for several hundred years.

This habitation pattern is reflected in the fact that houses were built and rebuilt on the same foundations for

Fig. 1. Map of south-eastern Europe with Neolithic sites mentioned in the text (Pelagonia highlighted in the red square): **1 *Vlaho,* 2 *Veluška Tumba,* 3 *Tumba Porodin,* 4 *Tumba Optičari,* 5 *Školska Tumba,* 6 *Čuka Topolčani,* 7 *Vrbjanska Čuka,* 8 *Markovi Kuli,* 9 *Mavropigi-Fillotsairi,* 10 *Revenia-Korinos,* 11 *Paliambela-Kolindros,* 12 *Nea Nikomedeia,* 13 *Vashtëmi,* 14 *Ploča,* 15 *Ohridati,* 16 *Lin 3,* 17 *Pogradec,* 18 *Cerje Govrlevo,* 19 *Tumba Madjari,* 20 *Amzabegovo,* 21 *Kovačevo.***

generations. Not only the use of the same plot over generations, but also large clay installations in their interiors, such as granaries, bins and ovens for storing and processing cereals, characterize this residential lifestyle (*Simoska, Sanev 1976; Kitanoski* et al. *1990; Naumov 2016*). Constant access to resources and a permanent residence manifested itself in flourishing societies that produced impressive painted pottery, human representations, house models, clay tablets, and stamps (*Simoska, Sanev 1976; Garašanin 1979; Sanev 1995; Naumov 2020*).

Despite these remarkable features of Pelagonian tells, they were not of particular research interest until the 1970s. Before that, only restricted fieldwork was carried out, for example by Vladimir Fewkes and Walter Heurtley in the 1930s or by Josip Korošec, Radoslav Galović and Miodrag Grbić in the 1950s at Grgur, Porodin, Karamani, and so on (*Fewkes 1934; Heurtley 1939; Grbić* et al. *1960; Galović 1964*). However, it was Dragica Simoska who had the greatest impact on the study of prehistoric sites in Pelagonia with a series of surveys and excavations in the 1970s, which contributed to a much better understanding of the first agricultural and metallurgical communities in the region (*Simoska, Sanev 1975; 1976; 1977; Simoska* et al. *1977; 1979*). This was followed by the more modest research in the northern parts of Pelagonia with limited fieldwork by Blagoja Kitanoski (*Kitanoski 1977; Kitanoski* et al. *1978; 1980*). The archaeological boom of the 1970s turned out to be relatively short lived, as only a few sites were investigated in the next decade (*Todorović* et al. *1987; Kitanoski 1989; Simoska, Kuzman 1990*). What followed were two decades with a total absence of research in this region, until the 2010s when new and multidisciplinary explorations were initiated that are still ongoing (*Naumov 2022; Naumov* et al. *2014; 2018a; 2021; 2023a*). To better understand the prehistory of Pelagonia – particularly with regard to its neighbouring societies and wetland areas – further investigations were soon undertaken in the regions of Lake Ohrid and Lake Prespa (*Naumov* et al. *2018b; 2023b*).

These multidisciplinary projects and international collaborations were oriented towards newer methods, such as archaeobotany, dendrochronology, zooarchaeology, geoarchaeological and geophysical investigations, laser and LiDAR scanning, lipid and use-wear analysis, GIS and 3D modelling, most of which were implemented in Macedonian archaeology for the first time. One of the crucial aims was to obtain well-contextualized samples for radiocarbon dating providing an accurate chronological sequence of the sites. This way, a model could be created from the time of the initial inhabitation of first farming communities in Pelagonia until the social transformations occurring in the Late Neolithic and Early Chalcolithic. These chronological sequences and models can be used to include the Pelagonian chronology in the existing Balkan periodizations. In a first step, the proposition of a possible scenario related to the Neolithisation process in this region will be presented.

Pelagonia and the dating of Neolithic sites

After initial descriptions of the Neolithic in Pelagonia, attempts were made to better define its chronological framework. These were based on the relative chronology derived from analogies with other regions, as in the case of Tumba at Porodin (*Grbić* et al. *1960*). Although belonging to the EN, the material from Porodin was first suggested to be from the Late Neolithic – yet it was an initial modest step to understand the chronological scope of this period in Pelagonia. Later, with the definition of the Velušina-Porodin cultural group, the earlier dating was highlighted once again, but still in terms of relative chronology (*Garašanin 1979*). This approach was also followed by the division into phases (*Sanev 1995*) that were adjusted to the existing ones from Amzabegovo, and as such contributed to its dating from 6100 until 4900 BC (*Gimbutas 1976*). Despite the small scale of this research, it was nevertheless a prolific time in Macedonian archaeology when the Neolithic period in this area was also starting to attract international interest.

As a result of the enthusiastic initiative and dynamic research in the 1970s, there were a number of radiocarbon samples obtained from the tells at Porodin, Trn, Mogila, and Topolčani, which were run at the laboratories in La Jolla, in the United States, and in Zagreb, Croatia (*Srdoć* et al. *1977; Valastro* et al. *1977*). Although they were available as published resources, it is surprising that they were hardly used in Yugoslavian and then later Macedonian studies dedicated to the Neolithic and the Neolithisation process (*Garašanin 1979; Sanev 1994; Mitrevski 2003*). It was not until the year 2000 that the dates were finally included in the larger Balkan chronology related to the appearance of first farming communities in Macedonia (*Thissen 2000*). Consequently, they were incorporated into the radiocarbon database of the CANeW project, and later later the 14SEA project, that provided the most comprehensive chronological outline of the Balkans and Anatolia (*Reingruber, Thissen 2005; 2017; Thissen, Reingruber 2017*). The radiocarbon dates from Pelagonia were not only set into broad chronological sequences but also used in overviews of the Neolithisation process in North Macedonia itself (*Naumov 2009; 2015*; *2023b; Fidanoski 2019*).

With the new initiative for more intensified and multidisciplinary research of the Neolithic tells in Pelagonia at the beginning of the 2010s, radiocarbon dating has been a regular practice and the major method to provide a firm chronology for particular sites and for the entire region. The Center for Prehistoric Research in Skopje launched several fieldwork projects in the Pelagonian basin in order to provide versatile data for understanding the timeframe, environmental setting and social dynamics of the Neolithic in this area, and consequently samples were taken from specific contexts to obtain well-founded sequences for each site (*Naumov 2023b*). Besides regional surveys and geomagnetic prospections, three particular sites in three different parts of the basin were focused on in order to determine the similarities and differences of communities that lived here: Vrbjanska Čuka at Slavej in the northern part of the valley, Veluška Tumba at Porodin in the central part and Vlaho at Živojno in the southern highlands. Systematic excavations at the three settlements provided the majority of samples for dating, and these will be used to establish the duration of specific building-phases at each site. In a second step, the sequences will be used to obtain a temporal perspective for the entire region of Pelagonia, particularly in relation to the Neolithic Balkans.

Samples from archaeobotanical, archaeozoological, and anthropological investigations were mainly used for the current dating of the investigated sites, *i.e.* the remains from seasonal plants, animal and human bones (*Antolín* et al. *2020; 2021; Naumov* et al. *2021; Sabanov* et al. *2022; 2023*). Short-lived seeds of cereals and legumes were preferred in this study, while the bones of pigs and humans, although dated, were generally excluded as they are susceptible to the reservoir effect. Similarly, the dating of charcoal was usually avoided due to the old wood effect. The datings were performed at the laboratories of the Universities of Seville (CNA), Bern (BE), Zurich (ETH) and Bristol (BRAMS), and have been published before as unmodelled dates on several occasions (*Stojanovski* et al. *2020; Naumov* et al. *2021; 2023b; Sabanov* et al. *2023*).

In this study, all 36 dates (Tab. 1, see below) were calibrated to the latest calibration curve[1] and Bayesian statistics were applied for modelling the sequences.[2] These results are subsequently rounded by 10 and interpreted in the 1σ range (at 68.3% probability). We then use their median values in order to reach the greatest limitations possible that are methodologically still acceptable (we are aware that new data will lead to more precise models).[3] This chronological study was executed at the Department for Prehistory in the Free University Berlin and at the Einstein Center Chronoi in Berlin. Besides the samples from Vlaho, Veluška Tumba and Vrbjanska Čuka, the recent ones from Tumba at Optičari, Školska Tumba at Mogila and Tumba at Porodin were also included in the study, while those from the 1970s are only mentioned in the general overview of the Neolithic chronology of Pelagonia.

Vlaho

Vlaho is situated on the lower slopes of the Nidje mountain, on a 6ha sandstone terrace created by two rivers (Fig. 2). Systematic research was started in 2020 and since then the site has been continuously excavated (*Naumov* et al. *2023a*). The geophysical prospections indicated the presence of a dozen of semicircular ditches, and their EN association has been verified by the excavation of three such features. Both geophysical coring and excavation confirm the existence of cultural layers 1.60m and 2.40m deep in which a number of unfired daub buildings have been detected, as well as structures made from laterally placed grinding stones. The unearthed pottery, models, and figurines form an apparent relationship with other EN sites in Pelagonia,

1 Radiocarbon dates used in this study that are not listed in Table 1 and 2 can be viewed in the Excel spreadsheet at www.14SEA.org (*Reingruber, Thissen 2017*).

2 Calibration and modelling were carried out using OxCal 4.4.4 (*Bronk Ramsey 2021*) and the IntCal20 atmospheric curve (*Reimer et al. 2020*).

3 Regarding the qualities of the dates we distinguish three levels of accuracy: single dates obtained on long-lived species (mainly charcoal) that were calibrated to the newest curve can be used only as a *Terminus post quem* (*TPQ*-cal), even when modelled statistically together with other such dates (*TPQ*-mod), although in this latter case the precision may be much better. Only dates stemming from a sequence that has been modelled according to short-lived species can be regarded as a *Terminus a Quo* (*TaQuo*) – not to be confused with *Terminus ante quem* (*TAQ*).

but also with some in Central and Western Macedonia in Greece. In view of these features of the material culture, but also the geographical location and dating, Vlaho proves to be one of the settlements that played a significant role in the early Neolithisation processes in the Balkans.

Fig. 2. Aerial photo from the site of Vlaho in the hilly area (©Center for Prehistoric Research).

The continuous excavation of Vlaho in the last few years has provided samples for archaeobotanical and archaeozoological analyses that were also used for its dating (*Antolín* et al. *2021; Naumov* et al. *2023a; Sabanov* et al. *2023*). There are only six dates available for the site so far, but many more are expected. The samples are related to stratigraphical units from the initial to the final stages of the EN occupation, so that a temporal overview of the general duration can be established. Most samples derive from cereals, but some were obtained from the bones of sheep and cattle.

The earliest date from Vlaho, ETH-132740, comes from a sheep bone found on the floor of Building 2. The sample ETH-132741, taken from cattle bone, strengthens the early dating of Building 2 since the calibrated and rounded by 10 the results are between *c.* 6420 and 6250 cal BC (compare Tab. 1 and Fig. 3). This building, one of the earliest at the site, is located above Building 1, for which there are no dates available yet. Two samples analysed in Seville (CNA-6151 and CNA-6152) place the activity within Building 3 at the same time of or a bit later than Building 2. It is followed in the stratigraphical record by Building 5, for which only a single date is available with a median of 6320 cal BC. The youngest date, CNA-6150, comes from a cereal sample in Building 7, which is situated in the top layers of the Vlaho stratigraphy. This date is much younger than the rest of the dates (6060–5990 cal BC).

These six dates were used for the Bayesian model (Fig. 4) based on their context within a particular building. At this stage of excavation, it is premature to define specific phases for the whole settlement. Nevertheless, the vertical disposition of buildings, one above the other, enables a stratigraphical succession from the earliest to latest buildings. This way the model can be used as a reference for either a continuous occupation and/or for the detection of cultural gaps. Judging by the median values of the model's boundaries, the EN community founded the settlement between 6400

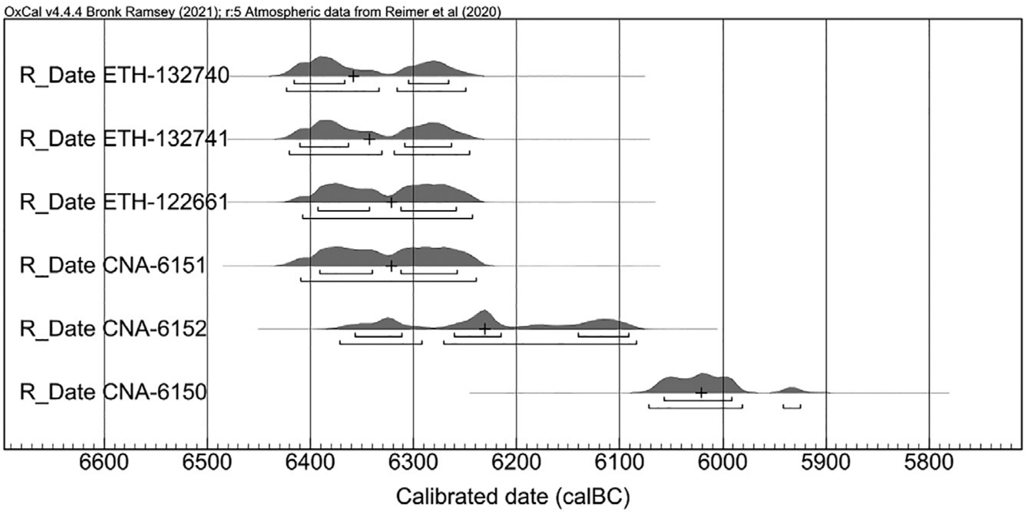

Fig. 3. Calibrated dates from Vlaho, sorted by age.

and 6360 cal BC; the activity within Building 3 may have occurred in the 2nd half of the 64th century BC, followed soon after around 6300 cal BC by Building 5. The next date, CNA-6150, is much younger, with a median of 6030 cal BC.

The provision of more dates for these contexts, but also for the site in general, will enable a more consistent chronological sequence. This significantly concerns the temporal gap between Buildings 5 and 7 of *c.* 150 years. This may indicate a lack of dates (including those from Building 6) or a brief inactivity in this part of the settlement or even in the entire site. Only intensified excavations of these levels in various parts of the site, together with more frequent sampling will resolve this question.

Nevertheless, we should not underestimate the importance of this high-quality data in our evaluation system. Despite the absence of dates from the earliest Building 1, a start of the sequence around 6400 cal BC (as *TaQuo,* see footnote 3) seems probable. It ends after *c.* 400 years of occupation latest at 5980 cal BC, according to the end of the model's boundary. This corresponds to the EN period in Aegean terminology and, as such, it is much earlier than any modelled sequence from Neolithic sites in the Balkans.

Veluška Tumba

The tell site of Veluška Tumba is positioned 400m south of Porodin on the lowest slopes of Baba Mountain next to the flatland plain of central Pelagonia (Fig. 5). It was largely excavated in the 1970s and 1980s, when its EN stratigraphical record of 4m height together with its distinct material culture were highlighted (*Simoska, Sanev 1975; 1976; Simoska 1986*). Novel multidisciplinary research was initiated in 2017, first with non-invasive investigations (archaeological and geophysical

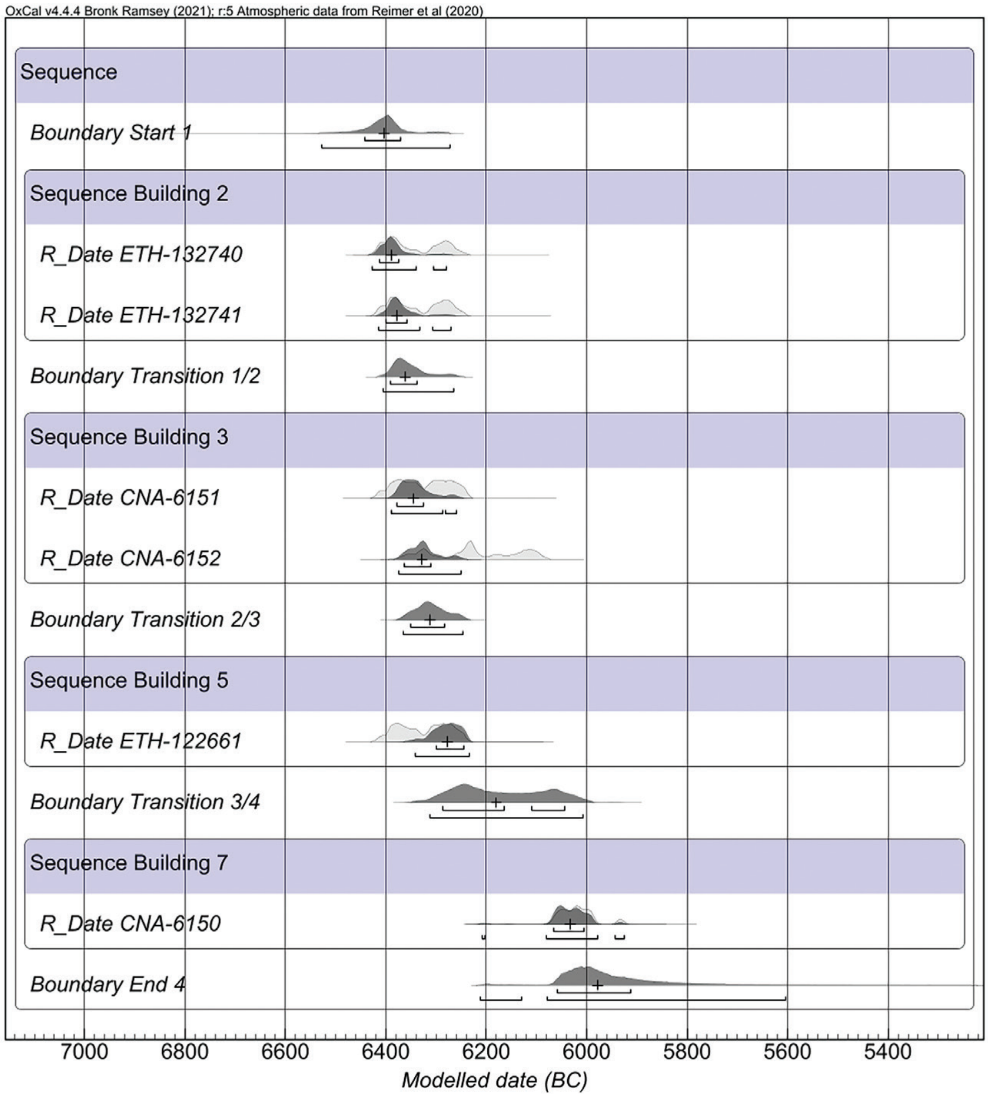

Fig. 4. Radiocarbon dates from Vlaho, modelled according to four building sequences.

prospections), followed by the still ongoing excavations (*Naumov 2022*). The recent research of Veluška Tumba provides detailed information on the spatial organization of this EN settlement, which is enclosed by two narrow ditches and daub buildings positioned in a north-east–southwest direction, often rebuilt in up to 13 architectural levels. The buildings contained several clay installations, such as ovens and bins, as well as dozens of large grinding stones.

Fig. 5. Photo from Veluška Tumba (©Center for Prehistoric Research).

The excavations and study of material culture were accompanied by archaeobotanical analysis which also provided samples for dating (*Antolín* et al. *2021; Sabanov* et al. *2023*). Besides these, samples of hazelnut and charcoal were also dated, but they are not included in this chronological study as they belong to the Mesolithic with results at 8846 BP (median at 8000 cal BC) and 7973 BP (median at 6900 cal BC). They also need additional revision and discussion, as at this stage it cannot be confirmed whether these samples are related to cultural activities or to natural events (*Naumov 2023b*). Similar to Vlaho, the Veluška Tumba samples derive from the stratigraphical units related to particular buildings, mainly concentrated in the earlier stages of the Neolithic settlement, some of which are synchronic, while others are erected one on top of another.

From the 18 samples from Veluška Tumba, two failed to be dated, two are from the Mesolithic, and one sample (BRAMS-4497), although from the EN layers, dates to the last century of the 6th millennium BC and may have been displaced by a rodent.[4] However, the 13 remaining samples provide a solid sequence ranging from 6020 to 5760 cal BC according to their medians (Fig. 6). The earliest Neolithic date is provided by the cereal sample BRAMS-4499 (6060–5990 cal BC: see Tab. 1) and it marks the foundation period of the settlement. The youngest date in the EN-sequence is ETH-122645 at 5760 cal BC according to its median. However, the sample, a pulse, was found in Building 1, one of the earliest in the sequence. Note that the date shows a high standard deviation and thus, if it has not been displaced by rodents or other agents, it may even be in line with the earliest occupation phase shortly after 6000 cal BC. Therefore, the cereal sample ETH-122646, dated to 5890–5720 cal BC (median of 5800 cal BC), provides the latest date from a secure unit. Still, this date is also not from the final stages of the settlement as there is stratigraphical evidence for at least nine more buildings erected above it.

The Bayesian model for the dates from Veluška Tumba provide a reliable dating of several buildings, as all the samples were taken from their interiors. Since the chronological modelling corresponds to the stratigraphical position of the buildings, it can be used for a better determination of phases along with the observed changes in the material culture in the future. Given the medians in the Bayesian model (Fig. 7), the chronological frame is set in the period between 6000 (as *TaQuo*) and 5820 cal BC, according to the boundary medians. Thus, the four consecutive building phases correspond well with the EN in Pelagonia.

It should be noted that the earliest date from Veluška Tumba is related to the level of protosoil in which the remains of material culture and cultivated plants were found. This could be a result of intensive building and rebuilding of houses for which the foundations were often dug deeper into the soil, as proven not only for this site but also at Vrbjanska Čuka (*Naumov 2020*). That this activity is related to the founding phase of the settlement is also indicated by the Bayesian model with a median of *c.* 5990 cal BC for this early date. The earliest detected architectural unit at Veluška Tumba so far is Building 16, with two dates (according to their medians) of 5970 and 5940 cal BC, respectively. Stratigraphically, it is followed by Building 1, which

4 In terms of Balkan chronology this would correspond to the Late Neolithic, but so far, no finds of this period were made. However, there is possibility that the upper part of the tell has been destroyed by constant ploughing in the last two centuries.

held most of the samples. Inclusive of the date ETH-122645 they narrow down the activity within this building to the time around 5920/5890 cal BC. Building 14, just above it, has a median of *c.* 5870 cal BC, and is in its turn succeeded by the last dated unit, Building 2, dated around 5850/5840 cal BC. Of course, these medians only represent a general chronological range for each of these buildings. They nevertheless indicate a gradual temporal perspective of the building intensity in the EN stages of Veluška Tumba. They should be regarded as approximate dates for the occupational period of these four buildings between 40 and 60 years each. With the future provision of more dates for each building phase, their time span will be determined more precisely.

The model from Veluška Tumba shows no temporal gaps, unlike the aforementioned model for Vlaho. This appears to be largely due to the higher number of samples, but also the stratigraphical records with no indications of geological events related to shorter or longer phases of abandonment. The dense succession of buildings in the stratigraphy also demonstrates an intensive occupation on this tell, which most likely was continuously inhabited (*Naumov* et al. *2020*). According to the boundaries of the model the duration of single sequences is between 70 and 20 years. Nevertheless, future dating of the phases following Building 2 is necessary to understand whether or not there was an uninterrupted occupation at this site.

For Veluška Tumba, the dates from the 1970s should also be mentioned. We did not include them in the discussion so far, due to the nature of their origin (charcoal samples from poorly defined layers). Despite their broad standard deviations, the calibrations reveal results around 5800 cal BC (as *TPQ*-cal). Thus, they overlap mainly with the younger part of the newly obtained sequence, and they substantiate this period as one of the most intensive occupations in the tell's stratigraphy. These findings will be discussed below in relation to the general chronology of Pelagonia.

Vrbjanska Čuka

The site of Vrbjanska Čuka is positioned in the northern part of Pelagonia, between the cities of Prilep and

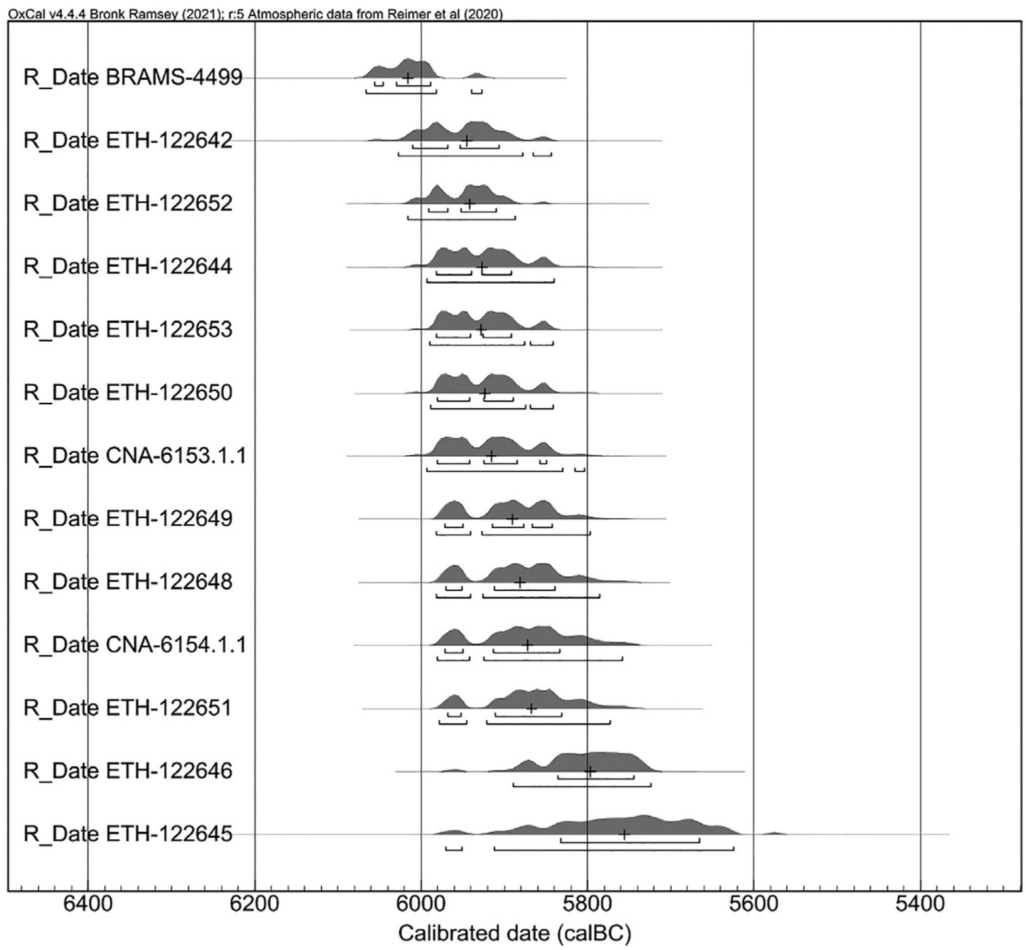

Fig. 6. Calibrated dates from Veluška Tumba, sorted by age.

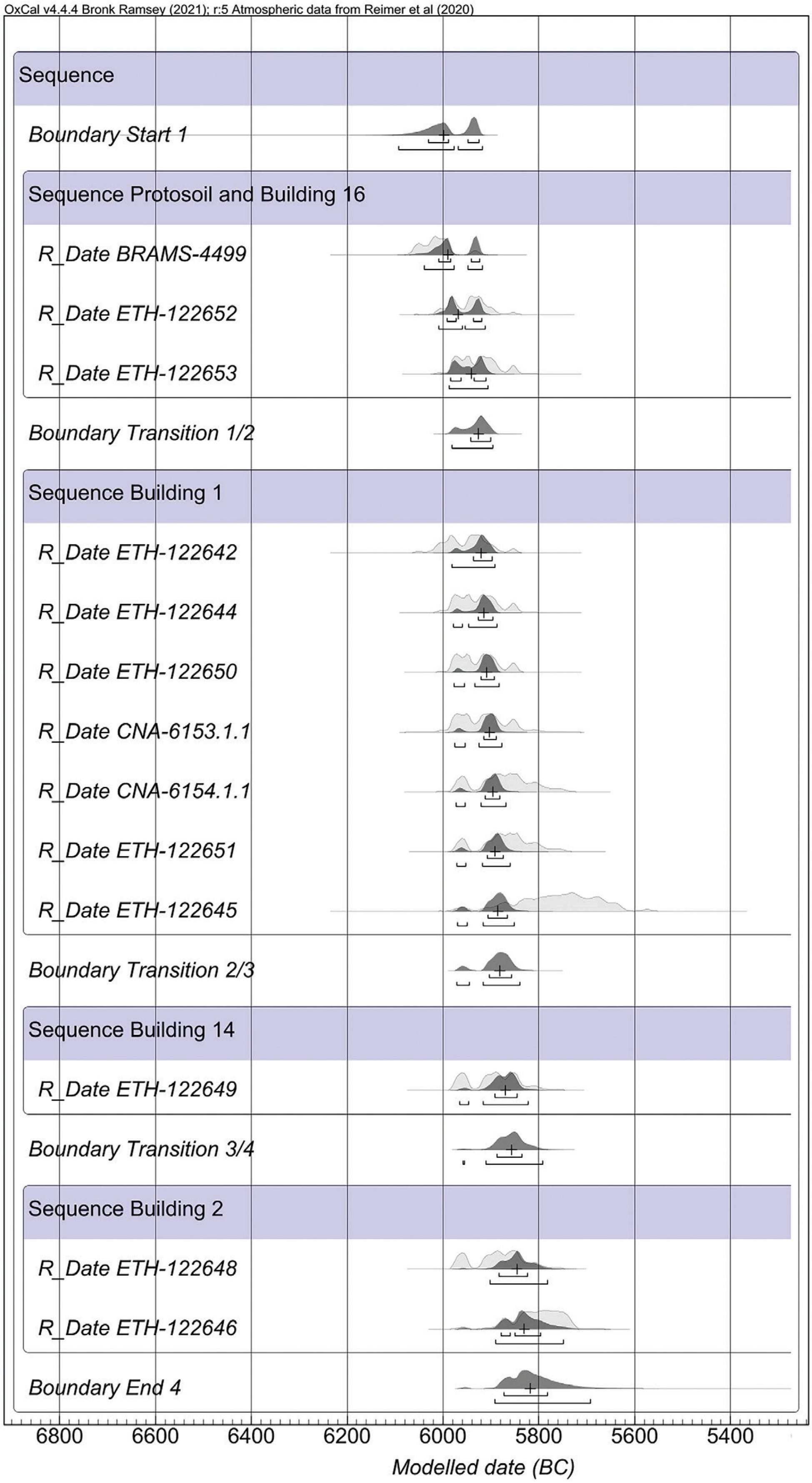

Fig. 7. Radiocarbon dates from Veluška Tumba, modelled according to four building sequences.

Kruševo, *i.e.* in the flatlands, 1.3km south of the village of Slavej (Fig. 8). The initial excavation was performed in the 1980s when its Neolithic character was determined through its impressive material culture and architecture (*Kitanoski 1989; Mitkoski 2005*). New multidisciplinary research started in 2016 and is still ongoing (*Naumov* et al. *2021; Naumov* et al. *2023c*). Other than the aforementioned sites, Vrbjanska Čuka ends with a Late Roman *villa rustica* and depositional pits, which were further used in the Medieval period, when this tell served as a necropolis. Only 1.30m of its height consists of EN layers, but these demonstrate a dynamic settlement with seven building layers enclosed by a broad ditch. The buildings, positioned in the NW–SE direction, contained a large number of massive clay installations (ovens, granaries and bins) as well as grinding stones. Like the cases of Veluška Tumba and Vlaho, the painted pottery, figurines, house models and tablets indicate distinct craftsmanship with complex symbolic and social features. An infant burial was discovered in the wall foundation of a house (Building 16).

Fig. 8. Vrbjanska Čuka as seen from the south (©Center for Prehistoric Research).

The archaeobotanical research provided the majority of radiocarbon samples, but also samples from lipid analyses and the above-mentioned infant burial were dated (*Beneš* et al. *2018; Antolín* et al. *2020; Stojanovski* et al. *2020; Sabanov* et al. *2022; 2023; Naumov* et al. *2023c*). Altogether 20 samples were sent to different laboratories, of which two belong to the Medieval period and another four were of poor precision. The remaining 14 samples are related to indoor stratigraphic units, *i.e.* particular buildings from different levels of the settlement. Not only the quantity but also the quality of the samples thus provide a reliable chronological sequence that demonstrates the temporal span of this EN settlement from its beginnings until its abandonment.

The earliest date is related to the cereal sample ETH-122658 from Building 11 (Tab. 1 and Fig. 9). It is calibrated to 6100–6000 cal BC, with the median of 6050 cal BC. The latest date, CNA-4705, was obtained from a lentil (5730–5670 cal BC, median of 5700 cal BC) and it overlaps with the lipid sample BRAMS-2838. The chronological frame of the medians suggests a temporal range of the EN settlement between 6050 and 5700 cal BC. It must be stressed that sample ETH-138166 from Building 16 belongs to an infant buried in the foundation for this structure (*Naumov* et al. *2023c*). The calibrated date has a median at 5900 cal BC and is as such *c.* 200 years older than expected on behalf of the stratigraphical position of the building between Buildings 5 and 14. We did not include it into the model as it is susceptible to the reservoir effect.

Given the reliable set of dates, we created a model with five sequences according to the excavated building units (Fig. 10). The building sequences represent three different architectural horizons that were dated on behalf of their stratigraphic disposition (*Naumov* et al. *2021*): The earliest is Building 11, which is in the same layer as Building 2 and next to it. Therefore, it is not surprising that their temporal ranges overlap, although sample ETH-122658 implies a possible earlier establishment of Building 11 at the end of the 7th millennium BC (5990 cal BC as *TaQuo*). On the other hand, the large number of dates from Building 2 determine its occupation between 5900 and 5860 cal BC. Given its stratigraphic position, Building 5 may also belong to this initial phase of Vrbjanska Čuka and can be chronologically attributed to the 59th century with its modelled median of 5830 cal BC.

As for the second architectural horizon, there are no dates available so far, but samples from interiors of Building 4 and Building 21, which are from this horizon, are ready for dating, so they will be incorporated in the updated version of the model.

The third architectural horizon consists of two subphases, each represented by a building unit. From Building 14 sample CNA-4705 was dated to *c.* 5790 cal BC. Building 8, which was founded above the previous one, largely corresponds to this dating with one median of 5760 (BRAMS-4542) and 5750 cal BC (BRAMS-2838).

Therefore, the model limits the duration of occupation at this site according to the boundaries between 6030–5740 cal BC. Nevertheless, despite the large number of samples and the thorough sequencing of Vrbjanska Čuka, more dating is still necessary in order to develop a better chronology of this site. Intensive dating of Building 4 would end in a more precise chronological understanding of the 2nd architectural horizon, while more dates from structures of the last occupational stage of this tell are also needed. Dating of the newly discovered Building 19 and Building 21 in the northern part of the trench will provide additional information on the settlement expansion and its temporality.

Dating other Pelagonian tells

Besides the sequences and models elaborated above for Vlaho, Veluška Tumba, and Vrbjanska Čuka, and next to the few dates obtained in the 1970s, there are also some newer dates available from other sites, yet only one to three per site. These are not sufficient for detailed observations, but they do contribute to a better understanding of the temporal determination of the tells and the dispersion of the Neolithic in Pelagonia, and will therefore be included in this chronological overview.

There are three samples from the EN site of Tumba at Optičari, taken from seed and animal bones unearthed in the 1980s when this tell was excavated (*Simoska, Kuzman 1990*). They were recently dated as part of the current projects (*Naumov 2023b*). The seed sample BE-5280 was dated to 5980–5850 cal BC (median of 5910 cal BC) (Tab. 2, see below). The two bone samples are almost a century younger with a median of *c.* 5800 cal BC. In this respect, the Optičari dates overlap with those from Veluška Tumba and Vrbjanska Čuka, indicating a synchronic occupation of these tells.

There is another tell in the same central part of Pelagonia that has been recently dated. Školska Tumba was excavated in the 1970s and again in 2014, providing more information on the complexity of Neolithic tells (*Simoska* et al. *1979; Naumov, Tomaž 2015*). Five sam-

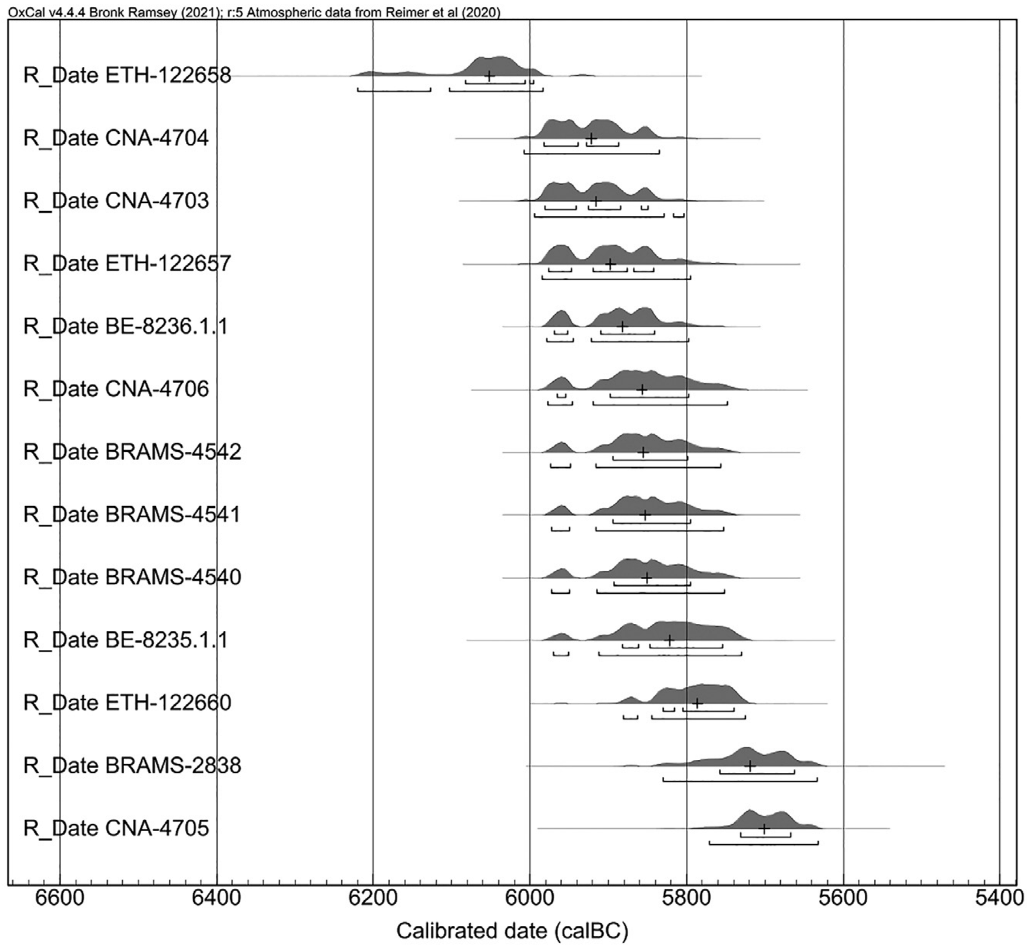

Fig. 9. Calibrated dates from Vrbjanska Čuka, sorted by age.

ples were taken from this site, yet only the two bone samples related to the earliest layers gave good results, whereas the seeds were dated to the Middle Ages (6th to 9th centuries AD), a period that was recorded in the excavations of both teams. The bone samples were recently dated to 5700–5600 cal BC, thus indicating the most probable period for the establishment of the tell (see Tab. 2). In this case, it is noteworthy that the ini-

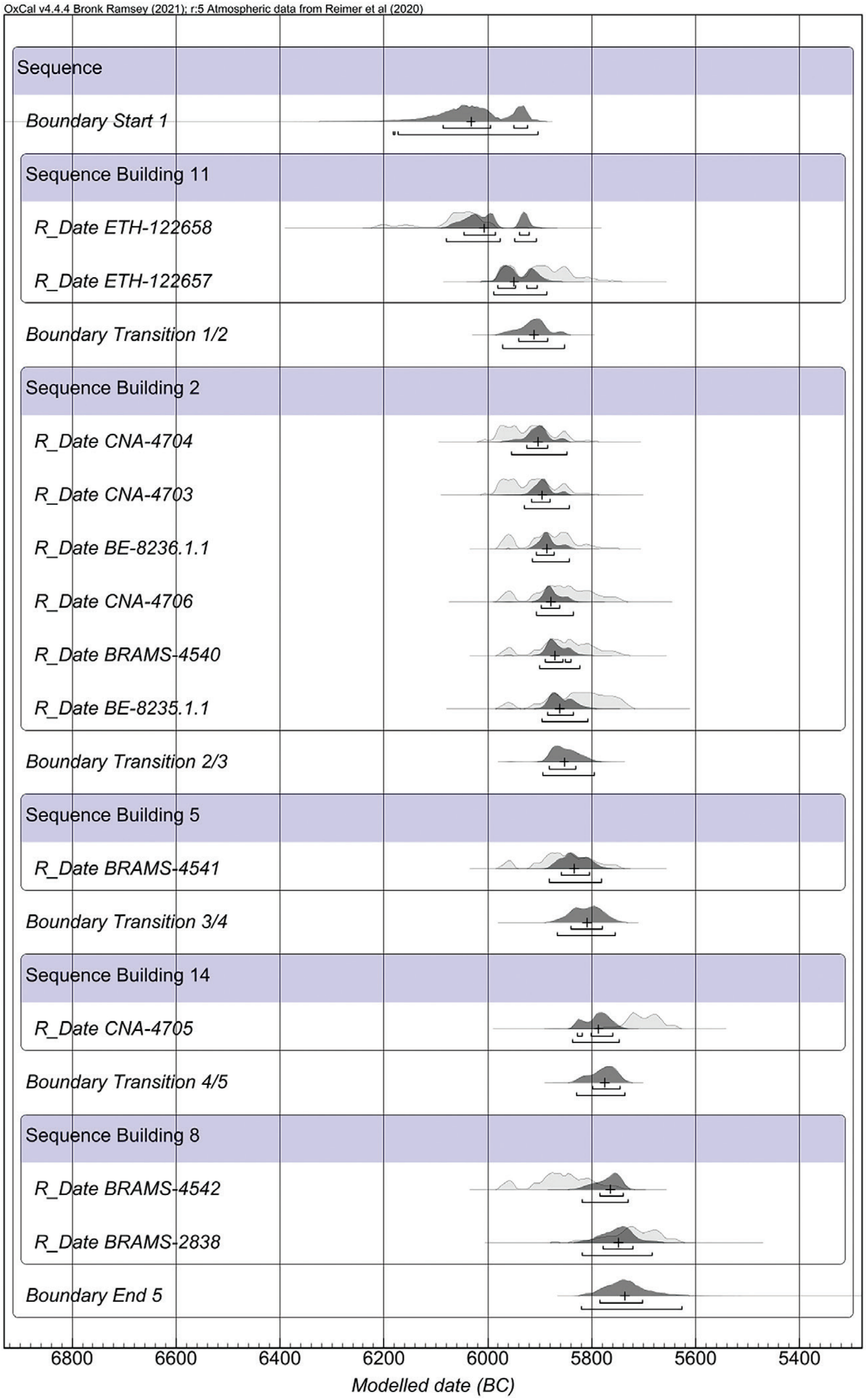

Fig. 10. Radiocarbon dates from Vrbjanska Čuka, modelled according to five building sequences.

tial inhabitation period of this tell is a bit later than the ones at Veluška Tumba and Vrbjanska Čuka. The two dates from Školska Tumba from the 1970s, however, give rather broad results: the earlier one is positioned between 6250 and 5560 cal BC and the later one between 5390 and 4680 cal BC (*Naumov 2023b*). Unfortunately, not only were the samples taken from unidentified charcoal but their standard deviations are also very large. Consequently, they cannot be used in this discussion.

Tumba Porodin is a tell very close to Veluška Tumba and was intensively excavated in the 1950s (*Grbić* et al. *1960*). Although three charcoal samples were dated in the 1970s, one of the seeds was recently sent for radiocarbon analysis. The sample BE-5281 (see Tab. 2) has results between 5840 and 5710 cal BC and a curve peak at approximately 5740 cal BC. Of the three aforementioned charcoal samples, the earliest has a smaller standard deviation and could be set at the end of the 7th millennium, while the two others are with broader results between 6000 and 5600 cal BC. As such they overlap with those from Veluška Tumba which is just 2km away. It appears that the two neighbouring tells may have, at least at times, been used synchronically.

There are three other Neolithic sites in Pelagonia that were dated in the 1970s, but no more recent radiocarbon analysis has been performed. From Čuka at Topolčani two dates are known: the older date has a broad standard deviation and covers the middle of the 7th millennium BC. This date has been discussed in depth since it was regarded as far too old for the Neolithic in North Macedonia, and it was presumed that old wood was used (*Naumov 2016; 2023b*). Besides, its exact context was not provided, and it is unclear as to which layer it belongs (*Srdoć* et al. *1977; Kitanoski* et al. *1978*). The second sample from this site was dated to the first half of 6th millennium BC, which is more or less comparable to the chronology of the other tells in Pelagonia.

Markovi Kuli above the city of Prilep is one of the rare sites that differs in terms of its natural setting and settlement features from the other sites. It is a rock shelter without specific Neolithic architecture, but with some typical pottery for this and the subsequent Chalcolithic period (*Cnotlivi 1990; Naumov, Mitkoski 2018*). The only analysed Neolithic sample comes from an animal bone and it provides a date of around 5600 BC. This overlaps with the date from Porodin and could be considered one of the latest EN dates in Pelagonia (*Naumov 2023b*).

The chronology of Pelagonia in a broader regional context

The detailed chronological overview of Pelagonia enabled a reliable determination of the start and end of the EN in this region. Our current aim is to embed this period into a broader context and particularly trace relationships with surrounding areas in which the Neolithic communities in Pelagonia established networks that are manifested in the material culture. Analogies in pottery and figural representations that reflect not only geographical but also chronological proximity can be observed with the south (Western and Central Macedonia in Greece), west (Lake Ohrid, Lake Prespa, Korça Basin) and north (Ovče Pole and Skopje basin).[5]

Western and Central Macedonia in Greece

Starting with the oldest Pelagonian dates, namely those from Vlaho, the relationship with EN sites in Western and Central Macedonia in Greece is particularly significant. As mentioned above, the southern part of the Pelagonian basin also stretches south of the border between North Macedonia and Greece, into the region of Western Macedonia. The closest comparable site is yet farther south, some 50km south of Vlaho. This site, Mavropigi-Fillotsairi, is located in the hilly area of Ptolemaida (Kozani district). It is a flat site with two separate architectonical phases: an earlier one consisting of mainly pits of different sizes and depths and a later one with quadrangular constructions (*Bonga 2020.Fig. 2; Reingruber 2024.86*).

There are 32 radiocarbon dates from Mavropigi, which cover the whole duration of the EN (*Starnini 2018; Bonga 2020*). The two oldest dates in the sequence fall within a flat portion of the curve and were obtained from charcoal (of an unknown species). Therefore, the sequence may not have started as early as 6600 cal BC, as suggested before (*Karamitrou-Mentessidi 2014. 245; Maniatis 2014.207; Karamitrou-Mentessidi* et

5 The connections between the Struma Valley and the areas to the west of it were recently discussed in a comprehensive contribution on the Neolithisation of southeastern Europe (*Krauß 2023.83–105*), so we omit this region from our overview and refer the reader to that study.

al. *2015; Starnini 2018.Tab. 1*), but several decades later (*Reingruber* et al. *2023*).

We have created a model according to Phases 1–3 as developed by the excavators (*Karamitrou-Mentessi* et al. *2015.58*) and discussed by Lily Bonga in her own work (*Bonga 2017; 2020*) and in collaboration with others (*Reingruber et al. 2023*). In our model we are relying on dates obtained on charcoal and seeds, excluding those on human bones (Fig. 11). As some of the dates do not match the sequence they are considered here to be outliers, unfortunately most of them on seeds (Fig. 12). One such outlier is from Phase 1: DEM-1716, 7314±30 BP (6230–6100 cal BC); two others are from Phase 2: MAMS-21099/DEM-2683, 7619±26 BP (6480–6440 cal BC) and OxA-31678, 7470±40 BP (6410–6260 cal BC). In Figure 11, the upper boundary is thus set at 6530 cal BC because the oldest date in the sequence falls onto the plateau in the calibration curve. Therefore, 6530 cal BC can be understood merely as a *TPQ*-mod, although the actual start may have been much later than this, as the date for this phase – which was obtained from seeds – suggests (DEM-2684 with a median of 6360 cal BC; but note that the result of another seed, attributed to Phase 3, DEM-2683, is dated to 6460 cal BC, Fig. 12).

According to the modelled medians, Phase 1 lasted over 200 years, between 6530–6310 cal BC. Phase 2 may have been of comparably short duration (6310–6220 cal BC), whereas Phase 3 has a seemingly longer duration again, between 6220–6000 cal BC. The extreme length of Phase 1 and the huge overlap with Phase 2 are indicative of how difficult it is to accurately separate contexts within pit sites. Moreover, the overlap between Phases 2 and 3 shows that more dates would be needed to derive a solid model without caveats during calculations executed with Oxcal. Therefore, we suggest the start at 6530 cal BC only as *TPQ*-mod and the date of 6460 cal BC, with reservations, as *TaQuo*.

The Pieria region is situated in Central Macedonia, between the lower Aliakmon River and the Aegean Sea. Some of the newly discovered EN sites that are located there have further changed our perception of how the Neolithic disseminated into the Aegean.

Revenia-Korinos is an open-air, flat extended settlement, only 10km away from today's coastline. The site is characterized by pits of varying sizes, some of them identified as subterranean or semi-subterranean pit dwellings. However, at "*6200/6100 BC […] the pit habitation mode is followed by aboveground, rectangular post-framed structures*" (*Maniatis, Adaktylou 2021.1025*).

Twenty-nine radiocarbon dates have been obtained from Revenia from samples of different materials, among them fish-eating species and charcoal of long-lived oak (*Maniatis, Adaktylou 2021*). It is noteworthy that two of the four oldest dates are either on pig bone (excluded due to the reservoir effect) or charcoal (old-wood effect), and their results need to be treated with care. Additionally, together with a third date, they cover a flat portion of the calibration curve, a so-called plateau (*Reingruber* et al. *2023.Fig. 5*), which artificially lengthens the duration by more than 100 years, between 6600 and 6500 cal BC. A fourth date attributed to the 'Primary habitation phase' was taken from cattle bone and is not affected by the plateau and thus a more reliable result (DEM-2823). These four dates, together with the five dates from charcoal and cattle bones, date the earliest pottery Neolithic at Revenia to between 6560 and 6300 cal BC (according to their medians). The later EN can be dated between 6420–6140 cal BC, according to the calibrated medians from 13 dates (among them seven from human bones). The huge overlap of dates from these two phases between 6420 and 6200 cal BC may reflect possible re-usages of pits and the difficulties associated with the chronological assessment of undecorated pottery and/or unidentifiable sherds. Another plateau on the curve between 6240 and 6020 cal BC creates the impression of a long duration of the last phase, when it actually may have been much shorter.

We modelled the dates according to three phases – 'Primary', 'Earlier EN' (EEN) and 'Later EN' (LEN) – including samples obtained on charcoal and cattle (excluding human bones) and obtained a more limited occupation of the sites (Fig. 13). Due to the plateau, the boundary start is set at 6560 cal BC as a *TPQ*-mod. According to the medians, the sequence of the Primary phase lasts between 6520 and 6430 cal BC. The EEN phase covers the period between 6380 and 6320 cal BC whereas the LEN is comparably short, from 6320 to 6240 cal BC. However, this model is only a rough framework, with less heavy re-modellings of the calibrated dates than was the case in Mavropigi. Yet we still encountered some issues during the calculation process. Other than in the model obtained by Yannis Maniatis and Fotini Adaktylou *(2021.1042*), in our model the transition to the LEN – the phase with rectangular buildings – is at 6320 cal BC.

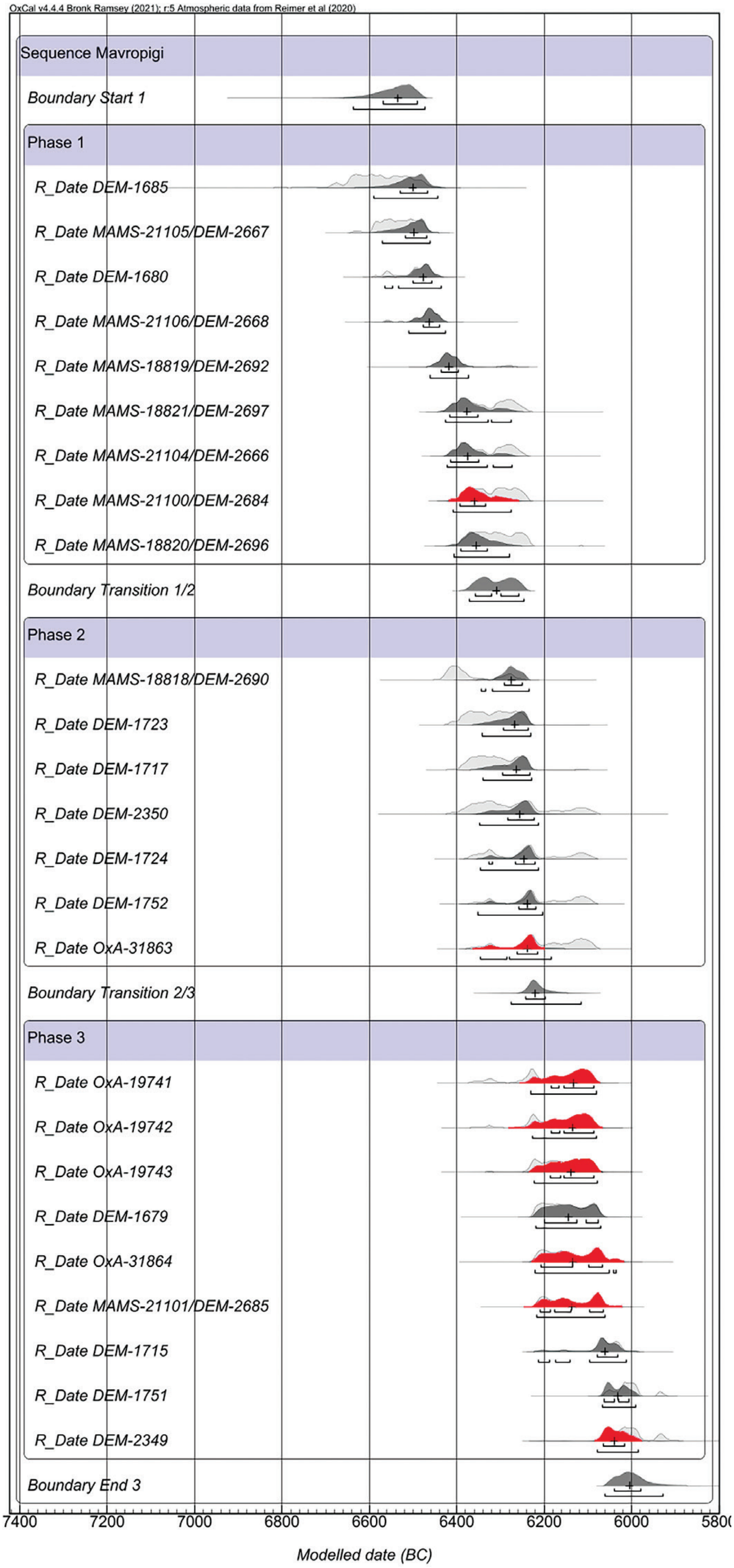

Fig. 11. Radiocarbon dates from Mavropigi, modelled according to three habitation phases (indicated in red are results obtained on grains).

Another site in the Pieria, approximately 20km north from Revenia, is Paliambela-Kolindros. The site is established on a small hill above flatlands and is laid out on terraces. During the later EN and at the transition EN/MN, it was surrounded (at least partially) by ditches. Like in Vlaho, structures like hearths and bedrock-mortars were cut into the soft bedrock (*Tsartsidou, Kotsakis 2020; Naumov* et al. *2021; Sabanov* et al. *2023*).

The sequence of dates from this site is not yet complete, but from the five dates obtained mainly from animal bone (*Maniatis 2014.208, Fig. 3*), the three oldest samples yielded results between 6530 (as *TPQ*-cal) and 6450 cal BC according to their medians (*Reingruber* et al*. 2023. Fig. 7*). The two other dates fall into the EN 2 between 6300 and 6000 cal BC (Fig. 14). Interestingly, and as in Revenia-Korinos, the oldest habitation phase is characterized by pits. There is a major change observable after 6300/6200 cal BC when rectangular constructions were erected above ground.

Exclusively above-ground constructions were encountered in Nea Nikomedeia, again a flat site with only 60 cm accumulation (*Pyke 1996*). As the dates from there have not been published according to contexts, another model will not be proposed here and consequently we rely on those already published (*Reingruber, Thissen 2017; Yanovich 2021*). The sequence starts only after 6300 cal BC (as *TPQ*-cal) and ends around 5900 cal BC. Thus, the change from pit-levels to above-ground constructions at or shortly after 6300 cal BC, as clarified for the previous two sites, can be regarded as secured.

The newly obtained dates from EN sites in Pelagonia, together with those from Pieria and Ptolemaida, thus provide more thorough foundations for the determination of the chronological scale in which social transformations occurred and communities from different sites established networks. If the chronological models proposed for Revenia, Paliambela and Mavropigi are accepted then we can conclude that not all sites were established in the same decades: those closer to the coast (Revenia and Paliambela, 6530/6520 cal BC) seem to be slightly earlier than Mavropigi (6460 cal BC) and Vlaho (6400 cal BC) in the hills. That Vlaho was also part of the initial spread of the Neolithic way of life into the Balkans is further evidenced by the resemblance of pottery technology, its decoration and the architectural features are comparable with the sites in Pieria and Ptolemaida (*Bonga 2017; Naumov, Nasuh 2023*). Particularly important is the relationship between Vlaho and Mavropigi, which are only 50km away from each other and set in similar hilly environments above marshy flatlands. It is interesting that the earliest and latest dated short-lived material – *i.e.* seeds – from both sites are almost identically dated to 6380–6020 cal BC, meaning that the EN-levels may have been at least partly contemporary, and that the sites were abandoned at the same time. Based on these relative and absolute chronological assessments, it should come as no surprise when more and better evidence for networks among these societies is revealed in the future.

Lake areas and basins in the border area of North Macedonia and Albania

Besides the earliest Neolithic sites, the tells in the flatlands of Pelagonia – those with dates between

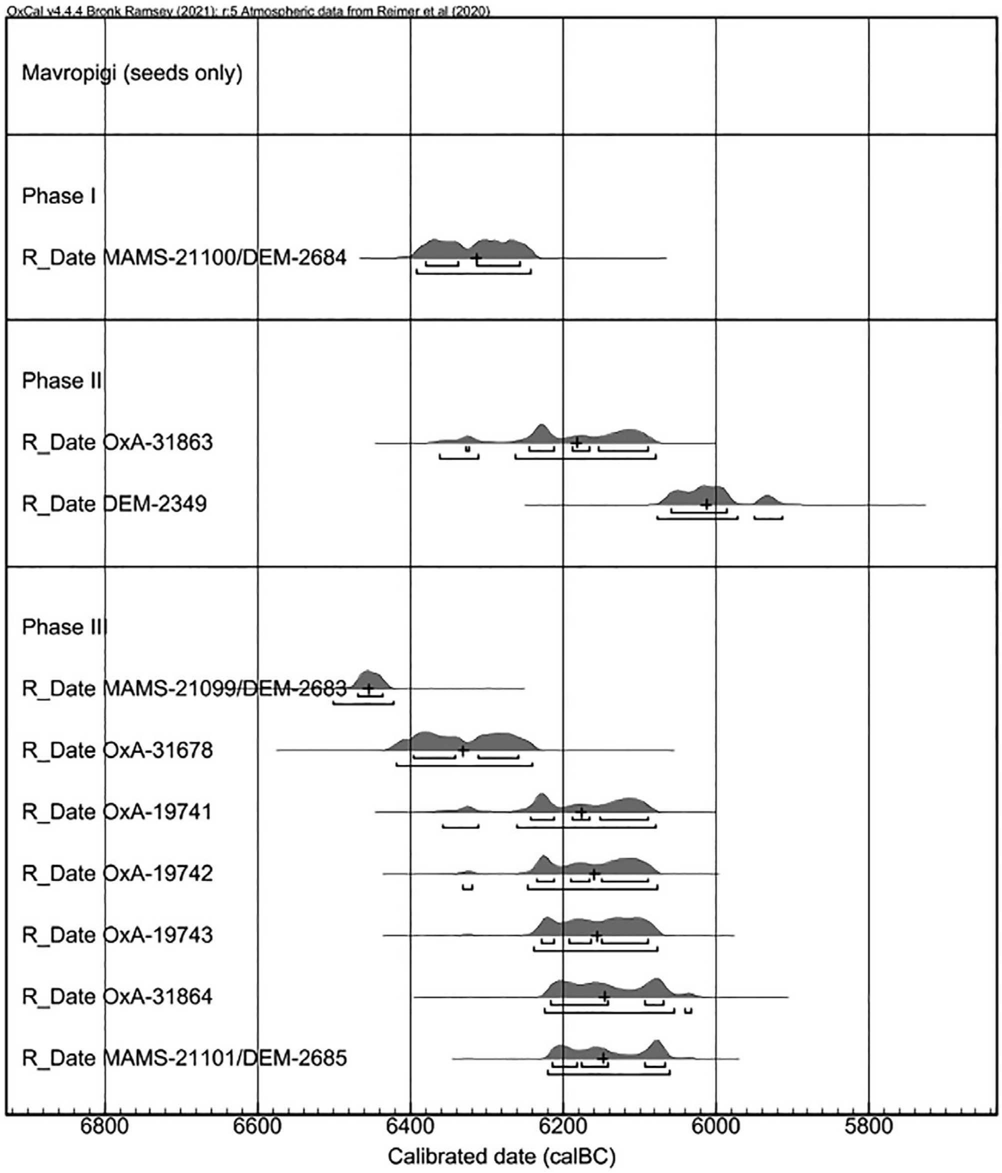

Fig. 12. Calibrated dates on seeds from Mavropigi, sorted according to the three building phases.

6000–5600 cal BC[6] – should also be regarded in a broader regional context. Due to their geographical proximity, the areas of the Lakes Ohrid and Prespa as well as the Korça Basin display the most evident relationships, as has been pointed out on several occasions (*Benac 1979; Sanev 1995; Andoni* et al. *2017*). Networks among wetland societies were certainly established in all periods of prehistory (*Naumov 2018*), although solid radiocarbon dates from the southwestern Balkans are still missing. Considering the Neolithic of Lake Ohrid, the relative chronology developed based on decoration patterns on vessels, figurines, tablets

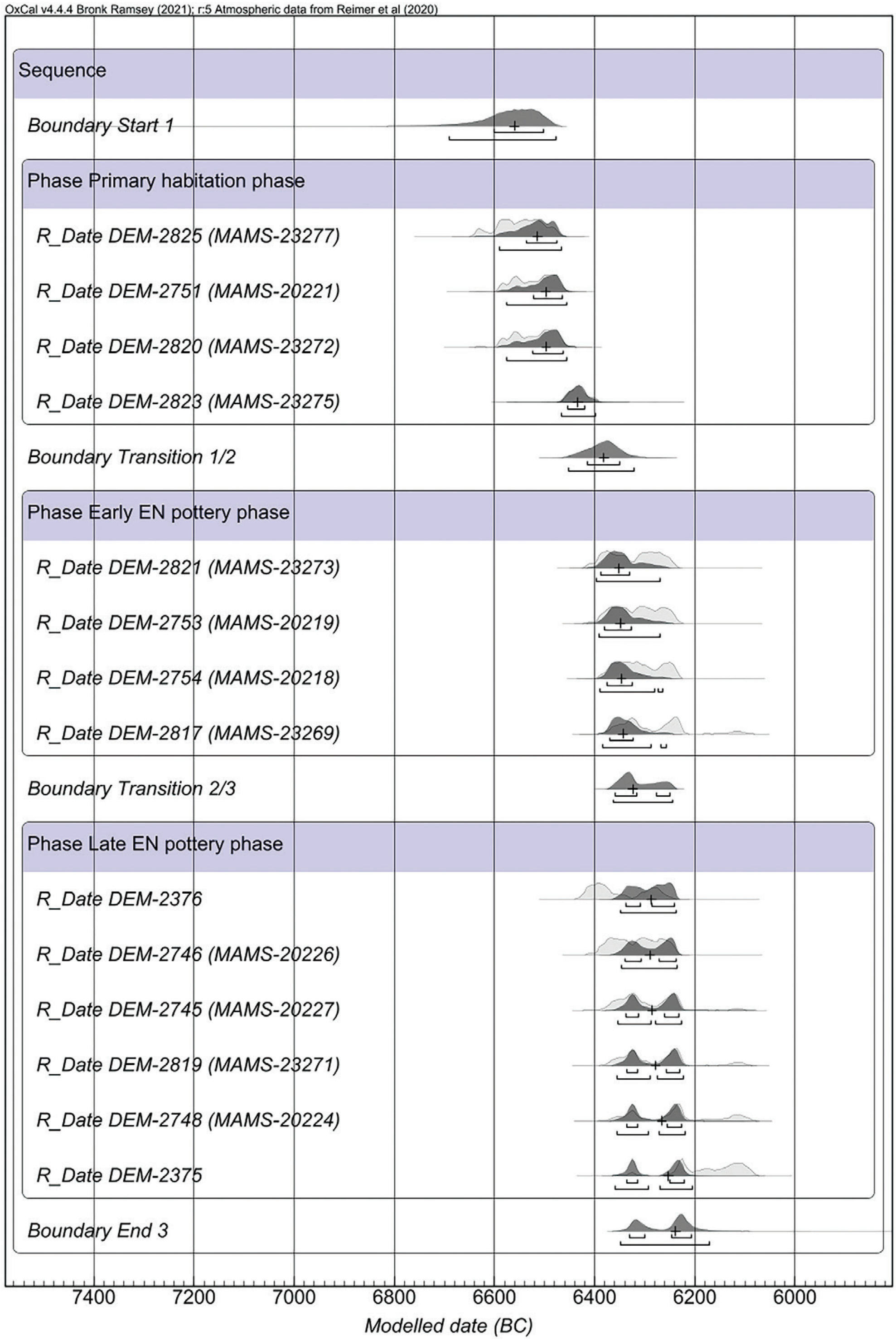

Fig. 13. Radiocarbon dates from Revenia, modelled according to three habitation phases.

6 This period is known as the Middle Neolithic period in Thessaly, but as the Early Neolithic in the Balkan terminology.

and anthropomorphic house models, authenticates the connects with Pelagonia in the Neolithic, and some of the few radiocarbon dates that are available contribute to this. They are related to pile dwellings of Ohridati, Ploča, and Lin 3, and belong to the first half of the 6th millennium BC, *i.e.* the period with the highest density of dates in Pelagonia as well (*Westphal* et al. *2011; Anastasi 2022; Holguin* et al. *in press*). According to the material culture, connections between Pelagonian tells can also be manifested with the dryland sites of Dolno Trnovo and Pogradec. So far, only dates from Pogradec are provided and they range between 6000 and 5800 cal BC (*Andoni 2017*). In the area of Lake Prespa not many Neolithic sites have yet been excavated and dated, except the one at Kallamas that was dated to the second half of the 6th millennium BC (*Oberweiler* et al. *2020*). Consequently, due to the lack of research in this region, only a little information related to the chronological and material connections with Pelagonia can be provided.

Better insights are available from sites in the Korça Basin in Albania, although only two have provided radiocarbon dates. The similarities in terms of painted pottery were already highlighted and they indicate evident communication with Pelagonia (*Korkuti 1982*). Absolute dates are available from sites near Vashtëmi and Podgorie, yet they do not derive from excavations but from coring. This is particularly an issue with the samples from Sovjan and Vashtëmi (dated to the first half of the 7th millennium BC), which are used as indicators for the initial spread of the Neolithic (*Allen* et al. *2014*). Another date from Vashtëmi, around 6400 BC, is also questionable as it is obtained from a charcoal sample from a core. Regardless, if more arguments in support of such early dates in this area are provided in the future, they would fall within the time of occupation of Vlaho. One should note that comparisons based on pottery alone do not suffice to establish early connections, as some pottery features are continuously present up to around 6000 BC.

The regions of Ovče Pole and Skopje basin in North Macedonia

When it comes to the first centuries of the 6th millennium BC, the sites of the so-called Amzabegovo–Vršnik group in particular must be mentioned, although this was traditionally conceived of as two distinct 'cultural groups' (*Garašanin 1979; Sanev 1994; Mitrevski 2013*). Judging from the material culture (pottery, figurines and house models), the farming communities in Pelagonia were closely linked with those in the valleys of Tikveš, Ovče Pole, Polog, and Skopje. To date, only the sites of Amzabegovo and Govrlevo have yielded radiocarbon dates, whereas most sites were never dated or provided only one or few dates per site. Therefore, the chronological comparison with Pelagonia will be based only on two sites. Amzabegovo is one of the rare

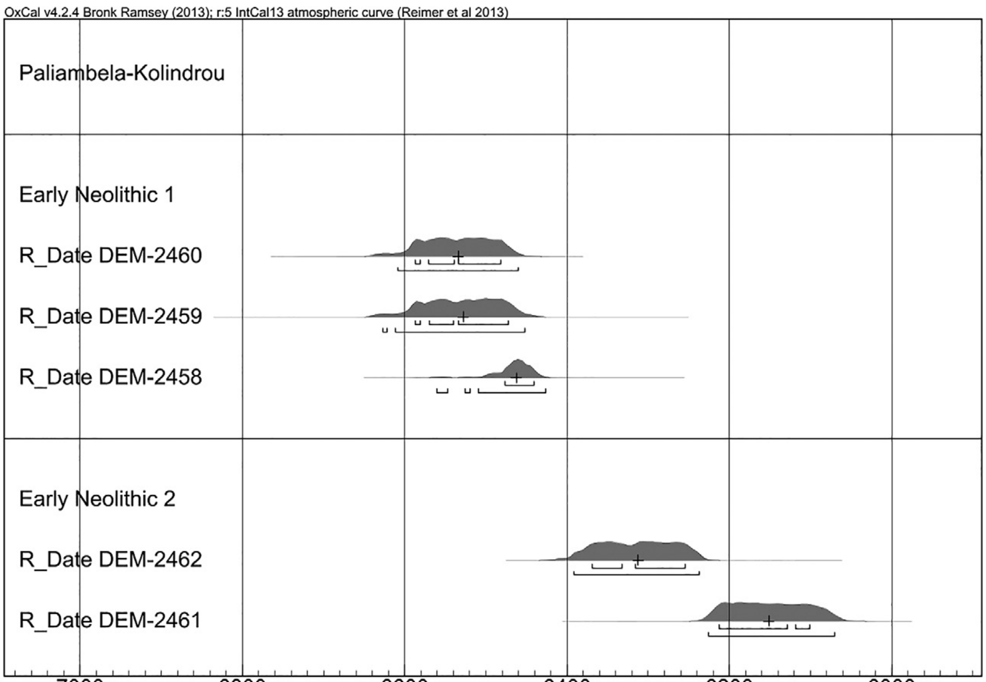

Fig. 14. Calibrated dates from Paliambela, sorted according to the two Early Neolithic phases.

examples of thoroughly explored Macedonian sites with implementation of multidisciplinary research in the 2nd half of the 20th century (*Gimbutas 1976*). Its detailed chronological sequence was later modelled and integrated into the Balkan chronology (*Reingruber, Thissen 2005*). The chronological range between *c.* 6100 and 5000 cal BC indicates the presence of all Neolithic phases at this site, some synchronous to the tells in Pelagonia. This is further supported by the striking resemblance of certain white painted pottery patterns which, besides in Pelagonia, are also present at the sites of Mavropigi and Nea Nikomedeia. Therefore, a possible gradual temporal dispersal of the Neolithic via various routes from the southern to the northern regions would certainly be reasonable.

The site of Cerje near Govrlevo is one of the most systematically excavated in the Skopje Valley, and provides a more exact insight into the Neolithic chronology of this region (*Bilbija 1986; Fidanoski 2012; Fidanoski 2023*). The chronological range of a dozen dates between 5950 and 5750 overlaps with those in Pelagonia and they can be related to a later stage of the Neolithisation process in this part of the Balkans. Similar dates are also present from other sites in the Skopje Valley, *i.e.* Tumba Madjari. Although extensively excavated for several decades only a few reports and radiocarbon dates similar to those from Govrlevo have been published (*Sanev 1988; Commenge 2009; Stojanova Kanzurova 2020*). In this respect, two more sites of the Amzabegovo–Vršnik group from the Ovče Pole region should be mentioned: Vršnik near Tarinci and Grnčarica near Krupište with results from first half of the 6th millennium BC (*Garašanin, Garašanin 1961; Stojanovski 2017*). Similar to Pelagonia, there is also no single date available for the centuries around the mid-6th millennium BC at these sites. The absence of cultural layers of this period (or at least of absolute dates) requires particular attention.

Discussion and conclusions: Pelagonian chronology and the spread of the Neolithic into southeastern Europe

The detailed insight into the chronological sequences of the Neolithic sites in Pelagonia, as well as the overview of the chronologies in the surrounding regions provide a solid time-frame for when and how the first farming communities appeared in North Macedonia. Thirty-nine of the 42 dates (compare Tabs. 1 and 2) rendered results between 6360–5700 cal BC (according to the modelled medians) and 6390–5750 cal BC (according to the calibrated medians). We can therefore ascertain that the Neolithic way of life in Pelagonia started much earlier than previously thought and, as another surprising insight, a change in habitation pattern or in behaviour generally occurred around 5750/5700 cal BC.

The site of Vlaho is of special significance as so far it is the earliest Neolithic site in Pelagonia, as well as one of the earliest sites in the broader Balkan area. Most likely, the initial settlement was established soon after those in the regions of Pieria and Ptolemaida. The sites of Mavropigi, Revenia, and Paliambela share similarities not only in impressed pottery production, which appears in quite a large amount in Vlaho as well, but also in the presence of dug out structures or dwellings (*Karamitrou-Mentessidi* et al. *2015.Figs. 6–11; Kotsakis 2018.Fig. 3.2; Bonga 2020.Fig. 2; Maniatis, Adaktylou 2021.Fig. 5; Naumov, Nasuh 2023; Naumov* et al. *2023a*).

The revised chronology of the initial stage of Paliambela, *c.* 100 years older than that at Vlaho and Mavropigi, and close to that from Revenia (*Reingruber* et al. *2023*), indicates the possible trajectories of the advance of Neolithic innovations like farming from the coastal areas to the hinterland of geographical Macedonia. The overlapping dates from Revenia (Primary and Early Phase) and Mavropigi (Phase 1) between *c.* 6500 and 6300 cal BC and those between Mavropigi (Phases 2–3) and Vlaho between 6400 and 6020 cal BC is something that should be used in future studies on demographic processes in the EN of the Balkans.

The distances of the sites to the Aegean Sea have not yet been well investigated, but according to John Bintliff (*1976.Fig. 10*) and Matthieu Ghilardi *et al.* (*2012.47–61*), Nea Nikomedeia was only 5km away from the Thermaic Gulf. Moreover, geological studies from other Aegean coastal areas revealed the proximity of sites to the sea that are nowadays located farther inland (*Horejs 2017.13–15, Fig. 1.3*). The spread of Neolithic innovations into the circum-Aegean area was thus in great part based on the maritime contacts between communities.

Plateaus in the calibration curve around and before 6600 cal BC and again between 6200 and 6000 cal BC (*Reingruber* et al. *2017.Fig.20*) complicate a precise estimation of the beginning or the end of a specific sequence. The former is important in the case of the Aegean, the latter for the Neolithisation of the Balkans.

We have no conclusive dates yet for the time between 6200 and 6000 cal BC from other sites in North Macedonia (apart from Amzabegovo), although it is the time when the first sites were established in other regions of the Balkans, *e.g.,* in Southern Bulgaria (Kovačevo) (*Thissen, Reingruber 2017.137–139*). The extreme decrease in global temperature for at least 200 years, if not longer, around 6200 cal BC (the 8.2 ka-event, *Weninger et al. 2009*) may have triggered the appearance of new sites in river valleys and wetlands (*Thissen, Reingruber 2017.Fig. 2*). Especially at or after 6000 cal BC many new sites appear around the marshes of Pelagonia (*e.g.,* Veluška Tumba, Tumba Porodin, Tumba Optičari, Vrbjanska Čuka and Školska Tumba) (*Naumov 2016*). If the old dates from Markovi Kuli and Čuka-Topolčani can be confirmed by new samples, then this flourishing period of the EN ends around 5600 cal BC.

Vlaho and Mavropigi are positioned in the lower hills of mountain slopes above marshes in the wetlands which nowadays have dried out as a result of the melioration processes in the 20th century (*Karamitrou-Mentessidi* et al. *2015; Naumov* et al*. 2023a*). Paliambela, *c.* 85km away from Vlaho, has also been established in a hilly setting. Three out of four very early sites (the exception being Revenia) are located on lower hills, above the plain. Therefore, we provisionally acknowledge a new settlement pattern that needs confirmation through future research. This is in contrast to previous observations that EN communities exclusively established their settlements in flat areas and on river terraces, while afterwards, in the LN, they moved to higher positions due to intensified conflicts (*Garašanin 1979; Sanev 1995*). Namely, the examples from Paliambela, Mavropigi and Vlaho demonstrate that the first farmers intentionally selected these elevated positions (up to 780 masl) and made modification to the bedrock in order to place the initial structures and hearths (*Kotsos, Urem Kotsou 2006; Karamitrou-Mentessidi* et al. *2015; Naumov* et al. *2021*). This was most likely due to the presence of marshes in the wetlands that were covering large areas in the period before the 8.2 ka event. Studies on the sizes of Thessalian lakes in prehistoric times (nowadays also dried out or drained in the 20th century) are now being carried out, but judging from the current results the lakes changed their outlines over the course of the millennia (*Reingruber, Toufexis 2021.42–43; Caputo* et al. *2022.35–63*). Tells also started to appear around marshes and lakes only a few centuries after the initial establishment of settlements in hilly areas: in Thessaly only after 6500/6400 BC (as a *TPQ*-cal) (*Reingruber 2008; Alexakis* et al*. 2011; Reingruber* et al. *2017*), and in Pelagonia around 6000 BC (*Naumov 2018*).

This habitation model, based on the current chronological results, explains the abrupt appearance of tells in the wetlands of Pelagonia around 6000 BC, after earlier sites in the hilly areas were abandoned. Both prospections and excavations confirm the presence of the majority of tells around marshes in the flatlands, a practice that was maintained in the Late Neolithic, Chalcolithic, and Bronze Age as well (*Alexakis* et al. *2011; Naumov 2016; Reingruber* et al. *2017*). This decision made by the first generation of farmers to settle at the transition between different habitats seems rational, especially if envisaging them as descendants of Mesolithic communities that explored not only water-rich areas like lakes and rivers (providing fish, birds, shells, reptiles, *etc.*), but also woods and hills with their abundant resources for hunting and gathering in the different seasons. We suggest that the later generations were not only 'hunters in transition', but also already well-established farmers for whom direct access to the resources of the wetlands was crucial: fertile soils for farming, mud and reed for buildings, clay for pottery, and water for animals were constantly available in direct proximity to the settlements.

It is evident that this period between 6000 and 5700 cal BC was quite dynamic in Pelagonia and the Balkans in terms of social activity if compared with the existing data before 6000 BC. But when looking at the younger dates, evidence is also scant: for the time around 5600 cal BC we have to rely on the old radiocarbon dates, and even then a temporal gap around 5500 BC becomes apparent, with only few dates from Školska Tumba at Mogila and Tumba at Trn (*Valastro* et al. *1977*), and the dubious one from Veluška Tumba at the end of 6th millennium BC. The situation is a bit different in the Struma Valley of Bulgaria, where at Kovačevo and Balgarčevo levels are present that fit into this temporal gap (*Grebska-Kulow, Zidarov 2021*), although no radiocarbon dates are available yet (*Thissen, Reingruber 2017*). Such a gap could be an artificial one that needs to be closed by future research. Alternatively, social and/or climatic processes may have caused the abandonment of most of the tells before the mid-6th millennium BC. This view is supported by the material culture as no elements of later pottery features are present. As this study focused on the early stages of the Neolithic in Pelagonia, the questions relating to the Middle and Late Neolithic will have to be addressed in a future study.

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Tab. 1. Radiocarbon dates from the three Pelagonian sites, listed according to building units; calibrated and modelled medians are rounded by 10.

Site	Lab. code	BP	StDev (±)	Sample material	Species	Context and layer	cal BC 1σ	cal BC 2σ	Median (cal)	Median (mod)	No.
Vlaho	ETH-132740	7486	26	Bone	*Ovis aries*	Building 2; SU 14, quadrant I	6416–6266	6424–6250	6360	6390	1
Vlaho	ETH-132741	7479	26	Bone	*Bos Taurus*	Building 2; SU 14, quadrant I	6411–6264	6421–6246	6340	6380	2
Vlaho	CNA-6151	7460	36	Cereal	*Triticum sp.*	Building 3; SU 08	6391–6259	6410–6240	6320	6350	3
Vlaho	CNA-6152	7371	36	Cereal	*Triticum sp.*	Building 3; SU 09	6357–6092	6372–6085	6230	6330	4
Vlaho	ETH-122661	7464	28	Cereal	*Tr. timopheevii*	Building 5; SU 7	6393–6259	6408–6243	6320	6240	5
Vlaho	CNA-6150	7151	36	Cereal	*Triticum sp.*	Building 7; SU 01	6058–5992	6072–5926	6020	5920	6
Veluška Tumba	BRAMS-4500	8846	29	Charcoal	*Charcoal*	Earliest layers; VT19-s-08; test trench 8	8172–7856	8205–7807	8000	-	7
Veluška Tumba	BRAMS-4498	7973	28	Wild fruit	*Corylus avellana*	Earliest layers; VT19-s-06	7035–6825	7044–6702	6910	-	8
Veluška Tumba	BRAMS-4499	7143	27	Cereal	*Tr. monococum*	Protosoil; VT19-s-05	6057–5989	6067–5928	6020	5990	9
Veluška Tumba	ETH-122652	7069	28	Pulse	*Lens culinaris*	Building 16; SU 154	5991–5910	6016–5888	5940	5970	10
Veluška Tumba	ETH-122653	7040	28	Cereal	*Triticum sp.*	Building 16; SU 155	5982–5892	5991–5842	5930	5940	11
Veluška Tumba	ETH-122642	7075	41	Cereal (chaff)	*Tr. monococcum*	Building 1; SU 2	6011–5907	6028–5844	5950	5920	12
Veluška Tumba	ETH-122644	7041	33	Cereal (chaff)	*Tr. monococcum*	Building 1; SU 2	5983–5892	5994–5841	5930	5920	13
Veluška Tumba	ETH-122650	7036	28	Pulse	*Pisum sativum*	Building 1; SU 137	5982–5890	5989–5842	5920	5910	14
Veluška Tumba	CNA-6153.1.1	7030	36	Cereal	*Triticum sp.*	Building 1; VT21-SU-153	5982–5850	5993–5831	5920	5900	15
Veluška Tumba	CNA-6154.1.1	6989	35	Cereal	*Triticum sp.*	Building 1; VT21-SU-154	5972–5834	5981–5943	5870	5900	16
Veluška Tumba	ETH-122651	6984	28	Cereal	*Tr. aestivum/durum*	Building 1; SU 140	5969–5832	5979–5773	5870	5890	17
Veluška Tumba	ETH-122645	6862	84	Pulse	*Pisum elatius*	Building 1; SU 2	5833–5667	5971–5625	5760	5890	18
Veluška Tumba	ETH-122649	7002	28	Cereal	*Hordeum vulgare cf. var. nudum*	Building 14; SU 83	5972–5843	5983–5798	5890	5870	19
Veluška Tumba	ETH-122648	6995	30	Wild fruit	*Rubus fruticosus*	Building 2; SU 79	5971–5840	5983–5786	5880	5850	20
Veluška Tumba	ETH-122646	6923	37	Cereal (chaff)	*Tr. monococcum*	Building 2; SU 57	5836–5745	5890–5725	5800	5830	21
Veluška Tumba	BRAMS-4497	6198	26	Cereal	*Tr. aestivum*	Early layers; SU 4	5212–5073	5287–5047	5130	-	22
Vrbjanska Čuka	ETH-122658	7198	47	Cereal (chaff)	*Tr. monococcum*	Building 11; Q24 S508	6083–5996	6220–5984	6050	6010	23
Vrbjanska Čuka	ETH-122657	7010	36	Cereal (chaff)	*Tr. monococcum*	Building 11; Q24 S508	5977–5843	5986–5796	5900	5950	24
Vrbjanska Čuka	ETH-122660	6915	28	Cereal	*(Outlier, not included in the model)*	Building 11; Q24 S515	5830–5741	5881–5726	5790	-	25
Vrbjanska Čuka	CNA-4704	7036	36	Fruit	*Prunus spinosa*	Building 2	5983–5887	6009–5836	5920	5900	26
Vrbjanska Čuka	CNA-4703	7030	37	Fruit	*Prunus sativa*	Building 2	5982–5850	5995–5804	5920	5900	27
Vrbjanska Čuka	BE-8236.1.1	6995	24	Cereal	*Triticum sp.*	Building 2; VC 28, Q27, Sq A/F, L5-10cm	5969–5842	5980–5798	5880	5890	28

Tab. 1. Continued

Vrbjanska Čuka	CNA-4706	6976	36	Cereal	*Tr. monococcum*	Building 2	5966–5798	5978–5949	5860	5880	29
Vrbjanska Čuka	BRAMS-4540	6971	29	Bone	*Bos taurus*	Building 2; SU 71, kv. 29	5894–5796	5973–5753	5850	5870	30
Vrbjanska Čuka	BE-8235.1.1	6946	44	-	*Cerna spec.*	Building 2; Q27, Sq X(V/X), L0-5cm	5883–5755	5971–5731	5820	5860	31
Vrbjanska Čuka	BRAMS-4541	6972	29	Bone	*Sus domesticus*	Building 5; SU 107, kv. 30	5895–5796	5974–5754	5850	5830	32
Vrbjanska Čuka	ETH-138166	7043	33	Bone	*Homo infans* (not included in the model)	Building 16; Q15_SU828	5983–5893	5995–5841	5900	-	33
Vrbjanska Čuka	CNA-4705	6824	35	Pulse	*Pisum sativum*	Building 14	5731–5668	5771–5633	5700	5790	34
Vrbjanska Čuka	BRAMS-4542	6974	29	Bone	*Capra hircus*	Building 8; SU 166, kv. 17	5895–5799	5974–5757	5860	5760	35
Vrbjanska Čuka	BRAMS-2838	6839	47	Residue	*Lipid*	Building 8; SU 78	5758–5663	5831–5634	5720	5750	36

Tab. 2. Radiocarbon dates from other Pelagonian sites recently dated; calibrated medians are rounded by 10.

Site	**Lab. code**	**BP**	**StDev (±)**	**Sample material**	***Species***	**Context and layer**	**cal BC 1σ**	**cal BC 2σ**	**Median (cal)**	**No.**
Tumba-Optičari	BE-5280	7019	22	Seed	*Pisum sativum*	Quadrant I in 1988 excavations	5976-5851	5983-5841	5910	1
Tumba-Optičari	BRAMS-4546	6949	29	Bone	*Bos taurus*	Quadrant I (southern half, spit 12) in 1988 excavations	5883-5774	5965-5737	5820	2
Tumba-Optičari	BRAMS-4545	6935	29	Bone	*Bos taurus*	Quadrant I (southern half, spit 11) in 1988 excavations	5841-5751	5887-5734	5810	3
Tumba-Porodin	BE-5281	6884	22	Seed	*Tr. monococcum*	Quadrant I in 1953 excavations	5784-5727	5831-5720	5760	4
Školska Tumba	BRAMS-4544	6768	29	Bone	*Bos taurus*	Quadrant I (SU 64) in 2014 excavations	5710-5635	5721-5627	5670	5
Školska Tumba	BRAMS-4543	6736	29	Bone	*Bos taurus*	Quadrant I (SU 64) in 2014 excavations	5703-5623	5714-5570	5650	6