# THE ORIGINS OF TRANSHUMANT PASTORALISM IN SOUTHEASTERN EUROPE: A ZOOARCHAEOLOGICAL INVESTIGATION

By

Elizabeth R. Arnold

A Thesis
Submitted to the Faculty of Graduate Studies
In Partial Fulfillment of the Requirements for the Degree of

MASTERS OF ARTS

Department of Anthropology
University of Manitoba
Winnipeg, Manitoba

0-612-62686-5

**THE UNIVERSITY OF MANITOBA**

**FACULTY OF GRADUATE STUDIES**
*****
**COPYRIGHT PERMISSION**

# THE ORIGINS OF TRANSHUMANT PASTORALISM IN SOUTHEASTERN EUROPE: A ZOOARCHAEOLOGICAL INVESTIGATION

**BY**

**ELIZABETH R. ARNOLD**

**A Thesis/Practicum submitted to the Faculty of Graduate Studies of The University of Manitoba in partial fulfillment of the requirement of the degree**

**of**

**MASTER OF ARTS**

# ABSTRACT

This thesis addresses the issue of the temporal origins of transhumant pastoralism in temperate southeastern Europe (northern half of the Balkan Peninsula). Several hypotheses have been suggested to explain when and why transhumant pastoralism with domestic animals appeared in this region. Each hypothesis proposes a different point in time when transhumance would appear, ranging from the appearance of the earliest domestic animals (advent of the Early Neolithic), to the appearance of secondary product exploitation (advent of the Post Neolithic), and to the appearance of complex societies (advent of the Roman era).

The hypotheses were tested by examining the tooth remains from three domestic animal taxa (*Ovis/Capra*, *Bos taurus* and *Sus scrofa*) from archaeological sites in the central part of the northern Balkans. Data from eleven sites in the region, and spanning period from the Early Neolithic through to the Early Iron Age, were tabulated.

The primary technique involved the creation of harvest profiles from mandibular tooth wear and eruption data of domestic animals to provide both age and season of death information for each taxon. This was supplemented by the secondary technique of cementum analysis of modern and archaeological mandibular *Ovis aries* and *Capra hircus* teeth to provide supplementary seasonality estimates. The specific hypothesis used in this investigation was that transhumant pastoralism would appear at the temporal point where complementary culling patterns between highland and lowland sites in the region appear. Based on other sources of data, such a pattern was expected to appear at the advent of the Post Neolithic.

It was not possible to provide any strong support for any of the above hypotheses. Conclusions based on both sources of data were limited by small sample size. However, the data did lend itself to provide further support for the Secondary Products Revolution model, which is hypothesized to occur at the advent of the Post Neolithic in the region.

## Acknowledgements

I would like to thank my advisor, Dr. Haskel Greenfield for his encouragement and support. I cannot begin to thank him for first introducing me to archaeology and providing me with so many opportunities to expand my interests and abilities in the discipline. I would also like to thank my other committee members, Dr. Chris Meiklejohn and Dr. Karin Wittenberg, for your involvement, patience and advice.

Special thanks to Clayton Robins (Manitoba Sheep Association) and Sharon Peddler (Manitoba Goat Association) for providing contacts and direction; to Monica Griffiths, for supplying all the goats as well as valued information, and for continued interest; to Lee Perreault and the staff at Prairie Abattoir and Jim and Doris Holmes and staff from Carmen Meats; and Randy and Solange Eros for having the interest and taking the time to provide several more sheep.

I would also like to thank Val McKinley and Dr. Ariane Burke for my training and their assistance in the University of Manitoba's thin sectioning laboratory. Val's support went far beyond simple technical advice. Thanks also must go to Beth Espey and Ian Streeter for putting up with all the questions and providing much needed advice. Special thanks must be given to Dr. Burke for giving me that extra push, without which I might not have finished this thesis so quickly.

Thanks must go to my fellow graduate students for the encouragement and friendship, as well as thanks to my friends outside the department, who were always there. I must also thank Dennis Murphy (Statistical Assistance Center, University of Manitoba) for his amazing last minute help with my statistical issues.

Many thanks must be extended to my families (both Braekevelt and Arnold) for their constant support. None of this could have been accomplished without them. Finally, I must thank my husband Scott, who put up with it all.

# Table of Contents

**Chapter 7. Data Description – Tooth Wear and Eruption**



**Chapter 8. Data Description – Cementum Analysis**



**Chapter 9. Data Analysis – Archaeological Tooth Wear and Eruption**

**List of Figures**

**List of Tables**

# Chapter 1:

# Introduction

***Theoretical background to research problem***

Transhumant pastoralism is an economic activity involving the seasonal movement of domestic herds between altitudinally differentiated and complementary pastures (Geddes 1983). It is still an important form of land use in many parts of the world, in particular in mountainous regions e.g. Africa (Evans-Pritchard 1940), Europe (southern Europe – Bartosiewicz and Greenfield 1999; Norway - Paine 1994), South America (Argentina - Glatzer 1982; the Andes - Lynch 1971, 1980, 1983), Near East (Iran - Barth 1961), and Asia (Pakistan - Ehlers and Kreutzmann 2000; and Tibet - Ekvall 1968). With a stronger understanding of its origins, we can better understand its development and effects on the shaping of a culture's social organization (Bartosiewicz and Greenfield 1999).

Historically, it has been a significant part of the economy in southern Europe, including the Mediterranean and the Balkans. Archaeologically, many researchers (Halstead 1981, Geddes 1983, Greenfield 1986) agree that it was also an important element of the economy in prehistoric times (Sherratt 1981, 1983; Harding 2000: 138). However, the exact temporal origins of transhumant pastoralism in Europe are still debated within the archaeological literature.

While the proposals of the various scholars appear to be greatly at odds, this is not really the case. They are essentially arguing differing explanations for different times and places. Geographically, Geddes (1982) and Halstead (1990) argue for the appearance of transhumant pastoralism in an essentially Mediterranean European environment (southern

France and Greece, respectively). Within a Mediterranean environment, the benefits of pursuing such practices, escaping summer heat and the provision of adequate water and pasture, are obvious (Greenfield 1999a: 15). In contrast, Greenfield (1986, 1988, 1991, 1999a) discusses its origins in a temperate European environment (northern Balkans). Within the temperate environment, the benefits of transhumant pastoralism are less obvious as there are few ecological incentives to the movement of herds to highland areas. The temperature extremes found in the Mediterranean environment do not exist in temperate lowland areas and a variety of micro-environments exist in the northern Balkans which provide sufficient water and graze in the lowland areas year round (Greenfield 1999a). All the researchers agree that transhumant pastoralism was an important part of the pre-modern economy of these regions.

It is the temporal origins of transhumant pastoralism that sparks the most debate within the archaeological literature. Geddes (1983) proposes that transhumant pastoralism appears at the Mesolithic-Neolithic junction. He argues that it is likely that prehistoric hunters and gatherers and early subsistence farmers would have easily incorporated domestic migratory stock into their seasonal exploitation of land and resources. Greenfield (1986, 1988, 1991, 1999a) hypothesizes that transhumant pastoralism, as an economic activity, becomes a major element of the changes in subsistence strategies in temperate southeastern Europe at the beginning of the Post Neolithic (Chalcolithic/Eneolithic and Bronze Age). The end of the Neolithic period in Southeastern Europe (ca. 3300 BC) was a time of significant cultural change. Greenfield proposes that the appearance of transhumant pastoralism was part of the shifts in settlement patterns, mortuary practices, architectural and artifactual remains, and economy (including the appearance of secondary animal products - Sherratt 1981, 1983) that occur at this time. There was also significant change in land use, such as the colonization of agriculturally marginal highlands in the northern, climatically temperate region of the Balkans. This model, which attempts to explain this relatively late colonization of the highlands and the accompanying changes, proposes pastoral transhumance as an essential element.

Both Geddes and Greenfield propose that the adoption of transhumant pastoralism is simply a change in local adaptation. In contrast, Halstead (1981, 1990) suggests that transhumant pastoralism only appears with the Late Bronze Age and Classical complex societies in the Mediterranean and is associated with large-scale economic specialization of transhumance (Harding 2000: 138). Halstead maintains that extensive use of upland pastures in a transhumant manner would not have occurred on a large scale until the development of extensive agriculture. He explicitly links this type of economic strategy with the use of secondary products (1981: 334). Several researchers, notably Lees and Bates (1974) and Cribb (1990) also argue in support of a later date for specialized pastoralism, suggesting that large scale mobility of people and their domestic herds had to occur at a time when specialization in either a pastoral or agricultural production had became a possibility.

However, once again, it appears that the various models are not really discussing the same situation. In fact, it may seem as if they are investigating "apples and oranges". Greenfield and Geddes are focusing upon the evolution of transhumant pastoralism as part of a diversified subsistence strategy, while Halstead, Lees and Bates, and Cribb are concerned with the evolution of specialized transhumant pastoralism as part of complex societies. It would almost seem as if Halstead is arguing that transhumance would not be visible in Greece until it became a specialized economic adaptation.

From the above summary, it should be clear that the presence or absence of transhumant pastoralism in prehistoric periods has not been firmly established (Greenfield 1999a: 16). This investigation seeks to delimit the origins of transhumant pastoralism, specifically within the temperate regions of southeastern Europe (otherwise known as the northern Balkans).

### *Methodology*

Two techniques within zooarchaeology will be utilized in this investigation. Harvest profiles will be created from the analysis of the tooth wear and eruption data from the mandibles of domestic animals specifically, sheep (*Ovis aries*), goat (*Capra hircus*), cow (*Bos taurus*) and pig (*Sus scrofa dom.*). This technique will provide both age and season of death information for each species. This will be supplemented by the secondary technique of cementum analysis in mandibular *Ovis/Capra* teeth to provide supplementary seasonality estimates.

### *Data*

There are two sources of data in this thesis – ancient and modern. The ancient data derive from ten archaeological sites in the central Balkans (and one from the southern Balkans). These data derive from the computerized faunal database compiled for the region by Haskel Greenfield (1977-1994). The modern comparative data consists *Ovis aries* and *Capra hircus* teeth collected from modern livestock breeders in Manitoba.

***Research goals and hypotheses***

In order to fill the lacunae in our knowledge concerning the emergence of transhumant pastoralism, this investigation seeks to test the above hypotheses by re-examining the evidence from one region – the central Balkans in southeastern Europe. This region was chosen for two reasons:

1. Data are available at the University of Manitoba based on previous research by Haskel Greenfield.
2. The data are appropriate for examining the theory that transhumant pastoralism may have arisen as part of a diversified economic strategy prior to the advent of productive specialization in the region.

Data from the beginning of the Neolithic through the Early Iron Age of the central Balkans will be evaluated. While the research will not be able to confidently evaluate the origins of transhumant pastoralism in the Mediterranean, it will be able to identify the origins of transhumant pastoralism in the temperate environment of southeastern Europe.

The specific hypotheses to test in this research are to determine whether transhumant pastoralism appears in the beginning of the Neolithic, Post Neolithic or later periods in the region.

*Major research questions*

When does the origins of transhumant pastoralism occur in a temperate environment of central Europe? Do the origins occur at the beginning of the Post Neolithic as proposed by Greenfield (1986, 1988, 1991, 1999a)?

*Minor research questions*

Can transhumant pastoralism be identified from faunal remains? Transhumant pastoralism implies that there is a complementary pattern in season of death of these animals between highland and lowland sites. As a result, animal remains should be particularly relevant to answering the question.

*Major hypothesis*

If transhumant pastoralism was present in southeastern Europe during the Post Neolithic, then a complementary culling pattern will be seen in settlements from this period between highland and lowland sites. The null hypothesis is, therefore, if transhumant pastoralism was not practiced, there will be a random culling pattern between highland and lowland sites.

The transhumant movement of domestic stock is predictable. The herd will move into highland pastures in the early spring, soon after lambing/calving occurs and returns to the lowlands during the autumn. Within a subsistence economy, the age groups that are slaughtered in the highlands and the lowlands will be different.

> Excess very immature (infants and juveniles 0-8 months) individuals would be culled from the herds while they are in the highland pastures. Once the herds have returned to the lowlands, the youngest cohort is at least 8 months old and would represent the selective core of the herd's reproductive potential. In the lowlands, it would be the excess sub-adults and adults who would be selected for differential slaughter, since there are no juveniles or infants present. Excess sub-adults and adults would be brought to the settlement for slaughter in increasing numbers as stored agricultural surpluses and wild food dwindle during the winter. As a result, the age structure within the harvest profiles from highland and lowland settlements should be complimentary (Greenfield 1999a: 19).

This hypothesis may be supported if it can be demonstrated that herds were largely absent from the region for part of the year. Conversely, the null hypothesis can be accepted if it is shown that herds were resident year-round in the highlands.

### *Minor hypotheses*

If transhumant pastoralism was present in southeastern Europe during the Post Neolithic, then tooth eruption and wear evidence from archaeological teeth of the youngest age classes from this period will show complementary age groups slaughtered between highland and lowland sites. Those ages that are slaughtered in highland sites will be missing from the lowland sites and vice versa. The null hypothesis is therefore, if transhumant pastoralism was not practiced, all age groups will be present at both site locations.

If transhumant pastoralism was present in temperate southeastern Europe during the Post Neolithic, then the season of death information will show complementary season of occupation of highland and lowland sites. The null hypothesis is that if transhumant pastoralism was not practiced, then the data will not show a complementary pattern of seasonal culling between highland and lowland sites.

## *Conclusion and significance*

Transhumant pastoralism is hypothesized to be an economic activity that is a major element of the subsistence strategies of cultures in southeastern Europe in the Post Neolithic. Its adoption is proposed as the essential ingredient for significant shifts in economic organization, settlement patterns, social and political organization during this time (Greenfield 1988, 1999a).

The proposed results of this research should reveal the temporal origins of transhumant pastoralism in a temperate environment in the Balkans. This will have a significant impact on the models of explanation for cultural development. It is not until the origins of transhumance are established in the Post Neolithic, that its role in the evolution of complex systems of land use in temperate climate zones of southeastern Europe be put forward and understood. The need to accurately establish its origins seems obvious.

The proposed results of this research promises to have several additionally important implications. If this methodology proves successful, it should end the debate as to whether pastoralism can be revealed through archaeological remains. Greenfield (1986, 1991, 1998) has argued that transhumant pastoralism can be revealed through the examination of the faunal remains of the domestic animals that are the focus of this economic practice. In contrast, others, notably Fleming (1971), argue that it would be difficult, if not impossible to prove the existence of pastoralism completely on archaeological evidence.

Additionally, both the utilized techniques, tooth wear and eruption and cementum analysis, have been critically evaluated for their utility in age and season of death determination within the archaeological literature. Tooth wear and eruption can be subject to error due to variations in diet, nutrition and health of the animals (Monks 1981: 189). These same problems may be relevant to cementum analysis, as the same factors may affect the deposition of cementum (Lieberman 1993b). Cementum analysis has also been criticized as being too subjective (A. Stutz, pers. comm., 2000). It is hoped that through the utilization of these techniques in conjunction with each other, some of the difficulties that limit their use may be overcome.

Finally, this methodology may be extrapolated to further understanding of other cultures with a pastoral basis. This investigation utilizes common zooarchaeological techniques through which transhumance can be revealed. As a result, its methodology can be applied to other areas of the world, to cultures that have a pastoral element. As the economic basis serves to structure other aspects of a culture, this methodology provides a starting point for the investigation of any pastoral society. Understanding the origins of transhumance patterns in an area will have significant implications to the understanding of behavioral and social patterns of the culture.

***Chapter summary***

Chapter 2 provides a definition and discussion of transhumant pastoralism and relevant environmental and ecological parameters.

Chapter 3 examines previous research on the origins of transhumant pastoralism in Europe focusing on both the Mediterranean and the northern temperate region of the Balkans. The research of Geddes, Halstead and Greenfield are the focus.

Chapter 4 introduces the characteristics of the regional environment including topography, climate and vegetation in order to consider the viability of transhumant pastoralism within the northern Balkans.

Chapter 5 summarizes the culture history of southeastern Europe from the Neolithic through the Early Iron Age. Aspects of settlement, technology, mortuary, fauna, flora and evidence of sedentism and mobility are examined.

Chapter 6 describes the methodology to be utilized in the thesis and details the two chosen techniques, tooth wear and eruption and cementum analysis.

Chapters 7 and 8 describe the data examined in this investigation. In chapter 7, each site is described, including site location, environment and nature of deposits. The mandibular and loose teeth remains are quantified by species and by major period. Chapter 8 describes the thin sectioning data, both the modern comparative collection and the archaeological sample.

Chapters 9 and 10 present the results of the data analysis. Chapter 9 focuses on the tooth wear and eruption data, examining both production strategies and implications for the transhumant movement of herds. Chapter 10 focuses on the thin sectioning results.

Chapter 11 presents the final conclusions regarding the data and discusses their implications in terms of the origins of transhumant pastoralism in the northern Balkans.

# CHAPTER 2:

# Transhumant Pastoralism

## Introduction to pastoralism

Since the focus of this investigation is the presence or absence of transhumant pastoralism in prehistoric periods in Europe, specifically within a temperate environment, it is first necessary to define both pastoralism generally, and transhumant pastoralism specifically. Unfortunately, this is not an easy task, as there is currently no agreement in the definition of the various forms of pastoralism (Khazanov 1984: 17). The definition that will be utilized within the context of this investigation is as follows: pastoralism is a distinctive form of human subsistence economy in which domestic animals play a predominant, but not an exclusive role in the shaping of the economic and cultural lives of the people who depend on them (Galaty and Johnson 1990: 1). Pastoralism is both a land use strategy and a system of animal production. Pastoralists are those who are largely dependent on their domestic stock for subsistence (Krader 1959: 499).

## Types of pastoralism

One of the problems in investigating the origins of any type of pastoralism is the lack of any clear or agreed definition of pastoralism. There is a wide spectrum in the forms of pastoralism (Ehlers and Kreutzmann 2000: 13). This is due to a range of factors and can include the quantitative and qualitative characteristics of the herds, the extent and range of mobility, degree of inclusion of agricultural products, environment and ecological aspects of the region and the extent of ties with an external market (Logashova 1982: 53). In general, pastoralism is grouped into two basic types, nomadic pastoralism and semi-nomadic pastoralism (or transhumance). On a very basic level, both types of pastoralism can be defined as the movement of domestic herds between altitudinally differentiated and/or seasonally complementary pastures. However, they can be further differentiated by a variety of means. For example, Chang (1993: 709) differentiates nomadic pastoralism and semi-nomadic pastoralism (or transhumance) utilizing patterns of mobility. Transhumance occurs between fixed locations, summer and winter residences, whereas the nomadic pattern exhibits residential flexibility and a high degree of territorial mobility over space and through time (Chang 1993: 709). In contrast, Khazanov (1984: 19) places greater importance on the percentages of agriculture and pastoralism within the economic systems in his definition of the basic forms of pastoralism, rather than on degree of mobility.

Nomadic pastoralism (also known as pure pastoralism) has been characterized by the absence of agriculture, "even in a supplementary capacity" (Khazanov 1984: 19). However, some researchers (e.g. Whittaker 1988) maintain that pastoralism has never existed in a pure form, with the total absence of agriculture. There is "always a spectrum in the relative importance of one towards the other" (Whittaker 1988: 1). It seems that Khazanov (1984) simply takes a more extreme viewpoint.

Nomadic pastoralism involves the movement of people and animals within a large and defined geographic area according to a set schedule. This is an economic adaptation where the major economic orientation of the culture relies upon domestic stock (Barth 1961). In nomadic pastoralism, the majority of the human population migrates with their domestic herds year-round within a system of pastures. These pastoralists are highly mobile, move over vast areas, and characterized by the absence of, or minimal investment in agriculture. This is the form of pastoralism practiced by the Basseri tribe of South Persia (Barth 1961). Their migratory pattern involves movement between arid steppes and mountainous environments in order to utilize extensive but localized pasturelands for their herds.

In contrast, semi-nomadic pastoralism or transhumance is characterized by an economy where pastoralism is the predominant activity but includes varying emphasis on agriculture as a supplementary activity. "Even limited occupation with agriculture exercises a considerable influence on many aspects of the life of semi-nomads, in particular on the species-composition of herds, the routes and seasonal prevalence of pastoral migrations" (Khazanov 1984: 19). Within semi-nomadic cultural groups, two main alternatives are observed. It may be that the entire population in a given society is involved in both agriculture and pastoralism. Alternatively, there are specialized groups within the society that devote themselves primarily, or even exclusively, to pastoralism, alongside groups that are primarily occupied with agriculture (Khazanov 1984: 20).

Transhumance is the seasonal migrations of domestic herds "(sheep and goats, cattle) between summer pastures in the mountains and winter pastures in the lowlands" (Ehlers and Kreutzmann 2000: 16). These periodical movements may involve journeys of several hundred kilometers or only a few kilometers (Walker 1983: 37) and can be a vertical movement between altitudinally different areas, or a lateral movement across the landscape. Transhumant pastoralism is part of a more broadly based economic system, which incorporates crop cultivation and transhumance in a single economic scheme (Geddes 1983: 51). The practitioners of this type of pastoralism, often-termed mixed or specialized pastoralism (Cherry 1988: 7), are often semi sedentary (Geddes 1983: 51).

Historically, transhumant pastoralism has been, and is, a significant part of the economy in the Mediterranean and the Balkans. "The seasonal migration of herds and herdsmen take place even today on a fairly large scale in different parts of Greece, Albania, Yugoslavia and Bulgaria" (Rafiullah 1966: 28). Many researchers (Halstead 1981, Geddes 1983, Greenfield 1986) agree that it was also an important element of the economy in prehistoric times (Harding 2000: 138). As a result, this investigation will focus on a specific type of semi-nomadic pastoralism, that is, transhumant pastoralism, rather than nomadic pastoralism.

**Elements of a pastoral economy**

Ethnographic research on pastoral societies can provide us with some general elements of a pastoral economy. The species composition, the age and sex structure of herds are determined by several factors. The biology of the species and geographic conditions will be the primary determinate. These same factors will affect whether animals are utilized for primary products (such as meat), or for secondary products (such as wool, milk, or traction). Additionally, it is important to realize that economic, social, political and cultural factors are also influential (Khazanov 1984: 27).

The mobility of livestock "has both spatial and temporal components" (Niamir-Fuller and Turner 1999: 22). A variety of factors will affect the distance, timing and location of the movement of livestock. These can include the location and seasonal changes of water and pasture, disease outbreaks, localized drought, the number of people involved in the herd movement and relations with non-pastoral groups.

Additionally, the mobility of pastoral groups is not limitless. Constraints, such as geographic knowledge, social contacts, and access to resources such as pasture, often result in pastoralists revisiting encampment points on an annual or semi-annual basis (Niamir-Fuller and Turner 1999: 22). "Livestock mobility does not necessarily correlate with human mobility" (Niamir-Fuller and Turner 1999: 22). The proportion of the human population traveling with the transhumant herds can vary culturally, but also "in response to political, economic and ecological circumstances" (Niamir-Fuller and Turner 1999: 22). This is an element of a pastoral society that will be difficult to establish archaeologically. However, it may be an avenue for further research.

**Elements of a transhumant pastoral economy**

Rafiullah (1966: 5) notes that the most important elements of a transhumant economy are the character of the movements and the pattern of settlement. This involves the examination of three aspects of transhumance:

1. What is the portion of the population traveling with the domestic herds? This is perhaps the most important aspect of transhumance and can vary from movement of the entire community to no movement of the community but rather solely movement of animals under the supervision of professional shepherds (Rafiullah 1966: 6). It is possible that the same groups in a given society (or sub-society) are occupied with both agriculture and pastoralism, or conversely, there are specialized groups that devote themselves primarily, or even exclusively, to pastoralism, in conjunction with groups which are primarily occupied with agriculture (Khazanov 1984: 20). This observation is further supported by Bar-Yosef and Khazanov (1992: 2) in their investigation of

pastoralism in the Levant. It notes that transhumant pastoralism may involve only specialized groups within a community. The majority of the population may be involved in agriculture or other economic activities such as hunting or gathering while a specific group within the community is focused on the maintenance of herds as a specialized occupation. The existence of variation is also supported by recent ethnographic investigations, which have shown that in modern transhumant economies, shepherds are wage labourers hired by livestock owners. This is in contrast to modern nomadic pastoral groups, where relatives manage their personal resources. The distinction of transhumance from other forms of pastoralism in recent ethnographic literature stems from the relationship of the shepherds to the animals (Ehlers and Kreutzmann 2000: 16).

2. What is the organization and number of villages included within transhumant movement? Three variations are recognized. The first pattern is two well-defined villages, one located in the summer pastures, and one in the winter pasture. The second pattern consists of multi village sites. The final pattern is of one well-defined village and a collection of transient settlements (Rafiullah 1966: 6).

3. What is the length of the migrations? Transhumant migrations can cover from only a dozen or so miles to more than 300 miles in the seasonal round (Rafiullah 1966: 5; Walker 1983: 37).

These are not issues that will be able to be resolved within this investigation. However, they are important avenues for future research. Once the temporal origins of transhumance have been established within temperate southeastern Europe, the structure of the human population is the final objective of the archaeological investigation.

**Advantages of pastoralism**

From the above discussion, it is obvious that a common element of all pastoral societies is the mobility of domestic herd animals. This movement of livestock has been noted historically as a method to reduce uncertainty and risk in the environment. The mobility of pastoral herds functions to:

1) take advantage of spatially and temporally variable ecosystems
2) take advantage of unpredictable resources
3) utilize pastures distant from settlements
4) make use of seasonal pastures
5) provide fodder for livestock at minimal labour and economic cost (Niamir-Fuller and Turner 1999: 21).

Additionally, the movement of domestic herds also protects against problems such as disease outbreaks and droughts (Niamir-Fuller and Turner 1999: 22). These functions have been noted for arid environments, where the majority of pastoral economies exist.

**Modern transhumant pastoralism in the northern Balkans**

Recent ethnographic research in the Balkans (Ryder 1999) performed in the 1970s and 1980s provide some evidence of the modern transhumant pastoral practices in the Balkans. This research has focused on the Vlachs, the transhumant shepherds whose range extends from northern Greece, through the former Yugoslavia and Bulgaria, and into Romania.

These shepherds practice transhumance as a means to avoid variations in climate and in order to economically exploit two environmental zones that would otherwise be unable to support livestock. The production of milk (stored as cheese) is the major focus of the herd (Ryder 1999: 190).

The permanent winter settlement is in the lowlands and the herd moves into the mountains in the late April or early May. The return to the lowlands occurs in late September or early October. The exact time of the movements depends largely on environmental conditions such as the melting of mountain snows in spring and the onset of bad weather in the autumn. Originally, entire families made the seasonal migration while today it is largely the work of men (Ryder 1999: 191).

**Transhumant pastoralism in the prehistoric Balkans**

In arid and alpine environments, the advantages of pursuing transhumant pastoralism are more obvious. Herds are moved to the highland pastures in the summer to escape high temperatures and provide sufficient water and pasturage. This would be the case in the southern Balkans. But in the temperate environment of the northern Balkans, the benefit of doing so is not as apparent. Pastoralists in non-alpine temperate environmental zones may herd their animals up into the mountains during the summer to avoid the greater heat and humidity in the lowlands and to take advantage of delayed plant growth, and potentially a higher quality of graze. However, the need to do so is not as great. Temperature extremes in the lowland are not sufficiently extreme during the summer to drive livestock into the mountains in search of grazing and water. Sufficient water and graze are available year-round in most low and mid-altitude pastures in temperate climatic zones. In the northern Balkans, sufficient microenvironments exist, such as marshes, streams, hills and plains, to allow for stock to be safely herded throughout the year in the lowlands. As a result, ecologically, there are fewer incentives for pastoralists from low and mid-altitude settlements in temperate regions to practice transhumance.

Greenfield has suggested an ecological explanation, which highlights the advantages of the adoption of transhumance in the Balkans during the Post Neolithic (c. 3300 BC). During the Post Neolithic, archaeological evidence has shown an extensive reorganization of settlement patterns and includes more closely spaced and smaller sites with horizontally displaced occupations, lower artifact densities and insubstantial structures. These sites tended to not reoccupy the same areas as Late Neolithic sites, and there is little evidence for large and internally well-organized communities (Greenfield 1997). This evidence has been "interpreted as an apparent population redistribution from one of substantial nucleation, with regional population concentrated in a few large settlements to a pattern of dispersion of population into a large number of smaller and less intensively occupied residential localities" (Greenfield 1997). The introduction of the wagon and the plough into this region at this time may well have contributed to this redistribution, offering increased efficiency in transportation and cultivation respectively (Greenfield 1997).

Additionally, paleo-environmental data indicates that significant change in the physical, vegetative and micro-mammalian environments took place at this time. While a variety of causes for these changes have been proposed, the net result of the shifts to the Sub-Boreal climatic regime was a decrease in the upper altitudinal limit for cultivation, mostly affecting highland communities.

> The combination of population dispersion throughout the lower altitudes obvious at the end of the late Neolithic, increased areas under cultivation in the low and mid-altitudes and decreased productivity potentials for highland settlements, would have meant that there would be less pasture available for domestic stock in the lowland. Herds would have to be moved farther away from settlements in order to find sufficient graze and forage. There is no need to hypothesize an increase in herd size to account for this. If herd size was increased, it would only serve to make the situation more acute (Greenfield 1997: 8).

Transhumant pastoralism is an efficient response to the problem of less available and predictable pasture. It encourages exploitation of minimally utilized highland zones, less suited for agriculture. It is likely that members of the lowland and mid-altitude communities would have been responsible for the colonization of these areas in order to ensure continued access to these new and vital grazing resources for their stock. "The highland settlements would also remain dependent upon lower altitude settlements and pastures to buffer the seasonal variability in resource in the highlands" (Greenfield 1997: 8).

**Conclusion**

Even though pastoralism is still an important form of land use in many parts of the world, little research has been conducted on its origins using archaeological methods and data. Chang and Koster (1986: 97) highlight the need to investigate utilizing a full range of archaeological materials and methods, including artifactual analysis, analysis of features and spatial analysis in addition to the usual focus on zooarchaeological methods. What they propose is a major undertaking.

The first step is a sound analysis of the zooarchaeological material of the region in question. The cranial and post-cranial material from the central Balkans has been thoroughly analyzed by Greenfield (1986, 1988, 1999a). However, cranial material, specifically the mandibles and teeth, were lumped with the post-cranial material and not given the attention they deserve. These are the bone elements with the most sensitive age data. This investigation seeks to complete the zooarchaeological analysis from the central Balkans in southeastern Europe as the first step towards the complete evaluation of prehistoric pastoralism from all lines of evidence provided by archaeological material that Chang and Koster (1986) advocate.

# Chapter 3:

# Previous Research on Origins of Transhumance Pastoralism in Europe

## Introduction

Transhumant pastoralism has been a significant part of the economy in the Mediterranean and the Balkans. Many researchers (Halstead 1981, Geddes 1983, Greenfield 1986) agree that it was also an important element of the economy in prehistoric times (Harding 2000: 138). However, the exact temporal origins of transhumant pastoralism in Europe are still debated. Geddes (1983), focusing on the Mediterranean environment, proposes that transhumant pastoralism appears at the Mesolithic-Neolithic junction. Halstead (1981, 1990) suggests that it only appears with the Late Bronze Age and Classical complex societies in the Mediterranean (Harding 2000: 138). Greenfield (1986, 1988, 1991, 1999a) focusing on the temperate European environment, hypotheses that transhumant pastoralism becomes a major element of the subsistence strategies in southeastern Europe only at the beginning of the Post Neolithic, that is, the Eneolithic and Bronze Age. A summary of the previous research conducted on transhumance in Europe both within southern Balkans, with its Mediterranean environment, and the temperate environment of the Northern Balkans is necessary.

## Mediterranean Europe

Geddes (1983) proposes that transhumant pastoralism appears at the Mesolithic-Neolithic junction. He argues that it is likely that prehistoric hunters and gatherers and early subsistence farmers would have easily incorporated domestic migratory stock into their seasonal exploitation of land and resources. Transhumance has played an important role in modern and historic times in the Aude Valley of southern France. This region provides classic geographic conditions, varied reliefs and a diversity of microenvironments, favourable to the adoption of transhumance as a dominant economic strategy (Geddes 1983: 51).

As the importance of domestic cereals increased through the Neolithic period, most suitable agricultural land in lowland and middle altitude area was brought under cultivation. Animal husbandry would have then become a competitor for land. Possible solutions to this dilemma would have been to raise fodder for the domestic animals, or to open fallow fields in the summer. However, the first solution would have necessitated the restriction of cereal production; the second meant restricting winter pasture. Additionally, in lowland areas, the available natural fodder decreases both in abundance and quality, so that by late summer/early autumn, it is of little nutrition value to domestic herds. "The development of transhumant movements to upland zones would have developed as a result of these constraints" (Geddes 1983: 52).

The faunal, geographical, and archaeological evidence from the Mesolithic sites in the Aude valley indicate that ovicaprid transhumance began at this time with the diverse exploitation of the lowland, middle altitude and mountain environments. Small domestic herds of sheep were easily incorporated into the seasonal round of Mesolithic groups. These domestic animals make up a small percentage of the faunal remains of these sites (Geddes 1983: 58) in both upland and lowland regions. The subsistence economy is still largely dominated by wild species including wild boar (*Sus scrofa scrofa*), red deer (*Cervus elaphus*), and the pyrenean ibex (*Capra pyrenaica*). The latter became more common as altitude increased. In conjunction with this faunal evidence, the archaeological material and macrobotanical evidence suggest that these sites were occupied on a seasonal basis (Geddes 1983: 57).

Several generalizations can be made about the Early Neolithic period in the Aude valley. There is increased agricultural activity, including the appearance of cultivated cereals and legumes and increased ovicaprid frequencies compared with the late Mesolithic. However, wild resources continue to be an importance element of the subsistence economy. Wild boar is often as frequent as the sheep/goat at all sites. "In the upland sites, red deer, roe deer, aurochs and ibex accompany the domestic animals" (Geddes 1983: 59). Geddes (1983) examines a series of Early Neolithic occupations and highlights the evidence of seasonal occupations concordant with transhumant movements among upland and lowland sites.

The Grotte Gazel is a lowland site in the Aude Valley. Here, domestic sheep/goat make up 50-60% of the Early Neolithic faunal sample. Wild boar remains are present but are secondary in abundance to the ovicaprid remains. Although red deer and roe deer were present in Mesolithic occupation layers, there are no remains found in the Early Neolithic layers. Within the ovicaprid remains, it is interesting to note that foetal and newborn lambs are numerous, with 60% of the sample slaughtered before the age of two. However, there is no seasonally marked butchering pattern. From this evidence it is hypothesized that the site was occupied during the winter and the spring lambing season. Additionally, the proximity of arable soil suitable for the cultivation of cereals and legumes suggest occupation for a greater part of the year (Geddes 1983: 59).

Abri Jean Cros is a middle altitude Early Neolithic site. Here, sheep/goat remains constitute 34% of the faunal remains. In contrast to the lowland site of Grotte Gazel, subadult/adult animals (54% of individuals) dominate the sample. Animals aged less than one year are rare and newborn lambs are absent. Wild species, including wild boar, red deer and roe deer persist in considerable numbers. Sedimentological and macrobotanical evidence suggests an autumn and spring occupation of the site.

In the upland site of Abri de Dourgne, domestic sheep and goat make up 27 and 33 percent of the large mammals in Early Neolithic levels. Cattle and pig are also present, but in limited numbers. It is likely that they played only a small role in the economy. Red deer and roe deer are also present, making up 11-16 % of the faunal assemblage. The faunal evidence, based mainly on the presence of frogs, suggests a summer occupation, perhaps continuing into early autumn. Year-round occupation of the Upper Aude valley did occur in historic periods. However, it required the cultivation of supplementary fodder crops and the sheltering of domestic stock from the rigorous winter cold, and so it is believed this type of perennial occupation of upland areas was not occurring in the Early Neolithic periods (Geddes 1983: 61).

> Together, these sites show that transhumance of domestic herds during the Early Neolithic follows seasonal movements into heterogeneous middle and high altitude environments for the exploitation of boar, red and roe deer, aurochs, ibex and, undoubtedly, wild plant resources, by herding subgroups of an agricultural society based in the Aude valley lowlands (Geddes 1983: 61).

In the final part of the early Neolithic, lowland sites show evidence of a mixed herding economy, with remains from domestic cattle and pigs in addition to domestic sheep and goat. However, the domestic ovicaprines continue to dominate the assemblages of the upland sites. In the Middle Neolithic, these trends are intensified and the archaeological evidence shows a reorganization of settlement and subsistence. Open air villages are established in lowland and middle altitude areas, while upland areas show specialized utilization of rock shelters for transhumance (Geddes 1983: 52).

In addition to the faunal evidence discussed above, Geddes (1983) bases much of his argument for the origins of transhumance at this time on the sedimentary and palynological evidence. At roughly 4500 bc, midway through the Early Neolithic, these lines of evidence provide signs of local deforestation, invasion of pioneer species, forest regeneration and increased rates of cave sedimentation. These trends are continued in the later Early Neolithic and into the Middle Neolithic as signs of environmental modification associated with intensified animal herding and the cultivation of domestic plant species. "The long term impact of ovicaprid herding on vegetation and soil may well have transformed transhumance from an advantageous agropastoral practice, into an ecologically determined necessity" (Geddes 1983: 52).

Geddes (1983) does realize that this explanation for the origins of transhumance in a Mediterranean environment relies on several assumptions of prehistoric population size and density, amount of area under cultivation, agricultural and animal husbandry techniques and agricultural crop and meat yields. All of these elements are difficult to infer from the archaeological record. Additional problems with the model include the fact that "mechanistic population –climate models ignore or drastically simplify the complex interrelationships between population, resources and environment" (Geddes 1983: 52). Given these limitations, Geddes extends the model for consideration.

In contrast to Geddes (1983), Halstead (1981, 1985, 1990) proposes that transhumant pastoralism only appears with the Late Bronze Age and Classical complex societies in the Mediterranean and is associated with large-scale economic specialization of transhumance (Harding 2000: 138). The extensive use of upland pastures in a transhumant manner would not have occurred on a large scale until the development of extensive agriculture (Halstead 1981: 334). "Transhumant pastoralism tends to be practiced only by flocks too large to be fed perennially in either the lowlands or uplands and is dependent on large scale clearance in both lowlands and uplands" (Halstead 1990: 302). This requires that extensive blocks of fallow land suitable for grazing be maintained in lowland regions, as well as an urban market or comparable outlet for pastoral produce. Halstead (1981, 1985, 1990) argues that these preconditions existed only from the second millennium bc (uncalibrated radiocarbon years). Even at this late date, evidence of extensive agriculture and sheep herding suggests that these practices may only have been characteristic of land use under the direct control of the late Bronze Age palaces (Halstead 1990: 302)

Halstead examines the archaeological and environmental evidence for Neolithic sites in Greece and proposes a model of land use. Sites in the Early Neolithic period were small and relied on small scale gardening of both pulses and cereals with crop rotation and regular manuring. Animal husbandry of domestic species including cattle, pig, and sheep/goat was also practiced. In early phases, sheep/goat dominated the archaeological deposits but decline in importance over time as cattle, and to a lesser extent, pig, become most important. Subsequently, between the fourth and second millenium BC sheep/goat once again came to dominate the assemblages (Halstead 1981: 322). Halstead interprets the varying proportions of the different species as a "compromise between man's changing needs and the suitability of each species to a changing environment" (Halstead 1981: 322). There is no evidence, which indicates an ideological preference for any particular species. Additionally, the faunal data indicates the preferential slaughter of immature individuals, highlighting the exploitation of species for meat. As secondary products were not yet an important element of the economy, no particular species is considered of prime importance (Halstead 1981: 323).

Halstead's interpretation of the settlement and subsistence evidence for Neolithic Greece has two important implications. The first is that with an economy based on small scale gardening, as he suggests, population pressures on available arable land would not have been sufficient to necessitate the colonization of agriculturally marginal areas or the adoption of new economic strategies. Settlement spacing in the Neolithic is interpreted as a need for access to wild resources in bad years. Additionally, the broadening of the subsistence base, to include such activities as olive cultivation, occurs for similar reasons. Halstead suggests that settlement size has a greater effect on patterns of land use. Increases in population size and corresponding increases in community size in the later Neolithic and Early Bronze Age may have undermined the garden economy of the Early Neolithic and triggered the need to adopt new exploitation strategies (Halstead 1981: 334). Again, as with Geddes (1983), Halstead bases his interpretation on an increase in population size occurring in the Late Neolithic and Early Bronze Age; an assumption that is difficult to prove archaeologically.

The second implication of the Neolithic gardening system, proposed by Halstead, is that it removes the seasonal imbalance in the availability of grazing which is a modern characteristic feature of arable lowland areas in the Mediterranean. The modest numbers of cattle, sheep and goats in the Early Neolithic periods suggest that a combination of stubble in the summer and autumn and fallow fields in the winter and spring would have provided sufficient grazing resources for domestic stock (Halstead 1981: 324). Consequently, use of upland pastures in the summer cannot be assumed to be a necessary progression associated with animal husbandry in a country of marked altitudinal relief (Halstead 1981: 334). The development of pastoral economies in these early periods may have been possible only in particularly favourable circumstances, specifically when the ability to exploit stock for their secondary products was acquired. "However, widespread use of upland pastures is not likely to have occurred until the development of more extensive agriculture with more frequent fallowing created a surplus of lowland winter grazing" (Halstead 1981: 334).

**Temperate Europe**

Greenfield (1984, 1986, 1988, 1989, 1991, 1999a) has conducted archaeological investigations throughout the central Balkans for the past two decades. The beginning of the Bronze Age in this area saw widespread changes in land use, settlement patterns and artifactual remains (Bankoff and Greenfield 1984, Greenfield 1986: chapter 1). His earlier work (1984, 1986, 1988, 1989, 1991) focused on the paleoeconomy of the area and the changing patterns of domestic animal exploitation utilizing zooarchaeological analysis. The zooarchaeological evidence shows that there was a reorientation of subsistence practices to include secondary products only after the Neolithic. Greenfield (1986, 1988, 1989, 1991) has linked these changes with shifts in animal husbandry and exploitation, specifically with the adoption of transhumance in the Post Neolithic. There is there is no evidence for the transhumant movement of herds in the Late Neolithic.

Recently, Greenfield (1999a) has proposed specific hypotheses on how the zooarchaeological remains may be used to investigate the origins of transhumant pastoralism within a temperate environment, specifically at sites in the central Balkans. These hypotheses are given substantial attention here, as this investigation utilizes data from the same region, seeks to test the specific hypotheses using additional data, and build on the conclusions put forth by Greenfield.

As discussed earlier, some researchers (e.g. Geddes 1983) have proposed the origins of transhumant pastoralism during the Mesolithic as an extension of the seasonal exploitation of highland and lowland areas by hunter-gatherers. Domestic stock were simply integrated into the already existing economy and mobility pattern. However, archaeological evidence from eastern and central Europe indicates minimal exploitation of agriculturally marginal areas of the highlands during the Neolithic (6500-3300 BC) (Greenfield 1999a). These areas were not extensively utilized until the Eneolithic and Bronze Age (3300-1000 BC). Colonization of these areas includes "the widespread adoption of transhumant pastoralism as part of the overall domestic animal management strategy" (Greenfield 1989: 37).

The transhumant movement of domestic stock is predictable in a mountainous temperate environmental zone. The herd will move into highland pastures in the early spring, soon after lambing/calving occurs and returns to the lowlands during the autumn. In a subsistence economy, the age groups that are slaughtered in the highlands and the lowlands will be different.

> Excess very immature (infants and juveniles 0-8 months) individuals would be culled from the herds while they are in the highland pastures. Once the herds have returned to the lowlands, the youngest cohort is at least 8 months old and would represent the selective core of the herd's reproductive potential. In the lowlands, it would be the excess sub-adults and adults who would be selected for differential slaughter, since there are no juveniles or infants present. Excess sub-adults and adults would be brought to the settlement for slaughter in increasing numbers as stored agricultural surpluses and wild food dwindle during the winter. As a result, the age structure within the harvest profiles from highland and lowland settlements should be complimentary (Greenfield 1999a: 19).

This hypothesis may be supported if it can be demonstrated that herds were largely absent from the region for part of the year. Conversely, the null hypothesis would be accepted if herds can be shown to have been resident year round in the highlands.

A major complicating factor to this general hypothesis will be the economic usage or herding strategy of the domestic herds. Production strategies, that is, whether the domestic animals were utilized for primary products, such as meat, or whether they were utilized for secondary products, such as milk, traction, wool or hair, will be reflected in the harvest profile derived from the data. The harvest profile is the distribution of age at death for a species (Payne 1973; Hesse 1982). The use of harvest profiles for the examination of exploitation strategies has several advantages over other methods. First, species frequencies in faunal samples are subject to taphonomic biases. Second, it is nearly impossible to reconstruct the original herd structure. Finally, the goal for archaeologists is to determine the ways the animals were managed. The harvest profile will reflect the different exploitation strategies, as "the different age and sex groups will be slaughtered by herders according to the type of products they wish the herd to produce" (Greenfield 1991: 170).

Payne (1973) originally developed the different harvest profiles. When herds are utilized primarily for meat, the profile consists of mainly young individuals, as the young males are killed as soon as they reach optimal weight gain (Figure 1). Only a few are kept for breeding. For milk production, the surplus breeding stock is slaughtered as soon as the milk yield is not affected (Figure 2). If wool or hide production is emphasized, adult animals, regardless of sex, are kept for production (Figure 3).

Earlier research by Greenfield (1986, 1988, 1989, 1991) has shown that secondary products exploitation of domestic animals became a major feature of European subsistence in the early Post Neolithic. As the data for this investigation covers periods from the Neolithic to the Early Iron Age, it is believed that harvest profiles from early to late Neolithic sites will show a focus on primary products. However, as the advent of transhumance is hypothesized to occur at roughly the same time as this shift to secondary products, this diversified economic focus will complicate the general hypothesis for the origins of transhumant pastoralism in southeastern Europe. Consideration of the use of secondary products of these herds is a factor, which cannot be ignored in this region.

Greenfield (1999a) breaks down the general hypothesis presented above into two more specific hypotheses in an effort to elucidate the origins of transhumance in temperate Europe utilizing zooarchaeological data and to distinguish between the different production strategies of the settlements in the region. In hypothesis I, Greenfield (1999a) presents two situations where there would be no significant differences between the harvest profiles between herds from the same or different altitudinal zones:

a) if herds were resident year round within a region and each herd is exploited for similar products;

b) if similar specialized or mixed strategies were pursued by herders in each region and these herders were economically independent of neighbouring areas.

However, problems in interpretation arise when herders in each region pursue different strategies. This results in differing herd harvest profiles between regions, depending on the nature of the productive strategy employed. This observation necessitates the breakdown of the main hypotheses into several more specific sub-hypotheses in an effort to identify the productive strategy employed.

**Sub-Hypothesis 1A** has several sections which each deal with the possible specializations in animal exploitation strategies within an exchange system. When secondary products, such as milk, are emphasized (**1A.1**), two types of zooarchaeological assemblages may be found, each with different herd profiles. The first type of assemblage will be found at sites where the animals and their products are produced, while the second is found at sites where these animals and/or their products are consumed. In the production sites, it is assumed that excess stock were not slaughtered on site, but instead were exchanged for other products needed by herding communities. As an animal reaches maturity, its value begins to decrease and the available return is less. As a result, in herding sites, one would expect to find the age classes of animals with the lowest exchange value to the herders, that is, the assemblage will be dominated by adult animals. In economies based upon specialized exchange, it is expected that the byproducts of domestic stock would be exchanged for agricultural products by herders. In contrast, in non-herding sites, inhabited by sedentary agriculturalists, the harvest profiles should be dominated by the animals with the highest exchange value (immature, with more infantile and juvenile than sub-adult). "From a regional perspective, the harvest profiles would begin to resemble those quantified by Payne (1973) in which the percentual proportion between infants/juveniles, sub-adults and adults respectively is 60:10:30%" (Greenfield 1999a: 21).

**Sub-hypothesis 1A.2** details economies focused on the specialized production of primary products, such as meat. Here, the goals of the herders differ from those who produce secondary products. As above, the economic value of animals declines as they reach maturity. The ultimate objective of herders producing mainly meat, is to wait as long as possible before exchanging or selling their stock in order to derive the maximum economic benefit. While herders producing milk would exchange mostly juveniles and infants, as they actively interfere with milk extraction, in a meat producing situation a larger proportion of the exchanged animals would be sub-adults. This results in the harvest profiles from herding sites being dominated by adults. As in the milk pattern, the younger age classes would be found dominating the harvest profiles in sedentary agricultural sites. However, this production strategy can be distinguished by the regional harvest profiles, which may approximate 30:40:30%, due to the greater numbers of subadults involved in exchange (Greenfield 1999a: 21).

Greenfield's **Sub-hypothesis 1A.3** presents a more readily identifiable production strategy, that is the specialization in wool production. A much greater proportion of animals are slaughtered only during adulthood. As a result, the optimal harvesting strategy for such herds is 30:10:60%. As with the strategies discussed above, it is expected that any excess immature animals would be used for exchange, and so the harvest profiles of herding sites would be dominated by adults. The striking difference here, in contrast to the other alternatives presented above, is in the harvest profiles of the more sedentary sites where the excess adults would eventually be slaughtered. The increased number of adults would come to equal, or even exceed the younger age categories in the harvest profiles.

The most complex situation, is found in economies which are dominated by specialized exchange, in which both milk and meat are produced (**Sub-Hypothesis 1A.4**). Unfortunately, the harvest profiles expected in such a situation cannot be adequately distinguished from those that have a focus on milk production. This is due to the fact that all of the products (both primary and secondary) would be produced for exchange. In the herding sites, only adults would be slaughtered for consumption as the least valued age class. "Virtually all of the younger age classes would be used for exchange purposes. As a result, it would be extremely difficult to detect whether harvest profiles from sedentary settlements were indicative of milk or milk/meat production strategies" (Greenfield 1999a: 21).

It is also necessary to consider a subsistence economy in which productive specialization, established exchange networks and transhumance are not elements of the economic pattern. In this case (**Sub-Hypothesis 1B**) one would expect to find insignificant differences in animal production strategies between settlements. "Harvest profiles should be relatively similar between settlements within the region, since all age groups would be exploited for a variety of products" (Greenfield 1999a: 22). Again, it is necessary to further divide this sub-hypothesis in order to deal with the situation of secondary products exploitation.

**1B.1** Harvest profiles in settlements that emphasized secondary products, such as milk, should show a 60:10:30% (infantile and juvenile: sub-adult: adult) distribution. A focus on wool production is not considered here. Full specialization in the exploitation of herds for wool is considered unlikely in these periods. The adult sheep population kept for milk production would likely have satisfied the demand for wool in most mixed subsistence communities, particularly in the absence of market exchange systems.

**1B.2** "If primary products (e.g. meat) are emphasized in production strategies, harvest profiles in each local settlement should show a 30:40:30% distribution" (Greenfield 1999a: 22).

**1B.3** In a mixed subsistence economy, where both primary and secondary products are utilized, a more balanced harvest profile results, with an even balance between infants/juveniles and sub-adult/adults. The more general economic strategy de-emphasized the role of any single age class as the optimal culling patterns for particular products are balanced out. No single age class is culled more frequently than any other is (Greenfield 1999a: 22).

The second major hypothesis considers a transhumant pattern where local subsistence economies are linked into a larger inter-regional system. It is expected that complementary harvest profiles will be found at highland and lowland sites. The movement of the herds into the highlands in the summer makes the animals unavailable to the lowland inhabitants during that part of the year and vice versa. This is perhaps best illustrated with an example. If cattle are moved in a transhumant fashion animals less than six months old would be poorly represented in lowland settlements, because calving would take place soon before or after the herds are moved to the highland pastures for the summer. These animals would not return to the lowlands until the end of autumn. At this time, these calves have grown and are now part of the next age group, that is 6-12 months.

This being stated, difficulties in interpretation arise when secondary products are considered. How is one to determine whether complementary harvest profiles indicate utilization of secondary or primary products? In order to answer this question, **hypothesis two** is further broken down into sub-hypotheses. A focus on primary products is considered, as well as a focus on milk production and a mixed subsistence pattern, incorporating both primary and secondary products. A focus on wool production is not considered here, as at this time in prehistory, "it is considered unlikely that wool production had yet developed to such an advanced state to necessitate special herds" (Greenfield 1999a: 24).

**A.** If exploitation strategies focused on primary products, in other word meat, the highland harvest profiles would be dominated by juvenile and younger age categories. As a result, these age classes would be notably absent from lowland assemblages, where sub-adult and adult classes would dominate the assemblage.

**B.** If herd production strategies were focused on milk production, the complementary pattern in the harvest profiles is similar to profiles generated by a focus on primary products. As above, juveniles and the younger age classes would again dominate the highland assemblage. However, herds that focus on milk production tend to have small percentages of sub-adults. As a result, adults would dominate lowland assemblages.

C. "If productive strategies included both primary and secondary products (meat, wool and milk), then less clear cut differences between highland and lowland harvest profiles might be evident" (Greenfield 1999a: 24).

Greenfield's previous research on transhumance in southeastern Europe utilizes zooarchaeological data collected from the Balkans over a period of more than two decades. The analysis consists of three-pole graphs where the respective percentage of the three age cohort variables are calculated and graphed. Infantile and juvenile classes are grouped together as very immature for this analysis, and so, the three variables are very immature, sub-adult and adult. The analysis (Greenfield 1999a) shows that the Post Neolithic data fits the expectations for a transhumant pattern, while the Late Neolithic sites do not. More specifically, the analysis predominantly supports Sub-Hypothesis 2C, that is, the exploitation of herds (cattle and ovicaprines) for both primary and secondary products.

## Conclusions

It may appear that an abundance of work has already been done on the origins of transhumant pastoralism, particularly in the temperate European environment. What is the need for more? There are several ways that the present research will serve to build on and complement the previous research. First, in Greenfield's previous research (1986, 1988, 1989, 1991), the focus has been on the use of gross age classes, which lump together post-cranial material, mandibular, maxillary and loose teeth data. Many researchers (e.g. Payne 1973: 284; Crabtree 1982) would argue that mandibular data provides the most accurate age information for archaeological material as it is less affected by differential preservation and recovery. It is time that this material was given the attention it deserves.

This study will provide a full analysis of the tooth wear and eruption data, but also will expand the regional coverage of the study area with a larger sample of sites than previously attempted by Greenfield. Finally, it is hoped that the application of a new technique, specifically thin sectioning, can provide some additional information to the question of the origins of transhumant pastoralism.

# Chapter 4:

# Regional Environment

## Introduction

An important factor in the consideration of the origins of transhumant pastoralism in any geographic area is the regional environment. Is transhumance a viable and productive economic strategy for that area? Would aspects of the regional environment affect or encourage its adoption as a dominant economic strategy? Before we can begin to answer these questions, we must first precisely define the area of interest. Then we must look at the regional environment including topography, climate and vegetation in order to consider the viability of transhumant pastoralism within this area.

The area of interest for this investigation is commonly referred to as the central Balkans (Figure 4) (and sometimes, northern Balkans). It is an arbitrary division that has no defining topographic, geographic or political borders. It can be defined to include Serbia and the Vojvodina, northwestern Bulgaria and southwestern Romania (the Banat and Oltenia) and is a region of varying topography and environment (Greenfield 1986: 36). Specifically, it lies within the Middle Danube Drainage and is the region encompassed within the arc of the Carpathian, Julian and Dinaric Alps and the mountain ranges of eastern and central Serbia. The boundary to the east is where the Danube passes through the Iron Gates (Ehrich 1965: 407; Greenfield 1986: 36). The Sava River forms the western boundary of the region while the Danube marks the northeast limit (Greenfield 1986: 36).

The topography of the central Balkans displays great variation within a small area, and includes the flat plains of Pannonia, the rolling hills of Serbia, the low mountains of western Serbia and the high mountain areas of Bosnia. Local climate is greatly influenced by this variation in landforms, and can be described as transitional between the arid Mediterranean climate and the more temperate climate of central Europe (Figure 5) (Greenfield 1986: 36).

> Climate and plant and animal communities take on different characteristics not only in a general N-S gradient but also do so with increasing altitude. Neighbouring valleys often exhibit very different combinations of regional environmental variables, yet retain the general pattern of environmental diversity within the area as a whole (Greenfield 1991: 162).

It is important to realize that the vast geographic area covered in combination with the extensive mountain ranges have created several micro-regions within the Balkan Peninsula. These are:

1. Central Serbia and the Morava Valley
2. The Pannonian or Northern Plains
3. Eastern Serbia and the Iron Gates

A transhumance strategy within this area would allow for the productive exploitation of the variety of resource areas. Prehistoric peoples had a wealth of environmental and ecological knowledge of a variety of plants and animals, which enabled successful adaptation to a variety of conditions (Flannery 1965: 1251). The adoption of transhumant pastoralism would have offered a viable strategy in order to take full advantage of the variety of micro-environments created by the topographic and climatic variations within the northern Balkan area. Additionally, cultural factors may have played a significant role in the adoption of transhumant pastoralism. As agricultural practices required more arable land, the movement of domestic herds may have been a practical response to changes in settlement patterns and restriction of pasture for domestic stock in lowland areas.

In this investigation, the adoption of transhumance is hypothesized to have occurred at the Late Neolithic/Post Neolithic boundary. This juncture coincides with the end of the Atlantic climatic optimum (ca. 3300 BC), when significant climatic changes also occurred (Greenfield 1986: 36). These climatic shifts affecting the physical, vegetative and micro-mammalian environments possibly provided an additional impetus to the adoption of transhumance as the dominant economic strategy. It has long been recognized that climatic change has important effects on human history and that human settlement responds to environmental conditions (Harding 1982: 2).

## Landforms

### *Topography*

The central Balkans is characterized by extreme topographic complexity and there are no rigid topographic boundaries that clearly define the extent of the region. A diversity of environmental conditions exists in both the highland and the lowland areas. Some highland areas are heavily forested, while others lack heavy forest cover. Lowland areas may be marsh-like while others are well-drained (Greenfield 1986: 35).

"The word "Balkan" is of Turkish origin and denotes "...a chain of mountains" (Greenfield 1986: 36), and is an accurate descriptive word for the region. Several major mountain chains dominate and divide the Balkan Peninsula into the major vegetation and climatic divisions that characterize the region. Perhaps the most important, and the one from which the area derives its name, is the Balkan range (or the Stara Planina in

Slavonic). This mountain range is related to the Carpathian system which forms an inverted 'S" as it curves through southeastern Europe. "The main part of the curve is in Romania and circles around the Transylvanian basin" (Gottmann 1969: 505). The Carpathian range is interrupted by the Danube at the Iron Gates. South of this division, is the Balkan mountain range which curves to the east and south of the Lower Danube. The northern slope of the Balkan range descends steeply to the low and flat Danubian Plain, while the southern slope is a complicated system of highlands and ranges that occupies almost the entire Balkan Peninsula (Gottmann 1969: 505).

In the northwest of the region is a system of ranges and plateaus that appear to be an offspring of the Italian Alps. These ranges extend from Slovenia and Macedonia (Greenfield 1986: 37) along the Adriatic Sea and are often called the Dinaric Alps (Gottmann 1969: 505). Steep cliffs overlook small plains in the lowland areas along the coast. Inland are a series of valleys and basins where altitudes range from roughly 300 meters to 650 meters while extensive plateaus are found above 1300 meters and even 2000 meters (Gottmann 1969: 505).

A third mountain range, which adds to the balkanization or division of the region into sectors, is the Rhodopian massif. It extends into southeastern Serbia, Macedonia and Bulgaria (Greenfield 1986: 37). This range runs roughly from east to west to the Black Sea (Danta and Hall 1996: 15).

The Balkan Peninsula is in an environment of complex tectonic activity. There are numerous fault, fold and joint systems that influence the relief of the region. Steep rugged slopes are the dominant features of the landscape, especially along the waterways. Additionally, the predominance of limestone especially in the western half of the peninsula has a great effect on landform development in the area. Limestone is porous and easily eroded. This causes abundant subsurface solution weathering which creates the karst topography characteristic of this region. Features of this type of landscape include underground caves, travertine terraces, sinkholes, *dolines* and *poljes*. *Dolines* are closed hollows larger than sinkholes. These can combine to form *poljes*, large flat areas that can extend for several kilometers and are often the only viable agricultural land in mountainous areas (Danta and Hall 1996: 16).

***Rivers***

The various rivers of the region cross cut the major mountain ranges of the region and play an important role in placing boundaries between areas. The Sava River in the west and the Danube in the northeast have been the traditional geographic limit between the Balkans and central Europe. At the same time, the major river systems and their tributaries are essential in communication and movement through the mountainous, forested and marshy areas of the region from prehistory to the present (Greenfield 1986: 36).

North of the Dinaric Mountain divide, all of the rivers and streams flow into the Danube (Greenfield 1986: 36), which flows south from Hungary to Belgrade and empties into the Black Sea. Along the way, it forms the borders between Serbia, Romania and Bulgaria. Major tributaries of the Danube systems include the Tisza and Maros that flow southwards from the Carpathians, the Morava which flows northwards from Kosovo and southern Serbia and the Sava and the Drava which flow northwards and eastwards, respectively, from the Dinaric and Julian Alps (Greenfield 1986: 36). The Sava also has several important tributaries including the Drina, Bosna and Una. Other important rivers in the region include the Neretva, Vardar and Martisa. Only the Danube and the Vardar are capable of supporting major water transport, as the others are too shallow, rapid or rocky to allow for safe passage of even small boats. While the river system in the Balkans is extensive, there are few large lakes in the region (Danta and Hill 1996: 16).

**Vegetation**

The vegetation of the Balkan region is varied. Grasslands and mixed forests predominate in the plains. Coniferous forests are found at higher elevations while scrub forests cover the coastal areas and the more southerly portions of the peninsula. Throughout the mountainous regions of the area, vegetation is sparser due to the limestone environment and its associated karst topographic features. Additionally, the soils that cover the limestone are often acidic. In contrast, the soils in the plains and river valleys are generally deep and fertile. Consequently, agriculture is limited to these lowland areas in much of the region (Danta and Hill 1996: 16).

Having discussed some general characteristic of the environment of the northern Balkans, it is important to realize that the vast geographic area covered in combination with the extensive mountain ranges have created several micro-regions within the Balkan peninsula. These are:

1. Central Serbia and the Morava Valley
2. The Pannonian or Northern Plains
3. Eastern Serbia and the Iron Gates

***Central Serbia and the Morava Valley***

The Morava is an extensive and important river system that is part of the Middle Danube Drainage Basin. It is split into a southern (the Južna) and a western branch (the Zapadna) and drains a large area south of the Danube. North of Niš, the western and southern branches converge to form the Lower Morava that empties into the Danube near Golubač. While the river meanders within a zone only three or four kilometers wide, the river plain is extremely wide (over 16 km) and flat. Fertile areas are found near the river, as flooding is common. The rest of river plain is relatively dry (Greenfield 1986: 38).

Abundant forests covered the hills and mountains bordering the Morava valley in prehistoric times. These were the focus of extensive clearing in prehistoric and historic times, and so little remains today. However, the soils are very fertile and today are under cultivation. The main crops include corn, sunflowers, wheat, alfalfa, vines, vegetable, and fruit orchards. A continental climate characterizes the area. Rainfall (roughly 640 mm annually) is evenly distributed throughout the year, and in combination with the water retentive soil, farming is possible without the use of irrigation (Greenfield 1986: 39).

To the west of the Lower Morava is a region called the Šumadija, the northern most extension of the Dinaric Alps. This is an area of high altitude (1000 metres) that decreases as it descends into the foothills and terraces of the Pannonian Plain (200-300 metres - Greenfield 1986: 41). It is within this region of central Serbia that the following sites discussed in this thesis are found (i.e. Blagotin, Novačka Ćuprija, Petnica, Sarina Medja, Vrbica and Večina Mala are found - Figure 6).

### *The Pannonian or Northern Plains*

Pannonia, as the plains north of the Danube-Sava line are called, is also known as the Great Hungarian Plain (Greenfield 1986: 41). It is located north of the Danube and Sava Rivers and is surrounded by the Carpathian, Dinaric and Alpine Mountains. As part of the Middle Danube Basin, the Pannonian plain is characterized by the extensive river system including the Sava, Drava, Tisza, Körös, Mureş and Timiş Rivers. Pannonia extends into Croatia, Serbia, Romania and Hungary (Greenfield 1986: 42).

Pannonia is an area of low, flat relief and lies between 100 and 200 metres above sea level. The floodplains of the rivers are wide and are bordered by low terraces and plains. The lowland areas experience frequent and devastating flooding (Greenfield 1986: 42). There are extensive permanent and seasonal marshes that are impassable and unusable for agriculture (Barker 1975: 100; Greenfield 1986: 42). The annual precipitation is 600-700 mm and increases slightly as one moves westward (Furlan 1977).

Soils are predominantly loess deposits, although small areas of alluvial and brown forest soils are found. Today, some lowland areas are used for agriculture. Additionally, some mixed oak forests are found in the higher elevations. On the upper terraces, pine and spruce dominate the vegetation (Greenfield 1986: 42). The sites of Foeni-Salaş and Opovo are located within this region (Figure 4 and 6).

### *Eastern Serbia and the Iron Gates*

This area can be further divided into three main physiographic areas. 1) the Balkan Mountains of eastern Serbia; 2) the Iron Gates region and 3) the western edge of the Dacian Plain (Greenfield 1986: 43).

The Balkan Mountains are an area of jagged, broken relief. They are highest in the south, generally more than 2000 metres, decreasing to roughly 1000 metres in the north. In the north, while still mountainous, the relief is gentler and broken up by various rivers and streams. Settlement in the northern part of this region appears to be restricted to a series of small isolated basins that provide the only areas suitable for agriculture. The basins to the south are larger and more contiguous (Greenfield 1986: 43).

The Iron Gates is a series of gorges that connect the Pannonian (or Hungarian) Plain and the Dacian basin. It is a corridor formed by the Danube cutting through the Carpathian and Balkan mountain range. While the mountains on either side of the river are steeply sloped, small basins where the river widens offers areas appropriate for settlement.

The Dacian basin is found where the Danube emerges from the Iron Gates, east of the arc of the Carpathians. Here, the Danube changes to a north-south orientation and the relief of the area is much more subdued. The site of Livade is found in this region (Figure 6) (Greenfield 1986: 45).

**Climate**

There are two major climatic zones found within the Balkan Peninsula (Figure 5). They are:

1. The Mediterranean (and Mediterranean Transitional) Zone, which includes the regions of the southern Balkans (Dalmatia, Macedonia, Greece, southern Bulgaria and the southwestern Black Sea Coast);

2. The Continental (temperate) Zone – this includes all countries north of the regions detailed above. This is a temperate climatic zone. This zone can be divided into two subzones:
    a. The Humid Continental Warm Summer Zone, which includes the northern Balkans (Serbia, northwestern Bulgaria and southern Romania); and
    b. The Humid Continental Cool Summer Zone, which is found to the north, closer to central Europe (Greenfield 1986: 35).

The area of investigation lies within climatic zone 2a. It can be described as a southern temperate climate (similar to that of central Europe) that retains features of the more arid Mediterranean climate zone to the south (Greenfield 1986: 35). The climate varies throughout the region as a function of altitude and proximity to the two neighbouring climatic zones. In general, the climatic pattern is continental with very cold winters and very hot summers (Figure 5) (Greenfield 1986: 45).

***Temperature***

Throughout the region, July is the warmest month of the year, while January is the coldest. Temperatures vary in the different regions due to variability in altitude and relief. In general in the northern Šumadija, the average summer temperature ranges from 20-25 degrees centigrade, while the average winter temperature ranges from 0-2.5 degrees. In the Vojvodina, July temperatures can reach as high as 35 degrees centigrade, in combination with high humidity. North of the Sava River January temperatures can fall to as low as –15 degrees centigrade. In the interior of the Balkan Peninsula winter temperatures are slightly warmer, ranging from -15 to -10 degrees centigrade. "The difference between winter minima and summer maxima over the area is generally between 50 to 55 degrees centigrade" (Greenfield 1986: 46). The most extreme temperature range is found in the Banat (eastern Vojvodina) where July maxima may reach 42 degrees centigrade and February minima may reach –12 degrees centigrade (Greenfield 1986: 46).

***Precipitation***

The region is characterized by a continental rainfall pattern, where the highest levels of precipitation fall in the summer (June) and the lowest levels fall in the winter (February). There is little variation in precipitation levels throughout the region over the course of the year and seasonal variations are not as extreme as in the Mediterranean areas further south. The majority of precipitation (nearly one-half) falls between April and July and the number of days with rain is high, often more than 150 days. This pattern generally ensures adequate water throughout the agricultural growing season, although in some areas, a high evapo-transpiration rate exceeds precipitation (Greenfield 1986: 46).

Again, as with temperature, the various microenvironments vary in the amount of precipitation that they receive. The annual mean in the Šumadija is between 600 and 1200 mm, the Banat receives somewhat less (600-700 mm) and the Iron Gates region receives the highest levels, between 800 and 1200 mm (Greenfield 1986: 46).

As temperatures begin to drop in the late fall and early winter, precipitation begins to fall in the form of snow. While the earliest frost can occur as early as the end of September, the average date is October 21st. Snow accumulations occur from January to

March. “The last frost generally occurs around April 13th, although it has been recorded during the first week of May. The amount and timing of frost and snow is largely a function of altitude” (Greenfield 1986: 47). In the uplands, snow accumulations can often remain for long periods and would have had significant effect on settlement and occupation, as movement would have been inhibited (Greenfield 1986: 47).

**Environment and climate in the Balkans during the Neolithic**

The Neolithic period is characterized by the spread of agriculture throughout Europe and corresponds with the warm, moist Atlantic phase (ca. 6200-3300 BC), dominated by a warm, maritime climate. This period was distinguished by warm, wet winters and cool, wet summers (Butzer 1971: 531). The climatic optimum is reached at the very beginning of the Atlantic period followed by a decrease in temperatures thereafter (Kordos 1978a: 224). During the climatic maximum, the average July temperature for Hungary ranged from a high of about 19° C to lows of 16° C toward the end of the period (Greenfield 1986: 55). Annual precipitation levels reached a peak at about 5700 BC then decreasing towards the end of the Atlantic (Kordos 1978a: 227).

The abundance moisture enabled maximum deciduous forest growth and spread, roughly 200-300 meters higher in altitude than today with dramatic increases in arboreal pollen throughout the Lower Danube drainage. Pine and spruce species dominated the upper altitudes, while oak, hazel, birch and spruce were common in other areas, dependent on soil type. Loess plateaus were dominated by steppe-grasses. Dry grassland conditions appear and spread during this period as well (Greenfield 1986: 55).

While minor cold fluctuations occurred throughout the Atlantic period, changes in temperature were slight. However, the last five hundred years of the period is characterized by a much "sharper oscillation toward a colder climate" (Greenfield 1986: 55). Changes towards the end of the period include a reduction of the altitudinal extent of the forest as spring and summer temperatures are cooler and frosts arrive earlier in the fall (Frenzel 1966: 106). Winters also become cooler. Elm and ivy species decline in the pollen spectra and spruce forests are replaced alpine meadows (Frenzel 1966: 103). The height of this cold period was reached at 3200 BC. This was followed by rapid improvement of the areas' climate shifting towards a more pronounced continentality (Frenzel 1966: 106).

**Anthropogenic environmental changes during the Neolithic**

It is also important to consider human action on the environment. While agriculture moved into southeastern Europe at roughly 5900 BC, the human effects on the environment were not immediately apparent. Recent paleoecological research (Willis and Bennett 1994: 327) indicates that the first indication of anthropogenic change on the landscape occurs between 6000 and 2500 BP. As agriculture and animal husbandry practices developed throughout this period, the increased proportion of cattle and sheep/goat would have caused progressive disturbances of the vegetation by humans. While this was a gradual process there would be long-term environmental effects resulting from continuous animal and human exploitation of vegetation with ruthless forest clearance for cultivation and the collection of fodder for domestic animals. These interpretations are supported by the faunal data that show the increase in the proportion of domestic species within assemblages (Halstead 1981: 324). Additionally, pollen diagrams indicate extensive manipulation of the ecosystem throughout the Neolithic period (Nandris 1976: 550; Greenfield 1986: 266). Even if one takes a highly conservative view of the magnitude of the climatic changes at the Atlantic to sub-Boreal transition, when these are combined with the human actions of deforestation and cultivation over the course of the Neolithic, they undoubtedly contributed to ecological changes during the Bronze Age (Greenfield 1986: 266).

**Environment and climate in the Balkans during the Post Neolithic**

The transition from Atlantic to sub-Boreal times (3400 to 3000 BC) is characterized by a climatic trend of gradual cooling (Frenzel 1966: 99; Butzer 1971: 530). There is a shift to a more continental climate and is characterized by increased dryness as compared with that of the preceding Atlantic period (Frenzel 1966: 99). Climate was significantly cooler (Kordos 1978b: 153) with an increase in frequency of temperature oscillations. Winter temperatures decease while summer temperatures increase slightly. While average July temperatures for Hungary at the beginning of the sub-Boreal demonstrated highs of roughly 16°C, these decreased to lows of roughly 15°C towards the end of the period (Kordos 1978a: 224). Annual precipitation levels are at their lowest levels of the post-Glacial period at the beginning of the sub-Boreal (Kordos 1978a: 226). These interpretations are supported by evidence from both vertebrate remains (Kordos 1978: 153) and palynological evidence from the northern Balkans (Frenzel 1966: 99; Butzer 1971: 530).

Fossil molluscan evidence from eastern Moravia dated to the end of the Atlantic period show that species characteristic of forest-steppes or open forests increased steadily while those mollusc species adapted to lakes, ponds and other moist environments decreased at this time (Frenzel 1966: 118). This data presents evidence of a worsening of the water budget, with reductions in the availability of water (Frenzel 1966: 116).

Changes in forest composition occurred as palynological evidence indicates a decline in elm and ivy pollen spectra (Frenzel 1966: 100) and in increased dominance of oak and beech (Butzer 1971: 531). Several small climatic fluctuations take place, with marked rainfall fluctuations (Greenfield 1986: 56).

**Anthropogenic environmental changes during the Post Neolithic**

The patterns of deforestation and increasing cultivation established in the Neolithic caused greater anthropogenic changes to occur during the Post Neolithic period. These included geomorphological and pedological changes particularly in the formation of soils at the end of the Neolithic and in the Early Bronze Age, caused mainly by erosion from the hills and deposition in the plain. These are seen as mainly man-induced due to reduced vegetation cover and impeded drainage. This resulted in a reduction of areas suitable for cereals in the lowlands and resulted in the abandonment of tell sites, which had been occupied for significant periods of time. These settlement shifts were the result of the reduction of environmental possibilities (Nandris 1977: 206). Analysis of sediments has been conducted in Mediterranean countries in order to provide data on processes of deposition and erosion in the past. Erosional processes in these areas caused shifts in settlement with an increase in settlements in the valley bottoms. "Sediment analysis suggest that misuse of the landscape in some Mediterranean areas dates back five millennia, to at least the Early Bronze Age" (Renfrew and Bahn 1991: 205) through a combination of deforestation and intensive agriculture.

**Transhumant pastoralism as a response to climatic change**

There is a correlation between a specialization in a pastoral form of production and a range of ecological factors. While these factors may serve to effectively limit the efficiency of agricultural production, this is not true in all areas and does not lead directly to the adoption of pastoralism (Bonte 1981: 34). Often, particularly in temperate environments, ecological conditions may not be directly limiting agriculture; rather, the combination of climatic and vegetative factors simply presents pastoralism as an equally viable economic strategy.

Archaeological and climatic investigations in the Deccan in India have shown that societies have reacted to climatic change with a switch from agriculture to a form of nomadic pastoralism (Dhavalikar 1989: 167). Climatic shifts caused a decrease in precipitation, which resulted in increased aridity leading to drought. Agricultural production suffered and the cultures shifted their economic production to a concentration on domestic animals, mainly sheep and goat. These shifts are supported by archaeological evidence including a decrease in domestic macrobotanical remains with a corresponding increase of animal bones. Additionally, there is a shift in architectural styles to a less substantial dwelling, indicative of a more mobile lifestyle. This was "not an isolated phenomena, but was repeated throughout the history of the region. Whenever there were successive droughts and famines, people had no alternative but to resort to pastoral nomadism" (Dhavalikar 1989: 167). The dominant cause of this culture change is climate change (Dhavalikar 1989: 167). While this was utilized as a short-term solution, it is not unreasonable to propose that Post Neolithic cultures may have utilized this same response to climatic changes. While climatic changes cannot necessarily be utilized to explain the continuance of this form of subsistence, they do provide a reason for its origins, in various parts of the world.

It should not be suggested that the climatic transformations of the Atlantic/sub-Boreal boundary were severe enough to have been the sole cause of the significant cultural changes seen at the Late Neolithic/Post Neolithic boundary. There were undoubtedly other factors both social and economic at work. However, the climatic shifts may have added some impetus to changes already taking place (Greenfield 1986: 56). It is suggested that the adoption of transhumant pastoralism as an economic and land use strategy was an obvious adaptation to these new ecological constraints.

# Chapter 5:

# Culture History

## Introduction

The hypotheses to be investigated here propose that the origins of transhumance took place at one of three time periods, the advent of the Early Neolithic, Late Neolithic/Post Neolithic junction, or with the advent of productive specialization (in this area, during the Roman period). The latter possibility cannot be directly investigated at this time since data have not been systematically collected to test this hypothesis for the Roman or Medieval periods. To properly investigate the other periods of interest, it is necessary to examine data from the periods preceding and following each of these temporal divisions. The culture history of southeastern Europe from the Neolithic through the Early Iron Age is summarized below.

The manufacture and decoration of pottery has traditionally been the focus of research in the Balkans (Bailey 2000: 76) and has been used to distinguish the different cultural groups, as well as to mark distinctions between periods (e.g. Dumitrescu 1983; Garašanin 1983; Bailey 2000). Much research has been done detailing the characteristics of this pottery and changes through time. "Grand descriptive schemes and detailed regional variation overwhelm the literature" (Bailey 2000: 76). However, as the focus of this investigation is the economic activities and subsistence practices, the issues underlying the analysis of pottery will not be discussed. The aim of this chapter is to provide a brief summary of the major periods of interest, and the general economic and culture history characteristics of each.

While this may seem like a simple goal, it is not an easy one to accomplish. There are several limitations to the potential for synthesis of the nature of the subsistence economy in the prehistoric periods of the Balkans. Some are methodological, while others are theoretical. Among the analytical issues, for example, the zooarchaeological analysis of data from sites has often consisted of no more than species lists or presence/absence data (Greenfield 1991; Bailey 2000: 132). Further zooarchaeological analysis has largely been ignored (Greenfield 1988: 573). Regular sampling is often ignored, dry sieving occurring at a limited number of sites, and wet sieving was even less common. Additionally, syntheses of existing analyses are confounded by the variety of methods of presentation, (e.g. bone counts, minimum number of individuals, meat yields). Few offer any attempt at reconstructing grazing patterns or cultivation systems. As a result, it is difficult to build the same kind of synthesis that may be possible if one were considering pottery or architecture (Greenfield 1986, 1991, 1993; Bailey 2000: 132).

Southeastern Europe or the Balkans can be divided into a northern and a southern region based on climatic divisions. Domestication was introduced into the southern Balkans from the Near East (ca. 6500 BC). The similar climatic conditions resulted in no significant changes in domesticated species or exploitation systems (Greenfield 1993; Jongsma 1997: 52). However, as agriculture spreads north of this area about 5900-5100 BC into a temperate environment, a re-adaptation is required. The existing domesticated plants (wheat and barley) and animals (sheep and goat) must be adapted to the new environmental conditions. Additionally, there is the need for the domestication of new species already indigenous to the area, such as cattle and pigs (Greenfield 1993; Jongsma 1997: 53). These changes, resulting from the climatic division, leads also to cultural divisions between the cultures of the northern Balkans (with its temperate European climate) and those of the southern Balkans (with its Mediterranean climate) (Greenfield 1991; Jongsma 1997: 54). The focus in this investigation is the cultures of the northern Balkans.

Throughout this area and the periods discussed, the chronological ages of each period and the radiocarbon ages often do not match in the published literature. It is widely recognized, particularly within the Neolithic periods, that there are considerable differences between the traditional relative chronology and the radiocarbon dates (Nikolava 1998). These differences are often as great as one thousand years (Garašanin 1983: 84). Attempting to reconcile the two is an exercise in frustration. It is beyond the scope of this investigation to attempt to resolve these issues. As such, the relative chronological ages of the period will be focused on, as the data have been analyzed within this context.

It is preferable to give calibrated (BC) radiocarbon dates as these have been corrected for the fluctuations in the formation of radioactive carbon, and so, provide exact dates (Cauvin 2000). Unfortunately, uncalibrated dates are the most common form of reporting from the region. As such, dates will be given in both uncalibrated (bc) and calibrated (BC) radiocarbon years where possible.

## Early Neolithic

### *Chronology*

The Early Neolithic began in the northern Balkans about 5900 BC, as agriculture spreads north from the southern Balkans (Greenfield 1993; Jongsma 1997: 52). The period ends roughly at 4500 BC, based on radiocarbon dates.

### *Cultures*

The cultures of the northern Balkans are "referred to collectively as the Karanovo I-Kremikovci-Starčevo- Körös-Anza-Criş culture group" (Jongsma 1997: 52). Each represents a geographical variation on the same larger material culture theme - Karanovo I is in S. Bulgaria, Kremikovci in W. Bulgaria and S. ex-Yugoslavia (Macedonia), Starčevo in eastern ex-Yugoslavia (Serbia and Bosnia) and Körös in SE Hungary, in NE Serbia (Vojvodina) and Hungary, and Criş is found in Romania (Tringham 1971: 78).

The abundance of different cultural names can generate a misleading picture of the cultural landscape. Tringham states (1971: 78) the different names correspond to variations in settlement type, location, and economy. There is little variation in material culture. Others suggest that the distinct names reflect adaptations to the micro-environments of the Balkan peninsula (Kaiser 1984: 46), or are the basis of distinct regional pottery styles (Barker 1985: 90). While these are all valid interpretations, archaeological nationalism can certainly not be ignored as a major factor (Jongsma 1997: 55)

> For example, sites in northern Yugoslavia (Starčevo) and southeastern Hungary (Körös) and southwestern Romania (Criş) have nearly identical assemblages. However, the cultures are called by different names. The division between Starčevo and Criş cultures in SW Romania simply coincides with the modern national border. The cultures of the Northern Balkans (i.e. Criş, Körös, Starčevo and Karanovo I) are differentiated mostly because each national school of archaeology prefers its own local name (reflecting the original type site in that country for the culture) for essentially the same archaeological culture (Jongsma 1997: 55).

### *Settlement*

Early Neolithic settlements are generally located on the terraces surrounding river valleys or on the edge of plateaus (Tringham 1971: 90). These early farming communities were located on the brown forest soils and alluvial deposits of the rivers. Settlements to the north of this area were found on the loess deposits of the Danube basin (Tringham 1971: 68). There is little evidence of multi-level occupations. Most sites have thin layers, often from a single occupation (Whittle 1996: 48). Early Neolithic sites are small, usually less than two hectares in size. Settlements are not differentiated into functionally distinct areas and there is no evidence of settlement hierarchy, social ranking or occupational specialization (Greenfield 1993: 112).

Settlements also varied enormously in duration and internal layout. Two general types of sites dominate the Early Neolithic landscape: flat sites, with a dispersed layout, less regular structures and without repeated occupations and tell or mound settlements, with an ordered layout, uniform structures, and repeated occupations (Whittle 1996: 54; Halstead 1990).

Two types of house construction can be found in southeastern Europe, the surface dwelling, and the semi-subterranean dwelling (Tringham 1971: 84). Houses are simple, square or rectangular one-roomed structures, with no evidence of internal differentiation. These structures varied in construction method from area to area and even from level to level within the same site but for the most part were similar in size. They commonly consisted of a wooden frame with a daub or clay covering and a stone footing. There was usually an oven on the back or side wall of each house (Whittle 1985: 50). "The houses were arranged in close proximity to each other but completely detached" (Tringham 1971: 72). On the basis that there is little variation in size of dwelling unites within a settlement model of internally undifferentiated or more or less egalitarian communities has been proposed (Champion et al. 1984: 142).

Evidence of spatial arrangement within settlements is limited by the lack of large-scale horizontal excavation of Early Neolithic sites (Tringham 1971: 87). This situation is changing as this type of excavation has now been completed in areas such as Blagotin in Serbia and Foeni-Salaş in Romania. Excavation of these sites has revealed a settlement organized around a large central pit house structure surrounded by a ring of smaller pit houses with an open plaza between them (Greenfield 1998).

***Technology***

The beginning of the Neolithic period can also be defined based on material culture. Blade and other chipped tools continue uninterrupted from the Mesolithic into this period (Tringham 1971). Additionally, there is the advent of polished stone axes, stone grinders and bone awls. Most characteristic of the period is the appearance of simple monochrome ceramic pottery, predominately in the form of globular bowls and footed cups (Whittle 1985: 39).

***Mortuary***

While burial practices varied widely throughout Europe, the trend in southeastern Europe was mainly individual burials within settlements, usually in refuse pits, to one side of the pit or in a slightly deepened grave. The dead were buried lying on their side, in a contracted position. These burials are found among the houses of the settlement with no specific grave area (Tringham 1971: 87). Separate cemeteries are found occasionally. The graves did not reflect any great social differentiation either in the treatment of the grave or in accompanying goods (Champion et al. 1984: 142). Few grave good are found and usually consisted of a pot, or simple ornaments such as a shell necklace (Tringham 1971: 87; Bailey 2000: 193).

### *Fauna*

In the subsistence economy of Early Neolithic sites, hunting and animal husbandry were of roughly equal importance. In some sites, hunting dominated over husbandry, and in others, the opposite was common (Greenfield 1993). The common domestic animals included sheep and goat, cattle and pig. These animals arrived into the northern Balkans already domesticated, and there is no evidence for local domestication during this period. Sheep and goat dominated the fauna assemblages over cattle. A small number of pig remains were found (Bökönyi 1974: 26). Wild species continued to be exploited in the Early Neolithic and included red deer, aurochs and wild pig. In settlements near appropriate water sources fish, waterfowl and other marine resources were exploited (Bökönyi 1974: 21; Champion et al. 1984: 118). There is a tendency for the proportion of domestic animals on any given site to decrease as one goes from south to north, balanced by an increase in evidence for hunting (Greenfield 1993; Meiklejohn 1997: 5).

### *Flora*

One of the main characteristics of the Early Neolithic was the introduction of new species of plants, many of which were of Mediterranean origin (Chapman 1981: 132). Two types of wheat, emmer (*Triticum dicoccum*) and einkorn (*Triticum monococum*) were the most common with emmer more frequent. In addition, barley and a variety of legumes were grown including peas, beans, vetch and clover (Bailey 2000: 139). These legumes were previously exploited in the area but were also believed to be deliberately sown based on frequency of occurrence and morphological changes indicating domestication. Regional variation for subsistence occurs since not all the staples mentioned occur on individual sites. Emmer, barley and legumes were the most important staples but a variety of different plants were grown at different sites (Bailey 2000: 139). The present pattern is for one or two cereals and one domestic animal species to appear dominant at any one site (Whittle 1985: 53). The method and scale of agricultural production also varied between villages and between regions (Bailey 2000: 140).

These suggested general patterns of plant exploitation for the Early Neolithic should be considered to be tentative. Recent paleobotanical research at the sites of Blagotin and Foeni-Salaş yielded few botanical remains (Jezik 1998). Additionally, the simple presence of cereals at a site is not a sufficient indicator of agriculture due to the fact that there are a large number of wild grasses indigenous to the area (Willis and Bennett 1994: 327).

### *Evidence for sedentism/mobility*

The Early Neolithic period has been assumed to be associated with greater sedentism (than in the preceding Mesolithic), with some researchers going so far as to say that the production of food demanded permanent settlements (Kalicz 1970: 7). Researchers have utilized many aspects of settlements such as depth of deposits, architectural remains, site size or organization and reliance on domesticates in an effort to substantiate claims of sedentism for the Early Neolithic. Although increased permanence and sedentism is listed as a defining difference between the Neolithic and the earlier periods, it is a characteristic that researchers admit is difficult to prove (Whittle 1985: 48).

In the past (Whittle 1985) it has been argued that tell sites are evidence of increased permanent settlement during the Neolithic. However, more recent research (Whittle 1996) has indicated that these sites have largely been misinterpreted. Evidence from tell sites such as Achilleion indicate periods of abandonment and relocations within the mound. Together with artifactual evidence and other occupational residues Whittle (1996: 71) provides the reinterpretation that permanent sedentism in the Neolithic was a gradual process throughout the period and should not be considered a defining characteristic of the earliest phase. While some sites such as Karanovo demonstrate depth of deposits is over 12 meters (Whittle 1985: 47), in other areas of the northern Balkan region, from northeastern Bulgaria through SW Romania and the southern part of the Hungarian plain, many settlements were relatively brief with thin occupation layers. It is here that the possibilities of movement, impermanence and seasonal shifts in occupation are clearest (Whittle 1996: 49). It took time for most aspects of the Neolithic to develop and there was still plenty of variation from region to region by 5500 BC.

Edwards (1989: 32) highlights that in order for assessments of the maximum stay at any site, there must be a consideration of the seasonal availability of food resources. Therefore, it is worthwhile to examine where Early Neolithic cultures choose to locate their sites across the landscape as these decisions have important implications for resource availability and, in turn, settlement stability (i.e. sedentism). During the Early Neolithic, settlements are located mainly in the floodplain environments (Barker 1975;

Chapman 1981; Sherratt 1983; van Andel and Runnels 1995: 481). These areas offered dry dwelling places on abandoned levee/channel systems and much arable land, which provided a buffer against drought years, enabling populations to survive and flourish. These environments were "also rich in natural resources, wild deer and boar, fish and shellfish, water birds and a wide range of plants that could be exploited" (van Andel and Runnels 1995: 490). When sites are mapped against soil types and topography, it is clear that the most favorable areas, which offer a range of soils for cultivation and grazing, were chosen (Champion et al. 1984: 122).

Increased investment in architecture within a settlement can also be used as an indicator of increased sedentism (Whittle 1996: 57). Semi-subterranean houses, or pit houses, are a common type of architecture during the Early Neolithic. These structures are characterized by very little modification of the living area. They were often large and irregular in shape, contained no internal structural features of postholes, and roofs were simple wooden affairs (Jongsma 1997: 86). These structural elements suggest structural impermanence and would have been appropriate for a lifestyle of considerable mobility (Whittle 1996: 52).

> The essential reason that pit houses would have been the common architectural form for the Starčevo-Criş culture is the nature of occupation. Short occupation spans seem to generally be the rule based on the thickness of deposits (characteristically thin horizons), the lack of overlapping deposits, and lower frequencies of features (i.e. ovens, hearths, etc.) (Jongsma 1997: 210).

Again, demonstrating the cultural variation throughout the region, Körös settlements in contrast have thick deposits with an abundance of features such as storage pits and hearths and generally are also associated with surface houses. While these characteristics suggest a longer and more permanent occupation period, this hypothesis fails when pit dwellings are also found associated with the Körös culture. Due to lack of systematic analysis of the relative chronology of surface and pit houses in this culture it is unclear whether pit houses evolve into or coexist with surface houses in this region (Jongsma 1997: 210). It is possible that these pit dwelling represent temporary occupations for a specific purpose, such as hunting or ritual.

The evidence for permanence rests on the assumption that increased investment in architecture and the constraining needs of subsistence activities will result in increased sedentism. However, the current reinterpretation of tell sites as discussed above and the extensive investigation into architectural styles in this area during the Neolithic by Jongsma does not (1997) support these assumptions. Additionally, it should be realized that the adoption of animal husbandry and plant cultivation does not inevitably lead to sedentism (Whittle 1996: 69). "Some of the first sedentary communities may not yet have had fully domesticated resources, and not all the users of domesticated resources need have been sedentary" (Whittle 1996: 40). Some researchers now believe that a sedentary population may have occupied Early Neolithic sites in the northern Balkans for short time periods, i.e. two or three years. These could not be considered permanent settlements and a degree of mobility was still an important element of the cultures (H. Greenfield: pers. comm.).

## Middle Neolithic

### *Chronology*

The Middle Neolithic period of the northern Balkans covers the period from 4500-4100 BC (Chapman 1981:18; Greenfield 1986: 113). The chronology for this period may appear confusing, as there are two major chronological systems in use. Milojčić (1949) divides the culture into four major periods, A through D, each with additional sub-phases. Also widely used is the system by Garašanin (1983). It divides the culture into only two major periods (with subdivisions), the earlier Vinča-Tordoš (I and II) and a later Vinča- Pločnik (I, IIA and IIB). These two systems are easily reconcilable as they are nearly co-terminus with "Vinča-Tordoš I = Vinča A, Vinča-Tordoš II = Vinča B, Vinča-Pločnik I = Vinča C, Vinča-Pločnik II = Vinča D" (Greenfield 1991: 163).

However, in Chapman's (1981: 31) extensive exploration of the Vinča culture, he suggests a new division of the culture into early and late phases. This new interpretation is based on radiocarbon dates and artifactual evidence that only a part of the total length of the Vinča culture is represented by the type-site of Vinča Belo Brdo. Therefore, Chapman suggests an early phase, contemporary with the Vinča A, B, and C phases at the type site, (c. 4500-3950 bc), and a late phase, (c. 3950-3300 bc), represented by the Vinča D phase at the type site and later occupations at other Vinča sites, such as Divostin.

All this being said, the system to be used in this investigation is the most well known and most widely cited in other publications, the Milojčić and Garašanin periodizations. The Middle Neolithic period is represented by the Vinča A and B cultures (c. 4500-4100 BC) (Greenfield 1986: 113).

The origin of the Vinča culture has been greatly debated. The oldest theory, that of diffusion, states that the culture developed from external sources or stimuli. The more recent view is that local development and evolution was the primary force in cultural development (Chapman 1981: 33). Leković (1990) emphasizes the continuity of the Early

Neolithic Starčevo culture into the Vinča culture. He compares nine factors including architectural features, subsistence system, art, tools and weapons and pottery to demonstrate this phenomenon. However, it may be that the Vinča culture is a compromise between the two alternatives. Both processes of local evolution and diffusion have been identified (Chapman 1981: 39).

### *Cultures*

In northern Bulgaria and southern Romania, the Middle Neolithic is represented by the Vădastra I culture in the west (Oltenia) and the Dudeştri culture in the east (Muntenia) (Tringham 1971: 108). In southern Bulgaria, the middle Neolithic is characterized by the Veselinovo culture (Tringham 1971:106). The culture that dominates the Vojvodina, southwestern Romania and southern Hungary is the Vinča A and B culture (c. 4500-4100 BC) (Tringham 1971: 108; Chapman 1981: 1;Greenfield 1986: 113), that is, the Vinča-Tordoš culture (Garašanin 1983).

### *Settlement*

The late Starčevo (Early Neolithic) settlements and early Vinča settlements share several similarities that can be used to describe the characteristics of the Middle Neolithic period of the Balkans. Sites from both periods are located in the same geographical area of the Balkans, as well as in similar environmental niches, specifically, on elevated plateaus, close to water sources (Leković 1990: 72). Early Vinča sites are assumed to be temporarily occupied but were, in contrast to Early Neolithic sites, often re-occupied, leading to the establishment of tell sites (Leković 1990: 72). Additionally, in the Middle

Neolithic, more sites appear and these are more widely spread across the landscape and encompass a wider range of sizes. Sites, such as Selevac (having both middle Neolithic and late Neolithic occupations) (Tringham and Krstić 1990: 52), were very large, occupying over 50 hectares. However, it is likely that this large area of occupation was the result of a series of shifting smaller occupations (Whittle 1996: 103).

There is a major change in the size and shape of houses in the Middle Neolithic. While semi-subterranean houses continue to be found throughout the region, surface houses become the norm (e.g. at Stragari). They are small, one roomed rectangular or square buildings. However, in southern Bulgaria (Veselinovo culture) there appears to be evidence for the internal differentiation of structures into more than one room with specific areas set aside for the oven, hearth and grinding implements (Tringham 1971: 113).

### *Technology*

The tools and weapons of the Middle Neolithic are of the same type and manufactured from the same materials as in earlier periods, mainly, stone, flint, obsidian and bone (Leković 1990: 72). Additionally, at this time, the range of lithic technology changed with the increasing dominance of polished stone implements. It is likely these tools performed a variety of tasks, including woodworking, digging and even preparing animal skins. Chipped stone tools continued to be an important find in these assemblages, but occurred in small quantities. Other than in southern Romania there are no finds of microlith blades similar to those from Mesolithic sites. This level of technology appears to have disappeared by this time. The blades that have been recovered are generally not longer than 6 cm and have little or no modification of their shape by deliberate retouch of the blade. Examination of wear traces on these blades indicates that they were used on both hard materials such as wood or bone and on softer materials such as plant remains or meat. "There is very little evidence of the way in which they were hafted, whether singly or compositely" (Tringham 1971: 75). Wooden implements may also have been equally important technologically, but were not adequately preserved (Tringham 1971: 75).

While it is possible to draw parallels between the pottery of the two periods in an effort to demonstrate cultural continuity (Leković 1990: 72), the major distinction of the Vinča period from the Early Neolithic is the advances in pottery, both in terms of technology and decoration. There is a transition from fine painted ceramic vessels to dark burnished ceramic wares (Tringham and Krstić 1990: 52). There are advances in decoration and form (e.g. biconical) (Tringham 1971: 109; Garašanin 1983).

### *Mortuary*

There is the same pattern for disposal of the dead in the early and middle Neolithic periods. The dead are buried lying on their side, in a contracted position. These burials are found among the houses of the settlement with no specific grave area (Tringham 1971: 78). Grave goods, if they were present, were few and simple (Bailey 2000: 193).

### *Fauna*

The Early Vinča sites were agricultural communities, but had less dependence on wild resources than in previous periods. (Leković 1990: 72). Most characteristic about this period was the increase in the importance of domestic cattle. In the more heavily forested areas, the primary domestic species was cattle, followed in decreasing order of frequency by pigs and then by sheep/goat. In the drier more open ecological zones, sheep/goat predominated, with cattle in second place, and pigs a distant third (Greenfield 1986: 26). There is evidence for increased local domestication as remains of aurochs increased as well as the transitional forms between domestic and wild cattle. The same pattern of local domestication is seen in pig. Wild pig remains increased as well as the occurrence of transitional forms. In contrast, species such as red deer decreased in importance (Bōkönyi 1974: 28).

### *Flora*

The patterns of plant cultivation established in the Early Neolithic continued into later phases of the period. There was continued cultivation of emmer and einkorn wheat, barley, millet and peas (Whittle 1996: 111). Regional variation for subsistence undoubtedly continues with not all the staple cereals and legumes occurring in all sites. The method and scale of agricultural production also varied between villages and between regions (Bailey 2000: 140).

### *Evidence for sedentism/mobility*

Sedentism was a gradual process during the Neolithic period. It is clear that the degree of sedentism of settlements increases throughout the Neolithic period. Researchers do not make solid claims for sedentism until later periods (Voytek and Tringham 1985; Whittle 1996: 71). As in the Early Neolithic, the evidence indicates that the Early Vinča sites were not permanently (year-round) occupied, but, in contrast, were more often re-occupied. This caused an increase in the formation of tell sites (Leković 1990: 72). However, flat sites without significant occupational development continue to exist, highlighting the lack of permanent sedentism and further demonstrating the range of variation throughout the region (Whittle 1996: 101). There is also evidence for increases in population (Leković 1990: 72). A good example comes from Selevac. The architectural evidence suggests that over the course of the period, houses became more solidly built and longer lasting (Tringham and Krstić 1990; Whittle 1996: 105).

It has been suggested that the Middle Neolithic period can be characterized by increased complexity in raw material procurement, with the appearance of small amounts of copper, and in craft production and consumption. These developments may be the result of increased sedentism. However, it is unlikely that this could be a simple causal relationship (Whittle 1996: 105).

### Late Neolithic

#### *Chronology*

The Late Neolithic period of the northern Balkans covers the period from 4100-3300 BC (Greenfield 1986: 113). The Middle Neolithic Vinča-Tordoš settlements were overlain in later periods by thick habitation layers of the Late Neolithic and Eneolithic Vinča- Pločnik cultures (Tringham 1971: 180; Chapman 1981).

#### *Cultures*

The Late Neolithic is represented by the Vinča-Pločnik I and II culture (Chapman

1981). As discussed above, this is equivalent to the Vinča C (c. 3700 - 3400 bc; 4100-3900 BC) and Vinča D (c. 3400-3000 bc; 3900-3300 BC) phases (Greenfield 1986: 113).

### *Settlement*

The Vinča-Pločnik settlements are often located in the same areas as the Middle Neolithic Vinča-Tordoš settlements, that is on the lower terraces of the rivers (Tringham 1971: 180). However, shifts in settlement patterns are evident as the Vinča-Pločnik sites are small and more dispersed across the landscape (Whittle 1996: 83). It is during this period that permanent and highly organized agricultural villages are established (Tringham and Krstić 1990: 1).

Late Neolithic sites demonstrate internally well-organized communities with contemporaneous houses arranged in regular rows (Greenfield 1986: 6). A significant change in houses is also apparent as buildings became more substantial. At this time, houses were built of thick clay on a framework of wooden posts. A central row of posts in the interior of the house supported a gabled roof. Dimensions of the houses were typically 15 meters long and 6-8 meters wide, consisting of a main room and an antechamber. Increased investment in houses is evident with evidence for the external decoration including painting, incised decoration and even clay representations of cattle heads. Many houses had thick clay floors over a foundation of horizontal logs. Each house contained an oven placed in the centre of the floor (Tringham 1971: 183).

### *Technology*

In early phases of the Vinča-Pločnik culture antler tools were commonly found at all sites. These were typically perforated, with pointed ends or wide cutting edges. Polished stone axes and adzes, and hammer axes continue to be found. Later in the period, these common tools began to be accompanied by perforated copper hammer-axes and copper chisels (Tringham 1971: 182).

There is a notable change in pottery form as wider, shallower vessels, storage jars and, amphora begin to appear. In addition, the development of handled vessels can be considered a defining characteristic of the late Vinča culture (Chapman 1981).

### *Mortuary*

There was a continuity of burial patterns from the Middle Neolithic into the Late Neolithic. Burials continued to be found within the houses of the settlement. Additionally, new practices were emerging. In Serbia and southwestern Romania, the deceased were buried within the limits of the settlement, although in an unused area of the site. In some instances, the deceased were buried in a designated place outside the settlement (Chapman 1981; Bailey 2000: 195).

An increasing array of grave goods were also present in burials of this period, including both bone and metal ornaments and tools, and pottery vessels. Of these, pottery was by far the most common grave good. While not all graves contained grave goods, several patterns of grave assemblages can be noted. Male burials contain more artifacts that females and children's burials have few goods at all (Bailey 2000: 200).

### *Fauna*

Trends in animal exploitation patterns established in earlier periods continue through the Late Neolithic. Domestic animals continue to dominate faunal assemblages and the significant species (cattle, sheep, goat and pig) remained unchanged. The most noteworthy development was a move away from ovicaprine exploitation to a focus on cattle (Tringham 1971: 182; Bailey 2000: 182). At this time, cattle typically constitute 53-76% of the major domestic fauna. What is most interesting to note is that in this period the faunal assemblages (when statistically analyzed) separate into upland and lowland clusters. This is due to differences in the pig and cattle ratio between these areas. Cattle dominate in all sites but pigs are more common in the lowlands than in the uplands (Greenfield 1991: 172). The major domestic species were all exploited primarily for meat, although goat gives some indication of also being exploited for secondary products such as milk (Greenfield 1991: 181).

Additionally, there is evidence for a significant increase in the hunting of wild species in the Late Neolithic settlements. Faunal remains from red deer, wild pig, aurochs, and fish in appropriate areas, constitute a high proportion of the faunal assemblage (Tringham 1971: 180; Greenfield 1986, 1991). The same type of lowland/highland division seen in the domestic species is seen in the wild species. There is a lower domestic:wild ratio in the lowland sites than in the upland sites. It has been suggested that because the upland areas were better suited for agriculture with well-drained soils and easily cleared land wild animals were pushed out of this environment. In contrast, the lowlands, surrounded by wetlands in the plains, specialized in the exploitation of microenvironments, and incorporated both wild and domestic species into the subsistence system (Greenfield 1991: 179). Fishing continued to play an important role in the subsistence economy (Greenfield 1986: 27).

### *Flora*

In considering the evidence for plant cultivation in the Late Neolithic, it is important to realize that "the composition of plant samples varies considerably between different archaeological contexts" (Dennell 1972: 157). Additionally, few published paleobotanical analyses have been done since Tringham's (1971) summary of the period. However, it was noted that both barley and wheat were cultivated in Late Neolithic sites to the east and west of the Vinča-Pločnik culture. As such, it was likely that these species were also cultivated within the area. Dennell (1972: 157) concludes that emmer was more important than six-row naked barley in the Bulgarian Late Neolithic sites of Chevdar and Kazanluk (Greenfield 1986: 20). More recent summaries (Bailey 2000: 177) also note the presence of wheat, barley, legumes and pulses in the paleobotanical samples.

### *Evidence for sedentism/mobility*

The archaeological evidence, specifically the architectural evidence, points to increases in settlement permanency (Chapman 1981: 133). There were increases in building durability, and more rigid demarcation of space including a focus on specialized areas for economic and production activities (Bailey 2000: 174). Sites are larger and there is greater longevity of settlement. This may be taken as an indication of increases in population size and a high degree of agricultural productivity (Chapman 1981: 133). Many of the Late Neolithic sites show relatively deeper (commonly over four metres in depth), stratigraphically superimposed deposits and structures. This results in better feature preservation and higher artifact and feature density over large areas (Greenfield 1986: 6).

In addition to this architectural evidence the faunal remains from Late Neolithic sites in the central Balkans argues for sedentary lifestyles without marked occupational seasonality. The age distributions of several of the domestic species include all age groups implying year-round occupation, as do the antler data (Greenfield 1991: 182).

**Eneolithic (Chalcolithic)**

***Chronology***

The Eneolithic period, also known as the Chalcolithic or Copper Age, was the period between the Neolithic and the time when metal was commonly found, but was not yet the dominant technology (Garašanin 1983: 136; Greenfield 1999a). The Eneolithic period of the northern Balkans covers the period from 3300-2500 BC (Greenfield 1986: 113). While sporadic finds of metals throughout the Balkans show that these were not unknown in earlier times, their incidental use did not have critical effects on cultural change (Garašanin 1983: 136). During this period there were significant changes in settlement patterns and subsistence that show a marked break from the Neolithic. These new patterns show continuity into the following Bronze Age (Champion et al. 1984: 154).

***Cultures***

The Balkan Eneolithic is characterized by widely spread large cultural complexes which are composed of a series of regional variants. (Garašanin 1983: 142). The main Eneolithic cultures of interest in this investigation include the Baden group, which consists of a series of regional variants, and the Bubanj-Hum (I-II – local southern

Serbian variant). In the northern half of the region, the Baden culture has been subdivided with an initial Baden subculture, followed by the Kostalac group.. In central Serbia, they could not be separated and are described as the Baden-Kostalac variant (Garašanin 1983: 153) (c. 3300-2500 B.C) (Greenfield 1986: 113). Additionally, in the Vojvodina, the Vučedol group appears after the Kostolac group.

***Settlement***

During the Eneolithic, tell sites are common in the north (Garašanin 1983: 149), but flat sites with laterally displaced deposits are common in the hill country to the south of the Danube-Sava line. However, in some areas, such as Bulgaria, while a small number continued to be occupied and some were fortified, many tells were abandoned (Champion et al. 1984: 162). Settlements of the Bubanj-Hum cultural groups are often located on "naturally dominating, fortified positions or in places suitable for defense" (Garašanin 1983: 149). The development of metallurgy and the new importance of sources of these metals created a new sense of territoriality and the need to secure access to these resources. As a result, clashes often occurred and introduced the need for fortification of sites (Garašanin 1983: 136).

In the Eneolithic, the "site locations preferred in the earlier periods were no longer used and in many places there was an expansion of the settled area" (Champion et al. 1984: 160). While in the Neolithic settlement patterns were characterized by continuous localized use of a small area, in the Eneolithic there was a change to a geographically more extensive approach. Linked with this new system were the increasing importance of domestic animals and the use of plough agriculture. As settlements expanded onto soils that were inappropriate for sustained crop agriculture, more land was cleared, which in turn left increasing amounts of land fallow to feed more domestic animals (Champion et al. 1984: 162).

### *Technology*

There were considerable advances in several technological areas during this period in the Balkans. Although there is little direct evidence, it is generally put forth that there was improvement in the techniques of plant cultivation and animal husbandry (Tringham 1971: 148). Stone tools, such as hammers, were still in use (Garašanin 1983: 149)

There were important developments in the manufacture of pottery particularly in firing temperatures. It is possible that this development enabled the exploitation of copper resources (Tringham 1971: 148) and the expansion of metallurgy in later periods. In the early phase of the Eneolithic, the production of metal implements was limited to small objects such as jewelry, needles and awls. In the later phase, techniques improved and larger tools were manufactured, often on a massive scale. This included hammers, axe-adzes and cruciform-axes (Garašanin 1983: 139).

### *Mortuary*

Mortuary practices of the Eneolithic differ dramatically from the previous Neolithic. Within the Baden culture, cemeteries are rare, with most burials located within the settlement itself (Garašanin 1983: 153). The appearance of tumulus burials has also been noted in the Eneolithic (Harding 2000: 100). An interesting mortuary element is the occurrence of a double ox burial, indicating a draught pair, in the cemetery of Alsónémedi of the Baden culture. This gives a strong indication of the importance of domestic cattle, in particular of their exploitation for traction (Sherratt 1980: 264).

With the rise of metallurgy the same forces that brought about the need for fortified settlements also caused the beginnings of social stratification. The greater use of metal meant an increase in wealth for a select portion of society. This process is perhaps best reflected in the appearance of marked distinctions in the social position of individuals, reflected by the occurrence of rich and poor graves (Garašanin 1983: 148).

It becomes common to find highly decorated burials accompanied by prestigious grave goods (Bailey 1994: 327). Additionally, social differences between gender are apparent in the graves as male graves contain more grave goods than female graves (Bailey 1994: 325).

***Fauna***

As in earlier periods, animal economic activities were dominated by the raising of domestic stock, primarily sheep, goats and cattle (Garašanin 1983: 153). However, there was an increasing differentiation in subsistence between regions. Agricultural systems became more closely adapted to their specific regions and environments and began to make use of the secondary products of the main domestic species (Champion et al. 1984: 156). There was an increase in the scale of animal keeping during the Eneolithic (Sherratt 1980: 286). In temperate Europe this included the use of animals for their secondary products, such as animal traction with the plough and the cart, the exploitation of wool in sheep and the milking of domestic animals (Greenfield 1986, 1988, 1989; Champion et al. 1984: 156). These changes in the exploitation of domestic animals had such an important impact on the cultures of the area; it has been termed by Sherratt (1980, 1983) the 'Secondary Products Revolution'.

### *Flora*

As in earlier periods, wheat, barley, legumes and pulses dominate the paleobotanical samples (Bailey 2000: 177). The use of secondary products of animals also had implications for crop agriculture. The use of the plough "increased production and made economic the cultivation of a range of poorer quality soils; it thus resulted in the colonization of a wider area that had been possible under previous systems of cultivation" (Sherratt 1980: 262).

### *Evidence for sedentism/mobility*

It is obvious that the Late Neolithic/Post Neolithic boundary represents an important transition period in the central Balkans. Prehistoric societies underwent dramatic reorganization as well as a demographic redistribution. The Late Neolithic pattern is one of high intra-settlement population density and size, with regional population heavily concentrated in large settlements. In contrast, the Post Neolithic pattern is one of low intra-settlement population density and size accompanied by population dispersion into a larger number of more closely spaced residential localities. This shift appears not be associated with a population decline, but rather is simply redistribution over the landscape. The largest settlements have broken up and their population dispersed while the smaller settlements continued to exist, but usually in different locations (Greenfield 1986: 7).

Evidence for sedentism and mobility within the Eneolithic is difficult to interpret. Settlements were occupied for shorter amounts of time and there was a more rapid turnover of cultivated areas, as compared with earlier periods (Sherratt 1980: 292). It has been suggested (Greenfield 1986: 32) that some lowland localities were only occupied during the wet and cold period from late autumn to early spring, as domestic stock was moved to these areas to provide greater protection from winter conditions and better quantity and quality of graze. At the same time, an alternative strategy would have been the occupation of these sites year round. Then, the "expectation is that livestock were probably grazed in a variety of micro-environments found around habitats which sheltered them from the winter such as marshes. During the rest of the year, they were grazed on fallow fields" (Greenfield 1986: 33). It is difficult at this time to support one hypothesis or the other for this period.

## Early Bronze Age

### *Chronology*

The Bronze Age period begins in 2500 BC (Harding 2000: 1) and ends at 1000 BC in the central Balkans (Garašanin 1983; Greenfield 1986) and is commonly divided into early, middle and late phases. The Early Bronze Age extends from 2700-2000 BC (2000-1700/1600 bc) (Greenfield 2001).

### *Cultures*

Cultural groups in the area, while mutually related, had their own regional limits and differences, based mainly on pottery types. These groups include Vinkovci in Srem and Slavonia and Bubanj-Hum III in the valley of the Južna Morava (Garašanin 1983: 170).

### *Settlement*

At this time, there are major changes in settlement patterns throughout the Balkans. In contrast to earlier periods, the Early Bronze Age pattern is one of low intra-settlement population density and size accompanied by population dispersion into a larger number of more closely spaced residential localities. Population increases and is accompanied by a redistribution of the population over the landscape (Greenfield 1986: 7; Greenfield 2001). The settlements of the Bronze Age are located in a wider range of environments, utilizing most of the major environmental zones of the Balkan Peninsula. This shift may be the result of the greater diversification of subsistence that necessitated a change in land use. Settlements were no longer restricted to the rich alluvial soils along water sources, but now were found in all areas, highland and lowland (Greenfield 2001).

In certain areas, such as the hills surrounding the Pannonian plain, settlement hierarchies emerge. Upper level sites are often fortified and located in naturally defensible positions such as on hilltops. While these sites are small, they are considered to be regional centres and were permanently occupied. "Each river valley area is dominated by one or two such sites" (Greenfield 2001). Lower level sites were small and undifferentiated villages or hamlets. River valleys may contain several of these sites.

However, this pattern of settlement hierarchies did not occur uniformly throughout the region (Greenfield 2001).

Another feature of Bronze Age settlements is that they are essentially shallow, usually with deposits of only 50 cm or less (excluding pits or disturbed plow zones). These Bronze Age settlements show insubstantial wattle and daub architecture, rarely more than one vertically definable occupation level, features that are easily disturbed by ancient and modern ploughing and horizontally displaced stratigraphy. Additionally, these sites are "spatially extensive and have low surface and subsurface artifact densities" (Greenfield 1986: 6).

While statements on community organization in the Early Bronze Age are limited by the lack of extensive excavation, two dominant patterns emerge. As in the Late Neolithic, some Early Bronze Age sites demonstrate internally well-organized communities with contemporaneous houses arranged in regular rows. In contrast, other sites show no organized distribution of structures with a haphazard layout (Greenfield 2001).

Both surface and semi-subterranean (pit houses) houses are known in the Early Bronze Age. Surface houses vary greatly in size but are generally small (3x4; 10x8; 7x5 m) and rectangular in shape. Houses are constructed with wattle-and-daub architecture. Inside, the floors were made of earth or wooden beams and hearths and clay ovens are commonly found. "There is little evidence of functional differences between houses within settlements, since the nature and distribution of artifacts does not vary dramatically" (Greenfield 2001). While little is known about the pit houses, descriptions of which tend to be poorly published, they were typically small and occupied only for short periods (Greenfield 2001).

***Technology***

The development of metallurgy continued in the Bronze Age with the same techniques that were in use at the time of its introduction. These included simple forms of casting followed by extensive reworking (Champion et al. 1984: 215). Metal objects included weapons, such as swords, daggers and axes, and ornaments (Greenfield 2001). Ornaments were generally made of hammered sheet metal or bent wire. In the early part of the period metal artifacts were few and were largely made of copper (Champion et al. 1984: 215; Greenfield 2001). Also at this time bronze tools begin to be produced. Silver and gold are also found. The majority of metal finds are associated with graves. However, hoards of metal objects begin to appear in this period. The majority of metal items were not utilitarian, and were of mainly social importance (Greenfield 2001). The spread of various kinds of metal objects indicates the expansion of trade links and commercial exchanges between regions on a much larger scale (Garašanin 1983: 163).

Stone tools appear to be less important in the Early Bronze Age, as they are no longer common finds within sites. However, analyses of cut marks on animal bones have revealed that stone tools continue in use as butchering tools in the sites of commoners. In contrast, the same analysis reveals that metal cutting tools are the usual butchering tools in the sites of elites (Greenfield 1999b).

Technologies associated with the development of the exploitation of animals for their secondary products become an important element of the Bronze Age. While both the plough and the cart appear during the Eneolithic, they are not utilized extensively. It is not until the Early Bronze Age that these new technologies are employed extensively and change the nature of food production and trade (Greenfield 2001).

In earlier periods, flax was the dominant material for the manufacture of textiles. Wool began to replace flax as the primary cloth for textiles beginning in the Eneolithic and continuing through the Early Bronze Age (Greenfield 2001). Ceramic spindle whorls and figurines of woolly sheep appear in the archaeological record. Analysis of the faunal remains reveals a change in the culling patterns for sheep, providing further evidence for a shift toward secondary products exploitation (Greenfield 1989, 2001).

### *Mortuary*

The occurrence of tumuli graves varies throughout the Balkans. They are found in western Serbia and eastern Bosnia (Harding 2000: 100) and are common throughout southern Croatia and Bosnia (Harding 2000: 101). They were generally of medium size, not very high and rarely with a diameter over 20 meters. Often the periphery was marked with stones and the inner core was constructed of a cairn of stones (Garašanin 1983: 173).

Cemeteries were common and contained two contemporary types of funerary rites, inhumation and cremation (Garašanin 1983: 174). In graves, skeletons were found in a contracted position (Garašanin 1983: 173) facing east, with a north-south orientation (Greenfield 2001). Multiple burials were common, often belonging to family groups (Garašanin 1983: 173).

As discussed above, this period saw the emergence of low-level social hierarchies. This is a pattern most vividly reflected in the mortuary practices of the settlements.

> During the EBA, some burials with much more elaborate graves goods than others appear, both within communal cemeteries and in separate spatial locations. Many of these have very sophisticated grave goods made of bronze, copper and gold and non-local goods obtained through long-distance exchange (Greenfield 2001).

These grave goods also give indications of status differences between genders as men are buried with more highly valued goods than women are. However, these hierarchical social distinctions are not visible in every settlement (Greenfield 2001).

***Fauna***

In the Bronze Age, farmers practiced a mixed subsistence strategy with cattle, sheep, goat and pig as the main domestic animals (Bökönyi 1974: 33; Harding 2000: 134; Bailey 2000: 256). Some variation in importance of each species occurs in response to local environmental conditions (Harding 2000: 134). Additionally, several changes were evident. Cattle decrease in frequency while still remaining the dominant species, with a corresponding increase in sheep, goat and to a lesser extent pig (Greenfield 1986; Harding 2000: 134; Bailey 2000: 256).

Horse is also present at Early Bronze Age sites. While horse remains were rare on earlier sites, they occur in large numbers in the Bronze Age. "This is the feature which most sharply contrasts the Bronze Age animal keeping with that of preceding periods" (Bökönyi 1974: 33). Large quantities of horse remains appear to be associated with "elite" settlements during this period (Greenfield 1986).

Wild species are still present in faunal assemblages and evidently continued to be part of the subsistence economy. But their importance was greatly reduced (Greenfield

1986; Harding 2000: 134). Fish continue to be an important component of the wild fauna, particularly in lowland sites (Greenfield 2001).

### *Flora*

"Although plant remains are commonly found, recovery techniques have frequently not been adequate to compose a satisfactory picture of the plant economy of the Bronze Age" (Harding 2000: 143). In spite of this observation, several generalizations about plant remains can be made based on observations and developments from earlier periods. While variation in importance of species between sites was common, agriculture was still the primary occupation, with evidence of wheat, oats, peas and lentils as domestic crops. There is also evidence of a wide range of fruits and berries (Harding 2000: 143).

### *Evidence for sedentism/mobility*

Significant shifts in subsistence and settlement patterns, mortuary practices, architectural and artifactual remains begin during the Eneolithic and continue during the Early Bronze Age (Greenfield 1986). It has been suggested that these important changes were the result of developments in agriculture and husbandry. Sherratt (1980, 1983) argues that increased specialization in the secondary products of the main domestic species, specifically the introduction of the cart, would have resulted in increased ease of movement for people at this time. An alternative suggestion has been the adoption of transhumant pastoralism as the dominant economic strategy. It has historically been a significant part of the economy in the Mediterranean and the Balkans. Many researchers

(Geddes 1983, Greenfield 1986, Halstead 1981) agree that it was also an important element of the economy in prehistoric times (Harding 2000: 138). Each of these hypotheses suggests greater mobility of populations across the landscape. The settlement data in particular supports this idea.

## Middle and Late Bronze Age

### *Chronology*

As defined above, the entire Bronze Age period begins in 2500 BC (Harding 2000: 1) and ends at 1000 BC in the central Balkans (Garašanin 1983; Greenfield 1986). Within the northern Balkans, the Middle Bronze Age extends from 1900-1400 BC (1500-1300 bc) while the Late Bronze Age extends from 1400-1000 BC (1300-1200 bc) (Garašanin 1983: 166).

### *Cultures*

As the Bronze Age progressed, closely linked cultural groups evolved that shared many common features. This makes the delimitation of their exact territories rather difficult as they often overlapped. As a result, the Middle and Late Bronze Age are often grouped together in publications (e.g. Garašanin 1983; Harding 2000). Major cultural groups include the Vatin and Dubovac-Žuto Brdo, found in southern Pannonia (the Vojvodina) and Danubian Serbia, and the Verbicioara ceramic groups found in Romania. These groups are known to extend into northern Bulgaria (Garašanin 1983: 175). These cultural groups all appear to be contemporary (Garašanin 1983: 175, 177) and fall within the Middle-Late Bronze Ages of the central Balkans (Reinecke – Br A2/B1 to D – ca.

1600-1200 bc). The end of the Bronze Age in the region is usually associated with the Halstatt A (following Reinecke - Greenfield 1986: 138).

### *Settlement*

The settlement patterns established in the Early Bronze Age continue into the later phases. There is low intra-settlement population density and size accompanied by population dispersion into a larger number of more closely spaced residential localities. A redistribution of the population over the landscape results in few large settlements and many smaller settlements. A distribution pattern of several sites per valley, dominated by a single regional center, is common (Greenfield 1986: 7)

Bronze Age settlements show shallow occupation horizons and have insubstantial wattle and daub architecture, rarely more than one vertically definable occupation level. These sites are "spatially extensive and have low surface and subsurface artifact densities" (Greenfield 1986: 6).

### *Technology*

Stone was still an important material in the later periods of the Bronze Age and common items were bored hammers. Bone rings were a common find. These materials are overshadowed by the increasing use of metal. Gold jewelry and a variety of bronze objects were widespread (Garašanin 1983: 177). During the Middle Bronze Age, there was increasing elaboration of ornaments, weapons and tools. At this time, metal begins to be widely used for more practical activities and not simply for social display (Greenfield 1999b). Large numbers of axes are found, which could have been both weapons and tools. Additionally, woodworking tools and the first bronze sickles appear at this time.

The trend of using metal for the manufacture of everyday tools was even more pronounced in the Late Bronze Age (Champion et al. 1984: 217).

### *Mortuary*

While inhumations continue in the Middle and Late Bronze Age they become less common. They are replaced by the widespread "ürnenfeld kulture" with cremations becoming the most common practice. However, both rituals seem to be practiced contemporaneously – although possibly in different settlements.

### *Fauna*

It is important to stress that there is little variation in animal husbandry across the region. The relative importance of each species in an assemblage seems to vary in response to local environmental conditions (Bökönyi 1974; Greenfield 1986; Harding 2000: 134). However, it is possible to highlight some trends within the period. Cattle are the dominant species, although it has declined somewhat in importance in comparison to the previous period. Sheep/goat increase in importance at the expense of cattle and pigs, although pigs increase in frequency somewhat as well (Bökönyi 1974: 34; Greenfield 1986).

In contrast to the variety seen in the exploitation of domestic animals, the hunting of wild species was barely incidental and much more homogeneous throughout the Bronze Age. Aurochs were less frequent than red deer and generally less than other wild species. This indicates two features of the later Bronze Age animal exploitation patterns. First, aurochs were becoming more rare throughout the landscape. Additionally, this indicates the decline of the domestication process. Animal husbandry had advanced to the point where it can "support itself not only by increasing the stock of domestic animals without further domestication and providing the population with meat but also supplying other foodstuffs (milk), giving draught power and material for clothing" (Bökönyi 1974: 34).

### *Flora*

There is little change in the types of cultivated plants that are found in sites in the Balkans until the later phases of the Bronze Age. A range of new species including spelt wheat, millet and several types of oil-bearing plants (e.g. poppy, flax) were exploited and there is suggestion that there was a corresponding increase in intensity of cultivation, particularly legumes. While these species were occasionally found in earlier periods, it is not until this time that they become abundantly utilized (Harding 2000: 144).

### *Evidence for sedentism/mobility*

Whether it was due to the increased use of the cart (Piggott 1982), or the adoption of transhumant pastoralism (Greenfield 1999a), the evidence seems to suggest that there was an increase in mobility of people across the landscape during the Bronze Age periods. Smaller site size and lack of significant architectural structures suggests a degree of impermanence in the settlements.

## Early Iron Age

### *Chronology*

Chronology for the Early Iron Age in the Balkans is problematic. Before World War II Reinecke's system for central Europe was extended to the Balkans and divided into three basic epochs; Bronze Age D, Halstatt A and Halstatt B. These last two periods are additionally subdivided into Halstatt A1-A2 and Halstatt B1-B3. The application of this system to the Balkan area was problematic as it was based on material with no direct connection to the Balkans. As a result it created more difficulties than it clarified. Subsequently, Bronze D and Halstatt A have been recognized to be part of the Late Bronze Age (1400-1000 BC). There is a transitional period between the Late Bronze Age and Early Iron Age (1000-800 BC) which is characterized by Halstatt B. Finally, the Early Iron Age is characterized by Halstatt C, and D. (Garašanin 1983; Greenfield 1986).

### *Cultures*

The Early Iron Age in southeastern Europe is represented by the Halstatt C and D (800 - 500 BC) cultures (Greenfield 1986: 113). The central European core of the Halstatt material culture covers a vast area from Budapest into central Europe and north into Germany (Wells 1984: 8).

### *Settlement*

During this period, there is a continuation of the trend of the abandonment of tell sites and settlement dispersion into smaller communities (Raish 1992: 15). These sites were commonly located on hilltops or other places well placed for defense (Garašanin

1983: 591) and were often fortified (Raish 1992: 15). The most common types of houses are oval or rectangular pit-dwellings, most of which contain a hearth (Garašanin 1983: 589), but surface houses of wattle and daub are also found (Garašanin 1983: 590).

### *Technology*

Use of pottery continues into the Early Iron Age and decoration and manufacture is often a distinguishing characteristic of the different regional cultures. While incised and stamped patterns are common, decorations are varied and more elaborate than previous periods. A variety of body and rim shapes are found and many vessels have handles (Garašanin 1983: 589).

Most cutting and manufacturing tools such as knives and swords were made of iron (Milisauskas 1978: 253). Bronze continued to be an important material particularly for ornaments, vessels, horse trappings, armour (Phillips 1980: 260) and arrow heads (Garašanin 1983: 597) and was often used in conjunction with iron (Phillips 1980: 260).

### *Mortuary*

Some of the best mortuary data for this period comes from cemeteries in the southern Morava region and the Kosovo area. Burials are arranged in groups in specially constructed graves. Burials were cremations with the remains placed in urns set on stone slabs and often covered by an additional slab. Often the urns were surrounded and covered by a stone layer of concentrically arranged white pebbles and boulders (Garašanin 1983: 597).

### *Fauna*

It appears that the patterns of animal husbandry and exploitation that were common in the Bronze Age continue into the Early Iron Age. There is the continued dominance of cattle over the other common domestic species of sheep/goat and pig and these species were exploited for both primary and secondary products. Horse remains became a common part of faunal assemblages. The most noted difference between faunal assemblages of this period and earlier periods is the almost complete lack of any bones of wild species (Bökönyi 1974: 34) although fishing may have continued in certain areas (Garašanin 1983: 590).

### *Flora*

The early part of the Iron Age is characterized by settlement expansion into agriculturally marginal areas. While this trend continues throughout the period, there is also evidence of certain areas being abandoned (Champion et al. 1984: 277). As increasingly marginal soils were brought under cultivation, some became susceptible to over-exploitation and exhaustion. As a result, this period shows evidence of new strategies of increasing agricultural output. This included new crops, such as rye in suitable areas, new tools and technology and more complex and intensive systems of agricultural organization (Champion et al. 1984: 278).

### *Evidence for sedentism/mobility*

The dominant settlement pattern of the Early Iron Age is a continuation of the patterns established in the Early Bronze Age. The occurrence of smaller more dispersed settlements seems to suggest an increased mobility of the population across the landscape. These observations have been interpreted as "facilitating the growing importance of pastoralism in the economy" (Raish 1992: 15).

**Conclusions**

The extensive temporal range of Balkan culture history summarized above traces the appearance of the first major animal domesticates (sheep/goat, cattle and pig) in the Balkans during the Early Neolithic. It also shows the development of the further exploitation of these species over time through the use of their secondary products. Additionally, other significant cultural change occurs throughout this time, specifically the development of pottery manufacture and the use of metals. However, the principal changes of interest in this investigation are the shifting importance of the various domestic species over time and the potentially interrelated changes in settlement patterns. Reitz and Wing (1999: 7) assert that it is the interactions of humans and animals, which forms "the basis of subsistence strategies and eventually of economic and other social institutions". This is not to suggest that the changing patterns of animal exploitation throughout the prehistory of the Balkans should be proposed as the sole causal factor of the changes observed throughout this time. However, some of the trends evident in this brief summary of the culture history of the Balkans from the Neolithic to the Early Iron Age may be explained through a more in-depth investigation into the nature of animal husbandry throughout this temporal period.

# Chapter 6:

# Methodology

## Introduction

The general approach or methodology chosen for this investigation is zooarchaeology. Olsen (1971:2) defines this as the study of animals in relation to man. Zooarchaeology is particularly suited to the investigation of transhumant pastoralism because it utilizes the remains of the animals of interest. While the proportion of the population that was involved in the movement of the livestock is still debated, the majority of animals were moved around the landscape in a mixed pastoral economy (Geddes 1983; Greenfield 1999a). As a result, the remains of the animals should yield a clear pattern of complementary movement between highland and lowland sites (Greenfield 1986, 1991, 1999a).

Within zooarchaeology, emphasis should be placed on interpretation, rather than simple identification (Olsen 1971:1). Preliminary identification and species determinations from all of the sites to be presented here have already been completed. The present investigation seeks to go beyond this preliminary identification to examine what these remains can reveal about a specific problem. The primary purpose of zooarchaeology is to investigate the interactions of humans and animals as this forms "the basis of subsistence strategies and eventually of economic and other cultural institutions" (Reitz and Wing 1999:7).

## Technique

### *Choice of technique*

The techniques chosen for this investigation must establish both age of death and season of death of the archaeological faunal remains of the three major domestic species. There are a variety of techniques for the determination of age of death of archaeological samples. These include epiphyseal fusion and closure of cranial sutures, tooth growth and replacement sequences, tooth wear, incremental structures and antler and horn development (Reitz and Wing 1999: 159). The main method of age determination has traditionally been epiphyseal fusion. There are several problems associated with this method. First, the chronological age of fusion is not known for most wild species. Second, the epiphyseal age classes are sometimes too coarse to establish meaningful mortality profiles (Klein and Cruz-Uribe 1984: 43). It is this second characteristic which is of great concern for this investigation. Additionally, the fusion of epiphyses ends relatively early in an animal's life (Payne 1973: 283) when an animal reaches maturity. This makes it very difficult to distinguish a prime adult (young but full-grown) from an aged one, based purely on the epiphyseal data (Crabtree 1982: 242; Klein and Cruz-Uribe 1984: 43). This is a necessary step in analysis if we are to reconstruct the economic uses of the domestic species (Crabtree 1982: 243). Finally, epiphyseal data are often biased because of differential attrition between early and late fusing bone ends, early fusing tending to be more resistant to attrition. This leads to a bias against certain age classes. The same is true for the very young age classes. Their bones are not fused and are very subject to attrition (Greenfield 1986, 1991; Lyman 1994). The disadvantages of epiphyseal fusion for ageing can be overcome by the use of teeth for age data.

Cementum analysis is a technique that is often separated from primary faunal identification because it requires specialized equipment (Reitz and Wing 1999:167), is significantly more time consuming, and is destructive of specimens. Its application has proven useful for the determination of both age and season of death in mammals (Lieberman and Meadow 1992: 57).

The University of Manitoba has a thin sectioning laboratory, allowing access to this equipment and training necessary for this investigation. However, the sample of archaeological teeth available for sectioning is limited. As a result, cementum analysis is chosen as a secondary technique to supplement the more complete database information on tooth wear and eruption. The "analysis of cementum can be of great assistance in testing hypotheses concerning seasonality that have been based on other sources of information" (Lieberman and Meadow 1992: 57). It is hoped that the combination of both techniques will provide a complete picture of the economic movement of these animals. Additionally, the combination of the two techniques may minimize some of the problems of interpretation associated with each technique.

***Tooth wear and eruption***

Tooth wear is one of the oldest techniques for age determination, and is particularly applicable to large herbivores (Davis 1987: 40). It has been supported as the most accurate method of age determination when it can be tied into a known age sequence (Lowe 1967) and is still widely utilized today (Hambleton 1999: Munson 2000).

The eruption of deciduous and permanent teeth in animals allows for ageing in much the same manner as the state of epiphyseal fusion of the post-cranial skeleton. However, using the dentition of animals offers several advantages. "Unlike epiphyses, teeth monitor age more or less continuously throughout the life of an individual. This means that teeth can be used to define a larger number of more narrowly bounded age classes" (Klein and Cruz-Uribe 1984: 44). Analysis of tooth wear and eruption enables a clear distinction between prime adults and senile adults (Klein and Cruz-Uribe 1984: 44). The mandibles and mandibular teeth "display greater survivability than most post-cranial elements, and are therefore less affected by preservation bias" (Hambleton 1999: 61) and differential recovery (Payne 1973: 284). This greater durability of teeth often makes them more abundant in a sample, and so, they are able to provide an interpretable profile when epiphyses cannot. Additionally, the wear, or degeneration of the teeth allows for ageing beyond the range of epiphyseal fusion and tooth eruption (Reitz and Wing 1999: 162). "Finally, unlike epiphyses, teeth are almost always identifiable to species" (Klein and Cruz-Uribe 1984: 44), so there is little need to lump categories together and reduce the precision of the data. The sequence and timing of the eruption of the teeth in the mandible for domestic animals has been established for a number of species (Silver 1969; Habermehl 1961; Getty 1975).

Previous research by Greenfield (1986, 1988, 1991) made minimal use of the tooth wear and eruption data that were recorded. It is time to give this material the attention it deserves. As such, the primary technique for the determination of age and season of death for this investigation is analysis of tooth eruption and wear patterns of the species of interest.

There are three main disadvantages associated with tooth wear and eruption. The primary disadvantage is that the nature of the animals' environment, specifically, the foods eaten, and the amount of grit consumed when eating can affect the degree of wear. As well, the general nutritional health of the animal can affect wear stages of teeth (Reitz and Wing 1999: 162). While tooth eruption and wear stages can provide a good estimation of physiological age of an individual, there are problems in attempts to assign an absolute age to wear stages (Hambleton 1999: 61). Finally, while cow and pig can easily be identified and distinguished from each other, there are currently no reliable means of distinguishing sheep and goat mandibles (Ewbanks 1964: 423) except in young animals (Payne 1985), particularly with fragmentary material. As a result, they must be considered together, as they often are in archaeological analyses, "despite possible differences between man's use of the two animals at the same site" (Payne 1973: 284). Attempts have been made to minimize some of these problems through the establishment and examination of comparative modern collections of tooth wear from a variety of species. However, Hillson (1986: 180) highlights that because the variation within archaeological populations cannot be known, there is still an element of uncertainty.

There are two main systems for the recording of tooth eruption and wear data. Both systems utilizes a series of diagrams showing successive tooth wear stages, where individual wear or eruption stage of each tooth is recorded by reference to the diagrams (Grant 1982: 105). The first was established by Grant (1975) and is applicable to sheep, cattle and pigs. The second system is from Payne and focuses on sheep/goat only. However, Halstead (1985) has adapted Payne's technique for use with cattle as well. Both systems identify tooth wear stages for permanent mandibular molars and the deciduous and permanent fourth premolar. The wear stages of each molar tooth are combined to provide a mandibular wear stage. The systems differ in terms of number of wear stages, how the tooth wear stages are defined and the relation to absolute age.

> Payne groups the mandibles according to their state of wear into broad bands which each represent a chronologically defined age group. Grant also groups mandibles according to their wear but in much smaller bands each of which represent a particular mandible wear stage that is defined by a number. This number relates to its age relative to other wear stages but not to absolute age. The different stages of all mandibles in a population are expressed by Grant in the form a frequency diagram showing the number of jaws representing each mandible wear stage. Payne expresses wear data in the form of a mortality curve by calculating the percentage of the population still alive at the end of each successive age stage (Hambleton 1999: 62).

***Converting the results of different analyses of mandibular tooth wear into a similar format***

Data was coded using a faunal coding system established by Greenfield (1986), based on Meadow (1978). Both the Grant and the Payne systems have been utilized in the recording of the tooth wear and eruption stages of the domestic animals in this investigation. For ovicaprines, the data collected between 1977-90 employs Payne (1973) for mandibular tooth wear and eruption, whereas the later data sets use Grant (1975). Therefore, it is necessary to first convert them into a similar format for comparison. Hambleton (1999), in her research on animal husbandry in Iron Age Britain, was faced with the same problem. Her research provides a method of conversion (Tables 1-3) from the Grant system of recording tooth wear to Payne's system since Payne's results allow for easier recognition of herd age structure and kill off patterns. Grant's method provides neither indication of absolute age, nor the relative duration of different wear stages. As a result, "it is harder to determine what the observed populations structures equate to in terms of the classic meat, milk or wool economies characterized by Payne" (Hambleton

1999: 63). The establishment of age distributions is an important element of reconstructing animal exploitation strategies (Greenfield 1988: 574) and having them in an easily readable and understandable format assists in interpretation.

The reliability of this method of conversion can also be tested utilizing the modern sheep and goat comparative that has been collected by the author. Both Grant and Payne wear stages have been recorded for these mandibles.

***Establishing absolute age***

In some investigations it is adequate to assign individual bones to age classes, such as juvenile, immature and adult. But where assessment of the economic significance of domestic species is required, establishing the absolute age of the species is highly desirable (Bullock and Rackham 1982: 73). In her conversion from Grant's to Payne's systems, Hambleton (1999: 64) ignores absolute ages completely and relies solely on comparisons of relative physiological ages. She does, however, provide data on suggested age using Payne (1973) for sheep/goat, Halstead (1985) for cattle and Higham (1967) and Bull and Payne (1982) for pig. For the purposes of this investigation, the assignment of absolute ages is a necessary step and will be assigned to each species as above.

The modern goat comparative collection provides a test of the assigned ages of sheep/goat given by Payne. The suggested ages listed by Payne for sheep/goat will be compared to the known ages of the collected specimens. While it would appear more logical to assume that the earlier breeds would be more applicable to archaeological populations, the research does not bear out that assumption.

Payne (1985) suggests that Silver's 19th century ages for cattle are inaccurate and that modern 20th century eruption timetables are more applicable to archaeological populations. Similarly for sheep study of the Harlow Temple assemblage indicates that Iron Age dental eruption is more analogous to Silver's modern figures than the 19th century dates, as the seasonal kill pattern of the Harlow Temple sheep only becomes apparent when using modern eruption times. The same is true for pig; modern and ancient wild boar share the same eruption times as modern domestic pigs (Hambleton 1999: 61).

Additionally, research on the dental eruption and wear of Soay sheep, a feral breed believed to be the closest living analogy to prehistoric breeds, also agrees with Silver's modern estimates and Payne's suggested absolute ages (Hambleton 1999: 62). Therefore, the use of a modern collected sample for this type of testing seems both appropriate and applicable.

The suggested ages for cattle and pig cannot be tested in this way, as there is no adequate comparative modern mandible collection of known age available to the researcher. The suggested absolute ages from Hambleton (1999) for these breeds will be accepted as valid.

Absolute age for mandibles in the database will be established with the following procedure. For the databases that use Grant's (1975) method, the Greenfield code assigned a numerical code to indicate the degree of wear of each tooth following Grant's wear stages. The code assigned by Greenfield is not the same as the numerical values assigned to each wear stage by Grant. Therefore, the faunal code utilized by Greenfield must be converted to the Grant wear stage letters. Then it is assigned the numerical value as per Grant's method (Table 4). The mandibular score is obtained by adding the numerical value of the three molar teeth only (Grant 1975: 442). The score for the mandible can then be evaluated against Hambleton's conversion to a Payne wear stage (for sheep/goat) and then to an absolute age (Tables 1-3).

For mandibles that are missing one of the three molar teeth, it is still possible to assign a mandibular stage using Grant's method. Grant (1982) provides a method whereby the wear stage of the missing tooth can be predicted. The wear stage of a missing tooth "is made by reference to complete molar rows in which the wear stages of the teeth are the same as those that are present in the incomplete mandibles" (Grant 1982: 96). It is possible to establish a range of mandibular stages, and so, a range of absolute ages, utilizing the charts discussed above (Tables 1-3).

Again, in databases that have utilized Payne's method of recording tooth wear and eruption, it is also necessary to treat complete mandibles (those with all three molar teeth) and those with missing teeth differently. It is relatively easy to assign a wear stage to a complete mandible, and the corresponding absolute age, following Payne's (1973) examples. To deal with mandibles with missing teeth, he too provides charts, which facilitate the assignment of a wear stage.

Loose Teeth

Loose teeth are useful especially in those sites where there are few or no mandibles. Normally, one does not like to use them because of the possibility of inflating the count of Minimum Number of Individual's. But in many cases in this investigation, it is necessary to use them due to the problem of small sample size. The only loose teeth included in the examination were those molar teeth that were specifically identified to number, i.e. first, second or third molar teeth. Lower loose teeth will be dealt with as if they were mandibles with two missing teeth.

***Determining stage distribution***

It is easy to record the stages of mandibles and loose teeth that fall nicely into one of the established age stages. It is more difficult to deal with mandibles and loose teeth that cover a range of stages, such as B-C. The data will be recorded in the following manner. The raw count represents mandibles and loose teeth that have been identified as belonging to each stage on the basis of the defined criteria as defined above (Payne 1973; Grant 1975; Hambleton 1999). Following the method proposed by Payne (1973) the corrected count represents specimens that cannot be placed more closely than within a group of stages. These specimens are proportionally allocated to the age stages based on the raw count data. This is explained by Payne's (1973) example (Figure 7).

***Production strategies and construction of harvest profiles***

Harvest profiles of faunal remains are widely utilized by archaeologists to elucidate the exploitation strategies of a society as "the different age and sex groups will be slaughtered by herders according to the type of products they wish the herd to produce" (Greenfield 1991: 170). The harvest profile is the distribution of age at death for a species (Hesse 1982; Greenfield 1988). Production strategies, whether the domestic animals were utilized for primary products, such as meat, or whether they were utilized for secondary products, such as milk, traction, wool or hair, will be reflected in the harvest profile derived from the data. The use of harvest profiles for the examination of exploitation strategies has several advantages over other methods. First, the species frequencies in faunal samples are subject to taphonomic biases. Second, it is nearly impossible to reconstruct the original herd structure. Finally, the goal for archaeologists is to determine the ways the animals were managed.

The harvest profiles for this investigation are established for all three domestic species (sheep/goat, cattle and pig) for each site and for each major period using the traditional methodology proposed in Payne's (1973) seminal study. All staged mandibles are counted and the percentage of the total sample calculated. These percentages are then sequentially subtracted from 100 and the resulting values graphed. Loose teeth are included where they provide a sufficiently narrow age stage or are necessary to provide a sufficient sample size.

In order to compare the degree of similarity between harvest profiles between sites, the chi square statistic was used in all cases where there are two or more profiles per period. The youngest age group was eliminated from consideration due to the taphnomic issues and the age groups E through to I were combined. The analysis was performed using StatXact 4 software. A significance level (p value) of less than 0.05 was considered to be statistically significant. The software provided both a usual p value that is the original chi square test and is best for large samples. Additionally, an exact p value was calculated, which corrects for small sample size (i.e. cells less than 5) and provides a more accurate calculation (Dennis Murphy, pers. Comm., 2001).

***Establishing season of death***

Monks (1981) provides a detailed examination of the various techniques for the determination of season of death. The majority of techniques are very similar to those for age of death determination. This is due to the fact that season of death is established by the combination of age, considered in months, with the month of birth for the species to provide an estimation of the season of death (Monks 1981: 186; Burke 1995: 3). This technique is only useful for the younger age groups, i.e. less than one year, as once age is greater than twelve months it is not possible to pinpoint season. It is this fact that necessitates the addition of the secondary procedure in this investigation, cementum analysis.

**Cementum analysis**

Incremental growth structures have been observed in a variety of organisms. These may be present in mineralized tissues, such as bone, molluscs, teeth, otoliths, fish spines and antler pedicles (Pike-Tay 1991: 28). Correlations between growth lines in teeth have been recognized for more than 30 years as the most reliable means of establishing age and season of death of individual specimens (Lieberman 1993a: 1162).

Teeth are composed of three distinct tissues, enamel, dentine and cementum. Enamel covers the crown of the tooth, while cementum covers the roots of a tooth. Dentine forms the main structure of the tooth and underlies both the enamel and the cementum (Hillson 1986: 9). Incremental structures have been identified in all three of the dental tissues (Lieberman and Meadow 1992: 57). While the study of incremental structures in teeth has previously focused on both the dentine and the cementum, it is the analysis of cementum that has proven more effective in the determination of both age determinations and season of death information (Pike-Tay 1991: 34). Therefore, it is the incremental structures in cementum of domestic animal teeth that are of interest in this investigation.

Dental cementum has been considered extremely reliable, since it is deposited through the entirety of an animal's life and is rarely resorbed (Gordon 1993: 9). Seasonal differences in the deposition of cementum are generally manifest and described as growth zones (which represent the period of active deposition of cementum), annuli (which occur as a result of growth slowdown) and Line of Arrested Growth that occur as a result of growth cessation. Together, these structures may be referred to as a Growth Line Group and is the equivalent of a year in time (Burke 1995).

### *Cementum composition and structure*

Cementum is composed of both organic (35%) and inorganic (65%) components (Burke 1995: 5). The organic component is collagen fibres and mucopolysaccharides while the inorganic component is calcium phosphate (hydroxyapatite). Additionally other elements, such as fluorine, are present in small quantities (Klevezal 1996: 121). Cementum is deposited around the roots of teeth by cementoblasts. The cementum is deposited on the surface of the dentine, within and around the Sharpey's fibers that protrude from the periodontal ligament (Lieberman and Meadow 1992: 59). Therefore, the earliest layers of cementum are closest to the dentin, while those formed later are closer to the outside part of the root (Klevezal 1996: 121).

There are several different types of cementum that differ in terms of histology, development and function. There are two major categories of cementum, cellular and acellular. By definition, acellular cementum does not contain cells, or cementocytes.

Acellular cementum tends to be found on the sides of the root close to the enamel border. In contrast, cellular cementum does contain cementocytes and is found at the apex of the root and in the inter-root pad. However, "in principle...both types of cementum can be found in any part of a tooth, and layers of cellular and acellular may even alternate" (Klevezal 1996: 121).

There is some disagreement with these distinctions in types of cementum. The presence or absence of cementocytes may be the result of the variable growth rate with which the two types of cementum are deposited. As in bone, the more slowly deposited layers will have a lower cell-space volume fraction than layers deposited more quickly, with a resultant lower tissue density. Therefore, the distinction of acellular and cellular cementum based on presence or absence of cells may not be valid for all species. It has been demonstrated in horse teeth that "the cementum layers contained lacunae (evidence of cementocytes) regardless of their location on the tooth" (Burke and Castenet 1995: 480). Similarly, in the sheep and goat teeth examined through the course of this research, evidence of the presence of cells is found throughout the tooth cementum (A. Burke pers. comm.). As a result, the principal distinction of the different types of cementum should be the organization of the collagen fibre matrix. This is the source of the observed structural variations in cementum (Burke and Castenet 1995: 480).

The type of collagen in the tissue further subdivides the two types of cementum, whether it is extrinsic, intrinsic or mixed. Intrinsic collagen is synthesized by the cementoblasts. It is a component of almost all cementum. However, most of the collagen in cementum is extrinsic. "Extrinsic collagen is synthesized by fibroblasts in the periodontal ligament" (Lieberman and Meadow 1992: 59). These extrinsic fibres anchor the tooth root to the periodontal ligament as they are mineralized as part of the cementum matrix. Acellular cementum has a high proportion of extrinsic fibres, with relatively fewer intrinsic collage fibres (Lieberman and Meadow 1992: 60). In contrast, cellular cementum has more intrinsic fibres and fewer and sometimes no extrinsic fibres (Lieberman and Meadow 1992: 62).

Additionally, there are two minor categories of cementum that are involved in the development of the tooth. These are intermediate (hyaline) cementum and cementoid (or precementum) (Lieberman and Meadow 1992: 59). For a full discussion of the histology and structure of the various types of cementum see Lieberman and Meadow (1992).

Acellular cementum is the most reliable for indications of age at and season of death (Lieberman and Meadow 1992: 59). It is deposited towards the cervical end of the tooth root and is composed of seasonally deposited bands that appear either opaque or translucent in polarized light (Lieberman and Meadow 1992: 61).

The causes of the annual growth cycle of cementum are still largely debated within the literature. Grue and Jensen (1979) provide a comprehensive summary. It is generally recognized that the formation of incremental structures in cementum are governed to a considerable degree by an internal rhythm related to the animal's growth and metabolism (Grue and Jensen 1979: 41). However, external factors can still exert some effects on cementum formation (Burke 1995: 11). These can include environment and climate (Grue and Jensen 1979; Burke 1995), dietary restrictions, hormonal changes, reduced food intake (Saxon and Higham 1969) and reduced nutrition and biomechanical stress (Lieberman 1993b). It is likely that it is the result of a complex of factors and the need for further investigation as to their influence is required.

***Observation of structures***

Several techniques are available for the observation of growth structures in cementum. These include polarized light, ordinary light, stained, histological thin sections, transmitted or scanning electron microscopy and microradiography (Burke 1995: 8). The chosen technique for this investigation is the examination of undecalcified, ground thin sections of teeth to be viewed using a polarizing light microscope with a rotating stage under both transmitted and polarized light. This is one of the few techniques that are applicable to both modern and archaeological teeth.

The wider, growth zones of cementum appear light in colour and opaque under reflected light microscopy and transmitted polarized light. In contrast, these same structures will appear dark under transmitted white (or natural) light. The narrower annuli in cementum appear dark in color and translucent under reflected light microscopy as well as with transmitted polarized light. In contrast, these increments will appear bright under transmitted white (natural) light (Burke 1995: 6; Pike-Tay 1995: 276-277).

Acellular cementum is deposited at the cementum-enamel junction, or the cervical region of the tooth. This makes this area of the tooth ideal for the counting of the incremental structures in the cementum. In this region, the lines are most distinct and even. Additionally, in ungulates it has been shown that layers in cementum are often disturbed in the apical area of the root, and layers here are less distinct. As a result, the coronal half of the root is preferred for interpretation (Grue and Jensen 1979: 19).

***The control sample***

The purpose of a modern control sample is to establish the time of formation of incremental growth structures in the cementum in order to apply this information to the study of an archaeological sample (Burke and Castenet 1995: 479). A sample of sheep and goat skulls were collected from August 2000 to March 2001 from local Manitoba abattoirs. Approximately six sheep per month were collected from Carmen Meats in Carmen, MB. The goats were collected from Prairie Abattoir in Portage la Prairie, MB. The abattoir slaughtered two animals per week, which were collected each month. The utilization of these local animals is considered applicable to archaeological material in the Balkans because the animals are obtained from an environment with roughly similar patterns of seasonality. The animals of the comparative collection are goats raised on small-scale farms in Manitoba. They are domestic farm animals raised with seasonal differences both in food availability and seasonal environment.

All the goats were born in the month of April, with a mean birth date estimated by the producer to be April $15^{th}$. The goats range in age from 6 months to a year and a half. As the pattern of slaughter was two animals per week and the specimens were collected at roughly the middle of each month throughout the collection period, date of death was estimated over a period of two months. This changed through the time of collection when collection was at the end of each month.

It was possible to obtain several older sheep, from a private producer who raises sheep for wool. This small sample included one sheep specimen that was four and a half years old (54 months) and two animals that were a year and a half-year-old at death. These were also included in the final sample in order to expand the age range covered by the sample. Additionally, two older sheep with no age information that were collected from the abattoir were included. As a result, the final modern comparative collection consists of both sheep and goat. There are forty three animals, twenty nine goats and fourteen sheep, in the sample that compares tooth eruption and wear. The thin sectioning sample consists of nineteen animals, fourteen goats and five sheep.

It was not detrimental to the analysis to include both sheep and goats in the sample. They are often lumped together in zooarchaeological investigations due to difficulties in reliably distinguishing the two species (Payne 1973: 284). The teeth of sheep and goat are very similar in structure and size (Hillson 1986: 97). Other researchers have utilized the application of goat thin sections to *Gazella gazella* (Lieberman 1993b: 117) based on the close phylogenetic relationship (family Bovidae).

Mandibles were extracted from the skull and defleshed. The tooth wear and eruption was recorded for each mandible, both with Payne's system and with Grant's system. Then, the M1 of the left side of the mandible was extracted for thin sectioning. While all teeth are equally useful for cementum analysis (Gordon 1984: 4 quoted in Pike-Tay 1991: 53), only mandibular M1 was selected for a variety of reasons.

1. The establishment of this control sample is for the purpose of interpretation of archaeological teeth.
2. Mandibular teeth are easier to section due to their simpler root forms.
3. Incisors and canines are less frequent than cheek teeth in archaeological samples.
4. Incisors and canines are more difficult to identify to the species level in archaeological samples than are cheek teeth.

A total of fourteen goats were included in the sample collected monthly from August to March of the same year. As these were animals slaughtered for meat consumption, they were generally young animals (less that a year and half). Due to the young age of the goats, the comparative sample was supplemented by five sheep specimens (over the age of 18 months) in order to bulk out the older age groups of the sample.

Sheep and goat are often lumped together in archaeological assemblages due to the difficulty of accurately distinguishing their remains to species (Boesseneck 1969; Payne 1973). Their lumping together here, in the control sample can be justified because of their close phylogenetic relationships (family *Bovidae*). The teeth of sheep and goats are very similar in form and size (Hillson 1986: 97).

The modern thin section sample of goats will provide an interesting methodological contribution by testing whether the incremental growth visible in the teeth of the goats agrees or does not agree with the eruption/wear stages and/or with the actual ages. It will act as a three-way comparison between tooth eruption and wear, incremental structures and true ages (A. Burke, pers. comm., 2001).

***The fossil sample***

As cementum is the least hard of the dental tissues, it can easily be stripped from the tooth as the result of post-mortem damage. As a result, only M1 still encased in the mandible are selected for the archaeological sample (Lieberman and Meadow 1992: 68).

The researcher did not have access to the teeth from all the sites for which there are tooth wear and eruption data available. As a result, the potential sample of archaeological teeth was limited. It was decided to section a sample of twenty left mandibular M1 teeth in total - ten teeth from a highland site and ten teeth from a lowland site. The sites chosen were Vinča (Belo-Brdo, Serbia), a lowland site that includes material from the Late Neolithic, Eneolithic and Middle Bronze Age, and Kadica Brdo (Knežina, Bosnia) a highland site that includes material from the Early Iron Age.

In the original analysis of the teeth selected for the archaeological thin sectioning sample, the majority was identified only to *Ovis/Capra*. As a result, it was necessary to attempt to distinguish them to sheep, *Ovis aries*, or goat, *Capra hircus*. While Payne (1985) provides distinctions between these species for the mandibles of young animals, the majority of the archaeological sample consisted of older individuals. As such, it was necessary to make these distinctions utilizing other criteria.

Based on observations made of both *Ovis aries* and *Capra hircus* mandibles in the Anthropology Laboratory at the University of Manitoba by the author and H. Greenfield, the following criteria were utilized to distinguish the mandibles to the necessary level of species distinction. As in Boesseneck (1962), the vertical ramus of sheep slopes upward (Figure 8). This is most noted in younger animals and is difficult to distinguish without a significant portion of the hinge. In the goat, the vertical ramus is oriented more straight up and down (Figure 9). The most useful distinction between the mandibles of older individuals of these species is the slope that is seen in the horizontal ramus. When the mandible is oriented with the occulusal surface as a guide, the horizontal ramus in sheep curves upwards towards the occulusal surface more steeply than in goats. Additionally, the break in slope, where the slope begins is also useful. It is under the anterior edge of M3 in sheep and it is under M2 in goats if it is present at all.

### *Materials and methods*

The teeth selected for sectioning must first be removed from the mandible. This was accomplished through the use of a small handsaw and a high-speed rotary saw. Two cuts were made on either side of M1 and the mandible was broken along these lines using a pair of cutters and/or a screwdriver. The modern teeth were then soaked in a degreasing agent (in a 50:50 solution with water) in order to remove as much of the fat and grease from the teeth. Teeth were soaked for five days, and then allowed two full days to air dry. This degreasing step was omitted for the archaeological teeth. All teeth were measured according to guidelines in Von den Driesch (1976) (Appendix A and B).

The tooth must be encased in resin (Buehler Epoxide) in order to fill any voids in the sample and protect fragile materials. Samples were placed into vessels, or boats, suitable to the size of the tooth. The appropriate amount of both hardener and resin was calculated, weighted and then mixed together (100 parts of resin to 36 parts of hardener by weight). The mixture was poured into the boat to fully cover the sample. The vessel was placed into the vacuum chamber for 15 to 20 minutes, removed and allowed to harden for 24 hours.

In order for the sample to be mounted on a slide for thin sectioning, an initial cut through the sample was necessary. The cut was made longitudinally, parallel to the cementum surface. An Isomet saw with a wafering blade was used. The block was then polished on a polishing/grinding machine as evenly as possible using first a 320 micron abrasive paper and, then with a 400 micron abrasive paper prior to mounting on glass slides.

Beuhler Epoxide was then used to glue specimens to slides. A small amount of resin was spread on the slide in a "T" shape, roughly the same length as the specimen to be glued. Beginning at the top of the "T", one edge of the specimen was placed on the slide. The block was then quickly lowered. The sample was moved around slightly to allow the resin/hardener to spread under the entire sample and release any air bubbles that may be trapped underneath the specimen. The sample was then positioned in the centre of the slide. Slides were left to dry, approximately 24 hours or more.

Next, the slide was mounted to the vacuum chuck of the thin sectioning machine that cuts away the majority of the specimen block. Using 320 and 400 micron abrasive papers, the freshly cut side was then hand thinned as evenly as possible on the grinding/polishing wheel. This was necessary to allow light to pass through the sample and provide a clear representation of growth increments. During this process the slide was checked periodically under the microscope to estimate how much more thinning was required to allow for optimal visibility of the growth increments.

Once the structures were clearly visible and readable under the microscope, a thin layer of resin/hardener was applied. This prevents the specimen from drying out and lifting from the slide. The appropriate amount the Epoxide resin/hardener is mixed and a thin layer spread on the slide and left to harden for at least twenty four hours.

The final stage of the thin sectioning process was to remove as much of this final layer of resin without exposing and further abrading the specimen. The 320 micron abrasive paper was used to carefully remove some of the top coat of resin. The 400 micron and finally the 600 micron abrasive papers were used in turn to remove scratches and polish the surface. Polishing was finished by applying a small amount of 0.05 micron powder polish to the specimen and rubbing with a chamois cloth. The slide was then accurately labeled with permanent ink.

### *Age determination*

In general, the "age of death of animals can be estimated by adding the number of seasons of cementum growth to the age at which the tooth erupted" (Lieberman 1993b: 525). In most species, cementum deposition begins shortly before or just at the time of eruption (Grue and Jensen 1979: 8). However, in order to most accurately determine age by the number of cementum layers, one must establish the time of the formation of the first increment line, from which counting should begin (Klevezal 1996: 171). "By counting layers, an observer determines the age of a given tooth. To estimate the age of the animal, it is necessary to add one year or more, depending on the time of this tooth eruption" (Klevezal 1996: 121).

The eruption time for M1 in sheep and goats will be taken to be three months, following Silver's (1969) modern eruption timetable. Because the timing of the eruption is before the beginning of the first winter, some amount of cementum is present on the root before the first winter. As a result, the first cementum layer visible corresponds to the first year of an animal's life. In these circumstances, there is a rule to be accepted in age determination by cementum layers. It is stated as follows:

> When we see the first (innermost) incremental line close to the dentin, it should be considered to be formed in the first winter of a given tooth function. When the first incremental line is separated form the dentin by a wide cementum band, then this line should be considered to be a line of the second winter of the tooth function (Klevezal 1996: 122).

### *Season of death determination*

Researchers have correlated growth layers in cementum with seasonal growth of many mammalian species. As a result, it is possible to deduce the season of death for archaeological samples. Under transmitted polarized light, the bands that appear opaque are usually deposited in most animals during the season of reduced growth; in contrast the bands that appear translucent are most often deposited during the growth season. The establishment of a control sample will determine in which season these different bands of acellular cementum are formed, then the season of death of an individual can be determined (Lieberman 1993b: 90) through an examination of the nature of the outermost band (Grue and Jensen 1979: 6; Lieberman 1993b: 525).

## Conclusion

The two zooarchaeological techniques chosen here utilize the most relevant source of information on the transhumant movement of domestic herds, that is, the remains of the animals of interest. The tooth wear and eruption data has only been analyzed in an informal manner (combined with the post-cranial material) in previous research. As a potentially informative source of information for this question, it deserves more significant attention. While providing additional age estimation, the cementum analysis will also supply more accurate season of death information, an important element in the consideration of the transhumant movement of herds.

# Chapter 7:

# Data Description

## Introduction

In this section, each of the sites used in the thesis will be briefly described in terms of their location, surrounding environment, and period of occupation. The sites examined within this investigation have already been investigated by Greenfield from a zooarchaeological perspective and have been described in detail in other publications.

Only mandibles and loose teeth that are identified as domestic will be considered in the analysis. Only species represented by sample sizes greater than ten elements per period per site are considered in this thesis. Some mandibles could not to be assigned to an age based on tooth wear and eruption due to the fact that they were missing the three molar teeth that are required to assign an age. A description of the remains and the final sample size for each species and period within each site is summarized below.

Before discussion of the analysis, it is necessary to note that data from a number of other sites were available for analysis (Greenfield 1986, 1994, 1996). However, these sites are excluded from the analysis due insufficient sample size of all domestic taxa. The following sites will not be considered further: Bukovačka Česma, Crkvina, Hajdučka Vodenica, Sarina Medja, Vrbica and Većina Mala.

### *Blagotin*

Blagotin, a site in central Serbia (Figure 6) is located at the base of the Blagotin Mountain (250 m asl) at the headwaters of the Blagotin stream. It is a mid-altitude site. It has nearby access to rolling hills and low mountains, but is surrounded by mixed oak forests and rich agricultural areas. The site is distributed partially on a gentle slope above the stream and partially on the flatter terrace above the slope. The slope has contributed to severe erosion in some areas of the site (Greenfield and Stanković n.d.).

The site has three periods of occupation, Early Neolithic, Eneolithic and Early Iron Age. The site is relatively small. It was c. 100x80 m during the Early Neolithic, 100x50 m in the Eneolithic, and 200x200 m during the Early Iron Age. It has deposits that range up to a depth of 3 m at the center of the site, with vertically superimposed remains. There was little laterally displaced stratigraphy at the site. Approximately 50% of the site was wet-sieved and floated (Greenfield 2000; Greenfield and Stanković n.d.).

***Mandibular and loose tooth remains***

Eighty five *Ovis aries* mandibles and loose teeth were recovered from Early Neolithic levels at Blagotin (81 mandibles and 4 loose teeth), all domestic. Thirty six mandibles and one loose tooth were unidentifiable to age, leaving forty five mandibles and three loose teeth in the final analysis (n=48 - Table 5). Table 6 summarizes the age stage distributions of *Ovis aries* remains from the Early Neolithic.

The Eneolithic and Early Iron Age samples of *Ovis aries* both consisted of only one mandible. Both were identifiable to age.

A total of 299 *Ovis/Capra* mandibles and loose teeth were recovered from Early Neolithic deposits at Blagotin (233 mandibles and 66 loose teeth), all domestic. There were 191 mandibles and nineteen loose unidentifiable to age, leaving forty two mandibles and forty seven loose teeth in the final analysis (n=89 - Table 5). Table 7 summarizes the age stage distributions of *Ovis/Capra* remains from the Early Neolithic.

As the Eneolithic sample of *Ovis aries* was too small for effective analysis, it was lumped into the *Ovis/Capra* category to increase sample size. As a result, nine *Ovis/Capra* mandibles and loose teeth were recovered from Eneolithic levels of Blagotin (3 mandibles, one of *Ovis aries* and 6 loose teeth), all domestic. Three mandibles were unidentifiable to age, leaving six loose teeth in the final analysis (n=6 - Table 5). Table 8 summarizes the age stage distributions of *Ovis/Capra* remains from the Eneolithic.

The Early Iron Age sample of *Ovis/Capra* included the single *Ovis aries* mandible from this period as well. Eighteen *Ovis/Capra* mandibles and loose teeth were recovered from Early Iron Age levels at Blagotin (9 mandibles and 9 loose teeth), all domestic. Five of the mandibles and two of the loose teeth were unidentifiable to age, leaving four mandibles and seven loose teeth in the final analysis (n=11 - Table 5). Table 9 summarizes the age stage distributions of *Ovis/Capra* remains from the Early Iron Age.

A total of 281 *Bos taurus* mandibles and loose teeth were recovered from Early Neolithic deposits at Blagotin (232 mandibles and 49 loose teeth), all domestic. There were 194 mandibles and nine loose teeth unidentifiable to age, leaving thirty eight mandibles and forty loose teeth in the final analysis (n=78 - Table 10). Table 11 summarizes the age stage distributions of *Bos taurus* remains from the Early Neolithic.

Nineteen *Bos taurus* mandibles and loose teeth were recovered from Eneolithic levels at Blagotin (8 mandibles and 11 loose teeth), all domestic. Five mandibles and two loose teeth were unidentifiable to age, leaving three mandibles and nine loose teeth in the final sample (n=12 - Table 10). Table 12 summarizes the age stage distributions of *Bos taurus* remains from the Eneolithic.

Twenty two *Bos taurus* mandibles and loose teeth were recovered from Early Iron Age deposits at Blagotin (15 mandibles and 7 loose teeth), all domestic. Thirteen mandibles and two loose teeth were unidentifiable to age, leaving two mandibles and five loose teeth in the final analysis (n=7 - Table 10). Table 13 summarizes the age stage distributions of *Bos taurus* remains from the Early Iron Age.

Nine domestic *Sus scrofa* mandibles were recovered from Early Neolithic levels at Blagotin. Seven were unidentifiable to age, leaving two mandibles in the final analysis (n = 2 - Table 14). Table 15 summarizes the age stage distributions of *Sus scrofa* remains from the Early Neolithic.

One *Sus scrofa* mandible was recovered from the Eneolithic levels at Blagotin. It was unidentifiable to age, leaving no Eneolithic *Sus* sample. In the Early Iron Age levels only one *Sus scrofa* mandible was found. It is identifiable to age and the final sample size is one.

### *Foeni-Salaş*

Foeni-Salaş is a lowland site located in the western edge of the Romanian Banat (Figure 4) near the village of Foeni (approximately 3 km away from the Serbian border). The site is in the flat alluvial plain of the Banat. It is located on the bank of the Timişat, a tributary of the Timiş river. This is an area distinguished by low altitude (c. 80 m asl) and low relief (Greenfield and Draşovean 1994: 46).

Two features of this area, a high water table and the gentle slope of the land, combine to contribute to frequent flooding of the rivers and the formation of swamps (Greenfield and Draşovean 1994: 46). The area was drained in the 19th century. Forests existed along the river edge, but these are no longer in existence. Most of the area is presently used for cultivation, but the soil tends to be very heavy. It was likely not extensively cultivated before the advent of the plough.

There are at least five periods of occupation at the site, the Early Neolithic, Eneolithic, Early Iron Age, Dacian (later Roman), and Medieval periods. Only the Early Neolithic, Eneolithic and Early Iron Age periods will be considered here. The site is found on a low natural mound, part of an ancient alluvial terrace. It is small, roughly half a hectare and consists of a single, thin Early Neolithic occupation horizon and discrete features from the Early Neolithic and other periods (Greenfield and Draşovean 1994: 46). The sample was almost entirely dry and wet sieved (c. 85%).

***Mandibular and loose tooth remains***

Twelve *Ovis aries* mandibles were recovered from Early Neolithic levels at Foeni-Salaş, all domestic. Two mandibles were indeterminable to age, leaving ten mandibles in the final analysis (n = 10 - Table 16). Table 17 summarizes the age stage distributions of *Ovis aries* remains from the Early Neolithic.

Five *Ovis aries* mandibles were recovered from Early Iron Age levels at Foeni-Salaş, all domestic. All were identifiable to age using tooth wear and eruption, making the final sample size n = 5 (Table 16). Table 18 summarizes the age stage distributions of *Ovis aries* remains from the Early Iron Age.

Four *Capra hircus* mandibles were recovered from Early Neolithic deposits of Foeni-Salaş, all domestic. Two mandibles were unidentifiable to age, making the final sample size n = 2. In the Early Iron Age levels, there was only one domestic *Capra* *hircus* mandible. As both the *Ovis aries* and the *Capra hircus* samples were small, they were lumped into the category *Ovis/Capra* for analysis.

Ninety three *Ovis/Capra* mandibles and loose teeth were recovered from Early Neolithic levels at Foeni-Salaş (76 mandibles and 17 loose teeth), all domestic. Forty mandibles and three loose teeth were unidentifiable to age, leaving thirty six mandibles and fourteen loose teeth in the final sample (n=50 – Table 16). Table 19 summarizes the age stage distributions of *Ovis/Capra* remains from the Early Neolithic.

Thirteen *Ovis/Capra* mandibles and loose teeth were recovered from Early Iron Age levels at Foeni-Salaş (11 mandibles and 2 loose teeth), all domestic. Four mandibles were unidentifiable to age, leaving seven mandibles and two loose teeth in the final analysis (n=9 – Table 16). Table 20 summarizes the age stage distributions of *Ovis/Capra* remains from the Early Iron Age.

There was no *Ovis/Capra* Middle Bronze Age sample for Foeni-Salaş as the sample consisted of one *Ovis/Capra* mandible that was undeterminable to age.

Forty two *Bos taurus* mandibles and loose teeth were recovered from Early Neolithic deposits at Foeni-Salaş (34 mandibles and 8 loose teeth), all domestic. Twenty four mandibles and one loose tooth were unidentifiable to age, leaving ten mandibles and seven loose teeth in the final analysis (n = 17 - Table 21). Table 22 summarizes the age stage distributions of *Bos taurus* remains from the Early Neolithic.

There was not any *Bos taurus* mandibles or loose teeth from the Middle Bronze Age deposits. Eleven *Bos taurus* mandibles and loose teeth were recovered from Early Iron Age levels at Foeni-Salaş (6 mandibles and 5 loose teeth), all domestic. Four mandibles and two loose teeth were unidentifiable to age, leaving two mandibles and three loose teeth in the final analysis (n=5 - Table 21). Table 23 summarizes the age stage distributions of *Bos taurus* remains from the Early Iron Age.

Eight *Sus scrofa* mandibles and loose teeth were recovered from Early Neolithic levels at Foeni-Salaş. Two were identified as belonging to wild species, (*Sus scrofa fer.*) and were eliminated from the sample. The total domestic sample size was six (4 mandibles and 2 loose teeth). Three mandibles and one loose tooth were unidentifiable to age, leaving one mandible and one loose tooth in the final analysis (n=2 - Table 24).

There was no Middle Bronze Age or Early Iron Age *Sus scrofa* sample from Foeni-Salaş, as these levels contained only one mandible from a domestic pig species. Both were unidentifiable to age.

***Kadica Brdo***

Kadica Brdo is located on a hilltop overlooking the western end of the Glasinac plateau in eastern Bosnia (Figure 4) and is located above and close (5 km) to the town of Knežina.

Glasinac is the largest highland plateau in Europe. It is found at elevations mostly above 1000 m asl, with surrounding mountain heights extending up to 2000 m asl. Extensive sub-alpine grasslands and coniferous forests cover the plateau. The area, today, is known mainly for grazing and forestry. This is not an environment suitable for extensive agriculture. Presently, there are pockets of small-scale agriculture located in various depressions within the basin.

The site at Kadica Brdo was occupied during the Eneolithic, Early Iron Age, and Late Iron Age. Only the faunal remains from the Early Iron Age levels derive from secure temporal contexts. As a result, only these will be considered in this investigation.

Kadica Brdo is a small site (100x50 m), surrounded by a thick fortification wall, which preserved the internal stratigraphy at the site. Only one trench was dry sieved, but selected samples across the site were also floated. Approximately 10% of the spatial contexts were systematically recovered (Greenfield, personal communication).

***Mandibular and loose tooth remains***

Fifty seven *Ovis aries* mandibles and loose teeth were recovered from Early Iron Age deposits at Kadica Brdo (49 mandibles and 8 loose teeth), all domestic. Ten mandibles were unidentifiable to age, leaving thirty nine mandibles and eight loose teeth in the final analysis (n=47 - Table 25). Table 26 summarizes the age stage distributions of *Ovis aries* remains from the Early Iron Age.

The total number of *Capra hircus* mandibles and loose teeth recovered from Early Iron Age deposits at Kadica Brdo was eleven (10 mandibles and 1 loose tooth), all domestic. Three mandibles were unidentifiable to age, leaving seven mandibles and one loose tooth in the final analysis (n=8). Table 27 summarizes the age stage distributions of *Capra hircus* remains from the Early Iron Age.

There were a total of 254 mandibles and loose teeth of *Ovis/Capra* recovered from Early Iron Age levels at Kadica Brdo (153 mandibles and 101 loose teeth), all domestic. Forty two mandibles and four loose teeth were undeterminable to age, leaving 111 mandibles and 97 loose teeth in the final analysis (n=208 - Table 25). Table 28 summarizes the age stage distributions of *Ovis/Capra* remains from the Early Iron Age.

Sixty six *Bos taurus* mandibles and loose teeth were recovered from Early Iron Age levels at Kadica Brdo (36 mandibles and 30 loose teeth), all domestic. Eighteen mandibles and one loose tooth were undeterminable to age, leaving eighteen mandibles and twenty nine loose teeth in the final analysis (n=47 - Table 29). Table 30 summarizes the age stage distributions of *Bos taurus* remains from the Early Iron Age.

Seventy two *Sus scrofa* mandibles and loose teeth were recovered from Early Iron Age levels at Kadica Brdo (65 mandibles and 7 loose teeth), all domestic. Twenty three mandibles were unidentifiable to age, leaving forty two mandibles and seven loose teeth in the final analysis (n = 49 - Table 31). Table 32 summarizes the age stage distributions of *Sus scrofa* remains from the Early Iron Age.

***Livade***

Livade is a lowland site located on the right bank of the Danube in northeastern Serbia at the western edge of the Dacian Plain (Figure 6). It is just beyond the eastern edge of the Iron Gates, on the eastern side of the mountains of eastern Serbia. It is near the modern village of Mala Vrbica, on the eastern edge of the area of investigation. The site contains ceramic and other artifactual remains with strong cultural affinities to the other sites in the study region (Greenfield 1986: 137).

Livade is located in the wide alluvial plain that borders the Danube. The Danube flows between a series of wide river terraces. The mountains of East Serbia are less than 5 km distant. On the left bank of the river, the broad Dacian plain begins.

The ceramic assemblage and figurines place Livade in the Dubovac-Žuto Brdo ceramic group. Some ceramic elements also reveal affiliation with the Verbicioara ceramic group across the river in Romanian Oltenia. As a result, Livade is considered to be a Late Bronze Age site. "Chronologically, the Dubavac-Žuto Brdo horizon falls within the Middle-Late Bronze ages of the central Balkans (Reinecke – Br A2/B1 to D – ca. 1600-1200 bc)" (Greenfield 1986: 138).

The size of Livade is difficult to determine because much of the site was buried beneath a thick sandy horizon (from river flooding). It extends for a distance of up to 100 m from the riverbank, and was investigated over a length of 200 m along the river. The sandy horizon preserved the site so that there was little mixing of remains in the cultural horizon (contrary to contemporary sites that are usually disturbed by ploughing). None of the site was sieved or floated (Greenfield 1986).

***Mandibular and loose tooth remains***

Sixteen domestic *Ovis/Capra* mandibles and loose teeth were recovered from Late Bronze Age levels at Livade (15 mandibles and 1 loose tooth). This included a single mandible of *Ovis aries*. Four mandibles and one loose tooth were unidentifiable to age, leaving eleven mandibles in the final analysis (n=11 - Table 33). Table 34 summarizes the age stage distributions of *Ovis/Capra* remains from the Late Bronze Age.

Twenty one *Bos taurus* mandibles and loose teeth were recovered from Late Bronze Age levels at Livade (14 mandibles and 7 loose teeth), all domestic. Four mandibles and one loose tooth were undeterminable to age, leaving ten mandibles and six loose teeth in the final analysis (n = 16 - Table 35). Table 36 summarizes the age stage distributions of *Bos taurus* remains from the Late Bronze Age.

Forty two *Sus scrofa* mandibles and loose teeth were recovered from Late Bronze Age levels at Livade (41 mandibles and 1 loose tooth), all domestic. Fifteen mandibles were undeterminable to age, leaving twenty six mandibles and one loose tooth in the final analysis (n = 27 - Table 37). Table 38 summarizes the age stage distributions of *Sus scrofa* remains from the Late Bronze Age.

***Ljuljaci***

Ljuljaci is found on Milica Brdo in the village of Ljuljaci, about 20 km west of the city of Kragujevac, in Serbia (Figure 6) (Greenfield 1986: 123), located on the western half of a natural plateau overlooking the surrounding valleys (Greenfield 1986: 124). Three sides of the plateau are steep with site only approachable from the eastern side. It is considered to be a fortified position due to its location. It is considered to be a mid-altitude site (c. 300 m asl). It is not part of the lowland area, but it cannot be considered truly to be a highland site.

A small stream, the Glavica, winds itself around the base of the plateau on the western, northern and eastern sides. The plateau area was subject to deforestation and cultivation during its period of occupation. The surrounding environment is one of rolling hills and low mountains covered by mixed oak forests and some agricultural cultivation.

Ljuljaci includes material from the late Early Bronze Age and the Middle Bronze Age. The stratigraphy of the site is relatively simple consisting of three layers. Dates are based on ceramic groups, and cross-dating with other sites.

1. Ljuljaci I – Early Bronze Age (ca. 1950 bc, uncalibrated)
2. Ljuljaci II – late Early Bronze Age- early Middle Bronze Age (1730-1690 bc)
3. Ljuljaci III – Middle Bronze Age (ca. 1600-1550 bc) (Greenfield 1986:125).

The site is relatively small, 100x50 m. In the early periods (Ljuljaci I and II), the settlement remained at about the same size. It expanded in size in the final period (Ljuljaci III). The stratigraphy was relatively thin, with a maximum depth of c. 1 m beneath the surface (except for the occasional pit). None of the site was sieved or floated (Greenfield 1986).

***Mandibular and loose tooth remains***

Five *Ovis/Capra* mandibles and loose teeth were recovered from Early Bronze Age levels at Ljuljaci (4 mandibles and 1 loose tooth), all domestic. Two mandibles were unidentifiable to age, leaving two mandibles and one loose tooth in the final analysis (n = 3 - Table 39). Table 40 summarizes the age stage distributions of *Ovis/Capra* remains from the Early Bronze Age.

In order to increase sample size, all materials were combined. There were a total of ten *Ovis/Capra* mandibles and loose teeth from the site (9 mandibles and 1 loose tooth), including one mandible identified as *Ovis aries*. All are domestic. Only one mandible was unidentifiable to age, that of the *Ovis aries*. Therefore, only eight mandibles and one loose tooth were included in the final analysis (n=9). Table 41 summarizes the age stage distributions of *Ovis/Capra* remains from the Early/Middle Bronze Age.

Two *Ovis/Capra* mandibles were recovered from the Middle Bronze Age period, domestic. One was identifiable to age. Therefore, the sample size is one. Table 42 summarizes the age stage distributions of *Ovis/Capra* remains from the Middle Bronze Age.

Seven *Bos taurus* mandibles were recovered from Early Bronze Age levels at Ljuljaci, all domestic. Five mandibles were unidentifiable to age, leaving two mandibles in the final analysis (n=2 - Table 43). Table 44 summarizes the age stage distributions of *Bos taurus* remains from the Early Bronze Age.

Again, to increase sample size, all levels were combined. There were a total of twenty four *Bos taurus* mandibles and teeth (16 mandibles and 8 loose teeth), all domestic. Eleven mandibles and one loose tooth were unidentifiable to age, leaving five mandibles and seven loose teeth in the final analysis (n = 12 - Table 43). Table 45 summarizes the age stage distributions of *Bos taurus* remains from the Early/Middle Bronze Age. The Middle Bronze Age *Bos taurus* sample consisted of only one mandible.

Eleven *Sus scrofa* mandibles and loose teeth were recovered from Early Bronze Age levels at Ljuljaci (10 mandibles and 1 loose tooth), all domestic. Six of the mandibles were unidentifiable to age, leaving four mandibles and one loose tooth in the final analysis (n = 5 - Table 46). Table 47 summarizes the age stage distributions of *Sus scrofa* remains from the Early Bronze Age.

Again, in order to increase sample size, all levels were combined. Two mandibles had no determination of domestication, but both were undeterminable to age and of no consequence to the sample. There were forty eight domestic *Sus scrofa* mandibles and loose teeth from the Bronze Age deposits (46 mandibles and 2 loose teeth). Twenty eight of the mandibles were unidentifiable to age, leaving eighteen mandibles and two loose teeth in the final sample (n = 20 - Table 46). Table 48 summarizes the age stage distributions of *Sus scrofa* remains from the Early/Middle Bronze Age.

Fifteen *Sus scrofa* mandibles and loose teeth were recovered from Middle Bronze Age levels at Ljuljaci (14 mandibles and 1 loose tooth), all domestic. Nine mandibles were unidentifiable to age, leaving five mandibles and one loose tooth in the final analysis (n = 6 - Table 46). Table 49 summarizes the age stage distributions of *Sus scrofa* remains from the Middle Bronze Age.

### *Megilo Nisi Galanis*

Megilo Nisi Galanis, in Greek Macedonia near the city of Kozani, is in the southern Ptolemais basin, the southernmost extension of the Pelagonian plain that stretching Macedonia into northern Greece (Figure 4). It is a large flat highland plateau surrounded by mountainous height but is considered a small mid-altitude site (c. 500 m asl) in terms of regional long distance transhumant pastoralists, with c. 100 x 100 m of thick deposits ranging from a depth of 2-3m. The entire site was dry and wet sieved. It is located on a paleo-lake drained in the 19th century, and falls within the Mediterranean climatic zone. Surrounding heights are currently used for grazing, the flats of the plateau for agriculture.

Megilo Nisi Galanis includes material from the Late Neolithic, Final Neolithic (=Eneolithic of central Balkans), and Early Bronze Age. Though out of the area of study, it is included for two main reasons; 1) it is a large and systematically collected and analyzed faunal sample from western Macedonia spanning the critical Late Neolithic-Post Neolithic temporal divide that is the focus of this investigation; 2) its inclusion in the sample provides a connection with the southern Balkans (H. Greenfield, pers.comm.; Greenfield and Fowler n.d.).

### *Mandibular and loose tooth remains*

Three *Ovis aries* mandibles were recovered from Late Neolithic/Final Neolithic levels at Megilo Nisi Galanis, all domestic. All were identifiable to age, and all were included in the final analysis (n = 3). Table 50 summarizes the age stage distributions of *Ovis aries* remains from the Late Neolithic/Final Neolithic.

Nine *Ovis aries* mandibles and loose teeth were recovered from Final Neolithic levels at Megilo Nisi Galanis (7 mandibles and 2 loose teeth), all domestic. Four mandibles could not be assigned an age, leaving three mandibles and two loose teeth in the final analysis (n = 5). Table 51 summarizes the age stage distributions of *Ovis aries* remains from the Final Neolithic.

Six *Ovis aries* mandibles and loose teeth were recovered from Final Neolithic/Early Bronze Age levels at Megilo Nisi Galanis (5 mandibles and 1 loose tooth), all domestic. One mandible was unidentifiable to age, leaving four mandibles and one loose tooth in the final analysis (n = 5 - Table 53)). Table 52 summarizes the age stage distributions of *Ovis aries* remains from the Final Neolithic/Early Bronze Age. As these samples were too small for effective analysis, they were combined with the *Ovis/Capra* remains.

Fourteen domestic *Ovis/Capra* mandibles were recovered from Late Neolithic/Final Neolithic levels at Megilo Nisi Galanis. Five were unidentifiable to age, leaving nine mandibles in the final analysis (n = 9 - Table 53). Table 54 summarizes the age stage distributions of *Ovis/Capra* remains from the Late Neolithic/Final Neolithic.

Fifty seven *Ovis/Capra* mandibles and loose teeth were recovered from Final Neolithic levels at Megilo Nisi Galanis (24 mandibles and 33 loose teeth), all domestic. Twelve mandibles and one loose tooth were unidentifiable to age, leaving twelve mandibles and thirty two loose teeth in the final analysis (n = 44 - Table 53). Table 55 summarizes the age stage distributions of *Ovis/Capra* remains from the Final Neolithic.

Eighteen *Ovis/Capra* mandibles and loose teeth were recovered from Final Neolithic/Early Bronze Age levels at Megilo Nisi Galanis (8 mandibles and 10 loose teeth), all domestic. Four mandibles and one loose tooth were unidentifiable to age, leaving four mandibles and nine loose teeth in the final analysis (n = 13 - Table 53). Table 56 summarizes the age stage distributions of *Ovis/Capra* remains from the Final Neolithic/Early Bronze Age.

There was no Late Neolithic/Final Neolithic sample of *Bos taurus* for Megilo Nisi Galanis. Only two mandibles were recovered, both unidentifiable to age (Table 57).

Ten *Bos taurus* mandibles and loose teeth were recovered from Final Neolithic levels at Megilo Nisi Galanis (4 mandibles and 6 loose teeth), all domestic. Two mandibles were unidentifiable to age, leaving two mandibles and six loose teeth in the final analysis (n = 8 - Table 57). Table 58 summarizes the age stage distributions of *Bos taurus* remains from the Final Neolithic.

Two *Bos taurus* mandibles and loose teeth were recovered from Final Neolithic/Early Bronze Age levels at Megilo Nisi Galanis (1 mandible and 1 loose tooth), both domestic and both unidentifiable to age. As a result, there was no sample included in the analysis (Table 57).

Two *Sus scrofa* mandibles were recovered from Late Neolithic/Final Neolithic levels at Megilo Nisi Galanis, both domestic. Only one was identifiable to age. As a result, the sample size is one (Table 59).

Nine *Sus scrofa* mandibles and loose teeth were recovered from Final Neolithic levels at Megilo Nisi Galanis (6 mandibles and 3 loose teeth). One loose tooth was identified as belonging to a wild species, and so, was eliminated from the final sample. The total number of *Sus scrofa dom.* was eight. Two mandibles were unidentifiable to age, leaving four mandibles and two loose teeth in the final analysis (n = 6 - Table 59).

Table 60 summarizes the age stage distributions of *Sus scrofa* remains from the Final Neolithic. There were no *Sus* species remains for the Final Neolithic/Early Bronze Age period.

*Novačka Ćuprija*

Novačka Ćuprija is a lowland site that is located roughly 5 km north of the city of Smederevska Palanka in Serbia (Figure 6). There are four main areas of the site. The main area is approximately four hectares in area and is located on the western edge of a low plateau east of a small tributary of the Jasenica River (Greenfield 1986: 161). In contrast to other Neolithic sites, such as Vinča, it is not located in the proximity of any large rivers (Greenfield 1986: 186).

The site is located in a non-obtrusive position, offering no significant vantage. In close proximity are suitable agricultural land, access to water and wood supplies. The plateau on which the site is situated is generally flat. It increases in width and rises slightly to the east (Greenfield 1986: 161).

Novačka Ćuprija is a lowland site that includes material from the Eneolithic through to the Roman period, although there is no evidence for occupational continuity over this entire time span. The most intensive occupation took place during the Early Bronze Age (Greenfield 1986: 161).

The prehistoric settlements at Novačka Ćuprija represents the remains of a series of small villages that laterally moved up and down the length of the terrace overlooking the stream. Each settlement probably represented no more of an area than 100x100 m. Because the site has moved laterally over time, the total length of the site is almost 1 km.

The deposits were relatively thin since there was little vertical deposition. Most of the material above the pit levels were disturbed and mixed by modern and ancient ploughing. The entire site was sieved or floated (Greenfield 1985, 1986).

***Mandibular and loose tooth remains***

Ten domestic Ovis/Capra loose teeth were recovered from Eneolithic levels at Novačka Ćuprija. All the teeth were assigned an absolute age and were included in the final analysis (n=10 - Table 61). Table 62 summarizes the age stage distributions of Ovis/Capra remains from the Eneolithic.

Thirty six *Ovis/Capra* mandibles and loose teeth were recovered from Early Bronze Age levels at Novačka Ćuprija (12 mandibles and 24 loose teeth), all domestic. Four mandibles were unidentifiable to age, leaving eight mandibles and twenty four loose teeth in the final analysis (n = 32 - Table 61). Table 63 summarizes the age stage distributions of *Ovis/Capra* remains from the Early Bronze Age.

Seventeen *Ovis/Capra* mandibles and loose teeth were recovered from Late Bronze Age deposits at Novačka Ćuprija (4 mandibles and 13 loose teeth), all domestic. One mandible was unidentifiable to age, leaving three mandibles and thirteen loose teeth in the final analysis (n=16 - Table 61). Table 64 summarizes the age stage distributions of *Ovis/Capra* remains from the Late Bronze Age.

Three *Bos taurus* mandibles were recovered from Eneolithic levels at Novačka Ćuprija, all domestic. One mandible was unidentifiable to age, leaving two mandibles in the final analysis (n=2 - Table 65). Table 66 summarizes the age stage distributions of *Bos taurus* remains from the Eneolithic.

Nine *Bos taurus* mandibles and loose teeth were recovered from Early Bronze Age levels at Novačka Ćuprija (5 mandibles and 4 loose teeth), all domestic. Three mandibles were unidentifiable to age, leaving two mandibles and four loose teeth in the final analysis (n=6 - Table 65). Table 67 summarizes the age stage distributions of *Bos taurus* remains from the Early Bronze Age.

Four *Bos taurus* mandibles and loose teeth were recovered from Late Bronze Age levels at Novačka Ćuprija (1 mandible and 3 loose teeth), all domestic. All were assigned an absolute age and the final sample size was n = 4. Table 68 summarizes the age stage distributions of *Bos taurus* remains from the Late Bronze Age.

Nine *Sus scrofa* mandibles and loose teeth were recovered from Eneolithic levels at Novačka Ćuprija (5 mandibles and 4 loose teeth), all domestic. One mandible was unidentifiable to age, leaving four mandibles and four loose teeth in the final analysis (n=8 - Table 69). Table 70 summarizes the age stage distributions of *Sus scrofa* remains from the Eneolithic.

Sixteen *Sus scrofa* mandibles and loose teeth were recovered from Early Bronze Age levels of Novačka Ćuprija (11 mandibles and 5 loose teeth), all domestic. Five mandibles and one loose tooth were unidentifiable to age, leaving six mandibles and four loose teeth in the final analysis (n=10 - Table 69). Table 71 summarizes the age stage distributions of *Sus scrofa* remains from the Early Bronze Age.

Four *Sus scrofa* mandibles and loose teeth were recovered from Late Bronze Age deposits at Novačka Ćuprija (3 mandibles and 1 loose tooth), all domestic. One mandible was unidentifiable to age, leaving two mandibles and one loose tooth in the final analysis (n=3 - Table 69). Table 72 summarizes the age stage distributions of *Sus scrofa* remains from the Late Bronze Age.

### *Opovo*

Opovo is a large lowland Late Neolithic settlement in the Banat, a region of northern Serbia located between the Danube and Romania (Figure 6). "Opovo is situated on a slightly elevated location and was surrounded on three sides by an extensive series of annually flooded lowland marshes" (Greenfield 1986: 98). The area around the site is not well suited to either crop cultivation or the herding of domestic animals. Drainage is poor due to the high water table. However, a wide range of wild resources including fish, birds, shellfish, amphibians, reptiles, wild pig, roe and red deer was available in the aquatic and semi-aquatic environments of the surrounding habitat (Greenfield 1986: 98).

Ceramic analysis provides the periodization of the site. It indicated the presence of two phases of the Late Neolithic Vinča-Pločnik period. The phases were not separable stratigraphically. As a result, the faunal remains were analyzed as a single temporal unit (Greenfield 1986: 98). None of the site was sieved or floated (Greenfield 1986).

#### ***Mandibular and loose tooth remains***

Six *Ovis/Capra* mandibles and loose teeth were recovered from Late Neolithic levels at Opovo (5 mandibles and 1 loose tooth), all domestic. All were included in the final analysis (n=6 - Table 73). Table 74 summarizes the age stage distributions of *Ovis/Capra* remains from the Late Neolithic.

Nineteen *Bos taurus* mandibles and loose teeth were recovered from Late Neolithic levels at Opovo (12 mandibles and 7 loose teeth), all domestic. Five mandibles were unidentifiable to age, leaving seven mandibles and seven loose teeth in the final analysis (n=14 - Table 75). Table 76 summarizes the age stage distributions of *Bos taurus* remains from the Late Neolithic.

The total number of mandibles and loose teeth of *Sus scrofa* from Late Neolithic Opovo was twenty seven (26 mandibles and 1 loose tooth). Two mandibles had no determination of domestication. Five mandibles were identified as probably wild, while the remaining twenty elements (19 mandibles and 1 loose tooth) were identified as domestic. Nine mandibles were undeterminable to age, leaving ten mandibles and one loose tooth in the final sample (n=11 - Table 77). Table 78 summarizes the age stage distributions of *Sus scrofa* remains from the Late Neolithic.

***Petnica***

Petnica is located in western Serbia, c. 5 km from the city of Valjevo. It is at the edge of the village of Petnica (Figure 6). The site is located on a slope overlooking a depression at the end of a valley. The site is situated at the base of a steep escarpment. Above (to the south) the site is a series of plateaus and ridges, beyond which the mountains of western Serbia rise. "The highlands above and the slopes around the site are still heavily forested and presents dissected landscape of flat and sloping terrain interspersed with steeper inclines" (Greenfield 1986: 111).

Below the site, a small stream flows down to the Kolubara River (which is a tributary of the Sava). The valley is a rich agricultural area, but forests cover the ridges and mountains to the south of the site.

There were five major occupation horizons at the site. From the earliest to the latest, Middle Neolithic Vinča B (c. 4000-3700 bc; 4250-4100 BC), Late Neolithic Vinča

C (c. 3700-3400 bc; 4100-3900 BC), Late Neolithic Vinča D (c. 3400-3000 bc; 3900-3300 BC), Eneolithic Baden-Kostalac (c. 3300-2500 BC) and late Bronze-Early Iron Age Halstatt A, B and C (c. 1300-800 BC) (Greenfield 1986: 113). Most of the Halstatt occupation is Halstatt A. Therefore, most is considered to be Late Bronze Age.

Petnica is a small site, occupying roughly one hectare. The stratigraphy extends to depth of 2-3 m across much of the site. Approximately 20% of the site was sieved or floated (Greenfield 1986).

***Mandibular and loose tooth remains***

Nine *Ovis/Capra* mandibles and loose teeth were recovered from Middle Neolithic levels at Petnica (6 mandibles and 3 loose teeth), all domestic. Two mandibles were unidentifiable to age, leaving four mandibles and three loose teeth in the final analysis (n=7 - Table 79). Table 80 summarizes the age stage distributions of *Ovis/Capra* remains from the Middle Neolithic.

Twenty one *Ovis/Capra* mandibles and loose teeth were recovered from Late Neolithic levels at Petnica (7 mandibles and 14 loose teeth), all domestic. Two mandibles were unidentifiable to age, leaving five mandibles and fourteen loose teeth in the final analysis (n=19 - Table 79). Table 81 summarizes the age stage distributions of *Ovis/Capra* remains from the Late Neolithic.

Seven domestic *Ovis/Capra* mandibles and loose teeth were recovered from Late Neolithic/Eneolithic levels at Petnica (3 mandibles and 4 loose teeth), including one loose tooth of domestic *Ovis aries*. Only the *Ovis aries* loose tooth was undeterminable to age, leaving three mandibles and three loose teeth in the final analysis (n=6 - Table 79). Table

82 summarizes the age stage distributions of *Ovis/Capra* remains from the Late Neolithic/Eneolithic.

Thirteen *Ovis/Capra* mandibles and loose teeth were recovered from Eneolithic levels at Petnica (9 mandibles and 4 loose teeth), all domestic. All elements were assigned an age. The final sample size is n = 13 (Table 79). Table 83 summarizes the age stage distributions of *Ovis/Capra* remains from the Eneolithic.

Fourteen *Ovis/Capra* mandibles and loose teeth were recovered from Late Bronze Age levels at Petnica (5 mandibles and 9 loose teeth), all domestic. Only one mandible was indeterminable to age. As such, the final analysis included four mandibles and nine loose teeth (n=13 - Table 79). Table 84 summarizes the age stage distributions of *Ovis/Capra* remains from the Late Bronze Age.

Eleven *Ovis/Capra* mandibles and loose teeth were recovered from Late Bronze Age/Early Iron Age deposits at Petnica (4 mandibles and 7 loose teeth), all domestic. One mandible and one loose tooth were unidentifiable to age, leaving three mandibles and six loose teeth in the final analysis (n=9 - Table 79). Table 85 summarizes the age stage distributions of *Ovis/Capra* remains from the Late Bronze Age/Early Iron Age.

Thirty four *Bos taurus* mandibles and loose teeth were recovered from Middle Neolithic deposits at Petnica (27 mandibles and 7 loose teeth), all domestic. Twelve mandibles were unidentifiable to age, leaving fifteen mandibles and seven loose teeth in the final sample (n=22 - Table 86). Table 87 summarizes the age stage distributions of *Bos taurus* remains from the Middle Neolithic.

Thirty six *Bos taurus* mandibles and loose teeth were recovered from Late Neolithic levels at Petnica (19 mandibles and 17 loose teeth), all domestic. Fifteen mandibles and two loose teeth were unidentifiable to age, leaving four mandibles and fifteen loose teeth in the final sample (n=19 - Table 86). Table 88 summarizes the age stage distributions of *Bos taurus* remains from the Late Neolithic.

Four *Bos taurus* mandibles and loose teeth were recovered from Late Neolithic/Eneolithic levels at Petnica (2 mandibles and 2 loose teeth), all domestic. Both mandibles were unidentifiable to age, leaving two loose teeth in the final analysis (n=2 - Table 86). Both the loose teeth were aged to cover mandibular stages G and I (adult-senile).

Twelve *Bos taurus* mandibles and loose teeth were recovered from Eneolithic deposits at Petnica (6 mandibles and 6 loose teeth), all domestic. Three mandibles were unidentifiable to age, leaving three mandibles and six loose teeth in the final analysis (n=9 - Table 86). Table 89 summarizes the age stage distributions of *Bos taurus* remains from the Eneolithic.

Twelve *Bos taurus* mandibles and loose teeth were recovered from Late Bronze Age deposits at Petnica (2 mandibles and 10 loose teeth), all domestic. Two mandibles and one loose tooth were unidentifiable to age, leaving nine loose teeth in the final analysis (n=9 - Table 86). Table 90 summarizes the age stage distributions of *Bos taurus* remains from the Late Bronze Age.

Eight *Bos taurus* mandibles and loose teeth were recovered from Late Bronze Age/Early Iron Age levels at Petnica (4 mandibles and 4 loose teeth), all domestic. Two mandibles were unidentifiable to age, leaving two mandibles and four loose teeth in the final analysis (n=6 - Table 86). Table 91 summarizes the age stage distributions of *Bos taurus* remains from the Late Bronze Age/Early Iron Age.

Fifty *Sus scrofa* mandibles and loose teeth were recovered from Middle Neolithic deposits at Petnica. Four mandibles had undetermined domestication and were eliminated from the sample. Thirteen mandibles and one loose tooth were identified as probably wild and also eliminated. The total sample identified as domestic was thirty two (31 mandibles and 1 loose tooth). Nineteen mandibles were unidentifiable to age, leaving twelve mandibles and one loose tooth in the final analysis (n=13 - Table 92). The final sample size is n = 13. Table 93 summarizes the age stage distributions of *Sus scrofa* remains from the Middle Neolithic.

Thirty *Sus scrofa* mandibles and loose teeth were recovered from Late Neolithic deposits at Petnica. Five mandibles and one loose tooth were identified as probably wild and eliminated from the sample. The domestic sample was twenty four (22 mandibles and 2 loose teeth). Eleven mandibles were unidentifiable to age, leaving eleven mandibles and two loose teeth in the final analysis (n=13 - Table 92). Table 94 summarizes the age stage distributions of *Sus scrofa* remains from the Late Neolithic.

Five *Sus scrofa* mandibles and loose teeth were recovered from Late Neolithic/Eneolithic deposits at Petnica. Two mandibles had undetermined domestication and were eliminated from the sample. One loose tooth was identified as probably wild and eliminated. The total domestic sample consists of only two mandibles and both were unidentifiable to age. There was no Late Neolithic/Eneolithic *Sus scrofa* sample for Petnica.

Twelve *Sus scrofa* mandibles and loose teeth were recovered from Eneolithic levels at Petnica (10 mandibles and 2 loose teeth), all domestic. Two mandibles were unidentifiable to age, leaving eight mandibles and two loose teeth in the final analysis (n=10 - Table 92). Table 95 summarizes the age stage distributions of *Sus scrofa* remains from the Eneolithic.

Nine *Sus scrofa* mandibles and loose teeth were recovered from Late Bronze Age levels at Petnica. Two mandibles were identified as probably wild and eliminated from the sample. The total domestic sample included five mandibles and two loose teeth. Two mandibles were unidentifiable to age, leaving three mandibles and two loose teeth in the final analysis (n=5 - Table 92). Table 96 summarizes the age stage distributions of *Sus scrofa* remains from the Late Bronze Age.

Seven *Sus scrofa* mandibles and loose teeth were recovered from Late Bronze Age/Early Iron Age levels at Petnica (6 mandibles and 1 loose tooth), all domestic. Two mandibles were unidentifiable to age, leaving four mandibles and one loose tooth in the final analysis (n=5 - Table 92). Table 97 summarizes the age stage distributions of *Sus scrofa* remains from the Late Bronze Age/Early Iron Age.

### *Stragari-Šljivik*

Stragari-Šljivik is a lowland site located on a tributary of the Western Morava at the edge of the village of Stragari, near the city of Kruševac, in central Serbia (Figure 6). The site is located in the floodplain of a deeply incised stream, surrounded by low rolling hills. Presently, it is a rich agricultural area. Stragari is a Middle Neolithic site, with two levels of occupation from the Vinča A and B cultures. It is a small site, extending c. 200x200 m, with deposits extending for about 1 m beneath the plough zone. None of the site was sieved or floated (H. Greenfield, pers. comm.).

***Mandibular and loose tooth remains***

Four domestic *Ovis aries* mandibles were recovered from Middle Neolithic levels at Stragari. All were identifiable to an age and included in the final analysis (n = 4). Table 98 summarizes the age stage distributions of *Ovis aries* remains from the Middle Neolithic. Only one domestic *Capra hircus* mandible was recovered from Stragari. It was unidentifiable to age. Due to these limited samples sizes, the *Ovis aries* and *Capra hircus* remains were lumped into the category *Ovis/Capra* to provide an adequate sample size.

Twenty four *Ovis/Capra* mandibles and loose teeth were recovered from Middle Neolithic levels at Stragari (9 mandibles and 15 loose teeth), all domestic. Two mandibles were unidentifiable to age, leaving seven mandibles and fifteen loose teeth in the final analysis (n=22 - Table 99). Table 100 summarizes the age stage distributions of *Ovis/Capra* remains from the Middle Neolithic.

Forty eight *Bos taurus* mandibles and loose teeth were recovered from Middle Neolithic levels at Stragari (31 mandibles and 17 loose teeth), all domestic. Eighteen mandibles and one loose tooth were unidentifiable to age, leaving thirteen mandibles and sixteen loose teeth in the final analysis (n=29 - Table 101). Table 102 summarizes the age stage distributions of *Bos taurus* remains from the Middle Neolithic.

Eighteen *Sus scrofa* mandibles and loose teeth were recovered from the Middle Neolithic levels at Stragari (17 mandibles and 1 loose tooth). Nine of the elements (8 mandibles and the loose tooth) were identified as wild. The domestic *Sus scrofa* sample size included nine mandibles. Two were unidentifiable to age, leaving seven mandibles in the final analysis (n=7 - Table 103). Table 104 summarizes the age stage distributions of *Sus scrofa* remains from the Middle Neolithic.

### *Vinča*

The site of Vinča-Belo Brdo is a lowland site located on the right bank of the Danube, 15 km southeast of the city of Belgrade, in Serbia (Figure 6). It is positioned in an optimal position to monitor and control movement along the major waterways of the region. It is near the confluence of the Danube with the Morava, the Tisza, the Timiš and the Sava rivers. On the opposite bank of the Danube are found the flat plains of Pannonia.

The soils surrounding the site are high quality fertile soils including river alluvium and chernozems. These were highly cultivable with the available Neolithic technology and continue to support modern grasslands and cultivated crops. Sporadic areas of deciduous forests are also found within the area (H. Greenfield, pers. comm.).

Vinča is a lowland site that extends throughout the entire Neolithic period, as well as having Eneolithic, Middle Bronze Age, and Medieval levels. This is the type-site for the Middle and Late Neolithic Vinča culture and is a 'yardstick' for the Balkan Neolithic (Greenfield 1986). The faunal data available for this thesis, however, derive from the Late Neolithic, Eneolithic and Middle Bronze Age levels.

The site of Vinča is a large artificial mound that extends for several hundred meters along the riverbank. It is estimated that over one-third of the site has been eroded by the river. The site is believed to have also extended several hundred metres back from the river as well. It is similar in construction to a tell site with the stratigraphy extending greater than nine metres (H. Greenfield, pers. comm.).

#### *Mandibular and loose tooth remains*

Fifty one domestic *Ovis/Capra* mandibles were recovered from Late Neolithic levels at Vinča. Seventeen were unidentifiable to age, leaving thirty two mandibles in the final analysis (n=34 - Table 105). Table 106 summarizes the age stage distributions of *Ovis/Capra* remains from the Late Neolithic.

The total sample of *Ovis/Capra* from Eneolithic deposits was a single mandible. It was ageable, and so the final sample size is one.

One domestic *Ovis aries* mandible and one domestic *Capra hircus* mandible from Middle Bronze Age levels were lumped into the *Ovis/Capra* heading. As a result, there were a total of twenty three *Ovis/Capra* mandibles and loose teeth from the Middle Bronze Age deposits at Vinča (13 mandibles and 10 loose teeth). All were included in the final analysis (n=23 - Table 105). Table 107 summarizes the age stage distributions of *Ovis/Capra* remains from the Middle Bronze Age.

Nineteen *Bos taurus* mandibles and loose teeth were recovered from Late Neolithic deposits at Vinča (eleven mandibles and eight loose teeth), all domestic. Five mandibles were undeterminable to age, leaving six mandibles and eight loose teeth in the final analysis (n=14 - Table 108). Table 109 summarizes the age stage distributions of *Bos taurus* remains from the Late Neolithic. There were no *Bos taurus* mandibular remains from the Eneolithic levels.

Twenty four *Bos taurus* mandibles and loose teeth were recovered from Middle Bronze Age deposits at Vinča (16 mandibles and 8 loose teeth), all domestic. Eight mandibles were unidentifiable to age, leaving eight mandibles and eight loose teeth in the final analysis (n=16 - Table 108). Table 110 summarizes the age stage distributions of *Bos taurus* remains from the Middle Bronze Age.

Forty six *Sus scrofa* mandibles were recovered from Late Neolithic deposits at Vinča. Two were identified as probably wild, and were not included in the sample. The domestic sample was forty four mandibles. Eleven mandibles were undeterminable to age, leaving thirty four mandibles in the final analysis (n=34 - Table 111). Table 112 summarizes the age stage distributions of *Sus scrofa* remains from the Late Neolithic.

In the Eneolithic layers, there was only two domestic *Sus scrofa* mandibles. Only one was determinable with an age. The sample size is one.

Thirty *Sus scrofa* mandibles and loose teeth were recovered from Middle Bronze Age deposits at Vinča (29 mandibles and 1 loose tooth), all domestic. Ten mandibles were unidentifiable to age, leaving nineteen mandibles and one loose tooth in the final analysis (n=20 - Table 111). Table 113 summarizes the age stage distributions of *Sus scrofa* remains from the Middle Bronze Age.

**Conclusions**

Ten sites from the Northern Balkan region have sufficient data to be utilized in this thesis. One site, Megilo Nisi Galanis (Kozani, in Greek Macedonia) in the southern Balkan region, is also included for consideration. The sites range in time from the Early Neolithic to the Early Iron Age.

The northern Balkan region can be divided into lowland, mid-altitude and highland areas. Lowland sites include Foeni-Salaş, Livade, Novačka Ćuprija, Opovo, Stragari and Vinča. Mid-altitude sites are Blagotin, Ljuljaci and Petnica. The only highland site is Kadica Brdo.

Only if the mandibular and loose tooth samples included ten or more elements per species and per period, were they considered in the final analysis and will be discussed in chapter nine. Sample sizes lower than ten were considered too small to provide accurate harvest profiles.

# Chapter 8:

# Data Description - Cementum Analysis

## Introduction

The purpose of the collection of the modern sheep and goat is to provide a sample of animals of known age and season of death. There were two reasons for collecting the comparative database. First, this comparative sample was utilized to test the agreement between the two most common methods of recording tooth wear and eruption (Payne 1973; Grant 1975) and the assignment of absolute age to the wear stages. Second, in order to accurately interpret any archaeological teeth that were sectioned, a comparative sample of the same species of known age and known season of death was required in order to accurately determine the timing of the deposition of the different cementum growth layers. The deposition of cementum growth layers in teeth is mainly genetically determined but is triggered by external stimuli such as seasonal environmental change (Burke 1995: 4). The modern thin section sample of goats provided an interesting methodological contribution by testing whether the incremental growth visible in the teeth of the goats agrees or did not agree with the eruption/wear stages and/or with the actual ages. It acted as a three-way comparison between tooth eruption and wear, incremental structures and true ages (A. Burke, pers. comm., 2001).

### *Tooth wear and eruption sample*

There are forty three animals, twenty nine goats and fourteen sheep, in the sample that compares tooth eruption and wear. All mandibles had their wear and eruption recorded separately using the Payne (1973) and Grant (1975) methods. This comparative collection seeks to test the agreement between tooth wear and eruption and the assignment of absolute age. A summary of the readings is presented in Table 114. As some of the specimens had no tag information, and therefore no information other than date of death available, some are of limited use.

However, the following observations can be made. The two tooth wear and eruption recording methods utilize similar diagrams for their representation of the different stages. Grant (1975) has many more stages and the diagrams are more representational. In contrast, Payne (1973) utilizes less stages and more stylistic representations. However, simple visual inspection of the two methods (see Table 114) shows good agreement between the two techniques.

Additionally, the modern comparative samples was to be used as a test for Hambleton's method for converting the results of different analyses of Ovis/Capra mandibular tooth wear into a similar format (Table 115).

The comparative collection demonstrates excellent agreement for the conversion method that Hambleton suggests. Within this sample, Payne's mandibular wear stage C is equivalent to Grant mandibular wear stages 9-13; Payne's mandibular wear stage D is equivalent to Grant's mandibular wear stage 21-26; Payne's mandibular wear stage E is equivalent to Grant's mandibular wear stage 33 and Payne's mandibular wear stage G is equivalent to Grant's stage 41. All fit with Hambleton's conversion. While it is not possible to test the conversion of cattle and pig MWS suggested by Hambleton in the same way within this investigation, the excellent agreement of the sheep/goat conversion makes the acceptance of the conversion suggested by Hambleton for the other species appear legitimate.

***The modern thin sectioning sample***

The modern thin sectioning sample consisted of fourteen goats and five sheep. All animals had their left mandibular M1 sectioned using the methodology discussed in Chapter 6. Where possible, two slides per tooth were produced. A summary of the sample appears in Table 116.

***Archaeological sample***

Site selection for cementum analysis was based on having sheep/goat material available at the University of Manitoba, an attempt to cover the periods within which transhumance is hypothesized to be present, and to include both highland and lowland areas. As such, two sites were selected, Kadica Brdo, an Early Iron Age highland site, and Vinča, a lowland site. All the teeth from Vinča were from Late Neolithic deposits. Ten teeth were sectioned from Kadica Brdo and nine teeth were sectioned from Vinča. A summary of the sample appears in Table 117.

# Chapter 9:

## Data Analysis – Archaeological tooth eruption and wear and the construction of harvest profiles

### Introduction

In this chapter, the data presented in chapter 7 will be analyzed. Harvest profiles of each taxon/site/period are constructed and analyzed utilizing the methodology discussed (see Chapter 6). The data analysis will consider the harvest patterns exhibited by each species over the time period covered in this investigation, that is, from the Early Neolithic to the Early Iron Age. The focus will be on changes over time, specifically at the Late Neolithic/Post Neolithic juncture as potential evidence for the appearance of the transhumant movement of domestic herds.

The sample utilized in this investigation was limited by the paucity of highland sites, of which there is only one (Kadica Brdo). However, the mid-altitude sites are hypothesized to be a relevant substitute in that they should show harvest profiles most similar to the highland sites in the transhumant movement of herds. This is because the over-wintering of herds in these mid-altitude regions would be difficult without sufficient shelter for the herds and collected fodder. As such, the environment of the mid-altitude sites in the region, like the highland sites, would force the movement of domestic herds out of this area during the colder months of the year (i.e. transhumance). This is in contrast to the lowland sites, where the variety of microenvironments in these areas can provide sufficient graze and water for herds year round. As discussed earlier, there is no environmental factor that forces the transhumant movement of lowland herds.

The absence of the youngest age classes for all the domestic species is a problem throughout this investigation. The hypotheses are stated in such a way as to place significant emphasis on the presence or absence of this age class. However, one must consider the taphonomic issues of differential preservation and excavation practices, specifically the extent of sieving at sites (Table 118). It is important to realize that the remains of the very young age classes are very fragile. It can be assumed that "a very high proportion of those originally present in archaeological contexts would be lost through pre- and post depositional processes and excavation procedures" (Munson 2000: 391; see also Cribb 1985: 91). The presence/absence of this age group is too affected by the taphonomic issues mentioned above to be considered reliable in making conclusions on the existence of transhumance. Munson (2000) goes as far as to exclude the consideration of neonatals and notes only presence/absence. As such, any indications of transhumance must be established by looking at the other age groups involved in the movement of herds, specifically the 2-6 months and the 6-12 month group in sheep/goat and the 1-8 month and 8-18 month group in cattle. The expected patterns for the lowland, mid-altitude and highland sites for each species are summarized in Table 119.

***Seasonality***

In order to establish seasonality through the analysis of tooth wear and eruption, it is necessary to link the age of the animal established using the tooth wear with the date of birth. In the northern Balkan area, the time of lambing/calving for all the major transhumant domestic species (cattle and sheep/goat) considered in this investigation is February. As the herds would not be moved immediately after lambing/calving, the herd would be found in the lowland areas from February to April. It is hypothesized that herds would then be moved into the highland areas from roughly May to September. The domestic herds return to the lowland areas in the autumn (roughly October) (Greenfield 1999a).

Seasonality of ovicaprids

In the transhumant movement of domestic ovicaprid herds, it is expected that the youngest age group (class A, 0-2 months) would be found only in the lowlands and would indicate a late winter/spring occupation. As the herds move into the highlands from roughly May to September, the presence of the next age stage (class B, 2-6 months) would be expected only in the highland areas would indicate occupation from May to August, or a late spring/summer occupation.

Seasonality of cattle

Unfortunately, the age stages that are established for cattle (Higham 1967; Halstead 1985) and utilized here to establish absolute age are not fine enough to enable the identification seasonal movement of herds. As with sheep/goat, calving occurs in the lowlands before the movement into highland areas. Therefore, the youngest age class (0-1 month) is expected to be found only in the lowland sites if there is transhumant movement of herds. This would indicate a late winter/early spring presence. The paucity of this age group due to the taphonomic issues discussed above limits the seasonality information that can be obtained.

The second youngest age class for cattle is 1-8 months. The seasonality information that can be gained by the presence of this age group extends from the early spring through to the late autumn. The end of this period extends into the time when the herd is hypothesized to have moved back down to the lowland areas before the onset of winter. While it is expected that the next oldest age group (1-8 months) would dominate the mortality profiles of the highlands according to the hypotheses presented, the age classes utilized for cattle do not enable the same type of control that the sheep/goat age classes provide. They are not fine enough. It would be ideal to be able to split the 1-8 month age class into finer categories to enable finer seasonal distinctions and age classes. However, there is as yet no valid analytical justification for this. As a result, the seasonality information that can be obtained from the 1-8 month age class extends from the Spring into the Late Autumn (March-October). As a result, this age class for cattle is of little use to the questions of this investigation. As a result, the cattle data are of limited use and will not be considered.

Seasonality of pigs

Seasonal statements of pigs are based upon a single birthing period during the year. This is because pigs were not kept ethnographically in stalls or fed throughout the year in this region. Instead, they were left to forage in the forests, with a pig herder. Whenever pigs were needed for food, the herder brought back one or more (Halpern 1999). As a result, it is unlikely that the modern conditions for multiple births throughout the year would have occurred in the past.

The birth month for pigs is hypothesized to be the same as for sheep/goat and cattle, that is February. As such, the occurrence of the 0-2 month age class indicates a late winter/early spring occupation of the site. The 2-7 month age group would indicate a summer/autumn occupation and the 7-14 month group would indicate an early winter occupation.

***Sus scrofa dom.***

Domestic pig, *Sus scrofa dom.*, will be discussed first because it can be considered a control for the transhumant movement of herds. It would be expected that the exploitation patterns of pig should not change over time as these animals were not subjected to the transhumant movement of either cattle or sheep/goat that is hypothesized to occur at the Late Neolithic/Post Neolithic juncture. This is due to the fact that pigs are less suited to the types of movement that is required of transhumant herds. Although some researchers have noted that pigs are capable of the movement, such as the driving of herds long distances to market (Halpern 1999), this tends to be a one time movement that should not be equated to the regular movements expected in transhumance.

It would be expected that domestic pigs were exploited predominantly for their primary products, as there are no secondary products that are readily available from pigs (Greenfield 1988). As a result, the harvest profiles constructed for pigs would be expected to show patterns similar to Payne's (1973) meat production kill off pattern (Figure 1).

As predicted, the harvest profiles for all sites and periods are most similar to Payne's meat production. Additionally, and most importantly for this investigation, the harvest patterns do not change over time. All the profiles can be characterized as showing a high mortality of animals between the ages of 2-7 months and 27-36 months. Virtually all animals are slaughtered before reaching adulthood.

None of the Early Neolithic assemblages had a large enough sample of pig remains to construct a harvest profile. This is due to the dearth of pig remains in such assemblages.

In the Middle Neolithic, only deposits from Petnica had a sufficient sample size. The harvest profile (Figure 10) shows a rapid mortality of the youngest age classes (0-21 months). The adult end of the profile shows the absence of subadults and adults, except for the presence of two senile individuals. The profile basically conforms to the expected exploitation pattern for meat. The presence of the earliest age groups (0-2 months through to 7-14 months) indicates that herds were present in some proximity to the site during all seasons.

Three Late Neolithic assemblages had sufficient pig remains to construct a harvest profile (Petnica, Vinča, and Opovo). Each of the sites shows essentially the same pattern, regardless of whether the sites are in lowland or mid-altitude locations. Chi square analysis indicates that the harvest profiles for each of the three sites show no statistically significant difference (Table 120). All are missing the youngest age class (0-2 months). There is a very high mortality of animals between the ages of 2-7 and 27-36 months. The Late Neolithic Petnica deposits (Figure 11) continue to show a presence of small quantities of senile individuals (n=1). Vinča (Figure 12) and Opovo (Figure 13) show an absence of senile individuals. In these two sites, all animals are slaughtered before the age of 21-27 months.

The Late Neolithic pattern is a continuation of the Middle Neolithic pattern. The profiles indicate exploitation for meat and the presence of very young individuals. The presence of very young individuals confirms the hypothesis that no domestic animals are moving between highland and lowland sites. While the youngest age group (0-2 months) is absent, this may be due to taphonomic issues discussed above. The presence of the earliest age groups (2-7 months through to 7-14 months) indicates that herds were present in some proximity to the site during all seasons.

Only one site contained sufficient Eneolithic material to construct a harvest profile - Petnica (Figure 14). The profile indicates the absence of the youngest age class (0-2 months). There is high mortality of animals between the ages of 2-7 months, and again between 14 - 21 months. The intervening age group is missing. Subsequently, there is a low rate of mortality until 27-36 months. Then, there is no mortality until the senile age group, with is a single senile individual. The Eneolithic profile indicates continuity of exploitation from the previous Late Neolithic. While the youngest age group (0-2 months) is absent, this may be due to taphonomic issues discussed above. The presence of the earliest age groups (2-7 months through to 7-14 months) indicates that herds were present in some proximity to the site during all seasons.

The Early and Middle Bronze Age material will be discussed together since one of the sites (Ljuljaci) overlaps both periods. There are three sites with Early and/or Middle Bronze Age materials (Vinča, Ljuljaci and Novačka Ćuprija). The profile from Novačka Ćuprija (Figure 15) indicates a very high mortality of animals between the ages of 2-7 and 21-27 months. There is a total dearth of remains from the 0-2 and >27 month classes. In the mid-altitude site of Ljuljaci (Figure 16), the harvest pattern remains the essentially the same. The only difference is that a few animals are being slaughtered at a slightly older age (up to 36 months as opposed to 27 months at Novačka Ćuprija). The same general pattern exists in the Middle Bronze Age deposits at Vinča (Figure 17). Just as in Ljuljaci and Novačka Ćuprija there is a very high mortality in the 2-7 to the 21-27 month age classes. Vinča, however, is more similar to Ljuljaci in that the age classes extend to the 27-36 month range. It differs from both of them by the presence of the youngest age classes (0-2 months). Statistical analysis indicates that the harvest profiles for each of the three sites show no statistically significant difference (Table 121). This result indicates continuity of exploitation in pigs over time. The presence of young individuals in lowland and mid-altitude sites also supports the hypothesis that pigs are not moving in a transhumant fashion. While the youngest age group (0-2 months) is absent, this may be due to taphonomic issues discussed above. The presence of the earliest age groups (2-7 months through to 7-14 months) indicates that herds were present in some proximity to the site during all seasons.

During the Late Bronze Age, there is only a single sample with sufficient pig remains, the lowland site of Livade (Figure 18). This profile follows the trend of the preceding periods. The absence of the 0-2 month class in a lowland site is likely a result of differential destruction of younger age classes at the site (Cribb 1985; Greenfield 1986; Munson 2000). The presence of the earliest age groups (2-7 months through to 7-14 months) indicates that herds were present in some proximity to the site during all seasons.

The Early Iron Age highland site of Kadica Brdo (Figure 19) yields a pattern broadly similar to those of the other sites. The highest mortality rate is between 2-7 months and 21-27 months. In addition, there are both very old and very young individuals at the site. The presence of the 0-2 month age class would indicate that animals are being birth at or near the site. This would indicate the lack of seasonal transhumant movement of pigs at the site. The presence of the earliest age groups (0-2 months through to 7-14 months) indicates that herds were present in some proximity to the site during all seasons.

The exploitation pattern of pigs does not change significantly over the entire time period considered in this investigation. Chi square analysis of sites of the major periods (Late Neolithic Petnica, Eneolithic Petnica, Early Bronze Age Novačka Ćuprija and Early Iron Age Kadica Brdo) indicate no statistically significant changes (Table 122). These sites were chosen because they represent the major periods of interest. The exploitation of pigs for their primary products continues to be the dominant feature of all of the pig harvest profiles. Most importantly for the investigation into the origins of transhumant pastoralism, there is no difference in the exploitation patterns of domestic pig between highland and lowland sites either before and after the Late Neolithic/Post Neolithic juncture or at any other time.

***Ovis/Capra***

Separate harvest profiles for *Ovis aries* and *Capra hircus* were not possible to produce. Only three sites had sufficient samples of *Ovis aries* remains to produce harvest profiles and no sites had sufficient remains of *Capra hircus*. Therefore, the remains of both taxa were combined in order to achieve a number of sites with a sufficient remains for analysis. The drawback of this approach is that it is difficult to separate out the pattern of sheep versus goat. This is somewhat negated by examining the frequency distribution of sheep and goat in each site. In every case, sheep remains far outnumber those of goats. Goats tend to be an insignificant part of total identified assemblages. In addition, most previously identified goat remains were from adult individuals (Greenfield 1985, 1986, 1988, 1991, 1994, 1996). Therefore, it is proposed that the perceived pattern probably represents the remains of sheep, with a slight influence by goats on the older age classes.

Early Neolithic

During the Early Neolithic period, both the lowland site of Foeni-Salaş and the mid-altitude site of Blagotin have sufficient sample sizes to produce harvest profiles for *Ovis/Capra*. At Foeni-Salaş (Figure 20), there is some, but very little mortality of the youngest age classes (0-2 months to 2-6 months). This is followed by very high mortality of the age groups 2-6 months to 1-2 years. Then there is a plateauing of the mortality rate between 1-2 and 2-3 year age classes. This is followed by a rapid mortality of the age groups from 1-2 years to 4-6 years, but at a decreased rate than during the previous rapid mortality phase. This pattern is essentially repeated at Blagotin (Figure 21), with two major differences: the absence of the plateauing of the mortality rate between 1-2 and 2-3 year age classes and the oldest age group (8-10 years). The general Early Neolithic mortality pattern for *Ovis/Capra* is shown in Figure 22. Statistical analysis indicates that there are no statistically significant differences between the profiles of Foeni-Salaş and Blagotin (Table 123).

*Production strategy*

The harvest profiles from both sites indicate the exploitation of the herd for primary products, that is meat production. It most closely resembles Payne's Model A kill-off pattern (see Figure 1).

*Implications for seasonality and transhumance*

The presence of the 0-2, 2-6, and 6-12 month age classes in both sites implies a year round availability of the herds. This, in turn, suggests a non-transhumant movement and continuous culling of the animals, and residential stability throughout the year. There is no complementarity between the sites and transhumance is not occurring between mid-altitude Blagotin and lowland Foeni-Salaş.

Middle Neolithic

There is only one site that provides information on the Middle Neolithic harvest profile patterns of *Ovis/Capra*. This is the lowland site of Stragari (Figure 23). The harvest profile of Stragari shows the same pattern as those from Early Neolithic. The 0-2 month class is missing, and there is very low mortality of the youngest age groups (2-6 months), followed by a rapid mortality from 6-12 months to 1-2 years. This is followed by a rapid mortality but at a decreased rate of older age groups (1-4 years). What is unusual about this profile in relation to the Early Neolithic is the complete lack of the oldest age groups (3-4 through to 8-10 years). However, these age stages are not sensitive to the hypotheses being tested.

*Production strategy*

The harvest profile mostly closely resembles the herd exploitation model for primary products, that is meat production, during this period (Payne's 1973 Model A kill-off pattern - see Figure 1). Where it differs from the production model and from the Early Neolithic assemblages is in the absence of the oldest age groups (4-6 to 8-10 years). Otherwise, this Middle Neolithic site follows the same general pattern established in the Early Neolithic.

*Implications for seasonality and transhumance*

Stragari is a lowland site. The 0-2 month age class would be expected to be present. The absence of the 0-2 month age class would normally imply that the animals are not being born in and around the site. The absence of this age class may be because this is an unsieved sample, but such remains are present in other unsieved or partially sieved samples. The presence of the 2-6 and 6-12 month age classes would indicate that the herds were around the site for the majority of the year. The continuity of occupation and exploitation from these age classes would imply that there is no evidence for transhumance during this period.

Late Neolithic

Two Late Neolithic assemblages have sufficient *Ovis/Capra* remains to construct a harvest profile (Petnica and Vinča). At the lowland site of Vinča (Figure 24), there is an absence of the youngest age group (0-2 months) followed by a very low mortality of the 2-6 month age groups. The profile shows a rapid mortality through the 6-12 months and 1-2 years age groups. There is a rapid, but continued high mortality rate, in comparison to the earlier groups, of the older age groups (2-3 years through to 8-10 years). At the mid-altitude site of Petnica (Figure 25), a slightly different pattern emerges. Both the 0-2 months and the 2-6 months are absent (whereas they were present in all earlier and contemporary assemblages). Following this, there is a rather steady rate of mortality from the 6-12 month group through to the 6-8 year stage. The oldest individuals are also absent.

The harvest profile of the Late Neolithic for *Ovis/Capra* (Figure 26) from the lowland site of Vinča and the mid-altitude site of Petnica show no statistically significant differences between the profiles (Table 124). Petnica shows slightly less mortality of the younger age groups (less than 2-3 years), while Vinča shows slightly less mortality of the older age groups (greater than 2-3 years).

*Production Strategy*

The harvest profiles of Vinča and Petnica mostly closely resemble the herd exploitation model for primary products, that is meat production, during this period (Payne's 1973 Model A kill-off pattern - see Figure 1).

Neither the Vinča nor the Petnica harvest profiles appear to fully fit the expected pattern for Neolithic ovicaprid exploitation with its absence of the earliest age groups. These sites stand in contrast to the profiles created for the other sites in the sample for the Neolithic period. It cannot be argued that the absence of these youngest age groups was the result of differential recovery practices as this absence is most pronounced at Petnica, where approximately 20% of the sample was sieved. Also, there is no evidence for additional taphonomic issues that might plague Petnica in contrast to other sites from this and later time periods (Greenfield 1986, 1991).

*Implications for seasonality and transhumance*

While the absence of the youngest age groups (especially in the lowland site) may be seen as an indication of transhumant movement in the Late Neolithic, this is not believed to be the case here. If transhumance was present, the second youngest age group (2-6 months) would be expected to be present in mid-altitude sites. The absence of both the 0-2 and 2-6 month class in the mid-altitude sites (e.g. Petnica) would argue that these age classes were not being exploited. The absence of the youngest age groups from Late Neolithic Petnica, a mid-altitude site, would argue against the appearance of transhumance during the Late Neolithic.

Eneolithic

There are two sites from the Eneolithic - lowland Novačka Ćuprija and mid-altitude Petnica. At Novačka Ćuprija (Figure 27), there is a complete absence of the early age groups (0-12 months). There is low mortality of the 1-2 year group, none in the 2-3 year group and extremely high mortality of 3-4 year animals. Then, the mortality rate plateaus until 8-10 years. At Petnica (Figure 28), there is an absence of the youngest age groups (0-2 months and 2-6 months) followed by a very high mortality of the 6-12 month age group. Subsequently, there is a decreased rate of mortality at 1-2 years, which slightly levels off at 2-3 years. It continues at this rate until the 4-6 year class. There is a complete absence of the two oldest age groups (6-8 years and 8-10 years). Chi square analysis indicates that there is a marginally statistically significant difference between these two sites in this period (Table 125). While the usual p value is given as 0.0110, the exact p value is 0.048. If one were to consider only the usual p value, one might assume that the results are extremely significant. However, as it is the exact p value that corrects for small sample sizes (as is the case here), its values indicate that the difference is not as strong as it is implied by the other value. If transhumance was occurring, these differences would be expected between mid altitude Petnica and lowland Novačka Ćuprija at this time. However, the small sample size mitigates our ability to confidently identify its presence.

*Production strategy*

Neither of these patterns fit any of Payne's proposed specialized herd production models. Both, however, conform to Greenfield's (1988) expectations for a herd based on long-term stability and animal exploitation with a mixed subsistence economy (both primary and secondary products) and an emphasis on secondary products.

*Implications for seasonality and transhumance*

If transhumance was to appear during the Eneolithic, the youngest age group, then the 0-2 months class should be present at lowland sites. Can their absence be the result of differential attrition? Sieving is an unlikely cause since Novačka Ćuprija was completely sieved. However, the assemblage was not deeply buried and was subject to higher rates of weathering than many of the other contemporary assemblages (Table 134). The absence of the expected 0-2 month class at Novačka Ćuprija cannot be used to monitor the presence or absence of the transhumant movement of herds.

As a mid-altitude site, Petnica is expected to show mortality profiles similar to that of a highland site. This would require the absence of the youngest age class (0-2 months) and the presence of the second youngest age class (2-6 months), which would indicate a seasonal presence in the highlands between May and August. However, both of these age classes are missing from the profile. As a result, it can be concluded that there is no evidence for transhumance since Eneolithic Petnica does not conform to the expectation of a highland site involved in the transhumant movement of herds.

The mid-altitude site of Petnica is missing the expected 2-6 month class for a transhumant pattern and the lowland site of Novačka Ćuprija is missing its 6-12 month age group. In addition, the 6-12 month class is present in Petnica. The animals in this age class would be expected to have returned to their lowland pastures for the Autumn and Winter months. As a result, it is less likely that transhumant pastoralism is taking place at this time.

Early/Middle Bronze Age

As with pigs, the Early and Middle Bronze Age are considered together. There is a great deal of cultural continuity between these periods. Only two sites yielded samples, both of which are from the lowlands - Early Bronze Age Novačka Ćuprija and Middle Bronze Age Vinča. The Novačka Ćuprija (Figure 29) mortality profile shows the absence of the youngest age group (0-2 months) followed by little mortality of the 2-6 and 6-12 months age groups. This is followed by rapid mortality of age groups 1-2 years and finally a rapid mortality, but at a decreased rate, of the older age groups (2-10 years) in comparison to the earlier groups. The harvest profile from Vinča (Figure 30) shows an absence of the youngest age groups (0-2 and 2-6 months). There is continued and rapid mortality of the age groups beginning with 6-12 months and continuing through to 8-10 years, with slight changes along the way.

The profiles of Early Bronze Age Novačka Ćuprija and Middle Bronze Age Vinča are very similar. There are no statistically significant differences between the profiles of these sites (Table 126).

*Production strategy*

Neither of these patterns fit any of Payne's proposed specialized herd production models. Both, however, conform to Greenfield's (1988) expectations for a herd based on long-term stability and animal exploitation with a mixed subsistence economy (both primary and secondary products) and an emphasis on secondary products.

*Implications for seasonality and transhumance*

Since both samples come from lowland sites, they should have evidence of the 0-2 and 6-12 month, and absence of 2-6 month age classes if transhumance is occurring.

The 0-2 age class is missing in both cases. The absence of the expected 0-2 month class is not surprising in these sites. It may be a function of assemblage attrition, given the lack of sieving at Vinča (Table 134). The slightly older age classes should be less affected (cf. Munson 2000). The absence of the 2-6 month class and presence of the 6-12 month class at Vinča are in accordance with the expectations for a lowland site involved in the transhumant movement of herds. The problem is that the presence of the 2-6 month classes at Novačka Ćuprija is not accordance with the expectations for a lowland site involved in the transhumant movement of herds. Therefore, the evidence for transhumance from this period is somewhat mixed. One site may be interpreted to be part of a transhumant system and the other may not. A major problem with this period is that there is an absence of mid-altitude and highland site locations with sufficient data with which to compare them.

Late Bronze Age

The situation is different for the Late Bronze Age. Three sites yielded sufficient data for this period - mid-altitude Petnica and lowland Novačka Ćuprija and Livade. Novačka Ćuprija (Figure 31) shows an absence of very young age groups (0-6 months). There is a medium mortality rate of age classes 6-12 months and 1-2 years followed by a higher mortality rate through the 2-6 years age classes. After this, the rate declines (6-8 years). There are no remains from oldest age group (8-10 years) sample. At Livade (Figure 32), there is complete absence of age groups 0-12 months and a steep decline in the profile indicating a rapid mortality of subadult/adults (2-3 years through to 6-8 years). There is an absence of the oldest age group (8-10 years). Petnica (Figure 33) shows a different pattern. Even though the youngest age groups (0-2 months) are absent, the next age group (2-6 months) is present at the site. There is a pattern of gradual mortality from 2-6 months through to 2-3 years followed by a more rapid mortality of the age groups 3-4 years and 4-6 years. There is an absence of the oldest age groups (6-8 years and 8-10 years).

It would be expected that the lowland sites of Novačka Ćuprija and Livade would be similar to each other and significantly different from the mid-altitude site of Petnica (Figure 34). However, chi square analysis of the profiles from all three sites from this period indicates that there is no statistically significant difference between them. It is probable that the sample sizes are not sufficiently large to reflect the expected differences using statistics.

*Production Strategy*

Neither of these patterns fit any of Payne's proposed specialized herd production models. Both, however, conform to Greenfield's (1988) expectations for a herd based on long-term stability and animal exploitation with a mixed subsistence economy (both primary and secondary products) and an emphasis on secondary products.

*Implications for seasonality and transhumance*

The presence of the 2-6 month class, and the absence of the younger class would indicate the presence of herds around Petnica during this crucial period of the year. It is in accordance with expectations that highland herds, and not necessarily lowland herds, must be moved in a transhumant fashion. The presence of the 6-12 age class at Petnica, however, would not be in accordance with expectations that transhumance has appeared. The absence of the 2-6 month age class at both lowland sites (Livade and Novačka Ćuprija) is expected if they are participants in a transhumant economy.

The lack of the 0-2 month class from both the mid-altitude and lowland sites is not surprising. It may be a function of assemblage attrition due to low or lack of sieving at Petnica and Livade, respectively (Table 118). The absence of this age class at Novačka Ćuprija is surprising since this is where it would be expected. This is a sieved site. Its absence may be a reflection of the lower rate of preservation at Novačka Ćuprija than many of the other sites (Greenfield 1986).

The presence of the 6-12 month class at Novačka Ćuprija would be in accordance with expectations for a transhumant economy. But the absence of this class at Livade is contrary to expectations. The complete absence of all individuals at Livade, with its high rate of weathering, is not unexpected (Table 134). The result, however, is that no conclusions concerning the presence or absence of transhumance at Livade is possible.

This may imply that animals are not being moved in a transhumant fashion from lowland sites. However, as discussed in earlier section, it is not hot and dry enough in the central Balkans (contrary to the Mediterranean) to force this pattern for lowland sites.

Early Iron Age

The harvest profile of the highland Early Iron Age site of Kadica Brdo (Figure 35) shows a very low mortality in the youngest age groups (0-6 months), followed by rapid mortality of age groups 6-12 months and 1-2 year, followed by a slowing in the 2-3 year, and a final very rapid mortality rate between 3-4 and 4-6. There is a very low rate of older age groups (6-8 and 8-10 years) in comparison to the earlier groups. There are no gaps in the youngest age groups (0 to 1-2 years).

*Production strategy*

The harvest pattern at Kadica Brdo does not fit any of Payne's proposed models for exploitation strategies, but conforms to Greenfield's (1988) expectations for a herd based on long-term stability and animal exploitation with an emphasis on secondary products.

*Implications for seasonality and transhumance*

The remains from the Early Iron Age highland site of Kadica Brdo are not indicative of the presence of transhumance. The harvest profile shows the presence of the youngest age classes that implies a year round availability of the herds. This, in turn, suggests a non-transhumant movement and continuous culling of the animals, and residential stability throughout the year. It may be that at this later period, highland areas have developed enough to support year round residence of domestic herds through the production and storage of winter fodder and appropriate shelter available for the animals.

The Southern Balkans

Megilo Nisi Galanis was included in the analysis in an effort to make a comparison with the southern Balkans. The data from each period are considered separately.

Final Neolithic

Samples sizes were only large enough to consider *Ovis/Capra*. The profile shows low mortality of the 0-2 month age group. The 2-6 month age group is absent. There is a rapid mortality of the 6-12 month through to the 4-6 year age group. There are no 6-8 years or 8-10 year age groups present.

*Production strategy*

The mortality profile of the Final Neolithic (Figure 36) of Megilo Nisi Galanis mostly closely resemble the herd exploitation model for primary products, that is meat production, during this period (Payne's 1973 Model A kill-off pattern - see Figure 1).

*Implications for seasonality and transhumance*

The Final Neolithic period of the southern Balkans is temporally contemporaneous to the Eneolithic period of the Northern Balkans. Therefore, one would expect to see a profile similar to those seen in the Post Neolithic phases of the northern Balkans. The profile shows the presence of the youngest age group, 0-2 months, the absence of the next age group (2-6 months) and then a high mortality rate of the subsequent age groups. This appears to fit exactly with the expectations that a lowland site involved in a transhumant movement of herds. However, Megilo Nisi Galanis is a site located on a plateau, which makes it more of a mid altitude site. As a result, one would have expected the opposite pattern. In order to have an effective comparison between the transhumant patterns of the northern Balkans and the southern Balkans, a larger sample of sites from the southern Balkans is required including both highland and lowland areas.

Final Neolithic/Early Bronze Age

The profile of the Final Neolithic/Early Bronze Age of Megilo Nisi Galanis (Figure 34) shows the absence of the youngest age group (0-2 months) followed by a somewhat rapid mortality of the 2-6 month groups and the 6-12 months group. A much more rapid mortality rate is seen for the 1-2 year group, followed by a gradual mortality of the remaining groups.

*Production strategy*

The mortality profile of the Final Neolithic/Early Bronze Age of Megilo Nisi Galanis (Figure 37) mostly closely resemble the herd exploitation model for primary products, that is meat production, during this period (Payne's 1973 Model A kill-off pattern - see Figure 1). Culling of the youngest age groups is later than in the Final Neolithic within Megilo Nisi Galanis.

*Implications for seasonality and transhumance*

The harvest profile of the Final Neolithic/Early Bronze Age does not fit the pattern hypothesized for a mid-altitude site involved in transhumance where one would be expecting it. This would imply that a different pattern existed between the northern and southern Balkans. In order to have an effective comparison between the transhumant patterns of the northern Balkans and the southern Balkans, a larger sample of sites from the southern Balkans is required including both highland and lowland areas.

***Bos taurus***

Early Neolithic

In the Early Neolithic, both the lowland site of Foeni-Salaş (Figure 38) and the mid-altitude site of Blagotin (Figure 39) have sufficient sample sizes to produce harvest profiles for *Bos taurus*. The harvest profiles from the two sites have no statistically significant differences (Table 128). Additionally, there are no statistically significant differences between an average *Bos taurus* pattern and an average *Ovis/Capra* pattern (Table 129) for the same period (Figure 40). The harvest profile shows a rapid mortality of the youngest age groups (0-1 month), a slight reduction in mortality of the 1-8 month age class followed by rapid mortality of the 8-30 months age groups. The 30-36 month age group is missing from the profile. There is again a rapid mortality rate of the young adult age group. Adult and old adult age classes are also missing. This site was totally sieved, so the sample is believed to be well representative of the youngest age groups that may have been omitted in unsieved sites. This pattern is essentially repeated at Blagotin, with two major differences: both the 30-36 months age group and the old adult age group are present and there is an absence of senile individuals.

*Production Strategy*

The harvest profiles from both sites indicate the exploitation of the herd for primary products, that is meat production. It most closely resembles Payne's Model A kill-off pattern (see Figure 1).

*Implications for seasonality and transhumance*

The profile from the Early Neolithic at both Foeni-Salaş and Blagotin shows the presence of the youngest age classes (0-1, 1-8 and 8-18 months). This implies a year round availability of the herds which suggests non-transhumant movement and continuous culling of the animals, and residential stability throughout the year. The similarity between both profiles is remarkable, given that one is lowland and the other is mid-altitude. It would be correct to state that there is no complementarity between them and that transhumance is not occurring between highland and lowland areas.

Middle Neolithic

Two sites provide information on the Middle Neolithic harvest profile patterns of *Bos taurus*. These are the lowland site of Stragari (Figure 41) and the mid-altitude site of Petnica (Figure 42). The harvest profile of Stragari shows the same general pattern as those from Early Neolithic. There is low mortality of the youngest age group (0-1 month) followed by an absence of the 1-8 month age group. A rapid mortality rate of the 8-30 months groups is seen. The 30-36 months and young adult groups are both missing from the profile. A rapid mortality rate of the adult age group is seen and an absence of the old adult group. The harvest profile of Petnica shows similar patterns. But there are several differences: there is a low mortality from 8-18 months and rapid mortality of the young adult group. The adult group is also missing from the profile.

While both sites have adequate sample sizes, Stragari (n=29) and Petnica (n=22), both are missing important age classes for this investigation (Figure 43). Significantly, while both sites include the remains of the 0-1 month age class, both are missing the 1-8 months age class. The statistical analysis indicates that there are some statistically significant differences between the profiles for this period (Table 130). However, as the usual p value is greater than 0.05 and the exact is only slightly less than 0.05, this difference should only be considered to be a moderate effect.

*Production strategies*

The harvest profiles from both sites indicate the exploitation of the herd for primary products, that is meat production. It most closely resembles Payne's Model A kill-off pattern (see Figure 1).

*Implication for transhumance*

This would seem to imply the pattern expected for a lowland site where the herd is being moved in a transhumant fashion. However, as a significant amount of the age groups are missing from both profiles it may be suggested that there is a problem with the representativeness of the sample, rather than indication of transhumance.

Late Neolithic

The lowland sites of Opovo (Figure 44) and Vinča (Figure 45) as well as the mid-altitude site of Petnica (Figure 46) all have sufficient sample sizes of *Bos taurus* for the Late Neolithic. The site of Opovo shows a low rate of mortality for the youngest age groups (0-1 months through to 8-18 months). This is followed by a steep mortality of the 18-30 months group. The 30-36 month age class is missing from the sample. Finally, there is a rapid rate of mortality for the young adult age class, although more gradual than the previous classes. The adult and senile age classes are missing from the sample. At Vinča, there is a more rapid mortality rate of the youngest age classes and a very low mortality rate of the 30-36 month group through to adult. The senile group is missing at Vinča. The mid-altitude site of Petnica indicates the same harvest profile pattern. There is a gradual rate of mortality for the youngest age groups (0-1 months through to 8-18 months). The steep mortality of the 18-30 months seen Opovo and Vinča, extends to the 30-36 months group. This is followed by the low rate of mortality for the oldest age groups. There are no statistically significant differences between the harvest profiles of the three Late Neolithic sites (Table 131).

*Production Strategy*

The harvest profiles of all three Late Neolithic sites (Figure 47) mostly closely resemble the herd exploitation model for primary products, that is meat production, during this period (Payne's 1973 Model A kill-off pattern - see Figure 1).

*Implications for seasonality and transhumance*

The profiles from the Petnica, Vinča and Opovo show the presence of the youngest age classes (0-1, 1-8 and 8-18 months). This implies a year round availability of the herds. In turn, this suggests a non-transhumant movement and continuous culling of the animals, and residential stability throughout the year. It would be correct to state that there is no complementarity between them and that transhumance is not occurring between highland and lowland areas. This pattern conforms to the pattern established in the Early Neolithic.

Eneolithic

In the Eneolithic periods of Blagotin (Figure 48) the harvest profile shows a complete absence of the youngest age groups (0-8 months) followed by a steep mortality rate for the 8-18 month group through to the young adult group. There is the complete absence of the oldest age groups, adult, old adult and senile.

*Production strategy*

The pattern does not fit any of Payne's proposed specialized herd production models. It does, however, conform to Greenfield's (1988) expectations for a herd based on long-term stability and animal exploitation with a mixed subsistence economy (both primary and secondary products) and an emphasis on secondary products.

*Implications for seasonality and transhumance*

Blagotin is a mid-altitude site, and would be expected to conform to the highland pattern within a transhumant strategy. There would be an expected absence of the youngest age classes (0-1 month). This is the pattern that is seen. However, as discussed above, this age class in unreliable for indications of transhumance based on taphonomic issues. One should then look at the expected presence of the next age group (1-8 months) that would be expected to dominate the harvest profile. The complete absence of this age class would indicate that the harvest profile of Blagotin does not show results that conform to the expectations of a highland site involved in the transhumant movement of herds. A problem with this period is that there is an absence of lowland site locations with sufficient data with which to compare them.

Early/Middle Bronze Age

Only the mid-altitude site of Ljuljaci (Figure 49) has sufficient *Bos taurus* remains to construct a harvest profile for the Early/Middle Bronze Age period. The profile shows an absence of the youngest age class (0-1 months). This is followed by a rapid mortality rate of the 1-8 month group through to the 18-30 month group. The age class 30-36 months is missing from the profile. This is followed by a low mortality rate of young adults and a more rapid mortality of adult age groups. The old adult group is missing from the profile. The middle Bronze Age mortality profile for *Bos taurus* from Vinča (Figure 50) indicates some interesting patterns. There is a gradual mortality of the youngest age groups (0-1 month and 1-8 months). This is followed by a rapid mortality of the 8-18 month group and then a low mortality of the 18-30 month group. There is a complete absence of age stages 18-30 months through to adult.

*Production strategy*

The Ljuljaci harvest profile does not fit any of Payne's proposed specialized herd production models. It does, however, conform to Greenfield's (1988) expectations for a herd based on long-term stability and animal exploitation with a mixed subsistence economy (both primary and secondary products) and an emphasis on secondary products. The unusual pattern at Middle Bronze Age Vinča indicates that there is no culling of the subadult/adult age groups. This pattern strongly indicates a traction profile.

*Implications for seasonality and transhumance*

As Ljuljaci is a mid-altitude site the harvest profile is expected to show a highland pattern. Here, it seems that for *Bos taurus*, with the absence of the 0-1 month group and the occurrence of rapid mortality of the 1-8 months age group, Ljuljaci shows the expected pattern of a highland site. One would also expect the absence of the next age class as the herd moves back into lowland areas for the winter. However, the harvest profile shows a continuation of the rapid mortality of the earlier age class. As a result, Ljuljaci appears not to conform to the expectations of a transhumant movement of domestic herds. The lowland site of Vinča shows both the presence of the youngest age class (0-1 month), which is expected, and the presence of the next age class (1-8 months) which is unexpected if there was transhumant movement of the herd. It appears that Vinča does not fit the transhumant pattern for lowland sites. This is not surprising given the other aspects of the profile that indicate a strong traction profile. It seems likely that the subadult/adult age classes were kept in the lowland sites as agents of traction for agricultural cultivation.

<u>Late Bronze Age</u>

Only the lowland site of Livade (Figure 51) has sufficient sample size of *Bos taurus* for the Late Bronze Age period. The harvest profile indicates an absence of the youngest age classes (0-1 month and 1-8 months). There is a rapid mortality of the 18-30 month age group. The 30-36 month group is absent from the profile. This is followed by a low mortality rate of the young adult and adult age classes and finally there is a rapid mortality of the old adult and senile age classes.

*Production strategy*

The harvest profile from Livade does not fit any of Payne's proposed models for kill of patterns indicating a single exploitation strategy. Instead, it appears to follow Greenfield's (1988) pattern for mixed exploitation strategy of both primary and secondary products, with a greater emphasis upon the latter, and herd stability.

*Implications for seasonality and transhumance*

The absence of the 1-8 month group is expected in the lowland site of Livade assuming a transhumant movement of the domestic herds. The presence of the next age group 8-18 months also fits with the expectations of a transhumant movement. As such, it seems that the data implies that animals are being moved in a transhumant fashion.

Early Iron Age

The only highland site in this investigation, Kadica Brdo (Figure 52) provides the only harvest profile for the Early Iron Age. There is a very low mortality of the youngest age group (0-1 months), and complete absence of the 1-8 month age group. This is followed by a low mortality rate of the 8-18 month group and rapid mortality of the 18-30 month group. The 30-36 month group is missing from the profile. There is a rapid mortality rate of the young adult group through to senile, although at a reduced rate from the previous age groups.

*Production Strategies*

The harvest pattern at Kadica Brdo does not fit any of Payne's proposed models for exploitation strategies, but conforms to Greenfield's (1988) expectations for a herd based on long-term stability and animal exploitation with an emphasis on secondary products

*Implications for seasonality and transhumance*

The remains from the Early Iron Age highland site of Kadica Brdo are not indicative of the presence of transhumance. The harvest profile shows the presence of the youngest age classes, which implies a year round availability of the herds. This, in turn, suggests a non-transhumant movement and continuous culling of the animals, and residential stability throughout the year. It may be that at this later period, highland areas have developed enough to support year round residence of domestic herds through the production and storage of winter fodder and appropriate shelter available for the animals.

***Conclusions***

The pig harvest profile data conforms exceedingly well to the expectations of this investigation. The harvest profiles of these animals indicate their exploitation for primary products only and demonstrate no change over the entire temporal period of this investigation. As pigs have no secondary products for which they can be exploited, their harvest profiles are not complicated by issues of the Secondary Products Revolution, as are the other domestic species. The data demonstrates the expected pattern of non-transhumant movement of pigs.

For *Ovis/Capra* and *Bos taurus*, the Neolithic periods show the exploitation of the domestic herds solely for primary products. Additionally, the herds are resident year round in the region. This was the expected pattern, indicating the non-transhumant movement of the herds.

As the hypotheses are stated in this investigation, one would expect to begin to find evidence of the transhumant movement of herds in the Post Neolithic. However, the data was unable to adequately answer any questions about the transhumance. For

*Ovis/Capra*, only the harvest profile from the lowland site of Vinča begins to suggest some evidence of transhumance in the Early/Middle Bronze Age. All other harvest profiles of *Ovis/Capra* from other sites and periods do not. Only the harvest profile from the Late Bronze Age site of Livade suggests evidence for the transhumant movement of *Bos taurus*. All of the harvest profiles of *Bos taurus* from other sites and periods do not suggest evidence of transhumance. Due to small sample sizes and the inability to fully consider the youngest age group within the harvest profiles due to taphonomic issues, neither of these observations can be put forth as evidence of transhumance.

# Chapter 10:

## Data Analysis - Cementum Analysis

### Introduction

In this chapter, the data presented in chapter 8 will be analyzed. The modern comparative sample must be examined in order to establish the timing of the formation of the cementum increments in an effort to accurately investigate the nature of the increments visible in the archaeological sample. As such, the modern comparative sample will be discussed first, followed by a discussion of the archaeological sample.

#### *Modern comparative sample*

The number of growth line groups that can be counted in the cementum of each tooth and the nature of the final increment are recorded for each slide. The readings are summarized in Table 116. The following observations can tentatively be made on the comparative collection in order to aid in interpretation of the archaeological sample.

It appears that the annulus forms between November and February. This is suggested by the bright outer increment seen on teeth from animals slaughtered during this period. It is suggested in both the sheep and the goats but is most clearly shown by the sample - Goat 14 (slide b - Figure 53). Therefore, as the goats were born in April and the sheep in May, it can be expected that a growth zone will be apparently from April through to November.

It can also be noted that sheep and goats form annual increments that correspond well with absolute age. However, this observation must be cautiously applied as only one sheep in the collection demonstrates it (Sheep #1 - Figure 54). However, this may be due to the fact that the modern comparative collection consists predominantly of younger (<2 years) animals. In those where only one growth layer group is expected, it is often indistinct or unobservable. This may be due to the fact that the layers are indistinct until they have formed successive layers. In long living animals such as ungulates (Klevezal 1996: 83), that form the first growth layer of cementum during their first winter, the incremental line of the first growth layer is less distinct that the incremental lines of growth layers that are formed later (Klevezal 1996: 41). Klevezal (1996: 41) notes that in one-year-old animals there is considerable frequency of indistinct first incremental lines. This pattern is less frequent in older animals. These observations seem to indicate that the first incremental line is not very distinct in the period of its formation but becomes more distinct with age. However, "it may not become as distinct as the incremental lines formed during the later years" (Klevezal 1996: 41).

The cause of this poor contrast of the first incremental line is explained by the period of its formation.

> In young animals, seasonal rhythms of individual's growth are, as a rule, less distinct that those of older animals; retardation of growth is not so strong and not so long, so the element of the annual layer that is formed in winter is not very distinct (Klevezal 1996: 82).

The increase in the distinctiveness of this incremental line over time is explained by the secondary deposition of minerals (Klevezal 1996: 41) that is, secondary calcification in the already formed cementum over time (Klevezal 1996: 82).

Several readings had to be taken at the end of the root. This has been demonstrated to be not an ideal place for readings, and is demonstrated by the occurrence of two annuli on the root of an 8-month-old goat (Figure 55).

### *Archaeological sample*

The determination of the number of increments and the nature of the outer increment were performed both by the author and by Dr. A. Burke. Dr. Burke examined the slides in a blind test, so as the initial readings by the author were not known, in an effort to reduce bias.

In the Early Iron Age highland site of Kadica Brdo, the archaeological thin sectioning sample consisted of ten teeth. Of these, the slides of four teeth were unreadable. Of the six remaining teeth the number of increments counted (by both readers) agree with the age estimates obtained from tooth wear and eruption. The nature of the final increment was only determinable on four of the readable slides (Samples Kadica Brdo #2, 4, 6 and 10 - see Figures 56-59). These were all determined to be a growth zone. Sample Kadica Brdo #4 provided the best reading with the highest degree of confidence from both readers and indicates a growth zone final.

At the lowland site of Vinča, of the nine teeth that were sectioned, five were unreadable. Of the remaining four teeth, the number of increments counted generally agrees with the age estimates obtained from tooth wear and eruption. Although one tooth (Vinča sample #1) has 9 Growth Line Groups counted by the author and the tooth wear and eruption indicates an age of between six and eight years. However, the secondary reading by Burke indicates 6 growth line groups, which is exactly in line with what would be expected from the tooth wear and eruption.

The determination of seasonality estimates was problematic for the site of Vinča. The nature of the final increment was determinable for only three of the readable slides (Vinča samples #1, 6 and 10 - see Figures 60 and 61). Based on the observations established with the modern comparative sample, these were interpreted by the author as the forming of an annulus with a bright outer increment. However, both of the determinations made by A. Burke indicated a zone final. It must be realized that as the conclusions based on the modern comparative are limited by the extremely small sample size. While the modern comparative includes nineteen animals, which is extremely small already, the observations regarding increment formation are based on a single animal.

Additional problems exist with regards to the application of the modern comparative to the archaeological sample. As the birth month in the northern Balkan region is known to be February, and the birth of the modern comparative is known to be April/May, this implies a certain amount of incompatibility between the comparative and the archaeological sample. While the modern comparative can be used to establish that the increments formed by sheep and goat correspond well with absolute age, this is not the main focus of the archaeological sample. It was hoped that the thin sectioning of the archaeological teeth would provide seasonality information, as the primary technique of tooth wear and eruption is limited in its ability to establish this information. As the timing of the birth of these animals is significantly different, it can reasonably be assumed that the timing of the formation of the increments will also differ. The ideal would be the collection of a modern sample from the northern Balkan region.

One may be tempted to see that the nature of the final increments of the archaeological sample from the highland and lowland areas is complimentary. The readable slides from the lowland site of Vinča show an annulus as the final increment, while all the readable slides from the highland site of Kadica Brdo show a growth zone as the final increment. As such, while the timing of the formation of these increments may be only tentatively established based on the comparative collection, there is a complimentary pattern of seasonality between the highland and lowland sites. However, as the observations of the two investigators do not agree, one cannot use this result with confidence.

A final problem to consider, when attempting to draw any conclusions from this limited archaeological thin sectioning sample, is the period of the sites. The sample from the lowland site of Vinča is from the Late Neolithic. As transhumance is not hypothesized to be occurring at this time, the herd should be resident in this lowland site for the entire year. One would expect to find seasonality evidence for occupation year-round. Therefore, if one accepts either researcher's readings, the sample follows expectations. The highland site of Kadica Brdo, if involved in the transhumant movement of herds would be expected to show only a summer occupation, which it does. As such, while the sample from Kadica Brdo appears to conform to the hypotheses put forth in this investigation, it is severely limited by sample size as well as the lack of lowland sites of the same period.

**Conclusions**

The modern comparative collection is unfortunately not as good as originally hoped. It was difficult to obtain animals that were older than a year and a half. This is due to the fact that *Capra hircus* is primarily raised for meat in Manitoba, and so is slaughtered before this age. A good sample of *Ovis aries* was equally difficult to establish, for even though these animals are raised primarily for wool in Manitoba, the majority of producers are small scale and slaughter a minimum number of animals within the year.

The archaeological sample is also limited in size, and so, limits what conclusions can be made from the data. However, it can be stated with confidence that both sheep and goat develop increments in their dental cementum, which correspond well with their absolute age.

While the seasonality data is limited and contradictory, it can still be said to conform to expectations. However, the nature of the sample prohibits any conclusions both through its small sample size and the fact that the periods of interest are not adequately represented.

# Chapter 11:

# Conclusions

It was originally hypothesized that the origins of transhumant pastoralism in the northern Balkans would be firmly established at the Late Neolithic/Post Neolithic juncture. The major hypothesis of this investigation stated that if transhumant pastoralism was present in southeastern Europe during the Post Neolithic, then a complimentary culling pattern would be seen in settlements from this period between highland and lowland sites. The null hypothesis stated that if transhumant pastoralism was not present, there will be a random culling pattern between highland and lowland sites.

Several overriding methodological issues hampered this research. First, sample size was the major limitation of the investigation. Small sample size did not allow for the examination of every domestic species of interest, in each period, and at each site. Second, taphonomic issues, notably the extent of sieving and differential preservation of the age classes, were a major contributing factor to the small sample size. Third, the sample was also limited by a lack of highland sites from the earliest periods of the Post Neolithic, specifically the Eneolithic and the Early Bronze Age. Only one site was considered to be a true highland site (Kadica Brdo).

Shennan (1988) maintains that samples of mandibles less than 15-20 should be considered too small to provide accurate harvest profiles. The minimum sample size should be 40 mandibles. As a result, less than 20% of the harvest profiles produced in this investigation can be considered reliable. This is inadequate representation to make any conclusions on the origins of transhumant pastoralism. Therefore, even in profiles that show the expectations put forth by the major hypothesis of this investigation (Middle

Bronze Age Vinča for *Ovis/Capra* and Late Bronze Age Livade for *Bos taurus*), these cannot be considered to be evidence of a transhumant movement of domestic herds. As a result, the major hypothesis is rejected.

The evidence of seasonality from the cementum analysis of the domestic *Ovis/Capra* teeth was limited and problematic. There was no evidence for a complementary seasonality of culling between highland and lowland sites. As such, the minor hypothesis should be rejected. However, it is important to realize the limitations of the thin sectioning data for this investigation, most notably, its small sample size. Additionally, the modern comparative collection was limited by the absence of older individuals that made the establishment of timing of increments difficult. This, in turn, affects the conclusions presented for the archaeological sample. The most limiting factor of the thin sectioning sample was the absence of the main periods of interest, specifically the Eneolithic and the Early Bronze Age. As a result, while the hypothesis has been rejected, the lack of this type of evidence should not be considered to be evidence of a lack of transhumant pastoralism in the region at this time, but rather, a lack of an appropriate sample.

### *The Secondary Products Revolution*

The data were unable to answer questions about the origins of transhumance. However, it does appear to provide additional evidence for support of the Secondary Products Model. The advent of transhumance in southeastern Europe is hypothesized to occur at roughly the same time as the inclusion of secondary products in domestic animal exploitation strategies, ca. 3300 BC (Greenfield 1986, 1988, 1999a). Sherratt (1981,

1983) originally coined the term 'The Secondary Products Revolution of the Old World'. This hypothesis proposes that livestock, once domesticated, were utilized solely for meat production. It was not until after several millennia that these domestic animals began to be exploited for their other products, such as milk, wool or hide, and as agents of traction. While admitting that the evidence is varied and not conclusive, Sherratt (1983: 90) maintained that this was a critical phase of change in the Old World.

The developments of the secondary products revolution, the cart, the plough, wool and milk were not accidentally coincident. Sherratt (1981, 1983) asserted that they are all similar responses to the problem of population growth and territorial expansion initiated by the beginnings of animal and plant domestication in the Early Neolithic. "Such problems became especially acute with the need to penetrate increasingly marginal environments in a landscape containing sharp contrasts in climate and terrain within short distances" (Sherratt 1981: 286).

There were several obvious benefits to the use of secondary products. The plough and the use of animals as agents of traction allowed for the intensification of agriculture with the cultivation of a range of poorer quality soils. Additionally, the cart enabled easier transport of goods and reduced the difficulties in movement across the landscape. These developments enabled not only an expansion of areas under cultivation but also, expanded the range of settlement locations and settlement types. In these new areas, considered marginal in earlier periods, the development of new textiles made from wool provided a valuable commodity for trade, where there had previously been none. These areas were also well suited to the larger herds that were now possible with a focus on the production of milk. The growth of herds enabled the development of a pastoral sector of society (Sherratt 1981: 262).

The use of secondary products also had significant social implications. As intensification of both cultivation and animal husbandry occurred, two distinctive subsistence systems developed, agriculturalists (with the aid of the plough) and pastoralists. Each group was identified as having characteristic social features.

Chapman (1982) voiced many criticisms of the Secondary Products Revolution but focused on three major points: dating divergences, methodological bias, and speculative reasoning. Each is discussed in turn. His first criticism was with the use of the word revolution to describe the shift to the use of secondary products. While Sherratt recognized that there was regional variation in the rate and extent of the shifts to secondary products, he defined the Secondary Products Revolution as package of characteristics with resulting social changes. However, as Chapman noted (1982: 110), "the greater the chronological and spatial variability in innovation/diffusion rates of any revolution, the more difficult the task of demonstrating the inter-relatedness of the so-called revolutionary 'complex'". The tighter the time-space connection of the innovations, the more strongly these can be associated with a particular behaviour.

These obvious dating divergences are perhaps the most obvious failing of the Secondary Products Revolution hypothesis. Even Sherratt (1983: 94) admitted that it is over an extended period of time, as much as one thousand years, from c. 3500 to 2500 BC that these innovations probably arrived. Through Chapman's (1982) reanalysis of the available evidence, this period was extended to over two millennia. As such, it can neither be regarded as revolutionary, when it is in fact a cumulative and long term process (Chapman 1982: 110) nor can it be an adaptive response to problems of environmental deterioration (Chapman 1982: 120).

Chapman made the suggestion that Sherratt made several major methodological mistakes. He was guilty of deriving conclusions from a limited and even biased set of data. The data for Europe was solely prehistoric, and so, lacks any literary evidence. Additionally, the recovery of artefactual evidence in Europe was affected by preservational bias, as ploughs and carts will only preserve in exceptional circumstances. Plough marks tend only to be preserved in areas of northwest Europe, creating a significant geographical bias in the data.

Sherratt was also evaluated as being uncritical in his acceptance of his own speculation. Several unverified and unverifiable assumptions were made in support of the hypothesis. These were the lactose tolerance of farming populations, the ceramic evidence of the dairy industry and the interpretations of the faunal evidence (Chapman 1982: 116). While Sherratt admitted that his arguments are often speculative (1980: 313), these assumptions remain unproven, and so, affect the strength of the hypothesis. Most importantly, Chapman (1982: 111) suggested that Sherratt was guilty of omitting data that was incompatible with the hypothesis and goes on to extensively list examples.

Sherratt's model to explain the socio-economic patterns both before and after the Secondary Products Revolution was criticized as "a virtuoso piece of the highest creativity" (Chapman 1982: 117). The model proposed complex behavioural changes to explain changes in settlement patterns and socio-linguistics in both Europe and the Near East. Represented in a diagrammatic form, it did not demonstrate the systematic relationships between the variables. Nor was it possible to include all relevant variables in such a simplified manner (Chapman 1982: 117).

Next, Chapman examined Sherratt's settlement pattern model and leveled two main criticisms. The first was that the model is based on a misunderstanding of vital environmental parameters. The second was the neglect of Late Neolithic developments throughout Europe. Chapman (1982: 119) then proposed his alternative hypothesis. The plough played an important role in extending the subsistence base of later Neolithic populations. While the plough greatly reduced labour input, it also created the option of expanding the cultivated area for the same effort in case of population increase. This increase in both cultivated areas and pastureland for the growing animal populations necessitated more widespread use of the interfluve areas. The consequences were deforestation and soil erosion in some areas and in others, the exploitation of complementary wild resources. It was these conditions of plough agriculture in combination with increased population and intensified settlement that resulted in the decline of Neolithic climax societies, as well as the low-intensity, extended settlement patterns of the Early Bronze Age. These were a response to environmental deterioration and not merely a consequence of Late Copper Age pastoral practice (Chapman 1982: 119).

The model of the Secondary Products Revolution has been shown to have several major methodological and theoretical downfalls which have been noted not only by Chapman (1982) as discussed above, but also by several other researchers (Bankoff and Greenfield 1984, Greenfield 1986). However, it cannot be denied that secondary products had a wide-ranging effect on European prehistoric societies.

Chapman (1982: 120) maintained that the archaeological evidence for the secondary products that were solidly datable indicate that these products came into use as part of the late Neolithic adaptation. In this, he excluded milking and wool as undatable in the archaeological record. Greenfield (1988, 1989) has advocated the investigation of this question through the use of the remains of the domestic animals in question. Moreover, Greenfield (1989) has utilized the zooarchaeological data from the central Balkans to demonstrate that the significant changes that are hypothesized to occur at this juncture do exist. While the harvest profiles of pigs, an animal without significant secondary products, do not change over time, the profiles of both cattle and the ovicaprines show a significant change in exploitation strategies at the advent of the Post Neolithic (ca. 3300 BC). "Although the data do not indicate the presence of highly specialized production strategies (as implied in the Secondary Products model), they may be reflective of more diversified uses" (Greenfield 1989: 197). As such, while Sherratt's original proposal of the Secondary Products Revolution should not be accepted without proper consideration of its criticisms, the model does highlight the diversification of exploitation strategies in the Post Neolithic. Additionally, the model does provide suggestions of potential correlations, supported by selected evidence and provides avenues for further research (Chapman 1982: 117).

The harvest profiles of pig in this investigation were examined for changes over time (Figure 62). The major periods of interest were represented (Late Neolithic, Eneolithic, Early Bronze Age and Early Iron Age). The statistical analysis indicates no significant differences between the periods (Table 122).

For *Ovis/Capra* and *Bos taurus*, an average was constructed for the same periods (Figure 63 and 64). This involved the lumping of mandibular and tooth data from several sites, effectively increasing sample sizes. As a result, the limitations of small sample size were somewhat overcome. Now 62% of the profiles can be considered reliable. It would be expected that the Late Neolithic would differ significantly from the other major periods based on the use of secondary products with these species. The chi square analysis indicates that there is no statistically significant difference between the Late Neolithic and the Eneolithic for either *Ovis/Capra* (Table 132) or *Bos taurus* (Table 133). However, it is interesting to note that it is the Eneolithic period which is still limited by small sample size (*Ovis/Capra* n=21 and *Bos taurus*, n=12 - see above), perhaps explaining the lack of the expected pattern. The differences between the Late Neolithic and the Early Bronze Age, in *Ovis/Capra*, show a borderline statistically significant difference. In contrast, *Bos taurus* indicates a much stronger statistically significant difference between the two periods. Finally, for both species, the statistical analysis indicates no significant differences between the Late Neolithic and the Early Iron Age.

The period that shows the most significant shift in the profiles for both the species that would have been involved in the exploitation of secondary products is the Early Bronze Age. While the beginning of the Secondary Products Revolution is hypothesized to coincide with the Eneolithic, it has also been noted that its development was spread over an extensive temporal period. As such, shifts that would be expected to be seen in the harvest profiles may not be evident in the earliest periods, i.e. the Eneolithic. However, this does not explain the lack of an evident shift in the Early Iron Age. The Early Iron Age in the sample derives only from the site of Kadica Brdo. It might be that either the data from Kadica Brdo is not representative of the period in general, or that it does not conform to the typical Post Neolithic pattern because it is the only highland site in the sample. As such, more highland sites will need to be evaluated in order to answer these questions.

In conclusion, even though the data from this investigation has failed to elucidate the origins of transhumant pastoralism in temperate southeastern Europe, it has provided some further evidence in support of the Secondary Products Model.

### *Suggestions for future research*

It is suggested that the best avenue for future research to fully elucidate the origins of transhumant pastoralism in the Post Neolithic of the northern Balkans would be the collection of an extensive sample of domestic animal teeth appropriate for thin sectioning analysis. It is important that this sample cover lowland, mid-altitude and highland sites from all periods. Additionally, this sample should be collected with this technique in mind. As the sample utilized for this investigation was collected over an extensive period of time (nearly 20 years), during which the technique of thin sectioning was only just developing, the sample was not fully appropriate for use.

## References Cited


Bailey, D. W.
1994 Reading Prehistoric Figurines as Individuals. *World Archaeology* 25 (3): 321-331.

2000 *Balkan Prehistory. Exclusion, Incorporation and Identity*. New York: Routledge.

Bankoff, H. A. and H. J. Greenfield
1984 Decision-Making and Culture Change in Yugoslav Bronze Age. *Balcanica* 15: 7-31.

Barker, G.
1975 Early Neolithic Land Use in Yugoslavia. *Proceedings of the Prehistoric Society* 41: 85-104.

1985 *Prehistoric Farming in Europe*. Cambridge: Cambridge University Press.

Barth, F.
1961 *Nomads of South Persia. The Basseri Tribe of the Khamseh Confederacy*. Illinois: Waveland Press Inc.

Bartosiewicz, L. and H. J. Greenfield (eds.)
1999 *Transhumant Pastoralism in Southern Europe: Recent Perspectives from Archaeology, History and Ethnology*. Budapest: Archaeolingua.

Bar-Yosef, O. and A. Khazanov (eds.)
1992 *Pastoralism in the Levant : Archaeological Materials in Anthropological Perspectives*. Madison: Prehistory Press.

Boesseneck, J.
1962 Die Tierreste aus der Argissa-Magula vom prakeramischen Neolithikum bis zur mittleren Bronzezeit. In V. Milojčić, J. Boesseneck and M. Hopf (eds.). *Die deutsche ausgrabungen auf der Argissa-Magula in Thesselien* Bonn: Habelt. Pp. 27-99.

1969 Osteological Differences Between Sheep (*Ovis aries* Linne) and Goats (*Capra hircus* Linne). In D. Brothwell and E. Higgs (eds.). *Science in Archaeology* London: Thames and Hudson. Pp. 331-359.

Bökönyi, S.
1974 *The History of Domestic Mammals in Central and Eastern Europe*. Budapest: Akademiai Kiado.

Bonte, P.
1981 Ecological and Economic Factors in the Determination of Pastoral Specialization. *Journal of Asian and African Studies* 16 (1-2): 33-49.

Boroneanţ, V.
1985 Thoughts on the Chronological Relations between the Epi-Paleolithic and the Neolithic in the Low Danube. In *The Mesolithic in Europe*. Clive Bonsall (ed.). Edinburgh: John Donald Publishers Ltd. Pp. 475-499.

Bull, G. and S. Payne
1982 Tooth Eruption and Epiphyseal Fusion in Pigs and Wild Boar. In R. Wilson, C. Grigson and S. Payne (eds.). *Ageing and Sexing Animal Bones from Archaeological Sites.* BAR International Series 109: 55-72.

Bullock, D. and J. Rackham
1982 Epiphyseal Fusion and Tooth Eruption of Feral Goats from Moffatdate, Dumfries and Galloway, Scotland. In R. Wilson, C. Grigson and S. Payne (eds.). *Ageing and Sexing Animal Bones from Archaeological Sites*. BAR International Series. Oxford 109: 73-80.

Burke, A.
1995 *Prey Movements and Settlement Patterns During the Upper Paleolithic in Southwestern France*. BAR International Series 619. Oxford.

Burke, A. and J. Castenet
1995 Histological Observations of Cementum Growth in Horse Teeth and their Application to Archaeology. *Journal of Archaeological Science* 22: 479-493.

Butzer, K. W.
1971 *Environment and Archeology: An Ecological Approach to Prehistory*. 2d ed. Chicago: Aldine-Atherton.

Cauver, J.
2000 *The Birth of the Gods and the Origins of Agriculture*. Cambridge: Cambridge University Press.

Champion, T. and C. Gamble, S. Shennan and A. Whittle
1984 *Prehistoric Europe*. New York: Academic Press.

Chang, C.
1993 Pastoral Transhumance in the Southern Balkans as a Social Ideology: Ethnoarchaeological Research in Northern Greece. *American Anthropologist* 95(3): 687-703.

Chang, C. and H. A. Koster
1986 Beyond Bones: Toward an Archaeology of Pastoralism. In *Advances in Archaeological Method and Theory*, vol. 9. New York: Academic Press. Pp. 97-145.

Chapman, J. C.
1981 *The Vinča Culture of South-East Europe: Studies in Chronology, Economy and Society*. British Archaeological Reports (Oxford), I.S.S. 117 (Part 1 and 2).

1982 The Secondary Products Revolution and the Limitations of the Neolithic. *Bulletin of the Institute of Archaeology* 19: 107-122.

Cherry, P.
1988 Pastoralism and the Role of Animals in the Pre- and Protohistoric Economies of the Aegean. In C.R. Whittaker (ed.). *Pastoral Economies in Classical Antiquity*. Cambridge: Cambridge Philosophical Society, University Press. Pp. 6-34.

Crabtree, P. J.
1982 *Patterns of Anglo-Saxon Animal Economy: An Analysis of the Animal Bone Remains from the Early Saxon Site of West Stow, Suffolk*. Ph.D. Thesis; University of Pennylvania.

Cribb, R.
1990 *Nomads in Archaeology*. Cambridge: Cambridge University Press.

Cuncliffe, B.
1994 *The Oxford Illustrated Prehistory of Europe*. Barry Cuncliffe (ed.). Oxford: Oxford University Press.

Danta, D. and D. Hall (eds.).
1996 *Contemporary Balkan Questions: The Geographic and Historic Context. In Reconstructing the Balkans. A Geography of Southeast Europe*. New York: John Wiley & Sons Ltd.

Davis, S.
1987 *The Archaeology of Animals*. London: Yale University Press.

Dhavalikar, R.
1989 Farming to Pastoralism: Effects of Climatic Change in the Deccan. In J. Clutton-Brock (ed.) *The Walking Larder. Patterns of Domestication, Pastoralism and Predation*. London: Unwin Hyman. Pp. 156-168.

Dennell, R. W.
1972 The Interpretation of Plant Remains: Bulgaria. In E. S. Higgs (ed.). *Papers in Economic Prehistory*. Cambridge: Cambridge University Press. Pp.149-160.

Dumitrescu, V.
1983 The Prehistory of Romania from the Earliest Times to 1000 BC. *Cambridge Ancient History*. Cambridge: Cambridge University Press, vol. 3, part 1 (2nd Edition). Pp. 1-74.

Ehlers, E. and H. Kreutzmann (eds.)
2000 High Mountain Ecology and Economy: Potential and Constraints. In *High Mountain Pastoralism in Northern Pakistan*. Stuttgart: Steiner. Pp.: 9-36.

Edwards, P. C.
1989 Problems of Recognizing Earliest Sedentism: The Natufian Example. *Journal of Mediterranean Archaeology* 2 (1): 25-36.

Ehrick, R.
1965 Geographical and Chronological Patterns in east-central Europe. In R. Ehrick (ed.), *Chronologies in Old World Archaeology*. Chicago: University of Chicago Press, pp. 403-458.

Ekvall, R.B.
1968 *Fields on the Hoof: Nexus of Tibetan Nomadic Pastoralism*. New York: Holt, Rinehart and Winston.

Evans-Pritchard, E. E.
1940 *The Nuer: A Description of Modes of Livelihood and Political Institutions of a Nilotic People*. Oxford: Clarendon Press.

Ewbanks, J. M.
1964 Sheep in the Iron Age: A Method of Study. *Proceedings of the Prehistoric Society* 30: 423-426.

Flannery, K.
1965 The Ecology of Early Food Production in Mesopotamia. *Science* 147 (3663): 1247-1256.

Fleming, A.
1971 Territorial Patterns in Bronze Age Wessex. *Proceedings of the Prehistoric Society* 27: 138-66.

Frenzel, B.
1966 Climatic Change in the Atlantic/sub-Boreal Transition. In J. S. Sawyer (ed.). *World Climate 8000-0 BC*. London: Royal Meterological Society. Pp. 99-123.

Furlan, D.
1977 The Climate of Southeast Europe. In *Climates of Central and Southern Europe*. C. C. Wallen (ed.). Amsterdam: World Survey of Climatology, Elsevier Scientific 6: 185-235.

Galaty, J. C. and D. L. Johnson
1990 Introduction – Pastoral Systems in Global Perspective. In John G. Galaty, Douglas L. Johnson (eds.).*The World of Pastoralism: Herding Systems in Comparative Perspective*. New York: Guilford Press, pp. 1-67.

Garašanin, M.
1983 The Stone Age in the Central Balkans; The Bronze Age in the Central Balkans; The Early Iron Age in the Central and East Balkan Area, c. 1000-750 BC. *Cambridge Ancient History* Cambridge: Cambridge University Press, Vol. 3, part 1, pp. 75-135; 163-186; 582-618.

Geddes, D. S.
1983 Neolithic Transhumance in the Mediterranean Pyrenees. *World Archaeology* 15 (1): 52-66.

Getty, R.
1975 *Sisson and Grossman's The Anatomy of Domestic Animals*. Philadelphia: Saunders.

Glatzer, B.
1982 Processes of Nomadization in West Afghanistan. In *Contemporary Nomadic and Pastoral Peoples: Asia and the North. Studies in Third World Societies* 18: 61-86.

Gordon, B. C.
1993 Archaeological Tooth and Bone Seasonal Increments: The Need for Standardized Terms and Techniques. *Archaeozoologia* 5 (2): 9-16.

Gottmann, J.
1969 *A Geography of Europe*. 4th Edition. New York: Holt, Rinehart and Winston Inc.

Grant, A.
1975 The Use of Tooth Wear as a Guide to the Age of Domestic Animals. *Excavations at Portchester Castle*. Barry Cunliffe (ed.), vol. 2. London: Society of Antiquaries. Pp. 245-279.

1978 The Use of Tooth Wear as a Guide to the Age of Domestic Ungulates. In R. Wilson, C. Grigson and S. Payne (eds.). *Ageing and Sexing Animal Bones from Archaeological Sites*. BAR International Series 109 (Oxford), pp. 91-108.

Greenfield, H. J.
1984 A Model of Faunal Exploitation for the Bronze Age of the Central Balkans. *MASCA Journal* 3 (2): 53-55.

1986 *The Paleoeconomy of the Central Balkans (Serbia). A Zooarchaeological Perspective on the Late Neolithic and Bronze Age (ca. 4500-1000 B.C).* BAR International Series (Oxford) 304(i).

1988 The Origins of Milk and Wool Production in the Old World. *Current Anthropology* 29 (4): 573-748.

1989 Zooarchaeology and Aspects of the Secondary Products Revolution: A Central Balkan Perspective. *Zooarchaeologia* 3 (1-2): 191-200.

1991 Fauna from the Late Neolithic of the Central Balkans: Issues in Subsistence and Land Use. *Journal of Field Archaeology* 18: 161-186.

1993 Zooarchaeology, taphonomy, and the origins of food production in the Central Balkans. *Culture and environment: A fragile co-existence. Proceedings of the 24th Chacmool Conference*, edited by Ross W. Jamieson, Sylvia Abonyi and Neil A. Mirau. Archaeological Association, University of Calgary, Alberta, pp. 111-117.

1997 Sarina Medja, Vrbica, and Večina Mala: The Zooarchaeology of Three Late Bronze Age/Early Iron Age Transition localities near Jagodina, Serbia. *Starinar: Journal of the Archaeological Institute* 45-46:133-142.

1999a The Advent of Transhumant Pastoralism in the Temperate Southeast Europe: A Zooarchaeological Perspective from the Central Balkans. In *Transhumant Pastoralism in Southeastern Europe: Recent Perspectives from Archaeology, History and Ethnology*. László Bartosiewicz and Haskel J. Greenfield (eds.) (Budapest: Archaeolingua). Pp 15-36.

1999b The origins of metallurgy: distinguishing stone from metal cut marks on bones from archaeological sites. *Journal of Archaeological Science* 26 (7): 797-808.

2001 The Early Bronze Age of Central Europe. In *The Encyclopedia of Prehistory: Human Area Relations Files*, edited by Peter Peregrine and Melvin Ember. Kluwer Academic/Plenum Publishers, pp. 124-131.

n.d. The social and economic context for domestic horse origins in southeastern Europe: a view from Ljuljaci in the central Balkans. *Horses and Humans: The Evolution of Equine/Human Relationships*, edited by Sandra Olsen. Carnegie Museum of Natural History, Pittsburgh, PA. In press. 30 pages.

Greenfield, H. J. and F. Draşovean
1994 An Early Neolithic Starčevo-Criş settlement in the Romanian Banat: preliminary report on the 1992 excavations at Foeni-Salaş. *Annale Banatului: Journal of the Museum of the Banat* 3: 45-85.

Greenfield, H. J. and S. Stanković
n.d Preliminary report of the excavations of Blagotin 1989-1992. Unpublished manuscript.

Greenfield, H. J. and S. Stanković
n.d Preliminary report of the excavations of Blagotin 1989-1992. Unpublished manuscript.

Grigson, C.
1982 Sex and Age Determination of Some Bones and Teeth of Domestic Cattle: Review of the Literature. In Wilson, Grigson and Payne (eds.), *Ageing and Sexing Animal Bones from Archaeological Sites*. BAR International Series 109: 7-23. (Oxford).

Grue, H. and B. Jensen
1979 Review of the Formation of Incremental Lines in Tooth Cementum of Terrestrial Animals. *Danish Review of Game Biology* 10 (3): 3-49.

Habermehl, K. H.
1961 *Die Alterbestimmung bie Haustieren, Pelztieren und beim jagdbaren Wildtieren* (Berlin and Hamburg: Paul Parer).

Halpern, J. M.
1999 The Ecological Transformation of a Resettled Area, Pig Herders to Settled Farmers in Central Serbia (Šumadija, Yugoslavia) during the 19th and 20th centuries. In *Transhumant Pastoralism in Southeastern Europe: Recent Perspectives from Archaeology, History and Ethnology*. László Bartosiewicz and Haskel J. Greenfield (eds.) (Budapest: Archaeolingua). Pp.79-98.

Halstead, P.
1981 Counting Sheep in Neolithic and Bronze Age Greece. In *Patterns of the Past: Studies in Honour of David Clarke*. Ian Hodder, Glynn Isaac and Norman Hammond (eds.). Cambridge: Cambridge University Press. Pp. 307-339.

1985 Present to Past in the Pindhos: Diversification and Specialization in Mountain Economies. *Rivista di Studi Liguri A* 66: 61-80.

1990 Pastoralism or Household Herding? Problems of Scale and Specialization in early Greek Animal Husbandry. *World Archaeology* 28 (1): 20-42.

Hambleton, E.
1999 *Animal Husbandry Regimes in Iron Age Britain. A Comparative Study of Faunal Assemblages from British Iron Age Sites*. BAR British Series 282 (Oxford).

Harding, A. F.
1982 *Climatic Change in Later Prehistory*. A. F. Harding (ed.). Edinburgh: Edinburgh University Press.

2000 *European Societies in the Bronze Age*. Cambridge: Cambridge University Press.

Higham, C. F. W.
1967 Appendix. Stock Rearing as a Cultural Factor in Prehistoric Europe. *Proceedings of the Prehistoric Society* 33: 84-106.

Hillson, S.
1986 *Teeth*. Cambridge Manuals in Archaeology. Cambridge: Cambridge University Press.

Jezik, S.
1998 *The Origins of Agriculture in Temperate Europe: An Exploration into Subsistence Strategies of Two Early Neolithic Groups in the Central Balkans, Foeni-Salaş and Blagotin*. M.A. Thesis. University of Manitoba.

Jongsma, T.
1997 *Distinguishing Pits from Pit Houses through Daub Analysis: the Nature and Location of Early Neolithic Starčevo-Criş Houses at Foeni-Salaş, Romania*. M.A. Thesis. University of Manitoba.

Kaiser, T.
1984 *Vinča Ceramics: Economic and Technological Aspects Of Late Neolithic Pottery Production in Southeast Europe*. Ph.D. Diss. University of California, Berkley.

Kalicz, N.
1970 *Clay Gods, The Neolithic Period and the Copper Age in Hungary*. Budapest: Athenaeum Printing House.

Khazanov, A.M.
1984 *Nomads and the Outside World*. Cambridge: Cambridge University Press.

Klein, R. G. and K. Cruz-Uribe
1984 *The Analysis of Animal Bones from Archaeological Sites*. Chicago: University of Chicago Press.

Klevezal, G. A.
1996 *Recording Structures of Mammals. Determination of Age and Reconstruction of Life History*. Translated by M. V. Mina and A. V. Oreshkin. Rotterdam: A. A. Balkema.

Klevezal, G. A. and S. E. Kleinenberg
1967 *Age Determination of Mammals from Annual Layers in Teeth and Bones*. Academy of Sciences USSR. Translated 1969 Department of the Interior and National Science Foundation, US Department of Commerce, Clearinghouse for Federal Scientific and Technical Information, Springfield.

Kordos, L.
1978a Changes in the Holocene Climate of Hungary Reflected by the Vole-Thermometer Method. *Kulonnyomat A Foldrajzi Kozlemenyek* (1-3): 222-229.

1978b A Sketch of the Vertebrate Biostratigraphy of the Hungarian Holocene. *Kulonnyomat A Foldrajzi Kozlemenyek* (1-3): 144-160.

Krader, L.
1959 The Ecology of Nomadic Pastoralism. *International Social Science Journal* 11 (4): 499-510.

Lees, S. H. and D. G. Bates
1974 The Origins of Specialized Nomadic Pastoralism. A Systemic Model. *American Antiquity* 39 (2): 187-193.

Legge, A. J. and E. Dorrington
1985 Harlow Temple: The Animal Bones. In E. France and M. Gobel (eds.) *The Romano-British Temple at Harlow, Essex.* (Harlow: West Essex Archaeological Group). Pp. 122-133.

Leković, V.
1991 The Vinčanization of the Starčevo Culture. In *Vinča and Its World. International Symposium The Danubian Region from 6000 to 3000 BC.* (Belgrade: Serbian Academy of Science and Arts). Pp. 67-73.

Lieberman, D. E.
1993a Life History Variables Preserved in Dental Cementum Microstructure.*Science* 261 (27): 1162-1164.

1993b *Mobility and Strain: The Biology of Cementogenesis and its Application to the Evolution of Hunter-Gatherer Seasonal Mobility During the Late Quaternary in the Southern Levant.* Ph.D. Thesis. Harvard University.

1995 The Biological Basis for Seasonal Increments in Dental Cementum and Their Application to Archaeological Research. *Journal of Archaeological Science* 21: 525-539.

Lieberman, D. and R. Meadow
1992 The Biology of Cementum Increments (with an Archaeological Application). *Mammal Review* 22 (2): 57-77.

Logashova, B. R.
1982 Transformation of the Social Organization of Iranian Tribes. In *Contemporary Nomadic and Pastoral Peoples: Asia and the North. Studies of Third World Societies* 18: 53-60.

Lowe, V. P. W
1967 Teeth as Indicators of Age with Special Reference to Red Deer (*Cervus elaphus*) of Known Age from Rhum. *Journal of Zoology* 152: 137-153.

Lyman, R. L.
1994 *Vertebrate Taphonomy*. Cambridge Manuals in Archaeology. Cambridge: Cambridge University Press.

Lynch, T. F.
1971 Preceramic Transhumance in the Callejon de Huaylas, Peru. *American Antiquity* 36 (2):139-147.

1980 *Guitarrero Cave: Early Man in the Andes*. Toronto: Academic Press.

1983 Camelid Pastoralism and the emergence of Tiwanaku Civilization in the South-Central Andes. *World Archaeology* 15(1) :1-14.

Meadow, R. H.
1978 Bonecode – A System of Numerical Coding for Faunal Data from Middle Eastern Sites. In R. H. Meadow and M. A. Zeder (eds.). *Approaches to Faunal Analysis in the Middle East*. Peabody Museum Bulletin no. 2 Cambridge, Massachusetts, Harvard University. Pp. 169-186.

Meiklejohn, C.
1997 *The Transition to Agriculture. The Early Neolithic in Southeast Europe*. Lecture Notes. The University of Winnipeg.

Milisauskas, S.
1978 *European Prehistory* New York: Academic Press.

Monks, G. G.
1981 Seasonality Studies. *Advances in Archaeological Method and Theory*, vol. 4. London: Academic Press Inc. Pp. 177-240.

Munson, P. J
2000 Age-Correlated Differential Destruction of Bones and its Effect on Archaeological Mortality Profiles of Domestic Sheep and Goats. *Journal of Archaeological Science* 27: 391-407.

Nandris, J. G.
1976 The Perspective of Long-term Change in South-East Europe. In F. W. Carter (ed.). *A Historical Geography of the Balkans*. New York: Academic Press. Pp. 25-57.

Niamir-Fuller, M. N. and Turner
1999 A Review of Recent Literature on Pastoralism and Transhumance in Africa. In Maryam Niamir-Fuller (ed.). *Managing Mobility in African Rangelands: The Legitimization of Transhumance*. Rome: Food and Agriculture Organization of the United Nations.

Nikolava, L.
1998 *The Balkans in Later Prehistory*. BAR International Series 791. (Oxbow).

Olsen, St. J.
1971 *Zooarchaeology: Animal Bones in Archaeology and their Interpretation*. A McCaleb Module in Anthropology from the series Addison-Wesley Modular Publications. Pp. 1-30.

Paine, R.
1994 *Herds of the Tundra: A Portrait of Saami Reindeer Pastoralism*. Washington, DC: Smithsonian Institution Press.

Payne, S.
1973 Kill-Off Patterns in Sheep and Goats: The Mandibles from Aşvan Kale. *Anatolian Studies* 23: 281-303.

1985 Morphological Distinctions between the Mandibular Teeth of Young Sheep, Ovis, and Goats, Capra. *Journal of Archaeological Science* 12:139-147.

Phillips, P.
1980 *The Prehistory of Europe*. London: Indiana University Press.

Piggott, S.
1982 *The Earliest Wheeled Transport: From the Atlantic Coast to the Caspian Sea*. Ithaca, New York: Cornell University Press.

Pike-Tay, A.
1991 *Red Deer Hunting in the Upper Paleolithic of South-West France: A Study in Seasonality*. BAR International Series 569 (Oxford).

Pounds, N.
1969 *Eastern Europe*. Chicago: University of Chicago Press.

Raish, C.
1992 *Domestic Animals and Stability in Pre-State Farming Societies*. BAR International Series 579. (Oxford).

Rafiullah, S. M.
1966 *The Geography of Transhumance*. Aligarh: Aligarh Muslim University.

Reitz, E. and E. Wing
1999 *Zooarchaeology*. Cambridge: Cambridge University Press.

Renfrew, Colin. and P. Bahn
1991 *Archaeology. Theories, Methods and Practice*. New York: Thames and Hudson Inc.

Ryder, M. L.
1999 Did Vlach Shepherds Spread Sheep-Milking Customs through South-East Europe? In In *Transhumant Pastoralism in Southeastern Europe: Recent Perspectives from Archaeology, History and Ethnology*. László Bartosiewicz and Haskel J. Greenfield (eds.) (Budapest: Archaeolingua). Pp. 189-196.

Saxon, A. and C. Higham
1969 A New Research Method for Economic Prehistorians. *American Antiquity* 34 (3): 303-311.

Shennan, S.
1988 *Quantifying Archaeology*. Edinburgh: University Press.

Sherratt, A.
1980 Plough and Pastoralism: Aspects of the Secondary Products Revolution. In *Patterns of the Past: Studies in Honour of David Clarke*. Ian Hodder, G. Isaac and N. Hammond (eds.). Cambridge University Press. Pp. 261-306.

1983 The Secondary Exploitation of Animals in the Old World. *World Archaeology* 15 (1): 90-104.

Silver, I. A.
1969 The Ageing of Domestic Animals. In D. Brothwell and E. S. Higgs (eds.). *Science in Archaeology*. London: Thames and Hudson. Pp. 283-302.

Tringham, R.
1971 *Hunters, Fishers and Farmers of Eastern Europe 6000-3000 BC*. London: Hutchison University Library.

Tringham, R. and D. Krstić
1990 *Selevac. A Neolithic Village in Yugoslavia*. Ruth Tringham and Dušan Krstić (eds.). Los Angeles: UCLA Institute of Archaeology.

Van Andel, T. H. and C. N. Runnels
1995 The Earliest Farmers in Europe. *Antiquity* 69: 481-500.

Von den Driesch, A.
1976 *Bone Measurements for Archaeologists*. Peabody Museum, Bulletin no. 1 Harvard University.

Voytek, B. A. and R. Tringham
1985 Rethinking the Mesolithic: the Case of South-East Europe. In *The Mesolithic in Europe*. Clive Bonsall (ed.). (Edinburgh: John Donald Publishers Ltd.). Pp. 492-499.

Walker, M. J.
1983 Laying a Mega-Myth: Dolmens and Drovers in Prehistoric Spain. *World Archaeology* 15: 37-50.

Wells, P.
1984 *Farms, Villages and Cities. Commerce and Urban Origins in Late Prehistoric Europe*. Ithaca: Cornell University Press.

Whittaker, C. R. (ed.)
1988 *Pastoral Economies in Classical Antiquity*. Cambridge: Cambridge Philosophical Society, University Press.

Whittle, A.
1985 *Neolithic Europe. A Survey*. Cambridge: Cambridge University Press.

1996 *Europe in the Neolithic. The Creation of New Worlds*. Cambridge: Cambridge University Press.

Willis, K. J. and K. D. Bennett
1994 The Neolithic Transition – Fact or Fiction? Paleoecological Evidence from the Balkans. *Holocene* 4 (3): 326-330.

Appendix A
Comparative collection measurements (lower molar 1)

| Specimen Number | GL (mm) | Tht (mm) | Cht (mm) | OL (mm) | OW (mm) | Wt (g) |
|---|---|---|---|---|---|---|
| Goat #1 | | | | | | |
| Goat #2 | | | | | | |
| Goat #4 | | | | | | |
| Goat #5 | 26.54 | 26.54 | | 14.76 | 8.33 | 3.94 |
| Goat #6 | 24.17 | 24.17 | | 14.57 | 8.39 | 3.58 |
| Goat #7 | 24.1 | 24.1 | | 15.64 | 7.97 | 4.17 |
| Goat #8 | 24.13 | 24.13 | | 14.53 | 8.09 | 3.56 |
| Goat #9 | 23.72 | 23.72 | | 15.47 | 7.81 | 4.05 |
| Goat #10 | | | | | | |
| Goat #11 | | | | | | |
| Goat #12 | 35.12 | 35.12 | 21.6 | 14.05 | 8.47 | 3.51 |
| Goat #13 | 33.59 | 33.59 | 22.56 | 13.69 | 8.13 | 3.29 |
| Goat #14 | 34.71 | 34.71 | 22.49 | 15.17 | 8.87 | 4.33 |
| Goat #15 | 32.68 | 32.68 | 23.34 | 14.9 | 7.65 | 3.67 |
| Goat #16 | 32.74 | 32.74 | 22.38 | 14.33 | 7.87 | 3.29 |
| Goat #17 | 34.01 | 34.01 | 23.6 | 15.4 | 8.51 | 4.22 |
| | | | | | | |
| Sheep #1 | 28.93 | 28.93 | 9.99 | 12.01 | 7.98 | 2.22 |
| Sheep #2 | 38.83 | 38.83 | 23.51 | 15.36 | 7.7 | 4.18 |
| Sheep #3 | 39.09 | 39.09 | 23.89 | 15.4 | 8.3 | 4.7 |
| Sheep #4 | 35.71 | 35.71 | 22.93 | 15.5 | 8.27 | 3.71 |
| Sheep #6 | 39.35 | 39.35 | 23.6 | 15.54 | 8.22 | 4.13 |
| | | | | | | |

Definitions:
**GL** = greatest length
**Tht** = tooth height, or greatest length if broken
**CH** = crown height, crotch to highest part of the crown of the tooth
**OL** = overall length
**OW** = overall width
**Wt** = dry weight of the tooth after processing and drying

Notes:
The first group of samples had no measurements taken.
The omission was not realized until the teeth had already been embedded and cut.

Appendix B
Archaelogical thin sectioning sample tooth measurements
(lower molar 1)

| Specimen Number | GL (mm) | Tht (mm) | Cht (mm) | OL (mm) | OW (mm) | Wt (g) |
|---|---|---|---|---|---|---|
| V #1 | 23.32 | 23.32 | 6.70 | 10.73 | 7.67 | 1.57 |
| V #2 | Eliminated from sample, tooth completely broken during extraction | | | | | |
| V #3 | 19.61 | 19.61 | 6.01 | 9.59 | 6.81 | 1.28 |
| V #4 | 26.48 | 26.48 | 15.63 | 11.36 | 7.08 | 1.88 |
| V #5 | 23.41 | 23.41 | 11.85 | 11.03 | 6.91 | 1.87 |
| V #6 | 27.89 | 27.89 | 10.85 | 11.26 | 7.03 | 2.15 |
| V #7 | 26.20 | 26.20 | 11.55 | 11.23 | 7.03 | 1.96 |
| V #8 | 19.60 | 19.60 | 5.80 | 9.89 | 6.24 | 1.33 |
| V #9 | 30.12 | 30.12 | 17.92 | 13.21 | 6.91 | 2.67 |
| V #10 | 18.59 | 18.59 | 7.33 | 10.41 | 6.05 | 1.37 |
| | | | | | | |
| KB #1 | 26.73 | 26.73 | 15.81 | 11.90 | 7.34 | 2.28 |
| KB #2 | 26.19 | 26.19 | 11.77 | 11.46 | 7.40 | 2.04 |
| KB #3 | 31.40 | 31.40 | 22.61 | 12.64 | 6.75 | 2.94 |
| KB #4 | 20.81 | 20.81 | 11.88 | 11.62 | 6.67 | 1.54 |
| KB #5 | 20.38 | 20.38 | 6.34 | 10.50 | 7.61 | 1.71 |
| KB #6 | 21.72 | 21.72 | 6.98 | 10.31 | 7.31 | 1.36 |
| KB #7 | 31.04 | 31.04 | 16.40 | 12.15 | 7.40 | 2.47 |
| KB #8 | 30.43 | 30.43 | 21.80 | 13.63 | 7.12 | 2.71 |
| KB #9 | 26.93 | 26.93 | 12.50 | 11.92 | 7.74 | 2.32 |
| KB #10 | 32.42 | 32.42 | 21.37 | 14.01 | 6.58 | 2.74 |

Figure 1. Payne's meat production – mortality profile (from Payne 1973).

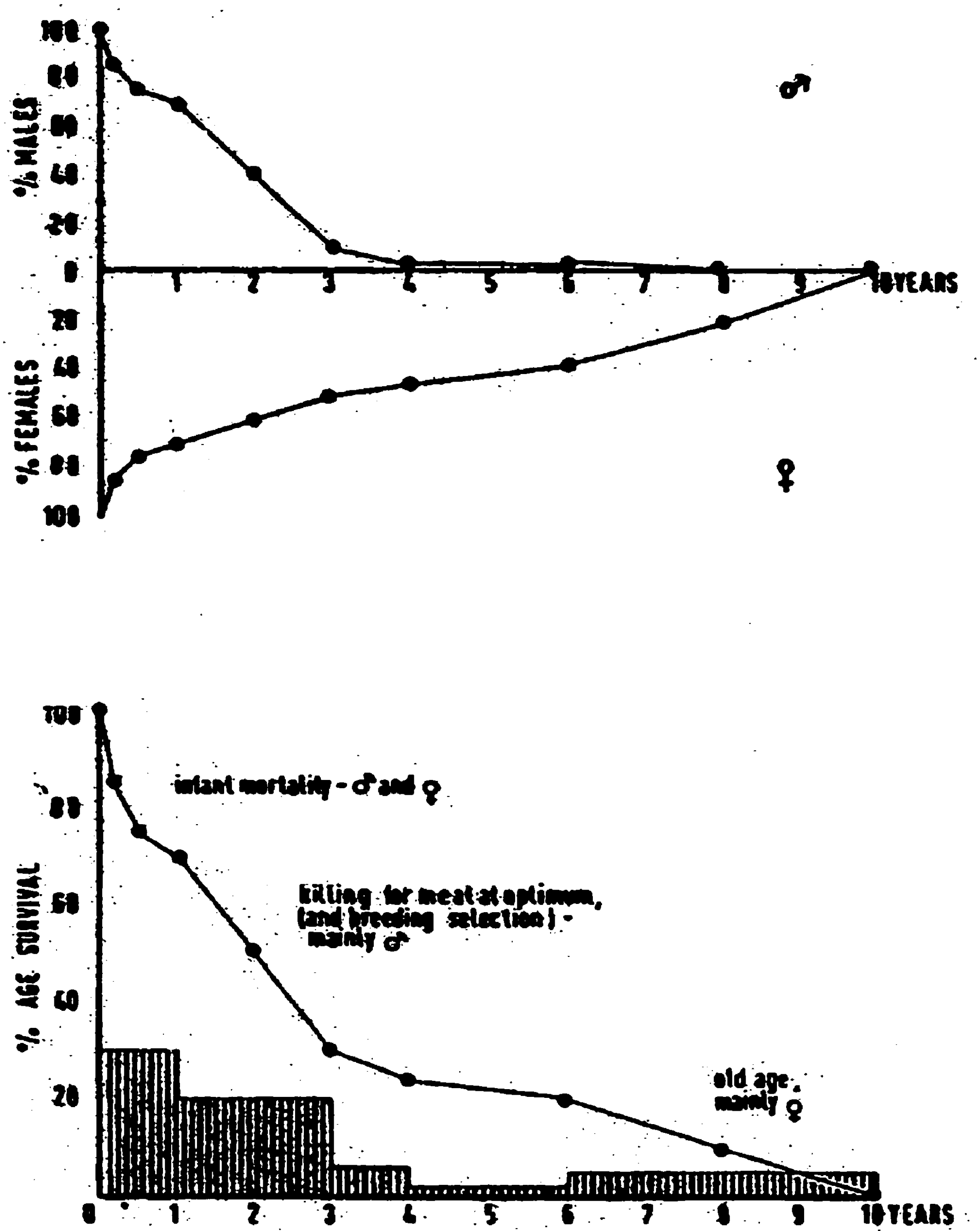


Figure 2. Payne's milk production – mortality profile (from Payne 1973).

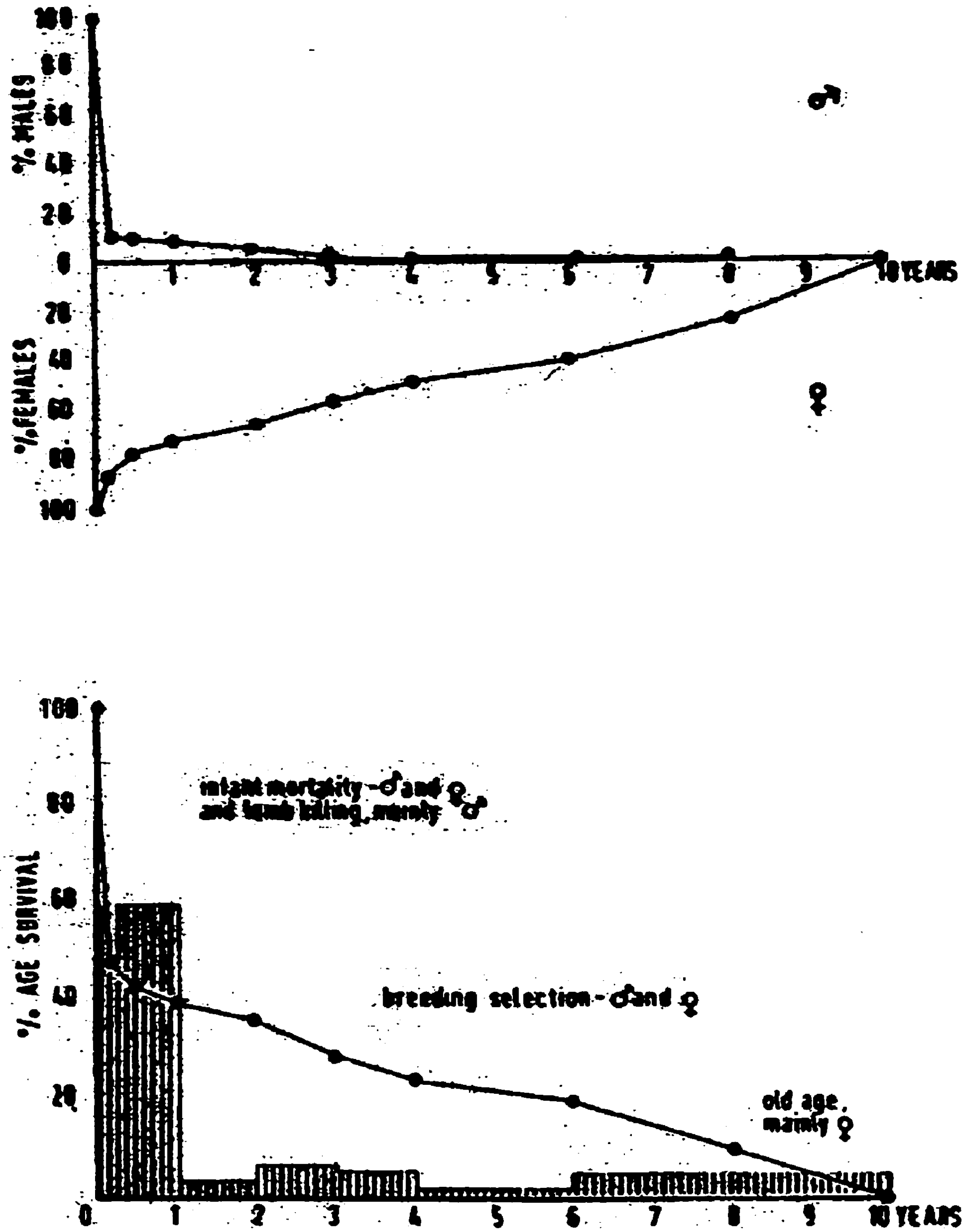
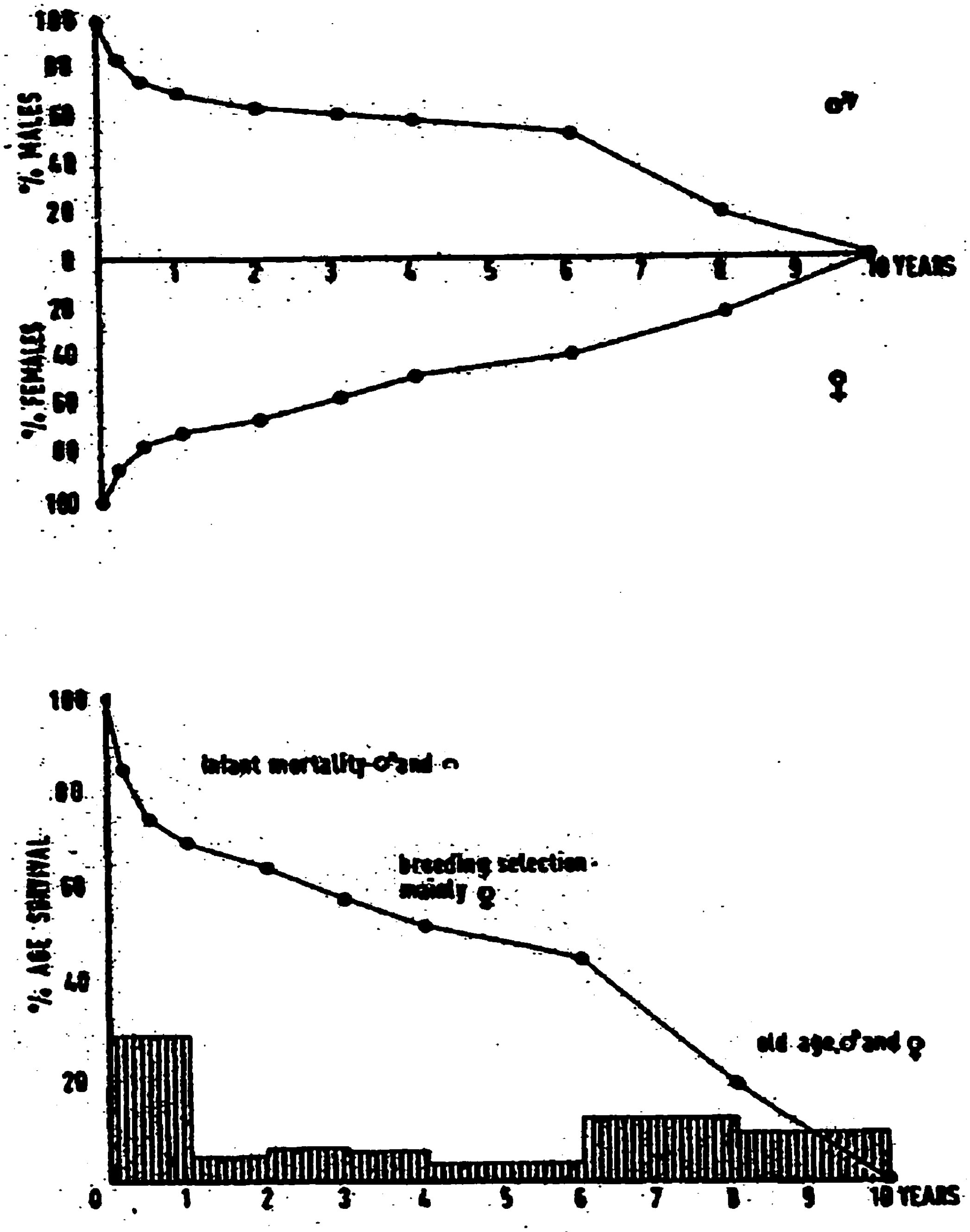


Figure 3. Payne's wool production – mortality profile (from Payne 1973).



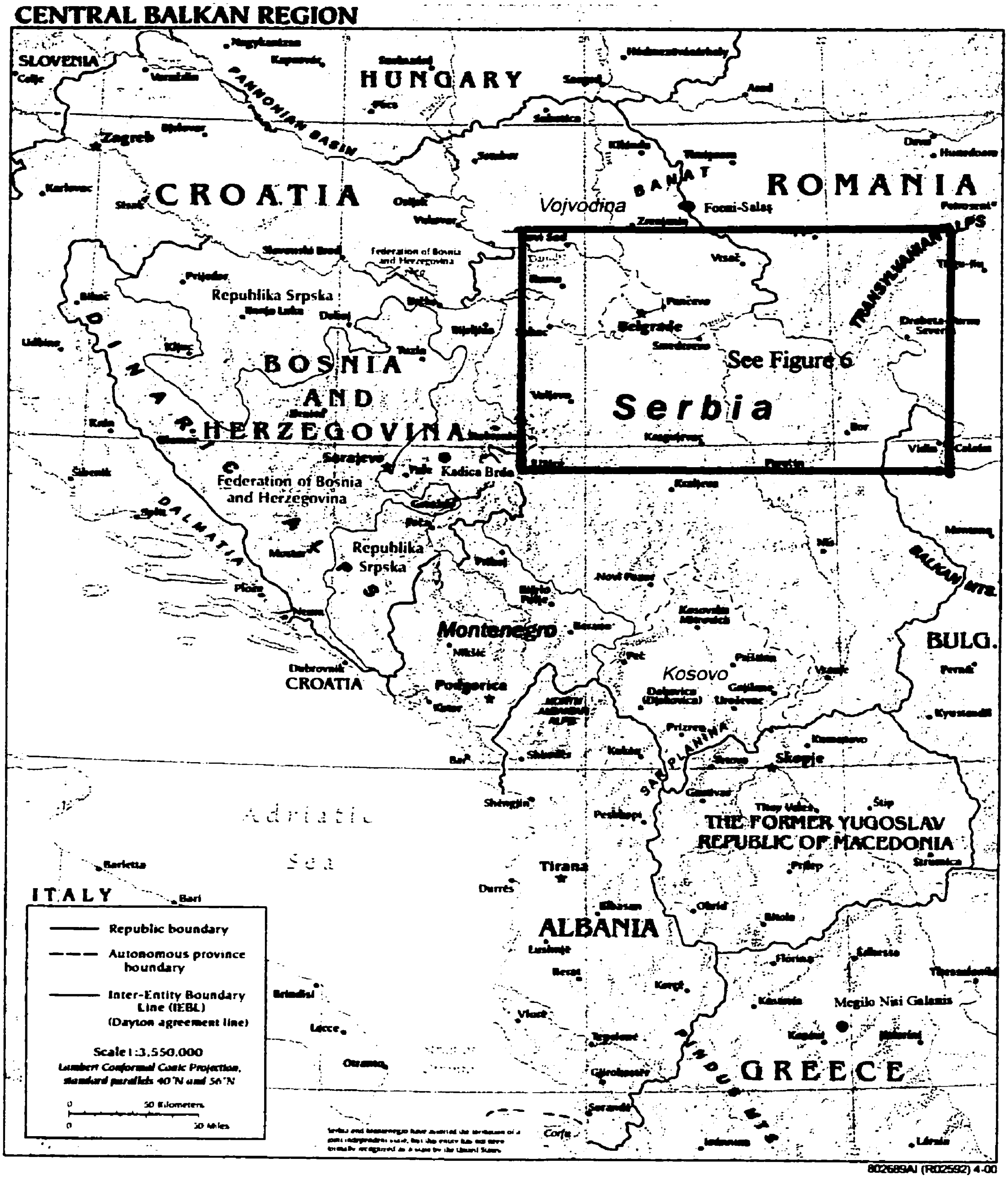



Figure 4. The Central Balkans
(www.lib.utexas.edu/maps/europe/centralbalkan_ref100.pdf)

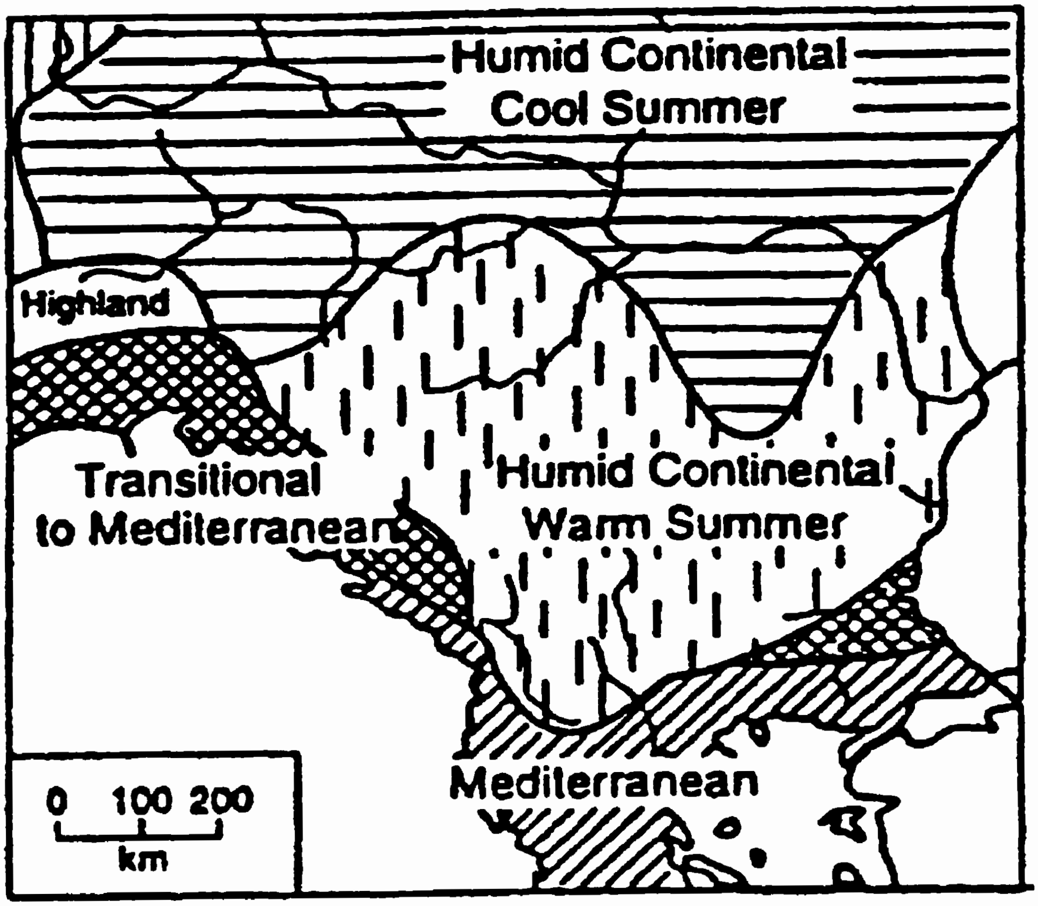



Figure 5. Map showing climatic divide between Mediterranean and temperate central Europe (Pounds 1969).

Figure 6. Location of Sites

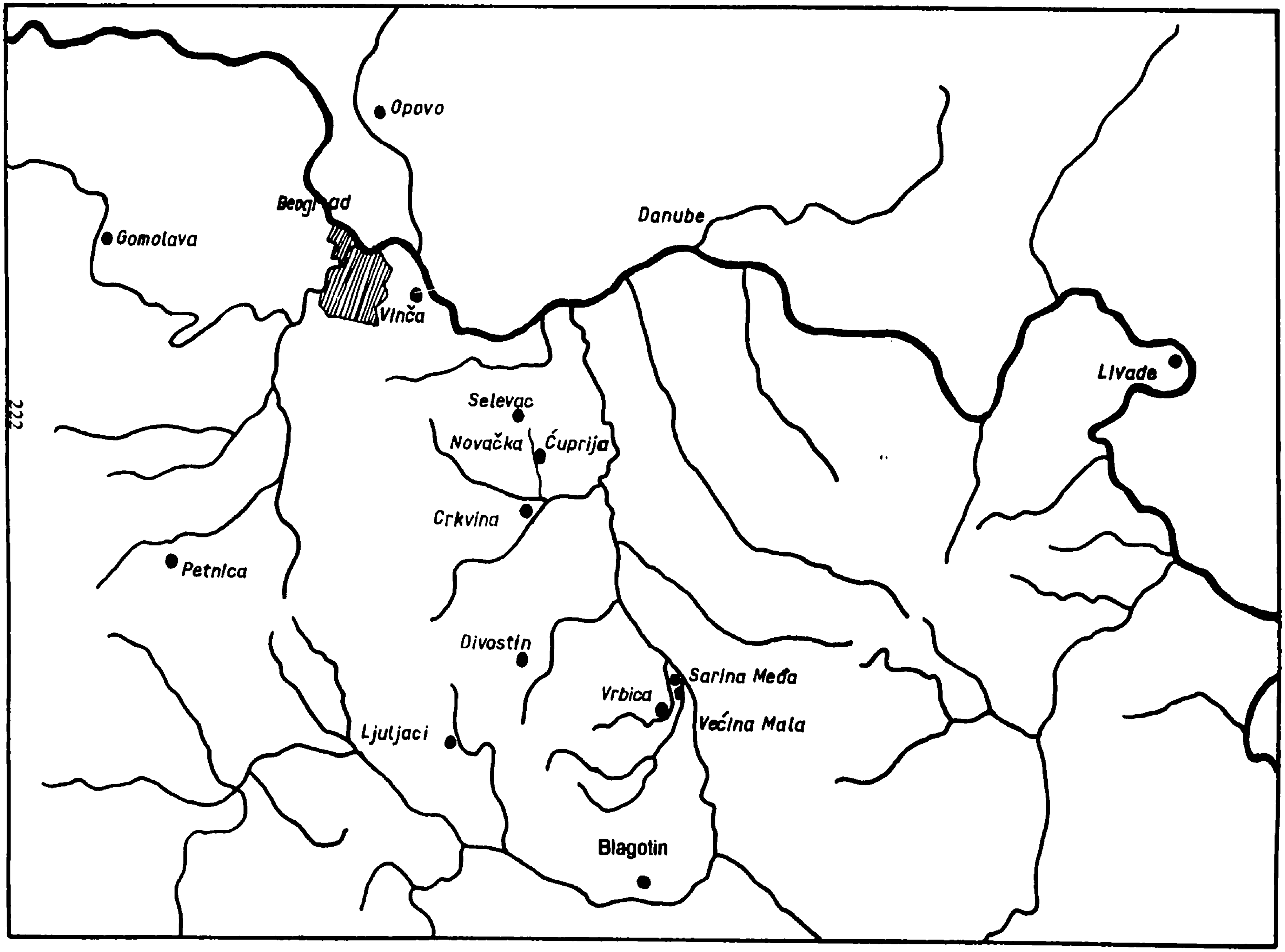
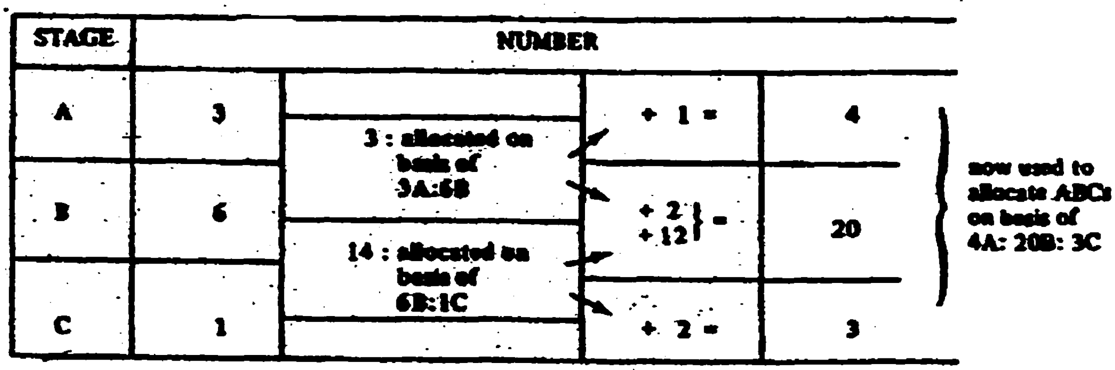


Figure 7. Proportional allocation example (from Payne 1973).




If there are 3As, 6 Bs, And 1C, one of the 3Abs is allocated to A and 2 to B according to the ratio 3A:6B; similarly the 14BCs are allocated 12 to B and 2 to C according to the ratio 6B:1C, giving 4As, 20Bs and 3Cs. ABCs are now allocated not according to the original 3A:6B:1C ratio, but according to the new ratio 4A:20B:3C (Payne 1973: 296).

Figure 8. *Ovis aries* mandible (from Boesseneck 1962).

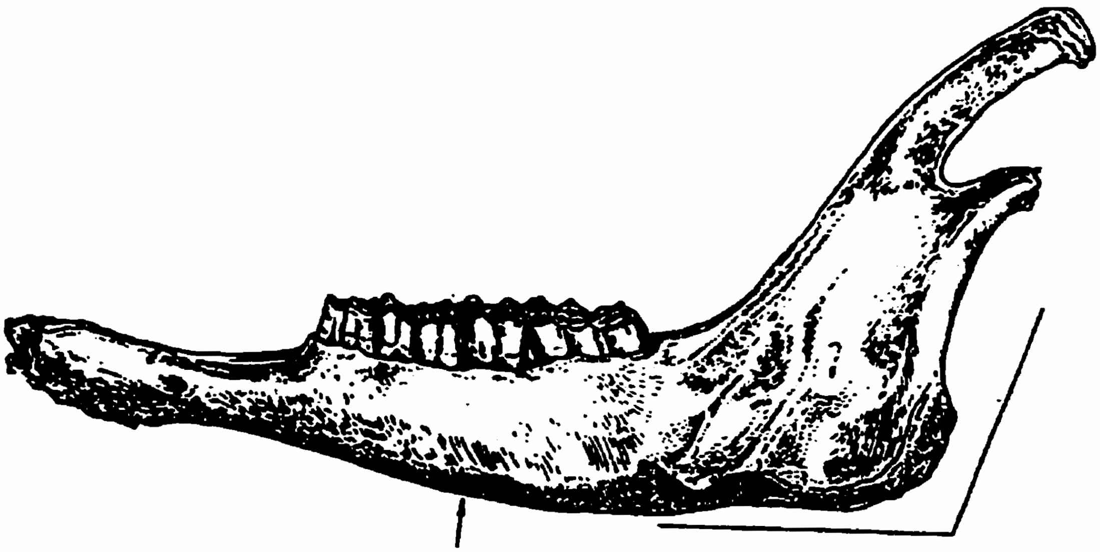


Figure 9. *Capra hircus* mandible (from Boesseneck 1962).

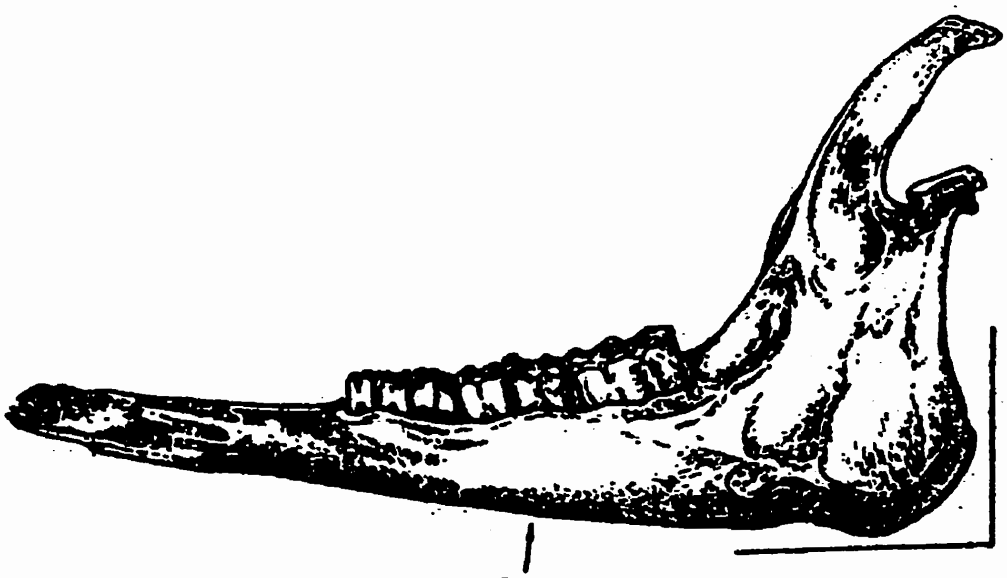


**Figure 10. Harvest profile (*Sus scrofa*) Middle Neolithic Petnica**

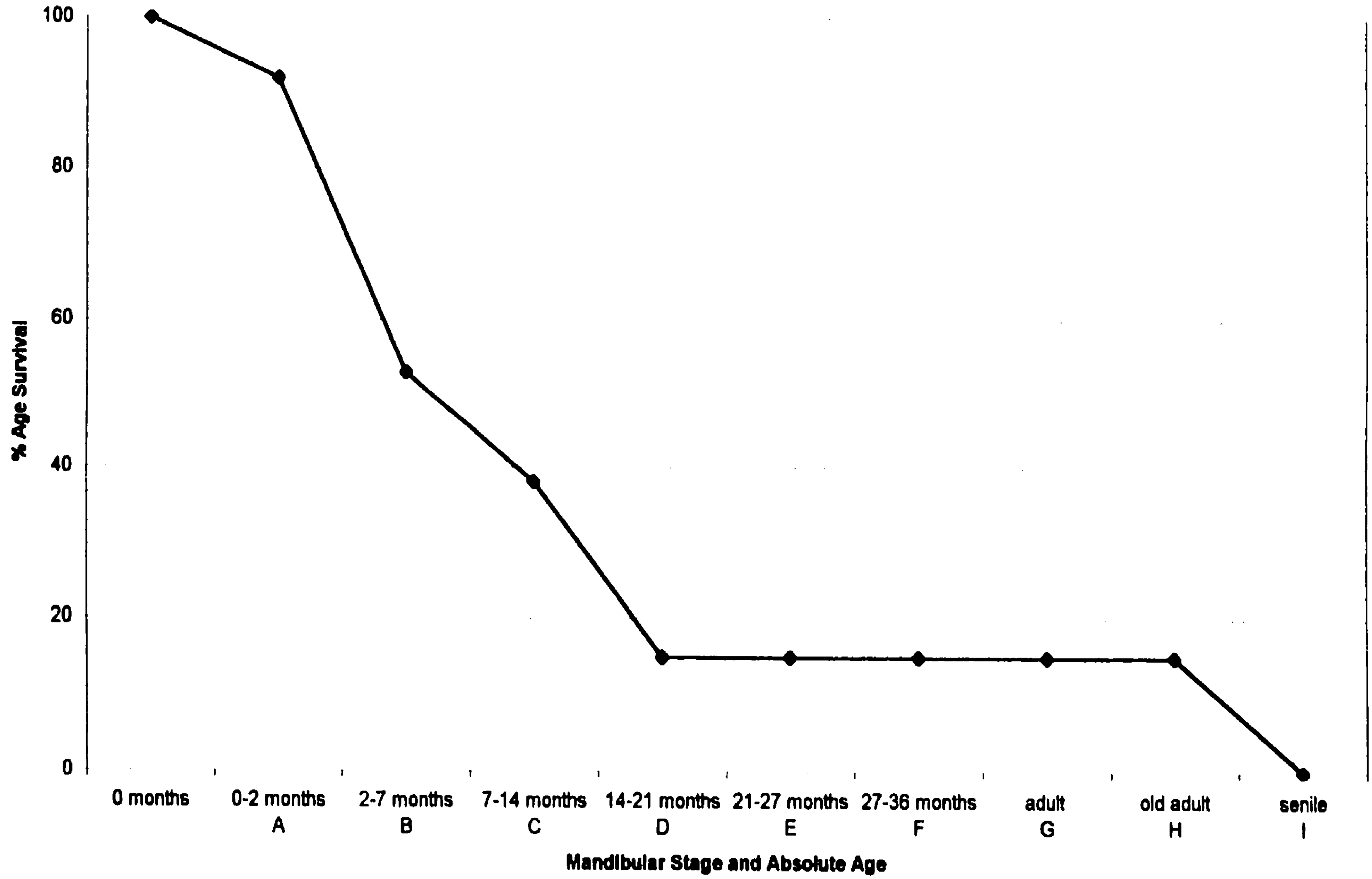


Figure 11. Harvest profile (*Sus scrofa*) Late Neolithic Petnica

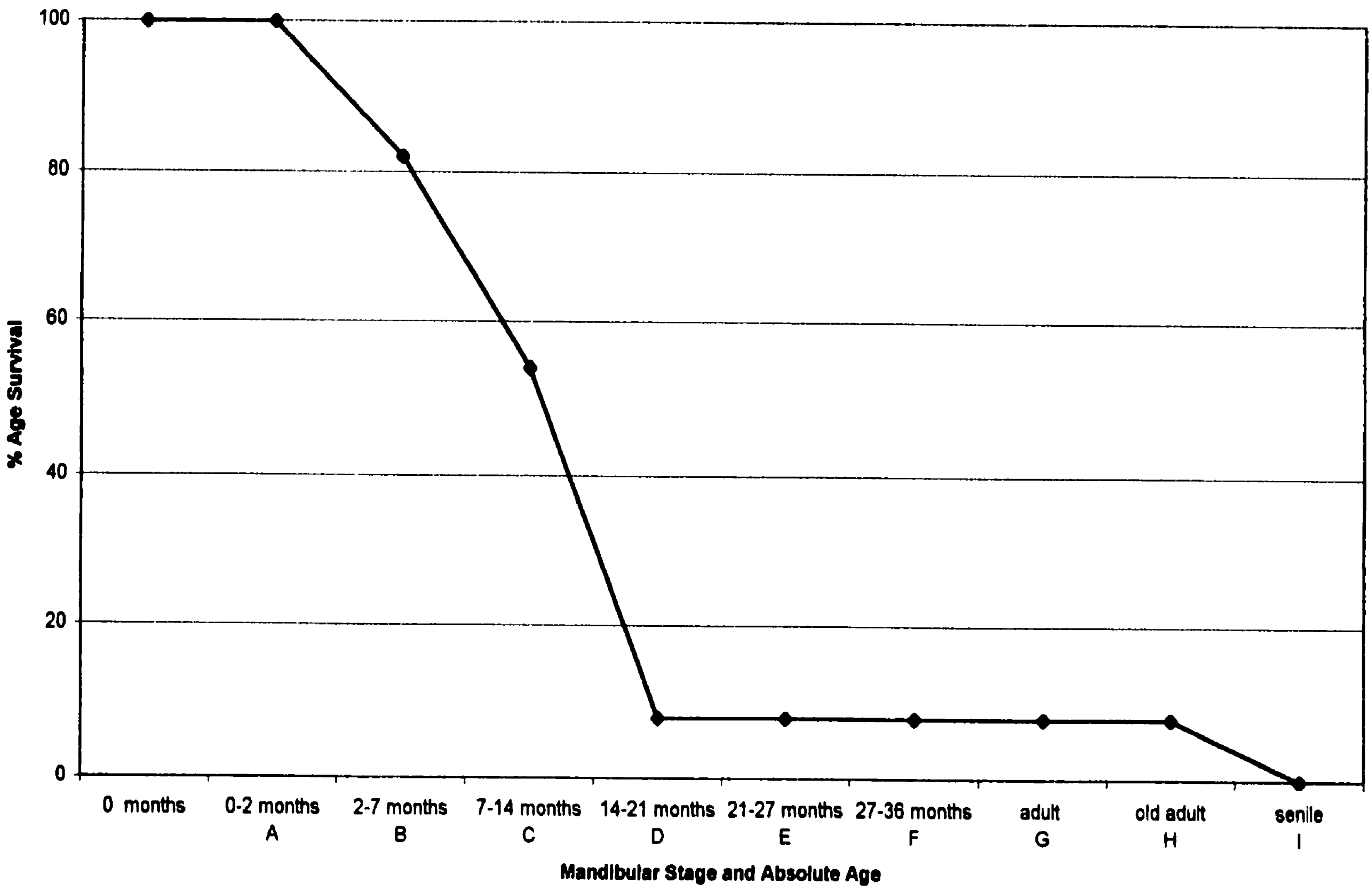


Figure 12. Harvest profile (*Sus scrofa*) Late Neolithic Vinča

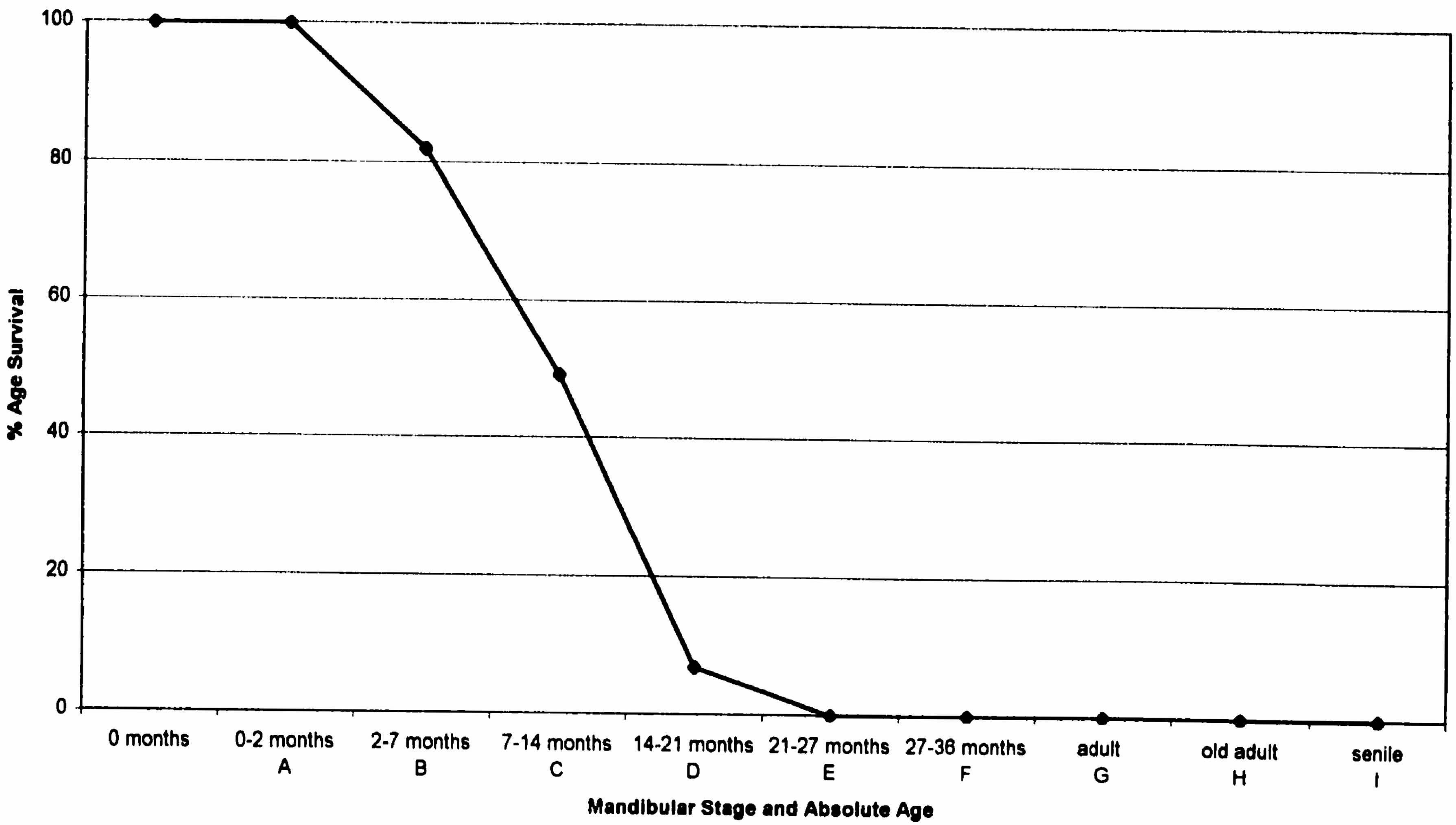


Figure 13. Harvest profile (*Sus scrofa*) Late Neolithic Opovo

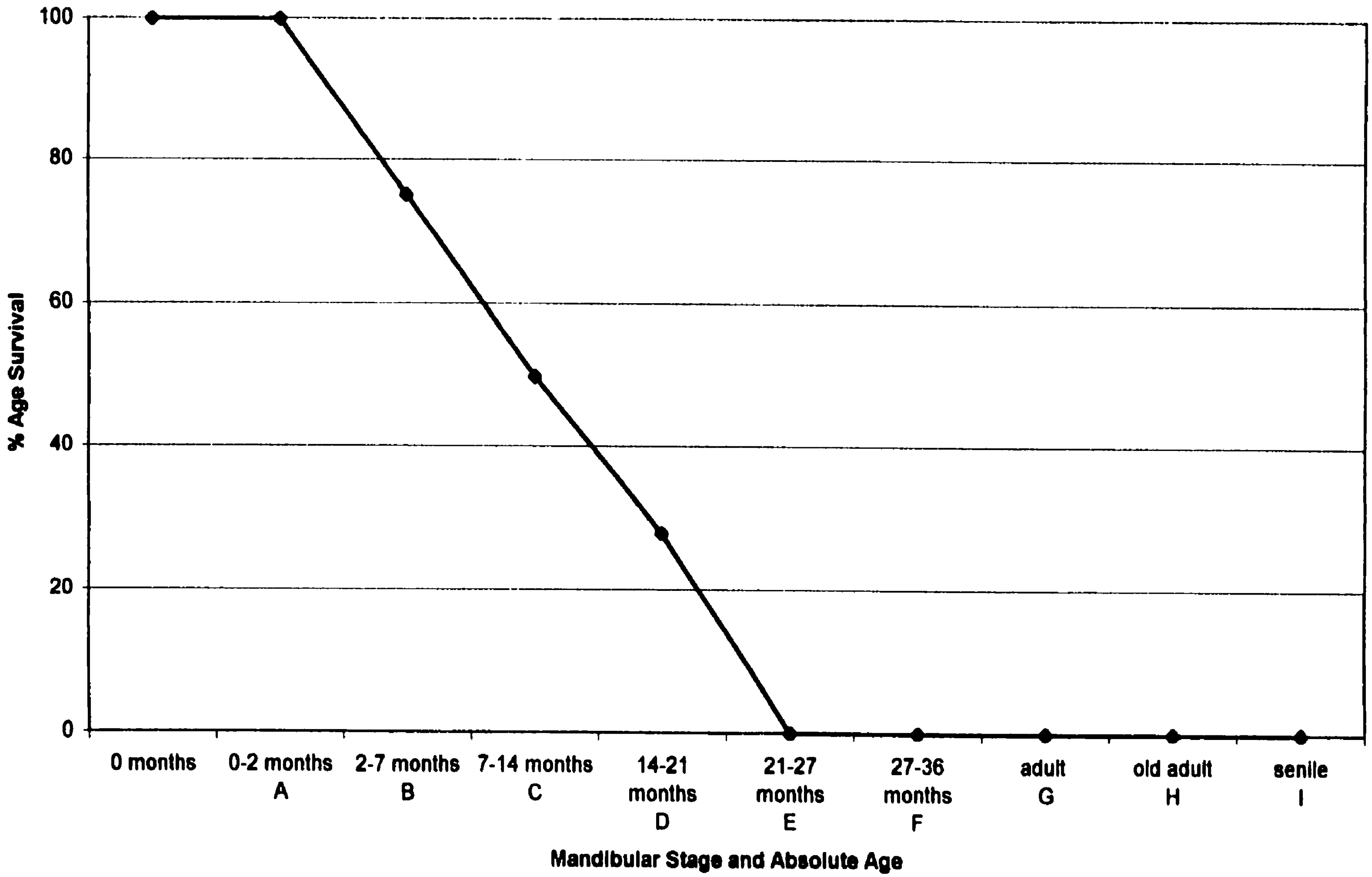


**Figure 14. Harvest profile (*Sus scrofa*) Eneolithic Petnica**

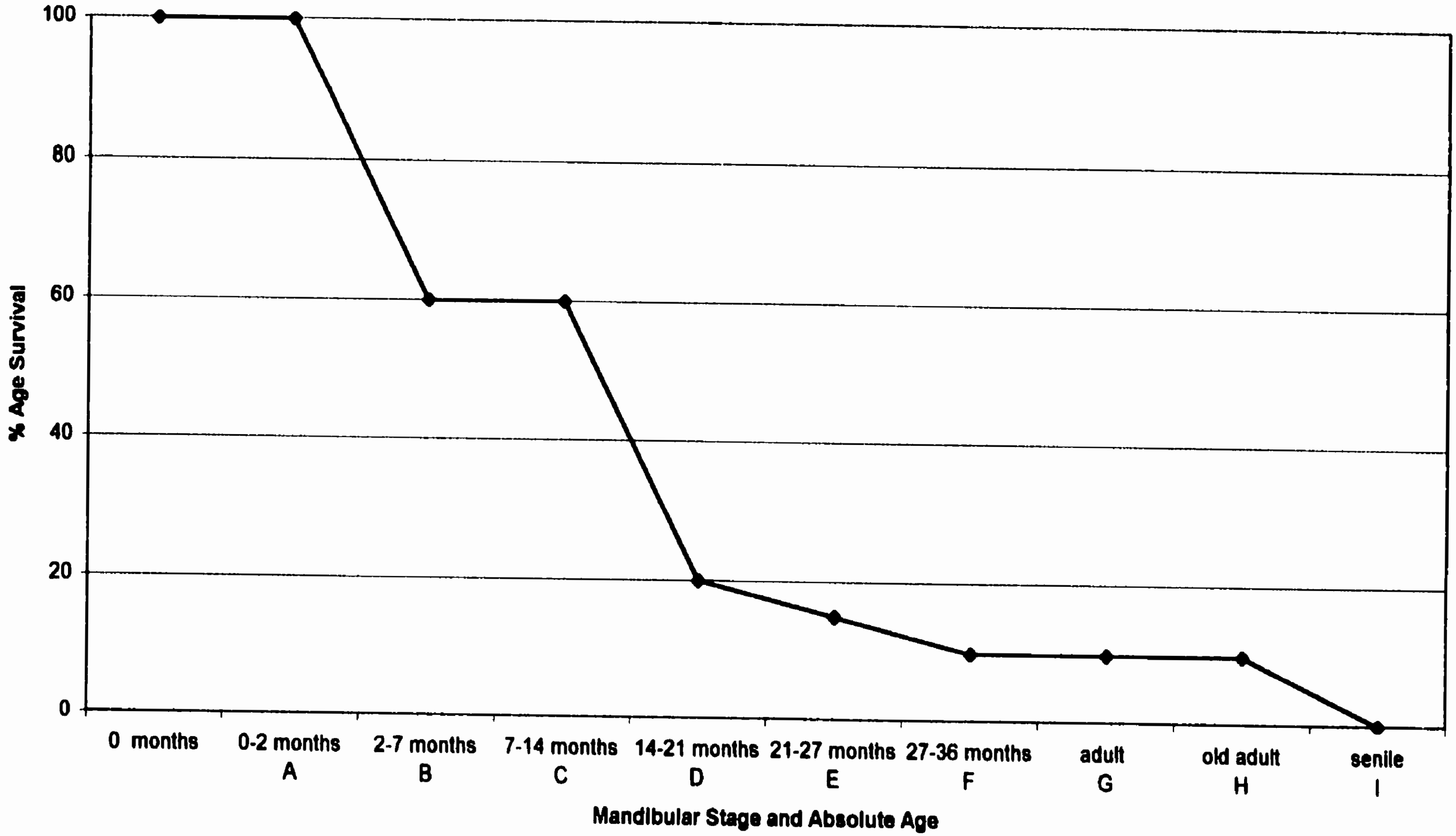


Figure 15. Harvest profile (*Sus scrofa*) Early Bronze Age Novačka Ćuprija

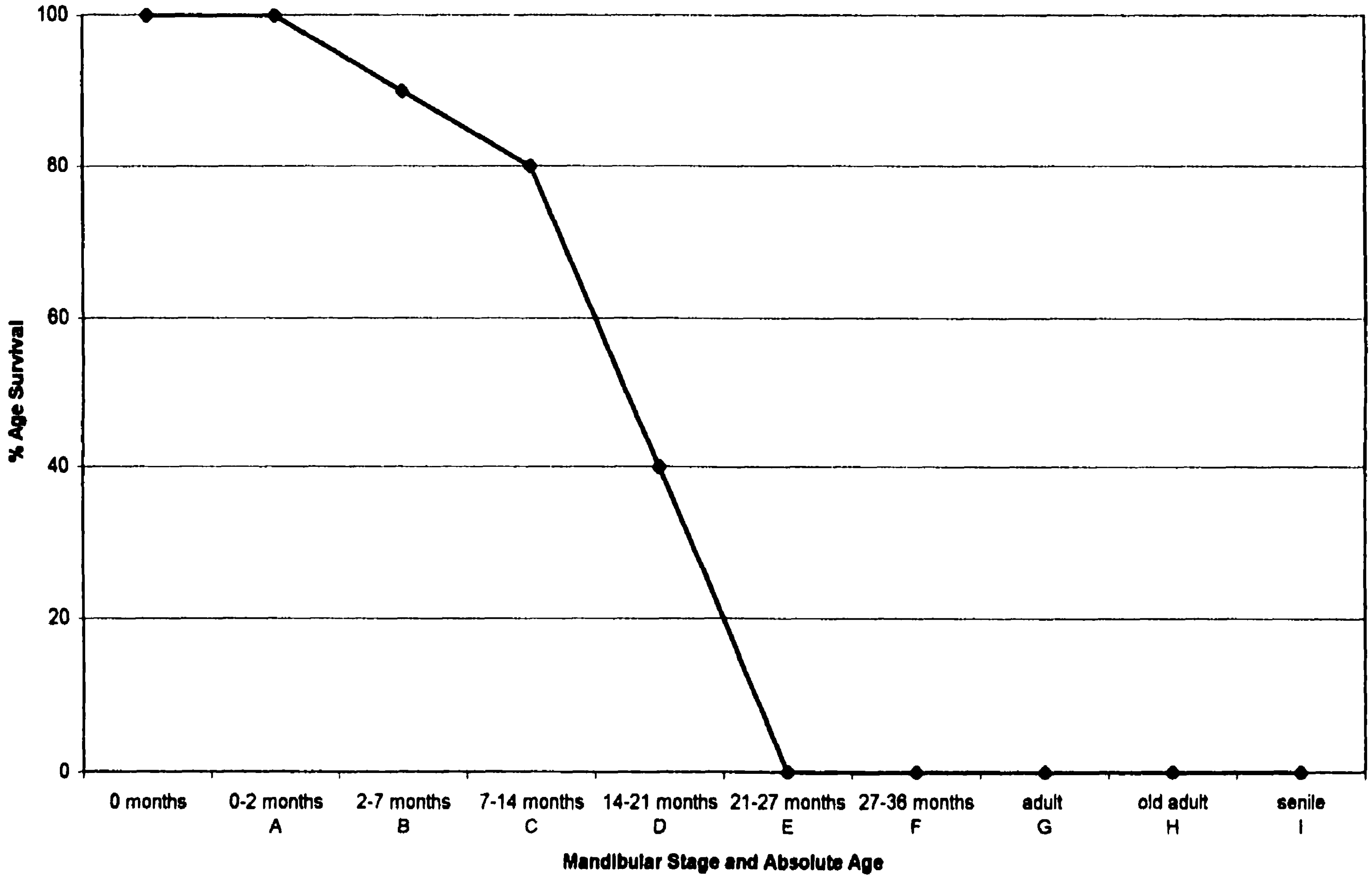


Figure 16. Harvest profile (*Sus scrofa*) Early/Middle Bronze Age Ljuljaci

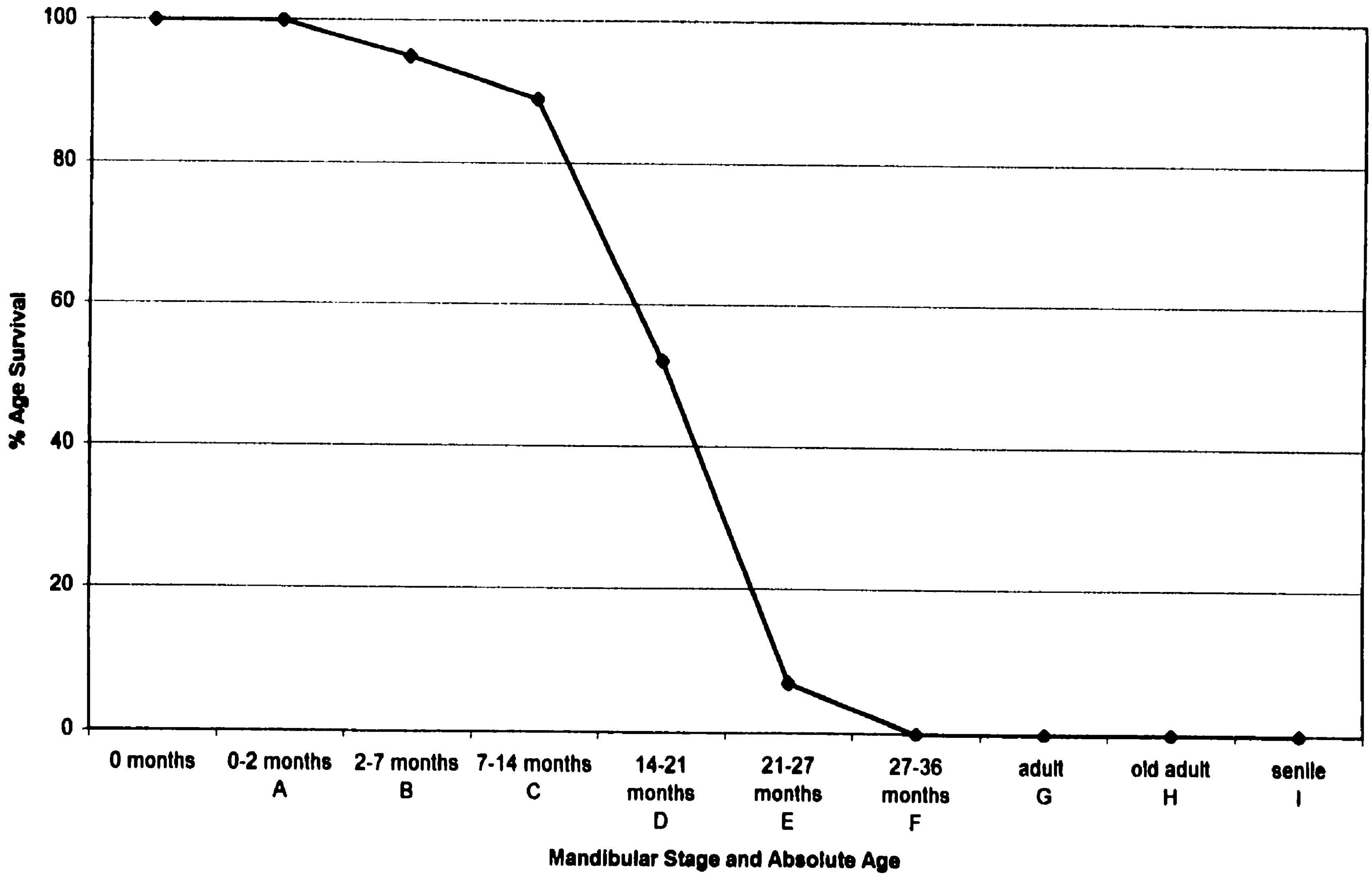


**Figure 17. Harvest profile (*Sus scrofa*) Middle Bronze Age Vinča**

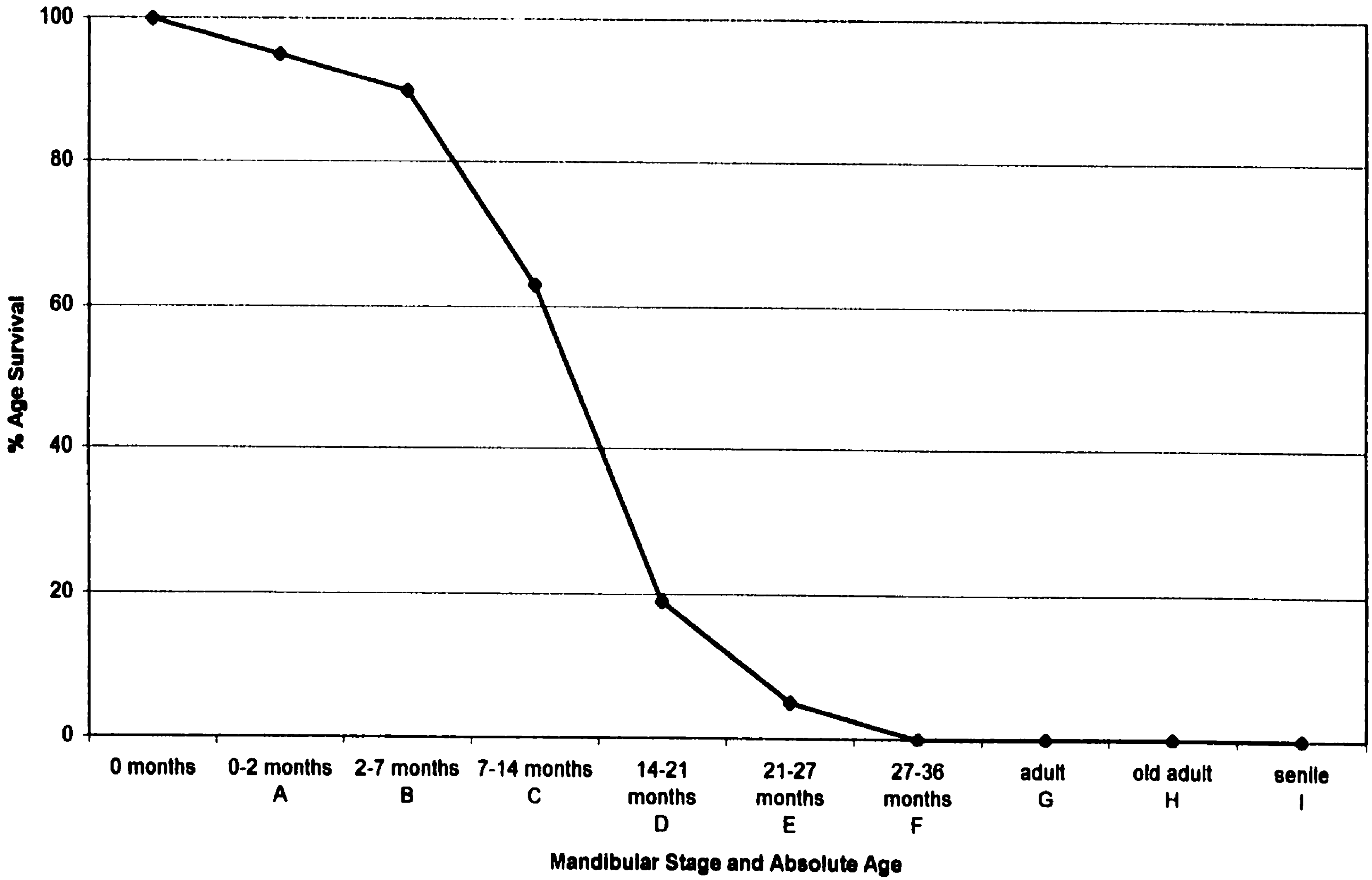


Figure 18. Harvest profile (*Sus scrofa*) Late Bronze Age Livade

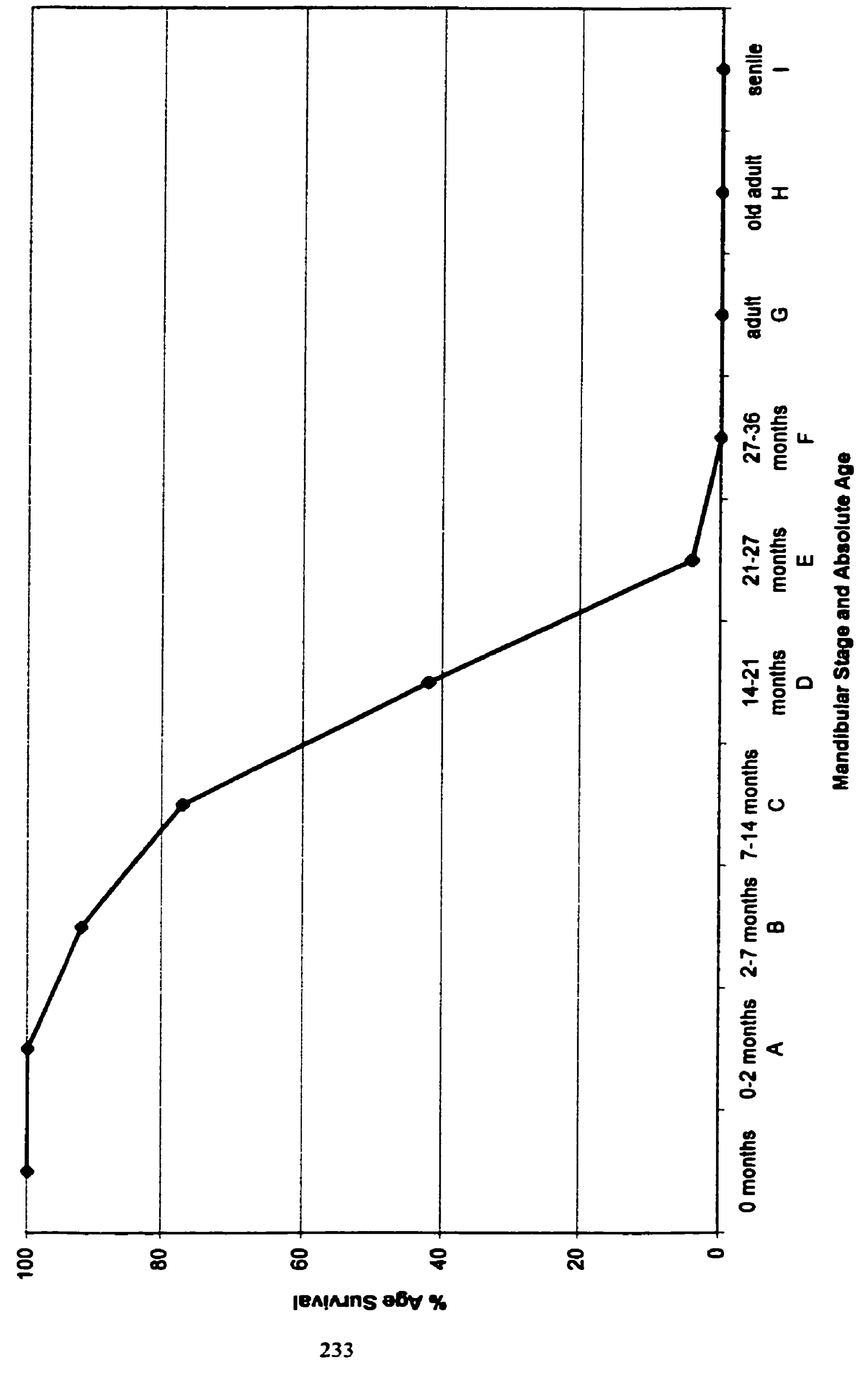


Figure 19. Harvest profile (*Sus scrofa*) Early Iron Age Kadica Brdo

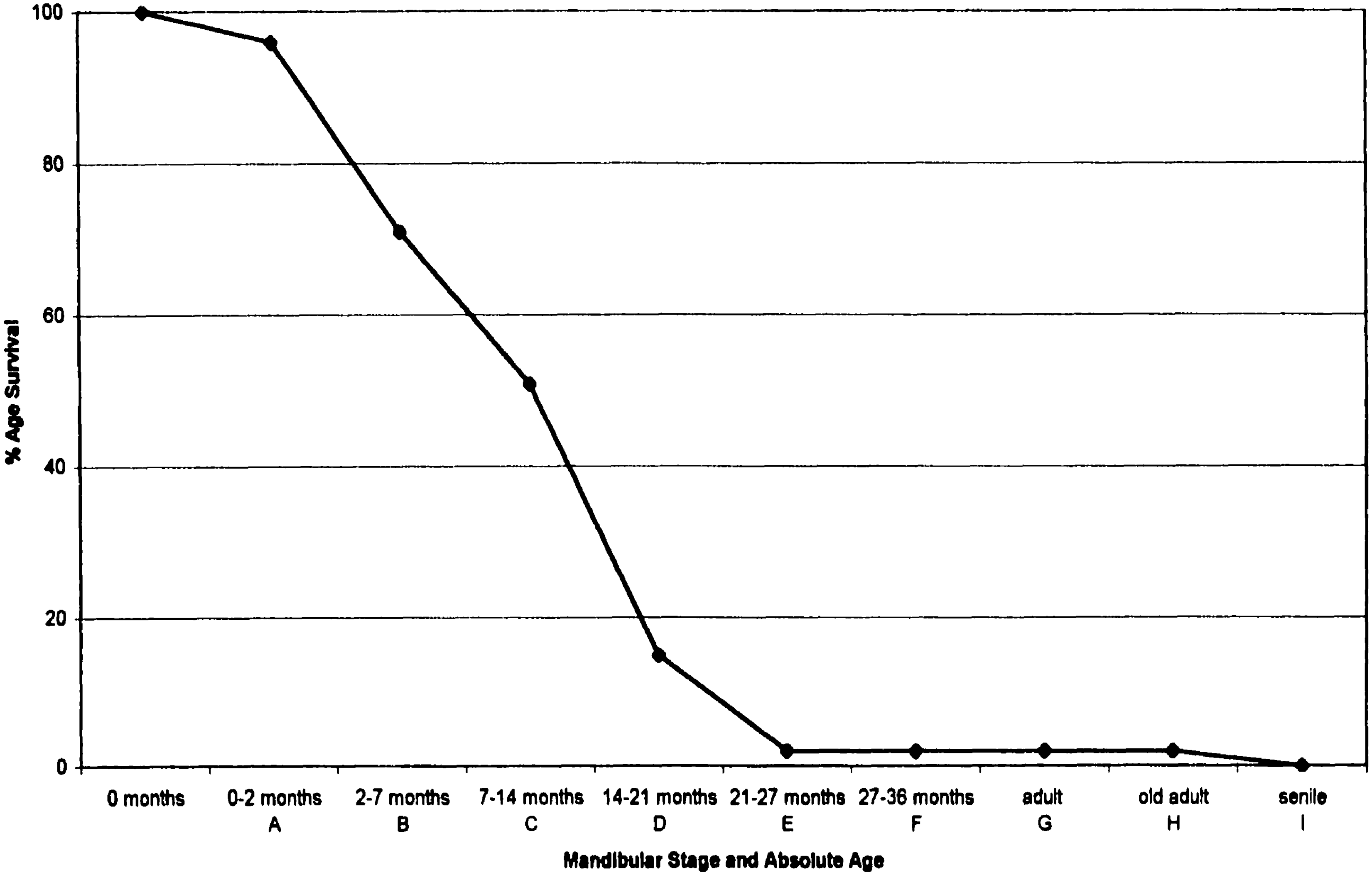


**Figure 20. Harvest profile (*Ovis/Capra*) Early Neolithic Foeni-Salaş**

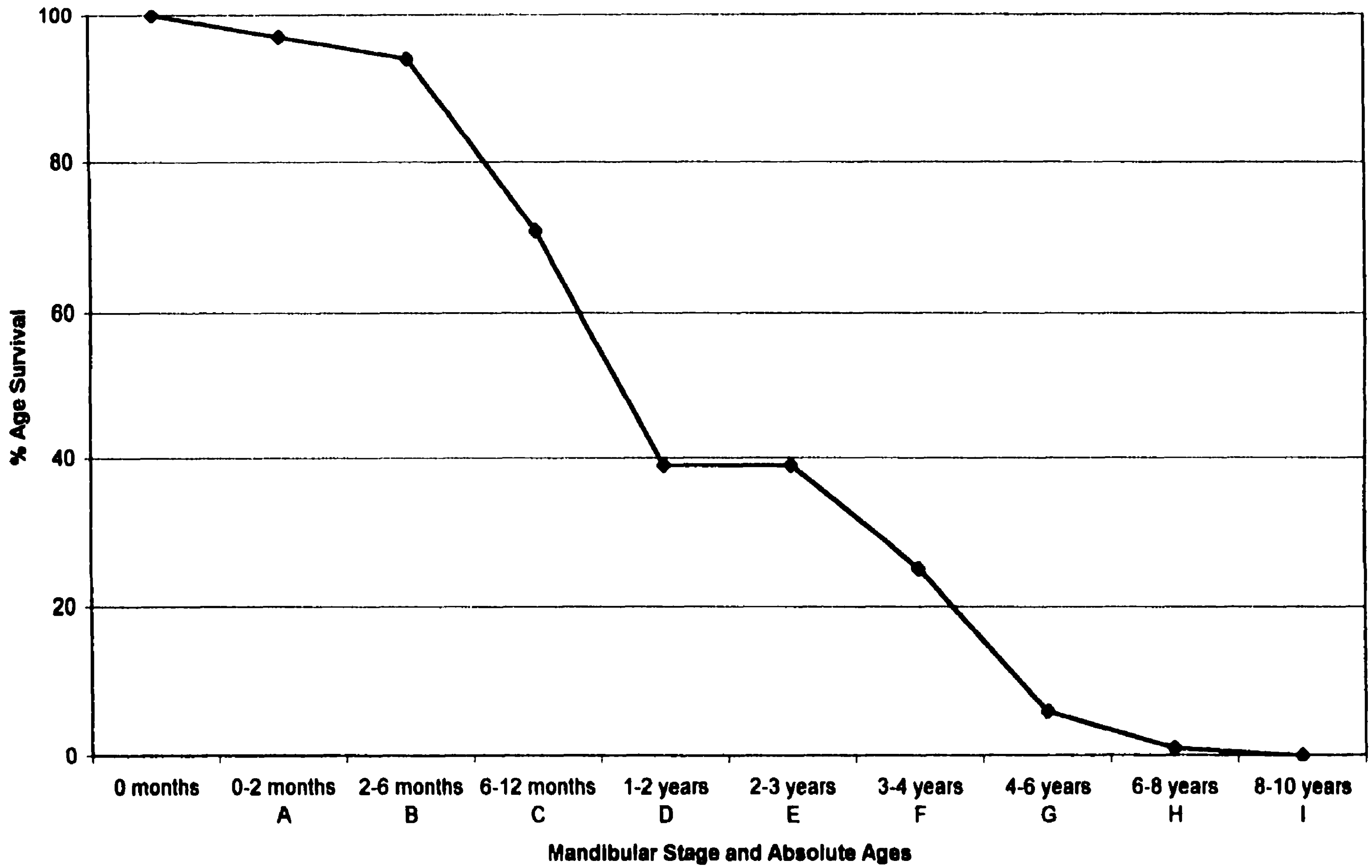


Figure 21. Harvest profile (*Ovis/Capra*) Early Neolithic Blagotin

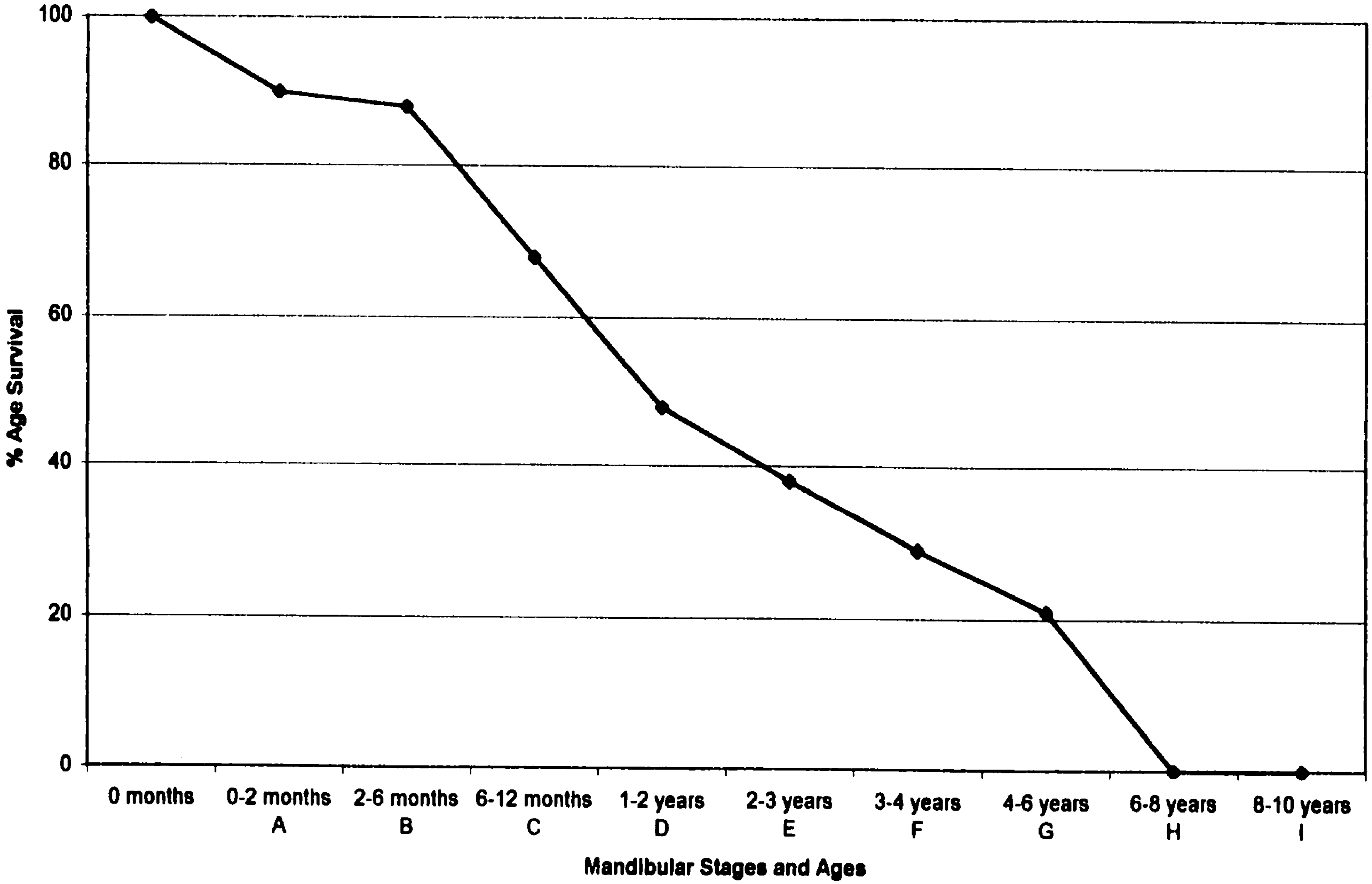


Figure 22. Harvest profile (*Ovis/Capra*) Early Neolithic

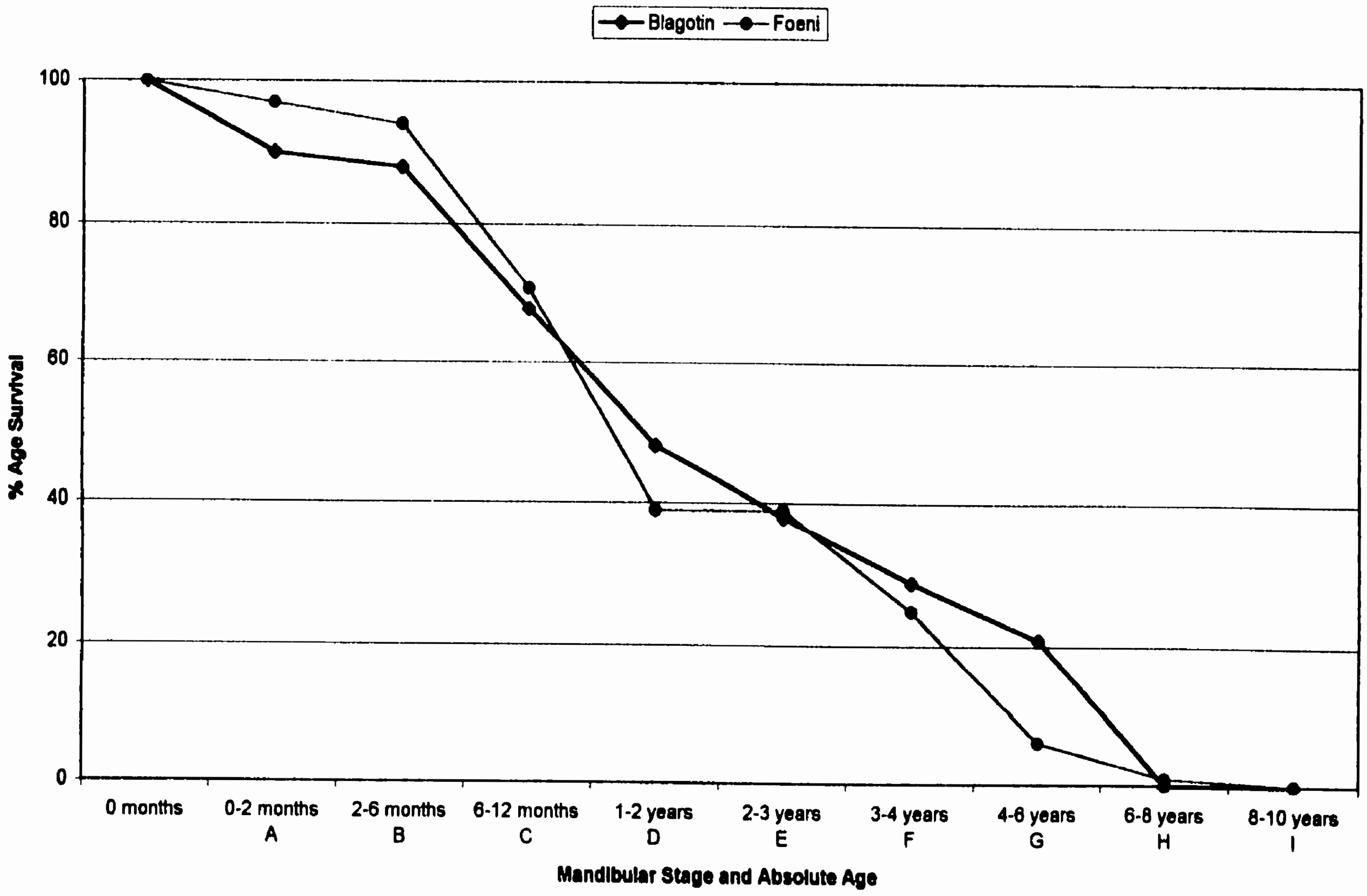


Figure 23. Harvest profile (*Ovis/Capra*) Middle Neolithic Stragari

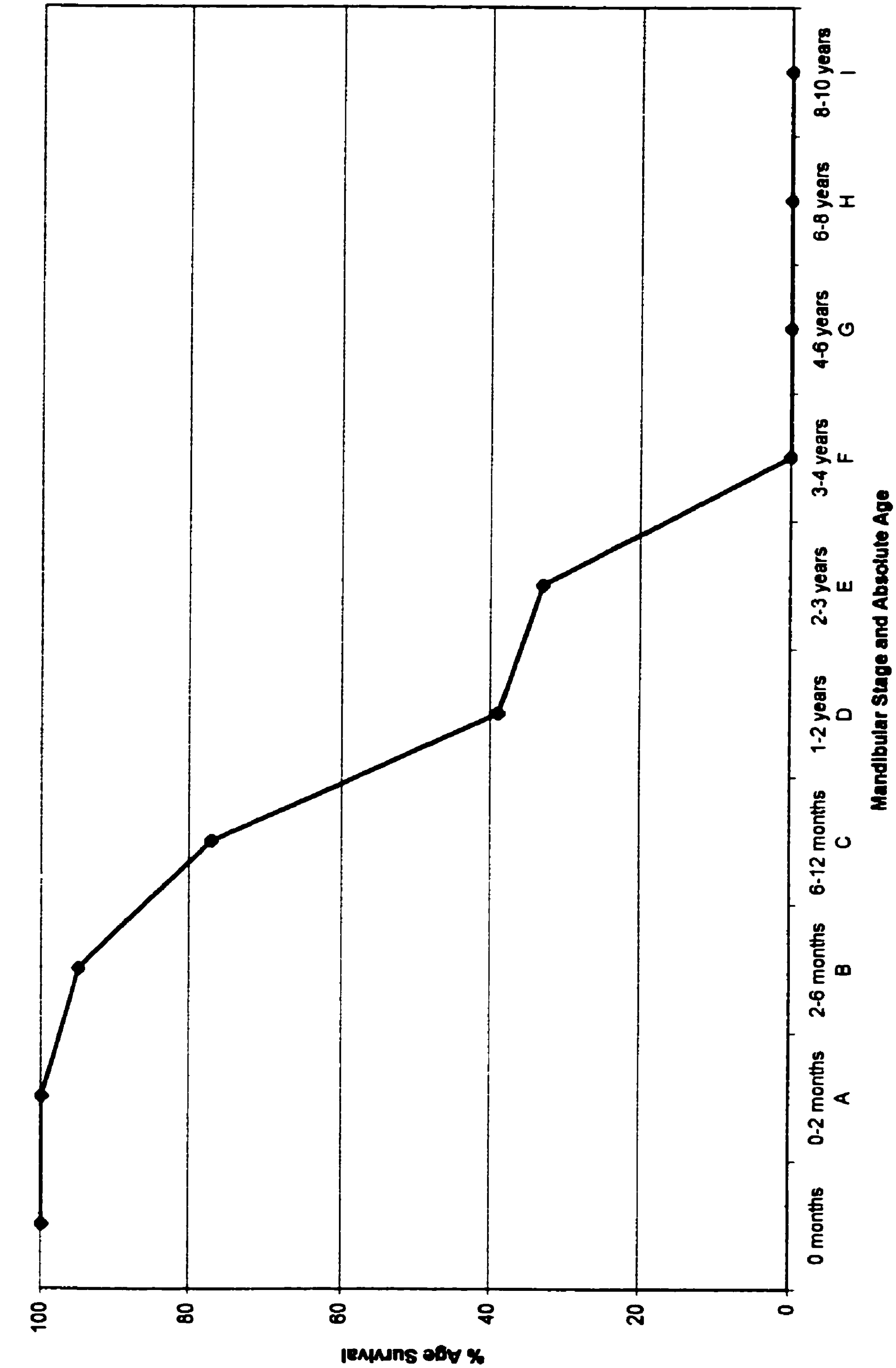


**Figure 24. Harvest profile (*Ovis/Capra*) Late Neolithic Vinča**

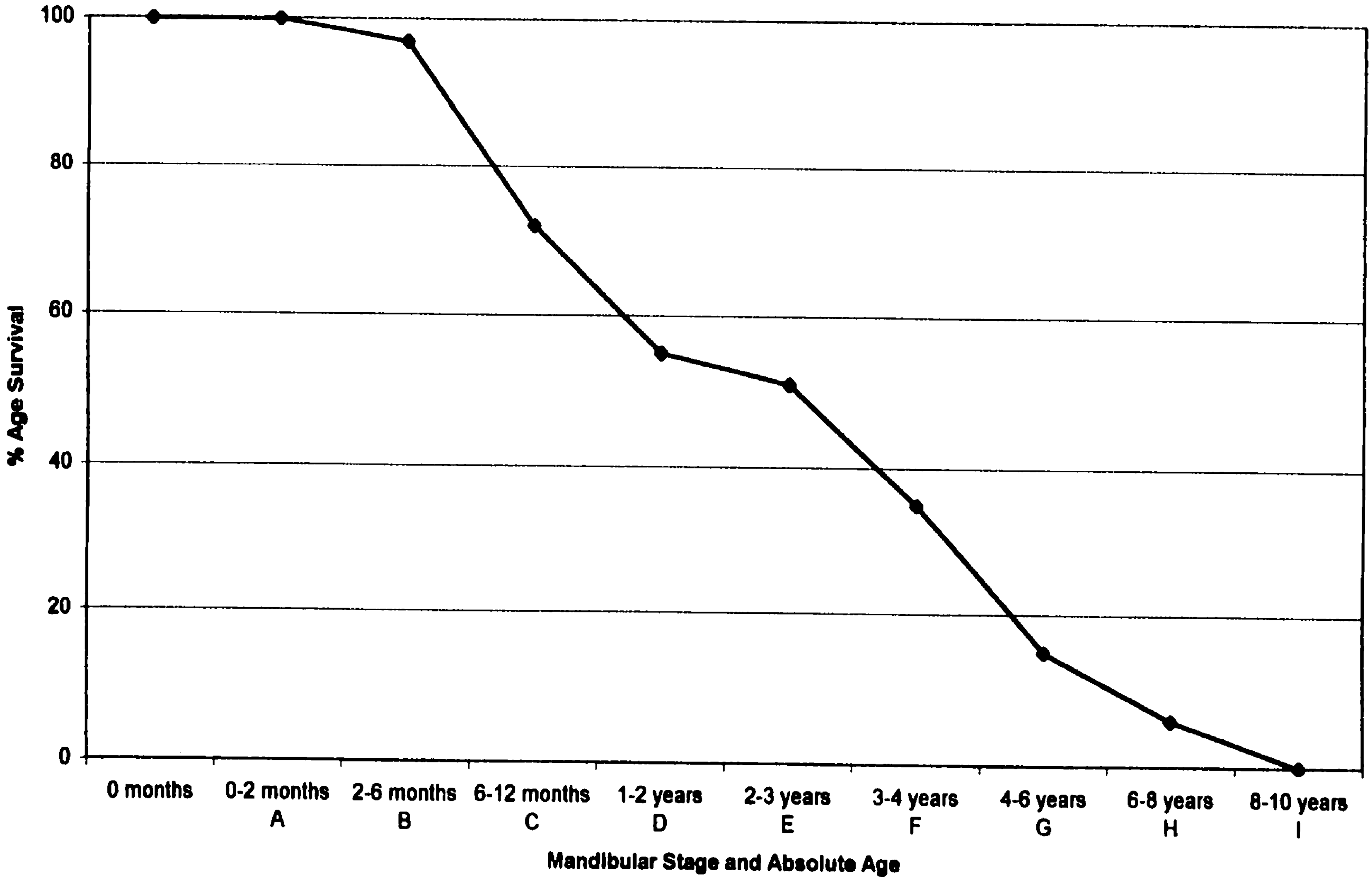


Figure 25. Harvest profile (*Ovis/Capra*) Late Neolithic Petnica

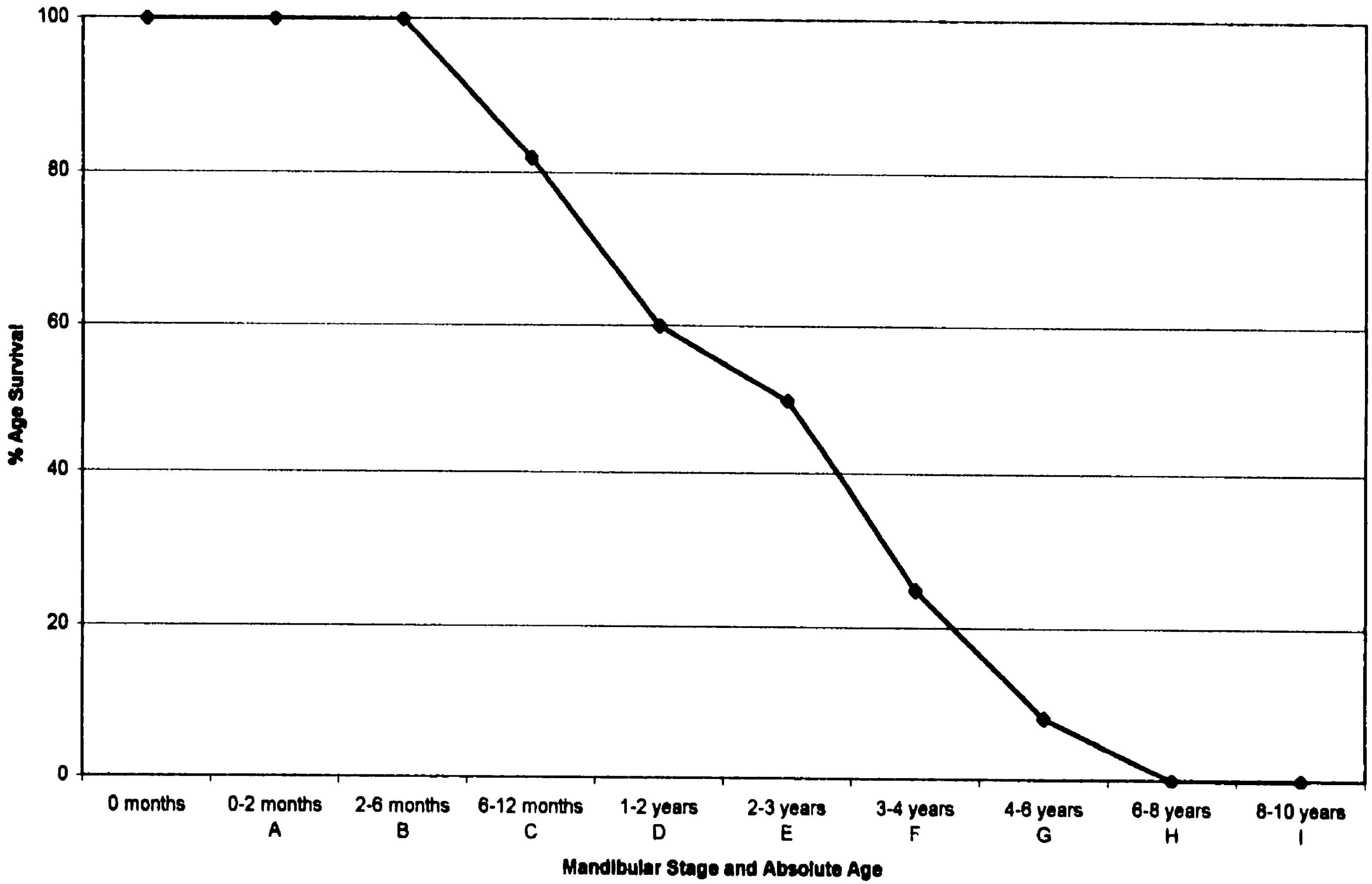


**Figure 26. Harvest profile (*Ovis/Capra*) Late Neolithic**

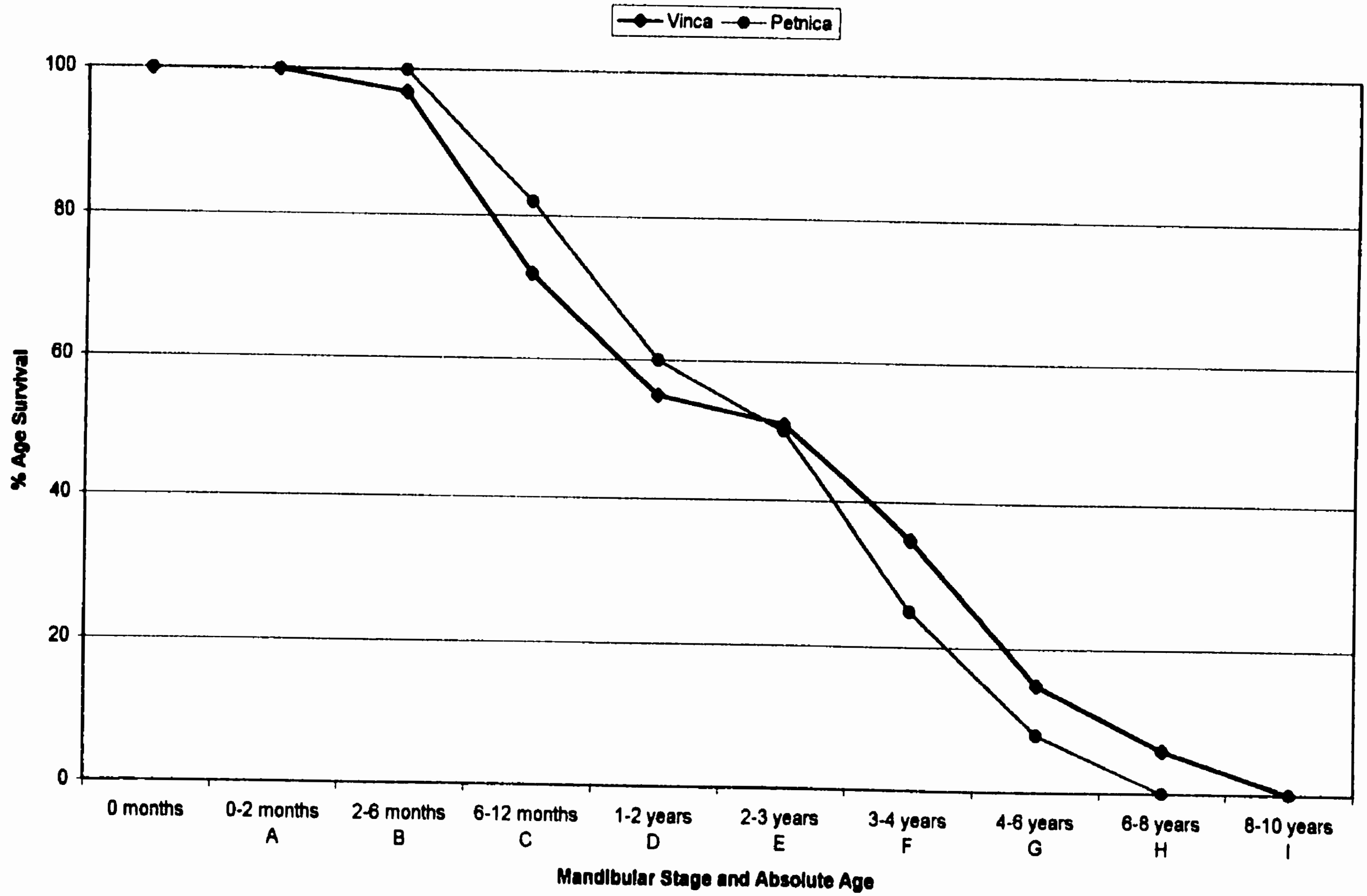


**Figure 27. Harvest profile (*Ovis/Capra*) Eneolithic Novačka Ćuprija**

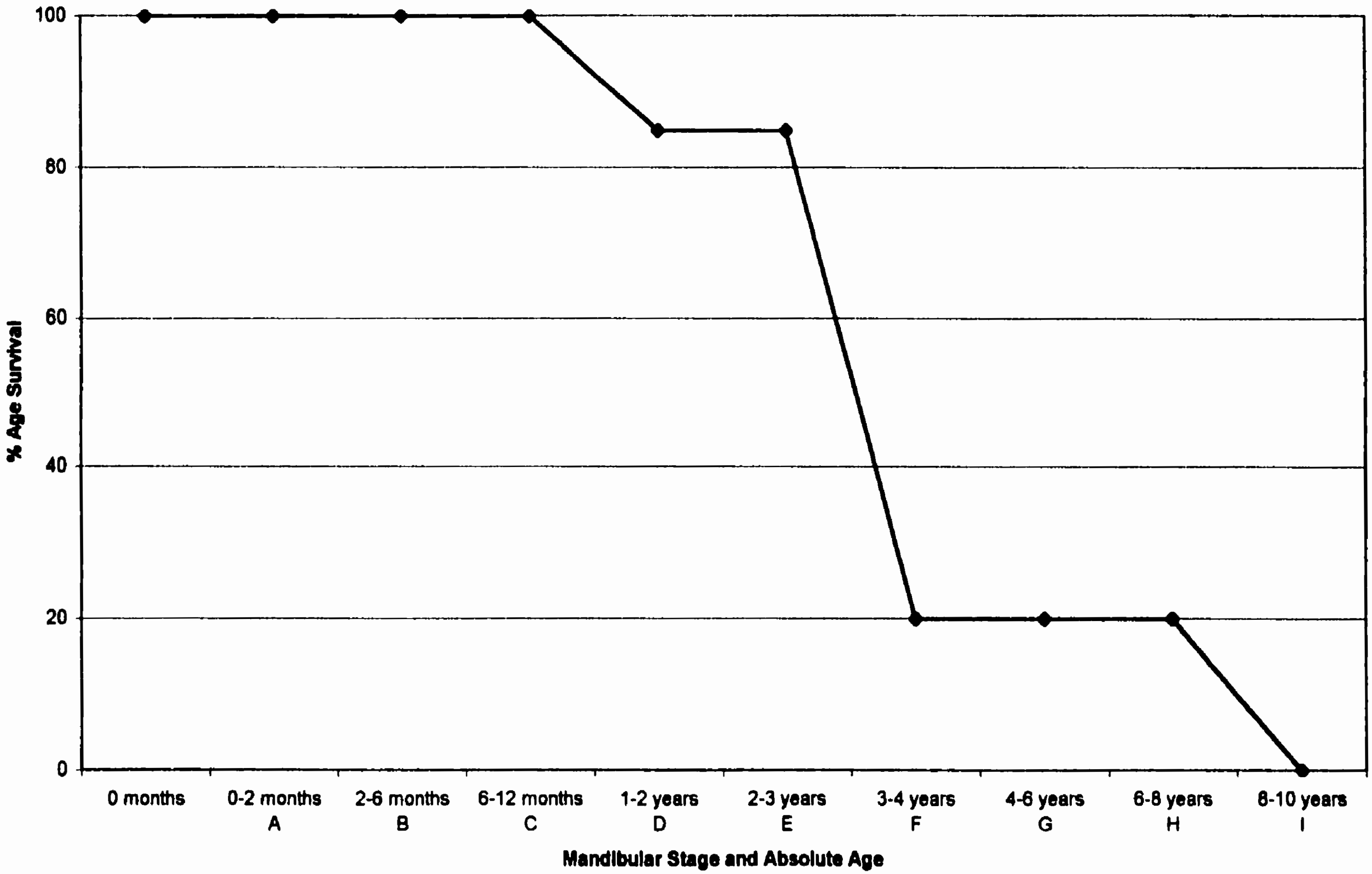


Figure 28. Harvest profile (*Ovis/Capra*) Eneolithic Petnica

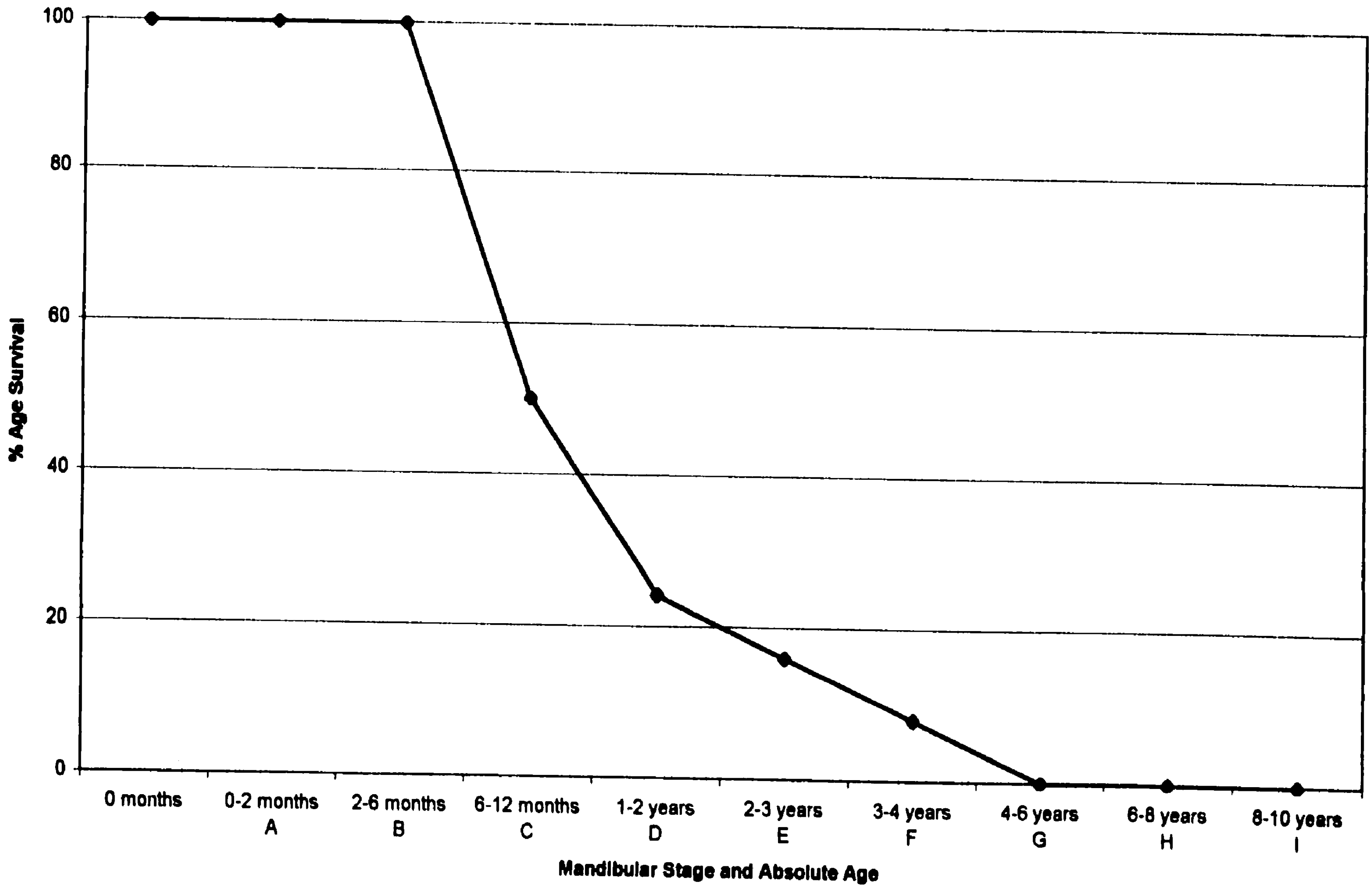


**Figure 29. Harvest profile (*Ovis/Capra*) Early Bronze Age Novačka Ćuprija**

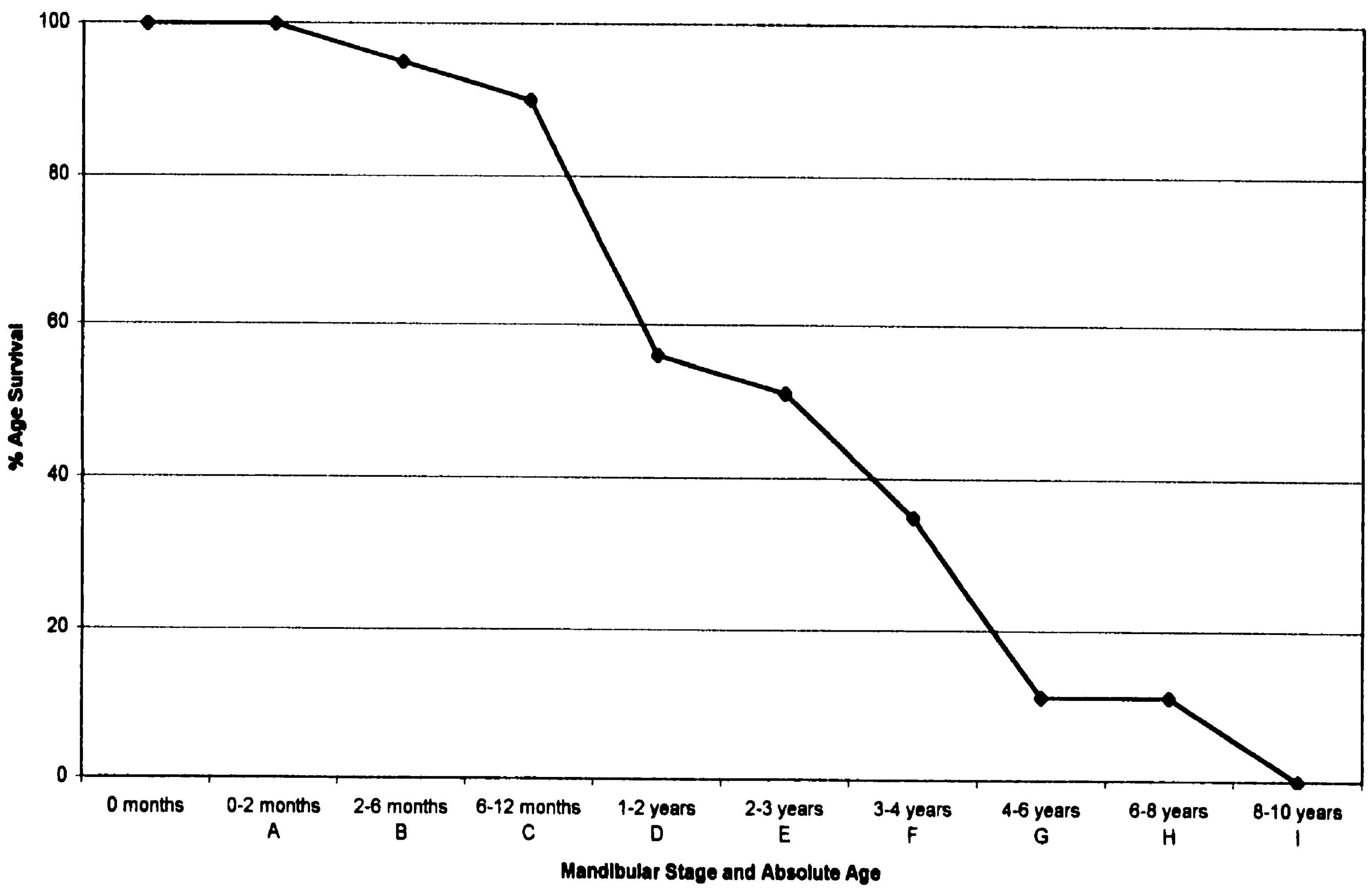


Figure 30. Harvest profile (*Ovis/Capra*) Middle Bronze Age Vinča

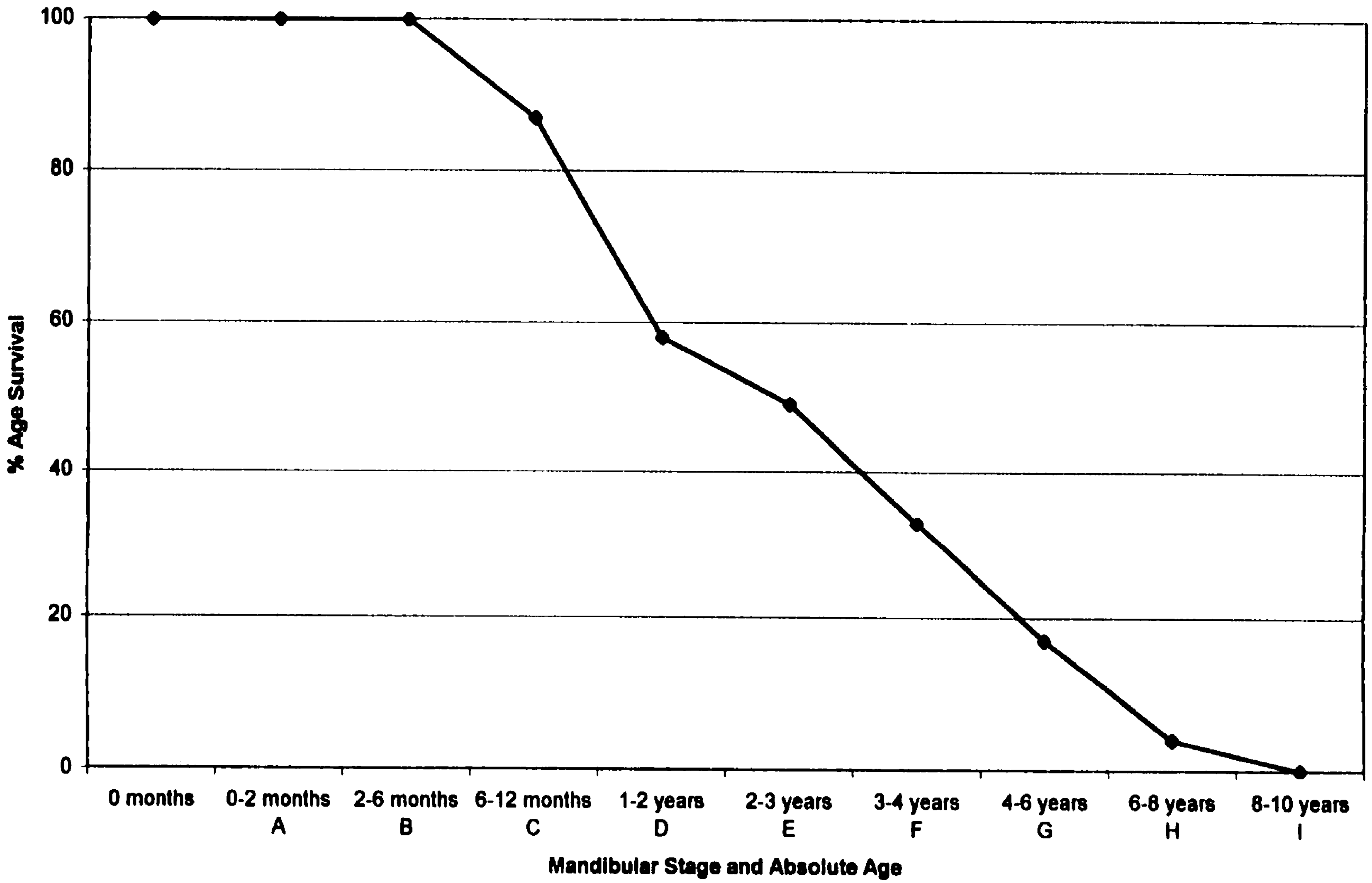


Figure 31. Harvest profile (*Ovis/Capra*) Late Bronze Age Novačka Ćuprija

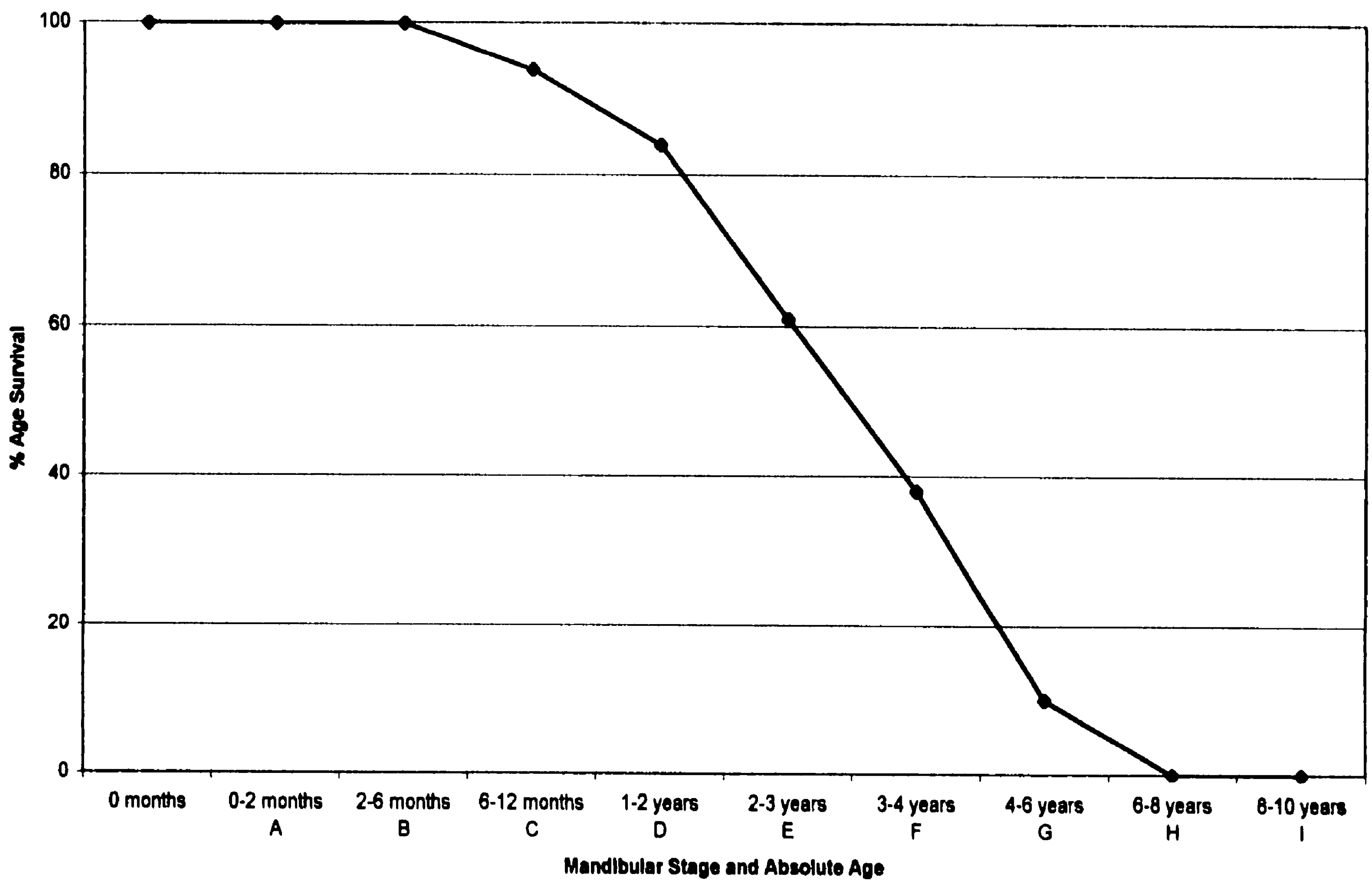


**Figure 32. Harvest profile (*Ovis/Capra*) Late Bronze Age Livade**

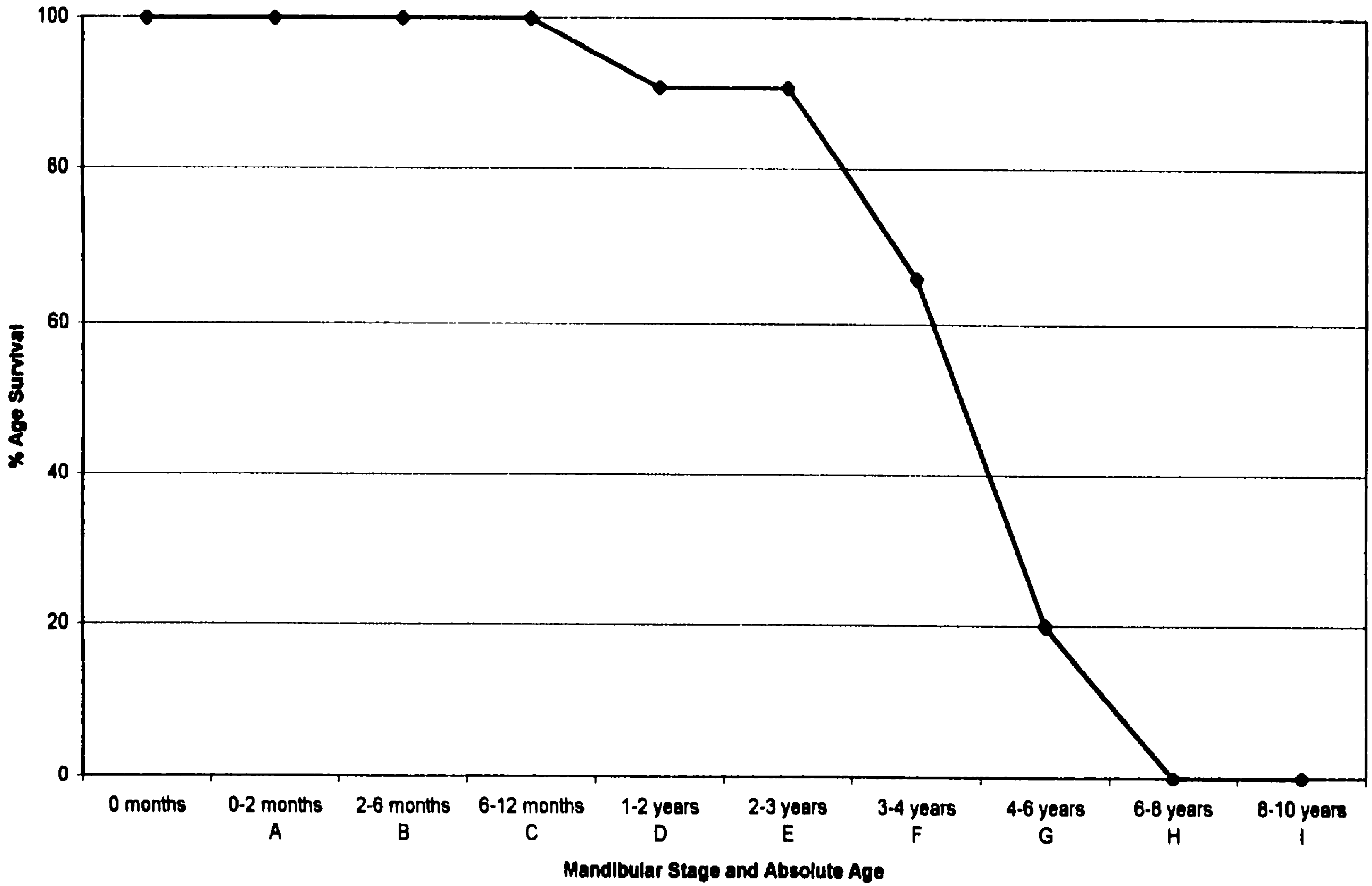


**Figure 33. Harvest profile (*Ovis/Capra*) Late Bronze Age Petnica**

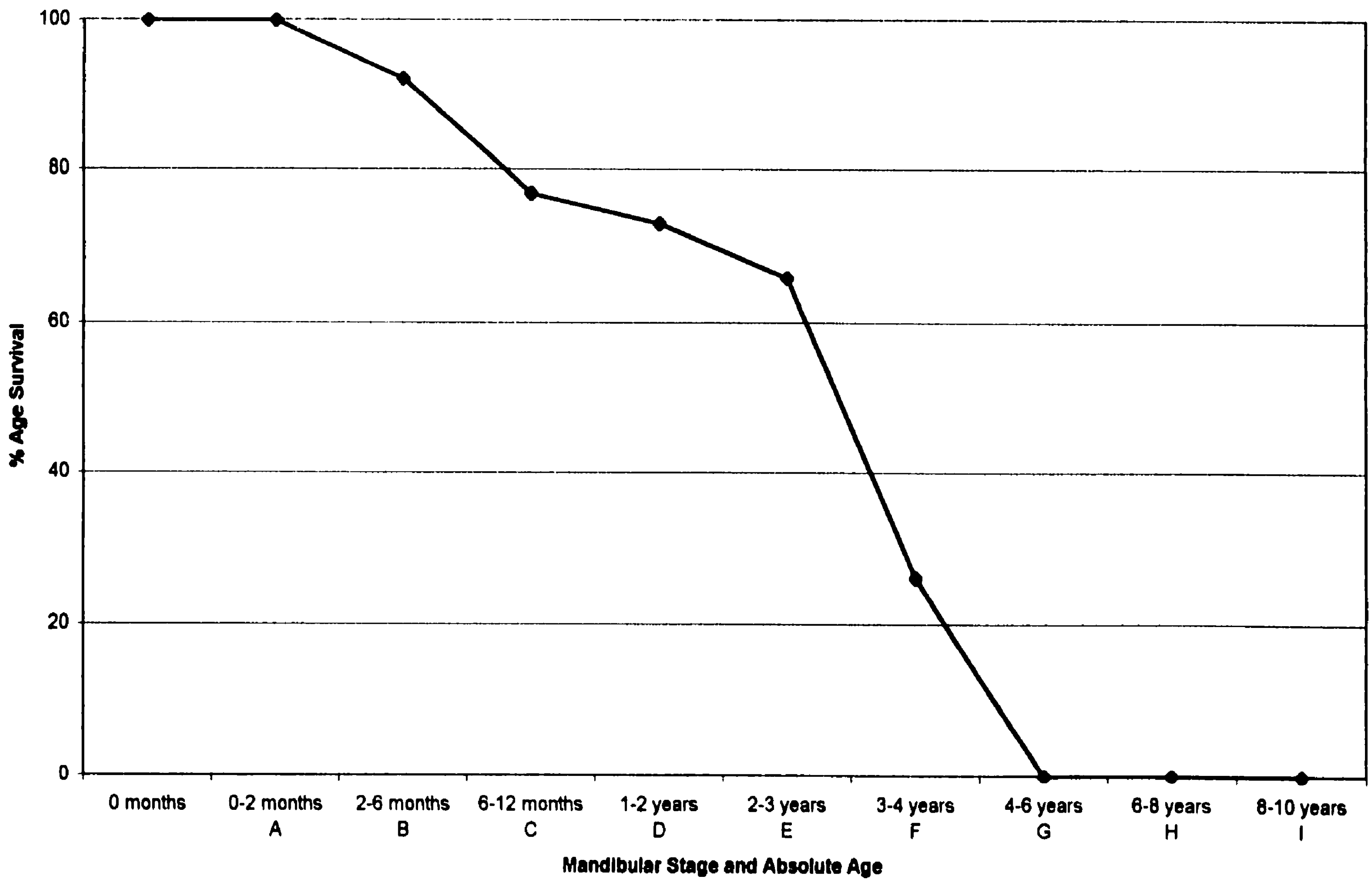


**Figure 34. Harvest profile (*Ovis/Capra*) Late Bronze Age**

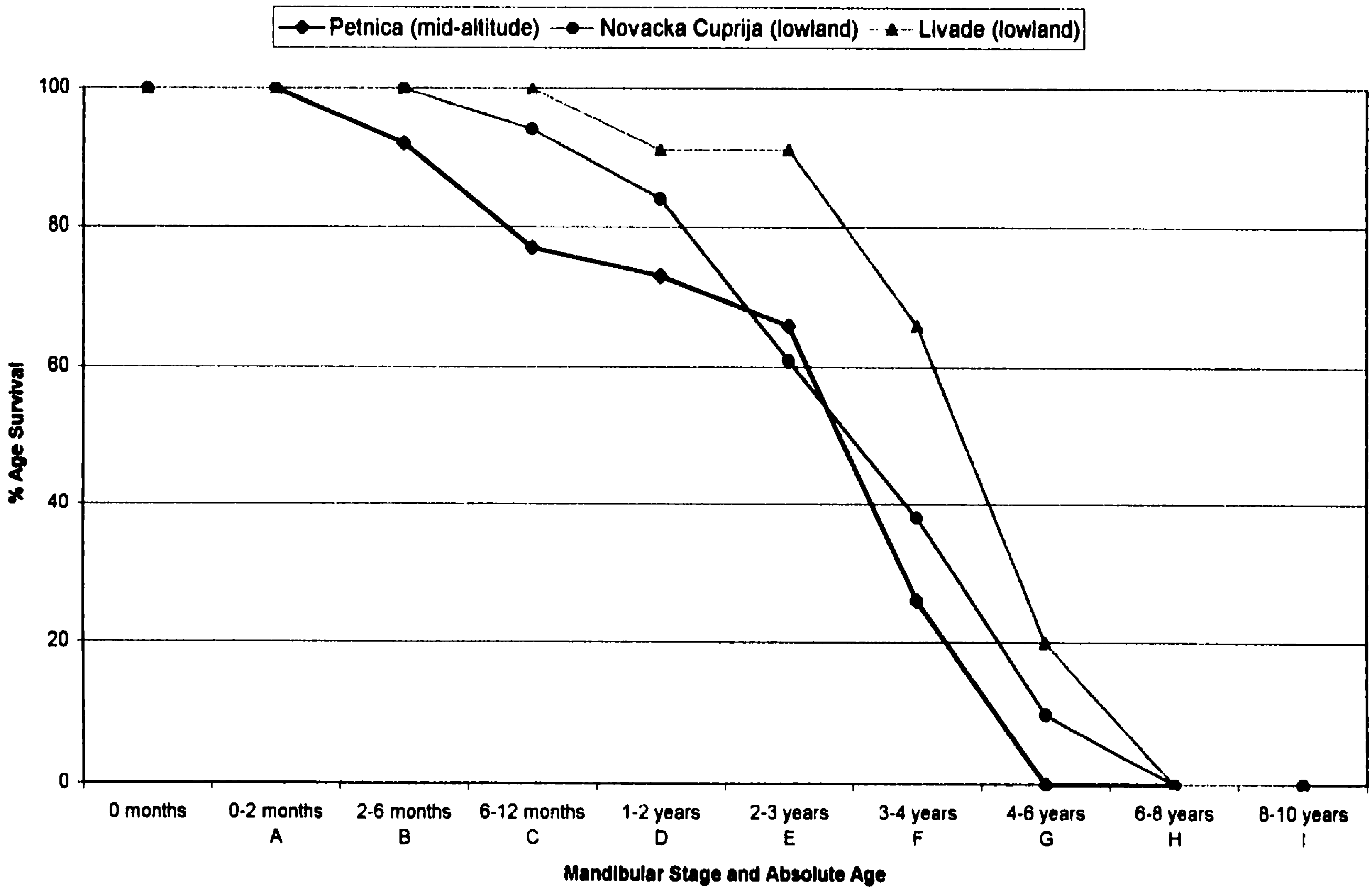


**Figure 35. Harvest profile (*Ovis/Capra*) Early Iron Age Kadica Brdo**

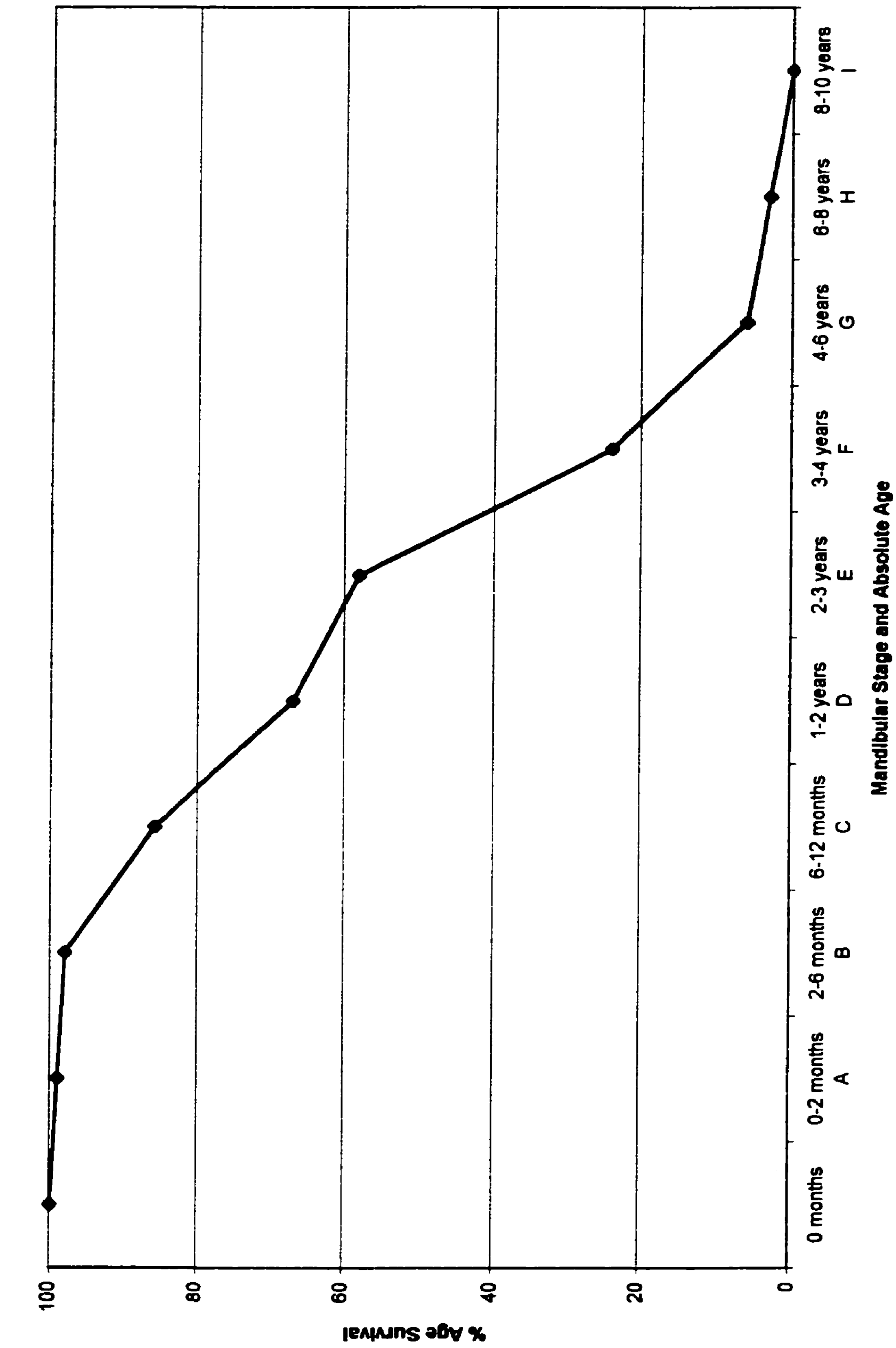


**Figure 36. Harvest profile (*Ovis/Capra*) Final Neolithic Megilo Nisi Galanis**

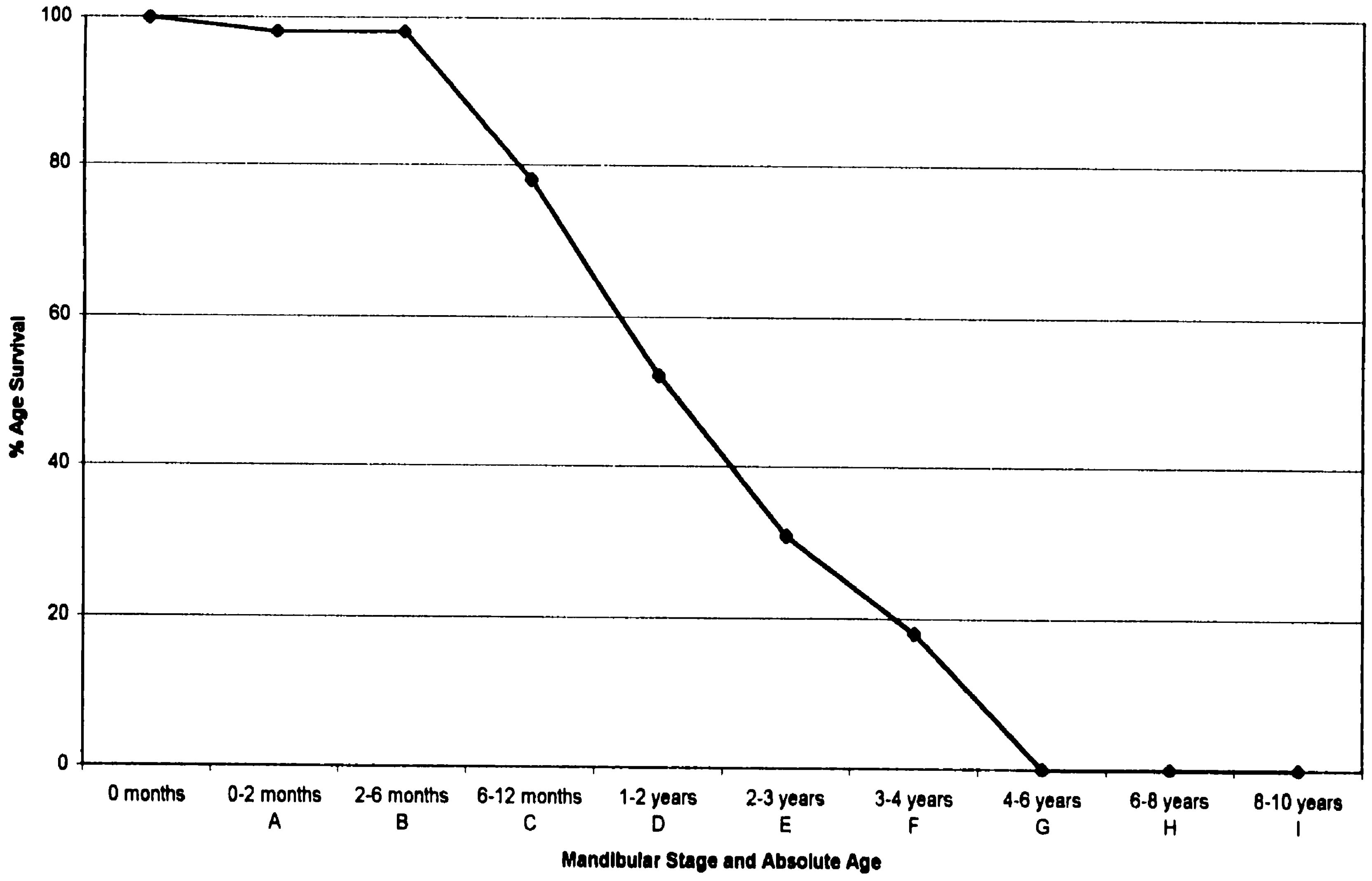


**Figure 37. Harvest profile (*Ovis/Capra*) Final Neolithic/Early Bronze Age Megilo Nisi Galanis**

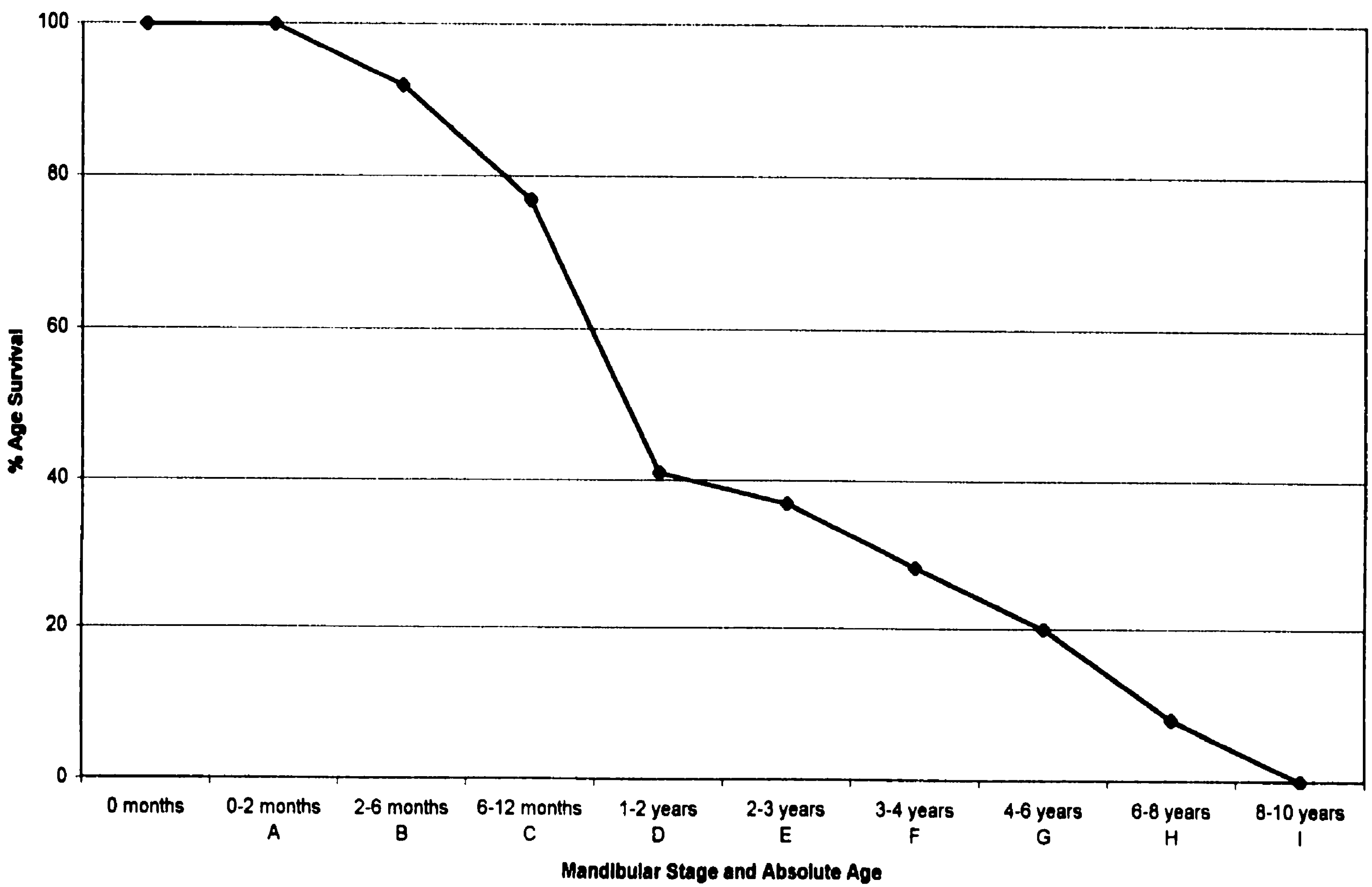


**Figure 38. Harvest profile (*Bos taurus*) Early Neolithic Foeni-Salas**

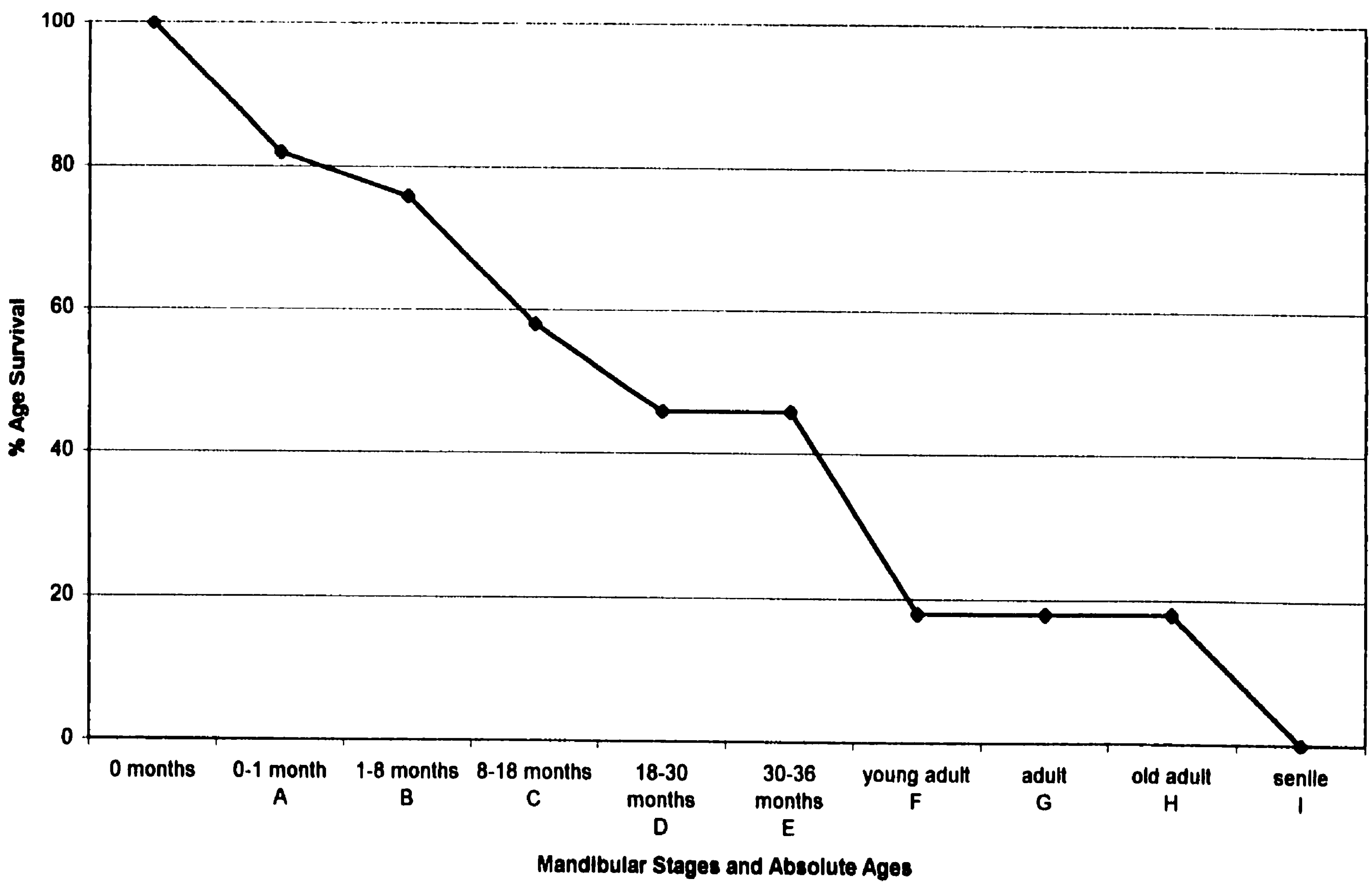


Figure 39. Harvest profile *(Bos taurus)* Early Neolithic Blagotin

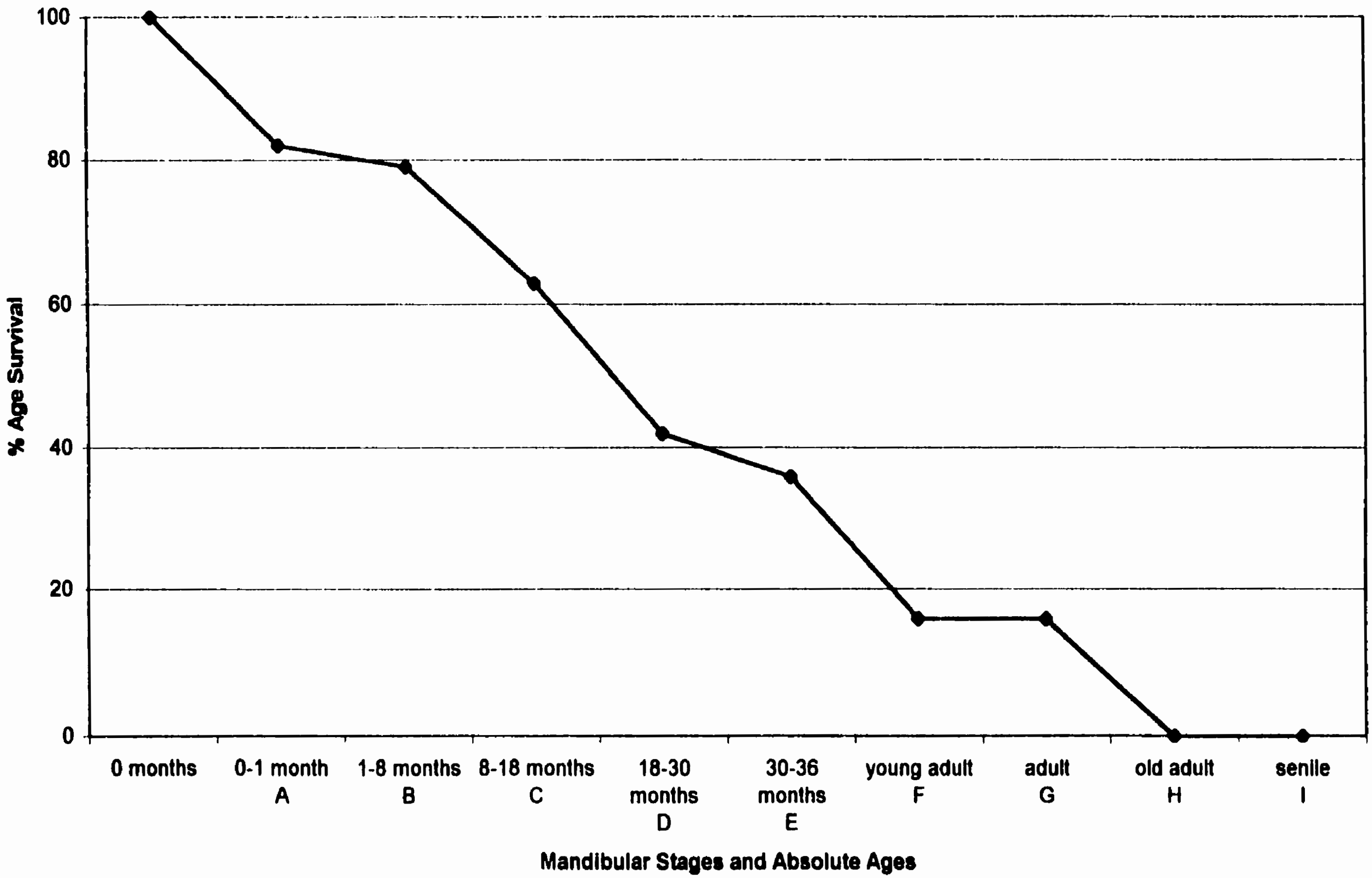


**Figure 40. Harvest profile Early Neolithic *Bos* vs. *Ovis/Capra***

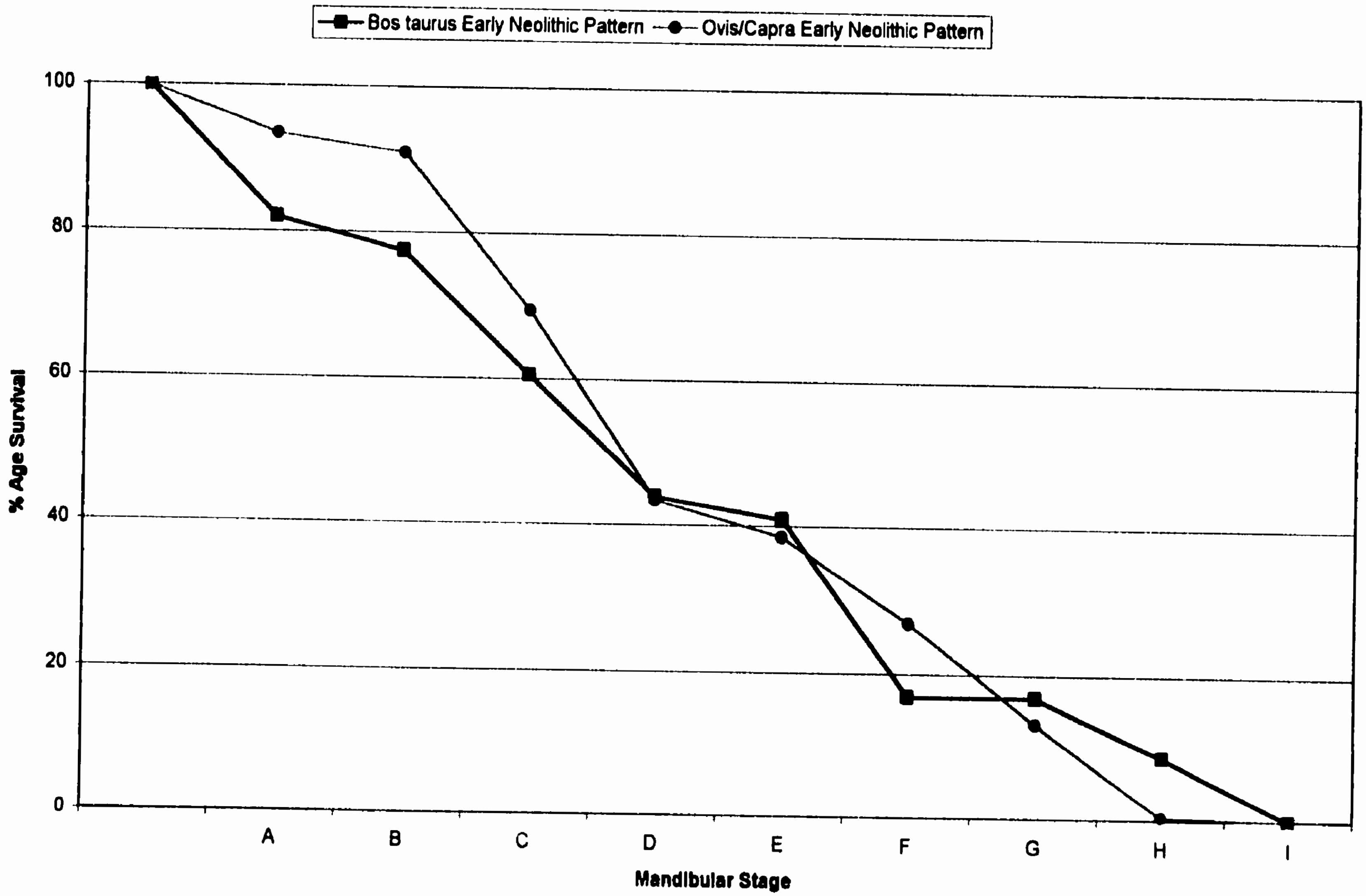


**Figure 41. Harvest profile (*Bos taurus*) Middle Neolithic Stragari**

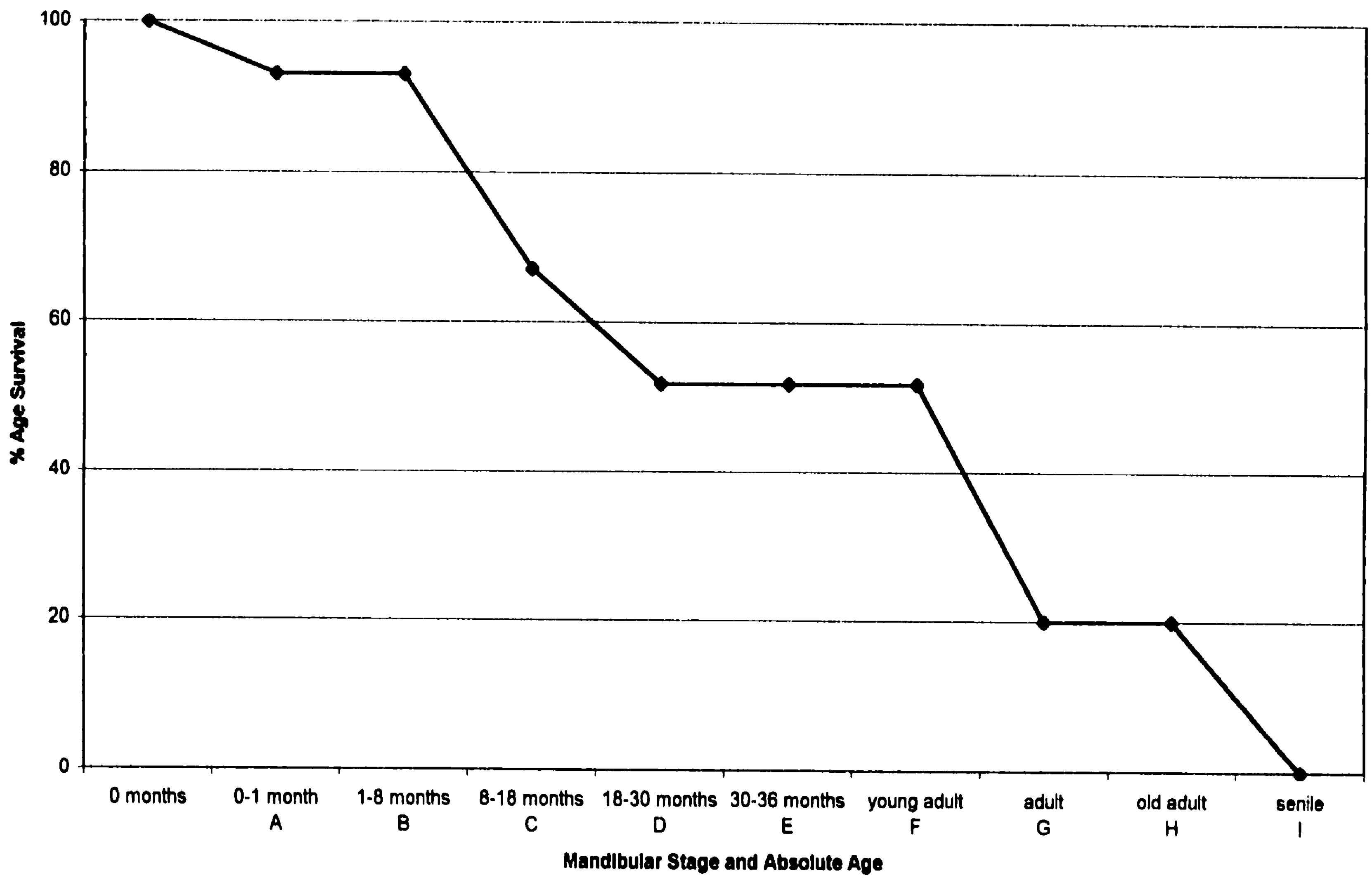


**Figure 42. Harvest profile (*Bos taurus*) Middle Neolithic Petnica**

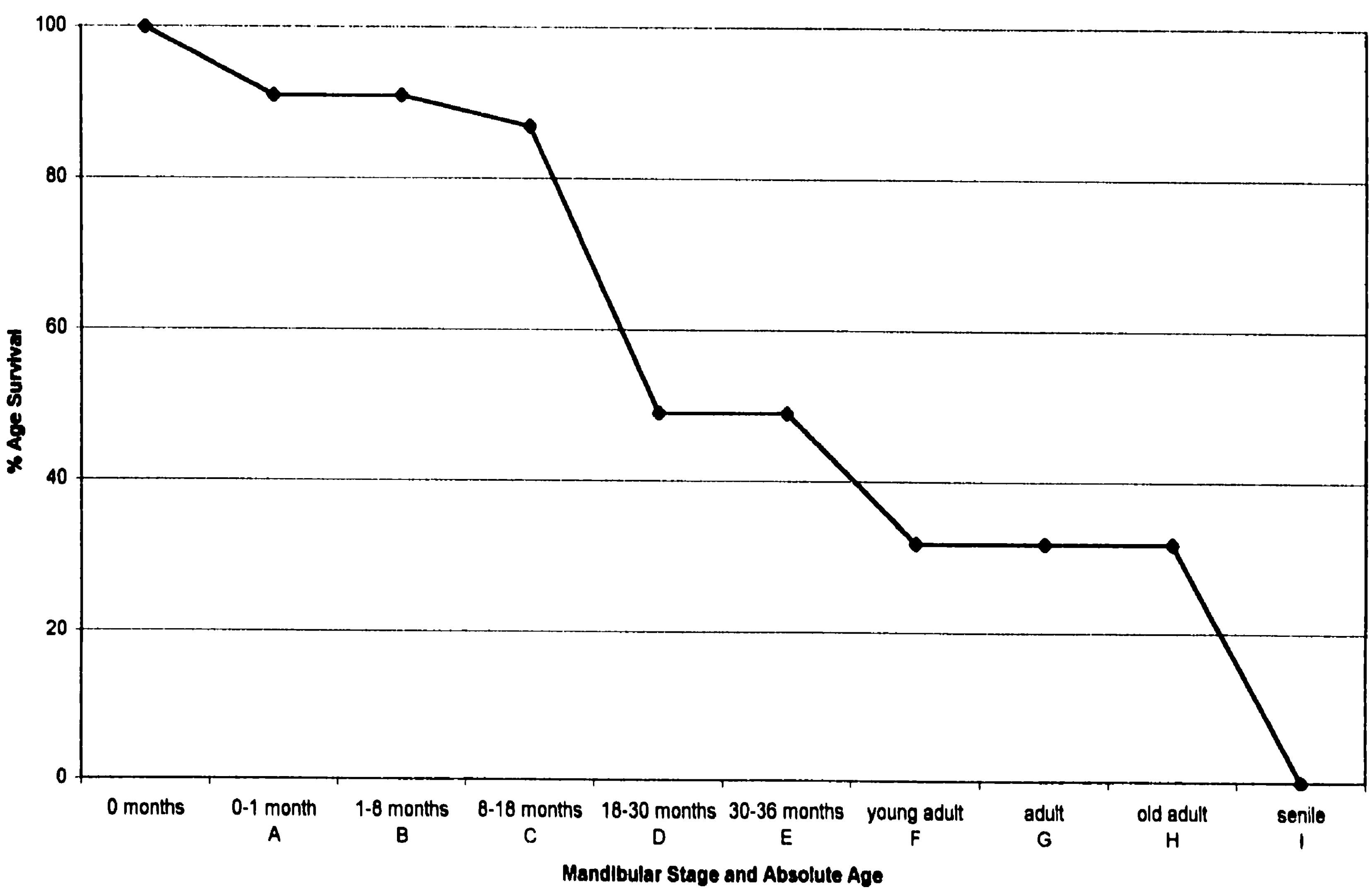


**Figure 43. Harvest profile (*Bos taurus*) Middle Neolithic**

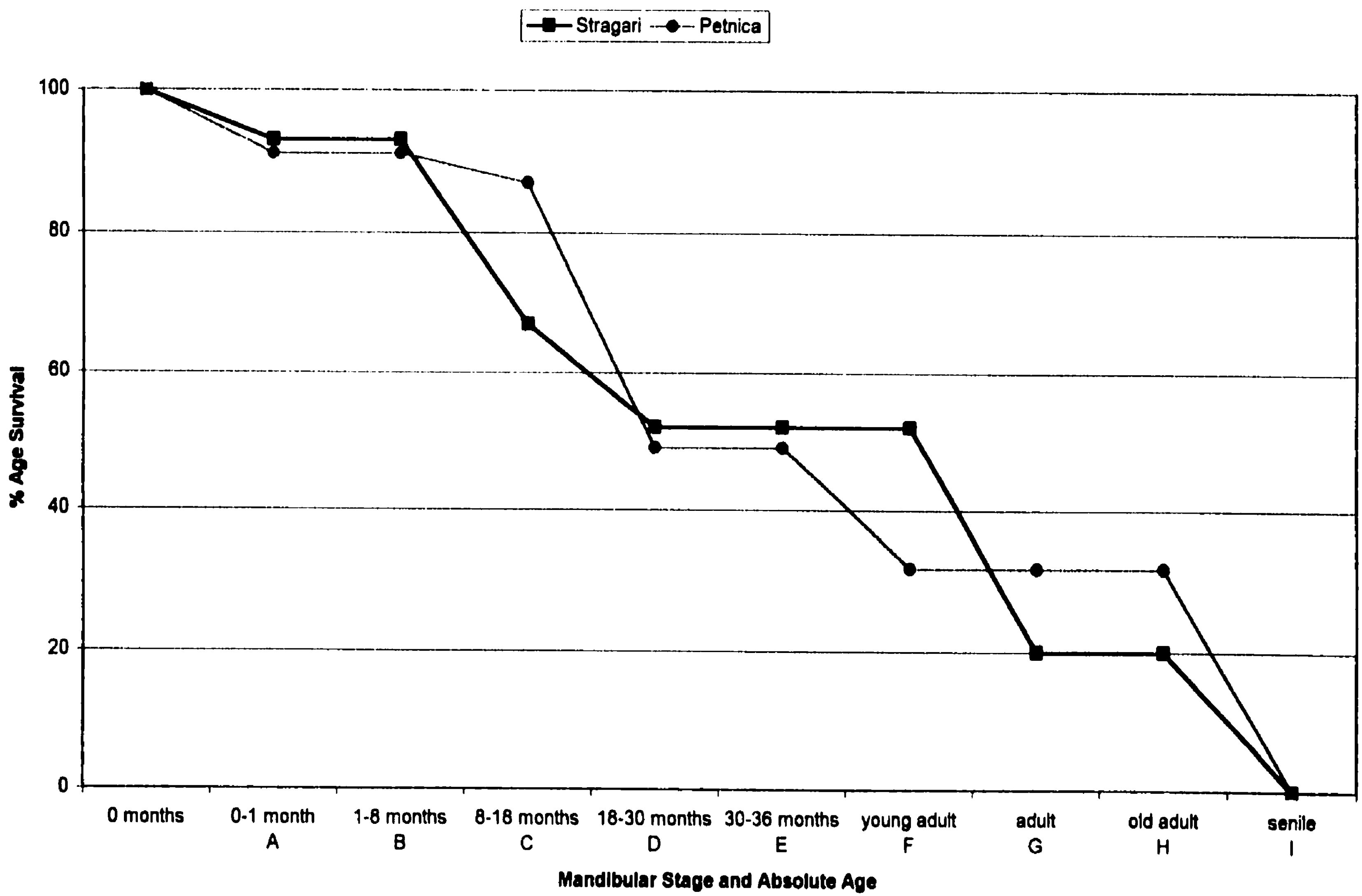


**Figure 44. Harvest profile (*Bos taurus*) Late Neolithic Opovo**

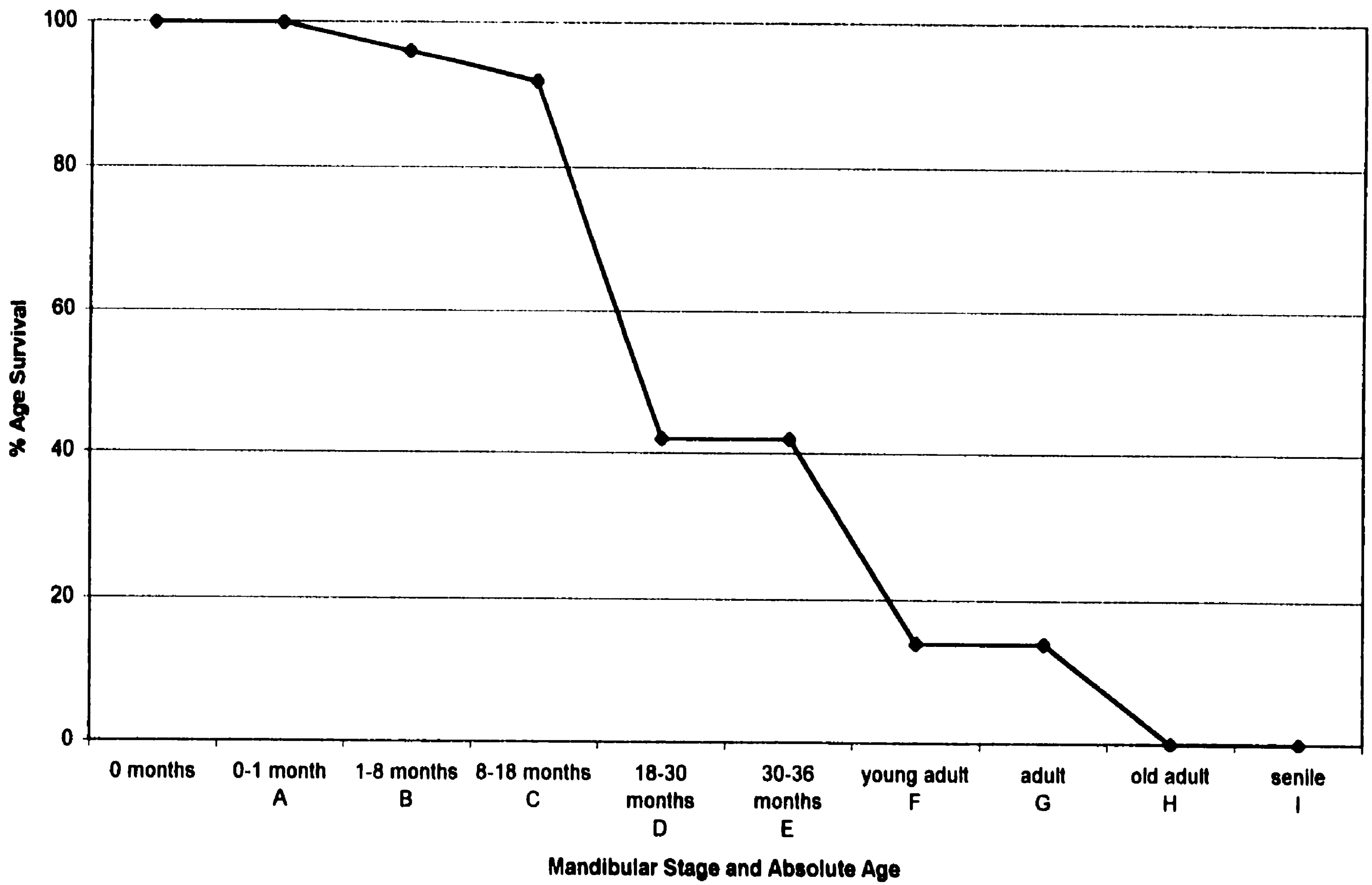


Figure 45. Harvest profile (*Bos taurus*) Late Neolithic Vinča

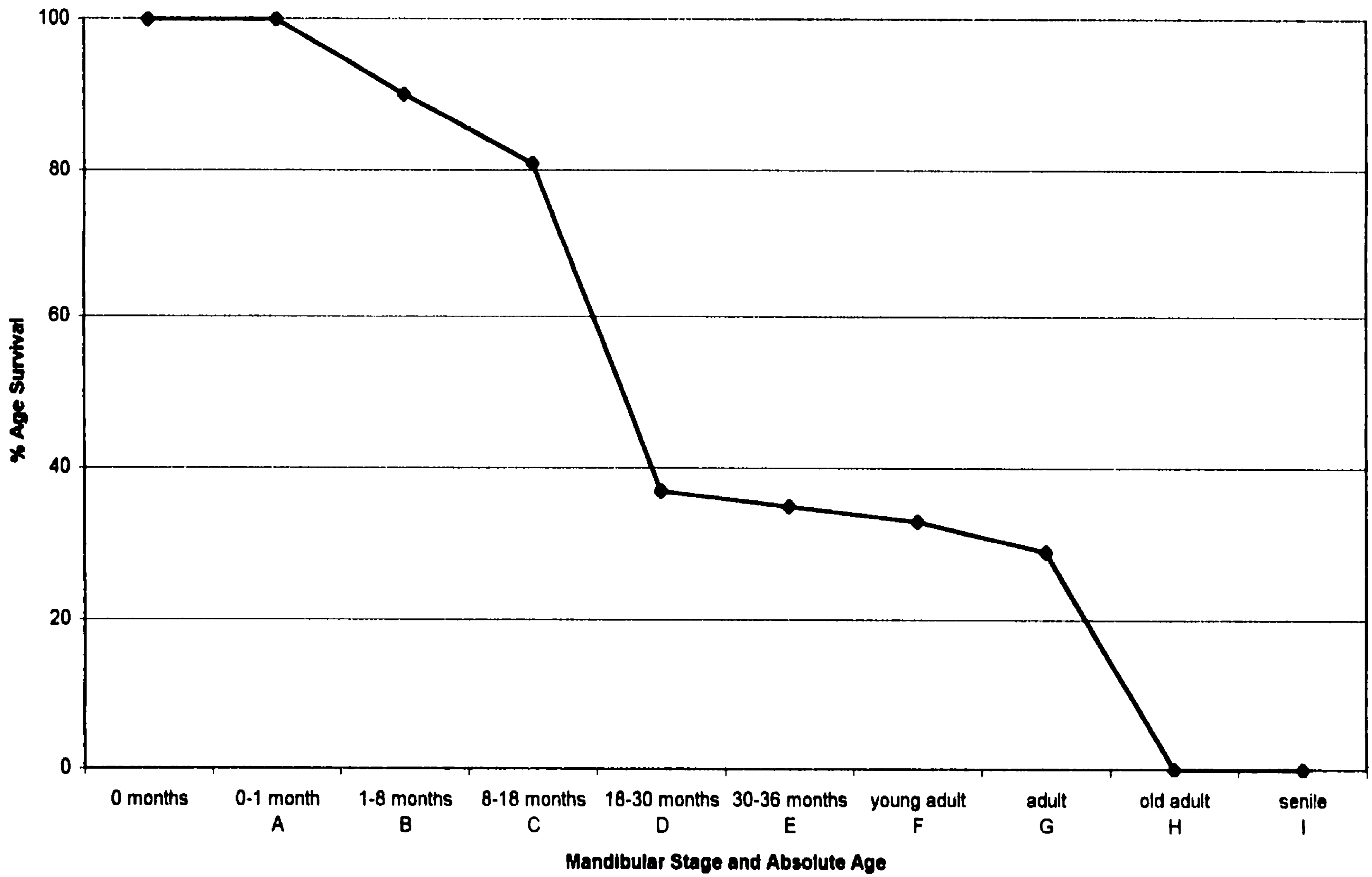


**Figure 46. Harvest profile *(Bos taurus)* Late Neolithic Petnica**

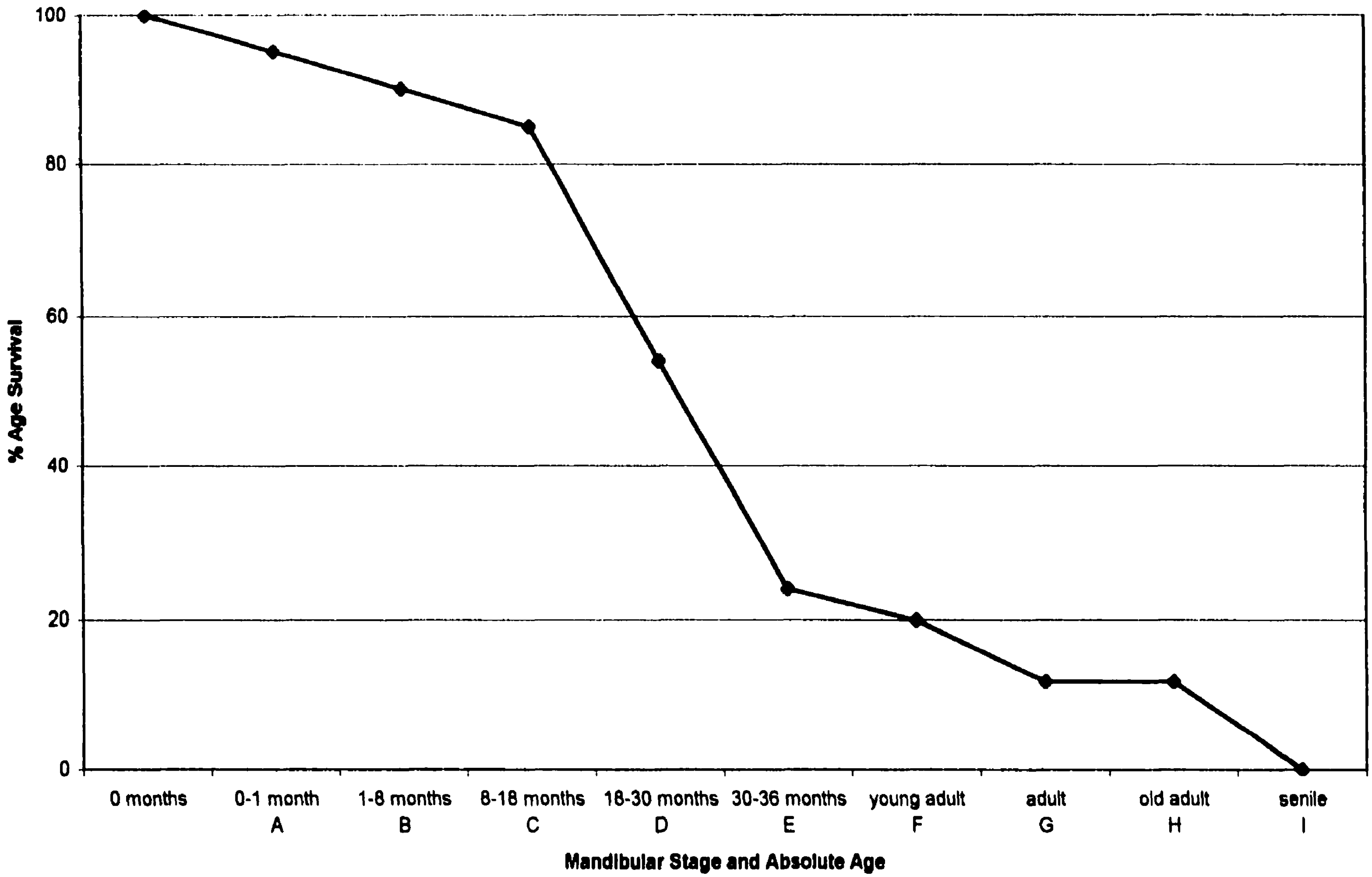


**Figure 47. Harvest profile (*Bos taurus*) Late Neolithic**

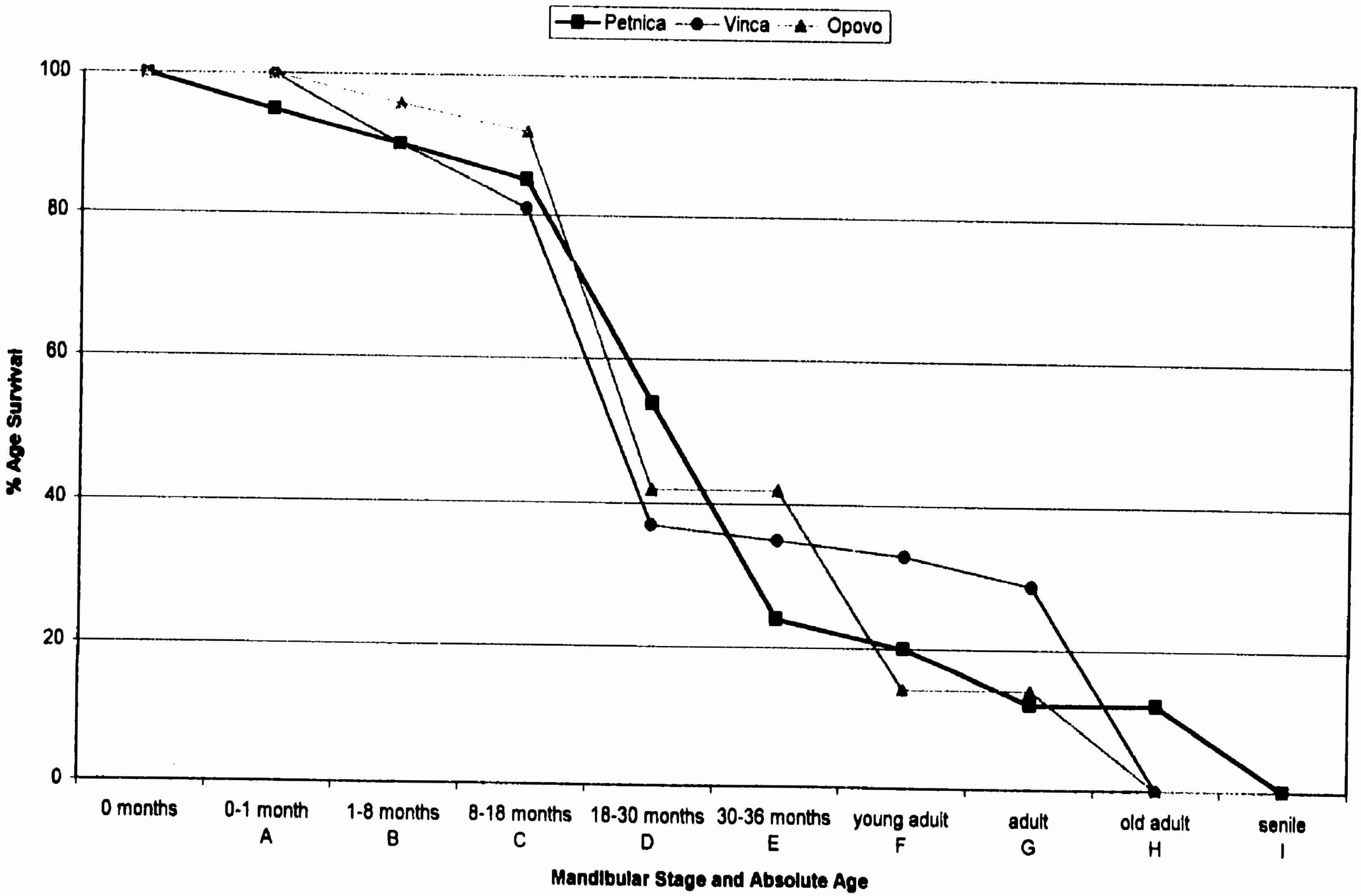


**Figure 48. Harvest profile (*Bos taurus*) Eneolithic Blagotin**

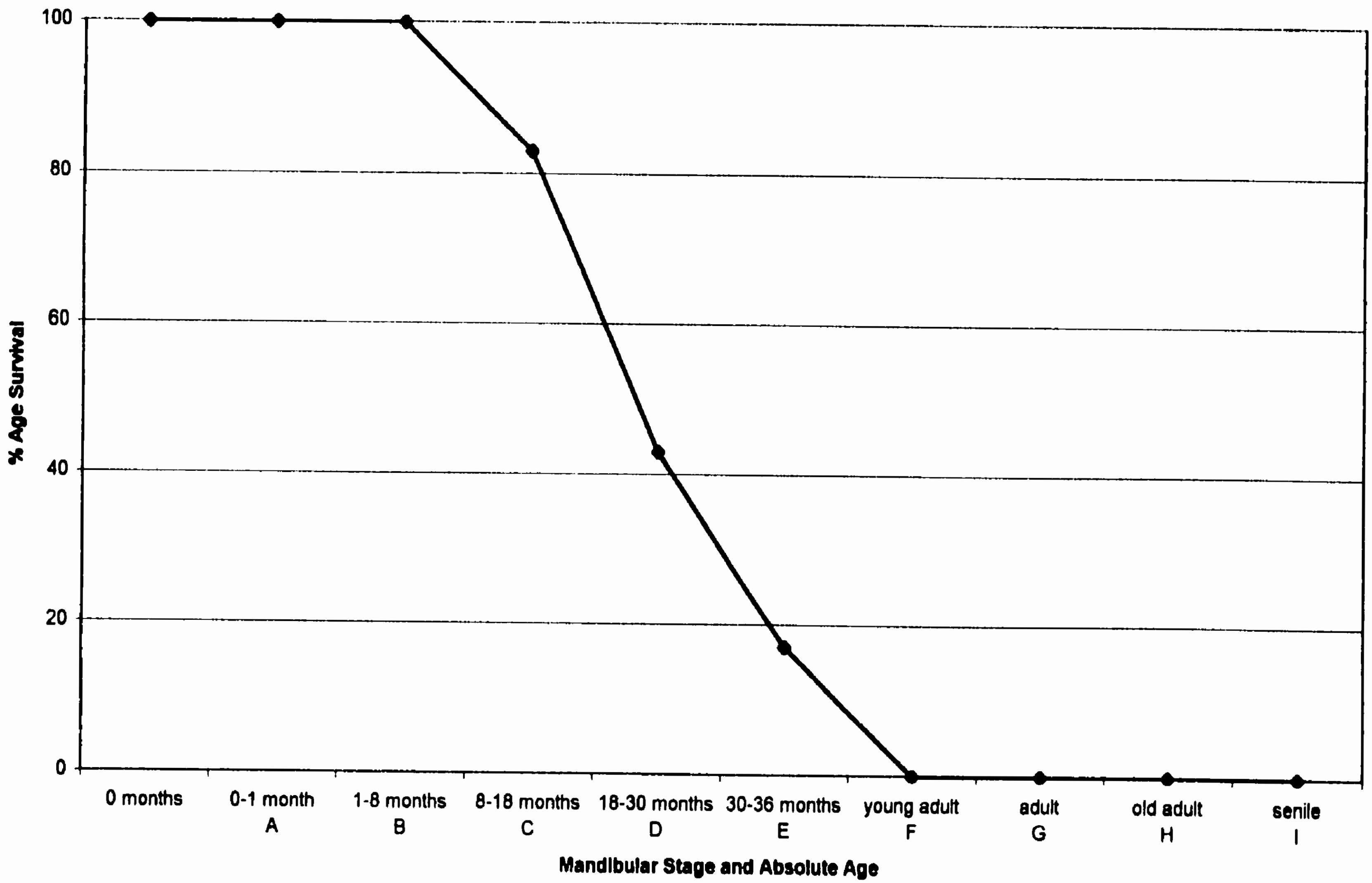


**Figure 49. Harvest profile (*Bos taurus*) Early/Middle Bronze Age Ljuljaci**

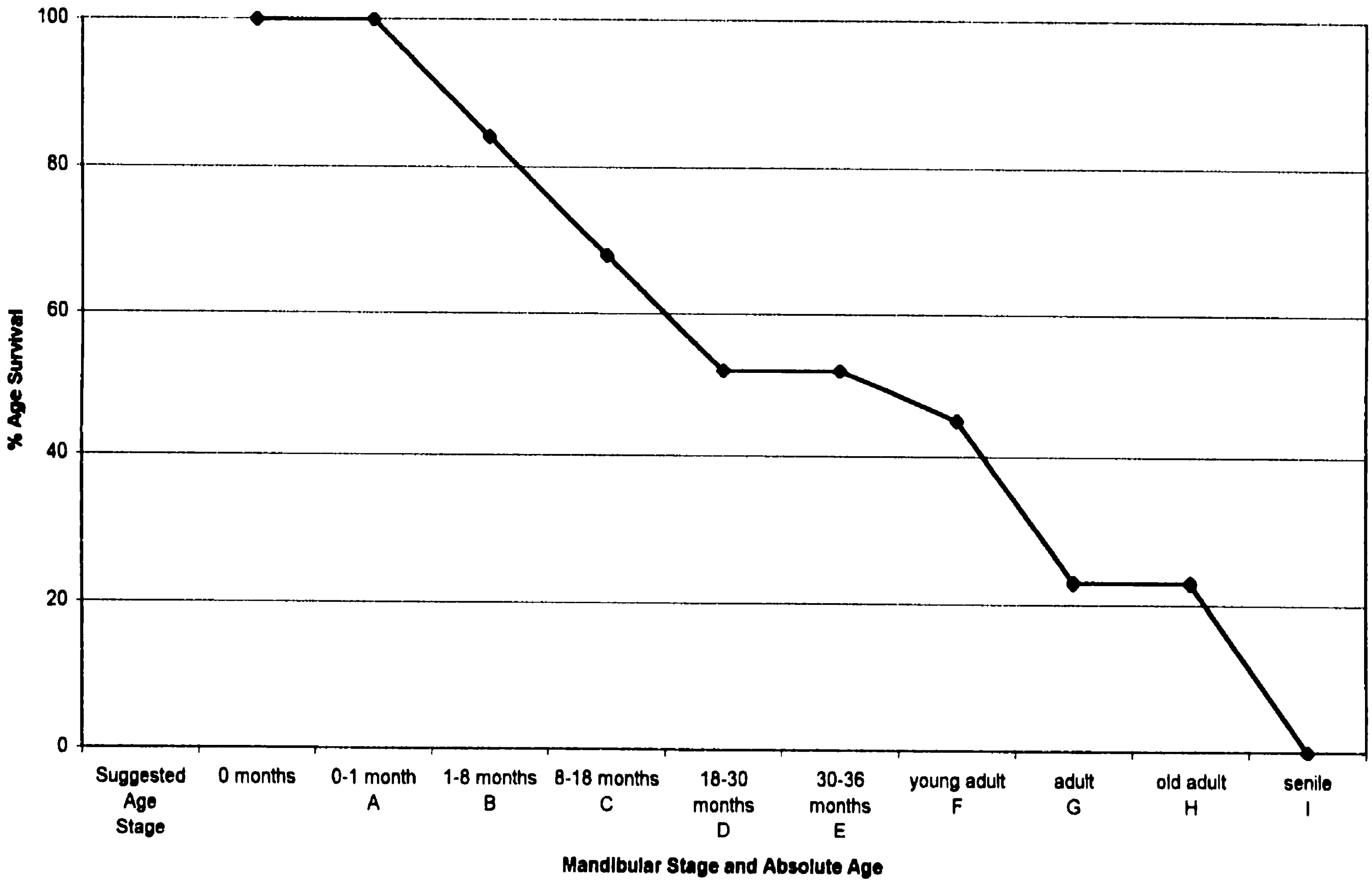


**Figure 50. Harvest profile (*Bos taurus*) Middle Bronze Age Vinča**

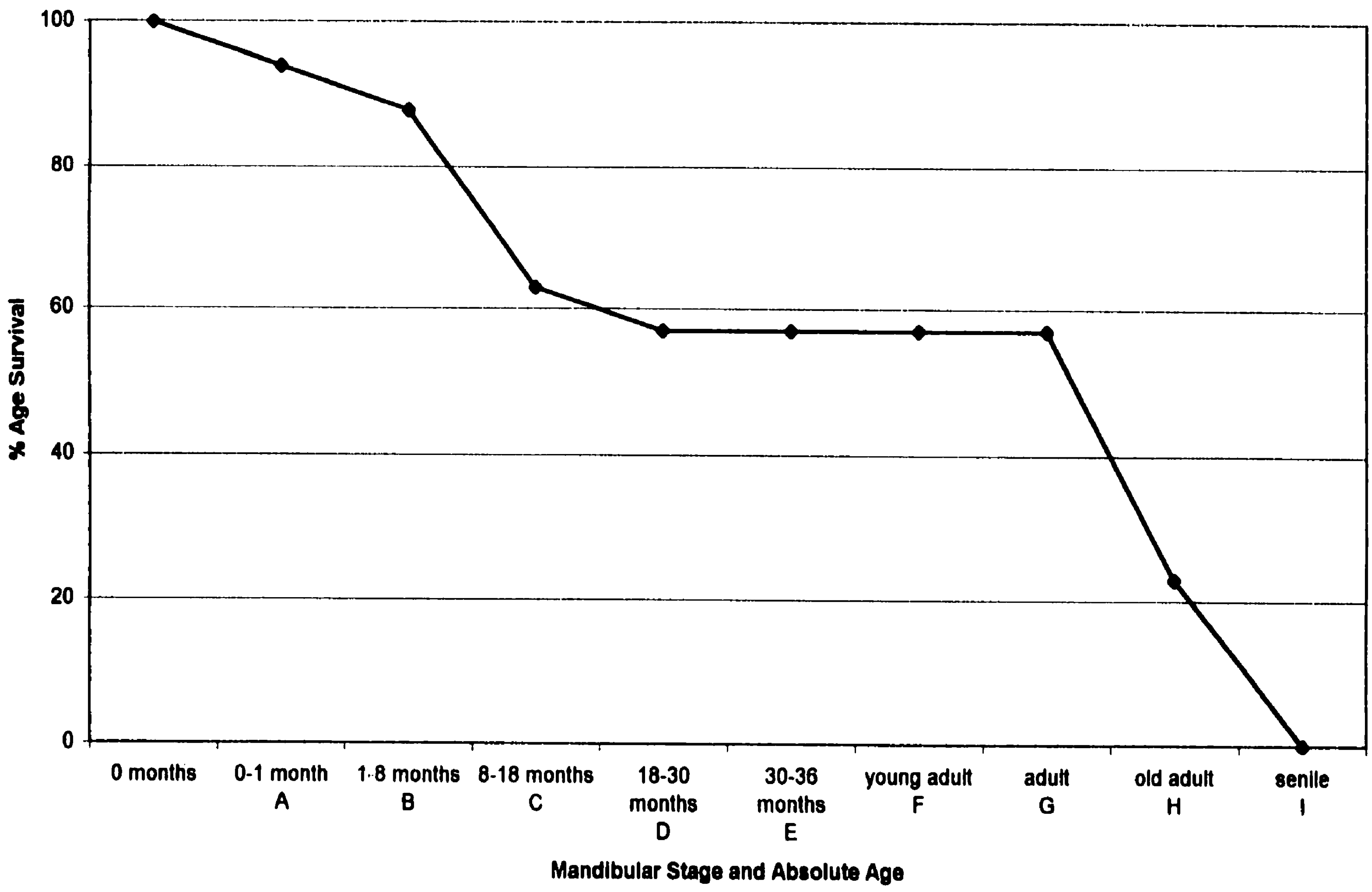


Figure 51. Harvest profile (*Bos taurus*) Late Bronze Age Livade

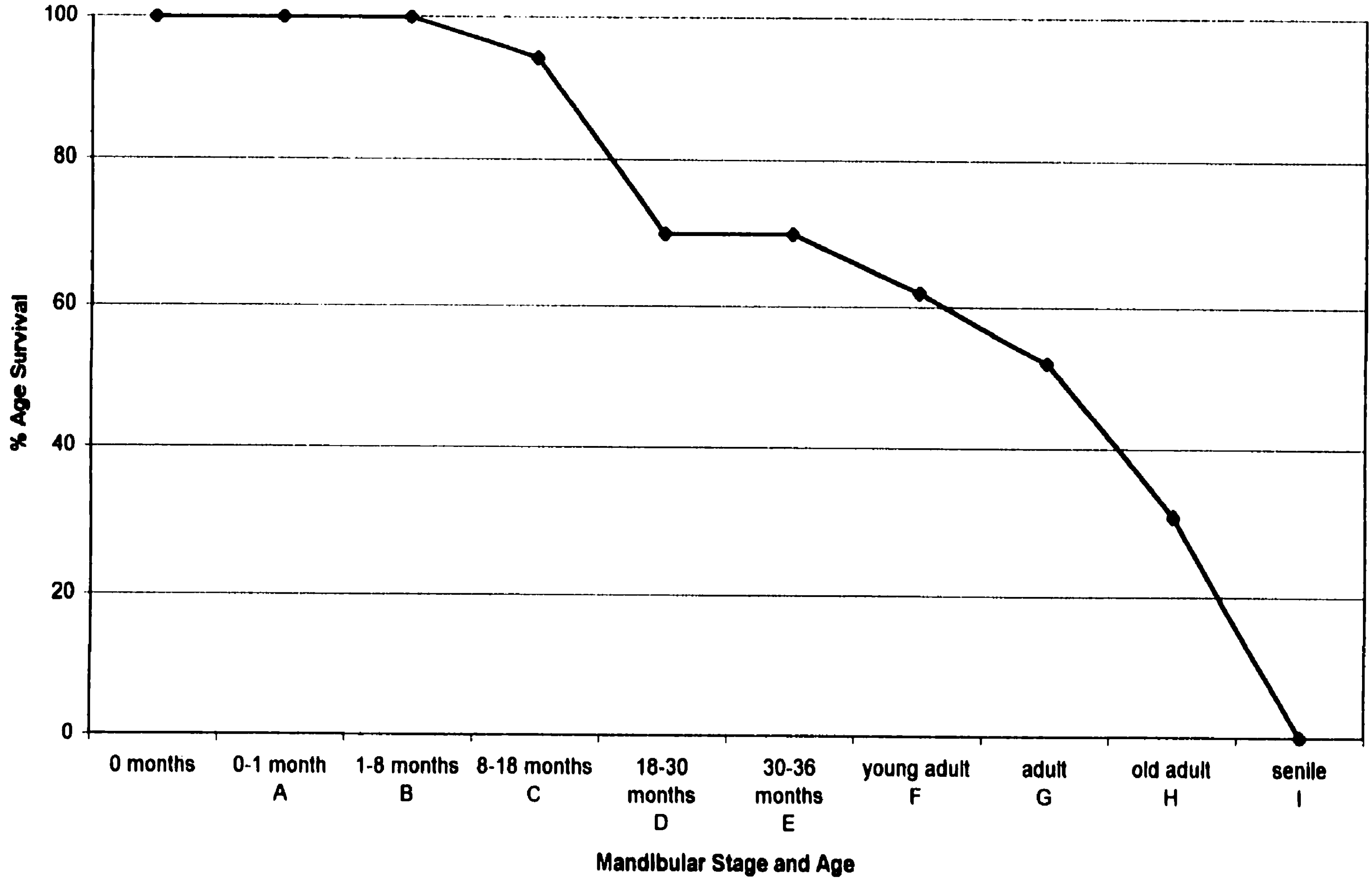


**Figure 52. Harvest profile (*Bos taurus*) Early Iron Age Kadica Brdo**

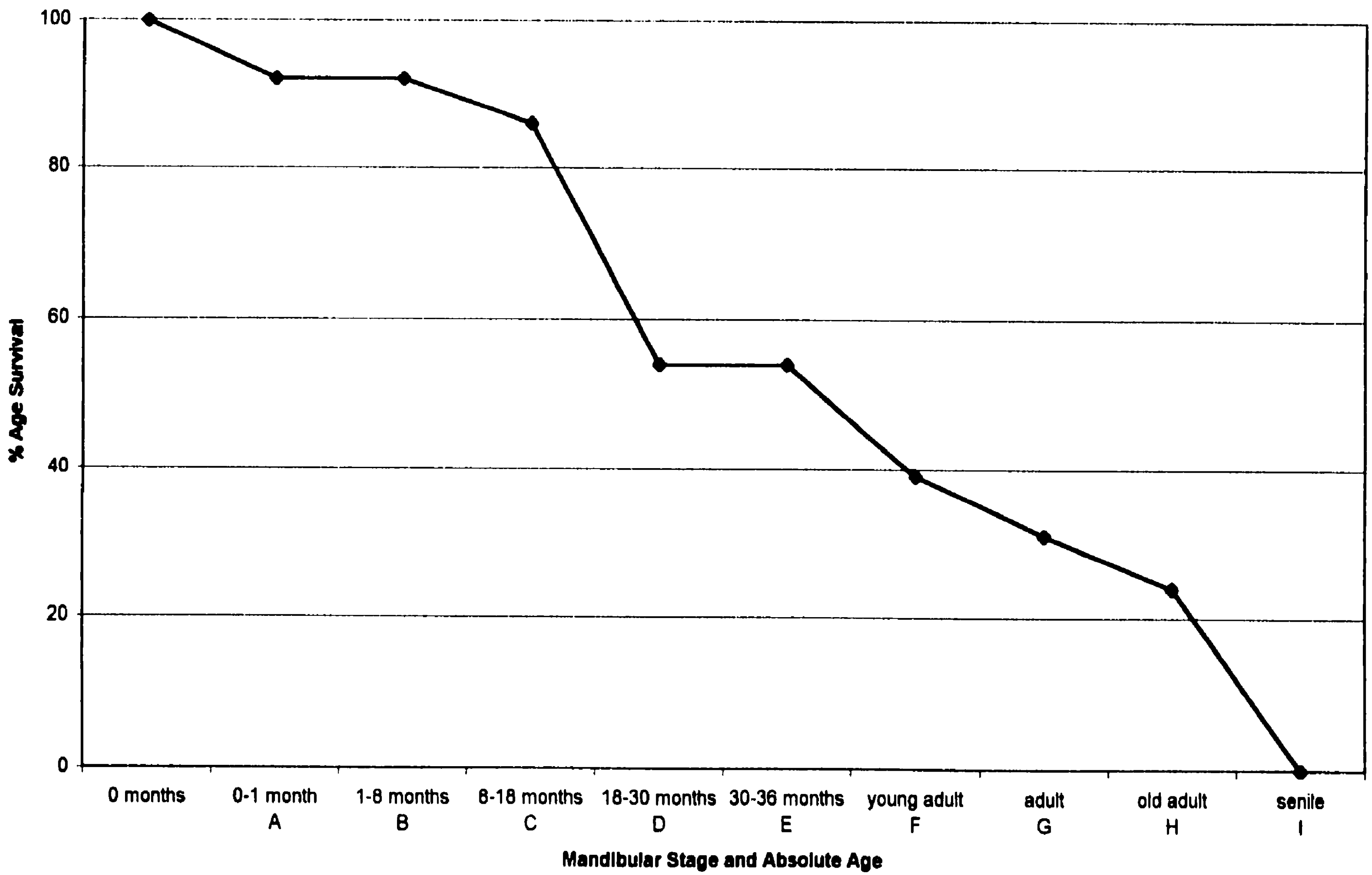


Figure 53. Modern comparative thin sectioning sample (Goat 14 b). The formation of the annulus is indicated by the bright outer increment.

Figure 54. Modern comparative thin sectioning sample. (Sheep #1). Demonstrates the agreement of Growth Line Group with absolute age.

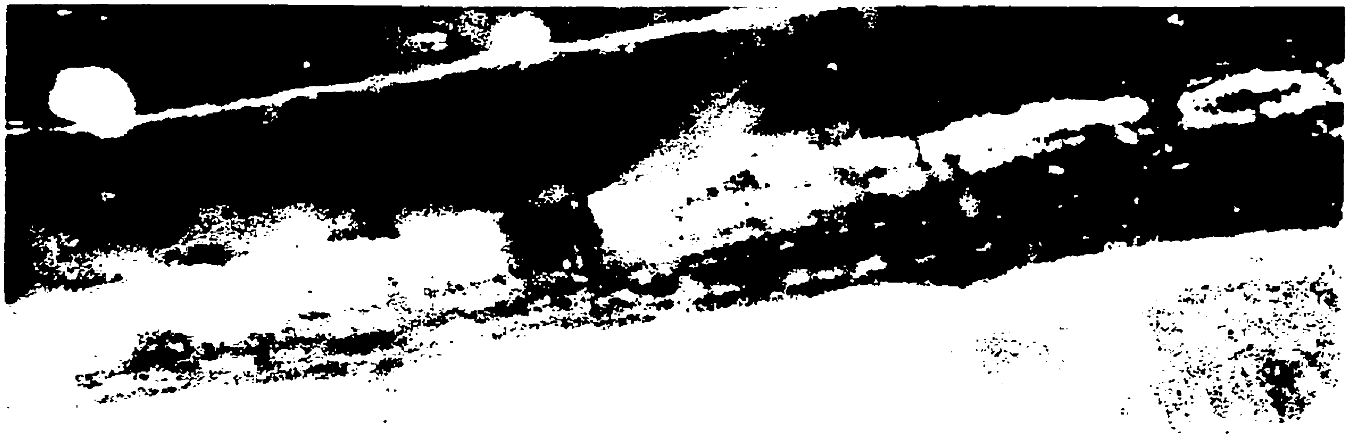


Figure 55. Modern comparative thin sectioning sample. (Goat 13 b). Demonstrates the danger of taking readings at the root. Note the formation of two annuli.

Figure 56. Archaeological thin sectioning sample (Kadica Brdo sample #2).

Figure 57. Archaeological thin sectioning sample (Kadica Brdo sample #4).

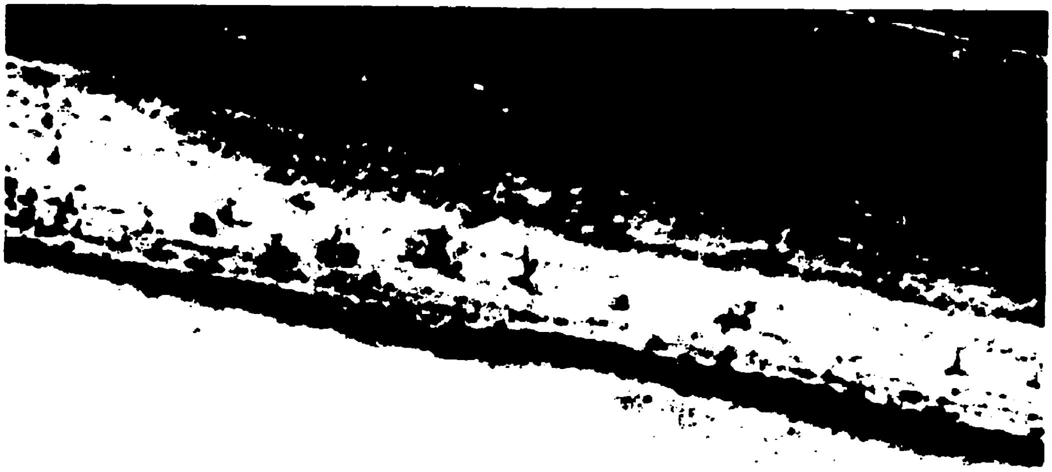


Figure 58. Archaeologial thin sectioning sample (Kadica Brdo sample #6).

Figure 59. Archaeological thin sectioning sample (Kadica Brdo sample #10).

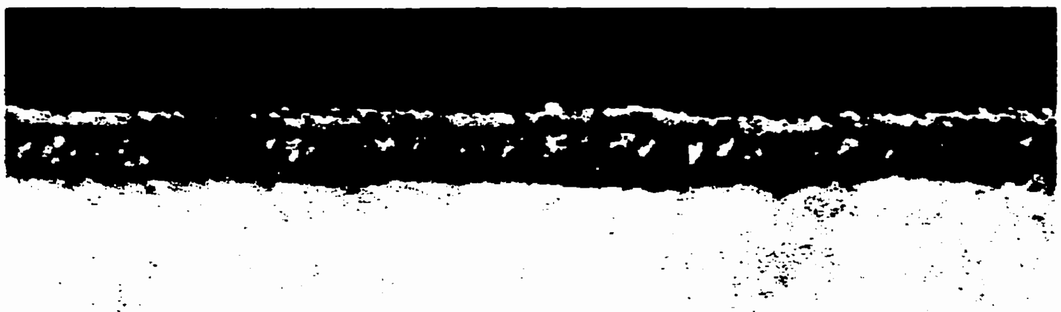


Figure 60. Archaeological thin sectioning sample (Vinča sample #1).

**Figure 61. Archaeological thin sectioning sample (Vinča sample #10).**

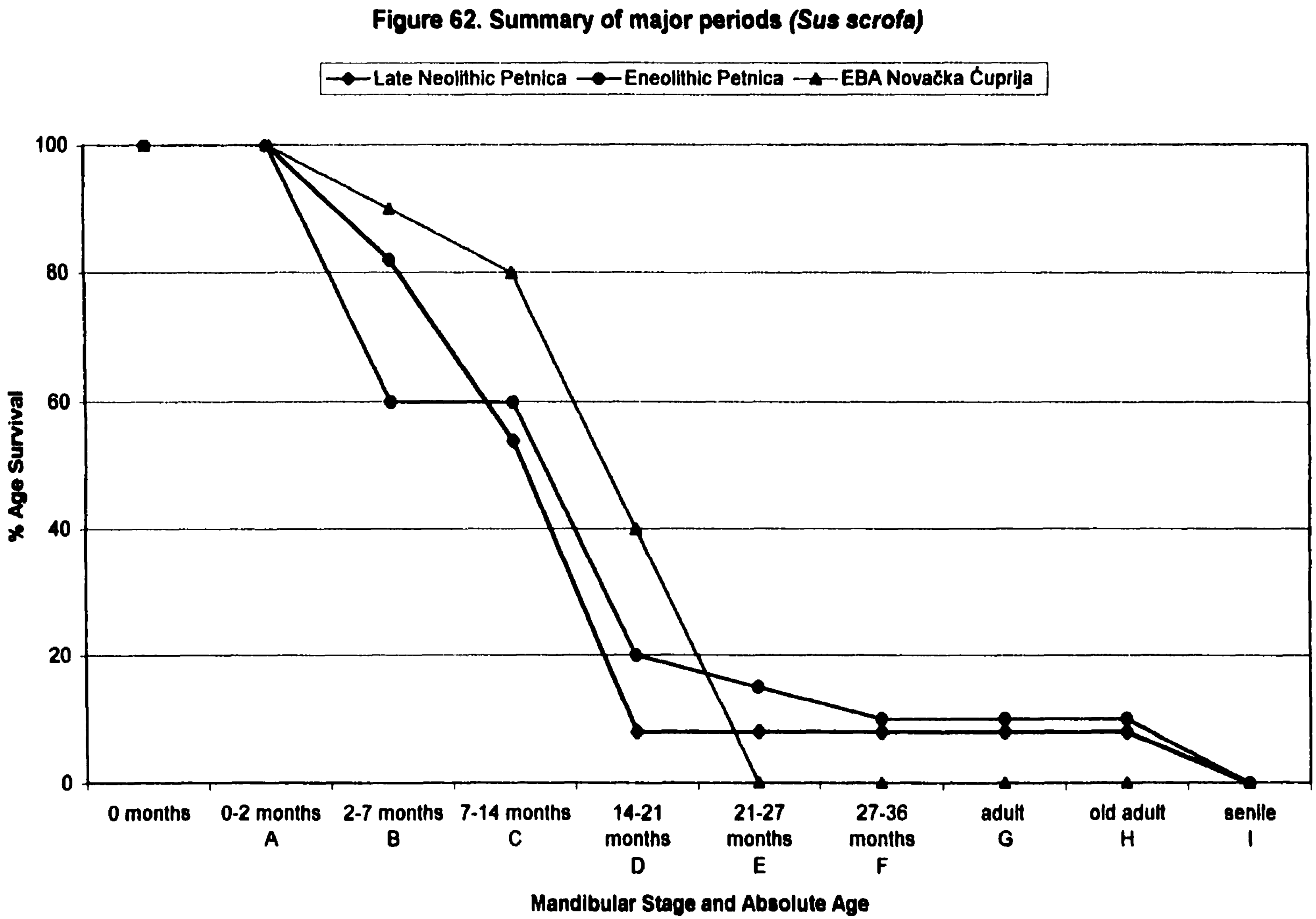


Figure 62. Summary of major periods (Sus scrofa)
Late Neolithic Petnica
Eneolithic Petnica
EBA Novačka Ćuprija
100
80
60
40
20
0
% Age Survival
0 months
0-2 months A
2-7 months B
7-14 months C
14-21 months D
21-27 months E
27-36 months F
adult G
old adult H
senile I
Mandibular Stage and Absolute Age

Figure 63. Summary of major periods *(Ovis/Capra)*

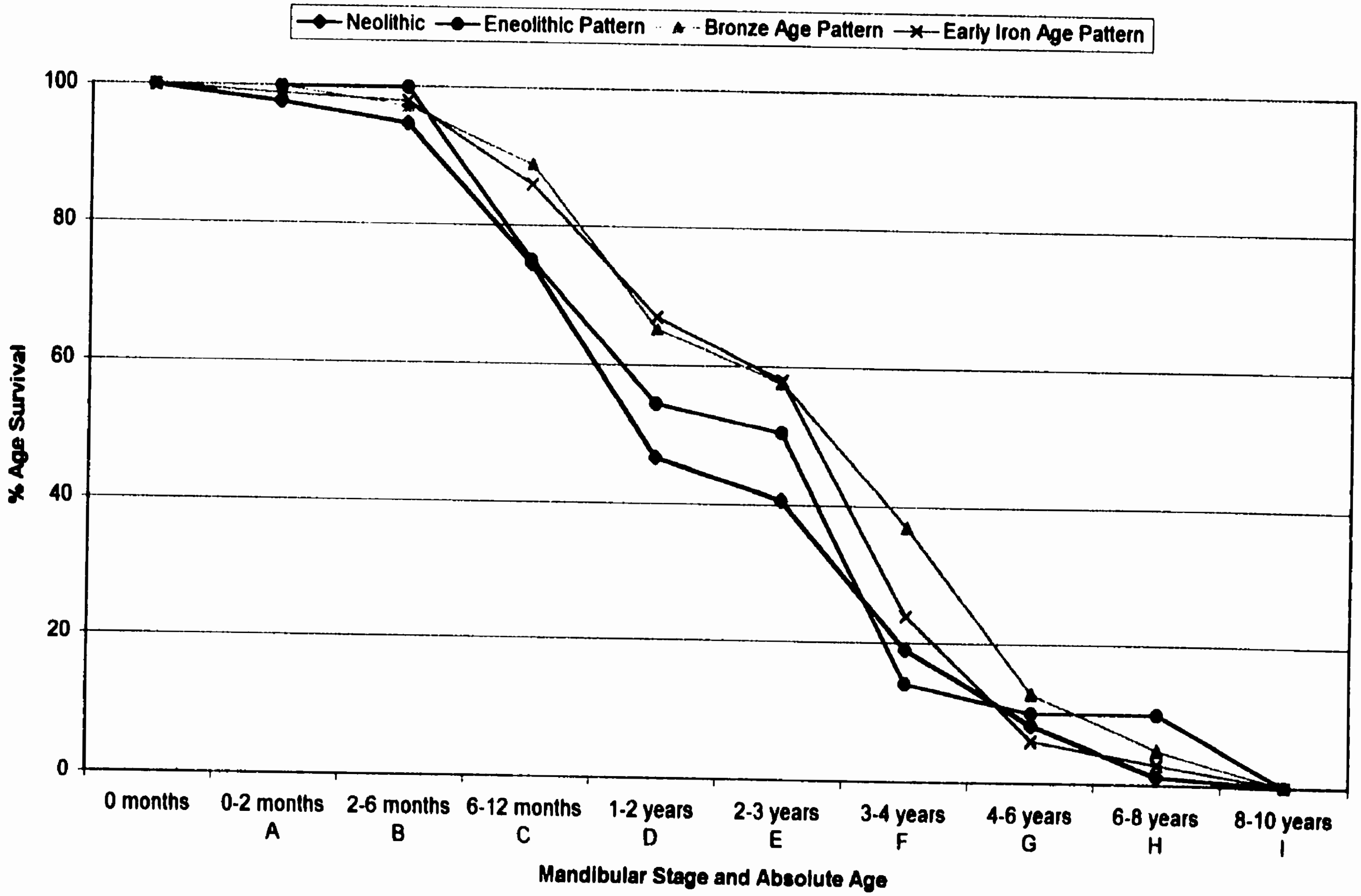


Figure 64. Summary of major periods *(Bos taurus)*

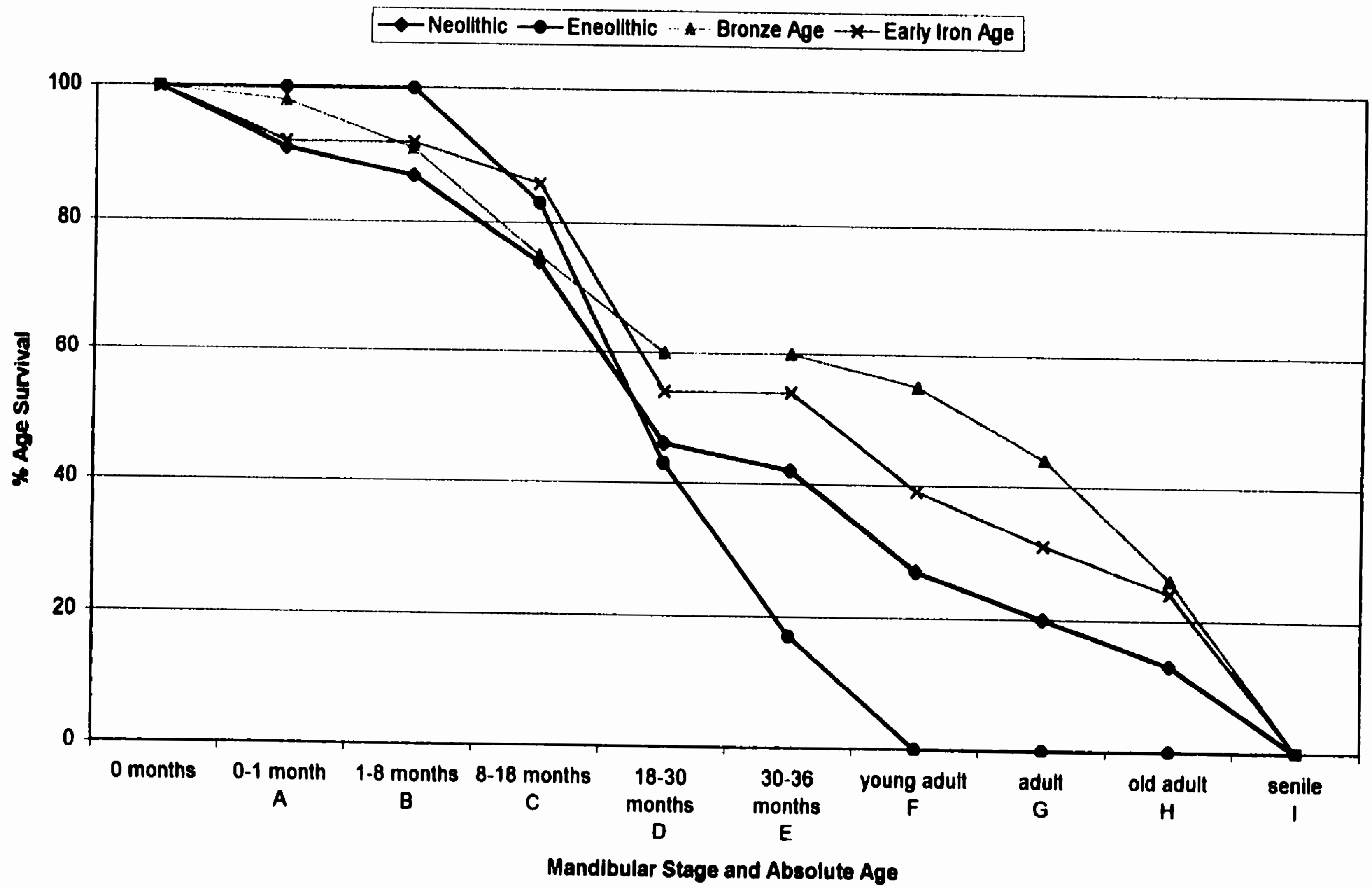


Table 1. Sheep/Goat mandibular wear stages (MWS) and suggested ages

| Payne MWS | Grant MWS | Suggested Age (Payne 1973) |
|---|---|---|
| A | 1-2 | 0-2 months |
| B | 3-7 | 2-6 months |
| C | 8-18 | 6-12 months |
| D | 19-28 | 1-2 years |
| E | 29-33 | 2-3 years |
| F | 34-37 | 3-4 years |
| G | 38-41 | 4-6 years |
| H | 42-44 | 6-8 years |
| I | 45+ | 8-10 years |

Table 2. Cattle mandibular wear stages (MWS) and suggested ages

| Payne MWS | Grant MWS | Suggested Age (Halstead 1985) |
|---|---|---|
| A | 1-3 | 0-1 months |
| B | 4-6 | 1-8 months |
| C | 7-16 | 8-18 months |
| D | 17-30 | 18-30 months |
| E | 31-36 | 30-36 months |
| F | 37-40 | young adult |
| G | 41-43 | adult |
| H | 44-45 | old adult |
| I | 46+ | senile |

Table 3. Pig mandibular wear stages (MWS) and suggested ages

| Payne MWS | Grant MWS | Suggested Age (Higham 1967; Bull and Payne 1982)) |
|---|---|---|
| A | 0-1 | 0-2 months |
| B | 2-8 | 2-7 months |
| C | 9-17 | 7-14 months |
| D | 18-32 | 14-21 months |
| E | 33-42 | 21-27 months |
| F | 43-46 | 27-36 months |
| G-I | 46+ | adult |

Table 4. Greenfield's tooth wear code and Grant's equivalent stages

| Greenfield faunal code | Grant wear stage | Grant wear stage number |
|---|---|---|
| | | |
| 0 | | |
| 1 | | |
| 2 | | |
| 3 | C | 1 |
| 4 | V | 2 |
| 5 | E | 3 |
| 6 | 1/2 | 4 |
| 7 | U | 5 |
| 8 | | |
| 9 | | |
| 10 | a | 6 |
| 11 | b | 7 |
| 12 | c | 8 |
| 13 | d | 9 |
| 14 | e | 10 |
| 15 | f | 11 |
| 16 | g | 12 |
| 17 | h | 13 |
| 18 | i | |
| 19 | j | 14 |
| 20 | k | 15 |
| 21 | l | 16 |
| 22 | m | 17 |
| 23 | n | 18 |
| 24 | o | 19 |
| 25 | p | 20 |

| Table 5. Summary of ageable *Ovis/Capra* remains from Blagotin | | | | |
|---|---|---|---|---|
| Species | Period | No. of Mandibles | No. of Loose Teeth | Total |
| *Ovis aries* | Early Neolithic | 45 | 3 | 48 |
| *Ovis/Capra* | Early Neolithic | 42 | 47 | 89 |
| *Ovis/Capra* | Eneolithic | 0 | 6 | 6 |
| *Ovis/Capra* | Early Iron Age | 4 | 7 | 11 |

Table 6. Stage distribution of *Ovis aries* mandibles and loose teeth from Early Neolithic Blagotin

| Stage | Suggested Age | Raw Count | | Corrected Count | |
|---|---|---|---|---|---|
| | | No. | % | No. | % |
| A | 0-2 months | 6 | 16 | 6 | 12 |
| B | 2-6 months | 3 | 9 | 3 | 7 |
| C | 6-12 months | 19 | 51 | 21.8 | 45 |
| D | 1-2 years | 4 | 11 | 6.4 | 13 |
| E | 2-3 years | 1 | 3 | 1.9 | 5 |
| F | 3-4 years | 2 | 5 | 2.9 | 6 |
| G | 4-6 years | 2 | 5 | 6 | 12 |
| H | 6-8 years | 0 | 0 | 0 | 0 |
| I | 8-10 years | 0 | 0 | 0 | 0 |
| | | 37 | 100 | 48 | 100 |

Table 7. Stage distribution of *Ovis/Capra* mandibles and loose teeth from Early Neolithic Blagotin

| Stage | Suggested Age | Raw Count | | Corrected Count | |
|---|---|---|---|---|---|
| | | No. | % | No. | % |
| A | 0-2 months | 4 | 14 | 4 | 4 |
| B | 2-6 months | 1 | 4 | 1.1 | 1 |
| C | 6-12 months | 10 | 35 | 13.9 | 16 |
| D | 1-2 years | 7 | 25 | 26 | 30 |
| E | 2-3 years | 1 | 4 | 6.6 | 7 |
| F | 3-4 years | 1 | 4 | 11.6 | 13 |
| G | 4-6 years | 1 | 4 | 9 | 10 |
| H | 6-8 years | 3 | 10 | 16.8 | 19 |
| I | 8-10 years | 0 | 0 | 0 | 0 |
| | | 28 | 100 | 89 | 100 |

Table 8. Stage distribution of *Ovis/Capra* mandibles and loose teeth from Eneolithic Blagotin

| Stage | Suggested Age | Raw Count | | Corrected Count | |
|---|---|---|---|---|---|
| | | No. | % | No. | % |
| A | 0-2 months | 0 | 0 | 0 | 0 |
| B | 2-6 months | 0 | 0 | 0 | 0 |
| C | 6-12 months | 2 | 66 | 2 | 33 |
| D | 1-2 years | 0 | 0 | 1 | 17 |
| E | 2-3 years | 0 | 0 | 1 | 17 |
| F | 3-4 years | 1 | 33 | 1 | 17 |
| G | 4-6 years | 0 | 0 | 0.5 | 8 |
| H | 6-8 years | 0 | 0 | 0.5 | 8 |
| I | 8-10 years | 0 | 0 | 0 | 0 |
| | | 3 | 99 | 6 | 100 |

Table 9. Stage distribution of *Ovis/Capra* mandibles and loose teeth from Early Iron Age Blagotin

| Stage | Suggested Age | Raw Count | | Corrected Count | |
|---|---|---|---|---|---|
| | | No. | % | No. | % |
| A | 0-2 months | 0 | 0 | 0 | 0 |
| B | 2-6 months | 0 | 0 | 0 | 0 |
| C | 6-12 months | 1 | 25 | 1.6 | 15 |
| D | 1-2 years | 2 | 50 | 4.4 | 40 |
| E | 2-3 years | 0 | 0 | 0 | 0 |
| F | 3-4 years | 0 | 0 | 0 | 0 |
| G | 4-6 years | 1 | 25 | 5 | 45 |
| H | 6-8 years | 0 | 0 | 0 | 0 |
| I | 8-10 years | 0 | 0 | 0 | 0 |
| | | 4 | 100 | 11 | 100 |

Table 10. Summary of ageable *Bos taurus* remains from Blagotin

| Period | No. of Mandibles | No. of Loose Teeth | Total |
|---|---|---|---|
| Early Neolithic | 38 | 40 | 78 |
| Eneolithic | 3 | 9 | 12 |
| Early Iron Age | 2 | 5 | 7 |

Table 11. Stage distribution of *Bos taurus* mandibles and loose teeth from Early Neolithic Blagotin

| Stage | Suggested Age | Raw Count | | Corrected Count | |
|---|---|---|---|---|---|
| | | No. | % | No. | % |
| A | 0-1 month | 9 | 20 | 9 | 12 |
| B | 1-8 months | 3 | 6 | 3 | 4 |
| C | 8-18 months | 12 | 26 | 12.4 | 16 |
| D | 18-30 months | 15 | 32 | 22.9 | 29 |
| E | 30-36 months | 2 | 4 | 3.9 | 5 |
| F | Young adult | 4 | 8 | 12.8 | 17 |
| G | Adult | 0 | 0 | 0 | 0 |
| H | old adult | 1 | 2 | 7.2 | 9 |
| I | Senile | 1 | 2 | 6.3 | 8 |
| | | 47 | 100 | 77.5 | 100 |

---

Table 12. Stage distribution of *Bos taurus* mandibles and loose teeth from Eneolithic Blagotin

| Stage | Suggested Age | Raw Count | | Corrected Count | |
|---|---|---|---|---|---|
| | | No. | % | No. | % |
| A | 0-1 month | 0 | 0 | 0 | 0 |
| B | 1-8 months | 0 | 0 | 0 | 0 |
| C | 8-18 months | 2 | 25 | 2 | 17 |
| D | 18-30 months | 3 | 38 | 4.8 | 40 |
| E | 30-36 months | 2 | 25 | 3.2 | 26 |
| F | Young adult | 1 | 12 | 2 | 17 |
| G | Adult | 0 | 0 | 0 | 0 |
| H | old adult | 0 | 0 | 0 | 0 |
| I | Senile | 0 | 0 | 0 | 0 |
| | | 8 | 100 | 12 | 100 |

Table 13. Stage distribution of *Bos taurus* mandibles and loose teeth from Early Iron Age Blagotin

| Stage | Suggested Age | Raw Count | | Corrected Count | |
|---|---|---|---|---|---|
| | | No. | % | No. | % |
| A | 0-1 month | 0 | 0 | 0 | 0 |
| B | 1-8 months | 0 | 0 | 0 | 0 |
| C | 8-18 months | 0 | 0 | 0 | 0 |
| D | 18-30 months | 1 | 33 | 2.7 | 39 |
| E | 30-36 months | 0 | 0 | 0 | 0 |
| F | Young adult | 1 | 33 | 1.7 | 24 |
| G | Adult | 0 | 0 | 0 | 0 |
| H | old adult | 1 | 33 | 2.6 | 37 |
| I | Senile | 0 | 0 | 0 | 0 |
| | | 3 | 99 | 7 | 100 |

Table 14. Summary of ageable *Sus scrofa* remains from Blagotin

| Period | No. of Mandibles | No. of Loose Teeth | Total |
|---|---|---|---|
| Early Neolithic | 2 | 0 | 2 |
| Eneolithic | 0 | 0 | 0 |
| Early Iron Age | 1 | 0 | 1 |

**Table 15. Stage distribution of *Sus scrofa* mandibles and loose teeth from Early Neolithic Blagotin**

| Stage | Suggested Age | Raw Count No. | % |
|---|---|---|---|
| A | 0-2 months | 0 | 0 |
| B | 2-7 months | 1 | 50 |
| C | 7-14 months | 0 | 0 |
| D | 14-21 months | 0 | 0 |
| E | 21-27 months | 1 | 50 |
| F | 27-36 months | 0 | 0 |
| G | adult | 0 | 0 |
| H | old adult | 0 | 0 |
| I | senile | 0 | 0 |
| | | 2 | 100 |

Table 16. Summary of ageable *Ovis/Capra* remains from Foeni-Salaş

| Species | Period | No. of Mandibles | No. of Loose Teeth | Total |
|---|---|---|---|---|
| *Ovis aries* | Early Neolithic | 10 | 0 | 10 |
| *Ovis/Capra* | Early Neolithic | 36 | 14 | 50 |
| *Ovis/Capra* | Early Iron Age | 7 | 2 | 9 |
| *Ovis aries* | Early Iron Age | 5 | 0 | 5 |
| *Ovis/Capra* | Middle Bronze Age | 0 | 0 | 0 |

Table 17. Stage distribution of *Ovis aries* mandibles and loose teeth from Early Neolithic Foeni-Salaş

| Stage | Suggested Age | Raw Count No. | % | Corrected Count | % |
|---|---|---|---|---|---|
| A | 0-2 months | 0 | 0 | 0 | 0 |
| B | 2-6 months | 1 | 11 | 1 | 10 |
| C | 6-12 months | 7 | 78 | 7.9 | 80 |
| D | 1-2 years | 1 | 11 | 1.3 | 10 |
| E | 2-3 years | 0 | 0 | 0 | 0 |
| F | 3-4 years | 0 | 0 | 0 | 0 |
| G | 4-6 years | 0 | 0 | 0 | 0 |
| H | 6-8 years | 0 | 0 | 0 | 0 |
| I | 8-10 years | 0 | 0 | 0 | 0 |
| | | 9 | 100 | 10.2 | 100 |

Table 18. Stage distribution of *Ovis aries* mandibles and loose teeth from Early Iron Age Foeni-Salaş

| Stage | Suggested Age | Raw Count No. | % |
|---|---|---|---|
| A | 0-2 months | 0 | 0 |
| B | 2-6 months | 0 | 0 |
| C | 6-12 months | 4 | 80 |
| D | 1-2 years | 1 | 20 |
| E | 2-3 years | 0 | 0 |
| F | 3-4 years | 0 | 0 |
| G | 4-6 years | 0 | 0 |
| H | 6-8 years | 0 | 0 |
| I | 8-10 years | 0 | 0 |
| | | 5 | 100 |

Table 19. Stage distribution of *Ovis/Capra* mandibles and loose teeth from Early Neolithic Foeni-Salaş

| Stage | Suggested Age | Raw Count No. | % | Corrected Count No. | % |
|---|---|---|---|---|---|
| A | 0-2 months | 1 | 4 | 1.5 | 3 |
| B | 2-6 months | 2 | 9 | 2.1 | 4 |
| C | 6-12 months | 12 | 52 | 16.5 | 33 |
| D | 1-2 years | 3 | 13 | 12.6 | 25 |
| E | 2-3 years | 0 | 0 | 0 | 0 |
| F | 3-4 years | 2 | 9 | 6 | 12 |
| G | 4-6 years | 3 | 13 | 11.7 | 23 |
| H | 6-8 years | 0 | 0 | 0 | 0 |
| I | 8-10 years | 0 | 0 | 0 | 0 |
| | | 23 | 100 | 50.4 | 100 |

Table 20. Stage distribution of *Ovis/Capra* mandibles and loose teeth from Early Iron Age Foeni-Salaş

| Stage | Suggested Age | Raw Count No. | % | Corrected Count No. | % |
|---|---|---|---|---|---|
| A | 0-2 months | 0 | 0 | 0 | 0 |
| B | 2-6 months | 0 | 0 | 0 | 0 |
| C | 6-12 months | 4 | 58 | 4 | 44 |
| D | 1-2 years | 1 | 14 | 1 | 11 |
| E | 2-3 years | 0 | 0 | 0 | 0 |
| F | 3-4 years | 0 | 0 | 0 | 0 |
| G | 4-6 years | 1 | 14 | 2.5 | 28 |
| H | 6-8 years | 1 | 14 | 1.5 | 17 |
| I | 8-10 years | 0 | 0 | 0 | 0 |
| | | 7 | 100 | 9 | 100 |

| Table 21. Summary of ageable *Bos taurus* remains from Foeni-Salaş | | | |
|---|---|---|---|
| Period | No. of Mandibles | No. of Loose Teeth | Total |
| Early Neolithic | 10 | 7 | 17 |
| Early Iron Age | 2 | 3 | 5 |
| Middle Bronze Age | 0 | 0 | 0 |

Table 22. Stage distribution of *Bos taurus* mandibles and loose teeth from Early Neolithic Foeni-Salaş

| Stage | Suggested Age | Raw Count | | Corrected Count | |
|---|---|---|---|---|---|
| | | No. | % | No. | % |
| A | 0-1 month | 3 | 25 | 3 | 18 |
| B | 1-8 months | 1 | 8 | 1 | 6 |
| C | 8-18 months | 3 | 25 | 3 | 18 |
| D | 18-30 months | 2 | 17 | 2 | 12 |
| E | 30-36 months | 0 | 0 | 0 | 0 |
| F | young adult | 2 | 17 | 5 | 28 |
| G | adult | 0 | 0 | 0 | 0 |
| H | old adult | 0 | 0 | 0 | 0 |
| I | senile | 1 | 8 | 3 | 18 |
| | | 12 | 100 | 17 | 100 |

Table 23. Stage distribution of *Bos taurus* mandibles from Early Iron Age Foeni-Salaş

| Stage | Suggested Age | Raw Count No. | % |
|---|---|---|---|
| A | 0-1 month | 0 | 0 |
| B | 1-8 months | 0 | 0 |
| C | 8-18 months | 0 | 0 |
| D | 18-30 months | 0 | 0 |
| E | 30-36 months | 3 | 60 |
| F | young adult | 1 | 20 |
| G | adult | 1 | 20 |
| H | old adult | 0 | 0 |
| I | senile | 0 | 0 |
| | | 5 | 100 |

Table 24. Summary of ageable *Sus scrofa* remains from Foeni-Salaş

| Period | No. of Mandibles | No. of Loose Teeth | Total |
|---|---|---|---|
| Early Neolithic | 1 | 1 | 2 |
| Early Iron Age | 0 | 0 | 0 |
| Middle Bronze Age | 1 | 0 | 1 |

Table 25. Summary of ageable *Ovis/Capra* remains from Kadica Brdo

| Species | Period | No. of Mandibles | No. of Loose Teeth | Total |
|---|---|---|---|---|
| *Ovis aries* | Early Iron Age | 39 | 8 | 47 |
| *Ovis/Capra* | Early Iron Age | 111 | 97 | 208 |

Table 26. Stage distribution of *Ovis aries* mandibles and loose teeth from Early Iron Age Kadica Brdo

| Stage | Suggested Age | Raw Count | | Corrected Count | |
|---|---|---|---|---|---|
| | | No. | % | No. | % |
| A | 0-2 months | 4 | 11 | 4 | 8 |
| B | 2-6 months | 5 | 14 | 5 | 10 |
| C | 6-12 months | 20 | 55 | 25.6 | 54 |
| D | 1-2 years | 5 | 14 | 9 | 20 |
| E | 2-3 years | 1 | 3 | 1.4 | 4 |
| F | 3-4 years | 0 | 0 | 0 | 0 |
| G | 4-6 years | 1 | 3 | 2 | 4 |
| H | 6-8 years | 0 | 0 | 0 | 0 |
| I | 8-10 years | 0 | 0 | 0 | 0 |
| | | 36 | 100 | 47 | 100 |

Table 27. Stage distribution of *Capra hircus* mandibles and loose teeth from Early Iron Age Kadica Brdo

| Stage | Suggested Age | Raw Count | | Corrected Count | |
|---|---|---|---|---|---|
| | | No. | % | No. | % |
| A | 0-2 months | 0 | 0 | 0 | 0 |
| B | 2-6 months | 0 | 0 | 0 | 0 |
| C | 6-12 months | 2 | 40 | 2 | 25 |
| D | 1-2 years | 1 | 20 | 1.3 | 16 |
| E | 2-3 years | 0 | 0 | 0 | 0 |
| F | 3-4 years | 1 | 20 | 3.4 | 43 |
| G | 4-6 years | 0 | 0 | 0 | 0 |
| H | 6-8 years | 1 | 20 | 1.3 | 16 |
| I | 8-10 years | 0 | 0 | 0 | 0 |
| | | 5 | 100 | 8 | 100 |

Table 28. Stage distribution of *Ovis/Capra* mandibles and loose teeth from Early Iron Age Kadica Brdo

| Stage | Suggested Age | Raw Count |  | Corrected Count |  |
|---|---|---|---|---|---|
|  |  | No. | % | No. | % |
| A | 0-2 months | 1 | 1 | 1 | 1 |
| B | 2-6 months | 1 | 1 | 1 | 1 |
| C | 6-12 months | 15 | 22 | 25.5 | 12 |
| D | 1-2 years | 10 | 14 | 40.5 | 19 |
| E | 2-3 years | 5 | 7 | 19.2 | 9 |
| F | 3-4 years | 16 | 23 | 69.8 | 34 |
| G | 4-6 years | 17 | 24 | 39.8 | 18 |
| H | 6-8 years | 3 | 4 | 5.6 | 3 |
| I | 8-10 years | 3 | 4 | 5.6 | 3 |
|  |  | 71 | 100 | 208 | 100 |

Table 29. Summary of ageable *Bos taurus* remains from Kadica Brdo

| Period | No. of Mandibles | No. of Loose Teeth | Total |
|---|---|---|---|
| Early Iron Age | 18 | 29 | 47 |

Table 30. Stage distribution of *Bos taurus* mandibles and loose teeth from Early Iron Age Kadica Brdo

| Stage | Suggested Age | Raw Count | | Corrected Count | |
|---|---|---|---|---|---|
| | | No. | % | No. | % |
| A | 0-1 month | 4 | 16 | 4 | 8 |
| B | 1-8 months | 0 | 0 | 0 | 0 |
| C | 8-18 months | 3 | 12 | 3 | 6 |
| D | 18-30 months | 8 | 32 | 14.5 | 32 |
| E | 30-36 months | 0 | 0 | 0 | 0 |
| F | Young adult | 2 | 8 | 7.1 | 15 |
| G | Adult | 1 | 4 | 3.8 | 8 |
| H | old adult | 1 | 4 | 3.3 | 7 |
| I | Senile | 6 | 24 | 11.2 | 24 |
| | | 25 | 100 | 46.9 | 100 |

Table 31. Summary of ageable *Sus scrofa* remains from Kadica Brdo

| Period | No. of Mandibles | No. of Loose Teeth | Total |
|---|---|---|---|
| Early Iron Age | 42 | 7 | 49 |

**Table 32. Stage distribution of *Sus scrofa* mandibles and loose teeth from Early Iron Age Kadica Brdo**

| Stage | Suggested Age | Raw Count | | Corrected Count | |
|---|---|---|---|---|---|
| | | No. | % | No. | % |
| A | 0-2 months | 2 | 6 | 2 | 4 |
| B | 2-7 months | 11 | 36 | 11.7 | 25 |
| C | 7-14 months | 4 | 13 | 10 | 20 |
| D | 14-21 months | 7 | 23 | 17.7 | 36 |
| E | 21-27 months | 6 | 19 | 6.5 | 13 |
| F | 27-36 months | 0 | 0 | 0 | 0 |
| G | adult | 0 | 0 | 0 | 0 |
| H | old adult | 0 | 0 | 0 | 0 |
| I | senile | 1 | 3 | 1 | 2 |
| | | 31 | 100 | 48.9 | 100 |

| Table 33. Summary of ageable *Ovis/Capra* remains from Livade | | | |
|---|---|---|---|
| Period | No. of Mandibles | No. of Loose Teeth | Total |
| Late Bronze Age | 11 | 0 | 11 |

Table 34. Stage distribution of *Ovis/Capra* mandibles from Late Bronze Age Livade

| Stage | Suggested Age | Raw Count | | Corrected Count | |
|---|---|---|---|---|---|
| | | No. | % | No. | % |
| A | 0-2 months | 0 | 0 | 0 | 0 |
| B | 2-6 months | 0 | 0 | 0 | 0 |
| C | 6-12 months | 0 | 0 | 0 | 0 |
| D | 1-2 years | 1 | 12 | 1 | 9 |
| E | 2-3 years | 0 | 0 | 0 | 0 |
| F | 3-4 years | 2 | 25 | 2.8 | 25 |
| G | 4-6 years | 3 | 38 | 5.01 | 46 |
| H | 6-8 years | 2 | 25 | 2.19 | 20 |
| I | 8-10 years | 0 | 0 | 0 | 0 |
| | | 8 | 100 | 11 | 100 |

Table 35. Summary of ageable *Bos taurus* remains from Livade

| Period | No. of Mandibles | No. of Loose Teeth | Total |
|---|---|---|---|
| Late Bronze Age | 10 | 6 | 16 |

Table 36. Stage distribution of *Bos taurus* mandibles from Late Bronze Age levels of Livade

| Stage | Suggested Age | Raw Count | | Corrected Count | |
|---|---|---|---|---|---|
| | | No. | % | No. | % |
| A | 0-1 month | 0 | 0 | 0 | 0 |
| B | 1-8 months | 0 | 0 | 0 | 0 |
| C | 8-18 months | 1 | 20 | 1 | 6 |
| D | 18-30 months | 1 | 20 | 3.86 | 24 |
| E | 30-36 months | 0 | 0 | 0 | 0 |
| F | Young adult | 0 | 0 | 1.3 | 8 |
| G | Adult | 0 | 0 | 1.58 | 10 |
| H | Old adult | 1 | 20 | 3.19 | 21 |
| I | Senile | 2 | 40 | 5.01 | 31 |
| | | 5 | 100 | 15.94 | 100 |

Table 37. Summary of ageable *Sus scrofa* remains from Livade

| Period | No. of Mandibles | No. of Loose Teeth | Total |
|---|---|---|---|
| Late Bronze Age | 26 | 1 | 27 |

Table 38. Stage distribution of *Sus scrofa* mandibles and loose teeth from Late Bronze Age Livade

| Stage | Suggested Age | Raw Count | | Corrected Count | |
|---|---|---|---|---|---|
| | | No. | % | No. | % |
| A | 0-2 months | 0 | 0 | 0 | 0 |
| B | 2-7 months | 1 | 6 | 2 | 8 |
| C | 7-14 months | 2 | 10 | 4 | 15 |
| D | 14-21 months | 7 | 39 | 9.5 | 35 |
| E | 21-27 months | 7 | 39 | 10.38 | 38 |
| F | 27-36 months | 1 | 6 | 1.12 | 4 |
| G | Adult | 0 | 0 | 0 | 0 |
| H | Old adult | 0 | 0 | 0 | 0 |
| I | Senile | 0 | 0 | 0 | 0 |
| | | 18 | 100 | 27 | 100 |

Table 39. Summary of ageable *Ovis/Capra* remains from Ljuljaci

| Period | No. of Mandibles | No. of Loose Teeth | Total |
|---|---|---|---|
| Early Bronze Age | 2 | 1 | 3 |
| Early /Middle Bronze Age | 8 | 1 | 9 |
| Middle Bronze Age | 1 | 0 | 1 |

Table 40. Stage distribution of *Ovis/Capra* mandibles and loose teeth from Early Bronze Age Ljuljaci

| Stage | Suggested Age | Raw Count | | Corrected Count | |
|---|---|---|---|---|---|
| | | No. | % | No. | % |
| A | 0-2 months | 0 | 0 | 0 | 0 |
| B | 2-6 months | 0 | 0 | 0 | 0 |
| C | 6-12 months | 1 | 50 | 1 | 33 |
| D | 1-2 years | 1 | 50 | 1 | 33 |
| E | 2-3 years | 0 | 0 | 0 | 0 |
| F | 3-4 years | 0 | 0 | 0 | 0 |
| G | 4-6 years | 0 | 0 | 0.5 | 17 |
| H | 6-8 years | 0 | 0 | 0.5 | 17 |
| I | 8-10 years | 0 | 0 | 0 | 0 |
| | | 2 | 100 | 3 | 100 |

Table 41. Stage distribution of *Ovis/Capra* mandibles and loose teeth from Early/Middle Bronze Age Ljuljaci

| Stage | Suggested Age | Raw Count | | Corrected Count | |
|---|---|---|---|---|---|
| | | No. | % | No. | % |
| A | 0-2 months | 0 | 0 | 0 | 0 |
| B | 2-6 months | 0 | 0 | 0 | 0 |
| C | 6-12 months | 1 | 25 | 1 | 11 |
| D | 1-2 years | 0 | 0 | 0 | 0 |
| E | 2-3 years | 0 | 0 | 0 | 0 |
| F | 3-4 years | 3 | 75 | 5 | 55 |
| G | 4-6 years | 0 | 0 | 1 | 11 |
| H | 6-8 years | 0 | 0 | 1.5 | 17 |
| I | 8-10 years | 0 | 0 | 0.5 | 6 |
| | | 4 | 100 | 9 | 100 |

Table 42. Stage distribution of *Ovis/Capra* mandibles and loose teeth from Middle Bronze Age Ljuljaci

| Stage | Suggested Age | Raw Count No. | % |
|---|---|---|---|
| A | 0-2 months | 0 | 0 |
| B | 2-6 months | 0 | 0 |
| C | 6-12 months | 0 | 0 |
| D | 1-2 years | 0 | 0 |
| E | 2-3 years | 1 | 100 |
| F | 3-4 years | 0 | 0 |
| G | 4-6 years | 0 | 0 |
| H | 6-8 years | 0 | 0 |
| I | 8-10 years | 0 | 0 |
| | | 1 | 100 |

Table 43. Summary of ageable *Bos taurus* remains from Ljuljaci

| Period | No. of Mandibles | No. of Loose Teeth | Total |
|---|---|---|---|
| Early Bronze Age | 2 | 0 | 2 |
| Early /Middle Bronze Age | 5 | 7 | 12 |
| Middle Bronze Age | 1 | 0 | 1 |

Table 44. Stage distribution of *Bos taurus* mandibles and loose teeth from Early Bronze Age Ljuljaci

| Stage | Suggested Age | Raw Count | | Corrected Count | |
|---|---|---|---|---|---|
| | | No. | % | No. | % |
| A | 0-1 month | 0 | 0 | 0 | 0 |
| B | 1-8 months | 1 | 100 | 1 | 52 |
| C | 8-18 months | 0 | 0 | 0 | 0 |
| D | 18-30 months | 0 | 0 | 0 | 0 |
| E | 30-36 months | 0 | 0 | 0 | 0 |
| F | Young adult | 0 | 0 | 0 | 0 |
| G | Adult | 0 | 0 | 0.3 | 16 |
| H | Old adult | 0 | 0 | 0.3 | 16 |
| I | Senile | 0 | 0 | 0.3 | 16 |
| | | 1 | 100 | 1.9 | 100 |

Table 45. Stage distribution of *Bos taurus* mandibles from Early/ Middle Bronze Age Ljuljaci

| Stage | Suggested Age | Raw Count | | Corrected Count | |
|---|---|---|---|---|---|
| | | No. | % | No. | % |
| A | 0-1 month | 0 | 0 | 0 | 0 |
| B | 1-8 months | 2 | 28 | 2 | 16 |
| C | 8-18 months | 2 | 28 | 2 | 16 |
| D | 18-30 months | 2 | 28 | 2 | 16 |
| E | 30-36 months | 0 | 0 | 0 | 0 |
| F | Young adult | 0 | 0 | 0.9 | 7 |
| G | Adult | 0 | 0 | 2.6 | 22 |
| H | Old adult | 0 | 0 | 0 | 0 |
| I | Senile | 1 | 15 | 2.9 | 23 |
| | | 7 | 99 | 12.4 | 100 |

| Table 46. Summary of ageable *Sus scrofa* remains from Ljuljaci | | | |
|---|---|---|---|
| Period | No. of Mandibles | No. of Loose Teeth | Total |
| Early Bronze Age | 4 | 1 | 5 |
| Early /Middle Bronze Age | 18 | 2 | 20 |
| Middle Bronze Age | 5 | 1 | 6 |

Table 47. Stage distribution of *Sus scrofa* mandibles and loose teeth from Early Bronze Age Ljuljaci

| Stage | Suggested Age | Raw Count | | Corrected Count | |
|---|---|---|---|---|---|
| | | No. | % | No. | % |
| A | 0-2 months | 0 | 0 | 0 | 0 |
| B | 2-7 months | 0 | 0 | 0 | 0 |
| C | 7-14 months | 1 | 50 | 1 | 20 |
| D | 14-21 months | 1 | 50 | 2 | 40 |
| E | 21-27 months | 0 | 0 | 0 | 0 |
| F | 27-36 months | 0 | 0 | 0 | 0 |
| G | Adult | 0 | 0 | 0.7 | 13 |
| H | Old adult | 0 | 0 | 0.7 | 13 |
| I | Senile | 0 | 0 | 0.7 | 13 |
| | | 2 | 100 | 5.1 | 99 |

Table 48. Stage distribution of *Sus scrofa* mandibles and loose teeth from Early/Middle Bronze Age Ljuljaci

| Stage | Suggested Age | Raw Count | | Corrected Count | |
|---|---|---|---|---|---|
| | | No. | % | No. | % |
| A | 0-2 months | 0 | 0 | 0 | 0 |
| B | 2-7 months | 1 | 8 | 1 | 5 |
| C | 7-14 months | 1 | 8 | 1.2 | 6 |
| D | 14-21 months | 5 | 38 | 7.3 | 37 |
| E | 21-27 months | 5 | 38 | 9 | 45 |
| F | 27-36 months | 1 | 8 | 1.5 | 7 |
| G | Adult | 0 | 0 | 0 | 0 |
| H | Old adult | 0 | 0 | 0 | 0 |
| I | Senile | 0 | 0 | 0 | 0 |
| | | 13 | 100 | 20 | 100 |

Table 49. Stage distribution of *Sus scrofa* mandibles and loose teeth from Middle Bronze Age Ljuljaci

| Stage | Suggested Age | Raw Count | | Corrected Count | |
|---|---|---|---|---|---|
| | | No. | % | No. | % |
| A | 0-2 months | 0 | 0 | 0 | 0 |
| B | 2-7 months | 0 | 0 | 0 | 0 |
| C | 7-14 months | 1 | 33 | 1 | 16 |
| D | 14-21 months | 1 | 33 | 2.5 | 42 |
| E | 21-27 months | 1 | 33 | 2.5 | 42 |
| F | 27-36 months | 0 | 0 | 0 | 0 |
| G | Adult | 0 | 0 | 0 | 0 |
| H | Old adult | 0 | 0 | 0 | 0 |
| I | Senile | 0 | 0 | 0 | 0 |
| | | 3 | 99 | 6 | 100 |

Table 50. Stage distribution of *Ovis aries* mandibles and loose teeth from Late Neolithic/Final Neolithic Megilo Nisi Galanis

| Stage | Suggested Age | Raw Count | | Corrected Count | |
|---|---|---|---|---|---|
| | | No. | % | No. | % |
| A | 0-2 months | 0 | 0 | 0 | 0 |
| B | 2-6 months | 0 | 0 | 0 | 0 |
| C | 6-12 months | 1 | 100 | 2 | 66 |
| D | 1-2 years | 0 | 0 | 0.5 | 17 |
| E | 2-3 years | 0 | 0 | 0.5 | 17 |
| F | 3-4 years | 0 | 0 | 0 | 0 |
| G | 4-6 years | 0 | 0 | 0 | 0 |
| H | 6-8 years | 0 | 0 | 0 | 0 |
| I | 8-10 years | 0 | 0 | 0 | 0 |
| | | 1 | 100 | 3 | 100 |

Table 51. Stage distribution of *Ovis aries* mandibles and loose teeth from Final Neolithic Megilo Nisi Galanis

| Stage | Suggested Age | Raw Count | | Corrected Count | |
|---|---|---|---|---|---|
| | | No. | % | No. | % |
| A | 0-2 months | 1 | 33 | 1 | 20 |
| B | 2-6 months | 0 | 0 | 0 | 0 |
| C | 6-12 months | 2 | 67 | 4 | 80 |
| D | 1-2 years | 0 | 0 | 0 | 0 |
| E | 2-3 years | 0 | 0 | 0 | 0 |
| F | 3-4 years | 0 | 0 | 0 | 0 |
| G | 4-6 years | 0 | 0 | 0 | 0 |
| H | 6-8 years | 0 | 0 | 0 | 0 |
| I | 8-10 years | 0 | 0 | 0 | 0 |
| | | 3 | 100 | 5 | 100 |

Table 52. Stage distribution of *Ovis aries* mandibles and loose teeth from Final Neolithic/Early Bronze Age Megilo Nisi Galanis

| Stage | Suggested Age | Raw Count No. | % |
|---|---|---|---|
| A | 0-2 months | 0 | 0 |
| B | 2-6 months | 1 | 20 |
| C | 6-12 months | 2 | 40 |
| D | 1-2 years | 2 | 40 |
| E | 2-3 years | 0 | 0 |
| F | 3-4 years | 0 | 0 |
| G | 4-6 years | 0 | 0 |
| H | 6-8 years | 0 | 0 |
| I | 8-10 years | 0 | 0 |
| | | 5 | 100 |

Table 53. Summary of ageable *Ovis/Capra* remains from Megilo Nisi Galanis

| Period | No. of Mandibles | No. of Loose Teeth | Total |
|---|---|---|---|
| Late Neolithic/Final Neolithic | 9 | 0 | 9 |
| Final Neolithic | 12 | 32 | 44 |
| Final Neolithic/Early Bronze Age | 4 | 9 | 13 |

Table 54. Stage distribution of *Ovis/Capra* mandibles and loose teeth from Late Neolithic/Final Neolithic Megilo Nisi Galanis

| Stage | Suggested Age | Raw Count | | Corrected Count | |
|---|---|---|---|---|---|
| | | No. | % | No. | % |
| A | 0-2 months | 0 | 0 | 0 | 0 |
| B | 2-6 months | 0 | 0 | 0 | 0 |
| C | 6-12 months | 2 | 100 | 3 | 33 |
| D | 1-2 years | 0 | 0 | 0.5 | 6 |
| E | 2-3 years | 0 | 0 | 1 | 11 |
| F | 3-4 years | 0 | 0 | 1.9 | 21 |
| G | 4-6 years | 0 | 0 | 1.3 | 15 |
| H | 6-8 years | 0 | 0 | 0.6 | 7 |
| I | 8-10 years | 0 | 0 | 0.6 | 7 |
| | | 2 | 100 | 8.9 | 100 |

Table 55. Stage distribution of *Ovis/Capra* mandibles and loose teeth from Final Neolithic Megilo Nisi Galanis

| Stage | Suggested Age | Raw Count | | Corrected Count | |
|---|---|---|---|---|---|
| | | No. | % | No. | % |
| A | 0-2 months | 1 | 8 | 1 | 2 |
| B | 2-6 months | 0 | 0 | 0 | 0 |
| C | 6-12 months | 5 | 38 | 8.8 | 21 |
| D | 1-2 years | 3 | 23 | 11.7 | 26 |
| E | 2-3 years | 2 | 15 | 8.6 | 20 |
| F | 3-4 years | 1 | 8 | 5.8 | 13 |
| G | 4-6 years | 1 | 8 | 8.1 | 18 |
| H | 6-8 years | 0 | 0 | 0 | 0 |
| I | 8-10 years | 0 | 0 | 0 | 0 |
| | | 13 | 100 | 44 | 100 |

Table 56. Stage distribution of *Ovis/Capra* mandibles and loose teeth from Final Neolithic/Early Bronze Age Megilo Nisi Galanis

| Stage | Suggested Age | Raw Count | | Corrected Count | |
|---|---|---|---|---|---|
| | | No. | % | No. | % |
| A | 0-2 months | 0 | 0 | 0 | 0 |
| B | 2-6 months | 1 | 17 | 1 | 8 |
| C | 6-12 months | 2 | 33 | 2 | 15 |
| D | 1-2 years | 3 | 50 | 4.7 | 35 |
| E | 2-3 years | 0 | 0 | 0.6 | 5 |
| F | 3-4 years | 0 | 0 | 1.2 | 9 |
| G | 4-6 years | 0 | 0 | 1 | 8 |
| H | 6-8 years | 0 | 0 | 1.5 | 12 |
| I | 8-10 years | 0 | 0 | 1 | 8 |
| | | 6 | 100 | 13 | 100 |

Table 57. Summary of ageable *Bos taurus* remains from Megilo Nisi Galanis

| Period | No. of Mandibles | No. of Loose Teeth | Total |
|---|---|---|---|
| Late Neolithic/Final Neolithic | 0 | 0 | 0 |
| Final Neolithic | 2 | 6 | 8 |
| Final Neolithic/Early Bronze Age | 0 | 0 | 0 |

Table 58. Stage distribution of *Bos taurus* mandibles and loose teeth from Final Neolithic Megilo Nisi Galanis

| Stage | Suggested Age | Raw Count | | Corrected Count | |
|---|---|---|---|---|---|
| | | No. | % | No. | % |
| A | 0-1 month | 0 | 0 | 0 | 0 |
| B | 1-8 months | 0 | 0 | 0 | 0 |
| C | 8-18 months | 0 | 0 | 0 | 0 |
| D | 18-30 months | 4 | 80 | 7 | 88 |
| E | 30-36 months | 0 | 0 | 0 | 0 |
| F | Young adult | 0 | 0 | 0 | 0 |
| G | Adult | 0 | 0 | 0 | 0 |
| H | old adult | 0 | 0 | 0 | 0 |
| I | Senile | 1 | 20 | 1 | 12 |
| | | 5 | 100 | 8 | 100 |

Table 59. Summary of ageable *Sus scrofa* remains from Megilo Nisi Galanis

| Period | No. of Mandibles | No. of Loose Teeth | Total |
|---|---|---|---|
| Late Neolithic/Final Neolithic | 1 | 0 | 1 |
| Final Neolithic | 4 | 2 | 6 |
| Final Neolithic/Early Bronze Age | 0 | 0 | 0 |

Table 60. Stage distribution of *Sus scrofa* mandibles and loose teeth from Final Neolithic Megilo Nisi Galanis

| Stage | Suggested Age | Raw Count | | Corrected Count | |
|---|---|---|---|---|---|
| | | No. | % | No. | % |
| A | 0-2 months | 0 | 0 | 0 | 0 |
| B | 2-7 months | 2 | 50 | 2 | 33 |
| C | 7-14 months | 0 | 0 | 0 | 0 |
| D | 14-21 months | 2 | 50 | 4 | 66 |
| E | 21-27 months | 0 | 0 | 0 | 0 |
| F | 27-36 months | 0 | 0 | 0 | 0 |
| G | Adult | 0 | 0 | 0 | 0 |
| H | Old adult | 0 | 0 | 0 | 0 |
| I | Senile | 0 | 0 | 0 | 0 |
| | | 4 | 100 | 6 | 99 |

Table 61. Summary of ageable *Ovis/Capra* remains from Novačka Ćuprija

| Period | No. of Mandibles | No. of Loose Teeth | Total |
|---|---|---|---|
| Eneolithic | 0 | 10 | 10 |
| Early Bronze Age | 8 | 24 | 32 |
| Late Bronze Age | 3 | 13 | 16 |

Table 62. Stage distribution of *Ovis/Capra* mandibles and loose teeth from Eneolithic Novačka Ćuprija

| Stage | Suggested Age | Raw Count | | Corrected Count | |
|---|---|---|---|---|---|
| | | No. | % | No. | % |
| A | 0-2 months | 0 | 0 | 0 | 0 |
| B | 2-6 months | 0 | 0 | 0 | 0 |
| C | 6-12 months | 0 | 0 | 0 | 0 |
| D | 1-2 years | 1 | 20 | 1.5 | 15 |
| E | 2-3 years | 0 | 0 | 0 | 0 |
| F | 3-4 years | 3 | 60 | 6.5 | 65 |
| G | 4-6 years | 0 | 0 | 0 | 0 |
| H | 6-8 years | 0 | 0 | 0 | 0 |
| I | 8-10 years | 1 | 20 | 2 | 20 |
| | | 5 | 100 | 10 | 100 |

Table 63. Stage distribution of *Ovis/Capra* mandibles and loose teeth from Early Bronze Age Novačka Ćuprija

| Stage | Suggested Age | Raw Count | | Corrected Count | |
|---|---|---|---|---|---|
| | | No. | % | No. | % |
| A | 0-2 months | 0 | 0 | 0 | 0 |
| B | 2-6 months | 1 | 6 | 1.5 | 5 |
| C | 6-12 months | 1 | 6 | 1.5 | 5 |
| D | 1-2 years | 8 | 46 | 10.9 | 34 |
| E | 2-3 years | 1 | 6 | 1.7 | 5 |
| F | 3-4 years | 3 | 18 | 5 | 16 |
| G | 4-6 years | 1 | 6 | 7.8 | 24 |
| H | 6-8 years | 0 | 0 | 0 | 0 |
| I | 8-10 years | 2 | 12 | 3.6 | 11 |
| | | 17 | 100 | 32 | 100 |

Table 64. Stage distribution of *Ovis/Capra* mandibles and loose teeth from Late Bronze Age Novačka Ćuprija

| Stage | Suggested Age | Raw Count | | Corrected Count | |
|---|---|---|---|---|---|
| | | No. | % | No. | % |
| A | 0-2 months | 0 | 0 | 0 | 0 |
| B | 2-6 months | 0 | 0 | 0 | 0 |
| C | 6-12 months | 1 | 25 | 1 | 6 |
| D | 1-2 years | 1 | 25 | 1.6 | 10 |
| E | 2-3 years | 1 | 25 | 3.6 | 23 |
| F | 3-4 years | 1 | 25 | 3.6 | 23 |
| G | 4-6 years | 0 | 0 | 4.5 | 28 |
| H | 6-8 years | 0 | 0 | 1.6 | 10 |
| I | 8-10 years | 0 | 0 | 0 | 0 |
| | | 4 | 100 | 15.9 | 100 |

Table 65. Summary of ageable *Bos taurus* remains from Novačka Ćuprija

| Period | No. of Mandibles | No. of Loose Teeth | Total |
|---|---|---|---|
| Eneolithic | 2 | 0 | 2 |
| Early Bronze Age | 2 | 4 | 6 |
| Late Bronze Age | 1 | 3 | 4 |

Table 66. Stage distribution of *Bos taurus* mandibles and loose teeth from Eneolithic Novačka Ćuprija

| Stage | Suggested Age | Raw Count | |
|---|---|---|---|
| | | No. | % |
| A | 0-1 month | 0 | 0 |
| B | 1-8 months | 0 | 0 |
| C | 8-18 months | 0 | 0 |
| D | 18-30 months | 0 | 0 |
| E | 30-36 months | 1 | 50 |
| F | young adult | 0 | 0 |
| G | adult | 0 | 0 |
| H | old adult | 0 | 0 |
| I | senile | 1 | 50 |
| | | 2 | 100 |

Table 67. Stage distribution of *Bos taurus* mandibles and loose teeth from Early Bronze Age Novačka Ćuprija

| Stage | Suggested Age | Raw Count | | Corrected Count | |
|---|---|---|---|---|---|
| | | No. | % | No. | % |
| A | 0-1 month | 0 | 0 | 0 | 0 |
| B | 1-8 months | 0 | 0 | 0 | 0 |
| C | 8-18 months | 0 | 0 | 0 | 0 |
| D | 18-30 months | 2 | 66 | 2 | 40 |
| E | 30-36 months | 0 | 0 | 0 | 0 |
| F | Young adult | 0 | 0 | 0 | 0 |
| G | Adult | 0 | 0 | 0 | 0 |
| H | Old adult | 0 | 0 | 0 | 0 |
| I | Senile | 1 | 33 | 4 | 60 |
| | | 3 | 99 | 6 | 100 |

Table 68. Stage distribution of *Bos taurus* mandibles and loose teeth from Late Bronze Age Novačka Ćuprija.

| Stage | Suggested Age | Raw Count No. | Raw Count % | Corrected Count No. | Corrected Count % |
|---|---|---|---|---|---|
| A | 0-1 month | 0 | 0 | 0 | 0 |
| B | 1-8 months | 0 | 0 | 0 | 0 |
| C | 8-18 months | 0 | 0 | 0 | 0 |
| D | 18-30 months | 0 | 0 | 0 | 0 |
| E | 30-36 months | 0 | 0 | 0 | 0 |
| F | Young adult | 0 | 0 | 0 | 0 |
| G | Adult | 0 | 0 | 0 | 0 |
| H | Old adult | 0 | 0 | 0 | 0 |
| I | Senile | 3 | 100 | 4 | 100 |
| | | 3 | 100 | 4 | 100 |

Table 69. Summary of ageable *Sus scrofa* remains from Novačka Ćuprija

| Period | No. of Mandibles | No. of Loose Teeth | Total |
|---|---|---|---|
| Eneolithic | 4 | 4 | 8 |
| Early Bronze Age | 6 | 4 | 10 |
| Late Bronze Age | 2 | 1 | 3 |

Table 70. Stage distribution of *Sus scrofa* mandibles and loose teeth from Eneolithic Novačka Ćuprija

| Stage | Suggested Age | Raw Count | | Corrected Count | |
|---|---|---|---|---|---|
| | | No. | % | No. | % |
| A | 0-2 months | 0 | 0 | 0 | 0 |
| B | 2-7 months | 1 | 20 | 1 | 12 |
| C | 7-14 months | 0 | 0 | 0 | 0 |
| D | 14-21 months | 3 | 60 | 5.5 | 69 |
| E | 21-27 months | 1 | 20 | 1.5 | 19 |
| F | 27-36 months | 0 | 0 | 0 | 0 |
| G | Adult | 0 | 0 | 0 | 0 |
| H | Old adult | 0 | 0 | 0 | 0 |
| I | Senile | 0 | 0 | 0 | 0 |
| | | 5 | 100 | 8 | 100 |

Table 71. Stage distribution of *Sus scrofa* mandibles and loose teeth from Early Bronze Age Novačka Ćuprija

| Stage | Suggested Age | Raw Count | | Corrected Count | |
|---|---|---|---|---|---|
| | | No. | % | No. | % |
| A | 0-2 months | 0 | 0 | 0 | 0 |
| B | 2-7 months | 0 | 0 | 1 | 10 |
| C | 7-14 months | 0 | 0 | 1 | 10 |
| D | 14-21 months | 3 | 43 | 4 | 40 |
| E | 21-27 months | 4 | 57 | 4 | 40 |
| F | 27-36 months | 0 | 0 | 0 | 0 |
| G | Adult | 0 | 0 | 0 | 0 |
| H | Old adult | 0 | 0 | 0 | 0 |
| I | Senile | 0 | 0 | 0 | 0 |
| | | 7 | 100 | 10 | 100 |

Table 72. Stage distribution of *Sus scrofa* mandibles and loose teeth from Late Bronze Age Novačka Ćuprija

| Stage | Suggested Age | Raw Count No. | % |
|---|---|---|---|
| A | 0-2 months | 0 | 0 |
| B | 2-7 months | 0 | 0 |
| C | 7-14 months | 0 | 0 |
| D | 14-21 months | 2 | 66 |
| E | 21-27 months | 1 | 33 |
| F | 27-36 months | 0 | 0 |
| G | adult | 0 | 0 |
| H | old adult | 0 | 0 |
| I | senile | 0 | 0 |
| | | 3 | 99 |

---

Table 73. Summary of ageable *Ovis/Capra* remains from Opovo

| Period | No. of Mandibles | No. of Loose Teeth | Total |
|---|---|---|---|
| Late Neolithic | 5 | 1 | 6 |

Table 74. Stage distribution of *Ovis/Capra* mandibles and loose teeth from Late Neolithic Opovo

| Stage | Suggested Age | Raw Count | | Corrected Count | |
|---|---|---|---|---|---|
| | | No. | % | No. | % |
| A | 0-2 months | 0 | 0 | 0 | 0 |
| B | 2-6 months | 0 | 0 | 0 | 0 |
| C | 6-12 months | 2 | 50 | 2 | 33 |
| D | 1-2 years | 1 | 25 | 1.3 | 22 |
| E | 2-3 years | 0 | 0 | 0 | 0 |
| F | 3-4 years | 0 | 0 | 0 | 0 |
| G | 4-6 years | 1 | 25 | 2.7 | 45 |
| H | 6-8 years | 0 | 0 | 0 | 0 |
| I | 8-10 years | 0 | 0 | 0 | 0 |
| | | 4 | 100 | 6 | 100 |

Table 75. Summary of ageable *Bos taurus* remains from Opovo

| Period | No. of Mandibles | No. of Loose Teeth | Total |
|---|---|---|---|
| Late Neolithic | 7 | 7 | 14 |

Table 76. Stage distribution of *Bos taurus* mandibles and loose teeth from Late Neolithic Opovo

| Stage | Suggested Age | Raw Count | | Corrected Count | |
|---|---|---|---|---|---|
| | | No. | % | No. | % |
| A | 0-1 month | 0 | 0 | 0 | 0 |
| B | 1-8 months | 0 | 0 | 0.5 | 4 |
| C | 8-18 months | 0 | 0 | 0.5 | 4 |
| D | 18-30 months | 6 | 75 | 7 | 50 |
| E | 30-36 months | 0 | 0 | 0 | 0 |
| F | Young adult | 1 | 12 | 4.01 | 28 |
| G | Adult | 0 | 0 | 0 | 0 |
| H | Old adult | 1 | 12 | 1.99 | 14 |
| I | Senile | 0 | 0 | 0 | 0 |
| | | 8 | 99 | 14 | 100 |

Table 77. Summary of ageable *Sus scrofa* remains from Opovo

| Period | No. of Mandibles | No. of Loose Teeth | Total |
|---|---|---|---|
| Late Neolithic | 10 | 1 | 11 |

Table 78. Stage distribution of *Sus scrofa* mandibles and loose teeth from Late Neolithic Opovo

| Stage | Suggested Age | Raw Count | | Corrected Count | |
|---|---|---|---|---|---|
| | | No. | % | No. | % |
| A | 0-2 months | 0 | 0 | 0 | 0 |
| B | 2-7 months | 2 | 22 | 2 | 18 |
| C | 7-14 months | 2 | 22 | 2.4 | 22 |
| D | 14-21 months | 3 | 33 | 3.6 | 33 |
| E | 21-27 months | 2 | 22 | 3 | 27 |
| F | 27-36 months | 0 | 0 | 0 | 0 |
| G | Adult | 0 | 0 | 0 | 0 |
| H | Old adult | 0 | 0 | 0 | 0 |
| I | Senile | 0 | 0 | 0 | 0 |
| | | 9 | 99 | 11 | 100 |

Table 79. Summary of ageable *Ovis/Capra* remains from Petnica

| Period | No. of Mandibles | No. of Loose Teeth | Total |
|---|---|---|---|
| Middle Neolithic | 4 | 3 | 7 |
| Late Neolithic | 5 | 14 | 19 |
| Late Neolithic/Eneolithic | 3 | 3 | 6 |
| Eneolithic | 9 | 4 | 13 |
| Late Bronze Age | 4 | 9 | 13 |
| Late Bronze Age/Early Iron Age | 3 | 6 | 9 |

Table 80. Stage distribution of *Ovis/Capra* mandibles and loose teeth from Middle Neolithic Petnica

| Stage | Suggested Age | Raw Count | | Corrected Count | |
|---|---|---|---|---|---|
| | | No. | % | No. | % |
| A | 0-2 months | 0 | 0 | 0 | 0 |
| B | 2-6 months | 1 | 20 | 1 | 14 |
| C | 6-12 months | 3 | 60 | 3 | 43 |
| D | 1-2 years | 0 | 0 | 0 | 0 |
| E | 2-3 years | 1 | 20 | 1.5 | 21 |
| F | 3-4 years | 0 | 0 | 0.75 | 11 |
| G | 4-6 years | 0 | 0 | 0.75 | 11 |
| H | 6-8 years | 0 | 0 | 0 | 0 |
| I | 8-10 years | 0 | 0 | 0 | 0 |
| | | 5 | 100 | 7 | 100 |

Table 81. Stage distribution of *Ovis/Capra* mandibles and loose teeth from Late Neolithic Petnica

| Stage | Suggested Age | Raw Count | | Corrected Count | |
|---|---|---|---|---|---|
| | | No. | % | No. | % |
| A | 0-2 months | 0 | 0 | 0 | 0 |
| B | 2-6 months | 0 | 0 | 0 | 0 |
| C | 6-12 months | 2 | 22 | 3.5 | 18 |
| D | 1-2 years | 2 | 22 | 4.2 | 22 |
| E | 2-3 years | 1 | 11 | 1.9 | 10 |
| F | 3-4 years | 2 | 22 | 4.8 | 25 |
| G | 4-6 years | 1 | 11 | 3.2 | 17 |
| H | 6-8 years | 1 | 11 | 1.5 | 8 |
| I | 8-10 years | 0 | 0 | 0 | 0 |
| | | 9 | 99 | 19.1 | 100 |

Table 82. Stage distribution of *Ovis/Capra* mandibles and loose teeth from Late Neolithic/Eneolithic Petnica

| Stage | Suggested Age | Raw Count | | Corrected Count | |
|---|---|---|---|---|---|
| | | No. | % | No. | % |
| A | 0-2 months | 0 | 0 | 0 | 0 |
| B | 2-6 months | 0 | 0 | 0 | 0 |
| C | 6-12 months | 1 | 33.3 | 2 | 33.3 |
| D | 1-2 years | 1 | 33.3 | 2 | 33.3 |
| E | 2-3 years | 0 | 0 | 0 | 0 |
| F | 3-4 years | 1 | 33.3 | 2 | 33.3 |
| G | 4-6 years | 0 | 0 | 0 | 0 |
| H | 6-8 years | 0 | 0 | 0 | 0 |
| I | 8-10 years | 0 | 0 | 0 | 0 |
| | | 3 | 99.9 | 6 | 99.9 |

Table 83. Stage distribution of *Ovis/Capra* mandibles and loose teeth from Eneolithic Petnica

| Stage | Suggested Age | Raw Count | | Corrected Count | |
|---|---|---|---|---|---|
| | | No. | % | No. | % |
| A | 0-2 months | 0 | 0 | 0 | 0 |
| B | 2-6 months | 0 | 0 | 0 | 0 |
| C | 6-12 months | 4 | 45 | 6.5 | 50 |
| D | 1-2 years | 2 | 22 | 3.3 | 26 |
| E | 2-3 years | 1 | 11 | 1.1 | 8 |
| F | 3-4 years | 1 | 11 | 1.1 | 8 |
| G | 4-6 years | 1 | 11 | 1 | 8 |
| H | 6-8 years | 0 | 0 | 0 | 0 |
| I | 8-10 years | 0 | 0 | 0 | 0 |
| | | 9 | 100 | 13 | 100 |

Table 84. Stage distribution of *Ovis/Capra* mandibles and loose teeth from Late Bronze Age Petnica

| Stage | Suggested Age | Raw Count | | Corrected Count | |
|---|---|---|---|---|---|
| | | No. | % | No. | % |
| A | 0-2 months | 0 | 0 | 0 | 0 |
| B | 2-6 months | 1 | 14 | 1 | 8 |
| C | 6-12 months | 1 | 14 | 2 | 15 |
| D | 1-2 years | 0 | 0 | 0.5 | 4 |
| E | 2-3 years | 0 | 0 | 0.9 | 7 |
| F | 3-4 years | 3 | 43 | 5.2 | 40 |
| G | 4-6 years | 2 | 29 | 3.4 | 26 |
| H | 6-8 years | 0 | 0 | 0 | 0 |
| I | 8-10 years | 0 | 0 | 0 | 0 |
| | | 7 | 100 | 13 | 100 |

Table 85. Stage distribution of *Ovis/Capra* mandibles and loose teeth from Late Bronze Age/Early Iron Age Petnica

| Stage | Suggested Age | Raw Count | | Corrected Count | |
|---|---|---|---|---|---|
| | | No. | % | No. | % |
| A | 0-2 months | 0 | 0 | 0 | 0 |
| B | 2-6 months | 0 | 0 | 0 | 0 |
| C | 6-12 months | 4 | 80 | 5 | 56 |
| D | 1-2 years | 0 | 0 | 0 | 0 |
| E | 2-3 years | 1 | 20 | 1.4 | 15 |
| F | 3-4 years | 0 | 0 | 0.7 | 8 |
| G | 4-6 years | 0 | 0 | 1.4 | 15 |
| H | 6-8 years | 0 | 0 | 0.5 | 6 |
| I | 8-10 years | 0 | 0 | 0 | 0 |
| | | 5 | 100 | 9 | 100 |

| Table 86. Summary of ageable *Bos taurus* remains from Petnica | | | |
|---|---|---|---|
| Period | No. of Mandibles | No. of Loose Teeth | Total |
| Middle Neolithic | 15 | 7 | 22 |
| Late Neolithic | 4 | 15 | 19 |
| Late Neolithic/Eneolithic | 0 | 2 | 2 |
| Eneolithic | 3 | 6 | 9 |
| Late Bronze Age | 0 | 9 | 9 |
| Late Bronze Age/Early Iron Age | 2 | 4 | 6 |

Table 87. Stage distribution of *Bos taurus* mandibles and loose teeth from Middle Neolithic Petnica

| Stage | Suggested Age | Raw Count | | Corrected Count | |
|---|---|---|---|---|---|
| | | No. | % | No. | % |
| A | 0-1 month | 2 | 20 | 2 | 9 |
| B | 1-8 months | 0 | 0 | 0 | 0 |
| C | 8-18 months | 1 | 10 | 1 | 4 |
| D | 18-30 months | 4 | 40 | 8.2 | 38 |
| E | 30-36 months | 0 | 0 | 0 | 0 |
| F | young adult | 1 | 10 | 3.8 | 17 |
| G | adult | 0 | 0 | 0 | 0 |
| H | old adult | 0 | 0 | 0 | 0 |
| I | senile | 2 | 20 | 6.9 | 32 |
| | | 10 | 100 | 21.9 | 100 |

Table 88. Stage distribution of *Bos taurus* mandibles and loose teeth from Late Neolithic Petnica

| Stage | Suggested Age | Raw Count | | Corrected Count | |
|---|---|---|---|---|---|
| | | No. | % | No. | % |
| A | 0-1 month | 1 | 17 | 1 | 5 |
| B | 1-8 months | 0 | 0 | 1 | 5 |
| C | 8-18 months | 0 | 0 | 1 | 5 |
| D | 18-30 months | 3 | 50 | 5.8 | 31 |
| E | 30-36 months | 1 | 17 | 5.5 | 30 |
| F | young adult | 0 | 0 | 0.8 | 4 |
| G | adult | 0 | 0 | 1.6 | 8 |
| H | old adult | 0 | 0 | 0 | 0 |
| I | senile | 1 | 17 | 2.3 | 12 |
| | | 6 | 101 | 19 | 100 |

Table 89. Stage distribution of *Bos taurus* mandibles and loose teeth from Eneolithic Petnica

| Stage | Suggested Age | Raw Count | | Corrected Count | |
|---|---|---|---|---|---|
| | | No. | % | No. | % |
| A | 0-1 month | 0 | 0 | 0 | 0 |
| B | 1-8 months | 0 | 0 | 0.5 | 6 |
| C | 8-18 months | 0 | 0 | 0.5 | 6 |
| D | 18-30 months | 1 | 25 | 2.5 | 28 |
| E | 30-36 months | 1 | 25 | 2.5 | 28 |
| F | young adult | 1 | 25 | 1 | 10 |
| G | adult | 0 | 0 | 0 | 0 |
| H | old adult | 1 | 25 | 2 | 22 |
| I | senile | 0 | 0 | 0 | 0 |
| | | 4 | 100 | 9 | 100 |

Table 90. Stage distribution of *Bos taurus* mandibles and loose teeth from Late Bronze Age Petnica

| Stage | Suggested Age | Raw Count | | Corrected Count | |
|---|---|---|---|---|---|
| | | No. | % | No. | % |
| A | 0-1 month | 0 | 0 | 0 | 0 |
| B | 1-8 months | 0 | 0 | 0 | 0 |
| C | 8-18 months | 0 | 0 | 0.5 | 5 |
| D | 18-30 months | 0 | 0 | 0.5 | 5 |
| E | 30-36 months | 1 | 50 | 2.7 | 30 |
| F | young adult | 0 | 0 | 0.8 | 9 |
| G | adult | 0 | 0 | 0.8 | 9 |
| H | old adult | 0 | 0 | 0 | 0 |
| I | senile | 1 | 50 | 3.8 | 42 |
| | | 2 | 100 | 9.1 | 100 |

Table 91. Stage distribution of *Bos taurus* mandibles and loose teeth from Middle Neolithic Petnica

| Stage | Suggested Age | Raw Count | | Corrected Count | |
|---|---|---|---|---|---|
| | | No. | % | No. | % |
| A | 0-1 month | 0 | 0 | 0 | 0 |
| B | 1-8 months | 0 | 0 | 0.5 | 8 |
| C | 8-18 months | 0 | 0 | 0.5 | 8 |
| D | 18-30 months | 0 | 0 | 1 | 17 |
| E | 30-36 months | 0 | 0 | 1 | 17 |
| F | young adult | 0 | 0 | 0 | 0 |
| G | adult | 0 | 0 | 0 | 0 |
| H | old adult | 0 | 0 | 0 | 0 |
| I | senile | 1 | 100 | 3 | 50 |
| | | 1 | 100 | 6 | 100 |

| Table 92. Summary of ageable *Sus scrofa* remains from Petnica | | | |
|---|---|---|---|
| Period | No. of Mandibles | No. of Loose Teeth | Total |
| Middle Neolithic | 12 | 1 | 13 |
| Late Neolithic | 11 | 2 | 13 |
| Late Neolithic/Eneolithic | 0 | 0 | 0 |
| Eneolithic | 8 | 2 | 10 |
| Late Bronze Age | 3 | 2 | 5 |
| Late Bronze Age/Early Iron Age | 4 | 1 | 5 |

---

Table 93. Stage distribution of *Sus scrofa* mandibles and loose teeth from Middle Neolithic Petnica

| Stage | Suggested Age | Raw Count | | Corrected Count | |
|---|---|---|---|---|---|
| | | No. | % | No. | % |
| A | 0-2 months | 1 | 8 | 1 | 8 |
| B | 2-7 months | 5 | 41 | 5 | 39 |
| C | 7-14 months | 2 | 17 | 2 | 15 |
| D | 14-21 months | 2 | 17 | 3 | 23 |
| E | 21-27 months | 0 | 0 | 0 | 0 |
| F | 27-36 months | 0 | 0 | 0 | 0 |
| G | adult | 0 | 0 | 0 | 0 |
| H | old adult | 0 | 0 | 0 | 0 |
| I | senile | 2 | 17 | 2 | 15 |
| | | 12 | 100 | 13 | 100 |

Table 94. Stage distribution of *Sus scrofa* mandibles and loose teeth from Late Neolithic Petnica

| Stage | Suggested Age | Raw Count | | Corrected Count | |
|---|---|---|---|---|---|
| | | No. | % | No. | % |
| A | 0-2 months | 0 | 0 | 0 | 0 |
| B | 2-7 months | 2 | 25 | 2.4 | 18 |
| C | 7-14 months | 3 | 38 | 3.6 | 28 |
| D | 14-21 months | 2 | 25 | 6 | 46 |
| E | 21-27 months | 0 | 0 | 0 | 0 |
| F | 27-36 months | 0 | 0 | 0 | 0 |
| G | adult | 0 | 0 | 0 | 0 |
| H | old adult | 0 | 0 | 0 | 0 |
| I | senile | 1 | 12 | 1 | 8 |
| | | 8 | 100 | 13 | 100 |

Table 95. Stage distribution of *Sus scrofa* mandibles and loose teeth from Eneolithic Petnica

| Stage | Suggested Age | Raw Count | | Corrected Count | |
|---|---|---|---|---|---|
| | | No. | % | No. | % |
| A | 0-2 months | 0 | 0 | 0 | 0 |
| B | 2-7 months | 2 | 50 | 4 | 40 |
| C | 7-14 months | 0 | 0 | 0 | 0 |
| D | 14-21 months | 1 | 25 | 4 | 40 |
| E | 21-27 months | 0 | 0 | 0.5 | 5 |
| F | 27-36 months | 0 | 0 | 0.5 | 5 |
| G | adult | 0 | 0 | 0 | 0 |
| H | old adult | 0 | 0 | 0 | 0 |
| I | senile | 1 | 25 | 1 | 10 |
| | | 4 | 100 | 10 | 100 |

Table 96. Stage distribution of *Sus scrofa* mandibles and loose teeth from Late Bronze Age Petnica

| Stage | Suggested Age | Raw Count | | Corrected Count | |
|---|---|---|---|---|---|
| | | No. | % | No. | % |
| A | 0-2 months | 0 | 0 | 0 | 0 |
| B | 2-7 months | 0 | 0 | 0 | 0 |
| C | 7-14 months | 1 | 33.3 | 2.3 | 47 |
| D | 14-21 months | 2 | 66.6 | 2.6 | 53 |
| E | 21-27 months | 0 | 0 | 0 | 0 |
| F | 27-36 months | 0 | 0 | 0 | 0 |
| G | adult | 0 | 0 | 0 | 0 |
| H | old adult | 0 | 0 | 0 | 0 |
| I | senile | 0 | 0 | 0 | 0 |
| | | 3 | 99.9 | 4.9 | 100 |

Table 97. Stage distribution of *Sus scrofa* mandibles and loose teeth from Late Bronze Age/Early Iron Age Petnica

| Stage | Suggested Age | Raw Count | | Corrected Count | |
|---|---|---|---|---|---|
| | | No. | % | No. | % |
| A | 0-2 months | 0 | 0 | 0 | 0 |
| B | 2-7 months | 0 | 0 | 0 | 0 |
| C | 7-14 months | 2 | 100 | 4 | 80 |
| D | 14-21 months | 0 | 0 | 0.5 | 10 |
| E | 21-27 months | 0 | 0 | 0.5 | 10 |
| F | 27-36 months | 0 | 0 | 0 | 0 |
| G | adult | 0 | 0 | 0 | 0 |
| H | old adult | 0 | 0 | 0 | 0 |
| I | Senile | 0 | 0 | 0 | 0 |
| | | 2 | 100 | 5 | 100 |

Table 98. Stage distribution of *Ovis aries* mandibles and loose teeth from Middle Neolithic Stragari

| Stage | Suggested Age | Raw Count | | Corrected Count | |
|---|---|---|---|---|---|
| | | No. | % | No. | % |
| A | 0-2 months | 0 | 0 | 0 | 0 |
| B | 2-6 months | 1 | 33 | 1 | 25 |
| C | 6-12 months | 2 | 66 | 3 | 75 |
| D | 1-2 years | 0 | 0 | 0 | 0 |
| E | 2-3 years | 0 | 0 | 0 | 0 |
| F | 3-4 years | 0 | 0 | 0 | 0 |
| G | 4-6 years | 0 | 0 | 0 | 0 |
| H | 6-8 years | 0 | 0 | 0 | 0 |
| I | 8-10 years | 0 | 0 | 0 | 0 |
| | | 3 | 99 | 4 | 100 |

Table 99. Summary of ageable *Ovis/Capra* remains from Stragari

| Period | No. of Mandibles | No. of Loose Teeth | Total |
|---|---|---|---|
| Middle Neolithic | 7 | 15 | 22 |

Table 100. Stage distribution of *Ovis/Capra* mandibles and loose teeth from Middle Neolithic Stragari

| Stage | Suggested Age | Raw Count | | Corrected Count | |
|---|---|---|---|---|---|
| | | No. | % | No. | % |
| A | 0-2 months | 0 | 0 | 0 | 0 |
| B | 2-6 months | 1 | 6 | 1 | 5 |
| C | 6-12 months | 3 | 18 | 3.9 | 18 |
| D | 1-2 years | 5 | 29 | 8.3 | 38 |
| E | 2-3 years | 1 | 6 | 1.4 | 6 |
| F | 3-4 years | 7 | 41 | 7.3 | 33 |
| G | 4-6 years | 0 | 0 | 0 | 0 |
| H | 6-8 years | 0 | 0 | 0 | 0 |
| I | 8-10 years | 0 | 0 | 0 | 0 |
| | | 17 | 100 | 21.9 | 100 |

Table 101. Summary of ageable *Bos taurus* remains from Stragari

| Period | No. of Mandibles | No. of Loose Teeth | Total |
|---|---|---|---|
| Middle Neolithic | 13 | 16 | 29 |

Table 102. Stage distribution of *Bos taurus* mandibles and loose teeth from Middle Neolithic Stragari

| Stage | Suggested Age | Raw Count | | Corrected Count | |
|---|---|---|---|---|---|
| | | No. | % | No. | % |
| A | 0-1 month | 2 | 17 | 2 | 7 |
| B | 1-8 months | 0 | 0 | 0 | 0 |
| C | 8-18 months | 6 | 50 | 7.5 | 26 |
| D | 18-30 months | 2 | 17 | 4.3 | 15 |
| E | 30-36 months | 0 | 0 | 0 | 0 |
| F | Young adult | 0 | 0 | 0 | 0 |
| G | Adult | 1 | 8 | 9.2 | 32 |
| H | old adult | 0 | 0 | 0 | 0 |
| I | Senile | 1 | 8 | 6 | 20 |
| | | 12 | 100 | 29 | 100 |

---

| Table 103. Summary of ageable *Sus scrofa* remains from Stragari | | | |
|---|---|---|---|
| Period | No. of Mandibles | No. of Loose Teeth | Total |
| Middle Neolithic | 7 | 0 | 7 |

Table 104. Stage distribution of *Sus scrofa* mandibles and loose teeth from Middle Neolithic Stragari

| Stage | Suggested Age | Raw Count | | Corrected Count | |
|---|---|---|---|---|---|
| | | No. | % | No. | % |
| A | 0-2 months | 0 | 0 | 0 | 0 |
| B | 2-7 months | 1 | 25 | 1 | 14 |
| C | 7-14 months | 2 | 50 | 3.3 | 48 |
| D | 14-21 months | 1 | 25 | 2.6 | 38 |
| E | 21-27 months | 0 | 0 | 0 | 0 |
| F | 27-36 months | 0 | 0 | 0 | 0 |
| G | adult | 0 | 0 | 0 | 0 |
| H | old adult | 0 | 0 | 0 | 0 |
| I | senile | 0 | 0 | 0 | 0 |
| | | 4 | 100 | 6.9 | 100 |

Table 105. Summary of ageable *Ovis/Capra* remains from Vinča

| Period | No. of Mandibles | No. of Loose Teeth | Total |
|---|---|---|---|
| Late Neolithic | 32 | 0 | 32 |
| Eneolithic | 1 | 0 | 1 |
| Middle Bronze Age | 13 | 10 | 23 |

Table 106. Stage distribution of *Ovis/Capra* mandibles and loose teeth from Late Neolithic Vinča

| Stage | Suggested Age | Raw Count |  | Corrected Count |  |
|---|---|---|---|---|---|
|  |  | No. | % | No. | % |
| A | 0-2 months | 0 | 0 | 0 | 0 |
| B | 2-6 months | 1 | 4 | 1.1 | 3 |
| C | 6-12 months | 6 | 23 | 8.0 | 25 |
| D | 1-2 years | 5 | 19 | 5.8 | 17 |
| E | 2-3 years | 1 | 4 | 1.5 | 4 |
| F | 3-4 years | 3 | 12 | 5.6 | 16 |
| G | 4-6 years | 5 | 19 | 6.6 | 20 |
| H | 6-8 years | 3 | 12 | 3.2 | 9 |
| I | 8-10 years | 2 | 7 | 2.1 | 6 |
|  |  | 26 | 100 | 34 | 100 |

Table 107. Stage distribution of *Ovis/Capra* mandibles and loose teeth from Middle Bronze Age Vinča

| Stage | Suggested Age | Raw Count |  | Corrected Count |  |
|---|---|---|---|---|---|
|  |  | No. | % | No. | % |
| A | 0-2 months | 0 | 0 | 0 | 0 |
| B | 2-6 months | 0 | 0 | 0 | 0 |
| C | 6-12 months | 3 | 27 | 3 | 13 |
| D | 1-2 years | 5 | 46 | 6.7 | 29 |
| E | 2-3 years | 1 | 9 | 2 | 9 |
| F | 3-4 years | 1 | 0 | 3.6 | 16 |
| G | 4-6 years | 1 | 9 | 3.6 | 16 |
| H | 6-8 years | 1 | 9 | 2.9 | 13 |
| I | 8-10 years | 1 | 0 | 1 | 4 |
|  |  | 13 | 100 | 22.8 | 100 |

| Table 108. Summary of ageable *Bos taurus* remains from Vinča | | | |
|---|---|---|---|
| Period | No. of Mandibles | No. of Loose Teeth | Total |
| Late Neolithic | 6 | 8 | 14 |
| Eneolithic | 0 | 0 | 0 |
| Middle Bronze Age | 8 | 8 | 16 |

Table 109. Stage distribution of *Bos taurus* mandibles and loose teeth from Late Neolithic Vinča

| Stage | Suggested Age | Raw Count | | Corrected Count | |
|---|---|---|---|---|---|
| | | No. | % | No. | % |
| A | 0-1 month | 0 | 0 | 0 | 0 |
| B | 1-8 months | 1 | 20 | 1.5 | 10 |
| C | 8-18 months | 1 | 20 | 1.2 | 9 |
| D | 18-30 months | 1 | 20 | 6 | 44 |
| E | 30-36 months | 0 | 0 | 0.25 | 2 |
| F | young adult | 0 | 0 | 0.25 | 2 |
| G | adult | 0 | 0 | 0.25 | 2 |
| H | old adult | 0 | 0 | 0.25 | 2 |
| I | senile | 2 | 40 | 4 | 29 |
| | | 5 | 100 | 13.7 | 100 |

Table 110. Stage distribution of *Bos taurus* mandibles and loose teeth from Middle Bronze Age Vinča

| Stage | Suggested Age | Raw Count | | Corrected Count | |
|---|---|---|---|---|---|
| | | No. | % | No. | % |
| A | 0-1 month | 1 | 11 | 1 | 6 |
| B | 1-8 months | 1 | 11 | 1 | 6 |
| C | 8-18 months | 4 | 45 | 4 | 25 |
| D | 18-30 months | 1 | 11 | 1 | 6 |
| E | 30-36 months | 0 | 0 | 0 | 0 |
| F | young adult | 0 | 0 | 0 | 0 |
| G | adult | 0 | 0 | 0 | 0 |
| H | old adult | 1 | 11 | 5.5 | 34 |
| I | senile | 1 | 11 | 3.5 | 23 |
| | | 9 | 100 | 16 | 100 |

Table 111. Summary of ageable *Sus scrofa* remains from Vinča

| Period | No. of Mandibles | No. of Loose Teeth | Total |
|---|---|---|---|
| Late Neolithic | 34 | 0 | 34 |
| Eneolithic | 1 | 0 | 1 |
| Middle Bronze Age | 19 | 1 | 20 |

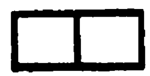
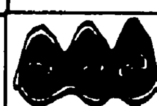
Table 112. Stage distribution of *Sus scrofa* mandibles and loose teeth from Late Neolithic Vinča

| Stage | Suggested Age | Raw Count | | Corrected Count | |
|---|---|---|---|---|---|
| | | No. | % | No. | % |
| A | 0-2 months | 0 | 0 | 0.0 | 0 |
| B | 2-7 months | 5 | 23 | 6.1 | 18 |
| C | 7-14 months | 8 | 34 | 11.3 | 33 |
| D | 14-21 months | 9 | 39 | 13.3 | 42 |
| E | 21-27 months | 1 | 4 | 2.3 | 7 |
| F | 27-36 months | 0 | 0 | 0.0 | 0 |
| G | Adult | 0 | 0 | 0.0 | 0 |
| H | old adult | 0 | 0 | 0.0 | 0 |
| I | Senile | 0 | 0 | 0.0 | 0 |
| | | 23 | 100 | 33.0 | 100 |

Table 113. Stage distribution of *Sus scrofa* mandibles and loose teeth from Middle Bronze Age Vinča

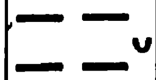
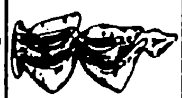
| Stage | Suggested Age | Raw Count | | Corrected Count | |
|---|---|---|---|---|---|
| | | No. | % | No. | % |
| A | 0-2 months | 1 | 6 | 1.0 | 5 |
| B | 2-7 months | 1 | 6 | 1.0 | 5 |
| C | 7-14 months | 5 | 31 | 5.5 | 27 |
| D | 14-21 months | 6 | 38 | 8.8 | 44 |
| E | 21-27 months | 2 | 13 | 2.8 | 14 |
| F | 27-36 months | 1 | 6 | 1.0 | 5 |
| G | Adult | 0 | 0 | 0.0 | 0 |
| H | old adult | 0 | 0 | 0.0 | 0 |
| I | Senile | 0 | 0 | 0.0 | 0 |
| | | 16 | 100 | 20.0 | 100 |

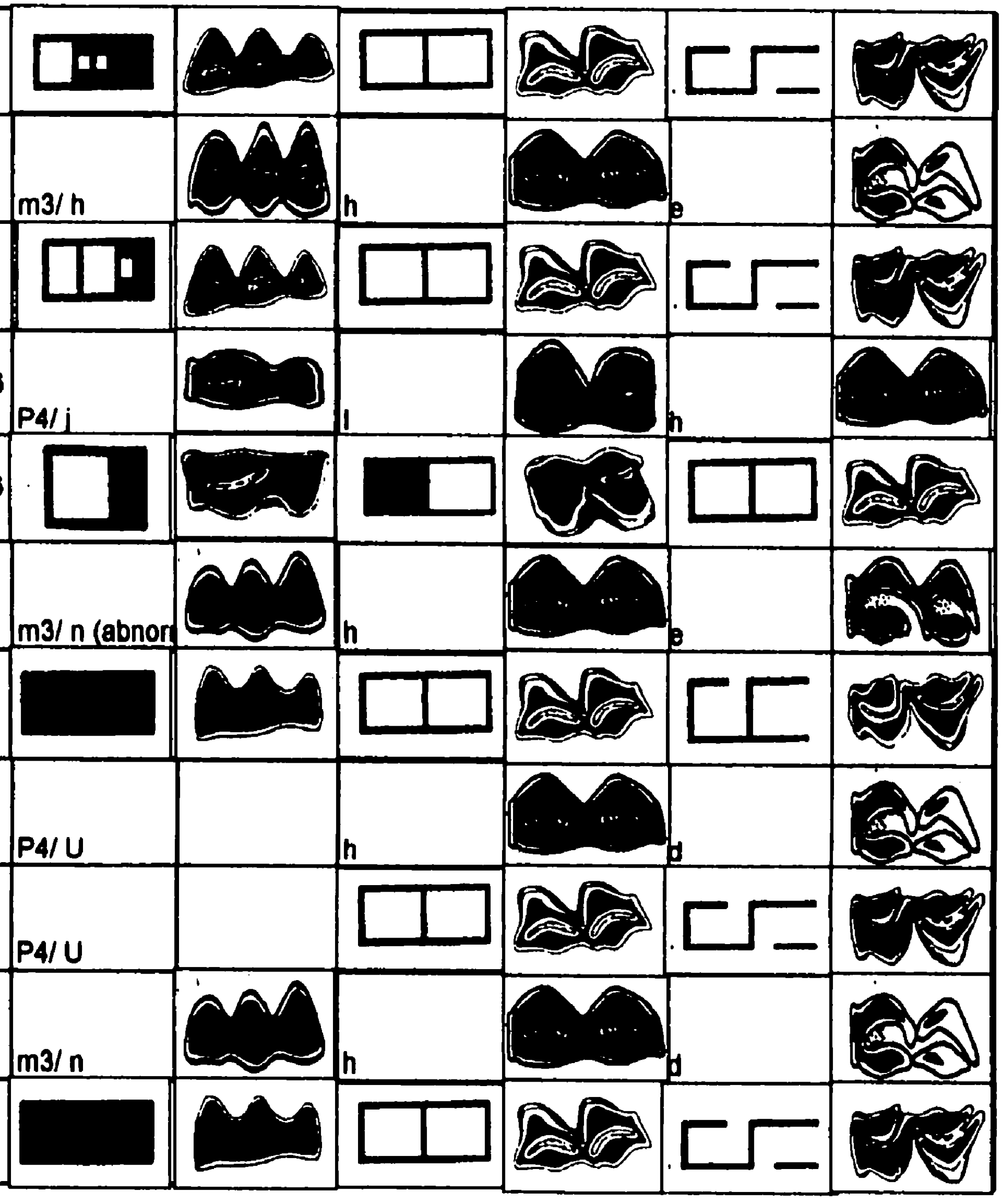
Table 114. Tooth Eruption and Wear Comparative - Grant and Payne Recording Methods

| Method | Species | Specimen # | Date of Death | Age at Death | m3/P4 code | m3/P4 description | M1 Code | M1 description | M2 Code | M2 description |
|---|---|---|---|---|---|---|---|---|---|---|
| Grant | Goat | Goat #3 | Aug/Sept 2000 | 1 year, 4-5 months | P4/ E | | h |  | e |  |
| Payne | Goat | Goat #3 | Aug/Sept 2000 | 1 year, 4-5 months | P4/ E | |  |  |  |  |
| Grant | Goat | Goat #4 | Aug/Sept 2000 | 1 year, 4-5 months | m3/ m |  | h |  | e |  |
| Payne | Goat | Goat #4 | Aug/Sept 2000 | 1 year, 4-5 months |  |  |  |  |  |  |
| Grant | Goat | Goat #1 | Aug/Sept 2000 | 1 year, 4-5 months | m3/ n |  | g |  | e |  |
| Payne | Goat | Goat #1 | Aug/Sept 2000 | 1 year, 4-5 months |  |  |  |  |  |  |
| Grant | Goat | Goat #2 | Aug/Sept 2000 | 1 year, 4-5 months | P4/ E | | g |  | e |  |
| Payne | Goat | Goat #2 | Aug/Sept 2000 | 1 year, 4-5 months | P4/ E | |  |  |  |  |
| Grant | Sheep | Sheep #8 | Sept 20/2000 | 5 months | m3/ g |  | d |  | V | |

| Method | Species | Specimen # | Date of Death | Age at Death | M3 Code | M3 description | Numerical Value (Grant 1975) | Age Class (Payne 1973) | Absolute Age |
|---|---|---|---|---|---|---|---|---|---|
| Grant | Goat | Goat #3 | Aug/Sept 2000 | 1 year, 4-5 months | C | | 24 | | |
| Payne | Goat | Goat #3 | Aug/Sept 2000 | 1 year, 4-5 months | C | | | D | 1-2 years |
| Grant | Goat | Goat #4 | Aug/Sept 2000 | 1 year, 4-5 months | C | | 24 | | |
| Payne | Goat | Goat #4 | Aug/Sept 2000 | 1 year, 4-5 months | C | | | D | 1-2 years |
| Grant | Goat | Goat #1 | Aug/Sept 2000 | 1 year, 4-5 months | V | | 24 | | |
| Payne | Goat | Goat #1 | Aug/Sept 2000 | 1 year, 4-5 months | C | | | D | 1-2 years |
| Grant | Goat | Goat #2 | Aug/Sept 2000 | 1 year, 4-5 months | V | | 24 | | |
| Payne | Goat | Goat #2 | Aug/Sept 2000 | 1 year, 4-5 months | V | | | D | 1-2 years |
| Grant | Sheep | Sheep #8 | Sept 20/2000 | 5 months | | | 11 | | |

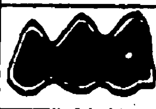
| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Payne | Goat | Goat #8 | Sept/Oct 2000 | 1 year, 5-6 months | P4/ 1/2 | | | | | |
| Grant | Goat | Goat #6 | Sept/Oct 2000 | 1 year, 5-6 months | m3/ m | | g | | c | |
| Payne | Goat | Goat #6 | Sept/Oct 2000 | 1 year, 5-6 months | | | | | | |
| Grant | Goat | Goat #7 | Sept/Oct 2000 | 1 year, 5-6 months | m3/ n | | g | | c | |
| Payne | Goat | Goat #7 | Sept/Oct 2000 | 1 year, 5-6 months | | | | | | |
| Grant | Goat | Goat #9 | Sept/Oct 2000 | 1 year, 5-6 months | m3/ l | | g | | c | |
| Payne | Goat | Goat #9 | Sept/Oct 2000 | 1 year, 5-6 months | | | | | | |
| Grant | Sheep | Sheep #6 | Oct 13/2000 | | P4 unrecordable | posterior cusp damaged | h | | g | |
| Payne | Sheep | Sheep #6 | Oct 13/2000 | | P4 unrecordable | posterior cusp damaged | | | | |
| Grant | Sheep | Sheep #10 | Oct 13/2000 | 6 months | m3/ g | | c | | V | |
| Payne | Sheep | Sheep #10 | Oct 13/2000 | 6 months | | | | | V | |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Payne | Goat | Goat #8 | Sept/Oct 2000 | 1 year, 5-6 months | V | | | D | 1-2 years |
| Grant | Goat | Goat #6 | Sept/Oct 2000 | 1 year, 5-6 months | C | | 21 | | |
| Payne | Goat | Goat #6 | Sept/Oct 2000 | 1 year, 5-6 months | C | | | D | 1-2 years |
| Grant | Goat | Goat #7 | Sept/Oct 2000 | 1 year, 5-6 months | C | | 21 | | |
| Payne | Goat | Goat #7 | Sept/Oct 2000 | 1 year, 5-6 months | C | | | D | 1-2 years |
| Grant | Goat | Goat #9 | Sept/Oct 2000 | 1 year, 5-6 months | V | | 22 | | |
| Payne | Goat | Goat #9 | Sept/Oct 2000 | 1 year, 5-6 months | V | | | D | 1-2 years |
| Grant | Sheep | Sheep #6 | Oct 13/2000 | | c |  | 33 | | |
| Payne | Sheep | Sheep #6 | Oct 13/2000 | |  |  | | E | 2-3 years |
| Grant | Sheep | Sheep #10 | Oct 13/2000 | 6 months | | | 10 | | |
| Payne | Sheep | Sheep #10 | Oct 13/2000 | 6 months | | | | C | 6-12 months |

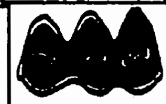
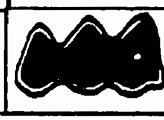
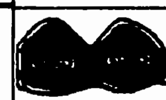


| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Payne | Sheep | Sheep #2 | Novembe r 26/00 | 1 year, 6 months | | | | | | |
| Grant | Sheep | Sheep #3 | Novembe r 26/00 | 1 year, 6 months | m3/ h | | h | | e | |
| Payne | Sheep | Sheep #3 | Novembe r 26/00 | 1 year, 6 months | | | | | | |
| Grant | Sheep | Sheep #1 | Novembe r 26/00 | 4 years, 6 months | P4/ j | | l | | h | |
| Payne | Sheep | Sheep #1 | Novembe r 26/00 | 4 years, 6 months | | | | | | |
| Grant | Goat | | Dec 2000 | | m3/ n (abnor | | h | | e | |
| Payne | Goat | | Dec 2000 | | | | | | | |
| Grant | Goat | | Dec 2000 | | P4/ U | | h | | d | |
| Payne | Goat | | Dec 2000 | | P4/ U | | | | | |
| Grant | Goat | Goat #13 | Dec 2000 | 8 months | m3/ n | | h | | d | |
| Payne | Goat | Goat #13 | Dec 2000 | 8 months | | | | | | |

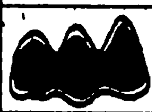
| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Payne | Sheep | Sheep #2 | November 26/00 | 1 year, 6 months | E | | | D | 1-2 years |
| Grant | Sheep | Sheep #3 | November 26/00 | 1 year, 6 months | E | | 26 | | |
| Payne | Sheep | Sheep #3 | November 26/00 | 1 year, 6 months | E | | | D | 1-2 years |
| Grant | Sheep | Sheep #1 | November 26/00 | 4 years, 6 months | g |  | 41 | | |
| Payne | Sheep | Sheep #1 | November 26/00 | 4 years, 6 months |  |  | | G | 4-6 years |
| Grant | Goat | | Dec 2000 | | V | | 25 | | |
| Payne | Goat | | Dec 2000 | | V | | | D | 1-2 years |
| Grant | Goat | | Dec 2000 | | E | | 25 | | |
| Payne | Goat | | Dec 2000 | | E | | | D | 1-2 years |
| Grant | Goat | Goat #13 | Dec 2000 | 8 months | V | | 24 | | |
| Payne | Goat | Goat #13 | Dec 2000 | 8 months | V | | | D | 1-2 years |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Grant | Goat | Goat #12 | Dec 2000 | 8 months | m3/ n |  | h |  | d |  |
| Payne | Goat | Goat #12 | Dec 2000 | 8 months |  |  |  |  |  |  |
| Grant | Goat | | Dec 2000 | | m3/ m |  | f |  | c |  |
| Payne | Goat | | Dec 2000 | |  |  |  |  |  |  |
| Grant | Sheep | | Novembe r 20/2000 | | m3/ j |  | e |  | E | |
| Payne | Sheep | | Novembe r 20/2000 | |  |  |  |  | V | |
| Grant | Sheep | | Novembe r 20/2000 | | m3/ j |  | e |  | V | |
| Payne | Sheep | | Novembe r 20/2000 | |  |  |  |  | E | |
| Grant | Sheep | | Novembe r 20/2000 | | m3/ h |  | e |  | E | |
| Payne | Sheep | | Novembe r 20/2000 | |  |  |  |  | E | |
| Grant | Goat | Goat #14 | Jan/Feb 2001 | 9-10 months | P4/ 1/2 | | h |  | e |  |

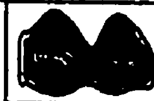
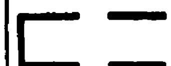
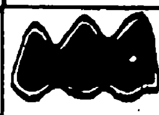
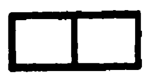
| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Grant | Goat | Goat #12 | Dec 2000 | 8 months | C | | 23 | | |
| Payne | Goat | Goat #12 | Dec 2000 | 8 months | V | | | D | 1-2 years |
| Grant | Goat | | Dec 2000 | | V | | 21 | | |
| Payne | Goat | | Dec 2000 | | V | | | D | 1-2 years |
| Grant | Sheep | | November 20/2000 | | | | 13 | | |
| Payne | Sheep | | November 20/2000 | | | | | C | 6-12 months |
| Grant | Sheep | | November 20/2000 | | | | 12 | | |
| Payne | Sheep | | November 20/2000 | | | | | C | 6-12 months |
| Grant | Sheep | | November 20/2000 | | | | 13 | | |
| Payne | Sheep | | November 20/2000 | | | | | C | 6-12 months |
| Grant | Goat | Goat #14 | Jan/Feb 2001 | 9-10 months | V | | 25 | | |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Grant | Sheep | Sheep #9 | Oct 13/2000 | 6 months | m3/ g |  | d |  | E | |
| Payne | Sheep | Sheep #9 | Oct 13/2000 | 6 months |  |  |  |  | E | |
| Grant | Sheep | Sheep #13 | Oct 13/2000 | 6 months | m3/ g |  | d |  | C | |
| Payne | Sheep | Sheep #13 | Oct 13/2000 | 6 months |  |  |  |  | C | |
| Grant | Sheep | Sheep #11 | Oct 13/2000 | 6 months | m3/ g |  | d |  | V | |
| Payne | Sheep | Sheep #11 | Oct 13/2000 | 6 months |  |  |  |  | V | |
| Grant | Goat | Goat #10 | Oct/Nov 2000 | 6-7 months | P4/ 1/2 | | Unrecordable | posterior cusp missing | d |  |
| Payne | Goat | Goat #10 | Oct/Nov 2000 | 6-7 months | P4/ 1/2 | | Unrecordable | posterior cusp missing |  |  |
| Grant | Goat | Goat #11 | Oct/Nov 2000 | 6-7 months | P4/ E | | g |  | c |  |
| Payne | Goat | Goat #11 | Oct/Nov 2000 | 6-7 months | P4/ E | |  |  |  |  |
| Grant | Sheep | Sheep #2 | Novembe r 26/00 | 1 year, 6 months | m3/ m |  | h |  | e |  |

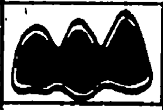
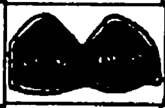
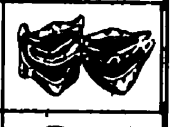
| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Grant | Sheep | Sheep #9 | Oct 13/2000 | 6 months | | | 12 | | |
| Payne | Sheep | Sheep #9 | Oct 13/2000 | 6 months | | | | C | 6-12 months |
| Grant | Sheep | Sheep #13 | Oct 13/2000 | 6 months | | | 10 | | |
| Payne | Sheep | Sheep #13 | Oct 13/2000 | 6 months | | | | C | 6-12 months |
| Grant | Sheep | Sheep #11 | Oct 13/2000 | 6 months | | | 11 | | |
| Payne | Sheep | Sheep #11 | Oct 13/2000 | 6 months | | | | C | 6-12 months |
| Grant | Goat | Goat #10 | Oct/Nov 2000 | 6-7 months | V | | Unrecordable | | |
| Payne | Goat | Goat #10 | Oct/Nov 2000 | 6-7 months | V | | | D | 1-2 years |
| Grant | Goat | Goat #11 | Oct/Nov 2000 | 6-7 months | V | | 22 | | |
| Payne | Goat | Goat #11 | Oct/Nov 2000 | 6-7 months | V | | | D | 1-2 years |
| Grant | Sheep | Sheep #2 | November 26/00 | 1 year, 6 months | E | | 26 | | |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Grant | Goat | | Sept/Oct 2000 | 1 year, 5-6 months | m3/ n |  | g |  | e |  |
| Payne | Goat | | Sept/Oct 2000 | 1 year, 5-6 months |  |  |  |  |  |  |
| Grant | Goat | | Sept/Oct 2000 | 1 year, 5-6 months | m3/ n |  | Unrecordable | lingual half of tooth missing | e |  |
| Payne | Goat | | Sept/Oct 2000 | 1 year, 5-6 months |  |  | Unrecordable | lingual half of tooth missing |  |  |
| Grant | Goat | | Sept/Oct 2000 | 1 year, 5-6 months | m3/ n |  | g |  | e |  |
| Payne | Goat | | Sept/Oct 2000 | 1 year, 5-6 months |  |  |  |  |  |  |
| Grant | Goat | | Sept/Oct 2000 | 1 year, 5-6 months | m3/ n |  | h |  | e |  |
| Payne | Goat | | Sept/Oct 2000 | 1 year, 5-6 months |  |  |  |  |  |  |
| Grant | Goat | Goat #5 | Sept/Oct 2000 | 1 year, 5-6 months | P4/ E | | Unrecordable | lingual half of tooth missing | e |  |
| Payne | Goat | Goat #5 | Sept/Oct 2000 | 1 year, 5-6 months | P4/ E | | Unrecordable | lingual half of tooth missing |  |  |
| Grant | Goat | Goat #8 | Sept/Oct 2000 | 1 year, 5-6 months | P4/ 1/2 | | g |  | c |  |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Grant | Goat | | Sept/Oct 2000 | 1 year, 5-6 months | C | | 23 | | |
| Payne | Goat | | Sept/Oct 2000 | 1 year, 5-6 months | C | | | D | 1-2 years |
| Grant | Goat | | Sept/Oct 2000 | 1 year, 5-6 months | C | | Unrecordable | | |
| Payne | Goat | | Sept/Oct 2000 | 1 year, 5-6 months | C | | | D | 1-2 years |
| Grant | Goat | | Sept/Oct 2000 | 1 year, 5-6 months | C | | 23 | | |
| Payne | Goat | | Sept/Oct 2000 | 1 year, 5-6 months | C | | | D | 1-2 years |
| Grant | Goat | | Sept/Oct 2000 | 1 year, 5-6 months | C | | 24 | | |
| Payne | Goat | | Sept/Oct 2000 | 1 year, 5-6 months | C | | | D | 1-2 years |
| Grant | Goat | Goat #5 | Sept/Oct 2000 | 1 year, 5-6 months | V | | Unrecordable | | |
| Payne | Goat | Goat #5 | Sept/Oct 2000 | 1 year, 5-6 months | V | | | D | 1-2 years |
| Grant | Goat | Goat #8 | Sept/Oct 2000 | 1 year, 5-6 months | V | | 22 | | |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Payne | Sheep | Sheep #8 | Sept 20/2000 | 5 months |  |  |  |  | | |
| Grant | Sheep | Sheep #7 | Sept 20/2000 | 5 months | m3/ g |  | c |  | C | |
| Payne | Sheep | Sheep #7 | Sept 20/2000 | 5 months |  |  |  |  | | |
| Grant | Sheep | Sheep #4 | Novembe r 21/00 | | m3/ n |  | h |  | e |  |
| Payne | Sheep | Sheep #4 | Novembe r 21/00 | |  |  |  |  |  |  |
| Grant | Goat | | Sept/Oct 2000 | 1 year, 5-6 months | P4/ E | | g |  | e |  |
| Payne | Goat | | Sept/Oct 2000 | 1 year, 5-6 months | P4/ E | |  |  |  |  |
| Grant | Goat | | Sept/Oct 2000 | 1 year, 5-6 months | m3/ m |  | f |  | d |  |
| Payne | Goat | | Sept/Oct 2000 | 1 year, 5-6 months |  |  |  |  |  |  |
| Grant | Goat | | Sept/Oct 2000 | 1 year, 5-6 months | P4/ E | | g |  | e |  |
| Payne | Goat | | Sept/Oct 2000 | 1 year, 5-6 months | P4/ E | |  |  |  |  |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Payne | Sheep | Sheep #8 | Sept 20/2000 | 5 months | | | | C | 6-12 months |
| Grant | Sheep | Sheep #7 | Sept 20/2000 | 5 months | | | 9 | | |
| Payne | Sheep | Sheep #7 | Sept 20/2000 | 5 months | | | | C | 6-12 months |
| Grant | Sheep | Sheep #4 | November 21/00 | | E | | 26 | | |
| Payne | Sheep | Sheep #4 | November 21/00 | | E | | | D | 1-2 years |
| Grant | Goat | | Sept/Oct 2000 | 1 year, 5-6 months | C | | 23 | | |
| Payne | Goat | | Sept/Oct 2000 | 1 year, 5-6 months | C | | | D | 1-2 years |
| Grant | Goat | | Sept/Oct 2000 | 1 year, 5-6 months | C | | 21 | | |
| Payne | Goat | | Sept/Oct 2000 | 1 year, 5-6 months | C | | | D | 1-2 years |
| Grant | Goat | | Sept/Oct 2000 | 1 year, 5-6 months | V | | 24 | | |
| Payne | Goat | | Sept/Oct 2000 | 1 year, 5-6 months | V | | | D | 1-2 years |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Payne | Goat | Goat #14 | Jan/Feb 2001 | 9-10 months | |  | |  | |  |
| Grant | Goat | Goat #15 | Jan/Feb 2001 | 9-10 months | m3/ n (very w |  | h |  | d |  |
| Payne | Goat | Goat #15 | Jan/Feb 2001 | 9-10 months | |  | |  | |  |
| Grant | Goat | Goat #16 | Jan/Feb 2001 | 9-10 months | P4/ U | | h |  | c |  |
| Payne | Goat | Goat #16 | Jan/Feb 2001 | 9-10 months | |  | |  | |  |
| Grant | Goat | Goat #17 | Jan/Feb 2001 | 9-10 months | M3/ n |  | Unrecordable | lingual half of tooth damaged | c |  |
| Payne | Goat | Goat #17 | Jan/Feb 2001 | 9-10 months | |  | Unrecordable | lingual half of tooth damaged | |  |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Payne | Goat | Goat #14 | Jan/Feb 2001 | 9-10 months | E | | | D | 1-2 years |
| Grant | Goat | Goat #15 | Jan/Feb 2001 | 9-10 months | C | | 23 | | |
| Payne | Goat | Goat #15 | Jan/Feb 2001 | 9-10 months | C | | | D | 1-2 years |
| Grant | Goat | Goat #16 | Jan/Feb 2001 | 9-10 months | V | | 23 | | |
| Payne | Goat | Goat #16 | Jan/Feb 2001 | 9-10 months | C | | | D | 1-2 years |
| Grant | Goat | Goat #17 | Jan/Feb 2001 | 9-10 months | E | | Unrecordable | | |
| Payne | Goat | Goat #17 | Jan/Feb 2001 | 9-10 months | E | | | D | 1-2 years |

Table 115. Hambleton (1999) Payne mandibular wear stages (MWS) and equivalent Grant stages

| | | |
|---|---|---|
| Payne MWS | Grant MWS | Suggested Age (Payne) |
| A | 1-2 | 0-2 months |
| B | 3-7 | 2-6 months |
| C | 8-18 | 6-12 months |
| D | 19-28 | 1-2 years |
| E | 29-33 | 2-3 years |
| F | 34-37 | 3-4 years |
| G | 38-41 | 4-6 years |
| H | 42-44 | 6-8 years |
| I | 45+ | 8-10 years |

Table 116. *Ovis/Capra* comparative thin sectioning collection - summary of readings

| Sample | Slide | Age | Date of Death | # of increments counted (GLGs) | Nature of final increment |
|---|---|---|---|---|---|
| Goat #1 | | 1 year, 4-5 months | Aug/Sept 2000 | indeterminable | growth zone? |
| Goat #2 | | 1 year, 4-5 months | Aug/Sept 2000 | 1GLG (partial) | no annulus/zone final |
| Goat #4 | | 1 year, 4-5 months | Aug/Sept 2000 | undeterminable | |
| Goat #6 | a | 1 year, 5-6 months | Sept/Oct 2000 | 1GLG | undeterminable |
| Goat #6 | b | 1 year, 5-6 months | Sept/Oct 2000 | 1GLG | undeterminable |
| Goat #7 | a | 1 year, 5-6 months | Sept/Oct 2000 | 1GLG | undeterminable |
| Goat #7 | b | 1 year, 5-6 months | Sept/Oct 2000 | undeterminable | |
| Goat #8 | a | 1 year, 5-6 months | Sept/Oct 2000 | 1GLG | undeterminable |
| Goat #8 | b | 1 year, 5-6 months | Sept/Oct 2000 | 1GLG | undeterminable |
| Goat #10 | a | 6-7 months | Oct/Nov 2000 | undeterminable | |
| Goat #10 | b | 6-7 months | Oct/Nov 2000 | no GLG | growth zone |
| Goat #11 | a | 6-7 months | Oct/Nov 2000 | no GLG | growth zone |
| Goat #11 | b | 6-7 months | Oct/Nov 2000 | no GLG | growth zone |
| Goat #12 | a | 8 months | December 2000 | indeterminable | indeterminable |
| Goat #12 | b | 8 months | December 2000 | no GLG | growth zone |
| Goat #13 | a | 8 months | December 2000 | undeterminable | |
| Goat #13 | b | 8 months | December 2000 | 2 annuli are formed low on the root | undeterminable |
| Goat #14 | a | 9-10 months | Jan/Feb 2001 | 0 GLG | undeterminable |
| Goat #14 | b | 9-10 months | Jan/Feb 2001 | 0 GLG | growth zone/annulus final |
| Goat #15 | | 9-10 months | Jan/Feb 2001 | 0 GLG | growth zone |
| Goat #16 | a | 9-10 months | Jan/Feb 2001 | 0 GLG | growth zone |
| Goat #16 | b | 9-10 months | Jan/Feb 2001 | 0 GLG | growth zone |
| Goat #17 | a | 9-10 months | Jan/Feb 2001 | undeterminable | |
| Goat #17 | b | 9-10 months | Jan/Feb 2001 | undeterminable | |

Table 116. (continued)

| Sample | Slide | Age | Comments |
|---|---|---|---|
| Goat #1 | | 1 year, 4-5 months | |
| Goat #2 | | 1 year, 4-5 months | |
| Goat #4 | | 1 year, 4-5 months | slide too thick |
| Goat #6 | a | 1 year, 5-6 months | reading taken at end of root |
| Goat #6 | b | 1 year, 5-6 months | reading taken at end of root |
| Goat #7 | a | 1 year, 5-6 months | reading taken at end of root |
| Goat #7 | b | 1 year, 5-6 months | root area too thick for accurate reading |
| Goat #8 | a | 1 year, 5-6 months | reading taken at end of root |
| Goat #8 | b | 1 year, 5-6 months | reading taken at end of root |
| Goat #10 | a | 6-7 months | unreadable |
| Goat #10 | b | 6-7 months | |
| Goat #11 | a | 6-7 months | |
| Goat #11 | b | 6-7 months | |
| Goat #12 | a | 8 months | |
| Goat #12 | b | 8 months | bright outer increment = annulus forming? |
| Goat #13 | a | 8 months | unreadable |
| Goat #13 | b | 8 months | reading taken at end of root |
| Goat #14 | a | 9-10 months | reading taken at end of root |
| Goat #14 | b | 9-10 months | reading taken at end of root |
| Goat #15 | | 9-10 months | tumor tooth |
| Goat #16 | a | 9-10 months | right side - bright outer increment = annulus forming? |
| Goat #16 | b | 9-10 months | number of secondary GLGs |
| Goat #17 | a | 9-10 months | unreadable |
| Goat #17 | b | 9-10 months | unreadable |

Table 117. Archaeological thin sectioning sample - summary of readings

| Sectioning Code | Site | Location | Level | Taxon | Absolute Age (from tooth wear and eruption) | # of increments counted | Nature of Final Increment |
|---|---|---|---|---|---|---|---|
| KB #1 | Kadica Brdo | Highland | 4 | *Ovis aries* | 3-4 years | unreadable | |
| KB #2 | Kadica Brdo | Highland | 24 | *Ovis/Capra* | 2-3 years | 2 GLG | growth zone |
| KB #3 | Kadica Brdo | Highland | 23 | *Ovis aries* | 1-2 years | 1 GLG | indeterminate |
| KB #4 | Kadica Brdo | Highland | 12 | *Ovis aries* | 4-6 years | 6 GLG | growth zone |
| KB #5 | Kadica Brdo | Highland | 1 | *Ovis aries* | 6-8 years | unreadable | |
| KB #6 | Kadica Brdo | Highland | 16 | *Ovis aries* | 4-6 years | 5 GLG | growth zone |
| KB #7 | Kadica Brdo | Highland | 24 | *Ovis aries* | 2-3 years | unreadable | |
| KB #8 | Kadica Brdo | Highland | 3 | *Capra hircus* | 6-12 months | 1 GLG | indeterminate |
| KB #9 | Kadica Brdo | Highland | 25 | Possible goat | 3-4 years | unreadable | |
| KB #10 | Kadica Brdo | Highland | 13 | *Ovis aries* | 6-12 months | 0 GLG | growth zone |
| V #1 | Vinca | Lowland | 6 | *Capra hircus* | 6-8 years | 9 GLG | possible annulus final |
| V #2 | Vinca | Lowland | 6 | *Ovis aries* | 4-6 years | Tooth completely broken during extraction | |
| V #3 | Vinca | Lowland | 5 | *Ovis aries* | 8-10 years | unreadable | |
| V #4 | Vinca | Lowland | 6 | *Ovis aries* | 4-6 years | unreadable | |
| V #5 | Vinca | Lowland | 6 | *Capra hircus* | 6 months - 4 years | unreadable | |
| V #6 | Vinca | Lowland | 5 | *Ovis aries* | 4-6 years | 4 GLG | possible annulus final |
| V #7 | Vinca | Lowland | 5 | *Ovis aries* | 2-3 years | unreadable | |
| V #8 | Vinca | Lowland | 5 | *Capra hircus* | 6-8 years | unreadable | |
| V #9 | Vinca | Lowland | 5 | *Ovis aries* | 1-2 years | 1 GLG | indeterminate |
| V #10 | Vinca | Lowland | 5 | *Ovis/Capra* | 3-10 years | 8 GLG | possible annulus final |

Table 118. Summary of Seiving and Weathering

| Site | Percentage Sieved | | | | | | Age class present (Ovis/Capra) | | | Age Class Present (Bos taurus) | | | Age class present (Sus scrofa) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 0 | 1-10 | 11-25 | 26-50 | 51-75 | 76-100 | 0-2 month | 2-6 month | 6-12 month | 0-1 month | 1-8 month | 8-18 month | 0-2 month | 2-7 month | 7-14 month |
| Blagotin | | | | 50 | | | x | x | x | x | x | x | no data | no data | no data |
| Foeni-Salaş | | | | | | 85 | x | x | x | x | x | x | no data | no data | no data |
| Kadica Brdo | | 10 | | | | | x | x | x | x | 0 | x | x | x | x |
| Kozani | | | | | | 100 | x | x | x | no data | no data | no data | no data | no data | no data |
| Livade | 0 | | | | | | 0 | 0 | 0 | 0 | 0 | x | 0 | x | x |
| Ljuljaci | 0 | | | | | | no data | no data | no data | 0 | x | x | 0 | x | x |
| Novačka Ćuprija | | | | | | 100 | 0 | x | x | | | | 0 | x | x |
| Opovo | 0 | | | | | | no data | no data | no data | 0 | x | x | 0 | x | x |
| Petnica | | | 20 | | | | 0 | x | x | x | x | x | x | x | x |
| Stragari | 0 | | | | | | 0 | x | x | x | 0 | x | 0 | 0 | 0 |
| Vinča | 0 | | | | | | 0 | x | x | x | x | x | 0 | x | x |

Table 119. Expectations for movement in transhumant pattern

| | | | |
|---|---|---|---|
| *Ovis/Capra* | Age class | | |
| | 0-2 | 2-6 month | 6-12 month |
| Lowland | Present | Absent | Present |
| Mid-altitude | Absent | Present | Absent |
| Highland | Absent | Present | Absent |
| | | | |
| *Bos taurus* | Age Class | | |
| | 0-1 | 1-8 months | 8-18 months |
| Lowland | Present | Absent | Present |
| Mid-altitude | Absent | Present | Absent |
| Highland | Absent | Present | Absent |

| Table 120. Statistical analysis data - Late Neolithic *Sus scrofa* | | | |
|---|---|---|---|
| | | | |
| Suggested Age | Late Neolithic Petnica | Late Neolithic Vinča | Late Neolithic Opovo |
| 2-7 months | 2 | 6 | 2 |
| 7-14 months | 4 | 11 | 2 |
| 14-21 months | 6 | 13 | 4 |
| 21 months - senile | 1 | 2 | 3 |
| | | | |
| $X^2$ = 4.431 with 6 degrees of freedom | | | |
| Exact p-value = 0.6486 | | | |
| "Usual" p value = 0.6185 | | | |

| Table 121. Statistical analysis data - Bronze Age *Sus scrofa* | | | |
|---|---|---|---|
| | | | |
| Suggested Age | Early Bronze Age Novačka Ćuprija | Early/Middle Bronze Age Ljuljaci | Middle Bronze Age Vinča |
| 2-7 months | 1 | 1 | 1 |
| 7-14 months | 1 | 1 | 6 |
| 14-21 months | 4 | 7 | 9 |
| 21 months-senile | 4 | 11 | 3 |
| | | | |
| $X^2$ = 9.315 with 6 degrees of freedom | | | |
| Exact p value = 0.1499 | | | |
| "Usual" p value = 0.1566 | | | |

| Table 122. Statistical analysis data - comparison of major periods (*Sus scrofa*) | | | |
|---|---|---|---|
| Suggested Age | Late Neolithic Petnica | Eneolithic Petnica | Early Bronze Age Novačka Ćuprija |
| 2-7 months | 2 | 4 | 1 |
| 7-14 months | 4 | 0 | 1 |
| 14-21 months | 6 | 4 | 4 |
| 21months–senile | 1 | 2 | 4 |
| | | | |
| $X^2$ = 9.396 with 9 degrees of freedom | | | |
| Exact p value = 0.4147 | | | |
| "Usual" p value = 0.4016 | | | |

| Table 123. Statistical analysis data - Early Neolithic *Ovis/Capra* | | |
|---|---|---|
| | | |
| Suggested Age | Early Neolithic Foeni-Salaş | Early Neolithic Blagotin |
| 2-6 months | 2 | 1 |
| 6-12 months | 16 | 14 |
| 1-2 years | 13 | 26 |
| 2-10 years | 18 | 44 |
| | | |
| $X^2$ = 6.501 with 3 degrees of freedom | | |
| Exact p value = 0.0870 | | |
| "Usual" p value = 0.0896 | | |

| Table 124. Statistical analysis data - Late Neolithic *Ovis/Capra* | | |
|---|---|---|
| | | |
| Suggested Age | Late Neolithic Vinča | Late Neolithic Petnica |
| 2-6 months | 1 | 0 |
| 6-12 months | 8 | 4 |
| 1-2 years | 6 | 4 |
| 2-10 years | 19 | 11 |
| | | |
| $X^2$ = 0.6755 with 3 degrees of freedom | | |
| Exact p value = 0.9523 | | |
| "Usual" p value = 0.8790 | | |

| Table 125. Statistical analysis data - Eneolithic *Ovis/Capra* | | |
|---|---|---|
| | | |
| Suggested Age | Eneolithic Petnica | Eneolithic Novačka Ćuprija |
| 2-6 months | 0 | 0 |
| 6-12 months | 6 | 0 |
| 1-2 years | 3 | 1 |
| 2-10 years | 3 | 8 |
| | | |
| $X^2$ = 9.028 with 2 degrees of freedom | | |
| Exact p value = 0.0480 | | |
| "Usual" p value = 0.0110 | | |

| Table 126. Statistical analysis data - Early/Middle Bronze Age *Ovis/Capra* | | |
|---|---|---|
| | | |
| Suggested Age | Early Bronze Age Novačka Ćuprija | Middle Bronze Age Vinča |
| 2-6 months | 1 | 0 |
| 6-12 months | 1 | 3 |
| 1-2 years | 11 | 7 |
| 2-10 years | 18 | 13 |
| | | |
| $X^2$ = 2.566 with 3 degrees of freedom | | |
| Exact p value = 0.4857 | | |
| "Usual" p value = 0.4634 | | |

| Table 127. Statistical analysis data - Late Bronze Age *Ovis/Capra* | | | |
|---|---|---|---|
| | | | |
| Suggested Age | Late Bronze Age Petnica | Late Bronze Age Novačka Ćuprija | Late Bronze Age Livade |
| 2-6 months | 1 | 0 | 0 |
| 6-12 months | 2 | 1 | 0 |
| 1-2 years | 0 | 2 | 1 |
| 2-10 years | 9 | 13 | 10 |
| | | | |
| $X^2$ = 6.007 with 6 degrees of freedom | | | |
| Exact p value = 0.4224 | | | |
| "Usual" p value = 0.4712 | | | |

| Table 128. Statistical analysis data - Early Neolithic *Bos taurus* | | |
|---|---|---|
| | | |
| Suggested Age | Early Neolithic Blagotin | Early Neolithic Foeni-Salaş |
| 1-8 months | 3 | 1 |
| 8-18 months | 12 | 3 |
| 18-30 months | 23 | 2 |
| 30 months-senile | 30 | 8 |
| | | |
| $X^2$ = 2.147 with 3 degrees of freedom | | |
| Exact p value = 0.5559 | | |
| "Usual" p value = 0.5425 | | |

| Table 129. Statistical analysis data - Early Neolithic *Bos* vs. *Ovis/Capra* | | |
|---|---|---|
| | | |
| Suggested Age | *Bos taurus* | *Ovis/Capra* |
| 1-8 months | 4 | 3 |
| 8-18 months | 15 | 30 |
| 18-30 months | 25 | 39 |
| 30 months-senile | 38 | 62 |
| | | |
| $X^2$ = 1.536 with 3 degrees of freedom | | |
| Exact p value = 0.6865 | | |
| "Usual" p value = 0.6740 | | |

| Table 130. Statistical analysis data - Middle Neolithic *Bos taurus* | | |
|---|---|---|
| | | |
| Suggested Age | Middle Neolithic Stragari | Middle Neolithic Petnica |
| 1-8 months | 0 | 0 |
| 8-18 months | 7 | 1 |
| 18-30 months | 4 | 8 |
| 30 months-senile | 15 | 11 |
| | | |
| $X^2$ = 5.764 with 2 degrees of freedom | | |
| Exact p value = 0.0440 | | |
| "Usual" p value = 0.0560 | | |

| Table 131. Statistical analysis data - Late Neolithic *Bos taurus* | | | |
|---|---|---|---|
| Suggested Age | Late Neolithic Petnica | Late Neolithic Opovo | Late Neolithic Vinča |
| 1-8 months | 1 | 0 | 1 |
| 8-18 months | 1 | 0 | 1 |
| 18-30 months | 6 | 7 | 6 |
| 30 months-senile | 10 | 6 | 5 |
| | | | |
| $X^2$ = 3.074 with 6 degrees of freedom | | | |
| Exact p value = 0.8342 | | | |
| "Usual" p value = 0.7995 | | | |

| Table 132. Statistical analysis data – summary of periods *(Ovis/Capra)* | | | | |
|---|---|---|---|---|
| Suggested Age | Late Neolithic | Eneolithic | Early Bronze Age | Early Iron Age |
| 2-6 months | 1 | 0 | 1 | 1 |
| 6-12 months | 12 | 6 | 4 | 25 |
| 1-2 years | 10 | 4 | 18 | 40 |
| 2-10 years | 30 | 11 | 31 | 140 |
| | | | | |
| Late Neolithic vs. Eneolithic | | | | |
| $X^2 = 0.6623$ with 3 degrees of freedom | | | | |
| Exact p value = 0.9165 | | | | |
| "Usual" p value = 0.8820 | | | | |
| | | | | |
| Late Neolithic vs. Early Bronze Age | | | | |
| $X^2 = 6.293$ with 3 degrees of freedom | | | | |
| Exact p value = 0.0823 | | | | |
| "Usual" p value = 0.0982 | | | | |
| | | | | |
| Late Neolithic vs. Early Iron Age | | | | |
| $X^2 = 5.164$ with 3 degrees of freedom | | | | |
| Exact p value = 0.1434 | | | | |
| "Usual" p value = 0.1602 | | | | |

| Table 133. Statistical analysis data - summary of periods (*Bos taurus*) | | | | |
|---|---|---|---|---|
| Suggested Age | Late Neolithic | Eneolithic | Early Bronze Age | Early Iron Age |
| 1-8 months | 2 | 0 | 3 | 0 |
| 8-18 months | 2 | 2 | 6 | 3 |
| 18-30 months | 19 | 5 | 3 | 14 |
| 30 months - senile | 21 | 5 | 14 | 25 |
| | | | | |
| Late Neolithic vs. Eneolithic | | | | |
| $X^2$ = 2.564 with 3 degrees of freedom | | | | |
| Exact p value = 0.4323 | | | | |
| "Usual" p value = 0.4637 | | | | |
| | | | | |
| Late Neolithic vs. Early Bronze Age | | | | |
| $X^2$ = 11.36 with 3 degrees of freedom | | | | |
| Exact p value = 0.0073 | | | | |
| "Usual" p value = 0.0099 | | | | |
| | | | | |
| Late Neolithic vs. Early Iron Age | | | | |
| $X^2$ = 3.261 with 3 degrees of freedom | | | | |
| Exact p value = 0.3709 | | | | |
| "Usual" p value = 0.3532 | | | | |

Table 134. Summary of strata and weathering

| Site | Superimposed strata | Weathering |
|---|---|---|
| | | |
| Blagotin | Deep | Low weather |
| Foeni-Salaş | Shallow | Medium weathering |
| Kadica Brdo | Deep | Low weather |
| Kozani | Deep | Low weather |
| Livade | Shallow | Very high weathering, except in deep pits |
| Ljuljaci | Shallow | Medium weathering |
| Novačka Ćuprija | Shallow | Medium weathering |
| Opovo | Deep | Low weather |
| Petnica | Deep | Low weather |
| Stragari | Deep | Low weather |
| Vinča | Deep | Low weather |