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Mesolithic-Neolithic Transformations
The Populations of the Danube Gorges

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Introduction

In the Danube Gorges that lie between Serbia and Romania, several archeological sites critical for the understanding of the transitions between the Mesolithic and Neolithic in southeastern Europe have been discovered. In particular, several preserved burial sites, containing around 500 individual skeletal remains, offer a unique opportunity to examine the life- and deathways of these communities. Through an analysis of skeletal remains and patterns of interment, this paper discusses questions of local versus non-local identities, as well as changes in diet throughout the Neolithization. One site in particular, Lepenski Vir, is the basis for research into the paleopathology of local populations. This study concludes that skeletal health parameters suggest a relatively good health status of this population over time, although treponemal infection (a group of diseases including syphilis, bejel, pinta, and yaws) affected large numbers of individuals at the Danube Gorges, and occur as a major pathological condition in all periods. Dental evidence also suggests relatively good health of the community, in contrast to other populations of the forager-farmer transition. Results of dental-based study indicate that changes in the biology of this population led to an increase of general health, though these changes were not the same for females and males.

Dušan Borić

Isotopic and Symbolic Identities: Mesolithic-Neolithic Transformations Among the Inhabitants of the Danube Gorges

In the past decade or so, several research teams carried out isotopic analyses on human burial remains and animal bones from the Danube Gorges Mesolithic and Neolithic sites.[1] This suite of new data has contributed significantly to our current understanding of dietary preferences and historical changes in this micro-region at the time of Mesolithic-Neolithic transformations (ca. 6300–5900 BCE).[2] This new research

1 The following isotopes have been analyzed: $\delta^{13}C$, $\delta^{15}N$ (Bonsall et al. 1997; Cook et al. 2009; Borić et al. 2004; Grupe et al. 2003) and $\delta^{34}S$ (Nehlich et al. 2010) for dietary patterns and trophic levels; $\delta^{18}O$ for ecological provenance (Grupe and Borić 2010); and $^{87}Sr/^{86}Sr$ for patterns of individual and population mobility (Borić and Price forthcoming).

2 This article uses the dating systems BCE and CE (Before the Common Era and Common Era), which are an alternative to BC and AD.

suggests that the pattern of fish-dominated diet—characteristic of the Late Mesolithic in the Danube Gorges—remained largely unaltered during Mesolithic-Neolithic transformations. However, dietary signatures of several individuals from the central site of Lepenski Vir indicate diets less reliant on fish, representing the trend that continued with the appearance of the first crouched (Neolithic) burials at the same site. Moreover, the same individuals contained non-local strontium signals, suggesting that they might have been (Neolithic?) migrants that came from the surrounding regions or from further afield (Borić and Price forthcoming). Based on these findings, this paper discusses the possible impact of Neolithic migrants on local populations and identities.

The earliest human remains in the Danube Gorges area date to the Early Mesolithic (ca. 9500–7300 BCE).[3] At Padina, for instance, one whole area at Sector III of this site was used for burial within several layers of a linear stone construction during the Early Mesolithic (Borić and Miracle 2004; Borić 2011). While some burials date to the last half of the tenth millennium BCE, others are from the turn of the ninth and eighth millennia BCE. Some are characterized by specific body positions, such as seated position with crossed legs—the "lotus" body posture.

Isotopic analysis of these human burial remains suggests a shift in dietary patterns in the region. For instance, isotopic analyses of nitrogen ($\delta^{15}N$) of burials from Padina, Lepenski Vir, and Vlasac show higher trophic levels (>13%) and indicate heavy protein intake, most likely due to the consumption of fish, a staple food in the Late Mesolithic of the Danube Gorges. However, this pattern of fish-dominated diet for the Early Mesolithic burials from Padina has been recently challenged by new isotope results (sulfur ^{34}S) that indicate no significant intake of fish at Padina, Vlasac, or Lepenski Vir during this period (Nehlich et al. 2010).[4] While these findings contradict our initial understanding of dietary preferences in the Early Mesolithic on the basis of carbon and nitrogen isotopic values, a more robust sample of individuals is needed to confirm these initial sulfur isotope results. Such work is currently in progress.

3 Only one burial—from the site of Climente II— might be from the Epipalaeolithic period (ca. 13,000–9500 BCE) but it has not been AMS-dated at present.

4 Early Mesolithic humans from Padina (Burials 12, 16, and 19a), Vlasac (Burials 16 and 17) and Lepenski Vir (Burials 67 and 68) have low ^{34}S values despite $\delta^{15}N$ values that are for the same individuals higher than 13% (Nehlich et al. 2010).

On the other hand, isotopic findings from a large number of later burials, dated to the Late Mesolithic (ca. 7300–6200 BCE), suggest the importance of fish in the diet of communities inhabiting the region. Burial practices may also reflect the significance of fish in local diets. The dominant burial position during this period is supine, with many individuals placed parallel to the Danube, often with their heads pointing in the downstream direction. This position may be related to the importance of anadromous sturgeon fish that migrate upstream to breed and might have held totemic, as well as dietary, significance (Borić 2005; Radovanović 1997).

This same burial position remains dominant in the period of Mesolithic-Neolithic transformations (ca. 6200–5900 BCE) during which the Danube Gorges foragers came into close contact with highly mobile Early Neolithic groups. Mesolithic supine burials along the Danube Gorges contain ample evidence of this contact, from the mixing of the local type of body decoration made from Cyprinidae (carp) pharyngeal teeth to new types of ornaments, such as Spondylus beads or red and white discoid limestone beads (Borić 2007). During this same period, the proliferation of carved sandstone boulders with hybrid human-fish depictions suggests an elaboration on local Mesolithic beliefs that stressed the importance of certain species of fish (Borić 2005).

These new cultural contacts altered dietary habits. Isotopic data reveal the seeds of change. In particular, a number of individuals found at the site of Lepenski Vir have reduced trophic levels, possibly indicating a reduction of fish in their diet (Bonsall et al. 1997; Cook et al. 2009). Strontium isotopic results suggest that several of these same individuals were migrants into this region, even though their burial position remained supine. Another migrant, buried in a crouched position, was discovered at the Neolithic site of Ajmana, situated some hundred kilometers downstream from Lepenski Vir. Ajmana and similar sites might have been contemporaneous with the continuation of local forager settlements in the upstream area of the region. In the period following circa 5900 BCE and lasting until the mid-sixth millennium BCE, new waves of migrants entered the region, their traces found at Lepenski Vir in particular (Borić and Price forthcoming). This pattern is also corroborated by lower $\delta^{15}N$ values, suggesting that fish became less important to the diet of these migrants. That these apparent changes in diet correspond to the spread of crouched rather than supine burials suggests that the community's symbolic identities were being constructed along new and foreign ideological, cultural, or religious values when compared to the Mesolithic.

Sofija Stefanović

Pathological Conditions on Skeletal Remains from the Site of Lepenski Vir

While research on the Danube Gorges populations suggests a relatively good health status over time, treponemal infections were widespread and constituted a major pathological condition in all periods. Although various studies indicate increases in infections as a consequence of Neolithic transitions, there are still no detailed studies explaining which infections might have affected human health at the start of the Neolithic period. Evidence for one kind of infection, caused by the bacterium *Treponema pallidum*, has been found at the Danube Gorges sites from the Mesolithic period, with a slight increase in the Neolithic period.

In this study, health changes in Neolithic transition were analyzed on 60 adult skeletons from the site of Lepenski Vir situated in the Danube Gorges. The skeletons date to the Early Mesolithic, Mesolithic-Neolithic transformation, and the Early/Middle Neolithic periods. (No Late Mesolithic burials or layers have been confirmed at Lepenski Vir.) Three kinds of pathological conditions have been identified: 1) trauma (observed on skulls and major bones of limbs); 2) cribra orbitalia and porotic hyperostosis (skull lesions, generally caused by anemia and iron deficiency, both characteristics of the transition from hunther-gatherer to agricultural populations); and 3) infection and periosteal reaction (observed on skulls and postcranial bones).

Evidence of trauma comes only from two individuals: one Early Mesolithic male with a trauma on the left tibia, and one Early/Middle Neolithic female with a trauma on the skull. Low frequencies of traumas indicate low rates of violence in all periods.

Evidence of skull lesions associated with anemia is more widespread. Cribra orbitalia is not present among the adults from Lepenski Vir during the Early Mesolithic and Early/Middle Neolithic, while seven individuals (four females and three males) have traces of cribra in the Mesolithic-Neolithic transformations. Cribra orbitalia in the form of gross lesions with excessive expansion only appears in three individuals, each of whom probably experienced severe health problems as a result. Based on available evidence, then, it appears that individuals from Lepenski Vir did not experience the same health problems during the Neolithic transition as seen in many other transitional populations.

In contrast to cribra, porotic hyperostosis was much more frequent among individuals from Lepenski Vir, appearing in all periods (three individuals from the Early Mesolithic, ten from the Transformation phase, and five from the Early/Middle Neolithic). However, only modest lesions and scattered fine-pitting on parietals and occipital bones were present, without cases of gross lesions with excessive cranial expansion and areas of exposed diploe. The causes of cribra and porotic hyperostosis are complex: they may have been caused by iron deficiency, various diseases, and/or parasites (Goodman and Martin 2002). Also, porotic hyperostosis might have been caused by inflammatory processes after scalping (Schultz 1993; Schultz 2001). Walker et al. (2009) suggest that porotic hyperostosis and many traces of cribra might have been caused by megaloblastic anemia (a form of anemia that results from inhibition of DNA synthesis in red blood cell production) but with different etiologies—cribra is caused by vitamin C deficiency while porotic hyperostosis is the outcome of the depletion of vitamin B12 reserves. With little evidence of cribra, inhabitants of Lepenski Vir appear to have been well supplied with vitamin C, with some exceptions during the Transformation phase. On the other hand, a high prevalence of porotic hyperostosis suggests that vitamin B12 reserves were depleted. However, since few cases of cribra and only modest forms of porotic hyperostosis have been found, such deficiencies probably had only a limited affect on the overall health of the prehistoric inhabitants of Lepenski Vir.

In addition to trauma and anemia, infection is also an indicator of the state of overall health in the Danube Gorges populations. Traces of infection caused by bacteria *Treponema pallidum*—found on cranial and postcranial bones, of 121 individuals—present important evidence of treponemal disease (Stefanović 2012). Traces of infection were studied on all bones and bone fragments and a numerical value was assigned to each type of pathological change. In the cases of postcranial skeletons, either an osteoblastic or osteoclastic reaction was determined, as well as whether the reaction was active or healed (or both). On skulls, lesions and other changes were recorded—necrotic and osteolytic damages, stellate scars, necrotic destructions and healing processes, and new bone formation.

Lesions were found on 24 individuals (seven in the Early Mesolithic, eight in the Transformation phase and nine in the Early/Middle Neolithic). On postcranial bones, the lesions are predominantly osteoblastic and affect the diaphyses of the many various bones. The pattern of many affected bones of an individual with bilateral symmetric lesions sug-

gests system infection. No individual has been found with periostal reaction affecting only the upper limbs. Osteoclastic lesions are much less present and also attack mostly lower limbs, especially the tibia. All the individuals with an osteoclastic reaction also have an osteoblastic reaction on many of their bones. Presence of bilateral symmetrical osteoclastic lesions suggests that treponemal infection contributed to the development of lesions, and we may assume the same etiology for most other osteoblastic reactions.

Although the sample size from Lepenski Vir is too small to compare the presence of disease in Mesolithic and Neolithic periods, the fact that there were many more individuals with an advanced stage of the disease at Lepenski Vir than at the (mostly) Mesolithic site Vlasac suggests that intensity of the infection increased during the Neolithic period. It is possible that population growth in the Transformational period, combined with an influx of migrants, may have increased pathogens in the Danube Gorges population.

Whether prehistoric people had attempted healing treatments for various infections is hard to ascertain, but some cut marks on skulls from Lepenski Vir indicate such a possibility. On some skulls, traces of cutting by thin and sharp tools have been detected, as well as possible instances of scalping. If these cuts were not post-mortem, they might indicate efforts to heal through the removal of soft tissue on the infected patients. If such interventions took place, it is possible that inflammation after cutting might have caused porotic hyperostosis in some cases, especially since porotic hyperostosis on many individuals has the form of scattered fine-pitting, and was unconnected with dietary problems.

The results of this study suggest a relatively good health status of inhabitants of Lepenski Vir over time, with the exception of infections, which occur as a major pathological condition in all periods represented in the sample of analyzed individuals. Changes in health status observed in other populations spanning the forager-farmer transition around the world—such as a decline in overall quality of nutrition—were not detected at Lepenski Vir. While higher rates of cribra orbitalia and porotic hyperostosis are found in the Transformation period, the small number of cases and their moderate appearance indicate stability in health over time. At the very least, they suggest no dramatic changes in the quality of life.

Marija Radović

Dental Pathologies and Tooth Wear at the Site of Lepenski Vir

The shift towards Neolithic lifestyles affected human biology significantly. In many instances, the transition to agriculture resulted in the increase of "stress," defined as a series of interrelated pathological conditions coupled with changes in dietary patterns and living conditions. Here, I examine differences in dietary patterns and subsistence on the basis of dental pathologies and tooth wear from the Danube Gorges during the period of Mesolithic-Neolithic transformations. I chose the site of Lepenski Vir as a case study for this research, and studied the dental status on 29 adult individuals, 14 males, and 15 females.[5] I examined 195 teeth for enamel hypoplasia (enamel defects), the rate of dental wear, and dental calculus, or plaque—all indicators of oral and general health in relation to food composition. I studied the defects in order to trace physiological stress and growth disturbance in childhood

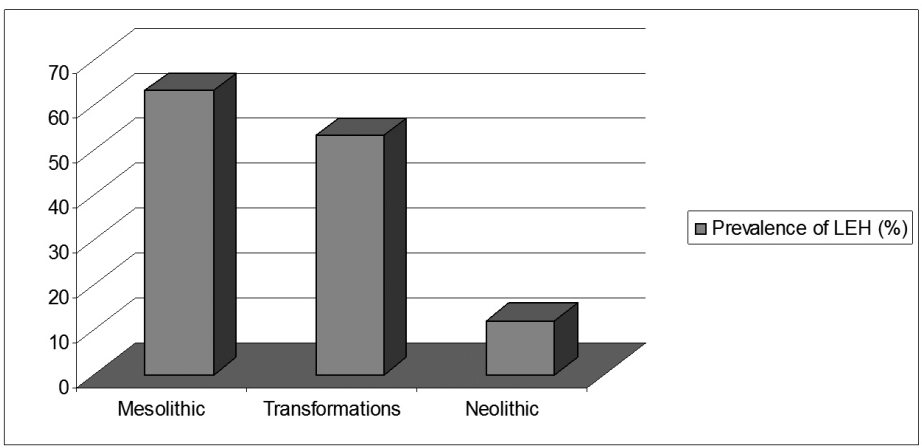

Table 1:
Prevalence of linear enamel hypoplasia, LEH, through chronological periods.

Changes in lifestyle adopted from the "Neolithic package"[6] may explain the evident decrease of systematic childhood stress from the Mesolithic to the Neolithic (Table 1). The distribution frequency of linear enamel hypoplasia (LEH) by sex of the individuals shows

5 Of the 29 specimens, six males date from the Mesolithic; five males and 11 females date from the Transformation phase; and three males and four females date from the Neolithic.

6 The term "Neolithic package" means a general shift to a sedentary way of life, cultivation of plants, domestication of animals, and/or labor specialization.

that females were less affected by growth disturbance or less exposed to physiological stress, though the sample is somewhat biased due to the absence of (Early) Mesolithic females at Lepenski Vir. Another possible explanation for differences in the rate of LEH between males and females may relate to females' premature mortality. The etiology of LEH does not indicate a single crisis episode. LEH defects generally first appear between two and five years of age. These results indicate weaning stress as a possible explanation.

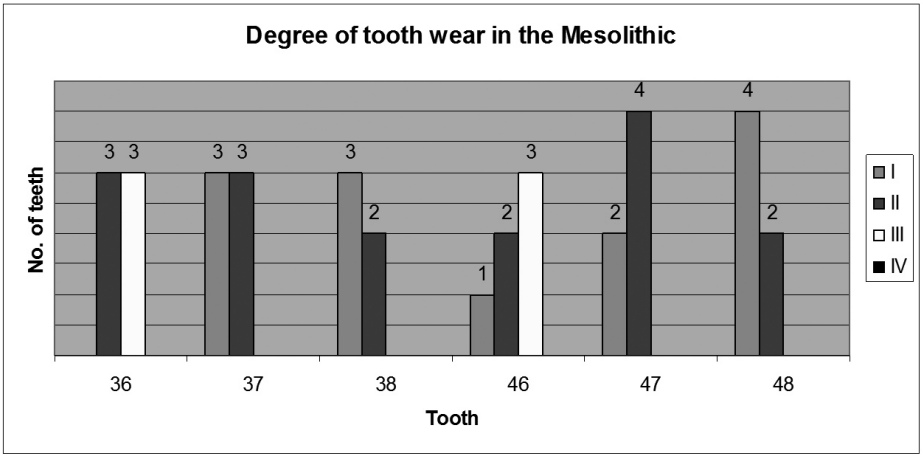

Table 2: Differences in degree of tooth wear of molars in the Mesolithic

Tables 2 and 3 show the results of changes in tooth wear pattern of molars from the Early Mesolithic to the Neolithic (the numbers 36, 37, 38, 46, 47, 48 represent the type of molar while the numerals I, II, III , IV represent degree of tooth wear). A high degree of tooth wear is evident in each chronological period, but there are no heavily worn teeth during the Early Mesolithic. Also, there is uneven wear on teeth from the right and left sides. These results suggest possible non-masticatory tooth use during the Transformation period and the Early/Middle Neolithic. Analysis of dental calculus or of mineralized plaque (which forms on teeth during one's life as result of specific food composition and also as result of oral hygiene) shows no evidence of change in the presence of dental calculus over time and that one-third of the crown was covered in half of the sample. With regard to the etiology of dental calculus, no subgingival calculus was found. This means that the calculus did not result from some tooth pathology but rather was the result of the high protein component of the local diet.

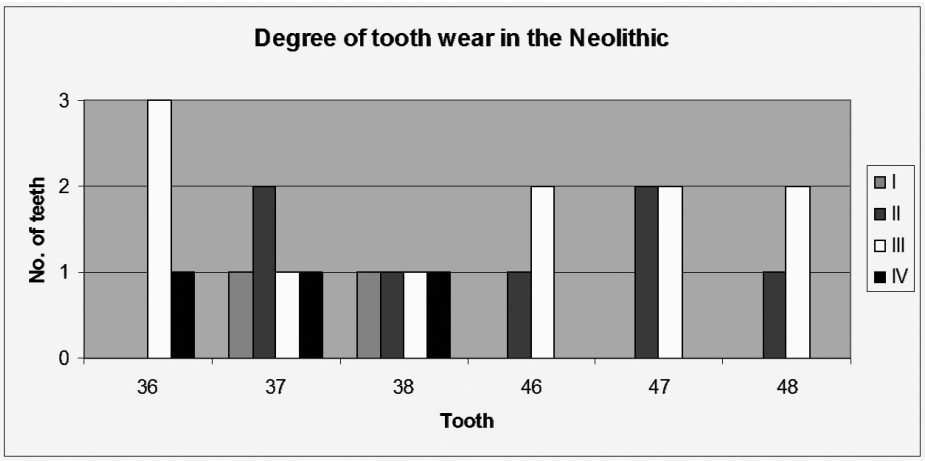

Table 3: Differences in degree of tooth wear of molars in the Neolithic

In the Early/Middle Neolithic an evident decrease of LEH was accompanied by more frequent distribution of LEH in males. The common age at which LEH defects were initiated was between two and five years of an individual life. The study of tooth-wear pattern showed non-masticatory tooth use after the Early Mesolithic, such as during the Transformation and Early Neolithic phases. Also, subgingival calculus was not found in the sample of analyzed individuals.

The results indicate a suboptimal level of health among subadults in the Danube Gorges. It seems that weaning stress decreased from the Early Mesolithic to the Early/Middle Neolithic. With the exception of the Early Mesolithic, Lepenski Vir females might have suffered premature mortality. There is evidence of new activities involving teeth after the Mesolithic, possibly due to the specialization of labor and/or new types of physical activities in the Transformation and Early Neolithic phases at Lepenski Vir. High protein diets remained constant over time.

In conclusion, this analysis of individuals from Lepenski Vir indicates a change in human biology of the prehistoric inhabitants of the Danube Gorges after Mesolithic-Neolithic transformations. That change was not equal for females and males. Overall, however, there was no decrease of general health in this population, most likely due to lifestyle and/or dietary changes over time.

Conclusions: Integration of Archaeological and Osteological Data from the Danube Gorges

Spanning the period from the Early Mesolithic through the Early/Middle Neolithic, the abundance of human remains found in the Danube Gorges offers a unique opportunity to examine life- and deathways of these communities through an analysis of skeletal remains and burial practices. Our three contributions have looked at both aspects of the data, trying to integrate archaeological findings with an array of new data obtained by studying skeletal remains. These include studies of isotopes for dietary patterns and mobility, pathological conditions (such as the incidence of traumas, cribra orbitalia and porotic hyperostosis, traces of infections and periosteal reaction), and a dental examination of linear enamel hypoplasia (LEH) and tooth wear.

While we used isotopic data to analyze several key Mesolithic-Neolithic sites in the Danube Gorges, our discussion of pathological conditions and teeth was restricted to Lepenski Vir, considered the most representative site of the later Mesolithic–Neolithic sequence (comprising the Mesolithic-Neolithic transformation, ca. 6200–5900 BCE, and Early/Middle Neolithic, ca. 5900–5500 BCE). However, we should add that at present Late Mesolithic (ca. 7300–6200 BCE) occupation has not been found at this site, either by direct dating of human remains or settlement deposits. On the other hand, there is a prominent presence of Late Mesolithic groups at other sites along the Danube Gorges, evidenced by a large number of burials, among other archaeological features. The lack of Late Mesolithic burials at Lepenski Vir to some extent limits our discussion of changing patterns of health status. For instance, while human remains from Lepenski Vir show a low level of violent injuries in all three bracketed periods, we have clear evidence of a number of violent injuries by bone projectile points found at the site of Schela Cladovei and Vlasac, all dated to the Late Mesolithic (Roksandić 2004).

No signs of major pathological conditions appear in populations at Lepenski Vir. However, there are clear skeletal traces of various infections, possibly indicating treponemal infections. In addition, evidence of apparent cuts on some skeletal elements, in particular skull bones, may point to attempts to heal such infections by removing soft tissue. This procedure, in turn, might have caused a higher level of porotic hyperostosis, which peaks in the Transformation period. It remains unclear and open to speculation whether

such infections during this period might have related to contacts with possible (Neolithic?) migrants, suggested by the presence of strontium at Lepenski Vir.

In particular, the examination of teeth shows little variation throughout the periods with regard to the changes in the quality of life. While enamel defects (LEH) appeared to affect males more, this pattern might be due to females' higher mortality, the likely consequence of frequent deaths while giving birth. It is interesting to note that the decrease of enamel defects in the Early/Middle Neolithic may be the consequence of improvements in dietary practices during this period. Isotopic data suggest that there was a general reduction in the reliance on fish in this phase. The level of subadult health is suboptimal in all periods, but is biased by the small number of burials. The level of wear on teeth is high in all periods, but there are no heavily worn teeth in the Early Mesolithic, while in the Transformation period, and the Early/Middle Neolithic teeth were used in a non-masticatory way for specialized everyday activities, which caused very specific wear patterns on certain teeth.

In sum, with some variations over time, the sample of human burials from the Mesolithic-Neolithic Danube Gorges of the Balkans suggests relative stability and good overall health conditions despite other major changes that the introduction of a food-producing economy and the arrival of foreign groups might have triggered. Such stability might have been the consequence of a rich and diverse environment along the Danube, which allowed the intake of high levels of protein, primarily coming from fish. The overall intake of fish was reduced in the Neolithic but, judging by the decrease in the incidence of LEH in this period, the introduction of food-producing practices was a risk-buffering step that might have reduced dietary shortages and episodes of famine. Still, one should not rule out the possibility that occasionally dietary stress and any subsequent health-related issues might also have been the consequence of cultural practices with social, ideological, and religious reasons ruling people's attitudes to foods and health.

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