Where the wild things are:

Wild animal exploitation during the Neolithic of the central Balkans

by

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Abstract

Before the sixth millennium BC, peoples across Europe subsisted as foragers: by hunting wild game, gathering wild foods, and fishing from rivers and oceans. These subsistence strategies changed with the advent of the Neolithic as food producing economies and societies were introduced or arrived in southeast Europe from the Near East. This shift appeared earliest in the regions adjacent to Turkey and the Mediterranean and slowly expanded northward and westward during the late 7th and early 6th millennium BC. As a result of this change, most zooarchaeological and palaeo-economic studies conducted in the Balkans for Neolithic remains focused on domestic livestock and consequences for subsistence and settlement, to the neglect of our understanding of the wild component of Neolithic economies and the information they can provide on subsistence and settlement. In this thesis, I examine the wild component of Neolithic subsistence in order to understand their contribution to diet and overall economic adaptations. In particular, I examine the remains of deer, which are the most common wild mammal exploited during the Neolithic of the region, in order to characterize deer exploitation strategies.

Data - The zooarchaeological remains from various sites that are already published and/or available in Professor Haskel Greenfield's research collection at the University of Manitoba Anthropology Lab will be used as the database. Sites from each of the major Neolithic sub-periods from the central Balkans will be represented in the sample (Petnica, Stragari, Blagotin, and Bukovačka Česma, Opovo, Hajdučka Vodenica, Vinča, Foeni-Salaş and Sânandrei).

Methods and techniques - Deer exploitation strategies are reconstructed through a detailed examination of their frequencies in assemblages, sex distributions, and season and age-of-death of both red and roe deer. Age-of-death is determined by the examination of tooth

eruption and wear sequences and the measurements of crown heights (the Quadratic Crown Height Method or QCHM). Additionally, seasonality is determined through the examination of dental annuli by creating thin sections of selected teeth from the sample. Dental cementum analysis provides the season-of-death, as well as a control on the age-of-death from other techniques.

The results obtained from this thesis are based on a small sample which did highlight some clear patterns for the exploitation of red and roe deer during the Neolithic in the central Balkans. It was found that wild fauna were abundant within certain environmental regions such as the Iron Gates, the Pannonian plains, and the Danube river valley, but not as plentiful in central Serbia or the Romanian Banat. There is also a clear preference at all sites for the exploitation of red deer during the Neolithic in the central Balkans signifying that they are an important part of the Neolithic diet. Roe deer, on the other hand, are consistently found in low frequencies, are not a major part of the Neolithic diet and were most likely hunted opportunistically.

Age and season-of-death results yielded some interesting patterns. It was found that both red and roe deer from nearly all sites analyzed from the central Balkans show a preference for adults, except for Hajdučka Vodenica where juveniles were preferred. This pattern of hunting mostly adults may be the result of Neolithic people maximizing the resources they would receive from larger animals. The season-of-death results presented in this thesis are mostly inconclusive, due to the small sample size (19 successful samples). However, there may have been some slight regional patterns that occurred in the central Balkans during the Neolithic. In central Serbia, red deer appeared to have died during the warmer seasons, while roe deer died during the cooler seasons. No seasonal exploitation pattern has been detected between the sites located in the

Romanian Banat and the Pannonian Plains. Temporal patterns only occurred between the Middle and Late Neolithic due to the sample composition. During the Middle Neolithic, red deer died during the warmer seasons, while during the Late Neolithic red deer died during the cooler seasons. Additionally, there is only evidence for a possible seasonal pattern of death for roe deer during the Late Neolithic, during which roe deer died during the cooler seasons. Despite these results being largely inconclusive, it was found through the dental cementum analysis that red and roe deer were mostly likely hunted year round, but at varying frequencies depending on the season.

The thesis research demonstrates that the hunting of red and roe deer was not necessarily a background activity, but an important part of the Neolithic exploitation strategy, for both food and other kinds of resources. By understanding these processes and their importance to Neolithic society, we are better equipped to understand the overall picture of subsistence strategies and the exploitation of other resources in the central Balkans during the Neolithic.

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Chapter 1: Goals and objectives

I. Introduction

The objective of this thesis is to characterize the exploitation patters of wild resources and the nature of the exploitation strategies (culling and seasonal) of red and roe deer from Neolithic sites in the central Balkans. Long before the late seventh millennium BC, peoples across Europe subsisted primarily on hunting wild game, gathering wild foods, and fishing from rivers and oceans (Bogucki, 1988; Price, 2000; Whittle, 1985). These subsistence strategies changed with the advent of the Neolithic as food producing economies and societies were introduced or arrived in southeast (SE) Europe from the Near East (Bogucki, 1988; Jezik, 1998; Price, 2000; Whittle, 1985). This shift appeared earliest in the regions adjacent to present day Turkey or Asia Minor and slowly expanded northward during the late 7th and early 6th millennium BC. In some places, there was a replacement of indigenous foragers by the intrusive food producing communities (e.g. Greece). In other places, foragers may have adopted the trappings of food producing societies (e.g. ceramics) and eventually became food producers themselves (Roksandić, 1999), Denmark (Price, 2000). Over time, domestic animals came to dominate the animal exploitation strategies.

Although raising domestic livestock was a very important component of the subsistence system during the Neolithic, hunting and fishing of wild animals (and gathering of wild plants) continued to play an important role in diet and resources. While it has long been realized that the exploitation of wild foods is a fundamental component of early food producing societies in Europe (Gregg, 1988; Orton, 2008), few researchers examine their role in any great detail and most of the literature focuses on the domestic component.

The variability in emphasis upon wild versus domestic animals depends on various ecological factors such as geographical location, vegetation, topography, etc. There appears to be more emphasis upon fishing along the northern coasts and in lowlands, and a heavier reliance upon domestic resources in the uplands. But, this varies highly depending on region and ecology of the area (Greenfield, 1991a; Tringham, 1971; Whittle, 1985). Most if not all Neolithic agricultural societies hunted and fished to a greater or lesser extent, while also exploiting domesticated foods (Greenfield, 1991a, 1993, 2008b; Gregg, 1988).

There are many reasons why the role of hunted fauna has been, for the most part, minimized in the Neolithic European data and literature. The most important is that the search for understanding the beginning of food producing societies has led to an overemphasis in analyses and discussion upon the newly introduced domestic taxa (Gregg, 1988; Orton, 2008). A second source of misrepresentation derives from the nature of excavation and the collection of data and the types of sampling methods. Large-scale excavations without any systematic recovery of faunal remains were (and in some areas, still are) the norm. The wild taxa, including small mammals, amphibians, reptiles, fish and birds; would be systematically underrepresented due to the absence of extensive sieving and flotation techniques (Greenfield, 1991a; Hesse & Wapnish, 1985; Lyman, 1982; Reitz & Wing, 1994). At the same time, large taxa are often the focus of collection and are typically over represented when compared to the small fauna. Additionally, depending on the research question, large fauna may only be collected or reported on. Third, various taphonomic processes may cause errors and misinterpretations. Small taxa, such as fish and birds, are more subject to bone attrition than are the larger mammals (Hesse & Wapnish, 1985; Reitz & Wing, 1999). Due to this fragmentation and the minimal nature of these bones, small animal bones are often overlooked primarily because they are the most difficult to

identify and few researchers are trained to recognize them by species. Fourth, it is difficult in some cases to distinguish wild animals from their domestic counterparts. Fifth, small animals may have been hunted and/or can be contributors to a variety of taphonomic processes therefore it is difficult to determine in many cases whether the remains of wild animals were exploited by humans or were present because they may have wandered onto a site during or soon after its abandonment and died (Hesse & Wapnish, 1985; Lyman, 1982; Reitz & Wing, 1999) or are active destroyers of the sites (rabbits, foxes and porcupines in shell middens of Portugal (Roksandić, de Souza, Eggers, Burchell, & Klokler, 2014).

The importance of data derived from hunted animals is largely underestimated. Wild fauna is as equally relevant as domestic fauna for analysis and understanding past human behaviour. Through an analysis of wild fauna where domestics have already been extensively studied, we may be able to gain a more holistic point of view of the economic transitions in food sources as well as procurement strategies that were practiced during the Neolithic period.

The lack of systematic investigation of Neolithic wild fauna creates a void in the information about subsistence practices and settlement patterns. The most common wild taxa that are hunted across Europe are red and roe deer. By reconstructing the culling patterns of these deer, it is possible to investigate the seasonal nature of resource exploitation and whether wild fauna were important seasonal supplements to domestic resources. This seasonal analysis can also yield information on whether deer were exploited systematically (exploited year round or during harsher months) or opportunistically (spring and summer i.e. as a result of crop raiding).

II. Research Questions

The focus of the analysis in this thesis is to determine if there were any changes in the seasonal hunting patterns of red and roe deer seen in southeastern Europe during the Neolithic.

Several specific questions and hypotheses will be examined to illustrate the importance of hunting in each settlement as well as the changes that occur throughout the Neolithic.

1. What is the imporatnce of wild fauna in the Neolithic diet?
    - Hypothesis - If wild fauna are an imporant part of the diet, then they should represent a significant percentage of the remains found at each site.
    - Null Hypothesis – If wild fauna are not an imporant part of the diet, then they should represent a small percentage of the remains or be absent at each site.
2. What are the frequencies of red and roe deer compared to the overall assemblage?
    - Hypothesis - If red or roe deer were exploited, then they would be present in the assemblage at each site.
    - Null Hypothesis - If red or roe deer were not exploited, then they would be absent at each site.
3. What are the percentages for the red and roe deer in relation to the wild assemblage?
    - Hypothesis - If red and roe deer are the primary wild fauna exploited, then they would have a higher percentage than all other wild fauna for each site.
    - Null Hypothesis - If red and roe der are not the primary wild fauna exploited, then they would have a lower percentage than when compared to the other wild fauna for each site.
4. Are red and roe deer an important part of the Neolithic diet (in terms of protein contribution)?
    - Hypothesis - If red and roe deer represent a large part of the diet, then they would have the highest percentage of all wild fauna at each site.
    - Null Hypothesis - If they are not a significant part of the diet, then they would have one of the lowest percentages of all wild fauna at each site.

5. Is there a preference for certain age groups in red and roe deer that were hunted?
    - Hypothesis 1 - If all specimens are adults, then only adults and old individuals were hunted.
    - Hypothesis 2 - If all specimens are juveniles, then only young individuals were hunted.
    - Null Hypothesis 1 - If there is a mix of adult and juveniles, then all age groups were exploited.
    - Null Hypothesis 2 - If no teeth were found in the sample, then it cannot be determined at which age the individual died.
6. During which seasons were red and roe deer predominantly hunted?
    - Hypothesis 1 - If dental annuli appear with the lightest layer on the outer surface, then deer were killed in spring or summer
    - Hypothesis 2 - If the dental annuli appear dark on the outer layer, then the deer were killed in fall/winter.
7. Is there evidence of shifts in deer exploitation strategies through time (between and across the various phases of the Neolithic)?
    - Hypothesis - If there is a shift over time, then exploitation strategies did change
    - Null Hypothesis - If there is no shift over time, then exploitation strategies did not change.

These questions will be examined more closely in relation to the appropriate method and techniques used in the investigation.

III. Data

In order to investigate these questions, zooarchaeological data relevant to deer exploitation were analyzed from the central Balkans of SE Europe that Prof. H Greenfield

gathered over many years. The following sections below will be more extensively discussed in each chapter.

IV. Region

The central Balkans includes the modern countries of Serbia, eastern Bosnia, southwest Romania, and northeastern Bulgaria (Figure 1). This region was chosen since it is the first region within temperate Europe (which encompasses central Europe) to experience the transition from an economy based purely on wild resources, to one based on primarily domestic resources. This is the first region where early farming populations expand out of a Mediterranean environment (mild seasonal variations) into a temperate central European climate (warm summers and cold winters) (Greenfield, 1986). For this reason, any results could be applicable to other sites in the European temperate climatic zone.

There is an abundance of zooarchaeological data available for study from Serbia and southwest Romania. Data from a number of Neolithic sites are available for analysis and comparison due to a previous generation of zooarchaeological research in the region. An abundance of original and unpublished data from this area is available in the University of Manitoba Laboratory that will be included in the analysis.

V. Period

One of the goals of this thesis is to see if there is any change of deer exploitation over time from the appearance of the earliest farmers (Early Neolithic dated to around: 6100-5950 B.C.) to the end of the Neolithic (Middle and Late Neolithic dated to around: 4850/4650-4600 B.C.). After the Neolithic, the frequency of deer exploitation dramatically declines in the region and elsewhere in Europe (Greenfield, 1986). The Neolithic of region is characterized by two culture groups and three temporal periods. The Starčevo-Criş culture is characteristic of the Early

Neolithic, while the Vinča culture group is characteristic of the Middle and Late Neolithic. The Early Neolithic is important because it is the time of initial colonization, while the Middle and Late Neolithic represents a period of settling into a new environment. The chronology, cultures, and settlement patterns of the Early, Middle and Late Neolithic are more extensively discussed in Chapter 2. Chapter 3 will review the existing literature on hunting in each of the Neolithic periods for this region.

VI. Sites

Seven sites are in Serbia (Petnica, Stragari, Blagotin, Bukovačka Česma, Opovo, Hajdučka Vodenica, and Vinča) and two sites are from Romania (Foeni-Salaş and Sânandrei). These nine sites will form the core of this study (Figure 1). Each site will be described more fully in Chapter 4. The analysis of the data from these seven sites creates a large enough sample for patterns in subsistence over time to be visible.

VII. Types of data to be analyzed

Two major types of data will be examined from each site. The first is the zooarchaeological databases (created by Prof. H. Greenfield) that already exist from each site will be mined for information that can be used to answer questions 1, 2, 3 and 4 in the research questions above. The second is the red and roe deer teeth collected from each site and brought back to the University of Manitoba. They will be used to answer research questions 5, 6, and 7. The list of teeth from each site organized according to period and species can be seen in Table 1. The methods and techniques used to analyze these teeth to acquire the age and season of death for red and roe deer will be discussed in Chapter 5.

VIII. Methods and techniques

Zooarchaeology provides the means to investigate the questions posed in this thesis. Analysis will be carried out on the remains of wild fauna from the assemblages available from the sites under study described above. The goal of this thesis is to gain an understanding of the seasonal variations in the exploitation of red and roe deer. To do this, four techniques will be employed: database analysis (epiphyseal fusion, antler), tooth eruption and wear analysis, crown height measurements, and dental cementum analysis. These techniques are more fully discussed in Chapter 5.

A. *Review of previously examined specimens in database and environmental variation*

Each site studied in this thesis has an excel database of previously analyzed material which will be examined using pivot tables to review the frequencies of all wild specimens, epiphyseal fusion, and data on teeth, antlers, and aging. The analysis of these databases will allow a comparison of regional frequencies of wild specimens between sites to determine environmental variability in wild exploitation.

B. *Age-at-death and tooth eruption and wear*

Tooth eruption analysis is the observation, documentation and recording of the stages at which adult teeth erupt, replacing the deciduous (or milk) teeth and the enamel and dentine wear stages in both adult and juvenile teeth (O'Connor, 2000). Tooth eruption and wear information can determine at what age, and sometimes which season, an animal was killed depending on the breeding cycle of the species (such as deer). Several manuals and publications that document and illustrate tooth eruption and wear stages of several species typically found at archaeological sites (Brown & Chapman, 1991; Grant, 1982; Hewison et al., 1999; Lowe, 1967; Tomé & Vigne, 2003).

C. ***Age-of-death and crown heights***

The measurement of crown heights from red and roe deer will be used to measure the wear stage of a tooth by measuring its height. Usually crown height measures are taken from the first mandibular molar (M1) because this is the first permanent tooth to erupt and therefore more accurate than later erupting teeth (Steele, 2004). To measure crown heights accurately for red and roe deer, several publications and manuals will be used as references for measurements (Brown & Chapman, 1991; Klein, Wolf, Freeman, & Allwarden, 1981; Lowe, 1967).

D. ***Age and season of death and dental cementum analysis***

Cementum analysis is a well-established means to determine the age and season of death for both wild and domestic animals since the late 1960s (Aitken, 1975; Beasley, Brown, & Legge, 1992; Lieberman & Meadow, 1992; Lowe, 1967; Mitchell, 1967). Dental cementum is a depositional tissue deposited around the roots of teeth as they wear throughout an animal's life. Like crown height measurements, dental cementum analysis is often done using the first molar (M1) since it is the first permanent tooth to erupt and subject to attrition the longest (Mitchell, 1967).

IX. Conclusion

While most research on early food producing economies during the Neolithic focussed on the introduction of domestic animals and plants, wild resources remain important. In fact, they continue to be an important aspect of Neolithic (and later) economies in Europe. Wild resources would have provided a variety of food, tools and other resources that were not available through domestic livestock. This thesis hopes to capture the other half of the economic processes that are normally ignored by most analysts concerned with the Neolithic.

By characterizing the seasonal exploitation strategies of deer utilized by farming communities in the central Balkans during the Neolithic, it will be possible to create a detailed picture of these strategies. With the use of techniques, such as dental cementum analysis, tooth wear, epiphyseal fusion, crown height measurements, and antler data; it will be possible to determine the age and season of death for the red and roe deer exploited at Neolithic sites. Additionally, by examining these patterns temporally, regionally, and ecologically; we may also be able to document shifts in patterns in frequencies, season, and age of individuals.

Chapter 2: Regional culture history

I. Introduction

This chapter summarizes the archaeological cultures, chronology, settlement locations and organization, and subsistence practices and patterns for each of the major sub-periods (Early, Middle, and Late) of the Neolithic of the central Balkans. It is important to summarize this information because it provides the necessary context for understanding the information analyzed and the results discussed in the later chapters of this thesis.

II. Region – geography and environment

A. *Boundaries*

The Balkan Peninsula can be divided into two major physiographic/climatic regions: northern and southern. The southern Balkans are composed of the Mediterranean littoral, and include the modern countries of Greece, European Turkey, the Former Yugoslavian Republic of Macedonia, and Albania. The northern Balkans includes Bosnia, Bulgaria, Romania, and Serbia. Many scholars divide the north into three east-west sub-regions: eastern, central and western. The focus of the research described in this thesis derives from the central sub-region (Dumitrescu, 1983).

There are no fixed and hard boundaries for the central Balkans (Ehrich, 1965; Greenfield, 1986). As a region, it has been defined in the following way. The eastern boundary is defined by the eastern edge of the mountain ranges along the eastern border of Serbia. The northeast boundary includes the Danube River, where there is a break between the extensive lowlands of Pannonia (which includes the great lowlands of the Banat, Vojvodina, and Hungarian Plain), and its tributary the Sava river which runs through the Pannonian plain, and the mountains to the south. However, most archaeologists include the southern part of Pannonia because the Neolithic

cultural remains transcend this boundary. The southernmost boundary follows the topographic divide created by the western arm of the Rhodope mountain range between Serbia and the Former Yugoslavian Republic of Macedonia. The western boundary is generally recognised as being marked by the Bosna and Sava rivers. The eastern border follows the line of the mountainous divide between Serbia and Bulgaria. All of the sites analyzed as part of this thesis fall within these geographic limits (Bailey, 2000; Dumitrescu, 1983; Greenfield, 1986, 1991a; Markotić, 1984; Navy, 1945; Orton, 2008; Schevill, 1991).

B. *Highlands vs lowlands*

There is great variation in the topography within the central Balkans. The central Balkans can be subdivided into lowlands and highlands. The highlands found in the central Balkans include: the rolling hills and low mountains located in Serbia, and the high mountains of eastern Bosnia and Serbia, SW Romania, and the Iron Gates region. The highlands are cooler, dryer and have dense broadleaf forests in the lower elevations and sparse coniferous vegetation in the mountains. The lowlands include the Pannonian Plain and the Morava River Valley. The lowlands consist of dry grasslands, mixed forests, and marshes. Even within these regions, there is substantial geographic variation (Chapman, 1981; Dumitrescu, 1983; Greenfield, 1986, 1991a; Navy, 1944; Schevill, 1991).

C. *Rivers*

The largest river running through the central Balkans is the Danube, which has several major tributaries that drain the region. The Morava River drains much of eastern and central Serbia northward from the Rhodopian Massif, and the fringes of the Dinaric Mountains. The Tisza and Maros Rivers generally flow west and then southward from the Carpathian Mountains.

The Sava and Drava Rivers flow northwards and eastwards, respectively, from the Dinaric and Julian Alps (Dumitrescu, 1983; Greenfield, 1986; Markotić, 1984; Navy, 1944; Schevill, 1991).

D. ***Climate***

The central Balkans feature a southern temperate climate. This is a transitional climate between the warmer northern Mediterranean climate and the cooler temperate climate of central Europe. There is a clear temperature gradient in this region going South (warmer) to North (cooler). During the winter months, the central Balkans are humid and cool. This region can experience temperatures well below freezing (-10 to -15 degrees average) and will receive snow. During the summer months, the central Balkan region is humid and warm with temperatures up to 20-25 degrees C on average. It is also during these months that the majority of rainfall is received (Greenfield, 1986; Markotić, 1984; Navy, 1944).

Typically, mountains and highlands tend to receive more rainfall than the lowlands due to the rain shadow effect created by the surrounding mountains described above. Most regions within the central Balkans will show great variation in rainfall patterns. The plains of the Sava, Danube, and Tisa rivers receive only a total of 20-27 in of rain fall annually. In the highlands rainfall is heaviest in June and light in February. In the lowlands rainfall is evenly distributed throughout the seasons with slightly more frequency in the summer months (Furlan, 1977; Greenfield, 1986; Navy, 1944).

E. ***Vegetation***

The vegetation in the central Balkans varies greatly depending on geographical location, specifically the highlands and lowlands. In general, coniferous forests are found on the mountains and highlands. The frequency of these coniferous forests also tends to lessen towards the south, where they are replaced by deciduous forests. These deciduous forests include: oak,

ash and elm, with hazelnut growing as a shrub, all of which will grow densely in areas of heavy rich soils and sparsely in areas of lighter less rich soils (Bailey, 2000; Chapman, 1990; Greenfield, 1986; Markotić, 1984; Navy, 1944).

The following are forms of forest vegetation that are found within the central Balkans: Aleppo pine, black pine, summer green oak and mixed forests, Beech forests, and coniferous forests (Both pine and fir can be found) (Navy, 1944). A variety of brushwood communities can also be found such as: brush woods that are a mixture of evergreen and deciduous shrubs usually found in transitional areas between the Mediterranean and central Europe; Karst woods (e.g. oaks, hornbeams, maple, nettle trees, wild pear, mountain ash, etc.), high mountain brushwood (Mountain pine and dwarf Juniper). Herbs include: Many varieties of grasses, clovers, and a wide variety of flowering plants (Arnold & Greenfield, 2006; Chapman, 1990; Greenfield, 1986; Halpern, 1967; Navy, 1944; Schevill, 1991).

Based on the geographical information described above, the central Balkans is a transitional region between the Mediterranean climate zone and temperate central Europe. For this reason, the central Balkans are an important unit of analysis for studying early farming societies and their migration and transitions as they move northward through Europe.

III. Early Neolithic (Starčevo-Criş culture)

The Early Neolithic is marked by the appearance of food producing cultures in the central Balkan region. These cultures are thought to have originated in the Aegean and expanded from the southern into the central Balkans. With this migration, there are dramatic changes in settlement patterns, material culture and subsistence (e.g. the introduction of permanent and semi-permanent settlements, pottery, and domesticated animals) (Bailey, 2000; Gimbutas, 1991).

These changes occurred relatively quickly in SE Europe, even though there is a time lag of 500-1000 years between the arrival of the earliest food producing communities in the Aegean and their spread to the central Balkans. This time delay for the spread of food production is partly due to geographical obstacles, such as mountain chains that criss-cross the peninsula, and the influence of climate on food production systems that early farmers relied on. It probably took some time for Mediterranean plants and animals to adjust to the temperate continental climatic region, where the growing seasons are reversed from that of the Mediterranean where they originated (Gimbutas 1991 Bogucki, 1988; Greenfield, 1993, 2008; Sørensen & Karg, 2012; Willis & Bennett, 1994).

A. *Archaeological culture groups*

During the Early Neolithic, there are several regional archaeological culture in the central Balkans. To the east and southeast was the Karanovo I culture in central and southern Bulgaria; to the south and southeast was the Kremikovci culture in southwest Bulgaria and eastern Macedonia. To the north, was the large Starčevo-Criş-Körös culture complex which extends across southern Romania, Serbia, eastern Bosnia and Croatia, and southeastern Hungary (Arnold & Greenfield, 2006; Bailey, 2000; Gimbutas, 1991; Manson, 1990; Minichreiter, 2006; Russell, 1993; Tringham, 1971).

In recent years, it is recognised that the Starčevo-Criş culture pattern rapidly differentiated from that of the Körös based on settlement pattern, subsistence, etc. (Tringham, 1971; Whittle, 1996). Hence, these groups should not be treated as interchangeable. This is not an issue for this thesis since all of the Early Neolithic sites under consideration are all part of the Starčevo–Criș culture group.

The Starčevo and Criş cultures may have different names, but their material culture is remarkably similar and is considered to be the same cultural group (Arnold & Greenfield, 2006; Gimbutas, 1991; Jezik, 1998; Tringham, 1971). The differences in the names are based on historical and nationalistic rather than real cultural differences. Of course, the cultures are different in their geographical distribution, but simply grade into each other. For example: Starčevo derives its name from its type site Starčevo located near Belgrade. The Criş variant derives its name from sites along the Criş River in Romania (Gimbutas, 1991; Jezik, 1998; Tringham, 1971; Whittle, 1996).

B. ***Chronology***

The most common methods used for dating artifacts and sites are the use of ceramic typologies and radiocarbon dating (carbon 14 dating). Most often for Balkan sites, their dates and regional chronologies are based purely on ceramic chronotypologies that trace changes in style and decoration temporally through time. However, 25 years ago this changed with the introduction of combined method proposed by Manson (1990) which utilized both ceramic typologies, controlling for cultural groups, and radio carbon dates. Manson (1990) proposed that the Early Neolithic spanned from 6100-5100 cal BC.

Luca and colleagues (2011) recently took Manson's method and perfected it using radiocarbon samples from Romania, resulting in the most recent dates for the Early Neolithic Starčevo-Criş culture. The results propose that the Early Neolithic period was from 6100/6000-5600/5500 BC cal. with the final phase ending at different times, depending on the region (Greenfield & Jongsma-Greenfield, 2014; Luca, Suciu, & Dumitrescu-Chioar, 2011). There are four cultural sub-phases for the Early Neolithic that have been dated. The first phase of the Starčevo-Criş culture (SC I) dates to 6100/6000-5900/5800 BC cal. The second sub-phase (SC

IIA) runs from 5950/5850-5800/5700 BC cal. The third sub-phase (SC IIB) starts around 5800/5700 BC cal. and ends around 5600/5500 BC cal. Lastly, the final phase (SC III) as shown above starts around 5600/5500 BC and ends at different times depending on the region of study (c. 5400 BC as an average end date for the Early Neolithic of the central Balkans (Borić 2008).

C. ***Regional settlement patterns***

Early Neolithic sites in the Balkans are located in lowlands or mid-altitude ranges. Often these sites are found on terraces or levees overlooking floodplains of rivers and streams, and near bodies of water (e.g. banks of rivers, streams and marshes), on mounds in the vast floodplains, and in the large inter-montane plateaus, such as Transylvania (Arnold & Greenfield, 2006; Bailey, 2000; Garašanin, 1954; Gimbutas, 1991; Manson, 1990; Tringham, 1971; Whittle, 1996) . An example of this is Starčevo, the type site for the Starčevo-Criş culture, which overlooked the broad wooded and marshy Danube floodplain (Bailey, 2000) . Some sites may have been inhabited seasonally or for longer periods of time (Greenfield & Jongsma, 2006, 2008; Greenfield & Arnold, 2014a).

Some sites were also located strategically. The levees or terraces overlooking river and stream channels had an abundance of arable soils that was suitable for Neolithic farming technology (e.g. hoe). Their proximity to water also provided a buffer against drought years (Arnold & Greenfield, 2006). Divostin for example, is located on a gentle slope close to a stream positioned in a transitional zone between the mountains and plains. This kind of position allowed people access to both the near-by densely forested mountains and the open steppes (Bailey, 2000). These environments were rich in natural plant and animal resources, such as deer, boar, fish, shellfish, birds and wild plants.

D. ***Intra-site patterns***

Most settlements were small, sometimes appearing as a line of houses strung along a terrace or in a circle. Settlements in a circular or semi-circular formation usually were built surrounding a large central pit house (Arnold & Greenfield, 2006; Greenfield, 2000b; Greenfield & Jongsma, 2008; Srejović, 1972).

Typical Starčevo houses were single room pit dwellings which varied in shape from circular to oval with a hearth located inside the structure (Bailey, 2000; Bogdanović, 1988; Greenfield, 2014a; Greenfield & Jongsma, 2008; Srejović, 1972; Whittle, 1996). One theory as to why the pit structures were round suggests that these were temporary seasonal sites, which is supported by the thin occupation layers seen at most Starčevo sites during the Early Neolithic (Greenfield, 2014a; Greenfield & Jongsma, 2006, 2008). Some sites (e.g. Divostin I) also include rectangular dwellings. While rare for the Early Neolithic in the Balkans, it seems that this is a later form of structure on Early Neolithic sites (Bogdanović, 1988; Manson, 1990; Orton, 2012; Whittle, 1996). The semi-subterranean rectilinear earth cabins/structures at Divostin Ib featured load bearing frameworks with vertical walls which supported a separate roof structure. These rectilinear houses remained semi-subterranean until the Divostin Ic phase towards the end of the Early Neolithic during which they began to be built on the surface (Bogdanović, 1988).

E. ***Subsistence***

During the Early Neolithic, most sites have exploited more domestic than wild animals. Additionally, the percentage of wild versus domestic increases towards the north as the climate becomes cooler and more temperate. For example the Körös sites on the Pannonian plain have higher percentages of wild than domestic fauna being exploited than their Starčevo-Criş neighbours to the south (Gronenborn, 1999). For example the sites located in the Iron Gates

region which primarily exploited wild animals, unlike the sites outside this region predominantly subsisted on domestics (Greenfield, 2008a). This gradient seen within the faunal assemblages may be due to the fact that sheep and goats had to adjust to the temperate climate to the north before they could be properly exploited there (Arnold & Greenfield, 2006; Bogucki, 1988; Gronenborn, 1999; Tringham, 1971).

1. Domestic fauna

During the Early Neolithic, most Starčevo-Criş sites are dominated by the remains of domestic animals. The main domestic animals used for subsistence were cattle, pig, sheep, and goat (Arnold & Greenfield, 2006; Greenfield & Jongsma, 2008; Tringham, 1971; Whittle, 1996). Sheep and goat were the most abundant followed by cattle and then pig (Gimbutas, 1991; Greenfield & Jongsma, 2008). Cattle and pig are believed to have been domesticated from local wild varieties, which will appear in higher frequencies in later periods (Chapman, 1981; Greenfield, 1986).

2. Wild fauna

Unlike the domestic fauna, the percentage of wild fauna at most sites is quite low, the exception being sites located in the Iron Gates region, as mentioned above. Among the wild fauna, the most common are red and roe deer, followed by wild boar and aurochs (Arnold & Greenfield, 2006; Greenfield & Jongsma, 2008). Other wild resources such as fish and waterfowl have also been documented at sites located near water sources. This evidence is based on sieving at some sites and artifacts (e.g. net weights and fishing spear points) at others.

IV. Middle and Late Neolithic (Vinča culture)

The Middle Neolithic is characterized by the appearance of the early Vinča culture, known as Vinča A (Proto-Vinča) and B (Vinča Tordoš) (Chapman, 1981; Tringham, 1971;

Whittle, 1996). The Vinča culture during the entire Middle and Late Neolithic extended to include all of Central Serbia, Kosovo, the southern part of Vojvodina, the Romanian Banat, part of Hungary immediately north of the Maros River, the Iron Gates region, parts of Oltenia, the far north-west parts of Bulgaria, northern Macedonia, and the easternmost areas of Slavonia and Bosnia (Chapman, 1981; Gimbutas, 1991; Markotić, 1984; Whittle, 1996).

The exact origin of the Vinča culture is still largely under debate. Based on the dates from the earliest Vinča sites, it is believed that the Vinča culture appears somewhere within the Mures River region and then spread from north to south throughout the central Balkans (Markotić, 1984). There is also a long standing discussion about whether there is local development from the Starčevo to the Vinča culture in the central Balkan region or if the appearance of the Vinča culture is the result of migration and/or diffusion from outside the region (Chapman, 1981; Leković, 1990; Jovanović 2006). The evidence for local development is based on the presence of sites with both Starčevo and Vinča artifacts in the same stratigraphic levels (Leković, 1990). The issue remains open and unresolved still.

A. ***Chronology***

New dates for the chronology of the Vinča culture have been recently proposed. The earliest date for Vinča A (Vinča Tordoš I) is c. 5400/5300 cal BC and ends sometime around 5200 cal BC. The Vinča B phase of the culture (Vinča Tordoš II) begins c. 5200 cal BC and finishes around 5000 cal BC. These new dates push back the Vinča culture nearly 1000 years earlier from the accepted dates of a generation ago (Borić 2009).

The Late Neolithic is a continuation of the Vinča culture. The first phase is Vinča C (Pločnik I) dates to 5000/4950-4850 BC. The second phase is Vinča D (Pločnik II) which dates to 4850-4650/4600 BC, marking the end of the Neolithic (Borić 2009; Chapman, 1981).

B. ***Archaeological culture groups***

The Middle Neolithic in the northern Balkans, is marked by the introduction of new cultural groups in the region. These new groups include: the Veselinovo, which replace the Karanovo I and II culture, the Vădastra appears in the Criş area of northern Bulgaria and southern Romania and the Dudeşti appear to the west. The culture of interest for this thesis is the Vinča culture (the Vinča Tordoš culture, also known as Vinča A and B), which dominates the previous Starčevo-Criş area of Serbia and Romania (Arnold & Greenfield, 2006; Chapman, 1981; Russell, 1993; Tringham, 1971).

The Late Neolithic is marked by a shift from the Vinča Tordoš culture to the Vinča Pločnik I-II culture (also known as Vinča C and D). Other groups in the surrounding regions include: the Marista which replace the Veselinovo culture group, the Boian who replace the Dudeşti in north east Bulgaria and southeast Romania. In northern Bulgaria and southern Romania is the Vădastra II culture which is a continuation of Vădastra I in Northern Bulgaria and Southern Romania (Chapman, 1981; Russell, 1993; Tringham, 1971). In many aspects the Late Neolithic is a continuation of the Middle Neolithic, with minor shifts in settlement composition and subsistence practices (Russell, 1993; Tringham, 1971).

C. ***Regional settlement patterns***

During the Middle and Late Neolithic, the most common location for settlements was in valley bottoms, foothills or near low-lying marshy areas near rivers, brooks, lakes and swamps (Arnold & Greenfield, 2006; Chapman, 1981; Gimbutas, 1991; Leković, 1990). Some sites are located on tells, as is the case with Vinča Belo-Brdo, Parţa, and Gomolava (Chapman, 1981; Gimbutas, 1991; Leković, 1990; Whittle, 1996). Some sites also show continuity from the Early to the Middle Neolithic, and few into the Late Neolithic (Gronenborn, 1999).

Most Middle and Late Neolithic Vinča sites are an average size of 25-30 ha. While the larger sites reach sizes of 50ha and some of the largest reached sizes of 100 ha. (Arnold & Greenfield, 2006; Chapman, 1981; Whittle, 1996). These large sites were inhabited for longer periods. Vinča culture sites had considerably larger populations than the Early Neolithic sites of the Starčevo culture. Some sites (usually those over 20 ha.) were inhabited by as many as 2000 people at any one time. While it might be assumed that the larger sites had more population, the very largest (e.g. Parta and others) might have had more empty space (Chapman, 2000; Chapman, 1981; Gimbutas, 1991; Tringham et al., 1992).

The location and distribution of settlement sites changed during the Late Vinča period as sites spread further apart from each other and settlements became dense (Tringham, Krstić, Voytek, & Kaiser, 1980; Whittle, 1996). Settlements tend to be evenly spaced and arranged in simple functional spatial hierarchies because many of the larger sites were surrounded by smaller satellite sites. Some sites show evidence defences around settlements (e.g. palisades and ditches) (Arnold & Greenfield, 2006; Chapman, 1981). These settlement systems dominated the archaeological landscape with substantial settlements with high remain densities and a high degree of preservation (Chapman, 1981; Greenfield, 1991a; Whittle, 1996).

D. ***Intra-settlement patterns***

The beginning of the Middle Neolithic (especially the Vinča A period) was a transition in terms of house construction. Houses during this time share features of both Early and Late Neolithic constructions. Towards the end of the Middle Neolithic, a shift occurred and the houses became more like those seen in the Late Neolithic during the Vinča C phase. These houses were single or two room rectangular post and daub buildings often built in rows, which continued to

be used well into the Late Vinča period (Chapman, 1981; Gimbutas, 1991; Markotić, 1984; Schier, 2006; Tringham, 1971; Tringham, Brukner, & Voytek, 1985; Whittle, 1996).

Houses during the Late Neolithic in the central Balkans underwent yet another transition with the Vinča Pločnik culture (Tringham, 1971). Many Vinča Pločnik houses were built in what appeared to be a spatially planned manner. Houses were placed often parallel to one another rather than in the semi-circular fashion typical of the Starčevo houses (Bogdanović, 1988). Unlike the rectangular houses built in the Middle Neolithic, these later houses became more complex and mirrored those found to the south and in the Mediterranean (Tringham, 1971). Each house was built on the surface and made of thick clay and chaff walls on a wooden post framework with a row of heavy posts in center of the interior of the house to support the gabled roof (Bogdanović, 1988; Markotić, 1984; Russell, 1993; Tringham, 1971). On average, these houses were 15m long and 6-8m wide, featured a room with an antechamber or three-four separate rooms (Bogdanović, 1988), and had thick clay floors over a foundation of horizontal logs (Tringham, 1971).

E. ***Subsistence***

The subsistence patterns during the Middle and Late Neolithic appear very different from those of the Early Neolithic. The Middle Neolithic economy shows a stronger dependence on domestic resources over wild animal resources (Arnold & Greenfield, 2006; Tringham, 1971). While both the Early and Middle Neolithic cultures primarily subsisted on domestic fauna, there was increasing evidence that the Late Neolithic shifted back towards a heavier reliance on wild fauna in some environmental regions within the central Balkans, while others show a marked or continued decrease (Greenfield, 1991b; Greenfield & Jongsma, 2008; Orton, 2008).

1. Domestic fauna

In heavily wooded areas during the Middle Neolithic, the dominance of sheep and goat in the Early Neolithic is replaced by cattle, followed by pig. In drier areas, sheep and goat continue to dominate the assemblages followed by cattle and then pig (Arnold & Greenfield, 2006; Chapman, 1981; Greenfield, 1986). There is evidence, based on transitional forms, that wild cattle (aurochs) and wild boar were actively domesticated from local stock (Bökönyi, 1974a). The increased importance of cattle may have resulted from their roles in exchange networks (a form of wealth), and increasing cohesiveness of communities through activities such as competitive feasting (Orton, 2012; Russell, 2012).

The domestic animal exploitation patterns during the Late Neolithic showed an increasingly marked difference than those observed from the Early Neolithic sites (Arnold & Greenfield, 2006; Greenfield, 1986; Tringham et al., 1985). The Late Neolithic continued the same pattern of increasing exploitation patterns of cattle, while sheep (especially) and goats became increasingly less important. This shift in emphasis in the exploitation of domestic fauna resulted in cattle being the most important followed by pigs and then sheep and goats (Bogucki, 1988; Chapman, 1981; Greenfield, 1986; Greenfield & Arnold, 2014a; Jongsma & Greenfield, 1996). The shift in the importance of pig applies mostly to lowland sites. In upland sites, sheep and goat continue to be the second-most important domestic resource (Arnold & Greenfield, 2006; Greenfield, 1986).

While sheep and goats were mainly exploited for their primary products, meat, there is increasing evidence that goats may have also been exploited for their secondary products, i.e. milk (Arnold & Greenfield, 2006; Greenfield, 1991a; Greenfield, 2005; Greenfield & Arnold,

2014a). Domestic pigs, as with earlier periods, were kept for their major protein contribution to the diet (Greenfield, 1986; Greenfield & Arnold, 2014a).

2. Wild fauna

During the Middle Neolithic, wild fauna begin to slowly increase in percentages, but remain secondary to domestic fauna. At this time, there is a marked increase in the occurrence of wild boar (possibly related to the domestication of wild stock). Red deer, on the other hand, show a slight decrease (Arnold & Greenfield, 2006; Bökönyi, 1974a). However, despite the decrease in importance, deer outnumber wild boar and aurochs (Chapman, 1981).

During the Late Neolithic wild fauna became increasingly important (Greenfield, 1986, 1991b; Greenfield & Fowler, 2005). Compared to earlier periods; red deer seemed to decrease in exploitation, but remain important at most sites. Roe deer seem to remain the second most common wild animal exploited. By contrast, wild boar became increasingly important in some assemblages (Arnold & Greenfield, 2006; Jongsma & Greenfield, 1996; Tringham et al., 1985).

The wild and domestic animal exploitation patterns during the late Neolithic are also affected by the ecological location, particularly sites located in lowlands and highlands. There is a lower domestic to wild animal ratio at lowland sites, while highland sites have a higher domestic to wild animal ratio. Lowlands surrounded by wetlands, on the other hand, tended to incorporate both wild and domestic animals into their subsistence nearly equally (Arnold & Greenfield, 2006; Greenfield, 1986, 1991a).

V. Conclusion

This chapter summarised the Early, Middle, and Late Neolithic periods in the central Balkans based on region, cultural group, chronology, settlement patterns and subsistence patterns. Throughout the Neolithic, there are marked cultural differences between the southern

(Mediterranean areas) and northern halves of the Balkans (which includes the central and the eastern Balkans). In the southern Balkans, people built their houses as rectilinear mud-brick houses, at times with multiple stories. In the central Balkans, houses are first built as circular pit houses in the Early Neolithic which later are replaced by rectilinear wattle and daub houses in the Late Neolithic (Bogdanović, 1988; Chapman, 1981; Greenfield & Jongsma, 2008; Tringham, 1971).

Settlement patterns change over time between the Early, Middle and Late Neolithic. The Early Neolithic settlements are arranged in semi-circular formations or a line of houses along terraces or levees in lowlands and mid altitude ranges. During the Middle and Late Neolithic the settlements remained in some of the same areas as the Starčevo sites from the Early Neolithic, with some in new locations such as: valley bottoms, foothills or near low-lying marshy areas, rivers, brooks, lakes, swamps and tells. Additionally, Vinča culture sites featured considerably larger populations than compared to the Early Neolithic sites of the Starčevo-Criș culture group (Chapman, 1981; 2000; Gimbutas, 1991; Leković, 1990; Tringham et al., 1992; Whittle, 1996).

The architectural patterns also changed from the Early, Middle and Late Neolithic and more dramatically than the above summarised settlement patterns. The typical Starčevo houses were single room pit dwellings which varied in shape from circular to oval (Bailey, 2000; Bogdanović, 1988; Greenfield, 2014a; Greenfield & Jongsma, 2008; Jezik, 1998; Srejović, 1972; Whittle, 1996). At the beginning of the Middle Neolithic some Vinča architecture was reminiscent of the Early Neolithic Starčevo houses however, towards the end of the Middle Neolithic, the houses became more like those seen in the Late Neolithic during the Vinča C phase (semi subterranean to above ground). These houses were single or two room rectangular post and daub buildings often built in rows (Chapman, 1981; Gimbutas, 1991; Markotić, 1984;

Schier, 2006; Tringham, 1971; Tringham et al., 1985; Whittle, 1996). Houses during the Late Neolithic in the central Balkans underwent yet another transition with the Vinča Pločnik culture (Tringham, 1971). These houses were complex and built on the surface, usually in a spatially planned manner with houses placed parallel to one another rather than in the semi-circular formation as seen during the Early Neolithic (Bogdanović, 1988).

There was a heavy reliance on agriculture and the exploitation of domestic animals (especially sheep and goats). Agriculture and pastoralism plays an important role in each region. Sheep and goat are the most common in the south, while cattle and sheep are more common in the north. Wild fauna are increasingly exploited in the north. In this region, hunting and fishing can be of great importance and in many instances wild fauna outnumbers the domestic fauna (Table 3). In the eastern Balkans, the archaeological record is more similar to that of the Mediterranean in the south and Serbia and Romania in the north (Bailey, 2000; Chapman, 1981; Dumitrescu, 1983; Milisauskas, 1978; Schevill, 1991; Tringham, 1971).

Several changes occur over time in regards to subsistence during the Neolithic. The first is that during the Early Neolithic, domesticates were the primary food source at most sites, while wild fauna were still present but in lower numbers. Second, there is a north-south gradient during the Early Neolithic in which domestic fauna dominate the economy to the south, while wild fauna dominate the economy to the north. Third, sites located in the Iron Gates region are an exception to the general pattern because wild fauna far outnumber domesticates. This pattern is also present at some sites during the Late Neolithic. During this time, sites in lowlands have higher wild frequencies than domestic, while the domestic frequencies outnumber wild in the highlands (mid-altitude). Fourth, during the Early Neolithic, domestic fauna are a primary source of subsistence. During the Middle and Late Neolithic, the percentages of wild fauna increases. In

some sites, wild animals are the dominant taxa exploited. Lastly, in nearly all periods except for the Late Neolithic, red and roe deer are the most abundant of the wild fauna exploited.

The archaeological cultural information summarized in this chapter provides the necessary contextual information required for an understanding of the patterns observed in the wild faunal exploitation discussed in later chapters. The next chapter will be in two parts. The first part will discuss various variables that would affect the nature (including type and intensity) of hunting during the Neolithic of the central Balkans. The second part will summarize previous studies on Neolithic hunting patterns in the central Balkans based on site reports.

Chapter 3: Review of previous studies on hunting, aging and seasonal studies of deer in the central Balkans during the Neolithic

I. Introduction

The goal of this chapter is to illustrate the need for the study of wild fauna and specifically the exploitation of deer in the central Balkans for the Neolithic period. From these data, we can try to reconstruct the exploitation of wild animals and the seasonal culling and hunting patterns of deer in the region. This chapter will be organized into two parts. The first part will discuss variables that would affect the nature (including type and intensity) of hunting during the Neolithic of the central Balkans. The second section will summarize and discuss previous studies on Neolithic hunting patterns in the central Balkans based on site reports.

There are three different types of literature dealing with the wild fauna from the Neolithic of the central Balkans: 1) Synthetic studies of wild fauna that discuss the remains within a larger regional and temporal framework in the central Balkans are rare (Greenfield, 1986, 1993, 2008b; Orton, 2008, 2012; Russell, 1993); 2) Detailed reports on the faunal remains from single localities without putting them into larger regional and temporal perspectives are more common (Bökönyi, 1974b, 1988; Greenfield, 1986, 1991a, 1993, 1994, 2008b, 2013; Greenfield & Draşovean, 1994; Greenfield & Jongsma-Greenfield, 2014; Jongsma & Greenfield, 1996; Legge, 1990; Russell, 1993). In these studies, wild fauna were not the focus of the analysis, partly due to their lower numbers in the assemblage and partly due to the research focus on the introduction of domestic fauna in the region; and 3) General lists of the wild fauna recovered from various Neolithic sites in the region (Bökönyi, 1971; Lazić, 1988; Tringham et al., 1985). This type of data is the least useful, since it rarely discusses the significance and the context of the remains. It simply lists the fauna present, their frequencies, and the associated period. This nature of

reporting largely occurred during the earlier period of faunal analysis in the region (1960s-1980s), when there was little investment in the recovery and analysis of faunal remains.

Very few of these studies document the culling profiles and the seasonal exploitation strategies of the various wild taxa. Even fewer of these studies are able to ascertain enough seasonal information to reconstruct culling patterns at each site. Some notable exceptions for the region are the studies by Greenfield and collaborators, Orton and Russell (Arnold & Greenfield, 2006; Greenfield, 1986; Orton, 2008; Russell, 1993).

II. Variables that affect hunting in the Neolithic of the central Balkans

Many researchers and archaeologists in the past have considered the role of hunting and farming during the Neolithic, but most do not discuss the significance of hunting in any great detail. In the past forty years, there has been a shift in the acknowledgement of the continued importance of hunting during the Neolithic in the central Balkans. It is now accepted that wild fauna are far more than simply material resources such as meat and tools. Instead, they interact with people and have symbolic meaning (Orton, 2008; Russell, 1999, 1993, 2012). Recently, Orton (2008) proposed an analytical model for understanding the importance of the presence and relative frequencies of hunted wild fauna in Neolithic faunal assemblages from the Balkan region. Orton outlined six major driving forces for hunting: micro-regional specialization, seasonal resources, risk buffering, raw materials, garden hunting, and social roles. These six driving forces and examples from other studies in the region will be briefly discussed below.

A. *Micro-regional specialization*

Micro-regional specialization is represented when there is abnormally high frequencies of wild fauna found at certain sites (Orton, 2008). The idea that an increase in hunting may have been due to the site's location and the environment was first proposed for the Early Neolithic

previously (Greenfield, 1986, 1991a, 1993, 2008a, 2008b). The effect of environment is particularly visible in the difference between the Early Neolithic Iron Gates faunal assemblages and those outside of the region (Greenfield, 1982, 2008b), where wild fauna always outnumber domestics (except where recovery was not systematic and only the largest bones were collected). It is also seen along the edges of the marshland that bordered large river valleys, such as at Bukovačka Česma (Greenfield, 1994). In both of these cases, the wild fauna outnumber the domestic to varying extents. These communities are considered to be specialized fishing and hunting communities, within the context of the larger Early Neolithic pattern wherein domestics dominate.

B. ***Seasonal resources***

All animal and plant resources are considered to be seasonally available because they are not equally and uniformly available through the year. For this reason, there will always be a seasonal aspect to wild animal exploitation (Bogucki, 1988; Orton, 2008). This would imply a seasonally changing labour requirement and cycle of activities (e.g., most of the hunting in the warmer months and less in the winter due to the cold). This labour cycle may vary between regional environments and taxa, depending on their spatial and temporal availability throughout the year. The seasonal exploitation of animals may also be dependent on when labour is available, since the harvest and planting periods are labour intensive.

The general assumption that wild animal resources are exploited on purely seasonal basis may not always be the case. For example, red and roe deer were probably hunted to some extent year-round at Opovo (Greenfield, 1986; Orton, 2008; Russell, 1993). A similar pattern was seen at Hajdučka Vodenica, where wild fauna were hunted year round, but with different species being proposed for exploitation on a seasonal schedule (Greenfield, 2008b). In general, red and

roe deer are available in the Balkans year-round. However, as shown with Hajdučka Vodenica, red deer may migrate between highlands and lowlands seasonally in mountainous regions, therefore making them harder to access in colder months (Chaplin, 1977; Greenfield, 2008b). Other wild fauna, such as fish and birds, are more readily available during the warmer months (spring and summer), but not in colder months (fall and winter) due to migrations or weather conditions. For example, in winter, most seasonal birds will migrate south to warmer regions and fish become in accessible due to frozen rivers. Some large wild species, such as aurochs and boar, will be available year round in the region.

C. ***Risk management/buffering***

A most common conception about the importance of hunting during the Neolithic is that it was of minor importance since wild resources were being replaced by those provided by domestic fauna. This original view of hunting has since been largely replaced in the literature in recent years (Gregg, 1988; Orton, 2008; Russell, 1993). Hunting in communities relying on agriculture or pastoralism is now viewed as a means of risk management (Halstead 1989). Risk is an unpredictable variable outcome that results from a behavior that brings consequences to an organism's fitness or utility. Risk is different than hazard; hazards are the potential sources of harm (Martson, 2011; Winterhalder, Lu, & Tucker, 1999). There is always a risk of food shortage in any food producing community that could be the result of events such as droughts or disease. However, the actual outcome event of a famine is the hazard, since this is what large numbers of people would die from.

Risk would have been present during the Neolithic since this was a dynamic time in the spread of food producing communities. For example, the transition from the Mediterranean to the Balkans increased the chance of food shortages from die-off of both agricultural products and

pastoral products. This increase in risk is because the plants and animals brought by people coming from the Mediterranean regions needed a period of adjustment to the temperate climate of the central Balkans (Bogucki, 1988; Gimbutas, 1991; Greenfield, 1993, 2008a; Jezik, 1998; Sørensen & Karg, 2012; Willis & Bennett, 1994) Therefore, it is believed that during transitional periods these people used adaptive strategies that lessened risk and prevented hazards.

There are many different strategies utilized by agriculturalists to lessen risk and prevent hazards. These strategies fall into two categories: diversification and intensification (Martson, 2011; Winterhalder et al., 1999). Diversification may include: increasing crop types (or multi-cropping) and herd composition, the increase of agricultural fields or spatial diversification of fields and herds, temporal variations in food production, economic activities (e.g. agro-pastoralism and hunting and foraging), and the transfer, exchange and sharing of resources. The results of diversification can be seen archaeologically in many ways. Crop diversification can be observed by comparing the ratios of specific plant or animal species (e.g. for plants - wheat (need more water) and barley (drought resistant animals); animals - cattle and sheep/goats (require more water). Economic diversification can be observed when plant and animal remains are quantified to illustrate the overall diversity of economic activities at a site. Spatial diversification may be seen archaeologically as evidence of transhumant pastoralism (seen in high ratio of sheep and goats to cattle) (Arnold & Greenfield, 2006, 1986, 1991a, 1999; Greenfield & Jongsma, 2008; Martson, 2011).

Intensification during the Neolithic may have included an increase in crop and herd size (overproduction), irrigation and water management, trade, exchange, sharing, etc. Over production can be observed archaeologically through dramatic increases in storage vessels and structures (non-residential buildings). Irrigation can be seen archaeologically by the dramatic

increase in the presence of plants that require excess amounts of water (e.g. rice), and irrigation installations in the landscape (Martson, 2011).

Additional strategies for risk management can also involve social aspects of behaviour. These include raiding and theft, reducing consumers (moving members of families to relatives in other regions), and reducing demand for limited food by restricting non-food uses (Winterhalder et al., 1999). Currently, there is very little evidence in the Balkan Neolithic literature for such behaviour. Part of the reason is Neolithic excavations have not been conducted in a manner that yields the kind of high level chronological resolution needed to detect short-term shifts in risk management or hazards (e.g. famine) at specific sites. Despite this fact, it is very likely these events happened and risk management strategies were used (Orton, 2008).

D. ***Raw materials***

Animals are typically hunted for raw materials, which include meat, fur, sinew, bones, antlers, etc. Raw material acquisition is often cited as one of the main reasons for the hunting of wild animals. It is likely that most of the wild animals exploited during the Neolithic were used for various purposes.

Different types of animals would have been hunted for different raw materials. Carnivores would have been hunted for their fur, claws, and status. They are present in most assemblages, but in very small numbers (Greenfield, 1986, 1991a; Orton, 2008). Larger herbivores, such as deer, would have been hunted for skin, meat, antler, bones, etc. The body part representation at most sites would appear to support this since they are largely represented by cranial and distal elements (Greenfield, 1986; Russell, 1993).

Red deer can provide a wide variety of products. Antler could be used for producing a wide variety of tools (handles, hafts, decorative items, etc.) and they were very common at many

sites, e.g. Gomolava, Petnica, Opovo and Selevac (Greenfield, 1985, 1986; Greenfield & Arnold, 2014b; Orton, 2008, 2011; Russell, 1990, 1993; Tringham et al., 1992; Tringham et al., 1980; Tringham et al., 1985). Deer also have relatively straight bones (such as metacarpals and metatarsals) which are optimal for making tools such as: awls, needles, and etc. Tendons and other tissues can be used to make sinew. Hooves can be boiled to make glues, etc. Aurochs are great sources of protein and their horns were most likely kept as decoration and status symbols. Wild boar were especially difficult to hunt (requiring more than one hunter and a planned strategy), and they provided an excellent meat source, tusks that can be carved into tools or decorations, or skulls and tusks that were kept as trophies and status symbols. Birds were hunted for their straight hollow bones (great for making delicate tools and ornaments), meat and feathers. Fish may have also been exploited for more than just their meat but also for their thin flexible bones which could be used to make delicate items such as awls and needles for finer work.

E. ***Opportunistic/garden hunting***

It is clear from the overwhelming abundance of faunal and floral remains from Neolithic sites that for most Neolithic sites, domestic resources were their most important resource (Orton, 2008). Unfortunately, for early farmers, domestic field crops would be especially attractive to the three most common wild species found in Neolithic sites from the region: wild boar, red deer and roe deer. Roe deer are especially known to be endemic crop raiders (Bogucki, 1988; Orton, 2008; Prior, 1995).

When such taxa appear in very low frequencies in assemblages, it may suggest that they are background noise to the large subsistence pattern. Bogucki (1988) argues that the low frequency of wild fauna at Neolithic sites may be because they were hunted while raiding crops

and that there was little organized hunting behaviour. In this situation, they would be considered pests.

Orton (2008: 113) proposes that garden hunting can be identified based on seasonality and age-of-death studies of remains. He suggests that assemblages with fewer deer and animals killed as primarily adults may be the result of a combination of selective hunting and encounter based hunting. However, Orton (2008) adds that the seasonal and age-of-death data from Vinča sites is very limited and does not currently support this since there is no evidence of a spring/summer trend in mortality profiles. As proposed in this thesis, the study of season and age-of-death using histological methods such as dental annuli analysis may resolve this issue. Orton's suggestion that an assemblage (as at Opovo) of mostly mature adults indicates garden hunting may not be entirely correct. It would be safe to assume that opportunistic hunting would imply less preference and less planning, which results in a wider range of age groups each with frequencies that would mimic the demography of animals present in the wild during the growing season. This would include lots of young animals (infants and juveniles). Additionally, Orton's proposition ignores the roe deer data, which is surprising since, today roe deer are especially known to raid crops close to settlements and are therefore more visible and available (Prior, 1995). There is a clear preference for large adult red deer remains in the Neolithic assemblages which suggests a different hunting pattern.

Garden hunting may have been one of several driving forces for hunting. While it is very likely it happened, it is also highly unlikely to have been the only force at work at any settlement. Opportunistic hunting most likely occurred often, especially when there was the potential for crop raiding by deer.

F. ***Social roles of hunting***

Social roles are the relationships that people and animals share and the construction of identity and the issues that contribute to the decisions that individuals make in relation to those animals (Orton, 2008). The act of hunting may have been a specialist activity, with a specific social identity in which specific people, households, or settlements may specialize. These groups would have a specialized skill set and knowledge base involving wild animal behavior, hunting strategies dependent on each species, how to maintain and make tools for hunting, etc. The combination of their special skill set, weapons and knowledge would have allowed them the ability to take down large wild animals, a feat often awarded with increased prestige (Russell, 2012). For this reason, depending on the species, either communal or individual hunting may have taken place. For example, deer can be hunted by a solitary hunter or a small group, because deer are often solitary by nature or live in small family herds (Prior, 1995). Wild boar, on the other hand, required a larger group of hunters using very different strategies and weapons than they would for deer. Therefore, in the case of garden hunting, where crops were defended against species that would raid them (i.e. roe deer, red deer, and wild boar), the role of hunting most likely fell to the individual whose crop is being raided rather than the community (Orton, 2008).

There is also a possibility that hunting may not have been practiced as much in Early Neolithic societies and was obtained through exchange relationships with the contemporary later Mesolithic hunter-gatherers that remained in the region (Greenfield & Jongsma, 2008; Gregg, 1988; Kaczanowska & Koz1owski, 2003; Lazarovici, 2006; Todorova, 1995; Tringham, 1971). In this scenario, wild animal products would be the result of trade between Neolithic people for wild products and Mesolithic people for the domestic products. Gregg (1988) also suggests that settlements themselves may have different approaches to hunting. She argues that some sites,

such as those in the Iron Gates, may be Starčevo or Vinča sites that specialize in hunting and trade their resources with other settlements that specialize in domestic products as was discussed above in the regional specialization section.

Animals also serve a social role in the form of food, as proposed by Russell (1999), who interprets her data as reflecting competitive feasting at Opovo. This is supported by the increase in decorative cookware and serving dishes that coincides with the increase of cattle remains recovered at the site. This supports the idea that cattle were highly valued and that a large herd was symbolic to wealth. Although domestic animals are not the focus of this thesis, this issue is relevant, particularly since large and often dangerous wild animals (such as red deer, roe deer and wild boar, particularly males) were most likely served during such competitive feasts as a display of prestige and wealth (Russell, 1999).

Animals can also fulfil other social roles besides being a protein source. Wild animals, similar to domestic animals, can serve as symbols, deities and taboos (Russell 2012). They can also become involved in ritual, become trophies (antlers), and represent wealth and prestige. As mentioned above, hunting itself can be a prestige activity, especially in association to the hunting of large fauna such as aurochs (Russell, 1993, 2012).

III. Hunting in the Neolithic by period

As shown by the examples above of the six primary motivations for hunting, it is clear that there was never a single motivation at play alone at any site. It is highly likely that all motivations were at play at any given time. The following section summarises and discusses the hunting patterns observed for each major period (Early, Middle, and Late) within the Neolithic of the central Balkans.

A. ***Early Neolithic***

There are two patterns of wild frequencies in overall faunal assemblages during the Early Neolithic. There are in reality two patterns. The first pattern is domestic fauna are much more frequent than wild fauna. In these cases, wild fauna account for generally <20% of assemblages. This is illustrated by a variety of sites, such as Blagotin, Foeni-Salaş, Divostin I, etc. (Table 3) (domestic vs wild frequencies only). For example, wild fauna only account for 13.8% of the sample at Foeni-Salaş (Greenfield 1994). Divostin also displays this pattern, with roughly 8% of the overall assemblage from wild taxa (Bökönyi 1988). This holds true even where collection strategies differ (Greenfield 2008a).

The second pattern is wild taxa far outnumber the domestic taxa. Bukovačka Česma (overlooking the Morava River floodplain), Hajdučka Vodenica, and Lepenski Vir III (in the Iron Gates) are examples. High numbers of wild fauna are present at each site with 61.5%, 82%, and 74.5% respectively, as shown in Table 3 (Bökönyi 1972; Greenfield 1994; 1993, 2008b).

There are several possible reasons for these patterns. The first is sample size. While analysis of assemblage size has a dramatic effect on diversity, it does not account for the unusually high or low numbers of wild fauna found at some sites. Second, sites where recovery techniques such as sieving and floatation were not used missed many of the smaller wild fauna (e.g. birds, fish and rodents). This is particularly true for sites along riverine or lacustrine environments. But, it does not appear to have an effect on the sites farther away from such environments (e.g. Divostin, Blagotin, etc.) Third, sites with high concentrations of wild fauna are located in certain environments where wild fauna were more numerous, or it was more advantageous to hunt rather than rely purely on domesticated fauna. This is especially the case for sites located in the Pannonian plains (typically Körös sites) and the Iron Gates region. The

Pannonian plains are moist marshlands that are not well suited for domesticated fauna. The Iron Gates sites, on the other hand, are located toward valley bottoms with steep highlands, hills, mountains and surrounded by forests. Therefore, land suitable for farming or herds of domesticates was not easily accessible or as abundant in comparison to that available for wild resources.

Three possible reasons have been proposed for the unusually high numbers of wild taxa at these sites (Greenfield, 2008a). The first reason is high concentrations of wild fauna may be due to sites being located in an ecologically rich area, where high numbers of wild fauna are present (e.g. marsh lands). The second reason is these sites were originally inhabited by Mesolithic hunters and gatherers that adopted domestic farming and herding but maintained their Mesolithic hunting traditions (Gregg, 1988). This is confirmed by the aDNA results recovered from human remains which show continuity with Mesolithic populations in the region and does not resemble that of the Neolithic agriculturalists migrating into the region (Roksandić 1999). Lastly, these sites may be specialized hunting and trading areas, since they are located in the centre of regions with an abundance of wild resources. Many of these factors may be true and it is possible that all contribute to the patterns that are observed in the Iron Gates.

B. *Middle Neolithic*

As described in Chapter 2, the Middle Neolithic begins around 5400/5300 BC cal. and ends around 5000 BC cal. (Borić 2009). The Middle Neolithic continues many of the same trends in animal exploitation seen in the Early Neolithic. During this time period there is a slight rise the number of hunted wild fauna taxa in the assemblages. This phenomenon will be discussed further below. Some sites still exhibit higher percentages of domestic taxa than wild taxa and vice versa (Table 3). For example, Stragari and Petnica show a higher percentage of

wild taxa at 76% and 50.6% respectively, while Sânandrei only reaches 22.55% (Greenfield, 1986, 2015b; Jongsma & Greenfield, 1996). As above, Sânandrei follows what is considered the expected Neolithic pattern (high percentage of domestics and low percentage of wild) (Orton, 2008). It has been proposed that the low percentage of wild taxa at Sânandrei is due to its ecological location in the center of a flat alluvial plain with small rivers, streams, and probably only ribbon forests. This location would have been optimal for farming and herding, but not for hunting wild animals that may have preferred woodlands (Greenfield, 1986; Jongsma & Greenfield, 1996).

C. ***Late Neolithic***

.The Late Neolithic typically followed the same basic wild animal exploitation patterns as seen in the Middle Neolithic. Both Russell (1993) and Greenfield (1986) found that Opovo, unlike many earlier Neolithic sites, had more wild fauna than domestic fauna (roughly 70% and 50.8% of the assemblage) (Table 3). Other sites, such as Petnica, Gomolava, Vinča, and Divostin II have more domesticated taxa than wild. Interestingly, there were some shifts in the percentages of wild fauna over time. Petnica has fewer wild than domestics according to Greenfield (1986). But, Orton (2008) reports that there are slightly more wild taxa than there are domestics. This shift may be due to further excavations resulting in a sample size increase.

Late Neolithic Sânandrei exhibits a shift in the composition of fauna at the site as well. Unlike the Middle Neolithic, where the wild and domestic animals nearly equalled each other, the wild fauna dropped dramatically from 22.5% during the Middle Neolithic to 16.54% during the Late Neolithic (Table 4) (Jongsma and Greenfield 1996). The most common wild fauna found at the site also shifted from wild boar being the most common wild taxa during the Middle Neolithic, to red deer, followed by roe deer and then wild boar during the Late Neolithic.

Some other issues arise when considering the changing frequencies of wild fauna during the Late Neolithic. For example, two sites were studied by more than one analyst and yield different percentages because they come from different excavation seasons and excavators. At Vinča, Greenfield's (2014b) frequencies are vastly lower than that reported by Dimitrijević (2006). It is not clear that Dimitrijević sieved her material, but Greenfield's was carefully hand-collected. Opovo also displays a drastic difference, as well, in the number of wild fauna between Russell (1993), who worked on the material from the joint American-Serbian excavations with its extensive sieving operations, while Greenfield's (1986) earlier study of the hand-collected Serbian excavations at the site. The problem is that different parts of the site have been excavated, with different recovery methods, and sometimes at different occupation levels. Despite these changes, the general pattern remains the same, in which overall, the domestic fauna outnumber wild at most sites, with a few exceptions as was discussed for the Early Neolithic above.

IV. Deer exploitation during the Neolithic

During the Neolithic, as shown in Table 3, there is a basic pattern for deer exploitation. Red deer are the most hunted taxa followed by roe deer. This pattern is seen throughout the Early, Middle, and Late Neolithic.

During the Early Neolithic, red deer outnumbered roe deer consistently. In most situations, red deer percentages are generally far above 10% of the total assemblage (includes both known and unknown specimens). In other cases, the percentages of red are lower than 10% (Divostin I, Foeni-Salaş, Obre I, and Starčevo). All of these above sites with low percentages of deer also have consistently higher amounts of domesticated than wild fauna (Table 3). Roe deer

percentages, on the other hand, almost always remain below 10%, except for Divostin where they account for 13%.

During the Middle Neolithic, the pattern of wild animal exploitation remains the same. Red deer greatly outnumber roe deer with percentages well over 10% of the wild assemblage, as in the Early Neolithic. During this time, there is a small shift in the values for roe deer. The roe deer percentages (aside from a few over 10%) mostly account for fewer than 5% of the overall assemblage during the Middle Neolithic (Table 4). Most notable is Stragari, which also has the most identified specimens at 506 NISP than any other site in any period. The reason for this increase is not fully understood. It has been hypothesized that at the end of the Middle Neolithic and into the Late Neolithic, hunting increases in frequency (Greenfield, 2015b; Orton, 2008).

The Late Neolithic is not that much different from the Middle Neolithic in terms of red and roe deer exploitation. During this time, red deer specimens rise in frequency. They continue to represent over 10% of the overall faunal assemblage, as was already observed during the Early and Middle Neolithic. In contrast, roe deer frequencies represent less than 10% of the overall faunal assemblage and their numbers remain constant throughout the Neolithic (Table 4).

As is clear from these sites and publications describing them, the most common wild taxa exploited during the Neolithic were red deer, roe deer, aurochs, and wild boar. Additionally, each site exhibits different patterns of wild fauna exploitation. Some sites exhibit geographical patterns (i.e. lowland vs. highland), while others exhibit other factors such as length of occupation, possible seasonal occupation, cultural factors, and other unknown variables that may contribute to some sites hunting more than others.

V. Conclusion

This chapter investigated three main issues for the exploitation of wild fauna during the Neolithic of the central Balkans. The first section discussed the many reasons why a Neolithic population would hunt the wild animals found in the areas surrounding their villages. These reasons include: micro-regional specializations, seasonal resources, risk buffering, raw materials, garden hunting, and social roles. The second section of this chapter discussed the patterns observed throughout the Neolithic at several sites in the central Balkans spanning from the Early Neolithic to the Late Neolithic.

The clearest patterns are those that pertain to micro-regional specialization (i.e. the Iron Gates vs plains and lowland sites). As was shown above, there are very clear differences between the Starčevo sites located in the Iron Gates and the sites located elsewhere. The Iron Gates sites are located in valley bottoms near large rivers and surrounded by good farm land and dense forests. The implication is that these sites had prime farming land available, but they also had a large wild animal population within the vicinity. Therefore, they display a higher percentage of wild fauna compared to other sites. The differences in seasonal availability of animals found at the various Neolithic sites limit the likelihood of certain species appearing in the assemblage at certain times of the year during an occupation. Many small animals, such as amphibians, snails, lizards and migratory species (fish and birds), are most commonly hunted or gathered in the summer. In contrast, larger mammalian taxa, such as red and roe deer, boar, and aurochs, do not hibernate and might have been encountered in the winter months as well. It is for this reason that seasonal analysis of the teeth from these species is important and may indicate a pattern of exploitation.

The final section described the deer exploitation patterns that were already visible in the central Balkan literature for the Neolithic. Consistently, at nearly all Neolithic sites, red deer are the most exploited of the deer taxa. It is argued that red deer are the most sought after of the deer, while roe deer are most likely hunted opportunistically because of their consistently low frequencies. Some temporal patterns were also described in the literature. Between the Early and Middle Neolithic, it was found that red deer specimens begin to rise in number and remain over 10% of the overall assemblage, while roe deer specimens start to drop in percentage at each site. However, as during the Middle Neolithic and into the Late Neolithic, both red and roe deer are hunted more often, as illustrated by the increase in NISP at most of the Late Neolithic sites. As a result, red and roe deer frequencies are consistently higher than those of the Early Neolithic (Table 3).

The next chapter will discuss each of the sites that form the core of the seasonal analysis of wild deer remains conducted for this thesis. The nature of the location and archaeological remains can provide insight into the cause of seasonal exploitation of resource patterns.

Chapter 4: Sites under analysis

I. Introduction

This chapter describes the sites that form the core of the seasonal analysis of wild deer remains conducted for this thesis. The remains derive from several sites in the region that were collected by Professor H. Greenfield during the course of his research in the central Balkans. The sites described below were chosen because much of the data needed for analysis were already present and available at the University of Manitoba. The sites under examination come from two neighboring countries: Serbia and Romania. There are seven sites from Serbia (Petnica, Stragari, Blagotin, Bukovačka Česma, Opovo, Hajdučka Vodenica, and Vinča) and two from Romania (Foeni-Salaş and Sânandrei). These sites are relevant for the analysis because they span (as a group) the period of time from the beginning of the Early Neolithic to the end of the Late Neolithic (Figure 2, 3 and 4). The sites also provide some geographic spread since they do not occur as a single cluster. These sites also represent different environmental regions. This will aid in the determination of seasonality patterns, and if they are different because of environmental region

II. Petnica

A. *Location and environment*

Petnica is a small mid-land settlement located on a north facing slope overlooking a small stream tributary of the Kolubara river (a tributary of the Sava river), situated 5 km away from the city of Valjevo and at the edge of the village of Petnica, in the mountains of Western Serbia (Arnold & Greenfield, 2006; Greenfield, 1985, 1986, 1991b; Orton, 2008). Unlike sites such as Opovo, mentioned below, Petnica was a small settlement in a peripheral location to regional and inter-regional exchange networks and regional population centers (Greenfield, 1991b)

The site is situated on a slope that overlooks a depression at the end of the valley and is also situated at the base of a steep escarpment. Located above Petnica are a series of plateaus, ridges; with the mountains of Serbia beyond them. The highland areas above the site are still heavily forested, while the valley has rich agricultural areas (Arnold & Greenfield, 2006; Greenfield, 1985, 1986; Orton, 2008).

B. *Periods*

The site of Petnica occupies roughly one hectare of land with the stratigraphy extending to a depth between 2-3 meters across most of the site (Greenfield, 1991b). At Petnica there are five major horizons: Middle Neolithic Vinča B, Late Neolithic Vinča C, Late Neolithic Vinča D, Eneolithic Baden-Kostalac, and late Bronze-Early Iron Age Halstatt A, B and C (Arnold & Greenfield, 2006).

C. *Excavation and recovery*

Around 20% of the site was sieved or floated and over 20,000 fragments from the 1980-1986 excavations were recovered and analyzed.

III. Stragari

A. *Location and environment*

Stragari-Šljivik is a lowland site on the Riljačka stream, a tributary of the Western Morava River near the city of Kruševac and downstream from the village of Stragari in central Serbia. Stragari is found 200 km south of the modern city of Belgrade (Arnold & Greenfield, 2006; Greenfield, 2015b). Stragari sits in an agriculturally rich valley surrounded by high mountains with narrow upstream and broad downstream valleys, thick forests and a series of low rolling hills.

Stragari is located within a rolling hills environment, surrounded by high mountains with narrow upstream and broad downstream valleys. Stragari itself is located on the floodplain of one of these broad stream valleys (Greenfield, 2015b). Due to its location, Stragari has excellent conditions for agriculture, but also great environments surrounding the site for hunting.

B. *Period*

Stragari is a fairly small site extending approximately 200x200 meters, with three major cultural horizons. These horizons are from the Starčevo, Vinča Tordos I and II, and the Late Bronze Age (Arnold & Greenfield, 2006; Greenfield, 2015b).

C. *Excavation and recovery*

During excavation between 1987 and 1989 over 10,000 bone fragments were recovered and analyzed. The remains from Stragari were carefully hand collected. There is a consistency in hand-collection between the Blagotin, Stragari and Vinča collection since they were all directed by Stanković, with Greenfield's frequent presence on-site.

IV. Blagotin

A. *Location and environment*

Blagotin is a mid-altitude site located in central Serbia on the northern outskirts of the village of Poljna about 12 km north of the village of Velika Drenova and about 50 km northeast of the town of Trstenik (Greenfield, 2000b; Greenfield & Jongsma-Greenfield, 2014).

Blagotin is situated on a gentle slope over-looking a stream which extends into the flatter terrace above the slope, which has contributed to severe erosion in some areas of the site (Arnold & Greenfield, 2006; Greenfield & Jongsma-Greenfield, 2014; Greenfield, 2015a; Jezik, 1998) Around Blagotin are rolling hills, low mountains, mixed forests and agricultural areas. The site is a small site situated on a gentle sloping terrace at the base of Blagotin Mountain and above an

incised stream valley (Arnold & Greenfield, 2006; Greenfield & Jongsma-Greenfield, 2014). Blagotin has three occupation periods.

B. ***Period***

The earliest habitation occurred during the Early Neolithic dating between 6100-5100 BC. During this time, Blagotin was a relatively small site roughly 100x89 meters with horizons which produced Neolithic ceramics and lithics that were linked stylistically with those of the Starčevo culture (Greenfield, 2000a). The site was then abandoned at the end of the Early Neolithic and then reoccupied later during the Eneolithic and the Early Iron Age (Greenfield, 2000b; Greenfield & Jongsma-Greenfield, 2014; Jezik, 1998).

C. ***Excavation and recovery***

Blagotin was first identified as an archaeological site in the 1970s during a survey of the region by Nikola Berić and Emilija Tomić (Greenfield, 2000b). Once excavations began it became clear that Blagotin was a multiple period site with a highly complex stratigraphy. During the 1989-1994 excavations, 50% of the site was sieved and floated (Arnold & Greenfield, 2006). From these excavations over 35,000 animal bone fragments were collected and analyzed.

V. Bukovačka Česma

A. ***Location and environment***

Bukovačka Česma is a lowland site located approximately 3 km north of the city Jagoding in Serbia (Greenfield, 1994). The site is dated to the Early Neolithic Starčevo culture dating around 6100-5100 BC calibrated, and was a settlement located within the Morava river drainage upon a rise which over-looks the confluence of the Lugomir river, a west bank tributary of the lower Morava River.

This particular site is of importance because it is located in an area which is considered to be an important route for the spread of Early Neolithic adaptations from the Aegean to central Europe and also the center for Starčevo settlement (Greenfield, 1994). This site also represents an important link in understanding the spread of early farming adaptations from out of the Levant and Mediterranean areas into the central Balkan region.

Another reason why this site is of great importance is because the faunal assemblage is relatively unusual when compared with most of the other contemporary Starčevo sites beyond the Iron Gates region (Greenfield, 1994). The reason for the high distribution of wild faunal remains, is more similar to those from the Mesolithic hunter gatherers from the Iron gates region than from other Starčevo sites. This pattern is in part due to Bukovačka Česma's close proximity to marshlands, which attract a wide variety of wild fauna.

B. *Period*

Bukovačka Česma is a single period site. All remains from this site date to the Early Neolithic (Greenfield 1994). There are no other periods documented at this site.

C. *Excavation and recovery*

There were two separate seasons of excavation. The excavation of the site began as a salvage operation in 1972 by Sava Vetnić during which nine trenches were opened. A total of 544 bones and fragments were recovered using only hand collection techniques (Greenfield 1994).

VI. Opovo

A. *Location and environment*

Opovo-Ugar Bajbuk is a large lowland late Neolithic settlement found in the Banat, a region of northern Serbia, and is situated between the Danube and Romania (Arnold &

Greenfield, 2006; Russell, 1993). The site is located on the southern edge of the Pannonian plain, in the lower Tamiş River drainage valley on a low tell, atop a well-drained rise surrounded by marshes that flooded seasonally, causing poor drainage due to the resulting high water table (Arnold & Greenfield, 2006; Russell, 1993; Tringham et al., 1985). For this reason, the site is not well situated for crop cultivation or for the herding of domestic animals (Arnold & Greenfield, 2006). However, in these aquatic and semi-aquatic environments the area surrounding the site had an abundance of wild resources including fish, birds, shellfish, amphibians, reptiles, wild pig, roe and red deer (Arnold & Greenfield, 2006; Tringham et al., 1985). Additionally, Opovo is centrally located with respect to the movement of local and nonlocal resources and materials. This site is very important because of the size of occupation and the artefact assemblage complexity which may indicate that Opovo in prehistory played a central role in the regional settlement of the lower Tamiş River (Greenfield, 1991b).

B. ***Period***

The site is a 5ha settlement about 4 km from the Kolubara River. In prehistory, the river, or one of its branches, was probably much closer to the site (Greenfield, 1991b; Russell, 1993; Tringham et al., 1992; Tringham et al., 1985). The site was inhabited only during the Vinča period dating between 4000-3800 bc uncalibrated or 4700-4500 BC calibrated, which will probably be recalibrated in the final reports (Russell, 1993). The site features three building horizons (BH1 being the latest, and BH3 being the earliest) with accompanying pits, ovens and midden deposits, all of which spanned between 100-200 years (Orton, 2008; Russell, 1993). The cultural deposits are about 1.6 and 2.5m deep and are dated to the Late Vinča-Tordos/ early Vinča-Pločnik between 4300 and 3700 bc uncalibrated (Tringham et al., 1985). The main

occupational deposit consists of burned and rubble strata which is also observed in later strata as well. Currently, there is no evidence of any lateral spread of the settlement.

C. *Excavation and recovery*

All of the faunal materials found at the site were collected by hand and sieved, with over 950 fragments recovered and analyzed from the 1979-1980 excavations (Greenfield 1986). Russell (1993) in her later study of Opovo found that out of 46,594 specimens, Opovo had over 70% wild fauna from each building horizon, with an average of 69%.

VII. Hajdučka Vodenica

A. *Location and environment*

Hajdučka Vodenica, known as Brigand's Watermill, is located 35 km from the right bank of the River Danube as it passes the Iron Gates on its way to the Black Sea (Borić & Miracle, 2004; Greenfield, 2008b). The site is located in the eastern half of the gorge, in a broad cove between the Mai Strbac hill and the Danube (Greenfield, 2008b).

The prehistoric section of the site is located on the river bank and first terrace above the river. The surrounding environment consists of riverine, shoreline, small meadows in the mountains and high altitude deciduous and evergreen forests. The area today is used for the grazing of domestic animals; however wildlife and wild plants are still very present and exploited.

B. *Period*

This site is a multi-period site with deposits dating to the Early Neolithic then abandoned until the terminal Neolithic, after which it was abandoned once again and then inhabited again during the Early Iron Age. Hajdučka Vodenica was again inhabited in the Roman period. The focus of this thesis will be the Early Neolithic data from the site.

C. ***Excavation and recovery***

Excavations of Hajdučka Vodenica took place between 1966 and 1969 which coincided with the excavations of many other sites in the gorge (Greenfield, 2008b). At this time total of 250 specimens were hand collected and analyzed from this site. Hajdučka Vodenica is important because there may be evidence for continuity from Mesolithic to Neolithic as seen in lithic assemblages and architecture (Borić & Miracle, 2004; Radovanović, 2006). This brings to question if this site may be an example of Mesolithic hunters and gatherers adopting a farming lifestyle.

VIII. Vinča

A. ***Location and environment***

Vinča, also known as Vinča -Belo Brdo is a lowland site on the right bank of the Danube River near the confluence of the Danube and Morava, the Tisza, the Timiş, and the Sava rivers and opposite the plains of Pannonia (Arnold & Greenfield, 2006; Greenfield, 2014b). Vinča is unique because it is one of the very few tell sites found in the central Balkans and during the later Neolithic reached a height of 8 meters (Chapman & Gaydarska, 2006; Chapman, 1981) The site is positioned about 15 km southeast of the city of Belgrade, in Serbia. The site itself is located in an optimal position to monitor and control the movement along the major waterways of the region.

B. ***Periods***

Vinča has a large artificial mound that stretches for several hundred meters along the bank of the Danube (Arnold & Greenfield, 2006; Greenfield, 2014b). As currently seen from the Danube, the tell rises majestically up from the loess terrace. In prehistory, the mound probably would have risen more gently from the riverbank. It reached a height of over 8 meters by the end

of the Neolithic period (Chapman & Gaydarska, 2006). This mound features levels representing the entire Neolithic period, the Eneolithic, the Middle Bronze Age, and Medieval periods and is considered the 'yardstick' or type site for the Balkan Neolithic (Arnold & Greenfield, 2006; Chapman & Gaydarska, 2006; Chapman, 1981; Markotić, 1984). The first settlement at Vinča - Belo Brdo dated to 5700 BC cal. during the Early Neolithic Starčevo phase (Chapman & Gaydarska, 2006). At the end of the Early Neolithic, the site was briefly abandoned and then re-inhabited during the Middle Neolithic and was occupied during the Vinča B phase. Both Vinča C and D were present at Vinča Belo-Brdo during the Late Neolithic. Directly after the Late Neolithic, Vinča was then inhabited during the Eneolithic, followed by the Middle Bronze Age, Late Bronze Age, and Medieval periods. The Vinča D deposits from the sites date between 3800-3400 cal. BC, making the end of the Neolithic at the site (Greenfield, 2014b; Schier, 1996; Stadler et al., 2001). Therefore, the Neolithic occupation at the site ranged from 5700-3400 cal. BC (Chapman, 1981; Greenfield, 2014b).

C. ***Excavation and recovery***

It is believed that an estimate of over one-third of the site has been lost due to erosion by the river and is thought to have also extended for several hundred meters back from the river. However, despite the erosion, over 10,000 animal bone fragments were collected and analyzed from the 1982 excavations. Only 1962 specimens from the Late Neolithic Vinča levels were collected and analyzed since the Late Neolithic was only beginning to be investigated during the only season that Greenfield was allowed to participate and record the faunal remains (Arnold & Greenfield, 2006; Greenfield, 2014b).

IX. Foeni-Salaş

A. *Location and environment*

Foeni-Salaş is a lowland site located 3 km north of the village of Foeni, and approximately 3 km from the Serbian Border and on the western edge of the Romanian Banat (Greenfield & Draşovean, 1994; Jezik, 1998; Jongsma & Greenfield, 2001). The site is in the midst of the flat alluvial plain on the bank of the Timişat, a tributary of the Timis River, and atop the southwest half of a natural rise (extending SW-NE) that rises above the Pannonian plain. It is thought that this natural rise was part of an ancient alluvial terrace.

Evidence has shown that forests had existed along the river edge around the site (Arnold & Greenfield, 2006). Today these forests are no longer in existence because most of this area is presently under cultivation. It is likely that this site was not extensively excavated until the invention of the plough because the soils were too tough for the Neolithic technology.

B. *Periods*

Foeni-Salaş has six periods represented in its levels (Arnold & Greenfield, 2006). These levels cover a single and very thin occupation level with only a single phase in Early Neolithic, which is believed to be a very short occupation. This level has been characterized as a Starčevo II A sub-phase of the local Starčevo-Criş culture which dates in the area from 5900-5100 cal. BC (Jongsma & Greenfield, 2001). Other periods include the Eneolithic, Middle Bronze Age, Early Iron Age, Dacian, and Medieval (Jezik, 1998; Jongsma & Greenfield, 2001).

C. *Excavation and recovery*

Excavations were directed by Haskel Greenfield and Florin Draşovean and took place from 1992-1994 (Greenfield & Draşovean, 1994; Jezik, 1998). During these seasons, nearly all

of the soils were dry or wet sieved. Using these recovery methods, over 11,391 fragments were recovered and analyzed (Arnold & Greenfield, 2006; Greenfield and Jongsma 2008).

X. Sânandrei

A. *Location and environment*

Sânandrei is a lowland site located approximately 500m SE of the Village of Sânandrei, which is c.a. 20 km north of the city Timisoara, in the Banat region of SW Romania in the middle of a modern field (Arnold & Greenfield, 2006; Jongsma & Greenfield, 1996). Sânandrei is on a low ellipse shaped natural mound rising slightly above the surrounding plain and is bounded on three sides by stream beds (ancient and modern) and on one side by a dirt road leading to the asphalt road between the village and Timisoara. The site is approximately 108m (E-W) and 140m (N-S) in size, and its maximum extent.

B. *Periods*

Three major phases of occupation were found at the site. Based on these findings, it there appears to be a more or less continuous occupation from the beginning of the Middle Neolithic Banat culture into the late Neolithic Vinča culture C phase. The site is abandoned at the end of the Vinča C occupation. The site remains abandoned until the Early Medieval period, when it is reoccupied briefly again.

C. *Excavation and recovery*

Excavations at Sânandrei were directed by Florin Draşovean (museum of Banat). The data were analyzed during 1992 (Arnold & Greenfield, 2006; Jongsma & Greenfield, 1996). Only the remains from Banat and Vinča C horizons were sufficiently *in situ* to be extensively analyzed (Arnold & Greenfield, 2006; Jongsma & Greenfield, 1996). The fauna from Sânandrei is one of the few collections from this region that show the transition between the Middle and

Late Neolithic periods, which have been and systematically analyzed from a single site. A total of 1143 specimens were recovered from these excavations, 275 specimens that could be securely dated to the Banat level, while 272 specimens were assigned to the Vinča C levels. All faunal remains were collected by hand collection techniques (Jongsma and Greenfield 1996).

XI. Conclusion

This chapter describes each site under investigation in this thesis. Several patterns can be seen in this chapter that were mentioned in the previous chapter. All of the sites being examined from both the Starčevo and Vinča culture groups were located in strategic locations close to bodies of water, usually rivers and streams. The following sites: Petnica, Blagotin, Hajdučka Vodenica, Vinča, and Sânandrei were all multi period sites. Stragari, Bukovačka Česma, Opovo, and Foeni-Salaş were occupied for a single period. Among the sites chosen, Foeni-Salaş, Blagotin, Bukovačka Česma, Hajdučka Vodenica have early Neolithic assemblages that will be analyzed. The remaining sites all have Vinča assemblages.

The next chapter describes the various methods phases that will be use used in this thesis (e.g. preliminary database analysis, age-of-death analysis, and season-of-death analysis) and techniques employed in this season to ascertain the age and season-of-death of red and roe deer. Through the use of these methods and techniques it may be possible to gain insight into the wild resource exploitation patterns during the Neolithic in the central Balkans

Chapter 5: Methods of analysis

I. Introduction

The objective of this chapter is to describe the methods and techniques utilized to reconstruct wild fauna exploitation patterns of the Neolithic in the central Balkans. There are three major goals for this thesis. The first is to determine the relative importance of wild fauna and red and roe deer remains in Neolithic sites. The second is to identify the age-at-death of each red and roe deer mandible and tooth specimen. The third is to determine the season-of-death for each of the aged samples. To do this, seven questions with their corresponding hypothesis and null hypothesis were initially presented in Chapter 1 to guide the structure of this investigation.

The faunal databases record as much information about the material from an archaeological site as possible. These databases are created and organized based on the questions asked during the time of the original study. But, data bases are not static, they are typically dynamic in nature. This means that specific questions may be asked at the beginning of the study and other questions may be added later, after the initial study. This results in modifications to the databases in order to extract new information that was not foreseen at the time. Occasionally, errors in the database are discovered and then rectified that can have an impact of earlier studies. For example, Greenfield found that the fauna described for Blagotin (Greenfield and Jongsma-Greenfield 2014) had an error in the number of fish bones. Instead of 4, only 1 was correct and the rest were fragmentary bird bones. These small, but slight changes can have an impact upon interpretations, such as overemphasizing fish. Databases are the main reporting tool used by archaeologists. Databases will be discussed further below.

Teeth are one of the most common elements found at archaeological sites. Teeth preserve well, sometimes in mandibles, as parts of skulls (maxillae) and on their own as loose teeth. This

makes teeth very important tools in archaeology. Teeth are the means by which animals eat, communicate, and defend themselves. Because of this, teeth record the events in an animal's life. Teeth can provide useful information such as the age-of-death, season-of-death, migrations and origins, diet, diseases and stress, etc. Just like the individual animal, teeth can also tell zooarchaeologists a lot about a site, the people who lived there and the animals that were exploited or kept there. For the purpose of this thesis, only teeth will be examined in great detail to answer specific questions about the deer from the central Balkan sites described in the previous chapter.

II. Method and technique

A method is the means by which investigations are carried out and how one goes about structuring studies and experiments to test out hypotheses. A method may have one or more techniques associated with it (see below). The goal of the methods in this thesis is to gain an understanding of the importance of red and roe deer exploitation, the seasonal variations in their exploitation, and selectivity in age or sex culling.

In order to understand these variations, three major methods are used in this thesis. The first method is the preliminary analysis of analyzed material that exists in the zooarchaeological database from the region. This method aims to answer questions 1-4 as stated above. This method ultimately led to the selection for specific samples from various sites for analysis and the tooth samples that will be further studied using methods 2 and 3 (described next). The second method is the assessment of the age-of-death for both types of deer to answer Questions 5 and partially 6. The third method is the determination of season-of-death for red and roe deer using tooth remains.

Once all of the analysis has been complete and Questions 1-6 have been answered, all of the data from each site will be synthesized and examined for any evidence for larger temporal and regional patterns that may help to answer Question 7. The aim of the synthesis is to illustrate the exploitation patterns of red and roe deer over the course of the Neolithic and will also document any shifts that may have occurred. These techniques associated with each method will be discussed in further detail next.

A technique is the specific execution or application of a method to evaluate a hypothesis. A method may have several techniques associated with it. Each technique can be equally valid and may lead to similar or different results depending on the question posed. Most of the methods used in this thesis employ several techniques to answer the questions.

There are five techniques employed in this thesis to investigate the age-of-death and season-of-death of red and roe deer remains from Neolithic sites in the Balkans located in southeastern Europe. In many cases the techniques often will overlap between the two methods.

III. Method 1: Assessment of taxonomic frequency from existing databases

The first stage of the analysis was what is called preliminary data analysis. Due to the fact that the faunal material from each site has already been identified by Professor Haskel Greenfield, no taxonomic identification was necessary for this thesis. Each database includes information on the site, provenance, taxonomy, element, part, age, and many other variables. The databases will be used to answer Questions 1-4 from Chapter 1. These questions aim to establish the basic importance of wild fauna, and red and roe deer in the overall assemblages from each site.

A. ***Techniques for calculating taxonomic frequency, diversity and evenness***

Calculation of taxonomic frequency is based on NISP for each assemblage. These were determined previously from the original faunal reports from each of the sites.

Taxonomic diversity was calculated by totalling the number of different taxa represented. While this thesis does not use any statistical tests of significance, it explores the issue of taxonomic diversity (also known as variety) through the use of presence/absence data of the various taxa. For example, if site A has 10 wild taxa and 5 domestic taxa, then wild fauna are more diverse (e.g. types of species). This form of analysis is also known as a measure of taxonomic richness, often abbreviated as NTAXA. Many different terms are used interchangeably in the zooarchaeological literature to describe taxonomic diversity, such as taxonomic density and richness (Lyman 2008).

In contrast, taxonomic evenness is a measure of the frequencies of individuals within categories or distributions of individuals across categories (Lyman 2008). The analysis of taxonomic evenness occurs each time the frequencies of red and roe deer are described individually.

IV. Method 2 – Age-of-death analysis

This section aims to answer question 5 and 7 posed in Chapter 1. Through the use of the various techniques, it is possible to create an age profile for red and roe deer from each site. All sites were analyzed for age-of-death information based on epiphyseal fusion. However, due to a lack of appropriate tooth specimens from four sites (Vinča, Bukovačka Česma, Hajdučka Vodenica, and Foeni-Salaş), only five sites (Stragari, Opovo, Sânandrei, Petnica, and Blagotin) were used for the analysis of dental assessments of age- and season-of-death.

A. ***Determining age-of-death***

There are several techniques to ascertain the age of death of an archaeological specimen. One method is the fusion of elements. The fusion of elements entails the fusion of epiphyseal planes or the ossification of skeletal elements. Often bone growth occurs in the mid shaft and the epiphyses, which are unattached in young individuals, and eventually fuse to the shaft of the bone in older individuals. Epiphyses fuse at different times in an animal's life but at a predetermined rate with all bones fused at full maturity (Banning, 2000).

Teeth are a more precise but an indirect scale of aging (Banning, 2000). This technique entails the study of tooth eruption, the stage at which deciduous teeth are replaced by permanent teeth and the wear of both the deciduous and permanent teeth. Additional methods are the calculation of crown heights based on the metric measurement of the height of the crown, and counting of dental annuli at the dental cementum junction after the tooth has been thin sectioned. For the purpose of this thesis only the techniques used for aging tooth samples were further analyzed and discussed below.

B. ***Technique 1 – Tooth eruption and wear***

Sequential tooth eruption for young animals and the degree of tooth wear for older animals has been employed in animal husbandry and game management for age determination for many decades (White, 1974). The method proves to be easy, non-time consuming, inexpensive, and does not require equipment (Ervynck, 2005). The tooth eruption and wear technique is the observation of the patterns of dental eruption and tooth wear using known aged samples and has been used for aging a variety of mammals (Tomé & Vigne, 2003). Tooth eruption occurs from the time the tooth breaks through the jaw bone and enters abrasion. For example, when you have the following teeth present in a tooth row: dpm2, dpm3 and dpm4, then

it is safe to assume that the animal is under the age of one year (Tomé, 1999). Tooth eruption is also based on the fact that deciduous teeth are replaced on a schedule that is known in known aged samples of modern animals today (Reitz & Wing, 2008).

There are many different ways of recording tooth eruption and wear. For example, Aitken, Carter, Hewison and colleagues, and Tomé (Aitken, 1975; Carter, 1997; Hewison et al., 1999; Tomé, 1999) studied the tooth eruptions and wear patterns for roe deer. Carter and Lowe, (Carter, 2002; Lowe, 1967) proposed systems for both roe and red. White (Brown & Chapman, 1991; Ervynck, 2005; White, 1974) examined the occlusal surface of the teeth to determine wear for red deer. Tooth eruption and wear were recorded and analyzed to ascertain the culling profiles of red and roe deer at each site of interest.

1. *Sub-technique 1 - Tooth eruption for red deer*

Two systems of tooth eruption and wear were used to create the sequence below, for the relationship between tooth eruption and age (Lowe 1967; and Brown & Chapman 1991). These two systems were combined because Brown and Chapman's system was missing the sequence for the M3.

- M1 is fully erupted at 5-6 months and is functional;
- M2 is fully erupted at 13 months and is functional;
- Deciduous teeth are often replaced around 14 -15 months; and
- M3 erupted around 25-26 months.

2. *Sub-technique 2 - Tooth eruption and wear for roe deer*

There are very few studies available on the relationship between age and tooth eruption and wear for roe deer. One study was found not to be useable it only used whole mandibles and did not provide useful illustrations or tables on the relationship between age and tooth eruption

and wear for more fragmentary material (Aitken, 1975). In contrast, Tomé and Vigne's (2003) deal with the issue of fragmentary dental sequences, including isolated teeth. They document the relationship between age and eruption and wear pattern of each tooth from the Lpm3 to LM3 from the point the tooth erupts to when the tooth is completely worn flat. For this reason, all of the tooth eruption and wear analysis based on tooth wear schematics are based on Tomé and Vigne's (2003) study. According to Tomé and Vigne the following is the tooth eruption sequence for roe deer

- Milk teeth begin to wear around the age of 2 months;
- M1 enters wear around the age of 4 to 5 months;
- M2 enters wear around the age of 8 and 9 months;
- The replacement of deciduous teeth by permanent adult teeth takes place around 11 and 14 months of age; and
- M3 has fully erupted and enters wear around the age of 15 months.

C. ***Technique 2 – Tooth wear score (red deer only)***

Tooth wear scores use a scoring system and a simple formula to calculate age based on a set of criteria that can be seen by viewing the occlusal surface of the tooth. Høye, and Tomé and Vigne (Høye, 2006; Tomé & Vigne, 2003) examined tooth wear scores for roe deer. Brown and Chapman (Brown & Chapman, 1991) studied tooth wear scores from red deer.

Tooth wear stages (TWS) are coded by comparing a set of drawings, illustrating the proceeding attrition of the occlusal surface of the teeth (Figure 5) (Ervynck, 2005). The codes are then added into numerical values and assessed for the three mandibular molars. This creates the Mandibular wear stages (MWS) which can reach a maximum of more than 50 units making it possible to further subdivide a population into these subclasses.

Molar tooth wear scores were only assessed for red deer based on Brown and Chapman's (1991) article. The score for these locations were added together to create a total overall score for a single mandible. These scores were then placed in a formula created in Excel to determine the age of the sample. It was found that this technique works best only when the entire mandible and all teeth are present. Missing teeth result in a lower tooth wear score which can underestimate the age of the sample.

Tooth wear scores for red deer were conducted by examining the enamel slopes along the edge of each cusp. If the enamel was worn without exposing the dentine, then the section of tooth received a score of 1. If the dentine was exposed, it received a score of 2 (Brown & Chapman, 1991).

D. ***Technique 3 – Dental crown heights***

Tooth eruption and wear are only useful up until all of the teeth have erupted and are in wear. Herbivores with high crowned teeth stop growth early in life, and therefore teeth from and individual can be aged based on the height of their crowns (Banning, 2000). Crown heights are important for two reasons. The first is that once all of the adult teeth are in wear, observations of aging are not as reliable. The second is that crown heights, especially in species like deer, can show sexual dimorphism, therefore allowing us to sex the samples based on their size. While this technique can be used for sexing, it is only useful if the species is strongly sexually dimorphic.

The measurement of crown heights is especially useful because they are objective, reliable and can be replicated easily (Klein, Wolf, Freemana, & Allwardena, 1981; Mysterud & Østbye, 2006; Steele & Weaver, 2012). Crown heights for this thesis were measured using digital calipers by measuring the minimum distance between the occlusal surface and the crown-root junction on the buccal surface on the anterior lobe or cusp of the tooth (Figure 7) (Steele &

Weaver, 2012). Carter, Hewison and colleagues and Tomé and Vigne (Carter, 1997; Hewison et al., 1999; Tomé & Vigne, 2003) examined crown heights by measuring the first mandibular molar for roe deer. Alternatively, Mysterud and Østbye (Mysterud & Østbye, 2006) observed crown heights by looking at the second mandibular molar. Klein and colleagues, Lowe, Steele, Steele and Weaver, and Tušek and colleagues (Klein et al., 1981; Lowe, 1967; Steele, 2004, 2002; Steele & Weaver, 2012; Tušek, Mihelić, Babić, & Trbojević-Vukičević, 2001) examined the crown heights of red deer.

Special attention should be paid to crown heights because each researcher will measure the crown heights differently depending on the research questions they are asking, the species they are examining, or the problems they had encountered. For example: Tušek and colleagues (Tušek et al., 2001) measured the crown heights of the third and fourth adult premolars and the first and third molars on the lingual side of red deer. This was the opposite from what Steele and Weaver, who measured from the buccal face. Mysterud and Østbye (2006:102) measured the height of the second molar to the nearest 0.1mm. Tomé and Vigne (2003) measured the crown heights of the lower mandibular teeth excluding only the Pm2 because of its unusual wear pattern ranging from triangular to quadrangular in shape.

To date, there are no studies that fully illustrate the entire formula for the calculation of the relationship between roe deer crown heights and age. In particular, the major studies that use this formula (Carter, 1997; Hewison et al., 1999; Tomé & Vigne, 2003) do not clearly document their formulas or how they calculated their results. Due to the absence of a published formula for roe deer, Klein's crown height method was used as a substitute (Klein et al., 1981). The tooth eruption sequence from Tomé and Vigne's (2003) article was used to input the missing variables (e.g. maximum longevity, month the tooth erupts, etc.). Other formulas (Klein et al., 1981; Klein

& Cruz-Uribe, 1983; Spinage, 1972; Twiss, 2008) were tested, but were found to be inaccurate because they did not match the results obtained by other age-of-death techniques. Below is the formula used to determine the age-of-death for red and roe deer.

The crown height formula for deciduous teeth:

$$Y = \frac{Ys}{Xmax}\ (x) + Ys$$

Y = Age
X = Crown height
Xmax = Crown height at eruption
Ys = Age at shedding (when deciduous teeth fall out)

The crown height formula for permanent teeth

$$Y = \frac{Ypel - Ye}{Xmax}(x) + Ypel$$

Y = Age
X = Crown height
Xmax = Crown height at eruption
Ypel = Age at potential longevity (e.g. roe deer = 10 years; red deer = 12-15 years) (prior 1995, Brown and Chapman 1991)
Ye = Age at eruption

V. Method 3 – Season-of-death analysis

Faunal remains are one of the best forms of evidence for archaeologists to reconstruct season-of-death. Seasonality studies through the examination of antler and teeth can estimate in which season the site was occupied or when the remains were deposited at a site (Banning, 2000). Aitken, Ashby and Henry, and White (Aitken, 1975; Ashby & Henry, 1979; White, 1974), observed dental annuli for roe deer. Lastly, Lowe and Mitchell (Lowe, 1967; Mitchell, 1967) examined dental annuli for red deer. In this thesis. Seasonality can also be attained from tooth eruption and wear for mammals born in brief and predictable seasons (i.e. such as red and roe deer who fawn around late May and June). This type of analysis of tooth eruption and wear only works with very young animals under a year in age (Banning 2000). However, it only works well if there is a large enough sample of animals in their first few months of life and only if the

stages corresponding to each of these months is well known from known aged samples of the same species. Animals closer to a year in age show too much variation in their dental cementum and therefore it is best to age them using tooth eruption and wear rather than dental cementum analysis. These very young individuals (6 months and under) are not present in the tooth sample and therefore they could not be analyzed. All specimens in the sample are from individuals one year (or very close) or older. Seasonality analysis will only be done through dental cementum analysis.

All of the age-of-death analysis techniques were completed before dental cementum analysis due to the fact that dental cementum analysis is destructive and the data must preserved both quantifiably, and visually for future use. Once the above techniques are finished, red and roe deer teeth are ready to be selected for dental cementum analysis.

Cementum increment analysis has become a widely used method for aging ungulates (Banning, 2000; Mysterud & Østbye, 2006), but it is time-consuming and expensive in comparison to the analysis of tooth eruption and wear. Cementum incremental analysis has been used extensively since the late 1960s, particularly in North America, to monitor the age structure of various species for game management. Additionally, over the last 40 years archaeologists have applied cementum analysis to determine the seasonal use of sites around the world (Lam, 2008; Lieberman & Meadow, 1992; White, 1974; Wedel, 2007). However, the different types of cementum should be discussed because there have been some misunderstandings of cementum biology and misinterpretations of cementum increments in the literature which have caused imprecise and inaccurate estimates (Lieberman, 1994). Since teeth are the most abundant skeletal element found at archaeological sites, they are very useful in providing unambiguous biological and seasonal data for the animals that were exploited at a site. This information can further

answer questions such as: the hunting and culling strategies employed at or around a site, the environment around a site, and the possible reasons for why people exploited a specific taxa. (Lyman, 1994).

Dental cementum analysis is a dual method which counts the darker striations (winter lines – seasonally retarded growth) and light striations (summer lines – season of increased growth) to determine the season and age-of-death (Mysterud & Østbye, 2006). Many researchers have claimed that this method and the crown height method are more accurate and less subjective than other methods such as aging by tooth wear analysis because they are quantifiable and easy to reproduce.

In ruminants, such as deer, their teeth will erupt only once, but will continue to grow for their entire life, constantly depositing dental cementum around the roots of the teeth and the pads between the tooth and the roots (Hewison et al., 1999; White, 1974). For this thesis the permanent first molar was selected from all of the roe and red deer mandibles (including loose lower teeth) that were available for each site of interest (See Table 1). The first molar was chosen because it is the first permanent tooth to erupt, appears within the first year of life, and will have the most accurate number of increments (Ashby & Henry, 1979; Mitchell, 1967). From this molar it is both possible to ascertain the age at and season of death of a mammal. This technique has been highly successful for species such as deer that live in northern temperate climates with a distinct contrast in seasons (i.e. summer warm with abundance, winters cold with lack of abundance).

Seasonality studies utilizing cementum increments in teeth have been especially useful in natural resource management for many decades. In this field they have been used to accurately determine the age, compare the growth, breeding performance, and survival rates of deer

populations (Mitchell, 1967). For archaeological specimens, dental cementum increments are used to determine the season that the animal had died (e.g., deer for this thesis) which enables reconstruction of culling profiles and the seasonal occupation of a site.

Once the teeth are sectioned, they are placed under a polarized light microscope and the number of translucent and opaque lines counted. The last line towards the outer portion of the cementum will indicate the season of death. By counting the increments in pairs (1 light and 1 dark), it will be possible to age the specimen as well (White, 1974).

A. *Questions*

The questions that this method aims to answer is: During which seasons were red and roe deer predominantly hunted? Through the use of the dental cementum analysis technique, it is possible to determine the season of death profile. Once the seasonal profile has been determined the secondary hypothesis question, if there were any shifts over time, can then be investigated. If any major shifts exist through time, they will be visible and can be recorded.

Seasonality can be determined using three different techniques. By observing the ages of the youngest samples, tooth eruption and wear, tooth wear scores and crown heights can provide estimation of the season of death. This is especially useful when the fawning months are known. Roe and red deer fawn around mid-May to mid-June. Although these methods will provide the season of death for the very young they do not help determine the season of death for the subadults and adults. Therefore this information will be only further discussed in Chapters 6 and 7.

Dental cementum analysis techniques on the other hand provide a season-of-death for all individuals older than one year and can provide the rest of the missing information not yet attained by the age-of-death method by identifying the outermost dental annuli location at the

Enamel Cementum Junction. Secondarily dental cementum analysis can also provide the age of an individual based on the pairs of light and dark increments that are visible. The technique for dental cementum analysis is discussed below.

B. *Technique – Thin-sectioning and dental cementum analysis*

Teeth have two components: the crown and the root. The crown is the part of the tooth that extends beyond the gum line and is responsible for chewing. The crown is also the element that experiences wear as the animal ages. Roots, on the other hand, are located in the gums and are what anchor the crown within the jaw. Roots do not experience wear as the animal ages and can be a host to many pathologies that may appear as the animal ages. These pathologies include: enamel hypoplasia, pathological growth of the roots (growing together, in unusual directions), infections, etc.

1. Components of the crown

The crown has four main components: enamel, dentine and cementum, all of which produce increments, and pulp (Lieberman & Meadow, 1992). The hard and shiny surface of a tooth is called enamel, which stops being deposited once the tooth has erupted (Hillson, 2005; Lieberman & Meadow, 1992; Lyman, 1994). Surrounding the enamel is cement; this cement forms a coating around the enamel to protect it. Cement will be further discussed in detail below. Under the enamel is another layer of dental tissue called dentine. Dentine is a very strong and highly resilient tissue, similar to ivory, which grows internally and fills the pulp cavity (Mitchell, 1967). Beyond the dentine layer is the pulp chamber of the tooth, forming the inner most layer. Unlike cementum which is deposited throughout life, dentine stops being deposited once the pulp cavity is filled (Hillson, 2005; Lieberman & Meadow, 1992). Within the pulp chamber are found the soft tissue of the pulp, dentine cells and the blood and nerves. The structure and chemical

composition of these parts will not be discussed because they exceed the scope of this thesis and are not necessary for interpreting results. Although dentine has increments, it is not suitable for study because dentine increments have a tendency to become smaller the closer to the center of the tooth they get, therefore making them very difficult to count. For this reason cementum has been the best choice for increment analysis because it is deposited at a regular rate compared to dentine, which stops once the pulp cavity has filled (Hillson, 2005; Lieberman & Meadow, 1992; Mitchell, 1967).

2. Cementum

Dental cementum is a bone-like connective tissue that is first laid down immediately before the tooth erupts. Cementum continues to be secreted throughout the life of an individual around the roots of teeth to keep the tooth attached to the periodontal ligament (the gums), and therefore maintaining the tooth's position in the jaw (Banning, 2000; Lam, 2008; Lieberman, 1994; Lyman, 1994; Mitchell, 1967; White, 1974; Wedel, 2007). Dental cement covers the external dentine surface below the gum line and also covers and protects the roots (Mitchell, 1967).Cement also forms a thick pad under the crown of molar teeth.

The rate of cementum growth is related to the rate of wear on the teeth and as a result is much greater on molars than incisors or canines (Mitchell, 1967). Consequently older individuals with heavy tooth wear have abnormally thick layers of cement around the gum line and the outer surface of the roots. It is for this reason that there is an inverse relationship between the crown height and the number of cementum increments, which indicates that older individuals will have more increments and a more worn crown than a younger individual. Cementum is also important for another reason: it is rarely remodelled or resorbed because it grows from a singular

mineralization front (avascular). In this way cementum provides a longitudinal record of the factors that affect its growth (Lieberman & Meadow, 1992; Lieberman, 1994).

3. Cellular cementum

Cellular cementum is a type of cementum found in teeth that is rich in cementocytes (also known as lacunae) and is laid down rapidly (Hillson, 2005; Lieberman & Meadow, 1992; Lieberman, 1994; Lyman, 1994). Cementocytes were originally cementoblasts (cells that are involved in the creation and laying down of cementum) that had been trapped in the cementum matrix and eventually died leaving behind holes. Cellular cementum is distinctive for this process. Cellular cementum is deposited towards the apical end of the tooth root (Hillson, 2005; Lieberman & Meadow, 1992; Lieberman, 1994; Lyman, 1994). It is believed that cellular cementum is deposited to minimize the movement of a tooth in the periodontal ligament during occlusion (Lieberman & Meadow, 1992).

Cellular cementum increments are characterized by large bands of poorly mineralized cellular cementum separated by darker thinner and more mineralized bands of cellular cementum. Because of this these increments are located around the apical end of the root and are uneven in size, distribution and width (Lieberman, 1994; Lyman, 1994). Translucent bands (hypomineralized) are bands that result from periods of rapid cementum growth, while opaque bands are periods of 'rest lines' that resulted from slower deposition periods (Lieberman, 1994).

Cellular cementum is useful in estimating the age-of-death of animals but they are not nearly as useful as acellular cementum due to their dynamic nature and uneven growth rate (Lieberman & Meadow, 1992; Lieberman, 1994). Acellular cementum is far better suited for these types of studies because it can be used for both aging and seasonality studies. The reason is

that acellular cementum grows at a much slower and constant rate (Lieberman, 1994; Lyman, 1994).

4. Acellular Cementum

Acellular cementum, unlike cellular cementum, is formed lacking the cementocytes and is formed as the result of a slower deposition process than cellular cementum (Hillson, 2005; Lieberman, 1994; Lyman, 1994). This form of cementum is deposited along a single mineralizing front at the margin of the periodontal ligament, located at the coronal end of the tooth (Hillson, 2005; Lieberman & Meadow, 1992; Lieberman, 1994; Lyman, 1994). Because it forms on a single mineralizing front, the cementum creates a longitudinal record of the factors that have affected its growth and is rarely remodelled (Lieberman & Meadow, 1992; Lieberman, 1994).

Like tree rings, acellular cementum has demonstrated a consistent relationship between annual seasons and the formation of alternating light and dark increments (Lyman, 1994; Wedel, 2007). The pattern of cement growth over a year will also correspond with body growth and the condition of the individual rather than the other features associated with the animal's lifecycle (Mitchell, 1967). Changes in cementogenesis result in incremental bands that correlate with seasonal growth in most species living in temperate regions with extreme seasonal fluctuations in availability of food resources (Lyman, 1994; Reitz & Wing, 2008). These incremental bands both appear in cellular and acellular cementum.

Within the cementum are alternating layers composed of different types of cementocytes which will be discussed below (Mitchell, 1967). One of these layers is thick and rich in cementocytes, the other will be thin with fewer cementocytes. By counting the increments in pairs of light and dark bands in cementum it is possible not just to age the individual but also to

get the age-of-death. Often this method of aging is accurate within two and a year and a half range of error (Lyman, 1994; Wedel, 2007).

Winter layers, also known as arrested cementum increments, appear as thin, dark or opaque lines under polarized light, while the summer seasons, or growth increments appear as a translucent light lines usually corresponding with summer and autumn months (Aitken, 1975; Ashby & Henry, 1979; Mitchell, 1967; Wedel, 2007). The winter layers correspond with periods of starvation usually around late winter and early spring (Mitchell, 1967).

Thin section analysis provides information on the condition of the hunted animals and the seasons during which they were hunted. This type of analysis provides a more holistic outlook of the entirety of the natural resources exploited in the region during the Neolithic. Additionally, according to Mysterud and Østbye (2006), tooth sections are the most widely used ageing method in ungulate research in Scandinavia and North America. It has proven to be a highly reliable ageing technique for a number of ungulates inhabiting the strongly seasonal environments of the northern latitudes.

White broad bands represent summer and autumn, the two seasons during which food is easily accessible. These white bands represent an abundance of engulfed cells called cementocytes. Dark narrow bands represent winter and spring, the seasons when food is less available. The dark bands represent amorphous acellular material (Aitken, 1975). The pattern of alternating light (translucent) and dark (opaque) increments in cementum, as seen under transmitted polarized light, corresponds with histological differences in the orientation of collagen fibres and their degree of mineralization (Lam, 2008).

Tooth sectioning is based on counting annuli in the tooth cementum, which arise due to seasonally retarded growth during winter and increased growth during summer (Mysterud & Østbye, 2006).

5. What causes these increments?

These increments reflect the rate and growth during an annual cycle, as discussed above. Incremental structures are found in all three types of dental tissue: dentine, cementum, and enamel (Lyman, 1994). However, these increments do not always show the same patterns. For example, only cementum (specifically acellular cementum) has a correlation with a seasonal deposition.

Two major factors that contribute in the differences in the translucent and opaque cementum bands. The first factor is the variation in the relative mineralization of the cementum. The second factor is the variation in collagen orientation within the tooth. Lieberman (1994), Lyman (1994) and Wedel (2007) describe this process for cementum by stating that hyper-mineralized layers of extracellular matrix alternate with less mineralized layers creating alternating light and dark increments much like tree rings are created. Cementum is laid down first just before the tooth erupts and more layers are added as the animal ages until it dies. Secondary causes of banding are the factors that vary seasonally or annually which influence the aspects of the cementum microstructure that creates the bands (Lieberman, 1994).

6. Rate of mineralization

Nutritional - Changes in the rate of mineralization of cementum bands may be caused by three factors. The first factor to change the rate of mineralization is calcium deficit, which may be caused by poor diet and may relate to the available calcium supply in the body for mineralization, therefore resulting in what is called hypo-mineralized bands. The second is

nutritional deficit, which could slow the mineralization front by inhibiting cementogenesis, resulting in hyper-mineralized bands that are denser and less cellular. Third, nutritional deficit can reduce the production of Sharpey's fibers in the periodontal ligament, therefore resulting in bands that are hyper-mineralized (Lieberman, 1994; Lyman, 1994).

Biochemical - Cementum bands may reflect responses to biochemical stress (forces) and strain (deformation) from changes in the quality of resources available and the hardness of the seasonal diets (Lieberman, 1994; Lyman, 1994). For example, the diet for animals during dry or winter seasons is often tougher and lower in nutritional quality than diets during wet or summer seasons.

Cementum could respond to higher strains in three ways. The first is by increasing the number of collagen fibre bundles that attach it to the periodontal ligament. The second is by growing more slowly, therefore resulting in greater mineralization. The third is by mineralizing Sharpey's fibres at a more vertical angle during periods of increased occlusal forces (Lieberman, 1994).

However in most cases, acellular cementum bands probably result from differences in both collagen orientation and relative mineralization, because seasonal changes in diet usually affect levels of occlusal strain as well as the nutritional status of animals (Lyman, 1994). Mitchell (1967) states that the growth of cementum most likely corresponds with the body growth and condition rather than any other features of the individual's annual life cycle.

Although Lieberman (1994) discusses the possible effects of hormones (specifically estrogen and testosterone), there is very little evidence for a direct relationship between cementum deposition and growth and reproductive activity. Lieberman states that both males and females exhibit the same banding patterns, even if their reproductive behaviors are different.

However, there is a possibility that nutritional stresses caused by events such as pregnancy or the rut can cause changes in the growth of cementum, and therefore result in rut lines in males and milk lines in females (Lieberman 1994). Simply, changes in strain and nutrition can independently cause cementum banding, but for very different reasons.

By using this method, the number of bands can provide information about the age at which an individual has died, provided the increments are occurring at a regular rate. Additionally the season of death can be obtained by observing whether the outermost band is translucent or opaque (Lieberman & Meadow, 1992).

C. ***Sample preparation and digital recording for thin-sectioning***

In order to accurately record the seasonality of deer teeth, the teeth need to be properly documented before dental cementum analysis was started. Teeth were checked against each site database, tagged, bagged and then entered into a database. Crown heights, tooth lengths and widths were measured and entered into the database. Tooth wear patterns were then recorded and entered into the database. The tooth wear patterns for roe deer were recorded based on the scheme created by Tomé & Vigne (2003). The red deer tooth eruption and wear patterns recorded in the Greenfield's database were linked to Brown and Chapmans (1991) control study.

Teeth from aurochs, wild boar, roe deer and red deer were sorted from their storage at the University of Manitoba Anthropology lab and organized into site, period, and species. Sites with less than five samples were omitted because they do not provide enough information about the age variation over time between these species (e.g., Vinča has only one roe deer mandible). Any other wild fauna were not included due to their considerably low representation.

Although this is not a method, the second stage of preparation of samples was the recording of the mandibles and teeth in each sample. Two different techniques were used to

document these samples prior to destruction. The first technique was traditional recording methods such as drawing and measurements. The second technique is each was digitally photographed from a variety of angles.

Drawings were made of each mandible and loose tooth from their occlusal, lingual, buccal mesial, and distal sides. A dorsal view was also drawn to show the tooth wear pattern of the teeth. Measurements were made using digital calipers, of each tooth and mandible based on the measurements provided in Von Den Driesch (1976). The following measurements were made for each mandible: total mandible length, premolar and molar row length, and lastly the length, breadth, and height of each tooth.

For the digital method, digital photographs were taken of the same faces as was drawn. This was done to create a digital recording of the teeth before they were thin sectioned. Each tooth was placed on a dark background with a scale to show their actual size. Just as was done with the drawings all faces of the sample were photographed.

1. Extraction and Preparation

In preparation for dental cementum analysis, the teeth that are still attached to the mandible are removed from the mandible by using a hack saw, taking care not to damage the roots. The use of a hacksaw on the initial preliminary samples was found to be damaging to the mandible and at times to the molars being extracted. Later samples were extracted using an electric band-saw which had greater control and maneuverability. Great care needed to be made also extracting the teeth from the alveolar bone which anchors it into the mandible; often it was found a dental pick was enough to dislodge the tooth. Once all of the first molar teeth are removed from the mandible they were measured, photographed.

For dental cementum analysis, all first molars were soaked in Ethanol for 24-48 hours to remove any excess moisture. A resin solution was then prepared using 1.9g of epoxy hardener and 5.0g of resin. Typically with larger teeth it is possible to double or triple the solution, however it was found that larger tooth samples require less hardener since they tend to harden much more quickly compared to smaller teeth due to the surface area of the mold holding the teeth is greater. To make a proper resin mold, these measurements had to be as exact as possible otherwise the solution will not work. Once the solution was measured in separate cups, the hardener was poured into the resin and gently mixed together. The solution was then poured into holders coated in release agent (unless the holder is coated in saran wrap). The hardening agent and resin were mixed for one minute until the solution is clear. Once mixed the mixture was placed within a vacuum for 5-6 hours. Once the resin is semi hardened and the tooth was placed on the first layer of resin, repeat the process. The goal is to remove as many bubbles as possible. During this process it was found that larger teeth had a tendency to produce more bubbles therefore requiring a lot of observation. Often it was found that smaller bubbles do persist but they often reach the surface of the resin and are not hindering the resin around the tooth as much as it would on a smaller tooth. Large bubbles are to be avoided at all times.

2. Making thin sections

The teeth were cut on an Isomet 100 diamond edged saw with the weight between 76-26 grams and a speed of 100. This is standard for cutting teeth and avoiding scratches, it was found however that a weight of 80-90 grams and a speed of 150-200 is also effective and can be efficient for cutting many teeth without major scratches. Great care was needed to make sure the cutting plane was a straight as possible on the longitudinal plane (Figure 6) to reduce the time spent grinding the teeth down to a proper thickness later.

Once the first cut was made a slide was placed on a hot plate. Once the slide was warm a small amount of dental wax is placed on the slide and the side of the section intended for examination will be carefully placed on the dental wax, taking care not to create any air bubbles. Once the tooth is stuck to the slide, the slide was placed back on the saw and the cut was repeated. Some slides require the use of a slide chuck – these are for samples that could not be placed into the conventional chuck.

3. Polishing and mounting the thin sections.

Once the sections were cut, they needed to be polished to reduce the number of scratches or gouges that were visible from the saw blade and to make the thin sections clear. Polishing allowed the sections to be better viewed under a polarized microscope, scratches and gouges make it harder to count any increments in the section. The sections were mounted on a slide slide-mount. To polish the slides, the 600µm sand paper was used initially to reduce the thin section down to 0.25 mm. Once this is done the slide needs to be cleaned so that there is no debris left over from polishing, which could damage or scratch the sample. Because the 600µm sand paper was used, the slide was then placed in the 600µm bath to remove the debris for about a minute. Then, the thin section will be polished on the 5ųm polishing cloth until the scratches are no longer visible. Then, the slide with the thin section is placed into the 5µm bath and let it vibrate to remove the loose debris for a minute. Next, the thin section is polished on the 3µm polishing cloth until it becomes glossy. Afterwards, the slide and thin section were placed into the 3µm bath for one minute.

Once polishing is complete, the slide is ready to be mounted permanently. First, the fresh permanent slide is cleaned with ethanol to remove any vestigial dirt. Once the slide is clean, it is placed aside to dry for 3 minutes. While the permanent slide dries, ultra violet resin is spread on

the surface of the thin section. Using bulldog clips, the thin section is sandwiched between the wax slide and the newly cleaned permanent slide. The sandwiched slides are then placed under a UV light for 1 minute. After 1 minute, the two sandwiched slides are then placed on a hot plate with the wax slide facing down. This will cause the wax slide to release the thin section. Once the wax slide is removed the permanent slide with the thin section now attached is placed in a shallow dish of xylene waste. The Xylene waste will remove any excess UV resin in a few minutes. After soaking in the Xylene waste, the slide must sit for one hour in a fume hood until the fumes from the Xylene waste have dissipated.

D. ***Teeth not suitable for sectioning***

Throughout the documentation process it was found that some of the samples were not viable for sectioning. The following criteria are required for teeth to be sectioned.

1. Tooth wear, tooth wear score (where applicable) and crown height must be established
2. The root must be at least 50% intact;
3. The enamel must be intact, it cannot be broken from the tooth;
4. At least one cusp must be intact; and
5. The tooth for sectioning must be a first molar; all other teeth will not be sectioned due to inaccuracies in ageing created by eruption cycles (e.g. the first molar is the first permanent tooth to erupt and come into wear).

Any teeth that do not meet these criteria were omitted from the analysis, but documented as much as possible. First molars that have these criteria were removed from the mandibles and sectioned. Similarly, sites with less than five samples as mentioned above in the sample size section were omitted from the analysis. This meant that sites such as Blagotin, Vinča, Hajdučka

Vodenica, and Foeni-Salaş were omitted from the seasonal analysis due to small or no samples being present.

VI. Conclusion

The goal of this thesis is to learn at what age and season red and roe deer died at each site under investigation. This chapter discussed the various methods and techniques that were used to analyze the deer teeth from the sites under investigation. These methods and techniques include: preliminary data extraction and analysis from pre-existing databases which will be described fully in chapter 6, age-of-death which used the tooth eruption and wear, crown height and tooth wear score (for red deer only) techniques, and season-of-death which used primarily tooth eruption and dental annuli analysis.

Age-of-death results were collected using several techniques as described in this chapter. Tooth eruption and wear is a two-fold technique. The first step is to identify which teeth are erupted and which are not. For example, if the M3 is fully visible, erupted, and in wear, the individual is considered to be an adult. If the M1 is not present, but the dPM2, 3 and 4 are present, the specimen is from a juvenile individual. The second part of the technique is tooth wear analysis, which takes schematics from known aged deer (Brown & Chapman, 1991; Hewison et al., 1999; Høye, 2006; Lowe, 1967; Mysterud & Østbye, 2006; Tomé & Vigne, 2003) and compares the archaeological samples to these schematics. Each schematic or drawing will correspond to an age or age class.

Since teeth are in wear the moment they erupt through the gums, crown heights measures the age of individuals based on the amount of vertical wear on the crown of the tooth. If the crown is fully erupted, but with little wear, the individual is young. How young, depends on which tooth is being examined. If the crown is short with a lot of wear, the individual may be old

for the M3, but younger for the M1 or 2. Simple formulas are then used to calculate the age in months based on these measurements (see Chapter 5).

Tooth wear scores take the tooth and view it from the occlusal surface. As proposed by Brown and Chapman (1991), a schematic and code is then used to determine the level of wear. These schematics are ranked by a point system that is then calculated by observing the degree that dentin and enamel are visible on the surface.

Dental cementum analysis is the most intensive and expensive of the techniques used for ageing. Originally, dental cementum analysis was intended for the analysis of the season-of-death, but it is also very useful for determining the age-of-death for an individual (Greenfield, 2015c). Since dental annuli are deposited biannually, with a dark line in the cooler months and light line in the warmer months, it is possible to count every second line as a year. Therefore, it is possible to determine the age of an individual by the alternating pairs of light and dark lines visible in the cementum. This is a very simple technique for age-of-death analysis and it has often been found to be useful for testing the validity of the other techniques discussed above.

Season-of-death also utilized tooth eruption and wear analysis for younger specimens. With the use of all of these technique, as discussed by (Mysterud & Østbye, 2006) it may be possible to combine several methods to improve the accuracy in determining the age-of-death. However, this would only work if the same individuals are not over or underestimated by the methods used. Great care was taken to document each step as teeth were examined. Photographs and measurements were taken at every stage. With the use of tooth eruption and wear, crown height analysis, tooth wear scoring and dental cementum analysis it is possible to gain insight into the seasonal exploitation patterns during the Neolithic.

The next chapter will discuss the data under investigation in this thesis. The chapter will describe the sample size and the wild animal frequencies. Additionally all of the relevant deer data including: frequencies (wild vs. domestic, deer taxa and etc.) teeth recovered from site, teeth found in data set, antlers, etc. that could be obtained before analysis is presented in Chapter 6.

Chapter 6 Data Description

I. Introduction

The goal of this chapter is to examine the variation in wild fauna exploitation strategies within the central Balkans and over time, with a focus on the seasonal exploitation of red and roe deer. The data sets analyzed in this thesis were chosen because they were the most readily available for analysis, as well as being relevant (chronologically and spatially) to the research questions.

This chapter focuses on the red and roe deer data and describes the elements that are most useful for seasonality and age-at-death. These include the antler, loose teeth, mandibles and maxilla. All specimens considered to be wild, regardless of their taxonomic level of identification, are included in the analysis below. The database results will appear different than the results based on the past literature discussed in Chapter 3. The reason is that unknown specimens and taxa are only identified to the genus level (excluding fish, snails and birds), and are presented in much of the literature to illustrate how many specimens are found at each site. However, the focus is on the known specimens only, and with a focus on red and roe deer. For this reason, these unknown categories were excluded in the analysis in order to simplify the data and to illustrate any environmental or temporal patters more clearly. Similarly, the tables in this chapter will report all age classes (including subadult/adult and etc.). The text in this chapter will only discuss the confirmed age classes (adult, subadult, and juvenile). Unknown or questionable age classes (e.g. adult?) are not included in both the tables and the text in order to simplify the data. Age classes, such as subadult/adult, are kept because with some elements it is impossible to tell one from the other based on size, fusion, muscle marking, or porosity.

II. Early Neolithic Starčevo-Criș culture assemblages

A. *Blagotin*

1. Wild fauna frequency

At the site of Blagotin, there are a total of 8649 specimens identified to a taxon of family or lower. Of these specimens, 661 (7.64%) are from wild taxa (Table 5), with the remainder representing domestic taxa. The most common wild taxa at Blagotin are red deer (*Cervus elaphus*) (39.49% of wild taxa), roe deer (*Capreolus capreolus*) (28.44%), wild boar (*Sus scrofa fer.*) (12.25), land snail (*Unio pictorum*) (7.41%), Aurochs (Bos *primigenius*) (6.66%), and European hare (*Lepus europeaus*) (3.18%). The remaining wild fauna occurred under 1% and can be seen in Table 6.

2. Red and roe deer frequency

Red and roe deer are the most common wild taxa. They comprise 449 specimens of the 661 total wild specimens recovered and identified to an identified taxon (Table 7). At Blagotin, red deer (58.13%) are far more common than roe deer (41.87% of the total deer sample).

3. Deer elements

Nearly all elements are represented in the red and roe deer samples. In the roe deer sample the most common elements are the thoracic vertebrae (6.90%) followed by metatarsals (4.9%) and both the tibia and scapula (3.79% each) (Table 8). Cranial elements are the most common (8.91%) red deer element, followed by radius (4.45%), and the metatarsus (4.90%). Based on the fact that there are nearly all elements present, it is clear that in most cases the entire deer was brought to the site after hunting.

Antler was present in both the red and roe deer assemblages. Roe deer have a total of three antlers (0.67%) (Table 9). All roe deer antler samples (NISP = 3) are from fragments. Red

deer have a total of 26 antler samples (5.79%). The majority of the samples are from antler fragments followed by shafts and tine tips. There is no information available to determine if these antlers were shed or not, therefore it is impossible to tell if the antlers were attached to the cranium when the animal was killed or shed and collected.

4. Teeth and mandible frequency in database

The deer tooth sample only accounts for a 0.45% of the total deer assemblage. Roe deer teeth remains are fewer (NISP = 2). This includes: one lower loose tooth and one upper loose tooth (0.22% respectively) (Table 10). Red deer teeth represent only 3.35% of the total deer sample. These samples include: two maxillae with teeth (0.45%), seven lower loose teeth (1.77%), four upper loose teeth (0.89%), and one loose tooth fragment (0.22%). There is also a single loose tooth associated with a mandible (0.22%).

5. Deer teeth

Based on the overall database, roe deer account for 13.33% of the sample (Table 11). This sample includes: one lower loose tooth and one upper loose tooth, each make up 6.67% respectively. The red deer tooth sample accounts for the remaining 86.67% of the deer tooth sample. These teeth include: eight lower loose teeth (53.35%), three upper loose teeth (26.65%). and one mandible with a loose tooth associated with it (6.67%).

6. Roe deer frequencies only

There are a total of 188 roe deer specimens from Blagotin (Table 12). When comparing only the roe deer elements, teeth only make up 4.98% of the roe deer sample. Each tooth described above accounts for 0.53% of this sample respectively.

7. Red deer frequencies only

The red deer sample has a total of 261 specimens; teeth only make up a total of 5.36% of this sample (Table 13). The teeth from this sample include: four maxillary teeth (1.53%), and eight lower loose teeth (3.43%).

8. Teeth found in collection and considered for thin-sectioning analysis

Seven samples of mandibles and teeth from red deer from Blagotin were identified in the assemblage. The two samples include one loose maxillary premolar 3 or 4 and two fragmentary maxillae with teeth one with a premolar 4 and molar 1 and the second with only the molar 2 and 3. The remaining mandibular teeth include: one mandible with a fragmentary molar 1 and 2, a loose molar 2, a fragment of a molar 1, and a loose premolar 2.

All seven teeth from the red deer sample are used for tooth eruption and wear analysis, tooth wear scoring and crown height analysis. Based on previous analysis completed by Haskel Greenfield, all teeth are from adults, but one may have been a subadult or adult. Out of this small sample, only one tooth is confirmed as a mandibular molar 1. However, because the tooth is fragmentary, it is not suitable for cementum analysis. Therefore, no teeth from the Blagotin sample were used in the dental cementum ageing and seasonal analyses.

B. ***Hajdučka Vodenica***

1. Wild fauna

At Hajdučka Vodenica, there are a total of 5 identified wild taxa. From these wild taxa, there are 28 specimens, which account for 66.66% of the total fauna found at the site (Table 14). These are red deer (82.14%), wild boar (7.14%), aurochs (3.57%), brown bear (Ursus *arctos*) (3.57%) and unidentified fish (3.57%) (Table 15). The percentages show that red deer were the most common wild taxon followed by wild boar, aurochs, brown bears and fish. There were no

roe deer found at Hajdučka Vodenica and this is very unusual for a site from the Neolithic in the central Balkans.

2. Wild fauna elements

At Hajdučka Vodenica, there are no roe deer remains, and very few red deer remains (NISP=23). The most common remains were cranial fragments (52.17%) (Table 16). Within the cranial element group of fragments, there are a four antler samples, all of which are shed antler bases. The second most common element is the scapula (13.04%). The number of elements does not accurately represent the red deer at the site; this may be due partly to the collection methods. Hajdučka Vodenica was hand collected rather than sieved and many of the smaller elements may have been overlooked during the excavation (Greenfield, 2008).

3. Red deer only

The red deer sample has a total of 23 specimens (Table 16). Many different elements are present, as described above, but teeth were not found. The absence of teeth is probably because they were small and missed by the excavators. For this reason, there are no samples available for analysing age or season-of-death. This sample will only serve as a comparison for the first half of the analysis.

C. *Bukovačka Česma*

1. Wild fauna

At Bukovačka Česma there are a total of 241 specimens from 11 different identified taxa found at the site during excavations (Table 17). Three of these taxa are from domesticated taxa (41.49%). The remaining eight taxa were from wild taxa (58.51%).

There are a total of 141 wild specimens (Table 18), represented by red deer (56.03%), wild boar (19.86%), roe deer (11.35%), beaver (Castor *fiber*) (5.67%), unidentified fish (2.84%),

aurochs (2.13%), land snail (1.42%), and brown bear (0.71%). These percentages show red deer are the most common followed by wild boar, and roe deer out of the wild fauna.

2. Red and roe deer

As shown above, red and roe deer are the most common wild taxa. Comparing just the deer, red deer are far more common than roe deer with 83.16% of the total deer sample (Table 19). Roe deer only make up only a total of 16.84% of the deer sample.

3. Red and roe deer elements

In total, there are 16 roe deer specimens at Bukovačka Česma. The most common element is the scapula (4.21%), followed by ilium, metacarpus 3-4, and tibia elements (2.11%, each) (Table 20). The red deer sample is larger with 79 specimens. Nearly all elements are present in the red deer assemblage. The most common specimens are the humerus, lumbar vertebrae, and the radius (8.42% each). There are a total of four antler fragments present in the sample, all of which are from red deer. All of the red deer antler samples consist of base fragments. No antler fragments were found from roe deer

4. Deer elements vs teeth

The roe deer sample accounts for 16.84% of the total deer sample (Table 20).No teeth were found in the roe deer sample. Red deer make up 83.16% of the deer sample, 2.11% of this total accounts for the tooth sample. This sample comprises of only two mandibles with teeth.

5. Red deer only

The red deer sample has a total of 79 specimens, of these the teeth only make up a total of 2.53% of that sample (Table 21). These teeth are as stated above two mandibles with teeth. Due to the tooth sample being much smaller than needed for dental cementum analysis, this sample was excluded from the season-of-death analysis.

D. ***Foeni-Salaş***

1. Wild fauna

At Foeni-Salaş, there were a total 2571 identified specimens and 34 different taxa. Of the 34 taxa, 28 were from wild animals. These taxa account for 538 identified specimens (20.93%) (Table 22). The wild taxa are unidentified fish (25.84%), red deer (21%), roe deer (16.36%), aurochs (11.71%), wild boar (7.25), unidentified bird (5.02%), European turtle (*Emys orbicularis*) (3.90%), European hare (1.86%), land snail (1.12%),), unknown snail (1.12%) (Table 23). These percentages show that fish, red deer and roe deer are the most common taxa out of the wild fauna. They are followed by aurochs, wild boar, unidentified birds, European turtle, European hare, and snails respectively.

2. Red and roe deer

Red and roe deer account for 201 identified samples out of the overall sample. As shown above, red deer are the most common and roe deer are the third most common taxa. Red deer are far more common than roe deer with 56.22% of the total deer sample. Roe deer account for only 43.78% of the sample (Table 24).

3. Deer elements

At Foeni-Salaş, both red and roe deer are represented by nearly every element. The roe deer sample has a total of 88 specimens. Among these specimens the most common elements are the metatarsus (9.95%) and the humerus (5.47%), all other elements occur in lower frequencies (Table 25). The red deer sample is represented by 113 specimens. The most common elements are tarsals (7.46%), metatarsals (6.97%), cranial, and vertebral elements (6.47% respectively).

For the roe deer sample, all antlers were attached to cranial elements. Roe deer antlers make up a total of 1.49% of the deer element sample with only three specimens (Table 26). Two

of the roe deer antler samples are still attached to the skull while the remaining sample is loose (possibly collected post shedding). The red deer antlers make up 4.48% of the deer element sample with eight specimens. There is no indication if the red deer antlers are still attached to the skull or loose.

4. Deer elements vs teeth

As stated above, the roe deer make up 43.78% of the deer sample (Table 27). Of this 43.87%, the tooth sample only accounts for a very low amount - 3.49%. This includes three lower loose teeth (1.49%), two upper loose teeth (1%) and two mandibles with teeth (1%). Red deer make up 56.22% of the deer sample, 3.98% of this total accounts for the tooth sample. These samples include: one lower loose tooth (0.50%), two upper loose teeth (1%), and five mandibles with teeth (2.49%).

5. Deer teeth

When comparing the deer tooth samples, separate from the elements, red deer outnumber the roe deer. Roe deer account for 43.78% of the sample (Table 28), nearly equal to the red deer sample. This sample includes: three lower loose teeth (20.00%), two upper loose teeth (13.33%) and two mandibles with teeth (13.33%). The red deer tooth sample accounts for the remaining 53.33% of the sample. These teeth include: one lower loose tooth (6.67%), and two upper loose teeth (13.33%). and five mandibles with teeth (33.33%).

6. Roe deer only

There are a total of 88 specimens in the roe deer sample from Foeni-Salaş (Table 29). When comparing all of the elements, teeth make up 7.95% of the sample. These samples are: three lower loose teeth (3.41%), two upper loose teeth (2.27%), and two mandibles (2.27%).

When the teeth are examined alone, the lower loose teeth make up 42.86% of the tooth sample; the upper teeth make up 28.57%, the mandible with teeth accounts for 28.57% of the sample.

7. Red deer only

The red deer sample has a total of 113 specimens. The red deer teeth only account for a total of 7.07% of the overall red deer sample (Table 30). The teeth include: one lower loose tooth (0.88%), two upper loose teeth (1.77%) and five mandibles with teeth (4.42%). The tooth sample accounts for: one lower loose tooth which makes up 12.50% of the sample, followed by two upper loose teeth (25%), and five mandibles with teeth (62.50%).

III. Middle Neolithic Vinča A

A. *Sânandrei*

1. Wild fauna

At Sânandrei, a total of 567 identified specimens were recovered from the site. Of these specimens, 224 are from wild taxa, which account for 39.51% of the total assemblage (Table 39).

There are a total of 6 wild taxa found at Sânandrei. The most common of these taxa are red deer (44.20%), wild boar (33.04%), and roe deer (20.98%). All other wild fauna are below 1% and can be seen in Table 40.

2. Red and roe deer

The deer found at Sânandrei are red and roe deer (Table 41). Roe deer has a total of 47 specimens and make up 32.19% of the deer sample. Red deer has a total of 99 specimens with a total percentage of 67.81%.

3. Deer elements

Nearly all elements are represented at Sânandrei for red and roe deer. The most common elements for roe deer are: mandibles (7.53%) followed by scapulae (4.11%) and humeri (5.42%).

For red deer the most common elements are antler (10.27%), followed by tibias (8.22%), and scapulae (6.16%) (Table 42). Both red and roe deer samples from Sânandrei have antlers in their assemblage. The roe deer antler sample only has one antler base, which is unclear if it was hunted or collected by the inhabitants at the site. The red deer sample has a total of 16 antlers. One of the antlers was still attached to the cranium and was classified as cranium in the database for this reason. This signifies that red deer, like the roe deer antlers were not all collected.

4. Deer elements vs teeth

The roe deer tooth sample accounts for 8.21% of the overall deer sample. This sample includes: one lower loose tooth (0.68%) and 11 mandibles with teeth (7.53%). The red deer tooth sample makes up 6.84% of the total deer sample. These samples include: one lower loose tooth (0.68%), one upper loose tooth (0.68%), and eight mandibles with teeth (5.48%) (Table 42).

5. Deer teeth only

The roe deer tooth sample accounts for 54.55% of the overall deer sample. There are a total of 12 tooth specimens (Table 43). These specimens include: one lower loose tooth (4.55%), and 11 mandibles with teeth (50.00%). The red deer tooth sample accounts for the remaining 45.45% of the overall deer sample with 10 tooth specimens. These specimens include: one lower loose tooth (4.55%), one upper loose tooth (4.55%), and eight mandibles with teeth (36.36%).

6. Roe deer only

Roe deer have a total of 47 specimens from the Vinča C sample from Sânandrei (Table 44). The tooth sample makes up 25.53% of the overall roe deer sample. These tooth samples are: one lower loose tooth (2.13%) and 11 mandibles with teeth (23.40%).

7. Red deer only

The red deer sample has a total of 99 specimens. Of these specimens, the teeth make up a total of 6.50% (Table 45). These specimens include: one lower loose tooth (1.01%), one upper loose tooth (1.01%) and eight mandibles with teeth (8.08%).

8. Teeth found in collection

A total of 10 deer teeth were found in the sample from Sânandrei. All of these teeth were from mandibles with teeth from roe deer. All eight teeth from the roe deer sample will be used for tooth eruption and wear analysis, tooth wear scoring and crown height analysis. Based on the previous analysis, all eight teeth were successfully aged (Jongsma and Greenfield 1996). Out of these teeth, four were from adults, and one from a subadult and three were from either subadults or adults. Of the eight teeth that were successfully aged, only three were chosen for cementum analysis.

A. ***Stragari***

1. Wild fauna

In the Middle Neolithic levels at Stragari, there are a total of 2332 identifiable specimens. Of these specimens, there are 2178 identifiable specimens from wild fauna accounting for up to 75.94%the faunal assemblage (Table 46). In this sample there are over 18 wild fauna. The most common of these wild fauna are: red deer (66.92%), roe deer (21.35%), wild boar (6.20%), and aurochs (3.63%) (Table 47).

2. Red and roe deer

Roe deer have a total of 506 specimens as stated above and make up 24.19% of the deer sample (Table 48). Red deer have a total of 1586 specimens representing 75.81% of deer specimens.

3. Deer elements

All elements are represented for red and roe deer. The most common roe deer elements are metatarsus 3-4 (3.52%), mandibles with teeth (2.08%), and radii (1.22%). For red deer the most common elements are metatarsus 3 and 4 (11.55%), metacarpus 3-4 (8.82%), and unidentifiable metapodials 3-4 (6.67%) (Table 49).

There are a total of 12 antler samples. Of these samples only one is from roe deer (0.5%) and the remaining 11 (0.53%) are from red deer (Table 50). It is unclear if these antler specimens are attached or not.

4. Deer elements vs teeth

The roe deer sample accounts for 2.54% of the overall deer sample. These teeth include: two lower loose teeth (0.10%), six upper loose teeth (0.29%), 40 mandibles with teeth (1.91%), and five maxillae with teeth (0.24%) (Table 49). The red deer tooth sample makes up 5.07% of the total deer sample. These teeth include: one loose tooth fragment (0.05%), 29 lower loose teeth (1.39%), 27 upper loose teeth (1.29%), 23 mandibles with teeth (1.53%) and 17 maxillae with teeth (0.81%).

5. Deer teeth only

The roe deer tooth sample accounts for 33.33% of the overall deer sample with a total of 53 specimens (Table 51). These specimens include: three lower loose teeth (1.26%), six upper loose teeth (3.77%), 40 mandibles with teeth (25.16%) and five maxillae with teeth (3.14%). The red deer tooth sample accounts for the remaining 66.67% of the sample with 106 specimens. These specimens include: one loose tooth fragment (0.63%), 29 lower loose teeth (18.24%), 27 upper loose teeth (16.98), 32 mandibles with teeth (20.13%), and 17 maxillae with teeth (10.69%).

6. Roe deer only

Roe deer have a total of 506 specimens (Table 52). When comparing teeth to all elements, teeth make up 10.49% of the sample. These tooth specimens include: two lower loose teeth (0.40%), six upper loose teeth (1.19%), 40 mandibles with teeth (7.91%) and five maxillae with teeth (0.99%).

7. Red deer only

The red deer sample has a total of 1586 specimens. The teeth in this sample only account for a total of 6.68% of that sample (Table 53). These include one loose tooth fragment (0.06%), 29 lower loose teeth (1.83%), 27 upper loose teeth (1.70%), 32 mandibles with teeth (2.02%), and 17 maxillae with teeth (1.07%).

8. Teeth found in collection

A total of 17 deer teeth were found, of which three are from roe deer. All three roe deer dental samples were from mandibles with teeth. There were also fourteen red deer teeth in this sample, which include eleven mandibles with teeth, one maxilla with teeth, one lower loose tooth, and one upper loose tooth. All 17 teeth from the red and roe deer sample will be used for tooth eruption and wear analysis, tooth wear scoring and crown height analysis. Two of the roe deer are from adults and one from a juvenile. The red deer sample consisted of seven mandibles with teeth, five of which are from adults and two from subadults. There is also one lower loose tooth in the red deer sample that was from an adult. A total of four teeth (3 red deer and 1 roe deer) from Stragari were chosen for cementum analysis.

IV. Middle Neolithic Vinča B

A. *Petnica*

1. Wild fauna

During the Vinča B period at Petnica, a total of 2451 identifiable specimens were identified. Of these specimens, the wild taxa account for 1705 specimens (69.56%) (Table 31). The most common wild fauna are: red deer (70.09%), roe deer (11.67%), wild boar (9.62%), aurochs (4.11%), and beaver (2.05%) (Table 32). During this time period red and roe deer are the most common wild taxa exploited at the site.

2. Red and roe deer

Red deer are the most common of the deer taxa exploited during the Middle Neolithic at Petnica with a total of 1195 specimens 85.72%. Roe deer have a total of 199 specimens, as stated above, and make up the remaining 14.28% of the deer sample (Table 33).

3. Deer elements

In Petnica's Vinča B levels, nearly all skeletal elements are represented for red and roe deer. Among the roe deer elements, the most common are the metatarsus 3-4 (3.52%) followed by mandibles with teeth (2.08%), and radii (1.22%). For the red deer in the sample, the most common elements are the metatarsus 3-4 (11.55%), metacarpus 3-4 (8.82%), and unidentified metapodials (6.67%) (Table 34). In the overall Vinča B sample there are 58 antler samples. 15 of these samples are from roe deer (25.86%). Red deer antlers account for 74.14% of the deer sample (Table 35). However, it is unclear if these antlers were shed or still attached to the cranium.

4. Deer elements vs teeth

The roe deer tooth sample accounts for 2.94% of the total deer sample (Table 34). This tooth sample includes: seven lower loose teeth (0.50%), one upper loose tooth (0.07%), 29 mandibles with teeth (2.08%), and four maxillae with teeth (0.29%). The red deer tooth sample makes up 14.86% of the overall deer sample. These tooth samples include: four loose tooth fragments (0.29%), 44 lower loose teeth (3.16%), 38 upper loose tooth (2.73%), 75 mandibles with teeth (5.38%) and 46 maxillae with teeth (3.30%).

5. Deer teeth only

Roe deer tooth sample, separate from the elements, accounts for 16.53% of the sample with 41 specimens (Table 36). These include: seven lower loose teeth (2.82%), one upper loose tooth (0.40%), 29 mandibles with teeth (11.69%) and four maxillae with teeth (1.61%). Red deer tooth sample accounts for the remaining 83.47% of the sample with 207 specimens. This tooth sample includes: four loose tooth fragments (1.61%), 44 lower loose teeth (17.74%), 38 upper loose tooth (15.32%), 75 mandibles with teeth (30.24%), and 46 maxillae with teeth (18.55%).

6. Roe deer only

Roe deer have a total of 199 specimens in the Late Neolithic sample from Petnica (Table 37). When comparing all of these elements from the tooth specimens, the teeth make up 20.60% of the sample. These teeth include: seven lower loose teeth (3.52%), one upper loose tooth (0.50%), 29 mandibles with teeth (14.57%), and four maxillae with teeth (2.01%).

7. Red deer only

The red deer sample has a total of 1195 specimens. The teeth in these specimens only make up a total of 17.32% of that sample (Table 38). These teeth include four loose tooth

fragments (0.33%), 44 lower loose teeth (3.68%), 38 upper loose teeth (3.18%), 75 mandibles with teeth (6.28%), and 46 maxillae with teeth (3.85%).

8. Teeth found in collection

A total of 41 deer teeth are found in the sample from Petnica. Of these 41 samples, there are a total of 21 roe deer teeth and all 21 samples are mandibles with teeth. Of these teeth, 19 were from adults and two are from subadults. The remaining 20 teeth are from red deer. These teeth are: five lower loose teeth, three upper loose teeth, and 18 mandibles with teeth.

All 41 teeth from the roe deer and red deer samples were used for tooth wear and eruption, tooth wear scoring and crown height analysis. All 21 roe deer teeth were mandibles with teeth, 18 of which are from adults and two from subadults. Of the 21 teeth, two will be used for cementum analysis. There are a total of 20 red deer teeth, of which only two will be used for cementum analysis. Out of these 20 teeth found in the collection, 15 were mandibles with teeth, ten of which are from adults, and the remaining five from juveniles. There were also three lower loose teeth from adults. From the red and roe deer tooth sample, a total of 4 teeth (2 red deer, 2 roe deer) were used for cementum analysis from the Vinča B levels of Petnica.

V. Late Neolithic (Vinča C)

A. *Sânandrei*

1. Wild fauna

At Sânandrei, a total of 567 identified specimens were recovered from the site. Of these specimens, 224 are from wild taxa, which account for 39.51% of the total assemblage (Table 39).

There are a total of 6 wild taxa found at Sânandrei. The most common of these taxa are red deer (44.20%), wild boar (33.04%), and roe deer (20.98%). All other wild fauna are below 1% and can be seen in Table 40.

2. Red and roe deer

The deer found at Sânandrei are red and roe deer (Table 41). Roe deer has a total of 47 specimens and make up 32.19% of the deer sample. Red deer has a total of 99 specimens with a total percentage of 67.81%.

3. Deer elements

Nearly all elements are represented at Sânandrei for red and roe deer. The most common elements for roe deer are: mandibles (7.53%) followed by scapulae (4.11%) and humeri (5.42%). For red deer the most common elements are antler (10.27%), followed by tibias (8.22%), and scapulae (6.16%) (Table 42). Both red and roe deer samples from Sânandrei have antlers in their assemblage. The roe deer antler sample only has one antler base, which is unclear if it was hunted or collected by the inhabitants at the site. The red deer sample has a total of 16 antlers. One of the antlers was still attached to the cranium and was classified as cranium in the database for this reason. This signifies that red deer, like the roe deer antlers were not all collected.

4. Deer elements vs teeth

The roe deer tooth sample accounts for 8.21% of the overall deer sample. This sample includes: one lower loose tooth (0.68%) and 11 mandibles with teeth (7.53%). The red deer tooth sample makes up 6.84% of the total deer sample. These samples include: one lower loose tooth (0.68%), one upper loose tooth (0.68%), and eight mandibles with teeth (5.48%) (Table 42).

5. Deer teeth only

The roe deer tooth sample accounts for 54.55% of the overall deer sample. There are a total of 12 tooth specimens (Table 43). These specimens include: one lower loose tooth (4.55%), and 11 mandibles with teeth (50.00%). The red deer tooth sample accounts for the remaining

45.45% of the overall deer sample with 10 tooth specimens. These specimens include: one lower loose tooth (4.55%), one upper loose tooth (4.55%), and eight mandibles with teeth (36.36%).

6. Roe deer only

Roe deer have a total of 47 specimens from the Vinča C sample from Sânandrei (Table 44). The tooth sample makes up 25.53% of the overall roe deer sample. These tooth samples are: one lower loose tooth (2.13%) and 11 mandibles with teeth (23.40%).

7. Red deer only

The red deer sample has a total of 99 specimens. Of these specimens, the teeth make up a total of 6.50% (Table 45). These specimens include: one lower loose tooth (1.01%), one upper loose tooth (1.01%) and eight mandibles with teeth (8.08%).

8. Teeth found in collection

A total of 10 deer teeth were found in the sample from Sânandrei. All of these teeth were from mandibles with teeth from roe deer. All eight teeth from the roe deer sample will be used for tooth eruption and wear analysis, tooth wear scoring and crown height analysis. Based on the previous analysis, all eight teeth were successfully aged (Jongsma and Greenfield 1996). Out of these teeth, four were from adults, and one from a subadult and three were from either subadults or adults. Of the eight teeth that were successfully aged, only three were chosen for cementum analysis.

A. ***Petnica***

1. Wild fauna

The total number of taxa found in Petnica's Vinča C levels drops significantly from 2451 to 971. The wild taxa frequencies at Petnica drop from 1705 to 529 identifiable specimens during the Vinča C period. The wild taxa make up 54.40% of the sample (Table 31). Among the wild

fauna, the most common taxa are red deer (63.23%), roe deer (15.87%), wild boar (15.34%), beaver (1.58%), and aurochs (1.32%) (Table 32).

2. Red and roe deer

There are a total of 74 roe deer specimens which make up 17.66% of the deer sample (Table 33). Red deer have a total of 345 specimens with a total percentage of 82.34%. This shows only a small increase in the percentage, between Vinča B and C, of roe deer exploited at the site.

3. Deer elements

The same pattern that was seen in the Vinča B levels above continues in the Vinča C levels. The most common roe deer elements are the cranial elements, unidentified metapodial 3-4, and metatarsals (1.91% respectively). The most common red deer elements are very similar to the roe deer elements, with metatarsals (10.50%), unidentified metapodials (9.55%) and metacarpus 3-4 (6.68%) (Table 34). There are a total of 33 antlers from the Vinča C levels of Petnica. Of these antlers, eight are from roe deer (24.24%) and 25 are from red deer (75.76%). It is unclear if these antler samples are shed or attached to the cranium (Table 35).

4. Deer elements vs teeth

The roe deer tooth sample accounts for 2.39% of the roe deer sample. These teeth include: two Lower loose teeth (0.48%), one upper loose tooth (0.24%), six mandibles with teeth (1.43%) and one maxilla with teeth (0.24%). Red deer have a higher tooth sample than roe deer with 10.74%. These samples include: one loose tooth fragment (0.24%), 15 lower loose teeth (3.58%), 11 upper loose teeth (2.63%), 14 mandibles with teeth (3.34%) and four maxillae with teeth (0.95%) (Table 34).

5. Deer teeth only

The tooth sample from roe deer accounts for 18.18% of the overall roe deer sample. There are 10 specimens in this sample (Table 36). These specimens include: two lower loose teeth (3.64%), one upper loose tooth (1.82%), six mandibles with teeth (10.91%) and one maxilla with teeth (1.82%). The red deer tooth sample accounts for the remaining 81.82% of the deer tooth sample. There are a total of 45 specimens in this sample. These specimens include: one loose tooth fragment (1.82%), 15 lower loose teeth (27.27%), 11 upper loose tooth (20.00%), 14 mandibles with teeth (25.45%), and four maxillae with teeth (7.27%).

6. Roe deer only

Roe deer have a total of 74 specimens from the Late Neolithic Vinča C deer sample from Petnica (Table 37). When comparing all of these elements to the tooth specimens, the teeth make up 13.51% of the sample. These include: two lower loose teeth (2.70%), one upper loose tooth (1.35%), six mandibles with teeth (8.11%), and one maxilla with teeth (1.35%).

7. Red deer only

The red deer sample has a total of 345 specimens. The red deer tooth sample makes up 13.05% of the total red deer sample (Table 38). These teeth include: one loose tooth fragment (0.29%), 15 lower loose teeth (4.35%), 11 upper loose teeth (3.19%), 14 mandibles with teeth (4.06%), and four maxillae with teeth (1.16%).

8. Teeth found in collection

A total of 14 deer teeth were found in the sample from the Vinča C levels of Petnica. Of the 14 samples, four were from roe deer and 10 were from red deer. The roe deer teeth are represented by four mandibles with teeth. The ten red deer teeth samples are from: five mandibles with teeth, two upper loose teeth, and three lower loose teeth. All 14 teeth from the

roe deer and red deer samples were used for tooth eruption and wear analysis, tooth wear scoring, and crown height analysis. From the red and roe deer tooth sample, a total of 3 teeth (1 red deer, 2 roe deer) were used for cementum analysis from the Vinča C levels of Petnica.

VI. Late Neolithic Vinča D

A. *Petnica*

1. Wild fauna

There are a total of 384 identifiable taxa from the Vinča D levels at Petnica. In this sample, wild taxa account for 203 identifiable specimens (52.86%) (Table 31). The seven different identified taxa are: red deer (73.48%), roe deer (15.91%), and wild boar (7.58%) (Table 32). The Vinča D period is marked by a noticeable drop in the number of wild taxa present at the site. However, the wild fauna still continue to outnumber the domestic fauna, as they had in previous periods.

2. Red and roe deer

At Petnica, roe deer have a total of 26 specimens as stated above and make up 15.95% of the deer sample (Table 33). Red deer have a total of 137 specimens in this sample with a total percentage of 84.05%.

3. Deer elements

The Vinča D levels of Petnica are slightly different simply because there are fewer specimens found in these levels. Not all red and roe deer elements are represented in the sample. The most common roe deer element is the radius (3.07%), followed by metatarsus 3-4 (1.84%), and metacarpus 3-4 (1.84%). The most common elements in the red deer portion of the sample is the metatarsus 3-4 (8.59%), followed by cranial elements (7.98%), and tibias (6.75%) (Table 34). There are a total of 13 antler fragments found in the Vinča D levels of Petnica. All of these

samples are from red deer. It is unclear if they are from shed antlers or those still attached to the cranium (Table 35).

4. Deer elements vs teeth

The roe deer tooth sample accounts for 1.84% of the overall deer sample (Table 34). These teeth include: two mandibles with teeth (1.23%) and one maxillae with teeth (0.61%). The red deer tooth sample makes up 10.43% of the overall deer sample. These tooth samples include: four lower loose teeth (2.45%), three upper loose teeth (1.84%), eight mandibles with teeth (4.91%) and two maxillae with teeth (1.23%).

5. Deer teeth only

Roe deer account for 15% of the deer tooth sample with three specimens (Table 36). These include: two mandibles (10%) and one maxilla with teeth (5%). Red deer tooth samples account for the remaining 85% of the deer sample with 17 specimens. These include: four lower loose teeth (20%), three upper loose teeth (15%), eight mandibles with teeth (40%), and two maxillae with teeth (10%).

6. Roe deer only

Roe deer have a total of 26 specimens in the Late Neolithic sample from Petnica (Table 37). The tooth sample make up 11.54% of the overall roe deer sample. These include: two mandibles with teeth (7.69%), and one maxilla with teeth (3.85%).

7. Red deer only

The red deer tooth sample makes up a total of 12.41% of the red deer sample (Table 38). These teeth include: four lower loose teeth (2.92%), three upper loose teeth (2.19%), eight mandibles with teeth (5.84%), and two maxillae with teeth (1.46%).

8. Teeth found in collection

A total of three deer teeth were found in the sample from Petnica. There are a total of two roe deer teeth found in this sample. All of these teeth were from mandibles with teeth from adults. There was only one red deer tooth found in the University of Manitoba sample, which was a mandible with teeth.

All three teeth from the red and roe deer samples will be used for tooth eruption and wear analysis, tooth wear scoring, and crown height analysis. Based on previous analysis conducted by Professor Haskel Greenfield, roe deer has a total of two teeth found, all of which will be used for cementum analysis. All of these teeth were from mandibles with teeth, one from a juvenile and another from an adult. Only one red deer sample was found and was from an adult. From the Vinča D levels of Petnica, a total of 2 tooth samples (1 red deer, and 1 roe deer) from the Vinča D levels of Petnica were used for cementum analysis.

B. ***Opovo***

1. Wild fauna

There are a total of 712 identified specimens from the Late Neolithic levels of Opovo. In this sample, 393 are from wild taxa, accounting for 55.20% of the assemblage (Table 54). The most common wild taxa at Opovo are red deer (32.72%), snails (9.97%), roe deer (5.76%), wild boar (2.81%), and aurochs (1.69%) (Table 55).

2. Red and roe deer

At Opovo, the roe deer sample has a total of 41 specimens accounting for 14.96% of the total deer sample (Table 56). The red deer sample has a total of 233 specimens with a total percentage of 85.04%.

3. Deer elements

At Opovo, all elements are represented for both red and roe deer. However, roe deer have fewer elements than red deer. The most common roe deer elements are cranial elements (2.92%), followed by mandibles with teeth (2.55%), humeri, and metatarsals 3-4 (1.46% each). The most common red deer elements are the cranial elements (11.31%), metatarsals 3-4s (6.93%), and mandibles with teeth (6.57%) (Table 57).

There are a total of six antler specimens (2.17%) from roe deer from Opovo. These specimens include: four bases or beginning of first tine (1.45%), a single tine or fragment (0.36%) and a base and first tine (0.36%) (Table 58). All roe deer antlers are from fragments and it could not be determined if they were shed or still attached to the cranium. The red deer sample has a total of 21 (7.65%) antler specimens found at Opovo. These antler specimens include: six bases up to the beginning of the first tine (2.18%), ten fragments of the column (3.65%), and five single tines or fragments (1.82%). There is no indication within the database whether these antlers were from shed specimens or still attached to the cranium.

4. Deer elements vs teeth

The roe deer tooth sample accounts for 2.55% of the overall Opovo deer sample. This sample is seven mandibles with teeth (2.55%). The red deer tooth sample accounts for 13.13% of the total deer sample. These specimens include: two lower loose teeth (0.73%), one upper loose tooth (0.36%), 18 mandibles with teeth (6.57%) and 15 maxillae with teeth (5.47%) (Table 57).

5. Deer teeth in general

The roe deer teeth account for 16.28% of the overall deer sample with seven specimens (Table 59). These samples are seven mandibles with teeth (16.28%). The red deer tooth samples accounts for the remaining 83.72% of the sample with 36 specimens. These specimens include:

two lower loose teeth (4.65%), one upper loose tooth (2.33%), 18 mandibles with teeth (41.86%), and 15 maxillae with teeth (34.88%).

6. Roe deer only

Roe deer have a total of 41 specimens from the Late Neolithic levels of Opovo (Table 60). Teeth make up 17.07% of this sample, which are seven mandibles with teeth (17.07%).

7. Red deer only

The red deer sample has a total of 233 specimens from the Late Neolithic levels of Opovo. The teeth in this sample accounts for 15.46% of the sample (Table 61). These teeth include two lower loose teeth (0.86%), one upper loose tooth (0.43%), 18 mandibles with teeth (7.73%), and 15 maxillae with teeth (6.44%).

8. Teeth found in collection

A total of 12 deer teeth were found in the sample from Opovo. There are a total of six roe deer teeth found in this sample and all of these teeth were from mandibles with teeth. There are also a total of six red deer teeth in the Opovo sample. These teeth are: three mandibles with teeth and three lower loose teeth.

All 12 teeth from the red and roe deer samples will be examined using tooth eruption and wear analysis, tooth wear scoring, and crown height analysis. Based on the previous analysis conducted by Haskel Greenfield, roe deer have a total of six teeth, five from adults, and one from a subadult. The red deer sample has a total of six teeth in the assemblage, five from adults, and one from a subadult. From this sample, only a total of six teeth (3 red deer, 3 roe deer) were chosen for cementum analysis.

C. *Vinča*

1. Wild fauna

At the site of Vinča, there are a total of 1037 identified specimens, of which 303 (29.22%) are from wild taxa (Table 62). There are a total of 14 different wild taxa found at Vinča. The most common wild taxa are: red deer (13.98%), aurochs (5.98%) unidentified snail (2.31%), roe deer (1.93%), and wild boar (2.31%) (Table 63).

2. Red and roe deer

Roe deer have a total of 20 specimens as stated above and account for 12.12% of the deer sample (Table 64). Red deer have a total of 145 specimens representing 87.88% of the deer.

3. Deer elements

All elements are present in the red and roe deer samples. The most common roe deer elements are scapulae, innominates, and cranial elements (1.82% each). Red deer have more elements represented in the sample than roe deer. The most common red deer elements are phalanges (15.15%), cranial elements (14.55%), and scapulae (7.27%) (Table 65).

Among the deer elements, roe deer have a total of two antler fragments (1.21%). These fragments are from: one antler tine or fragment and one base, first tine or column with tines (0.61% each) (Table 66). The red deer sample has a larger selection of antlers, with a total of 22 specimens. These specimens include: three bases and fist tines (1.82%), six single tines or fragments (3.64%), 12 fragments of the column (7.27%), and one column with tines (0.61%). It is not clear if any of the red or roe deer antlers were shed or still attached to the cranium.

4. Deer elements vs teeth

The roe deer tooth sample accounts for 1.21% of the overall deer sample. These teeth are two mandibles with teeth (1.21%). The red deer tooth sample makes up 4.25% of the total deer

sample. These tooth samples include: one loose tooth (0.61%), and eight mandibles with teeth (4.85%) (Table 67).

5. Deer teeth in general

When comparing the deer teeth on their own, separate from the elements, the roe deer sample accounts for 18.18% of the sample with two specimens, which are two mandibles with teeth (18.18%) (Table 68). The red deer tooth samples account for the remaining 81.82% of the sample with six specimens. These specimens include one loose tooth (18.18%), and five mandibles with teeth (45.45%).

6. Roe deer elements vs teeth

There are 20 roe deer specimens in the Late Neolithic at Vinča (Table 69). When comparing the tooth samples, separate from the other elements, teeth make up only 10% of the sample. These tooth specimens are represented by two mandibles with teeth (10%).

7. Red deer only

The red deer sample has a total of 145 specimens. The teeth in this sample only account for 4.83% of that sample (Table 70). These specimens include one loose tooth (0.69%), and five mandibles with teeth (3.45%).

8. Teeth found in collection

Only one roe deer tooth was found in the sample. Due to the small sample size, no teeth from Vinča were prepared for cementum analysis.

VII. Relationship between age- and season-of-death and sample size

There are a total of 104 mandibles and lower loose tooth samples from all five sites considered for age and season-of-death analysis. Of this number, 46 came from roe deer specimens and 58 came from red deer specimens.

Blagotin has a total of four red deer specimens, one was from a mandible and three were loose teeth. Two of these samples have M1s present. Due to its small sample size, Blagotin was omitted from the dental cementum analysis sample.

Opovo has a total of 11 samples 5 red deer and 6 roe deer. There are a total of five red deer samples from Opovo: three mandibles, and two loose teeth. The six roe deer specimens are complete or nearly complete mandible. All red and roe deer samples have M1s present. A total of six teeth from Opovo were chosen for dental cementum analysis (3 red, 3 roe deer).

Petnica has a total of 62 samples. More than half (NISP=34) specimens were from red deer which consisted of 25 mandibles and nine loose teeth. Twenty of these specimens had M1s present. The roe deer sample has 28 specimens, all of which were mandibles, and 27 of which have M1s present. A total of nine samples from Petnica were chosen for dental cementum analysis (4 red deer, 5 roe deer).

Sânandrei has a total of 10 samples all of which are from roe deer. All roe deer specimens from Sânandrei are mandibles and all but one have M1s present. Only three samples from Sânandrei were chosen for dental cementum analysis due to the condition of the teeth, all three samples were from roe deer.

Stragari has a total of 14 tooth specimens. Two of the specimens are from roe deer. These specimens are from mandibles, both of which have M1s present. The red deer sample from Stragari has a total of 12 specimens. These specimens are one loose tooth, one maxilla with teeth, and 11 mandibles with teeth. From this sample, only nine have M1s present. A total of 5 specimens (4 red deer, 1 roe deer) were chosen from Stragari for dental cementum analysis.

VIII. Conclusion

This chapter described the taxonomic data for the wild fauna from the databases for each site from the central Balkans during the Neolithic. Frequencies of red and roe deer were described in reference to the overall assemblage, the wild taxa and each other. The frequencies of red and roe deer elements and teeth were also described in great detail.

From the analysis of these databases it was found that that red and roe deer were most common wild specimens found in the Neolithic assemblages. Some notable sites (i.e. Vinča, Opovo, Sânandrei, Late Neolithic Petnica, and Bukovačka Česma) had roe deer in much lower numbers than other wild fauna (usually appearing as 3rd or 5th most common wild taxa).

Few of the sites examined in this thesis have enough tooth samples available for dental cementum analysis (Petnica, Stragari, Sânandrei, and Opovo). Other sites (Bukovačka Česma, Hajdučka Vodenica, and Foeni-Salaş) do not have any teeth present in the sample. A couple of sites (Vinča and Blagotin) have some teeth, but very they are small tooth samples (a single tooth each) that were not large enough to be considered for season-of-death analysis. Lastly, some sites that have small dental samples (e.g., Blagotin) could still be included in the age-of-death analysis because of the robustness of the database.

The next chapter will be split into two smaller sub-Chapters. Chapter 7A discusses the age-of-death using both the database and the four techniques (tooth eruption and wear, tooth wear scores, crown heights and dental cementum analysis). Chapter 7B, describes the season of death using only dental cementum analysis. The results from these analyses will be further explored and described in Chapter 8.

Chapter 7A Age-of-death analysis results

I. Introduction

This chapter presents the results obtained from the four techniques described in Chapter 5 to determine age- and season-of death of red and roe deer dental data from each site. Roe deer could only be aged using three of the age-of-death analysis techniques (tooth eruption and wear, crown height and dental cementum analysis). Both red and roe deer were subjected to dental cementum analysis, which was useful for both age and season-of-death results.

To simplify the data presented in this chapter, the chapter itself will be divided into two sub-chapters. Chapter 7A will discuss the age-of-death analysis results, while Chapter 7B will summarize the season-of-death results.

II. Age-of-death results between periods

This section describes the age-of-death analysis results. There are two parts to this section. The first part will describe the age-of-death results from the databases provided by Prof. Haskel Greenfield which include all elements including teeth. The second part will describe the age-of-death analysis results from the teeth found in the University of Manitoba collection.

Age-of-death can be determined, as described in Chapter 5, using several criteria. For most elements, age-of-death is determined by fusion (if the epiphyses are fused, not fused, or which stage they are fusing), porosity (if the bone is porous it is younger, if the bone is dense and not porous, it is then an older individual, usually an adult), size (young animals have smaller bones), and muscle markings (older individuals have more pronounced markings).

Teeth don't have these characteristics. Therefore, teeth must be aged using different techniques: tooth eruption and wear, crown height analysis, tooth wear scores, and dental cementum analysis. Tooth wear scoring was not possible for roe deer because the method

proposed by Tomé and Vigne (2003) does not work correctly. The formula is based on similar systems designed for red and fallow deer which have high cusps that wear slowly over time, in a highly predictable manner. Roe deer teeth have cusps that are much smaller and tend to wear faster, due to their varied diet (Brown & Chapman, 1991; Tomé & Vigne, 2003).

Age-of-death results could not be obtained for Hajdučka Vodenica, Bukovačka Česma, Foeni-Salaş and Vinča because there are no teeth available from these sites that could be analyzed for age-at-death. Only Blagotin, Sânandrei, Stragari, Petnica and Opovo have age-of-death data available from the tooth samples found in the University of Manitoba collection.

A. ***Early Neolithic***

1. Blagotin

a. Database age-of-death results (all elements)

Red deer

From Blagotin, there are a total of 259 ageable red deer specimens based on all elements (Table 71). Red deer show a preference for adults (49.42%) followed by subadults (16.60%) and juveniles (2.32%).

Roe der

There are 187 ageable roe deer specimens based on all elements from the Blagotin sample (Table 72). As with the red deer discussed above, roe deer show a preference towards adults (34.76%). Subadults are the second most exploited age class (17.11%) followed by juveniles (3.21%). Unlike the red deer, there is also evidence of remains from one infant or foetus (0.53%).

b. Age-of-death analysis results (teeth only)

Red deer

There are seven tooth samples from red deer from the Early Neolithic levels from Blagotin. Out of the seven teeth, only two teeth could be aged using all three methods (tooth eruption and wear, tooth wear scores and crown heights). Tooth eruption and wear analysis identified one subadult and one adult (Table 73). The tooth wear score also identified one subadult and one adult. The crown height method had different results since it aged both samples as adults. No teeth from Blagotin could be aged based on dental cementum.

2. Hajdučka Vodenica

c. Database age-of-death results (all elements)

At Hajdučka Vodenica there are a total of 23 red deer specimens based on all elements that can be aged (Table 74). Adults are the most common exploited age class (73.91%) followed by subadults (8.70%). There are no juveniles found in the sample.

d. Age-of-death analysis results

Hajdučka Vodenica does not have enough tooth samples for thin section analysis, tooth eruption and wear, and tooth wear score. Therefore, there are no results from either age-at-death or season-at-death analysis. Additionally, all teeth from the database are from animals older than one year, it is impossible to determine the season of death using tooth eruption and wear analysis or crown height analysis.

3. Foeni-Salaş

e. Database age-of-death results (all elements)

Red deer

At Foeni-Salaş, there are a total of 105 ageable red deer specimens based on all elements (Table 75). Adults are the most common exploited age class (52.38%) followed by subadults (15.24%) and juveniles (0.95%).

Roe deer

There are a total of 81 ageable roe deer specimens based on all elements from the Foeni-Salaş sample (Table 76). Of these samples, adults (30.86%) are the most common exploited age class, followed by subadults, (11.11%) and juveniles (1.23%).

f. Age-of-death analysis results

Foeni-Salaş does not have any tooth samples for thin section analysis, tooth eruption and wear analysis, tooth wear scores and crown height analysis. Therefore, there are no results from this type of analysis. Additionally, all teeth from the database are from animals older than one year, it is impossible to determine the season of death using tooth eruption and wear analysis or crown height analysis.

4. Bukovačka Česma

g. Database age-of-death results (all elements)

Red deer

Bukovačka Česma has a total of 79 ageable red deer specimens based on all elements (Table 77). Adults (34.18%) are the most common exploited age class, followed by subadults (17.72%) and juveniles (2.53%).

Roe deer

Roe deer at Bukovačka Česma have a total of 16 ageable specimens based on all elements (Table 78). The most common exploited age class at Bukovačka Česma is juveniles (56.25%), followed by subadults (18.75%), adults (6.25%), and infants (6.25%). Bukovačka Česma is unique because it is the only Early Neolithic site that has more juveniles than adults and subadults. Additionally, there is evidence of an infant found in the remains.

h. Age-of-death analysis results

Bukovačka Česma does not have enough tooth samples for dental cementum analysis, tooth eruption and wear, tooth wear scores and crown heights. Therefore, there are no results from this type of analysis. Since all teeth in the database are from animals older than one year, it is impossible to determine the season of death using tooth eruption and wear analysis or crown height analysis.

B. ***Middle Neolithic***

5. Stragari

i. Database age-of-death results (all elements)

Red deer

The Middle Neolithic levels of Stragari has a total of 1586 ageable red deer specimens based on all elements (Table 79). The most common exploited age class is adults (38.27%), followed by subadults (10.67%), juveniles (1.47%), and an infant (0.06%).

j. Roe deer

The roe deer sample from the Middle Neolithic levels of Stragari has a total of 506 ageable specimens based on all elements (Table 80). The most common exploited age class is adults (32.73%) followed by subadults (8.28%), and juveniles (1.4%).

k. Age-of-death analysis results (teeth only)

Red deer

There are a total of seven samples from Stragari that are aged using all three aging methods. The tooth eruption and wear method identified one juvenile, two subadults, and four adults (Table 81). Tooth wear scores have slightly different results. Tooth wear scores identified two juveniles, two subadults, and three adults. Crown heights identified one subadult, and six adults. Aging based on dental cementum analysis was conducted on four samples, one of which became unclear. However, all three of the successful samples are identified as coming from adults. Therefore, in this case, the dental cementum results show that crown heights are more accurate than the other two methods.

Roe deer

There are three roe deer samples from Stragari that can be aged using tooth eruption and wear and crown heights. Tooth eruption and wear identified one sample as a subadult, and two as adults (Table 82). Crown heights, on the other hand, identified all samples to be from adults. Dental cementum analysis results have only been obtained from one of the samples, which is identified as a three year old adult.

6. Petnica Vinča B

l. Database age-of-death results (all elements)

Red deer

The red deer samples from the Middle Neolithic levels of Petnica have a total of 1142 ageable specimens based on all elements (Table 86). The most common age class is adults (29.68%), followed by subadults (5.69%), juveniles (3.15%), and an infant (0.09%).

m. Roe deer

The Middle Neolithic samples from Petnica have a total of 187 ageable roe deer specimens based on all elements (Table 87). The most common exploited age class is adults (27.81%), followed by subadults (3.21%), and juveniles (2.14%).

n. Age-of-death analysis results (teeth only)

Red deer

There are a total of 27 tooth samples from the Vinča B levels of Petnica. Of these samples, only 22 could be aged using tooth eruption and wear, 24 could be aged using tooth wear scores, and 18 could be aged using crown height measures. For this reason, only 17 samples are discussed here. Tooth eruption and wear identified four juveniles, one subadult, and 12 adults. Tooth wear scores have a different result in that two juveniles, seven subadults and eight adults are identified (Table 88). Crown height measurements identified one infant, four juveniles, two subadults, and ten adults. Dental cementum analysis on the above two samples aged them as adults, which matches more closely to the tooth wear score and the tooth eruption and wear results.

Roe deer

There are a total of 21 roe deer samples that are aged using tooth eruption and wear and crown height method. Using tooth eruption and wear analysis, three subadults from the Middle Neolithic levels of Petnica are identified. The remaining 18 tooth samples are from adults (Table 89). The crown height measurements identified two subadults and 19 adults. This makes the results between the two aging techniques very similar. Only two roe deer samples from the Vinča B levels of Petnica were analyzed using dental cementum analysis. Both teeth are identified as adults, one three years of age, and the other four years of age.

C. ***Late Neolithic***

7. Sânandrei- Vinča C

o. Database age-of-death results (All elements)

Red deer

The red deer samples from the Late Neolithic levels of Sânandrei have a total of 91 ageable specimens based on all elements (Table 83). The most common exploited age class is adults (41.76%), followed by subadults (13.19%), and juveniles (1.10%).

p. Roe deer

The Late Neolithic sample from Sânandrei has a total of 41 ageable roe deer specimens based on all elements (Table 84). The most common exploited age class is adults (41.46%) followed by subadults (19.51%). No juvenile roe deer specimens are found at Sânandrei.

q. Age-of-death analysis results (teeth only)

Red deer

There are no red deer samples from Sânandrei available for age or season-at-death analysis from the University of Manitoba Laboratory.

Roe deer

There are a total of ten roe deer samples that are aged using tooth eruption and wear and crown height method. Tooth eruption and wear analysis identified only two subadults and eight adults (Table 85). A total of eight teeth from Sânandrei were aged using the crown height method. This age-at-death technique identified two subadults and six adults. Although the results from the tooth eruption and wear analysis and crown height measurements are very similar, the subadult age results did not agree between the two methods. Only three roe deer samples from

Sânandrei were analyze using dental cementum analysis. All three teeth are identified as adults, three, four and six years of age respectively.

8. Petnica Vinča C

r. Database age-of-death results (all elements)

Red deer

The red deer sample from the Late Neolithic Vinča C samples of Petnica has a total of 332 ageable specimens based on all elements (Table 86). The most common exploited age class is adults (31.63%), followed by subadults (3.92%), juveniles (1.81%), and one infant (0.30%).

Roe deer

The Late Neolithic levels from Petnica have a total of 70 ageable roe deer specimens based on all elements (Table 87). The most common age class is adults (34.29%), followed by subadults (5.71%), and juveniles (4.29%).

s. Age-of-death analysis results (teeth only)

Red deer

There are a total of six red deer tooth samples that are aged using all three ageing techniques from the Vinča C levels of Petnica. Tooth eruption and wear identified two juveniles, two subadults, and two adults (Table 88). Tooth wear scores identified three juveniles, one subadult, and two adults. The crown height measurements only identified one adult and one juvenile. The dental cementum sample identified the juvenile using both tooth eruption and wear and crown heights, and an adult using tooth wear scores, was found to be inconclusive.

Roe deer

There are a total of four roe deer samples from the Vinča C period at Petnica. Using the tooth eruption and wear technique, one sample was identified as a juvenile, and the remaining

three from adults (Table 89). The crown height measurements, on the other hand, identified all four specimens as adults. Dental cementum analysis found that the sample identified as a juvenile by tooth eruption and wear analysis was from and adult. The other dental cementum sample proved to be from an adult. This supports the initial estimate of the teeth all belonging to adults, as shown by the crown height measurement results.

9. Petnica Vinča D

t. Database age-of-death results (all elements)

Red deer

The red deer sample from the Late Neolithic Vinča D levels of Petnica has a total of 135 ageable specimens based on all elements (Table 86). The most common exploited age class is adults (32.59%), followed by subadults (2.96%), and juveniles (4.44%).

Roe deer

The Late Neolithic levels from Petnica have a total of 26 ageable roe deer specimens based on all elements (Table 88). The most common exploited age class is adults (11.54%), followed by subadults (3.85%), and juveniles (3.85%).

u. Age-of-death analysis results (teeth only)

Red deer

There are a total of three red deer samples from the Vinča D levels of Petnica, two of which have been aged using all four aging methods. Tooth eruption and wear identified one juvenile and one adult. The tooth wear score technique identified one juvenile and one subadult (Table 89). Crown height measurements had different results and identified one subadult and one adult. The sample identified as an adult, using both tooth eruption and wear and crown height measurements, and a subadult using tooth wear score, was found to be an adult using dental

cementum analysis. In this case, tooth eruption and wear and crown heights are more accurate than tooth wear scores.

10. Opovo

v. Database age-of-death results (all elements)

Red deer

At Opovo there are a total of 233 ageable red deer specimens based on all elements (Table 90). The most common exploited age class is adults (44.16%), followed by subadults (4.76%), juveniles (0.87%), and one infant (0.43%).

Roe deer

There are a total of 41 ageable roe deer specimens from Opovo based on all elements (Table 91). The most common exploited age class is adults (48.78%), followed by subadults (9.76%), and juveniles (4.88%).

w. Age-of-death analysis results (teeth only)

Red deer

There are a total of four red deer tooth samples from Opovo. Tooth eruption and wear identified all four samples to be from adults (Table 92). Tooth wear scores identified one subadult, and three adults. Crown height measurements identified all samples as adults. Three samples were analyzed using dental cementum analysis, from the four roe deer samples. One sample was found to be inconclusive. The sample that was identified as a subadult using tooth wear scores was identified by dental cementum analysis to be an adult, thereby also confirming the tooth eruption and wear and crown height results described above. The remaining thin sectioned sample analyzed for dental cementum was identified as an adult individual, further

confirming the validity of the tooth eruption and wear analysis and crown height measurement results.

Roe deer

There are a total of six roe deer samples from Opovo that are aged using both tooth eruption and wear analysis and crown height measurements. Tooth eruption and wear analysis identified all six samples as adult individuals (Table 93). The crown height measurements had different results. The crown height measurements identified one juvenile, three subadults, and two adults. Three samples were analyzed for dental cementum, with one of the three samples returning inconclusive. The remaining two samples are both identified as adults, which supports both the tooth eruption and wear analysis and the crown height measurement results.

11. Vinča

x. Database age-of-death results (all elements)

Red deer

At Vinča there are a total of 43 ageable red deer specimens based on all elements (Table 94). The most common exploited age class is adults (34.27%), followed by juveniles (11.19%), subadults (6.29), and an infant (0.70%).

Roe deer

The roe deer sample from Vinča has a total of 143 ageable specimens based on all elements (Table 95). The most common exploited age class is adults (52.63%), followed by subadults (10.53%), and juveniles (5.26%).

12. Age-of-death analysis results (teeth only)

Vinča does not have enough tooth samples for dental cementum analysis, tooth eruption and wear analysis, and tooth wear score analysis. Therefore, there are no results from either age-

of-death or season-of-death analysis. Additionally, all teeth from the database are from animals older than one year, and therefore it is impossible to determine the season of death using tooth eruption and wear analysis or crown height analysis.

III. Conclusion

This chapter served as a summary of the age-of-death results from various sites from the Neolithic of the central Balkans. The results presented in this chapter illustrate that the use of all four techniques (tooth eruption and wear, tooth wear scores, crown heights, and dental cementum analysis) is essential for estimating the age-of-death for deer from archaeological sites. It is essential to utilize several techniques because on their own each produces slightly different results.

The results of this analysis found that the majority of deer were killed as adults, usually followed by subadults and then juveniles. Infants are found in most of the samples, however in very small frequencies, usually as a single specimen (e.g. Blagotin, Bukovačka Česma, Stragari, Petnica, Opovo and Vinča). Hajdučka Vodenica was an outlier in this sample, because this site featured more juveniles killed than adults. The reason for this age-of-death pattern is still largely unknown. However, the overall pattern described in this chapter indicates a preference for larger older animals over the smaller younger animals. This may be connected to the resources (meat, fur, bone and antler) collected from these animals.

The next chapter will summarize the season-of-death analysis results. These results were obtained by the use of dental cementum analysis and will illustrate the seasonal exploitation patterns of red and roe deer during the Neolithic in the central Balkans.

Chapter 7B Season-of-death results

This chapter describes the results of the season-of-death analysis conducted on the teeth from the University of Manitoba collection. Season-of-death analysis was conducted successfully on nineteen samples from four sites from the Neolithic in the central Balkans. Unfortunately, due to the composition of the sample, only season-of-death results can be presented from the Middle and Late Neolithic. No results are available from the Early Neolithic.

Season-of-death was analyzed by use of dental cementum analysis techniques and the counting of dental annuli using a high powered polarized microscope. Both red and roe deer were analyzed using this technique, by manually counting dental cementum annuli and by digitally counting dental cementum annuli by graph.

The results presented here only discuss the seasons-of-death from the Middle and Late Neolithic sites of Stragari, Sânandrei, Petnica and Opovo. The sites of Blagotin, Hajdučka Vodenica, Bukovačka Česma, Foeni-Salaş, and Vinča did not have any deer tooth samples present in the University of Manitoba collection that were appropriate for cementum analysis. For this reason, the Early Neolithic was excluded from the season-of-death analysis. The remaining sites date to the Middle and Late Neolithic and are therefore only an example of the season-of-death patterns for the Vinča culture group.

I. Middle Neolithic

A. *Stragari season-of-death results*

Stragari has three successful red deer specimens examined for dental annuli. Two of these samples are identified as adults, roughly 3 years of age (Figure 7 & 9). One sample is identified as the season-at-death occurring during the warmer seasons, while the other sample shows the

season-at-death occurring during the cooler seasons (Table 81) (Figure 8). The remaining sample was the oldest, and was aged to eight years of age and associated with a warm season-of-death.

Only one roe deer specimen from Stragari could be analyzed using dental cementum analysis. This sample was identified to be a three year old adult that died during the cooler seasons (Table 82) (Figure 10).

B. ***Sânandrei Vinča C season-of-death results***

No red deer specimens were subjected for cementum analysis. Two roe deer specimens from the Middle Neolithic levels of Sânandrei were analyzed for dental annuli. These samples were identified as three, four, and six years of age each. The sample from the four year old roe deer was identified with a cooler season-of-death, while the three and six year old deer died during the warmer seasons (Table 85) (Figure 11, 12, & 13).

C. ***Petnica Vinča B season-of-death results***

Two roe deer specimens were analyzed for dental annuli from the Vinča B levels of Petnica. These samples are identified as adults, three and four years of age each. The sample from the four year old roe deer was identified with a warmer season-of-death, while the three year old deer died during the cooler seasons (Table 89) (Figure 17 & 18).

II. Late Neolithic

A. ***Sânandrei Vinča C season-of-death results***

No red deer specimens were subjected for cementum analysis. Two roe deer specimens from the Middle Neolithic levels of Sânandrei were analyzed for dental annuli. These samples were identified as three, four, and six years of age each. The sample from the four year old roe deer was identified with a cooler season-of-death, while the three and six year old deer died during the warmer seasons (Table 85) (Figure 11, 12, & 13).

A. ***Petnica Vinča C season-of-death results***

No samples for dental cementum analysis yielded conclusive information on the season of death from the Vinča B levels of Petnica.

There are two roe deer specimens from the Vinča C levels of Petnica that could be analyzed for dental annuli. Both samples were identified with a cooler season-of-death (Table 89) (Figure 19 & 20).

B. ***Petnica Vinča D season-of-death results***

Only one red deer specimen from Petnica's Vinča D levels was analyzed for dental annuli sample was thin sectioned. This sample was from an adult individual. The thin section analysis found that this individual died during the cooler seasons (Table 88) (Figure 16).

There are a total of three roe deer specimens from the Vinča D levels at Petnica, of these samples only one was analyzed for dental annuli. Dental cementum analysis identified the season-of-death for this adult specimen to have occurred during the cooler months (Table 89) (Figure 21).

C. ***Opovo Vinča D season-of-death results***

At Opovo there are two red deer specimens that could be analyzed for dental annuli. These samples, as described in Chapter 7a, are from adults. The oldest sample was identified with a warmer season-of-death, while the youngest specimen was killed during the cooler months (Table 92) (Figure 22 & 23).

There are two roe deer specimens from Opovo that were analyzed for dental annuli. Both samples were identified as to have been from adults. The oldest specimen was identified with a warmer season-of-death, while the younger specimen died during the cooler seasons (Table 93) (Figure 24). Interestingly, the thin section specimen that was identified as being two years old is

most likely from an older adult individual that had lost many of the outer dental annuli due to extreme dental wear from old age (Figure 26).

III. Conclusion

This chapter served as a summary of the season-of-death results from various sites from the Middle and Late Neolithic in the central Balkans. The results presented in this chapter illustrate that there are no clear patterns for the seasonal exploitation of red and roe deer for the Middle and Late Neolithic. Unfortunately, no patterns could be discovered for the Early Neolithic because there are no specimens from sites dating to that period. This has proven to be a major deficit in the data, especially for detecting temporal and shifting cultural patterns in the season-of-death for deer. Additionally, only a total of four sites from the Middle and Late Neolithic could be analyzed (Stragari, Sânandrei, Petnica and Opovo). Of these sites only one, Petnica, spans more than one of the Neolithic sub-periods. However, this site has a very small sample base.

The next chapter of this thesis will discuss the meaning of the age-of-death and season-of-death results presented in this chapter. The results will be examined for any ecological/geographical patterns, temporal patterns, and any patterns that may result from biases such as excavation collection strategies. The goal of this next chapter will be to determine if any patterns fall within these criteria.

Chapter 8: Data Interpretation

I. Introduction

This chapter will discuss the results from the age-of-death and season-of-death analyses in order to reconstruct the exploitation patterns of deer during the Neolithic in the central Balkans. This chapter is divided into five parts based on the questions presented in Chapter 1. Most of the questions posed in Chapter 1 will be interpreted based on environmental location, recovery method and temporal periods in this chapter. In the case of questions relating to season-of-death, only the Middle and Late Neolithic sub-periods are discussed due to the composition of the tooth remains. These remains are only available from sites dating to these sub-periods of the Neolithic. Sites from the Early Neolithic do not have any or enough tooth samples for dental cementum analysis.

Since this chapter serves as a synthesis of results and information presented in Chapters 6 and 7, some sites from the literature, as presented in Chapter 3 (Divostin, Lepenski Vir, Padina B), will be discussed here. The data from other sites (Foeni-Salaş, Blagotin, Hajdučka Vodenica, Bukovačka Česma, Sânandrei, Vinča, Stragari, Petnica, and Opovo), will be based on the databases used in the analysis for this thesis, as described in Chapters 6, 7A and 7B.

II. Research questions

A. *What is the importance of wild fauna in the Neolithic diet? (Figure 28)*

All sites have wild fauna present in the faunal assemblage, both among the sites under analysis and those in the literature. While they are always present, they will occur at varying frequencies (Table 4). This can be interpreted to mean that wild taxa are an important part of the diet, economy, or social world of the peoples living in the central Balkans during the Neolithic period.

Some sites have many different types of wild taxa present (e.g. Blagotin, Foeni-Salaş, Petnica Stragari, and Vinča), while others have relatively fewer (e.g. Hajdučka Vodenica, Bukovačka Česma, and Sânandrei). These differences in frequencies may be due to several factors such as: environmental region, recovery methods used during excavation, and temporal patterns. The reasons for these patterns will be described below.

Some sites exhibit higher frequencies of wild taxa than domestic taxa (e.g. Hajdučka Vodenica, Bukovačka Česma, Petnica, and Stragari), while others have very low frequencies for wild taxa (e.g. Blagotin, Foeni-Salaş, Sânandrei, and Vinča). Often these differences in wild taxa frequencies are due to environmental regional patterns, recovery methods (especially in the case of fish and rodents), and temporal patterns. The possible reasons for these frequencies are further explored below.

To investigate these patterns, each question presented from Chapter 1 will be summarized in five sections. The first section summarises the environments where the Neolithic sites are located. The environments surrounding the sites are examined here to determine if different hunting patterns are the result of the environment as opposed to other factors such as cultural choice. If the environmental and taphonomic patterns account for the variability then there is no clear evidence for social choice. The second section summarizes the faunal frequency patterns by environment. The third section summarises the collection strategies used during recovery at each site. The fourth section discusses the patterns between the collection methods and the environment of the site. The fifth section will discuss the faunal frequency by period for each site. There will also be a discussion of two types of frequencies discussed in the second part of this section

- Diversity of wild taxa as opposed to domestic taxa in terms of presence and absence (e.g. class, family, genus, species - e.g. 10 wild taxa; 2 domestic taxa) and
- Frequency of wild as opposed to domestic in general (e.g. 40% wild; 60% domestic).

1. Summary by environment

The sites analyzed in this these are found in four major environments which can be found in the Central Balkans. These environments are: central Serbia, Iron Gates, Romanian Banat, Pannonia and the Danube River valley. The goal of this section is to observe if wild fauna dominate the assemblage or not depending on which environment the sites are located.

a. Central Serbia (Divostin, Blagotin, Petnica, and Stragari)

The typical environments observed in central Serbia are mid altitude locations with well-drained soils and nearby rolling hills (or gentle slopes). These features make this region very attractive for agriculture and pastoralism. These environments are often found below the foothills of large mountains, close to streams, but far away from major rivers (Greenfield, 2000, 2014a; Greenfield & Jongsma-Greenfield, 2014; Orton, 2008). Four sites from our sample are found in this environment. These sites are: Divostin, Blagotin, Stragari, and Petnica.

All of these sites are distant from major rivers or floodplains that would be ideal for fishing (Petnica, Divostin, Stragari, and Blagotin). In these locations, there is poor availability of wild fauna year round. Since there are no major rivers, flood plains or marshlands that would attract a large amount of wild animals.

In consequence of being distant from lacustrine environments, Blagotin (8% wild, 92% domestic), Divostin I (8% wild, 93% domestic), and Divostin II (15% wild, 85% domestic) (Bökönyi, 1988) all show low frequencies of wild taxa. Very surprisingly, Petnica (64% wild, 36% domestic) and Stragari (80% wild, 20% domestic) have very high frequencies of wild taxa

in all Neolithic periods - they are consistently over 50%. This difference in taxonomic frequency may be in part due to Petnica and Stragari's relative proximity to streams (the Kolubara and Riljačka streams respectively), and not large rivers (the Sava and Western Morava rivers, respectively).

All sites located in the central Serbian environmental region, Blagotin (11 wild taxa, 5 domestic taxa), Stragari (18 wild taxa, 5 domestic taxa), Divostin I (10 wild taxa, 6 domestic taxa), Divostin II (13 wild taxa, 6 domestic taxa) (Bökönyi, 1988), and Petnica (13 wild taxa, 5 domestic taxa) all show high diversity in the wild taxa found at the site, with each site featuring over 10 different species found. It should be noted that Stragari had the highest taxonomic diversity.

b. Pannonia and Danube river basin (Opovo and Vinča)

Opovo and Vinča are situated on the edge of the Pannonian Plain and the Danube river basin. This environment lies within the major flood plains and marshlands of the Danube and its tributaries. These areas have very good year round availability for wild fauna. The river flood plains and marshlands provide a great variety of environments, food, and shelter for the animals in the area. Additionally, the soils in this environment are moist and are not suitable for farming. This region is similar to the Iron Gates region described below, in some ways.

Opovo, located on the Pannonian side of the Danube, reflects the possibility of higher availability of wild fauna in this area (55 % wild, 45 % domestic). The wild fauna diversity at Opovo (10 wild taxa, 6 domestic taxa) supports that there was a high variability and availability of wild fauna living around the site. However, the near equal balance between the wild and domestic fauna may also indicate that Opovo was actively diversifying their food resources.

Based on these results, the Danube and major flood plain region appears to be less dependent on wild fauna than the Iron Gates.

Vinča (14 wild taxa, 6 domestic taxa) has a very high taxonomic diversity and one that is even higher than seen at Opovo. However, Vinča (29% wild, 71% domestic) exhibits lower frequencies in wild taxa. The reason for this may be in part due to the fact that Vinča is located on a tell site, constructed on the loess terrace, which would provide good agricultural soils. This may explain why there is a more extensive exploitation of domestic fauna as opposed to the wild fauna. Opovo's location, on the other side of the river surrounded by seasonally flooding marshlands therefore, makes farming slightly less important and hunting a viable resource, due to the high number of fauna attracted to the marshlands.

c. Iron Gates (Hajdučka Vodenica, Lepenski Vir, and Padina B)

The Iron Gates region is located where the Danube River flows through a narrow gorge between the Balkan Mountains and the Transylvanian Alps, on the southern or Serbian shore and the Carpathian Mountains on the northern or Romanian shore. This region runs along the banks of the Danube River as it flows towards the Black Sea. Sites located in this region are found primarily along the bank of the Danube, in marshlands, and gorges. Environments in the region surrounding the sites of the Iron Gates include rivers, shorelines, small meadows, and high altitude deciduous and evergreen forests (Bailey, 2000; Chapman, 1990; Greenfield, 1986; Markotić, 1984; Navy, 1944). In our sample, sites such as Hajdučka Vodenica, Lepenski Vir, and Padina B are found within this environment.

The Iron Gates sites are especially known for their unusually high frequencies of wild fauna. All three sites discussed above for the \iron Gates feature higher than normal wild animal frequencies than found outside of the \iron Gates (Hajdučka Vodenica - 67% wild, 33%

domestic; Lepenski Vir - (74.5% wild, 25.5% domestic) and Padina B (66% wild and 33% domestic) (Clason, 1980) (Srejović, 1972) Greenfield 2008b. There is evidence of increased fish exploitation because of the proximity of each site to the Danube River. The pattern observed in the wild taxonomic frequencies is due to the environments found around these sites. Additionally, the Iron Gates environment is not well drained and therefore, is not as suitable for agriculture or pastoralism in contrast to the central Serbian region.

The sites of Hajdučka Vodenica (5 wild taxa, 3 domestic taxa), Lepenski Vir (19 wild taxa, 4 domestic taxa) (Srejović, 1972) and Padina B (27 wild taxa, 4 domestic taxa) (Clason, 1980) all show high levels of diversity in the wild taxa. Two sites feature over ten different taxa, while Hajdučka Vodenica only has five. The low diversity of wild taxa at Hajdučka Vodenica is due to its small sample size (Greenfield 2008b). Most likely, the low frequencies are due to the smaller sample size (NISP=43).

Overall, the taxonomic frequencies observed at these sites may be indicative of the environment surrounding the site. With the high abundance of fauna found at the site, inhabitants had the ability to specialize and hunt certain species, as opposed to hunting only what is available in the immediate area. This is especially the case when comparing the wild taxonomic frequencies at each site, which will be further discussed below.

d. Romanian Banat (Sânandrei and Foeni-Salaş)

The Banat region of Romania is a flat alluvial plain environment. Here, there are no hills (or very few), streams are very common and major rivers are far away. The environment is well drained with seasonal marshes, floodplains and prime agricultural land. This environment is good for agriculture and pastoralism, but not optimal for hunting since wild fauna are more

dispersed and are not always readily available. The sites of Foeni-Salaş and Sânandrei are located in this environment.

Both Foeni-Salaş (21% wild, 79% domestic) and Sânandrei (40% wild, 60% domestic) feature a very high percentage of domestic taxa and a moderately high percentage of wild taxa. Due to the seasonal changes that occur in this region, wild taxa most likely became more available during the seasons when marshes were flooding (during the spring and early summer). Foeni-Salaş (28 wild taxa, 6 domestic taxa) and Sânandrei (6 wild taxa, 7 domestic taxa) do not show any similarities in the diversity of taxa found at each site. This may be indicative of the collection methods used rather than the environment surrounding the site, which will be further explored below.

The high number of wild fauna at Foeni-Salaş may suggest that the inhabitants indiscriminately hunted the animals rather than having a preference or specialty for particular taxa. Although the site is located in an alluvial plain, wild fauna may have been more available at certain times of year, since the environment would have flooded annually. This may explain the high diversity in taxa found at the site.

e. Morava River Valley (Bukovačka Česma)

Only one site is located in the Morava River Valley: Bukovačka Česma. The environment around Bukovačka Česma features both marshlands and rolling hills. This environment is very similar to the Pannonian Plain environment surrounding Opovo, but less marshy. This environment has a high availability of wild taxa, but also fairly good soils for agriculture and pastoralism in certain areas (Greenfield 1986, 1994)

Bukovačka Česma (59% wild, 41% domestic) features higher frequencies of wild fauna than domestic. This is probably a reflection of the environment around the site. At Bukovačka

Česma, there is a moderately high taxonomic diversity of wild fauna compared to domestic (8 wild taxa, 3 domestic taxa). However, the relatively low values in wild fauna availability may be in part due to the smaller samples size (NISP 544) and the unsystematic collection strategies used when the site was excavated.

2. Summary by collection strategy

Not all of the central Balkan sites were collected in the same way. For this reason, some of the frequencies discussed above may be due to specific collection strategies. Collection strategies are important because they are determined by the questions pursued during an excavation and by the scope of the study. Excavations that only hand collect will result in the appearance of overwhelmingly high frequencies of large fauna being exploited. When in reality, large fauna were exploited in lower frequencies, in reality. The use of sieving (wet or dry) allows archaeologists to collect the smallest remains at a site in a systematic manner. Some of the faunal remains that can be collected by these methods include: small rodents, reptiles, fish, snails and shellfish. All of these fauna can be used to describe a site's environment at the time they were deposited. They can also be used to determine if these fauna were considered part of the diet. Often snails, rodents and reptiles are a background environmental factors, usually present at most sites, but in small quantities that reflect the environment rather than diet. They will have arrived at the site on their own; and not as a result of hunting or fishing by people. Fish and shellfish have a dual purpose, in that they can only arrive at a site when people bring them there, usually as food. As such, they can provide information about both the environment and subsistence (i.e. near a river, stream or ocean). The assemblages from sites such as Foeni-Salaș, Vinča, Opovo, Blagotin, Petnica and Stragari were all collected by both hand collection and sieving (either entirely or partially). This fact is illustrated by the high diversity of wild taxa present at each site.

Systematic collection techniques allows for greater opportunity to recover the smaller taxa present at the site and therefore may increase the taxonomic diversity of the faunal assemblage. This is illustrated by the difference in diversity of taxa found at two nearby sites: Foeni-Salaş (28 wild taxa, 6 domestic taxa), and Sânandrei (6 wild taxa, 7 domestic taxa), both of which are located in the Banat region but were collected in different ways. Foeni-Salaş' assemblage was collected by both hand and sieving. This collection strategy resulted in the higher diversity in the wild taxa. Sânandrei was not sieved and therefore shows a lower diversity in the wild taxa found at the site. The difference in values may also be related to the fact that Foeni-Salaş is an Early Neolithic site and Sânandrei is a Middle Neolithic site. This factor will be discussed further below.

There is no discernable relationship between the environment where the site is situated and the collection method utilized during excavation. The hand collected sites are located in several different locations. For example, Bukovačka Česma is found in an environment of marshlands and foot hills of the Morava River Valley, Hajdučka Vodenica in the Iron Gates, Stragari in central Serbia, and Sânandrei in the Banat region. Sieved or partially sieved sites are found also in different locations. For example, Foeni-Salaş is located in the Banat, Blagotin and Petnica, in central Serbian region, and both Vinča and Opovo are found on the edge of Pannonia. To clearly determine if collection techniques are a factor in the diversity and frequencies of fauna found at these sites, more sites collected by the same methods should be analyzed from the same region. In this case, all sieved and hand collected sites are located in different regions, and therefore a clear pattern is not detected.

3. Summary by period

a. Early Neolithic

During the Early Neolithic, the domestic fauna dominate in the environments of central Serbia and the Banat. Sites in these regions show a high diversity in wild taxa (Foeni-Salaş and Blagotin) and low frequencies of the wild fauna recovered (Foeni-Salaş, Blagotin, and Divostin I). This reflects less selectivity of what was hunted around the site, possibly due to low availability of wild fauna and the suitability of the environment to agriculture and pastoralism. Therefore, during the Early Neolithic, there is a high emphasis on domesticates in the Banat and central Serbian environmental regions. At some of these sites, such as Foeni-Salaş, there is a high possibility that many of the wild taxa were hunted seasonally. Additionally, people at these sites may have hunted every wild species that was available around them for both food and resources.

The Iron gates and marshland sites, on the other hand, show a fairly low diversity of fauna and a high frequency of wild fauna killed (Hajdučka Vodenica, Lepenski Vir, and Bukovačka Česma). This shows that there is a high availability of wild fauna in the surrounding environment of the sites, creating an emphasis on wild fauna. Sites that illustrate a low diversity of wild fauna may be specializing in hunting specific species as opposed to hunting all species available around them.

b. Middle Neolithic

Central Serbian sites, on the other hand, show an increase in the diversity of wild fauna recovered with an increase in overall frequency. The increase in both frequency and variety is found at both Petnica and Stragari and may be due to their location next to floodplain and marshland areas. However, comparable to Foeni-Salaş during the Early Neolithic, Petnica and

Stragari have a very high diversity of wild fauna, illustrating that the environment around these sites were heavily exploited. This increase in emphasis on wild taxa could be due to the population sizes increasing at the sites or a change in the exploitation patterns of domestics.

c. Late Neolithic

The Late Neolithic shows two different patterns at varying areas. In the Banat, domestic fauna still dominate the assemblage while wild frequencies remained low, but with low wild fauna diversity (Sânandrei). This means that the environment around Sânandrei promoted a heavy reliance on domestics and less on wild taxa. There is also a drastic drop in the variety of wild taxa found at Sânandrei than seen previously at Foeni-Salaş during the Early Neolithic. This may be due to there being far fewer wild fauna in the region to exploit or that for some reason the people of Sânandrei are specializing in only the larger wild taxa as opposed to exploiting nearly every available taxa around them

Sites analyzed in this thesis from the Late Neolithic of the central Balkans fall within two different environmental regions. The sites from the Pannonian plains include Opovo and Vinča. Opovo displays a nearly equal emphasis on the diversity and frequencies of wild fauna. This reflects that there was a balanced exploitation pattern at the site and therefore a more diversified economy. This economic diversification may be for several reasons. The first is population size. If the population size at Opovo was high enough there would be greater need to provide a more diversified diet. Second, there may have been such a high availability of wild fauna around the site that hunting was a common practice alongside agriculture and pastoralism. Lastly, the increase in diversification may be resulting from the use of risk management strategies, as discussed in Chapter 3.

Vinča, located on the edge of the Pannonian Plains region, has a different exploitation pattern than Opovo. In fact, Vinča has a very similar pattern to those observed at Foeni-Salaş during the Early Neolithic. At Vinča during the Late Neolithic, there are noticeably low frequencies of wild fauna indicating that the site is focused on a domesticate exploitation pattern. Additionally, the high diversity of wild fauna found in the assemblage indicates that the people living at the site fully exploited the different taxa surrounding them. The unusual pattern observed at Vinča, which reflects the Early Neolithic patterns seen at Foeni-Salaş, may be partly due to the fact that the site was situated on a tell. This location may mimic the conditions of the Banat, despite the fact that sites from the same region show a tendency towards a diversified economy.

In the central Serbian region, a similar pattern exists at the site of Petnica. Here, there is a shift towards a more diversified exploitation pattern from the Vinča C to the Vinča D period. This shift towards diversification is not unique to the region or site. Instead, it is unique to the time period since it is very similar to Opovo's exploitation patterns.

B. ***What are the frequencies of red and roe deer compared to the overall assemblage? (Figure 29)***

This research question was originally presented in Chapter 6. The section below will serve as a summary and synthesis of that information. The results will be presented in a similar manner as above where each site will be grouped in environmental regions, then discussed based on collection method, and finally by time period.

1. Summary by environment

a. Central Serbia (Blagotin, Divostin, Petnica, Stragari)

Sites located in the central Serbia environmental region all have a very similar pattern in deer exploitation. The sites of Blagotin (red deer 3.02%, roe deer 2.13%), Petnica (red deer 40-35%, roe deer 11-6%), Divostin I (red deer 2%, roe deer 1%), Divostin II (red deer 6%, roe deer 4%) (Bökönyi, 1988) and Stragari (red deer 67.75%, roe deer 21.48%) have varying frequencies. Blagotin, and Divostin I and II show that red and roe deer, in relation to the assemblage, are equally not very important. Stragari, followed distantly by Petnica, shows the highest frequencies for red deer than roe deer, which also make up a large percentage of the wild fauna overall. There is no reason why some sites in this region display a higher preference for red deer over all other species. Additionally, one pattern is clear, that roe deer are far lower in frequency and were clearly considered a less important resource than red deer at all sites in this region. The low frequencies in roe deer could be due to their considerably small size and which would result in less protein. Roe deer also have smaller and less robust antler racks than the larger red deer antlers.

b. Pannonian Plain and Danube River basin (Opovo and Vinča)

This environment hosts a large diversity of wild fauna around the sites as shown in the first section above. When comparing just the red and roe deer frequencies to each of the assemblages, both Opovo (red deer 32.72%, roe deer 5.76%) and Vinča (red deer 13.98%, roe deer 1.93%) show red deer to be the most common, followed by roe deer. This signifies that red deer were more actively exploited than roe deer in this environmental region. It should also be noted that the remains from aurochs are the second most common wild fauna at Vinča. This

places roe deer as the fifth most exploited wild taxa (Table 85). This further supports the fact that roe deer are not an important resource, especially at Vinča.

c. Iron Gates (Hajdučka Vodenica, Lepenski Vir and Padina B)

The Iron Gates sites of Hajdučka Vodenica (red deer 54.36%), Padina B (red deer 70.6%, roe deer 2.4%) (Clason, 1980), and Lepenski Vir (red deer 36.39%, roe deer 1.52%) (Srejović, 1972) show a very similar pattern. Here, red deer make up the bulk of the assemblage. These frequencies show that red deer are a very important resource in the Iron Gates. As discussed above, red deer are very attractive taxa for exploitation because they are larger animals and can provide more meat and secondary products like hide and antlers. The roe deer, on the other hand, are non-existent at Hajdučka Vodenica and appear in very low frequencies at other sites. The reason for the lack of roe deer at Hajdučka Vodenica is unknown. There are several possibilities as to why roe deer are so low in frequency in this region. One possibility is that roe deer are very low in numbers in the Iron Gates region during the Early Neolithic and were not present at all around the site of Hajdučka Vodenica. The fact that roe deer are typically found throughout all of Europe makes this theory less likely. A second theory may be that because wild fauna are particularly plentiful in the Iron Gates region, the people living at these sites may have had a preference for hunting specific taxa, in particular, the larger animals. Roe deer may have been seen as less important due to their small size compared to the more highly available and larger red deer.

d. Romanian Banat (Foeni-Salaş and Sânandrei)

The sites in the Banat region have a very similar pattern to that of Blagotin from the central Serbian region. In this environment, red deer are the most exploited taxa. Roe deer are not the second most common taxon but rather the third in most cases. Foeni-Salaş (red deer 4.40,

roe deer 3.42) illustrates this pattern very clearly. Fish are the most common wild taxon, with red and roe deer following closely behind (Table 23). Based purely on these values it appears as if red and roe deer are not the most important resource exploited by the people of Foeni-Salaş because their frequencies are below 5%, respectively. However, a single fish does not provide as many calories as a single deer, therefore the high numbers of fish are not indicative of their importance. For this reason, it is highly likely that red and roe deer remain an important resource. At Sânandrei (red deer 17.46, roe deer 8.29), red and roe deer are slightly more frequent than they are at Foeni-Salaş. However, just as at Foeni-Salaş, they are not an important resource at the site when comparing the domestic with the wild taxa.

e. Morava River Valley (Bukovačka Česma)

Bukovačka Česma (red deer 32.78, roe deer 6.64) features a very similar pattern of deer exploitation as Vinča, from the Pannonian region, and Padina B and Lepenski Vir, from the Iron Gates region. In this case, red deer vastly outnumber roe deer. Most likely, the people at Bukovačka Česma were highly selective for red deer, as in the Iron Gates region. Compared to all sites discussed in this section, roe deer are still exploited in small numbers.

2. Summary by recovery method

There is no pattern that relates recovery method to the frequencies of red and roe deer from each assemblage. The use of sieving, in this case, does not significantly affect the frequencies of red and roe deer at any of the sites. Red and roe deer are fairly large mammals and therefore are easily collected using hand collection techniques. The only frequencies that may have skewed the results by using sieving are those from Foeni-Salaş, where fish were the most common wild taxa even though they were still dwarfed by the domestic fauna. At most sites, red and roe deer are the most common wild fauna exploited at each site. Only Foeni-Salaş,

Sânandrei, Opovo, and Vinča do not have red and roe deer as their top two wild taxa (Table 23, 40, 55, & 63).

3. Summary by period

There is no clear temporal pattern in the exploitation patterns of red and roe deer throughout the Neolithic. This is due to the fact that frequencies are influenced by the surrounding environment of the site. Part of the issue is that there is a high range of taxonomic diversity for the different types of regional environmental areas within the central Balkans. Many of the sites that are inhabited during the Early Neolithic are re-inhabited during the later parts of the Neolithic, or new sites are inhabited in similar environmental regions close by.

a. Early Neolithic

During the Early Neolithic, red and roe deer occur in varying frequencies at varying sites. The Early Neolithic sites located in central Serbia, have low frequencies for red and roe deer when comparing them to the overall assemblage. This is seen in the assemblage of Blagotin, where red deer (3.02%) and roe deer (2.17%) are found in very low frequencies. Foeni-Salaş (red deer 4.40%, roe deer 3.42%) also follows this pattern, despite its location in the Romanian Banat. For sites located in the central Serbian environmental region, red and roe deer are not considered an important part of the overall assemblage and possibly diet. Other sites, such as Hajdučka Vodenica (red deer 54.76%) in the Iron Gates, and Bukovačka Česma (red deer 32.78%, roe deer 6.64%) in the Morava River Valley, are different. At these sites, red deer are recovered in higher frequencies and are clearly an important wild resource for these sites. Roe deer weren't recovered at Hajducka Vodenica and were in slightly lower frequencies at Bukovačka Česma. Because of this wide range of variation between different sites, there is no pattern during the Early Neolithic aside from those that are environmental.

b. Middle Neolithic

The Middle Neolithic assemblages show much variation. The sites located in the Banat region show similar patterns to those observed in the Early Neolithic. Sânandrei (red deer 17.46%, roe deer 8.29%) shows moderately low frequencies for red and roe deer. The sites located in central Serbia shifted from both red and roe deer exploited in low frequencies to a totally different pattern in this period. Both Petnica (red deer 70.09, roe deer 11.67) and Stragari (red deer 67.75, roe deer 21.48) have high frequencies for red deer and low frequencies for roe deer. This shift shows an increasing preference towards the exploitation of red deer, but roe deer remain at the same level of exploitation as seen during the Early Neolithic in this region. It is not clear why there is an increase in the frequencies of red deer, but it may be due to an increase in population at the sites, or the increased availability of red deer in the central Serbian environmental region.

c. Late Neolithic

The Late Neolithic shows high variability in the deer frequencies found at each site. The sites located in the Banat region show similar patterns to those observed in the Early Neolithic. Sânandrei (red deer 17.46%, roe deer 8.29%) shows moderately low frequencies for red and roe deer. The sites located in central Serbia shifted from both red and roe deer exploited in low frequencies to a totally different pattern in this period. The Late Neolithic levels of Petnica (red deer 35%, 7%), shows lower frequencies of red deer remains than in the Middle Neolithic levels. This shows a shift in the importance of red deer during the Late Neolithic in the central Serbian region. Vinča (red deer 13.98, roe deer 2.31) and Opovo (red deer 32.72%, roe deer 5.76%), located on the edge of the Pannonian Plain, also have moderately low red deer frequencies and

very low roe deer frequencies. Interestingly, the frequencies at Opovo nearly match those at Petnica.

During the Early Neolithic, red and roe deer both are hunted in low frequencies in the central Serbian and Banat regions. Only the Iron Gates were an exception, where red deer are hunted in high frequencies. During the Middle Neolithic, the exploitation for red deer increased in the central Serbian region. In the Late Neolithic however, red deer exploitation drops in frequency in the central Serbian region and the Pannonian Plain and remains low in the Romanian Banat region. It is not clear why red deer dropped in frequency from the Middle Neolithic to the Late Neolithic. There may be several factors at work in these regions that have created this drop in red deer frequencies. These factors may be attributed to: a drop in availability of red deer surrounding the site (over hunting in the region over time), a decrease in population size at the site (diversification through the exploitation of wild taxa was not necessary), or red deer are considered a less important resource (other wild resources were exploited instead).

Roe deer also have a very clear pattern throughout the Neolithic. Roe deer never appear in numbers over 50%, and only at Stragari do they exceed 20%. This pattern has been very consistent throughout the Neolithic and does not shift over time.

C. ***What are the percentages for the red and roe deer in relation to the wild assemblage? (Figure 30)***

The data presented here, and in the next four sections, will only feature the data analyzed from the databases used in this thesis. The percentages are all based on the results presented in Chapters 6 and 7.

1. Summary by environment

a. Central Serbia (Blagotin, Petnica, Stragari)

Sites located in the central Serbian region, such as Blagotin, demonstrate relatively low frequencies for red and roe deer within the overall assemblage. However, the frequencies appear very different when comparing the deer sample to only the wild assemblage. At Blagotin (red deer 39.49%, roe deer 28.44%), Petnica (red deer 65-70%, roe deer 11-14%) and Stragari (red deer 72.54%, roe deer 23.00%), red deer are very common. Roe deer, on the other hand, appear in far lower frequencies. The sites of Petnica and Stragari have the highest frequencies for red deer, while Blagotin has the highest frequencies for roe deer.

b. Pannonian Plains and Danube river basin (Opovo and Vinča)

The sites on the edge of the Pannonian plains have a similar patters to those observed at sites in central Serbia (Blagotin) and the Romanian Banat (Sânandrei). Both Vinča (red deer 47.855, roe deer 6.60%) and Opovo (red deer 59.29%, roe deer 10.43%) feature high frequencies of red deer, and low frequencies for roe deer. This shows a preference for the larger deer taxa.

c. Iron Gates region (Hajdučka Vodenica)

The Iron Gates region is unique because typically most sites have unusually high frequencies of wild taxa. In this section, only one site from the Iron Gates region was analyzed. Hajdučka Vodenica (red deer 82.14%) has very high frequencies of red deer, the highest among all sites analyzed in this thesis. Interestingly, this is the only site where roe deer are not present.

d. Romanian Banat region (Foeni-Salaş and Sânandrei)

The sites of Foeni-Salaş (red deer 21.00%, roe deer 16.36%) and Sânandrei (red deer 44.02%, roe deer20.98%) are located in the Romanian Banat region. Both sites feature high red deer frequencies and low roe deer frequencies. Sânandrei has the highest frequencies of red and

roe deer compared to Foeni-Salaş. However, wild taxonomic frequencies at Sânandrei place roe deer are third most common of the wild taxa (Table 40).

e. Morava River Valley (Bukovačka Česma)

The results from Bukovačka Česma (red deer 56.03%, roe deer 11.35%), located in the Morava River Valley, show that red deer occur at moderately high frequencies. As at other sites in the central Balkans, roe deer still occur at drastically lower frequencies.

2. Summary by period

a. Early Neolithic

During the Early Neolithic, Blagotin (red deer 39.49%, roe deer 28.44) and Foeni-Salaş (red deer 21.00%, roe deer 16.36%) both feature deer frequencies lower than 50%. At both sites, red deer outnumber roe deer, though most significantly at Blagotin. These patterns are indicative of the environments that both sites are situated. Bukovačka Česma (red deer 56.03, roe deer 11.35) also has high frequencies of red deer and low frequencies of roe deer. The site of Hajdučka Vodenica (red deer 82.14%) is unique and features red deer well over 50%. Both Bukovačka Česma and Hajdučka Vodenica have equally high frequencies of red deer.

b. Middle Neolithic

The Middle Neolithic assemblage features slightly different relationships than those observed during the Early Neolithic. Both Petnica (red deer 70.09%, roe deer 11.67&%) and Stragari (red deer 72.54%, roe deer 23.00%) feature very high frequencies of red deer and very low frequencies of roe deer. Interestingly, these two sites have very similar frequencies for red deer (both above 70%).

c. Late Neolithic

.The Late Neolithic assemblages of Petnica (red deer 63-67%, roe deer 12.81-13.99%) and Opovo (red deer 59.29%, roe deer 10.43%) feature high red deer frequencies and low roe deer frequencies. The site of Vinča (red deer 47.85%, roe deer 6.60%) and Sânandrei (red deer 44.02%, roe deer 20.98%), on the other hand, features lower red deer frequencies than those observed at Petnica and Opovo. However, at all three sites, roe deer frequencies remain very low (below 15%).

D. ***Are red and roe deer an important part of the wild diet during the Neolithic? (Figure 31)***

All deer taxa recovered from the Neolithic are considered to be of importance, but for different reasons. Deer as a resource are used in a variety of ways such as food, tools, materials, etc. Roe deer can provide the same resources as red deer, but in smaller quantities. For example, at Stragari roe deer tools account for 17% of the total tool assemblage and red deer represent, 34%, showing the importance of deer for non-dietary uses. And for these reasons deer can be seen as important, especially since nearly every site under investigation has red and roe deer present in their assemblages (Hajdučka Vodenica is the exception). However when the total assemblage for each site is examined based on dietary needs, deer become unimportant at most sites. This is because at the majority of these sites, domestic fauna such as sheep, goats, and cattle outnumber all wild fauna. Only at sites such as those located in the Iron Gates or Stragari, located in central Serbia show signs that deer were a numerically important dietary resource.

When observing the wild assemblage red and roe deer become an important part of the wild diet. Red deer are consistently the most common deer taxa at every analyzed site. Red deer appear in every wild assemblage as the first most common species exploited, except for Foeni-Salaş where fish outnumber all wild taxa. Roe deer, like red deer also appear in the assemblage

of ever site, but are usually the second most common wild taxa (Blagotin, Stragari, and Petnica). Though at times, roe deer can appear as low as the third or even fifth most exploited taxa in the wild assemblage (Bukovačka Česma, Foeni-Salaş, Sânandrei, Opovo, Vinča).

The high frequencies for red deer is not necessarily a result of the environment surrounding the site, though it could be a contributing factor. The ideal environments for red deer are patchy wooded areas that provide protection and cover during the winter months and open areas with good grazing and browsing during the spring and summer months (Steele 2002). Sites in these types of environments are located in the central Serbian region (Petnica and Bukovačka Česma), the Iron Gates (Hajdučka Vodenica), and the edge of the Pannonian Plain (Opovo and Stragari). Some exceptions do exist where red deer do not occur as the most exploited wild taxa (Foeni-Salaş, Blagotin, Sânandrei and Vinča). The fact that red deer appear as the second, third, or fifth most exploited taxa is indicative of the environment around these sites, rather than the preference of exploitation. Both Foeni-Salaş and Sânandrei are located in a well-drained and open plain environment, where red deer are not as common year round. Vinča is a tell site, and therefore red deer are not found close to the site and would have been harder to find and bring back after they have been killed (red deer are large and heavy). Blagotin is located in a region where other nearby sites feature high red deer frequencies. However, Blagotin is located in a well-drained but less densely forested portion of the region.

Roe deer always occur in lower frequencies than red deer and in consistently small frequencies throughout the Neolithic in the central Balkans. This means that roe deer are not an important part of the deer assemblage. Vigne Roe deer are readily available year round in most regions throughout the central Balkans during the Neolithic. Roe deer territories are small. They will often remain within the same boundaries throughout the same season or year round, and do

not migrate more than three kilometers from where they were born. Unlike red deer, roe deer prefer transitional zones at forest edges that provide enough foliage for food and cover for protection since they are browsers. These transitional zones occur naturally and the edges of forests and grasslands, but are also created by people as they clear away forests for agricultural fields and settlements. The creation of these zones by people during the Neolithic would have made these areas highly attractive for roe deer. Sites located in flat alluvial plains, such as Foeni-Salaş and Sânandrei, are not located close to forests, therefore roe deer are not as common. This is reflected in their frequencies, which occur consistently below 10%. Sites located in the central Serbian region, show some fluctuations, however, the same pattern persists. In this environment, there are some sparsely spaced forests. Sites located in the Iron Gates, and moist marshland areas (Hajdučka Vodenica, Bukovačka Česma, Stragari, and Opovo) are found in regions where roe deer are quite common, but they are still recovered in low frequencies. Based on these observations, the low frequencies of roe deer observed throughout the entire Neolithic, at nearly every site, is not related to any chronological pattern or surrounding environment around each site. This implies that roe deer were either opportunistically hunted or were considered a less suitable wild resource. This may especially be the case with Hajdučka Vodenica, where there are no roe deer remains recovered.

The results of the analysis of the frequencies of both red and roe deer indicate that red deer are a more important part of the wild portion of the Neolithic diet. Red deer are probably more common than roe deer because they are larger animals and can provide these resources in higher quantities for the energy expended to hunt them. This would make them more attractive for exploitation. However, the importance of red deer is not linked to only diet, but other resources that they can provide, since they are not the dominant taxa in most sites. Deer in

general provide many material resources, such as meat, antler, bone, etc., but they also can provide important social resources (e.g. ritual, hunting status, etc.).

Roe deer appear in low frequencies at every site throughout the Neolithic indicating that they are not an important part of the total Neolithic diet. Their low frequency does not mean that roe deer are unimportant since they are always present in all assemblages. Roe deer are probably less common in the assemblages because they are smaller and do not provide fewer resources for the energy expended to hunt them. Their constant, but low frequencies, may indicate that they provided an important set of resources that were needed less often. Their low frequencies could also indicate that roe deer were hunted opportunistically as they were encountered or roe deer were hunted only at certain times or for certain reasons.

The recovery methods used at each archaeological site probably affect the frequencies of roe deer in the Neolithic assemblages. However the fact that they are present even in unseived assemblages in fairly similar frequencies signifies that roe deer were exploited continuously at low frequencies. .

E. ***Is there a preference for certain age classes in red and roe deer that were hunted? (Figure 32)***

All deer samples examined in the database are discussed in Chapter 7. The database results describe a basic pattern in which adults were the most common hunted age class. Generally, subadults would be the second most common age class. However, in the case of the roe deer at Bukovačka Česma, juveniles were the most common (over 50%) age class, followed by subadults, and adults. It is not clear why this pattern occurred and more investigation is necessary to understand why the roe deer are killed at such a young age at this site.

Teeth selected for dental cementum analysis were not selected based on age. Only the complete M1 teeth that were available within the University of Manitoba collection were selected. This can create the appearance of a slight bias for age-of-death since M1 is not fully erupted in young juveniles (<6 months of age). This would create a gap for the spring and summer of the first year of these animal's lives. However, this does not create a bias for seasonality because the older animals cover those seasons of the year. In cementum analysis there is a bias for age-of-death because the first year does not appear in the increments. For this reason, other age-of-death methods can provide complimentary results for individuals under one year of age.

The dental cementum analysis results support the database results, in which all successful thin sectioned specimens (thirteen specimens) are found to have been from adults. There is no evidence for younger age groups (e.g. subadults). This supports the assumption that the Neolithic people from each site valued adults over younger animals. This may be because adults have more meat, their bones are fully fused, they have heavier fur coats, their antlers could be collected once they shed or died, etc. Younger animals provide meat that is more tender, flexible bones, and depending on the species, softer fur. Based on the results of the analysis, it is clear that adult deer were the most preferred age class during the Neolithic. Based these results the inhabitants at these sites preferred to hunt young and middle aged adult deer because they provided more resources.

F. ***During which seasons were red and roe deer predominantly hunted? (Figure 33)***

Nineteen samples were analyzed from the central Balkans for dental annuli to determine the season-of-death. In total, thirteen of these samples were successful in determining the season-of-death. There are no dental cementum samples for the following sites: Hajdučka Vodenica,

Bukovačka Česma, Vinča, Foeni-Salaş, and Blagotin. Due to the lack of dental cementum samples from these sites, the Early Neolithic will not be discussed in the remaining two sections. Additionally, there are no red deer samples available from Sânandrei, or the Vinča C levels of Petnica.

All data presented in this section is the result of a small sample. This sample is very small because only complete M1s could be used for dental cementum analysis and many of the teeth from the University of Manitoba collection were damaged and unusable for dental cementum analysis. The results presented in this section are preliminary and are only representative of the sample. The results are not conclusive enough to describe clear patterns of seasonal exploitation of deer during the entire Neolithic of the central Balkans.

1. Summary by environment for red deer

a. Central Serbia (Petnica, Stragari)

There are a total of six successful dental cementum samples from red deer from this region. Three samples are from Stragari, and three are from Petnica. From the Stragari sample, two individuals were killed during the warmer seasons. Alternatively, the remaining sample was culled during the cooler seasons. Two of the three samples from Petnica were killed during the warm seasons, while the last sample was killed during the cooler seasons. Based on these results, red deer in central Serbia were primarily killed during the warmer seasons.

b. Pannonian Plain (Opovo)

Only one site from this region had samples that are good for dental cementum analysis: Opovo. At Opovo, there are a total of two successful red deer specimens with dental annuli visible. One sample was killed during the warmer seasons, while the other sample was killed during the cooler seasons. This indicates that there is no detectable seasonal pattern at the site

from these samples. Russell (1993) in her thesis also analyzed red deer teeth and found that red deer were typically killed during the summer and fall months. This correlates with the results obtained from the analysis in this thesis. Therefore, the red deer from Opovo were killed during both the warmer and cooler seasons.

2. Summary by period for red deer

a. Middle Neolithic

From the Middle Neolithic sample, a total of five red deer specimens were analyzed for dental cementum. Three of the five samples are from the Vinča A levels of Stragari. Two of these samples were killed during the warmer seasons, while the remaining sample was found to have died during the cooler seasons. The remaining two samples are from the Vinča B levels of Petnica. Both of the samples from Petnica were identified with a warmer season-of-death. Based on these results, the red deer from the Middle Neolithic were primarily killed during the warmer seasons. However, these results are only based on a small sample. More analysis needs to be done for this time period and these sites to determine a more concise pattern.

b. Late Neolithic

There are a total of three red deer dental cementum specimens analyzed from the Late Neolithic sample. One specimen is from the Vinča D levels of Petnica. This sample was found to have died during the cooler seasons. The remaining two samples are from Opovo. One of these two samples was identified with a warmer season-of-death, while the other sample died during the cooler seasons. Based on these results, the majority of the samples died during the cooler seasons. However, these results are only based on a small sample. More analysis needs to be conducted for the Neolithic in order to determine a more concise pattern.

3. Summary by environment for roe deer

a. Central Serbia (Petnica, Stragari)

There are a total of six roe deer samples for dental cementum analysis from central Serbia. One roe deer sample is from the Vinča A levels of Stragari. This sample was found to have died during the cooler seasons. The remaining five roe deer samples are from Petnica. Four of the five samples were identified as having a cooler season-of-death, while the remaining sample died during the warmer season. Based on these results, the majority of roe deer in central Serbia died during the cooler seasons.

b. Pannonian Plain (Opovo)

There are two roe deer samples for dental cementum analysis from this region: Opovo. One sample was identified with a cooler season-of-death, while the other sample died during the warmer seasons. Based on these results, there is no pattern at Opovo related to the season-of-death in the roe deer sample. This same result has also been found by Russell (1993), who also determined that there was no detectable seasonal pattern in the culling of roe deer at Opovo.

c. Banat (Sânandrei)

There are a total of three roe deer samples for dental cementum analysis from Sânandrei. Two of the samples were identified with a warmer season-of-death, while the remaining sample died during the cooler months. These results imply that roe deer at Sânandrei, in the Romanian Banat region, died during the warmer seasons.

4. Summary by period for roe deer

a. Middle Neolithic

There are total of three roe deer samples analyzed for dental cementum from the Middle Neolithic. From the Vinča A levels at Stragari, there is one roe deer sample. This sample died

during the cooler seasons. Two samples, from the Vinča B levels at Petnica, died during the warmer and colder seasons respectively. The results from the Middle Neolithic samples illustrates that roe deer primarily died during the cooler seasons during the Middle Neolithic.

b. Late Neolithic

There are a total of eight roe deer samples for dental cementum analysis from the Late Neolithic. Three samples were from the Late Neolithic levels of Petnica. Two of these samples are from the Vinča C levels at Petnica. These samples were found to have died during the cooler seasons. The remaining sample from Petnica is from the Vinča D levels. This sample died during the cooler seasons as well. The remaining two Late Neolithic samples are from Opovo. One sample was identified with a warm season-of-death, while the other sample died during the cooler seasons. The remaining three samples are from the Late Neolithic levels of Sânandrei. Two of these samples were identified with a warmer season-of-death, while the remaining sample died during the cooler seasons. Based on these results roe deer were killed primarily during the cooler seasons during the Late Neolithic.

G. ***Is there evidence of shifts in deer exploitation strategies through time (between and across the various phases of the Neolithic)? (Figure 34)***

1. Regional patterns

There are some regional patterns in the season-of-death for red and roe deer. In central Serbia, red deer typically died during the warmer seasons, while more roe deer died during the cooler seasons. For both red and roe deer, there was no seasonal pattern in the Pannonian plains. In this environment, it appears as if deer were hunted year round, possibly due to their high availability around the site. As in central Serbia, the Romanian Banat region features a warmer season culling pattern for roe deer. However, no red deer specimens were analyzed from this

region. At present, the sample size used in this thesis was too small to clearly and definitively detect any clear regional relationships related to seasonal exploitation.

2. Chronological patterns

Within the small tooth sample there appears to be some shifts in the seasonal exploitation between the Middle and Late Neolithic. During the Middle Neolithic, red deer died primarily during the warmer seasons. During the Late Neolithic, red deer died during the cooler seasons. The roe deer samples also show a slight chronological shift. During the Middle Neolithic and Late Neolithic, roe deer died during the cooler seasons.

III. Conclusion

Although there appear to be some patterns in the exploitation of red and roe deer at the various sites analyzed in this thesis, it was consistently found that there was no relationship between the small sample size and the season-of-death results. The sample size was too small to make any definitive statement as to what the seasonal exploitation patterns were during the Neolithic. The clearest relationship that does come to light is that exploitation patterns are partially influenced by the environment around the site. This was especially the case when comparing the sites of the Romanian Banat region to those of the Iron Gates region.

Each site consistently exploited adult individuals, despite different environments or time periods. The only exception to this pattern was Hajdučka Vodenica, where the majority of deer killed were juveniles. This illustrates that at most sites there was a preference for larger older animals as opposed to smaller younger animals, therefore maximizing obtainable resources.

The season-of-death results appear to illustrate some minor patterns during the Neolithic. These patterns are based primarily on environment (i.e. central Serbia and Banat regions) and time period. It was found that in the central Serbian region, red deer were killed during warmer

seasons. Roe deer, on the other hand, were killed during the cooler seasons. This may support the suggestion that roe deer were hunted opportunistically, since roe would wander closer to human settlements and fields in search of food. Most likely, red deer were hunted during warmer seasons because it was easier to leave the settlement to look for them in denser forested areas.

Temporal patterns for the season-of-death were only found in the red deer samples. These results suggest that red deer primarily died during the warmer seasons during the Middle Neolithic, and the cooler seasons during the Late Neolithic. All other results did not provide any further temporal patterns.

The next chapter will be the concluding chapter to this thesis. It will describe the many issues encountered during the analysis through the use of the age and season-of-death techniques and suggest areas for further research.

Chapter 9: Conclusions

I. Introduction

The goal of chapter is to critique the techniques used during the age and season-of-death analysis on red and roe deer and to summarize the results presented in Chapter 8. This chapter is organized into two parts. The first part critique the analytical techniques used in this thesis for determining the age- and season-of-death for red and roe deer i.e. tooth eruption and wear, crown heights, tooth wear scores and cementum analysis. The second part of this chapter will conclude the thesis and suggest fruitful areas for future research and investigation.

Chapter 1 introduced the seven questions posed in this thesis, which were later answered in Chapter 8.Chapter 2 describes the region of the central Balkans and the regional cultural developments that occurred during the Neolithic. Chapter 3 discusses the motivations for hunting, as proposed by Orton (2008) and the literature on hunting during the Neolithic. Chapter 4 introduces the sites that were under analysis in this thesis. Chapter 5 describes the development of teeth and the methods and techniques utilized in this thesis to analyze the age and season-of-death. Chapter 6 describes the data from each site in terms of the wild vs domestic taxonomic frequencies, wild taxa frequencies, deer frequencies, deer elements frequencies, etc. Chapters 7A and B describes the results from tooth eruption and wear analysis, tooth wear scores (red deer only), crown height analysis, and dental cementum analysis. Lastly, Chapter8 discusses the results of the data and analysis that were described in Chapters 6, 7A and 7B using the questions posed in Chapter 1.

II. Critique of the analytical techniques

Throughout the investigation of the seasonal exploitation of red and roe deer, several points came to light regarding the analytical techniques that were used. The techniques, tooth

eruption and wear analysis, tooth wear score, crown height measurement, and dental cementum analysis, all proved to be highly useful; however, only when used in conjunction with each other.

A. ***Tooth eruption and wear technique***

Through the course of the analysis of the data presented in this thesis, it was discovered that there are currently very few studies that describe and document tooth eruption and wear sequences for roe deer. (Ashby & Henry, 1979; Hewison et al., 1999; Høye, 2006; Mysterud & Østbye, 2006; Tomé & Vigne, 2003), in contrast to red deer. In particular, Tomé and Vigne's (2003), one of the most widely cited supposed control studies, present a partial tooth eruption and wear table for roe deer. While this was an initial useful resource, it was quickly discovered that their tables do not accurately describe all age the stages. Many of the key stages are missing in each age class. For this reason, their technique proved to be unusable since many of the specimens could not be accurately aged with their system. It was only because I used other techniques that these specimens could be aged.

B. ***Crown height analysis***

Crown height analysis has proven to be fairly accurate (when compared to dental cementum analysis results) in determining the age-of-death for both red and roe deer. As described in Chapter 5, crown height analysis involves measuring the height of the tooth crown and then entering the results into an equation to gain the age-of-death. Because this technique utilizes measurements and formulas, which can be easily duplicated, it is considered to be one of the most objective techniques used to determine age-of-death (Mysterud & Østbye, 2006; Steele & Weaver, 2012).

Some issues have come to light during the analysis or red and roe deer in this thesis. It was found that the crown height method only works on teeth identified as M1, M2 and M3.

Currently, there are no formulas for PM2, 3 and 4, since these teeth do not wear uniformly (Tomé & Vigne, 2003). Another error that can occur during the analysis of crown heights is, often the older the individual is, the less accurate the technique becomes. The age-of-death for older individuals is often grossly overestimated. The same also applies to very young individuals where the age may be over or underestimated (Hewison et al., 1999; Tomé & Vigne, 2003).

C. *Tooth wear scores*

The tooth wear score analysis technique utilized in this thesis for the analysis of the age-of-death for red deer teeth has proven to be the least objective of the techniques used. This technique applies a scoring system to the wear areas on the occlusal surface of teeth. The crown height technique often encounters issues resulting in observer error due to the variation in individual wear of teeth. These errors can be easily avoided with the use of a known age comparative collection as a control alongside the scoring system.

Through the analysis of teeth for this thesis, several issues were discovered when this technique was used. These errors occur due to fact that the scoring system itself is very arbitrary. Additionally, this technique does not work for roe deer because their teeth wear irregularly due to their low cusps and browsing and grazing habits, which can wear teeth down quickly with high rates of variability.

The first error is related to the number of teeth present in the mandible. Mandibles with all teeth present will naturally gain a higher score, especially if the M3 is present. Accurate aging using the tooth scoring technique can only be conducted with the permanent adult molars. This is because premolars have unusual cusps and tend to wear irregularly, and therefore creating possible erroneous results (Brown & Chapman, 1991; Tomé & Vigne, 2003).

A second source of error when using this technique was found involving the M3. If the M3 is present, fully erupted and in wear, the score always appears to be higher because the third cusp is counted. This creates an imbalance in the results, naturally making mandibles with M3s present, to be much older than those without them (either lost in recovery during excavation, or lost in life before death).

A third issue encountered when using this technique is that single teeth or broken teeth could not be aged accurately using tooth wear scores because tooth wear scores require the entire mandible (the score of each tooth in the mandible is added together to receive the total age). Full mandibles are rare at archaeological sites. Therefore, this technique is not useful unless the majority of the sample is complete mandibles or another technique is used to age loose teeth.

The last error that can occur is the over-and under-estimation of the age of both very old and very young individuals. Unlike with crown heights, older individuals appear to reach an age cap of eight years (96 months). Therefore, with older individuals, this technique can only accurately confirm if the specimen is an adult. Young individuals are often underestimated, since not all molars may be erupted. Because the technique is best used on the permanent molars, it becomes difficult to age individuals that have not yet had their M2 or M3 erupt, or have deciduous teeth. Therefore, it is necessary when using this technique to employ other aging techniques such as tooth eruption and wear and crown heights, to accurately age tooth specimens. Errors in each technique are controlled by using as many age-of-death Analyses as possible. It was found that certain age-of-death techniques worked well for samples from some sites, but not for others. If more than one technique agrees, then they provide the most accurate age-of-death results for the individual. Then this age was used for that specimen.

D. ***Dental cementum analysis***

Dental cementum analysis is a dual technique that can determine both the age and season-of-death of an individual. Through the use of this technique several errors have come to light. The first error that can occur is this technique does not work well for determining the age or season-of-death of very young individuals (younger than one year), since annuli are deposited biannually. Issues may also arise in older individuals because once these individuals reach a certain age, dental annuli may have worn away or have become virtually undetectable. This was observed in one sample from Opovo in particular (Figure 27).

This technique is not objective and can be largely subjective. It has been found, throughout the course of the age and season-of-death analysis, that dental annuli must be both examined by eye and by digital graph. The reason for this is at times imaging may not see the lines present in the sample when generating a digital graph due to a slightly blurry image, noise or very faint lines. When examining the samples by eye shadows and scratches can be very easy to mistake for annuli.

This technique is very useful in determining the season and age-of-death of individual deer, and has proven to be valuable as a control for the other techniques mentioned above. For this reason, it has been suggested by other researches, that tooth eruption and wear, crown height, and dental cementum analysis techniques be used in unison alongside dental cementum analysis to obtain accurate age-of-death and season-of-death results (Mysterud & Østbye, 2006).

III. Conclusion

The results from these analysis techniques, described above and in Chapter 7A, 7B and 8, are varied. The strongest results for Neolithic exploitation patterns were those from different environmental regions, as discussed in Chapter 8. Sites located in the central Serbian region

feature low frequencies of wild fauna and low frequencies of red and roe deer (Petnica is the exception in this region). Sites located in the Romanian Banat region had very similar results to the central Serbian region. The Pannonian Plains and Iron Gates region both have high frequencies of wild taxa, which vastly outnumber the domestic taxa. In these regions, red deer are the most common among the wild taxa. Interestingly, Hajdučka Vodenica, from the Iron Gates, does not have any roe deer remains recovered from the site. This anomaly should be examined in the future to determine if this pattern is the result of collection strategies during excavations, the lack of roe deer in the environment around the site, or human behavior (selecting only for red deer).

There are no temporal patterns in the exploitation of red and roe deer during the Neolithic. The regional patterns discussed in Chapter 8 appear to apply to all periods. The exploitation of deer, in relation to the wild taxa, shows no temporal change, except for a small drop in red deer exploitation during the Late Neolithic at Petnica. However, despite the fact that there is no detectable pattern in this analysis, it does not mean that there is none. More analysis should be conducted on more sites from the Neolithic located within these regions. With this information it may be possible to detect a temporal pattern in the exploitation of deer, specifically between the Early, Middle and Late Neolithic.

There is s a clear preference at all sites for the exploitation of red deer during the Neolithic in the central Balkans. Red deer are clearly an important part of the wild diet during the Neolithic and were most likely hunted for other resources such as bone, hide, and antler. Roe deer, on the other hand, are consistently found in low frequencies and are not a major part of the Neolithic diet. These low frequencies for roe deer may indicate opportunistic hunting, in which

roe deer were only hunted as they were encountered or roe deer were hunted at certain times for specific reasons and resources.

Both red and roe deer from nearly all sites analyzed from the central Balkans show a preference for adults. This coincides with the fact that most sites are hunting primarily red deer. By hunting larger and/or older individuals (in the case of roe deer) the amount of primary (meat) and secondary (hide, antler, bone, etc.) resources is increased. Therefore the hunting of adult deer shows that Neolithic people were maximizing the resources they would receive rather than hunting whatever crossed their path. The exception is Hajdučka Vodenica, where juveniles appear to have been preferred. The reason for this preference for the young animals is unknown and should be examined in the future.

The season-of-death results presented in this thesis are mostly inconclusive, but do prove to show some slight regional patterns that may have occurred in the central Balkans during the Neolithic. In central Serbia, red deer appeared to have died during the warmer seasons, while roe deer died during the cooler seasons. No seasonal exploitation pattern has been detected between the sites located in the Romanian Banat and the Pannonian Plains.

Temporal patterns do appear in some cases for both red and roe deer. During the Middle Neolithic, red deer died during the warmer seasons. However, during the Late Neolithic red deer died during the cooler seasons. There is only evidence for a possible seasonal pattern of death for roe deer during the Late Neolithic, during which roe deer died during the cooler seasons. Despite these results, the sample sizes are far too small for any clear conclusive patterns.

The results from the season-of-death studies have proven to be inconclusive, but are still important. This inconclusive result is in part due to the small sample size (19 samples) stretched over a long period of time (Middle and Late Neolithic). Additionally, there are no dental

cementum samples from the Early Neolithic, which would have aided in gaining insight into the temporal shifts that may have occurred throughout the entire Neolithic. Despite these results being largely inconclusive, and based on the high variability of the results it was found that through the dental cementum analysis that red and roe deer were mostly likely hunted year round but at varying frequencies depending on the season. Currently, the results from this analysis are only preliminary and may change with a larger sample set, covering all periods equally. A larger study with sites that are inhabited for more than one of the Neolithic sub-periods with a much larger sample base would help clarify the results described in this thesis.

The results in this thesis not only described the importance of red and roe deer but also the nature and importance of forests during the Neolithic. Forests are mystical and dangerous places of legend and awe. For this reason forests are often viewed as the domain of young men, who may enter them for hunting or ceremonial reasons. Within these forests are not only deer, but larger more potentially dangerous animals such as bears, wolves, aurochs, and wild boar. The hunting of these animals would have had significant status implications within Neolithic society. Once these animals are brought back to the settlement they would have been proudly displayed for all to see. In essence this thesis describes that the majority of the animals come out of the forests during the Neolithic and that this is where the wild things truly are.

a.

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Tables

Sites	Taxa	Early Neolithic	Middle Neolithic	Middle/Late Neolithic	Late Neolithic	Mixed
Blagotin	*Cervus elaphus*	6	0	0	0	0
	Capreolus capreolus	0	0	0	0	0
Total		**6**	**0**	**0**	**0**	**0**
Stragari	*Cervus elaphus*	0	16	0	0	0
	Capreolus capreolus	0	14	0	0	0
Total		**0**	**30**	**0**	**0**	**0**
Petnica	*Cervus elaphus*	0	21	1	13	1
	Capreolus capreolus	0	18	0	6	1
Total		**0**	**39**	**1**	**19**	**2**
Sânandrei	*Cervus elaphus*	0	0	0	0	0
	Capreolus capreolus	0	0	0	8	0
Total		**0**	**0**	**0**	**8**	**0**
Opovo	*Cervus elaphus*	0	0	0	8	0
	Capreolus capreolus	0	0	0	5	0
Total		**0**	**0**	**0**	**13**	**0**

Foeni Salaş	*Cervus elaphus*	0	0	0	0	0
	Capreolus capreolus	0	0	0	0	0
Total		**0**	**0**	**0**	**0**	**0**
Vinča	*Cervus elaphus*	0	0	0	0	0
	Capreolus capreolus	0	0	0	1	0
Total		**0**	**0**	**0**	**1**	**0**
Bukovačka Česma	*Cervus elaphus*	1	0	0	0	0
	Capreolus capreolus	0	0	0	0	0
Total		**1**	**0**	**0**	**0**	**0**
Hajdučka Vodenica	*Cervus elaphus*	0	0	0	0	0
	Capreolus capreolus	0	0	0	0	0
Total		**0**	**0**	**0**	**0**	**0**
Grand Total	***All sites added***	**7**	**69**	**1**	**41**	**2**

Table 1: Red and roe deer teeth available for analysis in the University of Manitoba collection organized by site and period.

Author	Early Neolithic					Middle Neolithic					Late Neolithic						
	Starčevo	Starčevo I	Starčevo IIa/II	Starčevo IIb/III	Starčevo III/IV	Vinca A	Vinca B	B1a	B1b	B2	Vinca C	C1	C2	C3	Gradac	Vinca D D1	D2
Manson 1990	6100-5100	6100-5950	5950-5650	5650-5400	5400-5100												
Luca et al 2011	6100-5500	6100/6000-5900/5800	5950/5850-5800/5700	5800/5700-5600/5500	5600/5500-Differs by region												
Borić 2009	-5400				-5400	5400/5300-5200	5200-5000				5000/4950-4850				4850-4750	4850-4650/4600	
Tasić 2006	6300-6200					6052/5950-	5958-				5630-5521						
Chapman	6000-5000					5000-4000					4500-3500						
Lazarovici								5180/5040-5130/5040	5130/5040-5025/4950	5025/4950-4950/4860		4950/4860-4890/4800	4980/4800-4770/4720	4770/4720-4600			

Table 2: Chronologies of the Neolithic as discussed in Chapter 2 based on the central Balkan literature.

Site	Domestic %	Wild %	Domestic %	Wild %	Domestic %	Wild %
Blagotin (Greenfield and Jongsma-Greenfield 2014)	91.71	8.29				
Bukovacka Cesma (Greenfield 1994)	41.49	58.51				
Hajducka Vodenica (Greenfield 2008)	33.33	66.67				
Foeni Salas (Jongsma and Greenfield 2001)	79.07	20.93				
Stragari (Greenfield 2015b)			24	76		
Sânandrei (Jongsma & Greenfield 1996)					60.49	39.51
Petnica (Greenfield 1986)			30.44	69.56	46.33	53.67
Vinča (Greenfield 2014)					70.64	29.36
Divostin I & II (Bökönyi 1988)	92	8			85	15

Table 3: Domestic and wild fauna frequencies from the Neolithic literature from the central Balkans.

	Early Neolithic								Middle Neolithic					Late Neolithic								
Taxa	Blagotin	(Greenfield and Jongsma-Greenfield 2014)	Bukovačka Česma	(Greenfield 1994)	Divostin I	(Bökönyi 1988)	Foeni-Salaş	(Greenfield and Jongsma 2008)	Petnica Vinča B	(Greenfield 1986)	Stragari	Greenfield 2015)	Greenfield 2015)	Divostin II	(Bökönyi 1988)	Opovo	(Greenfield 1986)	Petnica Vinča C	(Greenfield 1986)	Petnica Vinča D	(Greenfield 1986)	Vinča	Greenfield 20014
Domestic	#	%	#	%	#	%	#	%	#	%	#	%	%	#	%	#	%	#	%	#	%	#	%
Bos taurus	2684	30.83	70	25.5	1117	47	895	34.92	32	19.5	468	5.14	5.14	6763	63	194	30.1	103	34.7	36	33.6	354	18.04
Ovis/Capra	5170	59.38	13	4.7	981	41	1015	0.7	5	3	99	1.09	1.09	1228	11	12	2.7	7	2.3	5	4.7	143	7.29
Sus Scrofa dom.	115	1.32	21	7.7	84	4	99	39.6	36	21.9	168	1.85	1.85%	1089	10	85	13.2	48	16.2	26	24.3	203	10.35
Canis familiarus	15	0.17			16	1	18	0.16	1	0.6	16	0.18	1800.00%	92	1	17	2.6	1	0.3			33	1.68
Wild Fauna	#	%	#	%	#	%	#	%	#	%	#	%	%	#	%	#	%	#	%	#	%	#	%
Aurochs	55	0.51	4	1.4	100	4	63	2.46	4	2.4	86	0.95	0.95%	627	6	15	2.3	1	0.3			62	3.16
Canis lupus	4	0.05			4		7	0.27			2	0.02	0.02%	5								1	0.05
Capreolus capreolus	188	2.16	19	6.9	13	1	87	3.39	15	9.1	506	5.56	5.56%	44		40	6.2	22	7.4	6	5.6	20	1.02
Cervus elaphus	260	2.99	78	28.5	45	2	113	4.41	60	36.6	1586	17.43	17.43%	416	4	232	36	82	27.6	31	29	145	7.39
Lepus europeanus	21	0.24			4		10	0.39	2	1.2	3	0.03	0.03%	6		4	0.6	1	0.3			1	0.05
Sus scrofa fer.	80	0.92	27	9.8	32		39	1.52	4	2.4	147	1.62	1.62%	495	5	23	3.6	23	7.7			24	1.22
Ursus arctos	6	0.07	1	0.4	1		2	0.08			4	0.04	0.04%	2									
Castor Fibre			8	2.9	1				5	3	15	0.16	0.16%	9				4	1.3				
Equid sp.							1	0.04														1	0.05
Felis silvestris											2	0.02	0.02%									2	0.1
Martes martes											1	0.01	0.01%			1	0.1						
Vulpes vulpes											1	0.01	0.01%	2				1	0.3				

Table 4: Domestic and wild taxonomic frequencies based on Neolithic literature from the central Balkans (includes only identified mammals).

Taxa	Blagotin Early Neolithic	
	NISP	NISP%
Domestic	**7988**	**92.36%**
Bos Taurus	2686	31.06%
Canis familiaris	15	0.17%
Capra hircuâ	282	3.26%
Oviâ aries	1052	12.16%
Ovis/Capra	3838	44.38%
Sus scrofa dom.	115	1.33%
Wild	**661**	**7.64%**
Bos primigenius	44	0.51%
Canis lupus	4	0.05%
Capreolus capreolus	188	2.17%
Cervus elaphus	261	3.02%
Corvus corone	2	0.02%
Corvus frugilegus	1	0.01%
Lepus europaeus	21	0.24%
Strix aluco	4	0.05%
Sus scrofa fer.	81	0.94%
Unio pictorum	49	0.57%

Ursus arctos	6	0.07%
Grand Total	**8649**	**100.00%**

Table 5: Taxonomic frequencies for Blagotin.

Taxa	Blagotin	Early Neolithic
	NISP	NISP%
Wild	**661**	**100.00%**
Bos primigenius	44	6.66%
Canis lupus	4	0.61%
Capreolus capreolus	188	28.44%
Cervus elaphus	261	39.49%
Corvus corone	2	0.30%
Corvus frugilegus	1	0.15%
Lepus europaeus	21	3.18%
Strix aluco	4	0.61%
Sus scrofa fer.	81	12.25%
Unio pictorum	49	7.41%
Ursus arctos	6	0.91%
Grand Total	**661**	**100.00%**

Table 6: Wild taxa frequencies from Blagotin

	Blagotin	**Early Neolithic**
Taxa	**NISP**	**NISP%**
Capreolus capreolus	188	41.87%
Cervus elaphus	261	58.13%
Grand Total	**449**	**100.00%**

Table 7: Deer frequencies from Blagotin

Deer elements	Blagotin NISP	Early Neolithic NISP%
Capreolus capreolus	**188**	**41.87%**
Carpal 2, 3	1	0.22%
Cranial	11	2.45%
Femur	11	2.45%
Humerus	3	0.67%
Innominate	16	3.56%
Loose tooth	2	0.45%
Mandible	6	1.34%
Metacarpus	7	1.56%
Metapodial	3	0.67%
Metatarsus	22	4.90%
Patella	1	0.22%
Phalanx 1	1	0.22%
Phalanx 1-Posterior	1	0.22%
Phalanx 2	1	0.22%
Phalanx 3	6	1.34%
Radius	10	2.23%
Radius, Ulna	2	0.45%
Rib	10	2.23%

Scapula	**17**	**3.79%**
Tarsal-Cuboid	**1**	**0.22%**
Tibia	**17**	**3.79%**
Ulna	**3**	**0.67%**
Vertebra-atlas	**1**	**0.22%**
Vertebra-cervical	**2**	**0.45%**
Vertebra-lumbar	**2**	**0.45%**
Vertebra-thoracic	**31**	**6.90%**
Cervus elaphus	**261**	**58.13%**
Astragalus	**7**	**1.56%**
Calcaneus	**1**	**0.22%**
Carpal	**1**	**0.22%**
Carpal 2, 3	**1**	**0.22%**
Carpal-radial	**2**	**0.45%**
Carpal-ulnar	**1**	**0.22%**
Cranial	**40**	**8.91%**
Femur	**16**	**3.56%**
Humerus	**5**	**1.11%**
Innominate	**10**	**2.23%**
Loose tooth	**13**	**2.90%**
Mandible	**10**	**2.23%**
Metacarpus	**12**	**2.67%**

Metapodial	**6**	**1.34%**
Metatarsus	**17**	**3.79%**
Patella	**1**	**0.22%**
Phalanx 1	**3**	**0.67%**
Phalanx 2	**8**	**1.78%**
Phalanx 3	**6**	**1.34%**
Radius	**20**	**4.45%**
Radius, Ulna	**4**	**0.89%**
Rib	**16**	**3.56%**
Scapula	**11**	**2.45%**
Sesamoid-distal	**1**	**0.22%**
Tarsal-Cuboid	**3**	**0.67%**
Tibia	**16**	**3.56%**
Ulna	**4**	**0.89%**
Vertebra	**5**	**1.11%**
Vertebra-cervical	**3**	**0.67%**
Vertebra-epistropheus	**2**	**0.45%**
Vertebra-lumbar	**3**	**0.67%**
Vertebra-thoracic	**13**	**2.90%**
Grand Total	**449**	**100.00%**

Table 8: Deer element frequencies from Blagotin

Deer Antler	Blagotin Early Neolithic NISP	NISP%
Capreolus capreolus	**3**	**10.34%**
Cranial	**3**	**10.34%**
Antler	3	10.34%
Fragment	3	10.34%
Cervus elaphus	**26**	**89.66%**
Cranial	**26**	**89.66%**
Antler	26	89.66%
Antler base, 1st tine	1	3.45%
Antler base, shed	1	3.45%
Beam	1	3.45%
Body	1	3.45%
Shaft	4	13.79%
Tine tip	2	6.90%
Fragment	16	55.17%
Grand Total	**29**	**100.00%**

Table 9: Deer antler frequencies from Blagotin

	Blagotin	Early Neolithic
Deer elements	**NISP**	**NISP%**
Capreolus capreolus	**188**	**41.87%**
Carpal 2, 3	**1**	**0.22%**
Cranial	**11**	**2.45%**
Antler	3	0.67%
Frontal, Horn Core	2	0.45%
Occipital	2	0.45%
Premaxilla	3	0.67%
Zygomatic	1	0.22%
Femur	**11**	**2.45%**
Humerus	**3**	**0.67%**
Innominate	**16**	**3.56%**
Loose tooth	**2**	**0.45%**
LPM3/4	1	0.22%
UPM3/4	1	0.22%
Mandible	**6**	**1.34%**
Alveolus, Ascending Ramus, Hinge	1	0.22%
Coronoid process	1	0.22%
Hinge	2	0.45%
Posterior half	2	0.45%
Metacarpus	**7**	**1.56%**

Metapodial	**3**	**0.67%**
Metatarsus	**22**	**4.90%**
Patella	**1**	**0.22%**
Phalanx 1	**1**	**0.22%**
Phalanx 1-Posterior	**1**	**0.22%**
Phalanx 2	**1**	**0.22%**
Phalanx 3	**6**	**1.34%**
Radius	**10**	**2.23%**
Radius, Ulna	**2**	**0.45%**
Rib	**10**	**2.23%**
Scapula	**17**	**3.79%**
Tarsal-Cuboid	**1**	**0.22%**
Tibia	**17**	**3.79%**
Ulna	**3**	**0.67%**
Vertebra-atlas	**1**	**0.22%**
Vertebra-cervical	**2**	**0.45%**
Vertebra-lumbar	**2**	**0.45%**
Vertebra-thoracic	**31**	**6.90%**
Cervus elaphus	**261**	**58.13%**
Astragalus	**7**	**1.56%**
Calcaneus	**1**	**0.22%**
Carpal	**1**	**0.22%**

Carpal 2, 3	**1**	**0.22%**
Carpal-radial	**2**	**0.45%**
Carpal-ulnar	**1**	**0.22%**
Cranial	**40**	**8.91%**
Antler	26	5.79%
Frontal	2	0.45%
Frontal, Horn Core	2	0.45%
Hinge	1	0.22%
Horn core	2	0.45%
Maxilla	2	0.45%
Nasal	1	0.22%
OCC,EAR,,ZYG,TEMP,PEDICLE,FRONTAL	1	0.22%
Occipital	1	0.22%
Premaxilla	1	0.22%
Temporal	1	0.22%
Femur	**16**	**3.56%**
Humerus	**5**	**1.11%**
Innominate	**10**	**2.23%**
Loose tooth	**13**	**2.90%**
LM1/2	1	0.22%
LM1/3	1	0.22%
LM2/3	1	0.22%

LM3	1	0.22%
LPM2	1	0.22%
LPM3	2	0.45%
LPM3/4	1	0.22%
Shaft	1	0.22%
UPM	1	0.22%
UPM2/3	1	0.22%
UPM3/4	2	0.45%
Mandible	**10**	**2.23%**
Alveolus	1	0.22%
Alveolus, Base of Alveolus	2	0.45%
Ascending Ramus	2	0.45%
Diastema	1	0.22%
Diastema, Alveolus	2	0.45%
Hinge	1	0.22%
Loose teeth	1	0.22%
Metacarpus	**12**	**2.67%**
Metapodial	**6**	**1.34%**
Metatarsus	**17**	**3.79%**
Patella	**1**	**0.22%**
Phalanx 1	**3**	**0.67%**
Phalanx 2	**8**	**1.78%**

Phalanx 3	**6**	**1.34%**
Radius	**20**	**4.45%**
Radius, Ulna	**4**	**0.89%**
Rib	**16**	**3.56%**
Scapula	**11**	**2.45%**
Sesamoid-distal	**1**	**0.22%**
Tarsal-Cuboid	**3**	**0.67%**
Tibia	**16**	**3.56%**
Ulna	**4**	**0.89%**
Vertebra	**5**	**1.11%**
Vertebra-cervical	**3**	**0.67%**
Vertebra-epistropheus	**2**	**0.45%**
Vertebra-lumbar	**3**	**0.67%**
Vertebra-thoracic	**13**	**2.90%**
Grand Total	**449**	**100.00%**

Table 10: Deer element frequencies showing teeth from Blagotin

Deer elements with teeth	Blagotin Early Neolithic NISP	NISP%
Capreolus capreolus	**3**	**14.29%**
Loose tooth	**2**	**9.52%**
LPM3/4	1	4.76%
UPM3/4	1	4.76%
Mandible	**1**	**4.76%**
Alveolus, Ascending Ramus, Hinge	1	4.76%
Cervus elaphus	**18**	**85.71%**
Cranial	**2**	**9.52%**
Maxilla	2	9.52%
Loose tooth	**12**	**57.14%**
LM1/2	1	4.76%
LM1/3	1	4.76%
LM2/3	1	4.76%
LM3	1	4.76%
LPM2	1	4.76%
LPM3	2	9.52%
LPM3/4	1	4.76%
UPM	1	4.76%

UPM2/3	1	4.76%
UPM3/4	2	9.52%
Mandible	**4**	**19.05%**
Alveolus	1	4.76%
Alveolus, Base of Alveolus	2	9.52%
Loose teeth	1	4.76%
Grand Total	**21**	**100.00%**

Table 11: Deer tooth frequencies from Blagotin

	Blagotin	Early Neolithic
Roe deer elements	**NISP**	**NISP%**
Capreolus capreolus	**188**	**100.00%**
Carpal 2, 3	**1**	**0.53%**
Cranial	**11**	**5.85%**
Femur	**11**	**5.85%**
Humerus	**3**	**1.60%**
Innominate	**16**	**8.51%**
Loose tooth	**2**	**1.06%**
LPM3/4	1	0.53%
UPM3/4	1	0.53%
Mandible	**6**	**3.19%**
Alveolus, Ascending Ramus, Hinge	1	0.53%
Coronoid process	1	0.53%
Hinge	2	1.06%
Posterior half	2	1.06%
Metacarpus	**7**	**3.72%**
Metapodial	**3**	**1.60%**
Metatarsus	**22**	**11.70%**
Patella	**1**	**0.53%**
Phalanx 1	**1**	**0.53%**

Phalanx 1-Posterior	**1**	**0.53%**
Phalanx 2	**1**	**0.53%**
Phalanx 3	**6**	**3.19%**
Radius	**10**	**5.32%**
Radius, Ulna	**2**	**1.06%**
Rib	**10**	**5.32%**
Scapula	**17**	**9.04%**
Tarsal-Cuboid	**1**	**0.53%**
Tibia	**17**	**9.04%**
Ulna	**3**	**1.60%**
Vertebra-atlas	**1**	**0.53%**
Vertebra-cervical	**2**	**1.06%**
Vertebra-lumbar	**2**	**1.06%**
Vertebra-thoracic	**31**	**16.49%**
Grand Total	**188**	**100.00%**

Table 12: Roe deer element frequencies from Blagotin

Red deer elements	Blagotin Early Neolithic	
	NISP	NISP%
Cervus elaphus	**261**	**100.00%**
Astragalus	**7**	**2.68%**
Calcaneus	**1**	**0.38%**
Carpal	**1**	**0.38%**
Carpal 2, 3	**1**	**0.38%**
Carpal-radial	**2**	**0.77%**
Carpal-ulnar	**1**	**0.38%**
Cranial	**40**	**15.33%**
Antler	26	9.96%
Frontal	2	0.77%
Frontal, Horn Core	2	0.77%
Hinge	1	0.38%
Horn core	2	0.77%
Maxilla	2	0.77%
Nasal	1	0.38%
OCC,EAR,,ZYG,TEMP,PEDICLE,FRONTAL	1	0.38%
Occipital	1	0.38%
Premaxilla	1	0.38%
Temporal	1	0.38%

Femur	**16**	**6.13%**
Humerus	**5**	**1.92%**
Innominate	**10**	**3.83%**
Loose tooth	**13**	**4.98%**
LM1/2	1	0.38%
LM1/3	1	0.38%
LM2/3	1	0.38%
LM3	1	0.38%
LPM2	1	0.38%
LPM3	2	0.77%
LPM3/4	1	0.38%
Shaft	1	0.38%
UPM	1	0.38%
UPM2/3	1	0.38%
UPM3/4	2	0.77%
Mandible	**10**	**3.83%**
Metacarpus	**12**	**4.60%**
Metapodial	**6**	**2.30%**
Metatarsus	**17**	**6.51%**
Patella	**1**	**0.38%**
Phalanx 1	**3**	**1.15%**
Phalanx 2	**8**	**3.07%**

Phalanx 3	**6**	**2.30%**
Radius	**20**	**7.66%**
Radius, Ulna	**4**	**1.53%**
Rib	**16**	**6.13%**
Scapula	**11**	**4.21%**
Sesamoid-distal	**1**	**0.38%**
Tarsal-Cuboid	**3**	**1.15%**
Tibia	**16**	**6.13%**
Ulna	**4**	**1.53%**
Vertebra	**5**	**1.92%**
Vertebra-cervical	**3**	**1.15%**
Vertebra-epistropheus	**2**	**0.77%**
Vertebra-lumbar	**3**	**1.15%**
Vertebra-thoracic	**13**	**4.98%**
Grand Total	**261**	**100.00%**

Table 13: Red deer element frequencies from Blagotin.

Taxa	Hajdučka Vodenica	Early Neolithic
	NISP	NISP%
Domestic		
Bos Taurus	3	7.14%
Canis familiaris	3	7.14%
Sus scrofa dom.	8	19.05%
Wild		
Bos primigenius	1	2.38%
Cervus elaphus	23	54.76%
Fish (unidentified species)	1	2.38%
Sus scrofa fer.	2	4.76%
Ursus arctos	1	2.38%
Grand Total	**42**	**100.00%**

Table 14: Taxonomic frequencies for Hajdučka Vodenica.

Taxa	Hajdučka Vodenica	Early Neolithic
	NISP	NISP%
Wild		
Bos primigenius	1	3.57%
Cervus elaphus	23	82.14%
Fish (unidentified species)	1	3.57%
Sus scrofa fer.	2	7.14%
Ursus arctos	1	3.57%
Grand Total	**28**	**100.00%**

Table 15: Wild taxonomic frequencies from Hajdučka Vodenica.

Deer elements	Hajdučka Vodenica	Early Neolithic
	NISP	NISP%
Cervus elaphus	**23**	**100.00%**
Tibia	**1**	**4.35%**
Scapula	**3**	**13.04%**
Radius	**2**	**8.70%**
Metacarpal 3 and 4	**1**	**4.35%**
Femur	**1**	**4.35%**
Cranial	**12**	**52.17%**
Cervical vertebra	**1**	**4.35%**
Calcaneus	**1**	**4.35%**
Astragalus (talus)	**1**	**4.35%**
Grand Total	**23**	**100.00%**

Table 16: Deer element frequencies from Hajdučka Vodenica.

	Bukovačka Česma	Early Neolithic
Taxa	**NISP**	**NISP%**
Domestic		
Bos Taurus	69	28.63%
Ovis/Capra	12	4.98%
Sus scrofa dom.	19	7.88%
Wild		
Bos primigenius	3	1.24%
Capreolus capreolus	16	6.64%
Castor fiber	8	3.32%
Cervus elaphus	79	32.78%
Fish (unidentified)	4	1.66%
Unio sp.	2	0.83%
Ursus arctos	1	0.41%
Sus scrofa fer.	28	11.62%
Grand Total	**241**	**100.00%**

Table 17: Taxonomic frequencies for Bukovačka Česma.

	Bukovačka Česma	Early Neolithic
Taxa	**NISP**	**NISP%**
Wild		
Bos primigenius	3	2.13%
Capreolus capreolus	16	11.35%
Castor fiber	8	5.67%
Cervus elaphus	79	56.03%
Fish (unidentified)	4	2.84%
Unio sp.	2	1.42%
Ursus arctos	1	0.71%
Sus scrofa fer.	28	19.86%
Grand Total	**141**	**100.00%**

Table 18: Wild taxa frequencies from Bukovačka Česma

	Bukovačka Česma	Early Neolithic
Taxa	**NISP**	**NISP%**
Capreolus capreolus	16	16.84%
Cervus elaphus	79	83.16%
Grand Total	**95**	**100.00%**

Table 19: Deer frequencies from Bukovačka Česma.

	Bukovačka Česma	Early Neolithic
Deer elements	**NISP**	**NISP%**
Capreolus capreolus	**16**	**16.84%**
Cranial	1	1.05%
Ilium	2	2.11%
Ischium	1	1.05%
Metacarpal 3 and 4	2	2.11%
Metapodial 3 and 4	1	1.05%
Metatarsal 3 and 4	1	1.05%
Pubis	1	1.05%
Scapula	4	4.21%
Thoracic vertebra	1	1.05%
Tibia	2	2.11%
Cervus elaphus	**79**	**83.16%**
2nd and 3rd carpal	1	1.05%
Anterior phalanx 1	1	1.05%
Astragalus (talus)	4	4.21%
Atlas	1	1.05%
Calcaneus	4	4.21%
Cranial	5	5.26%
Femur	3	3.16%

Humerus	8	8.42%
Ilium	1	1.05%
Ischium	2	2.11%
Lumbar vertebra	8	8.42%
Mandible with teeth	2	2.11%
Mandible without teeth	1	1.05%
Metacarpal 3 and 4	3	3.16%
Metapodial 3 and 4	1	1.05%
Metatarsal 3 and 4	5	5.26%
Pelvis (ischium, illium, pubis)	1	1.05%
Phalanx 1	2	2.11%
Radius	8	8.42%
Scapula	7	7.37%
Thoracic vertebra	2	2.11%
Tibia	6	6.32%
Ulna	3	3.16%
Grand Total	**95**	**100.00%**

Table 20: Deer element frequencies from Bukovačka Česma.

	Bukovačka Česma	Early Neolithic
Red deer elements	**NISP**	**NISP%**
Cervus elaphus	**79**	**100.00%**
2nd and 3rd carpal	1	1.27%
Anterior phalanx 1	1	1.27%
Astragalus (talus)	4	5.06%
Atlas	1	1.27%
Calcaneus	4	5.06%
Cranial	5	6.33%
Femur	3	3.80%
Humerus	8	10.13%
Ilium	1	1.27%
Ischium	2	2.53%
Lumbar vertebra	8	10.13%
Mandible with teeth	2	2.53%
Mandible without teeth	1	1.27%
Metacarpal 3 and 4	3	3.80%
Metapodial 3 and 4	1	1.27%
Metatarsal 3 and 4	5	6.33%
Pelvis (ischium, illium, pubis)	1	1.27%
Phalanx 1	2	2.53%
Radius	8	10.13%
Scapula	7	8.86%
Thoracic vertebra	2	2.53%
Tibia	6	7.59%

Ulna	3	3.80%
Grand Total	**79**	**100.00%**

Table 21: Red deer element frequencies from Bukovačka Česma.

Taxa	Foeni-Salaş Early Neolithic	
	NISP	NISP%
Domestic	**2033**	**79.07%**
Bos Taurus	898	34.93%
Canis familiaris	18	0.70%
Capra hircus	77	2.99%
Ovis aries	272	10.58%
Ovis/Capra	669	26.02%
Sus scrofa dom.	99	3.85%
Wild	**538**	**20.93%**
Anas platyrhynchos	2	0.08%
Anas querquedula	1	0.04%
Anas sp. (cf A. platyrhynchos)	2	0.08%
Anseriformes cf A. platyrhynchos	1	0.04%
Anseriformes indet.	1	0.04%
Anseriformes small (Anas? Aythya? Marmaronetta?)	1	0.04%
Aves indet.	5	0.19%
Aves sp.	27	1.05%
Bos primigenius	63	2.45%
Buteo buteo	1	0.04%
Canis lupus	7	0.27%

Capreolus capreolus	88	3.42%
Cervus elaphus	113	4.40%
cf Egretta garzetta	1	0.04%
Ciconia ciconia	1	0.04%
Columba palumbus	1	0.04%
Emys orbicularis	21	0.82%
Fulica atra	1	0.04%
Lepus europaeus	10	0.39%
Otis tarda	1	0.04%
Perdix perdix	1	0.04%
Pica pica	1	0.04%
Pisces sp.	139	5.41%
Sus scrofa fer.	39	1.52%
Tetrao tetrix	1	0.04%
Turdus cf merula	1	0.04%
Unio pictorum	6	0.23%
Ursus arctos	2	0.08%
Grand Total	**2571**	**100.00%**

Table 22: Taxonomic frequencies from Foeni-Salaş.

Taxa	Foeni-Salaş Early Neolithic	
	NISP	NISP%
Wild	**538**	**100.00%**
Anas platyrhynchos	2	0.37%
Anas querquedula	1	0.19%
Anas sp. (cf A. platyrhynchos)	2	0.37%
Anseriformes cf A. platyrhynchos	1	0.19%
Anseriformes indet.	1	0.19%
Anseriformes small (Anas? Aythya? Marmaronetta?)	1	0.19%
Aves indet.	5	0.93%
Aves sp.	27	5.02%
Bos primigenius	63	11.71%
Buteo buteo	1	0.19%
Canis lupus	7	1.30%
Capreolus capreolus	88	16.36%
Cervus elaphus	113	21.00%
cf Egretta garzetta	1	0.19%
Ciconia ciconia	1	0.19%
Columba palumbus	1	0.19%
Emys orbicularis	21	3.90%
Fulica atra	1	0.19%
Lepus europaeus	10	1.86%
Otis tarda	1	0.19%
Perdix perdix	1	0.19%
Pica pica	1	0.19%

Pisces sp.	139	25.84%
Sus scrofa fer.	39	7.25%
Tetrao tetrix	1	0.19%
Turdus cf merula	1	0.19%
Unio pictorum	6	1.12%
Ursus arctos	2	0.37%
Grand Total	**538**	**100.00%**

Table 23: Wild taxa frequencies from Foeni-Salaş.

Taxa	Foeni-Salaş	Early Neolithic
	NISP	NISP%
Capreolus capreolus	88	43.78%
Cervus elaphus	113	56.22%
Grand Total	**201**	**100.00%**

Table 24: Deer frequencies from Foeni-Salaş.

	Foeni-Salaş	Early Neolithic
Deer elements	**NISP**	**NISP%**
Capreolus capreolus	**88**	**43.78%**
Carpal	**1**	**0.50%**
Cranial	**3**	**1.49%**
Femur	**4**	**1.99%**
Humerus	**11**	**5.47%**
Innominate	**4**	**1.99%**
Loose tooth	**5**	**2.49%**
Mandible	**3**	**1.49%**
Metacarpal	**2**	**1.00%**
Metapodium	**2**	**1.00%**
Metatarsal	**20**	**9.95%**
Phalange	**5**	**2.49%**
Radius	**4**	**1.99%**
Rib	**3**	**1.49%**
Scapula	**5**	**2.49%**
Sesamoid	**1**	**0.50%**
Tarsal	**3**	**1.49%**
Tibia	**5**	**2.49%**
Ulna	**1**	**0.50%**
Vertebra	**6**	**2.99%**

Cervus elaphus	113	56.22%
Carpal	2	1.00%
Cranial	13	6.47%
Femur	5	2.49%
Humerus	8	3.98%
Innominate	3	1.49%
Loose tooth	3	1.49%
Mandible	5	2.49%
Metacarpal	7	3.48%
Metatarsal	14	6.97%
Phalange	1	0.50%
Radius	4	1.99%
Radius+Ulna	2	1.00%
Rib	3	1.49%
Scapula	3	1.49%
Tarsal	15	7.46%
Tibia	9	4.48%
Ulna	3	1.49%
Vertebra	13	6.47%
Grand Total	201	100.00%

Table 25: Deer element frequencies from Foeni-Salaş.

	Foeni-Salaş	Early Neolithic
Deer elements	**NISP**	**NISP%**
Capreolus capreolus	**88**	**43.78%**
Carpal	**1**	**0.50%**
Cranial	**3**	**1.49%**
Cranial	3	1.49%
Antler	1	0.50%
Frontal+Antler	1	0.50%
Frontal+Antler base	1	0.50%
Femur	**4**	**1.99%**
Humerus	**11**	**5.47%**
Innominate	**4**	**1.99%**
Loose tooth	**5**	**2.49%**
Mandible	**3**	**1.49%**
Metacarpal	**2**	**1.00%**
Metapodium	**2**	**1.00%**
Metatarsal	**20**	**9.95%**
Phalange	**5**	**2.49%**
Radius	**4**	**1.99%**
Rib	**3**	**1.49%**
Scapula	**5**	**2.49%**
Sesamoid	**1**	**0.50%**

Tarsal	**3**	**1.49%**
Tibia	**5**	**2.49%**
Ulna	**1**	**0.50%**
Vertebra	**6**	**2.99%**
Cervus elaphus	**113**	**56.22%**
Carpal	**2**	**1.00%**
Cranial	**13**	**6.47%**
Cranial	13	6.47%
Antler	8	4.48%
Internal auditory meatus	1	0.50%
Maxilla with teeth	1	0.50%
Premaxillary with teeth	1	0.50%
Zygomatic	1	0.50%
Femur	**5**	**2.49%**
Humerus	**8**	**3.98%**
Innominate	**3**	**1.49%**
Loose tooth	**3**	**1.49%**
Mandible	**5**	**2.49%**
Metacarpal	**7**	**3.48%**
Metatarsal	**14**	**6.97%**
Phalange	**1**	**0.50%**
Radius	**4**	**1.99%**

Radius+Ulna	**2**	**1.00%**
Rib	**3**	**1.49%**
Scapula	**3**	**1.49%**
Tarsal	**15**	**7.46%**
Tibia	**9**	**4.48%**
Ulna	**3**	**1.49%**
Vertebra	**13**	**6.47%**
Grand Total	**201**	**100.00%**

Table 26: Antler frequencies from Foeni-Salas.

	Foeni-Salaş	Early Neolithic
Deer elements	**NISP**	**NISP%**
Capreolus capreolus	**88**	**43.78%**
Carpal	**1**	**0.50%**
Cranial	**3**	**1.49%**
Cranial	3	1.49%
Antler	1	0.50%
Frontal+Antler	1	0.50%
Frontal+Antler base	1	0.50%
Femur	**4**	**1.99%**
Humerus	**11**	**5.47%**
Innominate	**4**	**1.99%**
Loose tooth	**5**	**2.49%**
Lower	3	1.49%
Incisor	2	1.00%
Molar	1	0.50%
Upper	2	1.00%
Molar	1	0.50%
Premolar	1	0.50%
Mandible	**3**	**1.49%**
Mandible with teeth	2	1.00%
Alveolus area (PM1-M3)	1	0.50%

Ascending ramus	1	0.50%
Mandible without teeth	1	0.50%
Heel	1	0.50%
Metacarpal	**2**	**1.00%**
Metapodium	**2**	**1.00%**
Metatarsal	**20**	**9.95%**
Phalange	**5**	**2.49%**
Radius	**4**	**1.99%**
Rib	**3**	**1.49%**
Scapula	**5**	**2.49%**
Sesamoid	**1**	**0.50%**
Tarsal	**3**	**1.49%**
Tibia	**5**	**2.49%**
Ulna	**1**	**0.50%**
Vertebra	**6**	**2.99%**
Cervus elaphus	**113**	**56.22%**
Carpal	**2**	**1.00%**
Cranial	**13**	**6.47%**
Cranial	13	6.47%
Antler	8	3.98%
Horn core	1	0.50%
Internal auditory meatus	1	0.50%

Maxilla with teeth	1	0.50%
Premaxillary with teeth	1	0.50%
Zygomatic	1	0.50%
Femur	**5**	**2.49%**
Humerus	**8**	**3.98%**
Innominate	**3**	**1.49%**
Loose tooth	**3**	**1.49%**
Lower	1	0.50%
Molar	1	0.50%
Upper	2	1.00%
Deciduous molar	1	0.50%
Premolar	1	0.50%
Mandible	**5**	**2.49%**
Mandible with teeth	5	2.49%
Alveolus area (PM1-M3)	2	1.00%
Alveolus area+Ascending ramus	1	0.50%
Diastema area (Canine - PM1)	2	1.00%
Metacarpal	**7**	**3.48%**
Metatarsal	**14**	**6.97%**
Phalange	**1**	**0.50%**
Radius	**4**	**1.99%**
Radius+Ulna	**2**	**1.00%**

Rib	**3**	**1.49%**
Scapula	**3**	**1.49%**
Tarsal	**15**	**7.46%**
Tibia	**9**	**4.48%**
Ulna	**3**	**1.49%**
Vertebra	**13**	**6.47%**
Grand Total	**201**	**100.00%**

Table 27: Deer element frequencies vs teeth from Foeni-Salaş.

Deer teeth	Foeni-Salaş Early Neolithic	
	NISP	NISP%
Capreolus capreolus	**7**	**46.67%**
Loose tooth	**5**	**33.33%**
Lower	3	20.00%
Upper	2	13.33%
Mandible	**2**	**13.33%**
Mandible with teeth	2	13.33%
Cervus elaphus	**8**	**53.33%**
Loose tooth	**3**	**20.00%**
Lower	1	6.67%
Upper	2	13.33%
Mandible	**5**	**33.33%**
Mandible with teeth	5	33.33%
Grand Total	**15**	**100.00%**

Table 28: Deer teeth frequencies from Foeni-Salaş.

Roe deer elements	Foeni Salaş Early Neolithic	
	NISP	NISP%
Capreolus capreolus	**88**	**100.00%**
Carpal	**1**	**1.14%**
Cranial	**3**	**3.41%**
Femur	**4**	**4.55%**
Humerus	**11**	**12.50%**
Innominate	**4**	**4.55%**
Loose tooth	**5**	**5.68%**
Mandible	**3**	**3.41%**
Mandible with teeth	2	2.27%
Mandible without teeth	1	1.14%
Metacarpal	**2**	**2.27%**
Metapodium	**2**	**2.27%**
Metatarsal	**20**	**22.73%**
Phalange	**5**	**5.68%**
Radius	**4**	**4.55%**
Rib	**3**	**3.41%**
Scapula	**5**	**5.68%**
Sesamoid	**1**	**1.14%**
Tarsal	**3**	**3.41%**

Tibia	**5**	**5.68%**
Ulna	**1**	**1.14%**
Vertebra	**6**	**6.82%**
Grand Total	**88**	**100.00%**

Table 29: Roe deer element frequencies from Foeni-Salaș.

Red deer elements	Foeni Salaş NISP	Early Neolithic NISP%
Cervus elaphus	**113**	**100.00%**
Carpal	**2**	**1.77%**
Cranial	**13**	**11.50%**
Femur	**5**	**4.42%**
Humerus	**8**	**7.08%**
Innominate	**3**	**2.65%**
Loose tooth	**3**	**2.65%**
Lower	1	0.88%
Upper	2	1.77%
Mandible	**5**	**4.42%**
Mandible with teeth	5	4.42%
Metacarpal	**7**	**6.19%**
Metatarsal	**14**	**12.39%**
Phalange	**1**	**0.88%**
Radius	**4**	**3.54%**
Radius+Ulna	**2**	**1.77%**
Rib	**3**	**2.65%**
Scapula	**3**	**2.65%**
Tarsal	**15**	**13.27%**

Tibia	**9**	**7.96%**
Ulna	**3**	**2.65%**
Vertebra	**13**	**11.50%**
Grand Total	**113**	**100.00%**

Table 30: Red deer element frequencies from Foeni-Salaș.

	Petnica					
	Middle Vinča B Neolithic		Late Vinča C Neolithic		Late Vinča D Neolithic	
Taxa	NISP	NISP%	NISP	NISP%	NISP	NISP%
Domestic	**746**	**30.44%**	**442**	**45.52%**	**181**	**47.14%**
Bos taurus	385	15.71%	258	26.57%	103	26.82%
Canis familiaris	7	0.29%	9	0.93%	1	0.26%
Capra hircus	5	0.20%		0.00%	1	0.26%
Ovis aries	13	0.53%	4	0.41%	2	0.52%
Ovis/Capra	45	1.84%	34	3.50%	18	4.69%
Sus scrofa dom.	291	11.87%	137	14.11%	56	14.58%
Wild	**1705**	**69.56%**	**529**	**54.48%**	**203**	**52.86%**
Bos primigenius	70	2.86%	12	1.24%	1	0.26%
Canis lupus	5	0.20%		0.00%		0.00%
Capreolus capreolus	199	8.12%	74	7.62%	26	6.77%
Castor fiber	35	1.43%	11	1.13%	4	1.04%
Cervus elaphus	1195	48.76%	345	35.53%	137	35.68%
Emys orbicularis	4	0.16%	1	0.10%	1	0.26%
Felis silvestri	5	0.20%		0.00%		0.00%
Lepus europaeus	4	0.16%	3	0.31%		0.00%
Martes sp.	11	0.45%	1	0.10%		0.00%
Pisces sp.	8	0.33%	2	0.21%		0.00%
Sus scrofa fer.	164	6.69%	79	8.14%	32	8.33%
Ursus arctos	3	0.12%		0.00%	2	0.52%

Vulpes vulpes	2	0.08%	1	0.10%		0.00%
Grand Total	**2451**	**100.00%**	**971**	**100.00%**	**384**	**100.00%**

Table 31: Taxonomic frequencies from Petnica.

	Petnica					
	Vinča B	Middle Neolithic	Vinča C	Late Neolithic	Vinča D	Late Neolithic
Taxa	NISP	NISP%	NISP	NISP%	NISP	NISP%
Wild	**1705**	**100.00%**	**529**	**100.00%**	**203**	**100.00%**
Bos primigenius	70	4.11%	12	2.27%	1	0.49%
Canis lupus	5	0.29%		0.00%		0.00%
Capreolus capreolus	199	11.67%	74	13.99%	26	12.81%
Castor fiber	35	2.05%	11	2.08%	4	1.97%
Cervus elaphus	1195	70.09%	345	65.22%	137	67.49%
Emys orbicularis	4	0.23%	1	0.19%	1	0.49%
Felis silvestri	5	0.29%		0.00%		0.00%
Lepus europaeus	4	0.23%	3	0.57%		0.00%
Martes sp.	11	0.65%	1	0.19%		0.00%
Pisces sp.	8	0.47%	2	0.38%		0.00%
Sus scrofa fer.	164	9.62%	79	14.93%	32	15.76%
Ursus arctos	3	0.18%		0.00%	2	0.99%
Vulpes vulpes	2	0.12%	1	0.19%		0.00%
Grand Total	**1705**	**100.00%**	**529**	**100.00%**	**203**	**100.00%**

Table 32: Wild taxonomic frequencies from Petnica.

	Petnica					
	Vinča B	Middle Neolithic	Vinča C	Late Neolithic	Vinča D	Late Neolithic
Taxa	**NISP**	**NISP%**	**NISP**	**NISP%**	**NISP**	**NISP%**
Capreolus capreolus	199	14.28%	74	17.66%	26	15.95%
Cervus elaphus	1195	85.72%	345	82.34%	137	84.05%
Grand Total	**1394**	**100.00%**	**419**	**100.00%**	**163**	**100.00%**

Table 33: Deer frequencies from Petnica.

	Petnica					
	Vinča B	Middle Neolithic	Vinča C	Late Neolithic	Vinča D	Late Neolithic
Elements by taxa	NISP	NISP%	NISP	NISP%	NISP	NISP%
Capreolus capreolus	**199**	**14.28%**	**74**	**17.66%**	**26**	**15.95%**
Astragalus	2	0.14%	3	0.72%		0.00%
Atlas		0.00%	1	0.24%		0.00%
Calcaneus	2	0.14%	1	0.24%		0.00%
Central and 4th tarsal	2	0.14%		0.00%		0.00%
Cranial	15	1.08%	8	1.91%		0.00%
Femur	5	0.36%	2	0.48%		0.00%
Humerus	10	0.72%	4	0.95%	2	1.23%
Ischium		0.00%	1	0.24%		0.00%
Loose tooth: lower	7	0.50%	2	0.48%		0.00%
Loose tooth: upper	1	0.07%	1	0.24%		0.00%
Mandible with teeth	29	2.08%	6	1.43%	2	1.23%
Mandible without teeth		0.00%	2	0.48%	1	0.61%
Maxillary with teeth	4	0.29%	1	0.24%	1	0.61%
Metacarpal 3 and 4	7	0.50%	1	0.24%	3	1.84%
Metapodial 3 and 4	14	1.00%	8	1.91%		0.00%
Metatarsal 2		0.00%	1	0.24%		0.00%

Metatarsal 3 and 4	49	3.52%	8	1.91%	3	1.84%
Pelvis	7	0.50%	4	0.95%	2	1.23%
Phalanx 1	3	0.22%	1	0.24%		0.00%
Phalanx 2		0.00%		0.00%	1	0.61%
Phalanx 3	2	0.14%	1	0.24%		0.00%
Posterior phalanx 1		0.00%		0.00%	2	1.23%
Radium	17	1.22%	3	0.72%	5	3.07%
Scapula	5	0.36%	4	0.95%	1	0.61%
Tibia	13	0.93%	5	1.19%	2	1.23%
Ulna	5	0.36%	6	1.43%	1	0.61%
Cervus elaphus	**1195**	**85.72%**	**345**	**82.34%**	**137**	**84.05%**
2nd and 3rd carpal	16	1.15%	1	0.24%	3	1.84%
2nd and 3rd tarsal	0	0.00%		0.00%	1	0.61%
Anterior phalanx 1	14	1.00%	12	2.86%	2	1.23%
Astragalus	24	1.72%	11	2.63%	6	3.68%
Atlas	4	0.29%		0.00%		0.00%
Axis	4	0.29%		0.00%		0.00%
Calcaneus	29	2.08%	8	1.91%	4	2.45%
Carpal	2	0.14%		0.00%		0.00%
Central and 4th tarsal	19	1.36%	6	1.43%	3	1.84%
Cervical vertebra	7	0.50%	2	0.48%		0.00%
Cranial	43	3.08%	25	5.97%	13	7.98%

Femur	37	2.65%	11	2.63%	3	1.84%
Fourth carpal	3	0.22%		0.00%	2	1.23%
General vertebra	1	0.07%		0.00%		0.00%
Humerus	37	2.65%	5	1.19%	4	2.45%
Ilium	4	0.29%	2	0.48%	1	0.61%
Intermediate carpal	4	0.29%	1	0.24%		0.00%
Ischium	2	0.14%		0.00%		0.00%
Lacrimal		0.00%	1	0.24%		0.00%
Loose tooth or tooth fragment	4	0.29%	1	0.24%		0.00%
Loose tooth: lower	44	3.16%	15	3.58%	4	2.45%
Loose tooth: upper	38	2.73%	11	2.63%	3	1.84%
Lumbar vertebra	9	0.65%		0.00%		0.00%
Mandible with teeth	75	5.38%	14	3.34%	8	4.91%
Mandible without teeth	10	0.72%	13	3.10%	5	3.07%
Maxillary with teeth	46	3.30%	4	0.95%	2	1.23%
Maxillary without teeth	1	0.07%		0.00%		0.00%
Metacarpal 3 and 4	123	8.82%	28	6.68%	5	3.07%
Metapodial 3 and 4	93	6.67%	40	9.55%	8	4.91%
Metatarsal 3 and 4	161	11.55%	44	10.50%	14	8.59%
Patella	3	0.22%		0.00%		0.00%
Pelvis	14	1.00%	6	1.43%	1	0.61%
Phalanx 1	58	4.16%	4	0.95%	3	1.84%

Phalanx 2	58	4.16%	7	1.67%	2	1.23%
Phalanx 3	17	1.22%	3	0.72%	3	1.84%
Posterior phalanx 1	20	1.43%	10	2.39%	7	4.29%
Posterior phalanx 3	2	0.14%		0.00%		0.00%
Premaxillary with teeth	1	0.07%		0.00%		0.00%
Radial carpal	5	0.36%		0.00%		0.00%
Radium	45	3.23%	21	5.01%	7	4.29%
Rib	3	0.22%		0.00%		0.00%
Sacrum	1	0.07%		0.00%		0.00%
Scapula	13	0.93%	12	2.86%	6	3.68%
Tarsal	2	0.14%		0.00%		0.00%
Thoracic vertebra	7	0.50%	3	0.72%	4	2.45%
Tibia	48	3.44%	13	3.10%	11	6.75%
Ulna	35	2.51%	11	2.63%	2	1.23%
Ulnar carpal	9	0.65%		0.00%		0.00%
Grand Total	**1394**	**100.00%**	**419**	**100.00%**	**163**	**100.00%**

Table 34: Deer element frequencies from Petnica.

	Petnica					
	Vinča B	Middle Neolithic	Vinča C	Late Neolithic	Vinča D	Late Neolithic
Antler	NISP	NISP%	NISP	NISP%	NISP	NISP%
Capreolus capreolus	**15**	**25.86%**	**8**	**24.24%**		**0.00%**
Cranial	**15**	**25.86%**	**8**	**24.24%**		**0.00%**
Base (base to beginning of first tine)	4	6.90%	5	15.15%		
Base and corpus (fragment of column)	1	1.72%	1	3.03%		
Some of corpus missing (single tine or fragments)	1	1.72%				
Some of tip missing (base, first tine, and column with tines)	1	1.72%				
base (base to beginning of first tine)	8	13.79%	2	6.06%		
Cervus elaphus	**43**	**74.14%**	**25**	**75.76%**	**13**	**100.00%**
Cranial	**43**	**74.14%**	**25**	**75.76%**	**13**	**100.00%**
Base (base to beginning of first tine)			2	6.06%	1	7.69%
Base and corpus (fragment of column)	22	37.93%	10	30.30%	9	69.23%

Complete (complete or nearly complete brace of antlers)			1	3.03%		
corpus and tip (column with tines)	1	1.72%				
Some of corpus missing (single tine or fragments)	10	17.24%	9	27.27%	2	15.38%
Tip (base and first tine)	10	17.24 %	3	9.09%	1	7.69%
Grand Total	**58**	**100.00%**	**33**	**100.00%**	**13**	**100.00%**

Table 35: Antler frequencies at Petnica

	Petnica					
	Vinča B	Middle Neolithic	Vinča C	Late Neolithic	Vinča D	Late Neolithic
Deer teeth	NISP	NISP%	NISP	NISP%	NISP	NISP%
Capreolus capreolus	**41**	**16.53%**	**10**	**18.18%**	**3**	**15.00%**
Loose tooth: lower	7	2.82%	2	3.64%		0.00%
Loose tooth: upper	1	0.40%	1	1.82%		0.00%
Mandible with teeth	29	11.69%	6	10.91%	2	10.00%
Maxillary with teeth	4	1.61%	1	1.82%	1	5.00%
Cervus elaphus	**207**	**83.47%**	**45**	**81.82%**	**17**	**85.00%**
Loose tooth or tooth fragment	4	1.61%	1	1.82%		0.00%
Loose tooth: lower	44	17.74%	15	27.27%	4	20.00%
Loose tooth: upper	38	15.32%	11	20.00%	3	15.00%
Mandible with teeth	75	30.24%	14	25.45%	8	40.00%
Maxillary with teeth	46	18.55%	4	7.27%	2	10.00%
Grand Total	**248**	**100.00%**	**55**	**100.00%**	**20**	**100.00%**

Table 36: Deer tooth frequencies from Petnica.

	Petnica					
	Middle Vinča B Neolithic		Late Vinča C Neolithic		Late Vinča D Neolithic	
Roe deer elements	**NISP**	**NISP%**	**NISP**	**NISP%**	**NISP**	**NISP%**
Capreolus capreolus	**199**	**100.00%**	**74**	**100.00%**	**26**	**100.00%**
Astragalus	2	1.01%	3	4.05%		0.00%
Atlas		0.00%	1	1.35%		0.00%
Calcaneus	2	1.01%	1	1.35%		0.00%
Central and 4th tarsal	2	1.01%		0.00%		0.00%
Cranial	15	7.54%	8	10.81%		0.00%
Femur	5	2.51%	2	2.70%		0.00%
Humerus	10	5.03%	4	5.41%	2	7.69%
Ischium		0.00%	1	1.35%		0.00%
Loose tooth: lower	7	3.52%	2	2.70%		0.00%
Loose tooth: upper	1	0.50%	1	1.35%		0.00%
Mandible with teeth	29	14.57%	6	8.11%	2	7.69%
Mandible without teeth		0.00%	2	2.70%	1	3.85%
Maxillary with teeth	4	2.01%	1	1.35%	1	3.85%
Metacarpal 3 and 4	7	3.52%	1	1.35%	3	11.54%

Metapodial 3 and 4	14	7.04%	8	10.81%		0.00%
Metatarsal 2		0.00%	1	1.35%		0.00%
Metatarsal 3 and 4	49	24.62%	8	10.81%	3	11.54%
Pelvis	7	3.52%	4	5.41%	2	7.69%
Phalanx 1	3	1.51%	1	1.35%		0.00%
Phalanx 2		0.00%		0.00%	1	3.85%
Phalanx 3	2	1.01%	1	1.35%		0.00%
Posterior phalanx 1		0.00%		0.00%	2	7.69%
Radium	17	8.54%	3	4.05%	5	19.23%
Scapula	5	2.51%	4	5.41%	1	3.85%
Tibia	13	6.53%	5	6.76%	2	7.69%
Ulna	5	2.51%	6	8.11%	1	3.85%
Grand Total	**199**	**100.00%**	**74**	**100.00%**	**26**	**100.00%**

Table 37: Roe deer element frequencies from Petnica.

	Petnica					
	Vinča B	Middle Neolithic	Late Vinča C	Neolithic	Vinča D	Late Neolithic
Red deer elements	**NISP**	**NISP%**	**NISP**	**NISP%**	**NISP**	**NISP%**
Cervus elaphus	**1195**	**100.00%**	**345**	**100.00%**	**137**	**100.00%**
2nd and 3rd carpal	16	1.34%	1	0.29%	3	2.19%
2nd and 3rd tarsal	0	0.00%		0.00%	1	0.73%
Anterior phalanx 1	14	1.17%	12	3.48%	2	1.46%
Astragalus	24	2.01%	11	3.19%	6	4.38%
Atlas	4	0.33%		0.00%		0.00%
Axis	4	0.33%		0.00%		0.00%
Calcaneus	29	2.43%	8	2.32%	4	2.92%
Carpal	2	0.17%		0.00%		0.00%
Central and 4th tarsal	19	1.59%	6	1.74%	3	2.19%
Cervical vertebra	7	0.59%	2	0.58%		0.00%
Cranial	43	3.60%	25	7.25%	13	9.49%
Femur	37	3.10%	11	3.19%	3	2.19%
Fourth carpal	3	0.25%		0.00%	2	1.46%
General vertebra	1	0.08%		0.00%		0.00%
Humerus	37	3.10%	5	1.45%	4	2.92%
Ilium	4	0.33%	2	0.58%	1	0.73%
Intermediate carpal	4	0.33%	1	0.29%		0.00%

Ischium	2	0.17%		0.00%		0.00%
Lacrimal		0.00%	1	0.29%		0.00%
Loose tooth or tooth fragment	4	0.33%	1	0.29%		0.00%
Loose tooth: lower	44	3.68%	15	4.35%	4	2.92%
Loose tooth: upper	38	3.18%	11	3.19%	3	2.19%
Lumbar vertebra	9	0.75%		0.00%		0.00%
Mandible with teeth	75	6.28%	14	4.06%	8	5.84%
Mandible without teeth	10	0.84%	13	3.77%	5	3.65%
Maxillary with teeth	46	3.85%	4	1.16%	2	1.46%
Maxillary without teeth	1	0.08%		0.00%		0.00%
Metacarpal 3 and 4	123	10.29%	28	8.12%	5	3.65%
Metapodial 3 and 4	93	7.78%	40	11.59%	8	5.84%
Metatarsal 3 and 4	161	13.47%	44	12.75%	14	10.22%
Patella	3	0.25%		0.00%		0.00%
Pelvis	14	1.17%	6	1.74%	1	0.73%
Phalanx 1	58	4.85%	4	1.16%	3	2.19%
Phalanx 2	58	4.85%	7	2.03%	2	1.46%
Phalanx 3	17	1.42%	3	0.87%	3	2.19%
Posterior phalanx 1	20	1.67%	10	2.90%	7	5.11%
Posterior phalanx 3	2	0.17%		0.00%		0.00%
Premaxillary with teeth	1	0.08%		0.00%		0.00%
Radial carpal	5	0.42%		0.00%		0.00%

Radium	45	3.77%	21	6.09%	7	5.11%
Rib	3	0.25%		0.00%		0.00%
Sacrum	1	0.08%		0.00%		0.00%
Scapula	13	1.09%	12	3.48%	6	4.38%
Tarsal	2	0.17%		0.00%		0.00%
Thoracic vertebra	7	0.59%	3	0.87%	4	2.92%
Tibia	48	4.02%	13	3.77%	11	8.03%
Ulna	35	2.93%	11	3.19%	2	1.46%
Ulnar carpal	9	0.75%		0.00%		0.00%
Grand Total	**1195**	**100.00%**	**345**	**100.00%**	**137**	**100.00%**

Table 38: Red deer element frequencies from Petnica.

Taxa	Sânandrei Late Neolithic	
	NISP	NISP%
Domestic	**343**	**60.49%**
Bos taurus	224	39.51%
Canis familiarus	7	1.23%
Capra hircus	3	0.53%
Equus caballus	1	0.18%
Ovis aries	10	1.76%
Ovis/Capra	43	7.58%
Sus scrofa dom.	55	9.70%
Wild	**224**	**39.51%**
Aves sp.	1	0.18%
Bos primigenius	1	0.18%
Canis lupus	2	0.35%
Capreolus capreolus	47	8.29%
Cervus elaphus	99	17.46%
Sus scrofa fer.	74	13.05%
Grand Total	**567**	**100.00%**

Table 39: Taxonomic frequencies for Sânandrei.

	Sânandrei	Late Neolithic
Taxa	**NISP**	**NISP%**
Wild	**224**	**100.00%**
Aves sp.	1	0.45%
Bos primigenius	1	0.45%
Canis lupus	2	0.89%
Capreolus capreolus	47	20.98%
Cervus elaphus	99	44.20%
Sus scrofa fer.	74	33.04%
Grand Total	**224**	**100.00%**

Table 40: Wild taxonomic frequencies from Sânandrei.

	Sânandrei	Late Neolithic
Deer taxa	**NISP**	**NISP%**
Capreolus capreolus	47	32.19%
Cervus elaphus	99	67.81%
Grand Total	**146**	**100.00%**

Table 41: Deer frequencies from Sânandrei.

Deer elements	Sânandrei Late Neolithic NISP	NISP%
Capreolus capreolus	**47**	**32.19%**
Antler	3	2.05%
Astragalus	1	0.68%
Calcaneous	1	0.68%
Cranium	1	0.68%
Humerus	5	3.42%
Innominate	2	1.37%
Loose tooth – Lower	1	0.68%
Mandible	11	7.53%
Metatarsal	4	2.74%
Pelvis	1	0.68%
Phalange 1	2	1.37%
Radius	3	2.05%
Scapula	6	4.11%
Tibia	1	0.68%
Ulna	4	2.74%
Vertebra – thoracic	1	0.68%
Cervus elaphus	**99**	**67.81%**
Acetabulum	1	0.68%

Antler	15	10.27%
Astragalus	3	2.05%
Cranium	3	2.05%
Cuboid	1	0.68%
Femur	9	6.16%
Humerus	5	3.42%
Innominate	5	3.42%
Loose tooth	1	0.68%
Loose tooth – Upper	1	0.68%
Mandible	8	5.48%
Metacarpal	1	0.68%
Metapodial	1	0.68%
Metatarsal	5	3.42%
Phalange 1	4	2.74%
Phalange 2	1	0.68%
Phalange 3	2	1.37%
Radius	4	2.74%
Rib	1	0.68%
Scapula	9	6.16%
Sternum	1	0.68%
Tibia	12	8.22%
Ulna	3	2.05%

Unknown	1	0.68%
Vertebra – epistropheus	1	0.68%
Vertebra – thoracic	1	0.68%
Grand Total	**146**	**100.00%**

Table 42: Deer element frequencies from Sânandrei.

	Sânandrei	Late Neolithic
Deer teeth	**NISP**	**NISP%**
Capreolus capreolus	**12**	**54.55%**
Loose tooth – Lower	1	4.55%
Mandible	11	50.00%
Cervus elaphus	**10**	**45.45%**
Loose tooth	1	4.55%
Loose tooth – Upper	1	4.55%
Mandible	8	36.36%
Grand Total	**22**	**100.00%**

Table 43: Deer tooth frequencies from Sânandrei.

	Sânandrei	Late Neolithic
Roe deer elements	**NISP**	**NISP%**
Capreolus capreolus	**47**	**100.00%**
Antler	3	6.38%
Astragalus	1	2.13%
Calcaneous	1	2.13%
Cranium	1	2.13%
Humerus	5	10.64%
Innominate	2	4.26%
Loose tooth - Lower	1	2.13%
Mandible	11	23.40%
Metatarsal	4	8.51%
Pelvis	1	2.13%
Phalange 1	2	4.26%
Radius	3	6.38%
Scapula	6	12.77%
Tibia	1	2.13%
Ulna	4	8.51%
Vertebra - thoracic	1	2.13%
Grand Total	**47**	**100.00%**

Table 44: Roe deer element frequencies from Sânandrei.

Red deer elements	Sânandrei Late Neolithic	
	NISP	NISP%
Cervus elaphus	**98**	**100.00%**
Acetabulum	1	1.02%
Antler	15	15.31%
Astragalus	3	3.06%
Cranium	3	3.06%
Cuboid	1	1.02%
Femur	9	9.18%
Humerus	5	5.10%
Innominate	5	5.10%
Loose tooth	1	1.02%
Loose tooth - Upper	1	1.02%
Mandible	8	8.16%
Metacarpal	1	1.02%
Metapodial	1	1.02%
Metatarsal	5	5.10%
Phalange 1	4	4.08%
Phalange 2	1	1.02%
Phalange 3	2	2.04%
Radius	4	4.08%
Rib	1	1.02%
Scapula	9	9.18%
Sternum	1	1.02%
Tibia	12	12.24%

Ulna	3	3.06%
Vertebra - epistropheus	1	1.02%
Vertebra - thoracic	1	1.02%
Grand Total	**98**	**100.00%**

Table 45: Red deer element frequencies from Sânandrei.

Taxa	Stragari Middle Neolithic	
	NISP	NISP%
Domestic	**154**	**6.60%**
Bos Taurus	117	5.02%
Capra hircus	4	0.17%
Ovis aries	3	0.13%
Ovis/Capra	9	0.39%
Sus scrofa dom.	21	0.90%
Wild	**2178**	**93.40%**
Bird (unidentified species)	2	0.09%
Bos primigenius	20	0.86%
Canis lupus	1	0.04%
Capreolus capreolus	501	21.48%
Castor fiber	14	0.60%
Cervus elaphus	1580	67.75%
Emys orbicularis	1	0.04%
Felis silvestri	2	0.09%
Fish (unidentified species	3	0.13%
Lepus europaeus	1	0.04%
Lepus sp.	2	0.09%
Martes martes	1	0.04%

Meles meles	3	0.13%
Rodent	2	0.09%
Sus scrofa fer.	39	1.67%
Unio pictorum	1	0.04%
Ursus arctos	4	0.17%
Vulpes vulpes	1	0.04%
Grand Total	**2332**	**100.00%**

Table 46: Taxonomic frequencies from Stragari.

Taxa	Stragari	Middle Neolithic
	NISP	NISP%
Wild	**2178**	**100.00%**
Bird (unidentified species)	2	0.09%
Bos primigenius	20	0.92%
Canis lupus	1	0.05%
Capreolus capreolus	501	23.00%
Castor fiber	14	0.64%
Cervus elaphus	1580	72.54%
Emys orbicularis	1	0.05%
Felis silvestri	2	0.09%
Fish (unidentified species	3	0.14%
Lepus europaeus	1	0.05%
Lepus sp.	2	0.09%
Martes martes	1	0.05%
Meles meles	3	0.14%
Rodent	2	0.09%
Sus scrofa fer.	39	1.79%
Unio pictorum	1	0.05%
Ursus arctos	4	0.18%
Vulpes vulpes	1	0.05%

Grand Total	**2178**	**100.00%**

Table 47: Wild taxonomic frequencies from Stragari.

	Stragari	Middle Neolithic
Deer taxa	**NISP**	**NISP%**
Capreolus capreolus	506	24.19%
Cervus elaphus	1586	75.81%
Grand Total	**2092**	**100.00%**

Table 48: Deer frequencies from Stragari.

Deer elements	Stragari NISP	Middle Neolithic NISP%
Capreolus capreolus	**506**	**24.19%**
Astragalus (talus)	7	0.33%
Atlas	1	0.05%
Axis (epistropheus)	6	0.29%
Calcaneus	4	0.19%
Cervical vertabra	9	0.43%
Cervical vertebra	1	0.05%
Cranial	36	1.72%
Femur	27	1.29%
Humerus	14	0.67%
Hyoid	1	0.05%
Ilium	2	0.10%
Innominate	4	0.19%
Ischium	4	0.19%
Long bone fragment	1	0.05%
Loose tooth: lower	2	0.10%
Loose tooth: upper	6	0.29%
Lumbar vertebra	17	0.81%
Mandible	3	0.14%

Mandible with teeth	40	1.91%
Mandible without teeth	8	0.38%
Maxillary with teeth	5	0.24%
Metacarpal 3 and 4	38	1.82%
Metacarpus	7	0.33%
Metapodial 3 and 4	18	0.86%
Metatarsal 3 and 4	60	2.87%
Metatarsus	13	0.62%
Pelvis (ilium+ischium+pubic)	12	0.57%
Phalanx 1	25	1.20%
Phalanx 2	5	0.24%
Phalanx 3	3	0.14%
Pubis	1	0.05%
Radium	38	1.82%
Rib	20	0.96%
Sacrum	3	0.14%
Scapula	28	1.34%
Thoracic vertebra	5	0.24%
Tibia	17	0.81%
Ulna	14	0.67%
Vertebra	1	0.05%
Cervus elaphus	**1586**	**75.81%**

Astragalus (talus)	18	0.86%
Atlas	14	0.67%
Axis (epistropheus)	11	0.53%
Calcaneus	25	1.20%
Carpal	14	0.67%
Central and 4th tarsal (cuboid)	23	1.10%
Cervical vertabra	18	0.86%
Cervical vertebra	5	0.24%
Cranial	130	6.21%
Cuboid	1	0.05%
Epistropheus (axis vert)	1	0.05%
Femur	82	3.92%
Fibula	1	0.05%
Humerus	74	3.54%
Humerus or femur fragment	1	0.05%
Ilium	11	0.53%
Ilium+ischium	1	0.05%
Indeterminate	1	0.05%
Indeterminate metapodial	1	0.05%
Indeterminate metatarsal	1	0.05%
Innominate	9	0.43%
Intermediate carpal	3	0.14%

Interparietal	1	0.05%
Ischium	7	0.33%
Lateral malleolus	1	0.05%
Long bone fragment	9	0.43%
Loose tooth or tooth fragment	1	0.05%
Loose tooth: lower	29	1.39%
Loose tooth: upper	27	1.29%
Lumbar vertebra	34	1.63%
Mandible	15	0.72%
Mandible with teeth	32	1.53%
Mandible without teeth	29	1.39%
Maxillary with teeth	17	0.81%
Metacarpal 3 and 4	88	4.21%
Metacarpus	28	1.34%
Metapodial 3 and 4	92	4.40%
Metapodium	3	0.14%
Metatarsal 3 and 4	124	5.93%
Metatarsal 5	1	0.05%
Metatarsus	41	1.96%
Patella	2	0.10%
Pelvis (ilium+ischium+pubic)	24	1.15%
Phalange 1 (posterior)	2	0.10%

Phalanx 1	99	4.73%
Phalanx 1 (anterior)	4	0.19%
Phalanx 1 (posterior)	9	0.43%
Phalanx 2	52	2.49%
Phalanx 3	16	0.76%
Pubis	4	0.19%
Radium	80	3.82%
Rib	35	1.67%
Sacrum	3	0.14%
Scapula	52	2.49%
Sesamoid	1	0.05%
Tarsal	1	0.05%
Thoracic vertebra	52	2.49%
Tibia	88	4.21%
Ulna	29	1.39%
Ulnar carpal	3	0.14%
Vertebra	5	0.24%
Vertebral centrum	1	0.05%
Grand Total	**2092**	**100.00%**

Table 49: Deer element frequencies from Stragari.

Deer elements	Stragari Middle Neolithic	
	NISP	NISP%
Capreolus capreolus	**506**	**24.19%**
Astragalus (talus)	**7**	**0.33%**
Atlas	**1**	**0.05%**
Axis (epistropheus)	**6**	**0.29%**
Calcaneus	**4**	**0.19%**
Cervical vertabra	**9**	**0.43%**
Cervical vertebra	**1**	**0.05%**
Cranial	**36**	**1.72%**
Antler	1	0.05%
Occipital	1	0.05%
(blank)	34	1.63%
Femur	**27**	**1.29%**
Humerus	**14**	**0.67%**
Hyoid	**1**	**0.05%**
Ilium	**2**	**0.10%**
Innominate	**4**	**0.19%**
Ischium	**4**	**0.19%**
Long bone fragment	**1**	**0.05%**
Loose tooth: lower	**2**	**0.10%**
Loose tooth: upper	**6**	**0.29%**

Lumbar vertebra	**17**	**0.81%**
Mandible	**3**	**0.14%**
Mandible with teeth	**40**	**1.91%**
Mandible without teeth	**8**	**0.38%**
Maxillary with teeth	**5**	**0.24%**
Metacarpal 3 and 4	**38**	**1.82%**
Metacarpus	**7**	**0.33%**
Metapodial 3 and 4	**18**	**0.86%**
Metatarsal 3 and 4	**60**	**2.87%**
Metatarsus	**13**	**0.62%**
Pelvis (ilium+ischium+pubic)	**12**	**0.57%**
Phalanx 1	**25**	**1.20%**
Phalanx 2	**5**	**0.24%**
Phalanx 3	**3**	**0.14%**
Pubis	**1**	**0.05%**
Radium	**38**	**1.82%**
Rib	**20**	**0.96%**
Sacrum	**3**	**0.14%**
Scapula	**28**	**1.34%**
Thoracic vertebra	**5**	**0.24%**
Tibia	**17**	**0.81%**
Ulna	**14**	**0.67%**

Vertebra	**1**	**0.05%**
Cervus elaphus	**1586**	**75.81%**
Astragalus (talus)	**18**	**0.86%**
Atlas	**14**	**0.67%**
Axis (epistropheus)	**11**	**0.53%**
Calcaneus	**25**	**1.20%**
Carpal	**14**	**0.67%**
Central and 4th tarsal (cuboid)	**23**	**1.10%**
Cervical vertabra	**18**	**0.86%**
Cervical vertebra	**5**	**0.24%**
Cranial	**130**	**6.21%**
Antler	11	0.53%
Frontal	1	0.05%
Maxilla	5	0.24%
Nasal	1	0.05%
Occipital	1	0.05%
Parietal	1	0.05%
Premaxilla	1	0.05%
Shaft/body fragment	2	0.10%
Temporal and auditory bulla	1	0.05%
Zygomatic	1	0.05%
(blank)	105	5.02%

Cuboid	**1**	**0.05%**
Epistropheus (axis vert)	**1**	**0.05%**
Femur	**82**	**3.92%**
Fibula	**1**	**0.05%**
Humerus	**74**	**3.54%**
Humerus or femur fragment	**1**	**0.05%**
Ilium	**11**	**0.53%**
Ilium+ischium	**1**	**0.05%**
Indeterminate	**1**	**0.05%**
Indeterminate metapodial	**1**	**0.05%**
Indeterminate metatarsal	**1**	**0.05%**
Innominate	**9**	**0.43%**
Intermediate carpal	**3**	**0.14%**
Interparietal	**1**	**0.05%**
Ischium	**7**	**0.33%**
Lateral malleolus	**1**	**0.05%**
Long bone fragment	**9**	**0.43%**
Loose tooth or tooth fragment	**1**	**0.05%**
Loose tooth: lower	**29**	**1.39%**
Loose tooth: upper	**27**	**1.29%**
Lumbar vertebra	**34**	**1.63%**
Mandible	**15**	**0.72%**

Mandible with teeth	**32**	**1.53%**
Mandible without teeth	**29**	**1.39%**
Maxillary with teeth	**17**	**0.81%**
Metacarpal 3 and 4	**88**	**4.21%**
Metacarpus	**28**	**1.34%**
Metapodial 3 and 4	**92**	**4.40%**
Metapodium	**3**	**0.14%**
Metatarsal 3 and 4	**124**	**5.93%**
Metatarsal 5	**1**	**0.05%**
Metatarsus	**41**	**1.96%**
Patella	**2**	**0.10%**
Pelvis (ilium+ischium+pubic)	**24**	**1.15%**
Phalange 1 (posterior)	**2**	**0.10%**
Phalanx 1	**99**	**4.73%**
Phalanx 1 (anterior)	**4**	**0.19%**
Phalanx 1 (posterior)	**9**	**0.43%**
Phalanx 2	**52**	**2.49%**
Phalanx 3	**16**	**0.76%**
Pubis	**4**	**0.19%**
Radium	**80**	**3.82%**
Rib	**35**	**1.67%**
Sacrum	**3**	**0.14%**

Scapula	**52**	**2.49%**
Sesamoid	**1**	**0.05%**
Tarsal	**1**	**0.05%**
Thoracic vertebra	**52**	**2.49%**
Tibia	**88**	**4.21%**
Ulna	**29**	**1.39%**
Ulnar carpal	**3**	**0.14%**
Vertebra	**5**	**0.24%**
Vertebral centrum	**1**	**0.05%**
Grand Total	**2092**	**100.00%**

Table 50: Deer element frequencies with antler from Stragari.

Deer teeth	Stragari NISP	Middle Neolithic NISP%
Capreolus capreolus	**53**	**33.33%**
Loose tooth: lower	2	1.26%
Loose tooth: upper	6	3.77%
Mandible with teeth	40	25.16%
Maxillary with teeth	5	3.14%
Cervus elaphus	**106**	**66.67%**
Loose tooth or tooth fragment	1	0.63%
Loose tooth: lower	29	18.24%
Loose tooth: upper	27	16.98%
Mandible with teeth	32	20.13%
Maxillary with teeth	17	10.69%
Grand Total	**159**	**100.00%**

Table 51: Deer tooth frequencies from Stragari.

Roe deer elements	Stragari NISP	Middle Neolithic NISP%
Capreolus capreolus	**506**	**100.00%**
Astragalus (talus)	7	1.38%
Atlas	1	0.20%
Axis (epistropheus)	6	1.19%
Calcaneus	4	0.79%
Cervical vertabra	9	1.78%
Cervical vertebra	1	0.20%
Cranial	36	7.11%
Femur	27	5.34%
Humerus	14	2.77%
Hyoid	1	0.20%
Ilium	2	0.40%
Innominate	4	0.79%
Ischium	4	0.79%
Long bone fragment	1	0.20%
Loose tooth: lower	2	0.40%
Loose tooth: upper	6	1.19%
Lumbar vertebra	17	3.36%
Mandible	3	0.59%

Mandible with teeth	40	7.91%
Mandible without teeth	8	1.58%
Maxillary with teeth	5	0.99%
Metacarpal 3 and 4	38	7.51%
Metacarpus	7	1.38%
Metapodial 3 and 4	18	3.56%
Metatarsal 3 and 4	60	11.86%
Metatarsus	13	2.57%
Pelvis (ilium+ischium+pubic)	12	2.37%
Phalanx 1	25	4.94%
Phalanx 2	5	0.99%
Phalanx 3	3	0.59%
Pubis	1	0.20%
Radium	38	7.51%
Rib	20	3.95%
Sacrum	3	0.59%
Scapula	28	5.53%
Thoracic vertebra	5	0.99%
Tibia	17	3.36%
Ulna	14	2.77%
Vertebra	1	0.20%
Grand Total	**506**	**100.00%**

Table 52: Roe deer element frequencies from Stragari.

Red deer elements	Stragari Middle Neolithic	
	NISP	NISP%
Cervus elaphus	**1586**	**100.00%**
Astragalus (talus)	18	1.13%
Atlas	14	0.88%
Axis (epistropheus)	11	0.69%
Calcaneus	25	1.58%
Carpal	14	0.88%
Central and 4th tarsal (cuboid)	23	1.45%
Cervical vertabra	18	1.13%
Cervical vertebra	5	0.32%
Cranial	130	8.20%
Cuboid	1	0.06%
Epistropheus (axis vert)	1	0.06%
Femur	82	5.17%
Fibula	1	0.06%
Humerus	74	4.67%
Humerus or femur fragment	1	0.06%
Ilium	11	0.69%
Ilium+ischium	1	0.06%
Indeterminate	1	0.06%
Indeterminate metapodial	1	0.06%

Indeterminate metatarsal	1	0.06%
Innominate	9	0.57%
Intermediate carpal	3	0.19%
Interparietal	1	0.06%
Ischium	7	0.44%
Lateral malleolus	1	0.06%
Long bone fragment	9	0.57%
Loose tooth or tooth fragment	1	0.06%
Loose tooth: lower	29	1.83%
Loose tooth: upper	27	1.70%
Lumbar vertebra	34	2.14%
Mandible	15	0.95%
Mandible with teeth	32	2.02%
Mandible without teeth	29	1.83%
Maxillary with teeth	17	1.07%
Metacarpal 3 and 4	88	5.55%
Metacarpus	28	1.77%
Metapodial 3 and 4	92	5.80%
Metapodium	3	0.19%
Metatarsal 3 and 4	124	7.82%
Metatarsal 5	1	0.06%
Metatarsus	41	2.59%

Patella	2	0.13%
Pelvis (ilium+ischium+pubic)	24	1.51%
Phalange 1 (posterior)	2	0.13%
Phalanx 1	99	6.24%
Phalanx 1 (anterior)	4	0.25%
Phalanx 1 (posterior)	9	0.57%
Phalanx 2	52	3.28%
Phalanx 3	16	1.01%
Pubis	4	0.25%
Radium	80	5.04%
Rib	35	2.21%
Sacrum	3	0.19%
Scapula	52	3.28%
Sesamoid	1	0.06%
Tarsal	1	0.06%
Thoracic vertebra	52	3.28%
Tibia	88	5.55%
Ulna	29	1.83%
Ulnar carpal	3	0.19%
Vertebra	5	0.32%
Vertebral centrum	1	0.06%
Grand Total	**1586**	**100.00%**

Table 53: Red deer element frequencies from Stragari.

Taxa	Opovo NISP	Late Neolithic NISP%
Domestic	**319**	**44.80%**
Bos taurus	197	27.67%
Canis familiarus	20	2.81%
Capra hircus	1	0.14%
Ovis aries	4	0.56%
Ovis/Capra	14	1.97%
Sus scrofa dom.	83	11.66%
Wild	**393**	**55.20%**
Bos primigenius	12	1.69%
Capreolus capreolus	41	5.76%
Cervus elaphus	233	32.72%
Helix sp.	6	0.84%
Lepus sp.	4	0.56%
Meles/Nutra sp.	1	0.14%
Rupicapra rupicapra	2	0.28%
Sus scrofa	3	0.42%
Sus scrofa fer.	20	2.81%
Unio sp.	71	9.97%
Grand Total	**712**	**100.00%**

Table 54: Taxonomic frequencies from Opovo.

Taxa	Opovo Late Neolithic	
	NISP	NISP%
Wild	**393**	**100.00%**
Bos primigenius	12	3.05%
Capreolus capreolus	41	10.43%
Cervus elaphus	233	59.29%
Helix sp.	6	1.53%
Lepus sp.	4	1.02%
Meles/Nutra sp.	1	0.25%
Rupicapra rupicapra	2	0.51%
Sus scrofa	3	0.76%
Sus scrofa fer.	20	5.09%
Unio sp.	71	18.07%
Grand Total	**393**	**100.00%**

Table 55: Wild taxa frequencies at Opovo.

	Opovo	Late Neolithic
Deer taxa	**NISP**	**NISP%**
Capreolus capreolus	41	14.96%
Cervus elaphus	233	85.04%
Grand Total	**274**	**100.00%**

Table 56**:** Deer frequencies from Opovo.

Deer elements	Opovo Late Neolithic	
	NISP	NISP%
Capreolus capreolus	**41**	**14.96%**
Astragalus	3	1.09%
Atlas	1	0.36%
Calcanius	3	1.09%
Cranium	8	2.92%
Femur	1	0.36%
Humerus	4	1.46%
Ilium	1	0.36%
Mandible with teeth	7	2.55%
Metacarpal 3 and 4	2	0.73%
Metatarsal 3 and 4	4	1.46%
Pelvis (Iluim, ischium, pubis)	1	0.36%
Radius	1	0.36%
Scapula	3	1.09%
Tibia	1	0.36%
Ulna	1	0.36%
Cervus elaphus	**233**	**85.04%**
2nd and 3rd carpal	1	0.36%
Anterior phalanx 1	8	2.92%

Astragalus	8	2.92%
Calcanius	12	4.38%
Central and 4th tarsal	8	2.92%
Cervical vertebra	3	1.09%
Cranium	31	11.31%
Epistropheus	3	1.09%
Femur	3	1.09%
Humerus	8	2.92%
Ilium	1	0.36%
Intermediate carpal	1	0.36%
Ischium	2	0.73%
Loose tooth lower	2	0.73%
Loose tooth upper	1	0.36%
Lumbar vertebra	2	0.73%
Mandible with teeth	18	6.57%
Mandible without teeth	1	0.36%
Maxillary with teeth	15	5.47%
Metacarpal 3 and 4	17	6.20%
Metapodial 3 and 4	2	0.73%
Metatarsal 3 and 4	19	6.93%
Pelvis (Iluim, ischium, pubis)	2	0.73%
Phalanx 1	5	1.82%

Phalanx 2	10	3.65%
Phalanx 3	1	0.36%
Posterior phalanx 1	10	3.65%
Pubis	1	0.36%
Radius	14	5.11%
Scapula	8	2.92%
Thoracic vertebra	4	1.46%
Tibia	9	3.28%
Ulna	2	0.73%
Ulnar carpal	1	0.36%
Grand Total	**274**	**100.00%**

Table 57: Deer element frequencies from Opovo.

Deer elements	Opovo Late Neolithic NISP	NISP%
Capreolus capreolus	**41**	**14.96%**
Astragalus	**3**	**1.09%**
Atlas	**1**	**0.36%**
Calcanius	**3**	**1.09%**
Cranium	**8**	**2.92%**
(blank)	2	0.73%
Base (or beginning of first tine)	4	1.45%
Some of corpus midding (single tine or fragment)	1	0.36%
Tip (base + first tine)	1	0.36%
Femur	**1**	**0.36%**
Humerus	**4**	**1.46%**
Ilium	**1**	**0.36%**
Mandible with teeth	**7**	**2.55%**
Metacarpal 3 and 4	**2**	**0.73%**
Metatarsal 3 and 4	**4**	**1.46%**
Pelvis (Iluim, ischium, pubis)	**1**	**0.36%**
Radius	**1**	**0.36%**
Scapula	**3**	**1.09%**
Tibia	**1**	**0.36%**
Ulna	**1**	**0.36%**
Cervus elaphus	**233**	**85.04%**
2nd and 3rd carpal	**1**	**0.36%**
Anterior phalanx 1	**8**	**2.92%**

Astragalus	**8**	**2.92%**
Calcanius	**12**	**4.38%**
Central and 4th tarsal	**8**	**2.92%**
Cervical vertebra	**3**	**1.09%**
Cranium	**31**	**11.31%**
(blank)	6	2.19%
Base (or beginning of first tine)	6	2.18%
Base and corpus (fragment of column)	10	3.65%
Indeterminable or missing	4	1.46%
Some of corpus midding (single tine or fragment)	5	1.82%
Epistropheus	**3**	**1.09%**
Femur	**3**	**1.09%**
Humerus	**8**	**2.92%**
Ilium	**1**	**0.36%**
Intermediate carpal	**1**	**0.36%**
Ischium	**2**	**0.73%**
Loose tooth lower	**2**	**0.73%**
Loose tooth upper	**1**	**0.36%**
Lumbar vertebra	**2**	**0.73%**
Mandible with teeth	**18**	**6.57%**
Mandible without teeth	**1**	**0.36%**
Maxillary with teeth	**15**	**5.47%**
Metacarpal 3 and 4	**17**	**6.20%**
Metapodial 3 and 4	**2**	**0.73%**
Metatarsal 3 and 4	**19**	**6.93%**
Pelvis (Iluim, ischium, pubis)	**2**	**0.73%**

Phalanx 1	**5**	**1.82%**
Phalanx 2	**10**	**3.65%**
Phalanx 3	**1**	**0.36%**
Posterior phalanx 1	**10**	**3.65%**
Pubis	**1**	**0.36%**
Radius	**14**	**5.11%**
Scapula	**8**	**2.92%**
Thoracic vertebra	**4**	**1.46%**
Tibia	**9**	**3.28%**
Ulna	**2**	**0.73%**
Ulnar carpal	**1**	**0.36%**
Grand Total	**274**	**100.00%**

Table 58: Antler and element frequencies from Opovo.

Deer teeth	Opovo NISP	Late Neolithic NISP%
Capreolus capreolus	**7**	**16.28%**
Mandible with teeth	7	16.28%
Cervus elaphus	**36**	**83.72%**
Loose tooth lower	2	4.65%
Loose tooth upper	1	2.33%
Mandible with teeth	18	41.86%
Maxillary with teeth	15	34.88%
Grand Total	**43**	**100.00%**

Table 59: Deer tooth frequencies from Opovo.

Roe deer elements	Opovo NISP	Late Neolithic NISP%
Capreolus capreolus	**41**	**100.00%**
Astragalus	3	7.32%
Atlas	1	2.44%
Calcanius	3	7.32%
Cranium	8	19.51%
Femur	1	2.44%
Humerus	4	9.76%
Ilium	1	2.44%
Mandible with teeth	7	17.07%
Metacarpal 3 and 4	2	4.88%
Metatarsal 3 and 4	4	9.76%
Pelvis (Iluim, ischium, pubis)	1	2.44%
Radius	1	2.44%
Scapula	3	7.32%
Tibia	1	2.44%
Ulna	1	2.44%
Grand Total	**41**	**100.00%**

Table 60: Roe deer element frequencies from Opovo.

Red deer elements	Opovo Late Neolithic	
	Number of specimens	NISP%
Cervus elaphus	**233**	**100.00%**
2nd and 3rd carpal	1	0.43%
Anterior phalanx 1	8	3.43%
Astragalus	8	3.43%
Calcanius	12	5.15%
Central and 4th tarsal	8	3.43%
Cervical vertebra	3	1.29%
Cranium	31	13.30%
Epistropheus	3	1.29%
Femur	3	1.29%
Humerus	8	3.43%
Ilium	1	0.43%
Intermediate carpal	1	0.43%
Ischium	2	0.86%
Loose tooth lower	2	0.86%
Loose tooth upper	1	0.43%
Lumbar vertebra	2	0.86%
Mandible with teeth	18	7.73%
Mandible without teeth	1	0.43%
Maxillary with teeth	15	6.44%
Metacarpal 3 and 4	17	7.30%
Metapodial 3 and 4	2	0.86%
Metatarsal 3 and 4	19	8.15%
Pelvis (Iluim, ischium, pubis)	2	0.86%

Phalanx 1	5	2.15%
Phalanx 2	10	4.29%
Phalanx 3	1	0.43%
Posterior phalanx 1	10	4.29%
Pubis	1	0.43%
Radius	14	6.01%
Scapula	8	3.43%
Thoracic vertebra	4	1.72%
Tibia	9	3.86%
Ulna	2	0.86%
Ulnar carpal	1	0.43%
Grand Total	**233**	**100.00%**

Table 61: Red deer element frequencies from Opovo.

Taxa	Vinča Late Neolithic	
	NISP	NISP%
Domestic	**734**	**70.78%**
Bos Taurus	354	34.14%
Canis familiaris	33	3.18%
Capra hircus	7	0.68%
Equus caballus	1	0.10%
Ovis aries	28	2.70%
Ovis/Capra	108	10.41%
Sus scrofa dom.	203	19.58%
Wild	**303**	**29.22%**
Aves sp.	2	0.19%
Bos primigenius	62	5.98%
Canis lupus	1	0.10%
Capreolus capreolus	20	1.93%
Cervus elaphus	145	13.98%
Ciconiidae (storks)	1	0.10%
Emys orbicularis	1	0.10%
Felis silvestri	2	0.19%
Lepus europaeus	1	0.10%
Lutra lutra	1	0.10%
Meles meles	1	0.10%
Pisces sp.	18	1.74%
Sus scrofa fer.	24	2.31%
Unio sp.	24	2.31%

Grand Total	**1037**	**100.00%**

Table 62: Taxonomic frequencies from Vinča.

Taxa	Vinča	Late Neolithic
	NISP	NISP%
Wild	**303**	**100.00%**
Aves sp.	2	0.66%
Bos primigenius	62	20.46%
Canis lupus	1	0.33%
Capreolus capreolus	20	6.60%
Cervus elaphus	145	47.85%
Ciconiidae (storks)	1	0.33%
Emys orbicularis	1	0.33%
Felis silvestri	2	0.66%
Lepus europaeus	1	0.33%
Lutra lutra	1	0.33%
Meles meles	1	0.33%
Pisces sp.	18	5.94%
Sus scrofa fer.	24	7.92%
Unio sp.	24	7.92%
Grand Total	**303**	**100.00%**

Table 63: Wild taxa frequencies from Vinča.

	Vinča	Late Neolithic
Taxa	**NISP**	**NISP%**
Capreolus capreolus	20	12.12%
Cervus elaphus	145	87.88%
Grand Total	**165**	**100.00%**

Table 64**:** Deer frequencies from Vinča**.**

Deer elements	Vinča	Late Neolithic
	NISP	**NISP%**
Capreolus capreolus	**20**	**12.12%**
Astragalus	1	0.61%
Cranium	3	1.82%
Femur	1	0.61%
Humerus	1	0.61%
Innominate	3	1.82%
Mandible	2	1.21%
Metacarpal	1	0.61%
Metatarsal	2	1.21%
Radius	1	0.61%
Scapula	3	1.82%
Tibia	1	0.61%
Vertebra	1	0.61%
Cervus elaphus	**145**	**87.88%**
Astragalus	9	5.45%
Calcaneus	1	0.61%
Carpal	2	1.21%
Cranium	24	14.55%
Femur	5	3.03%

Humerus	2	1.21%
Innominate	5	3.03%
Loose tooth	1	0.61%
Mandible	8	4.85%
Metacarpal	8	4.85%
Metapodial	6	3.64%
Metatarsal	9	5.45%
Phalange	25	15.15%
Radius	5	3.03%
Scapula	12	7.27%
Tarsal	2	1.21%
Tibia	9	5.45%
Ulna	7	4.24%
Vertebra	5	3.03%
Grand Total	**165**	**100.00%**

Table 65: Deer element frequencies from Vinča.

Deer elements	Vinča	Late Neolithic
	NISP	NISP%
Capreolus capreolus	**20**	**12.12%**
Astragalus	**1**	**0.61%**
Cranium	**3**	**1.82%**
(blank)	1	0.61%
Some of corpus missing (Single tine or fragments)	2	1.21%
Femur	**1**	**0.61%**
Humerus	**1**	**0.61%**
Innominate	**3**	**1.82%**
Mandible	**2**	**1.21%**
Metacarpal	**1**	**0.61%**
Metatarsal	**2**	**1.21%**
Radius	**1**	**0.61%**
Scapula	**3**	**1.82%**
Tibia	**1**	**0.61%**
Vertebra	**1**	**0.61%**
Cervus elaphus	**145**	**87.88%**
Astragalus	**9**	**5.45%**
Calcaneus	**1**	**0.61%**
Carpal	**2**	**1.21%**
Cranium	**24**	**14.55%**
(blank)	2	1.21%
Tip (base and first tine)	2	1.21%
Base and corpus (fragment of column)	12	7.27%
Base (Base to beginning of the first tine)	1	0.61%

Some of corpus missing (Single tine or fragments)	6	3.64%
Corpus and tip (column with tines)	1	0.61%
Femur	**5**	**3.03%**
Humerus	**2**	**1.21%**
Innominate	**5**	**3.03%**
Loose tooth	**1**	**0.61%**
Mandible	**8**	**4.85%**
Metacarpal	**8**	**4.85%**
Metapodial	**6**	**3.64%**
Metatarsal	**9**	**5.45%**
Phalange	**25**	**15.15%**
Radius	**5**	**3.03%**
Scapula	**12**	**7.27%**
Tarsal	**2**	**1.21%**
Tibia	**9**	**5.45%**
Ulna	**7**	**4.24%**
Vertebra	**5**	**3.03%**
Grand Total	**165**	**100.00%**

Table 66: Deer antler and element frequencies from Vinča.

	Vinča	Late Neolithic
Deer elements	**NISP**	**NISP%**
Capreolus capreolus	**20**	**12.12%**
Astragalus	**1**	**0.61%**
Cranium	**3**	**1.82%**
(blank)	3	1.82%
Femur	**1**	**0.61%**
Humerus	**1**	**0.61%**
Innominate	**3**	**1.82%**
Mandible	**2**	**1.21%**
With teeth	2	1.21%
Metacarpal	**1**	**0.61%**
Metatarsal	**2**	**1.21%**
Radius	**1**	**0.61%**
Scapula	**3**	**1.82%**
Tibia	**1**	**0.61%**
Vertebra	**1**	**0.61%**
Cervus elaphus	**145**	**87.88%**
Astragalus	**9**	**5.45%**
Calcaneus	**1**	**0.61%**
Carpal	**2**	**1.21%**

Cranium	**24**	**14.55%**
With teeth	1	0.61%
(blank)	23	13.94%
Femur	**5**	**3.03%**
Humerus	**2**	**1.21%**
Innominate	**5**	**3.03%**
Loose tooth	**1**	**0.61%**
Upper	1	0.61%
Mandible	**8**	**4.85%**
With teeth	5	3.03%
Without teeth	3	1.82%
Metacarpal	**8**	**4.85%**
Metapodial	**6**	**3.64%**
Metatarsal	**9**	**5.45%**
Phalange	**25**	**15.15%**
Radius	**5**	**3.03%**
Scapula	**12**	**7.27%**
Tarsal	**2**	**1.21%**
Tibia	**9**	**5.45%**
Ulna	**7**	**4.24%**
Vertebra	**5**	**3.03%**
Grand Total	**165**	**100.00%**

Table 67: Deer tooth and element frequencies at Vinča.

Deer teeth	Vinča Late Neolithic	
	NISP	NISP%
Capreolus capreolus	**2**	**18.18%**
Mandible	**2**	**18.18%**
With teeth	2	18.18%
Cervus elaphus	**9**	**81.82%**
Loose tooth	**1**	**9.09%**
Upper	1	9.09%
Mandible	**8**	**72.73%**
With teeth	5	45.45%
Without teeth	3	27.27%
Grand Total	**11**	**100.00%**

Table 68: Deer tooth frequencies from Vinča.

Roe deer elements	Vinča	Late Neolithic
	NISP	NISP%
Capreolus capreolus	**20**	**100.00%**
Astragalus	**1**	**5.00%**
Cranium	**3**	**15.00%**
Femur	**1**	**5.00%**
Humerus	**1**	**5.00%**
Innominate	**3**	**15.00%**
Mandible	**2**	**10.00%**
With teeth	2	10.00%
Metacarpal	**1**	**5.00%**
Metatarsal	**2**	**10.00%**
Radius	**1**	**5.00%**
Scapula	**3**	**15.00%**
Tibia	**1**	**5.00%**
Vertebra	**1**	**5.00%**
Grand Total	**20**	**100.00%**

Table 69: Roe deer element frequencies from Vinča.

Red deer elements	Vinča NISP	Late Neolithic NISP%
Cervus elaphus	**145**	**100.00%**
Astragalus	**9**	**6.21%**
Calcaneus	**1**	**0.69%**
Carpal	**2**	**1.38%**
Cranium	**24**	**16.55%**
With teeth	1	0.69%
(blank)	23	15.86%
Femur	**5**	**3.45%**
Humerus	**2**	**1.38%**
Innominate	**5**	**3.45%**
Loose tooth	**1**	**0.69%**
Upper	1	0.69%
Mandible	**8**	**5.52%**
With teeth	5	3.45%
Without teeth	3	2.07%
Metacarpal	**8**	**5.52%**
Metapodial	**6**	**4.14%**
Metatarsal	**9**	**6.21%**
Phalange	**25**	**17.24%**

Radius	**5**	**3.45%**
Scapula	**12**	**8.28%**
Tarsal	**2**	**1.38%**
Tibia	**9**	**6.21%**
Ulna	**7**	**4.83%**
Vertebra	**5**	**3.45%**
Grand Total	**145**	**100.00%**

Table 70: Red deer element frequencies from Vinča.

Red deer age classes	Blagotin	Early Neolithic
	NISP	NISP%
Cervus elaphus	**259**	**100.00%**
Juvenile	6	2.32%
Juvenile / Subadult	1	0.39%
Subadult	43	16.60%
Subadult / Adult	81	31.27%
Adult	128	49.42%
Grand Total	**259**	**100.00%**

Table 71: Red deer age classes based on all elements for Blagotin.

Roe deer age classes	Blagotin Early Neolithic	
	NISP	NISP%
Capreolus capreolus	**187**	**100.00%**
Foetal / Infant	1	0.53%
Juvenile	6	3.21%
Juvenile / Subadult	6	3.21%
Subadult	32	17.11%
Subadult / Adult	77	41.18%
Adult	65	34.76%
Grand Total	**187**	**100.00%**

Table 72: Roe deer age classes based on all elements from Blagotin.

Sample number	Age by tooth eruption and wear (TEW) (in months)	TEW age classes	Age by tooth wear score (TWS) (in months)	TWS age classes	Age by crown height (CH)(In months)	CH age classes
J-i			4.6	Juvenile	95.96	Adult
B-M-2	42	Adult	46.95	Adult	101.49	Adult
I-b	19	Subadult	4.6	Juvenile	40.78	Adult
A-I-15	30	Adult	4.6	Juvenile		
I-n	66	Adult	4.6	Juvenile		
J-h	18.5	Subadult	17.42	Subadult		

Table 73: Red deer age-of-death results from Blagotin.

Red deer age classes	Hajdučka Vodenica Early Neolithic	
	NISP	NISP%
Cervus elaphus	**23**	**100.00%**
Adult	17	73.91%
Subadult	2	8.70%
Subadult/Adult	4	17.39%
Grand Total	**23**	**100.00%**

Table 74: Red deer age classes based on all elements from Hajdučka Vodenica.

	Foeni-Salaş	Early Neolithic
Red deer age classes	**NISP**	**NISP%**
Cervus elaphus	**105**	**100.00%**
Adult	55	52.38%
Juvenile	1	0.95%
Subadult	16	15.24%
Subadult/Adult	33	31.43%
Grand Total	**105**	**100.00%**

Table 75: Red deer age classes based on all elements from Foeni-Salaş

Roe deer age classes	Foeni-Salaş NISP	Early Neolithic NISP%
Capreolus capreolus	**81**	**100.00%**
Adult	25	30.86%
Juvenile	1	1.23%
Subadult	9	11.11%
Subadult/Adult	46	56.79%
Grand Total	**81**	**100.00%**

Table 76: Roe deer age classes based on all elements from Foeni-Salaş

Red deer age classes	Bukovačka Česma	Early Neolithic
	NISP	NISP%
Cervus elaphus	**79**	**100.00%**
Adult	27	34.18%
Juvenile	2	2.53%
Subadult	14	17.72%
Subadult/adult	36	45.57%
Grand Total	**79**	**100.00%**

Table 77: Red deer age classes based on all elements from Bukovačka Česma.

Roe deer age classes	Bukovačka Česma	Early Neolithic
	NISP	NISP%
Capreolus capreolus	**16**	**100.00%**
Adult	1	6.25%
Infantile	1	6.25%
Juvenile	9	56.25%
Juvenile/subadult	1	6.25%
Subadult	3	18.75%
Subadult/adult	1	6.25%
Grand Total	**16**	**100.00%**

Table 78: Roe deer age classes based on all elements from Bukovačka Česma.

Red deer age classes	Stragari NISP	Middle Neolithic NISP%
Cervus elaphus	**1565**	**100.00%**
Adult	599	38.27%
Infant	1	0.06%
Juvenile	23	1.47%
Juvenile/Subadult	5	0.32%
Subadult	167	10.67%
Subadult/Adult	770	49.20%
Grand Total	**1565**	**100.00%**

Table 79: Red deer age classes based on all elements from Stragari.

Roe deer age classes	Stragari Middle Neolithic	
	NISP	NISP%
Capreolus capreolus	**495**	**100.00%**
Adult	162	32.73%
Juvenile	7	1.41%
Subadult	41	8.28%
Subadult/Adult	285	57.58%
Grand Total	**495**	**100.00%**

Table 80: Roe deer age classes based on all elements from Stragari.

Sample number	Age by tooth wear and eruption (TEW) (in months)	TEW Age classes	Age by tooth wear score (TWS) (in months)	TWS Age Classes	Age by crown height (CH) (in months)	CH Age Classes	Age by dental annuli by eye results (in years)	Age by dental annuli by graph (in years)	Season-of-death
A-c5-3	6.50	Juvenile	11.25	Juvenile	18.61	Subadult			
A-b3-3	22.00	Subadult	11.25	Juvenile	28.23	Adult			
G-i-6-c	22.00	Subadult	41.97	Adult	34.41	Adult	3	3	Fall/Winter
F-f-1-c	30.00	Adult	18.55	Subadult	67.23	Adult	3	3	Spring/Summer
D-a-3-g	30.00	Adult	65.35	Adult	41.75	Adult	Unclear	Unclear	Unclear
A-c2	54.00	Adult	33.51	Adult					
F-f-4	54.00	Adult	66.34	Adult	61.45	Adult	8	8	Spring/Summer
A	66.00	Adult	17.42	Subadult	96.03	Adult			
D/U-e-2	66.00	Adult	20.29	Subadult					
D/u-b-1	66.00	Adult			65.15	Adult			
G-g-8	90.00	Adult	43.6	Adult					
F-e-6-a			35.73	Adult					

G-p-6-m			62.41	Adult	51.31	Adult			
D-f-3					96.87				

Table 81: Red deer age-of-death and season-of-death results for Stragari.

Sample number	Tooth eruption and wear (TEW)(in Months)	TEW age classes	Crown height (CH) (in Months)	CH age classes	Age based on dental annuli by eye (in years)	Age based on dental annuli by graph (in years	Season-of-death
A	12	Subadult	25.7	Adult			
E-o,i-2	51.5	Adult	37.88	Adult			
E-f-1	51.5	Adult	55.94	Adult	3	3	Fall/Winter

Table 82: Roe deer age-of-death and season-of-death results for Stragari.

	Sânandrei	Late Neolithic
Red deer age classes	**NISP**	**NISP%**
Cervus elaphus	**91**	**100.00%**
Adult	38	41.76%
Juvenile	1	1.10%
Old subadult	1	1.10%
Subadult	12	13.19%
Subadult/Adult	39	42.86%
Grand Total	**91**	**100.00%**

Table 83: Red deer age classes based on all elements from Sânandrei.

Roe deer age classes	Sânandrei Late Neolithic	
	NISP	NISP%
Capreolus capreolus	**41**	**100.00%**
Adult	17	41.46%
Subadult	8	19.51%
Subadult/Adult	16	39.02%
Grand Total	**41**	**100.00%**

Table 84: Roe deer age classes based on all elements from Sânandrei.

Sample number	Age by tooth eruption and wear (TEW) (in months)	TEW age class	Age by crown height (CH) (in months)	CH age classes	Age by dental annuli by eye (in years)	Age by dental annuli by graph (in years)	Season-of-death
S64-3	24	Adult	17.86	Subadult			
S64-2	24	Adult	17.86	Subadult	3	3	Spring/Summer
S27	51.5	Adult	41.94	Adult			
S6	19	Subadult	42.36	Adult			
S64-1	12	Subadult	49.64	Adult			
GrM3	30	Adult	52.86	Adult			
S62	56	Adult	58.88	Adult	4	4	Fall/Winter
S28	76.5	Adult	59.02	Adult	6	6	Spring/Sumer
S37	51.5	Adult					
S85	72	Adult					

Table 85: Roe deer age-of-death and season-of-death results from Sânandrei.

	Petnica					
	Vinča B	Middle Neolithic	Vinča C	Late Neolithic	Vinča D	Late Neolithic
Red deer age classes	**NISP**	**NISP%**	**NISP**	**NISP%**	**NISP**	**NISP%**
Cervus elaphus	**1142**	**100.00%**	**332**	**100.00%**	**135**	**100.00%**
Infant	1	0.09%	1	0.30%		0.00%
Juvenile	36	3.15%	6	1.81%	6	4.44%
Juvenile/Subadult	4	0.35%	3	0.90%		0.00%
Subadult	65	5.69%	13	3.92%	4	2.96%
Subadult/Adult	697	61.03%	204	61.45%	81	60.00%
Adult	339	29.68%	105	31.63%	44	32.59%
Grand Total	**1142**	**100.00%**	**332**	**100.00%**	**135**	**100.00%**

Table 86: Red deer age classes based on all elements from Petnica.

	Petnica					
	Vinča B	Middle Neolithic	Vinča C	Late Neolithic	Vinča D	Late Neolithic
Roe deer age classes	NISP	NISP%	NISP	NISP%	NISP	NISP%
Capreolus capreolus	**187**	**100.00%**	**70**	**100.00%**	**26**	**100.00%**
Juvenile	4	2.14%	3	4.29%	1	3.85%
Juvenile/Subadult		0.00%	2	2.86%		0.00%
Subadult	6	3.21%	4	5.71%	1	3.85%
Subadult/Adult	125	66.84%	37	52.86%	21	80.77%
Adult	52	27.81%	24	34.29%	3	11.54%
Grand Total	**187**	**100.00%**	**70**	**100.00%**	**26**	**100.00%**

Table 87: Roe deer age classes based on all elements from Petnica.

Period	Sample number	Age by tooth eruption and wear (TEW) (in months)	TEW age classes	Age by tooth wear score (TWS) (in months)	TWS age class	Age by crown height (CH) (in months)	CH age class	Age by dental annuli by eye (in years)	Age by dental annuli by graph (in years)	Season-of-death
Vinča B Middle Neolithic	7-23-13-15	42	Adult	31.35	Adult	2.04	Infant			
	1-57-17-10	6.5	Juvenile	7.7	Juvenile	7.69	Juvenile			
	7-B8-26-18	6.5	Juvenile	12.21	Subadult	9.32	Juvenile			
	8-35-8-10-3	6.5	Juvenile	14.21	Subadult	11.2	Juvenile			
	7-38-16-25	5	Juvenile	6.48	Juvenile	14.06	Juvenile			
	7-64-22-18	30	Adult	33.51	Adult	20.82	Subadult	5	7	Spring/Summer
	7-37-16-43			13.7		21.67				
	8-20-8-98	30	Adult	17.98	Subadult	23.68	Subadult			
	7-48-14-12	42	Adult	54.88	Adult	25.18	Adult			

	7-B8-26-39	22	Subadult	17.98	Subadult	28.82	Adult			
	7-C5-28-23	30	Adult	15.78	Subadult	30.18	Adult			
	7-37-16-44	42	Adult	50.4	Adult	35.12	Adult			
	1-85-19-1	42	Adult	12.21	Subadult	35.58	Adult			
	7-A3-17-8	66	Adult	20.29	Subadult	74.97	Adult			
	7-B5-30-8	90	Adult	80.98	Adult	82.57	Adult	8	6	Spring/Summer
	7-A3-25-15	90	Adult	46.95	Adult	91.87	Adult			
	8-45-10-12	78	Adult	88.82	Adult	99.28	Adult			
	8-37-8-10-8	66	Adult	41.17	Adult	128.27	Adult			
Vinča C Late Neolithic	1-7-6-24			5.33	Juvenile					
	1-5-5-50	22	Subadult	5.71	Juvenile					
	4-26-13-3	42	Adult	8.98	Juvenile					
	4-19-12-13	6.5	Juvenile	16.87	Juvenile	55.79	Adult			
	5-13-13-22	66	Adult	19.12	Subadult					
	8-3-3-99	22	Subadult	26.55	Adult					

	1-9-7-32	8	Juvenile	46.1	Adult	7.37	Juvenile	Unclear		
	1-46-14-18	8	Juvenile							
	5-13-13-25	42	Adult							
	4-20-12-10					60.99	Adult			
	1-5-5-54									
Vinča D	9-65-19-17	6.5	Juvenile	14.21	Juvenile	24.2	Subadult			
Late Neolithic	3-42-16-23	66	Adult	21.48	Subadult	65.74	Adult	7	7	Fall/Winter
	4-16-10-20	66	Adult							

Table 88: Red deer age-of-death and season-of-death results from all periods from Petnica.

Period	Sample number	Age by tooth eruption and wear (TEW)(in months)	TEW age class	Age by crown height (CH) (in months)	CH age class	Age by dental annuli by eye (in years)	Age by dental annuli by graph (in years)	Season of death
Vinča B Middle Neolithic	1-24-12-20	15.5	Subadult	19.96	Subadult			
	1-B0-24-4	15.5	Subadult	21.92	Subadult			
	1-20-11-22	52	Adult	25	Adult			
	8-18-6-68	64	Adult	29.29	Adult			
	8-64-14-35	76.5	Adult	29.29	Adult	4	4	Spring/Summer
	5-17-17-77	52	Adult	36.48	Adult			
	8-22-7-56	76.5	Adult	39.14	Adult			
	1-24-12-18	24.5	Adult	39.56	Adult			
	8-80-15-52	52	Adult	39.56	Adult			

	8-18-6-31	15.5	Subadult	47.26	Adult			
	7-A6-19-25-26	51.5	Adult	49.64	Adult			
	1-92-14-19-5	52	Adult	53.28	Adult			
	8-18-6-30	56	Adult	56.5	Adult	3	3	Fall/Winter
	8-18-6-69	76.5	Adult	60.56	Adult			
	7-56-20-12	52	Adult	64.76	Adult			
	8-30-9-79	92	Adult	65.32	Adult			
	1-92-14-19-4	56	Adult	66.16	Adult			
	7-50-14-14	139	Adult	88.56	Adult			
	8-21-7-26	92	Adult	89.4	Adult			
	1-48-15-2	139	Adult	89.4	Adult			
	7-30-13-26	124.5	Adult	123.56	Adult			
Vinča C Late Neolithic	3-36-14-7	15.5	Juvenile	47.26	Adult	5	5	Fall/Winter
	1-11-8-21	30	Adult	47.54	Adult			
	1-5-5-48	106	Adult	56.22	Adult			
	9-27-12-9	76.5	Adult	84.64	Adult	2	2	Fall/Winter

Vinča D Late Neolithic	9-57-22-15	21.5	Subadult	11.28	Juvenile			
	9-59-21-29	76.5	Adult	68.12	Adult			
	4-14-10-1	76.5	Adult	74.14	Adult	6	4	Fall/Winter

Table 89: Roe deer age-of-death and season-of-death results from all periods at Petnica. Note that the specimen marked as two years of age by dental cementum analysis has higher age results using other age-of-death techniques, this is in part because the dental annuli had begun disappear due to the individual's old age.

Red deer age classes	Opovo NISP	Late Neolithic NISP%
Cervus elaphus	**231**	**100.00%**
Adult	102	44.16%
Infant	1	0.43%
Juvenile	2	0.87%
Juvenile/Subadult	1	0.43%
Subadult	11	4.76%
Subadult/Adult	114	49.35%
Grand Total	**231**	**100.00%**

Table 90: Red deer age classes based on all elements from Opovo.

Roe deer age class	Opovo Late Neolithic	
	NISP	**NISP%**
Capreolus capreolus	**41**	**100.00%**
Adult	20	48.78%
Foetal/Infantile	1	2.44%
Juvenile	2	4.88%
Subadult	4	9.76%
Subadult/Adult	14	34.15%
Grand Total	**41**	**100.00%**

Table 91: Roe deer age classes based on all elements from Opovo

Sample number	Age by tooth eruption and wear (TEW) (in months)	TEW age class	Age by tooth wear score (TWS) (in months)	TWS age class	Age by crown height (CH) (in months)	CH age class	Age by dental annuli by eye (in years)	Age by dental annuli by graph (in years)	Season-of-death
1-4-86	30	Adult	17.42	Subadult	33.5	Adult	7	7	Spring/Summer
1-7-8	66	Adult	79.89	Adult	63.33	Adult			
1-8-25	66	Adult	80.98	Adult	64.83	Adult	5	5	Fall/Winter
1-4-164	66	Adult	40.37	Adult	76.07	Adult	Unclear	Unclear	Unclear

Table 92: Red deer age-of-death and season-of-death results from Opovo.

Sample number	Age by tooth eruption and wear (TEW) (in months)	TEW age class	Age by crown height (CH) (in months)	CH age class	Age by dental annuli by eye (in years)	Age by dental annuli by graph (in years)	Season-of-death
2-9-12	30	Adult	8.54	Juvenile			
12-01-06	24	Adult	17.51	Subadult			
1-5-175	51.5	Adult	21.49	Subadult	Unclear	Unclear	Unclear
2-3-4	52	Adult	27.63	Subadult			
1-3-10	76.5	Adult	39.25	Adult	6	6	Spring/summer
1-5-113	106	Adult	99.84	Adult	2	2	Fall/Winter

Table 93: Roe deer age-of-death and season-of-death from Opovo. The tooth specimen identified as two years old has been aged as far older using other age-of-death techniques. As with the specimen from Petnica, the dental annuli have begun to disappear due to the individual's old age.

	Vinča	Late Neolithic
Red deer age classes	**NISP**	**NISP%**
Cervus elaphus	**143**	**100.00%**
Infant	1	0.70%
Juvenile	16	11.19%
Juvenile/Subadult	2	1.40%
Subadult	9	6.29%
Subadult/adult	66	46.15%
Adult	49	34.27%
Grand Total	**143**	**100.00%**

Table 94: Red deer age classes based on all elements from Vinča.

	Vinča	Late Neolithic
Roe deer age classes	**NISP**	**NISP%**
Capreolus capreolus	**19**	**100.00%**
Juvenile	1	5.26%
Subadult	2	10.53%
Subadult/adult	6	31.58%
Adult	10	52.63%
Grand Total	**19**	**100.00%**

Table 95: Roe deer age classes based on all elements from Vinča.

Period	Region	Site	Red deer		Roe deer	
Middle Neolithic	**Central Serbia**		**Warm season**	**Cool seasons**	**Warm seasons**	**Cool seasons**
		Stragari	2	1		1
		Petnica	2		1	1
Late Neolithic	**Central Serbia**					
		Petnica		1		3
	Danube and Marshlands					
		Opovo	1	1	1	1
	Romanian Banat					
		Sânandrei			2	1

Table 96: Season-of-death results for all periods and sites combined.

Figures

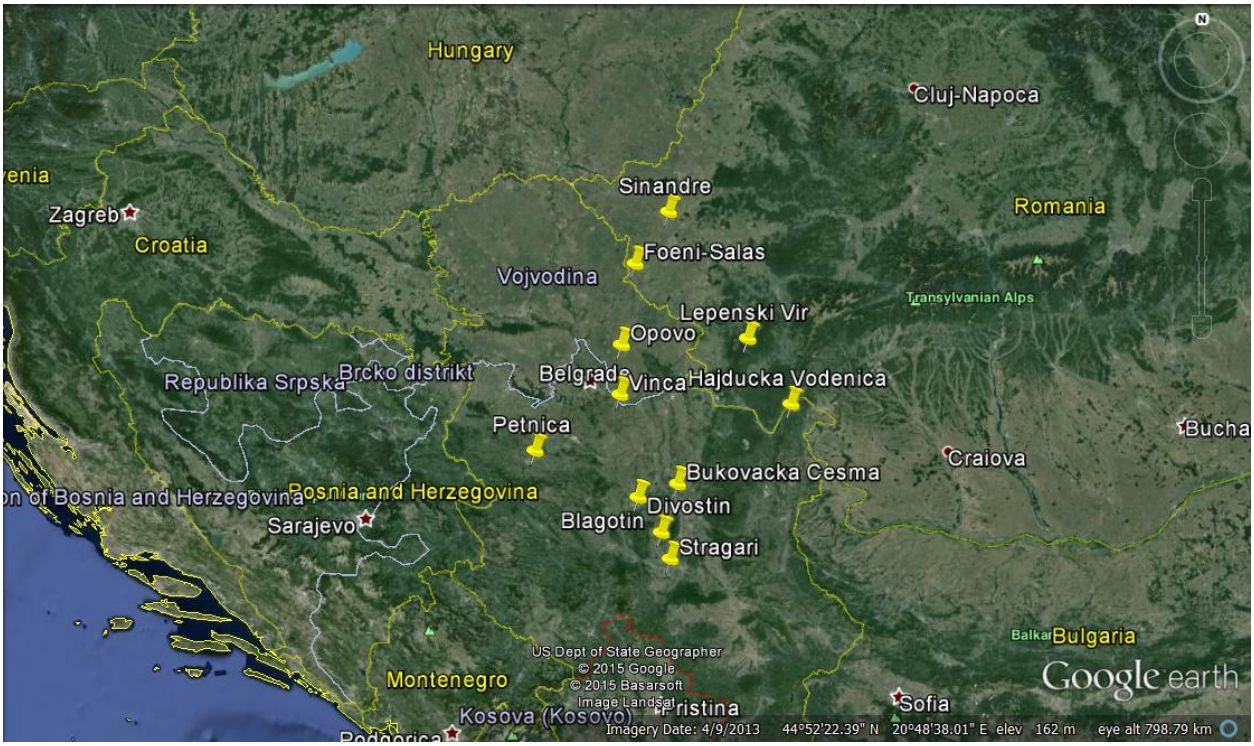


Figure 1: Map of the location of archaeological sites mentioned in this thesis.



Figure 2: Map showing the Early Neolithic sites analyzed in this thesis. These sites are Foeni-Salaș, Divostin I, Blagotin, Lepenski Vir, Hajdučka Vodenica, and Bukovačka Česma.



Figure 3: Map showing the sites from the Middle Neolithic that are analyzed in this thesis. These sites are: Petnica, and Stragari.



Figure 4: Map showing the Late Neolithic sites analyzed in this thesis. These sites are: Sânandrei, Opovo, Vinča, Petnica, and Divostin.

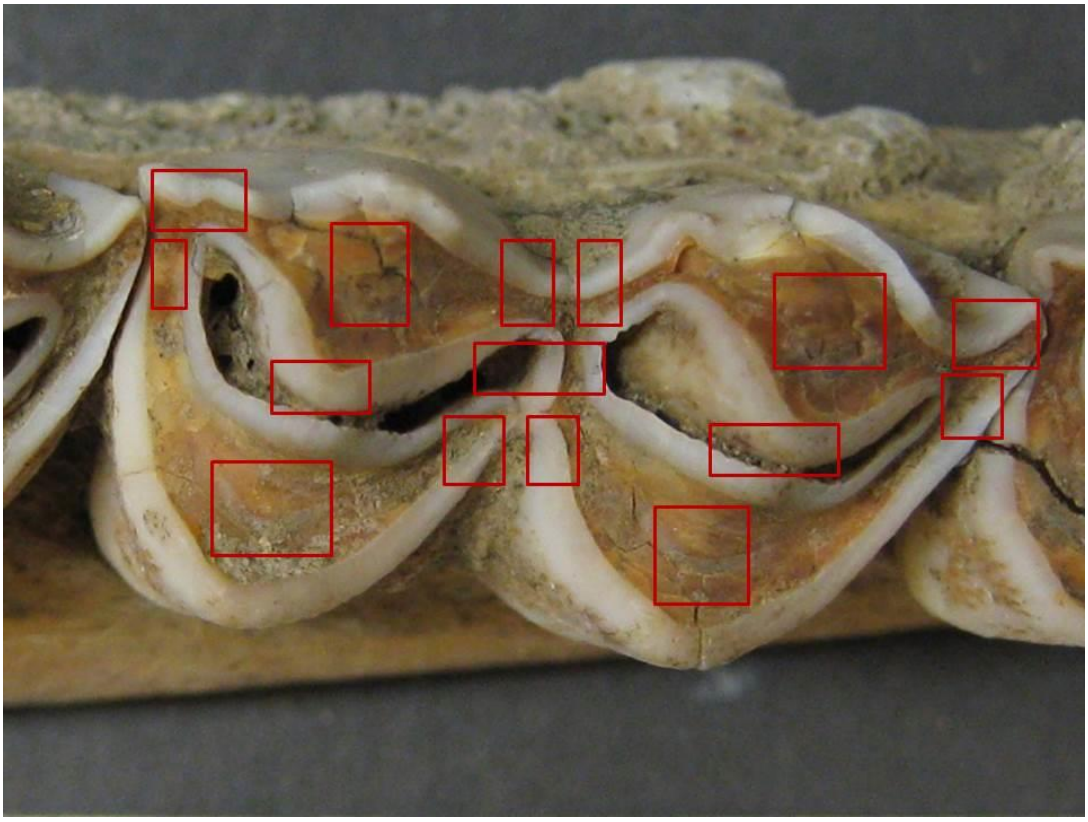


Figure 5: Image showing the tooth wear score areas. Each square represents a wear centre that will receive a score of 1 or 2 during assessment.



Figure 6: Location of longitudinal bisection of deer teeth. Teeth are cut longitudinally for dental cementum analysis because the acellular cementum is located at the enamel root junction.



Figure 7: Location of crown height measurements.

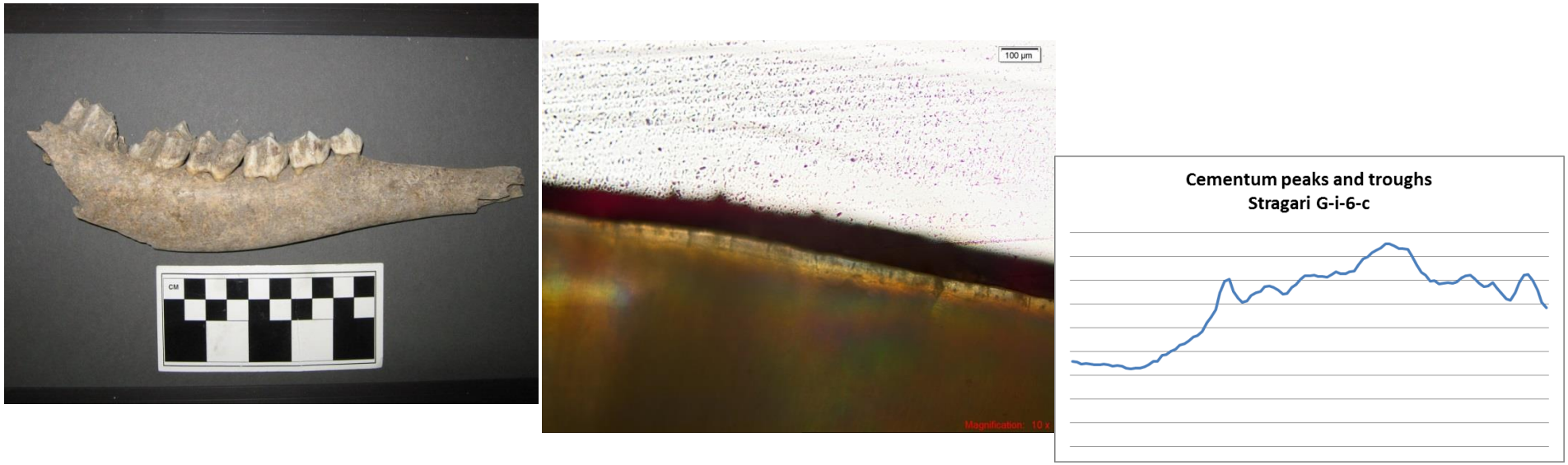


Figure 8: Images depicting the Stragari Red deer tooth sample: G-i-6-c. The first image is the original state of the sample. The second image is the thin sectioned sample. The third image depicts the graphical results of the dental cementum analysis of season-of-death.

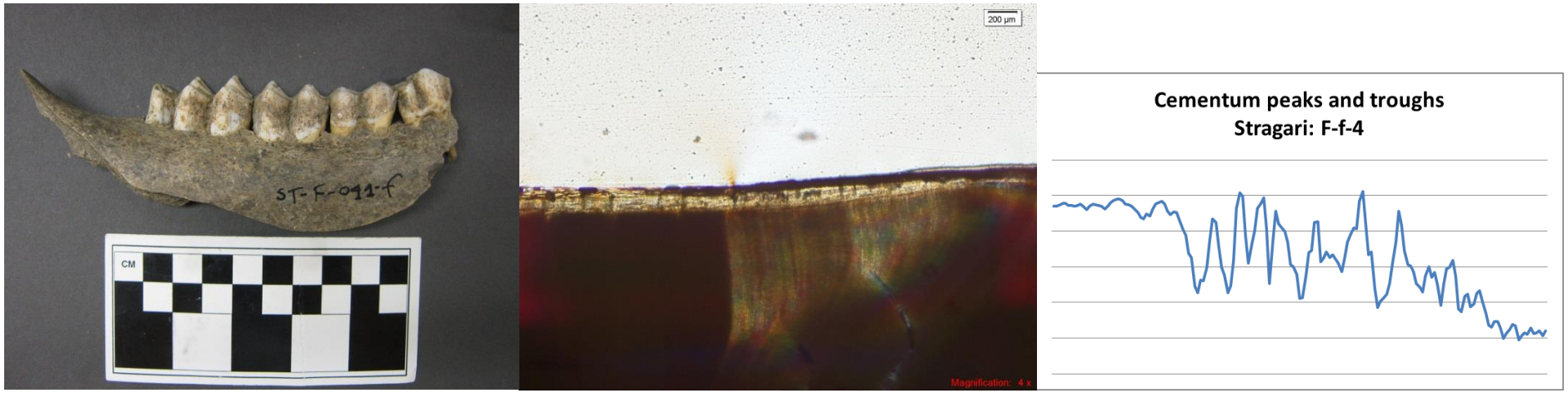


Figure 9: Images depicting the Stragari red deer tooth sample: F-f-4. The first image is the original state of the sample. The second image is the thin sectioned sample. The third image depicts the graphical results of the dental cementum analysis of season-of-death.

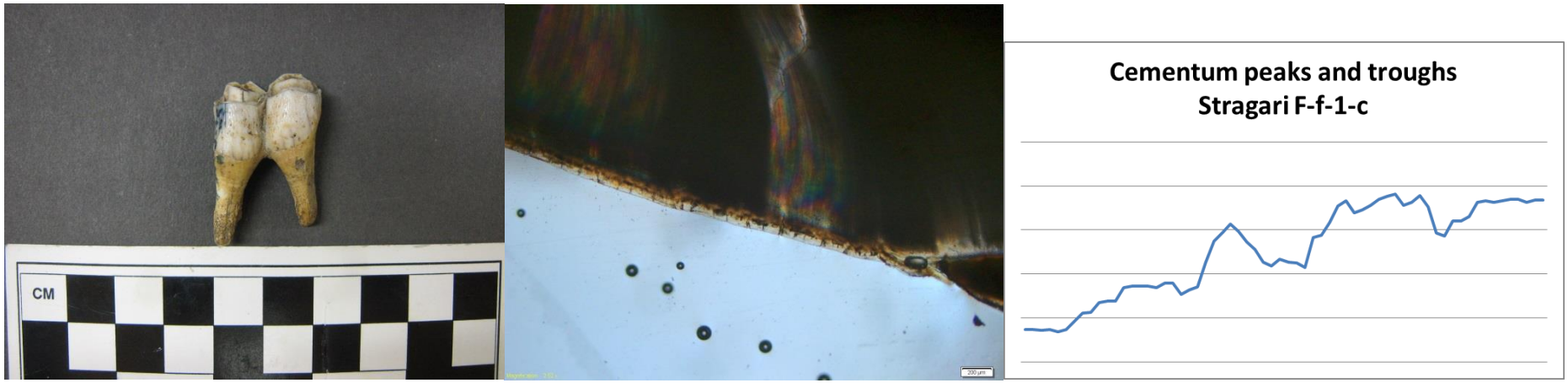


Figure 10: Images depicting the Stragari red deer tooth sample: F-f-1-c. The first image is the original state of the sample. The second image is the thin sectioned sample. The third image depicts the graphical results of the dental cementum analysis of season-of-death.



Figure 11: Images depicting the Stragari roe deer tooth sample: E-f-1. The first image is the original state of the sample. The second image is the thin sectioned sample. The third image depicts the graphical results of the dental cementum analysis of season-of-death.

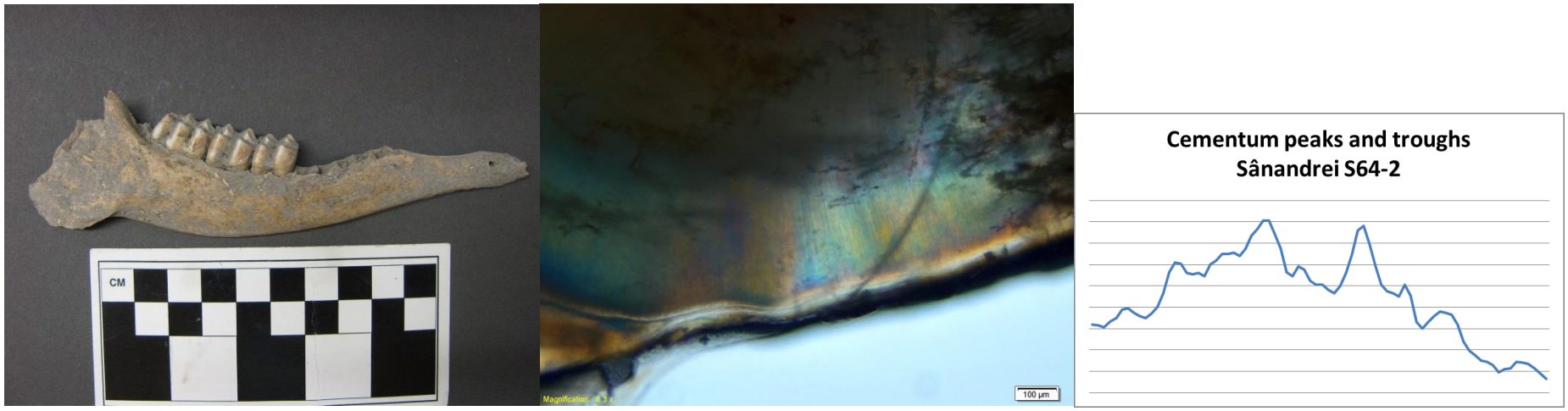


Figure 12: Images depicting the Sânandrei roe deer tooth sample S64-2. The first image is the original state of the sample. The second image is the thin sectioned sample. The third image depicts the graphical results of the dental cementum analysis of season-of-death.

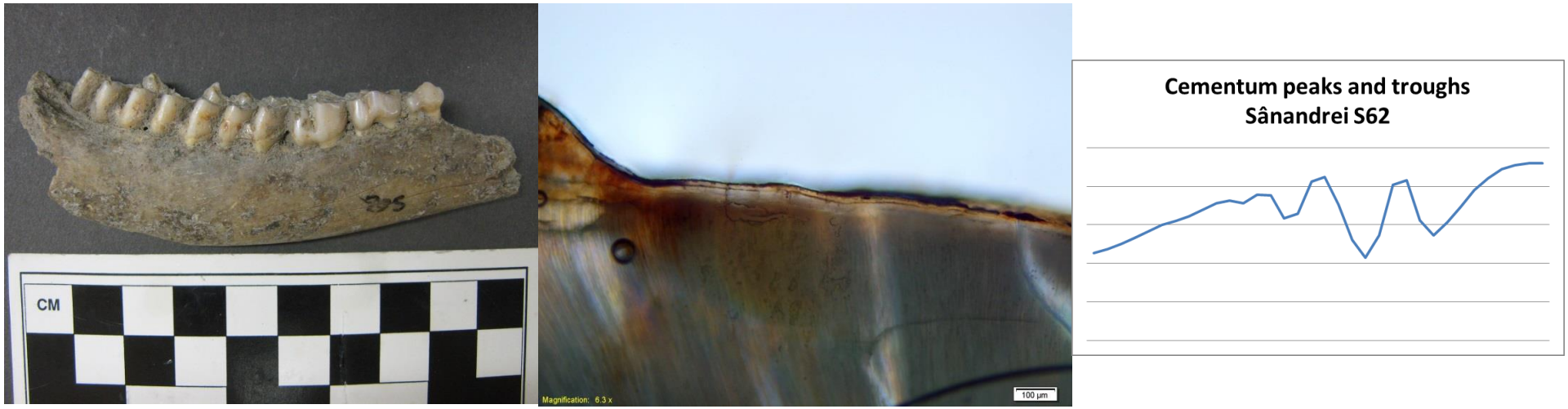


Figure 13: Images depicting the Sânandrei roe deer tooth sample: S62. The first image is the original state of the sample. The second image is the thin sectioned sample. The third image depicts the graphical results of the dental cementum analysis of season-of-death

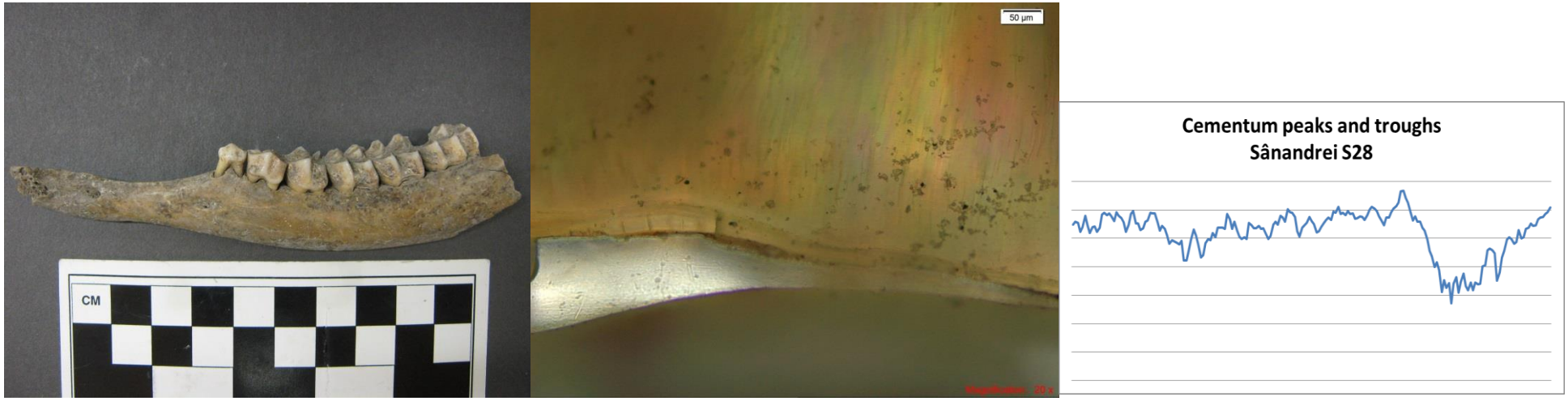


Figure 14: Images depicting the Sânandrei roe deer tooth sample S28. The first image is the original state of the sample. The second image is the thin sectioned sample. The third image depicts the graphical results of the dental cementum analysis of season-of-death.

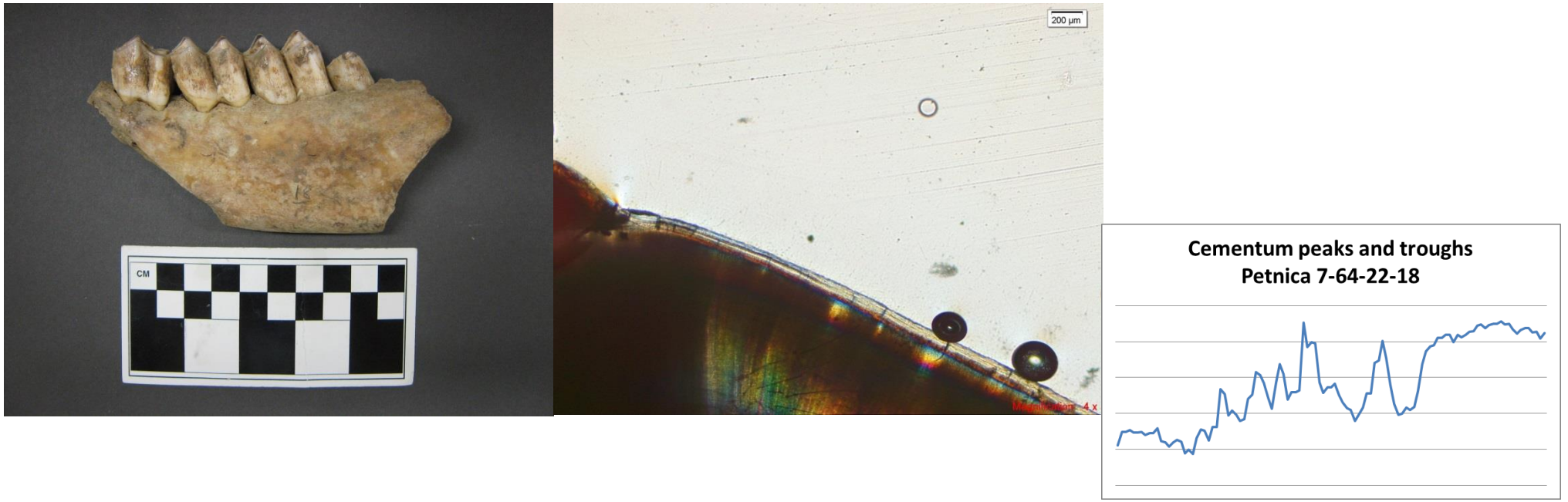
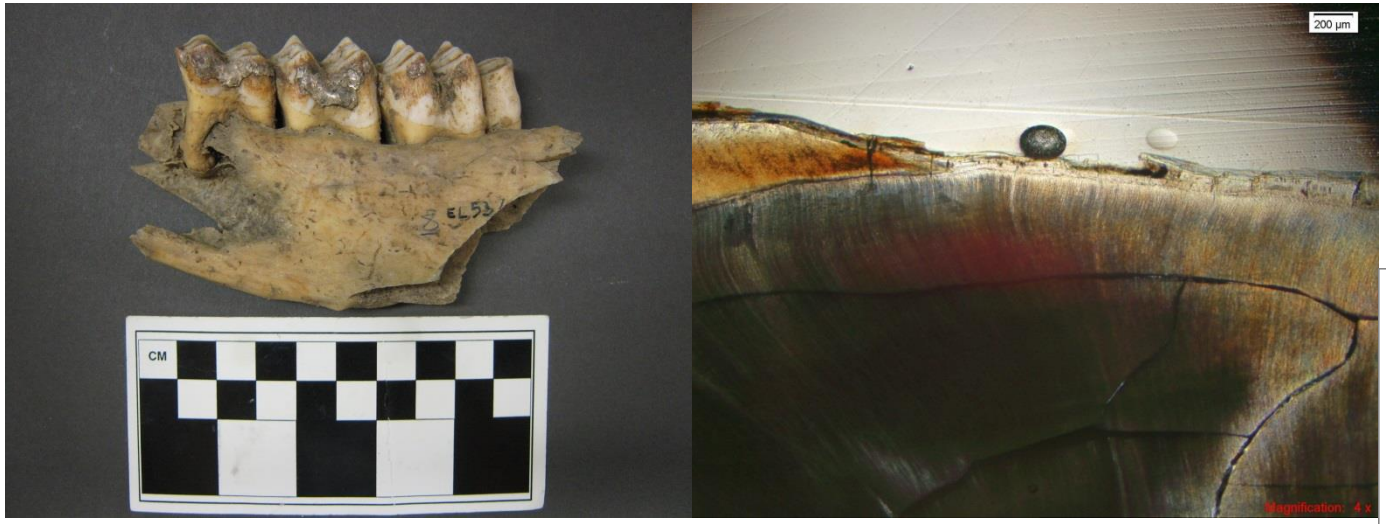


Figure 15: Images depicting the Petnica red deer tooth sample: 7-64-22-18. The first image is the original state of the sample. The second image is the thin sectioned sample. The third image depicts the graphical results of the dental cementum analysis of season-of-death.



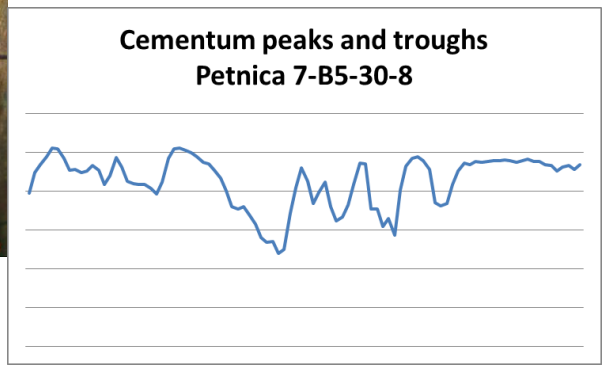


Figure 16: Images depicting the Petnica red deer tooth sample: 7-B5-30-8. The first image is the original state of the sample. The second image is the thin sectioned sample. The third image depicts the graphical results of the dental cementum analysis of season-of-death.

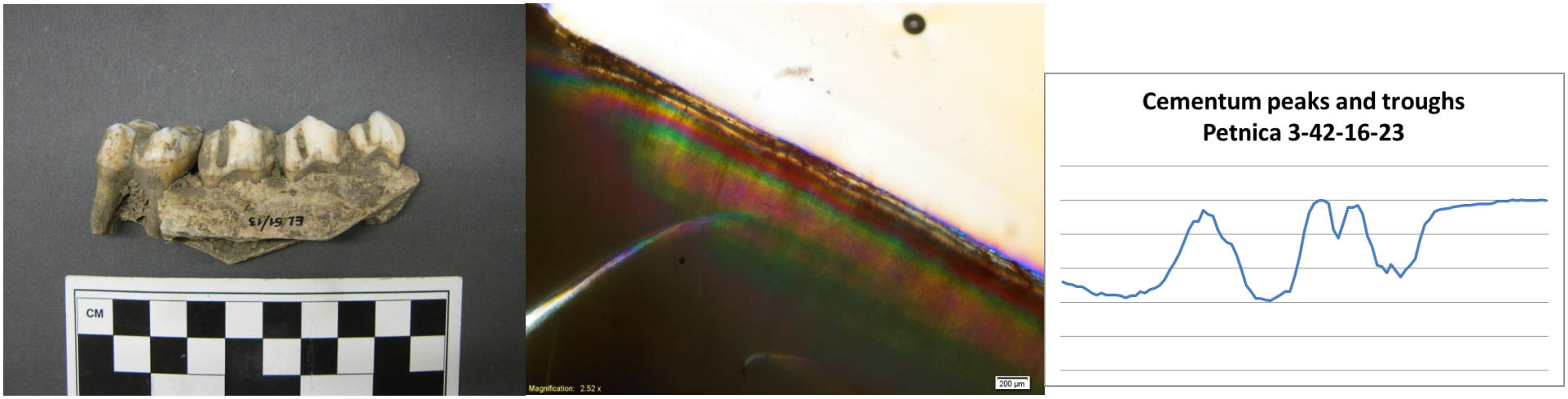


Figure 17: Images depicting the Petnica red deer tooth sample: 3-42-16-23. The first image is the original state of the sample. The second image is the thin sectioned sample. The third image depicts the graphical results of the dental cementum analysis of season-of-death.

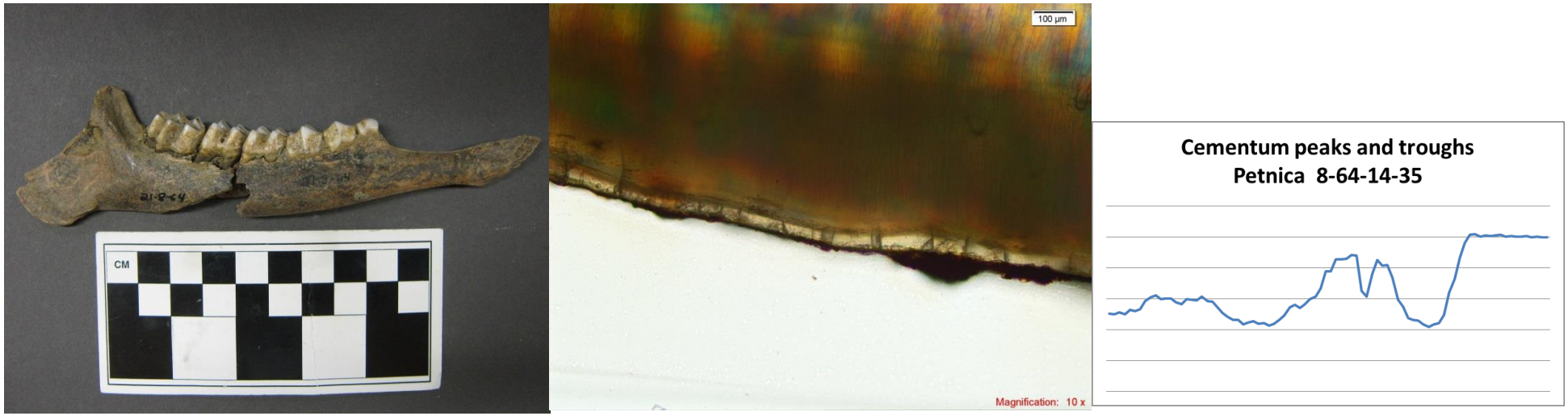
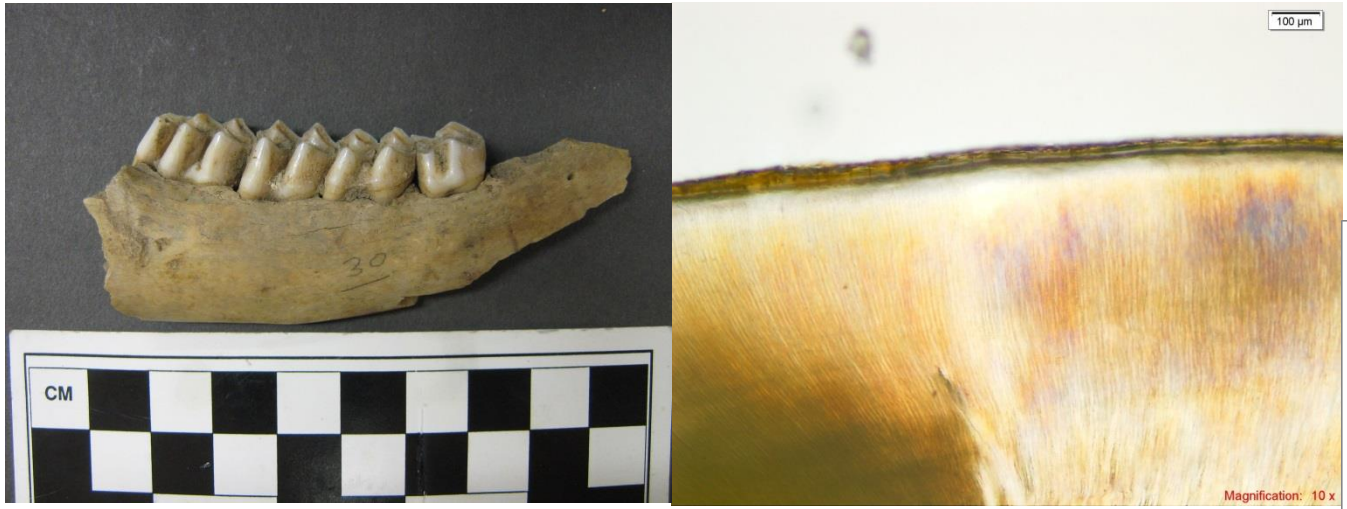


Figure 18: Images depicting the Petnica roe deer tooth sample: 8-64-14-35. The first image is the original state of the sample. The second image is the thin sectioned sample. The third image depicts the graphical results of the dental cementum analysis of season-of-death.



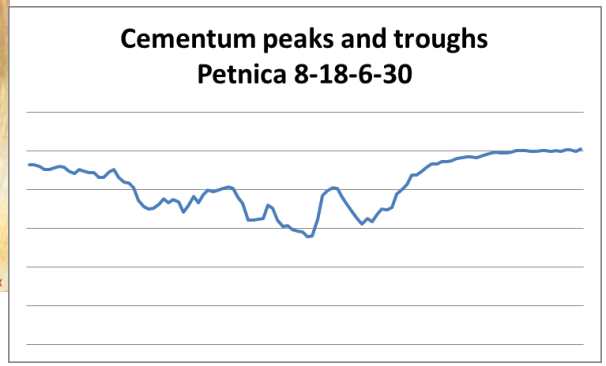


Figure 19: Images depicting the Petnica roe deer tooth sample: 8-16-6-30. The first image is the original state of the sample. The second image is the thin sectioned sample. The third image depicts the graphical results of the dental cementum analysis of season-of-death.

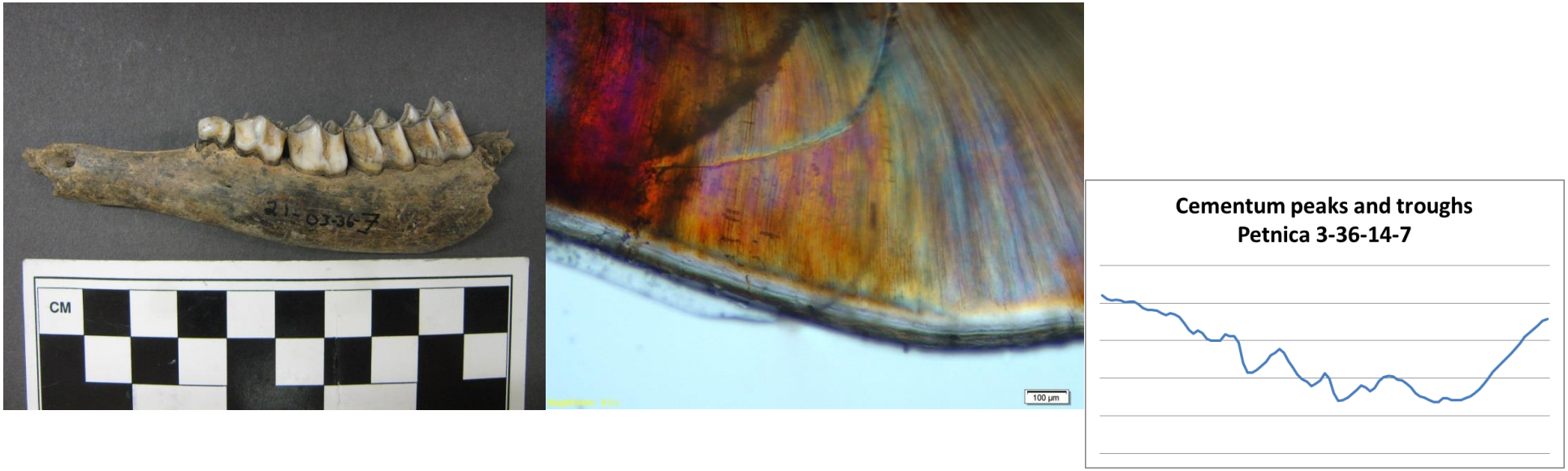


Figure 20: Images depicting the Petnica roe deer tooth sample: 3-36-14-7. The first image is the original state of the sample. The second image is the thin sectioned sample. The third image depicts the graphical results of the dental cementum analysis of season-of-death.



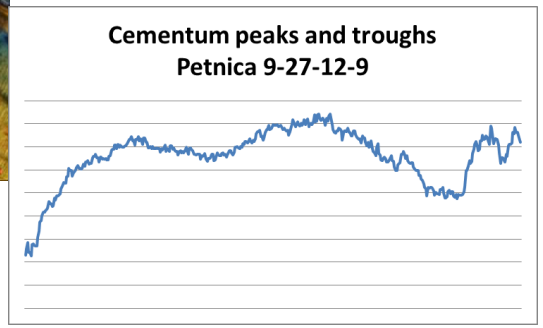


Figure 21: Images depicting the Petnica roe deer tooth sample: 9-27-12-9. The first image is the original state of the sample. The second image is the thin sectioned sample. The third image depicts the graphical results of the dental cementum analysis of season-of-death.

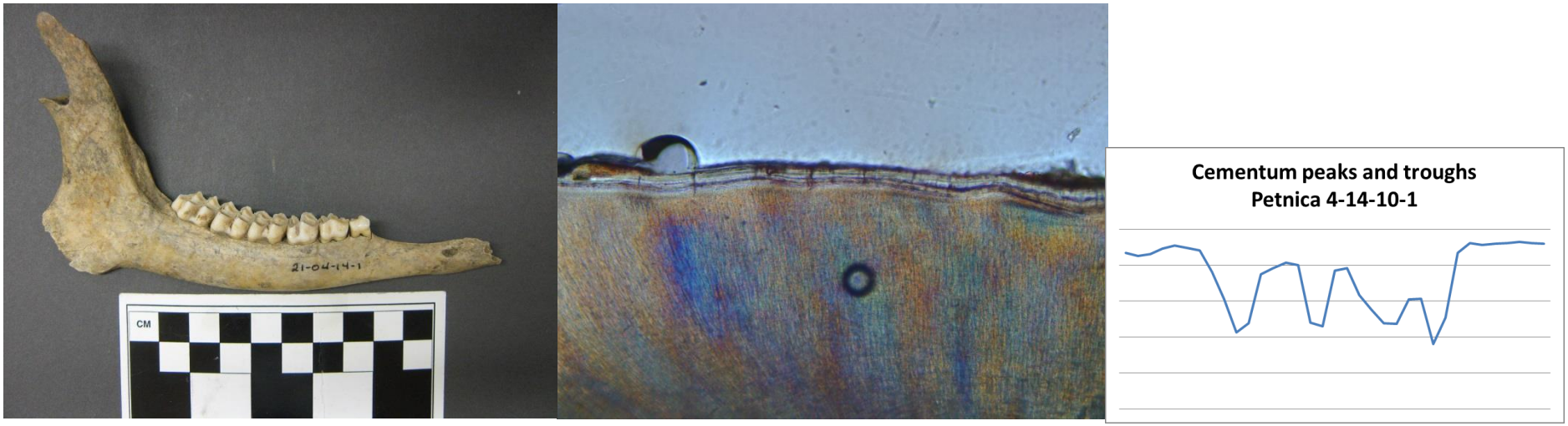


Figure 22: Images depicting the Petnica roe deer sample: 4-14-10-1. The first image is the original state of the sample. The second image is the thin sectioned sample. The third image depicts the graphical results of the dental cementum analysis of season-of-death.

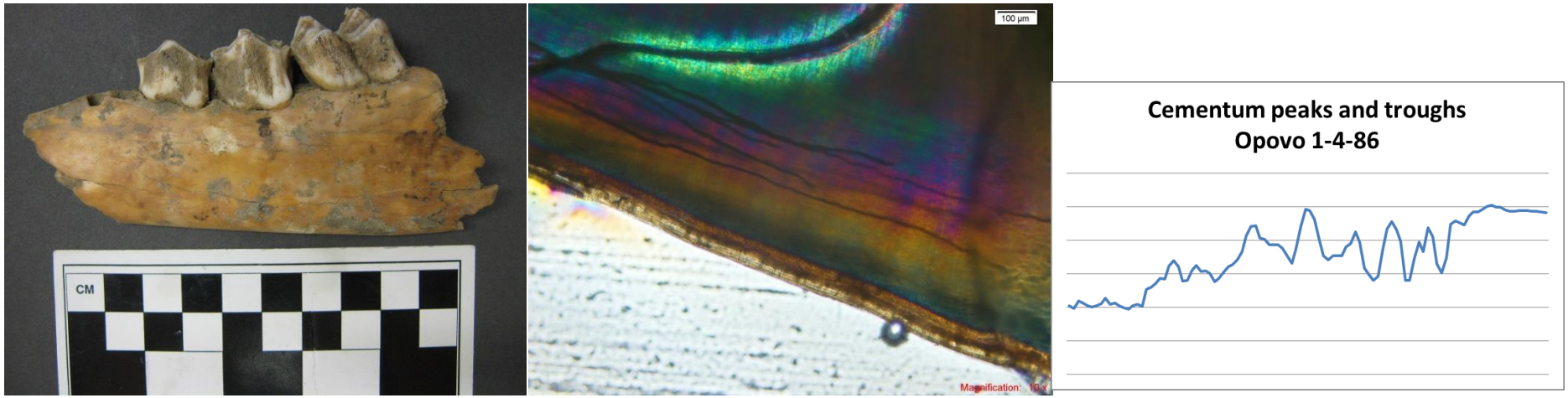


Figure 23: Images depicting the Opovo red deer tooth sample: 1-4-86. The first image is the original state of the sample. The second image is the thin sectioned sample. The third image depicts the graphical results of the dental cementum analysis of season-of-death.

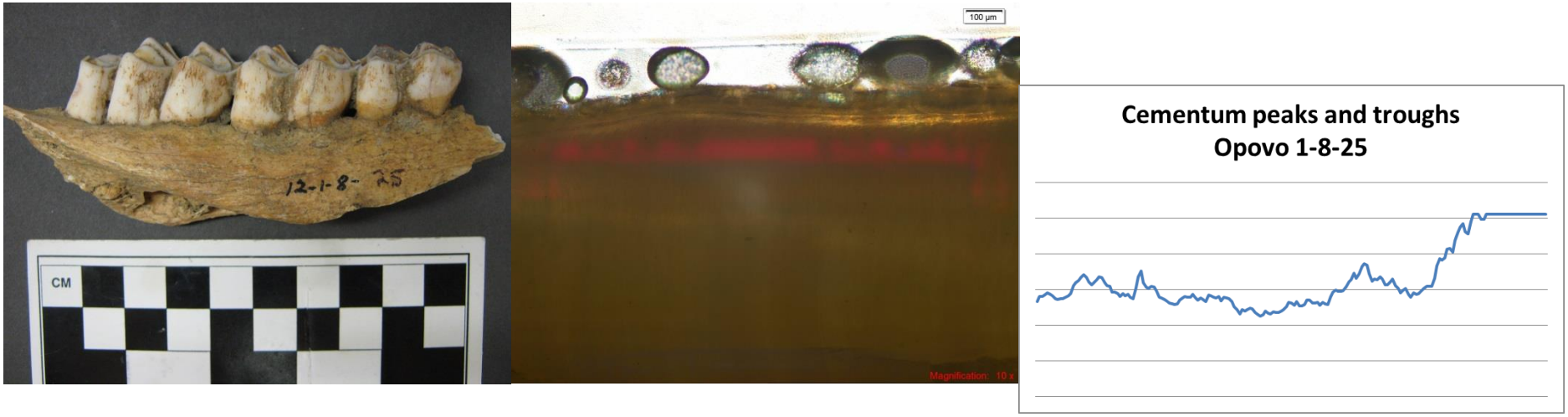


Figure 24: Images depicting the Opovo red deer tooth sample: 1-8-25. The first image is the original state of the sample. The second image is the thin sectioned sample. The third image depicts the graphical results of the dental cementum analysis of season-of-death.



Figure 25: Images depicting the Opovo roe deer tooth Sample: 1-3-10. The first image is the original state of the sample. The second image is the thin sectioned sample. The third image depicts the graphical results of the dental cementum analysis of season-of-death.

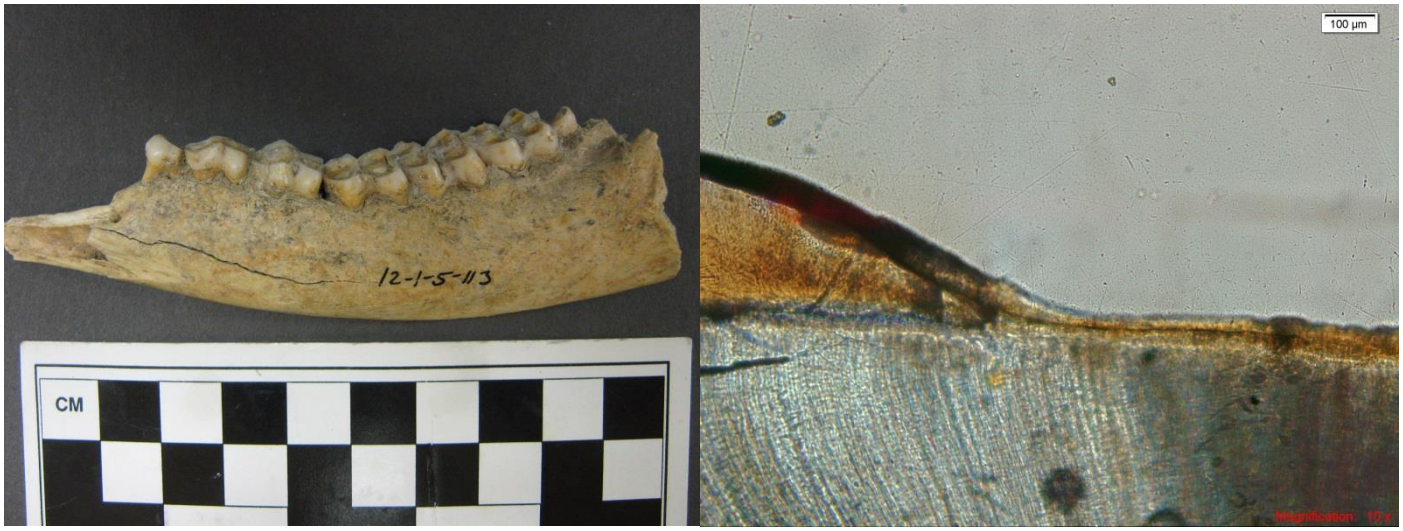


Figure 26: Images depicting the Opovo roe deer tooth sample 1-5-113 (No available line graph, season and age-of-death obtained by eye). The first image is the original state of the sample. The second image is the thin sectioned sample.

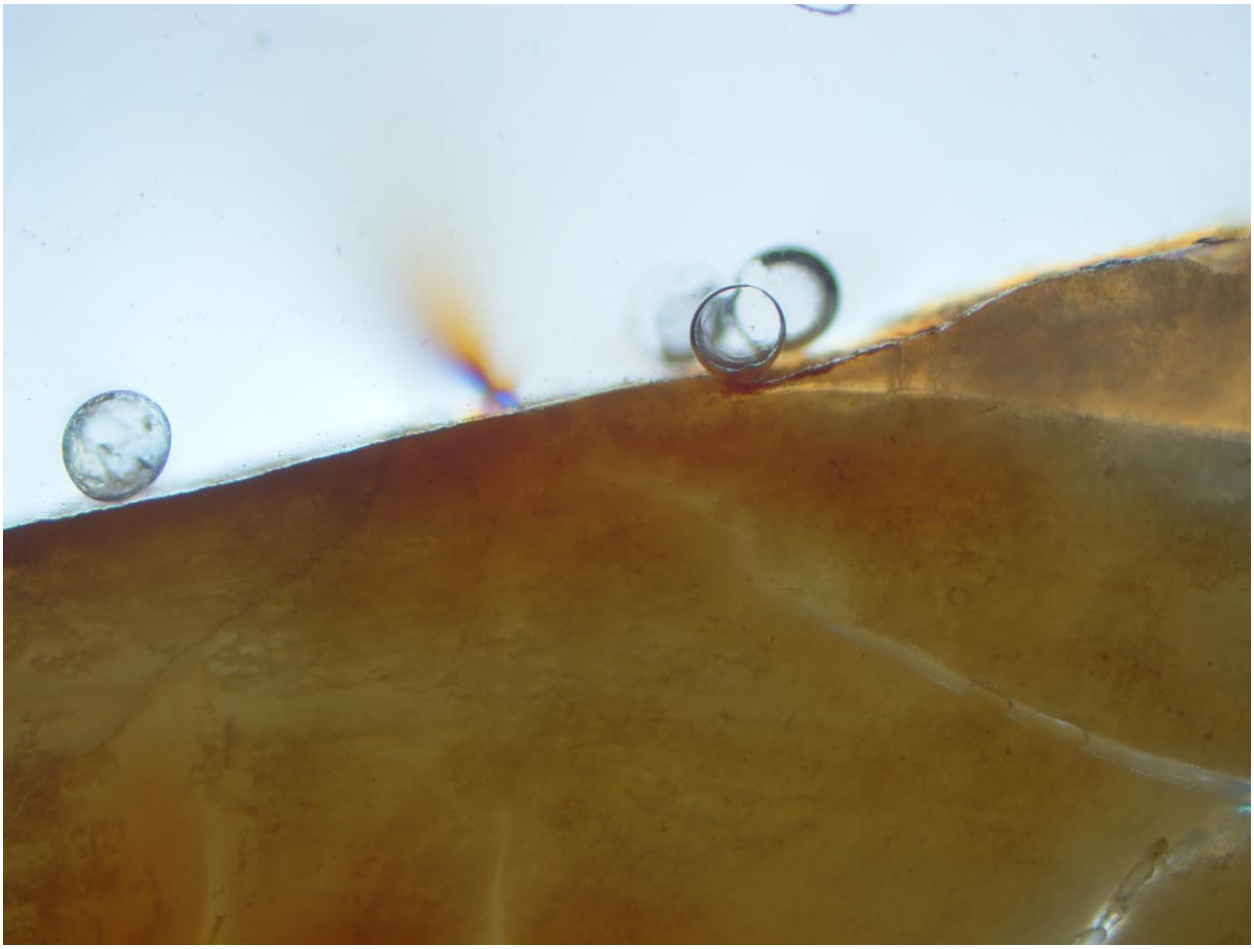


Figure 27: Stragari sample D-a-3-g. This sample is a senile individual showing a lack of dental annuli.

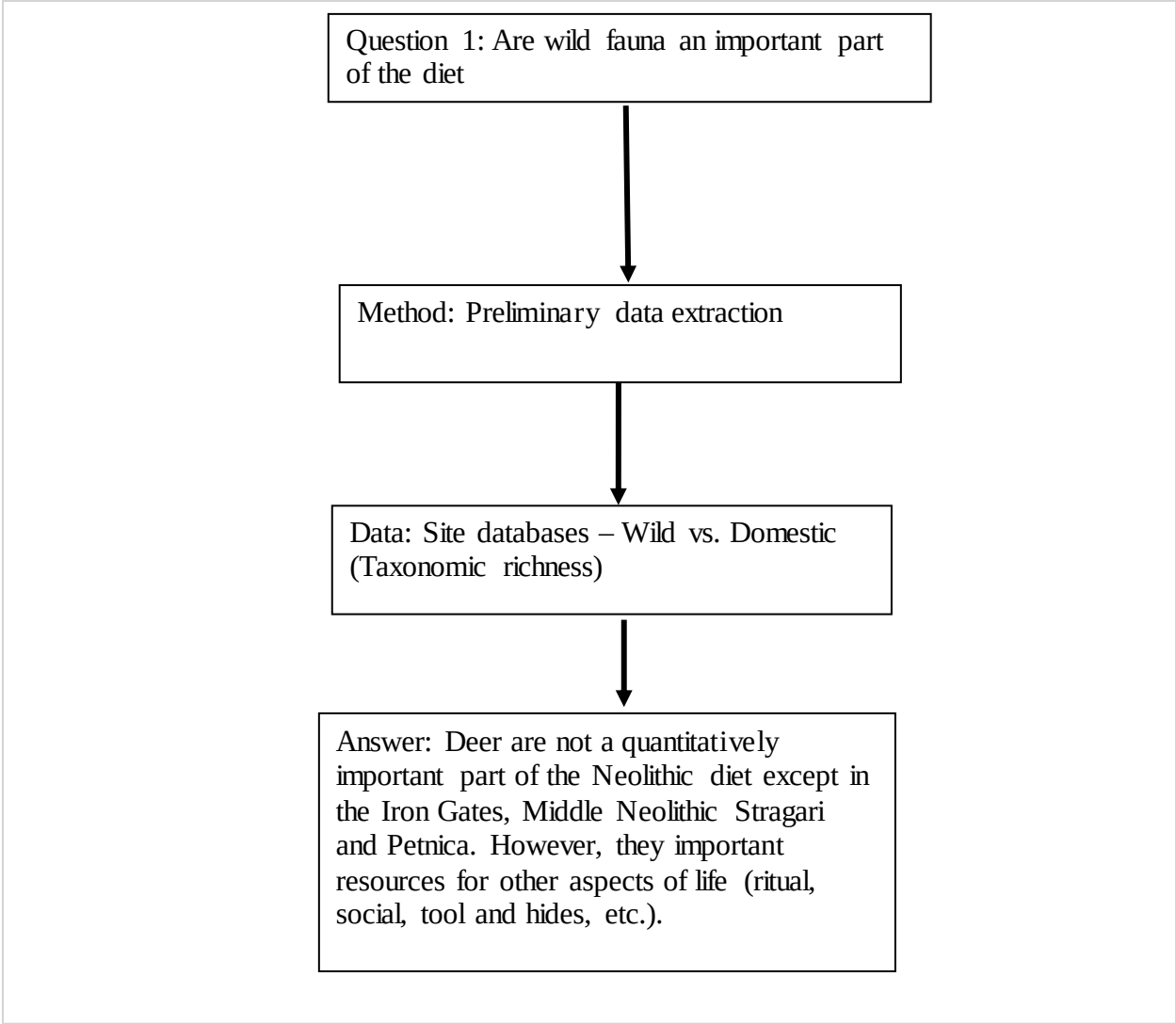


Figure 28: Flow chart for Question 1 in Chapter 8

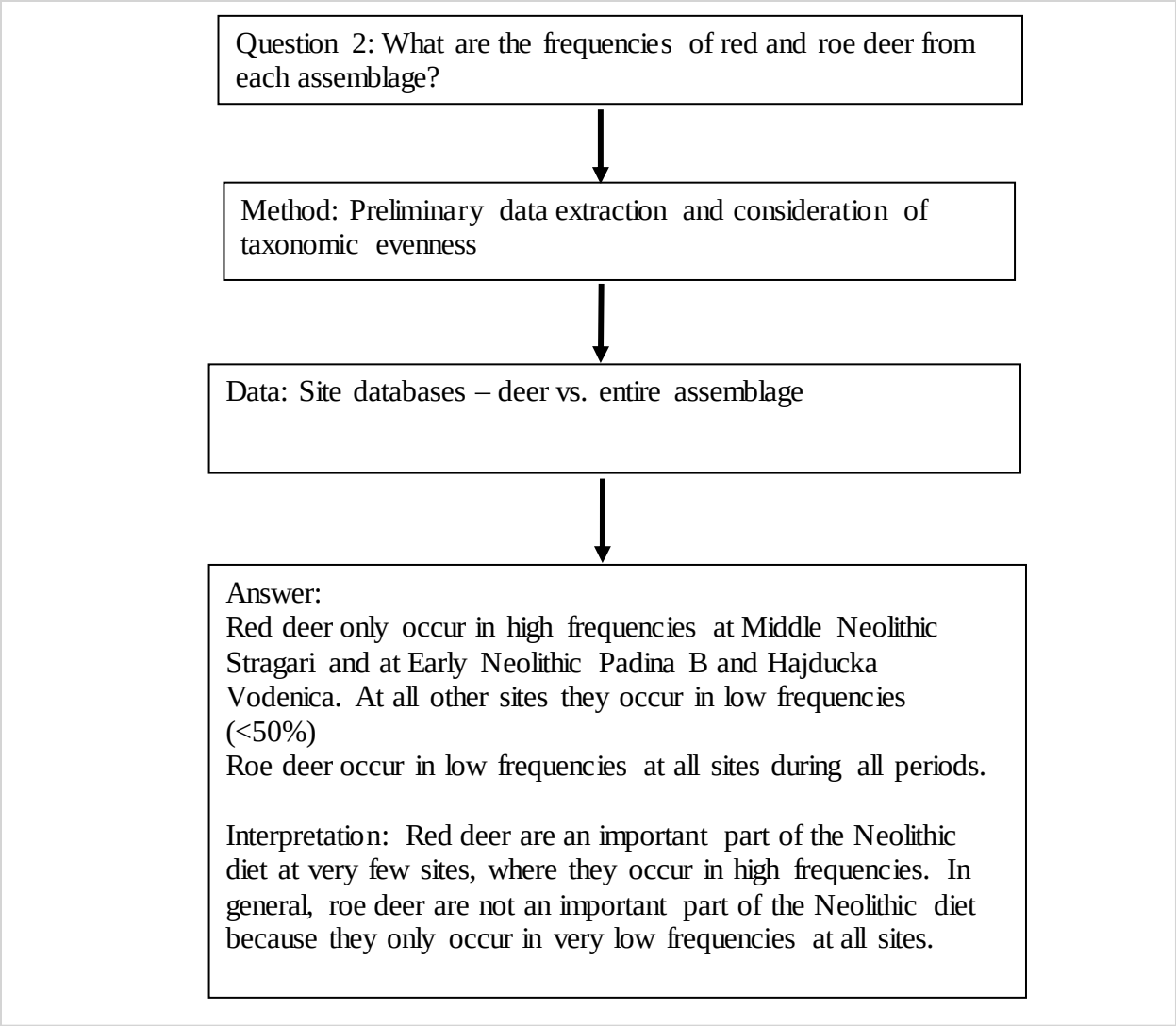


Figure 29: Flow chart for Question 2 in Chapter 8

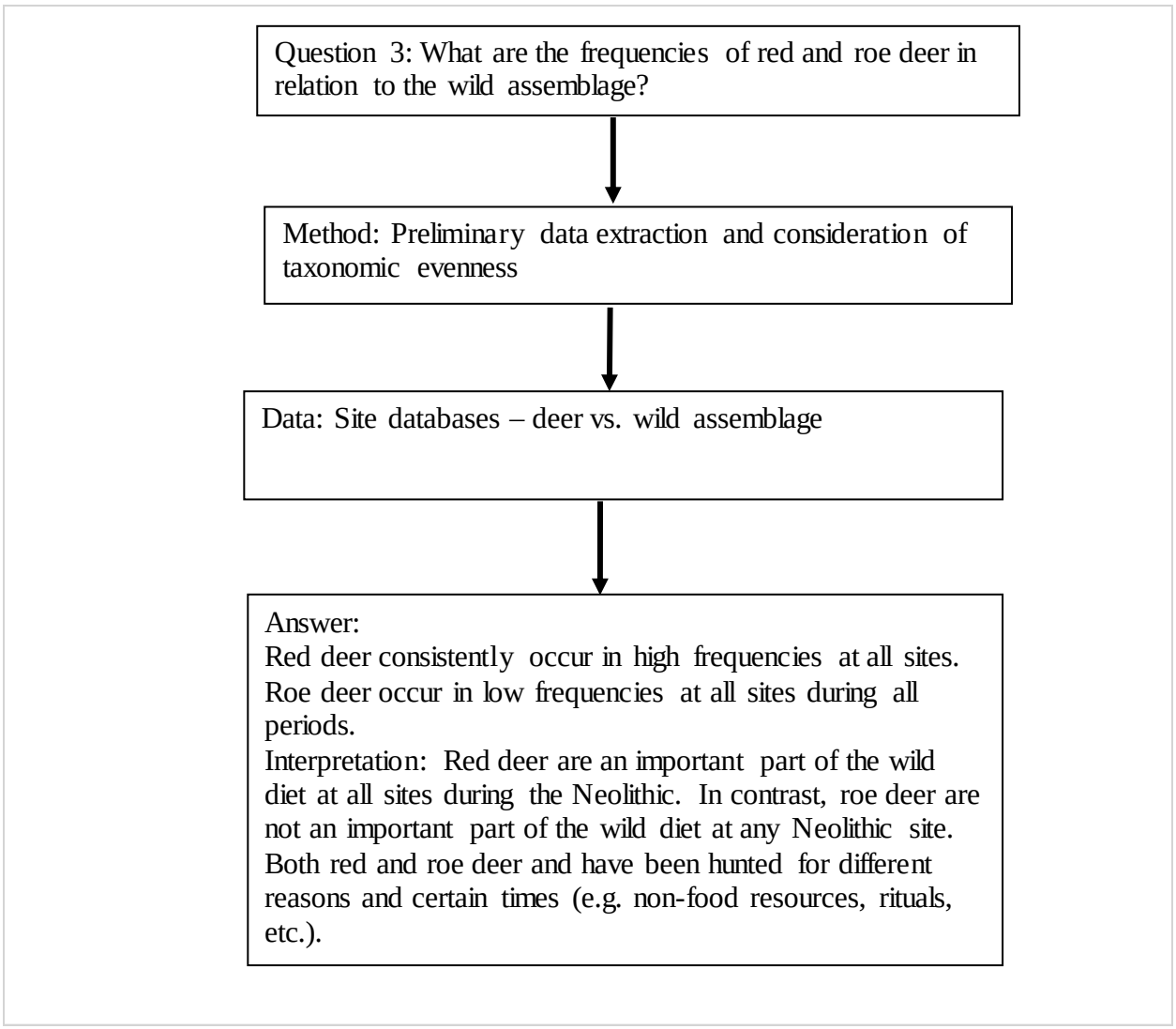


Figure 30: Flow chart for Question 3 in Chapter 8

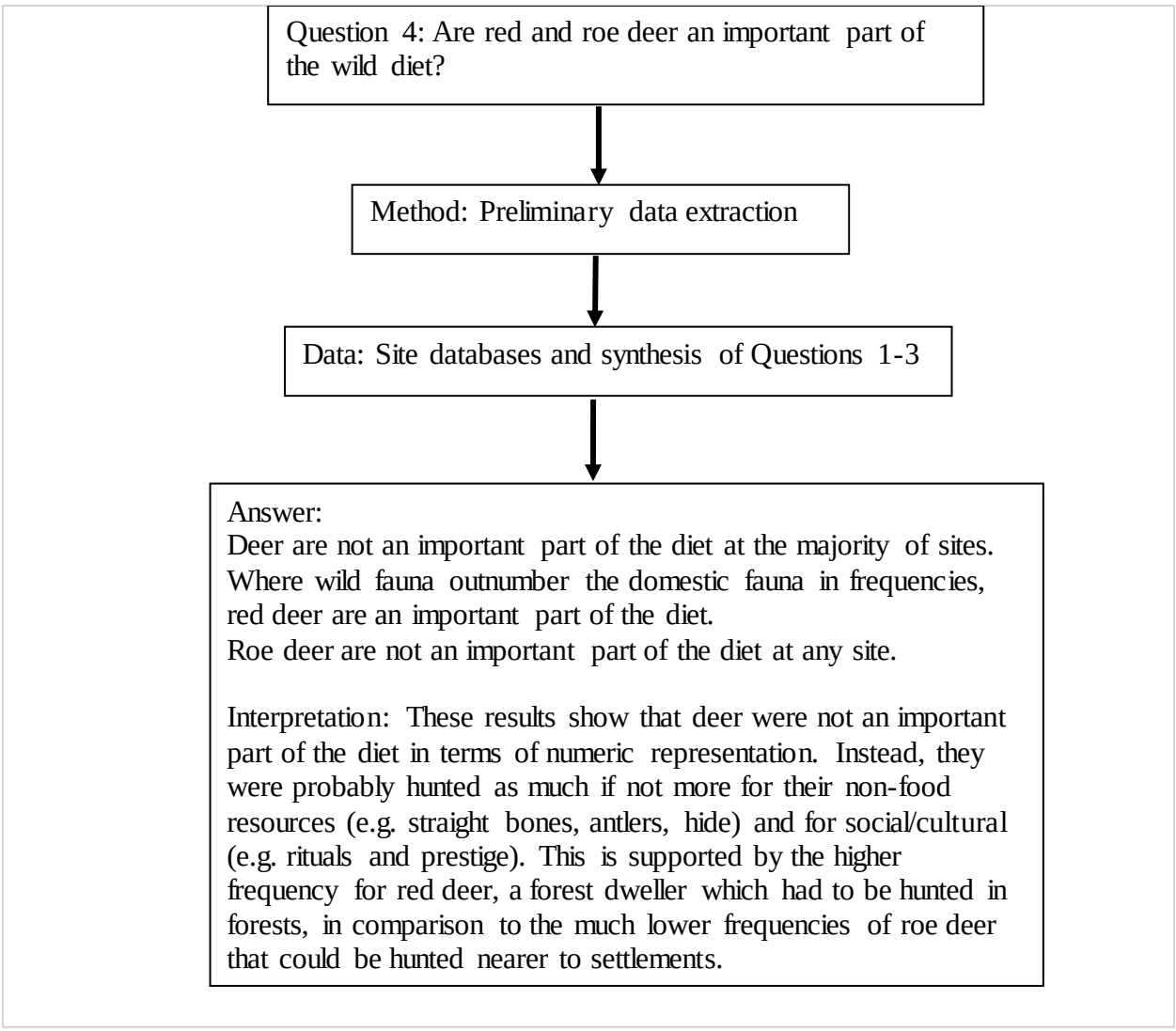


Figure 31: Flow chart for Question 4 in Chapter 8

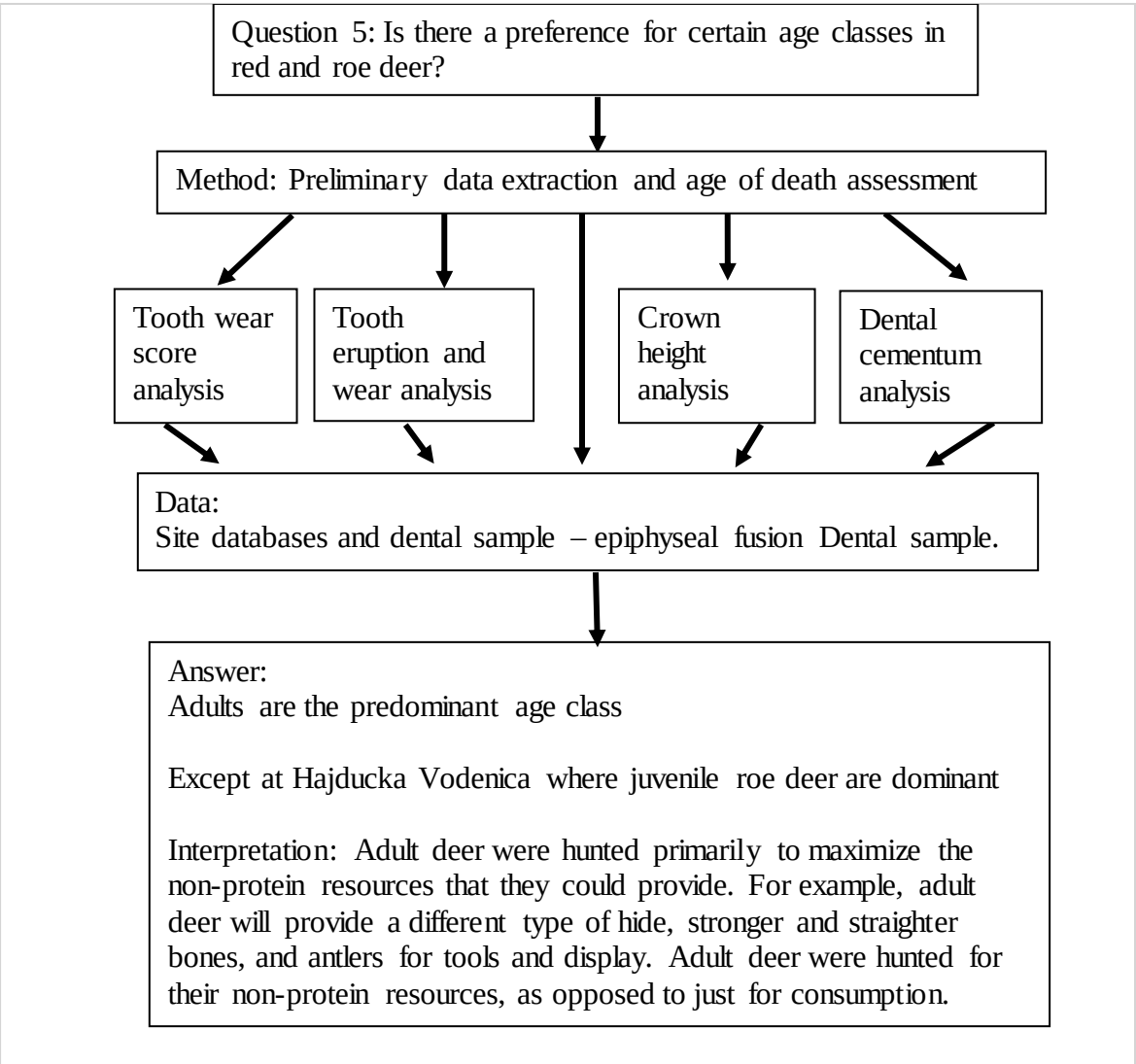


Figure 32: Flow chart for Question 5 in Chapter 8

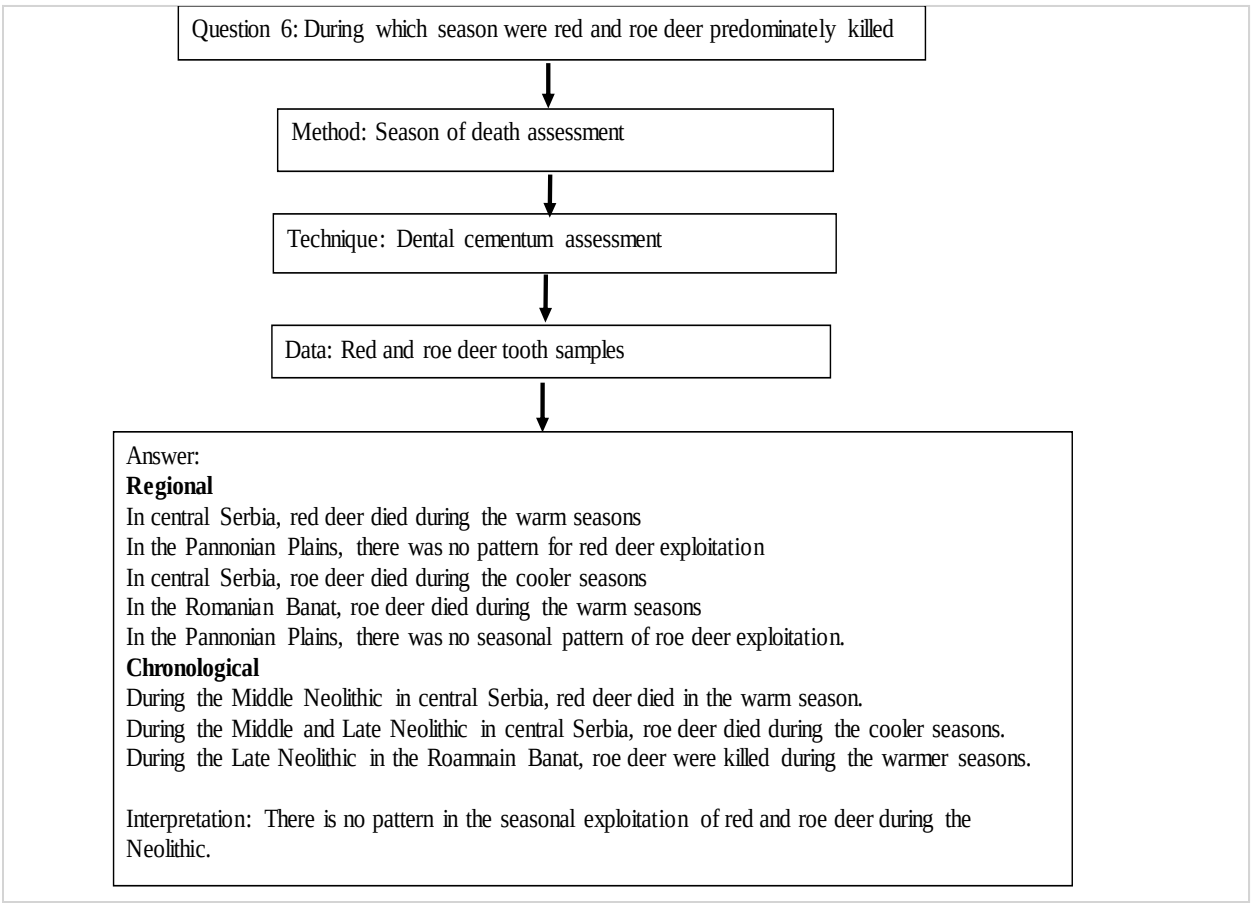


Figure 33: Flow chart for Question 6 in Chapter 8

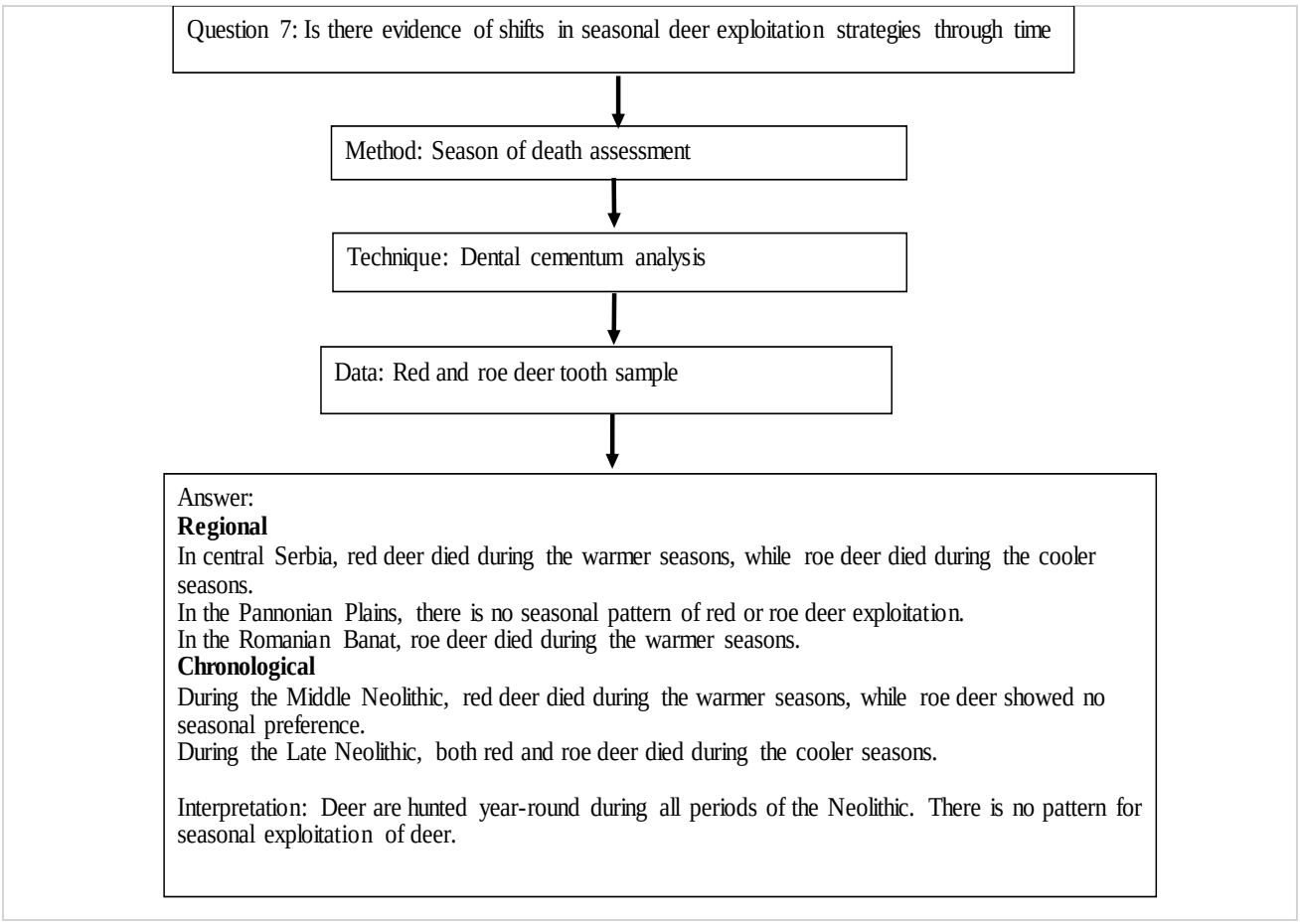


Figure 34 Flow chart for Question 7 in Chapter 8