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The Iron Gates Mesolithic – a brief review of recent developments

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Résumé

La région des Portes de Fer dans la basse vallée du Danube, le long de la frontière entre la Roumanie et la Serbie, présente une concentration unique de sites mésolithiques et néolithiques anciens couvrant la période allant d'environ 12.700 à 5600 cal BC. Plus de 50 grottes et sites de plein air ont été identifiés lors de prospections-inventaires archéologiques réalisés avant la construction du barrage dans les années 1960 et 1980, et les fouilles de sauvetage qui ont suivi ont révélé de nombreuse sépultures et vestiges architecturaux, d'importantes quantités de restes fauniques et des objets mobiliers, y compris des œuvres d'art et ornements sur os, coquille et pierre. La plupart des sites ne sont plus accessibles, submergés sous les réservoirs créés par les barrages Portes de Fer I et II. Depuis 1990, de nouvelles fouilles ont été menées à Aria Babi et Vlasac en Serbie, et Schela Cladovei en Roumanie, alors que l'étude détaillée des fouilles et découvertes anciennes et nouvelles a été entreprise par des chercheurs en Roumanie, en Serbie et au Royaume-Uni, alimentée par les progrès la science archéologique. Dans cet article, nous passons en revue les principales avancées de la connaissance du Mésolithique et de la transition vers l'agriculture dans les Portes de Fer faites au cours des 25 dernières années, et surtout depuis 2005. L'article est divisé en plusieurs sections portant sur la chronologie, les pratiques mortuaires, les analyses isotopiques sur la subsistance et la mobilité, ainsi que la nature et le moment de la transition entre le Mésolithique et le Néolithique dans la région des Portes de Fer. L'article se termine sur les perspectives des recherches en cours.

Mots clés: Portes de Fer, Mésolithique, transition néolithique, progrès archéologiques

Abstract

The Iron Gates section of the Lower Danube valley along the border between Romania and Serbia has an unparalleled record of Mesolithic and Early Neolithic settlement spanning the period from ca. 12.700 to 5600 cal BC. Over 50 cave and open-air sites were identified during archaeological surveys in advance of dam construction in the 1960s and 1980s, and follow-up rescue excavations revealed numerous burials and architectural remains and produced rich inventories of faunal material and portable artefacts including artworks and ornaments of bone, shell and stone. Most sites are no longer accessible, submerged beneath the reservoirs created by the Iron Gates I and II dams. Since 1990 new excavations have been conducted at Aria Babi and Vlasac in Serbia, and Schela Cladovei in Romania, while detailed studies of the finds from both new and old excavations have been undertaken by researchers based in Romania, Serbia and the UK fuelled by developments in archaeological science. In this paper, we review the main advances in knowledge of the Mesolithic and the transition to farming in the Iron Gates over the past 25 years, and especially the period since 2005. The paper is divided into sections dealing with chronology, mortuary practices, isotopic studies of subsistence and mobility patterns, and the nature and timing of the transition from Mesolithic to Neolithic in the Iron Gates region. The review concludes with a forward look at research in progress.

Key words: Iron Gates, Mesolithic, Neolithic transition, archaeological advances

Introduction

FIGURE 1 ABOUT HERE

The Iron Gates region has an unparalleled record of Mesolithic and Early Neolithic settlement spanning the period from the beginning of the Bølling–Allerød Interstadial to the Middle Holocene, ca. 12.700–5600 cal BC. The discovery and investigation of the Iron Gates sites was the outcome of a decision by the Yugoslav and Romanian governments to construct two hydroelectric dams on the Lower Danube – Iron Gates I (1964–1971) and Iron Gates II (1977–1984) – that would create a reservoir system over 230 km long, flooding areas on both banks of the river. Over 50 cave/rockshelter and open-air sites are known from this period (**Fig. 1**), which together have produced large numbers of burials and architectural remains, and rich inventories of faunal material and portable artefacts, including personal ornaments and other works of art. Most sites are no longer accessible, but new excavations have been possible at Schela Cladovei (Boroneanț et al., 1999; Bonsall, 2008) and Vlasac (Borić et al., 2014), and one new Early Neolithic site, Aria Babi has been identified and investigated (Borić and Starović, 2008).

Developments in archaeological science since the 1980s have given new impetus to research in the Iron Gates. Scientific analysis of existing and new collections, combined with new anthropological and zooarchaeological studies, have allowed us to revise our ideas about chronology, burial practices, mobility, diet and ancestry. In 2005, the senior author wrote a review of the Iron Gates Mesolithic, which attempted to summarize the state of research at that time (Bonsall, 2008). In the years since that paper was written there have been some significant developments. In this paper, we review some of those developments and look forward to the results from new avenues of research.

FIGURE 2 ABOUT HERE

Chronology

Any discussion of the chronology of early post-glacial settlement in the Iron Gates is complicated by inconsistent use of terminology. **Figure 2** shows two (of the many) interpretations of the Mesolithic sequence in the Iron Gates based on research done in the 1960s. Both schemes rely on stratigraphic observations supported by radiometric ^{14}C dates on bulk charcoal or soil samples from 10 sites, although the ^{14}C dates were regarded as potentially « unreliable » and were sometimes rejected when they did not agree with excavators' stratigraphic interpretations or their preconceived ideas of the absolute chronology. In both schemes the term « Epipalaeolithic » is preferred to « Mesolithic » although little effort was made to differentiate between the two. However, while Boroneanț (2000) referred to the pre-farming populations of the Late Glacial and Early Holocene as « Epipalaeolithic », Srejović (1969) restricted the term to the Early Holocene. In recent years, there has been a move to limit the term « Epipalaeolithic » to the Terminal Pleistocene. Thus, Borić (2011) uses « Epipalaeolithic » for the Late Glacial part of the sequence and « Mesolithic » for the Early Holocene portion, arguing that Epipalaeolithic and Mesolithic assemblages differ in terms of their lithic and ornamental traditions and their faunal inventories. This interpretation rests largely on the evidence from Cuina Turcului. However, the stratigraphic interpretation of Cuina Turcului has been challenged (Boroneanț 2012) and, currently, there are too few ^{14}C dates to provide an alternative chronological framework for the site (Bonsall and Boroneanț, 2016).

Since 1995 considerable effort has been put into single-entity dating of short-lived animal and human bones and plant remains. Excluding duplicate or repeat measurements, there are now 144 published AMS ^{14}C dates on animal bones and bone artefacts, 115 dates on human bone, and one date on a carbonized plant remain. It is these dates that now form the basis of the chronology of the Iron Gates Mesolithic–Early Neolithic sequence. However, dates on human bone are problematic. Nitrogen isotope ($\delta^{15}N$) measurements strongly suggest that human bone collagen samples from many Mesolithic and Early Neolithic skeletons contain freshwater diet-derived carbon, which is depleted in ^{14}C relative to the atmosphere resulting in radiocarbon ages that are « too old ». A method of correcting human bone ^{14}C ages for the « freshwater reservoir effect » was developed by Cook et al. (2001; 2002; 2009); their reservoir correction provides a date that is more accurate (i.e. closer to the true age of the sample) but less precise.

FIGURE 3 ABOUT HERE

In the absence of well-defined cultural changes within the earlier part of the time range at least, the present authors prefer to treat the period from 12.7–6.0 ka cal BC as a unitary phenomenon, which we refer to as « Mesolithic ». In **Figure 2** the AMS radiocarbon dates from ten sites on both banks of the river are plotted against the Late Glacial–Mid Holocene palaeoclimatic record, which is used to subdivide the Mesolithic into four phases. For convenience, phases I–II (corresponding to the Bølling–Allerød and Younger Dryas) are treated as « Early » Mesolithic, while phases III and IV are characterized as « Middle » and « Late » Mesolithic, respectively. The transition to the Neolithic took place during the climatic cooling phase known as the « 8.2 ka event » and this phase is sometimes distinguished as « Final Mesolithic » (Bonsall, 2008) or « Mesolithic–Neolithic transformation phase » (Borić and Price, 2013).

Mortuary practices

Our understanding of burial practices in the Iron Gates Mesolithic has improved significantly since 1990, thanks to new excavations at Schela Cladovei and Vlasac, and the application of AMS ^{14}C dating and stable isotope analysis to human remains from older excavations. Over 450 burials, containing the remains of more than 700 individuals, have been recorded from 15 sites, with five sites Lepenski Vir, Hajdučka Vodenica, Padina, Schela Cladovei and Vlasac accounting for over 95% of all burials known from the Iron Gates.

In the Iron Gates Mesolithic as a whole significant variation is observable in the treatment and disposal of the body. There are examples of primary and secondary inhumation, individual and collective burial, and cremation.

Among primary inhumations several different body positions are represented. Most characteristic are burials where the skeleton was disposed in the extended, supine position – lying on the back, body straight out, with the hands by the side or resting on the abdomen or chest. Such burials occur at sites in both the Iron Gates Gorge and the downstream area. There are a smaller number of cases where the upper body is supine and the lower limbs flexed. Quite widely represented are burials where the skeleton lay on one side, with the legs straight or flexed, and the arms flexed in various positions. In extreme cases, e.g. Vlasac burial 44 (Srejović and Letica, 1978, fig. 101) and burial M1 from the Climente II cave (Bonsall et al., 2012, fig. 2), the legs were tightly flexed at right angles to the body – a position that also characterizes some Early Neolithic burials in the Iron Gates. A distinctive group of burials are those that are sometimes described as « seated with crossed legs » (Borić and Miracle, 2004), examples of which were recorded at Padina and Vlasac in the Iron Gates Gorge and at Ostrovul Corbului and Kula in the downstream area. Burial 69 from Lepenski Vir may also belong to this group. In fact, the common characteristic of these burials is that the legs were pushed upwards, flexed and crossed at the lower leg or ankle. The upper body could be either supine or in a near-vertical position. This cross-legged body position is suggestive of the corpse having been placed in a grave that was too short to accommodate an extended burial (Bonsall et al., 2016).

Secondary burial refers to the burial of disarticulated bones or of body parts removed from a corpse before decomposition is complete. Many examples of secondary burial are known from the Iron Gates Mesolithic, implying that burial of the dead was often a multi-stage process (Boroneanț and Bonsall, 2012). In many cases, there are no signs of separation of body parts by sectioning (cutting) implying that excarnation (defleshing) was allowed to happen naturally. However, the recognition of cutmarks and scraping marks on some disarticulated human remains from Lepenski Vir and Vlasac (Cristiani, 2016; Wallduck and Bello, 2016) is evidence that post-mortem manipulation sometimes occurred before the body was completely skeletonized. Removal and reburial of crania (well known from the Epipalaeolithic and Early Neolithic of the Near East) appears to have been a widespread secondary burial practice in the Iron Gates region (Bonsall, 2008), while Borić (2016) has shown than human mandibles played an important role in secondary burial rites at Lepenski Vir.

Burned human remains have been reported from Mesolithic contexts in several Iron Gates Mesolithic sites, but only in one site is there clear evidence of the practice of cremation. At Vlasac reburial of exhumed bones and body parts was often preceded by cremation (Borić et al., 2009).

Primary and secondary burials were often made in simple pits and more rarely under stone heaps, although large stones were sometimes placed on top of a corpse, or part of a corpse, prior to filling in the grave. The outlines of burial pits were often indistinct, having been obscured or erased by soil processes, which makes it difficult to identify instances of multiple burials (graves containing two or more primary burials). There are, however, examples of collective burial, defined as successive deposition of human remains in the same location (cf. Borić, 2016: 57). Archaeothanatological analysis of the burials from Lepenski Vir by Borić (2016), based on examination of field plans and photographs, has revealed a few instances where the corpse may have been wrapped prior to burial.

Although ^{14}C dating of human bone from the Iron Gates is problematic, the availability of a large series of direct dates for individual burials from 11 sites has important implications for our understanding of temporal and spatial patterns in mortuary practices in the Iron Gates Mesolithic (Boroneanț and Bonsall, 2012; Bonsall et al., 2015a; Borić, 2016). Some temporal patterning can be observed in body position and burial orientation. Extended inhumation was the main form of primary burial throughout the Holocene portion of the Mesolithic time range. In the period 9650–7300 cal BC (Middle and Late Mesolithic) orientation of such burials with respect to the Danube was variable. The earliest dated examples have their long axes perpendicular to the Danube with the head away from the river; however, in the Late

Mesolithic (7300–6300 cal BC) burials aligned parallel to the Danube occur, often with the head pointing downriver. This became the predominant burial orientation in the final phase of the Mesolithic between 6300 and 6000 cal BC, although there are notable exceptions such as burial M3 at Icoana (Boroneanț and Bonsall, 2016). The small group of « seated burials with crossed legs » appears to belong to a specific time horizon within the Middle Mesolithic, with ^{14}C dates for eight examples from Padina, Lepenski Vir, Vlasac and Ostrovul Corbului ranging between ca. 8800 and 7300 cal BC.

Objects found with burials which can reasonably be interpreted as grave offerings include animal and human skulls, antler and bone tools, and body ornaments – although these were recovered from only a small proportion of Iron Gates Mesolithic burials. The scarcity of ornaments from burials may in part reflect the rescue nature of the excavations, in which small hand tools (such as trowels) and fine sieving were rarely used. There is some temporal variation in the types of ornaments that occur (Borić and Cristiani, 2016; Mărgărit et al., 2017a). For the Early and Middle Mesolithic there are no certain finds of body ornaments with burials. Beads made from marine and freshwater molluscs and pendants made from animal teeth have been recovered from « settlement contexts » in four sites on the Romanian bank of the Danube (Cuina Turcului, Climente II, Ostrovul Banului and Icoana); some of the ornaments from Cuina Turcului may have been associated with burials that were not recognized as such during excavations there. No perforated animal tooth ornaments have been recovered from Late and Final Mesolithic burials, where two main types of body ornament occur – shell beads and ornaments made from cyprinid teeth and shells of the marine gastropod, *Tritia neritea*, which were probably sewn or stuck onto clothing in the manner of appliqués (Cristiani and Boric, 2012; Cristiani et al., 2014; Mărgărit et al., 2017a). Annular stone beads and tubular beads of *Spondylus* shell (resembling those from Early Neolithic contexts in the Balkans) were found associated with some very late Mesolithic burials at Vlasac, while annular stone beads were also found with very late (or « Final ») Mesolithic burials at Lepenski Vir. (Borić, 2011).

The isotopic revolution in the Iron Gates

Stable isotope analyses of human bones and teeth allow us to study the life histories of individuals in various ways. Strontium isotopes are useful in analyzing mobility patterns in past populations, while C, N, and S isotopes provide information on diet and the weaning process. Such studies have been applied to the Iron Gates Mesolithic, in combination with AMS ^{14}C dating, since the mid-1990s (Bonsall et al., 1997).

Mobility and Migration

The $^{87}Sr/^{86}Sr$ ratio is used in migration research. The underlying principle is that strontium is released from rocks during weathering and gets into soil and water, from where it becomes incorporated into the tissues of plants and animals. The amount of ^{87}Sr in rocks varies according to the age of the rock, very old rocks having a higher $^{87}Sr/^{86}Sr$ ratio than much younger rocks. Thus, the $^{87}Sr/^{86}Sr$ ratio in human bones and teeth will reflect that of the geographical area in which a person lived while their bones and teeth were formed. Since teeth form during infancy and childhood, the $^{87}Sr/^{86}Sr$ of tooth enamel reflects that of an individual's childhood home.

Borić and Price (2013) analyzed the Sr-isotope composition of tooth enamel in 42 Mesolithic and Neolithic individuals from the Iron Gates. They compared the results against their estimate of the local bio-available range of Sr-isotope ratios and considered any individual who fell outside this range as non-local. From this they concluded that a significant number of non-locals entered the Iron Gates region after 6200 cal BC, who they interpreted as first-generation immigrant farmers. However, using this approach they were not able to determine the area or areas of origin of the non-locals, which could have been nearby or some considerable distance away. Much of the « migration » reflected in the Iron Gates $^{87}Sr/^{86}Sr$ data could be explained in terms of frequent intermarriage between fishing villages located on the Danube and farming villages in the hinterland. Intermarriage between neighbouring villages along the Danube (where baseline Sr values were similar) would likely not be detectable in the data. Thus, mobility in the Mesolithic, prior to the appearance of farming, may be underestimated in Borić and Price's (2013) study.

Diet

The first applications of dietary tracing using stable isotope analysis focused on C and N isotopes in bone collagen (Bonsall et al., 1997), and revealed a marked shift in values between Mesolithic and Early Neolithic. $\delta^{15}N$ ratios higher than +14‰ are characteristic of most individuals dated to period before 6300 cal BC, while individuals buried in the crouched body position typical of the Early Neolithic throughout much of the Balkans typically show values below +13‰. Average $\delta^{13}C$ values are also higher (less negative) among Mesolithic individuals.

Among early farming communities across Southeast Europe where archaeological evidence points to diets based almost exclusively on C_3 plant and animal resources (including dairy products), it is rare to see $\delta^{15}N$ values higher than +10.5‰ (e.g. Bonsall et al., 2007). Higher values than this suggest the regular consumption of high trophic level foods, such as fish and other aquatic resources. Thus, the high $\delta^{15}N$ values exhibited by Mesolithic people in the Iron Gates, combined with the abundance of fish bones from Mesolithic contexts, strongly suggest that Mesolithic subsistence in the Iron Gates was to a greater or lesser degree dependent on the aquatic resources of the Danube. It is also clear from the stable isotopic, artefactual and archaeofaunal records that fishing continued to make a significant (if smaller) contribution to the local economy during the Early Neolithic after 6100/6000 cal BC.

Since the pioneering study by Bonsall et al. (1997) there has been further palaeodietary research, mostly based on C- and N-isotope analysis and frequently undertaken in conjunction with AMS ^{14}C dating of human remains (e.g. Bonsall et al., 2000; 2004; Grupe et al., 2003; Borić and Miracle, 2004; Borić et al., 2004). The first palaeodietary study using sulphur isotopes was undertaken by Nehlich et al. (2010). Based on a small series of S, N and C measurements on humans, terrestrial mammals and fish, they argued that Iron Gates Mesolithic diets were not uniformly high in aquatic protein. Their data were reinterpreted by Bonsall et al. (2015b) to show there was a clear temporal trend in the $\delta^{34}S$ values, with a matching trend in $\delta^{15}N$ values, and that the S-isotope data did not necessarily contradict previous interpretations based on C and N isotopes. However, Nehlich et al.'s research does suggest that S may be a more sensitive indicator of fish consumption among communities living along the Danube, and further research is needed to explain the temporal patterns observed.

One limitation of the palaeodietary studies undertaken to date is that isotopic measurements have tended to be made on only a single bone per individual. It is well known that the rate of collagen turnover varies with the age of the individual and between different bones of the body (Tsutaya and Yoneda, 2013). In very simple terms, this means that different bones may reflect the diet at different stages of an individual's lifetime. Thus, teeth provide the dietary signal from childhood. Collagen turnover in cortical bone of, e.g., the femur diaphysis or skull, is thought to be more rapid during childhood and adolescence and to slow considerable thereafter, so that these bones (even in older adults) may reflect the diet during the teenage or early adult years. In contrast, collagen turnover in trabecular bone is thought to be more rapid than in cortical bone and to remain more-or-less constant throughout an individual's life, such that stable isotope measurements on ribs or vertebrae probably reflect an individual's diet over the 5–10 years before death. This has implications for interpreting the stable isotope data from the Iron Gates, which are touched upon in the following section.

The Mesolithic–Neolithic transition in the Iron Gates

The large number of Mesolithic and Early Neolithic sites in a relatively small area, where continuity of settlement can be demonstrated from the Late Glacial to Mid-Holocene, makes the Iron Gates region unique in Southeast Europe and an extremely important locality for studying the processes involved in the transition to farming. Since the first sites were excavated in the 1960s there has been an ongoing debate about the timing, duration and character of the transition. Some previous researchers have argued for a long period of « Mesolithic survival » in the Iron Gates, with local fisher-hunter-gatherers maintaining their traditional way of life for centuries after farming and the Neolithic way of life became established in other parts of the central and northern Balkans. Research since 1990 and particularly over the last decade – involving new excavations at Schela Cladovei and Vlasac, and scientific dating and analysis of finds from older excavations – has produced a wealth of new data that fundamentally alter our understanding of events surrounding the transition.

At Schela Cladovei in the downstream area there was a chronological gap of about 300 years between the end of Late Mesolithic occupation of the site ca. 6300 cal BC and the earliest Neolithic occupation. The Neolithic people who reoccupied the site around or shortly after 6000 cal BC belonged to the Starčevo-Criș culture. They combined fishing with farming, built rectangular plan houses, used pottery, imported raw materials such as obsidian and Balkan flint, and manufactured annular greenstone beads and distinctive forms of bone and stone tools. These and other aspects of Early Neolithic material culture at Schela Cladovei are in sharp contrast to the Late Mesolithic occupation of the site. Late Mesolithic primary burials at Schela Cladovei were almost invariably extended supine inhumations. No burials from this site have yet been dated to the Starčevo-Criș phase, but at other Early Neolithic sites in the downstream area (like Ajmana and Velesnica) the dominant burial position is tightly flexed or crouched on the left or right side, a form of inhumation that is universal across the Starčevo culture area in Southeast Europe. The earliest burials of this type in the downstream area may be those from Velesnica, with reservoir-corrected ^{14}C ages of between 6050 and 6000 cal BC (Bonsall et al., 2015a). Thus, in the downstream area of the Iron Gates region, the transition from Mesolithic to Neolithic must have occurred sometime between 6300 and 6050 cal BC. But so far there are no securely dated finds to fill this gap.

In the Iron Gates gorge, however, the evidence is rather better. There are several sites with burials or other finds that have been dated to the period between 6300 and 5900 cal BC; they are Padina, Vlasac, Lepenski Vir and Hajdučka Vodenica on the Serbian bank of the Danube, and Icoana and Cuina Turcului on the Romanian bank. Within this period there are burials in both the Mesolithic and Early Neolithic traditions, Starčevo culture elements such as pottery and ground stone tools, while bones of caprines (sheep or goats) imply livestock raising. Many, if not all, of the trapezoidal buildings and carved sandstone boulders found at

Lepenski Vir also appear to belong to this time range. However, establishing a reliable absolute or even relative chronology for these finds is not straightforward.

The rich archaeological record at Lepenski Vir for the period between 6300–5900 cal BC makes this a key site for investigating the Meso–Neolithic transition in the Iron Gates gorge. Dating of the appearance of key Neolithic indicators such as pottery, ground stone artefacts, imported raw materials like Balkan flint, and the presence of animal domesticates still rests largely on observations of stratigraphy and archaeological « association » made at the time of excavation. Some researchers (e.g. Perić and Nikolić, 2016) « date » the appearance of Starčevo culture ceramics as early as 6300 cal BC; others (e.g. Bonsall et al., 2008) find no unequivocal evidence of pottery use before 6000 cal BC. Direct dating by, e.g., ^{14}C analysis of lipids in pottery sherds (cf. Roffet-Salque et al., 2016), may be the only way of resolving this debate. The few AMS ^{14}C dates on bones of animal domesticates (cattle, caprines) from Lepenski Vir and Cuina Turcului (**Table 1**) suggest livestock husbandry was being practised in the Iron Gates Gorge by 5950 cal BC.

TABLE 1 ABOUT HERE

The key evidence, however, comes from burials. Many of the burials from Lepenski Vir are thought to belong to the period 6200–5600 cal BC. At the time of writing, there are 27 primary and secondary burials with direct AMS ^{14}C dates that fall into this time range (Bonsall et al., 1997; 2015a; Borić and Dimitrijević, 2009; Borić and Price, 2013; Borić, 2016). Of the 17 primary burials in this series, 10 are extended supine inhumations in the Mesolithic tradition, and 6 are crouched inhumations in the Starčevo culture tradition. The extended supine burials have median ages between ca. 6150 and 5930 cal BC, while the crouched burials have median ages between ca. 5920 and 5725 cal BC. These data suggest that an important change in mortuary practices took place at Lepenski Vir ca. 5950/5900 cal BC.

FIGURE 4 ABOUT HERE

Figure 4 compares the stable C- and N-isotope values for extended and crouched inhumation burials from the 6300–5600 cal BC (Final Mesolithic–Early Neolithic) time range at Lepenski Vir. Interpretation of these data is complicated by the fact that some individuals were non-locals who spent their childhood years elsewhere, such that their bone collagen isotope signatures may not be entirely representative of that part of their lives spent at Lepenski Vir. Most individuals from extended inhumations exhibit $\delta^{15}N$ >14‰, characteristic of diets rich in aquatic protein. In contrast, all individuals from crouched burials have $\delta^{15}N$ <13‰ (9.8–12.8‰) indicative of diets that included significantly more protein from terrestrial resources. A few individuals from extended inhumations (burials 7/I, 26, 54c and 54e) also show $\delta^{15}N$ values of 13‰ or lower. Among those individuals with $\delta^{15}N$ <13‰ are several affected by carious lesions on their teeth or by ante-mortem tooth loss, including extended burial 26 (Borić, 2016: 251), and crouched burials 32a and 88 (Radović and Stefanović, 2013). Oral pathologies of this kind are extremely rare in Iron Gates Mesolithic populations prior to 6300 cal BC (cf. Boroneanț et al., 1999). The most parsimonious explanation is that starchy foods, such as cereals, were important in the diets of these individuals. However, since all three individuals were non-locals (Borić and Price, 2013; Borić, 2016) it is possible their oral pathologies were related to diet during childhood or adolescence, before they moved to Lepenski Vir. Better evidence of dietary change among the local population after 6300 cal BC is provided by another extended burial (7/I) from Lepenski Vir. This individual, an adult male who died at age 50–60, was not only affected by tooth loss (Radović and Stefanović, 2013) but also shows stable isotopic evidence of a change in diet during his lifetime, from one heavily reliant on aquatic resources to one that was likely based on a combination of aquatic and terrestrial foods (Bonsall et al., 2015a). Collagen from compact bone of the femur shaft (some or most of which was likely synthesized during adolescence) gave a $\delta^{15}N$ value of 16.1‰, while collagen extracted from a rib (likely synthesized in the few years prior to death) gave a $\delta^{15}N$ value of 11.5‰, within the range of Neolithic skeletons from the Iron Gates. The combined evidence from stable isotopes and dental pathologies hints at a significant change in subsistence patterns at Lepenski Vir prior to 5950 cal BC, associated with the introduction of farming, at a time when the Mesolithic tradition of extended supine burial was still practised there.

This apparent shift in subsistence practices was likely preceded by a period of contact between the Iron Gates Mesolithic fishing communities and Early Neolithic farmers. Several lines of evidence hint at such contact before 6000 cal BC. At Lepenski Vir and Vlasac several very late Mesolithic (extended supine) burials contain body ornaments that differ in form and raw material from those found in the Iron Gates Mesolithic before 6300 cal BC. Flat annular stone beads were associated with four burials (46, 54e, 87 and 93) at Lepenski Vir (Srejović and Babović 1983; Borić 2016) and burial H63 at Vlasac (Borić 2007). In the last-mentioned case, the flat disc beads were accompanied by two tubular beads made from *Spondylus* shell. Such ornaments are characteristic of the Early Neolithic throughout the Balkan Peninsula, and in the southern part of the region have been found in contexts dating back before 6000 cal BC (Perlès, 2001). From the Early Neolithic occupation phase (6000–5600 cal BC) at Schela Cladovei in the downstream area of the Iron Gates there is abundant evidence of the local manufacture of annular beads, comprising debitage from all stages of production of the beads together with flint drill bits that were used in their manufacture. In contrast, from Lepenski Vir and Vlasac only finished beads have been reported, and it is not clear if these were locally made or imported. Other evidence of Neolithic « influence » at the end of the Iron Gates Mesolithic is represented by the presence of aurochs (*Bos primigenius*) skulls in two Mesolithic extended supine burials (7/I and 89a). These have been interpreted as acts of ritual deposition that represent a change in ideology and mortuary practice inspired by contact with immigrant farmers of Near Eastern ancestry (Borić, 2016). While the presence of Neolithic-type ornaments and aurochs symbolism in burials that in other respects follow the local Mesolithic tradition likely reflects contact with farmers, it is not clear when such contact began and over what distances the interaction took place.

The calibrated ^{14}C ages of the burials in question – Lepenski Vir 7/I, 54e, 89a, 93, and Vlasac H63 (Bonsall et al., 2015a; Borić, Price, 2013; Borić et al., 2008) – have relatively low precision (with overlapping spans of ca. 280–405 yr between 6220–5780 cal BC), partly because of the need to apply a freshwater reservoir correction to human bone ^{14}C dates from the Iron Gates (Cook et al., 2001) and partly due to the shape of the radiocarbon calibration around the time of the Mesolithic–Neolithic transition in the Iron Gates. However, it is worth noting that the date for Vlasac H63 (an adult female) was obtained on collagen from a rib and is associated with a $\delta^{15}N$ value of +17‰, which (given the rapid collagen turnover characteristic of ribs) suggests this individual had a typical Mesolithic fish-dominated diet right up until her death. This could be taken as circumstantial evidence that H63 lived and died before the apparent shift in diet seen in individual 7/I from Lepenski Vir, given the two sites are only a few kilometres apart and (based on Sr-isotope data) neither individual appears to have been an immigrant.

Potentially relevant to the timing of contacts between Iron Gates Mesolithic foragers and Early Neolithic farmers is the work of Cristiani et al. (2016a). They found starch granules from grasses of the Triticeae tribe (which includes domesticated wheat and barley and their wild relatives) trapped in dental calculus on teeth of several Late to Final Mesolithic skeletons from Vlasac. Only one of the skeletons (H81) had been directly dated, with a calibrated ^{14}C age of 6690–6475 cal BC. Two other skeletons, H232 and H53 were assigned age estimates of ca. 6500 cal BC and ca. 5900 cal BC, respectively, based on their stratigraphic relationships to dated terrestrial samples. From this, Cristiani et al. (2016a) concluded that Late Mesolithic fishers at Vlasac were consuming small quantities of domesticated cereals by ca. 6600 cal BC, which they obtained through social exchange with farmers. Since there are no Neolithic sites in the Balkans north of Greece dated earlier than 6200 cal BC, Cristiani et al. (2016a) suggested that the presence of cereals at Late Mesolithic Vlasac was likely the result of long distance exchange. While long distance exchange over hundreds of kilometres is documented both archaeologically and ethnographically among foragers and farmers (Kelly, 1995; Jefferies, 1996), there remains the possibility that the starch granules associated with Late Mesolithic humans at Vlasac emanate from wild grasses that were native to the Iron Gates region.

The longstanding debate among archaeologists about how farming reached Southeast Europe and ultimately the Iron Gates has now been largely resolved by ancient DNA research. Two recent aDNA studies (González-Fortes et al., 2017; Mathieson et al., 2018) have between them presented genomic data for a large number of Mesolithic and Neolithic skeletons from Southeast and Central Europe, including over 50 individuals from six sites in the Iron Gates – Padina, Lepenski Vir, Vlasac, Hajdučka Vodenica, Schela Cladovei and Ostrovul Corbului. The genetic data confirm that the appearance of farming and Neolithic material culture throughout the Balkans was associated with the large-scale dispersal of people of Anatolian ancestry, although the degree of admixture between 'Anatolian' farmers and indigenous hunter-gatherers was regionally variable. A synthesis of aDNA, ^{14}C and stable isotope data suggests there was a substantial degree of interaction and interbreeding between immigrant farmers and local hunter-gatherers throughout the Lower Danube valley including the Iron Gates, beginning before 6000 cal BC and continuing for generations. The first 'Neolithic' immigrants identifiable in the Iron Gates Gorge – represented, for example, by individuals 17 and 54e at Lepenski Vir who had exclusively Anatolian ancestry – were mainly women who likely married into Mesolithic fisher-hunter-gatherer communities along the Danube. They and their proximate descendants (e.g. individual 61 at Lepenski Vir and individual 4 at Padina, who show mixed farmer–hunter-gatherer ancestry) were buried according to local Late Mesolithic custom and consumed an essentially Mesolithic diet. Forager-farmer interactions continued in the Iron Gates region and, eventually, Mesolithic traditions of architecture, burial and technology were supplanted by those of the Early Neolithic Starčevo-Criș culture. This change may have occurred later in the Iron Gates Gorge than in the downstream area (Bonsall et al., 2015a).

Conclusions

Advances in the study of the Iron Gates Mesolithic over the past decade, though involving new excavations at the sites of Aria Babi, Schela Cladovei and Vlasac, have been driven primarily by archaeometric analysis of finds from excavations that took place half a century ago, which have fundamentally changed our ideas of chronology, subsistence, burial practices, and the nature and timing of the Neolithic transition. This work continues and at time of writing new lines of enquiry are being pursued. « The Hidden Foods Project » led by

Emanuela Cristiani (Rome) is aimed at reconstructing the role of plant foods in Upper Palaeolithic and Mesolithic economies in Southeast Europe and Italy, including the Iron Gates, and is employing a range of techniques to recover plant remains from soil samples, dental calculus and the surfaces of ground stone tools (Cristiani et al., 2016a; 2016b). The bioarchaeology of the Iron Gates Mesolithic and Early Neolithic lies at the heart of another ERC-funded project [1], led by Sofija Stefanović (Belgrade) and aimed at reconstructing and interpreting changes in demography and fertility across the Mesolithic–Neolithic transition in the Central Balkans (e.g. Porčić et al., 2016). In addition to continuing the excavations at Schela Cladovei, the present authors are currently involved in experimental studies of body ornaments and bone artefacts from the Iron Gates Mesolithic and Early Neolithic (e.g. Mărgărit et al., 2017a; 2017b) and continue to contribute to research on the genetic background of the Mesolithic–Neolithic transition in Southeast Europe including the Iron Gates. Such is the pace and scope of current research on the Mesolithic and the transition to farming in the Iron Gates that it is likely all attempts to review the « current state » of the research will be short-lived, if not out-dated by the time of their publication.

Notes

1. « BIRTH. Births, mothers and babies: prehistoric fertility in the Balkans between 10,000–5000 BC », funded by the European Research Council (ERC) (https://erc.europa.eu/) under the European Union's Horizon 2020 research and innovation programme.

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FIGURE CAPTIONS

Fig. 1. Mesolithic and Neolithic sites in the Iron Gates region. Locations of sites mentioned in the text are indicated.

Sites mésolithiques et néolithiques dans la région des Portes de Fer. Les sites mentionnés dans le texte sont nommés.

Fig. 2. Periodization, chronology and terminology of the later Stone Age in the Iron Gates, according to Srejović (1969) and Boroneanț (2000).

Periodisation, chronologie et terminologie de la fin de l'âge de pierre dans les Portes de Fer, selon Srejović (1969) et Boroneanț (2000).

Fig. 3. Chronological and palaeoclimatic divisions of the Iron Gates Mesolithic: + – bulk sample (radiometric) dates; ○ – single-entity (AMS) dates. The double arrow (↔) indicates the period within which the Mesolithic–Neolithic transition is thought to have occurred. For details of the ^{14}C dates, see Bonsall (2008), Bonsall et al. (2015a), Bonsall and Boroneanț (2016), Boroneanț and Bonsall (2016), Borić (2011). Climatic curve generated with OxCal 4.2.3 (Bronk Ramsey 2009).

Divisions chronologiques et paléoclimatiques du Mésolithique des Portes de Fer: + – datations ^{14}C radiometrique (échantillon global); ○ – datations ^{14}C AMS (seule entité). La double flèche (↔) indique la période au cours de laquelle la transition mésolithique-néolithique est censée avoir eu lieu. Pour plus de détails sur les datations ^{14}C, voir Bonsall (2008), Bonsall et al. (2015a), Bonsall et Boroneanț (2016), Boroneanț et Bonsall (2016), Borić (2011). Courbe climatique générée avec OxCal 4.2.3 (Bronk Ramsey 2009).

Fig. 4. Bone collagen stable carbon and nitrogen isotope values for extended (●) and crouched (★) inhumation burials from Lepenski Vir dated to the period 6300–5700 cal BC, corresponding to the final phase of the Mesolithic and the early part of the Neolithic. A symbol within a circle represents a 'non-local' individual (cf. Borić and Price 2013). The values plotted for burial 7/I are those obtained on a rib bone by Grupe et al. (2003); the dashed line represents the change in $\delta^{13}C$ and $\delta^{15}N$ during the lifetime of this individual, as reported by Bonsall et al. (2015a).

Valeurs isotopiques stables du carbone et de l'azote du collagène osseux pour des inhumations étendues (●) et accroupies (★) de Lepenski Vir datées de la période 6300–5700 cal BC, correspondant à la phase finale du Mésolithique et au début du Néolithique. Les symboles entourés d'un cercle représentent des individus « non locaux » (Borić et Price 2013). Les valeurs représentées pour la sépulture 7/I sont celles obtenues sur un os de côtes par Grupe et al. (2003); la ligne pointillée représente la variation de $\delta^{13}C$ et $\delta^{15}N$ pendant la durée de vie de cet individu, tel que rapportée par Bonsall et al. (2015a).

Table 1 AMS ^{14}C dates on bones of domestic livestock from Cuina Turcului and Lepenski Vir in the Iron Gates Gorge (cf. Fig. 1). Lepenski Vir data from Borić and Dimitrijević (2009), Borić (2011); C:N ratios provided by ORAU. Calibrations performed with OxCal 4.3 (Bronk Ramsey, 2009) and the IntCal13 dataset (Reimer *et al.*, 2013).

Datations ^{14}C AMS sur les ossements de bétail domestique provenant de Cuina Turcului et de Lepenski Vir dans les gorges des Portes de Fer (voir figure 1). Les données de Lepenski Vir sont issues de Borić et Dimitrijević (2009), Borić (2011); C:N ratios fournis par ORAU. Étalonnages effectués avec OxCal 4.3 (Bronk Ramsey, 2009) et l'ensemble de données IntCal13 (Reimer et al., 2013).

FIGURE 1

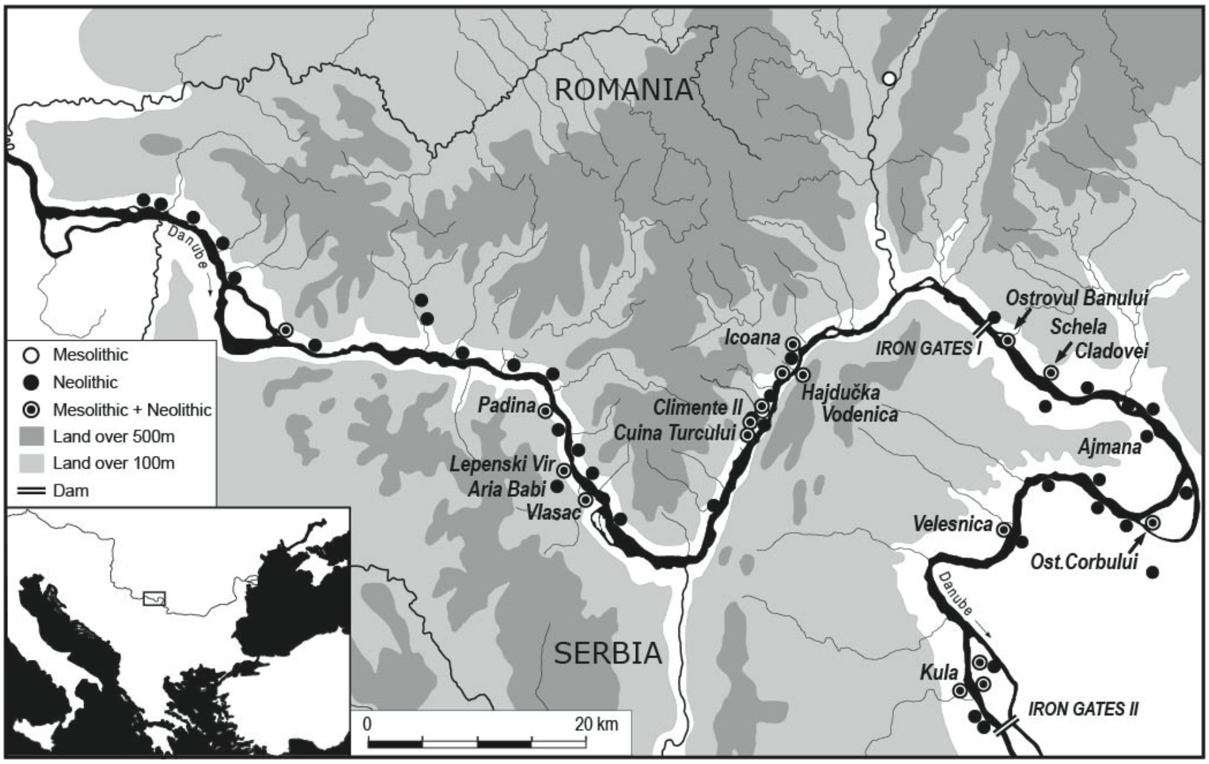

FIGURE 2

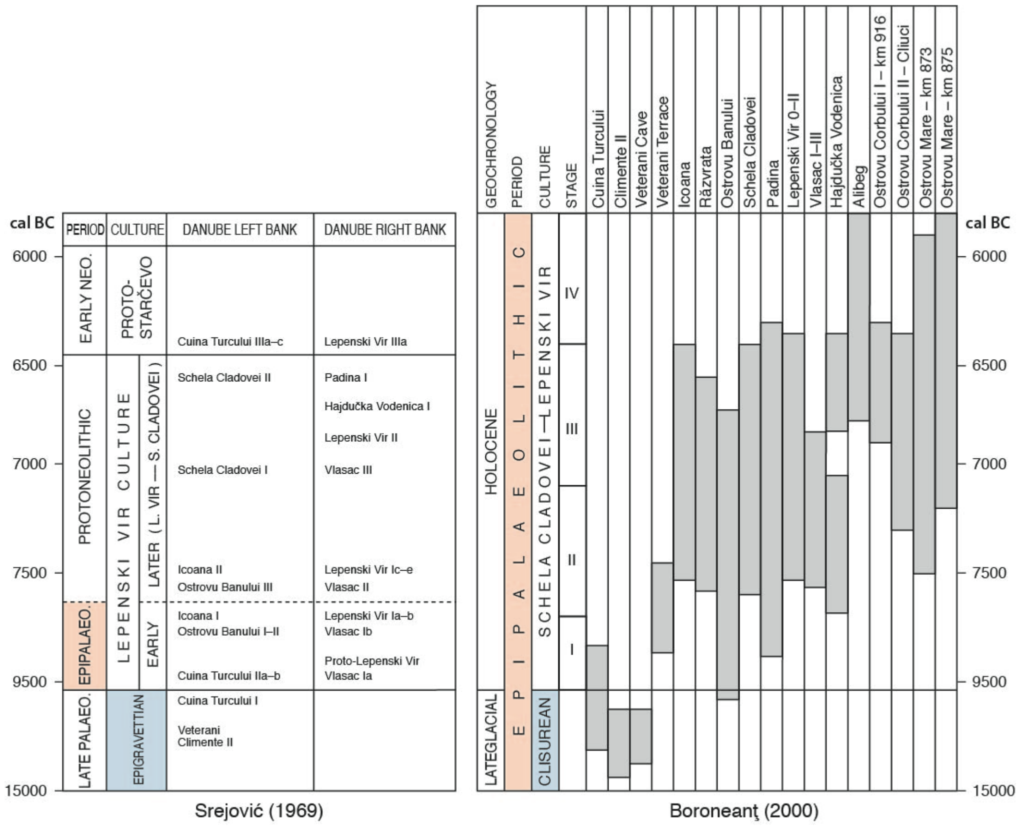

FIGURE 3

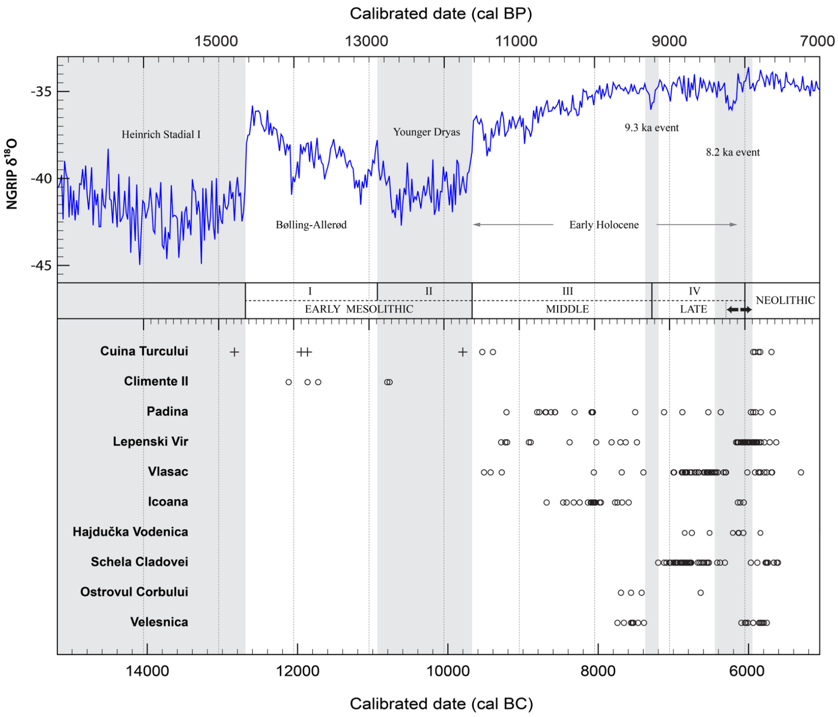

FIGURE 4

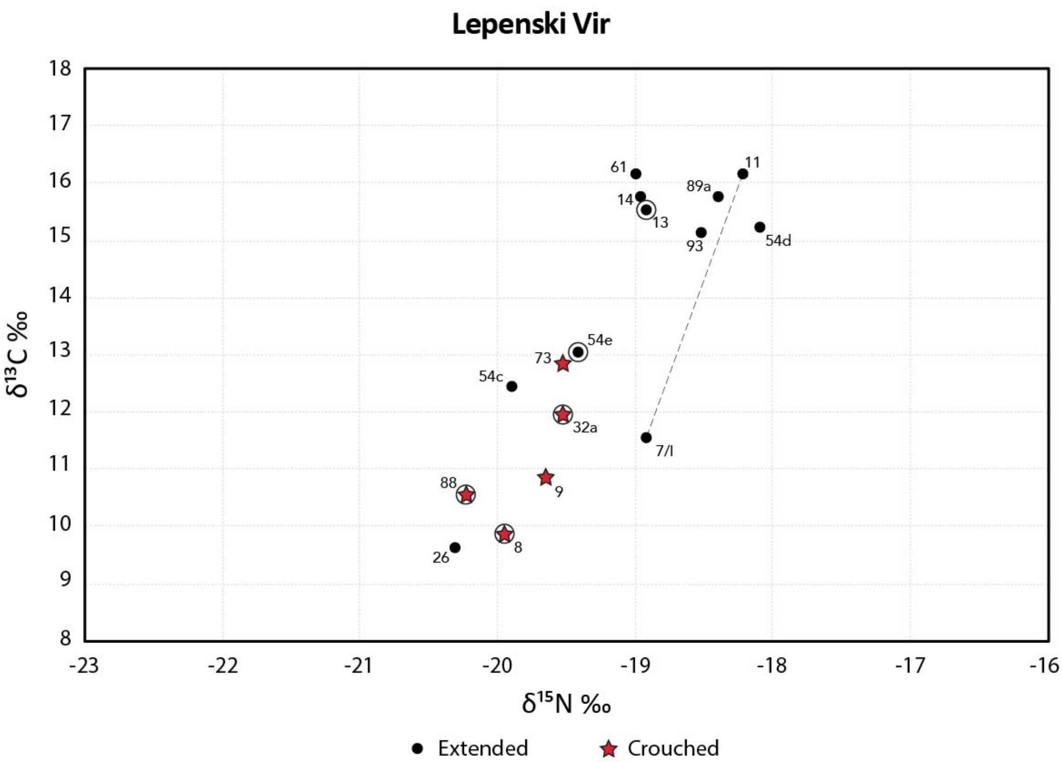

TABLE 1

Lab ID	Sample details	Context	^{14}C age (BP)	$\delta^{13}C$ (‰)	$\delta^{15}N$ (‰)	C/N	Calibrated age BC (95% confidence)
Cuina Turcului:							
OxA-30446	Bone, acetabulum (caprine)	Trench Ș, -1.60 ("Criș level I")	7075±39	-19.7	5.1	3.2	6026–5881
OxA-30443	Bone, metatarsal (caprine)	Trench M ("Criș level III")	7029±35	-19.6	6.6	3.3	5996–5841
OxA-30444	Bone, metatarsal (caprine)	Trench M ("Criș level I")	6827±39	-19.8	7.6	3.3	5782–5638
OxA-30445	Bone, acetabulum (caprine)	Trench M ("Criș level III")	4727±33	-20.0	6.9	3.3	3635–3376
OxA-30442	Bone, mandible (caprine)	Trench M, -1.38, 640 ("Criș level III")	4143±28	-20.0	6.1	3.3	2874–2625
Lepenski Vir:							
OxA-16213	Bone, prox. metatarsus (*Bos taurus*)	Sq. c/I, spit 7 (LV 39, unit 905a) (01/08/1968)	7043±37	-21.5	8.3	3.2	6001–5847
OxA-16212	Bone, prox. metatarsus (*Capra hircus*)	Domed oven, sq. d/3, spit 6 (LV37, 831a) (26/07/1968)	7041±35	-19.8	6.8	3.2	6000–5846
OxA-16079	Bone, scapula (*Sus domesticus*)	Pit 1, Sq. a/VII, spit 9 (LV35, 665) (12/07/1968)	7037±39	-20.2	9.3	3.2	6005–5842
OxA-16211	Bone, horn core (*Bos taurus*)	Pit 3, Sq. a/VIII, spit 9 (LV36, 674) (15/07/1968)	7021±36	-21.1	6.7	3.2	5995–5812
OxA-16253	Bone, mandible (*Capra hircus*)	Sq. C/XVI, spit III (LV38) (16/08/1968)	7008±38	-20.7	7.1	3.2	5988–5799