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# Challenges and new directions in faunal analysis in Bulgarian prehistory: A view from the past decade

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**Abstract**

*This paper discusses some of the major challenges facing the successful integration of faunal studies into broader archaeological investigations in Bulgarian prehistory and presents some of the lessons learned by a zooarchaeologist over the past decade in Bulgarian archaeology. In scope, the paper considers three fundamental issues that affect faunal analysis of prehistoric assemblages: recovery, quantification, and the integration of zooarchaeology with archaeometry. This is not meant to be an exhaustive list of priorities for faunal researchers; rather, it addresses issues common to bone assemblages across time and space and should therefore be applicable to researchers working in any period of prehistory or later. Each theme is illustrated with concrete examples from the author's field and lab work. This article is meant to serve as a roadmap for early career scholars with an interest in learning zooarchaeological methods and interpretation, but has a larger agenda: to demonstrate the value of methodologically robust faunal studies to larger issues of archaeological concern within Bulgarian prehistory, including – but not limited to – chronology, migration, economies, and the rise of political complexity and social inequality. As in many places, much work remains to successfully move zooarchaeology from niche specialty into major contributor to archaeological interpretation.*

**Keywords:** *zooarchaeology – recovery – quantification – archaeometry – Bulgarian prehistory.*

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## Introduction

In this paper, I would like to discuss some of the fundamental challenges facing faunal researchers working on assemblages from prehistoric sites in Bulgaria and hopefully, to offer some thoughts and potential solutions for overcoming these challenges that arise out of the nearly 10 years that I have spent studying animal bone assemblages in the country. This paper is primarily intended as a roadmap for early career scholars and students of zooarchaeology, whether Bulgarian students enrolled in a university or foreigners who, like me, found appeal in Bulgaria's rich cultural heritage and the fascinating diversity of archaeological sites and materials. But I also hope that this paper will serve to demonstrate the potential for carefully analyzed and interpreted faunal collections to weigh in on broader issues of archaeological significance in Bulgarian prehistory, including – but not limited to – chronology, migration, economies, and the rise of political complexity and social inequality.

I began my zooarchaeological career in Bulgaria over 10 years ago, as a student at the early Neolithic site of Illindentsi–Masovets. In the years since, I have examined collections of animal bones from numerous archaeological sites, including prehistoric sites from the early and late Neolithic, the Late Bronze and Early Iron Ages, and even later sites from the Roman period and Late Antiquity. Here I will only discuss some of those sites (fig. 1). Obviously, no two faunal collections are the same, but I was surprised by the variability even within assemblages from sites of the same chronological period. For example, at Illindentsi, the limited bone assemblage was highly fragmented and thus difficult to

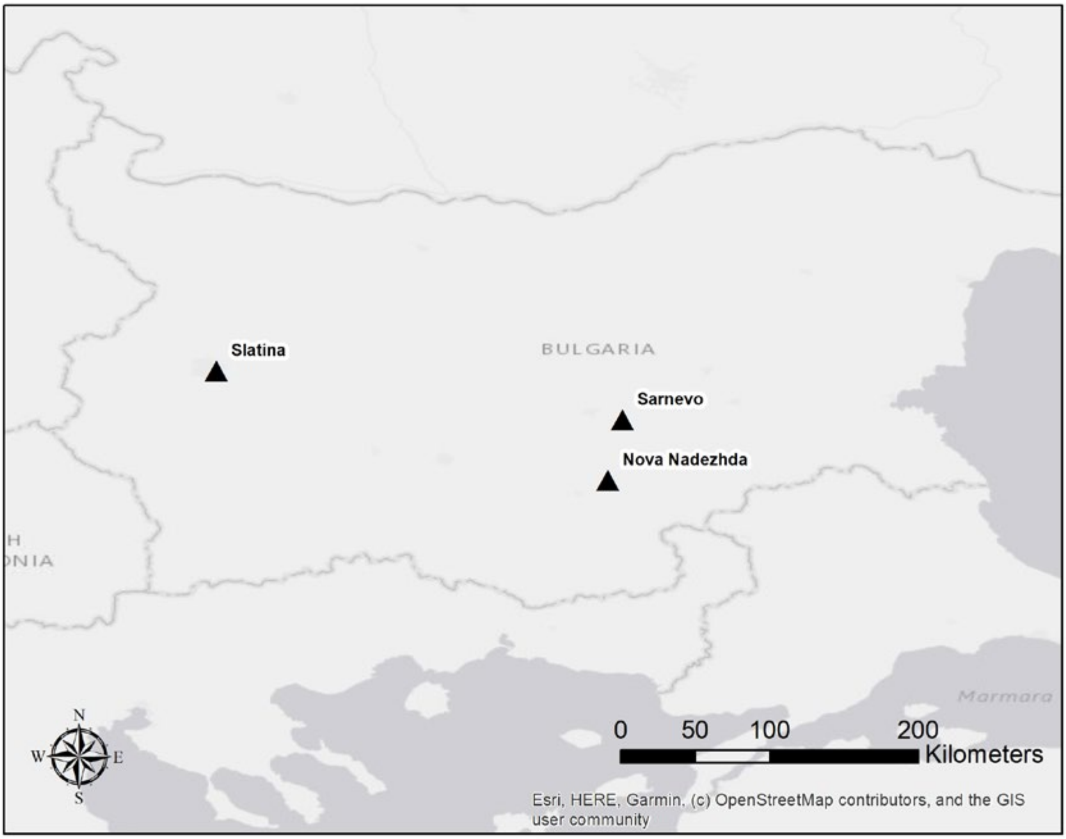

***Figure 1.*** *Map with locations of sites discussed in the text. Image Credit: Esri, HERE, Garmin, (c) OpenStreetMap contributors, and the GIS user community.*

identify, whereas the assemblage from the site of Slatina in the Sofia Basin (also an early Neolithic site) contained a higher number of intact bones, which enabled a larger suite of statistical and biometric approaches.

Since faunal assemblages vary so greatly even within similar geographical or chronological contexts, there can be no 'one size fits all' strategy for analyzing them. Even the methodological considerations discussed in this paper can only serve as a rough guide, a set of prescriptions that will apply more to some assemblages than to others. Nevertheless, I consider them fundamental to good zooarchaeological practice and in one form or another, applicable to all faunal studies, regardless of size, preservation, or antiquity. I divide this paper into three parts: recovery, quantification, and zooarchaeology and archaeometry. The first part, recovery, deals with the very real consequences of collection methods on zooarchaeological interpretation. The second, quantification, gives a very brief introduction to measures of abundance as they have been traditionally applied to Bulgarian faunal assemblages and discusses some of the shortcomings and potentialities of each. The final, and in many ways most exciting part of this paper, deals with the role that zooarchaeology should play within the larger field of archaeometry, or the application of scientific techniques to archaeological problems.

A quick note at the beginning: throughout this article I use the term zooarchaeology rather than archaeozoology, even though in both practice and theory, Bulgarian faunal analysis owes an intellectual debt to Central European animal studies, who typically use the term archaeozoology when discussing the study of archaeological bone assemblages. There are real differences between these terms, rooted both in intellectual traditions and in their analytical focus as discussed by Bartosiewicz (2001), but in practice, they are often used synonymously. As a scholar trained in the Anglo-American tradition of faunal studies, which emerged out of archaeology's processual movement, I use the term zooarchaeology.

## Recovery

Because animal bones are affected in particular ways by a multitude of taphonomic factors, special consideration is required during excavation to ensure that a representative sample is available for analysis. Early sieving experiments in the 1970s at Sesklo and Argissa Magoula (Payne 1972) and elsewhere (Clason & Prummel 1977) demonstrated the efficacy of both dry and wet (flotation) sieving for recovering bones that are often missed in hand-picked and troweled assemblages. Since that time, numerous experiments have confirmed this assertion, demonstrating that recovery techniques (e.g., Gordon 1993; Cannon 1999; James 1997).

A full history of these experiments is not possible here, but the lesson of these and other actualistic studies of recovery is that generally speaking, systematic sieving leads to a greater representation in faunal assemblages of both smaller skeletal elements (e.g., phalanges), and the elements of smaller taxa, helping to mitigate bias toward larger bodied species (e.g., cattle). The effect is even more pronounced for microfauna, fish, and small invertebrates – species crucial to seasonality studies and paleoenvironmental reconstruction.

These points can be illustrated using some of the faunal data from the early Neolithic (late seventh to mid-sixth millennium cal BC) site of Slatina in the Sofia Basin, where I conducted a limited program of sieving between 2016 and 2017 using a 6mm dry sieve. I began in the first year by sieving all soils from one excavation block and select soils from another. My sieving decisions were limited by the availability of time and labor, but the goal was to completely sieve an entire quadrant for comparison with unsieved quadrants. The following year, the strategy was modified to focus on 'high priority' contexts, such as house floors and interhouse spaces. In total, 35.16 $m^3$ of sediment were passed through the dry sieve.

The sieved sediments from 2016 and 2017 represent about five percent of the total excavated volume over the same period. This number is probably inflated because sediment volume was not recorded from every excavation quadrant. Although small, I think

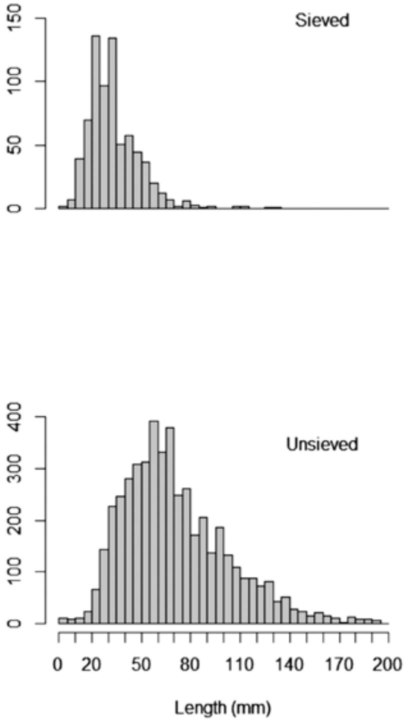

*Figure 2. Histogram of fragment length for sieved and unsieved portion of the Slatina assemblage. Image Credit: J. Gorczyk.*

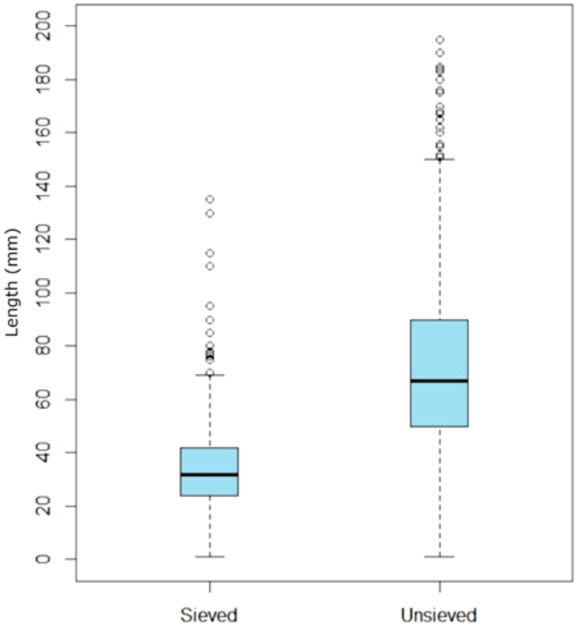

*Figure 3. Boxplot of fragment length (mm) for sieved and unsieved portions of the Slatina assemblage. Image Credit: J. Gorczyk.*

the sieved portion of the assemblage does provide a preliminary glimpse into recovery biases and demonstrates that they were an issue at Slatina. For example, figure 2 shows the size distribution of faunal remains by recovery method. As expected, the sieved sample is characterized by smaller fragment sizes (mean=34.4 mm) than the hand-collected samples (mean=73.8 mm). For comparative purposes, bone fragments larger than 200 mm (only present in the hand-collected sample) have been omitted from the histograms. Figure 3 highlights the greater range in fragment sizes within the hand-collected assemblage, which is characterized by more outliers and has a larger midspread than the sieved portion. This is likely driven by the greater number of both larger and more complete bones in the hand-collected assemblage.

One of the most dramatic effects of sieving was the recovery of bones from unfused specimens (representing younger animals), which tend to get missed during hand collection due to their smaller size. Figure 4 shows that there does seem to be a difference in the sieved and unsieved sub-assemblages in the number of younger bones (the 'younger' category includes fetal, infantile, and juvenile) recovered. This difference is significant ($\chi2=56.7$, $p<.001$), indicating that these differences are likely due to excavation technique.

The limited program of sieving implanted at Slatina led to a greater recovery of sheep-sized and hare-sized bones. This played a critical role in the interpretation of animal husbandry during the earlier phases of the settlement, which was dominated not by cattle as in later phases (Bökönyi 1992), but by domestic caprines. It also led to greater recovery of bones from younger species, which aided in the interpretation of mortality profiles, one of zooarchaeology's most important proxies for studying prehistoric animal management practices.

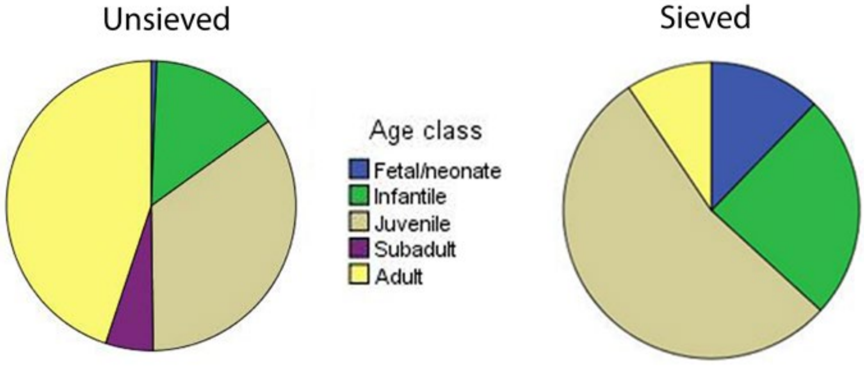

***Figure 4.*** *Proportional representation of age classes by excavation technique.*
*Image Credit: J. Gorczyk.*

## Quantification

Quantification – how animal bones and the populations they represent are counted – remains one a thorny issue in zooarchaeology. Discussions of quantification abound in the literature and cannot be summarized here, so I refer the reader to Reitz & Wing (1999), O'Connor (2000), Gifford-Gonzalez (2018) and Lyman (1994 & 2008). Ultimately, choices about quantitative methods must be informed by a project's research questions, suited to the assemblage at hand, and robust enough that they measure what they purport to measure. Here, I want to discuss only a small subset of quantitative measures and the problems (and opportunities) they present to researchers working in Bulgarian prehistory.

A review of archaeological reports in the Bulgarian literature in the early postwar period (1950s), mostly from articles published in *Arheologia* (journal of the National Institute of Archaeology & Museum of the Bulgarian Academy of Sciences) and individual chapters within site excavation volumes, reveals that when faunal data are presented at all, prior to 1960 they tended to be given very limited treatment, and not formally quantified at all (e.g., Slatina stuff). Beginning in the 1960s and 1970s, detailed quantitative measures of faunal remains were present in many site volumes (e.g., Ivanov & Vasilev 1975 and 1979). At that time, following trends from Central European archaeozoology (e.g., Boessneck 1969; Bökönyi 1969 & 1970; Uerpmann 1979), faunal researchers in Bulgaria began using two common measures of quantification: number of identified specimens (NISP) and minimum number of individuals (MNI).

NISP is the most commonly used quantitative method in faunal reports in Bulgaria and most of Europe, and in many ways, is the easiest measure to calculate: one simply adds up the numbers of specimens identified to a particular taxonomic grouping (e.g., species, genus, or higher). But this simplicity can be deceptive since assumptions about what constitutes a specimen and what counts as identifiable may vary considerably between analysts and is not always clearly defined. Inter-analyst conceptions of 'specimen' vary (cf. Lyman 1994), although many agree (e.g., Reitz & Wing 1999; Gifford-Gonzalez 2018) that it is best defined as a discrete bone unit, fragmentary or complete. Thus, a long bone shaft fragment would count as one specimen as would the complete long bone itself. Regardless of how it is defined, researchers should always explicitly state how categories such as 'identified' and 'specimen' were constructed.

A more serious issue with NISP is interdependence, the potential for several specimens to come from the same individual, thereby inflating the count. Gautier (1984) argued that interdependence has a minimal effect on NISP; however, his argument relied on the assumption that the deposition of each specimen is taphonomically independent of the others (Lyman 2008, 38), a scenario not borne out by ethnographic studies on the division and sharing of articulated carcass segments (e.g., Marshall 1994) or those on breaking bones for grease or marrow extraction (e.g., Outram 2001).

The impacts of interdependence on faunal assemblages will vary greatly on Bulgarian prehistoric sites, since they exhibit much variation in the degree of fragmentation and preservation. Conventional wisdom dictates that fragmentation will inflate NISP counts to a certain point, at which time NISP will decrease as bone fragments become more difficult to identify (Marshall & Pilgram 1993, 265). That is, the relationship is linear only to a point. For assemblages that are characterized by moderate to high degrees of fragmentation, this could present a serious problem. However, Cannon's (2013) fragmentation experiment, which lent empirical support to Marshall's and Pilgrim's observations, suggested that fragmentation's inflating effect on NISP is not as high as some had feared, meaning that NISP should continue to be used as a baseline quantitative measure for prehistoric faunal assemblages.

Given the high degree of variability in bone fragmentation on Bulgarian prehistoric sites, which I mentioned in the introduction, I would encourage faunal analysts to explore and document the statistical relationship between fragmentation and NISP. To start, I recommend recording specimen fragment size during analysis. For instance, I typically record the percentage (e.g., 'complete', '> ¾', 'between ½ and ¾', 'between ¼ and ½,' and '< ¼') of the entire element represented by each fragment, following Binford's criteria (1981), although this is not the only method.

A second commonly used method of quantification in use for decades is minimum number of individuals (MNI). It appears that in Bulgarian faunal reports, MNI was initially adopted to counter some of the problems inherent to NISP but to also estimate the actual number of animals represented by a context, an occupational layer, or an entire site. MNI is a derived measure that is calculated from fragment counts (usually from NISP). Several methods of calculating MNI have been developed in the days since White first introduced the method to zooarchaeology. In his original formulation, he simply took the highest count of a single element from a skeleton, accounting for side (White 1952, 397). Klein & Cruz-Uribe (1983) also used this approach, accounting for side but not age or sex, although they considered it an option. Bökönyi (1970) calculated MNI separately for individual age classes and animal size. As with NISP, faunal researchers must document how MNI is calculated to facilitate comparisons with other assemblages.

Major criticisms of MNI have been offered by Grayson (1984), Plug & Plug (1990), and later with extreme prejudice by O'Connor (2000, 60f). These critiques are now common knowledge among zooarchaeology students. As demonstrated by Marshall & Pilgram (1993), as a function of NISP, MNI drops off considerably with increasing fragmentation. It is therefore susceptible to the vagaries of NISP calculation and even more affected by fragmentation than NISP. Perhaps the most serious problem is that as a derived measure, MNI is not additive and therefore must be recalculated at various levels of aggregation: one cannot simply add up MNI counts from various contexts or stratigraphic units and arrive at a reasonable estimate of animals without good reason to suspect that bones from the same individual could not occur across different units. This renders them inappropriate for most statistical analyses. Summarizing Grayson, Gifford-Gonzalez (2018, 401) points out that in stratified sites, specimen interdependence cannot be guaranteed, eliminating one of the major arguments in favor of using MNI.

I dislike MNI for all these reasons, but also because with rare exception, I do not think the number of individual animals is the appropriate analytical focus of most zooarchaeological studies. Rather, I believe that the number and proportional representation of carcass parts are of greater interpretive value to faunal analysts trying to reconstruct the practices of consumption and discard that have created the faunal record. Therefore, I prefer to use other methods, such as minimum number of elements (MNE) to estimate these frequencies. In one way or another, MNE underlies many, if not most, derived measures such as MNI and MAU (Marean et al. 2001, 333), so its calculation should be documented by researchers for each assemblage.

Methods for calculating MNE vary but can be grouped into two large categories: 'overlap' methods and 'landmark' or fractional methods (Gifford-Gonzalez 2018, 190). Because they are simpler to use, I prefer landmark systems, which operate by dividing each skeletal element into a series of osteologically recognizable features ('landmarks'), for example, the greater trochanter of the femur. Oftentimes called 'diagnostic zones' (Watson 1979; Dobney & Reilly 1988), these features must: (a) occur only once per element per side; and (b) be more than 50 percent complete to be counted. Wherever possible, landmarks should be defined on elements that exist across all taxa under consideration. Returning to the issue of fragmentation noted above, one drawback of landmark systems is that in highly fragmented assemblages, where more than 50 percent of the element is not likely to occur, they will be less effective for estimating taxonomic abundance. Finally, perhaps the single greatest advantage of landmark systems is that landmarks can be simply tallied up across contexts and units, rendering other measures based on them (e.g., MNE) immune to the problems of derived measures discussed above.

The late Neolithic (5400–5200 cal BC) site of Sarnevo in the Stara Zagora District illustrates this concept. Here, faunal remains were deposited together with other material culture in dozens of pits located in a field close to a tell site (Bacvarov & Gorczyk 2018, 141). Initially, Karastoyanova (2011) investigated the bone assemblage from the largest of these pit features, Feature 9, and quantified the remains by both NISP and MNI. Using both measures, she demonstrated that cattle were the most abundant taxon represented in Feature 9 (Karastoyanova 2011, 21). When the analysis was expanded to include a larger number of pits from the site (2013), MNI could not be used to compare taxonomic abundance across pits, for the reasons stated above. When quantified by diagnostic zones (following Watson 1979), the taxonomic composition for individual pits accorded well with Karastoyanova's data: cattle were the most abundant taxon followed by fallow deer and sheep.

This demonstrated that for a single feature, using MNI alongside NISP provided a reliable indicator of taxonomic abundance. However, using diagnostic zones enabled comparison across pit features at Sarnevo and lent additional empirical support to the argument that the pit features demonstrated various configurations of a 'ritual package' that included, among other components, animal bone remains of large consumption events that occurred elsewhere and were later distributed among the pits (Bacvarov & Gorczyk 2018, 153).

### Faunal analysis and archaeometry

The final area in which I see great potential for zooarchaeology to contribute to Bulgarian prehistory is within archaeometric, or archaeological science applications. Using animal bone samples for radiocarbon dating has been an established practice for decades, but other obvious examples are ancient DNA (aDNA) analysis, stable isotopic analyses, and zooarchaeology by mass spectrometer (ZooMS). Faunal remains are critical to each of these approaches not only because they provide the raw materials used by each, but also because these techniques produce information about the life history of individual animals or animal communities that cannot be gleaned from traditional osteological study: information such as diet, mobility, birth seasonality, lineage, habitat, and more. Soil micromorphology, an indirect technique which can be used to study animal dung deposits, investigates many of these same issues. Bulgarian Neolithic sites are particularly good candidates for soil micromorphology, because they are often stratified, and the good preservation of house remains makes it easy to identify interhouse spaces where animals may have been kept while alive.

Returning to the early Neolithic site of Slatina, the combined zooarchaeological and stable isotopic analyses produce more information than either could alone. Although I was ultimately unable to secure funding to perform soil micromorphology on the suspected dung samples I collected, the pilot isotopic study yielded critical information on the location of animals in the landscape at various times of the year. This in turn helped to identify the rhythms of human-animal interaction on the daily and seasonal scales.

For example, stable oxygen analysis from sequentially sampled dental enamel from sheep yielded valuable information on the timing of sheep births at Neolithic Slatina. The y-axis of figure 5 ($x_0/X$) represents time series data from the growth of individual teeth divided into twelve increments, each representing one month, with January on the bottom. Figure 5 demonstrates that the inhabitants of Slatina scheduled lambing around April–May. These results are similar to those from another early Neolithic site, Nova Nadezhda, which also clustered around April–May (Balasse et al. 2020). In both cases, a reference sample of modern sheep from Kemenez was used for comparison. The Kemenez sheep birth distribution is earlier than both Slatina and Nova Nadezhda, with births clustering around February and March, and is argued to represent a 'natural' birth seasonality unaffected by human intervention. Thus, the isotopic study of sequential enamel samples at both Slatina and Nova Nadezhda provides valuable insight into human decision making during the earliest period of animal husbandry in Bulgaria. As more comparative data become available from prehistoric sites across Bulgaria, it will be interesting to investigate the full suite of Neolithic husbandry practices.

The isotopic data from Slatina also provide clues as to where domestic animal communities could be found in the prehistoric landscape. By examining the carbon-13 ( $\delta^{13}C$) values from the same sequentially sampled herbivore (cattle and sheep) teeth and comparing them with the $\delta^{13}C$ values from roe deer – a known forest dweller – it becomes clear that sheep and cattle molars do not exhibit the 'canopy' effect, where animals feeding on plants near the forest floor exhibit depleted $\delta^{13}C$ values as a result of the depletion gradient from canopy to forest floor (van der Merwe & Medina 1991; Doppler et al. 2017). Compared to the mean $\delta^{13}C$ value of -27.9 parts per mille (‰) for the roe deer, the sheep and cattle values are much higher, suggesting feeding in open areas (fig. 6). Since it has been shown that an alluvial forest environment persisted near Slatina in the early Neolithic (Marinova & Ntinou 2018), it must have been the intention of human groups to prevent domestic herbivores from freely feeding there, grazing them instead in open areas of the landscape, perhaps those that had already been cleared to provide wood and space to grow crops.

Both isotopic analyses provide much more information about the lived experience of animals, and the people who cared for them, than osteological alone study could. These and other archaeometric approaches need to be more regularly incorporated into the study of Bulgarian prehistory. There are promising moves in this direction (e.g., de

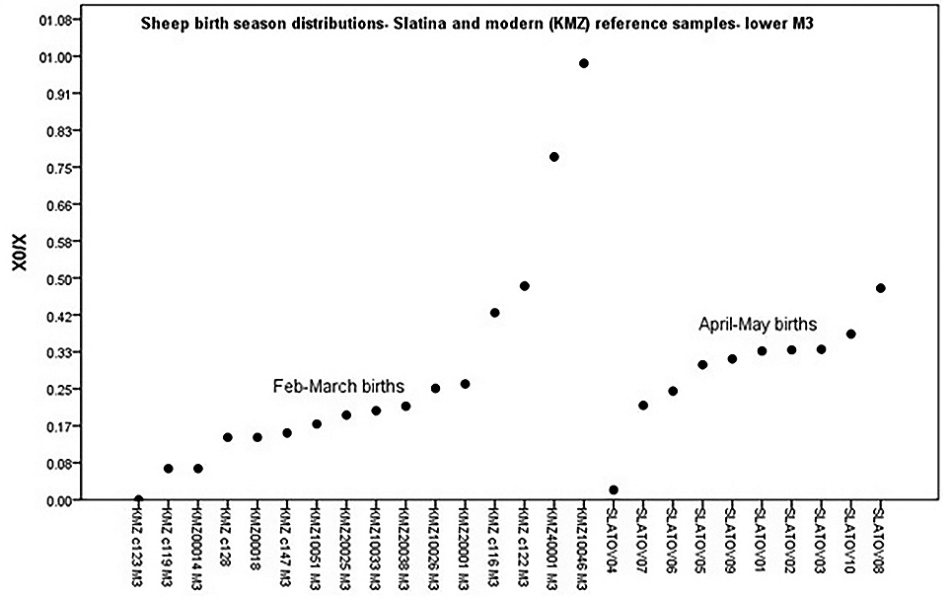

***Figure 5.*** *Results of the normalization function for sheep sequential tooth enamel samples. The y axis represents time series data for tooth formation, divided into 12 increments, representing the months of the year (January at the bottom). Comparison between Slatina samples and modern reference samples from Kemenez. Image Credit: from Balasse et al. 2017 & 2020.*

Groene et al. 2018), but faunal research has much to do to catch up with, for example, archaeobotanical studies.

## Discussion

The three themes discussed above represent only small fraction of the possible considerations for the zooarchaeology of prehistoric Bulgaria. I chose them not only because I believe they are fundamental to all faunal analyses, but also because they represent three arenas in which I have witnessed major growth over the past decade, and which merit some further discussion here.

Recovery methods are vitally important aspects to any faunal study. Although many factors that adversely affect the composition of bone assemblages are taphonomic and out of the archaeologist's control, systematic recovery is easy, fast, and can be built into any project from the initial stages.

At Slatina, sieving selected sediments through 6mm mesh led to an increase in overall sample size, an important consideration for researchers working on small excavations where the faunal sample is already limited. Such limited excavations should especially consider sieving. As the Slatina sieving experiment demonstrated, even projects constrained by time, funding, or labor availability can still benefit from sieving to help

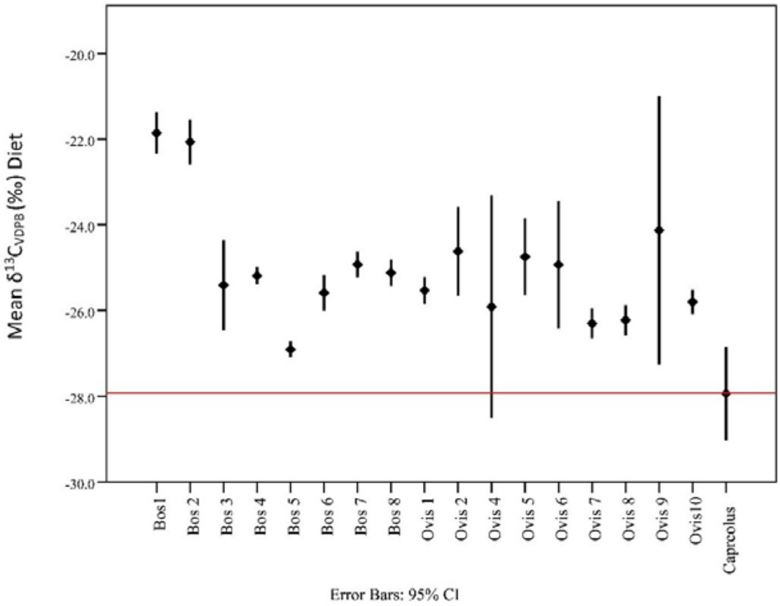

***Figure 6.*** *Mean carbon (δ13C) values corrected for diet (14.00 ‰ depletion) for cattle and sheep molars. Red line represents the cutoff for the 'canopy effect', determined from the mean value of the Slatina roe deer (Capreolus). Image Credit: J. Gorczyk.*

identify and control for potential biases in archaeofaunal assemblages. Sieving is also crucial because it leads to the recovery of bones from age cohorts that are often underrepresented in hand-picked assemblages. This has a major impact on the interpretation of mortality profiles, which are crucial to reconstructing herding strategies, seasonality, and practices of consumption.

Sieves can be easily constructed using inexpensive material from local hardware stores and can be built to fit directly over a standard wheelbarrow. The extra time they add is negligible, especially when considering the range and quality of data that they add. They should be implemented on both research and salvage projects, to ensure comparability in bone assemblages recovered from prehistoric sites across the country. The sieving program at Slatina was far from perfect. For instance, using 6mm mesh did not lead to greater recovery of birds, microfauna, fish, or invertebrates. These species are often critical for paleoenvironmental reconstruction, so researchers who are interested in using zooarchaeology for that purpose could place a 1mm sieve beneath the 6mm sieve and should also implement a robust flotation strategy.

Regarding measures of quantification, there is no right or wrong answer to which a researcher should choose. Ultimately, methodological choices should be driven by the research questions at the center of the analysis. Truly the best strategy would be to use several measures of quantification, especially those that complement each other by reducing some of the negative effects inherent to both primary and derived measures. The issues of recovery bias and quantification are interlinked, as demonstrated above. As a simple specimen count, NISP will obviously be affected if certain taxa or skeletal elements are underrepresented in an assemblage due to recovery bias. In turn, derived measures such as MNI will be affected.

In contrast to some faunal researchers (e.g., O'Connor 2000), I do not believe that MNI is a useless method of quantification. There may be some instances in which it is desirable to estimate the number of animals present in a discrete context. A good example would be animal burials. The number of animals included in a burial (whether or not human remains are also present) can inform archaeologists about funerary rites, animal sacrifice, and human-animal kinship. In my experience, animal burials are rare in earlier prehistory in Bulgaria, with more spectacular examples present in later periods. Nevertheless, in such cases MNI may provide more relevant information than either NISP or MNE.

Finally, zooarchaeology and archaeometry are natural partners, and animal bones have always provided an important source of raw materials for scientific techniques in archaeology, namely radiocarbon dating. But with isotopic archaeology (Pollard 2011) a now established field of the discipline, and with the proliferation of aDNA studies on prehistoric migration throughout the Near East and eastern Mediterranean, Bulgarian prehistory stands to benefit immensely from ongoing collaborative effort between archaeologists and specialists as well as the development of the infrastructure necessary to perform various scientific techniques.

The thread that ties these themes together is the desire (and need) for zooarchaeology to move away from being a niche discipline whose lessons are known only to specialists and whose results are 'banished to the appendix of the site volume' (Sykes 2014). This is a foundational concept for social zooarchaeology, which aims to study the non-subsistence roles that animals play in prehistoric societies (Russell 2012, 8), but it should be of major concern for all faunal researchers and archaeologists, regardless of their interpretive framework. There are many ways that Bulgarian prehistory specifically would benefit from such an integration, but here I will focus on the concept of neolithization – the spread of farming communities throughout southeastern Europe – an important research topic for Bulgarian prehistory. There are two specific realms in which a greater unification of faunal data and archaeological interpretation will enhance our understanding of the timing and characteristics of neolithization.

The first deals with the unique ecological relationships between animals, plants, and humans that characterized Neolithic communities. Recent scholarship has demonstrated that Neolithic crop and animal husbandry systems were highly contingent, shaped by a complex interplay of climatic variables that constrained and enabled the spread of early farming communities (e.g., Ivanova et al. 2018; Krauß et al. 2018). Local manifestations of the Neolithic 'package' of domestic cereals and herbivores can be seen as adaptive mechanisms that enabled Neolithic communities to cope with the varying climates encountered on their move through higher latitudes, leading in turn to the creation of novel environmental niches. Untangling this web of ecological relations requires specialist fields such as zooarchaeology to engage with complementary forms of analysis at the onset of an archaeological project. The limited isotopic data from Slatina demonstrated this potential, as they produced important information that could not be gleaned from that faunal analysis alone.

Second, Bulgarian faunal data (alongside other data, such as archaeobotanical) have been incorporated into numerous metanalyses that have attempted to investigate neolithization over broad chronological and geographic swaths of Europe (e.g., Conolly et al. 2011 & 2012; Orton et al. 2016). Often associated with the use of 'Big Data' in archaeology, such studies investigate large scale trends in the adoption and adaptation of the Neolithic package throughout Europe, highlighting variation in crop and animal husbandry practices that may be correlated with population dynamics, climate, and cultural factors. But metanalyses necessarily involve the loss of data granularity as datasets are aggregated, cleaned, and standardized to facilitate comparative analysis. Oftentimes the local, regionally specific characteristics of neolithization are glossed over in favor of a broad narrative. It is thus critically important to have robust, site based integrated archaeological studies to provide contextualizing information about human-animal relationships during the Neolithic.

### Conclusion

While there is still much work to be done to build the infrastructure necessary to provide the zooarchaeological expertise to accommodate the huge body of prehistoric materials produced from Bulgarian excavations every year, the situation is much improved since the time I first arrived in 2011. This is largely due to the efforts of a few dedicated faunal researchers, and the small but significant increase in the number of students in academic archaeology who choose to focus their studies on faunal analysis. The challenge before us is to continue to foster interest in both zooarchaeological method and interpretation among younger students as well as to open dialogue with scholars who may not consider faunal evidence to be as important as other data classes, such as ceramics. Where possible, training opportunities outside of the university, such as zooarchaeological field schools, should be encouraged. In all our efforts, we should strive for a greater integration of zooarchaeological and other datasets within larger questions of archaeological interest in Bulgarian prehistory.

### Acknowledgements

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