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PALEOECONOMY OF THE CENTRAL BALKANS - A ZOOARCHAEOLOGICAL PERSPECTIVE ON THE LATE NEOLITHIC AND BRONZE AGE

Greenfield, Haskel Joseph, Ph.D.
City University of New York, 1985

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PALEOECONOMY OF THE CENTRAL BALKANS - A ZOOARCHAEOLOGICAL PERSPECTIVE ON THE LATE NEOLITHIC AND BRONZE AGE

by

HASKEL J. GREENFIELD

A dissertation submitted to the Graduate Faculty in Anthropology in partial fulfillment of the requirements for the degree of Doctor of Philosophy, The City University of New York.

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ABSTRACT

PALEOECONOMY OF THE CENTRAL BALKANS - A ZOOARCHAEOLOGICAL PERSPECTIVE ON THE LATE NEOLITHIC AND BRONZE AGE.

by

Haskel J. Greenfield

Advisor: Thomas H. McGovern

The onset of the Bronze Age in eastern Europe was a time of dramatic change. The archaeological record is full of examples of changes in settlement patterns, mortuary practices, and artifactual inventories. Many explanatory models have been proposed for the seeming upheaval at the end of the Neolithic, including migration, diffusion, and local evolution. However, most have failed to integrate shifts in the subsistence base into descriptions of this transformation. This is largely due to the dearth of subsistence-related data. The implications of these explanatory models will be explored in this thesis. Newly gathered zooarchaeological data from several seasons of research in Yugoslavia on late Neolithic and Bronze Age sites will be presented, with particular attention to the interrelationship between subsistence and settlement. It is argued that the economic and settlement strategies practiced

during the Late Neolithic were fundamentally different from those during the Bronze Age. In the former, the emphasis in animal exploitation was placed upon "primary" products, such as meat and hide. Herds of domestic animals were grazed within a limited range of altitudinally differentiated environments. Lowland herders were not moving their herds far into the highlands during warmer times of the year. In contrast, during the Eneolithic and Bronze Age, herding strategies shifted toward the explcitation of "secondary" products, such as milk, wool, and traction. Herds of domestic animals were moved from lowland to highland pastures as part of an annual transhumant trek. The movement of herds was timed tc coincide with the appearance of richer pastures or forage in the higher altitudes as the temperature warmed. Herds were moved down into the more protective lowlands for the winter. At the same time, exploitation of wild resources decreases, but not uniformly across the region. Lowland sites, except in particularly rich micro-environments (such as on the Danube), contain very few wild animal remains. In contrast, highland localities continue to exploit wild animals as important supplements to the subsistence system. These findings were particularly important because they signal the advent of a pattern of animal management that persisted from the advent of the Bronze Age into modern times.

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Abbreviations used in text, illustrations and tables

Elements:
Ant/Hor - loose, unattached horn or antler fragments
Cra+Ant - cranial elements with horn or antler still attched
Cran - cranial elements, with the exception of horn or antler
Max - maxillae, with and/or without teeth
Man - mandibles, with and/or without teeth
Teeth - loose teeth
PC - post-cranial limb bones
Vert - vertebrae
C Vert - cervical vertebrae
LVert - lumbar vertebrae
Sacr - sacrum
Rib - rib(s)
LB - long bone
Scap - scapula
Hum - humerus
Rad - radius
MC - metacarpus
Carp - carpal
Acet - acetabulum
Pel - pelvis
Isch - ischium
Ili - ilium
Fem - femur
Tib - tibia
MT - metatarsus
Astr - astragalus
Calc - calcaneus
MP - metapodial
Pha 1- phalanx 1
Frag - fragment
? - unknown

Part:
P - proximal
S - shaft
D - distal
W - whole
C - cranial

Age groups:
? - unknown
Im - immature
F/I - foetal/infantile
I - infant
I/J - infant/juvenile
J - juvenile
J/S - juvenile/sub-adult
S - sub-adult
S/A - sub-adult/adult
A - adult
Tot - total

Sites:
A - Anza
A IV - Anza IV
C - Crkvina
D - Divostin
D IV - Divostin IV
F - Franchthi
G - Gomolava
L - Livade
LP - Livade pits
LS - Livade sloj
Lj - Ljuljaci
Ljul - Ljuljaci
Nov Cup - Novačka Ćuprija
NB - Novačka Ćuprija Eneolithic
NE - Novačka Ćuprija Early Bronze Age
NL - Novačka Ćuprija Late Bronze Age
O - Opovo
OB - Obre
OB II - Obre II
PB - Petnica Eneolithic
PV - Petnica Vinca
PL - Petnica Late Bronze Age
PVA - Petnica Eneolithic, all fragments
PVB - Petnica Eneolithic, only post-cranial fragments
Sar Med - Sarina Medja
SM - Sarina Medja
V - Vrbića
VM - Večina Mala
VMala - Večina Mala

Periods:
V - Vinča
E, En, Eneo - Eneolithic
E/MBA - Early/Middle Bronze Age
EBA - Early Bronze Age
MBA - Middle Bronze Age
LBA - Late Bronze Age

Contexts:
S - sloj
P - pits

Sex:
♂ - male
♀ - female

% - percentage of
N, no, n - number of

CHAPTER 1: INTRODUCTION TO THE PROBLEM

I. INTRODUCTION

The onset of the Bronze Age in eastern Europe was a time of dramatic change. The archaeological record is full of examples of changes in settlement patterns, mortuary practices, and artifactual inventories. Many explanatory models have been proposed to account for the seeming upheaval at the end of the Neolithic, including migration (population replacement), diffusion, and/or local evolution. However, most have failed to integrate shifts in the subsistence base into descriptions of this fundamental transformation. This is largely due to the dearth of subsistence-related data available outside of Hungary. The implications of these explanatory models will be explored in this thesis. Newly gathered data relating to Bronze Age subsistence will be presented as tests of current models. This research will begin to provide the basis for understanding the nature and extent of changes in the paleoeconomy (cf. Higgs 1975) of the area between the late Neolithic and Bronze Age. Only one aspect of the prehistoric economy will be addressed - animal husbandry and exploitation.

Southeastern Europe (Ill. 1) is thought to be the first region with a temperate climate to have developed or received domesticated plants and animals. Initial introduction was followed by intensification of production through the exploitation of the secondary products of domestic animals (Sherratt 1980b). As the earliest center of change outside of the Near East, southeastern Europe is an important source of comparative data in understanding the ramifying influences of domestication and intensification of agricultural production upon cultural and environmental systems. The evolution of complex systems of land use and the increased intensification of food production systems are phenomena that are still little understood. Generation of behavioral models can contribute toward a greater understanding of human-animal interactions, of how these interactions have changed over time, and of the eventual effects they have had upon other aspects of cultural systems.

In order to evaluate the models to be presented below, I have been collecting faunal data from a number of archaeological localities in the region since 1977. The data to be discussed in this thesis were collected between 1977-1982. Fieldwork has continued since then and the new data are currently undergoing analysis. The systematic analysis of the animal bones excavated from

archaeological sites in the Central Balkans has only recently been undertaken. The pioneering works of Dr. Sandor Bökönyi (1971b; 1974b; 1976; 1978a; n.d.), followed by those of Dr. A. T. Clason (1979; 1980), have provided a basic outline of some of the changes taking place during the Mesolithic, Neolithic and late Iron Age (La Tene) periods of the region. However, due to the extremely complex nature of the archaeological record in this region and rarity of such analyses until recently, our understanding of the early economies of this geographically complex and important region remains sketchy. This situation is compounded by the focus of most excavations upon the more spectacular Bronze Age mortuary remains (e.g. Bukvić 1979; Ecsedy 1979) to the neglect of settlements. Most Bronze Age settlements are poor by comparison. My fieldwork was begun as part of the response to the recognition of this obvious lacuna in the settlement data base. Crkvina and Novačka Ćuprija were excavated by a joint Yugoslavian-American team in 1977 and 1980 (Bankoff and Winter 1982; Bankoff, Winter and Greenfield 1980). The faunal assemblages were examined in 1980, while those from Livade, Opovo, Sarina Medja, Večina Mala, Vrbica, Ljuljaci and Petnica were analyzed during 1982. In between these two periods of research, I spent a period of time refining my technique of species identification with Dr. Sandor Bökönyi

in Budapest. Several additional assemblages were examined in 1982, but were not included in this study. They were either from an inappropriate time pericd (Hajdučka Vodenica and Bukovče Ćesma - early Neolithic Starcevo sites: Greenfield in press - and Medieval layers from Szekesferhevar, Hungary), did not produce reasonably comparable samples (Jela-Šabać) or were made available only for unpublished comparative use (Vinča-Belo Brdo).

This chapter will present and evaluate a series of explanatory and predictive models leading to economic change in the central Balkans at the onset of the Bronze Age (c. 2800 B.C. - cf. Bankoff n.d.). In contrast to prior studies conducted on this period and region which have focused upon methodological issues, such as time-space systematics, and which assume that change in the cultural inventory may be traced to population migration and displacement, this research has utilized an ecological-evolutionary perspective employing multi-causal explanations and hypothesis-testing (Flannery 1972; Sanders & Webster 1978). This systematic approach can offer alternative explanations for change in this area and should contribute to a greater understanding of the complex interaction of culture and environment. One of the other major objectives of this research was to demonstrate the utility of evaluating faunal assemblages within the total archaeological context, rather than in

relative isolation. If the analysis of animal bones is ever to contribute directly to brcader research questions, such as the integration of regional settlement and subsistence systems and/or socio-cultural change, it must be integrated into the total range of behavioral information available in the archaeological record.

II. FINAL NEOLITHIC-BRONZE AGE DIFFERENCES: THE PROBLEM

The realization that the central Balkans, in general, and central Serbia, in particular (Ill. 2)) would be particularly apprcpriate for the investigation of these problems grew out of the results of a season of site survey and excavation in the lower Morava Valley of north-central Yugoslavia in 1977 (Bankoff, Winter and Greenfield 1980). While surveying and testing later prehistoric sites in the Jasenica drainage of the Lower Morava region of north-central Serbia (Ill. 4) during 1977, several differences became apparent and for the first time could be quantified between the known late Neolithic Vinča-Pločnik (or Vinca C/D) phase sites (c. 4100-3300 B.C.) and those of the Bronze and Iron Ages (c. 2800-500 B.C.) in the area (Bankoff and Greenfield 1985).

The Thomsen tripartite age system (Stone, Bronze and Iron) with minor addition remains in full use in the Balkans and tends to hide real continuity between the phases. The archaeological cultural sequence has been most recently summarized by Garašanin (1983 - for the central Balkans), Basler et al (1979-1981 - for all of Yugoslavia), and Chapman (1981 - for the length and breadth of the Vinča culture). It includes those cultures known locally as Vinča-Pločnik (Late Neolithic), Bubanj-Hum (late Neolithic-Bronze Age), Baden-Kostolac-Vučedol (Eneolithic), Vinkovci (Early Bronze Age), Cmoljica-Pančevo, Vatin-Vršac (late Early Bronze-Middle Bronze Age), Slatina (Early Bronze Age), Dubovac-Žuto Brdo, Mediana (Middle-Late Bronze Age), Paracin (Middle-Late Bronze Age), Halstatt A (Late Bronze Age), Gava (transitional Iron Age) and Bosut (Early Iron Age) - see table 1. Many of these groupings represent local ceramic stylistic variations of larger style horizons. For example, the Dubovac-Žuto Brdo (Middle/Late Bronze Age) ceramic group is part of the larger Bronze Age incrusted ware horizon found along the middle Danube (cf. Brukner, Jovanović and Tasić 1974; Letica 1973). For the purposes of this chapter, this list of local archaeological cultures will be divided into two groups: late Neolithic and post-Neolithic. This will enhance the distinctions between the two temporal extremes of this continuum. By increasing the

sample size, I am allowing for a better comparative base from which change can be observed. In later chapters, the various sites and phases will be subdivided into finer chronological units. Archaeological "cultures" are not meant to imply a population as in the early Germanic tradition, but rather a re-occurring complex of artifactual traits (cf. Childe 1950). All dates presented here will be based upon corrected and calibrated radiocarbon determinations (5730 years half life and MASCA calibration), unless otherwise noted. The prehistoric chronology (absolute and relative) of the Balkans is extremely complex and not yet completely worked out. Several conflicting systems are in constant use. Rather than attempt to evaluate their relative utility and resolve conflicts between the available systems, I have chosen for simplicity sakes to use the calibrated chronologies recently discussed in Chapman (1981), Bankoff (n.d.), and Ehrich and Bankoff (n.d.). It should be noted that while the archaeologically-based determinations are being calibrated by these researchers, virtually no work has been done upon the geologically-based dates for the various climatic phases in the Holocene. As a result, the two chronologies are somewhat out of phase. At this point in time, it would be of little use to calibrate the radiocarbon determinations of the Holocene climatic phase because they are based upon

northern European data. As Kordos (1978a; 1978b) has already noted, the northern and central European climatic sequences are not completely synchronous. Often events seen in northern Europe appear several hundred years earlier in central Europe. Until a complete radiocarbon-anchored chronology for the central and southeastern Europe are available, it would be of little use to calibrate the periods based upon northern European dates. As a result, I will present the environmental dates as corrected, but uncalibrated.

The first difference between the periods is that while ceramic and lithic artifacts attributable to the Starčevo (early Neolithic), Baden/Kostolac (Eneolithic), Slatina (Early Bronze Age), Paracin (Middle/Late Bronze Age), Bosut (Early Iron Age), and Roman phases were found on one or more of the surveyed sites, only a single stray sherd attributable to the Vinca period was recovered. In addition, Vinča-Pločnik phase sites, both within and outside of our survey area (e.g. Medvenjak, Selevac, Divostin, Gomolava, Pločnik, Vinča) did not yield evidence of large-scale intensive occupation in the later periods. At Vinča, several strata of Eneolithic and Bronze Age deposits were found. However, they were characterized by pits and amorphous cultural strata (lacking substantial architecture). They are in strong contrast to the late

Neolithic levels (see 3rd difference). An exception to this pattern may be the substantial Eneclithic levels at Gomolava, but the Bronze Age layers follow the above pattern (Brukner 1979; Brukner, Jovanović and Tasić 1974). This seemingly exclusive distributicn suggests that site location criteria for Vinča-phase localities differed from those of later phases in the region.

Second, Bronze Age sites in the survey area are more closely spaced than the later Neolithic sites. The survey indicated that several Bronze Age sites may occur per small stream valley. This is in contrast to the apparent Vinca pattern of one large site per major valley. For example, there are at least twc contemporary Bronze Age localities on the Novacki Potok north of Smederevska Palanka (Ill. 4 - Novačka Ćuprija and Ive). They are approximately 5 km. distant from each other. One-half km. from Ive and c. 6 km. from Novacka Cuprija are found two other possibly contemporary Bronze Age localities (Crkvina and Vrela, respectively - Bankoff and Winter 1982; Bankoff, Winter and Greenfield 1980). In contrast, there are only two larger Vinča settlements known within the entire area of the preliminary survey: Medvenjak and Selevac (Tringham 1971; Tringham et al 1980). Each cf the late Neolithic sites lies within its own river drainage system, as compared with at least eight known Bronze/Iron Age sites, within a

single drainage system, which cover a time period of roughly equivalent duration. Chapman (1981) notes the existence of a few smaller Vinča sites further up the Jasenica, outside of the survey area. Also, several additional Bronze Age localities that were not examined during the survey are noted in the records of the Narodni Muzej of Smederevska Palanka (e.g. around Jerinin Grad). It would appear that the large Vinca sites (on the basis of their size, number and location) may have been functioning as central localities for a variety of smaller settlements, but this remains hypothetical in the absence of systematic regional surveys.

Third, many of the Vinča-phase sites often show relatively deeper, stratigraphically superimposed deposits and structures, and, as a result, better feature preservation and a higher artifact and feature density over rather large areas (ca. 800,000 sq. m. at Selevac). Over 15% of all Vinča sites with both early and late Vinča strata exceeded 4 m. in depth, while the distribution of all known Vinča stratigraphies peaked at 100-145 cm.

> "Vinča occupations were generally more settled and for that reason more substantial building materials were used, leading to incorporation of more debris into deeper stratigraphies" (Chapman 1981: 47).

In contrast, the Bronze Age settlements are essentially shallow (usually 50 cm. or less of undisturbed occupational deposits, excluding pits and disturbed plow zones (e.g. Ljuljaci, Petnica, Novačka Ćuprija, Crkvina, Vrela, Ive, Vinča, etc.), with: a) features in the sub-humus layer easily disturbed by ancient and modern plowing; b) insubstantial wattle-and-daub architecture; c) rarely more than one vertically definable stratum or occupation level; and d) horizontally displaced stratigraphy. They are spatially extensive and have low surface and subsurface artifact densities.

Fourth, later Neolithic sites like Divostin and Grivac (McPherron and Ralph 1970), Banjica (Glisić 1968; Peresić 1980), Vinča (Vasić 1932-36; Chapman 1981) and Gomolava (Brukner, Jovanović and Tasić 1974: 73; Petrovic 1982) and many others (Chapman 1981: 60) provide well-documented evidence for large, internally well-organized communities with contemporanecus houses arranged more or less in regular rows. No such crganized distribution of structures is known from Bronze Age sites in the same region, with the possible exception of Ljuljaci (in many ways a unique locality for the pericd - see chap. 6). It also appears that smaller areas on the sites were occupied at any one time in the Brcnze Age than during the later Neolithic.

The period from the end of the late Neolithic Vinča-Pločnik phase to the beginning of the Bronze Age, therefore, represents a crucial transition period (Tringham 1971: 206-207; Sherratt 1976; 1980a; 1980b) in which the prehistoric sccieties of the central Balkans underwent a dramatic systemic reorganization (cf. Bankoff and Greenfield 1985). The full significance of the data possibly bearing upon settlement distributions is difficult to assess in the absence of systematic regional surveys. Nevertheless, it may be inferred that the data do indicate an apparent demcgraphic redistribution from one of high intrasettlement population density and size, with regional population heavily concentrated in large settlements, to a pattern of low intra-settlement population density and size, and population dispersion into a larger number of more closely spaced residential localities. The population does not appear to have undergone a decline, but has been redistributed over the landscape. The largest settlements have broken up and their pcpulation dispersed to the countryside. The smaller village- and homestead-size sites continue to exist, but usually in different locations. Some large sites continue to show post-Neolithic occupation, but of a much reduced nature.

This is not the only documented example of disintegration of selected levels cf settlement hierarchies. One example

is post-Roman Britain. In this case, the Romanized urban centers fell into decay as the empire withdrew support and the "civitates" were left to fend for themselves (Hodges and Whitehouse 1982: 82). However, rural life continued unabated (Crabtree 1982; Finberg 1972). Another example comes from Mycenaean Greece. In this case, the palace complexes were abandoned, but the rural countryside remained populated (Bintliff 1977). A third example of selective site size depopulation comes from late Roman Italy. Urban centers, such as Rome, continued to be fully populated, while the rural countryside (i.e. in Etruria) underwent decline from the 2nd and 3rd centuries A.D. onward. Depopulation was not caused by the breakup of the empire in the fifth century. It was a function of the disastrous economic policies of the late empire which discouraged investment in agricultural production. By the time the Vandals arrived, the countryside was already largely abandoned (Hodges and Whitehouse 1982: 38).

III. MODELS OF CULTURAL CHANGE

IIIA. Migration/Invasion Models

Various models of cultural change have been proposed for the late Neolithic/Bronze Age juncture. The most widely known is that of the "migration" or "invasion" hypothesis (e.g. Gimbutas 1956; 1965; 1970; 1973; 1977; Garašanin 1973; 1983: 141; Brukner, Jovanović and Tasić 1974; Kovac 1977). In this hypothesis, waves of nomadic pastoralists (also known as "Kurgans") from the steppes of southern Russia sweep across the face of prehistoric Europe leaving a path of destruction in the wake of their conquests. Eventually, they settle in various regions as "patriarchal" overlords stimulating the development of warrior aristocracies and pastoral economies. The indigenous peoples of the newly conquered territories are partially displaced. The remainder mix with the conquerors merging both "old" and "new" European traditions. The supposedly late Neolithic hoe cultivating "matriarchially"-organized societies were replaced by plough cultivators, mobile warrior horsemen and "patriarchal" societies.

This model is based, originally, upon paleo-linguistic research (philology) and clearly relies upon historical analogies (Daniel 1962: 108ff; Sherratt 1973). Research in comparative philology during the 19th and 20th centuries on

the origin of the Indo-European language family group has suggested a common geographic point of origin somewhere in the steppes north of the Black Sea (Crossland 1971: 868). This conclusion is based upon the presence in widely separated Indo-European languages (including modern and early historic languages - e.g. Hittite) of words in common that describe such an environment. It is assumed that the peoples using this language group expanded "...by actual migrations..." from a single or series of closely related core areas (Crossland 1971: 824-826). The historic pattern of nomadic groups moving from the steppes into eastern and western Europe (e.g. Magyars, Huns, etc.), disrupting and conquering established orders (e.g. Roman and Byzantine empires) provided the model for such an assumption. The Indo-Europeans and their language arrived on the back of a horse, with sword in hand. The philological data perfectly complemented the historical invasion data by providing the necessary background support for such prehistoric population movements.

There are several problems with this approach. First, it is very difficult to see prehistoric tribes on the move. This model assumed that if their linguistic behavior leaves such tell-tale marks, then other features of cultural behavior may have been left behind. However, this ignores the fact that a single geographic origin for the Indo-European language families remains a simple unproven

assumption. Not all linguists are in agreement that the Indo-Europeans migrated into the Balkan peninsula. Some have argued that they may have existed in the region during the Neolithic based upon toponymic research (e.g. see Garasanin 1983: 142 and references). In fact, the so-called "homeland" has not been pinpointed with accuracy greater than the circum-pontic region. The Indo-European language family may have

> "...come from a zone extending from south-eastern Europe across the southern Pontic area and perhaps as far as Kazakhstan in the east" (Crossland 1971: 859).

Obviously, the situation is extremely complex and fraught with pitfalls. Also, movement of languages across space need not always involve the corresponding movement of large numbers of people nor need the spread be always warlike.

Second, the evidence brought to bear to support this theory is determined by the assumption that the invaders retained certain of the more conservative cultural elements in their new homes and lifestyles. For example, burial rite, ceramic forms and decorative motifs are frequently cited (Gimbutas 1977; Sherratt 1973: 420). Similarities between burial rite and ceramic form and motifs are drawn between those found in the Russian steppes and those from eastern Europe. There are several problems with this assumption. In the first place, assuming that burial rites

in two widely separated regions can be automatically explained by the same mortuary behavior is unwarranted (cf. Ucko 1969). Second, the use of archaeological data to support paleo-linguistic hypotheses can lead to tautological reasoning - "the Indo-Europeans migrated out of a core area, destruction levels are found in neighboring regions at the appropriate time, therefore, they were caused by the Indo-Europeans". However, alternative explanations for similarities in artifactual inventories and other aspects of paleo-human behavior between the two regions need to be fully considered - i.e. independent invention, diffusion, trade, etc. Migration may be considered the least likely of explanations, one which requires the greatest energy output on the part of the participants and one which is loathed even among modern peoples. Picking up and moving to a new and unfamiliar locale is a costly alternative and is rarely accomplished under pleasant circumstances. It is normally a reaction to stress on the part of the individual, group and/or system. Demonstrating that it is the most likely of explanations falls to its proponents rather than to its detractors.

There are several examples of the lack of correspondence between change in material culture and population. One example comes from early historic Nubia. Stylistic change in ceramics were unrelated to dramatic historically known

cultural changes. The Islamic revolution came and went with little effect upon ceramic inventories (Adams 1968; 1979). Another example is the replacement in post-Roman Britain of British by an Anglo-Saxon linguistic system. This change was traditionally explained as a result of large-scale population replacement of Celtic-speaking Romano-Britons by Anglo-Saxons. However, the archaeological data point toward a continuation of the Romano-British rural economy and, by implication, people (Crabtree 1982; Finberg 1972; Stuckert n.d.). A third example is the shift from a Sumerian to a Semitic based linguistic system in lower Mesopotamia at the end of the Ur III period (Albright and Lambdin 1970: 145). This change was associated with a political (Albright and Lambdin 1970: 151) rather than population change (Adams and Nissen 1972). There is, therefore, little reason to directly associate shifts in material culture with population change in the absence of supporting biological data.

There is, in fact, good ceramic evidence for continuity between the late Neolithic, Eneolithic and Bronze Age in the upper Morava drainage. The Bubanj-Hum ceramic horizon extends from the Late Neolithic into the Early Bronze Age. It is a local variant of the larger Balkan burnished ware horizon appearing during the later Neolithic (Garašanin 1972; 1973; 1983). The earliest phases appear to develop

out of the indigenous late Neolithic ceramic groups in the Upper Morava and are contemporary with the final Vinca-Plocnik occupations in the lower Mcrava. It continues to evolve through a number of phases (Ia - late Neolithic; Ib - Eneolithic; II and III - Bronze Age).

Third, the only certain means of demonstrating a common genetic origin for the occupants of two regions would involve chemical skeletal or genetic analyses of human remains. Unfortunately, few such analyses have been conducted. Most of the Physical Anthropological analyses have been plagued by a host of problems, such as

1. few late Neolithic burials, many Early Bronze Age internments, and mostly cremations during the developed and later Bronze Age of eastern Europe;
2. the use of outmoded cranio-taxonomic based "racial" classifications as the basis for morphological analyses; and
3. poor chronological controls over excavated data between the two regions.

Ongoing detailed analyses of of skeletal populations (using osteo-metric, cranio-taxonomic, and chemical-analytical methods) and blood group analyses in Hungary, Serbia and elsewhere in eastern Europe have begun to show long-term stability in indigenous populations. They can be seen slowly changing from the end of the Pleistocene up into

Roman times. The rate of change varies over this time, but there is no clear cut evidence of a complete or even large-scale turnover in morphological traits at any one period (e.g. during the Eneolithic of Bulgaria - Todorova 1978). The only major exception may be at the advent of the early Neolithic (cf. Menozzi et al 1978). Also, no studies have shown whether a relationship exists between status (as derived from mortuary remains) and skeletal morphology, an important test implication of the migration hypothesis. It is not until the Roman empire do the old populations dwindle and withdraw to the rugged interiors. Until then, they remain a pervasive feature of the physical anthropological landscape, mixed with the other classic "racial" types in varying relative frequencies (e.g. Boev 1972; Farkas and Liptak 1971: 259-261; Istvan Kiszeley - pers. comm.; Kiszeley and Schwidetzky 1979; Zhivanovic 1975; 1976; 1977). The predominance of cremation burials in the later Bronze Age and the paucity of later Neolithic internments provides a poor anthropometric data base for the evaluation of migration hypotheses (cf. Stuckert n.d.). Population shifts have been known to occur in historic and modern Europe and elsewhere (e.g. gypsies), but they would be extremely difficult to trace during prehistory.

A fourth problem with the "migration/invasion" hypothesis stems from the confusion between nomadic pastoralism and

mixed farming as economic strategies. The nomadic pastoralists that migrated from the steppes of Central Asia and invaded the Roman Empire (e.g. Huns) merely passed through the steppes of southern Russia where contemporary and historically-known populations subsisted with a strategy of mixed farming (agriculture and herding - Milisauskas 1978; Sherratt 1973: 421). The disappearance of the large intensively occupied late Neolithic settlements during the Bronze Age of central Europe was taken to mean that the population had abandoned a sedentary lifestyle in favor of a nomadic one. This has never been demonstrated, nor is it necessarily true for the source region (southern Russia - cf. Milisauskas 1978). One of the objectives of this thesis is to examine this assumption for the central Balkans.

Fifth, as argued above, nothing in the cultural inventory convincingly argues for migration (e.g. Renfrew 1969b; Bankoff 1974 contra Hammond 1976; Gimbutas 1977) rather than local evolution. Migration/Invasion has always been an appealing explanation for changes in cultural inventory (Adams 1968) which take place over a short period of time. This was fostered by a chronology that compressed the Bronze Age into a period of less than 1000 years, immediately following on the late Neolithic. The introduction of a radiocarbon chronology for these periods in southeastern Europe (cf. C. Renfrew 1973; Ehrich 1965; Ehrich and

Bankoff n.d.; Harding 1980) currently indicates a much longer span of time. At least two thousand years elapsed between the final Neolithic and the end of the Late Bronze Age (Bankoff n.d. - see table 1). This does not logically destroy the possibility of migrations or invasions, but does remove the need for them as the only possible explanatory devices. Alternative slower working explanations can be considered as well. The full re-evaluation of the evidence for migration (e.g. Gimbutas 1977), which will become necessary with a clearer picture of the rate and scope of change, falls outside of this thesis.

IIIB. Diffusion Hypotheses

The second major hypothesis that has been proposed to explain the observed changes in the archaeological record may be termed "diffusion". Cultural change is explained as a result of the diffusion of ideas, technologies from one region to the next. It emphasizes communication, via trade and other mechanisms, between areas and makes the crucial assumption of cultural "superiority". The civlizations of the Near East and the eastern Mediterranean influenced the non-civlized "barbarian" societies of temperate Europe (cf. Tringham 1974: 471). V. G. Childe (1929; 1958) was one of

the major proponents of this theoretical framework for Europe. His theory was developed partly in response to explanations current in the early decades of this century that saw all cultural innovations stemming from central Europe and carried forward by the "Teutonic Knights" (Childe 1950; Tringham 1983). The other major implicit model built into archaeological research of the time was a lack of interchange between local micro-regions. Relationships and similarities between regions were minimized at the expense describing and defining local artifactual complexes. Childe (e.g. in 1925; 1929; 1930) recognized inter-regional similarities and used these as part of the basis for his 'ex oriente lux' model (1934). He based this historical materialistic model (cf. Trigger 1982; Tringham 1983) upon the supposed cultural superiority and temporal pre-eminence of the Near Eastern urban societies over that of barbarian Europe. The latter, once contact was established, would recognize the advantages of civilization and adopt its basic tenets. The advent of radiocarbon dating and the ensuing realignment of inter-regional chronologies removed the temporal advantage of Near Eastern developments (Renfrew 1971; 1973). The result was a reassessment of eastern Europe as a center of independent change. It could be viewed as an active contributor rather than passive receivor of new ideas, technologies, etc.

An updated version of the diffusionist theorem has appeared of late (Sherratt 1980a; 1980b; 1982). In this series of seminal articles, Sherratt outlines the "Secondary Products Revolution in the Old World". As with the Agricultural and Urban revolutions proposed by Childe, this represented a crucial transformation in Old World food production and distribution systems. The ramifications extended beyond production to involve the spatial and hierarchial nature of Old World Civlization. The basic tenet of this theory for Europe is that population growth and pressure on resources set the stage for the evolution and widespread acceptance of five new technological improvements derived from the Near East. Agricultural production levels were raised by the use of the plough, which allowed tilling of a wider range of soil types. Domestic animal exploitation shifted from a focus upon primary products (i.e. meat, hide) to secondary products (i.e. milk, wool, and traction). This, in conjunction with sheep and cattle husbandry and transhumance, allowed a more optimal land use pattern to develop in the Bronze Age than in the Neolithic. A transport technology along with transhumance enhanced wider exchange networks and yielded opportunities for the development of early stratified societies. However, the new technology was expensive to produce and maintain. Its limited availability enhanced the

opportunities for local elites to dominate intra- and inter-regional exchange relationships. The model is in fact more complex and this summary cannct do it justice. Suffice it to say that Sherratt has opened up a new horizon in the understanding of advent of food production systems and has provided a set of testable hypotheses which can be evaluated.

In this model, change is viewed as a result of external stimulii (i.e. the invention cf new agricultural technology such as the plow, new transportation modes such as the wagon and domestic horse, and new breeds of domestic animals such as milking and draught cattle and wool sheep) to cope with local population growth and pressure on resources. The argument, in this case, is quite persuasive. However, it has several methodological and thecretical problems. For example, the timing and dispersal of the plough and cart are in dispute (Chapman 1982). Also, it dces not fully explain several important questions. The first is, why did the ancient occupants of the region adcpt this particular adaptation to population pressure? The second is, why did the socio-economic systems of the region change in a particular direction? These are questions not fully addressed. Also, arguing for populatiоn pressure is quite a different matter from demonstrating it. Adoption of new technologies may or may not have resulted in intensification

of production. The details of each case must be considered. In the Mediterranean, intensification was often associated with a greater investment in costly irrigation and terracing systems (e.g. Gilman 1981). In our area, there is no evidence for similar investments.

There is no evidence of the population pressing upon its resources during the late Neolithic of the central Balkans. Below, an attempt to model potential community population sizes for the late Neolithic and Bronze Age periods in the Central Balkans through catchment productivity and site size strongly suggests that there is little likelihood that settlement populations approached maximal carrying capacity (Zubrow 1975), even in the worst possible scenarios. Even then, such relationships are limited only to the upper tier of the settlement size hierarchy. This indicates that population pressure upon resources could not have functioned as a primary causative variable for the observed changes. Answers must therefore be sought elsewhere. This can be illustrated in the follcwing worst case hypothetical model of catchment areas and population parameters.

IIIC. Catchment areas and population parameters

Let us assume that the primary catchment area of a sedentary settlement during the warmer Atlantic Climatic phase (e.g. Frenzel 1966; Harding 1982 - ca. 6000-3300 b.c.) may be found within a three kilometer radius around it (Chisholm 1968: 66; Flannery 1976: 106). Although catchment area sizes found in the literature run from two kilometers (Dennell and Webley 1975) to five kilometers (Barker 1975; Higgs and Vita-Finzi 1972; Vita-Finzi and Higgs 1970), three kilometers is approximately one hour's walk over the cultivated and forested rolling terrain of the lower Morava (and the central Balkans in general - cf. Higgs 1975b: 223), and corresponds to about the spatial limit at which Chisholm (1968: 66) found that movement costs begin to significantly affect peasant cultivation choices. Taking the improbable best-case assumption that all land within the catchment area was arable and equally productive, then there are 2824.43 hectares of potential farmland for a village covering three hectares. Data from Bosnia suggest a yield of about 140-160 kilograms of grain per hectare under modern, although non-mechanized, conditions (Lockwood 1975: 93), of which about 20 kg./ha. must be kept for seed grain. This would leave approximately 120-140 kg. left for consumption. However, agricultural productivity in the mountainous regions of

Bosnia is not as high as in the mountains and lowlands of Sumadija (central Serbia) and the Vojvodina (Ill. 3). Since productivity levels differ between regions and modern conditions cannot be assumed to have been operative during the late Neolithic and Bronze Age, the discussion to follow will be framed within a range of maximal and minimal estimated values. Using a maximal estimate of 200 kg./ha. for our area (cf. Halpern 1967: 58), in order to give prehistoric cultivators the benefit of the doubt, accounting for the higher agricultural productivity in Sumadija than in Bosnia, and disregarding other land use possibilities, provides an estimated maximal productive capacity of 508,397 kg. of edible grain from the fields within the catchment area after the seed grain has been deducted (564,886-10%). This assumes a higher seed:yield ratio than may be warranted for prehistory, since it is based upon historic and ethnographic studies from the region. Actualistic research at Butser Farm produced seed:yield ratios for wheat ranging from a high of 1:7 to a low of 1:59 (Reynolds 1982: 109). Going to the other extreme and using an agricultural productivity estimate of 100 kg./ha. (which is below the modern values from Bosnia and assumes a lower productivity for prehistoric crops - a not necessarily valid assumption as the yields from Butser farm have shown - Reynolds 1982) produces an estimated productive capacity of 282,443 kg. of

edible grain. When 1/5 of the grain (20 kg./ha.) is removed for seed purposes (again a higher value than Reynolds -1982- found to be necessary) approximately 225,954 kg. of grain is left for consumption. The highest seed:yield ratio occurring at Butser Farm (in the chalklands of Britain) was 1:7. This occurred during years of exceptionally poor weather.

At one kilogram per person per day (Taylor and Orrea 1966: 52), this could feed 619-1393 (100-200 kg./ha. range) people, or 103-232 households (at six persons per household) for a year. This gives a possible population density for this hypothetical catchment area approximately one-quarter to one-half that supportable by modern methods in the same region (Halpern 1967: 56). The assumption of a system of field use in which crops were sown every other year, or half the fields were fallow in any given year (cf. Boserup 1965: 16) would further reduce the maximum supportable population to 310-697 people, or 52-116 households. Further utilization of the cultivated half of the catchment area for ritual activities, structures, the inclusion of higher aspiration levels for the entire community or even differentially according to age, status, sex, etc., within the community would serve to reduce the maximum population supportable in a settlement with a three kilometer radius catchment area in

this region. Obviously, utilization of other terrestrial (e.g. wild and husbanded animals) and/or aquatic resources can raise the ceiling on population levels, but natural topographic and soil variability preventing the use of the total area will lower it. It has been maintained that only the lighter weight soils of southeastern Europe would have been most favorable for pre-plow cultivators. The heavy chernozems and smonicas are often thought to have been unworkable with the Neolithic technology available prior to the adoption of the plough or ard (Dennell and Webley 1975: 100; Sherratt 1980a; 1980b; Dennell 1978; Barker 1975: 88), affecting the distribution of agricultural settlements. But, Chapman (1981: 91-95) argues to the contrary. The presence of Vinča settlements on a varied assortment of soil types, such as Brown Forest soils, chernozems, and smonicas and several large Vinča sites surrounded by soil types dominated by chernozems and smonicas makes it unlikely, given the indications of settlement permanence, that these soil types were ignored by prehistoric cultivators. This was explained by the introduction of an ard or plough technology into the region at an earlier moment than previously thought. If this was the case,

> "smonicas would present fewer difficulties /for cultivation/ than chernozems, given their developent under forest conditions and the subsequent lack of turf line" (Chapman 1981: 91).

Implications of these conclusions may include that a wider range of soil types were explcited and that a more efficient use of resources in catchment areas was possible. These are extremely rough estimates, meant to provide minimal and maximal parameters for the population of the later Neolithic settlements of the Lower Morava and throughout most of temperate southeastern Europe during the warmer Atlantic climatic phase. The higher productivity estimate appears to allow for a higher population than is documented for most, if not all, of the later Neolithic settlements in southeastern Europe. If this value is accepted as most accurate, it would seem that early agricultural villages drew on the land "at a level well below the potential carrying capacity of their respective environments" (Flannery 1976: 95). It would seem valid to infer that population pressure cannot be a viable causative agent for the explanation of the observed Neclithic/Bronze Age settlement changes. However, if the lower range of values are accepted an alternative relationship may exist between between intra-settlement population size and the potential productivity of surrounding catchments. The largest late Neolithic settlements (e.g. Vinča) probably contained population levels in excess of those predicted by the lower range of productivity values, while the much more numerous smaller, village-sized settlement (cf. Chapman 1981) would

have not. Therefore, it would seem that the larger settlements were drawing upon the excess productivity potential of the satellite settlements in their hinterlands to support their large size. The existence of specialized hunting/fishing stations, of mussels from the Morava river found over 13 km. away at Selevac, etc. (cf. Chapman 1981: 96) can be seen as support for the hypothesis that the larger settlements did not rely exclusively upon resources found within their immediate catchment area. It would seem that the largest sites were near or beyond the productivity limit of their catchment areas, whereas the smaller sites were not. This latter scenario is still considered a less likely alternative for explaining the observed abandonment of both large and small settlements at the end of the Neolithic for several reasons:

1. It assumes that being near or above "carrying capacity" results in resource depletion and eventual settlement abandonment. This need not be the only response to such a crisis. Development of greater inter- and intra-regional coordination and specialization in the production of resources may have been an alternative response, one for which supporting data can be found (e.g. in Chapman 1981).
2. Even if it did explain why the large settlements were eventually abandoned, it does not explain why the

plethora of smaller sites were also abandoned, since they were nowhere near their "carrying capacity".

3. It is also considered an unlikely explanation because many of the largest Vinča settlements were occupied for at least several hundred years. For example, Vinca, itself, spans most of the Vinča culture sequence (more than 1000 years). For much of that time, it was one of the largest sites in the central Balkans (ca. 6 ha.). If such sites were near or beyond their productivity capabilities, I would have expected abandonment to have been a more pervasive feature of large settlement histories. Instead, they show remarkable stability over time.

It would seem, therefore, that the lower productivity estimate for catchment areas is a more improbable explanation for settlement abandonment. Soil exhaustion was obviously less of a problem than proposed. Some alternation between cultivated and fallow areas must have been in effect as occurred throughout the Balkans prior to the introduction of artificial fertilizers.

It is interesting to note that Dennell and Webley (1975), estimating the prehistoric population of the Nova Zagora region of southern Bulgaria by a similar method, although with different seed:yield (25-33%), yield (300 kg./ha.), and consumption data (210 rather than 365

kg./year/person). They have independently arrived at an estimate of between 400 and 500 inhabitants for a village covering about three hectares (Dennell and Webley 1975: 106). Using their calculations for a three kilometer catchment area rather than their assumed two kilometer radius (with half left fallow) about doubles this estimate, which exceeds our upper estimate. According to their estimates, cereal production could have supported far higher potential population sizes than are hypothesized for the agriculturally richer Central Balkan zone. This is largely due to the use of lower estimates for personal consumption and higher values for seed:yield and yield.

Several sources of data are needed to evaluate these admittedly rough parameters. These include information on the size, number, and spacing of domestic and non-domestic structures within Vinča settlements and the site areas occupied in each phase of the settlements' existence. Although preliminary evaluation can be begun from the reports of partially excavated Vinča sites, it is hoped that these data will be forthcoming from new excavations of later Neolithic sites in southeastern Europe. Nonetheless, I think it improbable that new data will support an argument directly linking the observed changes in settlement patterns to a population pressure explanation.

Paleoenvironmental data indicate that approximately c. 3300 b.c. marked the end of the period of warmest times in the post-glacial era (Gribben and Lamb 1978: 69). The preceding Atlantic period (from ca. 6000 to ca. 3300 b.c.) was characterized by summer temperatures two to three degrees centigrade above the present European norms (Clark 1952: 14), by a generally wetter climate, and by the displacement of the sub-polar depressions and the axis of the main anti-cyclone belt northward, placing the high-pressure belt as far north as 40-45 degrees north latitude (Gribben and Lamb 1978: 69-70). World sea levels rose to slightly above present heights, as Alpine and Scandinavian glaciers melted (Lind 1969). The altitudinal tree line of the Alps was 300 meters higher than today (Butzer 1971: 571), and the percentage of tree pollen in Moldavia and along the Lower Danube increased (Iringham 1971: 31). Tringham notes that "everywhere in Europe there is evidence that the maximum growth of forest was reached ca. 4000 B.C. /uncorrected/" (1971: 33). In the last five hundred years of the Atlantic period, an advance of glaciers in Europe signals a sharper oscillation toward a colder climate (the "Piora Oscillation") than for any several thousand years previously (Frenzel 1966; Lamb 1977: 372). During the succeeding sub-Boreal (ca. 3300 b.c. to ca. 1000 b.c.) the

forests regained some ground as temperatures gradually returned to their warmer level. The period is, however, characterized by sharp rainfall fluctuations (Brooks 1949: 298; Lamb 1977: 373).

The later Neolithic farmers of southeastern Europe, faced with deteriorating climatic conditions, might have turned to crops which do better under cooler conditions, such as barley rather than wheat. Barley not only has a lower optimal germination temperature than wheat (Wilsie 1962: 197), but it is also less affected by precipitation vagaries (J. Renfrew 1973: 80-81; Johnson and Gustafson 1962). There are indications that barley cultivation may have increased during the Bronze Age in most of eastern and central Europe (J. Renfrew 1973: 205-207), although this is somewhat in in dispute (Hubbard 1976b). The larger amount of barley necessary to make up a kilogram of grain (approximately 45,000 grains of barley to 30,000 for wheat according to Flannery 1969: 85), would have also meant that a field of barley could support fewer people than an equivalent-sized wheat field. Thus population levels within settlements depending on barley could be as much as one-third lower than those with wheat fields of the same size. Using the figures calculated above for the late Neolithic, such settlements might contain a maximum of 205-465 people or 34-77 households. Again, it must be emphasized that these figures

are generally too high for Bronze Age sites and the smaller Vinca sites in the region, but within the range of the larger Vinca sites. For example, Ljuljaci is one of the few Bronze Age sites with plans of residential architecture. At least 29 small houses were excavated over the entire span of its occupation (Early-Middle Bronze Age - several hundred years). A large area of the site was tested (see chapter 6).

As yet it is impossible to evaluate the later Neolithic/Bronze Age changes evident in the paleobotanical record. As Dennell (1972: 157) notes

> "the composition of plant samples varies considerably between different archaeological contexts. Conclusions on the plant husbandry of a prehistoric site could therefore be misleading unless this factor is considered."

Thus, the preliminary publication of the botanical material from Gomolava (Van Zeist 1975), and the summary tabulation of plant remains from a number of eastern European localities (e.g. Hubbard n.d.) is of little use in the absence of associated contextual information (Dennell 1978; Hubbard 1976b). Dennell (1972: 157), after considering the context of the botanical remains, is able to conclude that emmer was more important than six-row naked barley in the Bulgarian late Neolithic sites of Chevdar and Kazanluk. But from the Early Bronze Age deposits from Ezero

> "it cannot be concluded whether barley or wheat was the more important crop in the Early Bronze

> Age, until a wider range of deposits is investigated. At present, neither einkorn nor bread wheat appears to have been important. /But,/...there is no evidence that that the economic importance of each cultigen changed in this region from the Neolithic to the Bronze Age" (Dennell 1978: 148-149).

Nevertheless, the size of einkorn grain appears to decrease in size from the Neolithic to the Bronze Age. This may be due to a local environmental change, such as increased deposition of clays (Dennell 1978: 150). This is in contrast to Hubbard (n.d.: 12) who has indicated an impressive increase in six-row barley associated with Early Bronze Age contexts in eastern Europe.

From the material presented above (catchment discussion), it is possible to rule out certain popular "prime movers" as explanations for cultural change between the later Neolithic and Bronze Age. As has been shown, the observed environmental conditions were not altered in a drastic enough fashion to account for any significant change in terms of cultural adaptation. Available pollen diagrams, as well as modern floral distribution, indicate that the Balkan environment was probably much the same in the Bronze Age as it is at present, barring modern deforestation (e.g. Beug 1982; Gigov 1956; 1965; Nandris 1976; 1977). The hypothetical reconstruction and analysis of the resources available in site catchment areas has also indicated that population pressure can be discounted as a significant variable even under a worst case situation.

A hypothetical response to a dearth of agricultural resources may have been increased competition for land. Increased inter-group conflict was also an implication of the "migration" hypothesis. This may be reflected in the evidence for inter-community conflict (e.g. warfare). However, increased conflict may be ruled out as a primary explanation for the observed changes. More unsettled conditions (e.g. due to warfare) should have produced a noticeable effect on the settlement pattern of the Bronze Age. One would expect the appearance of more new Bronze Age settlements on more readily defendable positions, with some sort of natural or artificial fortification, and/or a clustered, rather than dispersed settlement pattern. In fact, sites of this nature are found only late in the Bronze Age of the Balkans (Garasanin 1973: 294; 1983: 175-181). They are more often encountered earlier to the north (e.g. Otomani - - Dumitrescu 1983: 57-58; Hungary - Chcyke 1982). The presence of fences or ditches surrounding sites (cf. Tringham 1971; 1972; Tringham et al 1980) or sites on hilltop locations (e.g. Ljuljaci - Srejović 1965) does not necessarily indicate the presence of a fortification. Other less complex reasons may be suggested for the presence of fences or ditches on sites from the Neolithic through the Bronze Age (e.g. corrals, settlement social boundaries, etc. - Tringham 1972). The exclusion of these variables still leaves one

with the problem of explaining the demonstrable differences in settlement and subsistence patterns between the later Neolithic and Bronze Age. It seems apparent to many researchers that such changes are not a function of any one prime mover but of a number of interacting variables (Bankoff and Greenfield 1985; Sherratt 1980a; 1980b).

IV. AN ALTERNATIVE MODEL FOR SUBSISTENCE CHANGE

Both sets of models discussed above rely upon external factors to account for change. However, another school of explanations appears to fit the data just as well, if not better. Processual explanations emphasize the importance of continual evolution within a region, rather than replacement of peoples or cultural behavior from outside (e.g. Binford 1962; Renfrew 1973). This body of theory has recently been used to account for similar examples of seeming discontinuities in the archaeological record by collecting data necessary for the demonstration of continuity (e.g. Chapman 1981 - Starčevo/Vinča transition). With this in mind, I will present in this section a model for change that emphasizes local development, although it does not ignore the acceptance of new technological modes from neighboring regions nor the possibility of small-scale movement of peoples. Originally, there were very few data from Bronze Age localities with which to test the hypotheses concerned

with the interaction of subsistence change and the consequences of population redistribution. Therefore, on the basis of the available archaeological, zooarchaeological, and paleoenvironmental data, I constructed a model outlining options available to the human population at that time and their interactive effect upon the distribution of population and strategies of animal exploitation (Ill. 5). This model will be presented below.

As with Sherratt's model (1980b), the introduction of the wagon and the plough into southeastern Europe are thought to have had a ramifying effect upon the indigenous agricultural and settlement systems. They appear either in the late Neolithic, Eneolithic (Chalcolithic of the Hungarian Plain) or in the Early Bronze Age (Chapman 1981; 1982; Clark 1952; Piggott 1982; Sherratt 1980b). Their postulated appearance helped to stimulate the chain of events leading to a redistribution of population over the landscape. The wagon virtually revolutionized transport by making it more efficient for fewer people to move large quantities of bulky foodstuffs and materials. Transport costs would be significantly reduced. However, the data on specialization of production and, by implication, inter-community exchange do not indicate large volumes of exchanged products. For example, the number of obsidian pieces, non-local pots or metal artifacts are relatively few and could have been

brought to villages by a few bearers or by a single cart load every year or so. "The volume of material exchanged was relatively restricted" (Chapman 1981: 79). Only slightly larger quantities appear to have been transported to settlement performing "centralplace" functions, such as Vinca and from there distributed tc satellite settlements. But even at these sites, the quantities are so low "...as to cast serious doubt on the concept cf specialist traders or full time craftsmen" (Chapman 1981: 79). The use of carts might have been of greater importance in local agricultural production where crops would have to be transported to storage areas soon after being harvested. In this situation, the ability to move large volumes of such bulky materials within a short span of time is considered to be of greater importance to the local economy than is the ability to move the occassional "exotica" (contra Sherratt's 1976 Kula ring-like model). The plough offered the potential of opening-up supposedly uncultivable lands beyond the distribution of the soft alluvium and Brown Forest Scils around which earlier settlements are thought to have congregated (Barker 1975; Sherratt 1980a). However, the timing of its appearance and the distribution of soils surrounding earlier sites are now in contention (Chapman 1981; 1982; see above). The appearance of new technologies does not, as a matter of course, incite people to get up and

colonize the world. Conditions in the society must be present to encourage the dispersal seen in the Bronze Age settlement data.

The Vinča culture may be a good example of "scalar stress" (cf. Johnson 1982). The costs of integrating horizontally equivalent units within a socio-political system does not increase linearly with the number of units involved. Instead, the work load per unit is increased with each additional unit needing integration.

> "This work load may be decreased by the development of a specialized vertical control mechanism. ... Vertical specialization...reduced work load involved in information transfer" between units (Johnson 1978: 91).

In order to efficiently integrate the basic units (households, villages, etc.), hierarchial units of decision-making have to evolve. The evolution of status differences and rank inheritance rules would "...serve to reduce potentially disruptive competition and dissension in selection of individuals to occupy such positions" (Johnson 1978: 101). The Vinča culture may have experienced such a problem. The absence of evidence for hierarchial integration beyond low-level ranking (cf. Chapman 1981) and the consequent elaboration of ritual (Gimbutas 1974b) regulatory mechanisms (cf. Chapman 1981) would have made coordination within the large villages and between other villages extremely complex.

> "The Vinča culture illustrates, almost in extreme form, the high cost which small-scale societies are prepared to pay for ritually-ordered equilibration" (Chapman 1981: 75).

Integration beyond to the satellite villages and to the regulation of inter-community exchange would have been further complicated by the absence of administrative organizations which could efficiently coordinate the needs and activities of the substantial numbers of peoples and units involved.

In the absence of such regulatory mechanisms, stress would be predicted to have been a pervasive feature of the political landscape. The elaboration of "ritual" controls for the integration of Vinča societies may have been one response. A second response may have been dispersion of units (see above) and the evolution of new hierarchial levels of decision making (leading to greater socio-political differentiation). As far as can be determined, there is some evidence for the development of new hierarchially differentiated socio-political systems between the end of the late Neolithic and the earlier part of the Bronze Age in the central Balkans and in the regions immediately to the north (i.e. Hungary, Czechoslovakia, and Romania - e.g. in Dumitrescu 1983; Garasanin 1983; Giric 1971; Shennan 1975; Sherratt 1976; Skomal 1980). This may have developed as a response to the needs for

efficient decision-making heirarchies (cf. Johnson 1979) seen in the late Neolithic.

In this model, I offer the ethnographically supportable assumption of "population dispersal tendencies" as one of the necessary pre-conditions for the observed changes. This assumption was arrived at through evaluation of the evidence from both egalitarian and ranked modern societies (Fried 1967; Flannery 1972). These low-level hierarchial societies tend to undergo local descent group segmentation (Meggitt 1962; 1965 - New Guinea; Sahlins 1961 - Africa; Wagley 1951 - South America) upon the attainment of culturally specific community sizes and either expand at the expense of other peoples or bud into less densely populated areas through the dispersion of descent units (Carneiro 1970). Local "Big-Men" (Sahlins 1963), in the absence of movement constraints, tend to move to more optimal locations for the expansion of personal power. It is assumed that the centrifugal tendencies of large, but poorly integrated communities would favor their eventual fissioning. It is clear from the settlement data that the late Neolithic communities grew to sizes that far exceeded any before, or any for a long time afterwards (Chapman 1981; also see above). This tendency would be even more likely where there are no adjoining populations of significant density, as in early Neolithic Europe (Ammerman & Cavalli-Sforza 1971), in late Neolithic

southeastern Europe (Sherratt 1972), and in other essentially open systems (Binford 1968).

Chapman (1981) has amply demcnstrated that not all Vinča settlements were organized along similar lines. Some were characterized more by nuclear family units, others by extended family units and many by a combination of both. The growth and spread of Vinča settlements appears to have been linked to the budding-off of nuclear family units from the older settlements. These new units of production then struck off on their own to found new settlements. Most of the smaller sites are characterized by nuclear family-sized houses, while the older more established sites (e.g. Gomolava, Vinča) are dominated by long-houses (Chapman 1981; Brukner, Jovancvić and Tasić 1974; Petrovic 1982; Vasić 1932-36). Within most of the larger sites, both large and small residential structures can be found. This could imply that nucleated and extended family structures existed within the same settlements and that budding of nuclear family units may have been a continual process even within settlements.

Chapman (1981) has also traced the growth and decline of some of the larger early and late Vinča settlements (e.g. Tordos). Many Vinča settlements obviously exist for a long time. But few excavations have mapped their growth and decline. It is of interest to note that the largest

settlements were not all in the final period and that all sites were not abandoned at the same time. This may be explained as a function of continucus scalar stress. As settlements reached their zenith in size, the scale of stress increased out of proportion to the benefits of continuing large-scale village or town lifestyles. Hence, decline in size or abandonment would take place. Some unusually long lasting large sites did occur (i.e. Vinca). But it appeared to have played a ccrrespondingly unusual role in exchange and, by implication, inter-regional integration (Chapman 1981).

The combination of these changes and processes allowed and stimulated the shift in the focus of settlement, although contra Sherratt (1980a) the drier intefluves had been colonized earlier. The potentiality of increased efficiency in transport, in ccnjunction with already existing high local population densities and the continuing tendency for large local communities to fission from the earliest periods onwards, would have resulted in a proliferation of new, smaller, and mcre closely-spaced homesteads. The overall regional population may not have increased, but each homestead would have been inhabited by a smaller group of people. Initial effects may have included the spread of ecotones, such as between the edge of the forests and fields (cf. Mellars 1976). More homesteads

could have resulted in a larger dispersal of the areas under cultivation (but not necessarily larger in total area under cultivation), when combined with ccntinued forest clearance, would have negatively, in the long run, affected wild animal density, availability, and predictability.

The pollen data from central and southeastern Europe can form an independent measure of the changes in the physical environment. the few published pollen diagrams for the central Balkans indicate that the changes wrought by man were of much greater significance than those induced by climate (Gigov 1964; Nandris 1976; 1977; Zolyomi 1980). The continued record of human interference in forest ecosystems during the Atlantic climatic optimum indicates increased forest clearance and spread of areas under cultivation as time progressed. This is evident from the replacement of arboreal pollen (AP) by non-arboreal pollen (NAP), in particular cultigens (see chapter 2, section VII).

Consideration of the behavioral and ecological characteristics of the species exploited during the late Neolithic, as well as the available indications of paleoenvironmental change (whether naturally- or culturally-induced) allows prediction of the nature and extent of changes that may have occurred in the animal exploitation strategies during the Bronze age. The importance of

animal production in mixed farming subsistence strategies has been well illustrated by other research. Flannery (1969) has noted that in areas where agriculture is characterized by years of scarcity mixed unpredictably with years of bumper crops, "live storage" in the form of herds is a way of leveling these fluctuations. Even though Flannery was referring to arid environments in the Near East, this would hold true for temperate areas as well. Increasing animal production is obviously a way of increasing or maintaining the productivity level of sustaining areas by grazing on fallow areas or land beyond the immediate sustaining area. To investigate the widespread and drastic alteration in land use, which probably involves major shifts in economic strategy, it has been useful to combine archaeological settlement pattern data with archaeozoological analysis and generalized modelling of animal resource density, predictability and aggregation, in other words, the availability of animals to the dependent human population.

Before the onset of this research, the evidence in the literature allowed a basic reconstruction of the animal exploitation strategies for the late Neolithic Vinca-Plocnik period. The information on subsistence indicates an economy which exploited a diverse set of resources, both domestic and wild, terrestrial and riverine (Tringham et al 1980). No significant differences in the types of resources

exploited are observable between the early Neolithic Starčevo culture and the late Neolithic Vinča-Pločnik culture (Bökönyi, n.d.; Milisauskas 1978), except for a possible increase in the importance of wild species (Bökönyi 1974b; n.d.; Tringham 1971) which may be reflection of the small number of samples or the spread of ecotones and consequent localized high animal population densities at these points. Little is known about the subsistence economy of the intermediate middle Neolithic Vinča-Tordoš culture. Most of the material indicated the primary exploitation of domesticated cattle, followed in decreasing order of frequency by pigs and then sheep/goat in the more heavily forested areas (i.e. Bosnia and Serbia). In the more open and drier ecological zones (i.e. Macedonia and some areas of the Hungarian Plains), sheep/goat were the most common set of species, with cattle closely following in second place and pigs as a distant third (Bökönyi 1971a; 1974a; 1974b; 1976; Murray 1970). The hunting of wild ungulates such as aurochs, roe and red deer, and wild pigs was significant in Late Neolithic subsistence activities in Bosnia and Serbia (Bökönyi 1974a; 1974b; n.d.; Tringham 1971; Tringham et al 1980). Red and roe deer were important for meat and hide, as well as sources of raw materials for tools and tool manufacture (Bačkalov 1979; Nandris 1972). Fish continued to play a role, as evidenced by fish remains and fishing

equipment at Selevac (Tringham et al 1980), Vinča-Belo Brdo (Clark 1952), Gomolava (Clason and Prummel 1977), and elsewhere in the Middle Danube Basin (Bökönyi 1971a; Tringham 1971).

IVA. SECTION ONE OF THE MODEL

It can be predicted that increased forest clearance and the concomitant spread of areas under cultivation after the termination of the Atlantic optimum and the onset of the Sub-boreal functioned to decrease the importance of wild animal species favoring forest habitats and especially those species which would have competed with humans and domestic animals for access to standing cultivated crops and grazing resources. This would occur through a disruption of their habitat resulting in a decrease in the density, aggregation level and predictability of wild animal species, thereby reducing their importance to the subsistence economy. The spread of deciduous forests during the Atlantic optimum (ca. 6000-3300 b.c.) in conjunction with periodic clearing of forests for agriculture and the eventual regeneration would have favored relatively high population densities for roe deer, red deer, and swine, although the latter two species would be expected to show higher densities than the former due to inter-specific competition (cf. Jochim 1976: 102 and

references). Roe deer prefer mixed deciduous forests with numerous open areas and heavy undergrowth (Choyke 1982; Jochim 1976: 101-102 and references in both). Red deer have higher densities in open mixed forest and/or parkland environments, with ligh undergrcwth (cf. Clutton-Brock et al 1982; Darling 1937; Jcchim 1976: 101 with references). Pigs, who are omnivorous, prefer a moist, closed deciduous forest biotope with heavy undergrowth and tubet and find acorns, mast, etc. (Bratton 1975; Jochim 1976: 103 with references; 103 with references; Grigscn 1982: 299). In contrast, densities of aurochs, whc are thought to have preferred a parkland environment (Bökönyi 1974a; Jochim 1976: 97 with references), might have been somewhat depressed. Wild ungulates might be expected to experience further temporary local increases in density around areas cleared for agriculture, grazing, cr habitation, since plant regeneration would be most intense at such temporary ecotones (cf. Mellars 1976; Rhoades 1978).

With the onset of the sub-Boreal at about 3,300 b.c., pollen spectra from northern, central and southeastern Europe indicate a decrease in arboreal pollen. The spread of settlement, introduction and rapid spread of plough cultivation and perhaps of castrated cattle for traction appear to account for much of this widespread horizon rather than only climatic factcrs (Zolyomi 1980). Deforestation

does not appear to have been as widespread in temperate Europe, as it was in the more arid areas nearer to the Mediterranean (e.g. Beug 1982), although altitudinal zonation of deciduous forests was reduced. Nevertheless, an increase in the area of land under cultivation and for grazing is noticeable and so wild ungulates probably decreased in density as the preferred biotopes were reduced in extent. Their response to increased predation at the forest margins may have also been to retreat farther away from human frequented areas - in other words, there was a regional redistribution of wild animal populations to less affected areas.

Even domestic pig production may have been affected by these conditions. Pigs are known, historically, to have been raised in forest habitats in Europe (Grigson 1982). Domestic pig production may have been relegated to areas deep in the forests in order to keep them out of fields. In fact, this was the situation in historical Serbia (Halpern 1967), as well as northwest Europe (Grigson 1982). Pigs create all kinds of problems for cultivators. Regulation of pannage in northwest Europe was particularly strict (Grigson 1982: 300-301) to keep them away from cultivated fields. Decreases in the forested area close to settlements may have resulted in increased energy expenditure by herders to raise them in the more distant forest environments, which could be

easily offset by their high reproductive capability. The important role that domestic pigs continue to play in the economy and the lack of evidence for stock enclosures (i.e. stys - open or covered) in eastern European Bronze Age sites may imply that extra effort was made to remove them from habitation and agricultural areas. Overwintering of pigs in the open is known, historically and ethnographically, from the northern Balkans (Halpern 1967), Hungary (cf. Szabadfalvi 1968; Vincze 1980) and western Europe (Grigson 1982). They are frequently moved through a series of seasonal settlements where winter forage is available. Domestic cattle, sheep and goats are expected to increase as grasslands expand, and as man hunts out those wild animals competing for the same grazing resources and protects domestic animals from predation, thereby, favoring their reproductive potential.

Utilization of anadromous fish, such as sturgeon, probably decreased during the Bronze Age. During the Piora Oscillation and the Sub-boreal, with their associated temperature and precipitation fluctuations, continued forest clearance, resulting in increased variability in run-off, erosion and siltation, may have disrupted the shallower upstream spawning tributaries (Schalk 1977). During the Neolithic, when temperature and precipitation levels are thought to have been higher (Gribben & Lamb 1978), run-off

and stream discharge regimes would have been relatively favorable for the migration and spawning of anadromous fish. The predictable runs of anadromous fish to upstream spawning areas appeared to provide an important dietary resource during the Neolithic. But evidence for anadromous fish exploitation away from major rivers, such as the Danube and Sava, during the Bronze Age is non-existent. This cannot be solely attributed to biases in recovery procedures. The excavations at the Bronze Age sites in the Jasenica drainage conducted in 1977 and 1980 used 1 sq. cm. and 3 sq. mm. sieves (Bankoff & Winter 1982; Bankoff, Winter & Greenfield 1980). In addition, there is a notable absence of a bone fishing technology, which had been very prevalent during the Early and late Neolithic. This may be attributable to the use of metal as a substitute, but the absence of fish bone remains undermines this objection. The disruptions associated with the change to the Sub-boreal would have interfered with what is historically an important resource in this area (Rohan-Csermak 1965). It should be noted that until the construction of the Djerdap I Hydroelectric dam at Karatas and the pollution of the Danube, sturgeon came up the Danube as far as Budapest (Rohan-Csermak 1965). Catfish (Silurus glanis L.) have been found at the late Neolithic sites of Selevac (Tringham et al 1980) and Gomolava (Clason 1979). Utilization of catfish and other non-anadromous fish

resources would not be expected to change, as the environmental changes of the Sub-boreal would not have affected them. Similarly no change would be expected in the exploitation of seasonally available birds migrating through the area. They would have continued to move up such movement-limiting corridors as the Vardar-Morava (Navy 1) on their migrations to and from nesting grounds.

IVB. SECTION TWO OF THE MODEL

Studies concerned with the question of regional or intra-regional specialization in the production and distribution of goods have been relatively unanimous in their conclusions. Ceramics, bone tools, and other products made from locally available raw materials are produced largely by and for each settlement. There is little evidence for inter-settlement exchange in such mundane products. In contrast, items made of exotic raw materials, such as metals and fine stone (e.g. obsidian), are traded from source sites to, at least, large regional centers (e.g. Gomolava, Vinča) often in unfinished states (Chapman 1981). They seem to be roughly or finely finished for local distribution. The extent of such trade does not seem to have been of such a tremendous volume that full-time specialization was necessarily associated with it (R. K. Evans 1978; Chapman

1981). There is also little need to postulate exchange of such exotica for more mundane products, such as locally produced foodstuffs, ceramics, etc. Chapman's (1981) study of Vinca motifs provided unambiguous evidence for local production of ceramics rather than long-distance exchange. The repertoire of typical Vinča motifs and forms varied from region to region, with decreasing rates of similarity as distance increased from assumed source sites. Most artifact types (e.g. ceramics, bone tools, lithics, etc.) appear to have been produced by a varied asscrtment of people in a multitude of localities. There was little evidence for single regional foci for production of such items (Bankoff 1974; Chcyke 1983; R. K. Evans 1978; Kaufman 1977). During the late Neolithic and later prehistoric periods, metal production seems to have been in the hands of, at least part-time specialists. Explcitatien of raw material sources for flint, metals and other ores (i.e. at mines) is one of the most obvious examples of the advent of productive specialization (cf. Jovanović 1980). However, the extent of such activities and the percentage of time they involved over the course of a year are uncertain. Viewed from a regional perspective, locally procurable resources (e.g. foodstuffs, bone for tools, etc.) were not organized into a regional exchange system. There is no evidence for large scale movement of such items in any of the periods. All the

Bronze Age lithics appear to be derived from local river channels (Ira Berman, Brooklyn College - pers. comm.) and there is no evidence for the kind of long-distance exchange of stone as occurred in the Neolithic of this area, and elsewhere in Europe, during the Bronze Age (Sherratt 1976). A change is also evident among the bone tools. Analysis of Early and late Neolithic bone tools (Bačkalov 1979; Nandris 1972; Sterud & Sterud 1974; Tringham 1971) shows a tremendous diversity of species and elements used, of tool types, and of tool function. With the advent of the Bronze Age and the growing use of metals, we see a dramatic drop in the overall numbers of tools, tool types, and quality of bone tool manufacture (Choyke 1983). In central Serbia, there are only two or three major functional types (excluding ornaments) as opposed to over fifteen from earlier periods. The relatively sudden flowering of metal artifacts in graves during the Eneolithic and Early Bronze Age (e.g. Bognar-Kutzian 1963; Garašanin 1973; Girić 1971; Shennan 1975) and hoards during the later Bronze Age (Kosorić 1972) can be seen as another indication of this trend. A further implication of this is that the exchange networks of the Neolithic may have still been operative, but that other materials (metal instead of stone) were the archaeologically-visible manifestations of the process. However, due to recycling of raw materials, they would be rarely preserved.

In this respect, I do not see any reason to conceive of Vinca food production and distribution systems in terms of regional specialization - where villages are producing surplus crops to be traded to other villages for different surplus crops. Within any single region, there appears to have been enough sustaining agricultural land surrounding each settlement to produce large enough volumes of food for resident populations (see catchment discussion above). It is expected that in the absence of evidence for large-scale full-time productive specialization in non-metal related areas of the local economy during the late Neolithic (R. K. Evans 1978; Kaufman 1977) and Bronze Age (Bankoff 1974; 1977), animals would not be exploited in a specialized manner. Patterns of animal exploitation should not be differentiable into specialized exploitation strategies for obtaining meat, milk, or hides, but should represent a mixed subsistence strategy. Each local community should be self-sufficient, exploiting the full range of animal resources, rather than specializing in the production of one aspect of the animal husbandry economy (e.g. wool). In addition, as the exploitation of wild animals decreased, the set of resources that each species had contributed to the local economy would be replaced by those of domestic species. To date, there is little that can be said about productive specialization.

IVC. Section Three of the Model

The relationship between the exploitation of animal and plant resources (the subsistence system), on the one hand, and the duration, season of occupation and location of settlements other, is extremely complex. However, these are the closest areas of articulation between "man and his environment" (Jochim 1976: 9). The primary variables affecting the settlement system are related to subsistence. Changes in economic activities on a local or regional scale

> "...can directly affect the settlement pattern of the exploiting population... Not only the behavior, but the general spatial arrangement of economic resources can significantly influence human settlement patterns..." (Jochim 1976:47-48).

This is true not only of hunting-gathering, but of agricultural populations as well. Therefore, if economic strategies were different during the Bronze Age, the duration and season of occupation of settlement might also have been different.

Ungulates have great difficulty in foraging and moving through deeply snow-covered areas (e.g. more than 20 cm. deep - Smith 1959: 22 in Fleming 1972: 187). At the beginning of winter wild animals may have travelled and domestic animals may have been driven, from upland to lowland areas with less snow, greater protection from the wind, and greater density and variability of vegetation.

The accumulation of winter forage (Clark 1952) and the movement of herds to more temperate lowland environments are complementary strategies for ensuring the survival of herds over the winter. Both may have been practiced. The heavy snowfall (two meters of drift snow are not unusual - pers. obs.) necessitates fodder accumulation in this area (Halpern 1967). It is not suggested that fodder crops were grown, as there is no evidence for this until historic times; instead, fodder was probably collected (Dennell 1978). It is, therefore, possible that lowland localities, such as Novačka Ćuprija near Smederevska Palanka and Livade near Kladovo, at least, were occupied during the wet and cold period from late Autumn to early Spring. However, under the effort-minimization assumption that it is easier to grow and to store crops in the same location, it is suggested that these settlements may have been occupied year-round, although maintaining herds of domestic animals in close proximity to crops and to winter fodder during the growing season can create problems. In temperate environments, where the summers are moist and the relief low, it is not ecologically necessary to move herds to pastures in the cooler highlands and lowland areas. They are not dessicated by extreme heat and aridity. In the central Balkans, transhumant activities are known to have been largely a function of the unstable political conditions under the Ottomans and the 19th century

Serbian Dynasts. Even pigs, whc are nct usually thought of as viable transhumants (cf. Flannery 1965), are known to have participated in such movements (Navy 1). The local ethnohistoric reccrd cf extensive seasonal movement may not provide a fully valid model for Bronze Age pastoral activities.

The uniformly low density of sites during the Bronze Age (although higher than in the preceding late Neolithic) does not argue for the remcval of livestock to grazing grounds far (more than an hour or two walk) from from settlements and cultivated areas - i.e. lcng distance transhumance, as hypothesized by Sterud (1978), Sherratt (1972; 1980b), and others. The expectation is that livestock were probably grazed in a variety of micro-environments found around settlements. Part of the year was spent in non-cultivated habitats which sheltered them from the winter such as marshes. During the rest of the year, they were grazed on fallow fields, as is the case today and in the recent past (Szabadfalvi 1968; Vincze 1980). The presence of small Bronze Age sites with minimal occupaticn debris located at points strategic for controlling herd movements (e.g. Golo Brdo at the mouth of a narrow mountain valley and Jerinin Grad in the center of floodplain - Bankoff, Winter & Greenfield 1980) and between the larger settlements may support this expectation (Ill. 3). There is no evidence in

Central and Western Europe until the end of the Bronze Age for a shift to the stalling of cattle and other domestic artiodactyls (cf. Clason 1984; Waterbolk 1975). Why such a change would have taken place remains uncertain, since stalling brings more work for the herder. The animals must be constantly tended and fed. Stables must also be cleaned, although not necessarily very often. The evidence for stalling from earlier Linear Bandkeramik houses is unclear (Bogucki 1982) and absent from the central Balkans in their entirety.

V. CONCLUSIONS

The model has been framed from a regional perspective and, as a result, the data to test it had to come from a wide variety of environmental contexts. Otherwise, micro-environmental variation in the sample could easily skew any results that may have been obtained. The objective is to be able to pinpoint long-term temporal trends, even when modified by local environmental constraints. A sample of both upland and lowland localities was collected from each of the major temporal phases in order to limit such bias. This is obviously a very complex problem requiring a large data base for evaluation. The data to evaluae the above hypotheses will be presented in the following chapters. In the next chapter, I will define the region of study and

present some of its more important environmental characteristics in order to familiarize the reader with the area. It is relatively unknown to most westerners for a variety of political and linguistic reasons. Chapter 3 will be a general and specific discussion of theory and method in zooarchaeological research. It will focus upon the problems of conducting such research in the Balkans and the comparison of samples. Chapters 4 through 9 will present the results of each of the sites in order that trends within any single locality may be first identified. In the concluding chapters (10-12), a more regionally-oriented discussion will bring the discussion back to the model itself. Before I go any further, I would like to define the region and present some of its environmental characteristics.

CHAPTER 2: NATURAL ENVIRONMENT OF THE CENTRAL BALKANS

I. INTRODUCTION: DEFINITION OF REGIONAL UNIT

In this chapter, some of the physical characteristics that define the study region will be presented. There are no rigid topographic boundaries that clearly define the extent of our study area. The central Balkans (Ill. 2) cross-cuts modern geographic and political borders, to include north-eastern Yugoslavia (Serbia and the Vojvodina), northwestern Bulgaria, and south-western Romania (the Banat and Oltenia). The region is characterized by extreme topographic complexity, with closely juxtaposed and starkly contrasting environmental systems - high uplands (some heavily forested, other deforested) and lowlands (both marsh-like and well-drained). It has a climate with both temperate central European and arid Mediterranean aspects. It is the combination of these radically different environmental systems that distinguishes the region as a physiographic unit. There are three general climatic and vegetational zones found within the Balkan Peninsula. They are: 1. The Mediterranean Zone, which includes Dalmatia,

Macedonia, Greece, Southern Bulgaria, and the southwestern Black Sea Coast; 2. The Transitional Zone, which includes Serbia, Northwestern Bulgaria and South-western Romania; and 3. The Temperate Zone, which is found to the north, closer to central Europe (i.e. in Hungary).

The traditional geographic limit between the Balkans and central Europe is the Sava in the west and the Danube in the northeast. They are arbitrary boundaries, since the rivers cross-cut the various topographic features rather than separating them (Grubić 1980: 5). The Danube and its tributaries criss-cross the area and imposing a certain unity in terms of ease of communication. The river systems and their valleys form "natural corridors" through the mountainous, forested and marshy areas and have provided important lines of communication and movement from prehistory to the present (Ill. 1). For example, the Vardar-Morava corridor is the shortest stretch (ca. 500 km.) between central Europe and the eastern Mediterranean. North of the Dinaric mountain divide, all of the rivers and streams flow into the Danube, which empties into the Black Sea. The major tributaries of the Danube are: a. The Tisza and Maros flowing southwards from the Carpathians; b. The Sava and Drava flowing northwards and eastwards, respectively, from the Dinaric and Julian Alps; and c. The Morava which flows northwards from Kosovo and southern Serbia (Ehrich 1965; MacDonald 1970: 7; Navy 1).

The word "Balkan" is of Turkish origin and denotes "...a chain of mountains" (Navy 1: 1). The various mountain chains hinder movement between parallel drainage systems. The central Balkans lies within the southeastern part of the region more commonly known as the "Middle Danube Drainage". The latter has been defined as

> "...the entire region lying within the arc of the Carpathians, Julian and Dinaric Alps, and mountains of eastern and central Serbia. The point at which the region terminates in the east is when the Danube passes through the Iron Gates..." (Ehrich 1965: 407).

The Iron Gates (Djerdap) is the stretch of the Danube that carved a path through the Carpatho-Balkano mountains on its way to the Black Sea. One of our sites (i.e. Livade) falls immediately on the other side (east side) of the Iron Gates and will provide a control as to developments immediately outside the area, but sharing a similar ceramic group.

In the absence of clear topographic boundaries, I will pay most attention to material collected from Serbia and the southern part of the Vojvodina. This is due to several practical considerations:

1. The ceramic groups that I have dealt with were mostly centered on this area. The ceramic groups found in each of the prehistoric phases under consideration rarely respect natural boundaries. Instead, they have tended to center on major river systems where archaeological research was conducted;

2. This area represents a much neglected transition zone between the Mediterranean and central European environmental regions; and
3. Most of my research was conducted in this area. Some data from surrounding regions are available, but comparability problems may exist.

In the following sections of this chapter, I will describe each of the major regional units, in order to place the archaeological sites in their proper environmental context.

IIA. Physical Geography and Geology

II. INTRODUCTION: HISTORICAL BACKGROUND

The central Balkans is characterized by an extremely complex geological history. During the Late Tertiary, tectonic activities occurred which created the present-day topography. A phase of folding, fracturing and uplifting of the Pre-Cambrian crystalline Rhodopian massif (in southeastern Serbia, Macedonia and Bulgaria) and in the surrounding regions (i.e. the Dinaric Alps between Slovenia and Macedonia and the Carpathe-Balkano mountains in Hungary, Romania and northeastern Serbia), in conjunction with subsidence in the Hungarian Plain, the Adriatic and the

Black Sea basins functicned tc effectively cut off the Pannonian Sea from the Iethys (Butzer 1971; Markovic 1968; Navy 1: 1-4). This created a distinctive set of barriers (climatic, vegetative, zoological, etc.) between temperate Central and Mediterranean Eurcpe (Navy 1: 1). By the middle Miocene, the Pannonian plain had changed to a lowland, marshy depositional basin, where sands, clays, and marls were being deposited. The surrounding higher regions were better-drained (Bankoff 1974: 8-9; Markovic 1968; Navy 1: 10). This change took place as the Danube cut its way through the Carpathc-Balkano mountains, allowing it to drain into the Black Sea. As the Danube cut its way through the mountains, it created the famous Iron Gates gorge (Djerdap = Serbian), and divided the mountain system into two parts - the Carpathians to the north and the Balkan or East Serbian mountains to the south. These tectonic and other earth-molding activities fragmented the land-mass so that several micro-regions may be defined. "Balkanization" of the landscape is a well-known feature of the area. Each of the micro-regions will be treated separately in the sections below.

During the Pleistocene, there is evidence for small localized highland glacial activity. However, the effects of the more heavily glaciated and tundra environments north of the Carpathians were felt (Grubić 1980: 46; Tringham 1971: 28). A thick blanket of loess, which is a finely-

powdered aeolian sediment, blanketed the entire Pannonian basin and much of the surrounding areas. It originated during the periods of glacial advance and became the pedological basis of the rich modern soil covering (Navy 1: 13-14; Tringham 1971: 28). In addition, the more northerly floral and faunal zones were compressed into the Balkan peninsula as refugees, resulting in an unusually rich mixture of environments and organisms (cf. Alexander 1972: 13).

IIB. Central Serbia and the Morava Valley

The Morava river drains a vast area south of the Danube. It is the last southern tributary of the Danube before it enters the Iron Gates. It originates as far south as Montenegro and the northern border of Macedonia. The river system has, historically, been the route of easiest access between central Europe and all points to the south and east (e.g. Athens, Sofia, Istanbul, etc. - Navy 1: 87). In the south, the various tributaries flow through narrow gorges and steep defiles in very mountainous countryside. North of Nis, the Zapadna (Western) and the Južna (Southern) Morava converge to form the Lower Morava which empties into the Danube near Golubac. The river plain of the Lower Morava is extremely wide (over 16 kms.) and flat, although the river

itself sluggishly meanders within a restricted zone (3-4 kms. wide). The wide river plain is a result of a "...wide and deep gulf..." of the Tertiary seas that penetrated the area. Several broad flat terraces were carved along the edges of the surrounding uplands as the waters advanced and receded. The gradient and velocity of the river are very low. It loses less than 60 meters over a 96 kilometer distance between Stalac (128 meters a.s.l.) and its mouth on the Danube (76.2 meters a.s.l.). Flooded areas are common within the meander belt (Navy 1: 92). Throughout the rest of the riverplain, it is relatively dry. Together with terraces along the edges of the plain, it has been a focus of occupation from prehistory through the present (Barker 1975; Chapman 1981; Navy 1: 92). Large sections of the floodplain have been drained in recent times and are fertile agricultural soils, especially when cultivated through modern methods. This is not to imply that it was not under cultivation in the past as well (e.g. see dispute between Barker 1975 and Chapman 1981). North of Leskovac, the valley is bordered by hilly or mountainous country and forms an obvious route through the length of eastern Serbia.

The Morava river is one of the most important river systems in the Balkans. It is part of the Middle Danube Drainage basin. Together with its tributaries (the Southern and Western Morava and the Ibar rivers), it flows over a course of 1100 kilometers when measured from its

headwaters to its confluence with the Danube in the north at Smederevo, 50 km. east (or downstream) of Belgrade (Markovic 1968). Together with the Vardar (Greek=Axios), which rises in the mountains of northern Macedonia near Skopje and which flows about 370 km. southwards into the Aegean, they form a natural route or highway from north to south through the entire central and northern parts of the Balkan Peninsula (Mellaart 1975: 257). On paper, it appears easy to travel between the two river systems. In actuality, between their headwaters lies a small but formidable mountainous divide. It is more probable that the route led around this divide, through the Ovce Polje near Titovo Veles and returning subsequently to the Vardar valley (Bankoff 1974; Ehrich 1965).

In its upper and middle courses, and those of its southern tributaries, the Morava flows through a series of small Tertiary basins which are connected by sharp defiles and gorges (Osborne 1967: 205; Pounds 1969: 64). The Morava is split into a southern and western branch, which join at Varvarin, slightly to the north of Krusevac, to form the Lower Morava.

The hills and mountains bordering the Morava valley are very fertile. They were once covered by thick

forests, little of which remains today, having been cleared in historic and prehistoric times (Stoianovich 1965: 27-37). The soils covering the floodplains and hilly ridges are, presently, under cultivation. Very little of the latter two areas are under secondary forest growth. Corn, sunflowers, wheat, alfalfa, vines, vegetables, and orchares form the main crops. Corn, sunflower, wheat, and alfalfa are grown in an annual rotation without irrigation to retain and increase soil fertility (Halpern 1967: 56-69). The climate is continental and rainfall evenly distributed throughout the year, with an annual average of 640 mm. (Marković 1968: 857). This is sufficient for dry-farming, in conjunction with the water-retentive soil.

The area north of the mountainous Karst region and the line of the Zapadna Morava, south of the Danube, east of the Kolubara river and west of the Lower Morava is called "Šumadija". It is the heart of Serbia. Šumadija is the northernmost extension of the Dinaric Alps, which rise abruptly at the edge of the Adriatic and gradually decrease in altitude until the foothills merge with the terraces of the flat, open Pannonian Plains (MacDonald 1970: 12; Navy 1: 1). The Dinaric mountains show a northwest-southeast fold line (Alexander 1972: 12) and have a very level crest line over a considerable distance. In its lower ranges, it appears to to have been "...widely planated or bevelled...",

giving it the appearance of a highly dissected platform. In fact, this area has undergone extensive erosion and dissection of the softer and less-resistant deposits. The platforms are highest in the south (ca. 1,000 m. in altitude) and decrease in height tc the north (ca. 200-300 m. in altitude - Navy 1: 89). Thrcughout the area, groups of rocks protrude thrcugh and above the soft Tertiary mantle of limestone, sandstone and shale. These older and more resistant rocks, often containing mineral rich deposits, stand up as hills above the rest (e.g. Rudnik near Topola, Serbia). Another example is the cinnebar deposits in the hills behind Belgrade. It is located on one of the most northern extensions of the mountain foothills and overlook the plains to the north. The harder deposits force the Danube and Sava rivers to swing alongs its northern edge. This location provides a unique advantage in the control of all mcvement along the rivers and plains below (Navy 1: 92). Similarly positioned prehistoric lccalities (e.g. Vinča) attest tc the impcrtance of such "control" activities during prehistory (cf. Chapman 1981).

The Jasenica is the last major left bank tributary of the Morava river before it jcins the Danube (Ill. 4). It flows northeast from its headwaters in central Sumadija until it joins the Kbrsnica, a southeastwards flowing tributary at Smederevska Palanka. From there,

it is only about 10 km. to its confluence with the Morava at Velika Plana. The Jasenica, Kbrsnica and their tributaries drain approximately 900 sq. km. and dissect the hilly landscape to the north and south of the Jasenica into long north-south valleys. Each valley is separated by ridges rising 75-100m in altitude. The maximum width of the Jasenica floodplain is approximately 2 km. The dendritic drainage system is presently used as the modern route between the hilly interior and the flat lowlands of the Morava valley. Movement was probably similarly oriented in the past (Bankoff and Winter 1982: 151).

All the modern urban settlements are found on the edge, rather than within the Morava floodplain. Prehistoric settlements (e.g. Drenovac) are frequently found within the floodplain. Virtually all the known archaeological sites in the hills beyond the floodplain of the Morava are placed alongside of the streams cutting thrcugh the area and leading down to the major rivers (i.e. Neolithic and Bronze Age). Only the Iron Age, Roman (e.g. Mramorac and Kutrice) and sundry Medieval sites in the same general area are found directly in the floodplains adjacent to the small rivers (i.e. Jasenica and Kbrsnica). The Bronze Age and Neolithic sites are all situated on the slopes above the streams,

with easy access to water and protection from floods, except for special function localities such as Jerinin Grad (Bankoff and Winter 1982: 162). Deep ploughing (more than 1/2 meter in depth) has just begun in the area. All sites, however, share the problem that the uppermost meter of soil has been badly disturbed by modern and ancient agricultural activities.

Along the western boundary of Sumadija is the Kolubara river. It also rises in the mountains of the south and drains into the Sava river to the north. The Sava empties into the Danube at Belgrade. The Kolubara system is reminiscent of the Morava (but on a smaller scale). It is fed by several small mountain rivers and streams (e.g. Gradac), while it winds through the mountainous regions of Western Serbia. The floodplain of the Kolubara successively widens as the river descends from the mountains to the Pannonian lowlands and forms one of the major corridors for movement (both modern and early historic) from the lowlands into the mountains. Within the central Serbian region (or Sumadija) we find the largest number of our localities - Novačka Ćuprija, Crkvina, Petnica, Sarina Medja, Vrbica, Večina Mala, and the already analyzed site of Divostin.

IIC. The Pannonian or Northern Plains

The Yugoslavian section of the Great Hungarian Plain is locally known as the Pannonian or Northern Plains. The entire region was the bottom of the Tertiary Pannonian Sea and is a vast sedimentary basin. Today, its relief is generally low and flat. The basin lies between 100 and 200 m. above sea level (Grubić 1980: 6). Most of the softer rocky outcrops (e.g. the clays, sandstones, and limestones) have been gradually eroded, levelled and filled to form a peneplain - "...a vast surface of subdued relief" (MacDonald 1970: 12; Navy 1: 10). During the Pleistocene, the region developed its characteristic soil cover - loess. Depths of up to 40 m. have been recorded, testifying to the long-distance effect of the glaciers. Above the loess deposits are often found a wide variety of lacustrine and riverine deposits (Bankoff 1974: 8-9; Marković 1968; Tringham 1971: 28). The high loess and sand component and strong winds in the elevated non-marsh areas are often characterized by the formation of some of the largest inland sand dunes in Europe (Bankoff 1974; MacDonald 1970: 12).

The river systems are the most dynamic features of the landscape. They change course periodically, leaving oxbow formations in their old beds. Flooding above and beyond the normal flood plain is quite frequent (Navy 1: 41). The major rivers are over 150 m. wide and 2.5 m. deep, although

the Danube, in many places, is over 4 km. wide and 18 m. deep at high water. Great oscillations between high and low water are common. For the entire central Balkans, high water occurs from March through mid-June, while low water occurs between July and October (MacDonald 1973: 12-13). The floodplains are wide and are bordered by low terraces and plains, often only five tc ten meters above mean water level of the rivers. Scme of the rivers are rimmed by bluffs and terraces between 20 and 35 meters in height (MacDonald 1973: 12-13; Nandris 1970: 60). The rivers meander across fairly wide floodplains. During the late spring, the time of maximal river height, large areas are frequently flooded causing much devestation. Floodwaters in the Sava, Drava and Tisza have caused backups in the Danube leading to overflow of its banks. A four meter rise in the Danube has caused the Tisza to flow in reverse and flood the adjacent lowlands for up to one hundred kilometers (Nandris 1970: 60). Extensive areas of permanent and seasonal marshes cause large areas to be unpassable and unuseable for agricultural activities (Barker 1975: 100). The rivers both aid and hinder movement in and out of the area. Movement is usually along the flat valley sides or by boat. But they have served as barriers to invaders (e.g. the Turks - Navy 1: 41) and as refuges (Vincze 1980). The sites of Opovo, to be presented here, and Gomolava, already analyzed by Clason (1979), fall within this region.

IID. Eastern Serbia and the Iron Gates

This area can be readily divided into three physiographic units: a. The Balkan Mcuntains of East Serbia; b. The Iron Gates; and c. the western edge of the Dacian Plain (from Kladovo to the Timok).

IID.1. The Balkan Mountains

The mountains cf east Serbia are a section of the Carpatho-Balkano system which arcs down into Yugoslavia and is known locally as the Balkan mountains (Stara Planina in the south or Homolske Planina in the north). The Balkan mountains are bounded in the south by the area east of Leskovac, in the north near Gradiste on the Danube, in the west by the lower Mcrava valley, and in the east by the Dacian Plain. An arm extends into Bulgaria north of Sofia. Within the Yugoslavian segment, it is 48-64 km. wide. This is the northwestern ccrner of the eastern flank of the ancient Precambrian Rcdcpi massif. It is a zone of extremely broken relief, with the mountain ranges taking on a chaotic pattern. There is no trace of the regular "graining" or folding in relief characteristic of the

Dinaric range (Navy 1: 87-88, 98; Stoianovich 1966: 6, fig. 1). The entire region is an area of shattered, crushed and folded relief. In the south, the mountains are highest (often more than 2000 m.) and deeply scarred by ravines cut by torrential streams. In the north, the mountains decrease in height (rarely reaching 1000 m.) and the relief is gentler, although still extremely mountainous and broken by the various rivers and streams (MacDonald 1970: 98-99; Navy 1: 10 12). In the northern region, localized subsidence has tended to disrupt the relief and leave small isolated basins, filled in with Tertiary deposits. These basins have provided important areas of settlement and cultivation and routes of communication through an otherwise difficult landscape. Between the basins are often found streams flowing through narrow defiles. North-south communication is largely non-existent, while east-west movement is limited to following the system of basins and gorges cut by rivers (e.g. the Nisava between Niš and Sofia - MacDonald 1970: 12; Navy 1: 101-102). The ancient Rodopi massif is largely composed of crystalline metamorphic rocks, such as gneiss and schist (Navy 1: 87). They are most widespread in the north, immediately south of the Danube (Navy 1: 99). It is in this area that one finds some of the richest mineral deposits in Europe (e.g. copper near Majdanpek). Farther to the south, softer Cretaceous rocks (sandstones, shales, and limestones) are more prevalent (Navy 1: 99).

IID.2. The Iron Gates

Between Golubac in the west and Karatas in the east, the Danube takes an unusual route. It flows straight across the Carpathians, ignoring the direction of relief, to form a series of gorges, defiles, and small basins, over a distance of 72 miles, to connect the Hungarian and Dacian basins. This region is known as the Iron Gates (Djerdap = Serbian), although it most accurately applies only to the narrowest point in the gorge near Sip. It separates the Transylvanian-Carpathian system in the north from the Balkan Mountains in the south. In the defiles, the mountains on either side slope straight down to the water's edge. Alternating with the defiles are small basins where the river widens and the banks slope less precipitously. In such situations, most of the prehistoric localities (e.g. Lepenski Vir, Vlasac, Padina, and Hajdučka Vodenica) are found. The Danube sharply increases its average gradient (from 39 to 70 meters) and velocity, far exceeding those in the Hungarian and Dacian Plains (Navy 1: 102). Movement through the area is hampered by the extremely broken relief. It has tended, as today, to follow the river by boat or by a combination of foot and boat, hopping between basins. There is no continuous pathway from one end to the other, since the river frequently fills the valley from edge to edge (MacDonald 1973: 9; Navy 1: 102-105).

IID.3. The Western Edge of the Dacian Plain

The Dacian Plain begins after the Danube emerges from the Iron Gates. The Danube at Kladovo lies about 28 m. above sea level (Grubić 1980: 7). It quickly changes course to a north-south orientation and drops in velocity and gradient. The hills recede on both sides and the relief becomes more relaxed and subdued. The river flows within a series of well-incised river terraces carved into the less-resistant Tertiary and Holocene deposits (Navy 1: 106). On the Yugoslavian side, the river cuts against the older Tertiary rocks comprising the eastern foothills of the Balkan mountains. On the Romanian side, the river is eroding into a low, sloping loess terrace dotted with lakes and marshes. This side is more prone to flooding (Navy 1: 107). A wide alluvial plain borders the river within the terrace system. Sand deposits have a localized distribution and mobile sand dunes may appear (Grubić 1980: 7; Navy 1: 107). The site of Livade falls within this area. The mountains of East Serbia are never far away from the sites in the river floodplain.

III. REGIONAL CLIMATE

Unlike the physicgraphic units cf the study area, the region is easier to characterize in terms of its climate. It has a southern temperate climate, with features similar to those of central Europe. However, it does retain features of the more arid Mediterranean climatic zone to the south. The farther north from the Dinaric mountain divide, the more it resembles the Central European climatic regime. Climatic variability is largely a function of altitude and proximity to the two neighboring climatic regions. In general, winters are very cold and summers are hot. Rain can fall at any season of the year, but the maximum falls during the summer. This is the reverse of the Mediterranean climatic type (Halpern 1967: 6; MacDonald 1970: 13; Navy 1: 217).

IIIA. Regional Temperature

July is the warmest month of the year, with an average temperature of 20-25 degrees centigrade (65-74 degrees F.), while January is the coldest month, with an average of 0-2.5 degrees centigrade (35 degrees F.) in the region between Belgrade and Orasac, both in northern Sumadija (Furlan 1977: 195-197; Halpern 1967: 6-7). Mean monthly maxima for

temperatures in the Vojvodina in July are 35 degrees C., a relatively high temperature when considered in conjunction with the accompanying high humidity levels. Mean monthly temperature minima for January in the region north of the Sava river fall at -15 degrees C., as opposed to the slightly warmer trend slightly to the south in the interior of the Balkan peninsula (-15 - -10 degrees C.). Obviously, the difference between mean minima for January is not great within the area, whereas the mean maxima for July show considerable differences directly traceable to variability in altitude and relief. The most extreme temperature range is found in the eastern end of the area, in the Banat and the Timok, with temperature ranges decreasing westwards. In Belgrade, July maxima may reach 42 degrees centigrade (108 F.) and February minima may reach -12 degrees centigrade (10 degrees F.). Very rapid changes in day to day temperatures may occur since the area is very flat and open to invading airmasses. A short distance to the south in Orasac, summer highs range up to 42 degrees centigrade and winter lows to c. -26 degrees centigrade (-17 degrees F.). The difference between winter minima and summer maxima over the area is generally between 50 and 55 degrees centigrade (Furlan 1977: 195-201; Halpern 1967: 6-7; MacDonald 1970: 13-15; Navy 1: 234-239).

IIIB. Regional Precipitation and Snow

Precipitation shows relatively small variation over most of the area and over the course of the year. The area has a continental rainfall regime, with the highest precipitation during the summer (June) and the lowest during the winter (February). Precipitation is fairly evenly distributed throughout the year and seasonal variations are not as great as in the Mediterranean. Almost one-half of the precipitation falls between April and July and the over-all number of days with rain is high (more than 150 days in Belgrade). This is an important quality for ensuring an adequate water supply through the agricultural growing season, although evapo-transpiration rates can exceed precipitation in some localities. Most of the region receives an annual mean level of precipitation of 600-800 mm. (24-48") . Over the Northern Plains and in the Morava Valley, it is slightly less, 600-700 mm. (20-27"), due to rain shadow effects of the mountains to the south and west. The major exception to the rainfall patterns is the Iron Gates, where the mean annual precipitation is 800-1200 mm. This is due to the high altitude mountain ranges and their effect upon passing rain cloud systems. The patterns of rainfall distribution is that less than 508 mm. (2") falls in January and March, 508-1016 mm. (2-4") falls in May and July, less than 508 mm. (2") in September (in the Iron Gates

and the Vojvodina) and 508-1016 mm. in Sumadija, and in November, most areas had between 508-1016 mm., with the exception of the Iron Gates (<508 mm.). Even during the month of minimum precipitation, Belgrade showed the greatest number of rain days (n = 10) for the entire peninsula (Barker 1975: 87 100; Furlan 1977: 203-208; Halpern 1967: 7; Navy 1: 86, 242-151).

In the late fall and early winter, snow begins to accompany the alteration in temperature. It is most frequent from January to March. The average date for the earliest frost is October 21, but extremes include the last part of September. The last frost generally occurs around April 13, 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. On the Pannonian Plains, snow falls between 20 and 30 days of the year, but in the more mountainous regions (500-600 m. a.s.l.) there are usually between 35 and 40 snow days. The last snow fall days occur during the last 10 days of March in Pannonia and during late April and early May at higher altitudes. Relatively small temperature differences can have a substantial effect on the number of snow days and the length of time that it remains on the ground. The open plains of Pannonia allow snow accumulations to be easily blown away by the winds. In the uplands, accumulations often remains for long periods of time inhibiting movement. Also fast flowing

streams and rivers freeze in the lowlands, but less in the uplands (Furlan 1977: 209-210; Halpern 1967: 7; MacDonald 1970: 13-15; Navy 1: 253-254).

IIIC. Regional Wind Pattern

In the spring, the area is warmed by southern and southwestern winds. During the fall and winter (between October and April), the predominant wind direction is from the north, northeast, or northwest. The northeastern winds are the coldest and driest. The Kosava is an example of a bitter, cold and dry wind which sweeps in from the northeast, gusting up to 48.3 kilometers/second and can last for 2-3 days and sometimes weeks without much of an interruption. If it comes early enough, it can contribute to extensive crop damage. Those from the northwest bring some humidity with them (Halpern 1967: 7; MacDonald 1970: 15; Navy 1: 218).

IV. REGIONAL SOILS

Several different soil types are differentially distributed over the area influencing potential economic productivity. An understanding of each is essential to any discussion of economy.

IVA. Alluvial Soils

Alluvial soils are located along the edges of and within stream and river valleys. These soils have their nutrients renewed annually by periodic flooding of silt-laden waters. Loamy and clayey sub-types have been noted. Because of seasonal or perennial water-logging and flooding, marshes and wet meadows frequently form (Barker 1975: 96, 99; Tanasijević et al 1966; Pesić 1967: 24 164).

IVB. Brown Forest Soils

In the hill country to the south of the Danube (in Sumadija and the western half of Eastern Serbia), the most common soil types are Brown Forest Soils (Gajnjaca = Serbian). They have a reddish-brown coloring due to the presence of iron compounds and develop under conditions where the soil is moist year-round. The A(B)C stratigraphy

lacks a distinct boundary between the A and (B) horizons, but has a strong (B)C boundary. They form on sub-soils with a 5.5-7.5 ph. The A horizon is rich in humic materials because they form under mixed deciduous forests. While the protective forest cover stands, the soil is prevented from degeneration and erosion. The tree roots bring up important chemicals from the lower horizons which are leached out. The leaf-fall also replaces lost nutrients. The forest canopy stabilizes this pedological system. It is a water-retentive type, but generally does not suffer excessive water-logging or dryness. It is seldom subjected to lengthy periods of drought or freeze and the snow cover thaws intermittently during the winter. When the forest canopy is cleared, a variety of degredation processes are initiated. The most dramatic, erosion, has a drastic effect upon fertility levels, reducing them by as much as 25-35%. The long-term result of erosion and leaching is the formation of podsols, sols lessives, and gleys (Barker 1975: 88; Cornwall 1958: 87, 103; J. G. Evans 1978: 75-78; Navy 1: 296; Tanasijević et al 1966: 61).

IVC. Podsols or Bleached Earths

These soils develop under cool and humid climatic conditions. They have a strong ABC stratigraphy, with high acidity levels and raw humus. They develop on acid subsoils in areas with high rainfall. The result is a strong leaching of the A intc the B horizcn. The longer the soils remain undisturbed, the more marked will be the horizons. Coniferous forest species (conifers, birch, heathers, brackens, bilberry and cther acid-tolerant species) usually cover these soils. Podsols are found distrubted over parts cf western Sumadija (near Valjevo) and skeletal podsols are distruibuted over the mcre mountainous parts of eastern Serbia (Butzer 1971: 87; Cornwall 1958: 87, 108-109; J. G. Evans 1978: 77-78; Navy 1: 296-299).

IVD. Chernozems or Black Earth Soils

These soils have a very high humic percentage (8-10%), are very dark in color, range from neutral to alkaline, are found in large continuous stretches and are rich and easily worked for agriculture. They are distributed over much of Pannonia and in pockets to the south of the Danube in the Morava valley. They are part of the A/C series of steppe soils and occur in regicns with a strong continental

climatic regime. The A horizon is very thick, often attaining depths of one or more meters. The crumb structure and fertility are excellent for cereal cultivation. They are usually covered by steppe-grasses. Weathering of chernozems is inhibited by the alkaline reaction, excess calcium carbonate and the winter freeze which brings all chemical and biological activity to a halt. This is one of the reasons for the inordinate thickness of the humic A horizon. As the snow melts, drainage is often impeded by frozen sub-soil causing water-logging and puddling and making low-lying areas impassable. This contributes to the regeneration of the luxuriant carpet of annual grasses over the area. In the summer, the soil is progressively dried out and arid, dusty conditions will prevail. During this period, the grasses will ripen and parch brown. The most common parent materal is loess and other calcareous sediments. Three possible phases of Holocene Chernozem development may have taken place: a. During the Boreal; b. during the early sub-Boreal; and c. during the later sub-Boreal (Bankoff 1974: 15-16 and references; Barker 1975: 88 and references; Butzer 1971: 93; Cornwall 1958: 95-96; Chapman 1981: 88; J. G. Evans 1978: 79; Marković-Marjanović 1971: 15-21; Navy 1: 296-299).

IVE. Smonica

Smonica is a very heavy soil type generally found in the lowest elevations of river valleys (i.e. the Lower Morava Valley). They superficially resemble alluvial deposits, in that a large propotion of clay deposits accumulate. They are hydromorphic black or dark-grey soils developed from calcareous clays overlying sands. Swamp soils will develop into smonica's as ground water is lowered and meadow-bog vegetation is replaced by grass-steppe, scrub and tree flora. The humic A horizon is up to one-half meter thick and has a good crumb texture for cultivation. The next Ca horizon consists of a water-soluble salt accumulation. The lowest horizon (C) is generally of sandy material. No sharp breaks delimit the horizon boundaries. The A horizon has a neutral to low ph, inhibiting chemical weathering, and allwing a rich accumulation of nutrients, making smonicas one of the most fertile soils in the region. The high clay component results in high water retention and water-logging, if poorly drained, during the late winter, spring, and early summer. During the drier parts of the year, such as the late summer and early fall, they will dry out and deep cracks will form (Barker 1975: 88; Chapman 1981: 88; Dennell 1978: 62; Kůbiena 1953: 138).

IVF. Riverine Soils

Two major varieties of riverine soils have been differentiated - sandy and clayey soils. The sandy soils are usually found in the upper tributaries of a river's drainage, where drainage is adequate and stream velocity and gradient high. Clayey soils are found in the lower courses of the drainage system, where velocity and gradient are very low allowing clay and silt deposits to accumulate, such as in the floodplains of the larger rivers (e.g. the Danube, Drava, Morava, etc.). Marsh and bog-type vegetative communities develop in the clayey deposits (Barker 1975; Dennell 1978: 62).

V. MODERN FLORAL COMMUNITIES

The plant communities of the area fall within the central European biotic region. The warm and moist seasons are the main periods of biotic activity (Navy 1: 256). There is usually an eight and a half month growing season (between the last and first frosts of the year) - from the middle of March through November (Halpern 1967: 7). Climatic change, deforestation and agricultural practices have all functioned to transform the biotic landscape. Two major sub-regions can be identified: the plains of Pannonia and the region to the south (Šumadija and Eastern Serbia).

Central Serbia is known locally as "Sumadija", which derives from the Serbian word for woods (=Suma). Before the nineteenth century intensive recolonization of the area, it was covered by a thick mixed oak forest. To travel from Belgrade to Nis, often required up to a week. Today, one sees only relict stands of this once great forest. The extent and density of the Sumadijan forests have varied over time, depending upon colonization efforts, political conditions and climate (Chapman 1981; Halpern 1967: 7; Stoianovich 1965: 27-37). Today, much of the valleys and lowlands of Serbia are under cultivation. Flood-control measures have extended the limits of cultivation into the once frequently flooded floodplains of the large rivers. A normal altitudinal zonation of biotic associations is found. In the lowest elevations are found marsh and bog-like environments (e.g. along the Lower Morava). The oak deciduous forests are situated on the rich non-calcareous soils above the floodplains. These occur on the rolling lowlands and the lower slopes of the mountains. They are sources for hardwood, tanning, and fodder. Pigs, in particular, are fond of acorns. Today, the lowlands are largely cleared for cultivation and only a thin ribbon of native deciduous trees are found below the coniferous forest zone. Beginning at about 1000 m. (a.s.l.), a beech forest zone begins. The leafy branches of the beech forests were

favored fodder for horses, sheep, and cattle. At about 2300 m. (a.s.l.), the coniferous forests begin to appear. Above them, at 5000-6200 m. (a.s.l.), lie the high mountain brushwood and grasslands (Navy 1: 258-275). The dramatic change in the modern flcra is attested by the prevalence of acacia throughout the fcrmer domain of the oak woodlands. It was introduced intc the area during the nineteenth century. Also, cultivated fruit trees, especially the plum, are widespread and favored. The national alcoholic drink is sljivavec, a plum brandy. Today, cak is found in only occassional patches (pers. obs.; Halpern 1967: 6).

Along the northern edge of the area, on the sandy soils near the Danube, a flcral community with steppe characteristics appears - "...herbaceous and sub-shrubby communities with large numbers cf grasses and bulbous plants" (Navy 1: 275). In the plains cf Pannonia, oak woodlands border the river floodplains and a steppe vegetation covers the terraces and plateaus above the floodplains. Marsh, meadow and other aquatic communities border the rivers, oxbows and other wet depressions dotting the area (Bökönyi 1974a; Navy 1: 276-277).

VI. SOIL POTENTIAL FOR AGRICULTURE

The major problem in estimating soil fertility and use over time lies in the fact that soils are not static entities. They evolve, spread, and become degraded - processes which increase or decrease their overall fertility. At different stages of development, the soils may be subjected to alternative use strategies. In addition, the technological sophistication of the user must be also kept in mind. Chapman (1981: 90-91) has offered important criticisms of the application of modern land use studies back into prehistory simply on the basis of soil types. Unfortunately, until studies are undertaken to examine the developmental history of each soil type and it's utilization, we are largely left with the tools provided by modern catchment studies. Most researchers have divided up the different soil types along the following lines: high arable; medium arable; and low arable potential (Higgs and Vita-Finza 1970; Dennell 1978; Chapman 1981: 90). The soil type with the highest arable potential is that of the Brown Forest Soils. It can be made to yield relatively high yields (Ianasijevic et al 1968) with only a moderate labour input and a simple agricultural technology (e.g. a digging stick - Chapman 1981: 90). Smonicas, with the development of the ard or plough, would also be relatively productive relative to labor input. Chernozems would have created the

largest problem because of the existence of a thick turf line. Only with the development of a metal technology with good cutting capability could it have been heavily utilized. Alluvial soils were dependant upon seasonal inundation for the renewal of their fertility. There are plenty of soil types with high to medium potential for clultivation in the area. The problem, as Chapman (1981: 91) has noted, is that

> "the limitation on arable in such areas is not lack of soil fertility but the size of the fertile area, restricted tc valleys and further diminished by the extent cf perennial standing water."

Precipitation levels are adequate throughout the region to support dry-farming, except in a few lccalized areas in Pannonia where evapc-transpiration rates exceed precipitation levels (Dohrs 1971: 275 in Barker 1975).

VII. CLIMATIC AND BIOTIC CHANGES THROUGH TIME

Unfortunately, the sequence cf climatic phases utilized for eastern and southeastern Europe was originally based upon material found in northern Europe. Relatively little Holocene paleoclimatic research has been conducted in the Balkans. As a result, we are still largely dependent upon the classic Holocene sequence from the north. Some recent Hungarian studies are available tc evaluate the validity of this scheme to the regicn (Janossy and Kordcs 1976; Kordos

1978a; 1978b). The Hungarian research focused upon micro-vertebrate biostratigraphic succession in the Bukk and other mountains of Hungary during the Holocene. It was able to establish a series of "faunal" phases - Bajót, Körös, Bükk, Kőhát and Alföld - for the first part of the Holocene. They correspond somewhat to the north European sequence based upon plant succession. But, many of the trends visible in the latter appear to have culminated earlier in Hungary (500-1000 years earlier - Kordos 1978b: 153). The classic and the Hungarian sequences will be discussed in some detail below.

Towards the end of the Pleistocene (10th and 11th millenia b.c.), most of the upper elevations were covered by coniferous tree forests. The lower elevations were covered by a dry steppe vegetation. The area functioned as a refuge for plant and animal species driven south by glacial activities (Butzer 1971).

During the initial Holocene phase, the pre-Boreal (ca. 8300-7500 b.c.), there is a rise in temperatures, recolonization of the region by deciduous tree species, and a limiting of the distribution of the more cold-tolerant plants and animals. The region was characterized by a warm, continental environment. July temperatures were similar to those of today (Butzer 1971: 529-530). In the Iron Gates,

paleobotanical data indicate that the more cold-tolerant birches and pines are restricted tc the upper elevations, while the warmth and moister loving species (i.e. hackberry, fig, tsuga, and beech) were found along the banks of the Danube (Misic et al 1971: 174).

The general trend frcm the pre-Boreal through the Boreal (ca. 7500-6200 b.c.) is that of warmer and drier summer climatic conditions (Butzer 1971: 531; Chapman 1981: 85; Kordos 1978b: 153; Misic et al 1971: 174). In Greece, Bottema (1974) notes the spread of mixed deciduous oak woodlands over the lowlands. Gigov (1956) has traced the continuing dominance of coniferous forests over the lowlands further to the north. As one mcves further northward, the proportion of conifercus to deciducus species increases. The mountains of the Balkans continue to be dominated by the former (Gigov 1964; Chapman 1981: 85 and references). Thermophilous trees (e.g. hazel) begin to colonize the plains of Pannonia (Carciumaru 1971a in Chapman 1981: 85). The earliest of the Hungarian phases, the Bájot, corresponds largely to the pre-Boreal and the first 2/3 of the Boreal. It began and ended several hundred years earlier than the corresponding northern periods. It was characterized by climatic conditions cooler than today, but gradually rising summer temperatures (Kordos 1978b: 146, 153). The average July temperature for Hungary started in the early part of

the period with a low of c. 17.2 degrees centigrade (during the colder Dryas II). A slow continuous rise took place until temperature values of c. 19 degrees centigrade were reached at the end of the period (Kordos 1978a: 224, fig. 2). The climatic optimum in temperature was reached soon afterwards in the initial part of the ensuing Koros period (c. 7700 b.c. - Kordos 1978a: 224). Coniferous forests, with pine and birch, dominate in the initial part of the Bajot. Deciduous forests slowly expand with the advent of higher temperatures until they are pre-eminent by the advent of the Körös phase. Humidity levels increased only slightly during the Bajót (Kordos 1978a: 226, fig. 4). The phase is also characterized by a significant, but decreasing percentage of cold-loving Pleistocene faunal survivors (Janossy and Kordos 1976: 17). The upper boundary of the phase is marked by when the survivors are outnumbered by the warmth-loving newcomers by a 1:2 ratio (Kordos 1978b: 146). The Bájot phase is synchronous with epi-Paleolithic and Mesolithic stone industries in the region (Kordos 1978b: 152).

The advent of the Atlantic (c. 6200-3000 b.c.) climatic optimum, signalled the beginning of a phase of warmer and wetter winters and cooler and wetter summers (Butzer 1971: 531; Chapman 1981: 86; Tringham 1971: 31). This is the period of maximum deciduous forest growth and spread. They

occur in the highlands and lowlands, along the floodplains and terraces (Gigcv 1956; Zolyomi 1953 in Chapman 1981: 86). We see a dramatic increase in arboreal pollen counts all over the Lower Danube drainage. The phase cf continued forest spread continues until ca. 4000 b.c. over most of Europe. Forests grew 200-300 m. higher in altitude than today (Tringham 1971: 33). Summer temperatures were at least 2 degrees centigrade warmer than today (Butzer 1971: 572). Pine and spruce continued tc dominate the upper altitudes (Chapman 1981: 86). The Brown Forest soils would probably have been covered by thick deciduous climax forests and undergrowth (oak, hazel, birch), the podsolized and acidic soils with lighter forest ccvers (pine and birch), the moist bog-like soils with spruces, and the loess plateaus by steppe-grasses. Along the rivers, gallery forests grew (Bökönyi 1974a; Chapman 1981: 86; Tringham 1977: 31). The second phase in the Hungarian sequence is called the Körös. In this phase, Pleistocene survivors are fully subordinated (Janossy and Kordos 1976: 22; Kordos 1978b: 146). Dry grassland ccnditicns appear and spread (Janossy and Kordos 1976: 22). This phase corresponds to the latter part of the Boreal and the first 2/3 of the Atlantic (Kordos 1978b: 153). A marked climatic "high" occurs within a short time after the advent of the phase, followed by a pronounced cooling trend. The "...climatic

optimum had its maximum not in the Atlantic, but earlier, at the turn of the Boreal and Atlantic phases" (Kordos 1978b: 153). The climatic optimum was reached c. 7700 b.c. and temperatures decreased thereafter (Kordos 1978a: 224). Average July temperatures for Hungary ranged from highs of c. 19 degrees centrigrade during the temperature maximum to lows of 16 degrees centigrade toward the conclusion of the phase (Kordos 1978a: 224, fig. 2). Annual precipitation levels significantly increased during the first half of the Koros (c. 6200 b.c.), reaching a peak about 5700 b.c., and thereafter decreasing until the end of the phase (c. 3000 b.c. - Kordos 1978a: 226-227, fig. 4). The Koros is probably synchronous with the Hungarian Neolithic (Kordos 1978b: 152).

A group of three short-term cold oscillations have been documented for the pericd c. 5500-4500 b.c. (the "Mesox Oscillation"). The intervening phases were warmer allowing forests of fir, hazel, alder, lime and elm to spread (Frenzel 1966: 103). Throughout all of these cold "snaps", the importance of cold sensitive plants decreased, but changes in temperatures were slight (Frenzel 1966: 111). The last five hundred years of the Atlantic period signals a sharper oscillation toward a colder climate (the "Picra Oscillation") than for any several thousand years previously (Frenzel 1966; Lamb 1977: 372). The upper forest limit declines in altitude (Brooks 1949: 298; Lamb 1977: 373)

induced by a lowering of spring or summer temperatures or the early arrival of frosts in the autumn. Winters also become cooler (Frenzel 1966: 106). Elm and ivy decline in the pollen spectra, the Swiss glaciers readvance, sedimentation of moss and sedge peat is replaced by sand, spruce forests are replaced by Calluna and Empetrum heaths and later by alpine meadows. The mode of plant succession, the readvancement of the glaciers and the altitude of the sites of investigation all rule out the possibility of human causation for this phenomenon (Frenzel 1966: 100-103). The height of the Piora Oscillation was reached c. 3200 b.c. and was followed by "... a rapid improvement of climate tending to a more pronounced continentality" (Frenzel 1966: 106).

During the next climatic phase, the sub-Boreal (c. 3000-1000 b.c.), climate becomes more continental. During the first half, winter temperatures are lowered slightly, while summer temperatures increased. However, the water budget worsens. Forests regain ground and the alpine tree limit reaches its highest elevations (c. 300-400 m. above the modern tree-limit). Several small climatic fluctuations take place, with sharp rainfall fluctuations (Butzer 1971: 572; Brooks 1949: 298; Frenzel 1966: 113 118; Lamb 1977: 373). During the second half of the sub-Boreal (c. 1500-900 b.c.), a reverse tendency is seen. Climate becomes more oceanic, the water budget is more balanced and mean

annual temperatures decrease slightly. These changes are also interrupted by minor climatic oscillations.

> "In consequence, not only the effects of climate on vegetation in the Atlantic/sub-Boreal and sub-Boreal/sub-Atlantic transitions but those of minor and short-term climatic oscillations too, including the Piora oscillation, may be hidden or retarded by other effects, only one of which was human interference with vegetation" (Frenzel 1966: 118).

While it is unlikely that in and of itself the climatic deterioration of the Atlantic/sub-Boreal boundary was severe enough to have been a cause of drastic cultural systemic realignment, it may have added some impetus to changes already taking place (e.g. smelnica development and consequent effect on agriculture - cf. Chapman 1981).

But when the Hungarian climatic data are taken into consideration, a much more drastic climatic change can be seen taking place. The Bükk phase is the is synchronous with the latter part of the Atlantic and the first half of the sub-Boreal. It is a period characterized by an unambiguously modern faunal spectrum. A few Pleistocene species remain in small isolated mountain areas (Kordos 1978b: 146; Janossy and Kordos 1976: 22). From the end of the Körös (= end of Atlantic optimum and Neolithic), the climate takes a sudden turn for the worse (Kordos 1978b: 150). The climate becomes markedly cooler (Kordos 1978b: 153). Short temperature oscillations increase in frequency and average July temperatures for Hungary beginning with

highs of c. 16.25 degrees centigrade during the first half of the Bükk, begin to continuously decrease until lows of c. 15.5 degrees centigrade are reached in the latter half (Kordos 1978a: 224, fig. 2). Annual precipitation levels increase from the post-glacial low at the beginning of the phase, eventually culminating in a post-glacial high during the succeeding Kohat phase (Kordos 1978a: 226, fig. 4).

In the succeeding Köhát phase, the last of the Pleistocene species disappear or are limited to "relic" areas (Janossy and Kordos 1976: 22; Kordos 1978b: 146). This phase continues the gradual cooling trend of the Bukk. Annual precipitation levels reach the post-glacial high as well (c. 1500-500 b.c. - Kordos 1978a: 226-227, fig. 4). The Bükk and Köhát phases encompass the Hungarian Copper, Bronze and Early Iron Ages (Kordos 1978b: 152). For the entire region of south-central Eurcpe (Hungary, Czechoslovakia, and southern Germany), the temperature minimum was reached between 2500 and 1000 B.C. In Hungary, it appeared to have occurred c. 2000 b.c. (Kordos 1978a: 225).

Whether there is a direct relationship between these changes and the transition frcm the Hungarian Copper to the Bronze Age remains to be seen. There is no question of the synchroneity of events, but it is causality with which we

are concerned. Demonstrating synchrcneity does not equal causal relationships. They may be simply a fortuitous series of events. The data cn animal exploitation to be presented below is hoped to be slightly more sensitive to climatic change than ceramic inventcries. If changes can be demonstrated in human exploitation strategies that are obvious adaptations to new ecological constraints, then we may be on firmer ground.

CHAPTER 3: ZOOARCHAEOLOGICAL RESEARCH METHODS: GENERAL AND PROBLEM-SPECIFIC

The analysis of the faunal remains from archaeological sites forms the focus of this research. Over the years, a variety of methods have been develcped to aid in the interpretation of the remains. Each of the different methods utilized in this study and their relevance to the problems under examination will be discussed in this chapter.

I. TAPHONOMY AND ZOOARCHAEOLOGY

IA. Some General Principles

Taphonomy was initially defined by Efremov (1940) as the study of the transformation of organisms from components of living populations through their incorporation within sedimentary deposits as fossils (Olson 1980). As such, it attempts to reconstruct the paths by which assemblages have moved from one temporal/spatial state to another. The accuracy of reconstruction is directly limited by the extent of our understanding cf the processes that effect such

transformations. Over time, information in the assemblage is deleted in a systematic manner. These sources of bias can be manifold, affecting assemblages to varying levels of extent. It can be difficult, but not necessarily impossible to eventually reconstruct the original conditions under which the elements of the data set were deposited if taphonomic considerations are recognized. In deposits mixed with other archaeological debris, a major consideration is the effect of human activities. The human-animal relationship is of paramount importance to research focusing upon paleoeconomy. Bones found on archaeological sites may, but not necessarily, represent the results of human food processing and consumption activities. They may also be a function of the activies of other animals (dogs, rodents, etc.) and non-food activities (e.g. tool production). The results of each set of activies must be identified before analysis can progress to questions of diet and consumption.

Initially, all bones belonged to living organisms participating in the biosphere. After the animal has died, the bones are no longer members of living organisms. In this state, carcasses are deposited on land surfaces (cf. Hanson 1980: 159). Before they are buried, they may become disarticulated and altered by human, animal and natural forces. Humans may butcher and distribute body parts to different parts of the site or to different localities

altogether (cf. Yellen 1977; Perkins and Daly 1968), destroy them through cooking (Bonfield and Li 1966), break them up for tool production, marrow extraction, or fat rendering (Choyke 1983). Carnivore damage can be extensive (cf. Binford 1981; Guilday 1970; Lyon 1970). Signs of canid gnawing include pitting, punch-like holes, scoring, 1/2 moon edging, etc. (Binford 1981). Although the effects of canids have been well researched, a number of other animals have also been known to scavenge bones - camels (Gauthier-Pilters and Dagg 1981), deer (Clutton-Brock et al 1982: 234), cattle, antelope and other bovids (Sutcliffe 1973; Gifford 1978: 78; Yellen 1977), as well as several types of carnivores (e.g. hyenas - Shipman and Conroy 1977). Bovid bone depredation usually occurs under conditions of mineral deficiency (e.g. phosphorus, calcium, aluminum, or iron). I have personally observed Serbian peasants feeding bones to pigs as part of their slop. Differentiating canid from suid tooth marks on bone is not always easy. Rodents are another common contributor to bias in assemblages. They are much more common in historic than prehistoric assemblages.

Bone that escapes the depredations of humans and other animals may still be further fragmented prior to and/or during burial. A variety of destructive forces may be involved, such as weathering, soil acid destruction, temperature and humidity fluctuations, water transport, etc.

Weathering occurs when the bones are left exposed on the ground surface for prolonged periods of time before burial or when re-exposed after burial. Smaller mammal bones have been observed to weather more quickly than those of large mammals (Behrensmeyer 1978; Gifford 1981). Cracks may appear parallel to the long axis of the bone or the outer surface of the bone may be destroyed (Miller 1975; Tappen 1969; Tappen and Peske 1970). Fluctuations in temperature and humidity levels may produce similar cracks and exfoliation. Trampling is another aspect of fragmentation that can be mentioned. The larger the bone, the greater is the likelihood that it will break up. Cattle bones break up into more fragments than corresponding sheep bones because they are larger and tend to fragment easier (cf. Binford and Bertram 1977). Movement by water, wind, gravity and other agents (e.g. humans) may differentially redistribute elements according to specific weight, size (Voorhies 1969) or body part. The relative time of epiphysial fusion and the specific gravity of the ends of limb bones are additional variables determining relative survival of elements (Binford and Bertram 1977; Brain 1967; 1969; Hill 1980: 147). Therefore, bone ends that fuse later tend to have lower specific densities and are more subject to destruction than are those that fuse earlier (e.g. proximal humerus versus distal humerus). Once the bone has been buried, soil composition and pH levels can enhance or reduce

assemblage attrition. A high pH, indicating relatively alkaline soils, will do little damage to bones, whereas a low pH (acidic) will eat away the organic structure of the bone (Gordon and Buikstra 1981). A high sand component in the soil can function to grind up bones into unidentifiable fragments within a relatively short time.

IB. Taphonomic Aspects of Balkan Assemblages

There are, as indicated above, many variables that intervene to affect the sample of bones. The filter of taphonomic processes includes diverse sources of attrition such as excavation methodology, recovery and storage, prehistoric hunting, butchering, cooking and disposal practices, recycling of organic refuse by dogs, pigs, rodents and other predators, differential fragmentation rates for different bones of each species, soil conditions, etc. (cf. Gifford 1981; Behrensmeyer and Hill 1980). Each sample to be described in the following chapters was individually evaluated for the presence or absence of attritional agents actively working to alter the nature of the original assemblage of bones. This was accomplished in several ways. The percentage of unidentified, minimally-identified (to a size level) and maximally-identified (species level) bones was used to reflect recovery

procedures at the site (see section on excavation and recovery methods). Fragmentation rates were derived from the proportion of identifiable:unidentifiable fragments. Chew marks and butchering activities are all reflected on the bones and allow an understanding of other forces, as well. Analysis of bones of each species by hardness and density can tell about other attritional forces. The ratio of early:late fusing long bone ends can be used as an indication of relative attrition between soft and hard bone ends. In a single skeleton, there are only 5 early fusing long bone ends, as opposed to 11 with late fusing ends (table 2). When the ratio in a recovered assemblage becomes unbalanced in favor of early fusing ends attrition must be taken into consideration. Collection technology is one of the most powerful of the taphonomic processes at work in this region. Few collections were sieved. The percentage of identifiable specimens in sieved collections can drop to 25% of the total number of fragments. In hand-collected samples, it may increase to as high as 75-80%. Recovery also affects the distribution of species and body parts for each species, with the smaller species and/or body parts being consistently underrepresented in unsieved samples (Payne 1972). The frequency of small bones (phalanxes, tarsals, carpals, astragalii, and calcaneii) can be used as a measure of this problem. When the proportion of such hard

and small elements in the recovered assemblage is less than would be expected if an entire skeleton had been present, then either ancient butchering practices or attrition must be taken into consideration. Butchering and disposal practices may have caused such parts to be left at kill or slaughtering sites, thrown to the dogs, etc. However, in order to control for this process, each activity area of each site in the settlement system must be adequately sampled a difficult, if not impossible task, given limited time and resources. Assuming that the carcass was processed on-site and that an adequate sample of activity areas was recovered (a unlikely proposition), the absence of small, hard (the same elements are also meat-poor) elements may be explained as a function of selective recovery. Such body parts are the most difficult to collect without the aid of sieves. Deciding which process is more likely to have determined element abundance in the collection is a necessary, but difficult task.

Reconstruction of butchering activities is a much more complex problem than many have realized. It is a process with many phases, several of which become visible only in very large samples. This holds true even for domestic animals (cf. Gilbert 1979). For example, marks are made on bones during the actual kill (e.g. Noe-Nygaard 1977). More marks are made on bones during primary dismemberment and

butchering (e.g. Speth 1982; Wheat 1979; Binford 1981). A tertiary series of marks are made by chopping meat into small units suitable for cooking (e.g. Binford 1978; 1981). Another embedded level cf butchering marks includes those left on the bone from eating the meat at the table. More marks are left on the bone from skinning, selection of bones for tool use, etc. All of these activities affect the bone assemblage before it is thrown "to the dogs" or recovered by excavation. It is unlikely that any single fragment will contain marks from each of the steps. As a result, larger and better controlled samples than were available for this study are required. The question cf the effect of butchering activities will have to be dealt with at a later time, except in the most rudimentary fashion. Due to obvious selective bias in the recovery of elements by size in many of the unsieved assemblages, when compared with sieved collections from the same region, I will be making the simplifying assumption that the butchering process was of a lesser influence on element abundance.

A small fraction of each sample appears to have been burnt. A very small percentage of the assemblages was directly exposed to an open flame. Most bone was probably encased within a sheath of meat when laid over a fire, was removed from the meat prior to cooking or was boiled in a stew-like concoction which would have limited contact

between the bone and the flame. A possibility also exists that since burnt bone breaks up easier than uncooked bone (Bonfield and Li 1966), it may have simply disappeared in the soil. Finally, cooking areas, such as hearths, and nearby dumps are the contexts in which burnt bone would be most likely to have been discarded and found are in cooking areas, such as hearths. Few of these have been preserved and even fewer have been found and excavated. Most domestic structures that have been excavated are remarkably clean, indicating that debris was periodically scooped up and disposed out of doors, into a harsher survival environment. PH levels were measured at several of the sites (Novačka Ćuprija, Petnica, and Vinča). The deposits in each had relatively alkaline soils, usually in the medium to high range (see each chapter for more specific data). The likelihood of destruction of this nature is thereby lessened. Livade, in contrast to the other localities, contained a high sand component in the soil. A great many of the bone elements were damaged by the grinding action of this coarse medium.

Analyzing material by the type of context from which it derived is of the utmost importance because different contexts often yield alternative, but complementary pictures of the larger situation at the site. Not all taphonomic processes were acting equally in all contexts. Internal

contexts (inside houses, pits, etc.) generally yielded much better preserved remains than outdcor deposits. Undifferentiated middens usually yielded the poorest quality data. Unfortunately, few samples of zooarchaeological specimens have been subjected to rigorous contextual analysis. Most collections are analyzed as a single unit with little regard for the influence of the origins of the various components from which it derives. When a sample is divided into units of similar contextual origins (e.g. pits verus sheet-wash), it will yield radically different results from each (Choyke 1983; Maltby 1979; Meadow 1978a; Uerpman 1973). For example, Meadow (1978a: 119) found that a significant difference existed between the quantity of pig remains between indoor and outdcor depcsits at a site in Iran - Hajii Firuz. This was explained as a function of bone size - due to their suppcsedly greater size, relative to ovicaprines, they were more visible and, therefore, more systematically collected by the inhabitants and disposed cutside the domestic living space. If only one or the other context was excavated, far different relative frequencies of each species would have appeared. However, since domestic pig bones are not always larger than those of ovicaprines, other processes should be considered as well (e.g. differential ability of the bones to withstand destructive forces in conjunction with refuse disposal and species selectivity).

The context from which the sample is drawn can dramatically affect the proportions of each species. Species can be over-represented in some deposits and under-represented in others (e.g. Maltby 1981; Meadow 1978a). For example, sheep/goat remains varied from 21.7% in ditches to 55.4% in pits reflecting the closed contexts of the latter and the consequent higher levels of preservation at Winnal Down (Maltby 1981). Ignoring contextual variability can lead to a swamping effect, where species with bones that are less resistant to erosion, survive at lower rates and become under-represented in the collection.

In this study, the samples from several of the localities were analyzed in this manner (i.e. Novačka Ćuprija, Livade, Crkvina, and the Late Bronze Age Svetozarevo sites). The remaining data sets were either not curated in a manner conducive to such analyses (Divostin, Obre, and Anza), information for each unit was not readily accessible (Gomolava), were too small to allow such an analysis to be useful (Petnica), or were obviously affected by certain attritional processes without having to conduct an analysis to make them apparent (Ljuljaci). Each assemblage will be examined individually for variation between types of deposits.

IB.1. Depositional Context of Late Neolithic Remains

In virtually every late Neolithic site under consideration, several types of depositional contexts were identified - pits, inside houses, under house eaves, exposed exterior surfaces, etc. At Obre II, the interiors of houses were remarkably clean of bones (Benac 1973). At Anza, all deposits from which bones derived were considered middens (Bökönyi 1976). No information is available on the distribution of faunal remains from Divostin. From both Divostin II and Obre II, it is known that the floors of the houses were littered with ceramics, grain and other debris (Benac 1973; Kaufman 1977). At Gomolava, some faunal remains were observed on the floors of houses (Clason 1979: 53). At Opovo and Petnica few remains were found lying directly on the floors, although the layers sandwiched between the floors and collapsed walls included abundant quantities of bones. Whether this material can be said to come from inside the houses or not remains a question. At Vinča, where faunal remains are common and well-collected, the house floors and eaves were almost clean of animal remains. Those that were found under the eaves are remarkably well-preserved reflecting the greater protection afforded by the structures against the wind, sun, and trampling. Most of the bones from each of the sites came from open-air, midden deposits. Few Vinča-period pits were found at Opovo and Petnica. This lends a certain degree of contextual

uniformity to the material, although future research should keep this problem in mind.

IB.2. Depositional Context of the post-Neolithic Bone Remains

The post-Neolithic sites exhibited a much wider range of contextual deposit types than did those from the Neolithic. The data were analyzed in the latter case as if the bones derived from a single, large and featureless stratum. This was because none of the bones in the Neolithic sites were collected, catalogued and analyzed with respect to their surrounding features. Collection and/or recording systems allowed material to cross-cut deposits, so long as they remained within broadly defined time periods (e.g. late Neolithic or Neolithic). The exact provenience of remains within a trench was not available. Therefore, contextual variability in the remains could nct be addressed. The data from Petnica will, when excavations are completed, be manipulated with this in mind. At this point in the Petnica analysis, too small an area of the site has been exposed making ccntextual assignments difficult. Among the post-Neolithic samples, only the data from Ljuljaci was treated in this way. Features are known to have existed on the site, but I was unable to match provenience description on the bag labels with the stratigraphic analysis of the features and

houses. Bone from "sloj" or featureless cultural strata were excavated at Petnica (Eneolithic and LBA), Novaćka Ćuprija (Eneolithic and EBA/MBA) and Livade (early - late Bronze Age). Pits were excavated in the EBA deposits at Novacka Cuprija and Crkvina and in the LBA deposits at Livade, Vrbica, Sarina Medja and Večina Mala. All of these sites can be considered lowland localities, on a stream or river. Pit deposits were notably absent in the upland sites. LBA floors with associated bone were identified at Večina Mala, Livade and Novaćka Ćuprija (all lowland localities). In analyses of several sites (chapters 7-9), I will show how different contexts yielded different remains and a different subsistence reconstruction. Species proportionality, body part preservation, etc. are all governed by context. If only a single context exists for a site, the chances of it being skewed are increased. Sample size of the remains from different contexts is another regulating variable. For example, the remains of bone at Livade are mostly found in the sloj. This affects the combined total for all remains at the site. The pits yielded only 1/10th of the number of specimens. The total for the site is a mirror reflection of the largest contributor (i.e. sloj). The pits had so few specimens that they were swamped by the sloj data. Evaluating each separately provide control over contextual variability

allowing for a greater understanding of the deposits and associated remains. Inter-site comparisons are best done with bones from similar contexts (i.e. only pits or sloj) to see if varying pictures of development emerge. If sample size and the type of deposit can be removed as influenced upon the nature of the recovered remains, then the argument that the assemblage is influenced to a larger extent by human activities is strengthened.

IC. Excavation and Recovery Methods in the Central Balkans

The methods utilized to excavate a site and recover artifacts imposes artificial limits on the ways in which the data can be manipulated. Materials from each of the sites were excavated and collected in varying ways. These will be described in greater detail in the relevant site descriptions. I was present for the excavation of three of the localities (Petnica, Novačka Ćuprija and Crkvina). The others were excavated prior to my arrival in Yugoslavia for this research. Rigorous recovery methods were only employed at the former set of excavations. This results in variance in the quality of assemblages, affecting inter-assemblage comparison. Nevertheless, each of the excavations shared several techniques in common. The main instruments of excavation were shovels and spades. Trowels or knives were

used only to clean specific features. Strata were excavated by "otkop sloj" (Serbc-Croatian for artificial horizontal units of excavation, frequently extending across the length and breadth of the minimal excavaticn unit, usually the quadrat or the trench). This system was initially developed at the turn of the century during the excavation of the site of Vinca, a site with unusually horizontal strata. It works under the assumption that the strata will be uniformly distributed in a horizontal manner acrcss an excavation area. Each otkop sloj is approximately 10 cm. in depth, although I have seen cases of far greater thicknesses. New units are begun whenever soil changes or features are recognized. Unfortunately, some mixture of remains from neighboring deposits can occur befcre recognition of new discrete deposits. New levels are reccgnized usually after an overlying section has already been removed. Only methods of excavations that dig by stratigraphic units, inbetween stripping/peeling of the sediment in very thin layers, can minimize the problem cf mixture. This is because differences in layers appear very early. Excavation of control test pits, at the same time, would allow previews of forthcoming stratigraphic changes (Hcle and Heizer 1969: 152-154). The technique of excavation varied slightly from site to site and, occasionally, frcm year tc year at certain sites (i.e. Petnica). More detailed discussions will be found with the description of each site. Ideally every bone

should be "...recovered and its stratigraphic provenience and three-dimensional coordinates...be recorded" (Klein 1980: 224). This would allow the eventual complete reconstruction of the assemblage in its stratigraphic context. In practice, this is rarely the case, since time, finances and other constaints would prevent the continuation of an excavation for the length of time necessary to collect a sufficient sample size and fraction (c. 30 years?). Bones were collected in batches or groups from a general location within a stratigraphic unit. This limited possibilities for the spatial analyses of remains, but yielded large enough quantities for analysis within the allotted time for excavation and analysis.

In the absence of rigorous recovery methods during excavation, the sample of artifacts will speak more of the behavior and decisions of the archaeologists during excavation than about prehistory. A large percentage of the artifacts present in the soil are missed when it is picked through for artifacts by hand-and-eye techniques (Casteel 1973; Payne 1972). When the soil is passed through a wire meshed sieve, a larger number of small artifacts are automatically caught and retrieved. These are normally hidden in clumps of dirt and remain invisible unless each clump is separately broken-up. Invariably, during hand-collection most blocks of soil are incompletely examined and

a substantial percentage of the smaller fragments are not recovered. In addition, when the soil is broken up in the trench or upon the discarded soil heaps, large numbers of small fragments fall into the surrounding dirt and are easily missed. Most excavators assume that hand-collection will recover a representative sample of the larger mammals (cattle, pig, sheep/goats, dog, red and roe deer, etc.). However,

> "sieving substantially alters the relative abundance of the bones of the different animals. /At Sitagroi,/ ...the number of cowbones is doubled, pig increased by a factor of ten, and sheep/goat by a factor of over twenty. As one would predict, the smaller parts of the skeleton are most strongly affected" (Payne 1972: 59-60).

An examination of the back-dirt or spoil heaps of an excavation usually illustrates the selectivity of collection at that site. It is often the small specimens that tell us the most about natural changes in the environment and human utilization of available resources (e.g. Stahl 1982). When the objectives of the research are paleoeconomy, the mass of seemingly inconsequential bone fragments, many less than one centimeter in length, represent information of paramount importance to one's conclusions. The general conclusion offered by Payne (1972a: 61) was upheld:

> "The smaller animals will tend to be underrepresented in relation to large animals, and that the smaller bones will be more affected than the larger".

In chapter 11, I cffer a methcd for correcting some of the biases evident in the assemblages. But, first the biases must be recognized.

Only three sites in the sample had some portion of their assemblages recovered with the use of sieves (i.e. Petnica, Novačka Ćuprija, and Crkvina). The percentage varied from site to site and reflected the concerns of the excavators in recovering substantial quantities cf unbiased samples in the face of time and financial constraints (100% - Crkvina and from all parts of Novačka Ćuprija used in this analysis; ca. 25% - Petnica). Water sieving was conducted systematically on features only at Petnica where samples of pits and other selected features were collected. Systematic water sieving was unsuccessfully tested at Novačka Ćuprija. The only micro-sieved material from Novačka Ćuprija was found in the mesh at the bottom of the flctation tank. The heavy fraction in the tank was not systematically examined. If a bone was easily apparent and caught the eye of the paleobotanist, it was collected. All cf the other sites were hand-collected. As a result, the samples are not directly comparable. The extent of recovery biases must be evaluated before any reconstruction cf the ancient economy or diet is attempted. Cnly at Novačka Ćuprija were the organic remains bagged separately before transportation to the field lab. In this way, post-excavation damage to the

bones was minimized. At all the other sites, the bones were separated from the heavier artifacts (ceramics, daub, and lithics) only after they were washed. No efforts were made to stabilize any of the organic remains.

IC.1 Data Recovery from late Neolithic localities

Three sites within the sample were excavated with the aid of mechanical recovery devices (i.e. sieves) - the American trenches at Anza (E. Sterud, pers. comm.), 1/4 of each trench from Petnica and numerous samples from Gomolava (Clason 1979; pers. comm. - 1985; Clason and Prummel 1977). The remainder collected artifacts and other debris by hand. Without the aid of such devices, it is difficult to collect representative samples of the finer, less visible remains (Payne 1972). To make matters more complicated, the same efficiency in hand-recovery operations did not extend from project to project, nor even from trench to trench within the same excavation. Bökönyi (1974b) convincingly explained the varying results between trenches at Obre II as a function of different levels of recovery. Fewer bones and significantly greater percentages of the bones of larger animals were recovered by one of the teams. Sebastian Payne compared the results from trenches at Divostin and found a similar situation (A. McPherron, pers. comm.). The situation at Divostin is more complex than it may seem. It

seems that sieving was attempted for, at least, a good part of a single season. The test sieving was conducted only in a couple of trenches. What percentage of the analyzed sample was sieved is uncertain. At Anza, a similar condition may have existed as well. It is certain that the differences between the compared trenches at Obre II and Divostin do not reflect spatial variability in the distribution of remains, since spatially contiguous areas of the sites were excavated by different groups. The differences in analytical results may be a reflection of the goals of each group during excavation - large scale horizontal exposure of architectural remains versus tight control over artifact distributions within limited excavation areas. Each has its value, but for paleoeconomy the latter is necessary. At Gomolava, only a small part of the hand-collected material has so far been published (Clason 1979; Clason and Prummel 1977).

IC.2. Data Recovery on post-Neolithic Localities

As with the Neolithic collections, there exist problems in comparing the various post-Neolithic assemblages. The different recovery methods used to collect the data in the field are especially apparent. Some of the faunal remains were collected by hand only (Livade, Sarina Medja, Ljuljaci,

Vrbica and Večina Mala). The remains from two sites (Novačka Ćuprija and Crkvina) were collected by sieving with 1 cm. sq. mesh. One quarter of each sonda at Petnica was also sieved, while the rest was hand cclleciea. The most noticeable effect of differential recovery procedures is the preferential recovery of large over small sized specimens (and animals) in the hand-collected samples. Cften, a simplistic assumption is made when collections are nct recovered with sieves - that the larger vertebrates would be overwhelming in impcrtance. This assumption can be tested by comparing the ratic cf large to medium sized animals in the various samples (table 3). Both the hand collected and fully sieved collections yielded similar results - c. 40:58% (large:medium sized animals). Cnly at Petnica, the only partly sieved collection, was there many more large animals (c. 64.5%). The effect of environment may be more paramount in this case, since Ljuljaci (also an upland locality) produced a similar large animal value (68.4%). The large collection from Livade is slightly more problemmatic. When fish are included in the small sized animals, the percentage of large animals decreases tc 49%. This is intermediate between the completely sieved collections from Novačka Ćuprija and Crkvina and the partly sieved collection from Petnica (and also the unsieved Ljuljaci collection). When fish are removed from consideration, the percentage of large

animals increases only slightly (tc c. 54%). The unsieved samples from the Svetczarevo area (Sarina Medja, Vrbica and Večina Mala) resemble the sieved samples. Obviously, any conclusicn about the relationship between sieving and the proportion of large and medium sized animals must be qualified. Attritiocn mcstly appears tc exist among the small sized animals. The absence cf fish remains in the Svetozarevo sites and at Crkvina and the dearth of fish remains at Livade (all sites where fish would be expected to play a prominent role in the subsistence system due to their location on or near major waterways where fish are known to frequent) is probably a direct result of the lack of sieving during excavation (with the exception of Crkvina). The high percentage of large animals at Ljuljaci probably does reflect excavator bias in the recovery of bone, plus the surrounding environment which appears to have been rich in large game. Livade appears tc be influenced by similar conditions. In general, the samples are probably reflective of the species available in the surrounding environment, but the exact percentage of their remains in particular collections is probably not very representative of their original importance to the ancient economy.

II. DATING THE ZOOARCHAEOLOGICAL SAMPLES

Another important source of information necessary in any analysis is the temporal span or dating of the deposits in which they were found. There are very few species of macro-mammals which can be used to date deposits and materials from Holocene sites and strata. The species changeover was not as dramatic as during the Pleistocene or Pleistocene/Holocene transition. As a result, dating falls, largely by default, within the domain of the excavator (who may be collecting organic samples for radiocarbon analysis) or to the other specialists, such as the ceramic analyst (who will attempt to evaluate the "cultural affinities" of the clay wares at the site). Few localities in the central Balkans have had radiocarbon determinations performed. Balkan archaeology, by and large, has been concerned with questions of culture history and time/space sytematics (Ehrich 1965; Gimbutas 1965; Garašanin 1973; 1983). A plethora of local archaeological cultures have been defined for every time phase. Some are more explicitly described, while others have remained in preliminary stages of publication. Spatial variation in ceramic types and decorative motifs are the most commonly utilized elements for archaeological culture definitions. However, reliance upon a limited number of "types" as index fossils arbitrarily enhances differentiation between artifactually-

defined groups. These archaeologically defined "cultures" follow the definitions originally presented by Childe (1929) of a consistently recurring assemblage of remains. These cultures are not only differentiated in time, but also in space. Within each temporal phase, different habitats are characterized by local manifestations of the larger ceramic horizons and can be largely accounted for by the unequal distributions of raw materials and networks of communications and exchange. For our purpose, these micro-regionally-defined cultural units will be largely ignored (e.g. classic Vatin versus West Serbian Vatin). All the sites within the sample fell within a relatively small area (ca. 200 km. from end to end) and belonged to micro-regional variants of greater cultural horizons (e.g. Dubovac-Zuto Brdo and the Incrusted Wares of Pannonia). The sites were, therefore, grouped according to temporal phase and further sub-divided according to macro-environmental variables (such as topography).

Four major phases were chosen for analysis. They are the following: late Neolithic (Vinča-Pločnik culture); Eneolithic (Baden-Kostolac); Early-Middle Bronze Age (Vinkovci, Omoljica-Pančevo, Vatin and variant cultures); and Late Bronze Age (Dubovac-Žuto Brdo, Mediana, Paracin, and Halstatt A groups) and Transitional Iron Age (Halstatt B groups, Gava). The periods are not of equal length or

equally comprehended. The faunal samples were grouped in this manner because it created a larger sample size for many periods which would otherwise be poorly represented and because of the chronological synchroneity between sites of each phase as opposed to preceding and following periods. Some temporal gaps do exist and are not resolved because either the data have never been collected or were inaccessible for our purposes (i.e. Eneolithic strata at Gomolava). Comparative material from Hungary, Bosnia and Macedonia do exist and were drawn upon as needed. The Early and Middle Bronze Ages were grouped together for two reasons:

1. The Vatin ceramic horizons (including both the Omoljica-Pančevo and Vatin phases) extends over the latter half of the Early Bronze Age (hereafter called EBA) and the whole of the Middle Bronze Age (hereafter called MBA); and
2. The ceramic samples from Vatin or Vatin-like deposits (i.e. Ljuljaci and Novačka Ćuprija) are not readily differentiated into Early or Middle Bronze Age.

Therefore, the separation is merely an artificial division of a ceramic continuum. Only the early part of the Early Bronze Age (Vinkovici culture) has been readily distinguishable (Tasić 1968) and no faunal materials are yet available from it. Any deposit not readily assigned to one of the above temporal groupings was not included in the

analysis. Most of the multi-component localities had at least a small mixture of undatable remains. Even in securely dated deposits, ceramic fragments from earlier periods were occasionally encountered. Excavation units with more than 10% of their ceramic inventories from other periods were dropped frcm the analysis. Several deposits contained only bone and/or temporally undiagnostic ceramics. One could say that the deposit originated in the Bronze Age, but exactly when would be anycnes guess. Novačka Ćuprija was especially plagued by this problem. A commonly heard complaint was the atypical nature cf the ceramics at the site.

III. METHODS OF QUANTITATIVE ANALYSIS IN ZOOARCHAEOLOGY

Until recently, most reports of faunal remains from archaeological sites were simple "laundry lists" of the species identified in the collecticn - "twitching" (Smith 1976: 278). This approach to the remains was the result of the lack of direct participation by zoologists in archaeolcgical prcjects. The specialists performing the identifications, mostly zoologists, paleontologists, veterinarians and anatomists, had little understanding of the natural and cultural forces modifying assemblages and approached the material from a perspective totally at

variance from that of the archaeologist. The latter brought a cultural perspective to the remains, wishing to reconstruct ancient diet, economy, animal behavior, etc. while the former was frequently interested in establishing the geographic and temporal distribution of various species and the advent of domestication. Reinforcing the tendency to dump bones in the lap of specialists far removed from the site and problem was the traditional division of labor practiced by "field" archaeologists. They worked with stone tools, ceramics, and, maybe, bone tools - the undoubted results of cultural behavior. The unmodified bones were "...not considered part of the analytical domain of the archaeologist" (Smith 1976: 278). This point of view has been somewhat rectified in recent years with the training of archaeologists in zoology and vertebrate paleontology. As a result, questions asked of the zoological remains have taken on a anthropological and ecological orientation, rather than purely zoological.

When dealing with food remains, as is the case here, calculating the relative importance or contribution of each species to the diet can be very important. Analysis of any quantity of bones requires careful consideration of the technique used for quantifying the abundance of remains. These numbers are then used to draw conclusions about the relative or absolute abundance of each species at the site.

Quantification has been the subject of numerous debates (see Grayson 1979 for a recent review of the problem). Several techniques have been prcposed, but cnly three have emerged as the most frequently used methods. They are the following: 1. total number cf fragments; 2. minimum number of individuals; and 3. adjusted relative frequency. There are several variants of each. Some less popular methods have been discarded, such as bcne weight (Casteel 1978; Uerpman 1973), cr are useful when interval data are unknown cr unreliable, such as ordinal measures (Grayson 1979). The former three techniques remain in widespread use, even with their acknowledged limitations. As a result, only these three methods will be discussed below.

IIIA. Total Number of Fragments (TNF)

The Tctal Number of Fragments method (TNF, TNB, NISP, E) is the most widely used methcd tcday, This method has various forms, but in its basic mode, it simply counts the number of fragments present from each taxon and uses this figure to asses the relative prcportions at the site. This measure has been widely discussed and a great deal of criticism has been directed at it. Grayson (1979: 201-203) has provided the most thorough recent discussion of the drawbacks of TNF. They include the following problems: 1. It is affected by butchering patterns - e.g. the bones of

larger animals can be cut up into many more pieces than those of smaller animals; 2. the number of bones in the skeleton of each species will vary - e.g. pigs have 5 metapodials per limb while artiodactyls have only one; 3. it assumes that all taxa are equally affected by "chance or deliberate" fragmentation; 4. taxa and bone elements may be differentially affected by preservation; 5. and by recovery methods; 6. entire skeletons may bias abundance measures; 7. "the unit may differentially exaggerate sample sizes across taxa"; and 8. the assumption of element independance (Grayson 1979: 201). This truly devestating list of problems with TNF as a measure of species abundance has dissuaded many analysts from considering it as an alternative or even supplemental means of monitoring variation within and between assemblages. However, when each criticism is examined separately, few are so damaging as to totally preclude its use. For example, Grayson (1979: 202) noted that consideration of the taphonomic history of each assemblage and the implementation of appropriate correction factors may remove criticisms 1, 3, and 4. Watson's (1979: 139) solution was the implementation of a "diagnostic zone" approach. Only bone elements or element parts, which could be easily and unambiguously identified to a taxon, were counted. They must be present in all species under consideration, commonly preserved and rarely broken or

split. Other criticisms, such as 2, 5, and 6, can be removed through the use of recovery procedures, such as sieving. Techniques, such as Adjusted Relative Frequency, to be disucussed below, attempt to adjust for the differences in numbers of identified bones from each species (Gilbert et al 1982; Gilbert and Steinfeld 1977; Perkins 1973). Identifying articulated units during excavations, including burials, should allow their removal from the sample prior to analysis. In large collections, articulated specimens rarely occur in large enough numbers to significantly bias the collection (Bogucki 1982: 216; Maltby 1979: 5). The most damaging criticism, the one hardest to avoid or rectify, is the assumption of specimen independence (number 8 and part of number 7). Identified specimens, other than the few articulations that may be apparent during excavation, cannot be shown, without great difficulty, to be from different skeletons. In other words, we do not know how many bone(s) each animal may have contributed to the overall assemblage. It may have been one or 200. Using simple TNF counts allows for little control over this variable. All the statistical procedures that are used to interpret samples (from simple frequencies and chi-squares to more sophisticated algoriths, such as factor analysis) make two critical assumptions: 1. the sample is a large and representative sample of the population and 2. each counted

element is independent from all others in the sample. No two fragments come from the same animal. If these conditions are not rigorously met, the application of the above procedures to INF data would be inappropriate and will yield misleading results. All of the above are relevant prior to the advent of assemblage attrition.

The problem of specimen representiveness cannot be largely overcome by better sampling and recovery methods during excavation (contra Grayson 1979). There is no guarantee that any sample will be representative of an archaeological site and the original population of artifacts. But, in order to make inter-assemblage comparisons, we must frequently assume that they are representative samples of the parent assemblage. A large sample size and sample fraction, in conjunction with tight provenience controls, are not incompatible goals, but trade-offs do occur. The problem of specimen independence has been tackled through the use of two quantitative procedures: MNI and ARF. Both, in their own way, attempt to reconcile this assumption with the data base by correcting the final counts used to determine species proportionality.

IIIB. Adjusted Relative Frequency (ARF.)

Adjusted relative frequency is a direct offshoot of TNF. It also counts all of the bone fragments, but then corrects for the frequency of each bone type (e.g. humerus) in the sample by dividing by the number of times that it occurs in the skeleton (n = 2). Left and right sides are averaged, thereby avoiding the prcblem cf uncertain side attributions for many elements. Next, the sum cf the corrected frequencies of bone types per taxon is divided by the number of different bone types recovered. This evens out and removes the advantage a species may possess in having more bones in its body. ARF ensures that the final value is a measure cf central tendency, rather than of its most frequent set of specimens. ARF and Relative Frequency (RF - Perkins 1973) sidesteps but dces nct address the problem of specimen independence, largely because it is a difficult if not impossible task. Nevertheless, this has not dissuaded advocates of ARF. It has continued to be employed because of its analytical sophistication and methodological simplicity.

IIIC. Minimum Numbers cf Individuals (MNI)

The Minimum Numbers cf Individuals (MNI) is another widely used method that attempts tc resolve the problem of

specimen independence. This method has a long history of use in paleontology (over 50 years), from which it was derived. Paleontologists developed the technique as a means of determining the minimum number of individuals present in a locality (i.e. in the La Brea tar pits). They count the most frequent bone element at the site for each species, divided by sex and age groupings. This technique accounts for specimen independence by focusing only upon mutually exclusive categories. For example, only right humerii or left proximal radii may be used to determine the frequency of a particular taxon (Bökönyi 1970; Chaplin 1971). There are a few drawbacks to MNI. MNI counts can be increased or decreased depending upon the number of attributes employed in the analysis - e.g. subdividing the material by age, sex, size of animal, stratigraphy, chronology, etc. Only if two researchers utilize the same level of distinctions and group the material in like fashion, then the results will be comparable (Bökönyi 1970). One frequent problem is when small samples are divided between depositional contexts or stratigraphic units. In these cases, very small frequencies are sometimes generated. The end result is that only 1 or 2 individuals appear in each unit, yielding frequencies too low to illustrate variability within and between samples. The second problem is that it tends to overemphasize rare taxa. A species represented by a single bone will yield a single individual in the final

count. A species with as many as 100 fragments that have been butchered, smashed, weathered, chewed, etc. may yield the same MNI value of a single individual because it is too fragmented. This problem is of correspondingly less importance with larger sample sizes (Casteel 1973; Grayson 1973; 1979; Uerpman 1973). With large sample sizes, TNF, as an ordinal measure, can provide the same basic information as MNI, without the trouble of calculating the more difficult subdivisions. As a result, there would seem to be "...little reason to employ minimum number analysis unless there is some special and convincing reason for doing so" (Grayson 1979: 224), such as clear evidence for skeletal articulation. As a result, many zooarchaeologists have ceased to utilize MNI as a measure of species abundance. Several other studies, most notably those by Casteel (e.g. 1977), examined and clarified some of the problemmatic underlying assumptions employed by those who use MNI.

An interesting simulation experiment was recently conducted at Columbia University (Gilbert et al 1982). It attempted to investigate the relative accuracy and precision of each of the three methods, discussed above, as estimates of species abundance. Sample sizes and the differences in relative abundance of the species were the two main variables that were altered during the experiment. In tests where species proportions were unequal or unbalanced, a

realistic condition, MNI showed the largest deviations for small sample sizes. It over-represented the rare species. But in large samples, the predictive ability of MNI, ARF and TNF were approximately similar depending upon the starting proportions of each of the four major species at the beginning of the simulation run.

Many studies have maintained a minimum quantifiable cut-off point below which the samples are deemed to be unreliable (e.g. Uerpman 1973; Chaplin 1971). In these cases, sample size is used as a proxy measure for sample fraction because it is usually the only measure available. Sample fraction is rarely known. For example, 500 bones is an oft-mentioned value. McGovern (pers. comm.) uses 300 identified specimens from each phase of occupation in a locality as the minimal frequency level. However, such conclusions assume that there are sufficient samples from a region and time to be able to pick and choose among the very best. In the central Balkans, the total number of available collections was very small (n = 13). Furthermore, these thirteen localities are spread over several thousand years of occupation. In fact, there are only a few samples from any single phase. Some phases may have only one or two localities to represent them. Under such conditions, choice between research resources is severely constrained by availability. To compensate somewhat for the varying quality of the different data sets, each sample was

independently evaluated for scurces of bias. Any implications that could then be drawn from the data that were pertinent to paleoeconomy were qualified by the recognition of attritional forces influencing the data set.

In order to cope with the varying levels of sample quality, the sites have been divided by "levels of usefulness".

1. High - In this level, the sites are characterized by larger samples (more than 500 fragments/temporal phase within the site). Assemblages falling within this group were found to be useful fcr interval analysis. They consistently produced data that were interpretable in light of deposits from the other assemblages. Sites falling into this group included: Obre II, Anza IV, Divostin II, Gomolava, Opovo, Petnica (Vinča and Eneclithic), Novačka Ćuprija (Eneolithic and E/MBA), Livade, and Ljuljaci.
2. Medium - In this group, the assemblages were useful as ordinal measures, such as rank order. Such assemblages usually contained 200-500 bone fragments. Their interval data were occassionally deviant indicating the lower degree cf assemblage reliability for such purposes. Assemblages falling within this group included Ncvačka Ćuprija (LBA), Sarina Medja I, and Petnica (LBA).

3. Low - The assemblages falling into this group were found to be the least reliable indicators of either interval or ordinal information. They contained less than 200 bone fragments, which were most useful as a listing of major species present in the site. Assemblages falling into this group include Vrbica and Večina Mala.

IIID. Meat Weights

While estimation of proportionate representation of each resource can form the basis for evaluating potential changes in their relative frequencies, calculations of meat yields can produce a more accurate estimate of resource importance (cf. White 1953; Smith 1976). One hundred hares will not produce the same volume or weight of meat as a single cow. At the same time, a single MNI determination does not necessarily indicate the presence of an entire carcass of that species. This is obviously another area fraught with pitfalls (e.g. see Milisauskas 1978), especially when "average" weights of modern species are indiscriminantly applied to archaeological faunal remains (cf. Stewart and Stahl 1977) and when modern concepts of meat utility are relied upon (Lyman 1977; 1979). The use of MNI has produced, at best, very poor results in this area (e.g.

Guilday 1970). Estimates based upon bone weight appear to also be far off the mark (Casteel 1978). It may not be possible to estimate exact or even minimum amounts of available meat and even less feasible to argue directly to length of occupation and/or population size. Various other techniques which attempt to multiply the weight of the animal for the various age and sex classes of each species against its ratio of importance in the assemblage result in untrustworthy values. "The importance of small but frequently found species is minimized while those of large but rare species is magnified" (Hesse 1978: 151). In consideration of the various sources of error in estimating meat yield, any calculations must be made and viewed with extreme caution, although Casteel (1976) has had some success with fish.

IIIE. Method Used in this Study

Each of the problems described above can affect the measure of species abundance. It is important that these be made clear. I have chosen to restrict my calculations to a version of TNF. In this version, every bone that is not obviously articulated with other bones is counted once. Articulations of two or more bones are counted only once. Bones fragmented into two or more pieces are also counted only once. This method was chosen over the others for several reasons:

1. MNI counts were not available for all of the previously analyzed samples, ARF had never been employed in the region, and INF counts were available for each;
2. None of the assemblages included whole skeletons and all of the materials were very fragmentary; and
3. The samples varied widely in size and diversity. It was felt that the simpler the technique employed, the less the technique itself would have impinged upon the results.

This method would, therefore, enhance comparability between the assemblages. It also sidesteps, rather than addresses, problems inherent in a INF approach (such as unequal quantities of identifiable elements between species - i.e. pigs have more bones than bovids - see section IIIB). But this was felt to be a minimal loss and one which could be corrected for at a later date.

Theoretical and practical discussions of the advantages and disadvantages of each have emphasized that their predictive capability will vary widely. Species diversity and sample size are two of the more tangible variables. In large samples, over 10,000 fragments, all of the methods appear to be equally predictive. Among the smaller samples, especially those with unbalanced species ratios, INF is much more useful than MNI (Gilbert, Singer and Perkins 1982).

MNI values are available for three of the sites (Obre II, Divostin II and Anza IV). TNF values are available for each of the samples. It, however, differs slightly from site to site. At Opovo and Petnica, for example, it is corrected for whole and partially articulated skeletons and limbs. Any observed articulation was counted only once. Antler and horn fragments are few and mostly attached to cranial elements. At Gomolava, the loose horn and antler fragments were not included in the TNF counts. The question of element articulation was not addressed in the TNF counts from Gomolava, Anza IV, Obre II and Divostin II. In the latter three, no whole skeletons were found. Methods, such as Relative Frequencies/Adjusted Relative Frequencies (cf. Perkins 1973; Gilbert and Steinfeld 1977), which attempt to resolve such problems could not be employed because element distribution data for each species were unavailable for the three largest Neolithic collections (Obre II, Divostin and Anzabegovo). As indicated above, there were large discrepancies between each of the Neolithic localities in how the relative frequencies of each species were calculated. For the post-Neolithic sites, quantification of species proportionality was accomplished in basically the same manner (each bone counted as an independent fragment = 1, except that articulations, always equal 1, even when whole skeletons are present).

IV. METHODS AND PROBLEMS IN SPECIES IDENTIFICATION

Each excavation unit or otkop slcj was examined individually. All the available remains from each unit were numbered and sorted into a variety of groups. Initially, the remains were separated according to class (mammal, mollusc, aves, pisces, etc.). The frequency of non-mammalian fragments were reccrded by ccunting the number of specimens, such as fish bones. Consideratien of potential or actual articulations were made. Only the valves of mollusca were counted tc avoid overemphasizing any one class. The fragments of each class were then bagged separately for shipment to appropriate specialists for further identification. The mammalian bones were examined by the author. They were sorted, initially, into unidentiable, potentially identifiable, and identifiable groups. The potentially identifiable specimens were, in most cases, finally identified. But under field conditions (without direct access to comparative collections), identification to the species was sometimes extremely difficult. These cases were either brcught to Budapest, where Drs. S. Bökönyi and D. Janossy kindly aided in the analysis or to the American Museum of Natural History in New York where extensive comparative cellections were used to make final identification. Identifying the species and body part of a bone fragment is frequently a time consuming and

frustrating task. When bones are relatively complete, it is much easier than when they are fragmented. With fragmented specimens, usually the part of the bone that is most diagnostic is also the section that has been broken off and lost - a local variant of Murphy's Law. Dealing with such fragments is very much like reconstructing a jig-saw puzzle in which the edge pieces have been lost - "you know the piece that you are holding belongs somewhere on the board, often you are certain that you have seen it and its matching sections before, but you cannot figure out where it goes now". Given unlimited time, finances and good comparative collections, most fragments can eventually be identified, at least to body part. Realistically, this is rarely the case. Most faunal analysts work under poor conditions. For example, under a worst case scenario, boxes of bones are dumped on their desks, far removed from the excavations with little conception of the stratigraphy, soil conditions and cultural context of the material. Time and finances are always limited and comparative collections either inadequate or unavailable. Several zooarchaeologists have attempted to circumvent these problems by joining excavation field staffs and undertaking initial identifications of the material soon after it is excavated. In this way, they avoid losing touch with the contextual origin and associated remains of the animal bones. Also, the analysis ceases to become a dry

listing of sub-fossil species at the site, with little relevance to the rest of the material. Instead, it becomes an integral part of the analysis of the site, integrating information from the other domains of analysis and contributing to the overall interpretation about depositional behavior. Building comparative collections at the site or identification center has also been a useful strategy for enhancing the level of analysis. This allows the identification of frequently difficult elements, such as ribs and vertebrae (with the exception of the atlas, axis and sacrum) or closely related and similarly-sized species (i.e. red deer, cattle and horse or roe deer, sheep and goat).

In this study, each fragment was identified to the most specific taxonomic level that was possible - usually that of the species. This knowledge was acquired through the examination of the extensive collections at the American Museum of Natural History, New York, Natural History Museum and Archaeological Institute, Budapest, and specimens collected at the field sites. The guidance of Dr. S. Bökönyi (Hungary) and Dr. T. McGovern (New York) were also invaluable during analysis. Supplemental on-site aids for the identification of closely related species (i.e. sheep versus goat) included the use of a variety of anatomical atlases and studies (e.g. Boesseneck et al 1964; Boesseneck

1969; Schmid 1972; Stojanović et al 1975-1976, etc.). All species were distinguished on the basis of diagnostic morphological features, rather than metric analysis as advocated by some (Payne 1969). This facilitated processing of large quantities of material during the limited time available. In this analysis, the remains of elements that were not diagnostic to the genus or species level were grouped into more general categoires (such as large, medium, and small mammal or artiodactyls). After species identification was established, various other attributes were described in computer format. A modified version of Richard Meadow's (1978b) BONECODE was used. See appendix 1 for a complete description of the code and sample coding sheet. Some of the majcr attributes used in this study will be described below. The data were computer coded at the field site on 80 column coding forms. These were later keypunched onto cards by the Data Prccessing Center, Lehman College, CUNY and then fed into the IBM 370 and 3031 units at the Computer Center of CUNY. The data were proof-read for possible keypunching and coding errors before sorting and analysis could begin. The powerful sorting and frequency procedures generated by the Statistical Analysis System (SAS) were used during much of the data analysis.

V. ESTIMATING AGE AND BUILDING HARVEST PROFILES

An estimate of the age of the animal at the time of death is of paramount importance in constructing mortality curves for each species. Without such estimates, it becomes very difficult to discuss modes of explcitation. Assignment to any age grouping was based upon the information derived from a number of observations. These included the size of the bone relative to an adult specimen, stage of bone development and epiphyseal fusion, and tooth eruption and wear patterns. In determining age, specimens were placed in one of the categories described below based upon the presence and absence of the various features diagnostic of each age grouping. The age groupings were based upon those developed by Bökönyi (1970).

1. Foetal/Infantile (0-3 months): Here, the bone is extremely small and thin. In artiodactyls, the metapodials are unfused longitudinally. All epiphyses are unfused and all small bones lacking epiphyses, such as carpals, tarsals, astragalii, etc., are spongy. Only deciduous teeth are present and worn slightly, if at all.
2. Juveniles (in ungulates - 3-12 months): The bones are still much smaller than those of adults. Both proximal and distal ends of all bones with epiphyses (long bones and vertebrae) and the proximal ends of

phalanxes are unfused. In bones lacking epiphyses, they begin to harden and loose some of their spongy quality. Diaphyses of shafts are also still a little spongy. Molar 1 erupts early in this stage (at about six months in ungulates) and molar 2 toward the end of this stage (at about 12 months in ungulates).

3. Sub-Adults: Bones from this age are larger than those of juveniles and have almost reached, but not quite, their adult size. Some epiphyses have fused, while others remain open. Element ends that fuse and/or achieve adult sizes during the transition from juvenile to sub-adulthood include: distal (tuber) of the scapula, distal humerus, proximal radius, proximal metapodial, distal tibia, acetabulum, and proximal phalanx. Bones lacking epiphyses will have completely hardened and achieved adult size (i.e. astragalus, carapals, and tarsals). The molar 3 begins to erupt by the time this phase has terminated. Molar 2 is beginning to show surface wear, whereas wear on molar 1 is extensive.
4. Adults: Bones in this group have grown to the full size of adult specimens. Both ends of bones with epiphyses have fused. Ends which fuse only with the onset of adulthood include the following: proximal humerus, tibia and calcaneus, distal metapodials,

proximal and distal femur, scapula (centrum in the distal scapula), and vertebrae, and the pubic symphisis of the pelvis. Molar 3 comes into wear, molar 2 is well worn and molar 1 has little enamel left. Specimens included in the adult grouping may also include young, middle-aged and elderly adults.

5. Young Adults: In this category, epiphyseal lines are visible on the ends of bones that fuse late. The third molar has erupted, but shows little wear yet.
6. Middle Aged Adults: Individual elements placed in this age class were usually mandibles, maxillae, and loose teeth. The eruption and wear patterns of the teeth placed them well into the adult range.
7. Mature/Senile: Assignment to this age group was based mostly upon symptons of advanced age, such as erosion of tooth enamel and dentyne in the second and third molar, development of exostosis on the shafts and ends of bones, and the well-developed ridges where muscles insert into bones. The amount of excess calcium build-up on bones at these points is somewhat related to age and can be used as an indicator of its advancement. The useful distinction between a mature and senile individual may be that with a mature specimen, exostosis is only beginning to appear. Among senile individuals, exostosis had developed into heavy ridges.

Criteria for ageing specimens were derived from several sources (Crabtree 1982; Habermehl 1961; Grant 1975; Payne 1973; Wilson et al 1982; Silver 1969). The ageing system described above is easiest to emplcy when whole bones or jaws are encountered. However, 99%+ of zooarchaeological materials tends to be fragmented tc greater or lesser degrees. In such a situation, for example, the assignment of some elements can be problemmatic. Decisions as to the allocation of specimens to age groupings must be rigorous and systematic. Otherwise, ccnfusicn will prevail. For example, a fused distal humerus is a frequently encountered specimen. Some systems of ageing specimens, such as that employed at the Zoological Identification Center in Canada, consider any bone end that is fused as an adult. The system employed here recognizes that it may not be an adult. A distal humerus fuses while the animal is still in the sub-adult stage. At the same time, the proximal end remains unfused. If only the former end is found, then it may be either an adult or sub-adult. A finer distinction is difficult to make unless the animal is of an advanced age and exhibits well-developed muscle attachments areas or exostosis. In such cases, one may consider it as a mature or senile specimen. This problem plagues assignment of all specimens that completely or partially fuse prior to adulthood. As a result, intermediate stages (i.e.

infantile/juvenile, juvenile/sub-adult, and sub-adult/adult) are used in such situations.

As several studies have noted (e.g. in Wilson et al 1983), it is virtually impossible to assign an absolute age (year/month) to an archaeological specimen. Bone growth is genetically regulated, but a variety of outside factors will influence development, as well. Some of these include variation over time and space in the nutritional base, stress, breed and stock management practices, etc. The same situation exists in assigning absolute ages to tooth eruption and wear rates. Differential eruption and erosion of the enamel and dentyne may occur because of breed, stress during growth, nature of feed, and the soil from which feed derives. Cattle feeding on sandy grasslands exhibit much more rapid rates of dental erosion than stall-fed cattle. As a result, the use of 17-19th century ageing data for unimproved European breeds of domestic animals (cf. Silver 1969) are always suspect when applied to prehistoric zooarchaeological specimens. It may be possible to assign a range of potential ages to individual specimens, but they will always be suspect. Instead, general relative age classes were favored here reflecting body development and maturity - as indicated above. A large number of declared criteria were utilized in the ageing of our specimens to enhance the possiblity that one day finer age sub-divisions

may be employed. The data can then be re-analyzed without having to re-examine the bones themselves.

From the ageing data, it is possible to construct harvest profiles (cf. Hesse 1978) of the ages of the animals slaughtered over time at a given site. Changes in the shape of the distribution may reflect alterations in the culling pattern and changes in the uses the animals were put to. The data from mandibles, maxillae and post-cranial specimens should be tabulated separately. In this way, any potential biases against certain age grades may be detected. For example, the post-cranial bones of juvenile and younger animals are much more likely to have succumbed to the destructive forces acting upon the sample than mandibles or the bones of older animals. In samples where attritional processes were at work (cf. Binford and Bertram 1977), they would have been underrepresented relative to their original values. In unsieved collections, the bones of smaller and/or younger animals are frequently less visible and not collected as systematically from the soil matrix as those of the larger individuals and species. For this reason, many studies have preferred to rely upon relatively hardy bone elements as a guide to the determination of age. The mandible is the most frequently chosen element. Several methods have been offered to build age profiles from mandibles and associated teeth (Carter 1975; Crabtree 1982;

Ewbank et al 1964; Grant 1975; Payne 1973; Wilson et al 1982). Unfortunately, relying upon only a single element type ignores the possibility of differential processing and disposal of such elements. For example, not all mandibles, or even a representative sample, may have been disposed within the excavation area. This would be especially true if the excavations were structured to investigate only certain types of contexts (e.g. the center and deepest part of the site with the most depositional debris and architecture). These relatively meat-poor elements might have been discarded off-site or used as tools (cf. Gilbert 1979), biasing their distribution in the assemblage. As a result, it is wise to consider the other sources of age information as well. Crabtree (1982) has found the maxillae, a frequently ignored dimension of data, to be useful as a further supplement. But they exhibit very different rates of survival than mandibles.

The numbers of bones of each species at a site is the most commonly used proxy measure of their abundance or absolute importance in the ancient economy. This and other quantification procedures based upon them (e.g. Minimum Numbers of Individuals) are usually meaningless, in light of excavation and recovery procedures that systematically select for certain size-classes of species. In addition, a host of processes intervene between the time the animals are killed and the time at which their bones are analyzed that

substantially alter the compcsition of the assemblage (Gifford 1981). As a result, the species list and the number of fragments may tell us little more than which species were present at the site. Simplistic uses of such data should be rightfully regarded as suspicious.

How then does one approach the problem of reconstructing ancient strategies of animal exploitation. One of the more productive approaches is to focus less upon species frequency in the assemblage than upon the manner in which individual species may have been exploited. This does not require estimations of the original numbers of each species, but looks at the age distribution within each species. Payne (1973) has offered several models for predicting modes of domestic animal production. Each model associates a particular subsistence strategy with a hypothetical mortality curve among the animals. In model A, where the production of animals for meat is emphasized, most surplus stock will be slaughtered before or just prior to maturity. At maturity, body growth significantly slows and there remains little further economic incentive for the retention of excess individuals in the herd. Males, in particular, are selected out of the herd for slaughter since they contribute little to herd reproduction. In areas of severe winters or where feed is scarce during a period of the year, slaughter may occur prior to the onset or early in the

winter in crder tc prevent unnecessary weight loss. One third of the animals are killed during their first year, another third before maturity and the rest are retained for reproductive purpcses (Higgs and Jarman 1969: 44; Payne 1973: 282, fig. 1). In model B, where milk production is emphasized, the stock that is not needed for breeding are slaughtered as socn as the milk yield is assured. In this situation, males would be slaughtered at very early ages (80% plus before the first year), while females will show high rates of survival through adulthood. 50-60% of the sample would be infants or juveniles, killed during the first year of life. The rate of attrition would decrease dramatically afterwards (Payne 1973: 281, fig. 2). In model C, the orientation is tcward wool production. The emphasis shifts toward adults, regardless of sex. Wool producing animals can be shorn year after year, while hide production would require an age distributicn mcre reminiscent of meat production (Higgs and Jarman 1969: 194; Payne 1973: 281, fig. 3). These models represent idealized situations and may not directly conform to real wcrld conditions. Most subsistence economies exploit their animal herds with a mixture of the abcve strategies, enhancing confusion in the interpretation of remains. If the mortality curve from a site conforms more to one of the abcve mcdels than to others, then it may be a possible explanation for the distribution of the remains.

The next problem invclves determining the mortality curve of the species. Most analyses have utilized the full range of bone parts from each species. Yet, this ignores problems of differential survival and recovery cf bone elements. The bones of younger individuals cr frcm less dense body parts will break up and disintegrate at a faster rate than those of older individuals or from the harder, more dense elements. Recovery procedures, such as hand-cclllection of artifacts without the aid of sieves, recovers larger proportions of the bones of larger (and usually adult) individuals over those cf the smaller (and younger) animals. As a result, a skewed sample of the age distribution will be created, with an artificial emphasis upon adults. There is a bone element that avoids many of these prcblems - the mandible. It is easily identifiable as a bone, large, dense, and durable. It survives the attritional fcrces acting upon the assemblage better than most other bone elements and is a frequently collected body part, even by excavations utilizing hand-cclllected techniques of recovery. Only a single site frcm the central Balkans (Serbia) has been heretofore published in a manner detailing such data - i.e. Gomolava (Clason 1979). Jaws are obviously useful fcr dating and avoid certain problems when only epiphyseal fusion data are relied upon. However, they should not be the only source of age data fcr the simple reason that the

mandibles, themselves, may be subject to a host of attritional biases (e.g. differential disposal of meat-poor versus meat-rich body parts, occassional feasts using an entire carcass, etc.). It is for this very reason that each indicator of age should be independently evaluated for biases before it is used in the reconstruction.

VI. DOMESTICATION

This attribute described whether the specimen belonged to a domestic or wild species. Several methods were used to distinguish wild from domestic forms of a species:

1. Animal species that do not have domestic counterparts, such as red and roe deer, bear, etc. were automatically classed as wild. Subsequent analysis of age and sex distributions in the assemblages invariably supported this decision;
2. Animal species whose domestic or feral form, only, are known from post-Pleistocene European contexts (i.e. sheep, goat, horse) were classed as domesticated. The absence of wild ancestral populations during the Holocene for these species has been frequently cited as support for the hypothesis that the domestic form was introduced from beyond the study area - i.e. the eastern Mediterranean basin for

ovicaprines and the steppes north of the Black Sea for horse (Bökönyi 1974a; 1978b; Clutton-Brock 1981: 53). Evaluation of age and sex distributions for each revealed harvest profiles typical of domesticated populations; and

3. Among species where wild ancestors had been or still were present in the region, distinguishing domestic from wild forms was a much more difficult task (i.e. pigs, cattle, dogs). This was accomplished through the use of both non-metric and metric morphological characteristics. In addition, the domestic status of species whose ancestral wild populations lie outside the region were checked in the same way.

A great deal of effort has been invested in distinguishing domestic and wild forms of species. Criteria for some species are more pronounced than for others. In order that the reader may understand the criteria utilized in this and other analyses conducted by myself, I will define them below. Essentially, European cattle from the Holocene can be divided into two major groupings: wild Aurochs (Bos primigenius Bojanus, 1827) and domestic cattle (Bos taurus L., 1758). At least two variants of the domesticated form were also present - a long horn (or primigenius-type) and a short horn (or brachyceros-type) (Bökönyi 1974a:97-98). Identifying the remains of aurochs

(plural = Aurochsen; Clutton-Brock 1981: 63) remains in an archaeological or paleontological collections is relatively easy when complete skulls and horn cores are found. Identification of post-cranial remains, especially when found in a fragmentary state, is more difficult. In addition, the broadly similar morphological structure of the European bison makes the task even more difficult. The incidence of bison and water buffalo in post-Pleistocene and prehistoric deposits in Europe is but a fraction of its close relatives, the aurochs and domestic cattle. Utilizing criteria put forth by Olson (1960) and Stampfli (1963), the assemblages were examined for the presence of bison. They were notably absent. Bökönyi (1974a: 106-109) has detailed several criteria for distinguishing aurochs from cattle. They include: 1. decrease in size (length - nearly 30 cm. by the early Neolithic - and breadth), fine structure and density of bones (cortical substance gets thinner, becoming more spongy, and the medullary canal is extended in long bones). The thickness of the walls of the diaphysis decreases (Bökönyi 1974a: 107) and the muscle insertion points become less pronounced (Bökönyi 1972b); 2. The horns become, at first, markedly smaller. Later, they become shorter. Associated with this change is a thinning of the supporting parietal areas of the skull. Increasing variation in horn core shape (aurochs bend forward and

gradually rise, eventually turning outwards) and hornlessness are other features of domestication. These latter two features appear somewhat later than the periods under consideration. Other minor changes include alterations to the cerebral and facial areas of the brain. From the first set of criteria it was possible to often separate domesticated from wild forms, even with fragmentary materials. Aurochs remains were so much larger and heavier, with pronounced muscle markings, that they were recognized immediately.

Pigs and wild swine are the second major concern here. Differences between wild swine (Sus scrofa fer. L., 1758) and domestic pig (Sus scrofa dom.) are basically of size. Most demonstrable morphological changes appear quite late (e.g. the loss of LPM1 becomes frequent only in Roman times as the jaw is shortened). The first symptom of domestication is a decrease in body size. This occurs soon after domestication, since even in the earliest Neolithic assemblages

> "...there was a considerable difference in the size of wild and domesticated swine and on the basis of this difference their bones could be easily separated. This difference in size...lasted up to modern times when modern breeds were developed; only these latter approximated the size of the wild ancestor. ...the proportions of the body remained unchanged for a long time. ... Only after the introduction of conscious breeding did significant changes appear, in particular in the decrease of the head size, the lengthening of the trunk and the shortening of the legs. Skull changes followed

> long after those of size. In general, the skull became shorter and relatively broader. The facial part and the mandibles showed particularly marked shortening. The occipital squama turned upwards so that the line of the profile became broken, sometimes to such an extent that a right angle was reached,... The shortening of the skull is shown clearly on the lacrymal bone... With European wild swine this bone is like an elongated oblong, but as a result of domestication it becomes shorter and finally its breadth exceeds its length (in such cases the lacrymal index - lower length/breadth - which is above 2 with wild swine, sinks below 1)" (Bökönyi 1974a: 204).

The size of wild swine gradually shrank over time as population levels decreased. But this took place much later. When contrasted with modern European wild swine,

> "...those of prehistoric times were remarkable on account of their size,... They had tusks suited to their considerable size. The length of the biggest lower tusk was approximately 300 mm. Their widest breadth 31 mm. Thus they outrivaled by far all the prize-winning trophies of the 1937 world exhibition of hunting" (Bökönyi 1974a: 205-207).

A number of changes were brought about in the morphology of the genus Canis during domestication. One of the earliest, and one which was readily apparent, was a shortening of the facial area of the skull. The concomitant result was a shortening of the upper and lower jaw causing tooth crowding. Eventually, the teeth decreased in size so that the UP4 (the carnassial) becomes shorter than the two molars. In wolves, the reverse is the case (Bökönyi 1974a: 314).

> "Domestication is associated with a decrease in body size... early Neolithic dogs hardly equalled

> 1/2 the size of wolves. After the launching of conscious animal breeding, big breeds of dogs were evolved, although these never reached the size of wolves. With domestication, marked changes also appeared in the proportions of the body" (Bökönyi 1974a: 316).

Large variations in body proportions and stature appear during Roman times (Bökönyi 1983; 1984). Neolithic dogs tend to be fairly small (turbary). Some medium-sized dogs already have appeared, although they become more common in the Bronze Age (Bökönyi 1974a: 318).

The domestication of the horse appears to have taken place in the forest region of the upper Dniester, in the area of the Tripolje culture. It is only in the steppes of easternmost Europe and Asia that wild horses survived in the Holocene. Domestication of the horse did not entail large scale changes. No clear decline in size took place. Mostly, the evidence involves a change in the age distribution among the remains to a typically domestic profile (e.g. large numbers of immature specimens - cf. Collier and White 1976; Hesse 1978; Payne 1973). "Osteologically, the remains of domestic and of wild horses can hardly be separated from each other" (Bökönyi 1974a: 236).

Since the Balkans are so near to the Near East and the possibility of the presence of wild ovicaprines always exists, I felt that the collections should be examined with

this in mind. In retrospect, the decision was a proper one since wild caprovines (chamois) were found in the early Neolithic assemblages from Lepenski Vir (Bökönyi 1971b) and Hajdučka Vodenica (Greenfield, in press). None of the collections examined in this thesis, however, contained any wild ovicaprine forms. Several morphological characteristics were used to check for possible wild sheep in the assemblage. These included a lentil-shaped, as opposed to triangular horn core cross-section, smaller body size and age distributions (Bökönyi 1974a: 162-166; Boesseneck 1962: 29; Hole, Flannery and Neely 1969). Among goats, the changes in domestcation involve similar parts of the anatomy. The horn core becomes almond-shaped, with a flattened medial surface. Simultaneously, the scimitar-shaped horn core starts to curve outwards, becoming smaller and thinner as well. Horn twisting did not always occur and hornlessness did not appear very frequently until Roman times. An overall decrease in body size also takes place (Bokonyi 1974a: 192-193; Hole, Flannery and Neely 1969). The wild caprines in the region (chamois and ibex) are larger than domestic forms and display characteristic horn (core) morphologies.

VII. OTHER ATTRIBUTES

All specimens were examined for the identification of additional attributes, such as body part, side, butchering, burning, chewing, etc. These are described below.

Element: This attribute described the part of the body that was identified (e.g. scapula, humerus, etc.). In this way, a distribution analysis of body parts from each species or size-group could be reconstructed and used to look for patterning in the remains that may reflect attritional processes or prehistoric economies.

Certainty: This attribute functioned as a control over the accuracy of species identifications. It established how certain I was of my decision to allocate individual specimens to a particular taxon. Values for this attribute ranged from certainty or total confidence to various degrees of likelihood.

Symmetry: This attribute specified the side of the body that the element was derived (i.e. left, right, medial, etc.).

Sex: The determination of sex through the use of fragmentary osteological remains is difficult. There are very few objective morphological criteria for sexing bones from any species. Canid penis bones, suid canines, deer

antlers (with the exception of reindeer), and the angle of the pelvic opening are the most commonly used and unambiguous indications of sex (Chaplin 1971: 100; Grigson 1983). Few species possess such criteria, few parts of the body of any single species may exhibit them, and even fewer survive the destructive forces exerted upon the assemblage. Most have been lost by the time the assemblage is analyzed. Metrical data have been the most popular tools for sex determination. There is a general correlation between the body size and weight of the animal and the dimensions of its bones (Chaplin 1971). In species with pronounced sexual dimorphism, bimodality in the distribution of the measurements of bone elements have frequently been taken as evidence for sexing specimens (Higham and Message 1969). Unfortunately, such distributional patterns become difficult to interpret when wild and domestic forms, more than a single breed of a domestic species, and/or castrates exist in the region. Each of these groups may overlap in size making it difficult to discriminate, for example, domestic bulls from wild cows. The possible presence of castrates makes interpretation even more difficult. Schwartz (1980) proposed that a multi-variate technique of analysis, such as factor analysis, may be more useful in these situations than are the uni- and bi-variate plots most frequently relied upon. Most attempts at utilizing metrical

data are further frustrated by the highly fragmented condition that most zooarchaelogical samples are in. The absence of large numbers of any single bone element from each species in the sample in which sexual variability may be observed, such as metapodials, represents an additional hinderance. Identifiying castrates among fragmentary skeletal parts is a task fraught with pitfalls. It appears that castration affects species differently. In species where sexual dimorphism is not pronounced it is most difficult to identify. Among species where sexual dimorphism is pronounced (e.g. cattle), castration can result in certain more or less predictable features. For example, among cattle, castration prior to the onset of puberty will suppress enzyme production for bone development, thereby delaying epiphyseal fusion. The bone would continue to grow past its normal time, resulting in a long, but slender skeletal structure (Palsson 1955: 465). They are usually closer in weight to males than females, but intermediate in size (Palsson 1955: 470).

Butchering: Every collection encountered will vary in its frequency of specimens exhibiting marks characteristic of butchering (dismemberment and/or meat removal) and skinning activities. Such information is normally rare in collections. It is even rarer for it to be recognized as such, analyzed and reported. Care must always be taken not

to confuse marks caused by butchering activities with those derived from alternative mechanisms (e.g. chewing, muscle markings, etc. - Shipman 1979). Care was also taken to distinguish between bone fracturing caused by actual butchering and those which may have fragmented along natural planes of fracture for a variety of other reasons. Some observers have assumed that the presence of "...any recurrent breaking point..." (Maltby 1979: 9) in an assemblage is indicative of butchering activities (e.g. separation of lower mandible edge from the alveolus - Clason 1979). Fragmentation studies, however, have illustrated that the mandibular alveolus will naturally separate from the lower part of the jaw when left exposed to the vagaries of temperature and weather systems (Binford 1981: 168). Though this study was not an in-depth analysis of butchering technologies and techniques (see above discussion in section IB), information on the location (bone element and part), angle relative to the long axis of the bone and whether it was caused by a slicing or chopping instrument were recorded for each specimen. In this way, a picture of the process by which skinning, dismemberment and final processing of the products from each species can be composed. Temporal changes in any of these can also be observed. Two basic types of butchering marks were identified: slice and chop marks. A slice mark was identified when the bone's surface was slightly cut - probably by the edge of a knife or blade

as it passed over it after cutting through the overlying meat, tendons or muscles. A chop mark was identified when the bone was cut completely or almost completely through the bone - probably by the force of an axe or some other heavy cutting instrument. It appeared to have frequently been accomplished with a single, or at most a few blows to the bone. Specimens were frequently examined under a low power microscope to check whether alternative mechanisms for the production of "butchering" marks could be possible. Photographs of representative specimens were taken, as well. This attribute, in conjunction with other attributes (i.e. polish and modification), provided valuable insight into the various ways animals and their bone parts were treated and transformed into food by-products, tools and ornaments. An initial expectation was that as technology shifted from stone to metal, a concomitant shift in butchering technique would accompany the change in technology. Less control over the instrument and greater wastage during preparation were originally expected to have been by-products of the change in technologies. However, fewer absolute and relative numbers of butchering marks were found among the post-Neolithic assemblages.

Modification: This attribute described whether the specimen was modified by human activity and made into a tool or some type of amulet.

Polish: The presence or absence and quantity of polish on a bone can be indicative of several processes. If the polish extends over the entire surface of the bone, it is probably natural in origin. If the polish is limited to a portion of the bone, it may have been caused by some sort of rubbing action. If the element is an antler tine, the polish may be natural in origin since deer frequently rub the tips of their antlers against trees when they are shedding antler velvet. Other bone elements present less of an interpretative problem. They may be due to use by humans as tools of some sort, whose original form remained unaltered. Such tools or potential tools are frequently missed in assemblages since the morphologically obvious tools (e.g. awls, hoes, etc.) are quickly recognized and separated for inventorying.

Chewing: The presence or absence of chew marks can tell a great deal about some of the attritional processes that have affected the assemblage. Rodents, canids, felids, suids, deer, humans, and other species frequently gnaw bone (see above). Rodents are the easiest to distinguish, since they leave parallel sets of thin striations on the surface of the bone. The other various carnivorous and omnivorous species are less likely easily distinguished. Carnivores, such as dogs and cats, frequently leave puncture marks on the bones as their powerful jaws try to crush them. Pitting

is also characteristic of carnivores, although pigs may produce them as well. In this study, rodent marks are distinguished as a group, while carnivore and suid chew marks are lumped to together as indistinguishalbe - except in rare cases. The frequency of chewed bone is testimony to the rate of burial of discarded bone refuse and the importance of this taphonomic process in modifying the assemblage.

Weathering: This attribute describes the state of erosion that has taken place on the surface of the bone specimen. It may range from fresh and recently disposed to heavily weathered with large cracks and much of the periosteum having been worn away. It is a very useful attribute for evaluating the length of time that specimens have been left exposed on the surface of the site. This topic was discussed in greater detail earlier in this chapter.

Burning: Whether or not the bone was burnt and how hot the fire was is recorded in this attribute. It provides an indication of the elements and their frequencies that were exposed directly to flames. Burning functions to break up the bone, resulting in a more rapid elimination of burnt specimens from the sample (Bonfield and Li 1966).

Pathology: In this category were noted all the specimens that exhibited any traces of abnormalities in bone growth. Bones of animals that had suffered or been born with some sort of disease (e.g. arthritis), trauma (broken bones) or infection (e.g. periodontitis) are included here (cf. Baker and Brothwell 1980). These are discussed individually, since they rarely compose more Than a fraction of any assemblage. An important research question is the commonly held assumption that prehistoric herds, more so than medieval and historic herds, were in better health. They would be freer of the diseases and congenital defects frequently associated with historic populations and which were a direct result of the large scale breeding programs begun by the Romans and continued into modern times. This can be called into question by the prevalence of pathologies among some wild animal populations, such as arthritis among red deer at Opovo.

Number of Fragments: This variable denotes the quantity of fragments coded on a single line. It may represent a single specimen or individual or several specimens, depending upon the information coded in articulation.

Number of elements per specimen: The number of separate elements in each specimen were counted. This enabled determination of the total potential number of elements that

may exist if each element had been broken off and found separately. For example, an artiodactyl mandible may contain at least twelve potential separate elements in each side.

Fragment Size: The size of the bone fragment relative to its original size is recorded here. It was noted whether the specimen was whole, 3/4, 1/2, or less than 1/4 of its original dimensions. This variable can be used to detail information on the rate of fragmentation by element and species and/or selectivity in recovery. It appears that each of the assemblages were not equally fragmented. In some sites, the inhabitants broke up the bones more thoroughly than in other sites. This may be related to a variety of activities, such as tool production, marrow exploitation, etc. It may also be a simple function of disposal behavior and exposure to the weather systems. Material dumped outside of houses and not in pits tends to be fragmented to greater degrees than material left in interior depositional contexts. Each assemblage needs to be independently evaluated to determine the influence of the various processes that may be at work here.

Part: In this section, the part of the element that is present is noted (proximal, distal, shaft, etc.). This section allows total control over the distribution of

various elements and procedures for quantifying the various species at the site. The Watson (1976) diagnostic zone system could not work without such information, nor the Bökönyi (1970) MNI system. It also allows evaluation of the parts of bones that may have disappeared due to erosion, chewing and other attritional processes.

Measurements: Bones of adult animals (i.e. those in which growth had ceased, ends fused and adult size reached) were measured whenever they were found undamaged (e.g. unburnt - see von den Driesch 1976: 3-5 for an appropriate discussion). In bones lacking epiphyses (e.g. astragalii), "the degree of compactness of the bone /was used/ as a criterion for age. Bones of young animals are more porous, their structure is more spongy, and they are lighter than bones from full grown animals" (von den Driesch 1976: 4). Measurements of bone elements and parts were undertaken for several reasons: 1. distinguishing closely related species (i.e. wild versus domestic forms); 2. to differentiate between the sexes of a species (male, female, and castrate); and 3. to monitor size changes over time and space (Chaplin 1971: 90). Other possible reasons that many zooarchaeologists measure bones are to reconstruct growth rates (which would involve the measurement of unfused bones) and to distinguish breeds (e.g. short and long-tailed sheep or short and long horned cattle). Invariably, few measurements of any one element were available per site. By

combining the specimens from contemporary localities within the region, patterns in the data were frequently visible and interpretable in light of the above questions (see sections on sexing, domestication, etc.). Widely recognized measurements were employed to ensure comparability with other already published samples. Bone measurement of zooarchaeological assemblages has had a long history in central and eastern Eurcpe. Duerst (1926), in a seminal work still widely cited, collected together all of the existing measurements of the day. He clearly defined the points to be measured and the measurements themselves. Von den Driesch's guide to bone measurement (1976) represents a collection of the points and measurements defined by Duerst that have been found, since 1926, to have the greatest relevance to zooarchaeological questions. In this study, the measurements defined by von den Driesch were utilized, unless otherwise noted. A few additional measurements were adopted from Bökönyi's extensive publications. These were also originally taken from Duerst, but were not included in von den Driesch's guide (1976). These were employed because they added a second dimension to distributional analyses of bone shape, allowing the results to be viewed as a function of a bi- rather than uni-variate relationship (e.g. greatest breadth versus greatest depth of distal humerii). All measurements utilized are listed in the bone measurement

appendices (2-7). Measurements were taken with the help of several instruments largely depending upon the size of the bone or bone fragment. Small pieces, less than 100 mm., were measured with a 15 cm. long sliding gauge caliper with a vernier scale. For larger specimens, a measuring box or 30 cm. sliding gauge caliper with vernier scale were used.

Articulation: The potentiality of articulation of the specimen under consideration with other specimens in the assemblage is recorded here. Articulated and potentially articulated specimens are placed one after the other. This attribute is extremely important in determing the independence of each element in the sample for construction of species counts.

From this large array of data on each fragment, a number of interpretative statements can be made. Data can be grouped and re-grouped according to a host of variables and attributes with the use of a computer. In the preceding chapters, I have outlined the problem, the temporal-spatial context, and the method and theory upon which the research was based. In the succeeding chapters (4-9), I will describe and interpret the data derived from each site individually. In this way, intra-site patterning can be delineated before discussion resumes on a regional scale.

CHAPTER 4: ANALYSIS OF THE LATE NEOLITHIC SETTLEMENT AT OPOVO

I. INTRODUCTION

Opovo (Ugar, Opovo) is a large late Neolithic settlement in the Banat, north of Belgrade (Ill. 1 and 2). The Banat is the region of northern Serbia situated between the Danube and Romania. It is the eastern part of the autonomous region of the Vojvodina. The site is located approximately 3.5 km. east of the village of Opovo, which is north of the town of Pančevo. Opovo is situated on a sightly elevated location and was surrounded on three sides by an extensive series of annually flooded lowland marshes. Presently, the entire area has been drained and placed under cultivation (e.g. crops such as corn and wheat). Few traces of the ancient flora exist in the region beyond the present-day marshes. The soil is characterized by a deep and rich chernozem, overlying Pleistocene loess deposits. Drainage was extremely poor because of the high water table. It was not an area as conducive to domestic crop cultivation or for the herding of most domestic animals as the better-drained regions of central Serbia. Nevertheless, the range of

potential natural wild resources in the surrounding habitat is much more varied and abundant. Wild fauna and flora abound in the aquatic and semi-aquatic environments that border the Danube and its tributaries flowing through the region. Fish, shell-fish, amphibians, reptiles and a large variety of wild mammals (e.g. wild pig, roe and red deer) are still present and thrive in the region's marshes and fields. Wild birds migrating between the Mediterranean and central and northern Europe stop here on their semi-annual trip providing a regular, but seasonally-limited resource. During the late Neolithic, Opovo was in a position to exploit the full range of such resources.

Based upon ceramic typology, two phases of the late Neolithic Vinča-Pločnik ceramic horizon were isolated during excavation. The earlier phase corresponds to the late Neolithic Vinča-Pločnik II period. The later phase is synchronous with the post-type site Vinča-Pločnik material which was found at sites, such as Divostin. The two phases were not separable stratigraphically. Individual otkopni slojovi (excavation levels) could not be assigned to one or the other (Lj. Bukvić - pers. comm.). Each otkop slej was approximately 10 cm. in depth. Since the two phases were nearly contemporaneous, the faunal collection was analysed as a single temporal unit.

The faunal materials from Opovo were recovered during the initial testing of the locality during 1979 and 1980 by Mila Prikić and Ljubomir Bukvić of the Narodni Muzej, Pančevo (Prikić and Bukvić 1980). A surface reconaissance of the site revealed at least seventy house daub concentrations on the surface. In situ archaeological features were preserved very close to the surface. Excavation of some of the concentrations corroborated the presence of sub-surface in situ materials. Preservation was so exceptional that daub walls of structures occasionally projected slightly above their associated floors (Bukvic - pers. comm.). Three trenches were excavated during 1979 and 1980, totaling 107 sq. m. of surface. Sonda 1 cut through a compact layer of house daub debris. The foundation was wider than the trench and could not be completely delineated. The floor and its associated materials were not separated from the collapsed overlying burden. Work was carried out until a depth of approximatlely 50 cm. (third otkop sloj). Sonda 2 included the remains of a compact layer of house daub. Beneath this horizontal stratum was found the remains of a hearth in a depression near the bottom of the trench. Sonda 2 probed to a depth of ca. 2 meters. Sonda 3 also uncovered the remains of a compact layer of house daub debris. A horizontal layer of wall daub fragments was found several centimeters above the floor of

the house. Ceramics, figurines, lithics and bone were recovered in varying quantities from each trench. Sterile soil was reached after about 1 1/2 meters. The deposits contained very abundant bone remains, which were also well preserved.

II. TAPHONOMY OF THE SAMPLE

All artifacts from the site were hand-collected. They were collected and bagged in artificial horizontal excavation levels (otkopni slojovi). Excavation was conducted utilizing shovels and spades as the primary tools. No sieves were used during recovery. Although excavator bias is expected in the recovery of the smaller and less visible bone fragments from the site, the problem is to determine the extent as compared to other collections. The surest indication is found among the fish bones. Fish bones in similarly situated localities (such as, La Tene Gomolava) were recovered in great quantities with the use of sieves, in strong contrast to their near absence in hand-collected samples from the same site (Clason 1979; pers. comm.). Fish bones at Opovo were few in number and all derive from an unusual concentration at the bottom of Sonda III. Consideration of the distribution of the larger vertebrate remains (i.e. cattle and red deer) points to relatively good

preservation and recovery of most body parts during excavation. All bone fragments showing erosion of the surface or chewing by carnivores/omnivores (dogs, pigs) were analyzed separately (tables 5 and 6). Each of the major species at the site were represented in the tables. It was very interesting to note that most of the eroded and chewed bones were found in Sonda 1 (n = 19). One eroded specimen was found in each of the remaining Sondas. 67 fragments of chewed bone came from Sonda 1, 5 from Sonda 2, and 7 from Sonda 3. Considering that the depositional context is very similar from all three excavation trenches, it is very probable that the differences in quantities reflects the larger sample of bones from Sonda 1. It probably says little, if anything, about the depositional conditions in each trench and more concerning the influence of sample size. 2/3 of the bones come from Sonda 1 (table 4).

Several depositional contexts were recognized during excavation. Differentiating material by context has proven productive elsewhere (Meadow 1976). The recognized contexts, all from the same temporal span, include inside houses, inside and around hearth foundations, below house floors, floating cultural strata, etc. However, artifacts were collected according to arbitrary horizontal excavation levels (otkopni slojovi) that extended the width and breadth of each trench.

The faunal sample from Opovo is not overly large (n = 962 bones). It is suggestive of the manner in which resources were exploited in a lowland zone surrounded by poorly-drained bodies of water (i.e. marshes) and the nearby channels of the Danube and its many tributaries. Within this sample, at least 16 different forms of life were identified. The remains are mostly the result of human feeding habits, with the exception of certain species (i.e. Homo sapiens sapiens - humans). Some of the remains of most of the other species show definite signs of having been processed by humans as food. It is difficult to go directly to discussions of relative importance of each species at the site, without first determining the extent of the attritional processes that may have modified the assemblage before it is seen by the archaeologists. The same attritional processes cannot be said to have affected each species of animal equally. Some species were more affected than others. Each species will be considered separately in the analysis.

III. THE SPECIES

Ovis aries L., 1758 (domestic sheep) and Capra hircus L., 1758 (domestic goat)

Domestic ovicaprines (sheep and goat) are present in small numbers at Cpovo - 2.7% (frequency: table 7; age: table 8). The percentages reflect only the potential food animals (e.g. humans are excluded) and are corrected for observed or potential articulations (see chapter 3). The low frequencies of ovicaprines are somewhat surprising when compared with the nearly contemporary samples from Obre II, Anazabegovo, Divostin (Bökönyi 1974b; 1976; n.d.) and Gomolava (Clason 1979: 60, table 4). This could reflect one or more of the following processes:

1. Areal sampling of the site - all the other excavations opened up a much larger sample of the site, reducing the potential for areal bias in the distribution of remains;
2. Bias in the sample according to size of bone - ovicaprine bones are generally quite small and difficult to see in unsieved dirt. The proportions of small and dense foot bones as compared to the frequency of early fusing long bones (table 9) is much smaller among sheep/goat than among any of the other articdactyls (i.e. cattle, red deer). Only roe

deer, a similarly sized animal, is characterized by a similar distribution of body parts. It is, therefore, likely that the sample underrepresents the smaller vertebrate species; and

3. Local economic adaptation - ovicaprines do not do very well in the moist conditions surrounding Opovo. The other previously mentioned sites are located in more arid environments (Anzabegcvo) or on better drained soils (Obre II, Divostin, Gomolava). The situation at Opovo does resemble other late Neolithic sites lying in or near the flcod plains of the river flowing through the Hungarian Plains (e.g. Polgar-Csoszhalom - Bökönyi 1974a: 29).

The likelihood of selective recovery biases as an explanation for the differences in relative frequencies between the late Neolithic collections is the least likely alternative. Each of the sites used similar recovery methods. Therefore, the first and last processes are more likely alternatives. Four fragments of domestic sheep, one of domestic goat, and fourteen of sheep/goat were identified (2.8% of the identified bone). Only a single metatarsal of a sheep was whole. The rest were usually less than 1/2 of their original dimensions. Using Zalkin's (1961) formula for calculating withers height /4.68 (quotient) X 126.6 (length) = 592.49 mm. (withers height)/ - it is possible to

place the specimen in the smaller end of the size range of sheep found in contemporary localities. A single, nearly complete, sheep horn core was also found. It had been broken off near its base. The three edges and a spiral twist indicated the presence of the "copper" variety (cf. Bökönyi 1974a: 158).

The age distribution of the sample is also of interest. Due to the small sample size, both species will be considered together. When all body parts are considered together, the sample indicates a 50:50 (n = 6:6 immature:mature) ratio. The mandibles, a very dense and durable body part and one of the more reliable indicators of age distributions (cf. Payne 1973), indicate a 40:20:40% (n = 2:1:2 juvenile:sub-adult:adult) distribution. It would appear that the majority of ovicaprines were slaughtered prior to maturity (before the age of three years). Among the immature specimens, juveniles (3 months - 1 year) dominate. The only potential goat in the assemblage was a proximal tibia of a sub-adult - an element often difficult to distinguish between adults when incomplete. It is likely that we are mostly considering sheep in our age distiributions. Such a distribution of age groups would imply an exploitation strategy emphasizing the exploitation of immature individuals, whose likely products would be limited to meat and hide. The absence of young juveniles or

infants makes it unlikely that milk production would have been of any importance. It is unlikely that differential recovery or survival of elements would shift this distribution more toward adults, since most of the sample already consisted of early fusing or dense, small bones. These are the very bones which best survive many of the attritional processes, such as erosion and alternating freeze/thaw and moist/dessicate processes. The domination of a youthful age spectrum even under these conditions would merely indicate that immature specimens may have originally been present in even greater numbers. The addition of more late fusing bones usually emphasizes the younger age spectrum. A single ovicaprine distal tibia (sub-adult/adult) was carbonized (table 10). Two bones, a distal metacarpal and a iliac sections of an acetabulum, showed evidence of butchering. The former was sliced by a knife parallel to the long axis of the bone. The latter was sliced perpendicular to the long axis of the ilium. Both were probably attempts at severing the muscles and ligaments attaching limbs (table 11).

Bos primigenius Bojanus 1827 (aurochs) and Bos taurus L., 1758 (domestic cattle)

Domestic and wild cattle are the second most frequent set of species at the site. The two species of cattle were not

very difficult to separate from each other, since the time of initial domestication in the region had long since past. No evidence for transitional individuals was found. The measurements (appendix 2) generally show the separation in size between the two forms. The distal metacarpal and proximal metatarsal scattergrams (Ill. 6 and 7) illustrate the differences quite well. Most of the Opovo sample falls into the domestic size range. Comparisons with similar variables from Obre II illustrates a similar situation (Bökönyi 1974b: 73, fig. 5).

Aurochs are, even during this early period, a numerically unimportant species at sites in the Balkans. At Opovo, only sixteen fragments (2.3%) were identified. Most were from the lower skeleton, but a single horn core and mandible were also found. Except for one astragalus and three calcaneii, the other elements were fragmented into less than 1/2 of their original size. Most of the fragments were early fusing or small, dense bones as with sheep/goat (table 9). The age distribution is overwhelmingly adult - 16.6:83.3% (sub-adult:adult). A very well worn LM3 was found in the mandible. This distribution is consonant with contemporary samples from surrounding sites and implies an exploitation strategy of a hunted population. The emphasis upon adults, who are larger and yield more energy return for the effort invested, is characteristic of such a resource use pattern.

The absence of foot and tarsal bones should not be construed as examples of the "schlepp effect" (cf. Perkins and Daly 1968) - where body parts with little or no meat are discarded at the kill site before the rest of the carcass is carried back to the settlement. These are the very body parts most frequently found at Suberde. The size of the site, smallness of the excavated area and the likelihood of specialized activity areas (such as for carcass dismemberment) mitigate against this more complicated explanation. Two aurochs bones were butchered - a distal radius was sliced parallel to the long axis and a proximal metacarpal was sliced perpendicular to the long axis of the bone (table 11). A distal scapula was burnt black (table 10).

Domestic cattle were the most important domestic species and rivaled red deer in frequency at the site when antler and horn cores are removed from consideration. This is a situation quite different from most of the other late Neolithic localities located in or near the floodplains (e.g. Gomolava - Clason 1979). In the latter site, domestic cattle exceeded, by far, red deer. At Opovo, 194 fragments of bone (30.1%) were identified. The majority of cattle bones identified were post-cranial. Samples of cranial elements, such as mandibles, were also found. The distribution of the various element categories according to bone density (table 9) shows a very balanced sample. Early

and late fusing and small, dense bone groups are nearly equal in frequency indicating the minimization of attritional processes, such as erosion, at the site. The good preservation of the sample would also indicate rapid burial of the bone after it was discarded. Some selectivity for larger over smaller bones during recovery is apparent, but does not seem to have been very severe.

The age distribution from the total number of fragments data emphasizes adults among the domesticated cattle stock - 42.4:57.6% (immature:mature). The slight domination of mature individuals may be traced to attritional processes, which removed much of the post-cranial bones of juveniles from the sample. The mandible sample, a usually more accurate measure of age groupings than the post-skeletal sample, reveals a 20:40:40% (juvenile:sub-adult:adult) age distribution. Most of the immature specimens were sub-adults. The relatively high frequency of immature specimens implies an exploitation strategy focused upon meat and hide production. The mandible/maxilla data indicate that the adults ranged from young adulthood to middle age. There is a noted dearth of very old or senile specimens. One vertebra, only, gave the impression of belonging to a very old individual. There is no evidence, yet, toward a shift in exploitation strategies utilizing secondary products, such as milk or traction (cf. Sherratt 1980b). Production

of animals for meat and hide appear to have been the primary objectives. Nine fragments of bone were burnt, ranging from loose teeth to lower limbs. The absence of vertebrae may be a product of the difficulty in separating out those of cattle from other large mammals (e.g. red deer). Two large mammal vertebrae were burnt (table 10). Fifteen fragments show evidence of butchering. Thirteen had slicing marks at the end of bones for limb dismemberment. Two were chopped. The method of carcass dismemberment for consumption was similar for both wild and domestic forms (table 11).

Sus scrofa fer. L., 1758 (wild swine) and Sus scrofa dom. (domestic pig)

At Opovo, suids lie midway in frequency between sites such as Gomolava and Obre II (Clason 1979; Bokonyi 1974b: table 5) and Anzabegovo IV and Divostin (Bokonyi 1976: 317; n.d., table 1). The differences probably reflect local econiches of the settlements in relation to surrounding habitats. A total of 117 fragments, including fused and articulated specimens, were identified. Of these, three immature mandibules and maxillae could not be assigned to the domestic or wild varieties because of their state of fragmentation. They were most likely domestic forms. Distinguishing between domestic and wild forms was based upon the separation in size between the two groups. The

lack of transitional individuals implies that a great deal of time has elapsed since domestication of local swine populations began. The scattergram of the length and breadth of LM3 illustrates the differences between the two groups quite clearly (Ill. 8 and 9).

Wild swine were relatively unimportant at Opovo. Twenty-three specimens (3.6%) were identified in the sample. Most of the specimens were from adults. The mandible data indicated a ratio of 25:75% (sub-adult:adult), while the post-cranial remains were ambiguous. On the basis of the tooth wear sequences, both young adults and middle aged adults were included. All the sexed specimens were from males. Most of the recovered bones belonged to early fusing elements (73.3% - table 9). The underrepresentation of small, dense and late fusing elements speaks of differential recovery by size and problems of pre-excavation preservation of bones. The presence of both cranial and foot bones, argues against off-site butchering and disposal of elements. None of the bones were burnt (table 10), although two were butchered - a distal humerus chopped and a coronoid process of an ulna were chopped and sliced, respectively, perpendicular to the long axis of the bone (table 11).

Domestic pigs are the third most frequent vertebrate species and second most important domestic species at Opovo.

Eighty-five fragments (13.2%) consisting of virtually all body parts were identified. Most were from the smaller, denser bone types indicating less of the problem of differential recovery by size (table 9). The low number of late fusing as opposed to early fusing elements points to the loss of the former through erosion and other attritional processes. The normal expectation, under such conditions, would be for overrepresentation of the older larger individuals. Yet the age distribution points in the opposite direction. A 67.2:32.8% (immature:mature) ratio is typical of domestic pigs explcited primarily for meat. Half of the immature specimens were killed before or during their first winter as juveniles (36%). The mandible/maxilla sample shows that most of the adults were relatively young. The LM3 was only recently erupted and showed little surface wear. Only a single specimen revealed an advanced stage of adult tooth wear. Two adult males and a single adult female were identified. A single proximal metapodial (sub-adult/adult) was sliced lengthwise to the long axis of the bone. A distal tibia (sub-adult) was burnt (tables 10 and 11).

Canis familiaris L., 1758 (domestic dog)

Seventeen fragments of domestic dog were found in the excavations (2.7%). All were small in size and the cheek

teeth were crowded in the lower jaws. Domestic dogs usually make up a small percentage of the animal remains from contemporary localities. The presence of a charred proximal ulna may indicate that they were, at least, occasionlaly cooked (table 10), but the lack of butchering marks makes this a less likely explanation. Most belonged to adults (75%). Cranial remains dominated over any other body part. This may reflect differential use of and disposal practices for crania and jaws versus the rest of the carcass (table 9). A comparison of the measurements from the canid remains with other prehistoric samples places them at both the large and small range of prehistoric domestic dogs (Ill. 10).

Cervus elaphus L., 1758 (red deer)

Red deer are the single most common species at Opovo (36%). A total of 232 (plus 8 articulated and 2 fused) fragments were identified. When deer antler are removed from consideration, the domestic cattle and red deer samples are nearly equal. This is an unusual situation among the late Neolithic sites of the central Balkans, where domestic cattle usually predominated. The situation at Opovo probably reflects the moist, swampy surroundings where domestic cattle would have fared rather poorly. The shift to locally available wild rescurces may not reflect the natural abundance of species in the environment but the

preference for easily cullable rescurces that require a minimum of investment in time and energy for population maintainance (e.g. as at Suberde). The survival and recovery biases in the bone sample are similar to those for domestic cattle (table 9), but show greater evidence for selection by size and bcne density. Virtually every body part is represented in the sarple indicating that entire carcasses were probably carried back to the settlement for processing. Few, if any, body parts were consumed or discarded at the kill sites. Those body parts that are poorly represented may be most easily explained by recovery biases (i.e. small elements) cr the difficulty in distinguishing them from similarly sized animals, such as cattle (i.e. ribs and vertebrae). Most burned and eleven butchered (tables 10 and 11). Most of the butchered elements were the result of disarticulation of the lower from the upper limbs. The area between the distal tibia and the proximal metatarsal for the hindlimb and the distal humerus and distal metacarpal fcr the forelimb was the focus of such activity. Both axis and cervical vertebrae also exhibited slicing marks. Six fragments exhibited some signs of pathologies. Most of the signs indicated arthritic-like growth conditions among sub-adults/adults or adults and concerned the articular areas of the lcwer limbs.

The age distribution is strongly oriented toward mature individuals - 14.7:85.3% (n = 16:97 immature:mature). Such a ratio is prevalent on most Neolithic sites and is consonant with a hunted distribution emphasizing adults. The mandible/maxilla tooth eruption and wear sequences reveal both young and middle-aged adults. Little evidence for senility was found. Two antler bases were found still attached to their pedicles. Red deer carry a full rack of antler from the latter half of Autumn into early Spring (Clutton-Brock et al 1982; Chaplin 1977: 106). This also coincides with the period of lowest biotic activity in the habitat, in which both domestic and wild resources are least accessible to human exploitation. Red deer, during this time of the year, would have made a valuable contribution to the local economy. They would have been easiest to find (because of population aggregates and lack of vegetative cover) and yielded the largest quantities and variety of byproducts (antler, hide, meat, and bone). No pedicles with shed antlers or shed antler bases were found, possibly indicating that they were a seasonally-limited resource - Fall through Spring. The strong sexual dimorphism evident in red deer is visible in the measurements (Ill. 11 and 12) of the bones. Both males and females are present. Some of the larger males approached the size range of small domestic cattle creating problems in identification of certain

morphologically similar body parts (i.e. vertebrae, ribs). This is evident in the large number of such remains in the red deer/domestic cattle category.

Capreolus capreolus L., 1758 (roe deer)

Forty specimens of roe deer were found (6.2%). Roe deer has never been found in large numbers at any of the prehistoric localities in the region. This is probably due to two processes: 1. recovery bias toward the larger animals and 2. their low rate of energy return for hunters when compared with other wild articdactyls of the area (i.e. red deer). They live in very small groups and prefer environments with dense vegetative cover making them more difficult to locate. The dearth of footbones is traceable to recovery biases, while the absence of vertebrae reflects the difficulty in distinguishing sheep/goat from roe deer. Off-site processing and discard of body parts is unlikely considering the prevalence of mandibules and other meat-poor body parts. The absence of shed antler and the presence of a single antler still attached to its cranium point to exploitation of roe deer sometime between March/April and October/November, the period between the completion of antler growth and their shedding (Chaplin 1977). Bagging of occasional infantile and juvenile individuals is consonant with a seasonally limited exploitation of roe deer. None of

the specimens were burned, but several were butchered (table 11). These were metapodials of sub-adults/adults or adults and were sliced parallel to the long axis of the bone. The age distribution is skewed toward adults - 26.9:73.1% (immature:mature).

Lepus capensis L., 1758 (brown hare)

Four fragments of hare were identified in the sample (0.6%). All were metapodials of adults or sub-adults/adults. They possibly represent the remains of a single individual, but were found in different contexts and were not articulated when excavated. Hare is an ubiquitous species in the region, frequently captured for its meat and pelt. The small size of the bones usually results in underreporting of its frequency. None were burnt or cut.

Meles/Nutra/Muskrat sp.

A single fragmentary mandible of an adult animal resembling the above set of species was found. Closer identification was impossible due to its fragmentary state.

Unio sp. (mussels)

71 fragments of bivalve freshwater mussels were found. They are commonly found throughout the low-lying areas bordering the Danube and its major tributaries. This total

does not include the tiny fragments that may have been derived from the same pieces of shell, but only those fragments showing the same section of the valve. This species was frequently exploited at sites along the river banks (e.g. Gomolava - Clason 1979: 52) and was probably a seasonally limited resource.

Helix sp. (snail)

Six fragments of the valve of snail shells were found. It is difficult to determine if these were eaten or accidentally included in the assemblage because they hibernate in the winter by digging holes in the ground. They are common throughout the area, but little direct evidence for their consumption exists. None were burnt and their association with garbage pits (as at Gomolava - Clason 1979: 53) may simply indicate colonization of man-made habitats. Consumption during the early autumn seems most likely given their poisonous physiology during the more active summer phase (Clason 1979: 153).

Pisces sp. (fish)

Thirteen fragments of fish bones were collected from a single deposit at the bottom of Sonda III. It is likely, given the environmental surroundings, that fish would have been more prevalent at the site. This, combined with the recovery strategy, makes it apparent that they are severely

underrepresented in the sample. Their small size militated against adequate recovery of fish bones without the aid of mechanical recovery devices, such as 1/2 mm. or smaller sieves. The fish fragments are currently undergoing analysis by D. Brinkhuizen of the Biologisch-Archeologisch Instituut, Groningen.

Homo sapiens sapiens (modern human)

Six fragments, three cranial and three post-cranial, were found scattered through the excavation area. A few human bones are invariably found in every faunal assemblage that has been examined. There is no reason to think that they were part of the food remains.

IV. CONCLUSIONS

During the 1979-1980 excavation of the late Neolithic settlement of Opovo, a large sample of faunal remains was uncovered. From the detailed analyses presented above, it is possible to deduce some general conclusions about the type of materials collected, their condition, the sources of bias inherent in the sample, and the prehistoric subsistence system in place at the site. At least sixteen different species of animals (13 mammalian, 2 molluscan, and at least 1 fish species) were identified. Red deer were the most

numerous, quickly followed by domestic cattle. The remaining species, both domestic and wild, accounted for less 33% of the remains. It is apparent from the analysis that domestic animals were an important but not pre-eminent source of food and other products during the late Neolithic in lowland settlements surrounded by aquatic environments. The original absolute importance of each species is difficult to determine considering the preservation and collection biases present in the faunal sample. Considering the surrounding semi-aquatic environment, fish were probably the most underemphasized of the species.

Tooth eruption and wear analysis of the mammalian ungulates revealed the approximate ages at which the animals were killed. From this information, different production emphases were proposed for each species. It appears that domestic and wild animals were exploited primarily for meat and not secondary products, such as milk, wool, or traction (cf. Sherratt 1980b). With our increased knowledge of the animal resources exploited at Opovo, it is possible to propose a broad 3-fold division of the subsistence system over the course of a year: summer - the consumption of infantile domestic animals and some wild resources, such as roe deer, fish and molluscs; autumn - the consumption of juvenile domestic animals; and winter/spring - the consumption of wild animals, such as red deer and boars.

Sub-adult and adult dcmestic animals were probably slaughtered during the late fall and early winter when fodder supplies would be most depleted. These hypotheses concerning the scheduling of resources must still be tested by further research, such as the sectiоning of teeth and examination of the layering in the dental cementum.

CHAPTER 5: ZOOARCHAEOLOGICAL RESEARCH AT PETNICA

I. INTRODUCTION

IA. Location and Surrounding Environment

Petnica is a small (ca. 1 hectare - cf. Chapman 1981; Jež - pers. comm.) prehistoric locality situated on the mountain slope to the east of the more famous cave site of Petnica Pecina. The site is located at the southern edge of the modern village of Petnica. The village is southeast of the city of Valjevo, Republic of Serbia, Yugoslavia (Ill. 2 and and Ill. 13). The slope overlooks an amphitheatre-like depression at the end of a long valley. The valley ends below the site. It slowly widens to the north where it eventually merges with the floodplain of the Kolubara river (c. 5 km.). Below the site flows a small stream, which issuing from the mouth of the famous Petnica cave, runs down the center of the valley until it empties into the Kolubara. Above the slope upon which the site is located begins a series of mountain ridges and plateaus which slowly rise in

a serrated pattern until they reach the backbone of the Dinaric Alps in Bosnia. The highlands above and the slopes around the site are still heavily forested and present a dissected landscape of flat and sloping terrain interspersed with steeper inclines. Rich Brown Forest soils and alluvium for agriculture, open meadows for grazing, forests for timber, chert sources for lithics and fresh water are available in the immediate surroundings of the site.

IB. History of Research

Excavations have been conducted inside and outside the cave since the turn of the last century (see references in Chapman 1981). There are two main cave chambers - an upper and a lower one. The lower one has a cold water stream flowing out of its mouth. It faces directly north and is the more comfortable and drier of the two caves. Access to the lower cave is also easiest, since it opens up only slightly above ground level. It appears to have been occupied at the end of the Pleistocene and at various times during the Holocene. However, its contents were removed by a series of excavations beginning at the end of the last century (Jež - pers. comm.). The stream issuing from the lower cave was channeled by the Austrians during the early part of this century to power a grain grinding mill

immediately in front of the cave. A man-made waterfall was created to power the mill. It provided an excellent source of quick flowing water for our flotation and water-sieving activities. The upper cave has a separate entrance. Rockfalls closed any connections between the two caves. The stream in the lower cave is fed by a underground pool of water in the lowest reaches of the upper cave. A natural siphon maintains the flow of water, although it occasionally shuts off. The upper cave was excavated by M. Novack of the Narodni Muzej in Valjevo during the 1960's. Pleistocene fauna were found within the upper cave (perso. obs. of museum display). At the same time that Novack was testing the upper cave, Prof. Dr. Branko Gavela of the University of Belgrade conducted a sounding of the exterior settlement. It is located on the hill slope to the east of the cave and mid-way between the two cave entrances. Based upon surface finds and Gavela's excavations, the open-air section of the locality was occupied during the late Neolithic (Vinča ceramic group). Aside from Novack's work, these earlier excavations have never been more than briefly published nor their records and materials curated (Ž. Jež - pers. comm.).

In 1980, Željko Jež of the Mladih Istraživackih Srbija decided to undertake a new series of excavations on the outer settlement. The goal of the new project, instead of being simple culture history, was the elucidation of the prehistory, ecology and economy of the early cultures of the

Valjevo region - an extension of his earlier studies on the origins of agriculture in the Central Balkans. The settlement at Petnica was chosen because of its known Neolithic occupation, early date, depth of stratigraphy and good preservation (based upon discussions with earlier excavators). Excavations at the site represent the first phase of a long-term research project dealing with the entire region. Changes in the society, economy and ecology of the region would, at first, be monitored from a single location - Petnica. Afterwards, surveys and excavations of other strategically located sites would enable a greater understanding of the spatial and temporal variability in developments throughout the region.

Systematic analysis of the animal bones from the site began in 1982. This chapter represents a summary of the activities conducted at the site by myself and my assistants during July and August 1982. The materials from earlier and subsequent years of excavations are presently under analysis and will be reported upon separately.

IC. Archaeological Sequence

Originally, it was predicted that only late Neolithic materials would be found at the site. However, after the

1982 excavations, it was possible tc identify five major horizons of occupation. Evidence for intermediate phases (e.g. Middle Bronze Age Vatin culture) are frequently present but lack depositional integrity (i.e. disturbed layers only). Frcm the earliest tc the latest, they are the following: 1. middle Neolithic Vinča B (c. 4000-3700 b.c.; 4250-4100 B.C.); 2. late Neolithic Vinča C (c. 3700-3400 b.c.; 4100-3900 B.C.); 3. late Neolithic Vinča D (c. 3400-3000 b.c.; 3900-3300 B.C.); 4. Eneolithic Baden-Kostolac (c. 3300-2500 B.C.); and 5. Late Bronze-Early Iron Age Halstatt A, B, and C - with B having the strongest representation (c. 1300-800 B.C.). (Radiocarbon dates derived from Garašanin 1983 and Chapman 1981).

II. EXCAVATION AND COLLECTION STRATEGIES

During 1982, excavation was conducted using the stratigraphic method in three trenches (1, 3, Excavation by arbitrary levels would have cross-cut cultural strata, as evidenced by some of the units from the 1980 and 1981 excavations at the site (Sonda 5, and upper parts of 1 and 2). Several units could not be included in the analysis as a direct result. Excavation progressed at a very slow and careful pace. The stratigraphy proved to be extremely complex. The site is on a slope with substantial erosion and

some probability of down-slope movement of artifacts and strata exists. Nevertheless, once the top layer of the cultivated and disturbed soil strata were removed, it was possible to segregate temporally homogeneous cultural layers. Sonda 1 was a continuation of the 1981 excavations (c. 4x6m). Sondas 3 and 4 were 4x4 m trenches situated to the east of the previously excavated areas. The stratigraphy in all the trenches was more or less similar. All bone fragments were collected by excavation unit, washed in the nearby stream, sun-dried and bagged for analysis. In the ceramic laboratory, all artifacts (i.e. ceramics, lithics, bone, etc.) were sorted, counted and separately bagged for final analysis. Some breakage of the bone remains probably occurred in the time between excavation and arrival in the faunal laboratory. However, it does not appear to have been an extensive phenomenon since very few modern breaks were noticed. Most of the bones had been fragmented by either prehistoric human activity or by natural geological processes, such as freezing, thawing, water-logging, and drying. Preservation, in general, was very good and a substantial proportion of the remains were identifiable to the species level (29.9%). A balanced pH level in the cultural horizons probably contributed to the high rate of identification (range: 5.8-7.0 pH).

Recovery of all artifacts has changed over the course of the excavation. Initially, all materials were hand-collected and bagged according to arbitrary excavation levels (1980-1981). In 1982, with the introduction of stratigraphic excavation techniques, sieving was begun. During 1982, we instituted a controlled recovery procedure in order to maximize artifact collection and to determine the extent of loss by the more traditional procedures. A section of each trench, usually 1-2 sq. m., was sectioned off and excavated separately. The earth from that section was passed through a 1 cm. sq. sieve. All clumps of earth were completely broken up in the sieve. All artifacts (i.e. stone, bone , ceramic, daub, etc.) larger (and many smaller) than 1 cm. sq., were caught in the sieve and collected and bagged separately from the rest of the trench. These units are called "sito" in the unit description register.

Whenever a potentially rich deposit was encountered (e.g. post-hole, pit, etc.), the deposit (or some substantial part of it) was subjected to flotation and water-sieving. Flotation was conducted by the immersion of the soil in a bucket of clean water. The water was stirred and the clumps of dirt broken up. Material that floated to the surface of the water was subsequently caught in a finely meshed sieve (0.80 sq. mm. mesh). This material was registered as "preflotacija". Large fragments were hand-picked from the soil beforehand and bagged separately. In the next stage,

"flotacija 1", the sludge at the bottom of the bucket was placed in a 1.70 sq. mm. sieve and carefully washed with clean running water. This material was then dried and bagged separately. Beneath this sieve was placed a finer sieve 1.00 sq. mm., to catch smaller items that might pass through the larger mesh. Some interesting surprises appeared in this mesh sieve, registered as "flotacija 2". They included the discovery of tiny fish vertebrae - a totally unexpected but enlightening discovery for a highland village site. The material from this stage was also dried and bagged separately. The finds from the flotation and water-sieving operations have only begun to undergo analysis and will dealt with in later reports on the material from the site.

From the flotation exercises, a small but important collection of paleobotanical remains has been recovered. Analysis of this material has not yet begun, but the remains of domestic grains are present.

III. THE SPECIES

In this analysis, the conclusions to be drawn are based upon the total number of fragments per species, corrected for any real or potential articulations from the 1982 excavations (frequency: table 12; age: table 13). In a previous analysis of the Petnica material (Greenfield 1985b), mostly postcranial fragments were used to estimate species proportionality in order tc avoid the problem of the differential presence of skull elements among species and the extreme fragmentaticn characteristic of crania. In this analysis, which had available new data from 1982 that were not available when the first preliminary report was written, all fragments will be considered. As a result, the frequencies for several species will be odds with those in the earlier report.

A total of 4306 fragments of bone were recovered during 1982 (excluding the floated and water-sieved material). Of this quantity, 3377 fragments (78.4%) came from tempcrally secure deposits - undisturbed. 929 (21.6%) came from disturbed contexts. 1012 fragments (30.0%) of the bones from temporally secure deposits were identifiable to the Genus or Species level, while 2365 (70.0%) were identified to grosser categories The 995 identifiable fragments were subsequently divided among the majcr occupational phases. The analysis of these by phase will be presented below.

Over half of the identified remains came from the late Neolithic layers (n = 568). The Eneolithic (n = 250) and the Halstatt layers (n = 194) yielded far fewer identifiable fragments.

Ovis aries L., 1758 and Capra hircus L., 1758

Ovicaprines (sheep and goat) are present in every phase of occupation. Their overall numbers never amounted to a significant proportion of the sample and varied from phase to phase. They were more significant at other sites, such as Divostin (Starčevo layer), Obre I, and Anzabegovo (Bökönyi 1974b; 1976; n.d.). Sheep and goat will be discussed jointly because their remains are few at this time and not easily separated. In the earlist phase, Vinča B, only 4 post-cranial and 1 vertebral fragments were found (3.0% of total) - 1 juvenile and 2 adult sheep and 2 sub-adult/adult goats. This is not enough information to discuss their role in the local economy. During the succeeding Vinča C phase, 3 post-cranial fragments, 3 loose teeth and 1 mandible of sheep/goat were identified (2.3% TNF). Five of the specimens were from subadult/adults and 2 from adults, implying mostly exploitation of adults (maybe for secondary products, such as wool or milk). In the Vinča D phase, no postcranial fragments were found, but 3 mandibles and 1 loose tooth (4.7% TNF) were found. All came

from adult individuals. This quantity is very similar to the earlier phases. During the Eneolithic, ovicaprines decrease suddenly to 2.6% of the sample (n = 13). The age distribution is bi-modal during this period: 50% immature and 50% mature. If loose teeth are removed from the sample, 60% are immature and 40% mature - a distribution more in accordance with exploitation for primary products (e.g. meat and hide). Secondary products would have been of lesser importance. In the Halstatt phase, cvicaprines increase to 10.8% (TNF; n = 15). The age distribution is nearly identical to the preceding period (60% immature:40% mature). When the loose teeth are removed increased emphasis is placed upon immature individuals (71.4:28.6%), probably indicating exploitation for meat and hides.

Bos primigenius Bojanus, 1827 (aurochs)

The wild ancestor of the domestic cattle is present in almost all phases. Its numbers are insignificant. During Vinča B, they are represented by only 4 fragments (2.4%). In the Vinča C phase, only 1 fragment was found (0.3% TNF). None were present during Vinča D. During the Eneolithic 1 fragment (0.4%) was identified. The same is true for Halstatt (0.5%). All fragments were aged to a subadult/adult or adult group and probably represent the remains of occasionally hunted individuals.

Bos taurus L., 1758 (domestic cattle)

Domestic cattle are of importance in every phase, but vary significantly over time. During the earliest phase, Vinča B, they are only 19.5% of the sample. It was the third most common species. The age distribution is contradictory - 75:25 (post-cranial) or 46.6:53.3% (all fragments) immature:mature. The single mandible with intact teeth showed an advanced age. The two ratios require further data before conclusions may be made. Vinča C material reveals a dramatic increase in the importance of cattle to first place (34.7%). Addition of loose teeth or cranial fragments does not significantly alter the age ratio - 42.1:57.9%. It can be seen more clearly that the emphasis is placed upon herd maintenance activities and the exploitation of products associated with adult animals (e.g. milk and traction). Vinča D shows a decline in cattle importance to 33.6%. The age distribution is enigmatic - 66.6:33.3 (post-cranial); 330.8:69.2% (TNF); 36.4:63.6% (Total, excluding loose teeth) immature:mature. One assumes that the post-cranial estimation is most accurate since a substantial proportion are immature - the category most likely to have disappeared. This may indicate a dramatic reorientation in cattle exploitation. During the Eneolithic, cattle remain in second place (22.4%). The age distribution points toward a preponderance of immature

individuals - 70:30 (post-cranial); 43.5:56.5 (Total); and 64.3:35.7% (Total, excluding loose teeth) - continuing the trend noticed in the previous pericd. In the Halstatt period, domestic cattle are overtaken by domestic pigs, but remain in second place (22.7%). The age ratio for this phase is also extremely unbalanced but opposite to that of the earlier period - 11.1:88.8 (post-cranial); 6.6:93.3% (Total) - toward a greater exploitation of adults. This is very much in line with Sherratt's (1980b) hypothesis on the secondary products revolution - cattle are valued and exploited for their milk and traction rather than for simple meat or hide production. In the uplands, this change must have taken place at some point during the Early/Middle Bronze Age.

Sus scrofa fer. L., 1758 (wild swine)

Wild pigs are never of great importance, but they do appear to have been a valuable rescurce at times. As with cattle, the underrepresentaticn of dcmestic or wild forms may exist since they are differentiated largely on the basis of size. In the absence of many whole or measurable specimens, subjective criteria were frequently relied upon. In the earliest period, Vinča B, they are 2.4% of the sample. The age distribution tentatively suggests an adult population. This would lend support to the hypothesis that they were hunted and not herded. In the Vinca C phase, they

increase in frequency (7.7%) to fourth place. This is the highest percentage attained by wild swine. Slightly more than 3/4 of the fragments were from mature individuals. Immature specimens were represented by 2 subadult fragments. During Vinča D times, they decrease to 2.8%. All the specimens, with the exception of one sub-adult, fell into the subadult/adult group. During the Eneolithic, their frequency increase slightly (3.2%) to fifth place. 85.7% of the specimens were adults. During the final phase, Halstatt, they increase to 5.2%, but remain in the same position (5th). All the ageable specimens were adults. During each period, the same pattern is visible - adult individuals, probably hunted, being exploited.

Sus scrofa dom. L. (domestic pig)

During Vinča B, domestic pigs represent 21.9% sample and fall into second place. Most are immature (c. 25% mature) - a normal age distribution for domestic pigs exploited for their meat products. In the next phase, Vinča C, pigs decrease to third place (16.2%). But the age distribution is dramatically different - approximately half are mature. This change is significant because it continues in the succeeding Vinča D phase. In this phase, pigs increase to 24.3% but remain in third place. The immature:mature ratio is also closely balanced (52.6:47.4% immature:mature - Total). In the succeeding Eneolithic, pigs remain in third

place but decrease in frequency to 19.4%. The age distribution is similarly balanced (50:50% immature:mature - Total). Removal of cranial fragments or loose teeth altered the relationship (66.6:33.3%). During the Halstatt period, domestic pigs increase to first place (31.4%). They increased at the expense of cervids and cattle. The age distribution is more similar to that of Vinca B than any of the intervening periods (80:20% immature:mature - Total). The contrast between the earliest and latest phases with all the intervening periods is very strong and potentially indicative of major reorientations in pig production and exploitation or some other as yet unidentified taphonomic process.

Canis familiaris L., 1758 (domestic dog)

Domestic dogs are very rare in all phases. Only one fragment was found in each of the early Vinča horizons (B and C), none in the Vinča D layer, and two fragments in the Halstatt. Most are subadults/adults, although one juvenile and one adult were identified (Eneolithic and Halstatt respectively).

Cervus elaphus L., 1758 (red deer)

Red deer are the most frequently represented animal at the site for most time periods. During Vinča B, they are in

first place (36.6%; n = 60). Most are adults (13:86.9% immature:mature - Total) and were probably hunted. Very few antlers were recovered (n = 2). In the next period, they dropped to second place (27.6%; n = 22), after cattle. Almost all the specimens were adults (8.8:91.1% immature:mature - total), as in the previous phase. Six antlers were found, three of which were bases still attached to the frontal bone. This could indicate probable occupation at least during the fall and winter - the period before antler are shed. During Vinča D, red deer remain in second place (29.0%; n = 31). Most are adults (71.4%), although the sample is poorer. The Eneolithic shows a different picture. Red deer are in first place (48%; n = 120). The age distribution, however, is contradictory. The total sample shows the same basic pattern seen earlier (8.1:91.9% immature:mature). But, the sample of immature specimens is larger (33.33:66.66% immature:mature) in the sample possibly reflecting a different emphasis in exploitation. Most are still adults, indicating the continued emphasis on hunting. But the trend toward more immature individuals may represent some disturbance in previous patterns of exploitation which needs explaining either in terms of attrition or economy. It may be that we are seeing an effort to eliminate wild competitors for the same food resources used by domesticated animals.

Inferential support for such an idea may be found in the Halstatt phase. Red deer decrease to third place (21.6%; n = 42) as domestic species increase in importance. A more usual age distribution prevails (12.5:87.5% immature:mature - TNF), with the return to earlier modes of exploitation.

Capreolus capreolus L., 1758 (roe deer)

Roe deer are never very significant, but frequently represent an important alternative or supplementary resource. In the Vinča B phase, they rank fourth (9.1%; n = 15), the highest rank and percentage attained by them at the site. The age distribution is biased toward adults (20:80% immature:mature - Total; 25:75% - postcranial). During the succeeding phase, Vinča C, they decrease slightly to fifth place (7.4%; n = 22). But the age distribution becomes more enigmatic (26.6:73.3% immature:mature - total; 57:43% - postcranial). The same problem in interpretation is seen here. With the small sample available one may only comment on the importance of hunting of mature individuals for a variety of by-products. The hunting of immature individuals may simply represent sample biases and are difficult to evaluate at this time. In Vinča D, they decrease in percentage (5.6%; n = 6), but not in rank (fourth place). All specimens are either subadults/adults or adults. In the next period, Eneolithic, they continue to decrease to fifth

place (3.6%). The same age distribution as in the preceding period prevailed (100% adult). One antler base attached to a frontal fragments was found. During Halstatt times, they drop to sixth place, but rise slightly in frequency (4.1%; n = 8). The age distribution is more evenly split (40:60 immature:mature).

Lepus capensis L., 1758 (hare)

Two fragments of hare were found in the Vinča B layer - one adult and one subadult/adult (1.2%). Both were post-cranial fragments. A single mandible (adult) was found in the Vinča C layer (0.3%).

Castor fiber L., 1758 (beaver)

Beaver are present onlyduring the earlier phases of the site. During Vinča B, they are represented by 3 sub-adults (post-cranial)and 3 adults (2 post-cranial and 1 mandible). They represented 3.0% of the sample. In the next phase (Vinča C), they decrease slightly to 1.3% and are represented by 2 adults (1 mandible and 1 post-cranial), 1 sub-adult/adult (post-cranial) and 1 unknown (post-cranial). They are the most common small mammal in the assemblage and probably lived in the nearby streams.

Lynx lynx (Lynx)

A humerus of an adult lynx was found in Vinča B strata. Such large carnivores are rare in most sites of the later prehistoric periods.

Vulpes vulpes L., 1758 (fox) In the Vinča C horizon, a single mandible of an adult fox (0.3%) was found.

Ursus arctos L., 1758 (brown bear)

Brown bear is the only wild carnivore frequently found at nearby contemporary sites. But it is limited to the Halstatt period at Petnica. Four fragments were found (2.1%) from a variety of elements. They included an articulated left and right mandible of an adult, 1 adult (post-cranial) and 2 sub-adults (post-cranial).

Equus caballus L., 1758 (domestic horse)

Domestic horse appeared very late at Petnica. Two fragments were found at Petnica in the Halstatt sloj (1.0%). Both were post-cranial fragments from adults.

Aves sp. (birds)

Two fragments of an unidentified bird were found in the Vinča B period and one from the Eneolithic.

Pisces sp. (fish)

A few small fresh water fish vertebrae were found within pits associated with a late Vinča (Vinča C) structure in sonda 4. Further analysis of the fish remains is awaiting new finds from the 1983-85 excavations.

IV. CONCLUSIONS

Several possible trends are visible in the data from the 1982 season at Petnica. Most importantly, we can see the overall increase in domesticated animals over time. However, it takes a long time for domesticated species to become as important as red deer. Wild animals remain an important resource throughout the lifespan of the site, possibly testifying to the poor reliability or productivity of domestics during this time. The question of seasonality remains open at this time, but the late Neolithic architectural and antler data are indicative of a fully sedentary community occupying the locality for the entire year. This strongly contrasts with the post-Neolithic layers where only direct evidence for late spring/early fall occupation (attached roe deer antler) was found. But new information from the 1980 and 1983-1985 seasons may alter this statement. It appears that the development of economies based upon domestic animals did not take place at the same rate throughout the Balkans. Some areas developed

faster than others. The Valjevc region, as exemplified by the data from Petnica, and the Kragujevac region, based on the data from Ljuljaci (see chapter 6), are remarkably similar. Both remained more dependant upon wild species for a longer period of time in comparison with contemporary communities in the more open and lowland environments along the Lower Morava and Danube.

CHAPTER 6: THE FAUNAL REMAINS FROM EARLY/MIDDLE BRONZE AGE LJULJACI

I. INTRODUCTION

The animals bones analyzed in this chapter come from the hilltop settlement of Ljuljaci. It is located on Milica Brdo in the village of Ljuljaci, about 20 km. west of the city of Kragujevac, Republic of Serbia, Yugoslavia (Ill. 2). Ljuljaci has been the focus of excavations for the better part of this century. It was first tested by the joint Yugoslav-American archaeological expedition directed by V. Fewkes (cf. Ehrich - pers. comm.; Jeremic and Bogdancvić n.d.). Various parts were excavated around the hilltop and down in the nearby valley. During the early 1950's, it was tested by the Narodni Muzej of Belgrade. In 1965, Dragoslav Srejović, under the auspices of the Narodni Muzej of Kragujevac and the Archaeological Institute of Belgrade, conducted an important series of excavations on the hilltop. He concentrated upon the Bronze Age settlement and was successful in exposing a surrounding (fortification?) ditch and a tripartite chronology for the first half of the Bronze Age. During 1976 and 1977, the Narodni Muzej of

Kragujevac and the University of Belgrade conducted a large-scale intensive excavation of the Bronze Age section of the locality. It was part of the larger research project concerned with the "Ethno-cultural movements of the copper and bronze age on the territory of central Serbia". Trenches were placed over various section of the site in order to investigate the fortifications, foundations of the settlement, thickness of the cultural layer, and stratigraphic relations within the site. Since 1965, Ljuljaci has been recognized as one of the most important localities for the development cf the Middle Bronze Age Vatin culture and its West Serbian variant (Garašanin 1973; 1983; Jeremić and Bogdanović n.d.; Srejović 1965). It is a highly unrepresentative locality for the time period and place because of the gccd ccnditions of preservations existing at the site. Most contemporary settlements are greatly disturbed by a variety of processes and, at best, may yield a few discrete rubbish pits (e.g. Novačka Ćuprija, Vinča, Crkvina). Tc find a Bronze Age locality with preserved house floors is an exceptional situation for this regicn.

The site is located upon the western half of a natural plateau, overlooking the surrounding valleys. The southwest approach tc the plateau resembles that of a steep ramp. The western and northern sides descend quite steeply

to the stream below. The western side is the widest.

The Glavica, a thin winding stream, bends around the western, northern, and eastern foot of the plateau. Then, it flows east and northeast until the valley opens up into the larger valley of the river Gruže. The Gruže flows south and east until it merges with the Western (Zapadni) Morava in the mountains to the south. On the opposite side of the stream, the terrain quickly rises up again. The region is one of broad and very dissected limestone platforms. Ljuljaci is frequently thought of as a "gradina" or small fortified locality because of its position atop a small plateau surrounded on three sides by steep slopes. Easy access was available only from the eastern side. The settlement may have been surrounded by a wooden and ditch (fortification?) system, contained preserved houses, both horizontal and vertical stratigraphy, and three discrete phases of occupation. Between 1965 and 1977, 386 m. sq. of the surface of the site were investigated (1965 - 82 m. sq.; 1976-1977 - 304 m. sq.). While most of the excavations were centered in the central and western parts, virtually every section of the site was sampled (Ill. 14). The Bronze Age settlement was built on the western side of the plateau. The thickness of the cultural layer varied from 130-148 cm. in the western and southwestern parts of the site to 30-40 cm. in the

eastern. The stratigraphy prcved to be quite simple. Three broad cultural strata were identified (Ljuljaci I, II, and III), horizontally laid down and parallel to the sterile substrate (M. Bogdanović, pers. comm.).

1. Ljuljaci I. Early Bronze Age (analogies with the Vinkovci and Bubanj-Hum III ceramic groups - ca. 1950 b.c.: uncorrected C-14);
2. Ljuljaci II. late Early Brcnze Age-early Middle Bronze Age (Pančevo-Omcljica variant of the Vatin ceramic group - 1730-1690 b.c.: uncorrected C-14); and
3. Ljuljaci III. Middle Bronze Age (classic Vatin ceramic group - ca. 1600-1550 b.c.: uncorrected C-14).

According to the radiccarbon dates, the site was occupied during the late Early Bronze Age (ca. 1950 b.c. - uncorrected radiocarbon dates) and was abandoned at the end of the Middle Bronze Age after approximately 300 years. All three phases cf occupation are found superimposed along the western half of the site (Sonda 1, 5, 6a, 6b, 7, 7a, 7b, 8, 8a, 8b, 8c 12 13, and 14). In the eastern half, only Ljuljaci III deposits were found (Sonda 2, 3, 4, 9, and 11). During Ljuljaci I and II, the settlement remained at about the same size. In the final period, it spread over most of the unoccupied area as well.

During the 1976-77 excavations, 29 free-standing houses and associated features and artifacts were uncovered. House foundations were constructed of wood, daub and stone. Limestone flooring was smeared with a layer of daub. The shape of the foundations resembled that of a quadratic right angle and foundation lengths varied between 3 and 4 meters. House frames were built of upright and deeply buried wood posts, with thinner pieces of brushwood woven in-between. Roof construction techniques are poorly known. Open hearths, grain mortars, ceramic vessels, and stone and bone tools are frequently found within houses. The houses appear to be similarly oriented - with one placed before the second and an intervening open space ranging from 2-4 meters separating them. Paths wind between the houses. In the southwestern part of the site, there appears to have been a relatively undeveloped section that may have been used by the inhabitants for a variety of possibly "communal" tasks - e.g. organization of hunting parties, distribution of hunted or collected catches, threshing of grain, production of goods, preparation of ritual tasks, etc. (cf. Jeremić and Bogdanović n.d.). Unfortunately, this proposition cannot be tested at this time. Artefacts found on the floor and around the houses were made of clay, stone and bone. In one house, almost 200 fragments of ceramic dishes were recovered. 12 basic ceramic forms,

with a variety of sub-forms are distinguished - ranging from a large pithos and amphora for storage to miniature cups and bowls. 74 fragments of worked stone were collected, including flint knives and awls and ground stone amulets. Bone and antler tools were also found and will be discussed below. Ljuljaci, because of its excellent preservation, seems to have been a much more organized and possibly standardized community than is expected by comparison with other contemporary sites. Other sites lend the impression of single or at most a few households inhabiting the locality at any one time, with few if any differences between them. Ljuljaci shows evidence for several contemporaneous households and the faunal remains indicate some differentiation between areas of the site (i.e. with boar mandibles - see below).

The sample was originally divided temporally. However, the resulting samples were temporally disproportionate and too small to adequately illustrate vertebrate exploitation at the site. In addition, certain dense concentrations of faunal remains seemed to cross-cut the temporally sub-divided strata (i.e. with swine in Sonda 12 - see below). As with the remains from Crkvina (chapter 8), they may have represented a single or closely related series of depositional episodes. As a result, it was decided to pool all the sub-samples and to analyze them as a single

unit. A total of 3,772 fragments were recovered from the site (3538 unarticulated bone fragments). The faunal sample comes from the last series of excavations at the site (1976-1977) conducted by Prof. Dr. Dragoslav Srejović of the University of Belgrade and Dr. Milenko Bogdanović of the Narodni Muzej, Kragujevac.

II. EXCAVATION AND RECOVERY STRATEGIES

Sondas 1 - 5 (Ill. 14) were excavated during 1965. Only Sonda 5 had any curated bones (n = 24). Since the excavation objectives were different than those of today, collection and curation of faunal remains were underemphasized. These bones were included in the overall analysis, since they belonged to the same temporal phase.

Sondas 6-14, which were excavated in 1976-1977, yielded most of the material. The excavated area of Sondas 6-14, excluding Sonda 10, was 304 sq. m. and the cultural layer varied between 30 and 160 cm. in depth. Sonda 10 yielded no bones because it was an old ditch used as a stratigraphic check for that part of the site. Within each sonda, bones were collected by otkopni slojovi (vertically superimposed excavation units) and internal zones. All remains were hand-collected. None of the earth was sieved,

resulting in potential under-representation of the remains of smaller animals and body parts. The smaller frequencies of the usually more numerous smaller bones at Ljuljaci points to differential recovery of bones by size. Larger bones were, generally speaking, more visible and recovered to a greater extent than smaller bones. In addition, the smaller the body size of a species (i.e. Ovis/Capra, Capreolus, Canis), the smaller the representation of small bones in the sample (mean = 6.99 for small animals as opposed to 36.92% for larger animals - Bos, Sus, Cervus, and Ursus - see table 15). This is interesting in light of the evidence for attrition. The smaller, more dense bones are usually more frequent than long bones and bone fragments in sieved assemblages. In this case, an opposite relationship is in effect, reflecting the greater influence of recovery procedures.

III. TAPHONOMIC CONSIDERATIONS

The site is located upon an exposed plateau, where post-depositional soil deposition was limited. The plateau has been deforested, inhabited, cultivated and reforested over the course of human occupation and utilization. The soil has, also, been subjected to the annual processes of freeze, thaw, saturation, and

evapotranspiration. These function to break-up and destroy bones, frequently leaving behind only the harder and more durable parts. This is reflected in the larger numbers of weathered bones and bone ends in the assemblage (see table 16). The soil probably consists of Brown Forest Soils, which is the dominant soil type in the region, and has a balanced pH level. Exposure to the elements (wind, sun, rain, water action) will leave erosional marks upon bones. These can be used to judge the degree of weathering to which the sample has been subjected. 8.78% of the assemblage showed light weathering indicating that they had been quickly covered over after disposal and not re-exposed afterwards. 11.2% showed medium to heavy weathering indicating longer periods of exposure before or after initial burial. A few (0.2%) were fresh. They showed no signs of weathering, possibly indicating recent contamination of some units. The rest appeared to have been unaffected by weathering processes. Invariably, the deeper the stratum, the better the preservation - a characteristic frequently encountered upon thinly stratified sites.

Burning can also contribute to bone disintegration. A very small percentage of the overall assemblage exhibited characteristic burn marks. 36 (0.95%) fragments were partly or completely burnt, most of which were

unidentifiable to the species level (63.9%). Cattle and pigs were the two next most abundant categories consisting of 13.9 and 11.1% respectively (table 16).

Gnawing by carnivores and omnivores is a more serious taphonomic process. Carnivcres are able to chew and break-up the hardest bones. Cmnivcres, such as pigs, are able to seriously deplete a faunal assemblage, as well. 15.3% (n = 576) of the assemblage shcwed chew marks. Distinguishing between canine and suid teeth marks on bones is difficult if not impossible. A distribution analysis of the species and bcdy parts most frequently chewed upon provides some guide in determining the nature and extent of the depletion. Unfcrtunately, it may also be the case that those which remained in the archaeological record to be found by the excavators may simply represent those parts least digestible. The softer and least represented body parts may simply have been devoured to the point of their disappearance and underrepresentaticn in the assemblage. This is very likely since erosion, weathering, etc. seem tc not have been major taphonomic factors and pH levels preclude bone disintegration.

A small percentage of the overall assemblage shows butchering marks. Most Bronze Age sites, as opposed to

earlier localities, exhibit a lcwer percentage of bones with cut or chop marks. This may have something to do with the introduction of the new technolcgy, metal, which allowed a different pattern cf carcass dismemberment and meat preparation. This, however, remains for further investigation.

IV. SPATIAL PATTERNING

Two areas of high bone concentration are visible: Zone A = Sondas 7, 7a, 7b, and 2 and Zone B = Sondas 8, 8a, 8b, 8c 12 13, and 14. Between the twc areas (Sondas 6a and 6b), there appears to be a decline in density and frequency. This may be attributable to differences in collection strategies between trench since bone densities and the stratigraphy are more or less the same on either side. To the west, the plateau drops down tc the valley. To the east and south, densities decline as the strata thin out. To the north, the plateau drops down fairly suddenly (table 14).

V. THE SPECIES

Ovis aries L., 1758 (domestic sheep) and Capra hircus L., 1758 (domestic goat)

Ovicaprines occur in very limited quantities at Ljuljaci (3.1%; n = 54 - frequency: table 17; age: table 18). This represents both recovery biases, environment, and the continuation of the trend noticed by Bökönyi (1974a; 1974b; n.d.) for both Hungary and Yugoslavia. Domestic sheep and goat, which were originally introduced to the Balkans during the early Neolithic from the southeast, undergo a decline in importance over time. Bökönyi (1974a) has suggested that this is due to their lower productive efficiency in the moister deciduous environments characteristic of temperate Europe relative to locally domesticated species (i.e. pigs and cattle). The presence of liver fluke (T. McGovern - pers. comm.) may also have inhibited their reproductive capabilities in the northern climes. A single goat horncore was found, but it was too fragmentary for a sex determination. A single sheep horn core appeared to belong to an adult male based upon its size. No hornless individuals were noticed although our sample of crania was very small. Only one fragment, an acetabulum of a sheep, was measurable. Therefore, the size variation of the population was impossible to describe. Comparative

dimensions will eventually be accumulated from contemporary neighboring localities. The age distribution of the sample is somewhat illustrative of the pattern of exploitation. The mandibular tooth eruption and wear sequence shows 7 (43.7%) immature and 9 (56.2%) mature individuals. The post-cranial epiphyseal fusion data shows that as much as 90.1% (n = 10 immature: 1 mature) of the remains came from immature specimens. The total fragment count resembled that of the mandibles (46:54 immature:mature). Erosion and differential rates of recovery would have acted against the smaller and more delicate specimens from immature individuals. Therefore, the proportion of immature individuals in the assemblage may have originally been greater. Nevertheless, it would appear that ovicaprine exploitation relied quite heavily upon mature individuals. This would indicate an emphasis on the production for meat, hides and other primary resources as well as some secondary products (e.g. milk). Further comparison with contemporary assemblages and larger sample sizes are needed before this can be fully resolved.

Bos primigenius Bojanus 1827 (Aurochs) and Bos taurus L., 1758 (domestic cattle)

As a group, Bos rank first (TNF) and fourth (MNI) in importance. This is a good illustration of the wide

discrepancy that may exist between counting procedures. Separation of aurochs and domestic cattle was possible through the series of criteria described by Bokonyi (1972b; 1974a) - size of bone, thickness of bone wall, development of muscle attachment and insertion area, etc.

Aurochs were represented by only 27 specimens (1.5% of the TNF). A large variety of body elements are present, including a fairly complete horn-core. Other than the phalanxes, all the bones are fragmented. All fall into the adult (or sub-adult/adult) age grouping. On the basis of the measurements (e.g. distal tibia - see Ill. 15), several of the cattle specimens fall clearly into the aurochs' size range. These were added to the aurochs distribution after the preliminary report was completed (Greenfield 1985a). Withers heights were determinable for only domestic specimens. The number of aurochs' bones found at Ljuljaci is unusual for a Bronze Age site. Bronze Age sites in the same region have yielded few or no bones of the species (e.g. Novačka Ćuprija, Livade, and several sites near Svetozarevo). This may be due to the retreat of the Aurochs to the more heavily forested and mountainous areas around places like Kragujevac. In the more open landscapes to the north and in the major river valleys, the aurochs would have been jeopardized by competition from herds and humans trying to protect

crops from depredation. However, their large size and the hand-collected nature of the assemblage may simply have caused the disproportionate representation at Ljuljaci. AT Petnica, which lies in a similar environmental context and whose collection techniques were more rigorous, only a single aurochs' bone was found in the Halstatt deposits.

Among domestic cattle, a different picture of exploitation emerges. They represent 21.6% of the identified assemblage, when corrected for articulations. In the total fragment count 63% of the fragments come from adults, 37% from sub-adults and juveniles and the remaining from younger categories. The age distribution based upon the bone fusion sequence (45.9:54.1% immature:mature) is and loose teeth specimens emphasize adults in the distribution, creating the dichotomy. The main thrust of cattle production appears to have been towards adult individuals who could have provided secondary products such as traction and dairy products. Meat and hides were of less importance, since the slaughter of immature individuals were not emphasized. This pattern is very different from that found at Starčevo and Vinča period settlements (e.g. Starčevo and Gomolava - Clason 1979; 1981). Withers heights were determinable for the domestic stock. Matolsci's formula (1970) was used. The cattle were similar in size to those from Gomolava

(Vinca phase - Clason 1979), but fell into the smaller size range when ccmpared to Hungarian Bronze Age material (Bokonyi 1974a: 140) - withers heights were eights based upon metacarpals (6.18 x greatest length): 111.858 cm; 103.206 cm; 119.25 cm; 108.03 cm. The predominance of adults remains is suspect since the collection was hand-collected and attrition extensive.

Sus scrofa dom. (domestic pig) and Sus scrofa fer. L., 1758 (wild swine)

The remains of both wild (21.4%; n = 379) and domestic (24.2%; n = 428) pigs are found at Ljuljaci in surprising numbers. Pigs are the most numerous animal species found on the site. It is not always a simple matter to determine whether a particular bone is from a wild or domestic form. This was accomplished by comparison with contemporary materials from other sites in the region and the presence of unambigucus material at Ljuljaci (i.e. wild boar mandibulae). Cn the basis of the measurements, there appears to be a minimal, if any, overlap between the domestic and wild size ranges (i.e. length versuss breadth cf the LM3 and breadth versus depth of the distal tibia - Ill. 16 and VI.9). Most of the measurements point to separate wild and domestic populations, with little genetic interchange between the pools. Thus, there is little support for the hypothesis

of continued local pig domestication from indigenous wild populations during the Bronze Age. Pigs prefer a deciduous forest with dense underbrush and nearby water sources. The juxtaposition of dissected stream valleys and wooded mountainsides around Ljuljaci would have been an optimal environment. In fact, some of the wild boars are among the largest recorded for this region. Estimates of withers heights, using Teichert's (1969) formula have yielded the following figures from astragali (17.9 x greatest length) and calcaneii (9.34 x greatest length) (in centimeters): 114.92, 96.30, 87.35, 99.88, 101.31, 96.66, 96.30, 89.14, 76.07, 98.45, 90.78, 94.80, 102.65, 89.29, 111.33, 100.78, and 101.53 cm. Even though pig bones are not highly desired as raw materials for bone tools because of their twisted bone structure, tusks are frequently used as ornaments on many sites. However, none of the modified pieces of bone found at Ljuljaci were identified as pig. Both the long bone epiphyseal fusion data and the mandibulae/maxillae tooth eruption and wear patterns indicate that the vast majority of wild pig bones were from adult individuals (92.4%). Mostly older males with large tusks were selected. Some female specimens, based upon measurements and the open root of the tusks, were also found. Meat and hides were probably the most important by-products utilized. Hunting of wild pigs as trophies and for

their meat and skins is still widely practiced in the Balkans.

A very interesting concentration of boar remains occured in Sonda 12, otkop sloj 2-7. 29 mandibles of old wild males were clustered around a single structure. Only a small quantity of bones from other suids, both domestic and wild, were found in the same units. This part of the body was largely limited to this area of the site. The dearth of female wild mandibles from this site may provide support for the idea of a periodic "ritual" slaughter of wild males, such as one finds in the ethnographic and historical record (Rappaport 1967; Homer - Odyssey). However, since this is an isolated case in the faunal record, little strength can be attached to such statements. When the site is compared to the dearth of comparable deposits in other neighboring and contemporary localities, this deposit stands out even more. Other reasons for such a deposit may have included attempts to limit genetic contamination or disruption of domestic herds and crops by the removal of wild males in the neighborhood. Idiosyncratic behavior, such as the collection of trophies by elites, may also be considered since all the mandibles were broken in the same way (behind the canine or PM1), are of approximately the same age and size, and are not associated with many other possibly articulating elements. This deposit was also responsible for the decision to

analyze the faunal sample frcm the site as a single unit, rather than tc divide it up. This sonda was frequently used as an example of the tri-partite stratigraphy found at the site (Bogdanović - pers. comm.). Either, the same activity was ccnducted in the same location at the site over its entire lifespan, the excavaticn units cross-cut natural deposits, thereby mixing material from different levels or the deposits were disturbed and mixed tcgether.

Domestic pigs compete with the wild fcrm for numerical dominance in the assemblage. However, the age and sex distribution are quite different. 61.8% of the domestic remains belonged tc immature individuals and equal numbers of both sexes were identified. Pig production was geared toward meat prcduction and individuals were culled from the herd in nearly equal numbers during each age class. The emphasis was quite different when compared to wild pig exploitation. This is in contradiction to the tooth eruption and wear sequence which shows many more older (66.6%) individuals. The majority were killed soon after the attainment of adulthood (eruptiсn and early phases of wear upon Molar 3). The difference is due to the greater number of immature specimens among the post-cranial remains. This, in ccmbination with the evidence for attrition (i.e. larger percentage of chewed and weathered remains), implies

that even greater numbers of immature specimens would have originally been present. Alsc, more or less equal numbers of males and females were identified in the assemblage in strong contrast tc the wild pig pattern. Obviously, a small fertile pcpulation of domestic individuals was kept to maintain the herd and to replace slaughtered individuals. This is a pattern common to the region even tcdy. Lccal villagers slaughter a substantial proportion of immature animals during the autumn and winter to reduce the costs of animal feed over the winter. This alsc implies that mandibles have been differentially discarded relative to pcst-cranial remains. They are a more durable grcup of elements and more likely to survive exposure than pcst-cranial elements. A similar situation probably existed among the cattle remains explaining a similar discrepancy between mandibular and post-cranial age distributions. Unfortunately, the disposal site for cattle and domestic pig mandibulae were not found, in contrast to that of the boars.

Canis familiaris L., 1758 (domestic dog)

Domestic dogs are found on virtually every archaeological site in the region from the Mesolithic through the present (Bökönyi 1974b; 1978a; Clason 1980). They are rarely very common (except at Vlasac - Bökönyi

1978a). At Ljuljaci, only 28 fragments were identified as domestic dog (1.6% TNF). On the basis of the measurements (e.g. length versus breadth of the carnassial and length of the molar row - Ill. 18), two body sizes may be distinguished - a medium (or late domestic) variety and a small (or turbary or early domestic) variety (cf. Bökönyi 1974a: 317-318). Most of the specimens were from mature individuals (90.5%). One partial skull and two maxillae with parts of the skull were found, mostly of medium-sized individuals. Dogs may have occasionally been eaten, since almost all the bones were broken and at least one fragment burnt. Clason (1980) noticed carving and gnawing marks on several canine bones from Padina, but at Ljuljaci this was not the case. The high frequency of gnaw marks on bones from other species at Ljuljaci would indicate that dogs and possibly pigs were important on-site scavengers of refuse. It is very likely that a substantial proportion of the original bone assemblage was destroyed by them.

Equus caballus L., 1758 (domestic horse)

The horse was initially domesticated on the steppes of southern Russia and spread to Central and Southeastern Europe at the beginning of the Bronze Age. Horse bones are frequently found in small numbers on earlier sites, but they are usually from wild individuals. The horse is the only

new domestic species to appear at this time. It represented a new feature on the domestic landscape and helped to revolutionize society by making communication, transportation, and warfare more efficient. Ljuljaci is one of the earliest sites in the central Balkans where domestic horses appear frequently (6.5%; n = 116). Few of the bones were measurable, but they appear to be of small stature and fall into the smaller end of the eastern European size range (cf. Bokony 1974a). They were Their remains were not necessarily venerated and buried, since most of the bones were broken-up and scattered around the site like the other meat animals, one fragment was burnt and several fragments were gnawed by dogs or pigs. Most of the specimens belonged to adults (81.5%) and according to the tooth eruption and wear sample, all of the adults except one young adult came from older individuals. Their major role would have been for transportation and traction, since such an age distribution would have been unlikely if they were being raised as a food resource. The appearance of wheeled vehicles in the archaeological record at this time lends credence to this hypothesis (cf. Sherratt 1980b).

Cervus elaphus L., 1758 (red deer)

Red Deer are the second most important wild species present at Ljuljaci but fourth overall (15.9%; n = 282). The age distribution is heavily biased toward adults (84%),

typical of hunters who aim for the largest individuals with the most yield. The high frequency of antler tools (over 75% of the antler fragments) illustrates the continued use in the Bronze Age for bone tools. The measurements show that body sizes were probably similar to those individuals found at Gomolava and Obre (Clason 1979; Bökönyi 1974b). Two shed antler bases of red deer were recovered. Neither appear to have been worked, although both were broken. Analysis of the cranial and antler remains revealed that none of the antlers were found attached to cranial remains. This implies negative evidence for winter occupation, but possible late spring/early autumn collection of shed antler, since shed antler are frequently consumed by the various forest fauna soon after they have been dropped by the deer.

Capreolus capreolus L., 1758 (roe deer)

As on most other sites in the area during any of the prehistoric time periods, roe deer are minimally represented (1.0%; n = 18). Their low importance in the assemblages may be a function of their position on the resource selection scale, due to small size, low density in such environments, and/or recovery bias against the smaller species. Most of the fragments are from adults (91.7%) indicating a selectivity by the hunters for larger

prey with by-products such as meat, hides, and antler. The roe deer lives in a wide variety of environments, but prefers woodlands with underbrush. Areas of secondary growth are frequently preferred. One antler was found still attached to its cranium indicating a late spring/early autumn kill.

Ursus arctos L., 1758 (brown bear)

A small number of bones belonging to Brown Bear were found during the excavations (1.2%; n = 22). No particular patterning in the remains were noticed that would indicate their association with a specialized activity, such as for rugs, ritual, clothing, etc. They were probably hunted for both food and clothing, since at least one fragment was burned. Most of the bones were from adults (84.6%), with the remaining from sub-adults. Bears will live in both highland and lowland forests. A canine was perforated as an ornament.

Lepus capensis L., 1758 (hare)

Two femur bones of possibly the same individual, a sub-adult, were found. They came from the same sonda, but from different sloj. They were counted only once (0.06%). The deciduous forests surrounding Ljuljaci, interspersed with cleared areas would have been a favorable habitat for hare,

leading one to expect that its exploitation might have been greater. Recovery biases or cultural preferences could have easily resulted in the above picture.

Castor fiber L., 1758 (beaver)

Beaver remains are limited to 3 fragments (0.2%): an ulna, radius and femur from one sub-adult and two sub-adults/adults specimens, respectively. Beaver would have thrived locally along the rivers and stream. Its low density at the site is probably a function of recovery, as with hare. But, it should be noted that among both the sieved and unsieved collections neither have been found in substantial quantities.

Meles meles L., 1758 (badger)

Six badger mandibles were collected (0.3% - TNF). All were from adults and may be fragments from 3-4 individuals. Badgers may have thrived in the surrounding environment, but the low quantity of remains makes it difficult to evaluate their role, if any, in the local economy.

Unio sp. (mussel)

1 fragment of a mussel was identified.

VI. CONCLUSIONS

Ljuljaci is one of the few sites from the Bronze Age where substantial architectural remains have survived and a large animal bone assemblage collected. The presence of substantial architecture implicitly argues for settlement permanence. But the animal bones yield direct evidence only for late spring/early autumn occupation - the presence of shed red deer antler and attached roe deer antler. The shed antler were probably gathered quite soon after they had been shed (in the springtime - cf. Clutton-Brock et al 1982). Otherwise, they would have been quickly consumed by the red deer themselves. The attached roe deer antler could have been from individuals hunted at any time between the late spring and early autumn, during which roe deer carry a full rack. The absence of attached red deer antler could be used as negative evidence for late fall/early spring occupation. But negative evidence may simply be a function of sampling design and a host of other processes unrelated to prehistoric behavior.

CHAPTER 7: THE VERTEBRATE REMAINS FROM BRONZE AGE LIVADE

I. INTRODUCTION

Livade (Ill. 4 and 19) is a Bronze Age locality situated on the right bank of the Danube near the modern village of Mala Vrbica in northeastern Serbia. Mala Vrbica is approximately 20 kilometers down river from the urban center of Kladovo, on the eastern side of the Iron Gates. It is the only site in the sample to be located on the eastern side of the mountains of eastern Serbia. It lies outside the geographical "core" area under examination in this research. However, it retains strong ceramic and other artifactual (or "cultural" - cf. Childe 1925) affinities with the ceramic groups within the core area. As such, it represents an important control sample for this study. If the sequence of events identified for the more central region of the Central Balkans were idiosyncratic or restricted to that area, we would not expect Livade to necessarily exhibit a similar situation.

It has been estimated that approximately half of the original prehistoric site has been eroded and washed away by the Danube (Vukmanovic 1982). A great deal of erosion of the Yugoslavian shore and its associated archaeological remains has occurred since it lies on the inner side of a great bend in the Danube. Once the Danube leaves the restricted channel of the Iron Gates, it quickly broadens and after a short distance changes from a eastern to a southern direction of flow. After Negotin, it again shifts to an eastern direction. Some of the erosion has taken place very quickly. For example, the contemporaneous Bronze Age necropolis of Glaminje, found near Korbovo (Krstic 1971), has virtually disappeared within the past two decades.

Livade was excavated during three one month field seasons (1980-1982), as part of the Djerdap II rescue operation. This multi-institutional operation was developed in response to the building of a second hydro-electric dam on the Danube near Negotin. The waters of the river would eventually back up and flood the shoreline and all low lying environments. As a result, the entire area to be flooded (between Karatas and Negotin on the Danube) was surveyed for potential archaeological sites or monuments. Livade has been known since the turn of this century (Vasic 1907). It was revisited during a survey of Early Iron Age localities conducted by Vasic (1977), but

never systematically examined. Its threatened destruction precipitated the current excavations at the site. The excavations were directed by Mira Vukmanović, Narodni Muzej, Belgrade and Petar Popović, Institute of Archaeology, Belgrade. During 1980 and 1981, the prehistoric section of the site was examined. In 1982, the Roman section was the focus of the excavations. The faunal materials to be discussed in this chapter are derived from the prehistoric Bronze Age part of the site (Vukmanović and Popović 1985).

The ceramic assemblage and associated artifacts (i.e. figurines) found at Livade mostly belong to the Dubovac-Žuto Brdo ceramic horizon. Elements revealing affiliation with theon with the Verbicioara ceramic group across the river in Romanian Oltenia are also pronounced (Vukmanović 1982). Vasić (1977) dates part of this ceramic group as transitional to the Early Iron Age. However, this is not the place to deal with this question of interpretation. Chronologically, the Dubovac-Žuto Brdo horizon falls within the Middle-Late Bronze Ages of the central Balkans (Reinecke - Br A2/B1 to D - ca. 1600-1200 b.c. uncorrected radiocarbon - Brukner, Jovanović and Tasić 1974: 460; Garašanin 1972; 1973; 1983: 165).

This ceramic group has been known since 1910, when M. Vasić (1907; 1910; 1911 - see full bibliographic references in Brukner, Jovanović, and Tasić 1974) carried out excavations at the type locality of Žuto Brdo in the village of Vinci on the Danube near Golubac, on the west side of the Iron Gates. Žuto Brdo refers to a light sandy section of the river bank, rather than a definite and discrete archaeological locality (Bankoff 1974). Dubovac, the second type site, lies near Kovin in the Banat and was examined somewhat later. The most definitive works on this ceramic group were carried out by D. Krstić (1971) at Glaminje near Korbovo (a few kilometers upriver from Livade) and V. Dumitrescu at Cirna (Dumitrescu 1983; Garašanin 1973: 627). Sites of this ceramic horizon are mostly found along the Danube from the confluence of the Sava and Danube near Belgrade in the west through the provinces bordering on the Danube (i.e. Banat, Serbia and Oltenia into northwestern Bulgaria in the region of Vidin in the east). It does not extend very far from the Danube, except in the region of the Lower Morava where it has been found in sites near Smederevska Palanka (Bankoff and Winter 1982; Garašanin 1983). It is a regional variant of the larger ceramic horizon known as the "incrusted wares". They are characterized by incised ornamentation and decoration filled with a white

paste. The related incrusted ware distributions include the regions of Srem and Backa in the south and western section of the Vojvodina (Brukner, Jovanović and Tasić 1974: 460). The Dubovac-Zuto Brdo group is a local variant of this larger ceramic horizon. Three geographical and chronological variants of the incrusted ware horizon have been tentatively distinguished. Western, central and eastern variants are visible. Dubovac-Zuto Brdo materials are limited to the Central and Eastern sectors (see map in Letica 1973: 50-51). The chronological phases are only typologically dated. Nowhere have they been substantiated stratigraphically. Internal chronological distinctions have frequently foundered upon the necessity of relying upon geographical distributions, intrusive deposits, typology, etc. The western sphere is considered earliest. In the second phase, all three regions are occupied. In the third and final phase, only the central and eastern regions show this ceramic form (Brukner, Jovanović and Tasić 1974: 460; Garasanin 1973: 628; Letica 1973: 50-51). Livade would have fallen into the eastern variant and been occupied during the second and third phases of the development of this horizon (Late Bronze Age). The origins of the Dubovac-Žuto Brdo group are unclear. Some relationship with the slightly earlier phases of the Vatin culture can be traced through certain

ceramic elements and commonalities in mortuary pattern. The localities of each are sometimes only a few kilometers apart. During the Middle Bronze Age, they appear to overlap somewhat in time (Garašanin 1972: 38; 1983). The Dubovac-Žuto Brdo group began in the last phases of the Early Bronze Age (Garašanin 1983). The differences between the two groups may be ecological, as well as temporal. The Vatin and Verbicioara groups occupy environments in the upper tributaries of the Danube, while the Dubovac-Žuto Brdo are limited to the alluvial ground around the Danube and Lower Morava. It therefore represents a local Danube valley ceramic variant and is only one of the many Middle and Late Bronze Age ceramic groups that derive from the Early Bronze Age Glina-Schneckenberg ceramic horizon (Bankoff 1974; pers. comm. - 1984). Local versions of the Verbicioara group continue to evolve in Oltenia (Brukner, Jovanović and Tasić 1974: 459; Dumitrescu 1983; Garašanin 1973: 628). The Dubovac-Žuto Brdo groups eventually evolved into the ceramic groups that appear during the transition phase to the Early Iron Age. Certain ceramic and mortuary elements have been traced to the later period supporting an argument for the continual evolution of local cultures in the region. It mixes, eventually, with Bassarabi (Early Iron Age) stylistic elements in the Romanian Banat, Oltenia and along

the Serbian Danube (Brukner, Jovancvić and Tasić 1974; Garašanin 1983; Vasić 1977). Vatin, in contrast, is swamped by the influx of Late Bronze Age fluted wares (Halstatt A - Reinecke). Stylistically, Vatin disappears after the end of the Middle Bronze Age (Bankoff 1974; Garašanin 1972: 38-39; 1973; 1983). Livade is considered, here, to be a Late Bronze Age (Dubovac-Zuto Brdo group) site. The absence of Early Iron Age (Bassarabi-style) elements at the site allow its placement in the period immediately preceding the appearance of the Bassarabi ceramic and decoration style. The eastern region in which Livade is located was not affected by this latter style horizon until the end of the Late Bronze Age.

This ceramic complex, as are most from the Bronze Age, is known chiefly from cemeteries. Mortuary behavior among the incrusted ware groups is relatively uniform. The dead were buried in cemeteries, containing from several dozen to several hundred individual burials. Single burials were the most frequent form. The cemeteries were often utilized over an extended period of time (a few hundred years) and were separated from residential or other activity loci (i.e. Glaminje - Krstić 1971). Individuals were cremated, and the bones and ashes deposited in large ceramic urns. The urns, in turn, were covered with a lid or bowl. Offerings of small

dishes, food (i.e. animal bones) or figurines were frequently placed with the urn. Metal was an infrequent offering. This pattern of disposal of the dead eventually spread over much of Central Europe during the Late Bronze Age replacing previous customs of inhumation (Childe 1929; Garašanin 1983: 177; Coles and Harding 1979; Brukner, Jovanović and Tasić 1974: 476; Krstić 1971). Our knowledge of settlements and other activity loci is quite limited. Most sites are located along the terraces of the Danube. None of the sites have yielded clearly differentiated and stratigraphically superimposed layers of occupation. They are usually composed of a single "cultural" stratum of varying thicknesses. Rarely have any structures been uncovered. Four sided structures were found at Dubovac and Zuto-Brdo (Garašanin 1973: 628). One of the most important outcomes of the excavations at Livade was the discovery of an residential locality which yielded discrete features (i.e. pits), which were systematically excavated.

II. STRATIGRAPHY

The stratigraphy of Livade has been recently analyzed by Vukmanovic´ and Popovic´ (1985). The section below is a summary of their analysis (table 19). A thick sandy overburden covered the site (1.10-1.30 m thick). This light yellow layer was culturally sterile. Beneath it lay a dark sandy clayey soil (1.0-1.4 m thick) containing artifacts and features. Beneath this layer lay the light sandy and clayey sub-soil. Frequently, pits were cut into this latter horizon from the cultural horizon up to a depth of 1.6 m beneath the sandy overburden. In the cultural horizon, three cultural-chronological divisions could be discerned: A. Verbicioara III; B. Dubovac-Žuto Brdo; and C. Gava. Each will be discussed in turn, signifying their importance to the forthcoming analysis of the bone remains.

The Verbicioara III horizon is the earliest on the site. Remains from this ceramic group, which falls into the Developed Bronze Age (Reinecke - Br C; 1500-1300 b.c. uncorrected). Most of the ceramics attributable to this group were found in the 5th, 4th and lower part of the 3rd otkop slcj. The layer was approximately 1/2 m thick and largely consisted of disturbed and mixed deposits. No "in situ" features were preserved. Ceramics from later Bronze Age and transitional horizons were found mixed among those from this horizon.

The Dubovac-Žuto Brdc horizon ccvers most of the site in a relatively horizontal layer. It was found over the entire excavated area and included all of the pits (with one exception), all of the features, and the middle layers of sloj. sloj included the upper half of the 3rd and the lower half of the 2nd otkop sloj. It was approximately 30 cm. thick. The ceramics found within these depcsits belong to the Dubovac-Žuto Brdo-Girla Mare group, with affinities to the Verbicioara IV group, a distinctive variant of the larger Pannonian incrusted wares tradition of the Late Bronze Age (Reineck - Br D-Ha A1; 1300-1100 b.c. uncorrected). All of the sloj deposits were found mixed with earlier and later Bronze Age materials. Only the features and pits retained their depositional integrity. The features and pits cculd be divided into three groups: 1. small or large concentrations cf hcuse daub, parts of floors, and unbaked wall daub. They ranged in size between 1.0 to 2.0 sq. m. and in thickness from 0.1 to 0.4 cm. Beneath these were frequently found shallow or deep pits full of ash, soot, small pieces of daub and fewer numbers of ceramic fragments (e.g. feature 1 in sonda 2 and features in sonda 1 and 6). These features were scmetimes difficulty to separate from the surrounding sloj. 2. This group of features consists of 16 pits, whose dimensions vary from 1.0 to 4.0 m (diameter). In some cases, the upper layer was

filled with baked pieces of daub and some unbaked wall and floor daub fragments (e.g. koncentracije u EI kod tacke E2). In the lcwer levels, they are filled with typical pit materials - fragments of ceramics, bones (frequently burnt), ash, soot, burnt pieces of wood, burnt earth, daub, and small, rounded pebbles. The upper layers were frequently difficulty to separate from the surrounding layers. In most of these pits (Sonda 5, pits 2 and 3; Sonda 2, pit 1; Sonda 4, pit 2; Sonda 9, pit 1), a less compact layer separated the upper and lower levels. Greater numbers of ceramic fragments were found within the upper levels. 3. This last group is, in some ways, the most intriguing (Sonda 5, pit 1; Sonda 11, pit 1). These are considered by the excavators to have been "zemunice" or pit-houses. They contained ceramics, daub, ash, animal bones and shell fragments. The botton surfaces were relatively flat across the entire pit (Sonda 11, pit 1) or in the center (Sonda 5, pit 1). Large concentrations of decaying daub were found in the center of the latter and in the northern half of the former. They were larger than most of the other pits, ranging in size from 2.8x1.6 (Sonda 5, pit 1) to 5.0x3.5 m. (Sonda 11, pit 1).

The upper-most horizon (upper part of the 2nd otkop sloj and the first otkop sloj) belongs to the Gava group (Reinecke Ha A1-A2; 1100 - 1000 b.c. uncorrected; M.

Garašanin - Iron I). This group is considered by many to be a transitional development between the end of the Bronze and beginning of the Iron Age. The horizon was about 30 cm. thick and contained a great deal of earlier Bronze Age materials, as well. A single feature, pit 1 in Sonda 12, was found on the periphary of the Verbicioara III and Dubovac-Žuto Brdo settlement layers. It was relatively undisturbed, but contained little faunal materials (n = 12).

In this analysis, the material will be separated according to type of deposits (sloj, feature, or pit) and time period (Dubovac-Žuto Brdc, Gava) in an attempt to control for different analytical results that may arise from lumping the remains from different contexts and for chronological change in the assemblage. The Verbicioara, Dubovac-Žuto Brdo and Gava sloj will be discussed as a single unit since the respective sloj were well mixed with other materials from each of the cultural-chronological complexes. Only a general discussion of Bronze Age faunal remains could be gleaned from this data. The pits and features provide our only temporally limited data set. Unfortunately, the pits and features contained little faunal remains. The data from the sloj, which are much more numerous, will be used to supplement and augment the contextual data.

III. EXCAVATION AND RECOVERY PROCEDURES

The topmost layer of sediment at the site was pushed by a bull dozer into the Danube. This was a thick and sterile layer of sandy overburden. The depth at which the cultural layer began was clearly visible in the profile cut by the river. The thickness of the overburden varied somewhat across the locality. As a result, the depth of the bull dozing had to be adjusted. After the sterile overburden was removed, a long rectangular trench was laid out and excavated in the center of the larger bull dozed depression. Each trench was excavated in 10 cm. thick levels extending over the length of the trench. All artifacts found within each level were collected, bagged and analyzed separately. If a feature or artifact concentration were encountered (i.e. pit), it was recorded, excavated, collected and analyzed separately from the surrounding deposits. Pits and other features were recovered as single units. All excavation and collection of artifacts at the site were carried out utilizing traditional tools (such as shovel and hoe) and methods (such as hand collection of the artifacts visible in the loosened soil).

Sand was present in nearly every deposit at the site. It was mixed in greater or less quantities with the other

soil matrices. Virtually all the bone, except those from the pits excavated during 1980, showed marked weathering of their outer surface. The persistence at the site of river sand throughout the non-discrete deposits (i.e. sloj horizons containing cultural material) probably indicates the extent to which the river overflowed its banks and flooded the site. This annual affair caused severe dislocation to the material discarded over the site. It also allows us to conclude that the pits along the river's edge, which were probably dug as borrow pits for the construction of wattle and daub structures, were probably filled-in quickly relative to those further away (i.e. in the area excavated during 1981). This would have enhanced the probability of survival of the material in these pits relative to those strewn outside. The depositional context and the recovery procedures would lead one to expect that a substantial proportion of the original bone assemblage was either destroyed in the soil or not collected during excavation. Other taphonomic processes could have further compounded these easily recognizable processes (see chapter 3). Three types of depositional contexts can be differentiated at Livade - pits and an amorphous cultural horizon. The types, volumes and degree of preservation differed in each. This

is a situation commonly found on other Bronze Age sites (i.e. Novačka Ćuprija, Vinča). As a result, the three types of deposits will have tc be first analyzed separately and then combined for the final analysis.

The temporal-ccntextual distribution of remains (table 20) is quite uneven. Only twelve fragments of bone and shell were found in the Gava pit. 200 bone and shell fragments were found in the Dubovac-Žuto Brdo pits and features. The vast bulk of materials from Livade came from the sloj. These will be the basic analytical units, since our analytical strategy is to ccntrol for contextual and temporal variability. Unfortunately, little of the Livade material can be securely dated to a limited time span. The material from the sloj will be used for comparison and to augment the higher integrity data.

IV. THE SPECIES

The full range of domesticated and wild species found on prehistoric sites in the regicn was present at Livade (frequency: table 20; age: table 22). Each will be discussed in turn.

Ovis aries L., 1758 and Capra hircus L., 1758

Domestic sheep and goat are rarely found in great numbers on Bronze Age sites from the Central Balkans. At Livade, such is the case. Only 132 (12.8%) whole and fragmented bones (plus a few articulations) were identified in the assemblage. Most of the ovicaprine specimens could not be positively identified to either sheep or goat (n = 105), and were coded as sheep/goat. 24 specimens were positively identified as sheep and 4 as goat. They were scattered throughout the various pits, features and otkopni slojovi. The vast majority were, however, found in the sloj deposits (n = 118; 86.1% of the cvicaprine sample - 22 sheep <91.6% of the sheepmore than; 4 goat <100.0%>; and 92 sheep/goat <87.6% of the sheep/gcat>). 2 sheep and 11 sheep/goat bones were found in Dubovac-Žuto Brdo pits, while 2 fragments of sheep/goat came from the Gava pit. Only 2 sheep/goat bones were recovered from Dubovac-Žuto Brdo features.

The distribution of ovicaprine body parts is very unbalanced (table 21). Several variables could have contributed to the obvicus assemblage attrition - recovery procedures, differential destruction by bone density, prehistoric refuse dispcsal, etc. The effect of differential selection cf bone elements for recovery when hand-collection methods are employed is quite well-known. The relative frequency of small bones (including the calcaneus, is much smaller than would be expected if all

bones in the skeleton were present. In an artiodactyl, about 25% of the skeletal elements belong to this class (table 2, chap. 3). However, only 5.5% (n = 4) of the elements in table 21 fall into this group. Small bones are difficult to spot in unsieved soil. Recovery techniques that employ hand-collection will inadvertently skew the sample toward the larger and more obvious bones. In this way, species with small bones will be underrepresented relative to those with larger-sized bones (e.g. sheep versus cattle).

Another source of bias is differential destruction of body parts by bone density (table 23). A variety of forces can cause this to occur - erosion, gnawing, butchering, cooking, etc. Evidence for weathering of the assemblage is extensive. Most of it comes from the ctkopni slojovi. None of the bones from features or pits showed erosion or destruction of the outer bone surface. Among the bones from the sloj, 25.5% (n = 34) showed signs of bone surface destruction. Almost every major body part was affected. 16 fragments belonged to bone ends, while the rest were parts of long bone shafts. Destruction by weathering was pervasive, as would be expected from the sandy soil condition at the site. The relative frequency of mandibles (n = 16; 12.0% of the identified ovicaprine body parts) can be used to illustrated the combined effect of both bone

density/durability with recovery prccedures (table 21). Mandibles are one of the densest and mcst durable parts of the body. At the same time, they are very large, visible and easily identifiable as a bone. As sucn, it survives erosional and other destructive forces quite well and is more frequently cclllected than many other less obvious bone elements. If complete sets of skeletons were present, mandibles would represent only about 1% of the data. At Livade, they are much mcre commcn.

Bone destruction by gnawing or chewing actions can be extensive. Dogs are the primary scurce, although destruction by omnivores (e.g. pigs) or herbivores (e.g. deer) shculd also be taken into consideration. Unfortunately, little comparative research has been undertaken to distinguish among these possibilities. As a result, the chew marks will be assumed to have come from canids. Rodent chew marks stand out clearly and are completely absent. 19 fragments of bone (14.3% of the total assemblage) were chewed (table 23). Of these, most came from the otkopni slojovi (n = 15; 12.7% of bones in the sloj), 2 were from the Dubovac-Žutc Brdo pits (15.4% of the pit bones), and 2 from the features (100.0% of bones in features). Among the chewed bones from the sloj, 9 were shaft fragments, 6 were early fusing and 1 was a small, dense bone. The chewed bones from the features were both

early fusing. From the pits, both were shaft fragments (table 21). The softer the bone or bone end, the less likely it was to show evidence of chewing. In this sample, none of the less dense (late fusing, pelvic, vertebral, etc.) bones showed evidence of chewing. It would seem that any bone "thrown to the dogs" would have lost their diagnostic ends, been digested completely, or disappeared through erosion leaving little trace of its presence. The harder, more dense parts would be more likely to have survived these destructive forces. The end result would be a skewing of the sample through underrepresentation of the late fusing and less dense elements. This will cause problems in the later analysis of age distributions by de-emphasizing age-specific age classes (e.g. adult, sub-adult, juvenile) in favor of the intermediate classes, such as sub-adult/adult. 6 of the bones showed signs of both weathering and chewing. May more may have been chewed, but extensive bone surface destruction by erosion would have destroyed any obvious traces.

Burning of bone also contributes to assemblage destruction. It allows the constituent molecules to unlock, causing the bone to break up more rapidly. Only 3 ovicaprine bones were burnt. All were found in the otkopni slojovi and were hindlimbs (femur) or cannon bones (table 23). They were calcined and/or carbonized. None showed any further signs of modification. Only a single fragment was

butchered - a sheep/goat ischium and pubis. It came from a Dubovac-Žuto Brdo pit deposit and was chopped perpendicular to its long axis. None of the Gava pit material showed signs of weathering, chewing, burning or butchering.

Domestic sheep are much more common than goats - 23:4 (5.75:1 ratio). This is a common situation in prehistoric faunal assemblages from the region. Most of the sheep bones were found in the sloj (n =21), while the balance were found in the Dubovac-Zuto Brdo pits (n = 2). Most of the fragments belonged to the post-cranial group. A single horn core fragment (sub-adult) and mandible (adult) were the only cranial elements. Both were found in the sloj. The mandible and 3 post-cranial elements (sub-adult/adult) were weathered. Two of the post-cranial elements - a distal scapula and proximal metacarpal (both sub-adult/adult) were chewed. Fused to one of the radii were parts of an ulna. Most of the sheep remains were immature (62.5%). Juveniles (and infants?) comprise the bulk of these. The remainder were sub-adults. Adults stand out as the largest single cluster, expressing the function of attritional variables discussed earlier which would have preferentially selected for the more durable adult specimens (i.e. mandibles, which are very dense, age-specific and very common). A single metacarpal was partially carbonized and found in a sloj deposit.

Only 4 fragments of bone were identified as domestic goat - 2 proximal radii (sub-adult/adult), a distal metacarpal (adult), and a calcaneus (sub-adult). All were from the sloj. One radius and the calcaneus were weathered. The calcaneus was also partially destroyed by canid chewing. The distal metacarpal had been carbonized.

106 fragments were identified as indeterminate sheep/goat. Due to the extreme morphological similarity between the species, it is frequently difficult to distinguish one from the other (cf. Boesseneck 1969; Boesseneck, Jecquier and Stampfli 1963). A wide variety of body parts were identified to this group, including many of species specific elements that had been reduced to a fragmentary state. Some were from very young individuals. Both conditions makes final species determination even more difficult, since many of the most diagnostic criteria are located on fragile bone ends and/or are visible only after developmental maturity or bone fusion has occurred.

Reconstructing the age distribution is an intriguing exercise under these conditions. For example, if each major body part (table 22) is used separately to calculate harvest profiles, clear-cut patterns do not emerge in the data. Different columns yield different sclutions. In the post-cranial sample, there are no clear-cut adults. This stands

in strong contrast to the mandibles, which are mostly from adults. It can be assumed that immature individuals would be underrepresented among the post-cranial remains due to erosion, chewing and the other attritional processes discussed earlier. If this is the case, what happened to the post-cranial adult bones that would have matched to the mandibles? Inequities in spatial distribution are unlikely to completely answer this question, since a wide area of the site was excavated. Mandibles were not discarded in one place, while their corresponding limb bones were discarded elsewhere. Mandibles are among the most dense parts of the body. They preserve well even under poor soil conditions, are less apt to be chewed by canids. Yet, only two of the mandibles were from immature individuals. Among the adults, 2 were from young adults and 7 from middle-aged individuals. No senile specimens were encountered. There are two realistic implications from this data. One, that bone ends that fuse late and would be most indicative of an adult age class are as susceptible to attrition as immature bones. The second, is that even the mandibles of immature individuals were susceptible to the forces of attrition. It is true that they are relatively denser than other parts of the body, but not completely so until adulthood is reached. As a result, if only a single column is used in table 22 (i.e. mandibles), one or more age groups may be underrepresented. Data on the different age groups are

selectively preserved in different columns. To achieve the possibility of a more balanced age distribution reconstruction where each group is represented, at least, minimally, all must be combined. The combined age group distribution for sheep, goat and sheep/goat shows that 31.4% were killed before they were a year old, 32.8% between 1 and 3 years (sub-adult) and 35.8% as adults. Among the Gava pit fragments, the sheep/goat bones could only be assigned to an indeterminate age class (sub-adult/adult). Among the Dubovac-Zuto Brdo pits and features, the vast majority were immature (87.5%). Sub-adults comprise the largest sub-grouping (62.5%). All, except two mandibles, were post-cranial elements. They included 2 sheep and 11 sheep/goat specimens. If we shift our discussion to the sloj materials, it is possible to observe a basically different pattern. All of the goat fragments, 95.6% (n = 22) of the sheep and 87.6% (n = 92) of the sheep/goat fragments were found in the sloj. This much larger body of data reveals a different and more detailed body of data. Firstly, the immature:mature ratio is much lower than in the Dubovac-Zuto Brdo deposits (61.4:38.6%). Larger numbers of adults are present due to the preponderance of mandibles and loose teeth and the evidence for extensive attrition in the sloj. The increased presence of infants and juveniles may be a simple function of sample size. The larger the sample, the

greater the probability that they would remain a visible component. In smaller samples, their presence can vary unpredictably. Most of the evidence in the pits, features and sloj indicate that ovicaprines were exploited primarily for meat. The majority survived until sub-adulthood, while a smaller fraction were retained for breeding purposes. Milking may have occurred in this context, but the large number of very young remains needed to substantiate such a proposition are lacking. It may have been present but masked by the substantial assemblage attrition.

Bos primigenius Boj., 1827

Two aurochs' bones were found in the sloj - a proximal femur and a complete calcaneus (both adult). They were distinguished from the domestic form based upon their overall greater size and pronounced muscle attachment and insertion areas. Both had been weathered. The calcaneus had been chopped parallel to the long axis of the bone. They represent an insignificant part of the assemblage (0.2%) as expected from their continual decline in frequency through the Neolithic and Bronze Age. Often they continue to survive as a relict species, deep in the forests far from human predators, until their final extinction in the 17th century forests of Poland (cf. Bökönyi 1974a). For most of this time, they were hunted for their meat and hide,

although horns were frequently prized as trophies of the hunt.

Bos taurus L., 1758

Domestic cattle are the most common vertebrate mammal found at Livade. A total of 353 unarticulated fragments and whole bones were identified, plus several articulated elements. The distribution of cattle elements is heavily biased toward the Bronze Age sloj (n = 323; 91.5% of cattle bones). The Dubovac-Žuto Brdo pits (n = 24; 6.8%), Gava pits (n = 3; 0.8%) and Dubovac-Žuto Brdo features (n = 3; 0.8%) comprise the rest. The measurements of various bones and bone ends reveals that the Livade material was roughly similar in size to that from the Bronze Age sites of Ljuljaci and Sarina Medja (e.g. length vs. breadth of LM3, breadth vs. depth of proximal metacarpal - Ill. 20 and 21). Only a single LM3 stood significantly larger than the rest. The possibility of a small aurochs remains open in this case.

Evidence for attrition and selective recovery are visible in the data. The question of attrition will be addressed first. The proportions of the early fusing, late fusing and small, hard elements are roughly similar from sloj to pit to feature (table 21). Some types of elements are found in much greater quantities in one context (i.e. mandibles,

crania, maxilla, pelvic and vertebral elements in the sloj). This may be a function of sample size variance, but may also indicate that the pits were not used simply for refuse disposal. In other contemporary localities (e.g. Novačka Ćuprija, Sarina Medja), pits with high densities of faunal remains more obviously functioned as waste disposal areas. The absence of such conditions at Livade may be used as indirect support for the excavator's hypothesis of pit function (e.g. as zemunica - pit houses). The features, themselves, were noticeably clean of bones. Substantial quantities of the assemblage were directly affected by a variety of attritional forces. This is most easily seen in the early:late fusing ratio for sloj material (50:29). This is highly unbalanced when compared to frequencies from a complete skeleton. The proportion of early:late fusing bones and small, hard:loose teeth are roughly similar for sloj and pit deposits indicating little contextual variability in the effect of attrition on bovine elements. However, all the weathered fragments, with the exception of one, are found in the sloj. This would indicate that the sloj materials were much more extensively affected than the pits. A similar situation exists for the chew marks. Three bones from the sloj were burnt. Each was either weathered or butchered, as well. Evidence for selective recovery is much less extensive among bovines than among ovicaprines.

The numbers of loose teeth and small, hard elements - parts normally difficult to see and recovery using hand-collection techniques - are absolutely and relatively larger among bovines. They approximate the frequencies for early and late fusing elements.

Cattle are obviously the most frequent species at the site. How this may translate into actual economic importance is a different question. It is true that it takes many more sheep to produce the equivalent of a single cow, but this relationship is somewhat obscured by the evidence for substantial attrition among smaller species due to selective recovery procedures and other forces which would artificially emphasize the importance of cattle. The differential fragmentation rate comes into play here. Ovicaprine whole long bones are more common (n = 5; 4.4% of the ovicaprine bones) while those of cattle are relatively fewer (n = 6; 1.7% of cattle bones). The larger the bone, the greater the change of it being broken and, thereby, contributing more fragments to the assemblage. Also, cattle bones, when broken, are easier to identify to the species or genus level than ovicaprine bones. This would further tend to over-emphasize the importance of cattle in the assemblage.

Interpretation of the age distribution is also strongly influenced by the above processes. In every context, with the exception of features, mature specimens are more common than immature. The vast majority of specimens belong to early fusing elements, which can only be aged to the indeterminate sub-adult/adult group. The post-cranial class shows the highest rate of attrition, particularly among the immature unfused specimens. Hence, the post-cranial group would probably emphasize adults. The mandibulae, a more durable element, indicates a much wider spread of the age categories when all contexts are lumped (23.8:9.5:66.6% - juvenile:sub-adult:adult). All mandibulae (with the exception of two adults - one each from a Dubovac-Žuto Brdo and Gava pits) were from the sloj. Of the adults, 33.3% (n = 3) are young adults, 44.4 (n = 4) are middle-aged, and 22.2% (n = 2) are old or senile specimens, based upon tooth eruption and wear patterns (cf. Grant 1975). Cattle survived to much greater ages than ovicaprines. Some immature cattle would be slaughtered quite early, as juveniles, for meat. The majority survived well into adulthood and were probably involved in milk production and traction activities.

Sus scrofa fer. L., 1758

Wild swine are found in greater quantities (2.6%) than their wild bovine counterparts. They were differentiated from their domestic counterparts on the basis of their greater overall bone size and density. Most of the fragments were found in sloj deposits (n = 25; 92.6% of swine bones). The remainder were found in Dubovac-Žuto Brdo pits. None were found in the features or Gava pit. In the sloj, both cranial and post-cranial elements were present. In the pits, only the latter occurred (table 21). The pit fragments included a distal ulna and a distal tibia (both sub-adult/adult) and were apparently unmodified by any attritional force. The sloj deposits, in sharp contrast, were heavily weathered (n = 9: 36% of swine bones from the sloj) and chewed (n = 6; 24%). One distal tibia, otherwise unmodified, was chopped parallel tc its long axis (table 23). The proportions of the different body parts yield little data because of small sample size. Loose teeth are as frequent as early fusing ends, but the proportions of small, hard bones are much fewer. Teeth and small bones would normally be expected to exceed early fusing ends in frequency. When compared to sieved collections (i.e. Novačka Ćuprija) selective recovery by bone size is apparent. Additional evidence for this condition may be found in the high percentage cf whcle long bones (n = 2; 7.4% of swine bones) - a relatively higher percentage than found among similarly sized species. Evidence for

differential survival of body parts because of destructive forces, such as weathering and chewing, are present. The early:late fusing ratio is relatively unbalanced (8:5). Almost every specimen had been weathered and/or chewed. All of the ageable specimens came from the sloj. The two pit fragments were assignable only to sub-adult/adult classes. The sloj material could be defined better - 15.4:84.6% (sub-adult:adult). Adults, as in other contemporary and earlier localities, were preferentially culled (e.g. Ljuljaci).

Sus scrofa dom.

Domestic pigs are the second most common species represented in the Livade faunal assemblage. Most were found in the sloj (n = 222; 84.7% of pigs bones), with the remainder coming from Dubovac-Žuto Brdo pits (n = 35; 13.4%) or features (n = 4; 1.5%). None were found in the Gava pit. A single fragment of a tibia shaft (juvenile/sub-adult) found in the sloj could not assigned to either the wild or domestic form.

Evidence of assemblage attrition is apparent among the pig bones (tables 21 and 23). It was greater in the sloj than pit and feature deposits. In the pits, the ratio of early:late fusing elements is almost balanced. In contrast, the ratio from the slcj is very unblanced. Early fusing ends are four times more frequent than late fusing ends. The better conditions for preservation in the pits enabled

the more fragile elements to survive in numbers somewhat approximating their original distributions. Differential weathering of the bones by context is present. 33.8% (n = 75) of the bones from the sloj had surface erosion, whereas only 11.4% (n = 4) of the bones from pits could be shown to be weathered. None of the feature bones were weathered. Almost all of the chewed bones in the assemblage came from the sloj (n = 54; 24.3% of the pig bones from the sloj). Only 2 bones from Dubovac-Žuto Brdo features and 1 bones from a Dubovac-Žuto Brdo pit (2.8% of the pit bones) were chewed. A large number of bones, most from the sloj, were both chewed and weathered (N = 24), including one that was also burnt. Only a single fragment from the sloj had a butchering mark. Another burnt piece was pierced, possibly to be used as an amulet. It was polished on its edge.

The differential survival of certain bone parts bears directly upon the age distribution. The sloj material shows a much higher percentage of adults than the pits. This is because most of the adult mandibulae were found in the sloj. It is frequently assumed that mandibles will best reflect the mortality curve of the species at the site because they are among the most durable of remains. Even among the immature age groups, mandibles will survive the forces of fragmentation and disintegration at a higher rate than other bones. If this is always the case, it may be asked why

mandibles emphasize adults and the post-cranial remains emphasize sub-adults and juveniles. Part of the answer to this dilemma lies in contextual variability. The sloj shows a much higher percentage of adult remains than do the pits. Higher rates of attrition for the late fusing bone ends removes from the deposit a substantial proportion of the more fragile bones of immature animals. The sub-adults and juveniles, in particular, were heavily damaged. Differential rates of surface erosion on the pig mandibulae provide excellent examples of this process. A higher percentage of mandibulae were weathered in the sloj (ca. 50%) than in the pits (ca. 33%). Erosion can destroy even the hardest of elements. The maxillary remains point toward a preponderance of immature, rather than mature specimens.

Pig measurements (Ill. 18; Appendix 4) reveals that Livade pigs were relatively small.

Canis familiaris L., 1758

32 fragments of domestic dog bones were identified in the assemblage. Most were found in the sloj (n = 29; 90.6%). Over half the remains belonged to cranial elements, with mandibles constituting the single largest category. Canid mandibles are frequently the most common canid element identified in prehistoric (Holocene) bone collections from the region. They are denser and, therefore, preserve better

than the relatively lighter weight limb bones which easily fragment. It is also interesting to observe that a relatively large percentage of the post-cranial fraction was found whole (n = 4; 12.5%). This is a much higher percentage than found among the other species at the site and may indicate that they were originally buried whole, rather than broken up for food. The lack of articulated dog skeletons may be a reflection of the depositional conditions at the site itself. A number of dog bones were weathered (n = 7; all were from the sloj) or chewed (n = 3; 1 from a pit and 2 from the sloj). None were burnt or butchered. Unless they had been deeply buried, the chances of obvious articulations surviving was further reduced by weathering and scavenging. Evidence for pathological deformities is limited to the mandibles. Typical crowding of the pre-molars is observable. This is a common syndrome among early domestic canids (cf. Bökönyi 1978a; Musil 1984). The teeth did not decrease in size as quickly as the mandible. Measurements of the mandibles placed them in the small to medium-sized range. Most of the remains were from adults, who may have been used for guarding the camp and livestock, hunting, etc.

Equus caballus L., 1758

Domestic horse is represented by 33 bones and bone fragments. They are only slightly more frequent than domestic dogs. Nearly all were found in the sloj (n = 32; 97%), with only a single bone fragment coming from a Dubovac-Žuto Brdo feature. The distribution of body parts is very interesting. A relatively large fraction of late fusing bone ends were found (6:8 - early:late fusing ratio). The large size of this species, relative to most of the other species at the site, may have contributed to its better preservation. The bone remains were large and dense enough to survive the forces of erosion and fragmention. Few of the bones were chewed (n = 3; 9.1%), all of which were found in the sloj. The fragment found in the Dubovac-Zuto Brdc feature was unmodified. Several of the sloj fragments were badly eroded (n = 12; 36.4% of the horse bones). This evidence for attrition of the sample is somewhat at odds with the late fusing data. Only 2 out of the 7 late fusing elements from the sloj were weathered, in contrast to the early fusing group where more (table 21) were weathered. It is possible that the lower rates of attrition on the late fusing ends may be due to maturity of the sample. The late fusing elements are represented mostly by adults, whereas the early fusing group may include sub-adults, as well. The adult bones, even though they fuse later, stand up to attrition at a better rate than immature

bones. Horse were explcited for traction and transport during the Bronze Age. Sturdy adults were preferred and their bones stood up better tc the destruction forces of attrition. One of the bones (a distal metatarsal) was modified into an awl as at Ljuljaci. A distal phalanx showed evidence for pathological bone growth (arthritis?).

Cervus elaphus L., 1758

Red deer are the fourth most common species in the Livade sample (n = 95; 9.2% TNF). Most of the remains were found in the sloj (n = 87: 91.6% of the red deer bones), with the balance being found in the Dubovac-Žuto Brdo pits (n = 7; 7.4%) and features (n = 1; 1%). Aside from fish remains, red deer are the most common wild animal species in the assemblage. A wide range of body parts were identified. Even the least worthwhile, in terms of meat and hide yield, sections of the body were found (e.g. phalanxes). Antler fragments were not disproportionately common. Antler tools were relatively frequent for a Bronze Age locality. It would appear that entire carcasses were brought back to the settlement for on-site processing. No evidence for the "schlepp effect" (cf. Perkins and Daly 1968) could be found. An antler base, still attached to the cranium was found in the sloj. It probably represents a late fall/early spring kill.

Most of the bone remains belcnged to the post-cranial group (proximal and distal limb elements). Except for the trunk, this is where most of the meat is found. Antlers were the next most frequent group, followed distantly, by mandibulae. The post-cranial elements are distributed in an interesting pattern. The relative frequencies of early:late fusing elements (12:13 - early:late fusing ratio) implies some attrition. It is not as extensive as among the species exploited at younger ages or amcng the smaller-sized species (e.g. pigs, ovicaprines, etc.). Ncne of the long bones were found in a complete state. Cnly the mandibulae survived occasionally whole. The absence of vertebrae and ribs is attributable to the difficulty in distinguishing them from those of closely related or similarly sized species (e.g. horse, cattle). The paucity of loose teeth may be traced to the good state of mandible preservation. The high frequency of small, hard elements (n = 26: 27.4%) indicates that recovery of this large bodied species was relatively good. A large number of bone had been badly weathered (n = 43; 45.3%). All, except one fragment from a Dubovac-Žuto Brdo feature, were found in the sloj. 11 fragments (11.6%) had been chewed. All were, also, fcund in the sloj. The vast majority of specimens were from adult individuals (85%). Single examples from the juvenile, juvenile/sub-adult, and sub-adult groupings were found.

Capreolus capreolus L., 1758

10 fragments (1.0%) cf roe deer were identified in the sample. All, but a single antler specimen, were found in the sloj (n = 9; 90% cf roe deer). The antler was found in one of the Dubovac-Žuto Brdo features. It was complete, had been shed, and was modified. The tip was highly polished. It may have been picked up in the surrounding countryside during any part of the year and is evidence for the continued interest in antler as a raw material for tool production during the Bronze Age. All of the bones from the sloj, with the exception of a mandible (adult) and atlas (immature), were post-cranial remains. The early:late fusing ratio (4:1; 80:20%) indicates differential preservation of most remains by bone hardness and density. As with the other medium-sized mammals (i.e. sheep/goat and pigs), the absence of foot bones and loose teeth may be considered a function of differential recovery by bone size. The atlas had been sliced by a knife parallel to its long axis. A proximal metacarpal had been badly weathered and a metatarsal shaft been made into a tool. The age distribution of roe deer differs from that of red deer at Livade and from the other roe deer samples in the Central Balkans (e.g. at Petnica, Opovo, etc.). 60% were from immature specimens and 40% from mature specimens. This is probably a reflection of the small sample size and uncontrollable variability.

Lepus capensis L., 1758

Hare is represented by 3 fragments and whole bones. All were found in the sloj and belong to adults. They include 2 metatarsal bones (possibly articulated) and a distal scapula fragment. None were burnt, chewed, eroded or modified in any fashion. Hare is frequently fcund in contemporary collections, but is never very numerous. The small size of the bones, in conjunctiсn with reccvery procedures, may have functioned to underrepresent this species in the collection.

Ursus arctos L., 1758

A single fragment of brown bear was found in the sloj - a right proximal femur from an adult. It had been chewed by a canid. Bears are occasionally represented in Neolithic and Bronze Age collections.

Castor fiber L., 1758

One fragment of a right proximal ulna of a beaver (sub-adult/adult) was found in the sloj sample. They had been widespread through the region before mcdern times. Sites located near streams and rivers usually contain a few beaver bones (e.g. Petnica, Vinča, Opovo).

Homo sapiens sapiens

Two fragments of human bones were found mixed among the sloj materials - a cranial and a post-cranial fragment. Human remains are occasionally found mixed among food refuse and probably represent interments that had become exposed and later re-buried through sedimentation.

Unio sp.

243 shell fragments of mussel were counted in the collection. This figure includes only the part of the shell where the upper and lower halves articulated in order to avoid overly-inflated counts. They were found scattered throughout the site and contexts. One feature, in particular, yielded a very large aggregation of mussel remains and may have been a direct outcome of food processing activities. Unio is still endemic to the area. They are still a commonly collected food source, easy to collect, rich in protein and probably represented an important supplement to animal foods and products.

Helix sp.

11 fragments of the trochlea of snail shells were found scattered throughout the site. If prepared correctly, escargaux can be a delicious treat. It remains to be seen whether the small scattering of snail shells represents food or intrusive remains.

Pisces sp.

80 fragments of fish bone were found and sent to Dick Brinkhuizen (Biologisch-Archaeologisch Instituut, Groningen) for identification. Each had been heavily covered by a thick sandy encrustation. A variety of body parts had been present. The small numbers of fish bones at Livade, when compared with the remains from sites like Vinča, Vlasac, and other sites along the Danube, is probably a function of the poor preservation (due to erosion) and recovery methods (they are very small and difficult to see without the aid of the smallest of sieves).

Aves sp.

Two fragments of unidentifiable bird bones were found. They were too fragmented to be identified to a more specific taxonomic level.

V. CONCLUSIONS

The data on domestic animals at Livade point toward exploitation for secondary products. The high red deer values, presence of unshed antler, shed roe deer antler, point to a late fall/early spring occupation. It is possible, but not certain, that the locality was occupied

year-round. The nature and density of architectural remains are ambiguous in this respect. Age profiles from the domesticated animals (i.e. pigs) would indicate a late summer and fall occupation, as well. From these two different trends in the data, it appears that Livade was occupied, at least, from the beginning of the late summer/early fall harvest through the beginning of the spring. Such a pattern of occupation would be consonant with a settlement pattern involving movement of domestic flocks to upland pastures in the summertime.

CHAPTER 8: THE LOWER MORAVA PROJECT: POST-NEOLITHIC CRKVINA AND NOVAČKA ĆUPRIJA

I. INTRODUCTION

The Lower Morava Basin project was initiated in 1977. Field work extended through 1981. Analysis of the material is ongoing, although some preliminary reports have been issued (Bankoff, Winter and Greenfield 1980; Bankoff and Winter 1982). The project was designed to collect information concerning cultural and ecological change in the region during the later prehistoric periods (post-Neolithic). The earlier periods (Neolithic) were being investigated by the Selevac project - another joint Yugoslav-American research project - in the nearby village of Selevac (Ill. 2 and 4). The two projects initially shared Yugoslavian co-directors (i.e. Dr. Dusan Krstić, Narodni Muzej, Belgrade). But, in 1980, Mira Vukmanović also of the Narodni Muzej in Belgrade was appointed as the new co-director for the Yugoslavian team. Dr. Krstić remained on the Lower Morava project as a consultant. The American side of the project was initially directed by Dr. H. Arthur Bankoff, who in 1980 was joined

by Fred Winter, both of Brooklyn College, CUNY. I was invited to participate on the project by Dr. Bankoff in 1977 as the field supervisor for the survey and surface collection activities. In 1980, my duties were expanded to include faunal analysis as well.

The first phase of the Lower Morava project was a season of site survey and test trenching of eight known post-Neolithic archaeological localities. None of the sites contained either visible standing or topographic features which would have distinguished them from the surrounding landscape. Surface collections had been haphazardly made over the years by local farmers and archaeologists and these allowed a preliminary temporal assignment - later some were found to be inaccurate. In most cases, site borders were difficult to define. As a result, a systematic surface collection of the archaeological debris found on the surfce was undertaken. In addition, each site, except one (Golo Brdo - a small single household-size site on a steep mountain slope), was sampled with at least one test trench. Novačka Ćuprija was sampled, most intensively, by ten test trenches. The material recovered from the surface collections and the 1977 excavations formed the basis of a series of statements concerning post-Neolithic changes in economy and settlement structure and organization

that were discussed in the introductory chapter. They provided our first systematically collected data dealing with post-Neolithic settlements and provided detailed insights into the nature of the dramatic re-organization that took place at the end of the Neolithic. It was soon realized that any explanation of these changes in settlement structure and organization must involve transformation in the economic organization of the region. Based upon the small samples of faunal remains recovered from the sites of Novačka Ćuprija and Crkvina - the only ones which produced preserved features with associated remains -, it was possible to see some evidence for a concomitant reorganization in the animal based segment of the economy. Domesticated species represented over 90% of the sample, as opposed to lower values in the Neolithic. With these results in mind, the project returned to excavate a large systematically derived sample of remains. It was hoped that the 1980 excavations would provide enough data to systematically test the conclusions of the earlier campaign and those of Bokonyi in the Balkans and central Europe and to enhance the creation of a tentative outline of the sequence and some suggestions as to the causes of the observed changes (Bankoff and Greenfield 1985; Greenfield 1984a; 1984b). The logical structure of any model is highly dependant upon the

sampling structure used to collect the data. At Novačka Ćuprija, as will be described below, the assemblage is probably a relatively reliable sample of the site. The same is not true of Crkvina. In terms of regional variation in the remains, neither are representative. This is apparent from the data collected in 1981 and 1982. In this chapter, the material from Crkvina and Novačka Ćuprija will be discussed.

II. CRKVINA

Crkvina is a multi-period locality situated a few kilometers west of the city of Smederevska Palanka, Serbia (Ill. 4 and 22). It lies along a ridge that is north of and overlooks the Bulino potok (stream) and the floodplain of the Jasenica river. The Jasenica empties into the Morava river about 20 km. to the east. The site is dispersed along the edge of the ridge and covers more than 30 hectares. It rarely extends more than a few hundred meters back from the edge of the terrace. There are no surface architectural remains on the site, except those of a Medieval church - from which the name Crkvina (Serbo-Croatian for church) is derived. It is a relatively flat and featureless site. The site was recognized as an archaeological locality some years earlier than the 1977

investigations after a grab sample surface survey conducted by the Narodni Muzej, Smederevska Palanka.

In 1977, it was chosen as one of the eight post-Neolithic prehistoric sites in the region to be surface surveyed, surface sampled and test trenched by the Lower Morava Project. An intensive surface survey and systematic collection of surface material were conducted. Over 10% of the 30 hectares surveyed were sampled before the allotted time expired. Only the eastern edge of the site was never defined. It appeared to continue in that direction for several hundred meters. The density of surface material was very light, but more or less constant over the entire locality. Based upon the surface and sub-surface remains, occupation appeared to have largely been composed of periodically shifting foci. For one reason or another, as structures were destroyed or abandoned, new structures were built and occupied a short distance away. In this way, the occupants continued to move back and forth over the length of the ridge. Analysis of the ceramic materials indicated that the north-central part of the site was covered by a Starčevo settlement. The rest was occupied from the beginning of the Bronze Age through Roman and Medieval periods. A small section of the site contains a modern farm. The numbers of large fragments of house daub recovered over the length of the site would indicate the residential nature of the site. But, no

prehistoric structures were reccvered. They were probably destroyed by prehistoric and historic ploughing activities. Today, the entire site is under cultivation with ploughs extending 1/2 meter in depth into the soil. Everything within this stratum has been disturbed and often are brought to the surface.

The excavation and survey operations were organized and directed separately. Dr. H. Arthur Bankoff and Dr. Dušan Krstić were overall project directors and supervised the excavation activities. Concurrent with the excavation, I supervised the surface survey and collection operations. A stratified unaligned sampling of 10% of the surface of the site was carried cut. All the surface material found within the designated surface collection units was gathered and analyzed (10 m. radius circle/52 sq. m. surface quadrat). It was hoped that the overall distributicn of surface remains could be predicted with some confidence. However, this goal was not met because of the effect of vegetation upon visibility of surface remains. The locations of the test trenches were not guided by the survey operations. They were based upon traditicnal and subjective archaeological criteria (e.g. perceived distribution of surface material, location of desired types) and other uncontrollable factors (e.g. desire nct to disturb standing crops). The goal of the excavation was to determine the

depth of stratigraphy and the chronology of the site. Two contiguous 2x2 meter trenches were excavated in the Bronze Age section of the site. The plow zone contained some ceramic material, but was mostly disturbed and yielded little faunal material. Beneath the disturbed humus (plow zone) stratum (0.0 - 0.5 meters), a dark layer rich in cultural materials was encountered (0.5 - 1.0 meters). The ceramic materials in this layer were attributable to the first phases of the Paracin ceramic group (end of the Middle Bronze Age). Beneath this layer, an ovoid pit was cut into the sterile loess below (1.0 - 1.4 meters). The ceramics in the pit showed strong affinities with the southern Morava Slatina ceramic group (Early Bronze Age). Even though the ceramic material from the cultural layer and pit were separable, many of animal bones from the pit articulated with elements from the upper cultural level. Also, no remains of a "floor" or surface from which the pit was originally cut was found. As a result, the material from the cultural stratum and the pit will be analyzed here as a single Middle Bronze Age entity. The Slatina pit is a rare example of an excavated non-mortuary Slatina feature (Bankoff and Winter 1982: 152-153; Bankoff, Winter and Greenfield 1980).

All excavated soil was passed through a 1 sq. cm. dry mesh sieve. Recovery of bone elements larger than this is

deemed reliable. A total of 483 fragments of bone were recovered (Ill. 23). This does not represent a large quantity but its importance, rather, lies in the rarity of residential debris from this time and ceramic group. A large number of the bones were burnt. The presence of burnt bone and ash layers within the pit would suggest that it was used for both outdoor cooking or roasting of food and eventually refuse disposal. The data from Crkvina will be discussed along with that from Novačka Ćuprija to enhance comparason between the two assemblages.

III. NOVACKA CUPRIJA

IIIA. Location

"Novačka Ćuprija" is the local name of a small bridge over the Novački Potok (Novač's stream), a small tributary of the Jasenica river. The site is approximately 4.5 km. north of the city of Smederevska Palanka (Ill. 4). The site is divided up into four localities due to topographic variation (Ill. 23). The central locality lies in the western edge of a low plateau to the east of the stream. It is approximately 4 hectares in area. The plateau increases in width to the

east, eventually joining with the plateaus, upon which the north and south localities are situated. The terrain remains more or less flat for approximately one and a half kilometers, rising at a continual but slight rate. After it reaches the main road between Smederevska Palanka and Grčac, the ground rapidly rises between 50 and 100 meters in height. After a few kilometers, it rapidly descends to the flats of the floodplain of the Lower Morava. The north locality is separated from the central by a gentle depression and occupies an area equivalent in size. The south locality lies across the village road. It is approximately five hectares in extent. None of the site's localities possessed any visual vantage in their location. They are located in relatively unobtrusive positions, with access to agricultural land, woods, and water.

IIIB. Survey and Excavation Strategies

Trenches of varying size were excavated on all three localities. Those excavated during 1977 (Sonda 1 - 10) were positioned by the excavators without regard for the surface pick-up operations. Both activities were conducted simultaneously preventing a feedback of data from one operation to the other. Possible excavator bias in

their placement allows the use of their data for only chronological interpretation. They ranged in size from 2x2 to 0.5x6 meters. Four trenches were placed on the southwest part of the central locality (Sonda 1, 3, 4, 9, and 10). Based upon the material recovered from them, this area was occupied during the Eneolithic, Bronze and Iron Ages. Pottery from the Paracin and Mediana groups (Middle-Late Bronze Ages) and fragments with Danubian Urnfield affinities (Late Bronze Age) were identified in these trenches. Occupation was limited to the upper, rather than slope of the plateau. Sondas 7 and 8 on the slope above the stream yielded only eroded remains. The occupational debris did not extend more than 200 meters east of the plateau's edge. Sonda 3 contained some Eneclithic Baden-Kostolac type pottery. Trench 4 yielded ceramics from the Early and Late Iron Ages and Roman period, including a fibula. Sonda 2, on the north Locality, yielded Iron Age material. The south locality contained Roman and Medieval deposits. Several trenches were opened there, but their locations were not recorded and their remains are too late for this thesis topic. Hence, they will not be discussed any further.

The 1980 excavations on the central and northern locality were conducted under more controlled conditions. Each trench was situated with respect

to one of the 1977 randomly generated surface pick-up units. In 1977, the site was divided into 52 m. sq. units. The grid system was oriented toward the cardinal magnetic directions. A 10% sample of the surface (or 75 sq. m.) of each grid was surface collected. A circle was chosen as the shape of the collection unit. Its central point coordinates were generated in the field by means of the program for the generation of pseudo-random numbers on the Hewlett-Packard HP-25 calculator (see Bankoff and Greenfield n.d. for a comprehensive description of the survey). The sample of surface units from 1977 was divided according to two dimensions: time and quantity of recovered material. In the first place, the major concern was with those areas showing Bronze Age occupation. As a result, the central, as opposed to the northern or southern locality, became a primary focus of the project. It was the only section to yield evidence of Bronze Age occupation. 15 of the 23 trenches excavated in 1980 were placed upon the central locality. 2 were opened on the northern, 4 on the southern and 2 on the western localities. Surface collection quadrats (52x52 m) showing both high and low densities of material on the central locality were samples to avoid unnecessary biases in the sample. At least one trench was placed within each of the 52 m. sq.

quadrats and placed 10 meters, in a randomly generated direction, from the center-point of the collection unit. The only consideration in laying out the excavations was the ground cover. We could not disturb areas with standing orchards, vineyards or alfalfa fields. These areas of the site were left out of the universe. The distribution of alfalfa fields, the most widespread of this group, changed from year to year. As a result, we were now able to test surfaces previously covered by alfalfa. In this way, each section of the central Locality was tested. The trenches were situated beyond the surface collection limits to avoid the problem of double collection of the site surface above each trench. Otherwise, this would have created uncontrolled biases in estimated surface-subsurface density relationships. In this way, the surface above each trench was collected and bagged separately as an additional test of the representativeness of the surface sample to the rest of the larger surface quadrat. Each 52 sq. m. quadrat on the central locality was sampled by at least one 5 sq. m. trench. If the initial results proved productive (e.g. sonda 23), then additonal areas around it were opened (e.g. sonda 31, 37, and 41 around 23; or 42 next to 25). If no preserved features were encountered, the quadrat was not explored any further.

The strategy of the 1980 excavation was to locate and open up a large area of Bronze Age contexts, from which a more complete picture of the subsistence and settlement system might be obtained. Previous reconstructions of the Bronze Age were largely dependant upon mortuary samples. Other excavations, such as Ljuljaci, were still unpublished at the time. The basic trench was 5x5 meters. Experience in this region has shown that a trench of this size is the best compromise in terms of exposure, excavation control and interpretatin of excavated features - unless the nature of the deposits are known beforehand. Each trench was further quadrated to permit additional control and to facilitate the investigation cf micrc-temporal and -spatial variation leaving an internal 1 meter balk. The maximum recovery unit, therefcre, was 2x2 sq. m. and never more than 10 cm. in thickness. In practice, they were frequently smaller.

The tctal number of fragments frcm both the 1977 and 1980 campaigns at Novačka Ćuprija consisted of 6646 bones and shells. The sample from prehistcric contexts, however, was smaller. Only 3169 (47.7%) fragments of bone and shell came frcm temporally-restricted Eneolithic and Bronze Age deposits. The rest were from Medieval, Roman, mixed Iron Age or temporally-mixed excavation units.

IIIC. Temporal and Contextual Units of Analysis: Novačka Ćuprija

The following provides a brief cutline of the finds from the central locality. The south locality yielded only Roman and Byzantine remains (0 A.D. - 10/11th centuries A. D.) and the North locality consisted mostly of mixed Iron Age/Roman remains. Neither will be dealt with here. The two trenches placed on the western locality, across the stream, proved tc be completely sterile. No evidence for a early Neolithic Starčevo locality was found on the western side, as reported from a Smederevska Palanka Narodni Muzej surface cclllection.

The excavations confirmed that the site was occupied from the Eneolithic (Baden-Kostolac ceramic group) through the Medieval period, with few if any breaks in occupatien. The most intensive occupation of the central locality tcok place during the Bronze Age, with some earlier and later deposits occurring there as well. Early, Middle, and Late Bronze Age material (with pottery similar to Slatina, Cmoljica-Pančevo, Vatin, Paracin and Mediana ceramic groups) predominated among the assemblages. There appears to have been little spatial/hcrizontal overlap. Contemporary occupation appears to have centered upon small sections cf the site. As time passed, the focus

of settlement shifted up and down stream, leaving a wide swath (approximately 200 meters wide) of cultural debris.

Slightly less than half of bones from Novačka Ćuprija were found in temporally restricted prehistoric deposits. These will be described below in temporal order of priority (Appendix 8).

1. Baden Sloj deposits - These consist of a series of excavation units, or lots, from a few trenches along the south edge of the central locality. They contained Eneolithic Baden or Baden-like ceramics, were featureless and were undistinguishable from the surrounding sloj (horizon), except for their pottery;
2. Early Bronze Age Pits - These are a series of pits (numbers 1, 2, and 3) in a set of contiguous trenches (23, 31, and 41) in the northeastern corner of the central locality. They contained pottery currently attributed to the Early Bronze Age (H. A. Bankoff - pers. comm.) These deposits are thought to be only slightly later than the Baden sloj. Each pit differed in size, quantity and nature of remains. The faunal remains are detailed separately for each (tables 26 and 27). Pit 2 was the largest and contained the highest quantity of remains for a feature at the site for all periods. The three pits, combined, comprised almost half of the sample considered in this analysis. The relative frequency

of species differed widely from pit to pit, probably a function of the varying sample sizes (cf. Grayson 1973). Pits 1 and 3, both of which contained relatively fewer remains, yielded more similar relative frequencies to each other than either did to pit 2. The domestic:wild animal ratio found in each of the pits follows the same pattern. The percentage of wild remains in pit 3 is considered to be inflated, since 3 of the 5 hare bones may have belonged to the same individual. If these are removed from consideration, the ratio becomes 43:3 (93.5:6.5%), a figure more reminiscent of pit 2;

3. The sloj above the Early Bronze Age pits (not including the plow zone) probably represents the upper edges of the pits that were mixed with slightly later Bronze Age deposits by plow and other actions. There appeared to be a thin stratum contaning little material separating the pits from the sloj above them. Chronologically, the ceramics would be only slightly later. It is interesting, however, to note that the pits and sloj above them are more similar to each other than to the other deposits (e.g. the identifiable:unidientifiable and domestic:wild proportions of the sloj above the pits almost matches that of pit 2). This may be attributable to the

relatively large sample sizes for pit 2 and the sloj above the pits; and

4. Late Bronze Age Features - These consist of two features, dating to the later Bronze Age. They are a large urn in Trench 24, and a fragmented floor and surface in Sondas 25 and 42. Neither sample was very large (n = 109 and 183, respectively). The urn was isolated in its three dimensional position. The floor appeared tc have been part of a larger disturbed surface, whcse extent was not fully defined. Several additional lots may eventually be added to the floor. The prcportion of identified specimens is similar fcr both deposits and reminiscent of the figures from both the pits and the sloj above the pits. This is scmewhat unexpected in light of the varying sample sizes and may simply reflect random variance. The domestic:wild ratio is substantially higher fcr both of the Late Bronze Age features than for the earlier Baden and EBA pits and sloj above the pits. Cnce again, this may possibly reflect randcm factors built into the small sample sizes.

If the data in tables 26 and 27 are arranged temporally, there is little indication of change from the Eneolithic through the end of the Bronze Age. Part of the problem is that large sample in pit 2 swamps the data from the other

contexts. This can be readily seen when all of the data from each context are combined (table 26), it closely follows the figures for pit 2 alone. The large variety of species in pit 2 differentiates it even further from the others.

IV. TAPHONOMIC CONSIDERATIONS: NOVAČKA ĆUPRIJA AND CRKVINA

IVA. Taphonomic Considerations: Excavation and Recovery Procedures

In general, the bones are extremely fragmented in comparison to most of the other samples from the area. This appears to be a direct function of sieving operations. All of the deposits analyzed so far for Novačka Ćuprija were sieved with 1 cm. sq. mesh. A few trenches (not included) were hand-collected. They yielded little to no faunal remains. Several deposits were also floated in a flotation tank. Some bone was recovered in the bottom of the tank which used a 3 mm. sq. mesh. However, this was a very haphazard part of the operation. Bones were collected from the flotation tank by the paleobotanist only when they were immediately obvious. They, therefore, should not be considered a representative micro-mammalian sample. The

percentage of identifiable tc unidentifiable is relatively low (22.9:67.1%). This strongly contrasts with the hand-collected samples where the identified percentage ranged occasionally up to 99% of the sample (e.g. Jela - Sabac). Almost all of the bones were broken into two or more fragments or completely splintered at some point in their depositicnal history. Only 6 whole long bones of the larger vertebrates (2 sheep, 1 pig, and 3 dog - table 28) were found. This represents a tiny fraction of the overall assemblage (0.2%). Whole skeletons were absent. A single obvious instance of an articulated limb was encountered (a sheep hindlimb - Novačka Ćuprija, in sonda 31, pit 1) and a less obvious example of an articulated vertebral column belonging to a sheep/goat/roe deer in the Crkvina pit. The former was recognized during excavation, while the latter was pieced together only in the laboratory. Mandibulae and maxillae were rarely intact. Ageing and sexing of remains was a constant problem due to the high degree of fragmentation.

The bones from the pit at Crkvina resemble those from contemporary deposits at Novačka Ćuprija (EBA pits and sloj above pits) in many respects. The dcmestic:wild ratio in the former is 93.7:6.2%, a slightly lower value than in the pits of the latter (97:3%). The relative frequencies of the bone identified to the species, size-class or unknown

categories are also very similar. The major difference lies in the percentage of the size class. It is lower at Crkvina (4.8%) than at Novačka Ćuprija (9.2%). The relative values for unidentifiable fragments is higher at Crkvina (73.1%) than at Novačka Ćuprija (66.4%), largely in response to the variation in frequencies in the size-class data. The frequency of identified elements was similar for both sites (Crkvina - 22.1%; Novačka Ćuprija - 24.4%). The low identified:unidentified ratio at both sites is a direct function of recovery procedures employed during excavation. The sieves enhanced collection of even the most fragmentary of specimens. In hand-collected assemblages, the smaller class of data would have been lost or underrepresented. Species diversity at Crkvina is much lower (n = 8) than at Novacka Cuprija (n = 19 in EBA pit and sloj above pit deposits). This is probably a function of the very small sample size in the former.

The differential preservation of bone is a function of the pre- and post-depositional processes that it is subjected to. During 1977, the bone and ceramics were placed in the same bags. This resulted in needless damage to many pieces between the field and laboratory sites. As a result, greater care was taken of the bone during 1980. Immediately upon removal from the soil matrix, all bone was bagged, tagged and washed separately from the ceramics, daub and other larger and heavier

artifacts. Bone bags were then carefully transported to the bone registration area of the lab, where the remains from each unit were weighed and packed in cotton for shipment to New York for more detailed analysis. All modern breaks were mended prior to packing. In addition, fewer and fewer pieces of bone were broken during excavation and recovery as the excavation crews became more proficient at recovery. The workmen were able to exercise increasingly greater care towards the bone materials. However, due to the nature of the soil and the unwieldy excavation tools, many pieces were damaged and some beyond recognition. Shovels and spades were the primary excavation tools. They were used to first loosen and then to remove the soil. Trowels were used to only clean surfaces or to clean out features, such as pits, with a looser and lighter soil than the surrounding deposits. The Holocene soil horizons of the site were composed of a heavy silt, with a high clay content which clung to the artifacts. Breaking it up often caused extensive damage to the encased bone. Excavation proceeded in arbitrary levels, usually between ten and twenty centimeters in thickness because it was difficult to discern internal stratigraphic divisions within the cultural horizon. There was little color change until the A(B) horizon boundary was reached at approximately one meter in depth.

IVB. Taphonomic Considerations: Post-Depositional Processes

Post-depositional prccesses appear to have been of some significance in the degree of bone preservation. Several factors were operating and the contribution of each will be evaluated separately.

The first set involves soil depth and plcughing activities. The Holocene soil horizons appears to have been composed of two sub-strata - the modern plough zone and the cultural horizon. The cultural horizon often extended into the plough zone. Iemperate Europe has been under plough cultivation since plcughs were introduced at the end of the Neolithic or beginning of the post-Neolithic (ca. 3300 B.C. - Sherratt 1980a; 1980b; 1982). Modern ploughing can extend to a depth of 50 centimeters below the modern land surface. All artifacts in the modern plough zone have been disturbed to scme extent. The extent of the disturbance differs from locality to locality. Recolonizatien of these surfaces by vegetatien and the resultant yearly cycle of growth have frequently added at least several dozen centimeters of soil to the horizon.

Beneath the modern plough zone can be found the cultural horizon. It usually lay at a depth of 40 - 100 centimers below the modern land surface, where there has been no significant erosion. This stratum lies within the same soil matrix as the plough zcne. Bcth sub-horizons probably developed under similar conditions - deciduous forest canopy. The cultural debris found in the lower sub-stratum rarely is found in asscciation with any recognizable surface or feature. This would appear to be the result cf two ccmplementary processes: After a section cf a lccality was abandoned, it was probably opened up to cultivation. Since the contemporary land surface was prcbably lower than today, ploughing in antiquity would have reached to the lower stratum. The preference for lightly constructed wattle-and-daub structure during the Bronze Age contributed to the situatien of poor structure preservation (Bankoff and Winter 1980). Structures, features, and associated surface remains were entirely destroyed by subsequent ploughing under of abandoned domestic areas. The other process may be found in the soil conditicns at the site. The soil has a very high percentage cf clay. Downward mcvement of artifacts has been frequently noted by investigators working in the area (R. Ehrich 1977; pers. comm.). When artifacts are stepped on after a heavy rain, they will quite easily sink 20-30

centimeters down into the soft mud. No compact surface forms in the open yards of modern peasant villages. Instead, the debris accumulates beneath the surface. The depth will depend upon the force exerted upon it. The net result is an amorphous stratum of artifacts and other cultural debris not in association with any recognizable surfaces. This situation is quite commonly encountered on post-Neolithic sites of the area. The only sites with well-preserved surfaces and features are those of the late Neolithic. The introduction of the plough cannot solely account for this difference, since the early Neolithic Starcevo sites are characterized by a situation similar to that of the Bronze Age. Most likely, the more solid construction techniques and rapid accumulation of material on late Neolithic sites helps to explain the difference in preservation.

The only areas of the sites which yielded undisturbed features were found beneath the "cultural horizon" or near its base. Occassionally, erosion brought previously deeply buried features near to the surface (e.g. floors). The former consists of pits dug into the underlying Pleistocene Tertiary horizons. This "C" horizon is much lighter in color, has a considerable sand and pebble component, and was easily distinguishable from intrusive and superimposed deposits. This horizon appears to have been

the result of aggressions and regressions of the ancient Pannonian sea that covered the region during the Tertiary. This layer, which underlies mcst of the region, has been frequently confused as Pleistocene loess deposits. Loess is quite different and does nct appear to have accumulated to any significant depth on the site. Features, whose outline could not be easily discerned in the cultural horizon, were easily spctted in the lighter sandy soils below. On the basis of debris densities, features then were traced upwards back into the cultural horizon. Conversely, sub-surface pits could often be recognized in the cultural hcrizon on the basis of debris density and preservation and confirmed as the lower stratum was reached. The bones from the Novacka Cuprija pits exceeded those fcund in the deposits from the features found in the cultural horizon (e.g. Sonda 25 and 42 - floor).

The second set of post-depcsiticnal processes involves soil pH. Soil acidity/alkalinity cr pH must also be taken into consideration with regard to bone preservation and recovery. Today, mcst of the agricultural fields in the area are manured at least once every couple of years. Farmers collect the excreta cf their cattle, which have accumulated over the winter, and spread it over their field, often to a depth of several centimeters (pers.

obs. - 1977). During the summer and fall, they frequently pasture cattle, sheep and goats on already harvested fields. This not only enhances the fertility of the soil, but also increases the level of acidity. It also contributes to increasing the thickness of the soil and slowly removes the devestating effect of the plough over time from the lower deposits. Increasing soil acidity is very destructive to the bone. PH tests were conducted in all the levels of several trenches at Novacka Cuprija. The pattern remains more or less the same for each tested trench. In general, pH levels were the lowest in the modern plough zone (ranging between 5.8 and 6.0), slightly higher in the cultural horizon (ranging between 6.5 and 6.9), and decreasing in the lowest soil horizon to values ranging between 5.8 and 5.9. In other words, they progressed from a relatively acidic soil level in the upper horizon to a slightly more alkaline one and then back to higher levels of acidity in the lowest horizon. Pits in the lowest horizon contained cultural horizon soils and acidity levels. The acid from the manure may have filtered down into the plough zone, but not into the cultural horizon. The Tertiary deposits contained a great deal of sand, a usually good indicator of poor conditions of bone preservation. Bone preservation was best in the intermediate cultural horizon and its associated pits where pH was highest.

A third set of processes which appear to have affected bone preservation may be called mechanical. The rates of bone preservation are highest in the intermediate soil horizon. Bones in the plough zone frequently fell apart when excavated. Areas of the site where the cultural horizon lies at the surface because of erosion yielded fragmentation rates similar to those elsewhere in the plough zone. During the summer, when our excavations were conducted, the extreme heat of the sun dried the heavy clay component of the soil into an almost ceramic-like texture and hardness. Excavating through this soil, one it had become sun-baked, was extremely difficult. A steel corer that was used to take soil samples from still unreached horizons looked like a corkscrew half way through the season. At a depth of about 40 centimeters below the surface, the soil remained sufficiently moist to dig through and remove material undamaged. Above this point or when a trench lay open for a few days, large cracks in the soil would appear and disappear as the sun and rain added and took away moisture from the soil. During the winter of 1982, I was able to observe a cycle of freezing and thawing of the soil and its contents, probably penetrating to at least this depth. The end result would be several contractions and expansions of the soil

matrix and bone over the ccurse of a single year. Mechanical processes, such as expansion and contraction associated with the annual freeze-thaw and soak-dry actions, in conjunction with ploughing can probably account for much of the differences in fragmentation rates between the different hcrizons. All of the whole long bones, with the exception of a single example, were found in the deep pits.

IVC. Taphonomic Considerations: Pre-Depositional Processes

Several pre-depositicnal processes appear to have influenced bone preservation. These are described below. Few bones in either assemblage showed any evidence for cutting or chopping activities. Ncvačka Ćuprija contained slightly higher frequencies of such remains (1.1%; n = 34) than did Crkvina (0.7%; n = 3). Each of the contexts in the former locality contained some butchered bones. The percentage, however, varied from a high of 1.3% (Early Bronze Age pits) to a lcw of 0.9% (Sloj above the Early Bronze Age pits; Late Bronze Age Urn). The pit from Crkvina yielded even lower values (0.7%) - 1 sheep/goat limb bone and 1 vertebra and 1 red deer antler. None of the deposits were significantly different from the others in terms of the distribution of butchered elements. Sample size variance

did not play much of a role in determining the prevalence of remains. None of the Crkvina butchered bones were burnt or otherwise damaged. In contrast, at Novačka Ćuprija, 6 were chewed (Baden, EBA pits, and Sloj above EBA pits), 2 were weathered (1 each in Baden and the Sloj above the EBA pits deposits) and 2 were burnt (1 each in the EBA pits and the sloj above). The meat and marrow bearing limb bones were more heavily damaged by such activities than were the small, hard elements. The former were almost invariably smashed or broken, while the latter tended to be recovered in better states since they were mostly left untouched after dismemberment took place.

A small percentage of the bone was burnt. Burnt pieces are generally small and completely calcined or blackened. Cooking weakens the molecular structure of bone allowing it to succumb more easily and quickly to weathering and other destructive processes. Most of the cooking debris, therefore, has disappeared from the archaeological record. It is likely that cooking activities would have taken place elsewhere (i.e. in hearths) - except at Crkvina where a thick ash deposit was encountered in the pit -, since most of the recovery contexts were refuse-oriented. The contexts did not show a significant difference in the distribution of burnt fragments. Upper limb, extremity, pelvic, and pectoral elements

predominate. Cranial and trunk specimens are much rarer. This is not unexpected since the latter group succumbs more easily to attritional processes (cf. Binford and Bertram 1977; Yellen 1977). Each context yielded some burnt bone at Novačka Ćuprija (2.6%; n = 79). The relative frequencies of burnt bone in the pits, sloj above the pits, the Baden sloj and the Late Bronze Age floor are relatively similar. Only the Late Bronze Age urn yielded an unusually high value (6.4%) which may be expected if the urn had been used for cremation with food cfferings. The burnt bone in the urn was unidentifiable to the species level. In the other contexts, at least some of the bone was identifiable to the species level. The pit at Crkvina yielded a very large relative frequency of burnt bone (13.1%; n = 59). This was more than twice as high as any of the Novačka Ćuprija deposits. All species, with the exception of roe deer and horse, had some burnt bones present. All areas of the skeleton, from the head tc the tces, were burnt among the various species. The highest proportion of remains were classed as unidentified or to various size-classes (n = 35; 59.3% of the burnt bone). Amcng the size class fragments, sheep/goat/roe deer fragments were the single largest grouping. Most were burnt pieces cf an articulated vertebral column (n = 10). When known sheep/goat fragments are added to this group, this brings the total to 22

fragments or 37.3% of all burnt bones, a larger value than any single set of closely-related and similarly-sized species.

The effect of scavengers upon the two assemblages was of some importance. Only a small number of bones had been chewed by dogs, and possibly some other omnivorous species, such as pigs (tables 28, 29, and 30). Chewed remains were more frequent at Novacka Cuprija (2.5%; n = 75) than at Crkvina (1.5%; N = 7). Canid remains are present at both sites. All bones with gnawing marks were also fragmentary. At Novacka Cuprija, the Late Bronze Age urn contained the lowest relative frequency (0.9%; n = 1). The Baden sloj contained slightly more (1.1%; n = 6), while the other contexts contained higher (EBA pits - 2.3%; Late Bronze Age floor - 3.3%; sloj above EBA pits - 3.5%). The Crkvina pit included an intermediate percentage (1.5%). This may imply that context type may have little direct influence over the amount of carnivore depredation taking place. Pits do not, necessarily, always yield lower values than open surfaces. This is a relationship that must be repeatedly demonstrated for each assemblage. Rather, the relationship between the frequency of chewed remains and context should be phrased in an alternative manner. The sooner the deposit is buried, the less likely it is to be subjected to such depredation. Based upon this relationship, it is possible to suggest that

the pit at Crkvina was closed more quickly than those at Novacka Cuprija. This can be supported by looking at the percentage of remains that were both chewed and weathered. At Crkvina, none were characterized by this pattern, but at Novacka Cuprija, 3 fragments in the EBA pit (0.2%) and 4 in the Baden sloj (0.7%) were both chewed and weathered. This helps to demonstrated that the Baden material was left exposed for a longer period of time, whereas the the Novacka Cuprija pits were open only slightly longer, if at all, than that at Crkvina. In Crkvina, only pig (n = 3) and cattle (n = 2) bones were chewed (table 31). At Novacka Cuprija, sheep/goat pig, sheep/goat, and cattle bones were chewed.

Weathering is the third major pre-depositional process to affect bone preservation. Over 99% of the bone recovered from both sites show little or no erosion of the bone surface (table 30 and table 29). This may be taken to indicate that the bone spent little time on the surface and exposed to the elements. Some that were chewed were weathered, as well. Most of the bones were apparently buried quite quickly after being discarded. The ones that remained on the surface were chewed, eroded and probably never reached the archaeological record. 26 bones from Novačka Ćuprija (0.8%) and 4 fragments from Crkvina (0.9%) were weathered. Each of the contexts at the former contained some weathered material (table 30). The percentage from context to context ranged from 1.6% to 0.6%,

with the Baden sloj and Late Bronze Age urn and floor containing the highest (1.6 and 1.1%, respectively),and the pits and sloj above the pits yielding the lower end (0.7 and 0.6%, respectively. The Late Bronze Age urn contained slightly more (0.9%). The pit at Crkvina was very similar to the pits from Novačka Ćuprija. The pits and floor are relatively protected types of contexts. Their lower incidence of weathered fragments attests to this. All of the Crkvina burnt fragments were small, hard types. Only a single bone was severely eroded. Cf the others in the pit, only 1 had been alsc burnt, a second also chewed (both pig) and 1 also chewed, burnt and polished (cow). It is apparent that once the pits were sealed, they were probably not re-opened. Hence, the low incidence cf weathered remains.

Bones with surface pclish were fcund on both sites - Crkvina (n = 4; 0.9%) and Novačka Ćuprija (n = 15; 0.5%). At the latter, the pits and sloj above the pits contained the lowest frequencies. The Late Bronze Age floor and urn had none. The Baden slcj yielded the highest (1.3%; n = 7). If pclish does indicate use as some kind of tool, this tentative data may project a trend of decreasing frequency over time with the advent of metallurgy. At Crkvina, the number was higher than in the ccmparable Novačka Ćuprija pits and sloj above the pits, but lower than in the Baden sloj. It included a pig mandible (alsc chewed), a cow/red deer rib worked into an awl with circular use striations

around the tip, an unidentified shaft and a small, hard cattle fragments (also burnt, chewed and weathered).

Only a few bones showed pathological deformities - Crkvina (n = 1; 0.2% - pig) and Novačka Ćuprija (n = 1 each in the Baden sloj, EBA pits and slcj above the EBA pits).

Two other processes appear tc account for some post-depositicnal movement of bone material - tree roots and rodents. Sumadija is known fcr its forest cover and this area was heavily forested within memory of its older inhabitants (cf. Halpern 1967). The effects of the heavy forest cover is evident from the numerous root holes passing through virtually all the deposits. The paleobotanical remains (cf. Willcox n.d.) indicate an oak forest cover in this area during each of the occupational phases. Root holes were not excavated separately from the surrounding matrix because cf the excavation methodology, plus time and financial constraints. Most were recognized after the fact, usually in the profiles. A secondary effect of the heavy forest cover was the ccntinual deposition of detritus upon the forest floor, building up the humus layer over time. When the of scme were recovered during the excavation (e.g. mice). Small burrowing animals were occasionally encountered (e.g. at Jerinin Grad in 1977 the remains of a badger lair was uncovered,

including the deceased badger and associated chicken bones). The effect of these two sets of disturbances was a filtering downwards of later bone remains. The best example was the finding the remains of modern chicken bones deep with the pit deposits (1/2 meter down) at both sites. They were not the remains of mid-day snacks belonging to the crew, since they were already stained by the soil and had lost the "feel" of modern specimens.

Within stratigraphically superimposed sites, these types of disturbances can severely affect the temporal integrity of the recovered materials. However, the results from both 1977 and 1980 seasons point to the horizontal displacement of occupation foci over time. The amorphous "cultural" stratum tended to be of a single temporal phase. Although deposits were probably disturbed in the space, their temporal integrity remains high. In trenches where some vertical stratigraphy was recognized, the deposits were analyzed with greater caution.

V. THE SPECIES

Ovis aries L., 1758 and Capra hircus L., 1758

Domestic ovicaprines are present throughout the sequence at both sites (frequency: tables 24 and 27; age: tables 25 and 32). Most of the remains were identified as simple sheep/goat. At Novačka Ćuprija, only a single fragment (from pit 2) was identified as probably goat. All of the other specimens were either sheep or sheep/goat. The percentage of ovicaprine remains varied from phase to phase, without any definable patterns (27.9% - Baden sloj; 31.8% - EBA pit/28.1% - EBA pit and sloj above pit; 26.4% - Late Bronze Age urn and floor). No significant temporal trend was obvious in the percentage of ovicaprine remains. There was also a great deal of variability in the importance of ovicaprine remains from context to context. It ranged from a high of 66.6% (EBA pit 3) to a low of 25% (EBA pit 1). Each of the deposits was excavated and collected in a similar manner. Recovery method can, therefore, be ignored as a source for these differences. If anything, ovicaprine remains are inflated at the site vis-a-vis Balkan unsieved collections. Loose teeth from sheep/goat (n = 107) comprise the largest single group of remains (53.5%) of these two species (tables 27 and 28).

Among the small, hard bone elements (n = 16; 8% of ovicaprine remains), which fuse early in life, our sample is much lower (table 28). This group of elements is much more difficult to distinguish between ovicaprines and roe deer. They tend to be underrepresented, since any which are difficult to identify are assigned to the various size-classes. However, in this case, this was not so. However, these elements in particular are nearly absent among the sheep/goat/roe deer and medium mammal data, with the exception of a single medium mammal calcaneus found on the Late Bronze Age floor. Foot bones of sheep/goat are present in the deposits, but in smaller than expected proportions. None of the small, hard elements had been chewed, but 25% of this group had been weathered (n = 4). This may be taken to indicate that the distal ends of the limbs were more extensively weathered than any other major body part. The adequate sampling design, in conjunction with the data on weathering, implies that distal ends of limbs were not discarded elsewhere, but were differentially destroyed through excessive exposure. Other data on attrition reveals that only two limb bones (a late fusing end and a shaft) had been chewed by canids. In the Baden sloj, a single tooth and 1 late fusing end were found with weathering marks. Three pieces (2 from the EBA pit and 1 from the Baden sloj) had butchering marks. Two pieces were also modified (1 each

in the EBA pits and sloj above the pits). The shaft of a tibia was polished, possibly for use as a tool handle.

The early:late fusing ratio for bone ends was found to be highly unbalanced in the EBA pits (13:3) and Baden sloj (6:1) in favor of early fusing ends. The Late Bronze Age features (0:1) and the sloj above the pits (0:1) contained too small a sample to make any conclusions about attrition. The whole long bones were both found in the EBA pits (a radius and a metacarpal). Because of the inferential evidence for attrition among the post-cranial remains (long bones and small, hard elements), I feel that they are inappropriate data for reconstructing age profiles. Element categories must be more resistant to destruction. Mandibulae and loose teeth fit the criteria better. Both of these latter two sets of elements. Yet when each set is calculated separately (table 32), the results vary widely (e.g. adults are 70% among the loose teeth and 37.5% among the mandibles in the pits). Not all age groups are represented in any single element category. That is why a number of element areas need be combined to produce a harvest profile. Unfortunately, no single set of body parts produced a adequate sample of age classes. The post-cranial yielded either adults or more ambiguous sub-adults/adults. Only among the loose teeth, are the data spread through each of the major age-grades for each chronological-contextual

deposit. In each deposit, loose teeth remains of adults were predominant (equal or greater than 70%). The percentage of sub-adults followed as a distant second (except in the Baden sloj, where they are absent - probably due to the small sample size). In the EBA pits and sloj deposits, juveniles follow closely in third position (c. 12%). None were found among the remains from the Late Bronze Age urn or floor deposits. When this distributional pattern is compared with the combined totals of all elements/deposit-type, we see broadly similar results. This, probably, is a function of the large contribution that loose teeth make to the ovicaprine sample. In effect, they swamp the quantitative contribution of all other elements. Choosing between conflicting data sets is always difficult. In this case, it would appear that certain groups of elements (e.g. mandibles) are particularly biased, considering the gaps in the age distribution vis-a-vis the loose teeth data. The absence of all age groups in the Baden sloj and juveniles and sub-adults in the sloj above the EBA pits and in the Late Bronze Age features is indicative of poor preservation, especially when considered with respect for the loose teeth data in which there are no such gaps. Double-counting among the loose teeth (or the possibility that two or more loose teeth came from the same jaw) is not considered likely here. The sample was not so

overly large that I was able to check for this possibility by comparing each fragment. If the loose teeth or the combined element data are used to construct the harvest profile, it is apparent that little temporal change is taking place. Adults, and their by-products, are emphasized (i.e. milk and wool).

At Crkvina, 24 bones and bone fragments were identified as sheep (n = 3; 3.1%) or sheep/goat (N = 21 + 2 articulated ulnas; 21.8%). No goat remains were recognized, a not unusual situation in small samples. They are invariably rare in European assemblages and will appear regularly only in large samples. At Novacka Cuprija, the single goat bone was a proximal end of a 3rd phalanx (sub-adult/adult) from pit 2. The overall ovicaprine sample (24.9%) is slightly lower than in contemporary deposits at Novačka Ćuprija (28% - EBA pits and slcj above pits). In contrast, pigs and wild fauna are slightly more frequent at Crkvina. The proportion of early:late fusing elements (4:4) is balanced at Crkvina, again in strong contrast to the pit deposits at Novacka Cuprija (13:3). In the latter site, attrition is much more extensive. The loose teeth remains are also more in balance with the small, hard elements at Crkvina (8:4) in comparison with those from the pits deposits at Novačka Ćuprija (50:5). Conditions of better preservation, lower rates of fragmentation and attrition existed at Crkvina for deposits similar to those from Novačka Ćuprija. Mandibles and

maxillae at Novačka Ćuprija were alsc more likely to have become fragmented in the pits than at Crkvina. This would have increased the relative frequency of loose teeth in the assemblage of the former site (49% - EBA pits at Novačka Ćuprija; 33.3% - Crkvina pit). The age distributions are poorly documented at Crkvina due tc the small sample size. It is interesting to note that both the loose teeth and post-cranial remains reveal a similar pattern - 1000% adult. Only single immature vertebra was identified, yielding a total element mortality distribution of 9.1:90.9% immature:mature. This distribution differs markedly from that in the contemporary depcsits at Novačka Ćuprija, but is very similar to the Baden slcj depcsits (11.1:88.8%). This similarity is probably a functicn cf the small quantities of ovicaprine bones involved in both sets of deposits. Two of the loose teeth, 4 small, hard, 3 early fusing, 1 late fusing and 2 mandibulae were burnt. 1 early fusing and 1 vertebra were butchered.

Bos taurus L., 1758

At Novačka Ćuprija, domestic cattle are the most frequent species in all deposits. The only exception was in pit 3 where ovicaprine remains predominated. This was probably due to the very small sample size in that context. Cattle represent 38.6% of the total remains from the contexts under

consideration, varying between 29.2 (pit 1) and 44.2% (sloj above EBA pits), with the exception of pit 3. As with sheep/goat, there are nc obvicus temporal trends in the data. Relative frequencies of cattle fluctuate narrowly between 38.9% (EBA pits and sloj above pits) and 35.3% (Late Bronze Age features), with the Baden sloj yielding percentages (38.4) similar to those from the Early Bronze Age. The higher than usual cattle frequency in the sloj above the pits (44.2%) may be due to greater attrition in that deposit than in the others. The evidence for attrition among cattle remains is least within the EBA pits - 9:12 early:late fusing ratio. This proportion is more in line with expectations based upon the original proportions in a complete skeleton. Loose teeth and small, hard elements are also present in substantial numbers. Cnly in the Baden sloj are the relative frequencies of these two groups larger than the combined total for early and late fusing long bone ends. More Early Bronze Age bones were weathered in the slcj than in the pits. Overall, cattle remains survived better than did those of ovicaprines. Obviously, survival was not equally distributed among all body parts. This is most apparent when the age distribution of remains is considered. As with ovicaprines, cnly loose teeth are present in abundant enough numbers to shcw that more than one or two age classes are present. Few of the mandible were useful

for ageing since they had lost their teeth. Both the loose teeth and the combined element columns show the same basic pattern - decreasing relative frequency of adults over time, from the Eneolithic Baden thrcugh the Early Bronze Age into the Late Bronze Age (75-42.8% - locse teeth; 85.7-45.4% - all elements). The lcw frequencies of remains at both ends of this distribution does make me wcnder about the validity of this trend. But, it remains a useful hypothesis to be tested later. Its implications, if upheld, would be that the secondary products revolution (cf. Sherratt 1980a; 1980b; 1982) may not have been uniformly accepted. This is because interpretations of the harvest profile imply a change from secondary tc primary products over this time - a complete reversal of positions. Many of the cattle bone fragments were chewed (n = 6 in the pits; 7 in the sloj above the pits, 2 in the Baden sloj, 1 in the urn and 2 on the Late Bronze Age flocr), weathered (4 - EBA pits, 7 - sloj above pits), butchered (8 - EBA pits, 7 - sloj above pits, 4 - Baden sloj), burnt (4 - EBA pits, 5 - sloj above pits), polished (1 - EBA pits, 2 slcj above pits, 1 - Baden sloj), and modified intc a tocl (1 - Baden sloj, 1 - EBA pits, 1 - Late Bronze Age urn). It is interesting tc note that the distribution of burnt, weathered and butchered cattle bone is very different from the summary frequencies of all bcne (table 29 and table 30). Cattle bones, modified

as such, were limited tc the Baden sloj, and EBA pits and sloj above the pits.

Domestic cattle at Crkvina are the single most common species (n = 31; 32.3%). They are slightly less frequent than in contemporary deposits at Novacka Cuprija (EBA pits - 35.3%). The distributicn of body parts strongly contrasts with that of sheep/gcat. The lcose teeth:small, hard ratio is 3:8, a reverse situation. Considering that recovery procedures were adequate at the site and that both sets of elements are relatively wear resistant, this ratio may either indicate differential dispoal patterns (cranial parts largely disposed of elsewhere) cr lower rates of mandibulae/maxillae fragmentaticn. The possibility fo the former may be evaluated by the relative frequencies of mandibles (6.4%) and loose teeth (9.7%) in the assemblage. These values are lower than fcr comparable sheep/goat elements allowing us to rule cut fragmentation as an explanatory factor. The early:late fusing ratio is 1:2, not large enough to point tcward much of a data trend. The higher survival rate cf lower density late fusing ends is further emphasized by the larger number of vertebrae and ribs (n = 12; 38.7%) than at Novačka Ćuprija. They are the largest single category of remains. Normally, they are too fragmentary to be identified to the species level. A single whole long bone was alsc preserved. All of these data point toward a significantly different pattern of body part

survival and treatment between cattle and sheep/goat. Only a single small, hard bone was burnt. The same fragment was also chewed, weathered and polished. A specimen in the vertebrae/rib group was also chewed and 1 pelvic fragment burnt. The proportion of remains damaged by post-mortem processes is much lower when compared with the data from the EBA pits and sloj above the pits at Novacka Cuprija. The age distribution at both sites is broadly similar, in terms of immature:mature ratios - 70:30 Crkvina; 69:31 Novačka Ćuprija.

Sus scrofa dom.

Domestic pigs were the third most frequent species represented in the Novačka Ćuprija assemblage (26%). They varied from a low of 0.3% (pit 3) to a high of 33.3% (Late Bronze Age floor) in individual contexts. When the deposit with the lowest pig representation is removed from the sample, due to its inordinately small sample size, the range of representation varied much less, from 24.1 (pit 3) to 33.3% (Late Bronze Age floor). Evidence for differential attrition of the pig bones between types of deposits is apparent from the early:late fusing ratios. The highest was found in the Baden sloj (5:1), while the lowest was found in the EBA pits (6:10) and sloj above the pits (5:9). The Late Bronze Age features yielded intermediate values (5:4).

These, and the sheep/goat and cattle data, make me suspect that the EBA sloj above the pits is largely composed of unrecognized pit units. The two yield very similar results. The proportions of loose teeth in the sample is quite high (n = 52; 29% of all pig bones), but less than that of sheep/goat (77.8%). Small, hard elements are poorly represented (n = 13; 7.3% of all pig bones), a condition similar to ovicaprines but at odds with cattle. Pigs and sheep/goat are similarly sized animals. It is obvious that even with recovery via sieving, a significant portion of the remains are lost. It is unlikely that they were destroyed by chewing, since few were observed to have chew marks. Most of the chewed remains belonged to early fusing bone ends. Only a single fragment of pig was weathered. Phalanxes, astragalii, calcaneii, carpals and tarsals are present in most of the deposits, so differential discard behavior is not a likely explanation. Probably, they were either being destroyed at greater rates because of their immature level of development or were passing through the 1 cm. sq. sieve mesh in use at the site. The latter is a more likely explanation.

The distribution of modified pig bones is also of interest. Most of the chewed bone came from either the EBA pits (n = 9) or sloj above the pits (n = 4). Only a single chewed fragment came from the Late Bronze Age features. The

only weathered fragment came from the Baden sloj. Butchered fragments were found in the EBA pits and sloj above the pits (1 and 1, respectively). Burnt pig bone was found in the Baden sloj (n = 1), EBA pits (n = 2), and on the Late Bronze Age floor (n = 1). Bone with surface polish was found only in the EBA pits and sloj above the pits (n = 2 and 1, respectively). Bone modified into tools or ornaments were found only in the Baden sloj (n = 1) and EBA pits (n = 3, including 1 also polished). A scapula with a healed puncture mark was found in one of the EBA pits. In sum, the bones with surface polish and/or modified for use were limited to the Baden or EBA deposits, whereas the other data are not contextually or temporally limited in their distribution.

The age distribution reveal a shift from predominantly immature specimens in the Baden and EBA deposits to mature specimens in the Late Bronze Age - Baden 61.5:38.5; EBA pits 61.3:38.7; EBA pits and sloj above pits 57.75:42.25; Late Bronze Age features 45.5:54.5 immature:mature. The question arises as to whether this is a spurious trend in the data or not. These proportions were determined by combining the age data from all body elements. No single set of elements appeared to be better preserved than the others for all phases and contexts. Each has some gaps in their data structure (e.g. lack of adults in Late Bronze Age feature post-cranial remains). The post-cranial data are more

poorly preserved in the sloj abcve the pits, the Late Bronze Age features and Baden sloj than in the EBA pits. The loose teeth data mirror the percentages presented above, but contain no foetal/infantile specimens. Sample size variance may have something to do with the observed trend in the data. The contextual-temporal units with the smallest samples are also thcse with the highest percentage of adults. The trend may, therefore, be spurious.

At Crkvina, pigs are the second most frequent species (n = 29; 28.1%). They are slightly mcre common than in the contemporary deposits at Novačka Ćuprija (EBA pits and sloj above pits). The distribution cf loose teeth:small, hard body parts (8:8) differs from that of both cattle (3:8) and sheep/goats (107:8). The early:late fusing ratio is 1:0. Vertebrae (n = 3) and ribs (n = 1) are less frequent (14.8%) than among cattle, but more than among sheep/goat. The loose teeth:small, hard ratio differs from that found in the Novacka Cuprija pits, reflecting the larger sample size and greater degree of fragmentation existing in the latter. Cranial/maxillary remains are mcre common among pigs at Crkvina (18.5%) than amcng any cf the cther domesticates at the site. Both sheep/gcat and cattle mandibles were more common at Novačka Ćuprija (EBA pits) than at Crkvina. A nearly complete infantile skull and articulated mandible were found in the Crkvina pit. Several bones were burnt (n

= 4, including one also weathered), chewed (n = 5, including one which was also polished and another also weathered), and weathered (n = 1). The age distribution is heavily balanced in favor of immature specimens (75:25% - immature:mature). This resembles the EBA pits and Baden sloj deposits at Novačka Ćuprija and is more or less typical of harvest profiles for the culling of pigs for meat and lard consumption.

Canis familiaris L., 1758

Domestic dog is represented by 19 fragments of bone at Novačka Ćuprija - 9 in the EBA pits, 7 in the sloj above the pits, and 3 in the Baden sloj. None were found in the Late Bronze Age deposits. Its absence in the latter is probably a a function of the small sample size, since they are present in other contemporary collections (e.g. Livade, Petnica, etc.). The distribution of body parts is relatively wide. Every major part of the skeleton, with the exception of the pelvis, is represented. Mandibles are the single most frequent element type (n = 5; 26.3% of all dog bones). This is probably due to their greater specific density and weight. 2 were found in the pits, 2 in the Baden sloj and 1 in the sloj above the pits. The percentage of whole bones is remarkably high for comparably sized mammals (n = 3; 15.8%). All of the whole long bones were

found in the EBA pits. Cattle remains produced no whole long bones, sheep/goat yielded only 2 (1%) and pigs 1 (0.5%). Only hare, a small-sized mammal, exceeded this value (n = 3; 27.3%). None of the dog bones were weathered, chewed, burned or otherwise modified by human or natural processes. They were, obviously, treated in a different manner than those of the more obvious food animals. It would appear that they were not eaten and were buried rather quickly after death in refuse pits or areas of the site. They were not buried in separate mortuary sites all of the time. Occassionally this may have been so (e.g. at Mokrin), but never consistently. All of the ageable specimens belonged to the adult category, with the single exception of a infantile/foetal fragment.

At Crkvina, domestic dog was the fourth most frequent species (n = 4; 4.2%). They were slightly more frequent here than in any of the Novacka Cuprija deposits (2,8% average for the site). The body part distribution is limited to a single loose tooth and 3 long bone fragments (1:2 early:late fusing). All of the bones were burnt. All were from adults. The significance of the burnt dog bones at Crkvina is unclear and may indicate any type of human behavior from that of a canid "roast" to accidental incorporation into a bonfire.

Equus caballus L., 1758

Domestic horse at Novačka Ćurpija is present in only small quantities (n = 10; 1.4%). It fell into fifth place in terms of relative frequency. The remains were found only in the EBA pits (n = 7) and sloj above the pits (n = 3). Domestic horse first begins tc appear in southeastern Europe after the end of the late Neolithic and it is no surprise to find examples here. Novačka Ćuprija and Ljuljaci, near Kragujevac, yield some of our earliest examples of domestic horse bones from the central Balkans. Its absence in the Baden and Late Bronze Age depcsits at Novacka Cuprija is probably a function of sample size, since they are usually only present in small fractions. All of the remains from late fusing bone ends were recovered in the pits (n = 4). Only the denser early fusing (n = 1) and small, hard elements (n = 2) were fcund in the sloj above where greater attrition would be expected. All cf the long bones were fragmented, as with similarly-sized cattle remains. Their large size, in combination with a tcne structure that enhances fragmentation, produced mcre fragmented samples among the larger mammals than among the medium- or small-sized mammalian species. One of the late fusing pit bones was weathered. None of the others were otherwise damaged or modified. All of the ageable specimens were from adults (n = 4 - all from the pits)

Two fragments of domestic horse bone were found at Crkvina (2.1%), placing them in 6th position, tied with roe deer. It is a similar frequency to that found at Novačka Ćuprija in the pits and sloj above the pits. Both fragments were small, hard elements, undamaged and ageable only to the ambiguous sub-adult/adult category.

Cervus elaphus L., 1758

Red deer are represented at Novačka Ćuprija by only a single fragment found in pit 2 (EBA). It is a very fragmentary proximal metacarpal of a sub-adult/adult. It should be cautioned that the species identification, in this case, is not certain and should be accepted only with caution. It had been very damaged by weathering. No antler fragments were found in the assemblage.

Three separate fragment series cf red deer antler were found at Crkvina. Whether these three groups of antler originally represented a single antler was indeterminable. They included a base fragment, plus several pieces of stem and beam. Assuming that they belonged to separate antler specimens and were not shed, red deer would be the fifth most frequent species at the site (3.1%). One of the stem fragmentsburnt and the second was cut perpendicular to its long axis. The base fragment was burnt and cut and cut above the pedicle. All belonged to sub-adult/adult age groups.

Capreolus capreolus L., 1758

Roe deer are represented by three fragments at Novačka Ćuprija (0.4%). One was found in the sloj above the pits, one in pit 2 and one on the Late Bronze Age floor. The pit contained a loose tooth, the sloj above the pit a mandible and the Late Bronze Age floor a distal shaft of a metacarpal. The first two fragments were from adults, while the third was from a sub-adult/adult.

Two loose roe deer teeth (2.1%) were found in the Crkvina pit. Both were from adults. They are more common here than in Novačka Ćuprija.

Lepus capensis L., 1758

Eleven fragments and whole long bones of the European hare were found at Novačka Ćuprija - 8 in the EBA pits, 1 in the sloj above the pits, and 1 each in the Late Bronze Age features. Three of the specimens from the pits were whole long bones. The three early fusing and one late fusing fragments were also found in the pits. One each of the small, hard bones were found in the pits, sloj above the pits and Late Bronze Age features. None were weathered, damaged or modified. Only a single piece from the pits had been burnt. 5 post-cranial fragments were found in the EBA pits, 1 post-cranial in the sloj above the pits, 1 post-

cranial in the Eneolithic Baden slcj. Three of the post-cranial remains from the pit were sub-adult/adults and the 1 Baden fragment was unageable. All the rest were from adults.

Mustela putarius

Two fragments of a weasel (a mandible and part of a cranium from the same individual) were found in pit 2. The remains of this species may have been intrusive.

Microtus sp.

A femur shaft of a vole was found in the sloj above the pits and may be intrusive.

Talpidae (family)

A cranium of a mole was found in pit 1 (juvenile?) and is considered intrusive.

Rodentia sp.

A pelvis of an unidentifiable rodent was found in the Baden sloj and is considered intrusive.

Unio sp.

112 pieces of mussel shell were collected at Novačka Čuprija. Most came from the EBA pits (n = 99), while the

remainder came from the sloj above the pits (n = 4) or the Baden sloj (n = 9). In most of the deposits, they represented a small fraction of the remains. But in pit 1, they were 19.1% of the organic remains (n = 47). This pit was also unique in that hare wand human remains were overly frequent. The mussels were probably carried some distance from either the Jasenica or Morava rivers or came from a presently dried up water source. None could be found along the modern stream.

Helix sp.

Six pieces of snail, plus several pieces of closely related forms (n = 13) were also found distributed through Novačka Ćuprija. Most came from the EBA pits and may have been accidentally included in the deposits. No evidence for consumption of escargot could be extracted from the data. They may have been naturally present on the ancient surface or in the bottom of the pits when they were filled in.

Other shell species, as yet unidentified, included a few marine-type species. Two specimens were perforated , to be worn as ornaments.

Homo sapiens sapiens

Human bone was found mostly in pit 1 (EBA; n = 3). None were articulated, weathered, chewed or modified. A few

crania were found in sonda 22, but were unassociated with any cultural remains. The pit 1 remains included a two scapula and a proximal shaft cf a femur. One of the scapulae belonged to an individual under the age over 30, but clearly that of an adult. No lipping around the margin of the glenoid socket was visible. The second belonged to an individual under the age cf 40. No clear triangular area around the medial end of the spinous process was visible. Both were definitely from adults based upon the strength of spinous process develcpment. The femur shaft included the pilaster, a bony buttress which often develops in response to bowing. It belonged to a fairly robust individual with strong muscle markings. The individual was, presumably, adult based upon the size and circumference of the shaft, the thick cortical layer in the bone, and the overall robusticity of the specimen. The trebeculae system was very dense. This may indicate a younger adult, since the trebeculae at the proximal end cf the bone become less dense (more spongy looking, with more space between them) as age progresses.

Aves sp.

Several fragments of bird bones from the pits at Novačka Čuprija and Crkvina were found. Unfortunately, they include the remains of modern chickens. The significance of this

identification, checked independently by other faunal analysts, is that either downward movement of the remains of smaller species occurred through a variety of mechanical and organic processes, such as rodent and tree root action or that there was little contextual integrity of all remains. The former is considered most likely given the high visibility of root and rodent holes running throughout the deposits. Given that the remains were stained by the soil (evidence that they spent some time in the soil), it is not likely that they belonged to mid-day meals of the crew.

VI. CONCLUSIONS

No fish remains were found at the site, despite flotation and wet-sieving activities. This may be a function of its location or the local economy. Novačka Ćuprija is situated above a small stream and several kilometers from the nearest running or standing body of water of a larger size (i.e. the Jasenica River). This is in contrast to Neolithic sites, such as Vinča and Selevac, which are located in the proximity of rivers. The latter sites yielded fish bones in varying quantities. Petnica, which also overlooks a small stream, yielded some small fish bone. But, only in the finest of sieves (1.0 mm). This is much smaller than the smallest sieve utilized at Novacka

Cuprija (3.0 mm). The total absence of fish may, therefore, be partly attributable to reccvery methodology at the site.

The absence of red and roe deer antler, plus the overall paucity of cervid remains at these sites may imply that either these species were not explcited at the site or that the remains were dispcsed in a different part of the site. The latter is considered less likely since the sampling design of the excavation allowed for testing of a wide variety of site sections. If deer were not exploited at the site, this could imply that either the site was not cccupied during the part of the year when deer would have been favored prey or that cervids were no longer an important facet of the overall subsistence system. The evidence can be read either way in this case. The presence of red deer antler in the Crkvina deposit implies that the sites were cccupied during the colder parts of the year (if it had been attached to a cranium). The absence of any roe deer antler would imply that the sites were not occupied during the warmer mcnths, when they carry a full rack. Such a seasonal pattern of cccupation is consonant with the seasonal movement of herds to be argued in later chapters. The absence of warm weather-specific species, such as pond turtle, at the site may be negative evidence for such a situation. Alternatively, the lack cf cervids and summer-time active species in the partly ccntemporary Svetozarevo sites (chap. 9) may imply that either recovery procedures in

the latter did not collect such specimens or that they were occupied at similar times of the year. The former is considered less likely (see chap. 9).

CHAPTER 9: THE ZOOARCHAEOLOGY OF THREE LATE BRONZE AGE SITES NEAR SVETOZAREVO

I. INTRODUCTION

Three late prehistoric localities near the city of Svetozarevo in Central Serbia will be discussed in this chapter - Sarina Medja, Vrbica and Večina Mala (Ill. 2). Each contains deposits dating to the late Bronze Age (Bronze D and Halstatt A - Reinecke) or the transitional period to the early Iron Age (Halstatt B). They will be considered together because of the near contemporaneity of deposits, similarity of depositional contexts and surrounding habitats, geographic proximity, and the small sample sizes contained in each. A brief discussion of the surroundings, dating, history of research, and the excavations will be presented, to be followed by the zooarchaeological analysis. The deposits are contemporary with faunal collections from Livade (Mala Vrbica), Novačka Ćuprija (Grčac), and Petnica (Valjevo). They represent examples of assemblages found in a lowland context, overlooking a floodplain environment, but in relatively close proximity to the rolling forested hills of Šumadija (Central Serbia) and the mountains across the river in East Serbia.

IA. Sarina Medja I

Sarina Medja is a multi-period prehistoric locality on the southern periphery of the city of Svetozarevo. It lies on a loess terrace between Djurdjevog brda (Georges hill), the Lugomir river, and an old terrace of the Velika (lower) Morava river. the Lugomir is a left-bank tributary of the Morava. The site overlooks the present-day floodplain of both watercourses. Until recently, the surrounding flatlands were annually flooded as the melting winter snows and summer rains fed the mountain tributaries of the Lower Morava, causing them to swell and overflow their banks.

Archaeological research at Sarina Medja began in 1967 (Vetnic 1967) and continued sporadically until 1977 (Stojić 1981; 1982). Approximately 1,000 sq. m. of surface area has been excavated over this time. The excavations revealed the presence of a narrow (70 meters wide) scatter of settlement debris (daub, ceramics, and bone) and features (pits) extended along the terrace for ca. 300 meters, in a north-south orientation. Two major find spots were distinguished - Sarina Medja I and II. Sarina Medja I is the earlier of the two and is found in the central part of the terrace (Stojić 1981: 141; 1982: 33). Our analysis will deal with the material from this part of the site.

The cultural horizon extended from the surface to a depth of 40-50 cm. Artifacts within this layer were, in general, disturbed by post-occupational activities (e.g. ploughing). Most of the artifacts in this layer could be typologically dated to the early and late Iron Ages. These were mixed with sporadic occurrences of Kostolac (Eneolithic) and Vatin (Middle Bronze Age) ceramics (Stojić 1982: 33, 37; Vetnic 1967). No clear stratigraphic divisions were noted during excavation of this layer, a widespread situation among settlment layers at Bronze Age sites (e.g. Crkvina, Novačka Ćuprija, Livade, Petnica, etc.). Five pits extended into the lighter colored sub-soil, beneath the cultural horizon, to a depth of 1.80-2.0 m. The tops of the pits and the surfaces from which they were cut were lost in the disturbed upper horizon. The earliest pit dated to the Vatin group. The second pit contained Paracin-like ceramics (Middle/Late Bronze Age). Both were extensively damaged by agricultural activities. The faunal materials from these two pits were not analyzed and will not be further discussed (Stojić 1981: 141; 1982: 33, 39). The three remaining pits were undamaged and represented sealed "in situ" deposits dating to the late Bronze Age and the transition to the Iron Age (Reineck - Bronze D and Halstatt A and B; M. and D. Garašanin - Iron I and II - Stojić 1982: 33). These pits are considered by the excavator to have been of a residential character - possibly that of semi-subterranean structures (pit houses,

"zemunica"). This conclusion is based upon the presence of domestic or midden-type debris (ceramic and bone) and house daub in all of the pits. A row of post-holes (25 cm. diamters) running through pit 1 and a possible "threshold-like" entrance leading into the same pit are used as additional evidence for its residential character (Stojić 1982: 33).

Pit 1 resembles a half dugout. It is ellipsoid in shape (3.7x2.4 m), with almost vertical walls. Two different surfaces, 15 cm. apart in depth, were distinguished, but the artifacts found on them were not collected separately. The feature was entered from the southwest, through a depression (2.4 m long). Between the depression and the pit lay a low bump which, according to Stojić (1981), served to prevent rain water from seeping into the pit. The row of post-holes were found toward the entrance (Stojić 1982: 33-34). Pit 2 lay only 2.6 m. from pit 1, had a truncated cone-like form (2.5 m. diameter) and extended to a depth of 2.8 m. On the western edge lay a later intrusion. 20 alternating layers of ash and soil were found in the pit, containg ceramics and bone. The lower levels are considered to have been dwelling floors, while one of the upper is thought to have been used for cultic/ritual activities. Finds above this layer indicated that the pit was, in its upper layers, used for refuse disposal. Pit 3 consisted of two mutually related

pits (4x2.2 m. - length and width). In the northern section, it was very shallow, while in the southern end it was much deeper and cylindrical in form (Stojic 1982: 33-35, fig. 1 and 2).

The residential hypothesis of pit function warrants closer examination. Semi-subterranean residences or structures have been popular constructs in the literature on prehistoric Europe. They are known, ethnohistorically, from Europe and other areas of the world. For example, semi-subterranean areas in Iranian houses were used for stabling domestic animals and storing foodstuffs (Kramer 1979). There is a reconstructed semi-subterranean weaving hut on display at the experimental farm near Orvelte, Netherlands (pers. obs. - 1981; Clason 1984, fig. 3). A wide range of activities may take place in these features. Just because they may resemble, even superficially, known structures and contained daub, ceramic and bone is by no means indicative of residential activities within the feature. All are commonly found in midden deposits. Rows of post-holes may be an indication of some superstructure within or above. It may also have been simply part of a fencing arrangement to keep out children and/or animals. Data from the Butser Farm experiment in England indicates that doorways in prehistoric (Iron Age) houses would be "...marked by a shallow depression /not a bump/ caused by walking in and out of the

house in wet weather and splashing away material" (Reynolds 1979: 36).

IB. Večina Mala and Vrbica

Two other nearby localities were recently excavated by Milorad Stojic of the Savedjanski Muzej, Svetozarevo (pers. comm.). Večina Mala and Vrbica are nearly contemporary. They overlap in time and slightly post-date Sarina Medja I. Vecina Mala dates to Reinecke's Halstatt A and is situated near the village of Majur. Vrbica falls into Reinecke's Halstatt A2 phase and is found near to the village of Dragovcvet. Both of these late Bronze Age localities exhibit stratigraphic conditions similar to those found at contemporary settlements - a very disturbed cultural layer extending about 1/2 meter down from the surface and pits cut into the deeper non-cultural sub-humus layers. At Večina Mala, a single undisturbed late Bronze Age pit filled with domestic refuse (ceramics, animal bone and daub) was excavated. At Vrbica, a undisturbed pit plus part of a slightly earlier (Halstatt A1/A2 transition) surface were found. The pit had cut through the surface establishing the relative stratigraphic relationship. The ceramics from both the pit and the surface were typologically dateable. Both sites are situated on small rises overlooking tributary stream and floodplain environments of the Lower Morava.

IC. Excavation Method and Recovery Procedures

Each of the samples were excavated and recovered with similar methods. Trenches were excavated by otkopni slojovi. These are the minimal excavation units, extending over the trench and usually no more than 10 cm. in depth. When a feature is enccuntered (pits in this case), it was recorded and the artifacts collected collected separately from the surrounding ctkop slcj. Excavation tools included spades and shovels. All artifacts were collected by hand after the dirt was loosened and before it was ejected from the trench. Recovery of the smaller vertebrates was adequate, as evidenced by the high proportion of medium mammal remains (e.g. ovicaprines, immature suids). However, small bones (e.g. phalanxes, carpals, tarsals, etc.), especially among the medium-sized mammals, were noticeably few implying some differential recovery by bone size. Therefore, some skewing of species frequency can be expected. No fish bones were recovered, possibly due to selective recovery methcds, since cther contemporary lowland localities (e.g. Livade) included fish bones in their assemblages.

II. TAPHONOMIC CONSIDERATIONS

IIA. Sample Size and Condition

Sarina Medja yielded the largest sample (n = 469, including shellfish fragments), while Vrbica (n = 162) and Večina Mala (n = 78) were substantially smaller (table 33). The small sample sizes, combined with the limited excavation areas, would ordinarily limit the utility of the data for paleoeconomic reconstruction. Sarina Medja fell into the moderately useful assemblage grouping, while the latter two fell into the minimally-useful group. In chapters 11 and 12, I discuss how the latter two sites are consistently at variance with the other contemporary assemblages found in similar environmental contexts. This is argued to be a function of their very small sample sizes. Nevertheless, the similar range of contexts, species and ecological positions of the sites represents a small group of samples from a limited temporal/spatial distribution. In addition, similarities between the Svetczarevo localities and other Lower Morava Bronze Age localities (e.g. Novačka Ćuprija) in context and species are remarkable. These distinguish the Lower Morava from the Serbian highlands and the Pannonian/Dacian Plains as distinct ecological entities. They add yet another dimension to our understanding of late Bronze Age lifestyles.

Only a single bone fragment from Sarina Medje I showed any evidence of surface erosion. Weathering of the sample was kept to a minimum. This is characteristic of bones derived from pit deposits. They were probably filled in and covered over relatively quickly, thereby protecting the contents from attrition through exposure to the elements. Fragmentation of the bones varied widely from site to site. At Vecina Mala, only 4% of the bones were totally unidentifiable, while at Sarina Medja I (9.9%) and Vrbica (20.8%) greater quantities were unidentifiable even to the size-level of analysis. The proportion of specimens identified to the genus/species level also varied from a high at Sarina Medja I (52.7%) to lower values at Vecina Mala (40.5%) and Vrbica (28.6% - table 33). Even with the removal of the bones found on the floor from Vrbica, it is apparent that the samples from each of the pits were different (table 34). The commonly made assumption that pit deposits are better preserved than sloj requires some qualification. Each pit deposit requires independent evaluation. Fragmentation rates will differ between pits. This is evidenced by the the varying percentages of identified remains at Sarina Medja I, Vrbica and Vecina Mala. Sarina Medja and Vecina Mala exhibit fragmentation rates more like the other hand-collected assemblages, while that of Vrbica was much more similar to sieved collections.

Considering that the same methods were employed in all three sites, it is unlikely that this reflects collection efficiency. For some reason, Vrbica's assemblage was more highly fragmented than comparably collected assemglages. Sources of fragmentation include the annual freeze/thaw and wetting/drying processes, plus breakage by humans and other organisms (e.g. dogs). Not all elements were equally affected. The bones of some species and age groups were more heavily fragmented than others.

The sites also varied, albeit less so, in the domestic:wild ratio. Sarina Medja I contained the highest ratio (98.1:1.7), while Vecina Mala (96.5:3.4) and Vrbica (90.9:9.1%) yielded slightly lower values. The ratics from Večina Mala and Vrbica may be indirect functions of their smaller sample sizes which resulted in inflated frequency values for rarer species. Red deer are a good example. Rarer species would normally make up only a small proportion of large assemblages. But a single specimen in a small sample yields a higher percentage than a single fragment in a large assemblage. Red Deer did not vary very much in absolute quantities from site to site (table 36). Contemporary localities near Smederevska Palanka (Novačka Ćuprija) yielded similar values, while highland and Danubian localities contained greater quantities.

IIB. Attritional Processes

There are a variety of natural and cultural forces which destroy or break-up bones, thereby affecting the value of the assemblage. During analysis of the bones, evidence for bone surface destruction by weathering, water-smoothing, chewing, burning and butchering were noted. Only a single weathered specimen was found, implying good preservation and lack of exposure after intial deposition. The bones were not exposed for any significant amount of time after they discarded. None were water-smoothed but many bones were chewed, burnt and/or butchered (tables 34, 37, 38 and 39). The high frequency of specimens with slice marks is indicative of lack of exposure to running water. For example, Shipman (1983) found that the most diagnostic part of butchering marks disappear when the bone has been rolling around in water for 5 or more hours. The differences between units, in terms of proportions, are not very great when corrected for sample size variance (table 34) and indicates a similar behavioral origin for the assemblages - domestic refuse disposal. None appear to have been the result of a special activity, such as ritual or industry, which would have set it apart. Whether the pits were initially used for dwelling, for digging daub, or something else is of little concern. Their final function was for refuse disposal. Few people prefer to live on top of their

own garbage, although some may clean out their residences more frequently than others (e.g. McGovern 1979).

Pit 1 from Sarina Medja I differed from the other deposits in several ways. The frequency of chewed bones was proportionately less (n = 2; 0.7% - table 34), while the absolute and proportionate values of butchered bones were higher than in the other pits and sites. Also the percentage of bones identified to the species level was highest in pit 1. This is indicative of a lower rate of bone fragmentation. The number of cooking vessels in pit 1 (e.g. pots with sieves) are another distinguishing feature (Stojić 1982: 35). For some reason, scavengers (e.g. dogs) were kept out of this pit more than the others, while cooking remains were dumped within. Pit 2, with its supposed ritual levels, does not stand out in any way from the other pit deposits. Pits 1 and 3 had similar proportions of burnt bone, while pit 2 had far less.

III. THE SPECIES

Ovis aries L., 1758 and Capra hircus L., 1758

Domestic ovicaprines are present only at Sarina Medja I (frequency: table 33; age: table 35). Only domestic sheep could be positively identified at the other sites.

Ovicaprines were most common at Sarina Medja (42.5%), and of substantially less importance at Vrbica (20.5%) and Večina Mala (13.8%). The presence of goat at Sarina Medja may simply be a function of the larger ovicaprine sample size (n = 100), which approached values large enough for the rarer of the two species to become more visible. At Sarina Medja I, a 6.9:1 sheep:goat ratio existed. When some of the more dubious elements originally assigned to goat are removed (i.e. 5 vertebrae), a 18.33:1 ratio is achieved. When only post-cranial fragments are considered, a 18.5:1 ratio ensues. The consistently high sheep:goat ratio is characteristic of other Bronze Age assemblages (9:1 - Ljuljaci, chapter 6). Element distribution analysis revealed that all major segments of the skeleton were present in each of the sites - cranial, trunk, limb and podial - but differed slightly from context to context. The age distribution for the Sarina Medja ovicaprines revealed that adults were most common. Immature fragments were most numerous only among the post-cranial elements (45%). Loose teeth and other cranial elements de-emphasize the immature proportion in the assemblage. When only post-cranial specimens are considered, the age ratio is as follows - 16.1:16.1:67.3 (juvenile:sub-adult:adult). All of the sexed sheep specimens were female according to criteria set forth in Boesseneck (1969). They include 6 pelvic, 3 cranial, 2

epistropheus and 1 metacarpal fragments. The age distribution for the female specimens was 1 juvenile (11.1%), 2 sub-adults (22.2%), 3 sub-adults/adults, and 6 adult (66.6%) fragments. Most of the females were, therefore, adults. The absence of male sheep may indicate that they were slaughtered elsewhere or, and more likely, they were culled out of the herd at very early stages of development. If the former was correct, it would support the argument in the final chapters for a pattern of herd transhumance (movement between upland and lowlands). The males would be slaughtered at relatively young ages in the highlands. If the latter scenario were true, it may be because the morphologically diagnostic sexual criteria may not have yet appeared. But females were visible, unlike the males who would not be in the former model. Females would have had a better probability of survival to adulthood than males. The age and sex distributions are relatively similar to mortality curves where nearly all of the males are slaughtered at early ages for meat, while most of the females are kept alive into adulthood. They are culled when their utility for herd reproduction and/or production of secondary products (e.g. wool and milk) decreases. A small pool of adult males would be retained into adulthood for breeding purposes. Wool sheep are known from figurine representation in the Bronze Age (Bokonyi 1974b; Sherratt

1980b). The shift in age distributions from predominantly immature to mature between the end of the Neolithic and the Bronze Age is another signal of this change. The low values for immature age groups at Sarina Medja are not a direct reflection of attritional processes working on the assemblage. A larger percentage of bone was burnt, contributing to bone destruction, but late fusing bones and bones with a low specific density, such as vertebrae, are very common. In general, the state of bone preservation was very good. A few hornless sheep specimens (n = 3), based upon the morphology of the epistropheus, were found in pits 1 and 2. Few bones were measurable, limiting analysis of size ranges. But using Zalkin's (1961) quotient for withers height for metacarpals, a value of 60.75 cm. (= 4.86 /quotient/ x 125.0 /metcarpal length/). This measurement would fall at the lower end of the Bronze Age samples from Hungary (Bökönyi 1974a: 171, fig. 49) and is probably from a female. Cross-plots of metacarpal proximal breadth versus depth measurements placed the Sarina Medja specimens in the center of the Hungarian and Serbian Bronze Age samples. Most of the ovicaprine butchered specimens were vertebrae (table 37). Not all pits at Sarina Medja had equivalent distributions of butchered remains.

From Vrbica, the body part (table 36) distribution of sheep and sheep/goat fragments is quite diverse, including

cranial, limb and podial elements. No vertebrae , rib, or distal podial elements (e.g. phalanxes) were found, although several rib fragments (n = 10) were grouped among the medium-sized mammal sample. The proportions of early:late fusing elements is 3:1 indicating, as with the absence of vertebrae and phalanxes, attrition of the assemblage from erosion and recovery methodology. Two chewed fragments were found in the pit. None were burnt. All the ovicaprid materials came from the pit. None were found on the floor (table 34). The age distribution resembled that of Sarina Medja - 20:20:60 (juvenile:sub-adult:adult). None could be assigned to either sex.

At Večina Mala, two well-preserved sub-adult sheep bones, plus two sheep/goat (1 sub-adult/adult and 1 adult) elements were identified. None showed any evidence for butchering, burning or chewing.

Goat remains were clearly identified only at Sarina Medja. Initially, 9 specimens were assigned to the species, but 5 of the specimens were cervical vertebrae assigned to goat on the basis of criteria suggested in Boessneck (1969). When these more ambiguous elements are removed, only 3 were clearly assignable to goat. The only definitively ageable fragment was that of an adult horncore. The others could have fallen into either sub-adult or adult

groupings. Such small quantities cf data cannot be reliably interpreted.

Bos taurus L., 1758

Domestic cattle are found at all three sites. They are the second most frequent species after ovicaprines at Sarina Medja (32.3%). They follow pigs at Vrbica (34.1%) and Večina Mala (17.2%). Nc aurochs fragments were identified, although they are occasionally enccuntered in other late Bronze Age localities (e.g. Petnica). They were either no longer present in the region cr were no longer exploited as a food source, in strong contrast to the earlier Neolithic pattern. These sites, also, continue a trend noticed in other Bronze Age samples (e.g. Ljuljaci), where domesticated pigs (with the exception of Sarina Medja) are fast becoming as or more common than cattle. The cattle at each of the sites were relatively small in stature and in an advanced state of domestication. Scattergrams cf measurements (breadth versus depth of proximal metacarpal) from Sarina Medja revealed that both males and females were present (Ill. 21). The two groups in the scattergram can be separated into twc slightly overlapping size ranges, similar to those from the earlier Bronze Age locality of Ljuljaci in the Kragujevac hinterland to the west. Equal numbers of both sexes were present in the scattergrams. Few of the cther elements were well enough preserved to yield

statistically reliable samples cf measurements. This is in strong ccntrast to the sheep measurement distributions, where largely females were visible in the scattergram.

At Sarina Medja, where cattle frequencies are more abundant, the age distribution is heavily biased toward adults (63.6%). Attrition of the cattle assemblage is apparent from a comparison of the early:late fusion ratio of long bone ends (16:8). In the skeleton, the normal ratio is 5:11. It is obvicus that the later fusing pieces, which are fragile for a longer period of time, are missing. 11 fragments were chewed and 3 burnt. Most of the chewed fragments come from pit 3, prcbably because the discarded bones were not buried quickly. The only piece with evidence cf weathering came frcm pit 1. Most of the butchered remains were found in pit 2. Some of the younger immature specimens may have been lost, but the more wear resistant sample of loose teeth indicate a largely adult sample. Cattle remains were scattered throughout each of the pits in varying quantities.

At Vrbica, limb, podial and cranial elements were found. Cnly early fusing and small, hard elements were recovered from the site. Only two small, hard fragments were recovered from the flcor (a carpal and a cuboid). Attrition through erosion was proably extensive in the pit and floor

deposits, considering the early:late fusion ratio. As at Sarina Medja, most of the bones were adult (66.0%), while the remainder were sub-adults (33.3%). The carpal from the floor was burnt, while a distal tibia from the pit was butchered. 3 podial elements from the pit were gnawed.

At Večina Mala, 5 fragments from diverse areas of the body were found in the pit. They included cranial, limb and podial elements. None were burnt, chewed or butchered. Only 1 distal radius could be measured. An even split between the sub-adult and adult population is observable in the age distribution. This is probably a reflection of the relatively good preservation (0:2 early:late fusion) and small sample size.

Cattle at each of these sites were not slaughtered at early ages in any great numbers. Most of the remains were those of adults. Any skewing of the assemblage by erosion and other sources of attrition would not have altered the age distribution greatly, since even in the more wear-resistant categories of elements (e.g. mandibles at Sarina Medja). Adults are represented by at least 50%. Mortality curves for cattle populations with large numbers of adults usually are more invovled in exploitation of secondary (milk, draught), rather than primary products (meat).

Sus scrofa dom.

Domestic pigs are the most frequent species at Večina Mala (58.6%) and Vrbica (36.4%), but only in third rank at Sarina Medja (20.8%). They are small in size based upon the measurements (breadth versus depth of distal tibia and breadth versus diamenter of proximal radius - Ill. 17) which place the specimens from Sarina Medja and Vrbica, respectively, at the lower end of the domesticated size distribution when compared with Bronze Age Ljuljaci. None were wild, once again in strong contrast to Ljuljaci and Livade, but like Novacka Cuprija. They were probably adult female specimens considering their small dimensions. The dominance of females in the assemblage is also supported by the canine data which showed only 2 females (1 adult and 1 sub-adult/adult).

At Sarina Medja, most of the pig remains came from pit 1, followed by pit 2 and finally pit 3. However, in terms of species proportions, pigs are much more common in pit 2, nearly equalling cattle and surpassing ovicaprines in frequency. If only this pit had been excavated, then pig remains would have been inflated, as in Vrbica and Vecina Mala (table 34). Sampling strategies are a constant source of variance in species representation. Most of the maxillae and mandibulae fragments were found in pit 2, while all ribs, vertebrae, and loose teeth and most limbs came from

pit 1. Maybe we are observing a spatial dichotomy in the distribution of discarded remains. In pit 2, one bone was both burnt and gnawed, while in pit 1, 2 pieces were burnt and butchered, respectively. The distribution of early:late fusing elements showed some skewing. But it would be further reduced if the whole bone sample would be included. The ratio would be nearly even then. Among the medium-sized animals (ovicaprines and pigs) attrition of the assemblage through exposure appears to have been minimal. Even fragile remains of immature animals are present and intact. The age distribution reveals that only 10% of the specimens were adult. The rest were immature, with juveniles (37.8%) as the largest component. The slaughter of piglets is supported by all categories of data. The age distribution corresponds to classic examples of mortality profiles from meat production economies.

At Vrbica, pigs are found on both the floor and the pit. Only a humerus shaft and rib fragment were found on the floor. A larger variety of specimens came from the pit. 3 fragments from the pit and 1 from the floor were gnawed. None were burnt or butchered. The early:late fusing ratio for the site is 1:2, but 1:1 for the pit. It is not a large sample, but does show indications of some skewing. 80% of the sample is immature, very reminiscent of the larger sample from Sarina Medja.

At Večina Mala, a wide range of elements were identified (cranial, trunk, limb and podial). 3 were chewed, but none were burnt or butchered. The early:late fusion ratio was 7:4, which combined with the chewed sample indicates attrition. All of the ageable specimens were juveniles or sub-adults. The prevalence of sub-adults and lack of adults may be construed as a function of problems of sample size and diversity.

Canis familiaris L., 1758

Domestic dog is found at Sarina Medja (1.7%) and Večina Mala (3.4%). They are frequently found on archaeological sites in small numbers. When compared with the Hungarian Bronze Age material (Bokonyi 1974b), these dogs fall into the smaller half of the size distribution. The data from Ljuljaci were roughtly similar. Balkan Bronze Age canids were smaller than those from the more northern plains. At Sarina Medja, they are unequally distributed throughout each of the pits - 2 metatarsals (sub-adult/adult) in pit 1 and 2 mandibles (adult) in pit 3. One of the pit 1 fragments was burnt. None were butchered or gnawed. Dogs were eaten occasionally in prehistory, as evidenced by occassional burning or butchering marks (cf. Clason 1981). Their main function, however, appears to have been as watchdogs and for herding. At Večina Mala, a single unmodified adult mandible

was identified. It was a medium-sized animal, based upon the length of the P1-P4 row.

Equus caballus L., 1758

Domestic horse was the last of the domesticated species to arrive in the Balkans before Roman times. They are found at Sarina Medja (0.8%) and Večina Mala (3.4%). All of the specimens were adults, who were prcbably involved in traction. At Sarina Medja, cne loose tooth and one post-cranial fragment were found in pits 1 and 3, respectively. The piece from pit 3 was burnt, indicating that horses were, at least occasionally, eaten after their usefulness as a pack, draught or riding animal ceased. At Vecina Mala, the single pelvic fragment was unmodified (adult).

Cervus elaphus L., 1758

Red deer are found in low quantities at each of the sites - Sarina Medja (1.3%), Vrbica (9.1%), and Večina Mala (3.4%). They were occasionally explcited in larger numbers in the late Bronze Age at highland sites surrounded by dense forests (Petnica) or alongside rivers with gallery forests (Livade). This occurred even with the shift from a stone/bone tool technclcgy tc a metal-based one. None of the bones were made intc tools. The deer were probably hunted for their meat and maybe hide, but not bone for

tools. At Sarina Medja, all were found in pit 1. They included a proximal metatarsal (sub-adult/adult) and 1 antler (adult) fragments. The 2 proximal metatarsals were butchered, while the antler stem was burnt and fragmented into 10 pieces. At Vrbica, a metacarpal and antler stem fragment were found in the pit, while two sets of antler stems and beams were found on the floor. All were from adults. None were burnt, butchered or chewed. A measure of the distal metacarpal placed it within the smaller end of the size range of Bronze Age cervids. It was probably from a female, since there is about 20% difference in body size between the two sexes. At Večina Mala, a single chewed adult distal metatarsal was found. It also fit into the smaller end of the size range.

Capreolus capreolus L., 1758

Roe deer was found only in pit 1 at Sarina Medja. It was an unmodified distal humerus (adult).

Homo sapiens sapiens

A single fragment of an adult human femur was found in Večina mala (proximal end). It was not modified in any way.

Helix sp. and Unio sp.

Remains of snails and mussels were found at all of the sites. This is not unusual since the former were gathered throughout the area and the latter whenever sites are located near rivers. The latter attests to exploitation of aquatic resources. The absence of fish, in such cases, may not be a function of their absence from the subsistence system.

IV. CONCLUSIONS

All three of the sites discussed in this chapter show relatively high states of bone preservation. Small sample size, however, make the proportional representation of the species somewhat unreliable. This is most obvious with the data from Vrbica and Večina Mala. In the concluding chapters (11 and 12), they will be shown to deviate significantly from the other lowland Bronze Age sites. It is probably a result of such unpredictable variance built into the data set. As at Novačka Ćuprija, cervidae are minimally represented. Red deer antler are present, but roe deer antler are notably absent. This may be taken as an indication that they were not important components of the subsistence system and/or the sites were not occupied during

the part of the year when roe deer would have carried their antlers. Probably both are factors in this case. Occupation of these sites during the colder weather would be consonant with movement to the more temperate uplands during the summer. Ovicaprines and cattle appear to have been exploited for secondary products. Having discussed the data based in the preceding chapters, I will now turn to a more general consideration of palececonomic trends during the late Neolithic.

CHAPTER 10: PALEOECONOMIC TRENDS DURING THE LATE NEOLITHIC

I. INTRODUCTION

Reviewing the evidence for late Neolithic animal husbandry and exploitation is a daunting task. Zooarchaeological research has had a very long history of development in Europe, extending back more than a century (see references in Bökönyi 1974a). Unfortunately, very little research has been undertaken in the central Balkans. The vast majority of the information on prehistoric economies in the region has been accumulated only within the past two decades by a few dedicated researchers. The questions studied and the quality of research varied widely between the different faunal analyses. An analysis of the faunal research conducted to date may suggest lacunae in the data and profitable directions for future research. In this chapter, I will review the late Neolithic data collected during this research and consider it in light of previous research undertaken by others.

The central Balkans (Ill. 2) is that part of the Balkan peninsula encompassed by Central and Southern Serbia, the southern Banat and Srem sections of the Vojvodina, eastern Bosnia and Yugoslavian Macedonia. All of these regions fall within the boundaries of the Federal Republic of Yugoslavia. It happens, for the most part, to coincide with the geographical extent of the late Neolithic Vinca culture (Chapman 1981) and some of its closely related neighboring cultures (e.g. Butmir). The focus upon this geographic unit to the exclusion of western Bulgarian and south-eastern Romanian evidence is a function of the dearth of data from these areas. Few if any comprehensive faunal reports were available for these other regions.

The temporal limits of this study are those of the Vinča culture - c. 4500-3300 B.C. (Chapman 1981; Garasanin 1983; Tringham 1971). This period of time is frequently subdivided into an earlier Vinča-Tordoš and later Vinča-Pločnik (Garašanin 1973; 1983) or into Vinča A, B, C, and D phases (Milojčić 1949). Further subdivisions of these phases are commonly offered. Unfortunately, the faunal analyses of most of the sites are rarely presented separately for each phase. Sites have been largely analyzed as single temporal units, even when stratigraphic subdivisions are apparent.

Only six archaeological sites from the study area and time period under consideration yielded significant quantities of faunal remains - Anza, Obre II, Divostin (Bökönyi 1974b; 1976; n.d.), Gomolava (Clason 1979), Petnica and Opovo. In the first section of this paper, problems inherent in the interpretation of the various samples will be discussed. In the second section, a species by species site comparison will be undertaken to determine the potentiality of paleoeconomic reconstruction. In other words, once the biases are recognized, can we still offer conclusions on the paleoeconomy of the late Neolithic. In the near future, a few more collections will become available enriching our comparative data base - Selevac (A. Legge - pers. comm.) and Vinča.

II. PROBLEMS IN PALEOECONOMIC RECONSTRUCTION

IIA. Chronological Problems in Assemblage Comparison

Most of the samples drawn upon here are either earlier or later in time than the others (table 40). Anza IV dates to the earlier phases of the Vinca group - to the Vinča-Tordoš or Vinča A-B phase (Gimbutas 1976). Obre II contains a late Neolithic Bosnian ceramic group (Butmir) closely related to

the Vinča group. Obre II is contemporary with the middle phases of the Vinča group - from Vinca B1 through Vinca C/D1 (Benac 1979: 455). Divostin II represents the final phases of the Vinča culture in central Serbia and includes some levels post-dating the occupational sequence from the original Vinca type site (Chapman 1981; McPherron and Srejović 1971). Petnica's earliest levels correspond to Vinča B. The Vinča C levels include thick deposits associated with a row of houses. The Vinća D horizon is sparsely distributed over the site. The Vinča levels at Gomolava began during the the latter half of the Vinča-Tordoš phase and continue through the Vinća-Pločnik (Vinča B-D - Brukner, Jovanović and Tasić 1974: 112). Opovo appears to have been more or less contemporary with Divostin II (Prikić and Bukvić 1980). Obre II, Gomolava and Petnica include nearly contemporaneous sequences of occupation (Middle to Late Vinča), while Opovc and Divostin slightly post-date them. Anza IV is the earliest and, as will be shown, stands out in other respects as well.

IIB. Geographic Variability in Site Location

The term "Balkan" is an apt descrition of the environmental context. It derives from the turkish word meaning "chain of mountains". Within such a region, each

valley is a microcosm in and of itself, frequently exhibiting entirely different sets of environmental parameters from the neighboring valley systems. High and low topographies are juxtaposed quite close to each other. Based upon criteria such as temperature, precipitation, vegetation, and topography, it is possible to divide the region into three major ecozones:

1. Mediterranean Zone - Anza is located in the relatively arid environs of Yugoslavian Macedonia. Its climatic regime is more that of the Mediterranean than central Europe. It lies adjacent to a small river in a long, fertile mountain valley;
2. Temperate Upland Zone - Obre II is also situated in a fertile valley bottom nestled among the high mountains of Bosnia. Climatically, it and the rest of the settlements belonged within the temperate central European regime. Divostin and Petnica are found amidst the forest and topographically dissected plateaus of Central Serbia. The well-watered undulating hill country of central Serbia lie half-way between the high mountain forests of Bosnia and southern Serbia and the fertile lowland plains of Pannonia; and
3. Temperate Lowland Zone - Gomolava and Opovo are located in the low-lying alluvial plains of Pannonia,

surrounded by small streams, marshes, ponds and rivers. The vegetaticn is adapted to soils with high moisture levels.

The geographic variability helps tc explain, somewhat, the presence/absence cf certain species. For example, the high proportion of ovicaprines at Anza is traceable to the Mediterranean-type climate. In the wetter, northern forests, pigs and cattle are predominant.

IIC. Problems in Data Presentation

The results frcm several cf the published excavations were grouped in ways that limit re-analysis. Stratigraphically subdivided assemblages were combined to increase sample size. Frequently, Early and late Neolithic levels are presented together. Shifts in species over time are noted in the majority of cases, but changes in the proportions of age and sex ratics from period to period are not. This limits the possiblities for recognition of temporal in the age and sex data. It is also difficult to link up particular phases of a culture group with the stratigraphic data that is available. For example, at Obre II, the fauna from Sonda VIII are separately enumerated for each stratum (or otkop sloj). Sterud and Sterud (1974) assigned most of the upper layers cf this sonda to the

Eneolithic Baden-Kostolac group, while the faunal report placed it within the late Neolithic Butmir phase (Bökönyi 1974b). The lack of agreement between Sterud and Sterud (1974), Benac (1973; 1979) and Gimbutas (1974a), as to the cultural affiliations of the various occupational phases at Obre II, does not help to untangle the situation. It is not possible to re-analyze several of the faunal collections with new questions in mind, since they were not curated (i.e. Obre, Anza, and Divostin).

IID. Assemblage Size and Species Diversity

From half of the sample (Anza IV, Divostin II, and Obre II), the total fragment count of identified and unidentified specimens is unknown. The following discussion will, therefore, center upon the identified fraction (table 41). A species by species breakdown by occupational phase is available from Petnica, Opovo, Anza IV, and Divostin. From Gomolava, the discussion includes the entire Vinca stratum and is not divided by obvious internal stratigraphic divisions. At Obre II, it is difficult to align the occupational phases with the strata summaries of the major species from Sonda VIII (see above).

Two of the sites (Obre II and Divostin II) yielded substantial quantities of material from the period under consideration. The rest of the sites were characterized by much smaller assemblages of identified remains. Of these latter sites, Anza IV had the largest while Petnica exhibited the smallest.

There appears to be a positive correlation between assemblage size and species diversity. The larger the sample, the greater is the likelihood that rarer species will be found. Rare species may appear in relatively small data sets, but it is only when the sample reaches certain quantitative levels - usually several thousand fragments - do the less common forms begin to appear regularly. Nevertheless, the rare the species the less important they probably were for subsistence. It may not have mattered much ot the analysis to lose them in the small samples. It is possible to see a positive correlation between the sample size of mammalian bone fragments and the number of mammalian species. Several factors may intervene to affect the normally linear relationship - e.g. recovery procedure, preservation of material, etc. Petnica, which has the smallest sample size, has a greater species diversity than Opovo probably because of the more rigorous recovery methods. At Gomolava, the excellent preservation found in the deeply buried Vinca levels enhanced the survival

probability of even fragile remains. In contrast, the deposits from Divostin II and Anza IV lay close to the surface and were subjected to the destructive forces of nature.

III. ECONOMIC STRATEGIES IN ANIMAL EXPLOITATION

When we begin to compare economic strategies in animal exploitation between the six sites, one might be led to inquire as whether we will be comparing "...apples and oranges..."? Unfortunately, the answer is "yes" - to some extent. The best and only response to such an inquiry is that there is little else available from the region. In years to come our repertory of knowledge concerning economic strategies during the late Neolithic will be enhanced by the analysis and publication of more material from the on-going projects at Petnica, Opovo, Gomolava, and Vinca. Since these will be available for some years to come, it may be useful to consider the evidence already gathered as a guide to future research. Contemporary data from Hungary, Bulgaria, Romania and Greece show essentially different pictures of development reflecting local cultural and environmental variables. Given the geographic spread of the sites, it is possible to assess the effect of the different

environmental contexts upon modes of exploitation. This section will present some of the detailed faunal evidence for each species to determine the various patterns of species utilization.

IIIA. The Domestic Stock

All the domestic species present during the late Neolithic had been domesticated in earlier phases. Cattle were probably domesticated during the early Neolithic from local Balkan populations (Bökönyi 1974a; Boesseneck 1962; Murray 1970). Pigs may have been domesticated earlier - during the Mesolithic - from local populations. Dogs were domesticated during the Upper Paleolithic from local populations (Bökönyi 1978a; 1983; Musil 1984). Sheep and goats were the only non-local domesticate, arriving in the region at the onset of the early Neolithic from the eastern Mediterranean. During the Eneolithic and Bronze Age, a new species (horse) and breeds of older domestic species (milking cattle and wool sheep) are thought to have appeared (Bökönyi 1974a; Sherratt 1980a). It is not until Roman times that domestic birds and other new species and breeds appear in substantial quantities (Bökönyi 1974a; 1983; 1984).

Domestic cattle are, with a single exception (Anza IV), the most common domestic species found in late Neolithic deposits. At Anza IV, ovicaprines are most prevalent. By the late Neolithic, a great deal of time has elapsed since initial domestication. Domestic forms have decreased in size and become more gracile. This helps in distinguishing one from the other. Some overlap is observable in the measurements, where the larger domestic bulls and smaller aurochs' cows form a continuous line. Wall thickness of the long bones, development of muscle insertion points and the specific weight of the bone aid in determining which are domestic or wild (Bökönyi 1974a; 1974b: 67). Cattle are most frequent at Obre II (65%) and Divostin (63%) and least at Anza (16%). Differences between assemblages are traceable to three processes:

1. Recovery quality - at sites where hand-picking was more casual, many of the smaller bones ended up on the back dirt (e.g. Divostin and Obre II). Unsieved soil dumps at Petnica, Gomolava and Vinca were personally examined and found to contain relatively few whole or fragmentary bones. Hand collecting of bone samples functions to shrink the percentages of the smaller species at the expense of the larger. This is most obvious at Obre I, where the results of two teams with different excavation goals were

compared. Cattle remains were 13% higher in one group (Bökönyi 1974b);

2. Environment - Cattle are not as well-adapted to the arid and hot climate of the Mediterranean as ovicaprines. This is reflected in the difference between Anza and the rest of the assemblage situated in a more central European climatic regime; and
3. Mode of exploitation - The age and sex ratio of a species provides the best indicator of the pattern of resource use. Cattle can be bred for a variety of purposes (traction, milk, meat, hide, bone and horn by-products).

At Obre I and II, most of the adult cattle horn cores and metapodia belonged to oxen. Most of the males were slaughtered at a younger age. A few were kept to maintain the herd stock. Such a sex and age distribution may be more characteristic of production for meat. But this will depend upon the percentage of infantile and sub-adult males. Some evidence for castration is present from Obre II in the ossification retardation of the metapodia and the thickening and twisting of the horn cores (Bökönyi 1974b: 68-69). From Divostin, adults are the dominant age group (greater than 60% in the combined phases). Their relative frequency increases slightly during Divostin II, as do the number of mature specimens, by about 5%. Sub-adults form the next

largest age group. Young (infantile and juvenile) specimens were rare, reflecting the fragility of their bones. Unfused elements do not withstand weathering very well. The cow:bull ratio, based upon the measurements, was 1:1. This pattern suggests a differing production emphasis than at Obre II. It has been suggested that the cattle at Divostin were raised for meat plus some other activity - e.g. traction, wealth and/or a status-related activity (Bökönyi n.d.: 4). Age distributions for the cattle are provided for all phases combined at Anza. The early and middle Neolithic levels are grouped together. Bökönyi (1976) considers the emphasis upon adults at Anza to be a result of attritional biases. It is likely that the frequency of immature specimens would have been larger. Analysis of the sheep element distributions also revealed significant under-representation of the younger age classes. This is probably the case for cattle as well (Bökönyi 1976). At Petnica, we see a change in cattle importance from 19.5% (Vinča B) to 34.7% (Vinča C) to 33.6% (Vinča D). Part of the variation is sample size, with most of the elements deriving from the middle phase. Where all fragments are included, the production emphasis would seem to fall upon adults. But most of the immature specimens survived among the post-cranial material, reflecting production of meat. Adult cranial fragments swamped the other categories. Analyses of the material from Divostin and Anza are probably victims of

the same conditions - differential survival of body parts by age group. The age distributions from Gomolava and Opovo are based upon the mandibulae, unless there was some obvious bias selecting against its preservation. The mandible is one of the densest elements and survives the forces of attrition better than many other parts. It is also easily recognized as a bone and well-collected even in hand-recovered assemblages. It, therefore, may provide a fairly accurate estimate of the mortality curve of the population (cf. Payne 1973). These two lowland localities provide an excellent opportunity to minimze the environmental variable and to look for common responses to habitat exploitation. Cattle during the late Neolithic of southern Pannonia, Central Serbia and probably elsewhere were probably exploited largely for their meat, hide and bone by-products (as determined by mortality curves - cf. Payne 1973; Hesse 1978; and bone tools - Bačkalov 1979).

Domestic sheep and goats may be put to a variety of uses (meat, hide, wool and milk production). The age and sex distributions will vary accordingly. The proportion of sheep/goat varied from a high of 67% (Anza IV) to a low of 2% (Opovo). All the rest had fewer than 11% . The essential distinction lies in the drier Macedonian environment. Sheep, except in some areas of the dry loess plateaus of the Carpathian basin, are rarely common on

temperate European sites. Their natural habitat did nct include the wet, forested environments to the north of the Mediterranean. Following domestication, they were never very successful beyond the open grasslands. At Obre II, the sheep:goat ratio is approximately 4:1. Most sheep were slaughtered at an immature age - as juveniles and sub-adults. No mature or senile specimens were found. A small pool of breeding adults was maintained. It may be concluded, based upon the above, that domestic sheep were raised and slaughtered primarily fcr their meat. The majority of goats were also juveniles and sub-adults. More adults were present than among sheep. A few mature and senile individuals were also found. The slightly larger pool of adult goats may point to scme milk production, in addition to meat (Bökönyi 1974b: 73-76). At Divostin, the sheep:goat ratio was 8:1. Most male sheep were killed before their first winter (infantile and juvenile) or as sub-adults. Surplus males were consistently selected out early, leaving a small residual pocl of breeding females. Based upon the horn cores, 23% cf the sample belonged to adults. Production was oriented primarily for meat.

Among goats, mcst were slaughtered as juveniles and sub-adults. As at Obre II, there were a few more adult goats than among sheep. A few mature and senile specimens were present. Milking remains a pcssiblity among goats (Bökönyi n.d.: 7). At Anza, ovicaprines are the most common species.

Among the bones sorted into either sheep or goat (less than 10% of the ovicaprine sample - 1,377 out of 14,100 fragments), a 6:1 sheep:goat ratio was established for Anza I-IV (Bökönyi 1976: 326). Among sheep, no females and only males were slaughtered before their first winter. 80% of the females and most of the remaining males were killed as sub-adults. Only 7.8% of the males and 20% of the females survived into adulthood, leaving a small breeding stock. Most of the animals were killed as juveniles and sub-adults, with the former represented by higher frequencies (Bökönyi 1976).

Identifying very immature ovicaprines to the more specific genus/species taxonomic levels is extremely difficult in the absence of cranial remains. The high frequencies of such remains at Anza made such a task possible. Based upon the above age distributions, it would appear that sheep were kept exclusively for meat at Anza, as at Obre II and Divostin. Goats revealed a strong bias toward adults. It is recognized that immature bones were more poorly preserved. The original analysis noted that it is unlikely that weathering and other attritional forces would have destroyed such a large section of the sample (Bökönyi 1976: 329-330). As a result, the pool of adults would have been even larger than among sheep. The sample size from Petnica is very small (n = 17; 2.9%). Only four

fragments were identified to the species level - 2 goat and 2 sheep - and all derived from the Vinča B levels at the site. In the later Vinča layers, only undiagnostic sheep/goat fragments were recognized. Only 1 infantile, and 1 adult sheep and 2 sub-adult/adult were identifiable to the species level. The other sheep/goat elements contained six adults and six sub-adults/adults. The seeming importance placed upon adults and by implication upon their secondary products may be a function of either the small sample size or of a different set of activities in surrounding localities. The former is considered the most probable explanation, since Petnica conforms in all other respects to the general pattern of animal explcitation found at the other localities. Until the more recent excavation years at Petnica are fully analyzed (1983-1985), the latter conclusion cannot be fully evaluated. From Gomolava and Opovo, the mortality curves are, once again, remarkably similar. Sheep and goat could not be distinguished (Clason - pers. comm.). The majority of mandibles from Gomolava and all of the elements from Opovc that could be aged were slaughtered before adulthood. Such mortality distributions are reminiscent of production profiles for meat. At Gomolava, the division of the sample intc diametrically opposed age classes - juvenile and adult - compares well with milk production profiles. the presence of a number of very young juveniles (ca. 3 months; n = 7) reinforces such

speculation. The differing emphasis in caprovine production may be attributed to the greater importance of goat over sheep at Gomolava (3:2 goat:sheep - Clason 1979) versus Opovo (1:4). The samples, however, are too small to be considered statistically reliable. The greater emphasis on ovicaprines at Gomolava (8%) as opposed to Opovo (3%), if not attributable to sample size variance, may be traced to the moiser swampy conditions that surround the latter. At the former, the soil is slightly better drained, with fewer standing bodies of water.

Domestic pigs are invariably raised for their direct protein contribution to the diet. Most archaeological samples, once attritional variables are understood and accounted for, yield classic harvesting mortality profiles for meat production - 80% or more immature. A small breeding population will consist of mostly adult sows, with a few males. From Divostin I and II (early and late Neolithic), 80% of the domestic pigs were immature (mostly juveniles and sub-adults, with a few new-born). The remainder were adults. No mature or senile specimens were noted (Bökönyi n.d.) . From Obre II, most of the specimens were also juveniles and sub-adults. A few infants and adults were present, while mature/senile individuals were absent (Bökönyi 1974b: 79). At Anza I-IV, the vast majority of specimens were juveniles (47%) and sub-adults (40%).

Only 13% fell into the adult range. Bökönyi (1976) noted that when attritional forces selecting out a greater percentage of the immature assemblage are taken into consideration, the adult breeding stock may decrease even further in abundance. At Petnica, the age distribution of all fragments is only slightly heavier on the immature than the mature end (56.0:43.9%; n = 37:29). This is a fairly obvious example of selective destruction of the younger age spectrum. When only the mandibular remains are considered, the immature:mature ratio begins to approach that of the other sites. From Opovo and Gomolava, we see nearly mirror images in the mortality curves for domestic pigs (Clason 1979). Pigs were most common at Petnica, where one-fourth of all the trenches was sieved. The other hand-collected assemblages clustered between 10 and 16%. It is apparent that the suid remains were probably underrepresented at these localities. The low frequency at Anza IV (11.4) is a reflection of the lack of emphasis upon pigs for protein in the more arid regions.

Domestic dog is the remaining domesticated species found in late Neolithic samples. It is found in virtually every locality, although in normally small quantities - 2.6-0.3% (table 42). They appeared to have been eaten, at least occasionally, on the basis of cut marks on the bones and fragmentation of remains (Bökönyi 1974b: 82; Clason 1979: 47). Most specimens derived from adults, whose primary

roles were probably as watchdogs, sheepherding dogs, tracking and hunting animals, and pets. They also scavenged food residues in and around the settlements destroying much of the discarded bones. At Cpovo and Petnica, respectively 9.2 and 8.4%, of the bone assemblage was chewed by carnivores/omnivores.

IIIB. Wild Animals

The husbandry of domestic animals and the exploitation of wild animals are complementary segments of the subsistence economy. The presence of the former in an assemblage implies that the species in question was kept and/or herded in or near the settlement or was procured from a neighboring locality. Absence rarely occurs where domesticates are locally available. Frequency may reflect the importance to the local economy and the manner of utilization (cf. Bökönyi 1975). The presence/absence and frequencies of wild animals in assemblages may have little to do with their distributions in the wilds surrounding the locality. It may be more of a reflection of the culturally-specific tastes, needs and desires of the local inhabitants, where species are preferentially and selectively culled to provide products not found among the domestic form. The presence/absence of species may be a reflection of decisions made on the part of the hunter rather than evidence for

environmental change (cf. Garrod and Bate 1937; Saxon 1974). Some animals are available in the area only at certain times of the year. The quality of the desired product (i.e. antler) may vary from season to season and not be available when the animals wander into local hunting territories. Shed antler may be gathered and traded from group to group without having to kill the animal. It is not always necessary to "follow the pack" (cf. Burch 1972).

The interpretation of wild animal age distributions is also fraught with analytic pitfalls. There has been little agreement as to what constitutes a classic wild population's age and sex profile, what do the variants mean, and which would be most likely to end up as part of the archaeological collection (Collier and White 1976; Wilkinson 1976). Payne (1973: 28) expected that hunters would preferentially cull the weakest animals in a herd. These would be the oldest and youngest. However, these are the very groups most lacking in each of our samples. Alternative explanations must therefore be sought. All wild animal populations are subject to a host of natural pressures. The commonest non-human causes of death include carnivore predation, malnutrition and starvation from changing or severe weather conditions (e.g. drought, high snowfall, hard ice layers above forage), birth scheduling (too early or too late in the season) and disease. Infants and juveniles (less than

one year) have the highest mortality rate and lowest life expectancy (Chaplin 1977; Clutton-Brock et al 1982; Darling 1937; Geist 1971; Schaller 1977). For example, up to 60% of the lambs born in temperate and cold climates can be lost during the first season. Those that survive to the yearling stage (after the first year) have a much higher survival rate and continue to grow stronger. The rate of attrition continues to decline until middle-age, when an accelerated phase of mortality begins because of predation. The mortality curve for adults approximates a bell-shaped distribution, with few dying in early and late adulthood. Those that live to old age tend to have been the strongest and most wiley of the group. Their continued survival spreads out the tail of the age distribution over many years (Geist 1971: 290-297). These conditions are held to be true for many wild ruminant poulations. The wild ruminants, it would appear, are well-culled even before the hunter has left his village. With the exception of the spring and summer months, the very young are absent from the herd.

Hunters do not randomly collect prey. Wild animal resources are exploited according to specific variables (i.e. size and weight of the animal, ease of locating prey, non-food yield such as bone, hide, prestige, etc. - Jochim 1976: 23-24). Among agriculturalists, the need to reduce grazing competitors has also been cited. All wild animals

can yield protein supplements, but this is rarely of the utmost importance among successful subsistence agriculturalists. Prctein requirements are most efficiently satisfied by the domestic animals. Wild animals may supplement protein during periods of the year when domesitc sources are poor in quality or lacking altogether. More frequently, however, non-food yields and competition for scarce pasture and crop resources are of greater importance in determining the mode of exploitation for wild animals. This will be illustrated thrcugh the evaluation of the frequency and age/sex distribution to be analyzed below.

Aurochs are found throughout the region in varying relative quantities - from 6% (Divostin II) to 0.72% (Anza IV). The differences between lccalities can be explained in terms of two variables:

1. lccal environment - Anza lies within a zone near to the edge of the preferred environmental range of the aurochs. They prefer an open-fcrest/forest-steppe habitat with abundant pasture. Aurochs existed in the more arid environs of the eastern Mediterranean, but never in the densities found in the more temperate northern climes. The rest of the sites located with the latter zone exhibited higher frequencies; and

2. recovery procedures - Aurochs bones, which are extremely large, would be preferentially selected for in hand-collected assmeblages. Divostin I and II and Obre II are particularly good examples, since they show higher than expected frequencies when compared with Petnica, a partially sieved collection. Aurochs probably never contributed more than a percentage point or two to the sample.

At Obre I and II, the relative abundance of aurochs declines over time - a situation paralleled throughout Europe (Bökönyi 1974a; 1974b; Degerbchl and Fredskild 1970). Cows were more common than bull (11:7) based upon the metcarpal measurements. All astragalii were deemed female, while the horncores from Obre II were also heavily inclined toward females (10:3 - Bökönyi 1974b: 71). Barring differential attrition between males and females (an uncontrollable variable at this point), this pattern may abe a function of either a husbandry strategy that emphasized culling of "superfluous" immature bulls (cf. Bökönyi 1974b: 72) or the exploitation of wild female herd. If wild bulls were preferentially selected for slaughter, wouldn't they be more common in the assemblage? Preferential slaughter of females may indicate that either a) the aurochs existed under similar herd managment practices as domesticates and should not, necessarily, be treated as a simple free-roaming

species cr b) that as with other wild artiodactyls, adult males and females spend much of the year apart in separate herds or alone (Cluttcn-Brock et al 1982; Darling 1937; Geist 1971; Hesse 1978). The sex distrubution of regional wild populations is rarely biased in favor of one sex or the other. Individual herds may be oriented toward one or the other sex. Hesse (1978) has discussed some of the problems stemming from the confusion between survivorship and mortality curves. Possibly we are seeing selective exploitation of some of these single-sex herds as they enter the site's catchment territory. At Divostin I and II, most of the aurochs were adult and mature. In contrast to Obre, 9 out 10 of the horncores were male, indicating a different exploitation strategy than at Obre (Bökönyi n.d.: 5). Aurochs, in Anza IV, were very rare and reveal a more balanced exploitation of the various ages. This may be a reflection of the continued effort to incorporate them into domestic stock and rid the area of ccmpetitors and predators for crops and grazing resources (Bckonyi 1976: 325). At Petnica, the frequency cf aurochs, as at Obre II, declines over time - from 2.4% (Vinča B) to 0.3% (Vinča C) to 0.0% (Vinča D). One aurochs fragment was found in each of the Eneolithic (0.8%) and Late Brcnze Age (0.4%) levels at Petnica. All of the specimens belcnged to the adult age grouping. None were measurable. Little is known about the Gomolava sample, cther than that they were mostly adult

(Clason 1979). At Opovc, the age distribution was overwhelmingly adult (75%), although sub-adult and mature fragments were also identified. From Cpovo, we can see that animals were either slaughtered on-site or brought back for butchering, since a wide distribution of meat-poor elements was found. The major problem with aurochs and swine age frequency distributions is that the immature end may be underrepresented due to the difficulty of identifying young wild forms of numerically more common domestic forms. They are easily confused with immature domestic stock.

Wild pigs are most prevalent in the well-watered reaches of both the forested upland and lowland Vojvodina sites (e.g. Gomolava - 10%; Petnica - 5%). The more arid region surrounding Anza IV either may not have contained high densities of wild pig populations or animal domestication was sufficiently developed to relegate wild resources to an insignificant segment of the subsistence base. Recovery procedures may have biased the suid remains somewhat in certain assemblages, but it appears that local availability and subsistence requirements were more important. The only sieved collection (Petnica) from the northern sample revealed quite high wild suid values. Several old boars were found at Obre I and II. A 3:13 male:female is observable in the distal humerii measurements (Bökönyi 1974b: 78, fig. 8), while other elements provide a less

concise picture. Entire carcasses were butchered on-site at Divostin (I and II). Both sexes were hunted. Most of the remains were sub-adults and adults, although a single young and a single mature sow were also present (Bökönyi n.d.). In Anza I-IV, the age distribution is split between immature and mature specimens (Bökönyi 1976). The greater selection of younger ages here may be a reflection of herd management policies designed not to reduce local wild populations but to maintain them, since they reproduce quickly and with large litters. Male mandibulae outnumber female at Gomolava (2.5:1). All wild suids were adult, with third molars already in wear (Clason 1979). The age distribution from Opovo emphasized adults, which included both young- and middle-aged individuals. Only males were identified. Swine from Petnica varied from 2.4% (Vinča B) to 7.7% (Vinča C) to 2.8% (Vinča D). Only one female specimen was identified. The vast majority of all swine were adults. The hunting of mostly males may have been designed not simply for trophies or status-related objectives, but to avoid culling of the reproductive base of the population.

Red deer are the most common wild species exploited. They varied widely in relative frequency from highs of 36% (Opovo) to lows of 0.68% (Anza IV). The constant low value of species preferring moist, forest or open-forest environments (pigs, red and roe deer, aurochs) in Anza IV

can no longer be simply construed as preferential selection for ovicaprines. It must also reflect the low density and availability of such creatures in the surrounding region, especially with the decimation and disappearance of forested habitats. The variability within the northern sample reflects environment, local availability and local subsistence strategies. Recovery procedures do not appear to have been of great importance. In the Vojvodina, where gallery forests and marshes were extant, exceptionally high values were derived (Opovo and Gomolava). These are areas where cervids survived until recently and may have contained particularly high population densities in the past. Bökönyi (1974b) has noted that some of the largest modern specimens come from the Hungarian plains. Local economies appear to have integrated the exploitation of red deer into the subsistence cycle. Temporally-limited products, such as fat, antler, bone and hide quality, were the more important determinants. Among the highland sites, Petnica seems to stand out having a very abundant red deer sample (31%). The other sites cluster at much lower values (4% - Divostin II; 5.6% Obre II). Removal of frequency inflating elements, such as cranial and antler fragments, from the Petnica counts would further increase the value of Cervids. Petnica is unusual in that cervids remain a mainstay of the local economy through the early Iron Age, possibly reflecting

local herd management policies. Occassionally, cervids were as frequent as the most common domesticated species (i.e. cattle at Cpovo and Petnica), possibly implying an unusually intensive explotation pattern for red deer at these localities.

Humans have explcited deer in Eurcpe for several hundred thousand years. Their territcrial behavior and lack of intra-grcup social dominance hierarchies have contributed to make them poor candidates for domestication (Clutton-Brock 1981: 55). Attempts to domesticate deer may have been made (cf. Jarman 1972), but little suppcrt for such hypotheses have been found among Mesolithic/early Neolithic Balkan faunal collections (Bokonyi 1978a; Greenfield, in press). The high cervid values probably represent intensive exploitation of lccalized populations. At Obre II, Divostin I-II, Gomolava, Opovo and Petnica, all bcdy elements were found indicating that entire carcasses were carried back to the site for butchering. Shed antler were collected at Obre II and Divostin I-II. At Cpcvo, only bases still attached to the cranium were found. Very few antler pieces were found at Petnica. None were shed, but three were still attached to their pedicles. Cn the basis of the measurements, both males and females were hunted at Cpovo, Obre I and II, in equal numbers at Divostin I-II, and in a 5:4 (male:female) ratio at Gcmolava. From Anza I-IV and Petnica, the remains were too fragmentary to determine sex.

Most of the specimens were adults, with a few young and sub-adults present at all the localities, with the exception of Gomolava. At Gomolava, both mature and immature specimens were caught, but the relative proportions are unknown (Bökönyi 1974b: 85-86; 1976: 333; n.d.; Clason 1979: 48). Herd management policies are unlikely. The young were not extensively exploited, but both sexes of adults were.

Roe deer are found on each of the northern localities, It is absent only at Anza IV in Macedonia. The absence at Anza or roe deer in conjunction with good recovery strategies may imply its absence from the subsistence system, but not necessarily from the surrounding environment. Roe deer remains in the northern series of sites were never found in great quantities, probably reflecting two variables: First, recovery - their small bones as with sheep/goat easily elude discovery in non-sieved samples. The Petnica collection (one-fourth sieved) yielded the highest values (7.87%). Obre II (1.11%) and Divostin II (0.41%) were unsieved, but located in similar hilly-forested habitat (Bökönyi 1974b: 87-88; n.d.: 9). Gomolava (4.9% - Clason 1979: 48, 61) and Opovo (6.2%) were more carefully collected by hand (pers. obs.) than some of the other hand-collected assemblages, possibly Resulting in the higher values. Second, the low density and herd size of roe deer made it a more difficult prey target. It was

easier to invest energy in searching for higher yield and easier to find prey providing similar products (red deer). Age distribution in each of the samples are remarkably similar (table 43). 75% or more of the samples were adults and both sexes were usually present. At Petnica, a decrease over time from 9.1% (Vinča B) to 7.4% (Vinča C) to 5.6% (Vinča D) is observable.

The remains of at least eleven other wild mammalian species were identified among the various assemblages. They include large species, such as brown bear, which were hunted for their meat, fur and possibly status-related by-products. Bear remains were found in three of the sites from the Serbian and Bosnian highlands. Small species, such as fox, hare, badger and beaver were probably hunted for their pelts, as well as meat. Brown hare and fox were the most widespread, absent only in Anza IV and Opovo, respectively. Wolf, beaver and badger are found at only four of the sites. Beaver remains are fairly common at Petnica, reflecting the numerous swift flowing stream in the vicinity of the site and the good recovery procedures employed during excavation. Lynx, wild cat, marten, chamois and wild horse were identified at individual sites reflecting some of the geographical spread of the species and sites - horse in the lowland plains (Gornolava), chamois in the mountains of Bosnia (Obre II), lynx and and wild cat in the forested hills and mountains (Petnica and Obre II, respecively).

The bulk of evidence for the exploitation of aquatic resources during the late Neolithic falls to the artifactual inventory of the lowland sites. Fish hooks, harpoons, net weights and other fishing paraphernalia abound in the excavated samples from sites such as Vinča-Belo Brdo (Vasić 1932-36). Excavations in the lowlands (with the exception of Gomolava) have generally been conducted in the absence of recovery methods suitable for the collection of only the largest of fish bones (i.e. vertebrae of large species). Two environmental zones may be differentiated in this discussion - those in the lowland, on or near large water courses and those in the hills and mountains, but alongside stream channels. Opovo, Gomolava and Vinča fall into the former, while Petnica, Divostin, Obre II and Anza fall into the latter. Selevac would also be placed in the latter group (Tringham et al 1980). At Gomolava, few fish bones were recovered in the hand-collected or micro-sieved samples from the Vinca levels, while thousands were present in the later La Tene (Late Iron Age) deposits (pers. comm. - A. Clason, D. Brinkhuizen). Fishing was probably not a significant part of the diet at Gomolava because the Sava river was farther away from the site during Vinca times. At Opovo, only a small sample of fish bones was collected from a single visible deposit. Many more fish bones are to be expected in the renewed excavations at the site, since it was formerly surrounded on three sides by annually-flooded

marshlands, teaming with aquatic life. At Vinča itself, few fish bones were recovered from the upper-most late Neolithic levels because of post-occupational disturbances and the absence of pit deposits (pers. obs.). More substantial quantities of fish remains were found in the Eneolithic and middle Bronze Age pits. Both mussels and snails were exploited at all three of the lowland sites. The stream-side upland localities, i.e. Obre II, Divostin, Petnica and Selevac, yielded a few fish bones each. It is of interest to note that the sites with the largest quantities of fishing artifacts are also those located alongside major waterways and with the expected high quantities of fish bones. Even with good sampling of various contexts and good recovery methods at Petnica and Selevac, only a few small river fish bones were found. At Petnica, they were only recovered in the deposits subjected to water-sieving through 1 mm. sq. mesh and contributed little to the overall diet.

Evaluating the evidence for the exploitation of avifaunal resources during the late Neolithic is difficult. The major problem is that few bird remains have been found. Most likely, this is a function of collection of bones by hand, rather than by sieves. Some remains have been found indicating that birds, when available, were hunted or trapped.

IV. CONCLUSIONS

It should be readily apparent that the analysis of vertebrate remains from late Neolithic Balkan localities is problemmatic, at best. Few cf the collections were assembled in such a way that all of the taphonomic variables may be understood and eliminated, allowing a direct linkage between the data and paleoeconomy. I have tried by comparing the different assemblages to reveal some of the underlying tendencies inherent in the data and, hopefully, to enhance future research in this area by revealing the various lacunae. This is not to denigrate the earlier research projects, but to prcvide future researchers with a clear conception cf some of the difficulties in undertaking such analyses and the sometimes not-so-obvious limitations that zooarchaeologists frequently must work under. As stated earlier in this chapter, to wait until only high quality data sets are avilable would be the equivalent of starting from scratch. The data sets are of varied quality and collected with a variety cf difference research questions in mind. Nevertheless, each can be used to define lacunae and trends in the data. There is no reason to "...throw the baby out with the bathwater...". We can elicit better responses from even cur poorest data base by acknowledging its limitation and trying to correct for attritional biases. With this in mind, it is possible to

make a few general observations concerning modes of production and exploitation of mammalian vertebrates in the central Balkans during the late Neclithic. Domestic cattle production appears to have been everywhere oriented toward meat production. Only at Divcstin does a possibly divergent situation exist which may be more easily explained by attrition of the assemblage. Sheep show a mortality profile characteristic of meat exploitation, whereas goat may have also been involved in early milk production. If this was the case, calcium intake from milk products may have been assured centuries earlier than heretofore expected. Only at Gomolava, based upon the mcrtality curve among the mandibles, is there any indication that sheep production may have been shifting towards milk. This mode becomes more fashionable in the Bronze Age. Milking, therefore, may have appeared in the late Neclithic in certain limited cases. Each of the localities displays similar tendencies with domestic pigs - production prcfiles for meat exploitation. Environment appears to have played only a small role in the local emphasis on pigs, since drier Anza IV compares favorably with the other more ncrthern sites in moister climates. The sieved remains from Anza and Petnica plus the small size of the bones and the immaturity cf the sample leads to the conclusion that at Obre II, Divostin II, and Opovo domestic pig prcduction may have been underestimated.

Among the wild fauna, some of the sites show evidence for selective culling of certain age and sex groups, such as at Divostin where male aurochs were being preferentially hunted. The possibility of differential survival of male horncores at Divostin because of greater robusticity cannot be ignored. Female horncores may have been more fragmented and less identifiable. Other species appear to have been subjected to more randomized hunting patterns, such as wild pigs where both sexes were killed indiscriminantly. Red deer show some selection for non-meat by-products, since more crania belonged to adult males than females. Exploitation of wild resources was probably seasonal in nature. Collection of shed antler is easy and could take place any time. But, most would have had to be collected soon after shedding, since red deer are known to chew shed antler. After any great length of time, few if any would be left on the forest floor. None of the samples showed any indication for or against transhumance (contra Sterud 1978). The investment in architectural features during this period can be used to argue for settlement permanence. The age distribution of several of the species (such as domestic pigs at Obre II, Divostin I-II, Petnica and Gomolava) and cattle (at Divostin II, Anza I-IV, Petnica and Gomolava), include both foetal/infantile and juvenile specimens. The ageing data, based upon tooth eruption and wear and

epiphyseal fusion, implied year-round occupation of Anza, Divostin, Obre II, Petnica and Gomolava. Other evidence for settlement permanence may be found in the antler data, where attached red and roe deer antler bases were found at Opovo. It leaves open the question of transhumance, in which flocks, rather than people, are moving about. The absence of infantile ovicaprid bones at most of the sites can be construed as the result of either transhumance or assemblage attrition. In the next chapter, I will review and synthesize the material from the post-Neolithic collections presented in the body of this thesis.

CHAPTER 11: PALEOECONOMIC AND ATTRITIONAL TRENDS DURING THE POST-NEOLITHIC (ENEOLITHIC-LATE BRONZE AGE)

I. PROBLEMS IN PALEOECONOMIC RECONSTRUCTION FOR THE POST-NEOLITHIC

IA. Chronological Problems in Assemblage Compararison

The post-Neolithic assemblages reviewed in this chapter are not fully contempcrary. The sample has been divided into three broad temporal phases fcr comparative purposes. The earliest belongs to the Eneolithic (Baden-Kostolac group). Deposits from both Ncvačka Ćuprija (Bankoff, Winter and Greenfield 1980; Bankoff and Winter 1982) and Petnica (Ž. Jež - pers. comm.) yielded ceramic artifacts typical of this phase. It lasted approximately from 3300 to 2800 B.C. The second phase lumps together the Early and Middle Bronze Ages (Vinkovci, Omoljica-Pančevc, Vatin, Slatina and Paracin groups - cf. Garašanin 1973; 1983). These two phases were combined into a single unit (Early/Middle Bronze Age = E/MBA) because the exact temporal status of several large faunal deposits has not been unquestionnably resolved. The

associated ceramics only broadly resemble those from the type-sites of the period (i.e. Novačka Ćuprija) or bones found in deposits specifically assigned to an Early or Middle Bronze Age date were found to articulate with bone remains from strata belonging to the other period (i.e. at Crkvina, bone in the Slatina layer articulated with bone in the Paracin layer; At Ljuljaci, bone in the Vatin-Vršac layer (Middle Bronze Age = MBA) articulated with bone in the Vinkovci layer - sonda 12; Early Bronze Age = EBA). It is difficult to imagine how such a stratigraphic situation may have arisen if the material from the two phases were not, in some way, mixed by human or other processes of disturbance. Most likely, the excavation methodologies cut across natural layers, mixing the remains of the two periods. The third phase (Late Bronze Age = LBA) belongs to the Late Bronze Age and the transition to the Iron Age (Halstatt A/B; Dubovac-Žuto Brdo, Verbicioara IV, Mediana III, Gava, etc.; Iron Age I - Garašanin 1973). This phase includes the "developed" Bronze Age. This phase contains the largest number of sites, with the widest geographical spread. Unfortunately, the samples from each of the localities are also the smallest for the entire time range under consideration.

IB. Geographic Variability in Site Location

Within each of the post-Neolithic phases (see above), there is a broad spread of sites over the major environmental zones in the region. If I had conducted this analysis without trying to take into account geographic variability, the resulting picture would have been very skewed. This is most cogently illustrated by my initial model (chapter 1), where I was dealing with only 2 localities (Novačka Ćuprija and Crkvina) from the same basic environmental zone - lowland stream-side. With the introduction of several other data sets from a broader range of environments, I began to realize how anomolous the original two sites were. In the discussions to follow, the sites are divided into two basic environmental zones - highland and lowland. In truth, there are a plethora of micro-environments dispersed through the balkanized topography. However, the data base is not yet rich enough to control for such extreme variability. As a result, I have chosen to simplify the level of analysis by limiting the comparisons and contrasts to these two zones. When obvious exceptions to the rule are encountered, these are dealt with separately. For example, it is possible to distinguish between three different groups of lowland sites: 1. those on a major river such as the Danube (i.e. Livade) and 2. those on a stream or small river leading to the

Morava and overlooking a flood plain (i.e. Crkvina, Sarina Medja, Vrbica, and Večina Mala); and 3. those on a small stream, away from the flood plains of the large rivers, but still in the lower elevations (i.e. Novačka Ćuprija). The upland sites include Ljuljaci and Petnica. Both are surrounded by extensive deciduous woodlands, overlooking running streams and in topographically broken terrain. In each of the phases, at least one site from the uplands and one from the lowlands are available for comparison.

IC. Problems in Data Presentation

In the previous chapter, I had great difficulty in comparing the late Neolithic assemblages because of the varying formats of the tabular data. Data presented in one format were difficult to directly compare to data presented in a second. This problem was not encountered in the post-Neolithic samples. This is due to the fact that all of the assemblages were analyzed by the same person (myself). All of the samples were identified, coded and analyzed in basically the same manner. This enhanced comparability between assemblages. The earlier assemblages (i.e. Crkvina and Novačka Ćuprija) were re-analyzed after several of the other sites were already completed since my skills had improved between 1979 and 1982. All of the collections have

been curated either in local Yugoslavian museums (at Petnica, Svetozarevo, Kragujevac and Karataš) or in New York (at the City University of New York). Samples of the collections stored in Yugoslavia were brought to the United States for further anaysis.

ID. Sample Size and Species Diversity

The post-Neolithic samples display a relatively linear relationship between sample size and species diversity (table 44). The number of species increases along with increases in sample size. The same situation was true of the late Neolithic assemblages. This relationship was not expected to have occurred, since the influence of sieving was thought to enhance the species diversity. Novačka Ćuprija, Crkvina and Petnica did not automatically yield a larger variety of species, especially among the smaller vertebrates, than did the unsieved sites. Obviously, sieving is sometimes of less importance than overall sample size for such questions. The larger the sample size, the more it is able to compensate for poorer recovery methods.

II. THE SPECIES

IIA. Domestic Stock

Domestic cattle are not, in contrast to the late Neolithic pattern, always the most frequent species on post-Neolithic localities. In some sites, they are pre-eminent. In others, they are not, but they never rank lower than second. Considering the available meat from a single head of cattle vis-a-vis most of the other species being exploited, their contribution to the local diet must have always been substantial. From table 45, it is apparent that no obvious temporal trends exist in the data. In the relative ranking of species, cattle will vary regardless of time. One variable that appears to partially account for this variation is the environmental position of the site. In the Baden and E/MBA phases, both sites from the upland zone ranked cattle as second. In Petnica, red deer dominated, while at Ljuljaci it was domestic pig. In both, however, cattle frequencies were only slightly exceeded by the others. In the LBA group of sites, cattle ranked second at three of the lowland localities - Livade (on the Danube, near to riverside gallery forests and the east Serbian mountains), Vrbica and Večina Mala (both overlooking the Morava and/or one of its major tributaries' floodplain) -

and the highland sites - Petnica (surrounded by broken terrain and deciduous forests). The two Morava lowland localities (Vrbica and Večina Mala) contain such small quantities of bone that they may simply be producing spurious statistics. In the other LBA localities (Livade, Novačka Ćuprija and Sarina Medja), cattle were the most frequent species in the assemblage. At Livade, however, the data are not so clear. In the tightly dated features and pits, cattle rank second after pigs, whereas in the more poorly dated sloj, they ranked first. We may be dealing here with two problems. One, the former set of deposits are both small samples, while in the latter they are very large. Two, the difference may be attributable to differing rates of attrition for the two species in different contexts. In the more protected pit and feature environments, attrition was lower and the generally immature and structurally weaker pig bones were able to survive at a much higher rate. The reverse was true in the sloj. If the latter explanation is more accurate, then it is possible to tentatively conclude that pigs begin to overtake cattle in importance during the LBA. It is also interesting to observe that where recovery procedures were most rigorous (Novacka Cuprija and Crkvina), cattle are in first position for all phases and contexts. The assumption that bones of smaller animals would be severely underrepresented in unsieved collections is brought

into doubt here. At all the other sites, every effort was made to collect all bones visible to the eye by hand collection. It is often assumed that if pigs only slightly dominated pre-excavation assemblages and sieves were not used to collect the material, large species, such as cattle, would be most frequent in excavated samples. Obviously, this was not always the case here. Novačka Ćuprija and Crkvina in particular display data anomalous to this assumption if pigs had been more frequent (or any other comparably sized animal, such as sheep/goat). The question begins to form as to why these two sites vary in an unexpected way from each of the other samples? Are they so atypical because of sieving, environmental location, subsistence economy, etc.? Each of these variables probably played a role in this. Sieving merely emphasized differences already existing from differences in local econiche. These two sites do not lie in the upland forests (like Petnica and Ljuljaci) nor astride large river floodplains (like Livade, Sarina Medja, Vrbica and Večina Mala). The range of available resources was probably different and the resulting economic strategies pursued by the occupants varied accordingly.

While rank may vary, the relative frequencies were relatively uniform from the different localities and phases. Most of the sites yielded cattle frequencies of between 30

and 39%. Only the sloj above the EBA pits at Novačka Ćuprija yielded higher values. The low values in Večina Mala and the features and pits at Livade are probably due to their small sample sizes, while the low values in Petnica and Ljuljaci are thought to reflect their highland environment and a corresponding preference for species more adaptable to such topography and vegetation. In the two Baden samples, widely differing harvest profiles are visible (table 46). The Novačka Ćuprija sample emphasizes adults (85.7%), whereas the Petnica data does only to a far less extent (43.5:56.5%). It should be noted that if loose teeth were excluded from the Petnica distributions, the proportion of immature remains would be far greater. The absence of adults among the post-cranial specimens in conjunction with their presence among the loose teeth inflates adults frequency when all fragments are considered together. Loose teeth were included in the Novačka Ćuprija sample, since the only immature specimens found were present among them. The data, poor as it may be, if taken at face value, is reminiscent of the general Neolithic trend - exploitation of cattle for primary, rather than secondary products products (i.e. meat, hide, etc.). If the harvest profile from Petnica without loose teeth are used, then one may interpret the data to mean that secondary products were beginning to be of importance in the Eneolithic. In the E/MBA samples, a

clearer pattern emerges from the age profiles. In these cases, all fragments were utiilized. Cnly those of ambiguos ages (i.e. sub-adult/adult, unknown) were deleted. In each of the samples (Novačka Ćuprija, Crkvina and Ljuljaci), adults dominate the age spectrum (c. 63% and greater). This remains true even when the Novacka Cuprija data is divided by context (pit versus sloj above the pits). The decreased emphasis upon immature individuals, even when attritional factors are taken intc account (see chapter 8), point toward a continued reorientation in animal production, begun in the Eneolithic. The products of adult animals (i.e. milking and traction) become more important than the products of immature individuals (i.e. meat and hide). Use of cattle for meat and hide decreases, reflecting both the advent of new uses they can be put to and the rise in pig production, an animal produced exclusively for its meat, fat and hide products. The LBA, with a few exceptions, continues the trend begun in the Eneolithic - harvesting of mostly adult individuals. In most cases, 2/3 or more of the aged sample were adult. The high value for adults in Petnica, and the low values in Vecina mala and Novacka Cuprija probably reflect the small samples of aged specimens in those sites. The Livade sample represents a combination of all contexts (sloj and pits, but not features). They yielded a broadly similar pattern in the data. The major difference between

the sloj and pit data was that juveniles would have been more common than sub-adults if only the pit data had been presented.

The percentage of ovicaprine remains in the sites varies quite widely - 3.1-42.2% (table 47). The variation is partly attributable to collection efficiency and partly to local economic orientation. The former exerted a greater influence upon the data. The influence of sieving activities is very strong among the ovicaprine data, in contrast to the cattle remains. Wherever sieving was not undertaken, with two exceptions (i.e. Sarina Medja and Vrbica) which were unusually dense and well-preserved pit deposits, the percentage of ovicaprine remains is very low (<15%). In contrast, the sieved deposits from Novacka Cuprija yielded remarkably high values. The sieving program at Petnica, although less extensive than at Novačka Ćuprija, yielded very low frequencies for ovicaprines. This may be attributable to the surrounding environment (densely forested uplands), which ovicaprines tend to avoid (cf. Geist 1971). If sieves had not been used, the ovicaprine percentage at Petnica may have resembled that from Ljuljaci. Underrepresentation of similarly sized species is obvious at the latter locality. No obvious temporal trends in the importance of ovicaprines are apparent from the data. Differences between upland and lowland sites are obscured by

the different reccvery methods employed during various excavations. In order to make the different data sets more comparable, I tried to factor out the noise generated by differential recovery methods. To dc this, I first determined the average percentage cf ovicaprines in hand-collected (22.3%) and sieved lowland ccntexts (26.4%) separately. Unfortunately, little distinction was apparent because the very high value from Sarina Medja (42.2%) inflated the unsieved mean value. If several types of contexts from the same site were present (i.e. sloj, pit, etc.), each counted separately because of the possibility of different levels cf attrition between them. If Sarina Medja was removed from the sample of unsieved sites, an average of 15.7% is achieved. This value represents only 70% of that from the sieved collections and is a more realistic estimate of the differences between the resvlts of the two methods. The sieved samples were, then, multiplied by .70 to bring them down to a level that may have existed if they had been hand collected. In the partly sieved collection from Petnica, the difference between it and the unsieved collections would have been smaller and proportional to the volume of soil sieved. As a result, the Petnica percentages were decreased by multiplying the value against .825. Only 1/4 cf each of the trenches had been sieved. Therefore, the reduction factor needed to be only 25% of the 30% reduction

used for the wholly sieved sites (.25 x .7 = .175). The essential outcome of this rather simplistic exercise was a separaton of highland (3.1-8.9%) and lowland (12.8-42.2%) values for ovicaprines. No overlap in the data now existed between the two zones. This is not a totally unexpected outcome, since sheep/goat are expected to be of less importance among the forested upland settlements. In general, they prefer open country and would not have fared as well among the dense forests of the central Balkans. Hence the increased emphasis upon forest loving species (pigs, swine, red deer, etc.) in the highland sites.

The data on age distributions are also difficult to interpret (table 46). Their significance is, by no means, clear. Assemblage attrition and differential recovery confound attempts at data interpretation. For instance, in the Baden levels at Petnica, the proportion of all elements (with the exclusion of loose teeth) produces an immature:mature ratio of 60:40%. If loose teeth are included, a 50:50 ratio appears. Deciding between the two sets of data is difficult. The latter distribution is considered, in some ways, more reliable since they are less subject to destruction and the site was partially sieved. In other words, they are less likely to be underrepresenting any single age group. The Baden sloj at Novačka Ćuprija yielded a much more disproportionate ratio (14.3:85.7%).

All fragments were utilized here, since the sample of ovicaprine remains is very small. Attrition is obvious in the younger part of the age distribution. The percentage of adults should probably be lowered somewhat. Both sites, nevertheless, produced harvest profiles more in accordance with an emphasis upon adults and, by implication, their products. A wide spread in the proportion of immature:mature fragments also exists from the E/MBA sites - Ljuljaci (46:54), Novačka Ćuprija, pits and sloj above pits (30:70), and Crkvina (9.1:90.9). The Ljuljaci and Novačka Ćuprija data are more similar to each other than either are to Crkvina. This can be attributed to the small sample size from the latter (n = 11) for ovicaprines, as opposed to the former sites (n = 35 and 87, respectively). The Crkvina data can be considered to be badly influenced by the effects of small sample size. The effect of attrition on the Ljuljaci and Novačka Ćuprija data sets was discussed in their respective chapters. In sum, Ljuljaci, an unsieved collection with widespread evidence for erosion and weathering of deposits, may underrepresent the immature part of the spectrum. The extent, however, is not clear. Attrition in the sieved Novačka Ćuprija collection is less. It is probably the most representative of the collections of the original harvest profile. The lower value for Ljuljaci would push the immature proportion to around 50%. Still,

the distributions are more in accordance with exploitation patterns favoring culling of adults from the herds. Obviously, a number of young were also culled implying a more mixed pattern of herd production.

The situation in the LBA is also difficult to interpret. Differential sample sizes has little direct influence upon the age distributions (table 48). The two largest samples (Sarina Medja: n = 76; Livade: n = 67) are separated, in terms of the percentage of mature remains, nearly by a factor of 2 (64.4 and 35.8%, respectively). When only the Livade pit data (Dubovac-Žuto Brdo group) are used, the more poorly dated sloj having been removed from consideration, there is still little evidence for a positive or negative correlation between the total sample size (for a particular set of temporally defined deposits) and the percentage of mature specimens. Novačka Ćuprija which yielded the highest percentage (75%) was sieved, whereas Petnica which was only partly sieved yielded a much lower value (40%). The influence of attrition in the former assemblage (from weathering, chewing, etc.) will have functioned to underrepresent the immature part of the assemblage, but no more than at the other sites most of which showed similar levels of such attrition. The major distinction between Novačka Ćuprija and the other LBA assemblages is in recovery procedures (i.e. the use of sieves). However, it was not

expected to produce the lowest immature:mature ratio in the group. In fact, quite the opposite was expected. If sieving and assemblage attrition through weathering, gnawing, etc. cannot explain the large difference in the percentage of mature specimens, then other variables must be considered. If Večina Mala is removed from the sample because of its extraordinarily low total bone sample size (n = 78), patterning in the data becomes slightly clearer. As with Crkvina, the very small sample size functioned to randomly skew the Večina Mala data. Environmental differences in site location (highland versus lowland) begin to emerge in the data. It is possible to distinguish two groups: a. upland - Petnica (40% mature - all fragments) and b. lowland - Sarina Medja, Vrbica, and Novačka Ćuprija (60-75% mature). It is predicted that Novacka Cuprija should have produced a Neonatal-Juvenile percentage at least 10% higher due to attrition and poor conditions for bone preservation at the site. The Danube lowland site of Livade produced the lowest mature percentage (12.5% - if only the Dubovac-Zuto Brdo pit data are used or 35.8% when all contexts are combined). The dichotomy between the two sets of lowland sites (those in the Lower Morava - Novačka Ćuprija, Sarina Medja and Vrbica - and Livade on the Danube far to the east) is difficult to explain in light of the secondary products hypothesis. The former group may be said to conform to the predictions, but the latter (plus the

highland site of Petnica) does not. Questions of settlement seasonality and/or herd movement tc and from settlements will be dealt with in the next chapter and will have some bearing upon this subject.

The ratio of sheep to goats in the post-Neolithic ranges from 1:0 to 17:1 (table 49). The presence/absence of goats in the different assemblages is strongly associated with sample size. The larger the sample size, the greater the probability that goats will be present (table 50). Goat specimens are found in regular frequencies only in the larger samples. To reduce the effect of differential levels of sample size, only the larger samples (more than 500 fragments) will be discussed. The upland localities (Eneolithic Petnica - 1.5:1; and E/MBA Ljuljaci - 9:1) are not overtly distinguishable from those in the lowlands (Eneolithic and E/MBA Novačka Ćuprija - 17:1 and 8:0, respectively; LBA Sarina Medja - 6.11:1; and LBA Livade - 5.75:1). Temporal trends are also not obvious. Sexing of the ovicaprine remains is complicated by the paucity of well-preserved cranial fragments (i.e. parietal areas and horn cores). The small samples from each of the sites, especially when broken down into temporal sub-divisions, and distinguishable tc either sheep or goat, limit the use of metrical distinctions. In any single locality there are not enough bones of a single species tc put together size

parameters as a guide to defining sex groups. This may be possible, eventually, on a regional scale.

Domestic pig bones, like those of sheep/goat, are relatively small and easily missed in unsieved collections. As a result, under-representation of pigs is a likely possibility. Using basically the same method as proposed earlier for sheep/goat, the pig percentages can be somewhat corrected for the influence of sieving. The mean value for pigs in sieved collections is 28.6% (n = 4 - Novačka Ćuprija: Eneolithic, E/MBA, and LBA; Crkvina). The mean for unsieved pig remains is 33% or 26.6% (if Vecina Mala, with its tiny and obviously biased sample is omitted). The latter value is considered the more accurate of the two. Vecina Mala was omitted because it yielded an extraordinarily high value for pigs (58.6%) which inflated the mean value for the unsieved collections by 6%. This would have made pigs in the unsieved collections more common than in the sieved - a totally unexpected result (table 51). By deleting Vecina Mala, the value was brought more into line with expectations based upon sieving experiments (e.g. Payne 1972). The sieved collections were decreased by 7% (multiplying their percentages against 0.93) to bring them more into line with the unsieved values. The Petnica data should be decreased by 1/4 of the 7% (multiply percentage against 0.9825) to compensate for the reduced level of sieving activities on the site. with this correction

factor, there is little evidence for temporal or topographical trends in the data. By and large, pig were an important source of animal protein at each of the post-Neolithic sites, yielding at least 20% of the assemblage. When the Vecina Mala data are excluded, the highland sites range between c. 18 and 30%, while the lowland extend from 20.7 to 36.4%. The lowland assemblages are only slightly more varied in their dispersion, which may simply be a function of their larger numbers of sites and types of contexts.

A single trend is apparent between the early post-Neolithic sites (Eneolithic and E/MBA) and the later ones (LBA). Pigs move up in rank importance - from 2nd, 3rd or 4th position to 1st, 2nd, or 3rd. 50% of the later sites have pigs as the most frequent. Highland and lowland localities are found to have pigs in the first rank of importance. Collection efficiency (i.e. sieving) has little effect upon the percentage of pigs in the post-Neolithic. It is apparent (table 52) that a second trend also exists. As sample size decreases from a high of 3678 fragments (Ljuljaci), the corrected percentage for pigs decreases in a linear fashion to a low of 18% in Eneolithic Petnica (n = 737). It then varies somewhat before reestablishing a second pattern. Once sample sizes become less than 500 fragments, the percentage of pigs increases. The relationship between sample size and percentage of pig

remains begins as a positive correlation, later inverting into a negative one. This example exhibits some of the worst aspects of relying upon samples of widely varying quality and, therefore, reliability. Positive correlations may be completely turned around.

The pig age distribution data (table 53) is very unlike that from the late Neolithic. No direct relationship between sample size and percentage of immature:mature specimens was apparent. Instead, the data are more polarized. Samples coming from assemblages of greater than 500 fragments usually have mature percentages larger than 30%. Those with smaller sample sizes, usually portray mature percentages of 25% or less. LBA deposits at Novacka Cuprija are the single exception to this rule, possibly due to its special nature. The urn may have been a funerary or storage container. Time is a second axis of variability. The Eneolithic and E/MBA sites have 25-50% mature, while the LBA sites (again with Novacka Cuprija as the exception) range from 0-20%. Might this indicate an increased emphasis upon younger individuals or is it another example of the influence played by sample size differences? The latter is the most likely explanation, given the fact that the larger sample sizes are found in the earlier group. Different levels of attrition by age group are also demonstrable for different types of contexts. Pits are associated with lower percentages of

mature, while sloj are strongly associated with higher percentages of mature (more than 26% - table 54). A substantial proportion of immature remains are lost in the sloj deposits, making them very unreliable sources for constructing harvest profiles. The pit data are more reliable and representative of the death assemblages. Novačka Ćuprija (E/MBA pits) is the only exception. This may reflect upon the special nature of these deposits. The influence of topography is difficult to control (table 52), since both highland sites (Ljuljaci and Petnica) contained only sloj deposits, whereas contemporary lowland localities yielded mostly pits and features. This created problems for comparing the sloj deposits in the highlands with the sloj and pit deposits from the lowlands. Recovery appears to have only a slightly negative association with the percentage of mature remains. The percentage of mature specimens increases slightly with sieving (table 55), although the small sample size obscures more than illuminates the relationship. The partially sieved data from Petnica are not included to avoid further clouding of the issue. 26% mature specimens was chosen as the dividing point because it was used earlier in the sloj/pit association table. It enhanced comparability between the two association coefficients.

Domestic dogs (table 56) are widespread throughout the post-Neolithic assemblages. Their frequency is unrelated to recovery practices. Even in the smallest collections, they are present in the same range of relative frequencies (<5%). This range is not unlike that from the Late Neolithic. In most of the assemblages, many of the dog bones were whole, showing no signs of having been chewed or processed for food. Crkvina, with its burnt dog bone, may be an exception to this generalization. Adults are the dominant age group. They and pigs are probably responsible for a substantial proportion of the missing segment of the assemblage. The percentage of chewed bones in the various sites did not vary with either the percentage of dog bones or with overall sample size. Knowing the frequencies of dog bones in an assemblage does not enable prediction of chewed bone frequency. This could imply that either dogs were not solely responsible for all chew marks on sites (a likely possibility given that pigs are fed the remains of meals as well) and/or erosion and other attritional factors differentially destroy bones which have been partially gnawed over. Both are likely explanations.

The appearance of domestic horse (table 57) is one of the hallmarks of the post-Neolithic. There have been intense debates over the domestic status of horse bones found in the Neolithic collections (e.g. Bökönyi 1974a; Vörös 1981). If they were domestic, are the bones intrusive or in situ? If

they are wild, did they belong to ancestors of the European domestic horse or from a wild population that went extinct, not contributing to the process of horse domestication? By and large, a consensus has emerged with the publication of data from Hungary, the Ukraine and points farther east. The ancestors of the early domestic horses were domesticated in the steppes north of the Black Sea during the period of the Cucuteni-Tripolje culture and maybe even further east (Bökönyi 1978b; Bibikova 1967). They begin to arrive in eastern and central Europe about 1,000 years later (Bökönyi 1974a: 239). The exact timing is still in doubt and appearst to vary considerably depending upon ease of movement and distance between various parts of Europe with the Ukraine. In the plains to the north of the Balkans, they arrive in the Eneolithic (Baden). At first, they are very infrequent. Over time, they increase in frequency (Bökönyi 1978b: 30-35). In the Central Balkans, horse bones are not found until the E/MBA. Each of the Eneolithic assemblages so far examined (Petnica, Novačka Ćuprija and Vinča) did not yield any. They appear for the first time in the EBA pit deposits at Novačka Ćuprija and in the Vatin sloj and pit deposits at Ljuljaci and Vinča. Ljuljaci contained an exceptionally large number of horse bones (c. 7%). All of the other sites, including the later ones, yielded values of 4% or less. The special nature of

Ljuljaci is emphasized by the exceptionally numerous horse and wild boar bones found at the site. They are not found in similar quantities anywhere else in the study region. The implications of these finds are unclear, but a look at some of the historical sources from the Bronze Age of the Aegean (e.g. the Odyssey) and the appearance of tumulii in west Serbia (Belotić-Bela Crkva), the Vojvodina and Hungary (Bukvić 1979; Ecsedy 1979; Garašanin 1973) leads one to wonder about the formation of early elites at this time. Part of the role elites played in these societies may have involved control over modes of transportation (owning horse herds and carts - both expensive to construct and maintain as part time occupations) and exclusive rights to the hunting of certain species, such as boar. Such species were very dangerous. A successful hunt may have been a sign of exceptional prowess and the unusual deposit of boar mandible at Ljuljaci makes one wonder about such relationships. Ljuljaci's location on the summit of a "gradina" (a hill with a steep embankment, excellent for defense) may somehow be related to these other indications of special functions of the site. During the Bronze Age, horses are not overly large. Their appearance after the termination of the late Neolithic imply that their diffusion through region and acceptance as a new mode for traction and transportation were results rather than causes of the changes in

subsistence and settlement. Their first appearance is chronologically later than this event. The appearance of horse bones in the central Balkans is coincident with the appearance of large numbers of horse bones in Hungarian sites (Bökönyi 1974a). Generally, horse remains of adults dominate. A few juveniles and sub-adults are occasionally found in the larger samples (table 53).

III. WILD ANIMALS

Red deer are the most important of the wild species during the post-Neolithic (table 58). It's importance varied quite widely between sites, environments and time periods. An interesting split in the data is apparent between upland and lowland localities. The upland sites have a much higher relative frequency (15.5 - 31.2%) than those in the lowlands (0 - 9.5%). Among the latter, those with the higher frequencies are found in locations overlooking river flood plains and/or in gallery forests along the river edge (i.e. Livade, Vrbica, Crkvina, Večina Mala, and Sarina Medja - 1.3-9.5%). Novačka Ćuprija, situated above a small stream and quite a distance from the nearest river floodplain (the Jasenica), yielded the lowest red deer value (0% - Baden sloj and LBA features; 0.2% - E/MBA pits and sloj). The obvious distinctions in the

emphasis placed upon red deer in the two major environmental types is not affected by the sieved samples from Novačka Ćuprija, Crkvina and Petnica. The influence of sieving probably would have caused a decrease in the percentage of red deer, a relatively large mammal, with respect to the medium and small sized mammal species. There is no obvious relationship between species frequency and sample size either (table 59). There is some possible evidence for a decrease in the exploitation of red deer over time. The data from Petnica shows a decrease from 31.2 to 21.4% between the Eneolithic and LBA slcj. However, this is accompanied by a corresponding decrease in overall sample size. In addition, the Eneolithic red deer relative frequency at Petnica was strongly decreased by deleting the very numerous antler beam and tine fragments (n = 57) from the percentages. This reduced the percentage from 48.0 to 31.2%. None of the other artiodactyls from this or the other phases at the site produced such a large horn core/antler sub-sample. As a result, antler/horn core fragments were included in the latter species.

The red deer age data are very poor (table 74). The sites with small quantities of red deer specimens usually produced only unageable or poorly ageable fragments (e.g. sub-adult/adult - Novačka Ćuprija, Crkvina, Sarina Medja). The two sites with only a single red deer specimen (Vrbica

and Večina Mala) produced artificially inflated adult categories, since both specimens belonged to adults. The remaining sites (Petnica, Ljuljaci and Livade) contained larger samples of ageable specimens. All three produced similar harvest profiles (75 - 89% mature). The remainder were identified as juveniles or sub-adults. In contrast to the domestic species, which yielded differing highland/lowland age distributions, red deer age distributions were similar in both types of topgraphic contexts. This is a classic hunted animal distribution, where the products of adults (meat, hide, antler and bone) are highly prized. The return is maximized for the energy outlay. No cranial fragments with attached antlers were identified in the upland samples. In the lowland, they they were only found at Livade. The total absence of female crania is interesting and maybe indicative of hunter selectivity. However, this can be checked out against metrical data from the ever increasing samples from Petnica. To date, the sample of measured red deer bones from a single locality indicates that both sexes were present (table 59).

Roe deer relative frequencies (table 58) in the post-Neolithic assemblages appear to have been influenced by both recovery procedures and environment (tables 60 and 61). Roe deer is a medium-sized mammal (sheep/goat size range) whose bones are easily missed with hand collecting of bone

remains. When recovery method differences are taken into account, the upland and lowland sites can be differentiated on the basis of relative frequencies. The exception to this is Ljuljaci where recovery was less systematic than at Petnica. Ljuljaci yielded far fewer medium-sized animals (table 3). The two highland assemblages with the highest percentage are from Petnica (Eneolithic and LBA sloj - 3.6 and 4.1%, respectively). Both were partly sieved collections. Ljuljaci, the other highland locality, yielded much lower roe deer relative frequencies (1.0%). Underrepresentation of medium and small sized mammals at Ljuljaci was demonstrated in chapter 3 (table 3). With stricter recovery procedures, roe deer probably would have been more common in the Ljuljaci assemblage. If Petnica had been completely sieved, the same would probably be true of it as well. If the unsieved Ljuljaci assemblage is dropped from consideration, the division between the highland (3.6 - 4.1%) and lowland (2.1 - 0%) localities is enhanced. Among the lowland sites, the samples with the highest roe deer frequencies are Crkvina (2.1%) and Novačka Ćuprija (LBA - 1.5%), both sieved collections. All of the hand-collected assemblages produced far fewer roe deer bone percentages. Probably they would have yielded slightly higher percentages if they had been sieved.

Roe deer age distributions differ somewhat over time (table 59). The Eneclithic and E/MBA sites yield a slightly different pattern than the later LBA sites. Sarina Medja was removed from the sample because it contained only a single ageable specimen. Each cf the earlier sites (Petnica - Baden, Ljuljaci and Crkvina) produced age distributions heavily weighted in favcr of adults (100.0, 87.5, and 100.0%, respectively). In contrast, the two LBA samples (Livade and Petnica) produced far lower adult percentages (40.0 and 60.0%, respectively). The implication of such a dichotomy is unclear at present and may represent the culmination of several processes (e.g. temporal change in exploitation strategies, uncontrolled variance due to small sample sizes). As yet, no obvious relationship between sample size of ageable roe deer remains and percentage of adults is apparent between sample size (large sample = more than 10 fragments) and percentage cf adults (tables 62 and 63). The LBA sites, which yield fewer roe deer specimens, are associated with lower adult relative frequencies. Petnica (Baden sloj) and Ljuljaci, two of the three earlier sites, were associated with higher adult percentages. Crkvina, the other earlier locality, yielded only two fragments of ageable remains. It was not considered, along with Sarina Medja (n = 1), because of the extremely small sample size. The low positive asscciation between sample

size and percentage of adults lessens the strength of the relationship between the latter and temporal trends in the data. In all probability, the percentage of adults in each of the periods was quite high (more than 75%), as among red deer. Human predators would have favored adults since they yielded the largest return for the energy invested. Only adults, and males in particular, would have produced all the desired products. The absence of female crania, as with red deer, is interesting in light of this conclusion.

Aurochs were present in only four of the post-Neolithic sites (Petnica - Baden and LBA, Livade and Ljuljaci). Only in the latter site were they found in any substantial frequency (n = 27) - see table 64. Their relative frequency is unaffected by recovery methods, since their large size ensures high visibility and probability of recovery even in hand collected assemblages. Sample size, in contrast, appears to have a more direct influence upon their presence/absence. They are positively associated with large assemblages (more than 500 fragments - table 65). Only LBA Petnica, with a smaller sample size, included aurochs remains. All of the other smaller assemblages did not. Having a large sample size, however, does not guarantee the presence of aurochs in the assemblage (i.e. Novacka Cuprija - Baden and LBA deposits). But, having a small one almost certainly predicted their absence. It is also interesting to note that the samples which produced large samples and

which were completely sieved did not yield aurochs remains. In contrast, those that were only were not or only partly sieved and which had large samples did contain the remains of aurochs. The site of Novačka Ćuprija may simply be an anomaly in this case as evidenced by uncommon data in many other respects (i.e. domestic:wild ratio). Aurochs appear to have persisted throughout the Eneolithic and Bronze Age in the central Balkans in the more marginal locations (uplands and in gallery forests along river edges). In these habitats aurochs may have differentially survived due to the increased ground cover and less competition from domestic animals and humans. In contrast, in the more open and settled areas of the lowlands they quickly disappeared. Each of the fragments found belonged to ambiguous age categories (sub-adult/adult - table 66).

The presence/absence of swine seem to be somewhat affected by sample size. Taking the small sample size into account, their presence may be associated with larger sample sizes (table 67). Also, each of the sites with swine present in the assemblage (table 64) are located in the uplands or on the Danube (Petnica - Baden and LBA sloj, Ljuljaci and Livade). A similar topographical distribution was found with aurochs. Each of the collections revealed the same basic age distribution. Adults dominated in each case (83% and greater - table 66). Little variation is visible in adult relative frequencies implying that the

conditions of swine hunting were basically similar in each of the habitats. They were probably hunted for meat, hide, trophies, etc. Ljuljaci yielded an extraordinarily large number and relative frequency of swine remains. Most of them came from a single trench (no. 12), outside of a house. The implications that can be drawn from this deposit were discussed in the chapter on Ljuljaci and need not be repeated here.

Bear remains were found in only three sites (Ljuljaci, Petnica - LBA, and Livade - 1.2, 2.1 and 0.1%, respectively). They are found in both large and small assemblages. The co-occurrence of bear, swine and aurochs is very interesting and may be suggestive of the very limited habitats of such animals in the post-Neolithic (table 68). They have probably retreated in the face of increasingly dense human settlement to refuges with dense cover and more limited human exploitation. Bears, who prefer forested uplands, can still be occasionally sighted in the mountains of Central and Eastern Serbia.

Beaver remains are found only in two sites (Ljuljaci - 0.2%; Livade - 0.1%). They are found in very small absolute frequencies as well (n = 3 and 1, respectively). Their presence is probably a reflection of surrounding environments suited to beaver exploitation, but in their

absence it is difficult to argue for the opposite. Both Ljuljaci and Livade fall into the larger sample distribution. Beaver remains are found only in the two sites with over 2000 fragments and may be affected by differential sample size on a larger scale. The remains from both sites could only be aged to a sub-adult/adult group.

Hare is another species found in the post-Neolithic assemblages. It is found on four sites, two in the E/MBA (Ljuljaci - 0.05%; Novačka Ćuprija - 1.7%) and 2 in the LBA (Novačka Ćuprija - 2.9%; Livade - 0.3%). They are found mostly in the larger assemblages. The only exception is LBA Novacka Cuprija, which was also sieved. Both upland and lowland sites are present. Recovery methodology and sample size are of some importance in determining presence/absence of hare remains, but not the only source of variation (table 69).

At least four other species were found in the post-Neolithic assemblages (excluding bird and fish). These include badger (Ljuljaci: n = 6; 0.3%), vole, weasel and mole (Novačka Ćuprija). Any and all of these species may have been intrusive since they are burrowing animals.

Bird remains were found at Novačka Ćuprija (Baden - 1.2%; E/MBA - 0.2%; n = 1 and 1, respectively), Crkvina (n = 3;

3.1%) and Livade (n = 2; 0.2%). They have not yet been identified to a specific taxonomic level due to their fragmentary nature. It is interesting to note that the very well preserved fragments from Novačka Ćuprija and Crkvina were from modern chickens. Some of the more fragmentary remains from Novačka Ćuprija were highly polished and used as ornaments (on a necklace?).

Fish remains are limited to Livade (n = 80; 7.7%). None of the other sites yielded any fish bones from the post-Neolithic. The presence of fish only at Livade is a reflection of its location on the bank of the Danube and the large size of the fish bones. They were from very large species and were, therefore, easy to pick up from the soil. All of the other sites were located on or near small streams or tributaries of the Morava. If fish bones had been present in these sites, they may have been from smaller species and missed without the aid of sieves. The only sieved sample near a small river was Crkvina, which was a very small sample size and only from a single pit. Its representativeness may be suspect. Recovery procedures are an obvious factor, since fish bones were found in sites on small streams only when 1.0 mm. mesh was employed (i.e. Petnica - Vinca deposits). A good comparison with the fish remains from Livade are those found in the Vatin pits at Vinča and the La Tene layers at Gomolava, both located on the edges of large rivers - Danube and Sava, respectively.

It would appear that fish were a relatively unimportant resource in sites away from the large rivers (Danube and Sava).

Unio or river mussels have wider geographic distribution than fish in the post-Neolithic. Sites with unio remains (table 70) include both upland and lowland environments. Both upland sites (Petnica - Baden and LBA; Ljuljaci) yielded the smallest values (0.0 and 0.03%, respectively, of the total number of fragments in the site). The Morava valley group of sites (Novačka Ćuprija, Vrbica, Sarina Medja, and Večina Mala) yielded an intermediate value (1.6-4.4%). The Svetczarevo group of sites, located near to the Morava floodplain (Vrbica, Sarina Medja, and Večina Mala), were characterized by a much smaller range of variation (3.6-4.3%) than were the Jasenica drainage sites (Crkvina - 0.0%; Novačka Ćuprija - 1.6-4.4%). The influence of topography is apparent (table 71). Unio remains are more commonly associated with lowland than with highland habitats. The swiftness of the running water is an obvious variable.

Snail shells (Helix sp.) are occasionally found, but never in large numbers. They may have been the remains of food. However, this is doubted because they were usually found whcle or nearly sc and undamaged by any cooking process (i.e. burning). They were never found in a dense

concentration indicating that a number had been processed simultaneously. Instead, they were thinly spread through a number of deposits. They are found only in lowland sites (table 72). Sieving does not seem tc have been a factor in their relative frequency, except tc imply a negative association - the smallest percentages of snail remains (Novačka Ćuprija) are associated with the use of sieves, while the larger percentages come from unsieved collections (Livade, Sarina Medja, Vrbica and Večina Mala - table 73). Their absence in highland localities is probably not reflective of habitat preferences, but the possibility of seasonal exploitation of such remains deserves further exploration. If the highland sites were only seasonally occupied, maybe they were not occupied during the period of the year that snail would have been collected.

Several other small snail species were found in the sieves at Novačka Ćuprija. Identification of these is not yet completed, but include fresh and possibly a salt water species.

The only other vertebrate species found in several of the post-Neolithic assemblages was that of humans. Remains of humans were found scattered in the pits from Novačka Ćuprija (E/MBA) and Večina Mala and in the sloj from Livade (n = 3, 1, and 2, respectively). All were scmewhat fragmented, but

otherwise undamaged. They were not chewed, burnt, etc. and probably represent episodes of deposition of exposed internments.

IV. CONCLUSION

Some patterning in the Eneclithic and Bronze Age data is apparent, especially when sample size and recovery procedures are held as constants during the analysis. Domestic cattle compete with domestic pigs as the most common species in assemblages. The age distribution of the former species are dominated by adults (if the larger assemblages only are considered - more than 20 ageable specimens). The implication of an exploitation pattern based upon the byproducts of adult cattle is unavoidable. Domestic sheep/goat relative frequencies are lower in the upland and higher in the lowland sites possibly reflecting differences in exploitation emphasis between the two environments. No distinctive temporal trends were apparent, except in the age data. It appears that increasingly larger percentages of the ageable remains become mature as time progresses during the post-Neclithic. If the Livade sloj data are deleted from the sample, such a trend largely disappears. It would then appear that mostly adults were present. Attritional factors in bone preservation would

lower their importance somewhat. In this light, emphasis upon adults and their byproducts would be somewhat less, but still of great importance. Domestic pigs retain a harvest profile typical of species with high reproductive rates and used exclusively for meat. Most of the remains are from immature specimens. Domestic horse remains appears as a regular part of the Bronze Age assemblage. Most of the remains were from adults, implying their use for traction and transportation. Environment appears to have played a strong role in the presence/absence of large sized wild animals (swine, aurochs and bears). They are usually found in the uplands or along the edges of rivers (in gallery forests). Possible evidence for selectivity in red deer sex by hunters may also be gleaned from the data. The question of settlement seasonality will be left open until the next chapter. In the final chapter, I will draw together the various lines of evidence indicating change in subsistence strategies between the end of the Neolithic and the Bronze Age.

CHAPTER 12: PALEOECONOMIC AND CULTURAL CHANGE DURING THE LATER PREHISTORY OF THE CENTRAL BALKANS

I. INTRODUCTION

It has often been suggested that the end of the Neolithic (ca. 3300 B.C.) was accompanied by dramatic changes in subsistence strategies and population distributions, in eastern Europe, in general, and the central Balkans, in particular (Bankoff and Greenfield 1985; Bökönyi 1971a; 1974a; Clark 1952; Greenfield 1984a; 1984b). However, the importance of the economic and demographic changes in Europe visible from the onset of the Bronze Age has often been overshadowed by the spectacular archaeological remains of the Neolithic. Within the central Balkans (which is more or less coincident with much of the geographic area encompassed by the preceding late Neolithic Vinča-Pločnik culture), several differences between the sites of the two periods are apparent. Bronze Age sites tend to be more closely spaced and smaller, have horizontally displaced occupations, lower artifact and feature densities, and insubstantial structures, rarely contain more than one occupation stratum,

tend not to reoccupy Late Neolithic sites, and show little evidence for the kind of internally well-organized communities of the late Neolithic. The settlement data can be interpreted as indicative of 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 larger number of smaller and less intensively occupied residential localities (see chapter 1).

Past syntheses (e.g. Boardman, Brown, and Powell 1971; Coles and Simpson 1968; Gimbutas 1965) tend to offer invasion-based explanations of the causes of important post-Neolithic developments in prehistoric Europe that are now being widely challenged (cf. Milisauskas 1978; Sieveking et al. 1976; Sherratt 1976; 1980a; 1980b; 1982; Coles and Harding 1979). Four major types of models have been offered to explain the observed differences between the late Neolithic and Bronze Age. Each emphasizes a different complex of processes and underlying assumptions (discussed in chapter 1). They include migration/invasion, diffusion/inter-regional exchange, environmental change/population pressure, and an alternative multivariate model. The multivariate model combines aspects of the diffusion and environmental change models, in addition to a constellation of previously unconsidered processes (e.g.

population dispersal tendencies, poor intra- and inter-regional integration, differential levels of population densities, absence of hierarchial decision-making authorities, etc.).

Until recently, the cultural changes observed in later European prehistory were explained largely by analogy to the historically documented large-scale ethnic movements of the first millenia B.C. and A.D. and/or diffusion of new ideas/technologies from the east (cf. Childe 1925; 1929; 1948; 1950; 1958; Gimbutas 1965; 1977; Piggott 1965; Sherratt 1980b). It is in the areas of temperate southeastern Europe (Yugoslavia, Hungary, Romania, and Bulgaria - Ill. 1) that these orientations have assumed and retained overwhelming importance. Generally, these models assume either an implicit military or technological advantage to incoming pastoralists to explain their evolutionary impact upon an agriculturally-oriented nucleated Neolithic community. In the migration/invasion model, there has been a pervasive confusion been a pervasive confusion of pastoralism with nomadism (also noticed by Milisauskas 1978), both of which are often contrasted with the supposedly more sedentary life led by the Neolithic farmers of eastern and central Europe. This has been fostered by methodological orientations which have largely focused upon problems of space/time systematics

(Ehrich 1965; Gimbutas 1965; 1977; Dumitrescu 1983). Traditional excavation and recovery procedures were not designed to monitor variation in dimensions of data more sensitive to the reconstruction of ancient behavioral systems. Assumptions of continuity of process with the Historical periods have led to an excessive reliance upon analogy with the Hun or Magyar nomadic incursions. Moreover, even those archaeologists who are concerned with process in later European prehistory rarely investigate the underlying causes why certain processes would have been operative or retarded at specific times. The problems inherent in using migration or diffusion as a primary or sole explanation for why and how new peoples, ideas, artifacts, and information are brought into a community (cf. Steward 1955: 17) have been often overlooked (see chapter 1).

With the rejection of explanatory models relying primarily upon exogenous sources of change, the differences between the settlement pattern and the possible land use of the later Neolithic and that of the Bronze Age in southeastern Europe led to a "population pressure" model (cf. Sherratt 1980a; 1980b). Such a condition could be viewed possibly as a function of soil fertility depletion (Sherratt 1980a; 1980b) and/or "climatic change" (see chapter 1; Bankoff and Greenfield 1985) as causative variables. These variables became significant because of

the seeming synchroneity between changes in the archaeological and palecclimatic records. They were relatively obvious variables which could be tested with independent sources of data. Chapman (1981) has evaluated the question of population pressure on resources from the soil depletion perspective in the late Neolithic. He concluded that the critical assumptions of soil use in the Neolithic needed complete re-evaluation. The climatic alternative seemed especially intriguing since the late Neolithic/Bronze Age transition seems to roughly correspond with the end of the warmer Atlantic climatic period and the onset of the cooler sub-Boreal (Gribben and Lamb 1978: 69). To evaluate these hypotheses and tc establish some rough population parameters, the analysis of a hypothetical site catchment area was attempted (chapter 1; Bankoff and Greenfield 1985). From this exercise, it was apparent that except for the largest late Neolithic settlements, intra-settlement population sizes were well below the critical level at which resource degredation could have taken place. As a result, population pressure on agricutural resources from climatic change cr soil fertility depletion could not be considered as viable primary causative variables for change. In fact, the observed changes can be explained without necessary reccurse tc models based on population displacement or growth. This apprcach agrees with

models which have been advanced for the explanation of the Neolithic/Bronze Age transition in Italy (Whitehouse 1968; 1973; Barker 1973) and Central Europe (Sherratt 1973; 1976), thus building toward a closer inter-regional synthesis and a more comprehensive theoretical base. In the fourth model (see chapter 1), I proposed a group of processes that, in some ways, overlapped with Sherratt's model, but which included a different emphasis. This model recognized the importance of accounting for the observed changes from a behavioral rather than technological perspective. It recognized the importance of several processes as direct and indirect influences upon the changes in settlement. These included population dispersal tendencies, high intra-settlment and low regional population densities, climatic change, introduction of new technologies and animal breeds, and the apparent absence of hierarchial decision-making authorities as integrative mechanisms during the late Neolithic. As a result, predictive hypotheses were generated given the current knowledge of Late Neolithic socio-political formations and subsistence. These hypotheses outlined the expected changes in settlement and subsistence strategies that took place from the end of the Neolithic to the advent of the Bronze Age. The predictions can be summarized as follows:

1. A decrease in the importance of wild animals favoring forested habitats and those which would have competed with domestic animals for grazing (i.e. red and roe deer, swine, and aurochs). This would have been most marked in the lowlands, where settlement was most extensive. Higher relative frequencies of wild animals would have persisted in the highlands;
2. Domestic animals would not be exploited in a specialized manner (i.e. for meat, milk, or wool). Instead, harvest profiles should indicate that each settlement would be exploiting the full range of domestic animal resources and uses;
3. Settlements would be occupied year-round and domestic herds would graze and forage close by. Herders would not be practicing transhumance, since the variety of micro-environments available in the lowlands would be able to provide sustenance throughout the year.

In the rest of this chapter, I will determine the predictive utility of these hypotheses in terms of the faunal data.

Since neither population change nor change in resource quality or quantity were deemed sufficient as primary explanatory mechanisms to account for the change in settlement and land use strategies on either side of the Neolithic/Bronze Age transition (see chapter 1), the next step was to examine those environmental factors, both

human and natural, which might have effected some changes in the cultural system which would be archaeologically visible. While it is unlikely that in and of itself the climatic change at the Atlantic/sub-Boreal boundary was severe enough to have been a primary cause of the drastic realignment in settlement (see catchment discussion in chapter 1), it may have added some impetus to changes already beginning to take place. For example, choice of a resource mix on the part of individuals is highly dependant on the sensitivity of the various resources to the vagaries of weather systems. For individual farmers and/or herds to survive in the long run, choices will be made in the direction of the resource mix which will produce "...the highest yield under the most adverse conditions, rather than the one with the highest yield if the weather were good" (Sherratt 1972: 497). This assumes that the frequency of adverse conditions is relatively high, while predictability of occurrence is low. If the reverse were true, this assumption would not necessarily hold true. High frequency and low predictability of occurrence also influence storage capability, since crops may fail several years in a row due to sudden frost, too much or too little precipitation at crucial moments, etc. Weather systems in the central Balkans are notable for their unpredictability (see chapter 2). From personal experience, one area may be in a march

snowstorm (i.e. Belgrade), while a neighboring valley (i.e. the Lower Morava) may be experiencing bright sunshine. The region has a "patchy" character, therefore, in terms of resource predictability over time and space and is especially vulnerable to the effects of climatic change.

To address this problem from a different perspective than previously attempted, a large body of zooarchaeological data was collected. It was felt that such data would yield a more comprehensive and insightful approach to the problem of changing land use because of the very close relationship that exists between subsistence and settlement systems. There appear to be some indications of an alteration in the subsistence system between the later Neolithic and the beginning of the Bronze Age. In my original model of subsistence change based upon the 1977 and 1980 trenches at Crkvina and Novačka Ćuprija, it seemed that fish and wild fauna had almost completely dropped out of the picture during the Bronze Age (Greenfield 1984a), whereas they represented at least ten percent of the animals exploited at Vinca sites (Tringham 1971; Tringham et al 1980: 28; Clark 1952: 56; Bökönyi 1974b). Faunal exploitation strategies in the Bronze Age appeared to be more heavily dependent on domesticated species, and there was a decrease in the number of species utilized in general. Barley appeared to increase in frequency until it becomes the predominant

domesticated grain of scutheastern Eurcpe during the Bronze Age (J. Renfrew 1973; Hubbard n.d.: 12; Sherratt 1980a: 319).

But, the more recent research cn paleoeconomic questions in the Balkans conducted for this thesis in 1982 has caused important revisicns in the initial assessment. Recovery procedures cn the older excavations of Neolithic localities often caused under-representation of several species, particularly among the smaller species. Data from the sites of Ljuljaci, Novačka Ćuprija and Petnica illustrate that the major change in regional paleoeconomy tcok place during the Eneolithic in the lowlands and after the Eneolithic in the highlands. Essentially similar systems cf animal resource exploitation existed during the late Neolithic and Eneolithic. By the advent of the Bronze Age, an appreciable change in economic orientation has taken place. A greater emphasis upon domestic species exists. Cattle and ovicaprine husbandry has diversified, placing greater emphasis upon adults and, by implication, secondary products. However, the evidence cautions us not to assume a single pathway for economic development in the regicn. Individual micro-regions underwent different paths and rates of change (e.g. upland versus lowland). Based upon the age and sex distributions of each species, it would appear that the

settlements may have been inhabited year-round. But the herds were on the move. A different subsistence schedule was in effect in the uplands than in the lowlands. This allowed for significant variability in domestic and wild animal exploitation. Hunting frequently continued to represent an important resource supplement in the highlands. An implication from this data is that human and domestic herd population densities in the highlands was lower than in the lowlands. Subsistence strategies emphasized coexistence, rather than exclusivity between domestic and wild resources.

It is apparent from the discussions in the earlier chapters that there exists definite comparative problems between the late Neolithic and post-Neolithic collections. In the latter, the level of detail is much greater, the method of quantification more uniform, control over contextual variability greater, etc. Since these represent our only samples from this time and place, there is little else that may be done. To discard them would be to lose all hope of wringing some answers from the data. To use them blindly, as if they were entirely adequate representations of the original archaeological assemblages, is equally dangerous. As I have argued for earlier in this thesis, they can be used, albeit judiciously, with every attempt made to explore the nature and scope of the biases present

in the data. With this in mind, in the following sections I will outline some of the more systematic differences in subsistence strategies between the two periods.

II. SUBSISTENCE CHANGE

IIA. Domestic:Wild Animal Ratio

Crossplots of the domestic:wild (%) ratio for late Neolithic (Ill. 24) and post-Neolithic (Ill. 25) sites revealed a negative linear correlation. The governing variables appear to be different in the two periods. In the late Neolithic, three out of the four highland localities exhibited high domesticated animal values (table 75). Both lowland localities had a much lower domesticated animal percentage. The highland locality of Petnica (Vinča) was the only exception to this pattern. It yielded a low domesticated animal percentage. This is not due to the frequency of antler tine and beam fragments because they constituted only a fraction of the Late Neolithic assemblage at the site. It is interesting that if the sample size of identified remains is substituted for environment (table 76), the same relationship emerges. No relationship was apparent between recovery procedures (i.e. sieving or hand-collecting) and the percentage of domestic animals for the late Neolithic or post-Neolithic (table 77).

A basic dichotomy between highland and lowland localities is visible. However, the domestic:wild ratio is reversed when compared to the post-Neolithic. Instead, the lowland sites have the lower domestic:wild ratio, while the highland sites have the higher domestic:wild ratio. Does this, however, make sense in terms of the cultural ecology of the region and time? Might it have something to do with the unusual environment that the lowland sites are placed in (surrounded by various wet-lands in the Vojvodina)? The highland sites are on well-drained soils, excellent for agriculture and easily cleared. Clearing of land would have affected wild animal populations relying upon the forest and brush for cover and forage. These species may have increase in density around the edge of such clearings as part of the response to the increased availability and predictability of plant growth in a more "patchy" resource environment (cf. Mellars 1976; Wiens 1977). This is possibly reflected in the slight increases in wild animal percentages seen in the final Neolithic at some sites (cf. Bökönyi 1974b; Tringham 1971). Eventually, these species may have withdrawn to more remote locations as they are selectively hunted by humans to clear the area of crop pests and domestic herd forage competitors. Land clearance may have been relatively easy to accomplish since the number of people involved and, concomittant, area of cleared land were probably not very large. What this may suggest is that the highland sites, on

the one hand, were clearing forests for agriculture and pasture, thereby pushing wild animals away and, on the other hand, the lowland sites were specializing in the exploitation of unusually rich, but localized micro-environments (rich in wild resources). For example, large numbers of fish and mussel remains were found in lowland sites on or near major watercourses (e.g. Livade, Opovo, and Vinca). Large wild fauna have persisted to this day (boar, roe deer) in and around the perimeter of the wet-lands. These are unusually rich micrc-environments for the exploitation of wild resources and there is little reason to think they were not otherwise in the past, as evidenced by the higher percentage of wild animals (i.e. red and roe deer and swine) found in late Neolithic lowland localities (i.e. Gomolava and Opovo).

The late Neolithic deposits from Petnica (Vinča-layers) do not follow this scenario. Petnica is more closely allied with the lowland localities. Was the difference due to population levels between the two groups of localities? Anza and Divostin were much larger than Petnica or Gomolava. But Opovo is also extremely large. This issue does not address contemporaneity of deposits over the site's expanse (see Chapman 1981 for fuller treatment of this issue), but evidence from Selevac (Tringham et al 1980) and Anza (Gimbutas 1976) demonstrate settlement growth, decline and drift.

On the other hand, the late Neolithic sites (i.e. Petnica and Divostin) are in exactly the same environmental position as the post-Neolithic sites of Petnica and Ljuljaci. Petnica retains the same basic pattern for animal exploitation until the LBA (lcw domestic:wild ratio). However, the two sites from the Kragujevac hinterland (Neolithic Divostin and Bronze Age Ljuljaci) do not exhibit the same overall pattern. Both sites from the latter group were excavated by the same basic teams (except that a small American crew participated in the excavations at Divostin) and field directors. This would reduce the role of excavation and recovery methodologies as causative variables. It is possible, nevertheless, that other factors were involved. These could include:

1. Different criteria for domestic:wild assignments by different analysts - This criteria is considered to be very unlikely since 3 out of the 4 late Neolithic highland localities were analyzed by the same person (Dr. Sandor Bokonyi). The fourth highland site was analyzed by myself after I had spent time with Dr. Bokonyi (in Budapest) familiarizing myself with his methods. The criteria used are, therefore, similar and outlined in chapter 3;
2. A more likely source of variability for the late Neolithic domestic:wild animal ratios is regional

variation in the exploitation and husbandry of animals. Two implications of regional variation may be drawn: a. people learn to more effectively exploit their local environment (a settling in process) and b. there was a better developed network of intra-regional exchange than heretofore thought. This is difficult to evaluate but the data on regional exchange systems (see discussion in chapter 1) makes one think that thie latter is a less likely alternative. The former is probably more likely, since the highand sites can be grouped on the basis of macro-environmental criterial. One group incldes Obre II and Anza, the latter located in a more Mediterranean-like environment and the former strongly influenced by the Adriatic coastal environment. In the second group are found Divostin and Petnica, located in the center of Serbia, situated in the midst of a more temperate environmental zone. This distinction must be kept in mind, since the next variable to be considered appears to have influenced this variable, as well; and

3. The year the faunal assemblage was excavated - This variable is very interesting because there is a strong dichotomy between the range of years that sites were excavated and the domestic:wild animal

ratio (table 78). All sites excavated before 1973 (Divostin, Obre and Anza) show high domestic:wild percentages, while these excavated since then show lower values (Petnica, Gomolava, and Opovo). Few students of Archaeology in this area would disagree with the contention that recovery methodology and effectiveness for animal bone, even among hand-collected assemblages, has improved since 1973. This is a direct outcome of the increasing interest in the reconstruction of paleoeconomic systems.

Thus, the validity of the pattern of high domestic percentages at late Neolithic sites (such as Divostin) excavated earlier than 1973 may be questioned. The evidence for natural and human sources of attrition at Divostin were discussed earlier (chap. 3). It implied a serious skewing of the remains from Divostin by species and element size. Any species smaller than cattle were under-represented. The vast majority of wild animals (with the exception of aurochs and bear) are smaller in size. The smaller species, red deer in particular, normally contribute the largest bulk of wild bone remains to assemblages. Probably, Divostin's domesticated animal percentage should be lowered to levels similar to that from Opovo, Gomolava and Petnica. The net result would be that there are few apparent distinctions between domestic:wild animal ratios between highland and

lowland sites in the late Neolithic in Central Serbia. This pattern stands in strong contrast to that from the post-Neolithic.

The post-Neolithic assemblages exhibit a reverse pattern. Highland and lowland localities are more clearly differentiated by their lower domestic:wild (%) ratio. In the uplands, they are relying upon local wild fauna to a greater extent than in the lowlands - reverse during the late Neolithic. They are exploited for protein, hide and bone tool needs. In the lowlands, wild fauna have become less abundant in collections, contributing to less than 25% of the total identified bones in each assemblage (table 75). This conclusion has several important implications for patterns of animal explcitatlcn in the region. In the post-Neolithic, there are either very few local populations of wild animals remaining in the lowlands and/or they have become insignificant as sources for human subsistence needs regardless of their availability. They have been replaced by other resources (i.e. domestic animals now provide the meat, hide, and bone and metal for tools, although metal was probably still relatively rare). To a large extent, the post-Neolithic pattern is a lcgical outcome of long-term settlement in the lowlands. The lcwlands were occupied longest and most intensively by the Neolithic agricultural societies. Populations of wild animals in the lowlands

would have been most adversely affected by human competition and predation in this area. In contrast, in the highlands, the density of human settlement was somewhat lower (how much lower remains a question in the absence of systematic surveys) and would have exerted less pressure upon local wild animal populations. In fact, it is in the upland localities that we find the greatest evidence for relic species - species who have withdrawn in the face of human pressure.

The role of animal husbandry and hunting in the post-Neolithic appearst to have been significantly different from that of the late Neolithic. The Neolithic modes of production survive for a longer period of time in the regions to the north of the central Balkans (cf. Bökönyi 1974a: 30). The percentage of wild animals in assemblages decrease in both highland and lowland contexts over time. However, wild animals remain particularly frequent in the sites found in the highlands and along the banks of the Danube. The distribution of wild species also undergoes change. Aurochs continue their previously noted decline. This slack is taken up by red deer and/or swine. Local environmental variability appears to be one of the keys to understanding domestic:wild percentages.

IIB. Major Domesticates - Changes Between the Late and post-Neolithic

When the frequency distribution of the major domestic species (cattle, sheep/goat, and pigs - table 79) is plotted on a 3-pole graph reveals a very interesting pattern. First, it should be noted that this graph is not directly comparable to Sterud's (1978: 402) 3-pole graph for the Early and late Neolithic of the Balkan peninsula due to a publishing error. By rotating the polar axes so that Sheep/Goat reads cattle, cattle reads pig, and pig reads sheep/goat, the graph matches the quantitative data as derived from his sources. Without such changes, Anza would be read as a pig- and not sheep/goat-dominated assemblage. In Sterud's and the analysis presented here, the Macedonian and southern Balkan sites (in a basically Mediterranean ecosystem) maintain a very distinctive high sheep/goat profile for the Early and late Neolithic. They fit into the lower right hand corner of Ill. 26. All of the sites in the more temperate climatic zone (in central Serbia) are found on the other side of the graph. Since my research focused upon the latter group of sites, the following discussion will concentrate upon them.

In this group, 3 different groups of sites can be differentiated. They represent temporal-spatial distinctions in the data base. First, all of the sites from

the late Neolithic are found clustered at the upper left hand side of the graph. This emphasizes their greater reliance upon cattle. As a group, cattle are much more frequent in the late Neclithic (53 - 76% of major domestic fauna) than in the post-Neolithic (19.2-50%). Ovicaprines are uniformly infrequent among the late Neolithic assemblages, while the percentage cf domestic pigs varies inversely with that of cattle. It is interesting that, as with the domestic:wild ratio, the late Neolithic highland and lowland sites were separated into two opposing groups. The distinction was in their pig:cattle ratio. It is higher in the lowland sites (Gcmolava and Opovo) and lower in the upland sites (Divostin and Obre). The Vinca layers at Petnica are very uncharacteristic of the other sites, a problem discussed in the previous section. This may be a function of differing recovery efficiencies between Petnica and the other late Neolithic upland localities.

The post-Neolithic sites are alsc clearly separated into lowland and upland groupings. The proportion of cattle remains is similar for both groups. The major distinction, in contrast to Late Neolithic, is in the ovicaprine:pig ratio. In the lowlands, the ratio is higher in favor of ovicaprines, while in the highlands it is lower. Ovicaprines will range from 22-44% in the lowlands and from 6-18% in the highlands. The data from Livade (the combined total of all deposits and/or from only Dubovac-Žuto Brdo

pits) and Večina Mala, both lowland localities, are somewhat uncharacteristic of this pattern. The latter site, as noted earlier, contained a very small total sample size (n = 78) and falls into the least useful of the site groupins. This substantiates the earlier division of collections on the bases of the various reliability indices (see chapter 3). The former site, in contrast, may be differentiated because of its location directly upon the banks of the Danube, beyond the Iron Gates in the Dacian Plain to the east. It is the most distant from our core area, belongs to a variant ceramic grouping, and, as a result, may be reflective of herding strategies different from those farther to the west. It may be interesting tc eventually compare Livade with some of the nearby Oltenian data tc see if systematic differences in herding strategies existed between the two areas.

Leaving the Dacian plain aside, the highland:lowland dichotomy becomes even clearer. Ovicaprines dominated over pigs in the lowlands, while the reverse was true of the highlands. The simplest explanaticn for such a distinction lies in ovicaprine ethology. They tend to avoid environments with dense forests (cf. Geist 1971; Hesse 1978; Schaller 1977). The uplands cf Serbia are still heavily forested and were probably the same in the distant past. They were probably more heavily forested than the lowlands, since clearing of forested land had been going on for a much

longer period of time in the latter. Zolyomi (1980) provided data from the Balaton region of Hungary that showed a decrease in arboreal pollen in lowlands during the sub-Boreal. The varying frequencies of arboreal pollen were directly linked to the density of human settlements in the area. How far south such a relationship can be postulated to have extended is uncertain. Nevertheless, the faunal data do imply differences in the density and extent of forested environments between the highlands and lowlands of Serbia.

The increased frequencies of ovicaprines in the post-Neolithic levels of lowland sites is of interest and somewhat at odds with contemporary data from the lowlands of Hungary (cf. Bökönyi 1974a). In Hungary, ovicaprines decrease in frequency during the Bronze Age. This may be a reflection of the environmental differences between the two areas. For example, in much of Hungary (with the exception of the loess plateau), the environment can be moister, with poorer drainage and more marshland. In contrast, the post-Neolithic lowland sites in the Serbian sample all lie on well-drained soils in the low but rolling hills of Serbia. Only at Livade, along the Danube, does the pattern of ovicaprine frequencies resemble the Hungarian distributions.

The decrease in pig husbandry in the lowlands is somewhat surprising. Part of the answer may lie in their physiology, which requires shade and water to help regulate their relatively inefficient body regulatory temperature systems (cf. Sterud 1978: 405). The forests of the highlands would have provided the necessary shade. The gallery forests and marshes along the rivers in the lowlands would have done as well. It is exactly in these two areas (highland sites - Petnica and Ljuljaci; lowland sites along the Danube - Livade) that we find higher values for pigs. The lower values for pigs and higher values for ovicaprines in the lowlands sites situated in the lower reaches of the dissected platforms of central Serbia may indicate that a more open environment may have existed in these areas during the post-Neolithic than previously, as argued above.

IIC. Changes in Cattle Production between the late Neolithic and post-Neolithic

Cross-plots of the percentage of immature:mature cattle (Ill. 27 and 28) from both sides of the temporal divide produced an unexpected pattern. Sherratt (1980b) had proposed that the data should show a shift from primary to secondary products. Such a shift could be reflected by a change from a high percentage of immature cattle in the late

Neolithic to a high percentage of mature in the post-Neolithic. In fact, this was not the case. Within each period, the sites were organized in a linear relationship, ranging from high immature to high mature. This relationship is not governed by differential levels of recovery efficiency (sieved versus unsieved), topography (highland versus lowland), time (late Neolithic versus post-Neolithic), total sample size and sample size of only ageable specimens (table 80a-e). Essentially, no simple statistically reliable relationship between any of the above variables and the percentage of immature:mature specimens could be identified - within or between periods. Whether or not the pattern is a function of more than one of these is a question left to a more sophisticated multivariate analysis of the data. I am not sure that the data are robust enough to warrant such scrutiny considering the problems outlined earlier (chapters 3-9).

It would, therefore, appear that the cattle age distribution in the death assemblage did not vary in accordance with the expectation of the secondary products revolution. However, when the ages of cattle are graphed onto a three-pole format, more subtle distinctions between sites and periods appear (Ill. 29). This was done by dividing the percentage of ageable remains into the following three age groupings: a. very immature (neo-natal,

infantile and juvenile); b. sub-adult; and c. adult. When juvenile/sub-adult specimens or thcse classified only as immature were enccuntered, they were divided evenly between groups a and b. Neo-natal, infantile and juvenile specimens were combined together for two reasons:

1. The difficulty in identifying the exact age group of the youngest and
2. the poorer levels of recovery and preservation of bones of the younger age groups.

By combining all cf the very immature classes, I had hoped to somewhat compensate for obvious attrition against these age groups. The sub-adults/adults were excluded from the analysis becuase they were not reflective of any given age grouping. They fuse earlier than cther bones, are more erosion resistant and are unreliable indicators of age. The Obre and Divostin data were nct included in this part of the analysis becuase they were not sufficiently quantified for our purposes.

Even so, patterns in the data are readily apparent. In the first place, a group of highland localities are distinguished (late Neolithic Petnica, Eneolithic Petnica, and E/MBA Ljuljaci) in the center of the graph. The later prehistoric lowland sites are spread along the perimeter of the graph. Only the LBA sloj from highland Petnica was found within this latter distribution. The third group consisted of the two lowland late Neolithic localites of

Gomolava and Opovo, plus the Macedonian site of Anza. They are more similar to the later prehistoric upland localities than to the lowland. Anza, which precedes the others and is located in a completely different environmental zone (Macedonia), is not comparable to the rest of the sample. Nevertheless, it is quite interesting to note that it fell into the distribution of the more northern late Neolithic lowland and post-Neolithic upland localities. The behavioral implication of such observations, which were not apparent in the two-dimensional graph, are that the later prehistoric upland localites were producing harvest profiles for cattle more similar to thcse from the late Neolithic than their lowland contemporaries. Only the very small sample from LBA Petnica produced a distribution more like the post-Neolithic lowland sites. Highland and lowland sites in the post-Neolithic are characterized by structurally different death assemblages and harvest profiles, which may reflect their differing subsistence orientations.

The late Neolithic sites and post-Neolithic highland localites produced age distributions for cattle most in line with exploitation for primary (meat, hide) products. In contrast, the lowland localities from the pcst-Neolithic fall into the secondary products distribution, along the perimeter (C-B axis). Attrition in all of the assemblages was too great to expect to find large numbers of very

immature specimens, even if milk production was assured. It is interesting that only in the exceptionally well-preserved contexts from LBA Novačka Ćuprija (and also sieved) does the proportions of the three major age groups begin to approach that expected in a production mode emphasizing secondary products (i.e. milk). Vecina Mala and Vrbica, the two smallest samples, are the most distant from any of the hypothetical production mode points. Livađe was characterized by higher levels of attrition than most of the other sites explaining part of its distinctiveness and lack of correspondence with expected values.

From these data, it is possible to begin constructing a scenario for cattle production during the post-Neolithic that encompasses both seasonal and spatial variability in behavior and strategies. The highland localites show an emphasis upon primary products, while the lowland sites seem to emphasize secondary products. This may be due to either different settlement and subsistence systems existing in the two sets of environments or a regional strategy for husbanding cattle that encompassed both highland and lowland zones. In the former model, cattle would be grazed in the immediate environs surrounding settlements, either in the lowlands or highlands, but not moved from one to the other. Transhumance would not be a factor. Each environmental zone would be characterized by separate systems of production.

In the latter scenario, the upland and lowland sites participated in a larger regional system of animal husbandry that involved movement of herds from cold weather pastures in the lowlands to warm weather pastures in the highlands. Considering the evidence for post-Neolithic interaction between upland and lowland sites, in terms of similarity in artifactual inventories, settlement patterns and mortuary structure, I consider it to be very unlikely that there were two separate systems of husbandry. One of the ways that contact between the occupants of the two zones may have been maintained and facilitated may have been through the movement of animal herds back and forth over the course of the year. They would be moved into the uplands during the late spring/early summer, trying to time the arrival for soon before the calves would drop (as Barker 1973 noted for ovicaprine transhumants in central Italy). Excess very immature calves would be slaughtered in the highlands, thereby producing a meat-profile. As the weather takes a turn for the worse during the late summer/early autumn, the herds would be brought back to the lowlands. There, they would be more protected from the oncoming inclement weather systems. They also can be milked, used to help transport the harvest in carts back to the village and help to plough the fields for the next crop in the spring. The schedule of agricultural events thus makes this latter scenario of

interdependence more likely. Upland/lowland transhumance has been postulated for the Early Neolithic in Bosnia and southern Serbia (Sterud 1978), late Neolithic Serbia (Chapman 1981) and prehistoric Romania (Nandris 1984). However, previous models for the development of transhumance (e.g. Fleming 1972; Nandris 1984; Sherratt 1980a; 1980b; Sterud 1978) have never been supported by faunal data. Moving pots and artifact styles around a landscape is very different from moving cattle. The similarities between the late Neolithic and upland post-Neolithic harvest profiles does not necessarily indicate that the earlier herders were not practicing any form of herd transhumance strategies. However, the age distributions of cattle do not support a hypothesis of significant Neolithic transhumance.

IID. Changes in Ovicaprine Distributions between the late Neolithic and post-Neolithic

Ovicaprine age distributions were plotted on two- (immature:mature - Ill. 30 and 31) and three-dimensional graph paper (very immature:sub-adult:mature - Ill. 32). The former showed the same basic negative linear relationship seen with cattle. As the percentage of immature specimens increase, the percentage of mature decrease. This relationship cross-cuts topography, time, sample size and

recovery methods. Obvicusly, a more complex relationship between age distribution and site period and location also exists. This is illustrated in the three-pole graph (Ill. 32), where a clearer set of relationships within the data are visible. In the two-dimensional graphs (Ill. 30 and 31), the different age groups compcsing the immature classes (very immature and sub-adult) are governed by different variables. In the three-pole graph, three groups of sites can be distinguished:

1. Neolithic grouping - characterized by Gomolava, Anza I-IV, and Opovo;
2. Post-Neolithic highland grouping - composed of the Eneolithic and LBA depcsits from Petnica and the E/MBA deposits at Ljuljaci; and
3. Post-Neolithic lowland grouping - composed of Novačka Ćuprija (Eneolithic, E/MBA and LBA deposits), Sarina Medja, Večina Mala, Vrbica and Crkvina.

Two sites fall beyond their expected associations: Livade (LBA) and Petnica (late Neolithic deposits). These will be discussed after the others.

The Neolithic grouping did nct include the data from Divostin and Obre II since the ovicaprine age distributions were not quantified in a manner useful for the above mode of analysis. Among the rest, it is interesting to see a basic pattern emerging. Both the two lowland localities in the

Vojvodina (Opovo and Gomolava) and the Macedonian locality at Anza (I-IV - early-middle Neolithic) show higher percentages of very immature specimens (40-47% of the ageable ovicaprine specimens) than in the post-Neolithic groupings. The Vinča layers at Petnica (late Neolithic) revealed an age distributions skewed heavily toward adults (c. 89% adults). However, the ageable sample of ovicaprine specimens from these layers at Petnica was very small (n = 8). This value may simply represent another example of sample size bias. The post-Neolithic upland group included all of the upland data sets from the Eneolithic and Bronze Age. The percentage of each of the major age groupings was more balanced. Sub-adults normally represented the fewest of the three age groupings. Adults ranged from 40-60%, sub-adults from 12-25% and very immature from 25-40%. The range of variability in the post-Neolithic highland group of sites is less that of the late Neolithic or post-Neolithic lowland samples. The post-Neolithic lowland grouping is distinguished by the very low very immature values (0-19%). Except at Vrbica, the adult values were correspondingly high (60-91%). Sub-adult values vacilated more widely (0-40%).

The above distributions are quite interesting in light of Payne's (1973) models for strategies of ovicaprine herd production. The idealized points for milk, wool and meat/hide production were plotted onto the three-pole

graphs. None fell within any of the three groupings (in contrast to the cattle pattern). In order to understand why little direct correspondence exists between our and Payne's age distributions, each time period and grouping must be examined separately. In the post-Neolithic lowland grouping, the samples are heavily weighted toward the presence of adults. Such a distribution would lead to speculation about exploitation strategies oriented toward adults and their products. Adult ovicaprines are not efficient producers of primary products (i.e. meat), since growth rates slow down, caloric costs remain high, and meat toughens upon the attainment of adulthood. They are useful for only two types of secondary products (i.e. milk and wool production). It is unlikely that they would have been exploited for primary products, since culling of immature animals is a more efficient strategy. The answer to this dilemma lies, as with the cattle distributions, in the differential levels of preservation and collection of the bone remains of the very immature specimens (neo-natal and infantile, in particular). These are the most susceptible to attrition. They are easily broken up by trampling, chewing and a host of other processes. They would also be difficult to recover in the absence of sieves. The result, as a whole, would be to underrepresent very immature specimens in the age distribution. If production was

oriented towards secondary products, sub-adults would be expected to be fewer in number. These two processes, the first causing underrepresentation cf the very immature and the second resulting in low values for sub-adults, would function to favor the presence cf adults in the surviving assemblage. It is interesting that sub-adults remain few in numbers even in the sieved collections (0-25%). The high frequencies of sub-adults at Vrbica and Večina Mala may represent sample size bias, since both produced very small sample sizes (minimally useful). If the bias against very immature specimens is corrected and the adult grouping correspondingly decreased, the post-Neclithic lowland distributions may begin to resemble production modes oriented toward secondary products. The arrows in Ill. Xii.14 indicate the direction each group would be moved if this was the case.

The late Neolithic grouping is spread over a large part of the upper half of the graph. The clustering may reflect the differing environmental contexts of the sites - Anza in drier Macedonia, and Gomolava and Cpovo in the moister Pannonian Plain. If attrition among the immature remains was as extensive as in the post-Neolithic samples, the samples from both Gomolava and Opovo would be moved closer to a position intermediate between the meat and milk modes. The Anza distribtution may be affected by differing environmental context and periodization of the remains.

It is interesting to see that more very immature specimens survived in the post-Neolithic upland than in the post-Neolithic lowland sites. If equal or greater attrition of the very immature remains is expected for the upland sites (because the lowland samples came from protected features, such as pits and the upland deposits were mostly sloj) this would further raise the percentage of the very immature specimens and decrease that of the adults. The highland sites, to begin with, contained larger quantities of very immature specimens. This would serve to emphasize the distinctions and would move the highland grouping toward the meat/hide mode and away from secondary products-type distributions. In essence, a similar distinction in ovicaprine production appears to have existed for the post-Neolithic as was indicated earlier for cattle. In the lowlands, production is oriented toward secondary products, while in the highlands, it is for primary products. Rather than postulating two independent and mutually exclusive herding systems operating within the same region and ignoring the advantages offered by environmental variability in the availability of resources, it is more likely that a herding strategy similar to that postulated for cattle production may have been in effect - highland-lowland transhumance. As part of the seasonal round of herding activities, herds of sheep/goats could be moved soon before

lambing to highland pastures. On the way up or in the highland pastures, the excess young in the herds could be culled. They would be the most susceptible to the hardships of the annual migration, thereby creating the expectation for higher mortality rates among the very immature. Milk production would be assured by waiting a few months, at least, before slaughtering the lambs. The herds could be returned to the lowlands in the late summer/early autumn, before or at the earliest sign of the oncoming winter weather systems. In the lowlands, they would be able to graze upon field stubble and overwinter, if necessary, in the open. The valleys and marshes would have afforded suitable protection (cf. Vincze 1980; Gürsan-Salzmann 1984). Milk production would have slowed down, but excess adults and sub-adults could be easily culled and brought to the settlement as other food supplies dwindled.

The two anomalous samples, from Livade and Petnica (Vinca layers), may be explained as a result of differing processes. Livade, as noted earlier for both the domestic:wild animal ratio and the cattle age distributions, is uncharacteristic of the rest of the samples. The sample was highly eroded and attrition extensive. The Vinca layers from Petnica are difficult to explain. A number of processes are possible, but the one the comes to mind is the limited area of the site that the Vinca layers come from.

The continued excavations and analysis at the site should help to clarify this point in the near future.

IIE. Pigs - Changes Between the Late Neolithic and Post-Neolithic

The pig age distributions help tc provide an independent test of the cattle and cvicaprine patterns. This is because pigs, of all the major domesticated animals, are usually produced for a single function - meat. They are the most specialized of the domesticated species. They have no secondary use, other than as scavengers. At the same time, they are competitors for some of the same sets of resources that humans and canids exploit. Unlike ovicaprines and other bovines, they dc not eat large quantities of foods indigestible to humans (e.g. grasses). The distributions in the three-pole graph are suggestive of this relationship and the emphasis upon primary products. Most of the sites, with the exception of two small grcups cf sites (a. Vecina Mala and Vrbica and b. Sarina Medja, LBA Petnica and Crkvina) cluster around the meat/hide mode. The former group (Vecina Mala and Vrbica) fall into the lowest level of reliability and are probably affected by sample size. Both sites contained very small samples cf bone remains. The latter group is characterized by only slightly larger sample sizes (the medium level of usefulness - 400-500 total number of

fragments). All of the remaining sites, with the exception of LBA Novačka Ćuprija yielded far larger sample sizes (more than 500 fragments). The asscciation between sample size (greater or less than 500 fragments) and distance from the meat production point on the three-pole graph (near or far) is visible in a 2x2 contingency table (table 81).

If only the samples with larger quantities of remains are accepted as representative of pig husbandry practices, no obvious temporal divisions are apparent. The implication exists that pig husbandry between the end of the late Neolithic and Bronze Age did not undergo the same kinds of fundamental transformation evident in the other two domesticated animal species (sheep/goat and cattle). However, geographic sub-divisions in the data are visible. The highland and lowland sites in the central grouping separate into nearly mutually exclusive distributions (Ill. 33). Only highland Ljuljaci is found within the lowland distribution. The highland sites tend to have lower frequencies of sub-adults (12-30%), while the lowland localities will have higher relative frequencies (22-46%). The lower very immature values at Ljuljaci, relative to the other highland localities, may be a reflection of the more systematic recovery of bones and lower levels of erosion at Petnica. Both of these processes would function to reduce the survival and recovery potential of the smaller, more

fragile remains of the youngest age grouping. This would account, somewhat, for their lower representation at Ljuljaci. The higher proportions of sub-adults in the lowland sites may be suggestive of seasonal exploitation of pigs. It is unlikely to have been a function of attrition. Seasonal movement of pig herds may have followed a similar pattern to that of cattle and sheep/goat. The yearling and older pigs may have been moved away from the lowland settlements during the warmer growing season. This would have removed them from the cultivated field areas surrounding the settlement and put less strain upon human inhabitants remaining in the settlement to protect the crops from depredation. Crop raiding would have been limited to wild animals and, possibly, other humans. Random destruction of crops by pigs would have been minimized. Bringing them to upland deciduous forests with acorn and mast for forage would have solved this other potential scheduling conflict. The older immature (sub-adults) pigs would have been selectively culled in the highlands. This would not hve affected the reproductive pool of the herds. The younger pigs may have been kept in and around settlements (in pens?) or they may not have been considered as large a menace to crops yet (cf. Rappaport 1967).

After the crops had been brought in, the herds of older pigs may have been brought back to the lowland settlements.

Forage in and around the harvested fields could have been exploited. During the colder weather, any and all of the age classes were present in and around the site and were available for culling. It is interesting to observe that the lowland sites yielded much more balanced age distributions (c. 30-35%) for each age grouping. This may be used as support for such a hypothesis. This pattern of pig husbandry is well-known ethno-historically from the region and from elsewhere in Europe (Grigson 1982; Vincze 1980). Alternative models of pig husbandry (i.e. stye production) would not fit the data as well. They would require consideration of explanations such as the following: The highland peoples culled their pigs in a different manner than the lowlands. Again the problem of inter-regional networks, or at least their possible existence, are ignored in such scenarios. Such a scenario remains a possibility, but given the obvious scheduling problems facing mixed subsistence agriculturalists in animal and crop management, the former is considered to be more likely as an explnation. Pigs would otherwise have to be kept in secure pens or constantly watched if they are to be constantly kept in or near the settlement and fields. This could easily create man-power problems, especially during critical periods such as the harvest. Crops must be harvested within a few weeks and everyone normally works long hours. Watching the pigs

would require more people than if the pigs were taken away from the site. The former alternative would reduce the number of available hands for harvest activities more so than simply assigning a herder or two to bring the pigs to the forests to forage.

IIF. Evidence for Seasonality in Occupation

The age data from the domestic and wild stock, in addition to the roe and red deer antler data, lends support to the contention that most, if not all, of the sites were occupied year-round. Virtually every locality had many age classes present, ranging from very immature to elderly individuals, implying occupation throughout the year (cf. Bökönyi 1972a). Lowland Opovo yielded red and roe deer antler still attached to pedicles, highland Eneolithic Petnica produced an attached roe deer antler, highland Ljuljaci yielded an attached roe deer antler, and lowland Livade yielded attached red deer antler. Antlers of red deer shed their velvet in the early autumn. The antlers, themselves, are not shed until late March/early April. Red deer begin antler growth during the summer. Roe deer display a diametrically opposite schedule. Antlers begin to grow over the winter, velvet is shed in April and antlers are shed in October (Clark 1972: 23, fig. 5; Chaplin 1977; Clutton-Brock et al 1982). The presence of shed antlers on

sites does not necessarily indicate occupation during the period of shedding. Shed antlers may be picked up at any time after shedding has occurred. They are, therefore, of much less use as seasonal indicators of occupation than attached antlers. However, deer have been noted to chew on shed antlers as a way of recycling lost nutrients (cf. Clark 1972; Clutton-Brock et al 1982). Also, small rodents are also commonly known to eat antlers (e.g. lemmings eat up caribou antlers by the end of the summer each year in the Arctic - T. McGovern: pers. comm.). Most shed antlers probably disappear in a relatively short time after shedding. With this in mind, plus the age distributions of the domesticated species, it would appear that the lowland post-Neolithic settlements were probably permanent in nature. In contrast, the highland localites showed direct antler evidence only for late spring/early autumn occupation. This data would support the concept of Bronze Age herd transhumance strategies, in association with settlement permanence. The late Neolithic highland sites yielded antler evidence for occupation during the colder half of the year (Petnica - Vinča layer; Divostin). This would not be the period of the year that people would be expected to be living at the sites if they were only seasonally occupied by herders, since the lowlands would be better environments in which to spend the winter. This is

in contrast to the antler data from the late Neolithic lowland localities which pointed toward year-round occupation. There is, of course, always the problem of negative evidence for site seasonality. But, this is a question which will have to await future research focusing on more specific seasonal indicators.

III. CONCLUSIONS

From the above discussion, it is possible to outline the nature of the changes taking place between the late Neolithic and Bronze Age. The settlement and subsistence data may be interpreted as indicating that the focus of food production changed from the village (late Neolithic) to the household (Bronze Age - 1985). late Neclithic production was dependant upon a large ccmmunal work force to cultivate, transport and process the necessary food stuffs upon which the sedentary late Neolithic settlements were dependant. This was especially time consuming in the suppcsed presence only of a Neolithic "hoe" type of cultivation. In contrast, in the Bronze Age, the earlier pattern appears to have been replaced by an equally integrated socic-political landscape, but which was based upon a dispersed, rather than nucleated settlement pattern. No longer can we envision the Bronze Age agriculturalists as economically independent, but part

of an overall regionally-based strategy of subsistence. Agriculturalists were free to disperse over the landscape because they possessed or could possess the necessary technology for production. The increased efficiency of transport and the ability of animal-drawn plough agriculture to work larger areas with a smaller workforce, in conjunction with the fissioning tendencies mentioned earlier (chapter 1) and the possible breakdown of mechanisms favoring nucleation (e.g. trade, ritual, etc. - cf. Chapman 1981; Renfrew 1969a), would produce a new picture of population distribution over the landscape. This would be characterized by new, smaller, more widely distributed and closely-spaced homesteads, each inhabited by a smaller group of people (than in a late Neolithic village) and practicing mixed temperate farming.

Evidence for such population dispersal exists, at least in preliminary form. The massive large settlements, the upper tier (cf. Chapman 1981; Johnson 1977), disappear. The lower tier of small settlements continues to exist after the end of the Neolithic (albeit often in different locations). In the lower Morava region, which can be considered fairly typical of the floodplain edge environments of the central Balkans, the later Neolithic settlement pattern of a single large site per small river valley (data derived from Chapman 1977) is not followed in the Bronze Age. The

pattern in other regions may differ strongly (i.e. Sava - Chapman 1981). The 1977 Jasenica survey (chap. 8) shows several examples of fairly extensive (ca. 5 ha.) contemporaneous sites in one river valley, together possibly supporting a population as large or larger than the former, single, but larger (ca. 15 ha.) Vinča settlement. If this population dispersal had begun, even in incipient form, as seems likely by the end of the Vinca-Plocnik period (later Neolithic data from Divostin and Selevac support this - S. Kaufman, R. Tringham pers. comm.), it would be reinforced by the improvements in subsistence and transport technology (Sherratt 1980b). However, it appears that this dispersal tendency was a constant - it was present from the early Neolithic (Starcevo) period onwards.

Changes in the subsistence and transport technologies are introduced into Southeastern Europe at the Neolithic/Bronze Age juncture (Sherratt 1980b). There is no a priori reason to assume, as Sherratt does (cf. 1980b), that simple technological change accounts for the observed cultural changes. Instead, it is the interaction of the introduction of lower movement costs and a more effective use of animal traction with a set of cultural and environmental parameters which were already beginning to lose their stability that produced the settlement and subsistence

configurations distinctive to the Bronze Age. Data from pollen diagrams from southeastern Europe (Nandris 1977; Gigov 1964; Zolyomi 1980) have been interpreted as indicating extensive ecosystemic manipulation by human groups throughout the Neolithic (Nandris 1976: 550; 1977). This manipulation operated within a set of extraordinary environmental parameters (the Atlantic "climatic optimum"). Even the comparatively minor changes in climate at the onset of the Piora Oscillation and sub-Boreal (see above), combined with continuing forest clearance during the Neolithic may have contributed to a further imbalance in the forest ecosystem during the Bronze Age. Clearing for cultivation, and collecting fodder for domestic animals are examples of the human activities which contributed to the alteration of ecological relationships (passim Pullar 1977).

Earlier in this chapter, I argued that a transhumant strategy of herd movement would be the most likely explanation for the observed patterns in faunal remains. This strategy seems to have appeared with the advent of post-Neolithic subsistence strategies, rather than earlier as hypothesized by others (e.g. Sterud 1978; Chapman 1981). In all honesty, other forms of herd management should be considered as potential explanatory mechanisms as well. These forms may include stalling/stye, horizontal movement, and inverse transhumance. As indicated earlier (chap. 1),

there is little evidence of stalling until much later in prehistory (cf. Clason 1984; Waterbolk 1975). Horizontal movement of herds within the same basic altitudinal and vegetation zone was originally proposed in chapter 1 based upon a movement minimization assumption. However, the test implications of such a prediction would have been a high degree of similarity in faunal remains (and especially age distributions and resultant harvest profiles) between sites from different altitudes. Highland and lowland sites should have been much more similar than was found to be the case. Only in the late Neolithic may have this been the case. By the advent of the Bronze Age the distributions were so different that they would have been very unlikely to have been caused by the same processes. The third alternative, inverse transhumance is often a complementary process to normal transhumance. Villages in the mountains send their herds to the lowlands in inclement weather (cf. Sterud 1978). This permits lambing/calving in milder climatic regimes. They would return tc the mountains in the spring with the lowland herders. Considering the lack of evidence for winter occupation at post-Neolithic highland sites, this may not have been a viable alternative during the Bronze Age. However, new research on tooth sectioning (cf. Borque et al 1978) to be performed may help to solve this dilemma.

What is visible from the data is a logical round of seasonal activities for each of the exploited species (Ill. 34). It is the combination of all of these that creates the subsistence pattern from the late Neolithic and post-Neolithic. During the fall, herds are moved to the lowland settlements and habitats, where they are grazed on field stubble and/or excess food stuffs. Cattle helped to cart in the harvest and plough the fields for the winter wheat. Ovicaprines and cattle would be used for milk production. Cattle, ovicaprine and pigs would be fattened for the upcoming dearth in winter forage. During the winter, milk production would slacken off as lactation ceases due to poorer nutritional levels and/or pregnancy. During this time, disease, weak or otherwise infirmed individuals could be culled from the herd. This would conserve fodder and forage supplies for the reproductive core of the herds and provide a low but relatively important supply of protein to replace dwindling milk supplies. Keeping herds in or around the lowland settlements, themselves situated in relatively protected habitats, would ensure easy access to such food on the hoof at a time when travel is normally difficult if not impossible. During the late winter/early spring, cattle, ovicaprines and pigs would begin to give birth. This is a crucial period of the year, since new foods are only beginning to appear and old food stores were

probably running low. Some of the neo-natal and infantile specimens would have been slaughtered at this time. The herds would represent "live storage" - on the hoof. It can be grown, but will not spoil until processed. It represents a crucial way of leveling fluctuations in food availability (cf. Flannery 1969: 87).

Meanwhile, in the highlands the snow would be slowly melting and plant growth begins. Plant growth in the highlands begins somewhat later and ends sooner than in the lowlands. This same process of regeneration is squeezed into a far shorter span of time in the highlands. Grasses, herbs, shrubs, etc. show a relatively more rapid period of growth in the lowlands between April and June. This is followed by a period of slower growth during the summer (June-August). A period of secondary growth may take place in the autumn.

> "From a herbivores viewpoint, the quality of the main food plants is closely related to their growth stage and is typically highest in spring and lowest in winter... Altitude and grazing prssure have far-reaching effects on the quality of hill vegetation. Spring growth is delayed at higher altitudes, and grasses that develop a high fiber content when mature consequently show higher digestibility later in the season at higher altitudes" (Clutton-Brock et al 1982: 23-25).

From a herbivores point of view, the best time to graze animals in the highlands is when grasses and other vegetation have fully matured. This occurs slightly later

than in the lowlands. Slowly brining animals up from the lowlands, where plant growth has begun to slow, would allow herd to continually exploit plants during their most nutritious stages. They would be consuming plants with the highest digestibility ratio and getting the best possible nutrient base. Herders and/or herding communities in the uplands would have been able to cull from the herds those individuals who were weakest (unable to make the trip back down to the lowlands in the autumn). Excess very immature individuals could have been dispatched before weaning to ensure a continuation in the milk supply. As the colder weather moves back in, herds could slowly be moved back to the lowlands, where the annual cycle of movement was begun.

Supporting evidence for such a cycle of events can be found in the age and sex structure of the domestic and wild specimens. Reduced presence or total absence of certain age classes (cf. Bökönyi 1972a) may imply that herds were elsewhere during the period of occupation. Where, exactly, always remains a question. The highland/lowland dichotomy has been proposed, however in reverse, by Bogucki (1982) for the Linear Bandkeramik sites from the Polish lowlands, with the lowlands being exploited during the summer.

The implication of settlement permanence and herd transhumance is important for understanding exchange

relationship between highland and lowland sites. Lowland shephards in the Balkans today and in the ethnohistorical past usually have some form of social or economic arrangement with villagers in their winter and summer pastures. Relatives and/or business partners are frequently called upon for help as part of the reciprocal exchange of news, help, products, etc. Widely dispersed networks of familial relations helps to integrate the area into a single economic unit.

A question that has arisen concerns milk production in highland pastures. In modern day Turkey, Romania, Greece and Yugoslavia (Bates 1974; Gusan-Salzmann 1984), milk from herds is whisked to markets by truck. For example, in Romania,

> "...by mid-May the women...travel 150-200 miles to the sheepfold in a jeep or truck. There they may help the men with the milking and cheese making, which go on for about four and one-half months, while back at the villages the frandparents care for the hay and the small potato fields..." (Gürsan-Salzmann 1984: 46).

Before rapid transportation was available, milk was processed into longer lasting cheese, which was then transported back to the village or to a local market.

Wool production and shearing activities among sheep herds would have followed a similar pattern. Shearing could have taken place in the lowland pastures at the end of the winter

before the herd was moved to highland pastures. If shearing was delayed until after the herd was in the highlands, the wool may have been either carted back to the village in raw or washed form, traded to surrounding mountain villages for local produce (food and other materials) and/or worked by family members who joined the herders in the mountains in seasonal sites. Both the first and last option become possible with the advent of new modes of transportations, such as the cart, horse and draught cattle. Raw and finished forms of wool, milk from sheep/goat or cattle could now be transported, slowly albeit, to non-local destinations. The absence of such transport technology in the late Neolithic may be a more important reason why we do not see evidence for transhumance rather than simply the absence of secondary products such as milk or wool.

The flow of animals across the landscape was part of a "risk-reducing strategy". The mobile lifestyle of the animal herder would have allowed exploitation of otherwise neglected resources, maintaining and producing food and other products at a higher rate than otherwise possible. It also

> "...afforded numerous opportunities for the exchange of valuable goods as well as information flow and genetic interaction" (Sterud 1978: 393).

With the resource types, information and technology available in the Bronze Age, the combination of mixed

farming, barley cultivation, and "modern" barnyard animals may well have been repeatedly developed or accepted by cultures throughout temperate Europe. The visible changes in the archaeological record at the onset of the Bronze Age can be explained by the prevalence of this resource mix and its effects at least as reasonably as migration/diffusion models. Flannery (1969: 87) has noted that in areas where agriculture is characterized by years of scarcity mixed unpreditably with years of bumper crops, "live storage" in the form of herds is a way of leveling these fluctuations. Moreover, a change in vegetation from forested land with its thick, easily worked humus, to a more grassy ground cover with a tightly knit root structure which could now be worked by animal-drawn ploughs would further increase the area of land suitable for herding. If Bronze Age subsistence is marked by an increased dependance on milk products (Sherratt 1980b), then these factors would tend to increase the importance of herding in the Bronze Age economy without any necessary introduction of new "pastoralists".

In sum, a dramatic re-orientation takes place in cattle and sheep/goat production soon after the conclusion of the late Neolithic. it may have occurred in slightly varying intervals in different places (hence the differences between Novačka Ćuprija and Petnica), but by the advent of the

Bronze Age the transformation had been completed. Cattle and sheep/goats were no longer exploited simply for their primary products (meat and hide), but for products which encouraged herd age structure to be shifted toward larger numbers of adults and their secodary products (milk, wool, and draught). Trends over the course of the post-Neolithic are also apparent. In the uplands, the proportion of mature animal remains are significantly lcwer than in the lowland sites along the Morava and its tributaries. The upland sites are exploiting animals in different ways than the lowland sites. These differences were best explainable by the advent of seasonal movement of herds from one habitat to a second - transhumance. Such data may also imply regional cooperation in production of domestic animals, to avoid conflicts in pasture usage between herders from lowland and highland communities utilizing the same basic sets of resources in the same time and place.

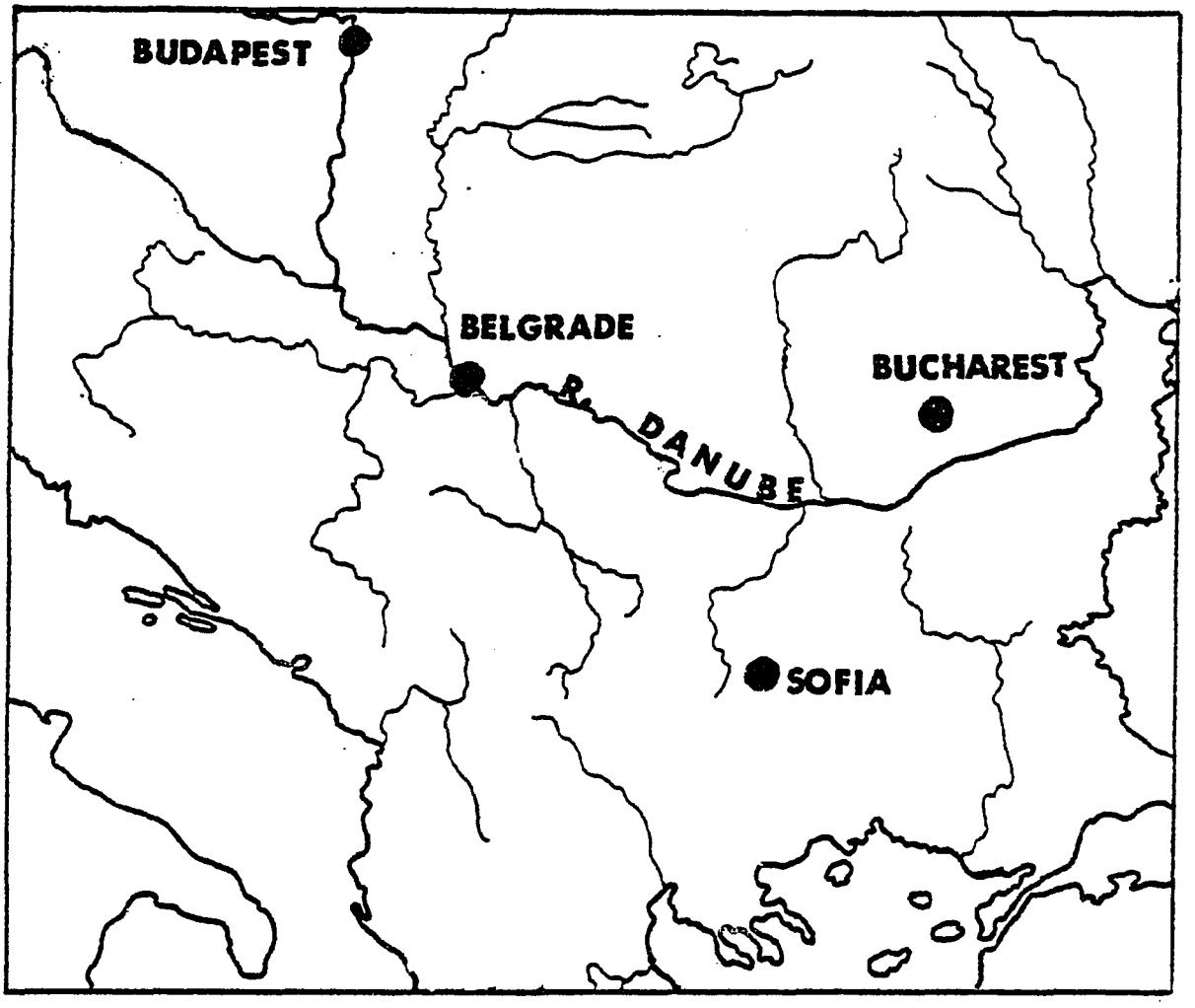
It seems logical, then, to maintain that all of the above factors, human and natural, exogenous and endogenous, were responsible for the initiation and acceptance of the observed systemic changes at this time. With the currently available data, it is not yet possible to weigh their relative importance. The net result was a pattern of life that differed radically from that known earlier in temperate Europe, one which was finally and

thoroughly divorced from Near Eastern urban models, and one which shaped the face of rural Eurcpe until the Industrial Revolution: the life of the small-scale subsistence farmer and his village.

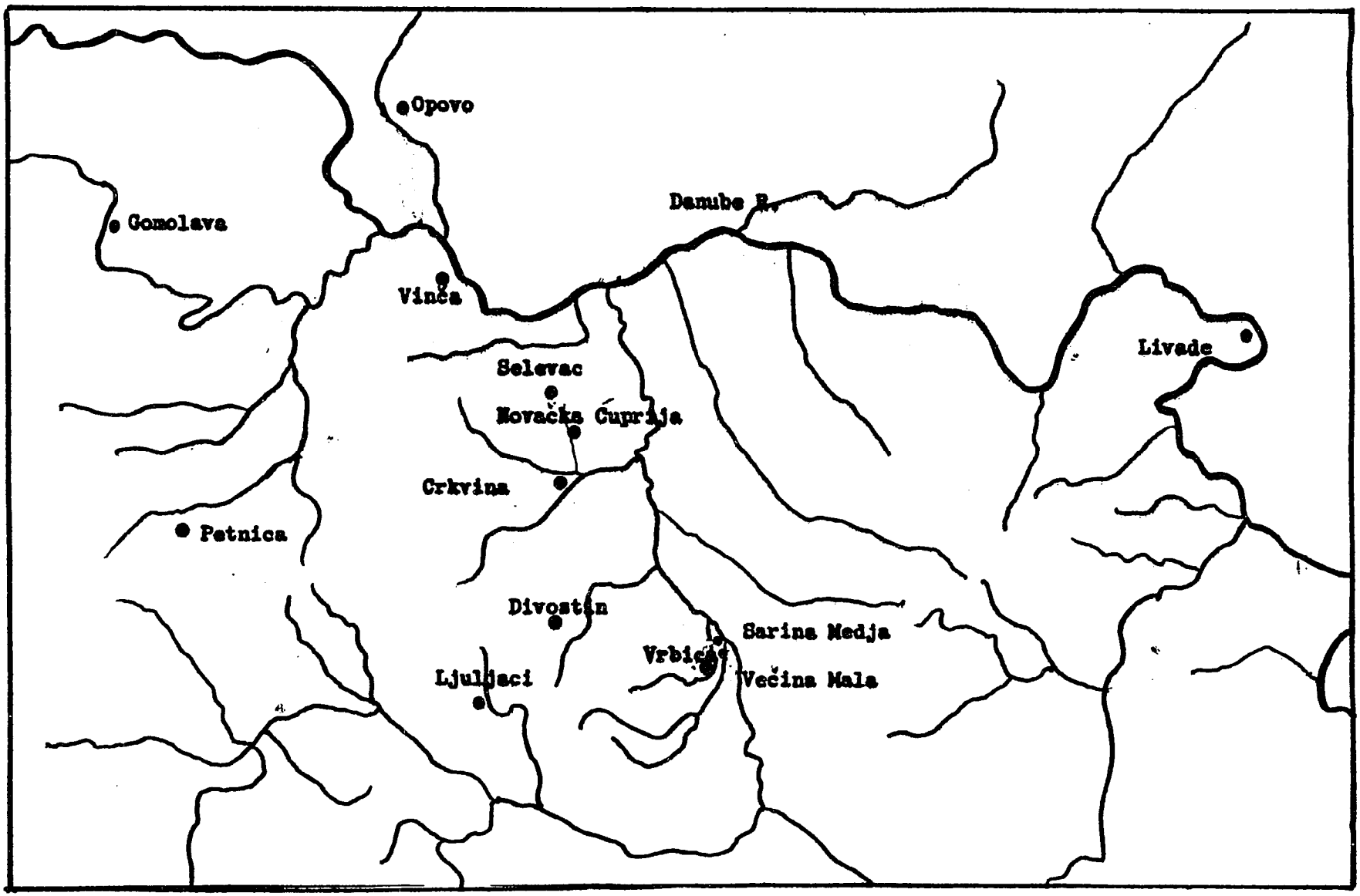
IVA. Suggestions for Future Research

Although the data base upon which the conclusions in this chapter were drawn is extensive, many questions remain completely or partially unanswered. Several of the hypothetical relationships need more robust and independent data before they can be fully tested. Obviously, this will require additional field work. A likely scenario, since I have proposed a herd management strategy involving transhumance would be tc choose a histcrically known corridor of transhumance and sample a series of sites from the different periods and altitudinal zones. By using the same methods of excavation and reccvery, an inherently more comparable series of assemblages than is presently available could be collected. In fact, such a project has been begun in western Serbia and southeastern Bosnia. The excavations at Petnica, overlooking the Kolubara, are ultimately designed to link up with excavations of sites from higher and lower elevations (Titovo Užice and Mačva). The Kolubara was long used as a major migration route for herds from the plains of Pannonia to the mountains until recently. As

such, it will provide an excellent labcratory for continuing this research within a more restricted geographic context.

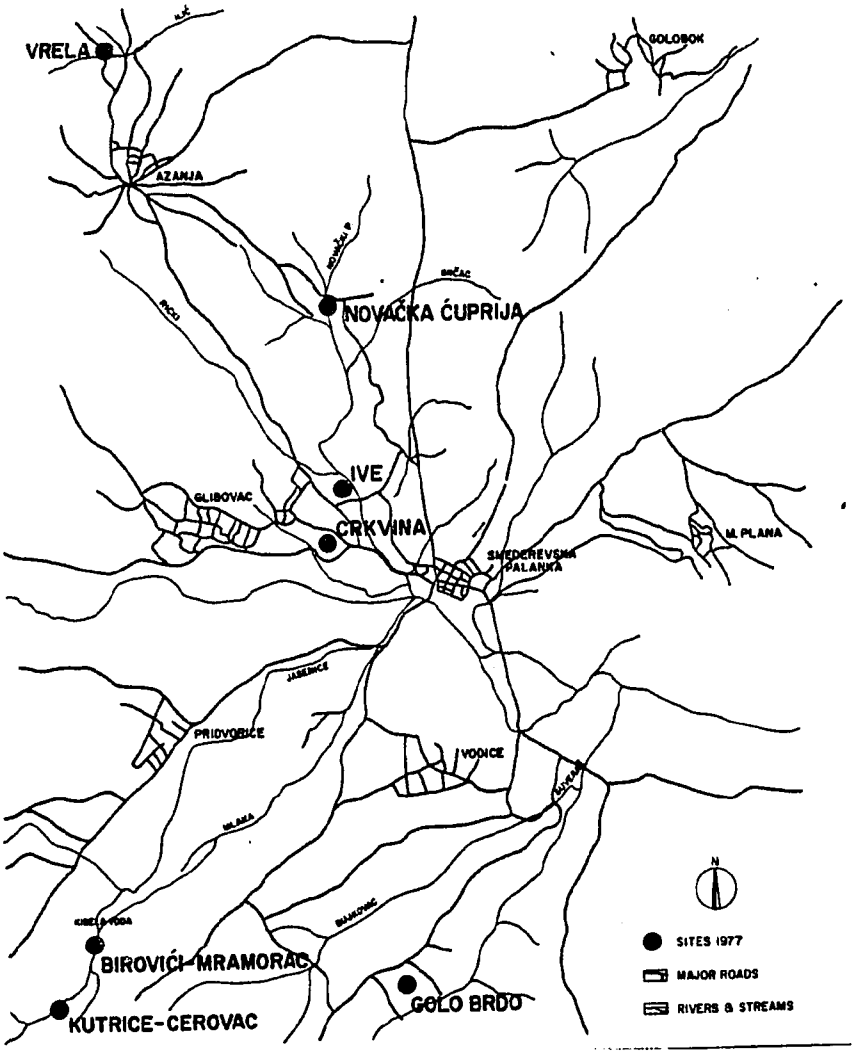


Ill. 1: Map of southeastern Europe (north and central part of the Balkan peninsula).

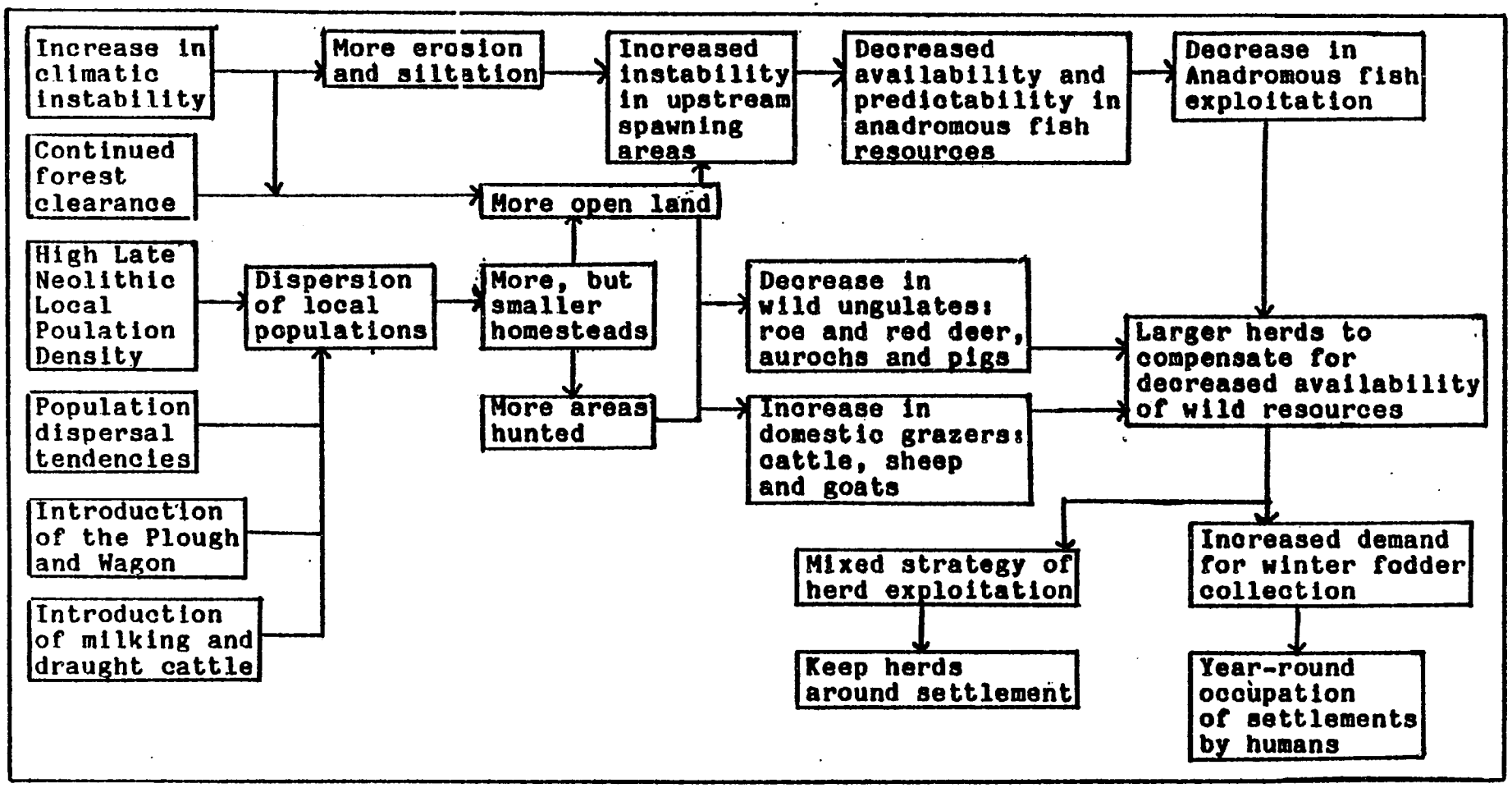


Ill. 2: Map of Central Balkans showing locations of important sites mentioned in text.

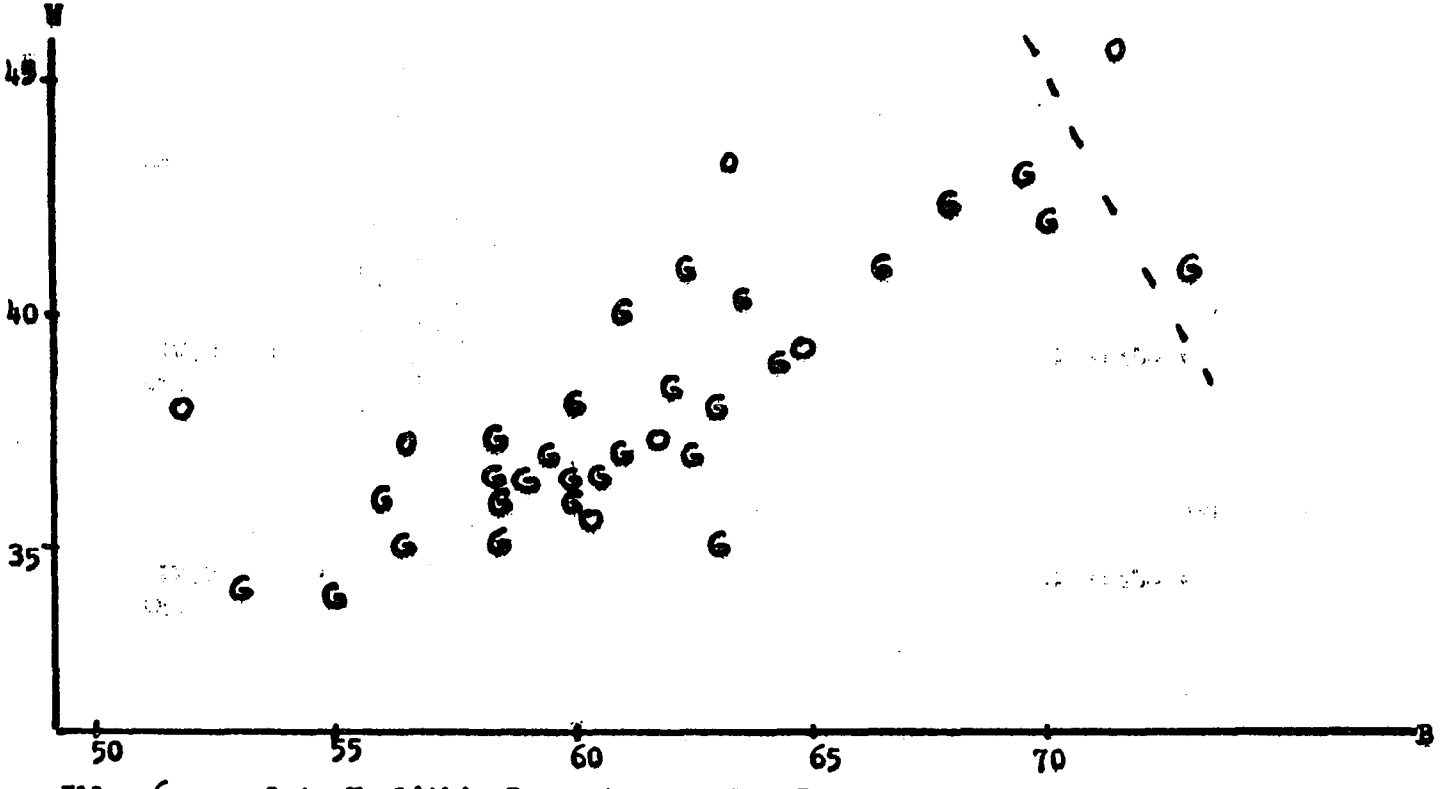
Ill. 3: Map of Yugoslavia and Europe.



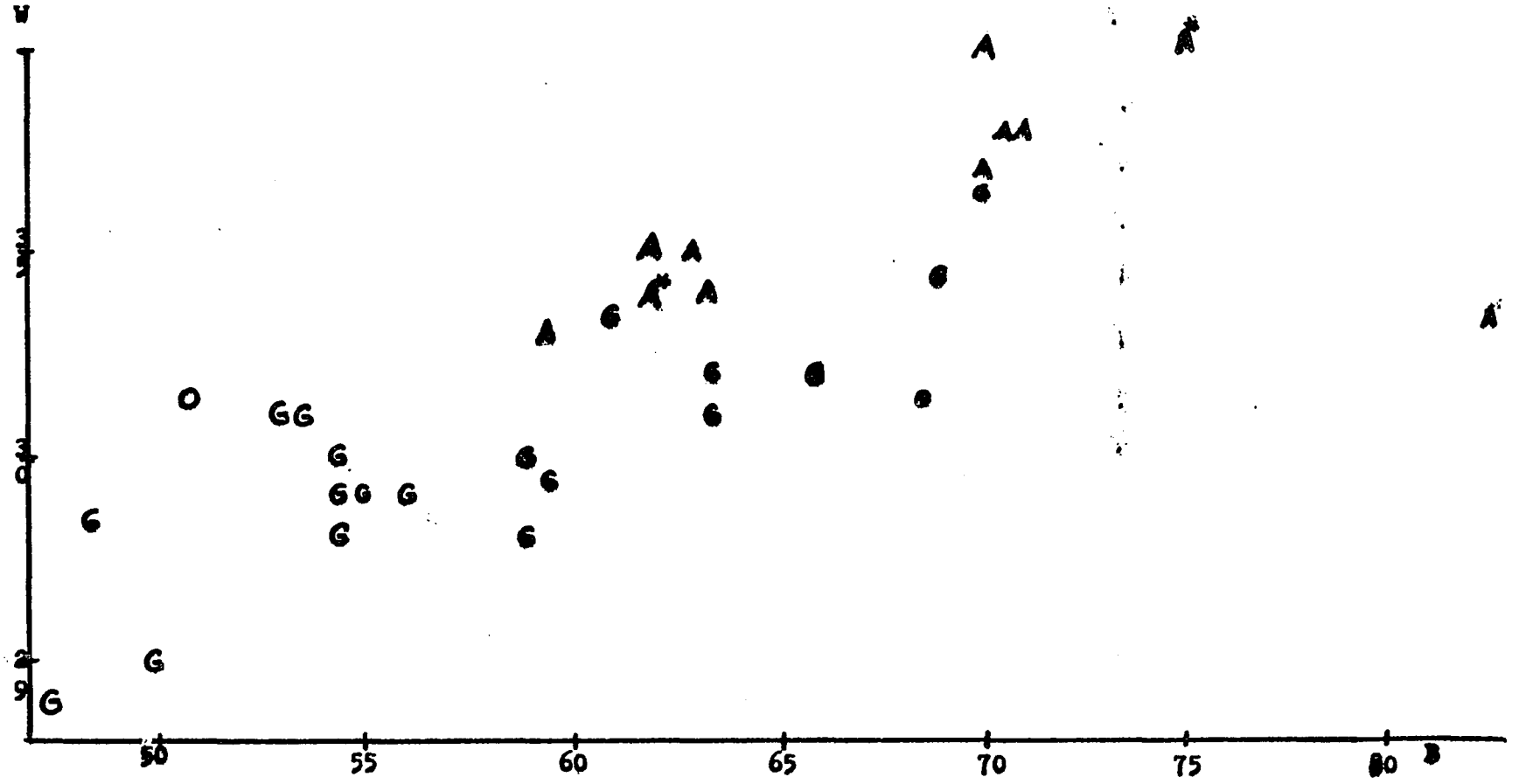
Ill. 4: 1977 survey sites in the vicinity of Smederevska Palanka.



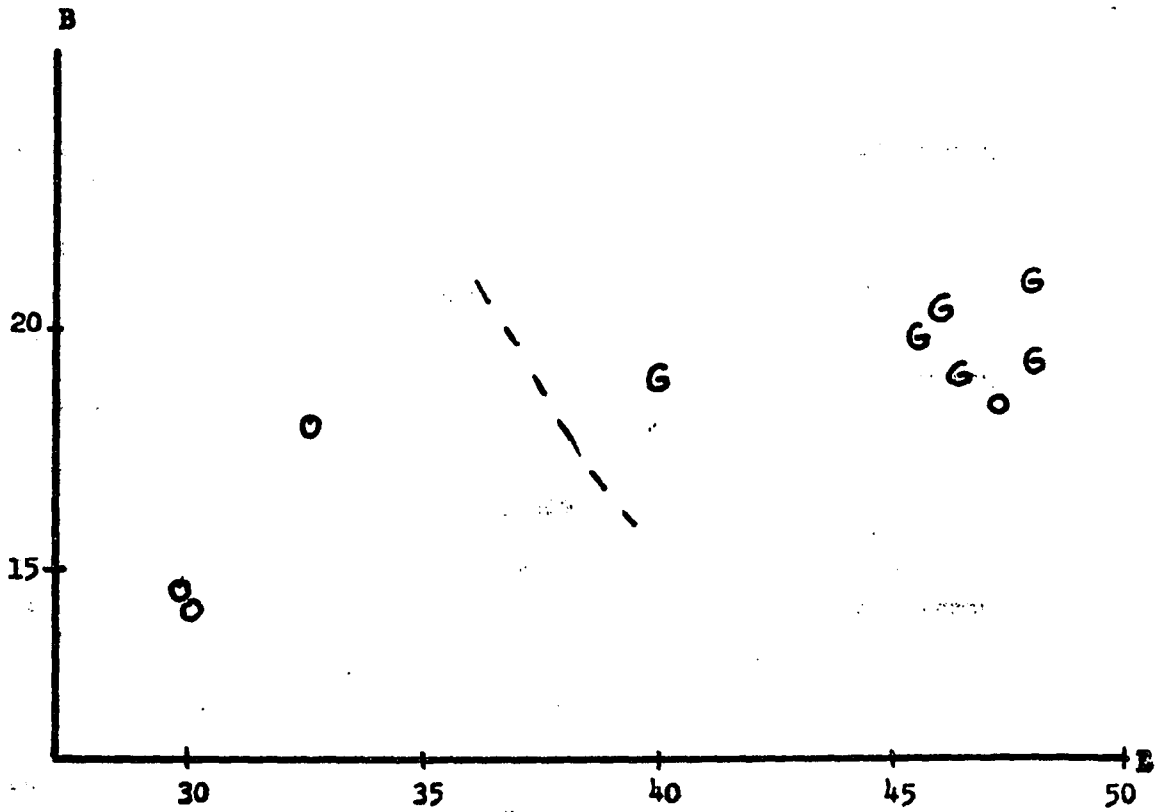
Ill. 5: Flowchart of the model outlining possible economic options available in the Bronze Age of the Central Balkans and their interactive effects on the ditribution of the human population and on strategies of animal exploitation.



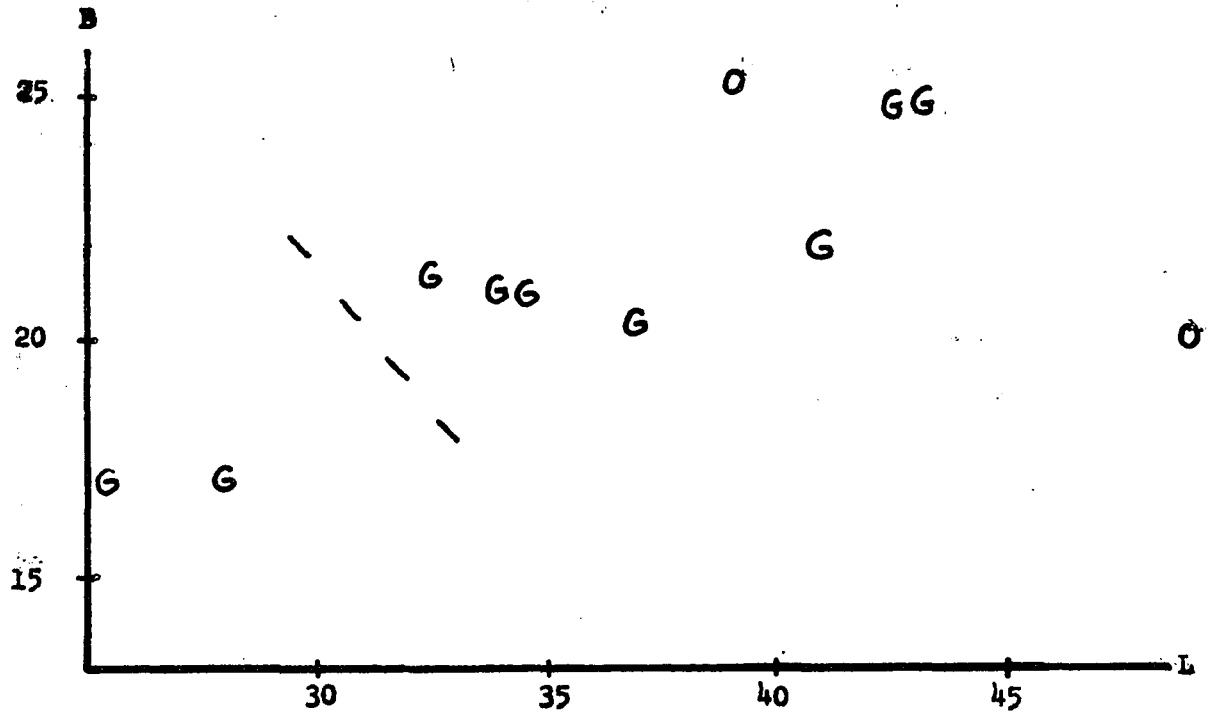
Ill. 6: Late Neolithic Bos metacarapal: Greatest proximal width versus breadth.



Ill. 7: Late Neolithic Bos Metacarpal: Greatest distal width versus breadth.(mm.).
(* = castrate, cf. Bökönyi 1976).

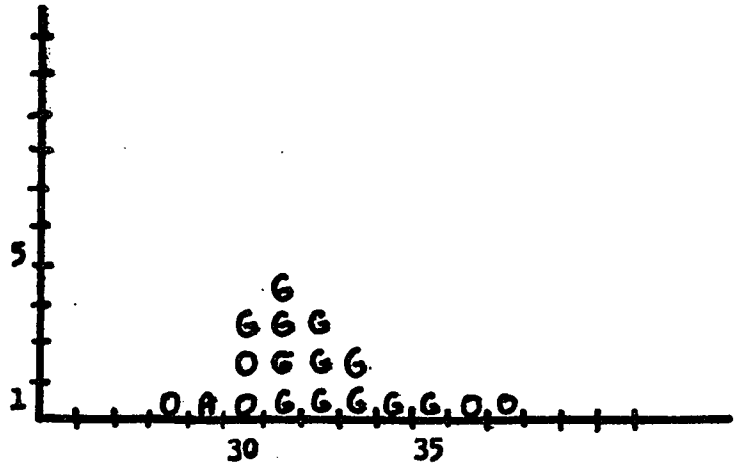


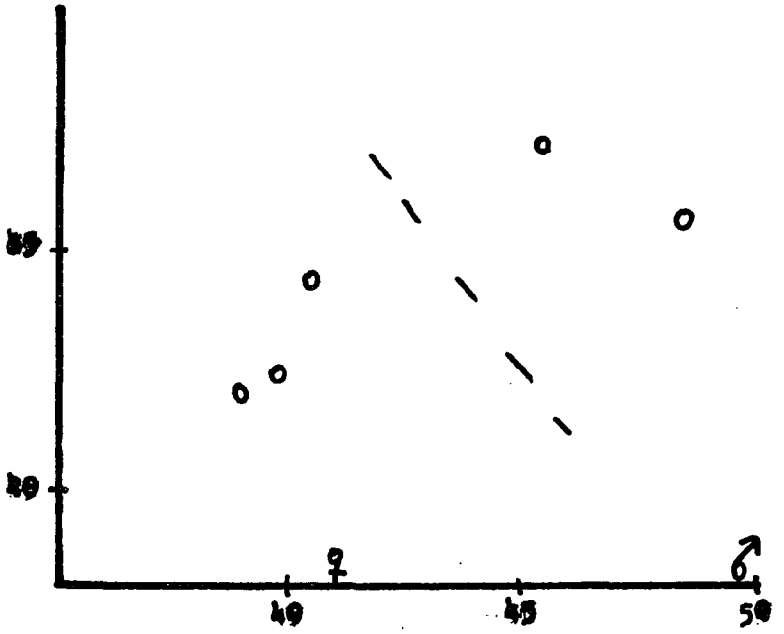
Ill. 6: Late Neolithic Sus scrofa: Greatest length versus breadth of the LM3.



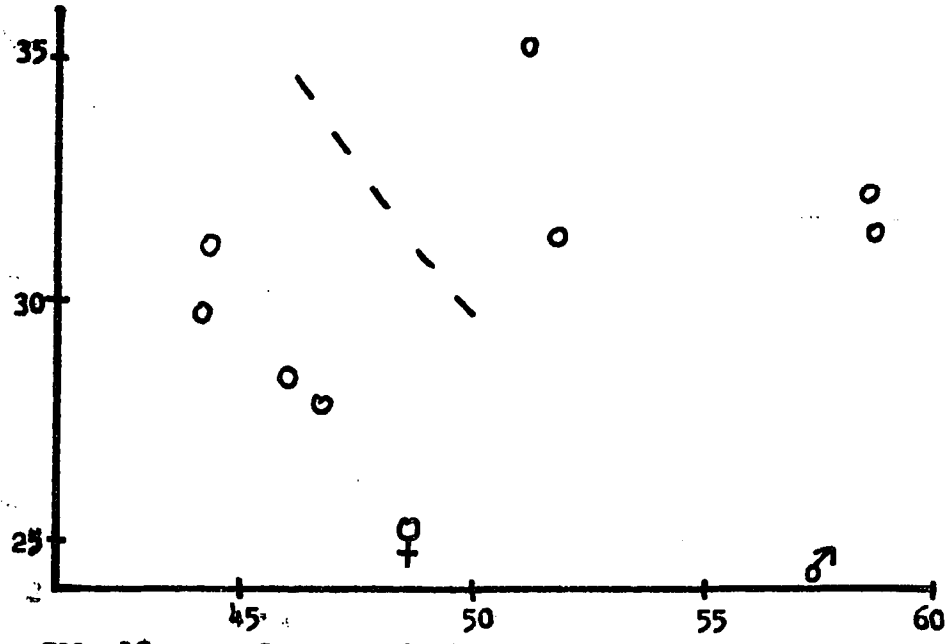
Ill. 9: Late Neolithic Sus scrofa - Greatest length versus breadth of UM3.

Ill. 10: Late Neolithic Canis familiaris - Histogram of the length of the molar row (mandibular) in mm.

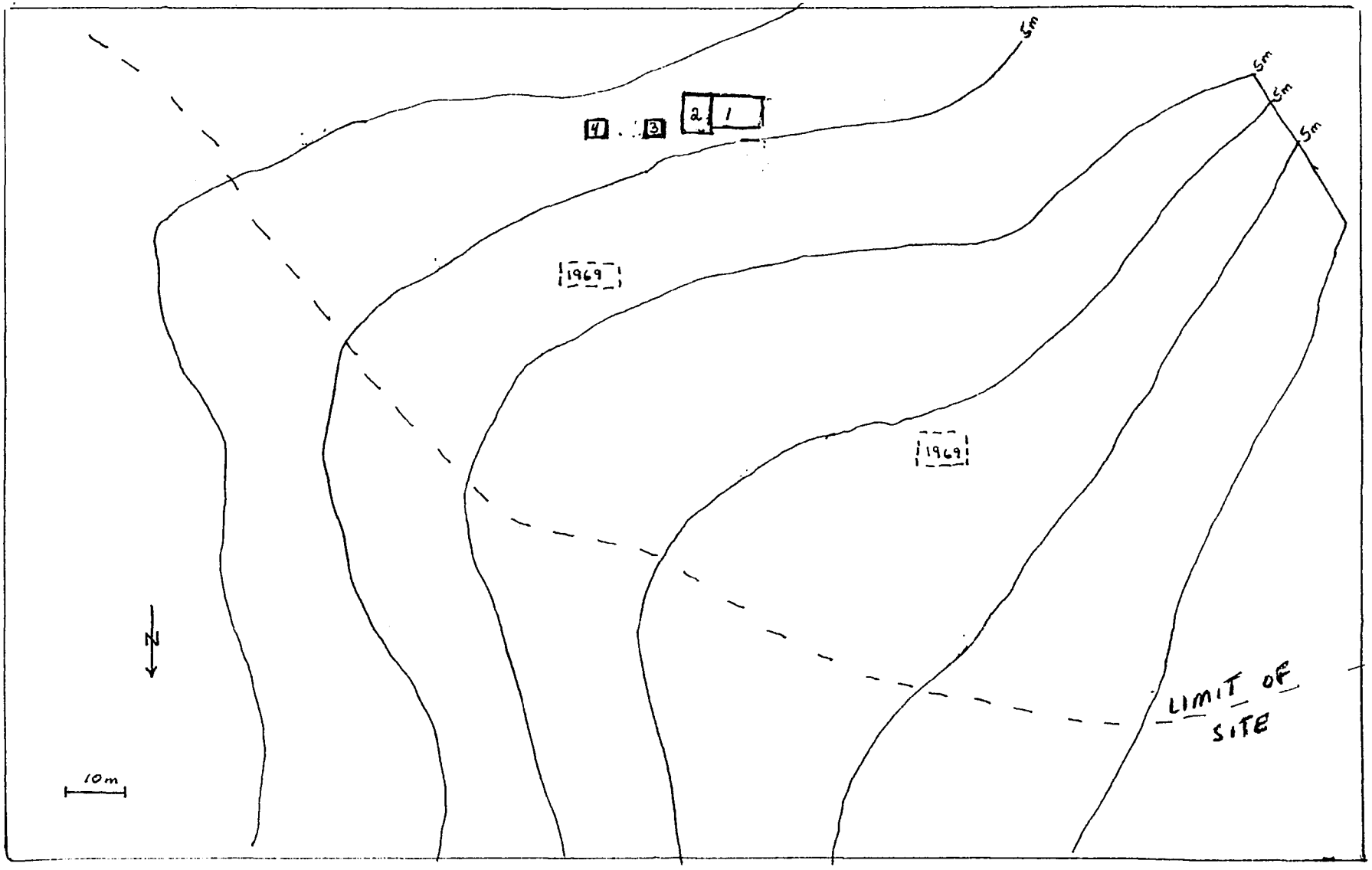




Ill. 11: Late Neolithic Cervus elaphus metatarsal from Opovo - Greatest proximal breadth versus width.

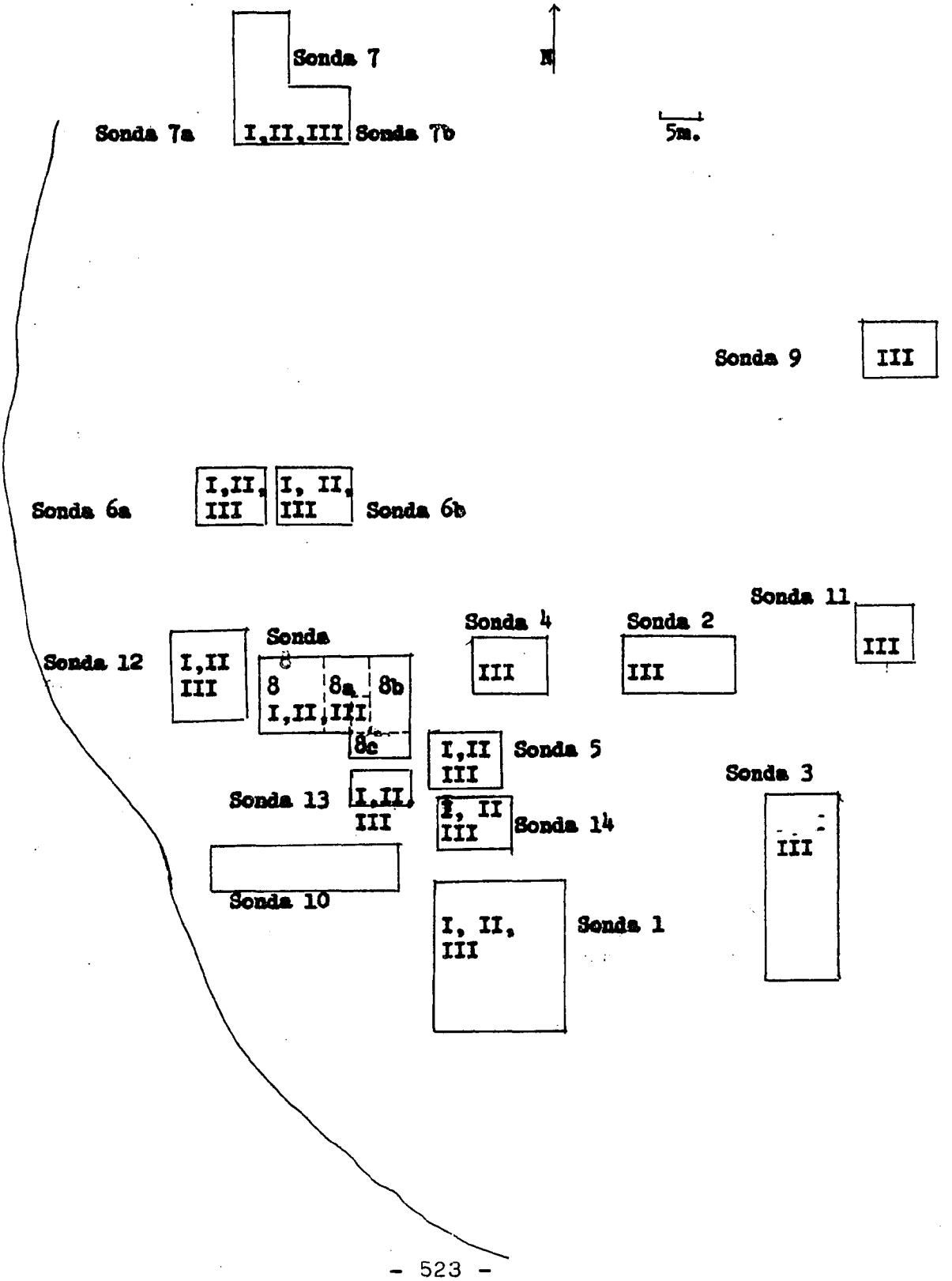


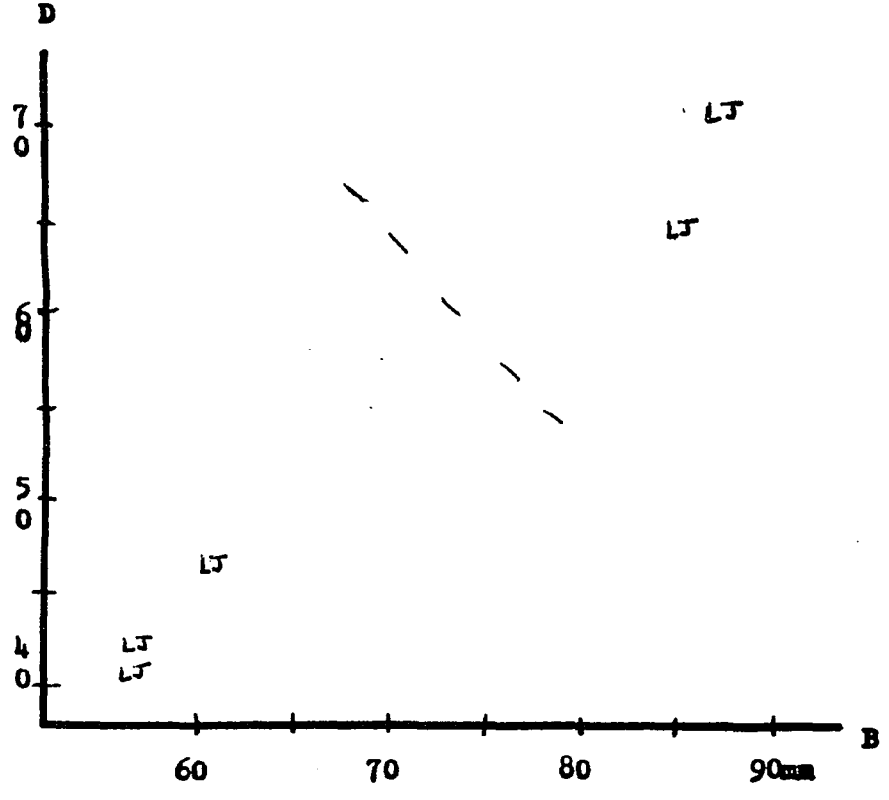
Ill. 12: Late Neolithic Cervus elaphus metacarpal from Opovo: Greatest distal breadth versus depth.



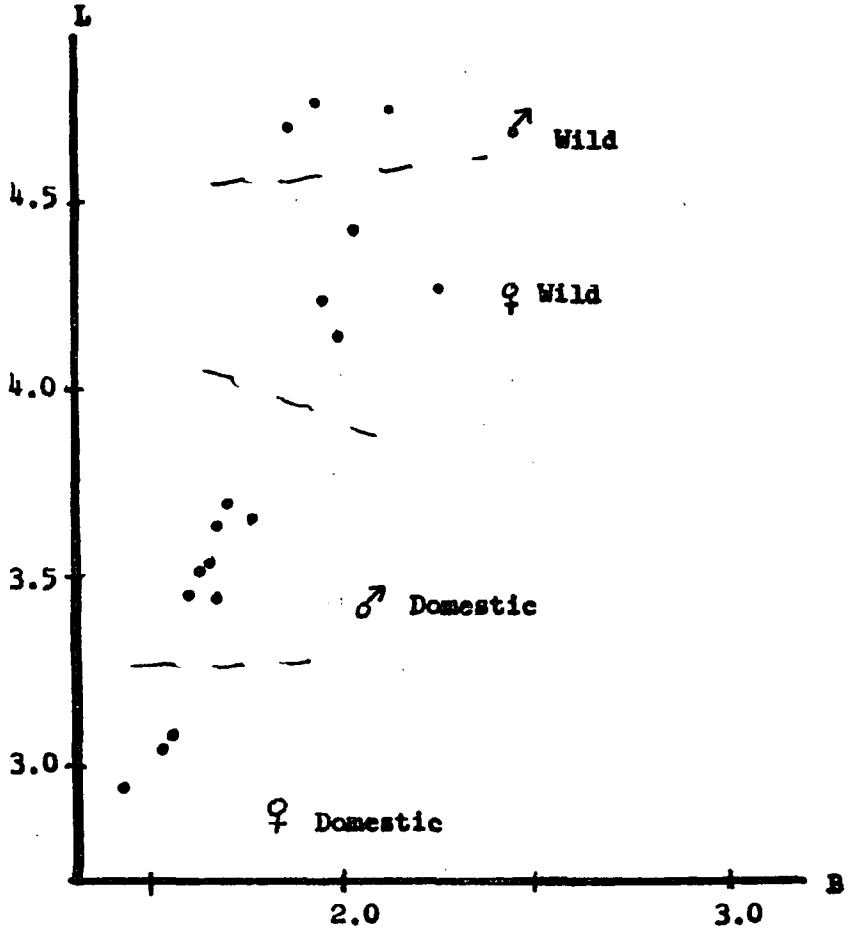
Ill. 13: Map of Petnica showing locations of 1969 and 1981-2 excavations and 5 meter contour interval.

Ill. 14: Map of Ljuljaci (I - Ljuljaci I; II - Ljuljaci II; III - Ljuljaci III).

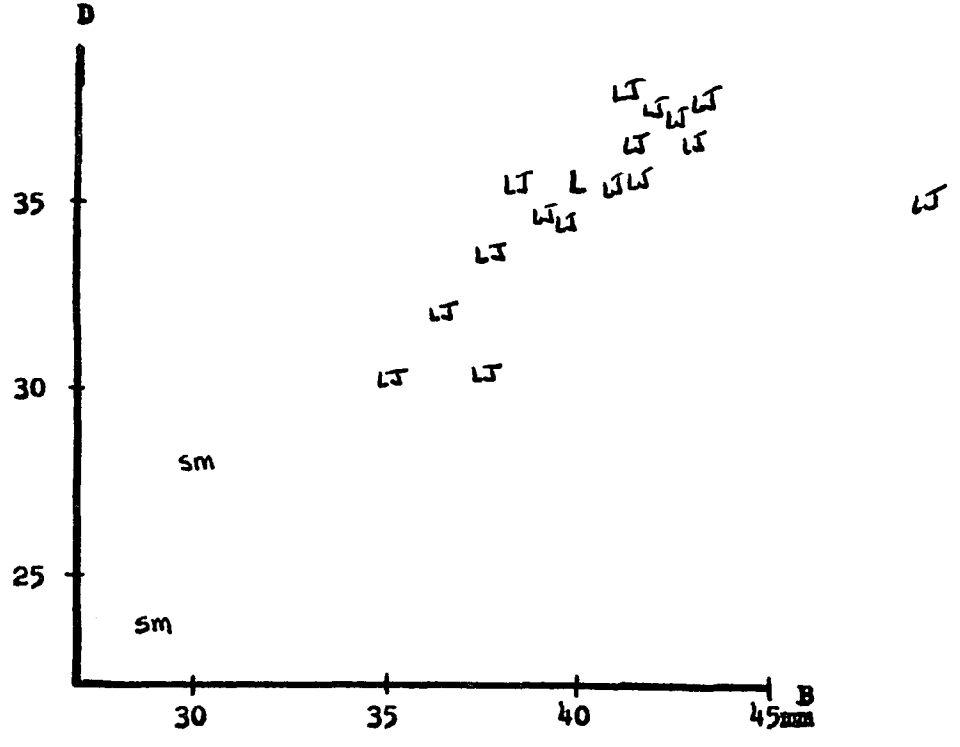




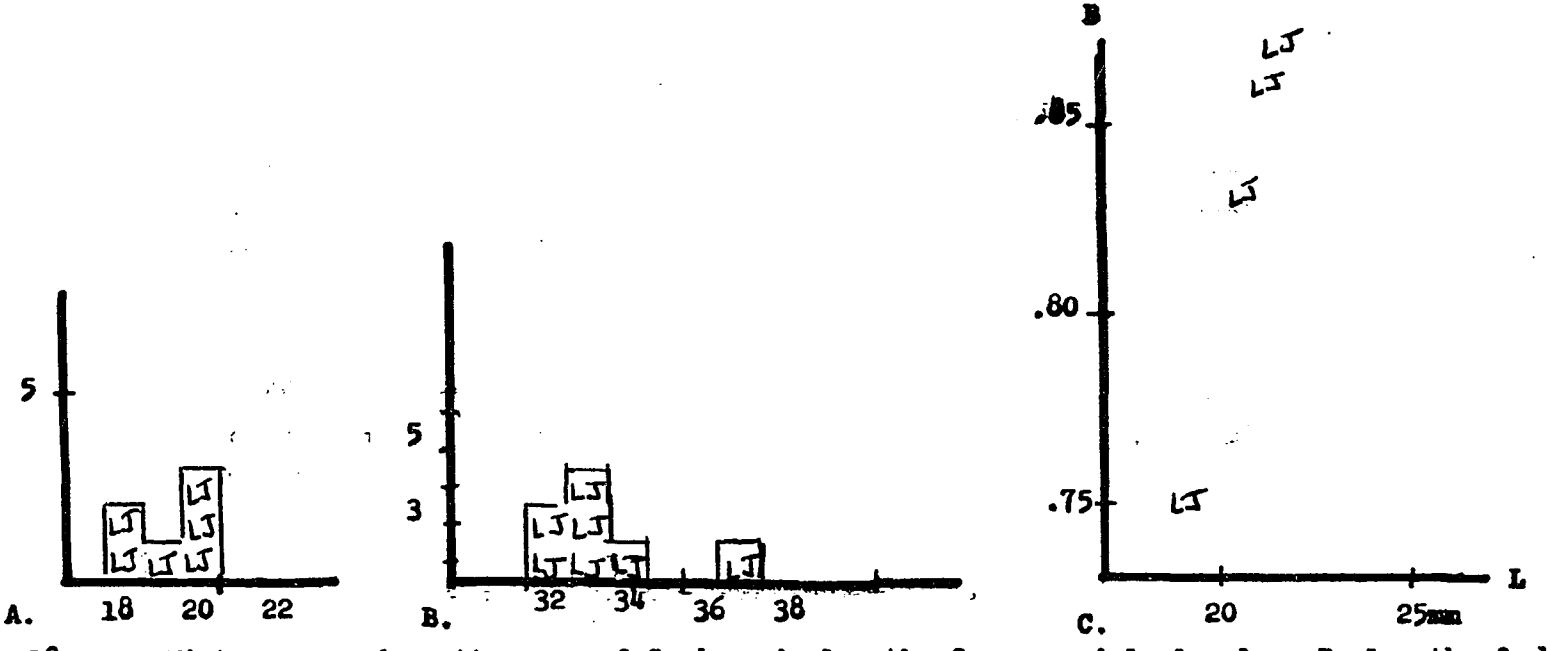
Ill. 15: Scattergram of Bos tibia - greatest breadth versus greatest depth of distal end.



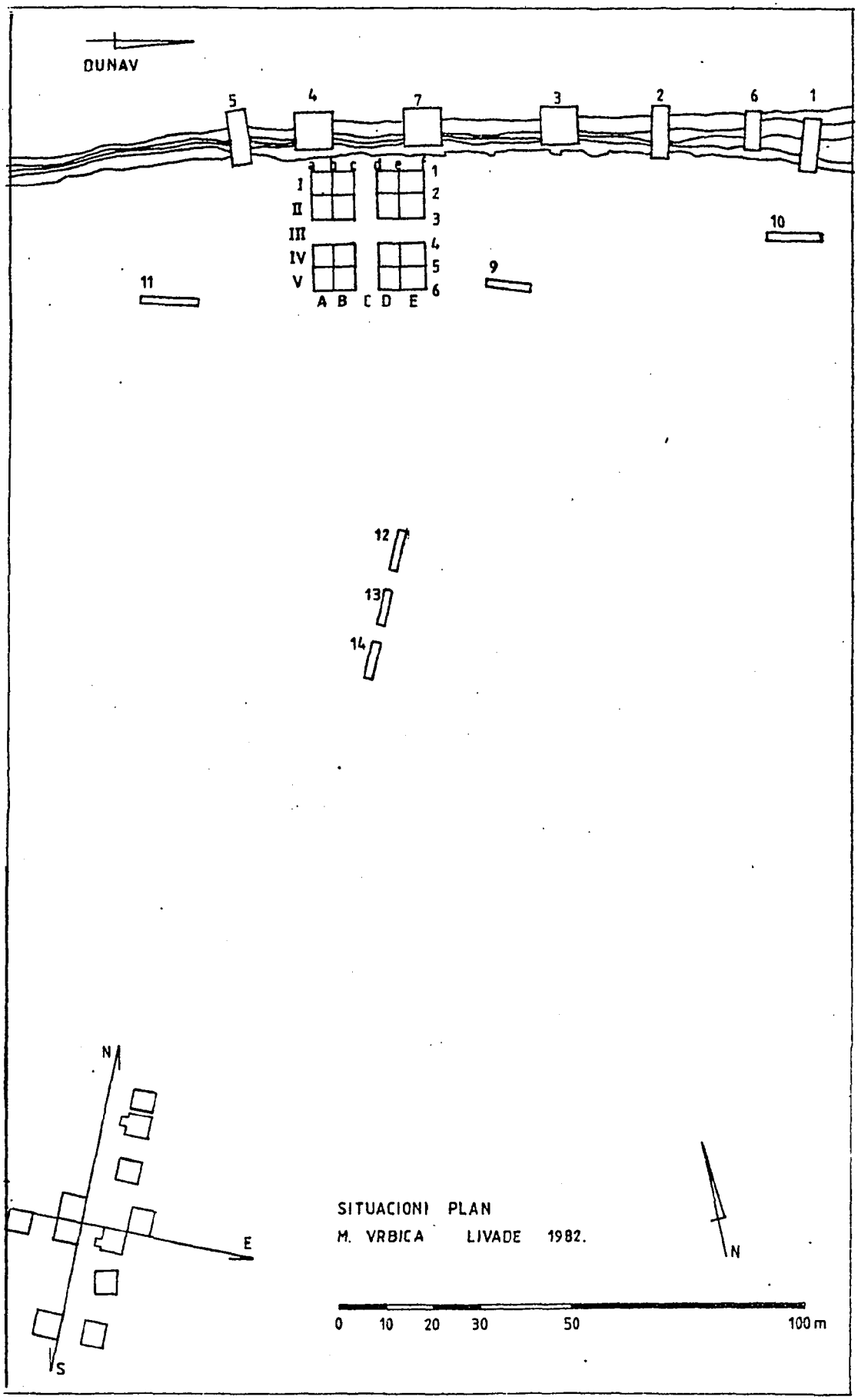
Ill. 16: Scattergram of Sus LM3 from Ljuljaci - Length versus Breadth (measured at base of enamel crown).



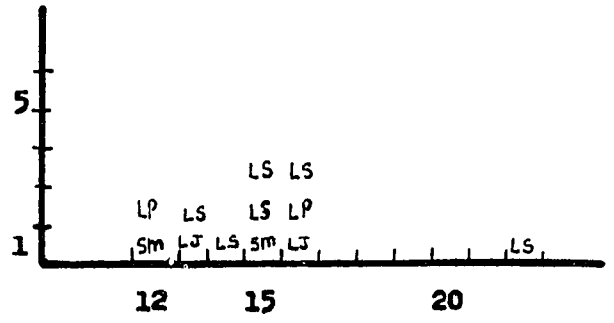
Ill. 17: Scattergram of Sus tibia - greatest breadth versus greatest depth of distal end (post-Neolithic).



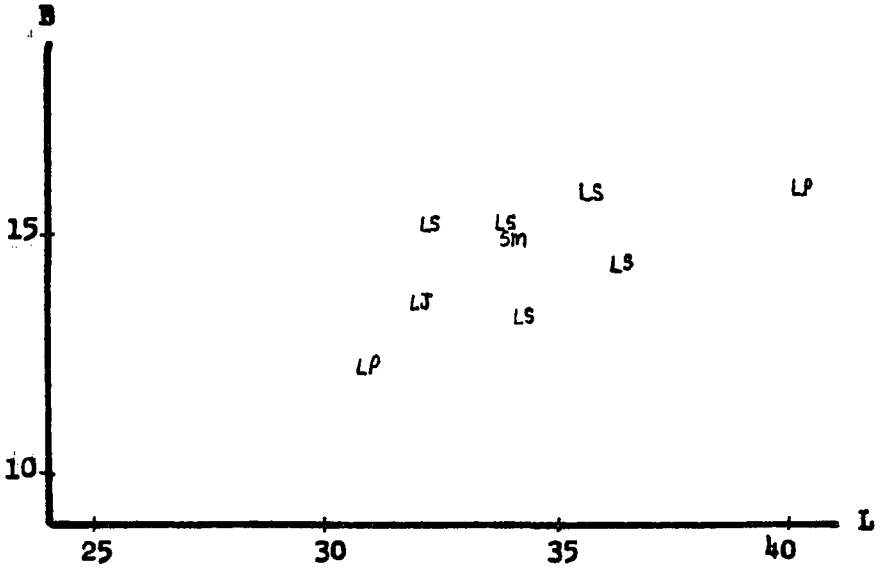
Ill. 18: Histograms and scattergram of Canis - A. length of carnassial alveolus; B. length of lower molar row; C. length versus breadth of carnassial (post-Neolithic).



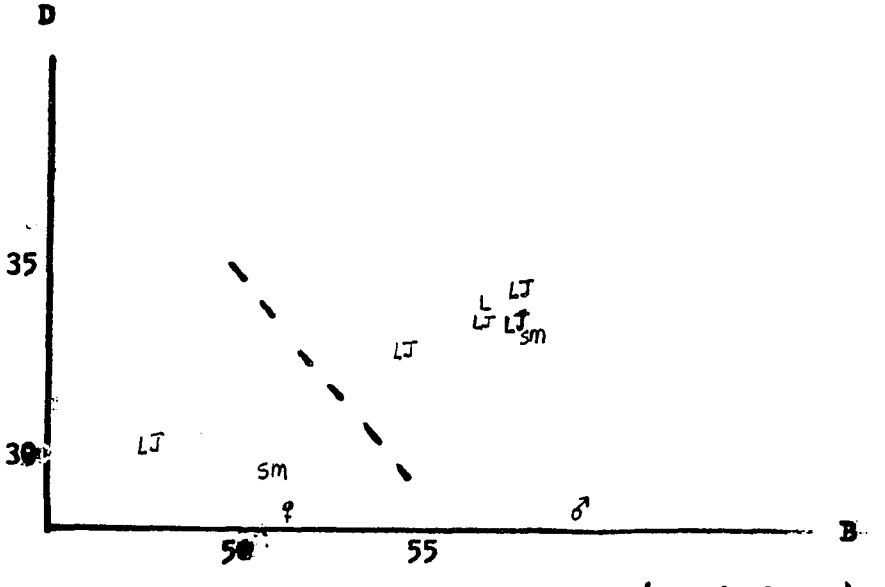
Ill. 19: Map of Livade showing locations of 1980-2 excavations.



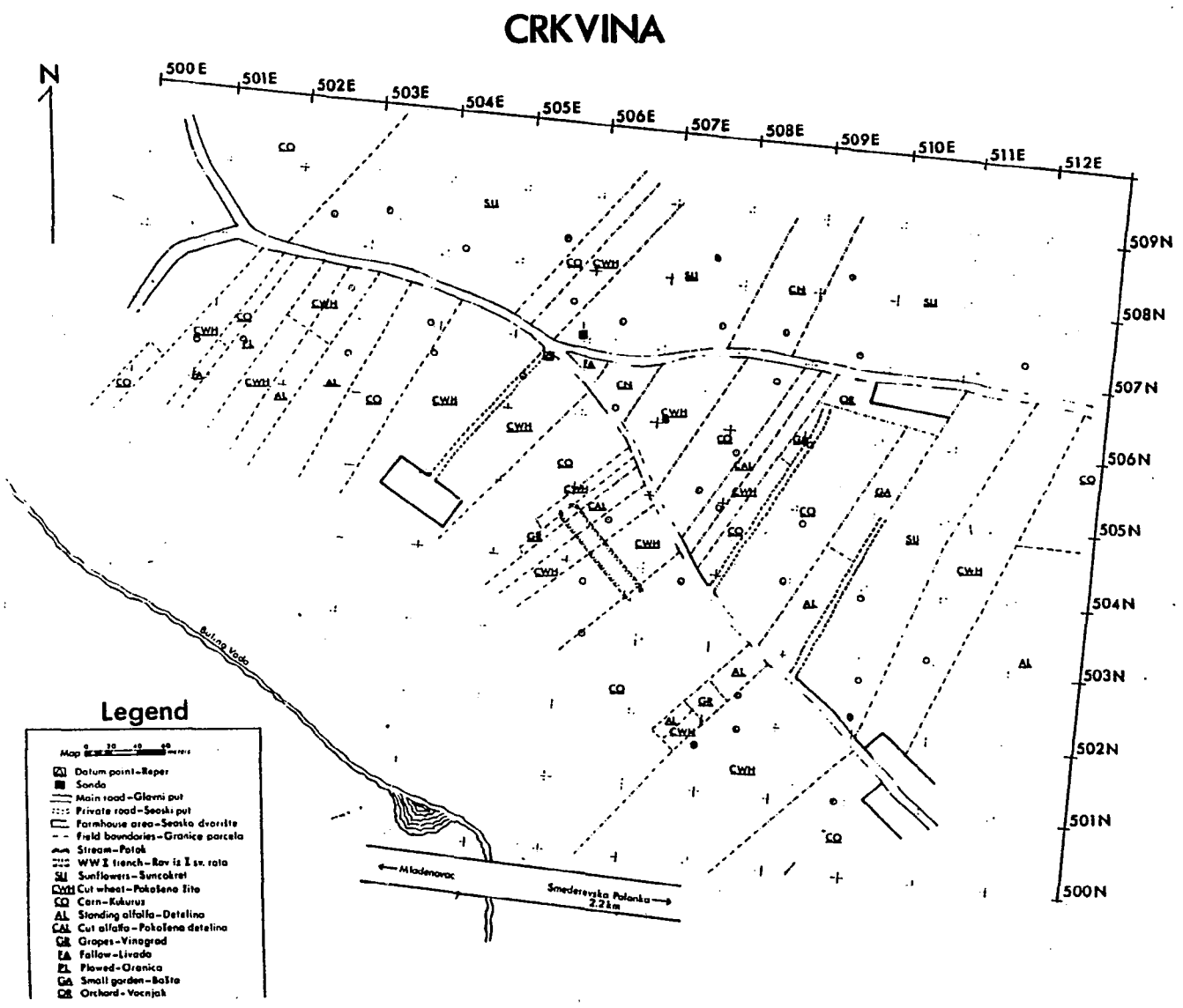
Ill. 20a: Histogram of LM3 breadth - Bronze Age cattle.



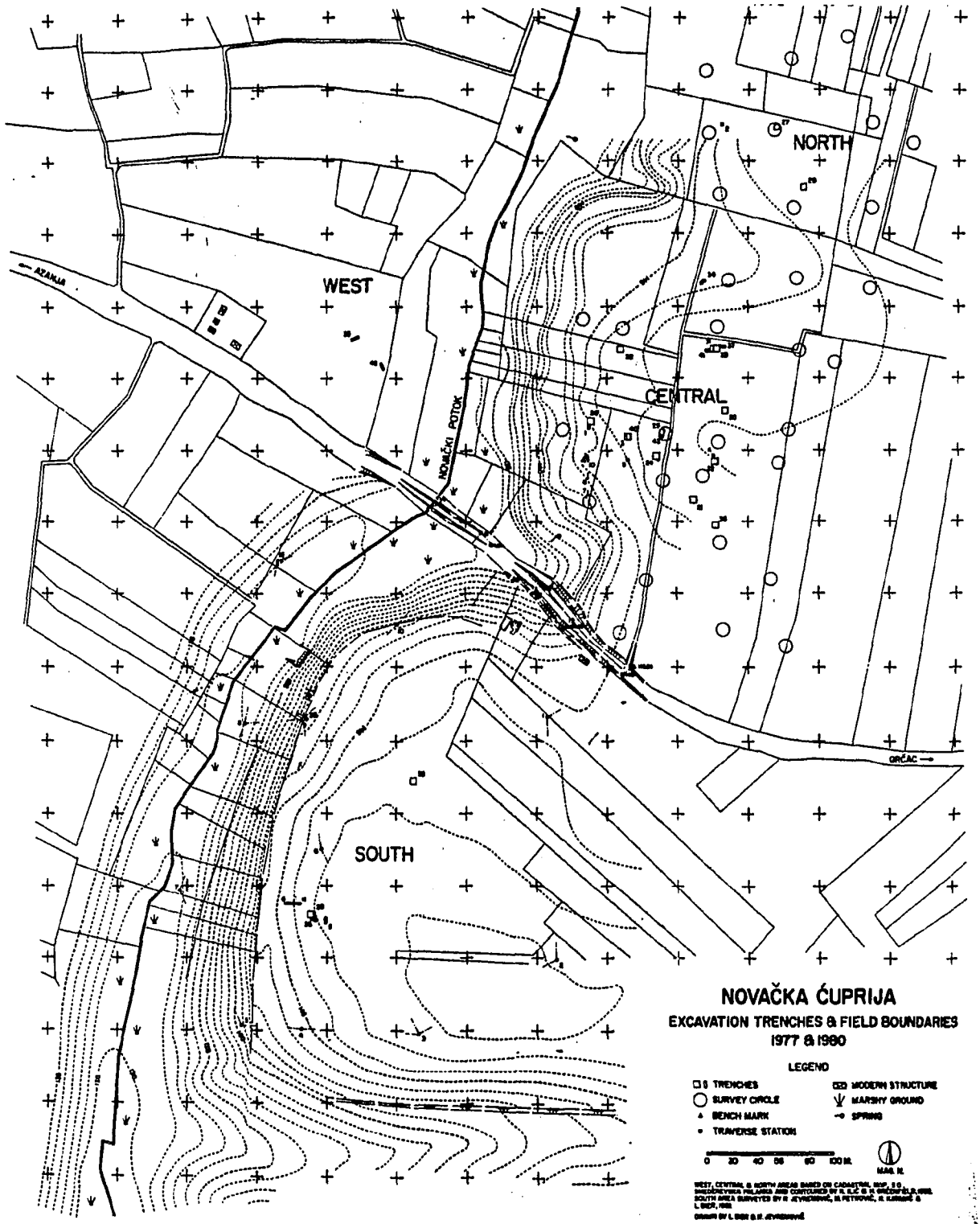
Ill. 20b: Cross-plot of Bronze Age cattle LM3 - length versus breadth.



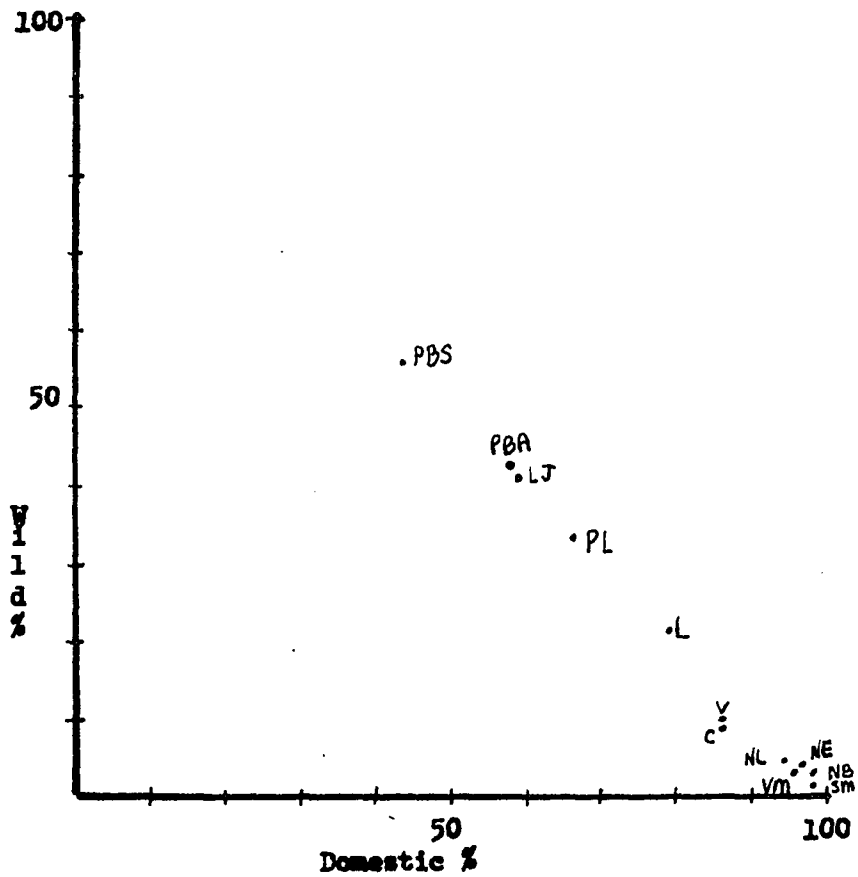
Ill. 21: Cross-plot of Bos metacarpus (proximal end) - greatest breadth versus greatest depth



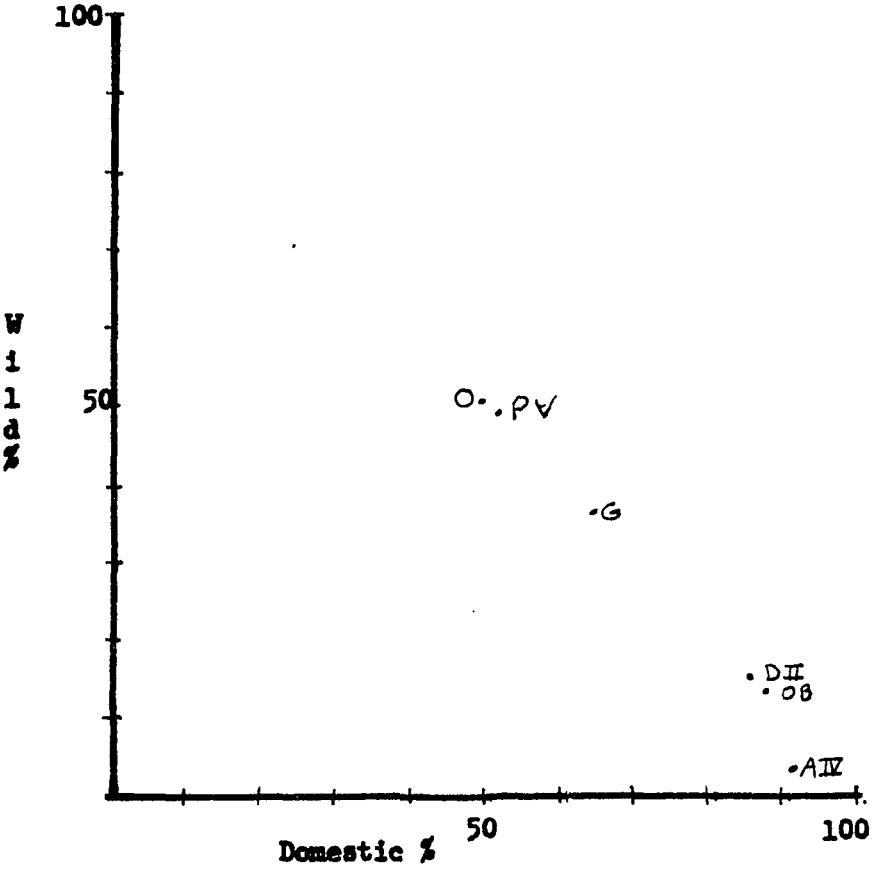
Ill. 22: Crkvina - 1977 survey map.



Ill. 23: Novačka Ćuprija - map of site

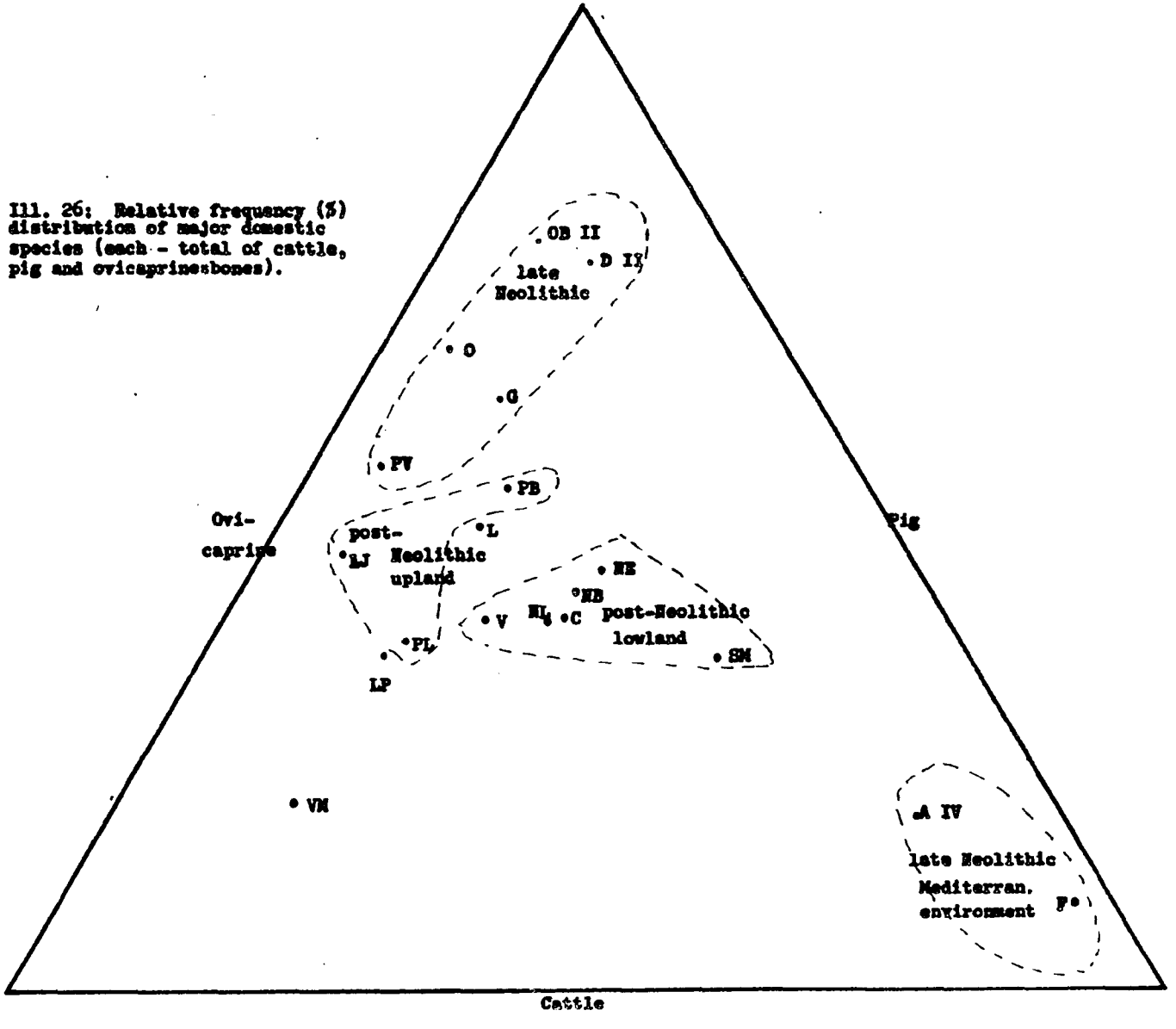


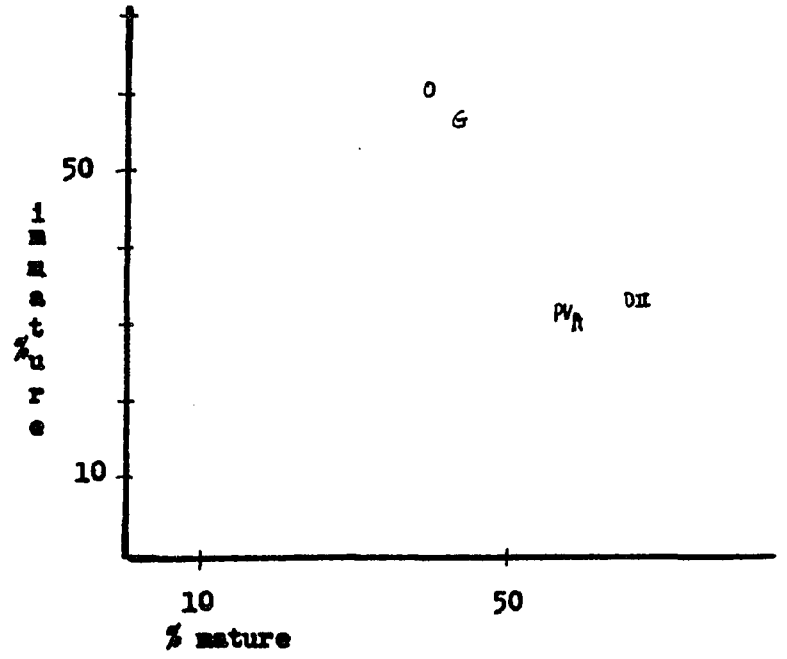
Ill. 24: Cross-plot of relative frequency (%) of domestic:wild animals in post-Neolithic assemblages.



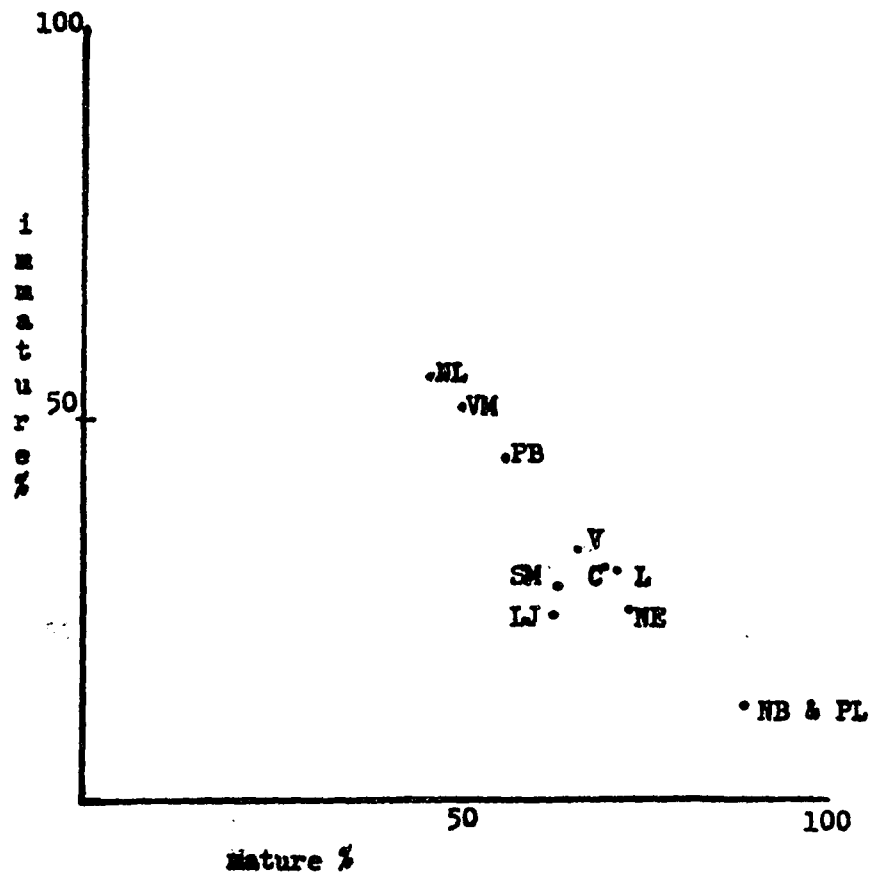
Ill. 25: Cross-plot of relative frequency (%) of domestic: wild animals in late Neolithic assemblages.

Ill. 26: Relative frequency (%) distribution of major domestic species (each = total of cattle, pig and ovicaprines:bones).



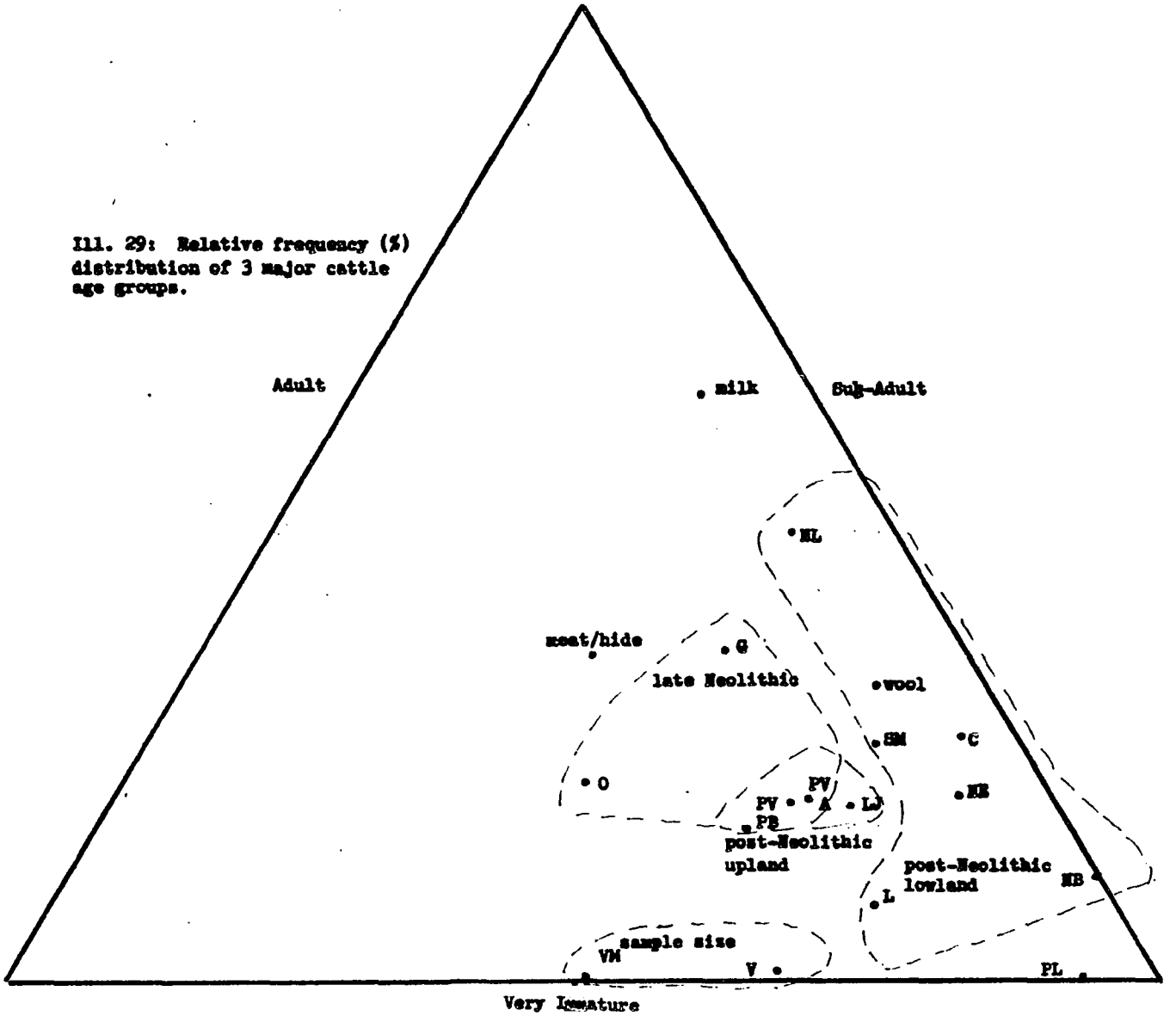


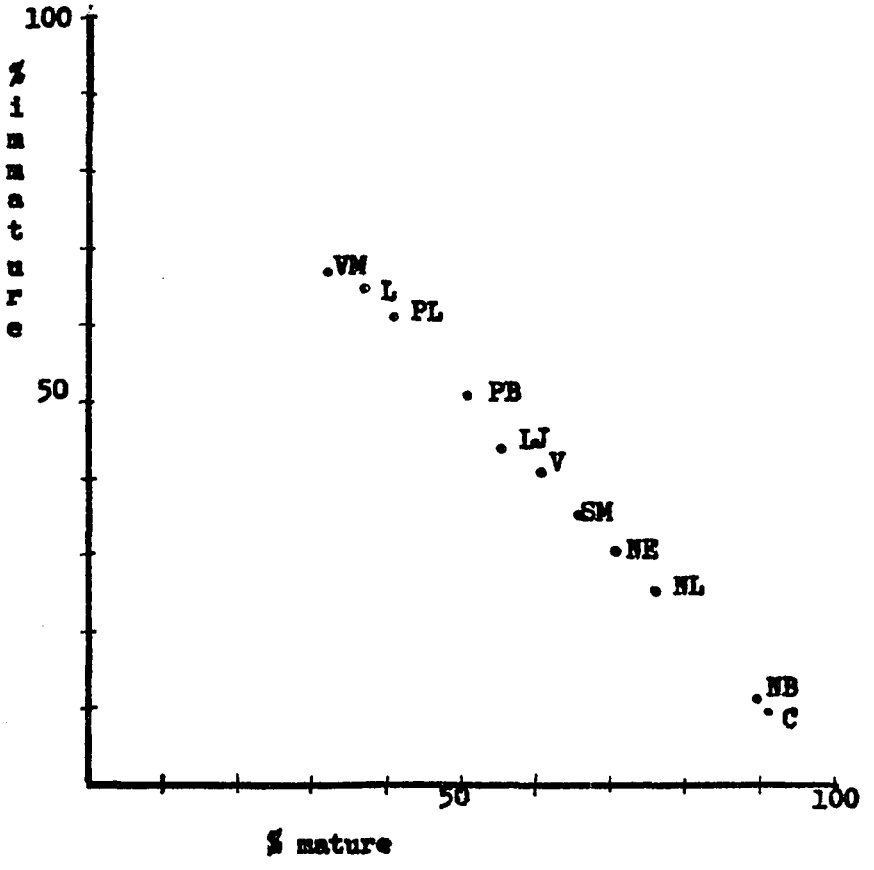
Ill. 27: Relative frequency of immature:mature cattle bones in late Neolithic assemblages.



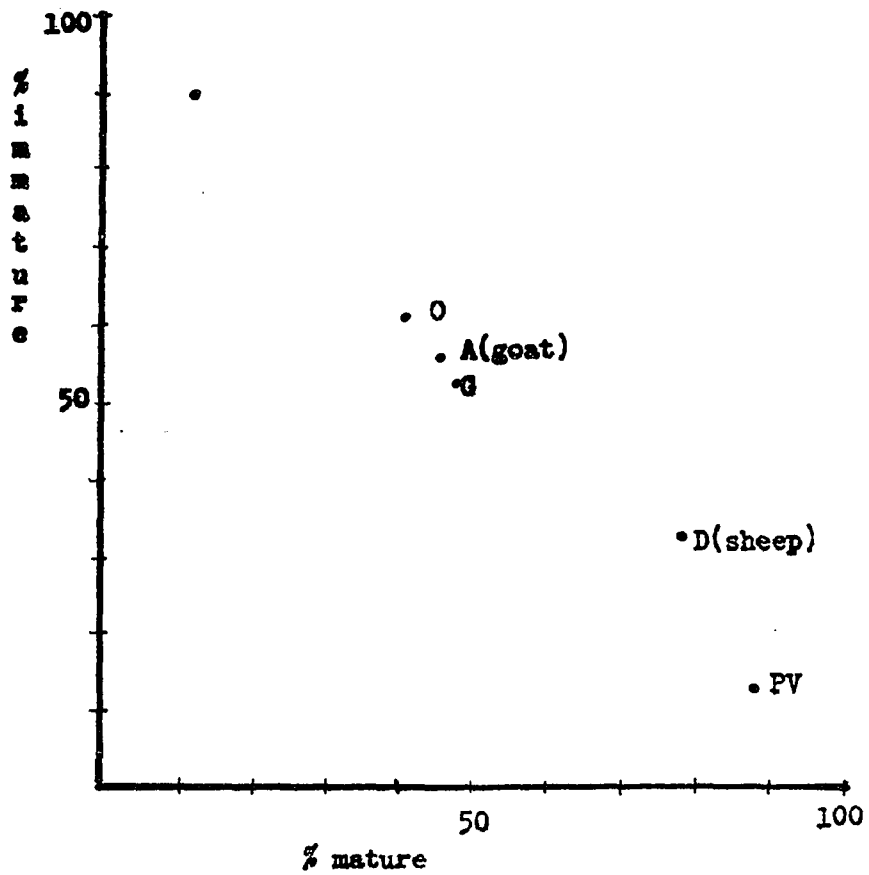
Ill. 28: Cross-plot of relative frequency (%) of immature: mature cattle - post-Neolithic.

Ill. 29: Relative frequency (%) distribution of 3 major cattle age groups.



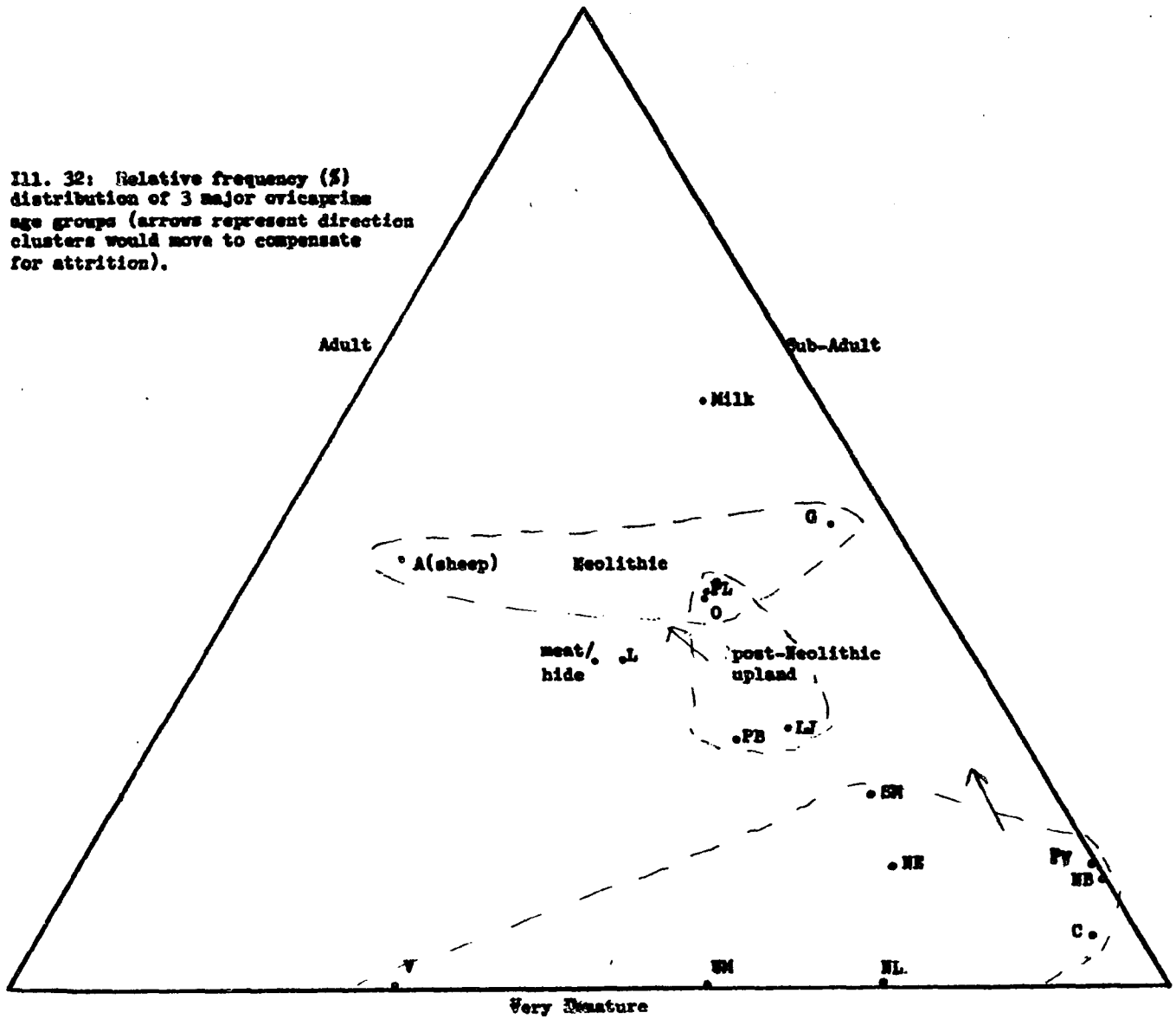


Ill. 30: Relative frequency (%) distribution of immature: mature ovicaprines in post-Neolithic assemblages.

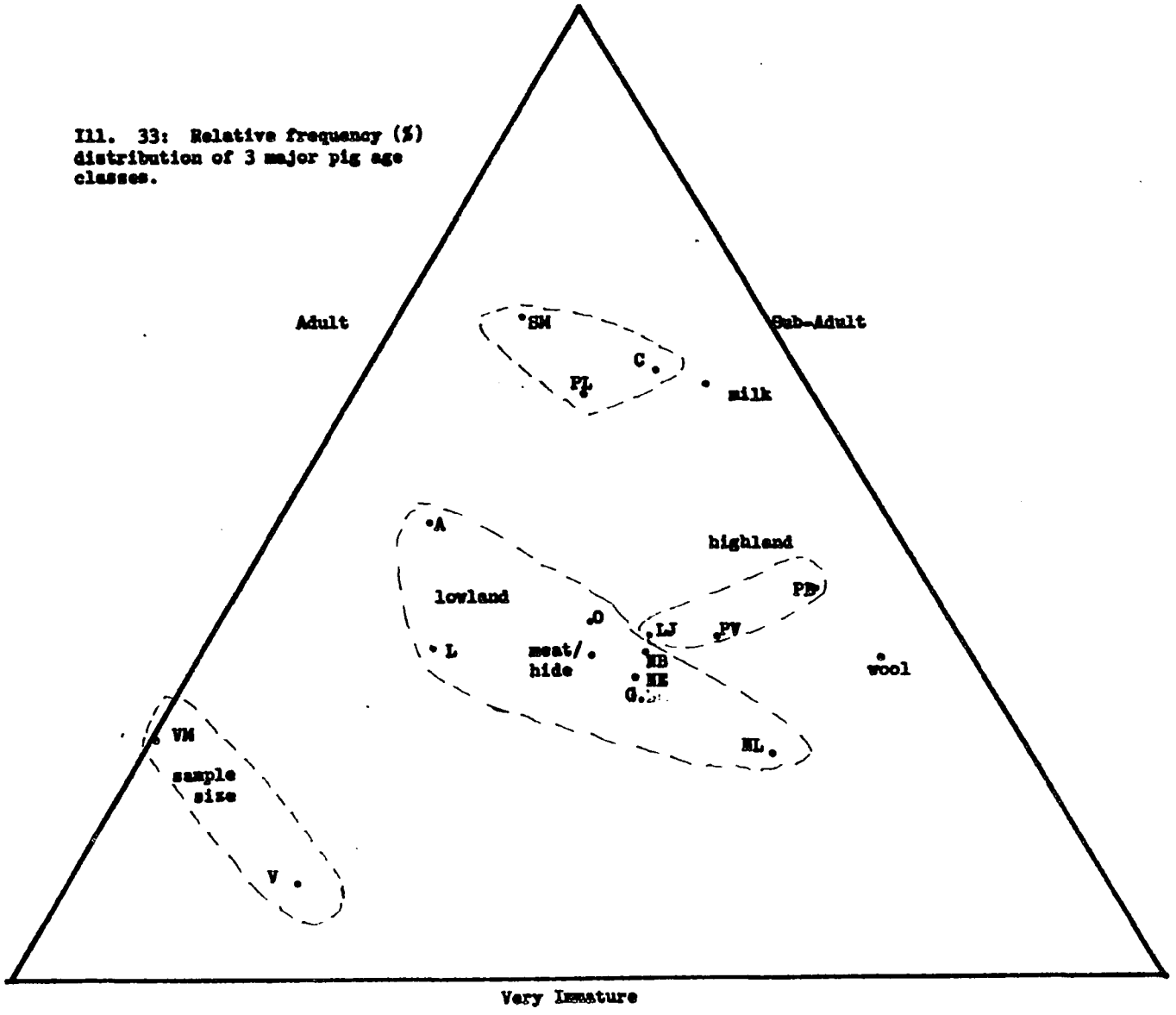


Ill. 31: Relative frequency (%) distribution of immature: mature ovicaprines in Neolithic assemblages.

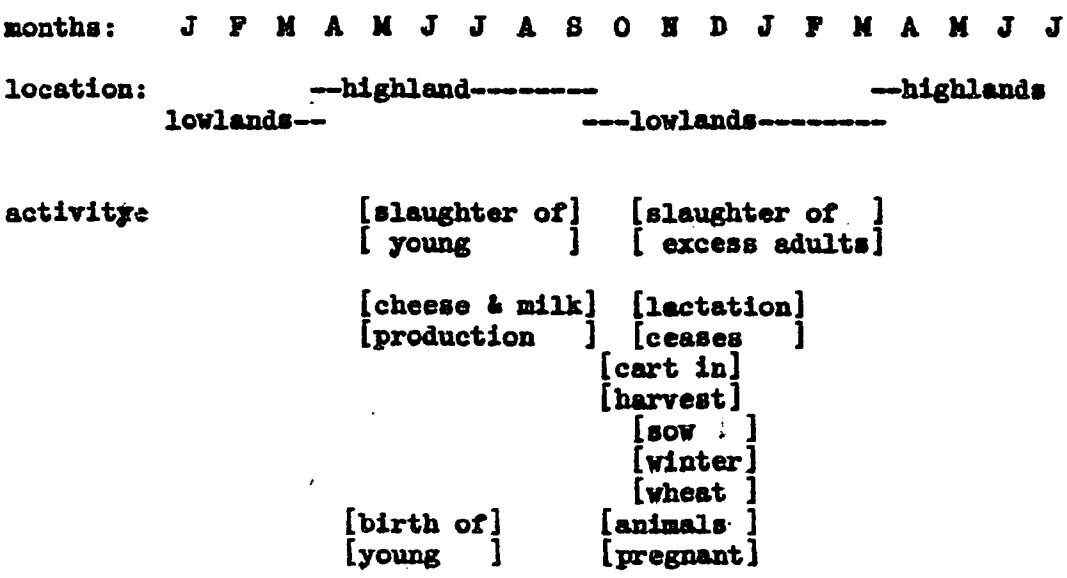
Ill. 32: Relative frequency (%) distribution of 3 major ovicaprine age groups (arrows represent direction clusters would move to compensate for attrition).

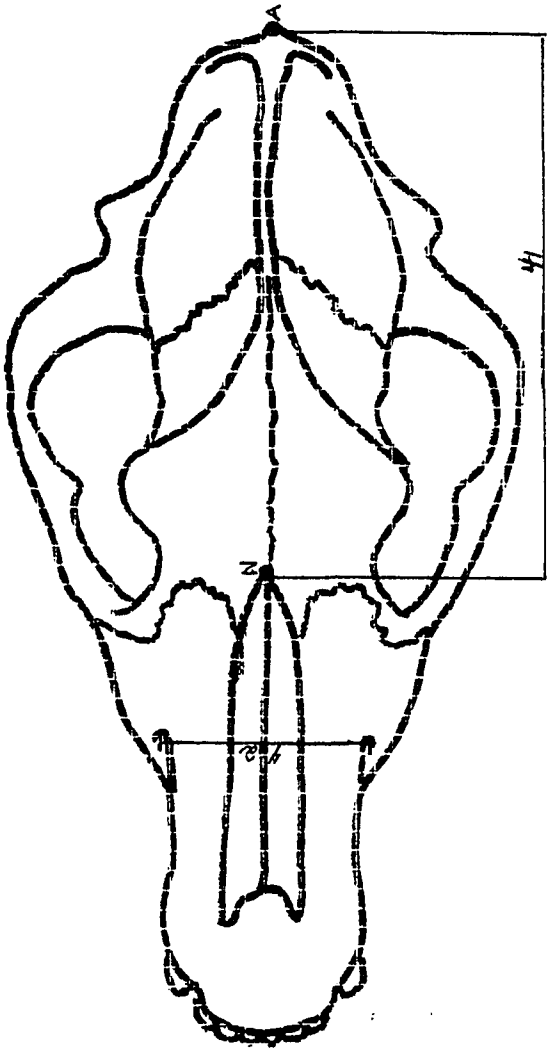


Ill. 33: Relative frequency (%) distribution of 3 major pig age classes.

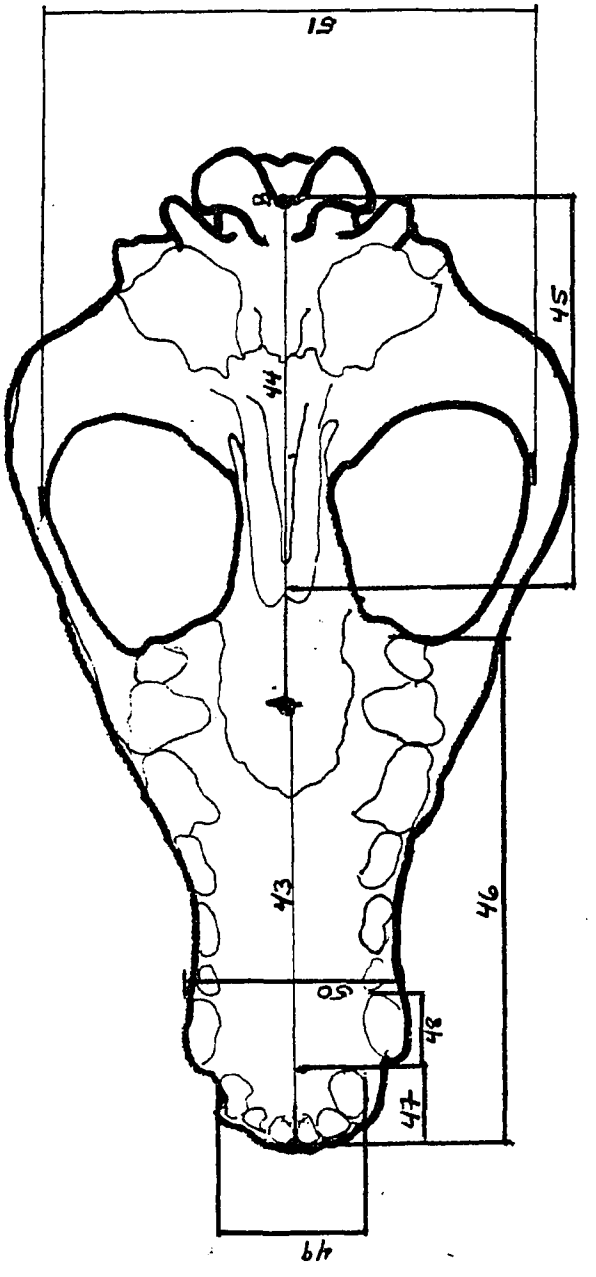


Ill. 34: Bronze Age seasonal cycle of domestic animal movement and exploitation





Ill. 35: Canis cranial measurements (41 & 42).



Ill. 36: Canis cranial measurements (43-51).

Table 1: Absolute chronology of prehistoric periods.

Date B.C.	Period	Danube Valley/Vojvodina		Serbia/Morava Valley	
1000	+		+	+	I
	+		+	+	+
1250	LBA		+	+	+
	+		Žuto-Brdo	+	+
1500	+		+	Paracin	II
	+		+ +	+	+
1750	MBA		+ +	+	Mediana
	+		+		+
2000	+		+	+	III
	+		Vatin	+	
2250	+		+	+	III
	+	+	+	+	+
2500	EBA	Vinkovci		Slatina	+
	+	+		+	Bubanj-Hum
2750	+	Vučedol			II
	+	+		+	+
3000	Eneolithic	Kostolac		Baden-	+
	+	+		Kostolac	Ib
3250	+	Baden		+	+
	+				+
3500	+	Vinča D		Vinča D	Ia
	+	+		+	
3750	Late	+		+	
	Neolithic	+		+	
4000	+	Vinča C		Vinča C	
	+	+		+	
4250	+	Vinča B		Vinča B	
	Middle	+		+	
4500	Neolithic	Vinča A		Vinča A	
	+				
4750	+	+		+	
	+	+		+	
5000	+	+		+	
	Early	Starcevo		Starčevo	
5250	Neolithic	+		+	
	+	+		+	
5500	+	+		+	
	+	+		+	
5750	+	+		+	
	+	+		+	
6000	+	+		+	

Table 2: Types of post-cranial limb bones

Small, Hard	Early Fusing	Late Fusing
Patella	Distal Humerus	Proximal Scapula
Astragalus	Proximal Radius	Distal Scapula
Calcaneus	Proximal Metacarapal	Proximal Humerus
Carapals	Distal Tibia	Distal Radius
Tarsals	Proximal Metatarsal	Proximal Ulna
Phalanx 1		Distal Ulna
Phalanx 2		Distal Metacarapal
Phalanx 3		Proximal Femur
Sesamoids		Distal Femur
		Proximal Tibia
		Distal Metatarsal

Types of Pelvic, Vertebral and Rib bones

Acetabulum	Proximal Ilium
	Pubic Symphsis
	Distal Ischium
	Vertebrae
	Ribs

Table 3: Frequency distribution of identified species/genera size ranges from post-Neolithic localities (all deposits combined).

site	Large* No.(%)	Medium**	Small***	Sieve
Crkvina	36(37.5)	57(59.4)	3(3.1)	+
Novačka Ćuprija	279(40.5)	393(57.0)	17(2.5)	+
Petnica	289(64.5)	158(35.3)	1(0.2)	+-
Večina Mala	8(26.7)	22(73.3)	-	-
Ljuljaci	1210(68.4)	550(31.1)	10(0.6)	-
Sarina Medja	81(34.3)	155(65.7)	-	-
Vrbica	19(43.2)	25(56.8)	-	-
Livade	513(49.6)	435(42.1)	86(8.3)	-
Livade (fish excluded)	513(53.8)	435(45.6)	6(0.6)	-

*Bos t./Equus c./Cervus e./Ursus a./Homo s./Sus s. f.
**Ovis aries/Capra hircus/Capreolus c./Canis f./Sus s. d.
***Castor f./Lepus c./Meles m./Pisces/Aves

Table 4: Bone frequency at Opovo by excavation unit

Unit Code	Description	No. frags.
01-02	Sonda 1, otkop sloj 2	30
01-03	Sonda 1, otkop sloj 3	42
01-04	Sonda 1, otkop sloj 4	189
01-05	Sonda 1, otkop sloj 5	185
01-06	Sonda 1, otkop sloj 6	106
01-07	Sonda 1, otkop sloj 7	63
01-08	Sonda 1, nivo skidanja lep	30
01-09	Sonda 1, otkop sloj 8	36
Sub-total		681
02-03	Sonda 2, otkop sloj 3	40
02-06	Sonda 2, otkop sloj 6 and 7 (na crtani material)	36
02-08	Sonda 2, otkop sloj 8 (specimens 1-3)	8
02-08	Sonda 2, otkop sloj 8, iz profil (specimens 4-10)	12
02-09	Sonda 2, otkop sloj 9	19
02- 7	Sonda 2, pepliste (small area next to hearth/oven)	2
Sub-total		117
03-04	Sonda 3, otkop sloj 4	64
03-05	Sonda 3, otkop sloj 5	31
03-06	Sonda 3, otkop sloj 6	7
03-07	Sonda 3, otkop sloj 7	2
03-10	Sonda 3, material prilikom ciscenja pode kuce, uz istocni profil	35
Sub-total		139
Total		937*

* - Plus 37 unprovenienced bone/antler tools.

Table 5: Distribution of Chewed Bone - Opovo

Element	Part.	Species: O/C.	Bp	Bt	Ss?	Ssf	Ssd	Cf	Ce	Cc	Mm	Lm	OCC	BtC	Total
Man				1			1					1			3
Rib														2	2
C Vert														1	1
Scap	D			1					2					1	4
Hum	P			1											1
Hum	S			1			1								2
Hum	D				3		3		1	2				2	11
Ulna	P			2		2	4	2	1						11
Ulna	D						1								1
MC	P			2											2
MC	S								1						1
Pha.1							2		2						4
Pel		1		2							1		1		5
Fem	P			3										1	4
Fem	D	1		1										2	4
Tib	P													1	1
Tib	D	1		2											3
Tib	W						1								1
Cal				1			6		2	1				1	13
MT	P			3											3
MT	D			2											2
MT	S								1						1
TOTAL		3		22	3	2	21	2	10	3	1	1	1	11	80

O/C - Ovis/Capra; Bp - Bos primigenius; Bt - Bos taurus; Ss? - Sus scrofa (?); Ssf - Sus scrofa fer.; Ssd - Sus scrofa dom.; Cf - Cervus elaphus; Cc - Capreolus capreolus; Mm - Medium mammal; Lm - Large mammal; OCC - Ovis/Capra/Capreolus; BtC - Bos taurus/Cervus.

Table 6: Frequency distribution of eroded (weathered) bones from Opovo.

Species: Element	Part	Ovis/ Capra	Bos taurus	Sus scr. dom.	Cervus elaphus	Capreolus capreolus	Large Mammal	Bos/ Cervus	Total
Horn/Antler with cranium		1				1			2
Humerus	D							1	1
Radius	D		1						1
Carpal					2				2
Metacarapal	P		1						1
Phalanx 1			1						1
Phalanx 2					1				1
Femur	D				1				1
Tibia	P				1			1	2
Tibia	S						1		1
Astragalus	W		2						2
Astragalus	D					1			1
Calcaneus			1	1					2
Cuboid					1				1
Metatarsal	D				1				1
Cervical Vertebra	C							1	1
Total		1	6	1	7	2	1	3	21

Table 7: Species Frequencies - Opovo

Species	No.(%)
Ovis aries	4(0.6)
Capra hircus	1(0.1)
Ovis/Capra	13(2.0)
Bos primigenius	15(2.3)
Bos taurus	194(30.1)*
Sus scrofa fer.	23(3.6)
Sus scrofa (?)	3(0.5)
Sus scrofa dom.	85(13.2)**
Canis familiaris	17(2.6)
Cervus elaphus	232(36.0)***
Capreolus capreolus	40(6.2)
Lepus capensis	4(0.6)
Meles/Mutra/	1(0.1)
Pisces sp.	13(2.0)
Sub-total	645(73.4 of total)
Unio sp.	71
Helix sp.	6
Homo sapiens sapiens	6
Medium mammal	18
Large mammal	13
Ovis/Capra/Capreolus	6
Bos taurus/Cervus/Equus	43
Bos taurus/Cervus	101
Sub-total	181(20.7 of total)
Unidentified	41(4.7 of total)
Total bone (excluding articulations and shell)	873
Total bone (including articulations)	885
Total bone and shell	968

* + 4 articulated and 2 fused bones
** + 3 fused bones
*** + 2 fused and 8 articulated bones

Domestic	314(48.7)
Wild	328(50.8)
	3(0.5)

Table 8: Distribution of Age Classes - Opovo - Number of fragments (%)

Ovis+Capra+Ovis/Capra

Age	PC ♀	PC ♂/C	Vert	Rib	Cra ♀	Cra+Ant	Ant/Hor	Man ♀	Man ♂/C	Max	Teeth	Total ♂/C	Ovis	Capra	♂/C
?															
Im															
F/I															
I															
I/J															
J		1							2						3
J/S															
S		1							1		1		1	2	
S/A	2	4									2			4	
A	1	1			1				2		1		2	4	
Tot	3	16			1				5		4		4	13	

Bos (taurus + primige.)

Age	PC ♀ ta	PC ♀ pr	PC ♂/C ta	Vert ta	Rib ta	Cra ♀ ta	Cra+Ant ta	Ant/Hor pr	Ant/Hor ta	Man ♀ pr	Man ♀ ta	Man ♂/C ta	Max ta	Teeth ta	Total ♂/C taurus	primigenius
?	1	1												4		
Im																
F/I																
I	1													1 (0.9)		
I/J																
J	2									2			2	6 (5.5)		
J/S	3												1	4 (3.7)		
S	20	1	1						4				9	34 (31.5)	1 (20.0)	
S/A	68	9	5				3		1 5				11	82	10	
A	35	3	8		2		1		4	1	4		9	63 (58.33)	4 (80.0)	
Tot.	132	13	15		2		4		15	1	4		22	194	15	

Tab. 8 cont: Distribution of Age Classes - Opovo - Number of fragments (%)

Sus scrofa (dom. + fer.)

Age	PC D	PC W	Vert D	Vert W	Rib D	Rib W	Cra	Cra+Ant	Ant/Mor	Man D	Man W	Max D	Max W	Teeth	Total Domestic	Total Wild
?	1											1			2	
Im																
F/I																
I		1													1(1.7)	
I/J																
J	3				1					8		1			13(22.0)	
J/S	4														4(6.8)	
S	7	2 1	1							7	1 4		3		22(37.3)	4(36.4)
S/A	18	10		1	3					1	1		1		24	12
A	6	2	1							7	3 2	3 2			19(32.2)	7(63.6)
Tot	39	12 4	2	1	4					23	5 8	3 6		1	85	23

Cervus;Capreolus

Age	Cer:Cap D	Cer:Cap W	Vert D	Vert W	Rib D	Rib W	Cra	Cra+Ant	Ant/Mor	Man D	Man W	Max D	Max W	Teeth	Cervus	Capreolus
?	1														1	
Im																
F/I																
I	1	1													1(0.9)	1(3.8)
I/J																
J	1	2								1					2(1.8)	2(7.7)
J/S	1														1(0.9)	
S	6	2					1			2	2 3				12(10.6)	4(15.4)
S/A	100	12 2			3	1	1 2			1 5		2	1		117	14
A	29	7 11	1		2	1	38			6 11		5 10		2	97(85.8)	19(73.1)
Tot	137	24 13	1		5	2	1 41			7 19		7 15		3	232	40

Table 9: Distribution of bone fragments by species and density at Opovo.

	Ovis/ Capra	Bos pr.	Bos t.	Sus scrofa fert.	Sus scrofa dom.	Canis fam.	Cervus elaphus	Capreolus capreolus
Loose teeth & small, hard:	2	3	46	1	19	0	40	3
Early fusing:	7	7	49	11	13	5	67	9
Late fusing*:	2	1	47	1	6	1	36	10
Vert/Rib:	0	0	17	2	5	2	13	1
Cran/Max**:	0	0	10	3	12	2	19	8
Mandible:	5	1	15	5	23	6	20	7
Pelvis:	2	0	10	0	1	1	6	3

*does not include antler or horn cores.
** includes calcaneus.

Table 10: Frequency distribution of burnt bone at Opovo.

Species: / Element:	Ovis/ Capra	Bos pri.	Bos tau.	Sus s. dom.	Canis fam.	Cervus elaphus	Medium Mammal	Large Mammal	Cervus/Bos/ Equus	Cervus/ Bos	?
Cranium			1						1		
Vertebrae									1		
Lumbar Vertebrae								1			
Scapula		1									
Radius						2					
Ulna					1			1			
Metacarpal			1			1					
Phalanx 1			2(B)			1					
Ilium			1								
Femur										1	
Tibia	1		2	1		1		1			
Calcaneus			1			1					
Long bone fragment											3
Unidentified								1			
Loose teeth			2				2	2			
Shell											1(A)
Antler frag.						2					
Mandible						3					
Total	1	1	10	1	1	11	2	6	1	1	4

(A) - includes 1 Unio sp. fragment.
(B) - includes 1 phalanx 2.

Table 11: Frequency distribution of butchered bone from Opovo.

Species:		Ovis/ Capra	Bos taurus	Sus scr. dom.	Sus scr. fer.	Cervus elaphus	Capreolus capreolus	Large Mammal	Medium Mammal	Ovis/ Capra/ Capreolus	Bos/ Cervus	?
Element	Part											
Cervical Vertebrae	Do					1(7)						
Thoracic Vert.						1(6)						
Lumbar Vert								1(6)	1(6)			
Sacrum	C										1(4)	
Humerus	D		1(6)		1(5)	1(6)						
Radius	P		1(6),1(7)								1(6)	
Ulna	P				1(7)							
Metacarpal	P		2(6),1(7)				2(6)				1(7)	
Metacarpal	D	1(6)				1(5),1(6)						
Phalanx 1			2(6)									
Pelvis	Ac	1(7)	1(5)									
Tibia	P		3(6),1(5)									
Tibia	D					1(7)						
Cuboid						1(7)						
Metatarsal	P					1(4)	3(6)					
Metatarsal	D		1(7)									
Metapodial	P					1(5),3(6)				1(6)		
Metapodial	D		1(6)	1(6)								
Mandible												26)
Total		2	15	1	2	12	2	1	1	1	3	2

(4) - chop mark (severed) parallel to long axis of bone.
(5) - chop mark (severed) perpendicular to long axis of bone.
(6) - slice/cut mark parallel to long axis of bone.
(7) - slice/cut mark perpendicular to long axis of bone.

Table 12: Species Frequencies - Petnica: TNF(%)

Species	.Vinca B	.Vinca C	.Vinca D	.Vinca tot..	Eneolithic Baden	LBA .Halstatt
Ovis aries	2(1.2).	.	.	2(0.3).	3(1.2).	4(2.1)
Capra hircus	2(1.2).	.	.	2(0.3).	2(0.8).	2(1.0)
Ovis/Capra	1(0.6).	7(2.3).	5(4.7).	13(2.3).	15(0.6).	15(7.7)
Bos primig.	4(2.4).	1(0.3).	.	5(0.8).	1(0.4).	1(0.5)
Bos taurus	32(19.5).	103(34.7).	36(33.6).	171(30.1).	56(22.4).	44(22.7)
Sus scr. f.	4(2.4).	23(7.7).	3(2.8).	30(5.3).	8(3.2).	11(5.7)
Sus scr. d.	36(21.9).	48(16.2).	26(24.3).	110(19.4).	34(13.6).	61(31.4)
Sus scr. (?)	.	3(1.0).	.	3(0.5).	.	2(1.0)
Canis fam.	1(0.6).	1(0.3).	.	2(0.3).	1(0.4).	2(1.0)
Equus cab.	.	.	.	.	.	2(1.0)
Cervus ela.	60(36.6).	82(27.6).	31(29.0).	173(30.4).	120(48.0).	42(21.6)
Capreolus c.	15(9.1).	22(7.4).	6(5.6).	43(7.6).	9(3.6).	8(4.1)
Lepus cap.	2(1.2).	1(0.3).	.	3(0.5).	.	
Ursus a.	.	.	.	.	.	4(2.1)
Castor fib.	5(3.0).	4(1.3).	.	9(1.6).	.	
Vulpes vul.	.	1(0.3).	.	1(0.2).	.	
Lynx lynx	1(0.6).	.	.	1(0.2).	.	
Pisces sp.	.	+(+).	.	+(+).	.	
Aves sp.	2(1.2).	.	.	2(0.3).	1(0.4).	
Reptile	.	1(0.3).	.	1(0.2).	.	
Sub-total	167	.297	.107	. 571	.250	. 194
Small Mam.	.	5	. 3	. 8	. 4	.
Medium Mammal	85	.148	. 57	. 290	. 74	. 50
Large Mam.	140	.260	.103	. 503	.157	. 85
Ovis/Capra/ Capreolus	7	. 5	. 7	. 19	. 12	. 5
Bos/Equus/ Cervus	8	. 22	. 8	. 38	. 23	. 7
Bos/Cervus	14	. 41	. 5	. 60	. 25	. 12
Sub-total	254	.481	.183	. 918	.295	. 159
Unidentified	114	.379	.255	. 748	.192	. 53
Total	535	.1157	.545	.2237	.737	. 393
Domestic	.	.	.	300(52.8).	111(44.4).	130(66.3)
Wild	.	.	.	26 (47.1).	139(55.5).	66(33.6)
Species	167	.297	.107	. 571	.250	. 194
Size-class	254	.481	.183	. 918	.295	. 159
Unidentified	114	.379	.255	. 748	.192	. 53

Table 13: Distribution of Age Classes - Petnica - Number of fragments (%)

	Age	PC R.	PC L.	Vert	Rib	Cra	Cra+Ant	Ant/Mor	Man	Max	Teeth	Total Vinca B.	Eneo	LBA
Ovis aries	?													
	Im													
	F/I													
	I													
	I/J													
	J	1	1	2								1	1	2
	J/S													
	S			1										1
	S/A	2											2	
	A			1	1							1		1
	Tot.	1	3	4	1							2	3	4
Capra hircus	?													
	Im													
	F/I													
	I													
	I/J													
	J													
	J/S													
	S													
	S/A	2	2	1								2	2	1
	A		1											1
	Tot.	2	2	2								2	2	2

Tab. 13 cont:

	Age	B;C; D	PC	Vert	Rib	Cra	Cra+Ant	Ant/Hor	Man	Max	Teeth	Total	Vinca B	Vinca C	Vinca D
Ovis/Capra	?										; ; 1				1
	Im														
	F/I														
	I														
	I/J														
	J														
	J/S														
	S														
	S/A	1;3;							;1;		;1;	1	5		
	A								; ;3		;2; 1		2		4
	Tot	1;3;							;1; 3		;3; 2	1	7		5
		En;LBA										Eneo.- LBA			
Ovis/Capra	?	1 ;										1			
	Im														
	F/I														
	I														
	I/J														
	J	1 ; 3							1 ;		; 1	2	4		
	J/S										1 ;	1			
	S	1 ; 1							; 1		1 ;	2	2		
	S/A	6 ; 8									3 ; 3	9	11		
	A	; 2							2 ;		3 ; 2	5	4		
	Tot	9 14							3 ; 1		8 ; 6	20	21		

Table 13 cont.:

		PC	Vert	Rib	Cra*	Cra+Ant	Ant/Hor	Man	Max	Teeth	Total	Vinca B	Vinca C	Eneo	LBA
Bos primigenius	Age	B;C;E;L													
	?														
	Im														
	F/I														
	I														
	I/J														
	J														
	J/S														
	S														
	S/A	3;1;1;1									3	1	1	1	
	A	1; ; ;									1				
	Tot	4;1;1;1									4	1	1	1	
		B; C;D.										Vinca B	Vinca C	Vinca D	
Bos taurus	?	1;1								; ;3			1	4	
	Im														
	F/I						1; ;				1(6.7)				
	I	1; ;1									1(6.7)			1(7.7)	
	I/J														
	J	2; 3;								; 2;	2(13.3)	5(13.1)			
	J/S	; 1;		; 1;			; 1;					3(7.9)			
	S	3; 4;3	; 1;		; ;1					; 3;	3(20.0)	8(21.0)	3(23.1)		
	S/A	13391	3. 1; 1;1	1;12;2			2; 9;1			; 3;1	17	64		19	
	A	2;12;2	2; 1;	1; ;3			2; ;2	; ;1	1; 9;2		8(53.3)	22(57.9)		9(69.2)	
	Tot	216020	3; 3;1	2;13;5	; ;1		5;10;3	; ;1	1;17;6		32	103		36	

Table 13 cont.:

	Age	En	LBA	PC	Vert	Rib	Cra	Cra+Ant	Ant/Mor	Man	Max	Teeth	Total Eneo	Total LBA
Bos taurus	?													
	Im													
	F/I													
	I													
	I/J													
	J	3;											3(13.0).	
	J/S	1;											1(4.3).	
	S	3;	1							2;		1;	6(26.1).	1(6.6)
	S/A	27;	25	; 1			1;	1		2;		3; 3	33	29
	A	37;	33	; 1					1;	1;		8; 6	13(56.5)	14(93.3)
	Tot						1;	1	1;	5;		12; 9		

	Age	B;	C;	D									Vinca B	Vinca C	Vinca D
Sus scrofa fer.	?														
	Im														
	F/I														
	I														
	I/J														
	J														
	J/S														
	S	;	1;								;	1;		2(18.2).	
	S/A	3;	12;	2						;	;1		3	12	3
	A	1;	4;							;	1;	; 1;	; 3;	1(100.0).	9(81.8).
	Tot	4;	17;	2						;	1;	1; 2;	; 3;	4	23 3

Table 13 cont.:

Sus scrofa fer.

Age	PC En	PC LBA	Vert	Rib	Cra	Cra+Ant	Ant/Hor	Man	Max	Teeth	Total Eneo	Total LBA
?												
Im												
F/I												
I												
I/J												
J								1;			1(14.3)	
J/S												
S												
S/A	1; 7										1	7
A	3; 3							2;	1;	1	6(85.7)	4(100.0)
Tot	4;10							3;	1;	1	8	11

Sus scrofa dom.

Age	B; C; D	Vinca B	Vinca C	Vinca D
?	1; 1; 1	10; ; ; 1;		1	11	2	2
Im							
F/I	; 2;					2(6.4)	
I	1; ; 1				1(6.2)		1(5.3)
I/J	; ; 1						1(5.3)
J	2; 1; 1	; 1;	; 3; 1	; 2; 3	; 1; ;	1	2(12.5)	8(25.8)	6(31.6)
J/S		1; ;	1; ;				2(12.5)		
S	3; 3; 1	2; 1; ; 1;		1; ; 1; 1; ;		7(43.7)	5(16.1)	2(10.5)
S/A	8;10; 4	; 1;	; 1;	1; ; 2; 3;	1	11	15	5
A	; ; 8	; 7; 1	; 2;	2; 2; 1; 2; 1; 3;	4(25.0)	16(51.6)	9(47.4)
Tot	15;17;17	3;10; 1	10; 1; 1; 7; 1	3; 5; 4; 2; 5; 4; 3; 3	36	48	26

Table 13 cont.:

Sus scrofa dom.

Age	PC	Vert	Rib	Cra	Cra+Ant	Ant/Mor	Man	Max	Teeth	Total Kneo	Total LBA
?	2.		2.								4
Im											
F/I	1;									1(5.0)	
I	1;									1(5.0)	
I/J											
J	5; 13.			1; 2.			; 9.		; 1.	6(30.0)	.25(89.5)
J/S	; 1.			; 1.							2(4.4)
S	1; 5.						1; 2.	; 1.	; 1.	2(10.0)	9(20.0)
S/A	9; 8.	; 1.	; 1.				1; 1.	1;	3; 2.	14	.12
A	4; 3.			; 1.			3; 1.		2; 5.	10(50.0)	9(20.0)
Tot.	21; 31.	; 1.	; 3.	2; 3.			5; 13.	1; 1.	5; 9.	34	.61

Canis familiaris

Age	B;C;E;L	L	Vinca B.	Vinca C.	Kneo	LBA
?	.1; ; ;		.1			
Im						
F/I						
I						
I/J						
J	; ;1;					.1(100.)
J/S						
S						
S/A	;1; ;1.				.1	.1
A		;1.				.1
Tot.	1;1;1;1.	;1.	1	.1	.1	.2

Table 13 cont.:

Cervus elaphus

Age	PC B	PC C	PC D	Vert.	Rib	Cra	Cra+Ant	Ant/Mor	Man	Max	Teeth	Total Vinca B	Total Vinca C	Total Vinca D
?	2;	; 1;									; 1;	2	1	1
Im														
F/I														
I														
I/J														
J	1;	; 1.									1; 1;1.	2(8.7)	1(2.9)	2(28.6)
J/S	; 1;										1; ;	1(4.3)	1(2.9)	
S		;1;											1(2.9)	
S/A	35;42;23.							; 4;			; 1;	35	47	23
A	11;16; 2.1;1;1.					2; 6;	.1; 3; 1.1;				4; 5;1.	80(87.0)	31(91.2)	5(71.4)
Tot.	49;59;27.1;2;1.					2; 6;	.1; 7; 1.1;				6; 8;2.	60	82	31

Cervus elaphus

Age	Kn;LBA	Kneo	LBA
?	3; 2	3	2
Im			
F/I			
I			
I/J			
J	2;	3(3.4)	
J/S	1;	1(1.1)	
S	2; 1; 1	3(3.4)	1(6.2)
S/A	29;22	30	24
A	11; 7 . 1;	80(91.9)	14(87.5)
Tot.	48;31 . 2; 1	120	42

Table 13 cont.:

Capreolus capreolus

Age	PC B;C ;D	Vert	Rib	Cra	Cra+Ant	Ant/Hor	Man	Max	Teeth	Total Vinca B	Vinca C	Vinca D
?	; 1;										1	
Im												
F/I												
I												
I/J												
J												
J/S	; 2;										2(13.3)	
S	.1; 2;	. 1;	;							2(20.0)	2(13.3)	
S/A	.5; 6;	4					;	;1		5	6	5
A	.3; 3;			.1; 1;		.1; 4;	.3; 2;	; 1;1		8(80.0)	11(73.3)	1(100.0
Tot.	9;14;4	1; ;		.1; 1;		.1; 4;	.3; 2;1	; 1;1		43	15	6

Capreolus capreolus

Age	En ;LBA									Eneo	LBA
?											
Im											
F/I											
I											
I/J											
J											
J/S											
S	; 2										2(40.0)
S/A	4; 3									4	3
A	; 2			1 ;	.1 ; 1	.3 ;				5(100.0)	4(60.0)
Tot.	4; 7			1 ;	.1 ; 1	.3 ;				9	8

Table 14: Bone Frequency Distribution by Sonda - Ljuljaci

Sonda (year).	Dimension.	Area (m^2)	Depth	TNF
5 (1965)	3x7m	21		27
6A(1976-7)	6x7m	42		21
6B "	6x6m	36		99
7 "	5x11m	55		427
7A "	5x7m	35		62
7B "				335
8 "	4x6m	24	50cm	349
8A "				375
8B "	3x4m	12		132
8C "	2x5m	10		138
9 "	3x6m	18	30cm	6
10 "	4x18m	72		0
11 "	5x5m	25		110
12 "	4x5m	20	160cm	708
13 "	2x3m	6	110cm	479
14 "	3x7m	21		475

Table 15: Frequency Distribution of most common Genera at Ljuljaci by type of post-cranial limb bone (small, hard verus large early/late fusing long bones -- see table 2 for definition)

SIZE	Canis.	Ovis/ Capra.	Capreolus.	Sus.	Cervus.	Bos.	Ursus
large	8	26	10	264	120	198	7
small	2	0	1	226	54	103	4

Table 16: Frequency distribution of burnt, chewed, butchered, pathological, modified, polished and weathered bones per species from Ljuljaci.

	Burnt	Chewed	Butchered	Pathology	Modified	Weathered	Polished
Ovis		3			1	2	
Ovis/Capra		5				5	
Bos primig.		7				5	
Bos taurus	5	107	4	2		42	
Sus scr. ?		3				3	
Sus scr. f.	1	65	4	2		33	
Sus scr. d.	3	105		2		28	
Canis fam.	1	1				3	
Equus cab.	1	27	1			30	
Cervus ela.	7	30	14		12	35	5
Capreolus c.		3	1		1	2	1
Ursus arc.	1	4				3	
Castor fib.		1					
Meles meles		1					
Small mammal	1						
Medium mammal	6	71	1		1	20	
Large mammal	6	96	1		1	76	
Ovis/Capra/ Capreolus		10				1	2
Bos t./ Cervus		14				8	
Bos t./Cervus/ Equus	1	23				17	
Unknown	9	17				97	
Total	42	595	26	6	16	410	8

Table 17: Species Frequency at Ljuljaci - no. (%)

Ovis aries	9	(0.5)	+ 1 articulated bone
Capra hircus	1	(0.0)	
Ovis/Capra	44	(2.5)	+11 " "
Bos primigenius	27	(1.5)	
Bos (?)	2	(0.1)	
Bos taurus	382	(21.9)	+25 " "
Sus scr. ferous	379	(21.7)	+ 3 " "
Sus scr. (?)	22	(1.3)	
Sus scr. dom.	428	(24.5)	+ 1 " "
Canis familiarus	28	(1.6)	+14 " "
Equus caballus	115	(6.6)	+ 4 " "
Cervus elaphus	257	(14.7)	+54 " "
Capreolus capreolus	18	(1.0)	
Lepus capensis	1	(-)	+ 1 " "
Ursus arctos	21	(1.2)	
Castor fiber	3	(0.2)	
Meles meles	6	(0.3)	
Sub-Total	1743	(47.8 of total, excluding shell)	
Unio sp.	1		
Small Mammal	377		
Medium Mammal	13		
Large Mammal	717		
Ovis/Capra/Capreolus	22		
Bos/Cervus	127		
Bos/Cervus/Equus	56		
Sub-Total	1312	(36.0)	
Unidentified	590	(16.2)	
Total	3646		
Total, including articulations	3760	+ 12 unidentified articulated bones	
Wild (exâluding shell)	712	(41.4)	
Domestic	1007	(58.6)	

Table 18: Distribution of Age Classes - Ljuljaci - Number of fragments (%)

	Age	PC	Vert	Rib	Cra	Cra+Ant	Ant/Hor	Man	Max	Teeth	Total
Ovis aries	?	1									1
	Im										
	F/I	2									2
	I										
	I/J										
	J										
	J/S										
	S										
	S/A	4									4
	A	1					1				8
	Tot	8					1				9
Ovis/Capra(& Capra)	?	2									2
	Im										
	F/I										
	I										
	I/J							1			1
	J	2						3			5
	J/S	3									3
	S	3						3			6
	S/A	8					1*	1			10
	A							9	1	8	18
	Tot	18					1*	17	1	8	45

*Capra hircus

Table 18 cont.:

	Age	PC	Vert	Rib	Cra	Cra+Ant	Ant/Hor	Man	Max	Teeth	Total
Bos primigenius	?										
	Im										
	F/I										
	I										
	I/J										
	J										
	J/S										
	S										
	S/A	23									23
	A		1				1♂	1	1		4
	Tot	23	1				1	1	1		27
Bos taurus	?	1									1
	Im										
	F/I										
	I	1									1(0.7)
	I/J	1									1(0.7)
	J	10						4	3	6	23(16.7)
	J/S	1									1(0.7)
	S	15						3		7	25(18.1)
	S/A	212	7		8	3		10		3	243
	A	33	6		7	7	5	6	4	19	87(63.0)
	Tot	274	13		15	10	5	23	7	35	382

Table 18 cont.:

Sus scrofa fer.

Age	PC	Vert	Rib	Cra	Cra+Ant	Ant/Hor	Man	Max	Teeth	Total
?										
Im										
F/I										
I										
I/J										
J										
J/S	2									2(1.0)
S	13									13(6.6)
S/A	174			1			5		2	182
A	113	2		1			37	4	25	182(92.4)
Tot	302	2		2			42	4	27	379

Sus scrofa dom.

Age	PC	Vert	Rib	Cra	Cra+Ant	Ant/Hor	Man	Max	Teeth	Total
?	16		1				2			19
Im										
F/I	3		7				2			12(4.9)
I	4						1			5(2.0)
I/J	1						1			2(0.8)
J	33		3	6			9	3	2	56(22.8)
J/S	10									10(4.1)
S	44	7		2			4	1	9	67(27.2)
S/A	131	1	1	10			9	4	7	163
A	9	7	1	6			33	17	21	94(38.2)
Tot	251	15	13	24			61	25	39	428

Table 18 cont.:

	Age	PC	Vert	Rib	Cra	Cra+Ant	Ant/Hor	Man	Max	Teeth	Total
Sus scrofa (?)	?	6		3	1						10
	Im										
	F/I										
	I										
	I/J										
	J			1							1
	J/S	1									1
	S										
	S/A	5						2			7
	A	1			1					1	3
	Tot.	13		4	2			2		1	22
Equus caballus	?							1			1
	Im										
	F/I										
	I										
	I/J										
	J	1									1(3.7)
	J/S										
	S	4									4(14.8)
	S/A	78	1					7		1	87
	A	15	3					3	1		22(81.5)
	Tot.	98	4					11	1	1	115

Table 18 cont.:

		PC	Vert	Rib	Cra	Cra+Ant	Ant/Mor	Man	Max	Teeth	Total
Canis familiaris	Age							1			1
	?										
	Im										
	F/I										
	I										
	I/J										
	J										
	J/S										
	S	1			1						2(9.5)
	S/A	5						1			6
	A	5	1					10	2	1	19(90.5)
	Tot	11	1		1			12	2	1	28
Cervus elaphus	?	1								1	2
	Im										
	F/I										
	I										
	I/J	1									1(0.7)
	J	2						4		6	12(8.3)
	J/S	1									1(0.7)
	S	4	2				1*			2	9(6.2)
	S/A	108						3			111
	A	52	7		6		45**	3	3	5	121(84.0)
	Tot	169	9		6		46	10	3	14	257

* shed base

**2 shed bases included

Table 18 cont.:

	Age	PC	Vert	Rib	Cra	Cra+Ant	Ant/Hor	Man	Max	Teeth	Total
Capreolus capreolus	?										
	Im										
	F/I										
	I										
	I/J										
	J										
	J/S										
	S	1									1(8.3)
	S/A	6									6
	A	4			3	1	2	1			11(91.7)
	Tot.	11			3	1	2	1			18
Ursus arctus	?										
	Im										
	F/I										
	I										
	I/J										
	J										
	J/S										
	S	2									2(15.4)
	S/A	7								1	8
	A	4						4	1	2	11(84.6)
	Tot.	13						4	1	3	21

Table 19: Schematic representation of Livade stratigraphy

Otkop sloj	Major cultural horizon	Objekti (features)
	ground level	
I	Gava	Jama in Sonda XII
II	Dubovac-Žuto Brdo	Svi objekti (all other features)
III/2		
III/1		
IV	Verbicoara III	
V		

Table 20: Frequency distribution of species at Livade

Context:	Total	Sloj	Dubovac-Zuto pits	Brdo features	Gava pit
Species:	No.(%)				
Ovis aries	23(2.2)	21(2.3)	2(2.1)	-	-
Capra hircus	4(0.4)	4(0.4)	-	-	-
Ovis/Capra	105(10.2)	92(10.0)	9(9.4)	2(13.3)	2(33.3)
Bos primigenius	2(0.2)	2(0.2)	-	-	-
Bos taurus	353(34.2)	323(35.3)	24(25.0)	3(20.0)	3(50.0)
Sus scrofa fer.	27(2.6)	25(2.7)	2(2.1)	-	-
Sus scrofa (?)	1(0.1)	1(0.1)	-	-	-
Sus scrofa dom.	261(25.3)	222(24.2)	35(36.4)	4(26.7)	-
Canis familiaris	32(3.1)	29(3.2)	3(3.1)	-	-
Equus caballus	33(3.2)	32(3.5)	-	1(6.7)	-
Cervus elaphus	95(9.2)	87(9.5)	7(7.3)	1(6.7)	-
Capreolus capreolus	10(1.0)	9(1.0)	-	1(6.7)	-
Lepus capensis	3(0.3)	3(0.3)	-	-	-
Ursus arctos	1(0.1)	1(0.1)	-	-	-
Castor fiber	1(0.1)	1(0.1)	-	-	-
Pisces sp.	80(7.7)	62(6.8)	14(14.6)	3(20.0)	1(16.7)
Aves sp.	2(0.2)	2(0.2)	-	-	-
sub-total	1033	916	96	15	6
Unio sp.	233	75	60	97	1
Helix sp.	11	7	4	-	-
sub-total	244	82	64	97	1
Homo sapiens s.	2	2	-	-	-
Small mammal	1	-	1	-	-
Medium mammal	258	221	35	2	-
Large mammal	400	374	20	6	-
Ovis/Capra/Capreolus	30	28	2	-	-
Cervus/Bos t.	136	128	5	3	-
Cervus/Bos t./Equus	27	22	1	4	-
sub-total	852	773	64	15	-
Unidentified	267	231	28	4	4
Total	2398	2004	252	131	11

Table 20 continued:

	Total No.(%)	Sloj	Dubovac-Zuto Brdo pits	Dubovac-Zuto Brdo features	Gava pit
Domestic	811(78.5)	723(78.9)	73(76.0)	10(66.6)	5(83.3)
Domestic?	1(0.1)	1(0.1)	-	-	-
Wild	221(21.4)	192(21.0)	23(23.9)	5(33.3)	1(16.7)
Identified to Species/Genus*	1035(48.0)	918(47.8)	96(51.1)	15(44.1)	6(60.0)
Size-class Unknown	852(39.5)	773(40.2)	64(34.0)	15(44.1)	-
	267(12.4)	231(12.0)	28(14.9)	4(11.8)	4(40.0)

*excludes shell species

Table 21: Frequency distribution of major body parts by density (and context, weathering, and chewing) from Livade - number of fragments.

Species:		Ovis/ Capra			Bos taurus			Sus scrofa fer.			Sus scrofa dom.			Canis fam.			Equus caballus			Cervus elaphus			Cap- reolus		Lepus cap.	Ursus arct.		Castor fib.
		N	C	W	N	C	W	N	C	W	N	C	W	N	C	W	N	C	W	N	C	W	N	W	N	N	C	N
Loose teeth	F										2																	
	P	1			3						4																	
	S	10		1	39		1	7			17		2	1			5		1	1								
Small hard	F																			1		1						
	P	1			4						2									3								
	S	3	1		59	5	18	2	1	1	15	2	2				6	1		22	5	11						
Early fuse	F	1	2								1	1																
	P	1			6			1	1		2																	
	S	22	6	10	50	12	18	7	3	4	26	7	8	4	1	1	6		5	12	2	7	3	1	1			
Late fuse	F				1	1					1	1					1											
	P				3	3		1			8	1	1	1	1					1								
	S	7		1	29	5	10	4		2	28	16	14				7		2	12	4	8	1			1	1	1
Vert./ rib	F						1																					
	P										1																	
	S	3			17	2	7				6									1		1	1					
Cran./ max.	F																						1					
	P										7									1								
	S	1			26		6	1		1	7		3	2						11		9						
Mandib.	F										2																	
	P	2			1						6		2															
	S	15		3	32	2	11				45		23	14		3	2		2	6		3	1					
Pelvis	P	4												1														
	S	2		1	13	1	7				11	5	5				2	1	2	1		1						
Whole long bone	F																											
	P										2			3		2												
	S	5			6	1	4	2		1	5		1												2			

F=Features; P=Pits; S=Sloj;
N=Number of bones that do not have weathering or chewing marks; C=Number of bones with chewing marks; W=Number of bones with weathering marks.

Table 22: Distribution of Age Classes - Livade - Number of fragments

	Age	S ; P	Vert	Rib	Cra	Cra+Ant	Ant/Hor	Man	Max	Teeth	Total	Total	Sloj	Pit
Ovis aries	?													
	Im													
	F/I													
	I													
	I/J	1;									1(12.5)	1(14.3);		
	J	2;									2(25.0)	2(28.6)		
	J/S	;												
	S	; 1				1;					2(25.0)	1(14.3)	1(100.0)	
	S/A	14; 1									15	14	1	
	A	2;						1;			3(37.5)	3(42.8)		
	Tot.	19; 2				1;		1;			23	21	2	
		S; P												
Ovis/Capra	?	4;									4	4		
	Im									1;	1	1		
	F/I	2;									2	2		
	I	4;									4	4		
	I/J													
	J	9; 1						1;			11	10	1	
	J/S	2; 1									3	2	1	
	S	6; 3	3;					1; 1		2;	16	12	4	
	S/A	38; 6*						1;			45	39	6*	
	A							11; 1		8;	20	19	1	
	Tot.	65; 11	3;					14; 2		11;	106	93	13	

*includes 2 post-cranial fragments from the Gava pit and 2 post-cranial fragments from Dubovac-Zuto Brdo features.

Table 22 cont.:

Ovicaprine totals

Age	PC	Vert	Rib	Cra	Cra+Ant	Ant/Mor	Man	Max	Teeth	Total Bloj	Pits	Total
?										4		4
Im										1(1.7)		1(1.5)
F/I										2(3.4)		2(3.0)
I										4(6.8)		4(6.0)
I/J										1(1.7)		1(1.5)
J										12(20.3)	1(12.5)	13(19.4)
J/S										2(3.4)	1(12.5)	3(4.5)
S										14(23.7)	5(62.5)	19(28.3)
S/A										54	5	61*
A										23(39.0)	1(12.5)	24(35.8)
Tot										117	13	132

Bos taurus

Age	PC S ; P	Vert	Rib	Cra	Cra+Ant	Ant/Mor	Man	Max	Teeth	Total Bloj	Pits	Total
?	2;	1;		1;			4; 1		2;	10	1	11
Im												
F/I	1;									1(0.9)		1(0.8)
I												
I/J												
J	1; 1						4;		1; 1	6(5.4)	2(22.2)	8(6.4)
J/S	1;									1(0.9)		1(0.8)
S	14; 1**	2;					2;		5;	23(20.5)	1(11.1)	26(21.0)
S/A	172;17	***3;		4;		5;	13;		4;	208	17	218
A	24; 4	5;[1]		12;		1;	9;	3;	27; 8	81(72.3)	6(66.6)	88(71.0)
Tot	215;23	11;		17;		6;	32; 1	3;	39; 3	323	27	353

*includes 2 fragments in Gava pits.
** plus 2 post-cranial fragments in the Dubovac-Zuto Brdo features.
[1] represents 1 vertebral fragments from the Dubovac-Zuto Brdo features.
***includes 3 post-cranial fragments from the Gava pit.

Table 22 cont.:

	Age	PC S	PC P	Vert	Rib	Cra	Cra+Ant	Ant/Mor	Man	Max	Teeth	Total Sloi	Total Pits	Total
Sus scrofa fer.	?													
	Im													
	F/I													
	I													
	I/J													
	J													
	J/S													
	S	2;										2(15.4)		2(15.4)
	S/A	11;	2		1;							12	2	14
	A	4;									7;	11(84.6)		11(84.6)
	Tot.	17;	2		1;						7;	27	2	29
Sus scrofa dom.	?	5;	1			; 1			1;1[1]	; 1	1;	7	4	12
	Im	1;										1(0.8)		1(0.7)
	F/I													
	I	1;										1(0.8)		1(0.7)
	I/J	3;			1;	; 1			1;			5(4.1)	1(4.0)	6(4.0)
	J	21;	5	1;					7; 1			29(23.8)	6(24.0)	
	J/S	8;	2			1;			2;		; 1	10(8.3)	3(12.0)	14(9.8)
	S	22.6[1]		2;					4; 1	3; 2	2; 1	33(27.0)	10(40.0)	44(29.1)
	S/A	79;	4 ; 1			1;			6; 1		7;	93	6	99
	A	5;[1]	1;		1;	1;			24;2[1]	2; 1	9; 2	43(35.2)	5(35.2)	50(33.1)
	Tot.	145;	18 2; 1		4;	3; 2			45; 6	5; 4	19; 4	222	35	262

[1] represents 1 fragments from the Dubevac-Zuto Brdo features x 4.

Table 22 cont.:

Canis familiaris

Age S ; P	PC	Vert	Rib	Cra	Cra+Ant	Ant/Mor	Man	Max	Teeth	Total Blo	Pits	Total
?				; 1							1	1
Im												
F/I 1;										1(4.2)		1(4.0)
I												
I/J							1;			1(4.2)		1(4.0)
J												
J/S												
S 2;										2(8.3)		2(8.0)
S/A 5; 1										5	1	6
A 2; 1				2;			13;	2;	1;	20(83.3)	1(100.0)	21(84.0)
Tot. 10; 2				2; 1			14;	2;	1;	29	3	32

Equus caballus

S ; F										Feature		
?												
Im												
F/I												
I												
I/J												
J												
J/S												
S 2;										2(18.2)		
S/A 18;							2;	1;		21		21
A 5; 1								4;		9(81.8)		10(83.3)
Tot.										32	1	33

Table 22 cont.:

Cervus elaphus

Age	PC S; P	Vert	Rib	Cra	Cra+Ant	Ant/Hor	Man	Max	Teeth	Total Sloj	Pits
?	1;									1	1
Im											
F/I											
I											
I/J											
J							2;			2(6.5)	2(6.1)
J/S	1;									1(3.2)	1(3.0)
S	1;						1;			2(6.4)	2(6.1)
S/A	5 4;5[1]						1;			55 .5	61
A	11; 1	1;			1;	10; 1	2;		1;	26(83.9) 2	28(84.8)
Tot.	68; 6	1;			1;	10; 1	6;		1;	87 .7	95

Capreolus capreolus

Age	S; F	Sloj	Feature	
?	1;	1		1
Im	1;	1(25.0)		1(20.0)
F/I				
I				
I/J				
J				
J/S	1;	1(25.0)		1(20.0)
S	1;	1(25.0)		1(20.0)
S/A	4;	4		4
A		1(25.0)	1	2(40.0)
Tot.	7;	9	1	10

[1] indicates number of fragments from Dubovac-Zuto Brdo features.

Table 23: Frequency distribution of modified bone from Livade by species and context - number of fragments. (S=Sloj; P=Pits; F=Features).

Species	Ovis/ Capra			Bos taurus			Sus scrofa fer.	Sus scrofa dom.			Canis fam.		Equus cab.	Cervus elap.		Capreolus cap.	Ursus arctos	Bos primig.
Context	S	P	F	S	P	F	S	S	P	F	S	P	S	S	F	S	S	S
Weathered	34						5	52	4		7		12	37	1	1		
Chewed	15	2	2	26	2	1	2	30	1	2	2	1	1	10			1	
Weathered & chewed	6			16	2		4	23					2	8				
Burnt	3							1								1		
Weathered & burnt	1			1														1
Butchered		1		4			1	1						1		1		
Butchered & chewed				1														
Tool					1			1					1			1		
Tool & weathered				1										1				
Butchered & weather				2										1				
Chewed, weathered, & butchered				1														
Chewed, weathered, & burnt								1										
Butchered, weathered, & burnt				1														
Tool, polish, burnt									1					1				
Tool, weathered, butchered														2				
Tool, weathered, polish														1				

Table 24: Species Frequencies - Crkvina

	no. (%)	
Ovis aries	3 (3.1)	
Ovis/Capra	21 (21.8)	+2 articulations
Bos taurus	31 (32.3)	
Sus scrofa dom.	27 (28.1)	+2 articulations
Canis familiaris	4 (4.2)	
Equus caballus	2 (2.1)	
Cervus elaphus	3 (3.1)	+3 articulations
Capreolus capreolus	2 (2.1)	
Aves sp.	3 (3.1)	
Sub-total	96 (22.1 of total)	
small mammal	4	
large mammal	1	
Ovis/Capra/Capreolus	8	+9 articulations
Bos t./Cervus/Equus	7	
Bos t./Cervus	1	
Sub-total	21 (4.8 of total)	
Unidentified	318 (73.1 of total)	
Total (excluding articulations)	435	
Total (including articulations)	451	
Domestic	88 (91.7)	
Wild	8 (8.3)	

Table 25: Distribution of Age Classes - Crkvina

	Age	PC	Vert	Rib	Cra	Cra+Ant	Ant/Hor	Man	Max	Teeth	Total
Ovis/Capra	?	1						2			3
	Im		1								1(9.1)
	F/I										
	I										
	I/J										
	J										
	J/S										
	S										
	S/A	6								3	
	A	5								5	10(90.9)
	Tot.	12	1					2		8	23
Bos taurus	?	1		8							9
	Im										
	F/I										
	I										
	I/J										
	J	1								1	2(20.0)
	J/S									1	1(10.0)
	S										
	S/A	10		1	1						12
	A	1	2	1				2		1	7(70.0)
	Tot.	13	2	10	1			2		3	31

Table 25 cont.:

Sus s. d.

Age	PC	Vert	Rib	Cra	Cra+Ant	Ant/Hor	Man	Max	Teeth	Total	
?	2						1		2	5	
Im											
F/I	1									1(6.2)	
I		1		3			1*	[1*]		5(31.2)	*same individual
I/J				1			1			2(12.5)	
J									2	2(12.5)	
J/S											
S		1							1	2(12.5)	
S/A	5								1	6	
A		1	1						2	4(25.0)	
Tot	8	3	1	4			3	[1*]	8	27	

Canis familiaris & Misc.

?											
Im											
F/I											
I											
I/J											
J											
J/S											
S											
S/A	1 [2**]				[3Cervus]				1	2	
A	2								[2Cap]	2	
Tot	3								1	4	

[2**] - 2 fragments of Equus caballus.
[3Cervus] - 3 fragments of Cervus elaphus.
[2Cap] - 2 fragments of Capreolus capreolus.

Table 26: Summary frequencies of bone fragments from Novačka Ćuprija - number of fragments (%)* identified to the species/genus level, size group, unidentifiable, domestic and wild.

Context	Species No.(%)	Size	Unidentified	Domestic	Wild**
Pit 1	51(26.0)	22(62.6)	122(62.6)	43(89.6)	5(10.4)
Pit 2	250(23.9)	98(9.4)	698(66.7)	242(97.2)	7(2.8)
Pit 3	12(15.4)	8(10.3)	58(74.3)	12(100.0)	0(0.0)
Pit total	313(23.7)	128(9.7)	878(66.6)	297(96.1)	12(3.9)
Sloj above pit	226(25.3)	75(8.4)	591(66.2)	222(98.2)	4(1.8)
LBA pits and sloj total	539(24.4)	203(9.2)	1469(66.4)	517(97.0)	16(3.0)
Baden sloj	87(16.3)	50(9.4)	396(74.3)	85(98.8)	1(1.2)
LBA urn	28(25.7)	12(11.0)	69(63.3)	37(97.4)	1(2.6)
LBA floor	39(21.3)	22(12.0)	122(66.6)	27(93.1)	2(6.9)
LBA total	67(22.9)	34(11.6)	191(65.4)	64(95.2)	3(4.5)
Total	691(22.8)	287(9.4)	2256(67.8)	666(97.1)	20(2.9)

*excludes all shell
**excludes burrowing rodents

Table 27: Species frequencies at Kovačka Ćuprija

Context: EBA	Pit 1	Pit 3	Pit 2	Pits total	Sloj above pits	EBA Pits & Sloj total	Eneolithic sloj
Species:							
Ovis aries	1(2.1)	3(25.0)	11(4.4)	15(4.9)	2(0.9)	17(3.2)	8(9.3)
Capra hircus	-	-	1(0.3)	1(0.3)	-	1(0.2)	-
Ovis/Capra	11(22.9)	5(41.6)	66(26.5)+2	82(26.6)	52(23.1)+2	132(24.8)	16(18.6)+1
Bos taurus	14(29.2)	2(16.6)	93(37.3)+2	109(35.3)	110(48.8)+3	208(39.0)	33(38.4)+9
Sus scrofa dom.	13(27.1)	1(00.3)	60(24.1)+3	74(23.9)	58(25.8)+1	132(24.8)	25(29.1)
Canis familiaris	3(0.6)	1(0.3)	5(2.0)	9(2.9)	7(3.1)	16(3.0)	3(3.5)+2
Equus caballus	1(2.1)+10	-	6(2.4)	7(2.3)	3(1.3)+1	10(1.9)	-
Cervus elaphus	-	-	1(0.4)	1(0.3)	-	1(0.2)	-
Capreolus capreolus	-	-	1(0.4)	1(0.3)	1(0.4)	1(0.2)	-
Lepus capensis	5(10.4)	-	3(1.2)	8(2.6)	1(0.4)	9(1.7)	-
Mustela putarius	-	-	1(0.4)	1(0.3)	-	1(0.2)	-
Aves sp.	-	-	1(0.4)	1(0.3)	-	1(0.2)	1(1.2)
sub-total	48	12	249	309	224	532	86
Unio sp.	47	4	48	99	4	103	9
Helix sp.	3	2	2	5	-	5	1
Unidentified shell	1	-	1	2	-	2	13
sub-total	51	4	51	106	4	110	23
Rodentia indet.	-	-	-	-	-	-	1
Microtus sp.	-	-	-	-	1	1	-
Talpidae indet.	-	-	1	1	-	1	-
sub-total	-	-	1	1	1	2	1
Homo sapiens s.	3	-	-	3	-	3	-
Small mammal	4	1	9	14	9	23	2
Medium mammal	3	2	39	44	23	67	3
Large mammal	-	-	7	7	1	8	5
Ovis/Capra/Capreolus	9	3	17	29	14	43	33
Bos t/Cervus/Equus	4	2	18	24	19	43	7
Bos t./Cervus	2	-	8	10	9	19	-
sub-total	22	8	98	128	75	203	50
Unidentified	122	58	698	878	591	1469	396
Total	246	82	1097	1425	895	2320	556

Table 27 continued

Context	LBA floor	LBA urn	LBA total
Ovis aries	1(2.6)	2(6.9)	3(4.4)
Capra hircus	-	-	-
Ovis/Capra	8(20.5)+1	7(24+1)	15(22.0)
Bos taurus	15(38.5)	9(31.0)+2	24(35.3)
Sus scrofa dom.	13(33.3)+2	9(31.0)	22(32.3)
Canis familiaris	-	-	-
Equus caballus	-	-	-
Cervus elaphus	-	-	-
Capreolus capreolus	1(2.6)	-	1(1.5)
Lepus capensis	1(2.6)	1(3.4)	2(2.9)
Mustela putarius	-	-	-
Aves sp.	-	-	-
sub-total	39	28	67
Small mammal	1	3	4
	4	3	7
Large mammal	-	1	1
Ovis/Capra/Capreolus	4	3	7
Bos t./Cervus/Equus	10	1	11
Bos t./Cervus	2	2	4
sub-total	22	12	34
Unidentified	122	69	191
Total	183	109	292

+ - number of articulated elements.

Table 28: Frequency distribution of elements by density - Novačka Ćuprija
(P=EBA pits; S=Sloj above pits; E=Eneolithic sloj; L=LBA urn and floor)

Species:	Ovis/Capra				Bos taurus				Sus scrofa d.				Canis fam.			Equus		Lepus			Cervus	Capreo
Context:	P	S	E	L	P	S	E	L	P	S	E	L	P	S	E	P	S	P	S	E	P	S
	No.																					
Loose teeth:	50	35	11	11	20	27	8	9	17	16	11	8	1	2		2						
Small, hard:	5	3	4	4	29	20	10	5	4	5	3	1		1			2	1	1	1		
Early fusing:	13	1	6		9	8	2	3	6	5	5	3		1			1	3			1	
Late fusing:	3		1	1	12	7	1	1	10	9	1	4			1	2		1				
Vert/ rib:	1	6			5	5	2		5	1		1		1								
Cranie/ maxillae:	4	2			11	14	3		10	4	2	2		1		1						
Mandible:	11	3		1	13	5	2	3	8	11	2	2	2	1	2							1
Pelvis:	1		1		4	7	1		2	1						1						
Whole long bone:	2									1			3					3				
Long bone shaft:	12	5	1	2	10	8	4	3	12	3			2			1						

Table 29: Frequency distribution of modified bone by species from Novačka Ćuprija
(P=EBA pits; S=sloj above pits; E=Eneolithic; U=LBA urn; F=LBA floor)

Species:	Ovis/Capra					Bos taurus					Sus s. d.				Equus	Cervus	Lepus	Aves	Shell	Unidentified				
Context:	P	S	E	U	F	P	S	E	U	F	P	S	E	F	P	P	P	P	P	P	S	E	U	F
chew	3				1	4	2				6	4		1						12	2	2		1
weather	2		2	1	1	3	4						1		1	1				1		1		
butcher	2		1			6	5	2				1										1		1
burn	1	1	1			3	3				1		1	1			1			15	15	5	4	1
polish	1	1	1			1	1				2	1										2		
tool		1									2		1						2					
pathology							1																	
pathology/chew											2													
polish/tool/pathology								1																
polish/tool			1			1					1							1		6	3			
polish/burn																						1		
chew/butcher						2	1(+1 burnt)																	
weather/butcher						1	1(also chew)																	
burn/butcher						1																		
weather/chew							2	1(also butcher)														1		
weather/burn							1																	
polish/chew							1																	
burn/chew/butcher											1													
tool/burn																						1		

continued:

	Small mammal		Medium mammal				Large mammal	Ovis/Capra/ Capreolus					Bos/Cervus/ Equus				Bos t./ Cervus	
Context:	U	S	P	S	E	F	E	P	S	E	U	F	P	S	E	F	S	U
chew		3		5	1				2			1		4				
weather					1		1									1		
butcher			3					1					1			1		1
burn	1		2			1	3	5	1	1	1			2	1			
tool													1					
tool/polish								1					1				2	
tool/polish/chew													1					
polish/chew									1									
burn/chew				3														
weather/chew					1													

Table 30: Summary frequencies of modified bone from Novačka Ćuprija and Crkvina

Novacka Cuprija:	Pit1-3 No.(%)	Sloj above pits	Baden sloj	LBA floor	LBA urn	Total	Crkvina pit
chewed	31(2.3)	31(3.5)	6(3.3)	6(3.3)	1(0.9)	75(2.5)	7(1.5)
weatherer	9(0.7)	5(0.6)	9(1.6)	2(1.1)	1(0.9)	26(0.8)	4(0.9)
burnt	30(2.3)	27(3.0)	12(2.2)	3(1.6)	7(6.4)	79(2.6)	59(13.1)
butchered	17(1.3)	8(0.9)	6(1.1)	2(1.1)	1(0.9)	34(1.1)	3(0.7)
polished	3(0.2)	5(0.6)	7(1.3)	-	-	15(0.5)	
tool	16(1.2)	6(0.7)	4(0.7)	-	1(0.9)	27(0.9)	
pathology	1(0.1)	1(0.1)	1(0.2)	-	-	3(0.0)	

Frequencies of bones with two or more modifications (also included in above totals):

chew/ weather	2		2
chew/ butch	2	1	
chew/butch weather	1		2
chew/ pathology	1		
weather/ butchered	1		
butchered/ burnt/chew	1	1	
butchered/ burnt	1		
weathered/ burnt		1	
burnt/chew		3	
polish/chew		2	
polish/tool	1(also chewed)		2(1 also with pathology)
burnt/tool			1
polish/burnt			1

Table 31: Frequency distributions of species at Crkvina by major body part and surface modifications.

Species: / Part:		Ovis/ Capra	Bos t.	Sus s. d.	Canis fam.	Equus cab.	Cervus elap.	Capre- olus c.	Mammal: Small	Mammal: Large	Ovis/Capra Capreolus	Equus/Bos/ Cervus	?
Loose teeth	Unmodified	6	3	8	1			2					25
	Burnt	2											
Small, hard	Unmodified		7	1(B)		2					1		
	Chewed		1*	2									
	Weathered		1*	3(C,E)									
	Burnt	4	1*	2									
Early fusing	Unmodified		1	1							1		
	Butchered	1											
	Burnt	3			1								
Late fusing	Unmodified	3	2								1		
	Burnt	1			2								
Vert/ Rib	Unmodified		11	3					1		1	6(F)	44
	Chewed		1	1									
	Butchered	1											
	Burnt								3	1	10(E)		
Cran/ Max	Unmodified			4							2		11
	Butchered						1						
	Burnt		1	1			2(D)						
Mandible	Unmodified	1	2	2									1
	Chewed			1(A)									
	Burnt	2											
Pelvis	Burnt		1										
Whole long bone	Unmodified		1										

* same fragments.
(A) - also polished.
(B) - also pathological.
(C) - 1 also burnt.
(D) - also butchered.
(E) - 1 also chewed.
(F) - plus 1 fragment identified as Bos/Cervus. It was an awl, with a polished surface made from a rib.

Table 32: Distribution of Age Classes - Novačka Ćuprija - number of fragments (%)

Ovis aries & Capra hircus

Age	PC P ; S	Vert	Rib	Cra	Cra+Ant	Ant/Hor	Man	Max	Teeth	Total EBA Pits	Total Sloj above pits
?	13 ; 2	; 2	; 1				2 ;		3 ; 3	18	8
Im	;	; 3									3(9.1)
F/I											
I											
I/J											
J							2 ;		5; 3	7(13.0)	3(9.1)
J/S											
S							3 ;		7; 4	10(18.5)	4(12.1)
S/A	17 ; 6			1 ;	1 ;	1 ;	1 ;	2 ;	7; 5	29	12
A	5 ;	1;				; 2	3 ;	2	28;19	37(68.5)	23(69.7)
Tot.	35 ; 8	1; 5	; 1	1 ;	1 ;	1 ;	2	11 ; 3	2 ; 50;34	101	53

Ovis/Capra & Ovis aries & Capra hircus

Age	E ; L									Eneolithic	LBA
?	2; 2								1;	3	2
Im											
F/I											
I											
I/J											
J									1;	1(11.1)	
J/S											
S									; 3		3(25.0)
S/A	11; 4									11	4
A	1;						; 1		7; 8	8(88.8)	9(75.0)
Tot.											

Table 32 cont.:

Bos taurus

Age	PC P	PC S	Vert	Rib	Cra	Cra+Ant	Ant/Mor	Man	Max	Teeth	Total EBA Pits	Total Sloj above pits
?	11	11	1	1	3	4	4	3	3	8	30	25
Im												
F/I		1									1 (2.4)	
I												
I/J												
J										2	2 (4.8)	2 (5.9)
J/S								1			1 (2.4)	
S	1	1							1	7	9 (21.4)	5 (14.7)
S/A	38	29	1			4	2			3	41	40
A	14	6	3				4		1	7	29 (69.0)	27 (79.4)
Tot.	64	47	4	2	1	3	4	4	3	7	113	99

Bos taurus

Age	PC E	PC L	Vert	Rib	Cra	Cra+Ant	Ant/Mor	Man	Max	Teeth	Total Eneolithic	Total LBA
?	5	1	1		1	1	1		2	4	13	3
Im		2								3		5 (45.4)
F/I												
I												
I/J												
J												
J/S												
S										1	1 (14.3)	1 (9.1)
S/A	12	8								1	13	10
A	1	1		1				1	1	3	6 (85.7)	5 (45.4)
Tot.	18	12	1	1	1	1	1	1	3	9	33	24

Table 32 cont.

	Age	PC	Vert	Rib	Cra	Cra+Ant	Ant/Hor	Man	Max	Teeth	Total LBA Pits	Total Sloj above pits
Sus scrofa dom	?	12; 8.		2; 1	5; 2			3; 4	1; 1	1; 5	24	21
	Im			; 2								2(8.3)
	F/I	2;						1; 1			3(9.7)	1(4.2)
	I											
	I/J											
	J	1; 6.							1; 1	3;	5(16.1)	7(29.2)
	J/S	3; 1.	1;							; 1	4(12.9)	2(8.3)
	S	1; 1.						1;	1;	4;	7(22.6)	1(4.2)
	S/A	14; 7.						2; 3		4; 2	20	12
	A	2;	2; 1					2; 3	1;	5; 7	12(38.7)	11(45.8)
	Tot	35;23.	3; 1	2; 3	5; 2			9;11	4; 2	17;15	75	57
		E ; L									Eneolithic.	LBA
Sus scrofa dom	?	1; 4.	; 1		1; 2				1;	2; 2	5	9
	Im	; 2.										2(18.2)
	F/I	1;									1(7.7).	
	I											
	I/J											
	J	1;								2; 1	3(23.1).	1(9.1)
	J/S	1; 1.									1(7.7).	1(9.1)
	S							; 1.		3;	3(23.1).	1(9.1)
	S/A	5; 2.								1;	6	2
	A							2; 1.		3; 5	6(38.5).	6(54.5)
	Tot	9; 9.	; 1		1; 2			2; 2.	1;	11; 8	24	22

Table 32 cont.

Canis familiaris

Age	PC P;S;E	Vert	Rib	Cra	Cra+Ant	Ant/Hor	Man	Max	Teeth	Total	EBA pits	Sloj above pits	Encoli.
?							1;1; 1			1	1		2
Im													
F/I	1; ;									1(12.5)			
I													
I/J													
J													
J/S													
S													
S/A	;2;								;1;		3		
A	4; ; 1.		;1;				2; ; 1	;1;	1;1;	7(87.5)	3(100.0)		2(100.0)
Tot.													

Equus caballus

	P ; S									EBA pits	Sloj above pits		
?	1;									1			
Im													
F/I													
I													
I/J													
J													
J/S													
S													
S/A	1; 3.								1;	2	3		
A	2;							1;	1;	4(100.0)			
Tot.	4; 3.							1;	2;	7	3		

Table 33: Species frequencies at Sarina Medja, Vrbica and Vecina Mala

Species	Sarina Medja No. (%)	Vrbica No. (%)	Vecina Mala No. (%)
Ovis aries	55(23.5)	1(2.3)	2(6.9)
Capra hircus	4(1.7)	-	-
Ovis/Capra	41(17.5)	8(18.2)	2(6.9)
Bos taurus	75(31.9)+1 articu-	15(34.1)	5(17.2)+1 fused
Sus scrofa dom.	49(20.8)+3 lations	16(36.4)	17(58.6)
Canis familiaris	5(2.1)	-	1(3.4)
Equus caballus	2(0.8)	-	1(3.4)
Cervus elaphus	3(1.3)	4(9.1)	1(3.4)
Capreolus capreolus	1(0.4)	-	-
Sub-total	235	44	29
Homo sapiens	-	-	1
Unio sp.	17(3.6 of total C)	7(4.3)	3(3.8)
Helix sp.	2(0.4 " " ")	1(0.6)	1(1.3)
Sub-total	19(4.1 " " ")	8(4.9)	4(5.1)
Medium mammal	92	52	20
Large mammal		15	11
Ovis/Capra/Capreolus		2	-
Bos t./Cervus	8	4	3
Bos.t./Cervus/Equus	68	7	7
Sub-total	168	80	41
Unidentified	44	32	3
Total bone (excluding articulations) - A	447	156	74
Total bone (including articulations) - B	451	156	74
Total fragments (including shell) - C	479	164	78
Domestic	231(98.3)	40(90.9)	28(96.5)
Wild	4(1.7)	4(9.1)	1(3.4)
Species (only bone)	236(52.7)	44(28.2)	30(40.5)
Size-class	167(37.4)	80(51.3)	41(55.4)
Unknown (excludes articulations)	44(9.9)	32(19.2)	3(4.0)

Table 34: Species frequency by context at Šarina Medja, Vrbica and Večina Mala

	Šarina Medja			Vrbica		Večina Mala
	Pit 1	Pit 2	Pit 3	Pit	Floor	Pit
	No. (%)	No. (%)	No. (%)	No. (%)	No. %)	No. (%)
Chewed	2(0.7)	19(13.1)	5(12.2)	14(8.9)	1(16.7)	7(9.0)
Butchered	27(9.5)	3(2.1)	-	1(0.6)	-	1(1.3)
Burned	21(7.4)	1(0.7)	3(7.3)	-	1(16.7)	1(1.3)
Ovis/Capra	84	13	3	9	-	4
Bos taurus	52	17	7	15	-	5
Sus scrofa d.	36	15	1	15	1	17
Canis fam.	1	4	-	-	-	1
Equus caballus	-	-	2	-	-	1
Cervus elaphus	3	-	-	4	-	1
Capreolus cap.	1	-	-	-	-	-
Homo s. s.	-	-	-	-	-	1
Unio sp.	7	9	1	7	-	3
Helix sp.	2	-	-	1	-	1
Medium mammal	50	33	9	52	-	20
Large mammal	-	-	-	14	1	11
O/C/Capreolus	-	-	-	2	-	-
Bos t./Cervus	8	-	-	3	1	3
Bos/Cer/Equus	23	36	9	7	-	7
Unidentified	17	18	9	29	3	3
total	283	145	41	158	6	78

(includes articulations

Table 35: Distribution of Age Classes - Sarina Medja - Number of fragments (%)

Ovis [& Capra]

Age	PC	Vert	Rib	Cra	Cra+Ant	Ant/Hor	Man	Max	Teeth	Total Ovis	Total [Capra]
?											
Im											
F/I											
I											
I/J											
J	5									5(12.5)	
J/S											
S	5									5(12.5)	
S/A	6 [2]			8 [1]			1			15	[3]
A	21*	5		1		[1]	3			30(75.0)	[1(100.0)]
Tot.	37 [2]	5		9 [1]		[1]	4			55	[4]

Ovis/Capra

	J	J/S	S	S/A	A	Tot.	Ovis/Capra	Ovicaprine tot.
?								
Im								
F/I								
I								
I/J								
J	6		2		2	10	(28.6)	(19.7)
J/S	4							
S	2		2		1	7	(20.0)	12 (15.8)
S/A	3		1	2		6		24
A	1	8	2	1	1	13	(51.4)	49 (64.4)
Tot.	12	13	2	4	3	41		100

*plus 2 fused ulnae

Table 35 cont.: Sarina Medja

	Age	PC	Vert	Rib	Cra	Cra+Ant	Ant/Hor	Man	Max	Teeth	Total
Bos taurus	?	1	1					1			3
	Im										
	F/I										
	I	1									1(4.5)
	I/J										
	J	1	2					1			4(18.2)
	J/S										
	S	1			1					1	3(13.6)
	S/A	44*	1					3		2	50
	A	9**						1	1	3	14(63.6)
	Tot.	57	4		1			6	1	6	75
Sus scrofa dom.	?	1									1
	Im										
	F/I										
	I	4									4(10.8)
	I/J										
	J	7	1		2			3***	1	1	15(40.5)
	J/S			12							12(32.4)
	S	1								1	2(5.4)
	S/A	8			1			1		1	11
	A			1				1	1	1	4(10.8)
	Tot.	21	1	13	3			5	2	4	49

*plus 1 articulated phalanx
**plus 2 fused ulnae
***plus 1 articulated maxilla and 2 articulated mandible fragments

Table 35 cont.: Vrbica

		PC	Vert	Rib	Cra	Cra+Ant	Ant/Hor	Man	Max	Teeth	Total	
Ovis aries & Ovis/Capra	Age											
	?											
	Im											
	F/I											
	I	1*									1(20.0)	*Ovis aries
	I/J											
	J								1		1(20.0)	
	J/S											
	S											
	S/A	4									4	
	A								3		3(60.0)	
	Tot	5							4		9	
Bos taurus	?	1									1	
	Im											
	F/I											
	I											
	I/J											
	J											
	J/S											
	S							1	1		2(33.3)	
	S/A	8									8	
	A	1						2		1	4(66.6)	
	Tot	10						2	1	2	15	

Table 35 cont.: Vrbica

		PC	Vert	Rib	Cra	Cra+Ant	Ant/Hor	Man	Max	Teeth	Total
Sus scrofa dom.	Age										
	?	2								3	5
	Im										
	F/I										
	I										
	I/J										
	J										
	J/S									1	1(20.0)
	S			1				1		1	3(60.0)
	S/A	5								1	6
	A									1	1(20.0)
	Tot.	7		1				1		7	16
Ovis aries & Capra	Većina Mala										
	?										
	Im										
	F/I										
	I										
	I/J										
	J										
	J/S										
	S	2*									2(66.6). *Ovis aries
	S/A	1									1
	A									1	1(33.3).
	Tot.	3								1	4

Table 35 cont.: Večina Mala

	Age	PC	Vert	Rib	Cra	Cra+Ant	Ant/Hor	Man	Max	Teeth	Total
Bos taurus	?	1									1
	Im										
	F/I										
	I										
	I/J										
	J										
	J/S										
	S								1		1(50.0)
	S/A	2									2
	A	1*									1(50.0)
	Tot	4							1		5
Sus scrofa dom.	?										
	Im										
	F/I										
	I										
	I/J										
	J	1						1			2(25.0)
	J/S										
	S	3	1					1		1	6(75.0)
	S/A	8						1			9
	A										
	Tot	12	1					3		1	17

*plus 1 fused proximal ulna

Table 36: Frequency distribution of major species by bone density (non-cranial elements)

species	site	early fusing	late fusing	small hard	pelvis	vert.	whole
Ovis aprines:	SM	6	8	9	8	18	9
	V	3	1				
	VM	2			1		
Bos taurus:	SM	16	8	15	1	4	
	V	5		6			
	VM		2	2			
Sus scrofa dom.	SM	8	4	1		1	3
	V	1	2				
	VM	7	4	1		1	

SM=Sarina Medja
VM=Večina Mala
V =Vrbica

Table 37: Frequency distribution of butchered bone - Number of fragments (type of cut - see bone code in appendix)

Site:			Sarina Medja			Vrbica		Večina Mala
Species	Element	Part	Pit1	Pit2	Pit3	Pit	Floor	Pit
Ovis/Capra								
	Axis		1(6)					
	Atlas		1(6)					
	LVert		3(6)					
	CVert		1(6)					
	Sacr		1(6)					
	Sacr		1(7)					
	Fem	W	1					
	Tib	W		1(7)				
	MC	P		1(6)				
Bos taurus								
	LVert		2(6)					
	Hum	S	1(7)					
	MC	P	2(6)					
	MC	D	1(6)					
	Tib	S				1(6)		
	MT	P	2(6)					
	MT	S		1(6)				
	MP	D	4(6)					
	MP	D	2(6)					
Sus scrofa dom.								
	Hum	D	1(6)					
Cervus elaphus								
	MT	P	2(6)					
Bos t./Cervus/Equus								
	Rib							1(7)

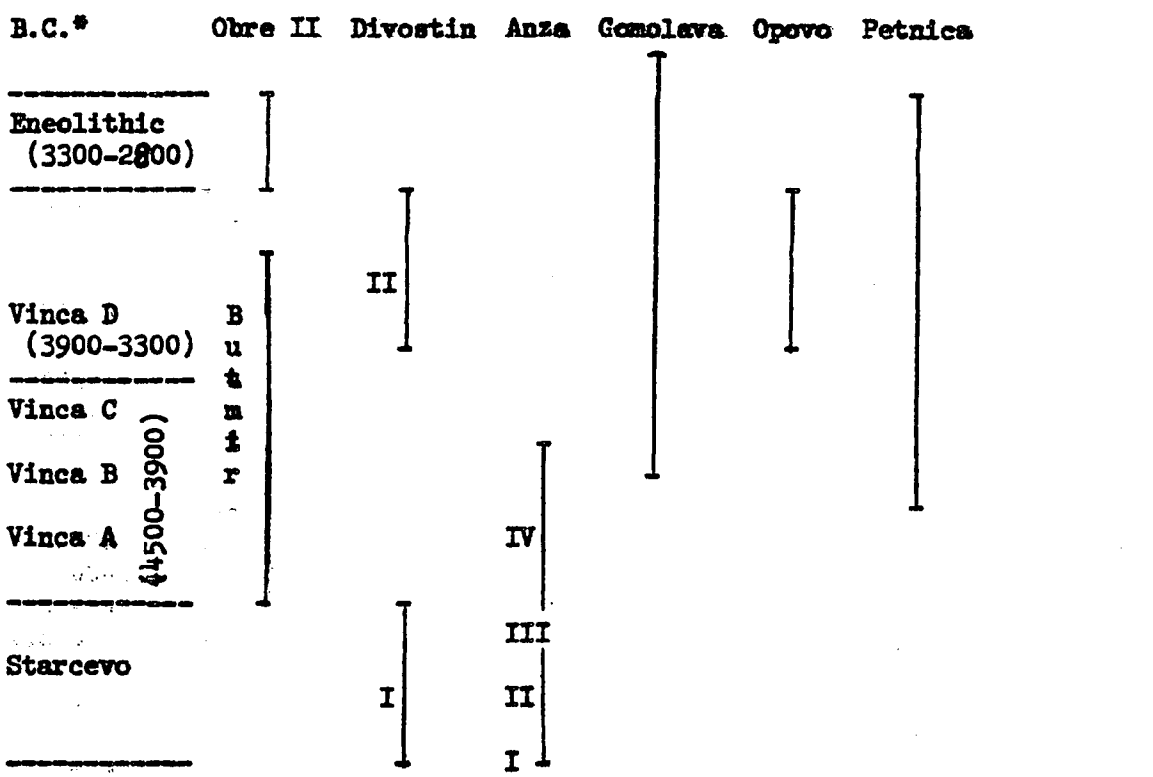
Table 38: Frequency distribution of chewed bone

Site:			Sarina Medja			Vrbica		Večina Mala
Species	Element	Part	Context:					
			Pit1	Pit2	Pit3	Pit	Floor	Pit
Ovis a.	MC	P				2		
Bos t.	Scap	D						1
	Hum	S			2			
	Ulna	P	1	3				
	MC	S		1	2			
	MT	S			1			
	MP	P				1		
	Calc	D		1				
	Astr					1		
Sus s.d.	Hum	S				1	1	1
	Hum	D		1	(also burnt)	1		1
	Fem	S				1		
	Tib	P						1
Cervus	MT	D						1
Medium mammal								
	LB	S		12		1		1
Large mammal								
	LB	S				1		
	Isch					1		
Ovis/Capra/Capreolus								
	Tib					1		
	Ili					1		
Bos t./Cervus								
	Scap	D	1					
	Rad	S						1
Bos t./Cervus/Equus								
	Ili					1		

Table 39: Frequency distribution of burnt bone

Site:			Sarina Medja			Vrbica		Vecina Mala
Species	Element	Part	Context:					
			Pit1	Pit2	Pit3	Pit	Floor	Pit
Ovis/Capra								
	Man		1					
	Atlas		1					
	Rad	W	1					
	LVert		1					
	Fem	D	1					
	Ulna	P	1					
	Tib	W	1					
Bos taurus								
	Carp						1	
	Rad	P	1					
	Scap	D	1					
	MC	P	1					
Sus scrofa dom.								
	Hum	D	1	1(also chewed)				
Canis familiaris								
	MT	P	1					
Cervus elaphus								
	Ant	S	1					
Equus caballus								
	MP	D			1			
Medium mammal								
	LB	S			1			
	Hum	S						1
Cervus/Bos taurus								
	Pel	Pub	1					
Bos t./Cervus/Equus								
	Hum	D	1					
	LB	S	½		1			
	?	S	2					

Table 40: Chronology of Late Neolithic Localities under consideration.



*corrected radiocarbon dates (cf. Chapman 1981; Bankoff n.d.)

Table 41: Late Neolithic assemblage size (number of mammal fragments identified to the species level) and diversity (number of identified mammal species)

Site	Size	Diversity
Obre II	29,909	18
Divostin II	10,782	15
Anza IV	3,007	12
Gomolava (Vinca layer)	2,668	15
Opovo	645	10
Petnica (Vinca layers)	568	13

Table 42: Species frequencies from Late Neolithic assemblages - number of fragments (%)

Species	Anza IV(A)	Obre II(B)	Divostin II(C)	Petnica(D)	Gomolava(E)	Opovo(F)
Bos taurus	496(16.2)	18873(65.2)	6763(26.7)	171(30.1)	984(37.9)	194(30.1)
Ovis aries			124	2(0.3)	2	4(0.6)
Capra hircus			15(11.0)	2(0.3)	3(8.1)	1(0.1)
Ovis/Capra	2067(67.4)	2128(7.3)	1089	13(2.3)	208	13(2.0)
Sus scrofa dom.	351(11.4)	3781(13.1)	1089(10.0)	110(19.4)	435(16.6)	85(13.2)
Canis familiaris	36(1.2)	321(1.1)	92(1.0)	2(0.3)	41(1.6)	17(2.6)
domestic sub-total	2950(96.2)	25108(85.0)	9172(85.0)	300(52.8)	1673(64.5)	314(48.7)
Bos primigenius	22(0.7)	896(3.1)	627(6.0)	5(0.8)	35(1.3)	15(2.3)
Sus scrofa fer.	5(0.2)	710(2.4)	495(5.0)	30(5.3)	271(10.4)	23(3.6)
Cervus elaphus	21(0.7)	1633(5.6)	416(4.0)	173(30.4)	467(18.0)	238(36.0)
Capreolus capreolus	-	322(1.1)	44(0.4)	43(7.6)	128(4.9)	40(6.2)
Meles meles	1	4	4	-	2	-
Canis lupus	1	15	5	1	2	-
Vulpes vulpes	2	14	2	1(0.2)	6	-
Castor fiber	-	8	9	9(1.6)	1	-
Lepus capensis	-	59	6	3(0.5)	6	4(0.6)
Ursus arctus	5	108	2	-	-	-
Lynx lynx	-	-	-	1(0.2)	-	-
Felis sylvestris	-	9	-	-	-	-
Martes sp.	-	18	-	-	-	-
Rupicapra rupicapra	-	5	-	-	-	-
Equus caballus	-	-	-	-	3	-
Reptilia sp.	-	-	-	1(0.2)	-	-
Tortoise indet.	60	-	-	-	5	-
Rodentia indet.	1	-	-	-	2	-
Aves sp.	-	28	3	2(0.3)	8	-
Crustacea sp.	-	-	-	-	1	-
Pisces sp.	-	3+	-	+	6	13(2.0)
Cyprinidae sp.	-	3	-	-	-	-
wild sub-total	118(3.8)	3835(13.2)	1613(15.0)	269(47.1)	919(35.4)	328(50.8)

Table 42 continued:

Total identified	3068	28943	10785	568	2592	642
Total unidentified	?	?	?	1669	4428	225

(A) - Bökönyi 1976
(B) - Bökönyi 1974b
(C) - Bökönyi n.d.
(D) - Chapter 5
(E) - Clason 1979
(F) - Chapter 4

Table 43: Relative frequencies of age classes from Late Neolithic sites (based upon all fragments, unless otherwise noted)

Ovis aries	Infantile	Juvenile	Sub-Adult	Adult	Mature/Senile	(comments)
Divostin I/II	----------77.0----------			23.0		
Obre II		-----most-------		rest		
Anza I-IV		44.0	44.0	11.9		(cranial elements only)
Capra hircus						
Obre II		-----most-------		rest	few	
Divostin I/II		-----most-------		rest	few	
Anza I-IV	.....-----50-60.0------			--40-50.0---....		
Ovis/Capra (all ovicaprine fragments)						
Gomolava		47.0	5.0	47.0		(mandibles only)
Opovo		40.0	20.0	40.0		(mandibles only)
Opovo		25.0	25.0	50.0		(all fragments)
Petnica		12.5		87.5		
Bos primigenius						
Obre II				most		
Divostin I/II				most		
Anza I-IV		13.2	26.3	57.9		
Gomolava				most		
Petnica				100.0		
Opovo			16.6	83.3		
Bos taurus						
Divostin II	----------30-35.0-------			65-70.0-----		
Anza	1.7	18.2	21.4	60.0		
Petnica	4.8	11.3	20.9	59.7		(all fragments)
Petnica	5.5	15.3	29.2	44.4		(post-cranial fragments only)
Gomolava	3.0	30.0	21.0	45.0		(mandibles only
Opovo		20.0	40.0	40.0		(mandibles only
Opovo	0.9	5.5	31.5	58.3		(all fragments)

Table 43 continued:

Sus scrofa fer.	Infantile	Juvenile	Sub-Adult	Adult	Mature/Senile	(comments)
Divostinel/II			-------most----------			
Anza I-IV		30.0	20.0	50.0		
Gomolava				100.0		(mandibles only)
Opovo			25.0	75.0		
Petnica			16.6	83.3		
Sus scrofa dom.						
Obre II	few	-----=most-------		few		
Divostin I/II	----------80.0-------			20.0		
Anza I-IV		47.0	40.0	13.0		
Petnica	8.9 (1.5)	23.9	20.9	44.8		
Petnica		43.5 (4.3)	13.0	39.1		(cranial elements only)
Petnica		50.0	20.0	30.0		(mandibles only)
Gomolava	9.0	22.0	30.0	39.0		(mandibles only)
Opovo		36.0	31.0	32.0		(mandibles only)
Opovo	1.7	22.0 (6.8)	37.3	32.2		
Cervus elaphus						
Obre II		-----some------		most		
Divostin I/II		-----some------		most		
Anza I-IV			7.1	78.6	14.3	
Petnica		8.0 (5.7)	3.8	77.4		(all fragments, minus antlers)
Petnica		7.8 (3.1)	1.6	87.5		
Gomolava		-----present---		present		
Opovo		7.0	14.3	78.6		(mandibles only)
Opovo	0.9	1.8 (0.9)	10.6	85.8		
Capreolus capreolus						
Obre II		-----some-------		most		
Petnica		(7.7)	15.4	76.9		
Retnica		9.5	19.0	71.4		(all fragments, minus antlers)
Opovo	3.8	7.7	15.4	73.1		
Opovo			28.6	71.4		(mandibles only)
Gomolava		10.7	3.6	85.7		(mandibles only)

Table 44: Frequency distributions for total sample size (by site and period) and species diversity (number of identified species)* from post-Neolithic localities.

Site	Sample Size: Eneo.	E/MBA	LBA	Total	No. of Species	Environment
Novačka Ćuprija	556(H)	2320(H)	292(L)	3168	18	Lowland
Livade	-	-	2398(H)	2398	18	Lowland
Ljuljaci	-	3678(H)	- -	3678	16	Highland
Petnica	737(H)	-	406(L)	1143	12	Highland
Sarina Medja	-	-	466(L)	466	11	Lowland
Večina Mala	-	-	78(L)	78	9	Lowland
Crkvina	-	449(L)	-	449	8	Lowland
Vrbica	-	-	164(L)	164	6	Lowland

(H) = large sample size (greater than 500 fragments)
(L) = small sample size (less than 500 fragments)
* each species counted only once. More general taxonomic levels (e.g. Aves, Pisces, Helix, Unio, etc.) were arbitrarily assigned a value of 1 for each

Table 45: Frequency distribution of domestic cattle in post-Neolithic sites.

Period	Site	Context	No.(%)	Rank
Eneo.	Novačka Ćuprija	Sloj	33(38.4)	1
Eneo.	Petnica	Sloj	56(22.4)	2*(after red deer)
E/MBA	Novačka Ćuprija	Pits	109(35.3)	1
E/MBA	Novačka Ćuprija	Sloj	110(48.8)	1
E/MBA	Novačka Ćuprija	Total	208(39.0)	1
E/MBA	Crkvina	Pit	31(32.3)	1
E/MBA	Ljuljaci	Sloj	382(21.9)	3 (after pig & swine)
LBA	Novačka Ćuprija	Urn	9(31.0)	1 (tied with pig)
LBA	Novačka Ćuprija	Floor	15(38.5)	1
LBA	Novačka Ćuprija	Total	24(35.3)	1
LBA	Sarina Medja	Pits	75(31.9)	1
LBA	Vrbica	Total	15(34.1)	2 (after pig)
LBA	Večina Mala	Pit	5(17.2)	2 (after pig)
LBA	Petnica	Sloj	44(22.7)	2 (after pig)
LBA	Livade	Pits	24(25.0)	2 (after pig)
LBA	Livade	Features	3(20.0)	2 (after pig)
LBA	Livade	Sloj	323(35.3)	1
LBA	Livade	Total	353(34.2)	1

*Red deer are inflated by an inordinate number of antler fragments. When these and cattle horn core fragments are removed, cattle are the more common species (29.1%).

Table 46: Frequency distributions of Cattle and Sheep/Goat age groups from post-Neolithic sites.

Cattle: (total number of fragments, unless otherwise indicated)

Period:	Eneo	Eneo.	E/MBA	E/MBA	E/MBA	LBA	LBA	LBA	LBA	LBA	LBA
Site:	Nov.Cup.	Petnica	Nov.Cup.	Crkvina	Ljul.	Nov.Cup.	Sar.Med.	Vrbica	V.Mala	Livade	Petnica
Age:	No.(%)		(A)							(B)	
Im					1(00.7)	5(45.4)					
F/I			1(1.3)		1(					1(0.8)	
I					1(0.7)		1(4.5)				
I/J					1(0.7)						
J	1(11.1)	5(13.0)	4(5.3)	2(20.0)	23(16.7)		4(18.2)			8(6.4)	
J/S		1(4.3)	1(1.3)	1(10.0)	1(0.7)					1(0.8)	
S		6(26.1)	14(18.4)		25(18.1)	1(9.1)	3(13.6)	2(33.3)	1(50.0)	26(21.0)	1(6.6)
A	8(88.9)	13(56.5)	56(73.7)	7(70.0)	87(63.0)	5(45.4)	14(63.6)	4(66.6)	1(50.0)	88(71.0)	14(93.3)
Total	9	25	76	10	133	11	22	6	2	124	15

Sheep/Goat:

Im			3(3.4)	1(9.1)						1(1.5)	
F/I					2(5.4)					2(3.0)	
I								1(20.0)		4(6.0)	
I/J					1(2.7)					1(1.5)	
J	1(11.1)	2(20.0)	10(11.5)		5(13.5)		15(19.7)	1(20.0)		13(19.4)	4(40.0)
J/S		1(10.0)			3(8.1)					3(4.5)	
S		2(20.0)	14(16.1)		6(16.2)	3(25.0)	12(15.8)		2(66.6)	19(28.3)	2(20.0)
A	8(88.9)	5(50.0)	60(70.0)	10(90.9)	20(54.0)	9(75.0)	49(64.4)	3(60.0)	1(33.3)	24(35.8)	4(40.0)
Total	9	10	87	11	35	12	76	5	3	67	10

(A) - pit and sloj above pits combined.
(B) - All contexts combined.

Table 47: Ovicaprine frequency distribution in post-Neolithic sites.

Period	Site	Context	No.(%)	Rank	Corrected %***
Eneolithic	Novačka Ćuprija	Sloj	24(27.9)	3	19.5
Eneolithic	Petnica	Sloj	20(10.6)*	4	8.7
E/MBA	Novačka Ćuprija	Pits	98(31.8)	2	22.3
E/MBA	Novačka Ćuprija	Sloj	54(24.0)	3	16.8
E/MBA	Novačka Ćuprija	Total	150(28.2)	2	19.7
E/MBA	Crkvina	Pit	24(24.9)	3	17.4
E/MBA	Ljuljaci	Sloj	54(3.1)	7	-
LBA	Novačka Ćuprija	Urn	9(31.0)	1	21.7
LBA	Novačka Ćuprija	Floor	9(23.1)	3	16.2
LBA	Novačka Ćuprija	Total	18(26.4)	3	18.5
LBA	Šarina Medja	Pits	100(42.2)	1**	-
LBA	Vrbica	Total	9(20.5)	3	-
LBA	Večina Mala	Pit	4(13.8)	3	-
LBA	Petnica	Sloj	21(10.8)*	4	8.9
LBA	Livade	Pits	11(11.5)	3	-
LBA	Livade	Features	2(13.3)	3	-
LBA	Livade	Sloj	117(12.8)	3	-
LBA	Livade	Total	132(12.8)	3	-

*Percentage calculated without antler/horn fragments.
**Tied with cattle.
***Sieved assemblages corrected (lower) to match unsieved.

Table 48: Frequency distribution of adult ovicaprines in Late Bronze Age contexts (%).compared against sample size.

Site	Context	Adult No.(%)	Sample Size-A	Sample Size-B
Livade	Pits	1(12.5)	13	252
Večina Mala	Total	1(33.3)	3	78
Livade	Total	24(35.8)	67	2398
Petnica	Sloj	4(40.0)	10	408
Vrbica	Pit	3(60.0)	5	164
Sarina Medja	Pits	49(64.4)	76	466
Novačka Ćuprija	Urn/Floor	9(75.0)	12	292

Sample Size-A - Number of ovicaprine fragments useful for ageing.
Sample Size-B - Total sample size from context type at site.

Table 49: Ratio of sheep:goat in post-Neolithic sites.

Period	Site	Ratio-A	Ratio-B
Eneolithic	Novačka Ćuprija	3:2	1.5:1
Eneolithic	Petnica	8:0	-
E/MBA	Novačka Ćuprija	17:1	-
E/MBA	Crkvina	3:0	-
E/MBA	Ljuljaci	9:1	-
LBA	Novačka Ćuprija	3:0	-
LBA	Sarina Medja	55:9	6.1:1
LBA	Vrbica	1:0	-
LBA	Večina Mala	2:0	-
LBA	Petnica	4:2	2.0:1
LBA	Livade	23:4	5.7:1

Ratio-A: Based upon raw frequencies from site.
Ratio-B: Frequency corrected in order that goat equals 1.

Table 50: 2x2 contingency table showing relationship between the presence/absence of goats and sample size (High: greater than 500 fragments; Low: less than 500 fragments) in post-Neolithic sites.

Goats	Sample Size: High	Sample Size: Low
+	4	2
-	1	4

$X^2 = 2.39$ (2 df) - c. 30° probability.

Table 51: Domestic pig frequency distribution in post-Neolithic sites.

Period	Site	No. (%)	Context	Rank	Corrected %
Eneolithic	Novačka Ćuprija	34(18.3)	Sloj	4	18.0
Eneolithic	Petnica	34(18.0)*	Sloj	2	17.7
E/MBA	Novačka Ćuprija	74(23.9)	Pits	3	22.2
E/MBA	Novačka Ćuprija	58(25.8)	Sloj	2	24.0
E/MBA	Novačka Ćuprija	132(24.8)	Total	3	23.1
E/MBA	Crkvina	27(28.1)	Pit	2	26.1
E/MBA	Ljuljaci	428(24.2)	Sloj	2	-
LBA	Novačka Ćuprija	9(31.0)	Urn	1**	
LBA	Novačka Ćuprija	13(33.3)	Floor	2	
LBA	Novačka Ćuprija	22(32.3)	Total	2	30.0
LBA	Sarina Medja	49(20.7)	Pits	3	-
LBA	Vrbica	16(36.4)	Total	1	-
LBA	Večina Mala	17(58.6)	Pit	1	-
LBA	Petnica	61(38.4)	Sloj	1	30.8
LBA	Livade	35(36.4)	Pits	2	-
LBA	Livade	4(26.7)	Features	1	-
LBA	Livade	222(24.2)	Sloj	2	-
LBA	Livade	261(25.3)	Total	2	-

*Percentage calculated without antler/horn.
**tied with cattle and ovicaprines.

Table 52: Corrected percentage of domestic pigs in post-Neolithic sites compared against sample size (deposit total) and percentage of adult specimens.

Site	Period	Corrected%	Sample Size	%Adult	Environment
Ljuljaci	E/MBA	24.2	3678	38.5	Highland
Livade	LBA	25.3	2398	20.0	Lowland
Novaćka Ćuprija	E/MBA	23.1	2320	41.8	Lowland
Petnica	Eneolithic	17.7	737	50.0	Highland
Novaćka Ćuprija	Eneolithic	27.1	556	38.5	Lowland
Sarina Medja	LBA	20.7	466	10.8	Lowland
Crkvina	E/MBA	36.1	449	25.0	Lowland
Petnica	LBA	30.8	406	20.0	Highland
Novaćka Ćuprija	LBA	30.0	292	54.5	Lowland
Vrbica	LBA	36.4	164	20.0	Lowland
Večina Mala	LBA	58.6	78	-	Lowland

Table 53: Frequency distributions of pigs and horse age groups from post-Neolithic sites (total number of fragments, unless otherwise indicated).

Pigs:											
Period:	Eneo.	Eneo.	E/MBA	E/MBA	E/MBA	LBA	LBA	LBA	LBA	LBA	LBA
Site:	Nov.Cup.	Petnica	Nov.Cup.	Crkvina	Ljul.	Nov.Cup.	Sar.Med.	Vrbica	V.Mala	Livade	Petnica
Age:	No.(%)		(A)								
Im						2(18.2)					
F/I	1(7.7)	1(5.0)	3(9.7)	1(6.2)	12(4.9)						
I		1(5.0)		5(31.2)	5(2.0)		5(13.5)				
I/J				2(12.5)	2(0.8)					1(4.0)	
J	3(23.1)	6(30.0)	5(16.1)	2(12.5)	56(22.8)	1(9.1)	14(37.8)		2(25.0)	6(24.0)	25(55.5)
J/S	1(7.7)		4(12.9)		10(4.1)	1(9.1)	12(32.4)	1(20.0)		3(12.0)	2(4.4)
S	3(23.1)	2(10.0)	7(22.6)	2(12.5)	67(27.2)	1(9.1)	2(5.4)	3(60.0)	6(75.0)	10(40.0)	9(20.0)
A	5(38.5)	10(50.0)	12(38.7)	4(25.0)	94(38.2)	6(54.5)	4(10.8)	1(20.0)		5(20.0)	9(20.0)
Total	13	20	21	16	246	11	37	5	8	25	45
Horse:											
Im											
F/I											
I											
I/J											
J					1(3.6)						
J/S											
S					4(14.3)					2(16.6)	
A			4(100.0)		23(82.1)		2(100.)		1(100.)	10(83.3)	2(100.)
Total			4		28		2		1	12	2

(A) - pits only.
(B) - all contexts combined.

Table 54: 2x2 contingency table showing relationship between percentage of mature pigs (High: greater than 26%; Low: equal or less than 26%) and contextual original of deposits (sloj, pit) in post-Neolithic assemblages (excludes Novačka Ćuprija and Livade features).

	%Adult High	%Adult Low
Pit	5	1
Sloj	1	5

X^2 = 5.33 (2 df); 5-10° probability.
Yates Corrections: 3.0; 20-30° probability.

Table 55: 2x2 contingency table showing relationship between percentage of mature pigs (High and Low defined above) and recovery procedures in post-Neolithic sites (excludes Petnica, which combined both procedures).

Sieve	%Adult High	%Adult Low
+	3	1
-	2	4

$X^2 = 1.66$ (2 df); 30-50° probability.

Table 56: Domestic dog and chewed bone frequencies in post-Neolithic sites.

Period	Site	Context	Dog No.(%)	Chewed
Eneolithic	Novačka Ćuprija	Sloj	3(3.5)	6(1.1)
Eneolithic	Petnica	Sloj	1(0.4)	
E/MBA	Novačka Ćuprija	Pits	9(2.0)	31(2.3)
E/MBA	Novačka Ćuprija	Sloj	7(3.1)	31(3.5)
E/MBA	Novačka Ćuprija	Total	16(3.0)	62(2.7)
E/MBA	Crkvina	Pit	4(4.2)	7(1.5)
E/MBA	Ljuljaci	Sloj	28(1.6)	600(17.0)
LBA	Novačka Ćuprija	Urn	-	
LBA	Novačka Ćuprija	Floor	-	
LBA	Novačka Ćuprija	Total	-	7(2.4)
LBA	Sarina Medja	Pits	5(2.1)	25(5.3)
LBA	Vrbica	Total	-	15(9.1)
LBA	Večina Mala	Pit	1(3.4)	7(9.0)
LBA	Petnica	Sloj	2(1.0)	
LBA	Livade	Pits	3(3.1)	
LBA	Livade	Features	-	
LBA	Livade	Sloj	29(3.2)	
LBA	Livade	Total	32(3.1)	163(6.8)

Table 57: Horse frequencies in post-Neolithic sites.

Period	Site	Context	Horse No.(%)
E/MBA	Novačka Ćuprija	Pits	7(2.3)
E/MBA	Novačka Ćuprija	Sloj	3(1.3)
E/MBA	Novačka Ćuprija	Total	10(1.9)
E/MBA	Crkvina	Pit	2(2.1)
E/MBA	Ljuljaci	Sloj	115(6.6)
LBA	Sarina Medja	Pits	2(0.8)
LBA	Večina Mala	Pit	1(3.4)
LBA	Petnica	Sloj	2(1.0)
LBA	Livade	Features	1(6.7)
LBA	Livade	Sloj	32(3.5)
LBA	Livade	Total	33(3.2)

Table 58: Red deer and roe deer frequency distributions in post-Neolithic sites

Period	Site	Context	Red Deer No.(%)	Roe Deer
Eneolithic	Petnica	Sloj	61(32.3)*	9(3.6)
Eneolithic	Novačka Ćuprija	Sloj	-	-
E/MBA	Novačka Ćuprija	Pits	1(0.3)	1(0.3)
E/MBA	Novačka Ćuprija	Sloj	-	1(0.4)
E/MBA	Novačka Ćuprija	Total	1(0.2)	2(0.4)
E/MBA	Crkvina	Pit	3(3.1)	2(2.1)
E/MBA	Ljuljaci	Sloj	257(14.7)	18(1.0)
LBA	Novačka Ćuprija	Floor	-	1(1.5)
LBA	Sarina Medja	Pits	3(1.3)	1(0.4)
LBA	Vrbica	Total	4(9.1)	-
LBA	Večina Mala	Pit	1(3.4)	-
LBA	Livade	Pits	7(7.3)	-
LBA	Livade	Sloj	87(9.5)	9(1.0)
LBA	Livade	Total	95(9.2)	10(1.0)
LBA	Petnica	Sloj	42(21.6)	8(4.1)

*percentage calculated without antler/horns.

Table 59: 2x2 contingency table showing relationship between percentage of red deer (Low: less than 10%; High: greater than 10%) and sample size (Low: less than 500 fragments; High: more than 500 fragments) in post-Neolithic sites.

Sample	% Red Deer High	% Red Deer Low
High	2	3
Low	1	5

$X^2 = .7486$ (2 df); 50-70° probability.

Table 60: 2x2 contingency table showing relationship between percentage of roe deer in post-Neolithic sites (Low: less than 2.0%; High: greater than 2.0%) and recovery method (includes Petnica as sieved).

	Roe Deer % High	Low
Sieve +	2	3
Sieve -	1	4

Table 61: 2x2 contingency table showing relationship between percentage of roe deer in post-Neolithic sites (Low and High defined above) and environment.

	Roe Deer % High	Low
Highland	2	1
Lowland	-	8

Table 62: Frequency distributions of adult roe deer in post-Neolithic sites.

Period	Site	Adults No. (%)
Eneolithic	Petnica	9(100.0)
E/MBA	Crkvina	2(100.0)
E/MBA	Ljuljaci	18(87.5)
LBA	Petnica	8(60.0)
LBA	Livade	10(40.0)

Table 63: 2x2 contingency table showing relationship between the percentage of adult roe deer in sites from Ill. XI.19 (Low: less than 75%; High: greater than 75%) and the total number of roe deer specimens (Low: less than or equal to 10; High: greater than 10 fragments).

		Sample: Low	Sample: High
Adult %	High	2	1
	Low	2	-

Table 64: Frequency distribution of Aurochs and Swine in post-Neolithic sites.

Period	Site	Aurochs No.(%)	Swine No. (%)
Eneolithic	Petnica	1(0.5)	8(4.2)*
E/MBA	Ljuljaci	27(1.5)	379(21.4)
LBA	Petnica	1(0.5)	11(5.7)
LBA	Livade	2(0.2)	27(2.6)

*Petnica Eneolithic percentage calculated without horn/antler.

Table 65: 2x2 contingency table showing relationship between sample size (Low: equal or less than 500; High: greater than 500 fragments) and the presence/absence of aurochs in post-Neolithic sites.

		Sample Size: High	Sample Size: Low
Aurochs	+	3 (1.8)	1 (2.2)
	-	2 (3.2)	5 (3.8)

$X^2 = 2.21$ (2 df); c. 35° probability.
Yates correction: .736; 50-70° probability.

Table 66: Frequency distributions of aurochs, swine, and bears age groups from post-Neolithic sites (total number of fragments).

Aurochs:		Swine:				Bear:		
Period:	E/MBA	Eneo.	E/MBA	LBA	LBA	E/MBA	LBA	LBA
Site:	Ljul.	Petnica	Ljul.	Petnica	Livade	Ljul.	Livade	Petnica
Age:	No.(%)							
Im								
F/I								
I								
I/J								
J		1(16.6)						
J/S			1(00.6)					
S			13(7.7)		2(15.4)	1(8.3)		
A	3(100.0)	5(83.3)	155(91.7)	4(100.0)	11(84.6)	11(91.7)	1(100.0)	2(100.0)
Total	3	6	169	4	13	12	1	2

Table 67: 2x2 contingency table showing relationship between presence/absence of swine and total sample size (Low: less than 500 fragments; High: more than 500 fragments) in post-Neolithic sites.

Swine	Sample Size: High	Low
+	3	1
-	2	5

X^2 = 2.21 (2 df); c. 35° probability.
Yates corrections = .74; 50-70° probability.

Table 68: 2x2 contingency table showing relationship between the presence/absence of bear and presence/absence of aurochs and swine in post-Neolithic sites.

Aurochs & Swine	Bear: +	-
+	3	1
-	-	6

Table 69: 2x2 contingency table showing relationship between the presence/absence of hare and the use of sieves (excludes Petnica) in post-Neolithic sites.

Hare	Sieve: +	-
+	2	1
-	1	3

Table 70: Frequency distributions Unio sp. in post-Neolithic sites (percentage reflects the relative frequency of mussels among the total bone and shell fragments).

Period	Site	No. (%)
Eneolithic	Novačka Ćuprija	9(2.6)
E/MBA	Novačka Ćuprija	103(4.4)
E/MBA	Ljuljaci	1(0.03)
LBA	Livade	233(9.7)
LBA	Sarina Medja	17(3.6)
LBA	Vrbica	7(4.3)
LBA	Večina Mala	3(3.8)

Table 71: 2x2 contingency table showing relationship between the presence/absence of Unio sp. and the environmental position of the site (highland/lowland) in post-Neolithic sites.

		Environment	
		High	Low
Unio	+	1	6
	-	2	-

Table 72: Frequency distributions of Helix sp. in post-Neolithic sites.

Period	Site	No.(%)
Eneolithc	Novačka Ćuprija	14(2.5)
E/MBA	Novačka Ćuprija	5(0.2)
LBA	Livade	11(0.4)
LBA	Sarina Medja	2(0.4)
LBA	Vrbica	1(0.6)
LBA	Večina Mala	1(1.3)

Table 73: 2x2 contingency table showing relationship between recovery methodology (sieved or unsieved) and presence/absence of snails (Petnica excluded) in post-Neolithic sites.

		Sieve +	Sieve -
Neolix	+	2	4
	-	2	1

$\chi^2 = 0.9$ (2 df); 50-70° probability.

Table 74: Frequency distributions of ped and roe deer from post-Neolithic sites (total number of fragments unless otherwise noted).

Red deer:								
Period:	Eneo.	E/MBA	E/MBA	LBA	LBA	LBA	LBA	LBA
Site:	Petnica*	Ljul.*	Crkvina	Sar.Mhd.	Vrbica	V.Mala	Livade*	Petnica*
Age:	No.(%)						(A)	
Im								1(10.0)
F/I								
I								
I/J		1(0.7)						
J	3(10.7)	12(8.1)					2(9.0)	
J/S	1(3.6)	1(0.7)					1(4.5)	
S	3(10.7)	9(6.1)					2(9.0)	1(10.0)
A	21(75.0)	125(84.4)			1(100.0)	1(100.0)	17(77.3)	8(80.0)
Total	28	148			1	1	22	10

Roe deer:								
Im							1(20.0)	
F/I								
I								
I/J								
J								
J/S							1(20.0)	
S		1(8.2)					1(20.0)	2(40.0)
A	4(100.)	11(91.7)	3(100.0)	1(100.0)			2(40.0)	3(50.0)
Total	4	12	3	1			5	5

*excludes antler tine and beam fragments except where only a single specimen was found.
(A) - all contexts combined.

Table 75: 2x2 contingency table showing relationship between environment (highland versus lowland) of site location and percentage of domestic animals in site (High: greater than 70%; Low: less than 70%).

Domestic %	Late Neolithic Environment: Highland	Late Neolithic Environment: Lowland	post-Neolithic Environment: Highland	post-Neolithic Environment: Lowland
High	3	-	-	8
Low	1	2	3	-

Table 76: 2x2 contingency table showing relationship between sample size of identified bones per site (Large: more than 1,000 fragments; Small: less than 1,000 fragments) and the percentage of domestic animals (High: more than 70%; Low: less than 70%) in Late Neolithic sites.

Domestic %	Sample Size: Small	Sample Size: Large
High	-	3
Low	2	1

Table 77: 2x2 contingency table showing relationship between recovery method (presence/absence of sieves) and percentage of domestic animals (High: more than 70%; Low: less than 70%) - Petnica included as sieved.

Domestic %	Late Neolithic Sieve: +	Late Neolithic Sieve: -	post-Neolithic Sieve: +	post-Neolithic Sieve: -	All periods Sieve: +	All periods Sieve: -
High	1	2	4	4	5	6
Low	1	2	2	1	3	3

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Table 79: Summary frequency distributions of major domesticates.

Period	Cattle		Sheep/Goat		Pig	
Late Neolithic	No.(%A)	(%B)	No.(%A)	(%B)	No.(%A)	(%B)
Anza IV	496(16.2)	(17.0)	2067(67.4)	(70.9)	351(11.4)	(12.0)
Obre II	18878(65.2)	(76.2)	2128(7.3)	(8.5)	3781(13.1)	(15.2)
Divostin II	6763(63.0)	(74.5)	1228(11.0)	(13.5)	1089(10.0)	(12.0)
Petnica	146(26.7)	(53.1)	17(6.3)	(6.2)	112(20.5)	(40.7)
Gomolava	984(37.9)	(60.3)	213(8.1)	(13.0)	435(16.6)	(20.6)
Opovo	194(30.1)	(65.3)	18(2.7)	(6.1)	85(13.2)	(28.6)
Eneolithic						
Petnica	56(30.1)	(50.9)	20(10.8)	(18.2)	34(18.3)	(30.9)
Novačka Cuprija	33(38.4)	(40.2)	24(27.9)	(29.3)	25(29.1)	(30.5)
E/MBA						
Ljuljaci	382(21.6)	(44.2)	54(3.1)	(6.2)	428(24.2)	(49.5)
Novačka Cuprija	208(39.0)	(42.4)	150(28.2)	(30.6)	132(24.8)	(26.9)
Crkvina	82(32.3)	(37.8)	24(24.9)	(29.3)	27(28.1)	(32.9)
LBA						
Petnica	44(22.5)	(34.9)	21(10.6)	(16.7)	61(30.1)	(48.4)
Novačka Cuprija	24(35.3)	(37.5)	18(26.4)	(28.1)	22(32.3)	(34.4)
Livade(1)	24(25.0)	(34.3)	11(11.5)	(15.7)	35(36.4)	(50.0)
Livade(2)	353(34.2)	(47.3)	132(12.6)	(17.7)	261(25.3)	(35.0)
Sarina Medja	76(32.1)	(33.8)	100(42.2)	(44.4)	49(20.7)	(21.8)
Vrbica	15(34.1)	(37.5)	9(20.5)	(22.5)	16(36.4)	(40.0)
Večina Mala	5(17.2)	(18.2)	4(13.8)	(15.4)	17(58.6)	(65.4)

(1) - Dubovac-Žuto Brdo pits only.
(2) - all contexts combined.
(%A) - percent of total identified bones.
(%B) - percent of three major domesticates.

Table 80: 2x2 contingency tables showing relationship between percentage of immature cattle (High: more than 50%; Low: less than 50%) and method of recovery (presence/absence of sieves), total sample size (High: more than 500 fragments; Low: less than 500 fragments), environment, sample size of specimens used only for ageing (High: more than 20 fragments; Low: less than 20 fragments), and time (Early: Late Neolithic; Late: post-Neolithic) in sites from all periods combined.- Excludes Obre II and Vedina Mala.

A.

Immature %	Sieve(1) +	Sieve(1) -
High	7	6
Low	5	1

B.

Sample Size - total High	Low
8	2
4	4

C.

Immature %	Environment Upland	Lowland
High	6	7
Low	2	-

D.

Ageable specimens(2) High	Low
9	4
-	1

E.

Immature %	Period Early	Late
High	4	9
Low	1	1

(1) - Petnica included as sieved. Excludes Vecina Mala and Obre II.

(2) - Excludes Odmestin.

Table 81: 2x2 contingency table showing relationship between sample size (High: more than 500 fragments; Low: less than 500 fragments - total sample from period) and distance from "meat" production strategy point (Near: less than 25%; Far: more than 25%) among pigs from all periods.

Distance	Sample Size: High	Sample Size: Low
Near	9	1
Far	-	5

APPENDIX 1: CODING SYSTEM FOR YUGOSLAVIAN FAUNAL MATERIALS

1. Site number (cols. 1-2)
   - 1.01 Crkvina
   - 1.05 Novačka Ćuprija
   - 1.10 Livade (Mala Vrbica)
   - 1.12 Opovo
   - 1.17 Sarina Medja
   - 1.18 Večina Mala
   - 1.19 Vrbica
   - 1.20 Ljuljaci
   - 1.21 Petnica

2. Sonda number (cols. 3-4)

3. Unit (locus) number (cols. 5-6)

4. Bone registration number (cols. 7-9)

5. Input formmat (col. 10)
   - 5.1 Post-Cranial (and cranial items limited to one element)
   - 5.2 Cranial (crania composed of more than one element within the cranium)

5.3 Measurement (refer to Von den Dreisch)

5.4 Archaeological context of the Unit

6. Class of bone (col. 11)

6.1 Mammalia

6.2 Aves

6.3 Reptilia

6.4 Amphibia

6.5 Pisces

6.6 Mollusca 7. Species (col. 12 - 14)

7.01 Sheep (Ovis aries)

7.02 Goat (Capra hircus)

7.03 Sheep/Goat

7.04 Cattle (Bos sp.)

7.05 Pig (Sus scrofa)

7.06 Canid (prob. Canis familiaris)

7.07 Equid (Equus sp.)

7.08 Red Deer (Cervus elaphus)

7.09 Roe Deer (Capreolus capreolus)

7.10 Fallow Deer (Dama dama)

7.11 Hare/Rabbit (Lepus sp.)

7.12 Red Fox (Vulpes vulpes)

7.13 Weasel (Mustela nivalis)

7.14 Brown Bear (Ursus arctcs)

7.15 Beaver (Castor fiber)

7.16 Badger (Meles meles)

7.17 Ibex (Rupicapra rupicapra)

7.18 Wild Cat (Felis silvestri Schreib)

7.19 Marten (Martes sp.)

7.20 Red Squirrel (Sciurus vulgaris L.)

7.21 Chamois (Rupicapra rupicapra)

7.22 Mustela putarius

7.23 Badger/Muskrat/Nutra

7.24 Lutra lutra

7.25 Lynx (Lynx lynx)

7.26 Gula

7.27 Vole

7.28

7.40 Shell sp.?

7.41 Bivalve Mussel shell (Unic sp.)

7.42 Helix (snail) shell

7.43/6 Special Shell species - to be looked at later

7.50 Rodent (unidentified species)

7.51 Mole (Spalax sp.)

7.52 Frog

7.60 Fish (unidentified species)

7.70 Bird (unidentified species

7.71 Domestic Chicken

7.72 Goose (Gallus sp.)

7.80 Reptile

7.81 Pond Tortoise

7.90 Human (Homo sapiens sapiens)

7.94 Medium mammal (dog/sheep/goat/roe deer/small

pig-sized mammal)

7.95 Small Mammal (squirrel/rabbit-size)

7.96 Large Mammal (larger than medium category)
Horse, Cow, large Pig-Size

7.97 sheep/goat/roe deer

7.98 horse/cattle/red deer

7.99 Unknown

7.100 cattle/red deer

7.101 = 094

7.102 = 100

7.CAR Carnivore

8. Element (cols. 15-17)

8.000 indeterminate

8.001 cranial

8.002 basiooccipital

8.003 occipital

8.004 sphenoid

8.005 pterygoid

8.006 vomer

8.007 palatine

8.008 interparietal

8.009 parietal

8.010 frontal

8.011 petrous

8.012 temporal

8.013 zygomatic

8.014 lacrimal

8.015 nasal

8.016 premaxillary with teeth

8.017 premaxillary without teeth

8.018 maxillary with teeth

8.019 maxillary without teeth

8.020 mandible with teeth

8.021 mandible without teeth

8.022 horn core

8.023 antler

8.024 hyoid

8.025 general vertebra(e)

8.026 atlas

8.027 axis (epistropheus)

8.028 cervical vertebra

8.029 thoracic vertebra

8.030 lumbar vertebra

8.031 sacrum (aves = lumbar sacrum)

8.032 caudal (ccccygeal vert.)

8.033 rib

8.034 costal cartilage

8.035 sternebra

8.036 scapula

8.037 clavicle

8.038 humerus

8.039 radium

8.040 ulna

8.041 carpal

8.042 radial carpal

8.043 intermediate carpal

8.044 ulnar carpal

8.045 accessory carpal

8.049 fourth carpal

8.051 2nd and 3rd carpal

8.052 metacarpal 1

8.053 metacarpal 2

8.054 metacarpal 3

8.055 metacarpal 4

8.056 metacarpal 5

8.057 metacarpal 3 and 4

8.058 indeterminate metacarpal

8.059 sesamoid

8.062 phalanx 1

8.063 phalanx 2

8.064 phalanx 3

8.066 pelvis (ilium+ischium+pubic)

8.067 ilium+ischium

8.068 ilium+pubis

8.069 ischium+pubis

8.070 ilium

8.071 ischium

8.072 pubis

8.073 penis bone (carnivores)

8.074 femur

8.075 patella

8.076 tibia

8.077 fibula

8.078 lateral malleolus

8.079 astragalus (talus)

8.080 calcaneus

8.081 tarsal

8.082 central tarsal

8.083 3rd tarsal

8.084 fourth tarsal

8.087 central and 4th tarsal (cuboid)

8.089 2nd and 3rd tarsal

8.090 metatarsal 1

8.091 metatarsal 2

8.092 metatarsal 3

8.093 metatarsal 4

8.094 metatarsal 5

8.095 metatarsal 3 and 4 (ruminants and birds)

8.096 indeterminate metatarsal

8.104 metapodial 3 and 4 (if pig = 3 or 4)

8.105 indeterminate metapodial

8.108 sesamoid

8.112 indeterminate phalanx

8.113 loose tooth: upper

8.114 loose tooth: lower

8.115 humerus or femur fragment

8.116 long bone fragment

8.117 indeterminate fragment

8.118 tooth fragment

8.119 burial

8.120 acetabulum (=066)

8.121 external auditory bulla

8.122 anterior phalanx 1

8.123 thoracic or lumbar vertebra wing or rib fragment

8.124 posterior phalanx 1

8.125 posterior phalax 2

8.126 posterior phalanx 3

8.127 indeterminate metapodial or phalanx fragment

8.128 paramastoid process

8.129 internal auditory bulla

8.200 valve of a snail shell

8.201 body of molluscan shell

8.202 carapax of turtle shell (upper = concave)

8.203 plastron of turtle shell (lower = flat)

8.204 turtle shell part

Format 1: post-cranial format

9. Domestication (col. 18)

9.10	not determinable
9.1	wild
9.2	probably wild
9.3	domestic
9.4	probably domestic
9.9	not applicable (e.g., homo sapiens)

10. Certainty of species and element identification (col. 19)

10.0	no identification possible
10.1	standard identification
10.2	preliminary identification
10.3	possible identification
10.4	probable identification
10.5	definite identification of a potentially questionnable item

11. Symmetry (handedness) (col. 20)

11.	not applicable (blank)
11.0	not determinable
11.1	right side (Helix - open end)
11.2	left side (Helix - closed end)
11.3	medial (axial)
11.4	right medial/left lateral (artiodactyl

phalange)

11.5 left medial/right lateral (artiodactyl phalange)

11.6 both left and right

11.7 left medial (articdactyl phalange)

11.8 left lateral (artiodactyl phalange)

12. Sex (col 21)

12.0 ?

12.1 male

12.2 male?

12.3 female

12.4 female? (based cn measurement distribution)

12.5 castrate (based upon morphology)

12.6 castrate? (based on measurement distribution)

12.7 male or castrate

12.8 female or castrate

13. Age (col. 22) (based on epiphyseal union)

13. not applicable

13.0 not determinable

13.1 young (not grown up at all)

13.2 foetal or infantile

13.3 infantile

13.4 infantile or juvenile

13.5 juvenile

13.6 juvenile cr sub-adult

13.7 sub-adult

13.8 sub-adult or adult

13.9 adult

14. Butchering (col. 23)

14.0 no butchering marks

14.1 butchering marks present

14.2 possible butchering marks present

14.3

14.4 chop mark/severed lengthwise to main axis

14.5 chop mark/severed crcss-wise to main axis

14.6 slice/cut mark lengthwise to main axis

14.7 slice/cut mark crosswise to main axis

14.8 angular chop mark

14.9 slice/cut mark and break in bone

15. Modification by human activity (col. 24)

15.0 no modification observable

15.1 possible modification

15.2 retouched

15.3 pierced

15.4 tool

16. Surface polish (col. 25)

16.0 no polish (matte surface)

16.1 light polish; some smoothing of surface, little or no gloss

16.2 medium polish; considerable surface smoothing; some gloss

16.3 heavy polish; major surface modification; high gloss

16.4 mottled black burnish

16.5 heavy black burnish

16.9 polish, nc other infcrmation available

17. Gnawing (col. 26)

17.0 no gnawing, intact surface

17.1 light canine gnaw marks (few)

17.2 heavy canine gnaw marks (many)

17.3 light rodent gnaw marks (few)

17.4 heavy rodent gnaw marks (many)

17.5 canine and rodent gnaw marks

18. Weathering (col. 27)

17.0 fresh bone; little or no discoloration

18.1 light weathering; discolcration, but surface unpitted

18.2 medium weathering; ccmpact surface pitted,

lightly eroded and cracked

18.3 heavy weathering; major destruction of compact surface; cancellous bones extensively exposed

18.4 water smoothed surface

19. Burning (col. 28)

19.0 unburnt

19.1 possible burning or burnt, but no other data

19.2 completely calcined (white)

19.3 partly calcined, partly carbonized

19.4 carbonized (black)

19.5 partly carbonized

19.6 burnt and partly carbonized

19.7 burnt (reddish)

19.8 partly burnt

19.9 slightly burnt

20. Pathology (col. 29)

20.0 healthy, no pathology observable

20.1 pathological: mark and set aside

20.2 malocclusion

20.3 exostosis

63. Number of pieces of bone (cols. 30-31)

64. Number of elements (cols. 32-33)

21. Weight (000.0grams) or length of fragment (000.0 cms.) (cols. 34-37).

Petnica and Ljuljaci = length of fragment

Novacka Cuprija and Crkvina = weight of fragment

22. Fragment size (col. 38)

22.0	indeterminate
22.1	whole bone
22.2	less than half, more than one-quarter
22.3	more than half, less than three-quarter
22.4	fragment (less than one-quarter)
22.5	half
22.6	more than three-quarter, less than whole
22.7	modern break, fragment size > one-half
22.8	modern break, fragment size < one-half

23. Part of the bone that is present (col. 39-40)

23.0	indeterminate
23.01	whole
23.02	shaft/body fragment
	ilium - includes groove of foramen
	radium - includes ulnar fossa on shaft
23.03	proximal end and less than half of shaft

shell - edge of shell plus less than half of body

23.04 distal end and less than half of shaft

shell - edge of shell plus more than half of body

23.05 medial (central)

shell - valve plus less than half of body

23.06 lateral (peripheral)

shell - valve plus more than half of body

23.07 anterior

23.08 posterior

23.09 ventral (lower part of vertebra; part of rib away from vertebra)

23.10 dorsal (upper part of vertebra; part of rib toward vertebra)

23.11 cranial (for pelvis)

23.12 caudal (for pelvis)

23.13 proximal end and more than half of shaft

24.14 proximal shaft

tibia - include part of posterior crest

radium - includes fossa for ulnar distal shaft

femur - part of synovial pit and/or tuber on lateral side

23.15 distal shaft

femur - include notch

metapodial - include distal foramen

tibia - fossa on medial part of shaft

scapula - collum and part of spine

23.16 distal end and more than half of shaft

23.17 plantar

23.18 planar/volar

23.19 right ventral

23.20 horizontal ramus

23.21 vertical ramus

23.22 distal epiphysis/articulation area

23.23 proximal epiphysis/articulation area

23.24 16 and 18

23.25 cranial epiphysis

23.26 nasal (oral)

23.27 nuchal (aboral)

23.28 basal

23.29 distal shaft and end, but distal epiphysis area is missing (unfused if marked unfused in calcaneus and ulna includes articulation area and a varying amount beyond (usually very little; incorrect for ulna, but used for 1977-1980; for 1981 and later used cat. #30)

23.30 proximal shaft and end, but proximal epiphysis area is missing (same as 29 or 50)

23.31 acetabulum area and some area beyond

23.32 crest of scapula

23.33 whole, except distal epiphysis is missing

23.34 whole, except proximal epiphysis is missing

23.35 indeterminate end

23.36 neck of scapula and part of the body=29, 15

23.37 shaft is whole, proximal and distal epiphyses are missing

23.38 antler/horn base

23.39 proximal condyle only (fused)

23.40 distal condyle only (fused)

23.41 lateral distal condyle

23.42 proximal end, lateral side, less than half of shaft

23.43 distal end, posterior fragment
scapula - includes glenoid fossa

23.44 distal condyle fragment

23.45 distal shaft, distal epiphysis missing
not missing

23.46 medial distal condyle fragment

23.47 medial condyle of metapodial

23.48 glenoid cavity of scapula =43

23.49 unfused end without epiphysis

23. if this is a cranial or mandibular element, the variables are those found in their sections normally reserved for format 2

24. Epiphyseal fusion (col. 41-42)

24. not applicable

24.00 not determinable

24.01 fused; epiphyseal line completely obscured

24.02 epiphyseal line visible or bone is porous

24.03 unfused

24.04 proximal fused/distal fused

24.05 proximal fused/distal epiphyseal line visible

24.06 proximal fused/distal unfused

24.07 proximal epiphyseal line/distal fused

24.08 proximal & distal epiphyseal line visible

24.09 proximal epiphyseal line/distal unfused

24.10 proximal unfused/distal fused

24.11 proximal unfused/distal epiphyseal line

24.12 proximal unfused/distal unfused

24.13 proximal unfused/distal ?

24.14 distal unfused/proximal ?

24.15 proximal fused/distal ?

24.16 distal fused/proximal ?

24.17 =08

24.18 =11 24.19 =05

24.20 probably fused on the basis of size comparison with already fused specimens from same site

24.21 proximal epiphyseal line visible/ distal ?

24.22 distal eiphyseal line visible/ proximal ?

24.23 probably not fused

for vertebra: proximal=cranial=dorsal
distal=caudal=ventral

Loose teeth

25. Tooth type (col. 43)

25.	not applicable
25.00	not determinable
25.01	upper deciduous (milk)
25.02	upper adult (permanent)
25.03	lower deciduous (milk)
25.04	lower adult (permanent)
25.05	upper tooth
25.06	lower tooth
25.07	deciduous (milk) tooth
25.08	adult (permanent) tooth

26. Tooth class (col. 44)

26.	not applicable
26.00	not determinable
26.01	incisor
26.02	canine
26.03	pre-molar
26.04	molar (deciduous and permanent molars)
26.05	cheek tooth (pre-molar or molar)

27. Tooth number (col. 45)

27.	not applicable
27.00	not determinable
27.01	first (=PM2 in articdactyl)
27.02	second (=PM3 in artiodactyl)
27.03	third (=PM4 in artiodactyl)
27.04	fourth
27.05	first or second
27.06	second or third
27.08	first, second, or third
27.09	second, third, or fourth

28. Tooth root (col. 46)

28.	not applicable
28.00	not determinable
28.01	open
28.02	separate but not closed, root is formed
28.03	closed
28.04	swollen
28.05	just beginning to form separate roots
28.06	probably closed on the basis of size and wear

29. Tooth wear (col. 47-48 - for I1-3, C, PM1-2, DM1-2) (for all), PM3 (for pigs and dogs), M1-3 (for dogs).

29. not applicable (in format 2, a blank in the tooth code represents the absence of that part of the mandible/maxilla where the tooth would have been found.

29.00 in format 1: indicates wear is not determinable, but tooth is present. In format 2: indicates that mandible/maxilla is present, but tooth is represented only by socket.

29.01 deciduous tooth lightly worn

29.02 deciduous tooth more than only lightly worn

29.03 permanent tooth bud present/milk tooth heavily worn or missing

29.04 permanent tooth present but wear not determinable

29.05 permanent tooth unworn/erupting

29.06 permanent tooth slightly worn, little dentyne visible)

29.07 permanent tooth moderately worn (dentyne is visible on all sides)

29.08 permanent tooth heavily worn (interior enamel is mostly eroded)

29.09 permanent tooth very heavily worn (no interior enamel visible, only dentyne)

The above listing of tooth variables are used in format 1 for incisors, canines, PM1,

PM2, and PM3, PM3 (for pigs), DM1, DM2 for all artiodactyls and pigs. dogs and all other animals use these categories for all teeth. for artiodactyl PM3, M1, M2, and M3 usedthe wear categories from Payne 1973 and Grant 1975.

59. Articulation (col. 69)

same as for articulation in format 2 (#59)

60. Storage location (col. 80)

same as for storage location in format 2 (#60)

Format 2: cranial format

30. Mandible - anterior (col. 38)

30. not applicable

30.0 fragment or missing (or portion not determinable)

30.1 incisor area

30.2 diastema area (canine - PM1)

30.3 alveolus area (PM1 - M3, sometimes includes diastema

30.4 horizontal ramus area (base only)

30.5 incisor and diastema area

30.6 incisor and diastema and alveolus

30.7 all anterior areas are represented

30.8 diastema and alveolus and horizontal ramus area

30.9 alveolus and horizontal ramus

31. Mandible - posterior (col. 39)

31. not applicable

31.0 fragment/missing (or portion not determinable)

31.1 heel area

31.2 ascending ramus area

31.3 area of articular process

31.4 coronoid process

31.5 heel + ascending ramus area

31.6 heel+ascending ramus area+articular process areas

31.7 all posterior areas represented

31.8 ascending ramus+articular process+coronoid process

31.9 ascending ramus+articular or coronoid process

32. Tooth wear - incisor 1 (see category 29 for values, col. 40)

33. Tooth wear - incisor 2 (see category 29 for values, col. 41)

34. Tooth wear - incisor 3 (see category 29 for values, col. 42)

35. Tooth wear - canine (see category 29 for values, col. 43)

36. Tooth wear - PM1 or DM1 (see category 29 for values, col. 44)
    = PM2 for ungulates

37. Tooth wear - PM2 or DM2 (see category 29 for values - col. 45)
    = PM3 for ungulates

38. Tooth wear - PM3 or DM3 (for non-ungulates see cat. 29) (col. 46 - 47) = PM4 for ungulates

39. Tooth wear - PM4 (cols. 71-72)

40. Tooth wear - M1 (col. 48 - 49)

41. Tooth wear - M2 (col. 42 - 43)

42. Tooth wear - M3 (col. 52 - 53)

The values for tooth wear PM3, M1, M2, and M3 are based upon Meadow 1975 for ovis/capra.
The values for cattle and pigs are based upon Grant 1975

Tooth eruption values for cattle and pig:

deciduous molars use same series but begin with #51.

41. presence of tooth not determinable (that portion
41.00 of jaw missing)
41.01 wear not determinable
41.02 tooth not yet erupted
41.03 perforation in crypt (jaw)
41.04 tooth visible in crypt (fully darkened)
41.05 tooth erupting through bone (partly darkened)
41.06 tooth half-erupted
41.07 tooth erupted, but not worn, full height
41.08 tooth coming into wear
41.09 socket present, tooth absent
41.10 wear stage a (Grant 1975)
41.11 wear stage b " "
41.12 wear stage c " "
41.13 wear stage d " "
41.14 wear stage e " "
41.15 wear stage f " "
41.16 wear stage g " "
41.17 wear stage h " "
41.18 wear stage i " "
41.19 wear stage j " "
41.20 wear stage k " "
41.21 wear stage l " "
41.22 wear stage m " "
41.23 wear stage n " "

41.24 wear stage c " "

41.25 wear stage p " "

41.26 loose unwcrn tcoth (never exposed, fully darkened=07)

41.27 loose worn tooth

note: for maxillary teeth, the same patterns are used as for the mandibulary teeth. except that the uM3 used a M2 pattern of wear. ovis/capra maxillary pattern is derived from Crabtree 1982.

43. Horncore <antler> - right side or side not determinable; ccl. 54)

43. not applicable

43.00 not determinable or missing

43.01 base <base to beginning of first tine>

43.02 corpus (bcdy fragment) <first tine>

43.03 tip <base + first tine>

43.04 base + corpus <fragment of column>

43.05 corpus + tip <column with tines>

43.06 some of base missing <crown>

43.07 some of corpus missing <single tine or fragments>

43.08 some of tip missing <base, first tine, and column with tines>

43.09 complete <complete or nearly complete brace of antlers>

43. Left horncore {antler} - left side (col. 55)
same as for right side

44. Parietal (col. 56)

44. not applicable or not present

44.00 side indeterminate and less than 2/3 present

44.1 2/3 or more of right side present

44.2 2/3 or more of left side present

44.3 2/3 or more of both sides present

44.4 less than 2/3 of right side present

44.5 less than 2/3 of left side present

44.6 less than 2/3 of right side present, 2/3 or more of left side present

44.7 less than 2/3 of left side present, 2/3 or more of right side present

44.8 less than 2/3 of both right and left sides present

44.9 comment

The input and output of the fcllowing are the same as for parietal

45. Interparietal (ccl. 57)

46. Occipital (col. 58)

47. Sphenoid (col. 59)

48. Pterygoid (col. 60)

49. Petrous (col. 61)

50. Temporal (col. 62)

51. Vomer (col. 63)

52. Zygomatic (col. 64)

53. Lacrimal (col. 65)

54. Nasal (col. 66)

55. Maxillary (col. 67)

56. Premaxillary (col. 68)

57. Frontal (col. 70)

59. Articulation (col. 69)

59. not applicable (e.g., for unidentifiable scrap)

59.00 comment

59.01 unless below

59.02 see succeeding specimen(s)

59.03 fused with preceding

59.04 articulated with preceding, counted together

59.05 articulated with preceding, counted separately

59.06 probably articulated with preceding

59.07 possibly articulated with preceding

59.08 probably part of preceding element

59.09 possibly part of preceding individual

60. Storage location (col. 80)

60. not applicable

60.0 unknown storage location

60.1 in species box

60.2 in scrap box

60.3 in tool box (inventoried)

60.4 in pathology box

60.5 1977 scrap to be reintegrated with rest of scrap

60.6 in problem box

60.7 in butchery box

60.8 part in scrap bag and part in species box

Format 3 - measurement format: Every five columns after column 18 represents a measurement. There are ten measurements per line. The first digit of each measurement is a modifier which indicates the accuracy of the measurement. The measurements follow von den Driesch 1975

in sequential order fcr each element that she lists. See measurement code key.

61. Modifier (cols. 18, 23, 28, 33, 38, 43, 48, 53, 58, 63)

61.1 measurement taken accurately

61.2 measurement estimated because area is damaged

61.3 measurement influenced by pathology

61.4 see comment

61.5 bone is not fused

61.6 measurement is taken on lingual side

61.7 measurement taken with string or tape measure

62. Line number (col. 80)

Since there are more than ten measurements for many bones, the measurement series continues sequentially from line to line. So, if the line number = 1 and the measurement = meas1, then it is the first measurement in the key for that particular element.

62.1 indicates that measurements 1 - 10 are on line

62.2 indicates that measurements 11-20 are present

62.3 indicates that measurements 21-30 are present

62.4 indicates that measurements 31-40 are present

62.5 indicates that measurements 41-50 are present

Measurement Code

Measurement#	Von den Dreisch
Equus cranium:	
1-50	same (excludes 22a and 24a)
Bos cranium:	
1-42	same
50	42a
43-47	same
48	length cf UM3 (measured at alveolus)
49	breadth of UM3 (measured at alveolus)
Ovis/Capra cranium:	
1-43	same
44	length cf UM3 (measured at ialveclus)
45	breadth of UM3 (measured at alveolus)
Cervus/Capreolus cranium:	
1-42	same
Sus cranium:	
1	1
2	1a
3	2
4	3
5	4
6	5

7	6
8	7
9	8
10	9
11	10
12	11
13	12
14	13
15	14
16	15
17	15a
18	16
19	17
20	18
21	19
22	20
23	21
24	22
25	23
26	24
27	25
28	26
29	27
30	27a
31	28
32	29

33	29a
34	30
35	31
36	32
37	33
38	34
39	35
40	36
49	length from prosthion to aboral border of I3

Canis cranium:

1-13	same
14	13a
15	14
16	14a
17	15
18	15a
19	16
20	17
21	18
22	18a
23	19
24	20
25	21
26	25
27-30	same

31	23
32-40	same
41	length from nasion to akrokranion
42-51	see ill. 35

Equus mandible:

1-6	same
7	6a
8	7
9	7a
10	8
11	8a
12	9
13	10
14	11
15	12
16	13
17	14
18	15
19	16
20	17
21	18
22	19
23	20

Mandible of Ruminantia (Bos/Cervus/Capreolus/Ovis/Capra):

1-9	same

10	10length
11	10breadth
12	11
13	12
14	13
15	14
16	15a
17	15b
18	15c
19	length of incisor row
Sus mandible:	
1-7	same
8	7a
9	8
10	9
11	9a
12	10breadth
26	10length
13	11
14	12
15	13
16	14
17	15
18	16a
19	16b
20	16c

21	17
22	18
23	19
24	20
25	21
26	10length
27	length from infradentale to aboral edge cf I3
28	length from aboral edge of I3 to oral edgeof P1
Canis mandible:	
1-12	same
13	13length
14	13breadth
15	14
16	15length
17	15breadth
18	16length
19	16breadth
20	17
21	18
22	19
23	20
24	21
27-33	see ill. 36
Ursus mandible:	

1-9	same
10	10length
11	10breadth
12	11length
13	11breadth
14	12length
15	12breadth
16	13length
17	13breadth
18	14
19	15
20	16
21	17
22	same as #28 for Canis (see ill. 36)
Atlas:	
1	GB
2	GL
3	BFcf
4	BFcd
5	GLF
6	LAd
7	H
Axis:	
1	LCDe
2	LAPa
3	BFcf

4	BPacd
5	BPtr
6	SBV
7	BFcd
8	H
Sacrum:	
1	GL
2	PL
3	GB
4	BFcr
5	HFcr
Scapula:	
1	HS
2	DHA
3	Ld
4	SLC
5	GLP
6	LG
7	BG
Humerus:	
1	GL
2	GL1
3	GLC
4	Bp
5	Dp
6	SD

7	Bd
8	BT
9	greatest depth of distal end dorsal-ventral) taken on medial side
10	smallest depth of shaft (dorsal ventral)
Radius:	
1	GL
2	PL
3	L1
4	BP
5	BFp
6	SD
7	CD
8	Bd
9	BFd
10	greatest proximal depth
11	greatest distal depth
12	smallest depth of diaphysis
Ulna:	
1	GL
2	LO
3	DPA
4	SDO
5	BPC
Pelvis:	

1	GL
2	LA
3	LAR
4	LS
5	SH
6	SB
7	SC
8	LFo
9	GBTc
10	GBA
11	GBTi
12	SBI
Femur:	
1	GL
2	GLC
3	Bp
4	BTr
5	DC
6	SD
7	CD
8	Bd
9	greatest depth of distal end
10	smallest breadth of diaphysis
Patella:	
1	GL
2	GB

Tibia:

1	GL
2	Ll
3	Bp
4	SD
5	CD
6	Bd
7	Dd
8	greatest depth of proximal end
9	smallest depth of diaphysis

Larger carpal bones:

1	GB

Astragalus (equids):

1	GH
2	GB
3	BFd
4	Lmt

Astragalus (articdactyls):

1	GLl
2	GLm
3	Dl
4	Dm
5	Bd

Astragalus (carnivcres and lagomorphs):

1	GL

Calcaneus:

1	GL
2	GB

Os centrotarsale:

1	GB
2	greatest depth

Metapodials (equids and ruminants):

1	GL
2	GL1
3	L1
4	Bp
5	Dp
6	SD
7	CD
8	DD
9	Bd
10	Dd
11	Bd
12	width of condyle (cf. Payne 1969)
13	width of trochlea (cf. Payne 1969)

Metapodials (Sus):

1	GL
2	LeP
3	Bp
4	B
5	Bd
6	greatest depth of proximal end

7	smallest depth of diaphysis
8	greatest depth of distal end

Metapodials (carnivores and lagomorphs):

1	GL
2	Bd

Phalanx 1 (equids):

1	GL
2	Bp
3	BFp
4	Dp
5	SD
6	Bd
7	BFd
8	smallest depth of diaphysis
9	greatest depth of distal end

Phalanx 1 (bovids and suids):

1	GLpe
2	Bp
3	SD
4	Bd
5	greatest depth of proximal end
6	smallest depth of diaphysis
7	greatest depth of distal end

Phalanx 2 (all species, except equids):

1	GL
2	Bp

3	SD
4	Bd

Phalanx 3 (ruminants and suids):

1	DLS
2	Ld
3	MBS

Appendix 2: Opovo measurements

MEASUREMENTS -- OPOVO

OBS	SITE	UNIT	BONENUM	FORMAT	CLASS	SPECIES	ELEMENT	MEAS1	MEAS2	MEAS3	MEAS4	MEAS5	MEAS6	MEAS7	MEAS8	MEAS9	MEAS10	LINENUM
1	12	0102	017	3	1	001	080	11248	10453									1
2	12	0305	003	3	1	001	095	11266			10188		10118		10097		10154	1
3	12	0305	003	3	1	001	095			10107	10108							2
4	12	0105	138	3	1	002	075			10405					10386			1
5	12	0104	163	3	1	003	020										10209	1
6	12	0104	163	3	1	003	020	10076										2
7	12	0105	087	3	1	003	020								10180			2
8	12	0304	046	3	1	003	020							10730	10506	10234	10231	1
9	12	0304	046	3	1	003	020	10087						10207	10129			2
10	12	0310	016	3	1	003	077		10107	10117	10027							2
11	12	0108	016	3	1	003	075				10102		10214	10178				1
12	12	0304	013	3	1	003	075					10136	10234	10289			10113	1
13	12	0304	052	3	1	004	001								10300	10226		5
14	12	0310	031	3	1	004	001								10309	10233		5
15	12	0103	009	3	1	004	020									10500		1
16	12	0104	161	3	1	004	020										10395	1
17	12	0104	162	3	1	004	020	10157										2
18	12	0105	092	3	1	004	020										10426	1
19	12	0105	092	3	1	004	020	10148										2
20	12	0106	079	3	1	004	020										10401	1
21	12	0106	079	3	1	004	020	10170										2
22	12	0108	028	3	1	004	020										10416	1
23	12	0108	028	3	1	004	020	10205										2
24	12	0203	015	3	1	004	020										10396	1
25	12	0203	015	3	1	004	020	10154										2

MEASUREMENTS - OPOVO

OBS	SITE	UNIT	BONENUM	FORMAT	CLASS	SPECIES	ELEMENT	MEAS1	MEAS2	MEAS3	MEAS4	MEAS5	MEAS6	MEAS7	MEAS8	MEAS9	MEAS10	LINENUM
26	12	0304	051	3	1	004	020	20160										2
27	12	0102	010	3	1	004	027				10873							1
28	12	0103	016	3	1	004	036				10540	20631	10565	10495				1
29	12	0103	017	3	1	004	036					10717	10597	20510				1
30	12	0108	010	3	1	004	036							10487				1
31	12	0203	011	3	1	004	036					10659	10598	10493				1
32	12	0310	001	3	1	004	036							10576				1
33	12	0104	123	3	1	004	038							10918	10835	10827		1
34	12	0310	002	3	1	004	038							10766	10773	10885		1
35	12	0103	020	3	1	004	039								10672	20685	20385	1
36	12	0105	128	3	1	004	039				10819	10738					10346	1
37	12	0102	020	3	1	004	057					10352						1
38	12	0103	035	3	1	004	057									10501	10315	1
39	12	0104	046	3	1	004	057				10819	10380						1
40	12	0104	051	3	1	004	057									10685	10315	1
41	12	0104	141	3	1	004	057				20631	10633	10331					1
42	12	0105	048	3	1	004	057				10648	10393						1
43	12	0105	143	3	1	004	057				10603	10358						1
44	12	0105	144	3	1	004	057				10064	10372						1
45	12	0105	148	3	1	004	057				10618	10376						1
46	12	0108	002	3	1	004	057				10714	10458						1
47	12	0102	011	3	1	004	066		10736	10688								1
48	12	0105	132	3	1	004	066		10701	10681								1
49	12	0105	132	3	1	004	066			10078								2
50	12	0106	018	3	1	004	066		10749	20592		10497						1

MEASUREMENTS - OPOVD

OBS	SITE	UNIT	BONENUM	FORMAT	CLASS	SPECIES	ELEMENT	MEAS1	MEAS2	MEAS3	MEAS4	MEAS5	MEAS6	MEAS7	MEAS8	MEAS9	MEAS10	LINENUM
76	12	0102	019	3	1	004	087	20418										1
77	12	0105	043	3	1	004	087	10538	10539									1
78	12	0105	142	3	1	004	087	10552	10540									1
79	12	0106	034	3	1	004	087	10545	10541									1
80	12	0102	021	3	1	004	095				10412							1
81	12	0102	022	3	1	004	095					10427						1
82	12	0105	053	3	1	004	095				10517	10550						1
83	12	0105	147	3	1	004	095									10572	10348	1
84	12	0105	149	3	1	004	095				10587	10560						1
85	12	0108	003	3	1	004	095								20302	10614	10380	1
86	12	0304	017	3	1	004	095								10270		10337	1
87	12	0305	002	3	1	004	095								10255	10567	10322	1
88	12	0104	060	3	1	004	122	10624	10255	10192	10242	10304	10173	10206				1
89	12	0104	145	3	1	004	124	10648										1
90	12	0105	057	3	1	004	124	10650	10302	10284	10295	10360	10190	10213				1
91	12	0105	058	3	1	004	124	10599	10311	10275	10388	10351	10200	10226				1
92	12	0105	059	3	1	004	124	10643	10339	10391	10315	10355	10212	10235				1
93	12	0107	040	3	1	004	124	10618	10291	10260	10290	10323	10180	10214				1
94	12	0108	008	3	1	004	124	10640	10334	10271	10297	10355	10289	10226				1
95	12	0103	014	3	1	005	001				20390	10256						4
96	12	0104	104	3	1	005	001				10498	10200						4
97	12	0206	052	3	1	005	001						20412					4
98	12	0102	001	3	1	005	020					10236						4
99	12	0102	002	3	1	005	020					10227						3
100	12	0102	004	3	1	005	020	10462										2

MEASUREMENTS -- OPOVO

OBS	SITE	UNIT	BONENUM	FORMAT	CLASS	SPECIES	ELEMENT	MEAS1	MEAS2	MEAS3	MEAS4	MEAS5	MEAS6	MEAS7	MEAS8	MEAS9	MEAS10	LINENUM
101	12	0105	102	3	1	005	020											1
102	12	0105	102	3	1	005	020	10686	10325									2
103	12	0105	102	3	1	005	020					10174	10180	10305				3
104	12	0105	168	3	1	005	020		10147						10440			2
105	12	0105	168	3	1	005	020						10297					3
106	12	0106	083	3	1	005	020								11255	10860		1
107	12	0106	083	3	1	005	020	10403	10473									2
108	12	0106	083	3	1	005	020						10187					3
109	12	0310	032	3	1	005	020		10140									2
110	12	0310	032	3	1	005	020						10300					3
111	12	0103	012	3	1	005	026			20790				10674				1
112	12	0106	063	3	1	005	026			10621				10591				1
113	12	0105	122	3	1	005	036					10477	10339	10247				1
114	12	0206	001	3	1	005	036				10363	10471	10370	10352				1
115	12	0105	125	3	1	005	038							10668	10414	10560	10305	1
116	12	0106	005	3	1	005	038							10543	10395	10522		1
117	12	0203	014	3	1	005	038							10477	10360			1
118	12	0105	012	3	1	005	039				10492	10284						1
119	12	0108	013	3	1	005	039				10375						20270	1
120	12	0304	003	3	1	005	039				10390	10390					80300	1
121	12	0104	130	3	1	005	040			10579		10333						1
122	12	0104	131	3	1	005	040					10310						1
123	12	0105	130	3	1	005	040			10443		10269						1
124	12	0106	015	3	1	005	040			10345	10269							1
125	12	0108	014	3	1	005	040			10500		10305						1

MEASUREMENTS - OPOVO

OBS	SITE	UNIT	BONENUM	FORMAT	CLASS	SPECIES	ELEMENT	MEAS1	MEAS2	MEAS3	MEAS4	MEAS5	MEAS6	MEAS7	MEAS8	MEAS9	MEAS10	LINENUM
126	12	0310	005	3	1	005	040					10278						1
127	12	0304	027	3	1	005	056	10748										1
128	12	0105	020	3	1	005	066		10450	10394								1
129	12	0103	029	3	1	005	076				10210		10409	10360				1
130	12	0104	025	3	1	005	076						10391	10341				1
131	12	0105	042	3	1	005	076						10390	10350				1
132	12	0104	029	3	1	005	079	10555	10500									1
133	12	0310	014	3	1	005	079	10498	10455									1
134	12	0107	050	3	1	005	092			10218			10290					1
135	12	0305	015	3	1	006	001									10158		2
136	12	0305	015	3	1	006	001			10177								3
137	12	0105	086	3	1	006	020							10671	10623	10578	10302	1
138	12	0105	086	3	1	006	020					10190						2
139	12	0105	086	3	1	006	020									10151	10185	3
140	12	0105	171	3	1	006	020							10546	10695	10447	10300	1
141	12	0105	171	3	1	006	020			10293	10078						10111	2
142	12	0105	171	3	1	006	020									10168	10198	3
143	12	0105	172	3	1	006	020			10				10704	10670	10696	10362	1
144	12	0105	172	3	1	006	020					10283					10092	2
145	12	0105	172	3	1	006	020										10160	3
146	12	0305	003	3	1	006	020	11073					10936	10644	10626	10571	10377	1
147	12	0305	003	3	1	006	020					10176						2
148	12	0305	005	3	1	006	020							11062	10217	10153	10162	3
149	12	0305	003	3	1	006	020	10760	10604	10082								4
150	12	0305	004	3	1	006	020	11054						10603	10593	10548	10286	1

MEASUREMENTS - OPOVO

OBS	SITE	UNIT	BONENUM	FORMAT	CLASS	SPECIES	ELEMENT	MEAS1	MEAS2	MEAS3	MEAS4	MEAS5	MEAS6	MEAS7	MEAS8	MEAS9	MEAS10	LINENUM
151	12	0305	004	3	1	006	020			10173	10072	10163					10085	2
152	12	0305	004	3	1	006	020								10232	10148	10162	3
153	12	0305	004	3	1	006	020	10746		10109								4
154	12	0106	066	3	1	006	027	10438		10265			10205	10157	10305			1
155	12	0104	015	3	1	006	040					10135						1
156	12	0305	008	3	1	006	040					10132						1
157	12	0103	027	3	1	006	074						10095		10230	10236	10095	1
158	12	0108	015	3	1	006	076				10122		10195	10144	10192			1
159	12	0104	171	3	1	008	001	10734										3
160	12	0106	061	3	1	008	001									11665	11425	4
161	12	0106	061	3	1	008	001	11645										5
162	12	0106	061	3	1	008	001										11410	4
163	12	0106	088	3	1	008	001		10533									3
164	12	02 7	001	3	1	008	001									71000	70935	4
165	12	02 7	001	3	1	008	001	70850										1
166	12	0103	008	3	1	008	020								10880		10487	1
167	12	0103	008	3	1	008	020	10163										2
168	12	0104	166	3	1	008	020									10510		1
169	12	0106	086	3	1	008	020										10358	1
170	12	0106	086	3	1	008	020	10156										2
171	12	0106	087	3	1	008	020		11104						10340			2
172	12	0108	025	3	1	008	020								10824		10352	1
173	12	0108	025	3	1	008	020	10159										2
174	12	0304	048	3	1	008	020									10548		1
175	12	0102	006	3	1	008	036				10415	10642	10505	10481				1

MEASUREMENTS -- OPOVO

OBS	SITE	UNIT	BONENUM	FORMAT	CLASS	SPECIES	ELEMENT	MEAS1	MEAS2	MEAS3	MEAS4	MEAS5	MEAS6	MEAS7	MEAS8	MEAS9	MEAS10	LINENUM
176	12	0105	001	3	1	008	036				10475	10721	10560	10521				1
177	12	0107	017	3	1	008	036					10667	10544	10504				1
178	12	0304	001	3	1	008	036						10458	10427				1
179	12	0104	121	3	1	008	038							10689	10600	10648		1
180	12	0104	122	3	1	008	038							10673	10606	10643		1
181	12	0105	009	3	1	008	038							10612	10550	10604		1
182	12	0206	004	3	1	008	038							10670	10602	10695		1
183	12	0206	005	3	1	008	038							10677	10602	10694		1
184	12	0209	008	3	1	008	038							10624	10536	10527		1
185	12	0104	011	3	1	008	039									10475		1
186	12	0104	011	3	1	008	039	10404										2
187	12	0104	126	3	1	008	039				10688	10637					10377	1
188	12	0104	127	3	1	008	039				10598	10572						1
189	12	0105	012	3	1	008	039								10490			1
190	12	0105	012	3	1	008	039	20350										2
191	12	0105	127	3	1	008	039				10672	10600					10342	1
192	12	0203	017	3	1	008	039								10580	10562		1
193	12	0203	017	3	1	008	039	10397										2
194	12	0206	006	3	1	008	039						10333	10520	10520			1
195	12	0206	006	3	1	008	039	10400										2
196	12	0107	035	3	1	008	051	10300										1
197	12	0102	023	3	1	008	057								20225	10585	10322	1
198	12	0103	036	3	1	008	057									10467	10279	1
199	12	0103	037	3	1	008	057									10441	10298	1
200	12	0104	050	3	1	008	057										10316	1

MEASUREMENTS -- OPOVO

OBS	SITE	UNIT	BONENUM	FORMAT	CLASS	SPECIES	ELEMENT	MEAS1	MEAS2	MEAS3	MEAS4	MEAS5	MEAS6	MEAS7	MEAS8	MEAS9	MEAS10	LINENUM
201	12	0105	145	3	1	008	057								10252	10512	10353	1
202	12	0106	044	3	1	008	057							10196	10460	10283		1
203	12	0107	036	3	1	008	057									10517	10313	1
204	12	0107	039	3	1	008	057				10464	10335						1
205	12	0109	004	3	1	008	057				10500	10365						1
206	12	0203	023	3	1	008	057								10253	10586	10315	1
207	12	0206	017	3	1	008	057				10472	10373						1
208	12	0304	020	3	1	008	057	12710			10430	10308	1	1	10200	10443	10313	1
209	12	0107	045	3	1	008	063	10448	10234	10174	10200							1
210	12	0107	046	3	1	008	063	10467	10233	10165	10910							1
211	12	0106	017	3	1	008	066		10627	10540		10394	10170					1
212	12	0304	008	3	1	008	066		10672	10530								1
213	12	0104	132	3	1	008	070						10593	10445				1
214	12	0104	020	3	1	008	074			20815		10379						1
215	12	0105	028	3	1	008	074								10778	10986		1
216	12	0103	028	3	1	008	076						10627	10463				1
217	12	0104	026	3	1	008	076						10406	10532				1
218	12	0104	133	3	1	008	076						10541	10410				1
219	12	0105	031	3	1	008	076				10377		10605	10500				1
220	12	0203	021	3	1	008	076						10516	10413				1
221	12	0304	012	3	1	008	076						10516	10405				1
222	12	0310	011	3	1	008	076						10695	10450				1
223	12	0102	016	3	1	008	079	10614	10608	10325	10373	10406						1
224	12	0104	033	3	1	008	079		10620	20413	10381							1
225	12	0104	130	3	1	008	079	10660	10616	10357	10375	10415						1

MEASUREMENTS -- OPOVO

OBS	SITE	UNIT	BONENUM	FORMAT	CLASS	SPECIES	ELEMENT	MEAS1	MEAS2	MEAS3	MEAS4	MEAS5	MEAS6	MEAS7	MEAS8	MEAS9	MEAS10	LINENUM
226	12	0105	033	3	1	008	079	10703	10659	10390	10370	10449						1
227	12	0105	034	3	1	008	079	10611	10574	10335	10368	10380						1
228	12	0106	035	3	1	008	079	10602		20321								1
229	12	02 7	002	3	1	008	079	10687	10542	10323	10321	10363						1
230	12	0310	013	3	1	008	079	10612	10572	10340	10360	10397						1
231	12	0105	037	3	1	008	080	11380	10465									1
232	12	0105	038	3	1	008	080	11380	10479									1
233	12	0107	033	3	1	008	080	11248	10400									1
234	12	0108	005	3	1	008	080		10380									1
235	12	0108	007	3	1	008	080	11290	10410									1
236	12	0209	003	3	1	008	080	11227	10390									1
237	12	0310	015	3	1	008	080		10410									1
238	12	0103	034	3	1	008	087	10524										1
239	12	0104	139	3	1	008	087	10430	10408									1
240	12	0105	044	3	1	008	087	10412	10441									1
241	12	0105	045	3	1	008	087	10373	10386									1
242	12	0105	046	3	1	008	087	10404	10382									1
243	12	0107	034	3	1	008	087	10447										1
244	12	0304	025	3	1	008	087	10423	10455									1
245	12	0103	039	3	1	008	095				10485	10458						1
246	12	0104	053	3	1	008	095				10405	10444						1
247	12	0104	053	3	1	008	095				10480							1
248	12	0106	045	3	1	008	095							10257	10499	10316		1
249	12	0107	038	3	1	008	095				10455	10473						1
250	12	0108	001	3	1	008	095				10370	10420	10232					1

MEASUREMENTS - OPOVO

OBS	SITE	UNIT	BONENUM	FORMAT	CLASS	SPECIES	ELEMENT	MEAS1	MEAS2	MEAS3	MEAS4	MEAS5	MEAS6	MEAS7	MEAS8	MEAS9	MEAS10	LINENUM
251	12	0206	016	3	1	008	095				10398	10424						1
252	12	0209	001	3	1	008	095									10470	10318	1
253	12	0104	142	3	1	008	104									10529	10340	1
254	12	0102	024	3	1	008	122	10615	10249	10202	10233	10286	10171	10199				1
255	12	0104	055	3	1	008	122	10488	10134	10200	10210	10278	10172	10190				1
256	12	0104	057	3	1	008	122	10622	10245	10215	10240	10291	10172	10201				1
257	12	0104	059	3	1	008	122	10600	10232	10168	10213	10280	10152	10176				1
258	12	0105	060	3	1	008	122	10624	10238	10200	10229	10276	10170	10195				1
259	12	0105	151	3	1	008	122	10762	10245	10212	10233	10290	10164	10190				1
260	12	0107	041	3	1	008	122	10659	10254	10212	10242	10312	10180	10217				1
261	12	0103	040	3	1	008	124	10661	10246	10195	10232	10296	10181	10208				1
262	12	0104	146	3	1	008	124	10598	10223	10170	10205	10253	10153	10186				1
263	12	0106	052	3	1	008	124	10568	10204	10179	10224	10242	10167	10181				1
264	12	0107	042	3	1	008	124	10580	10231	10185		10251	10143					1
265	12	0107	043	3	1	008	124	10615	10231	10170	10215	10286	10150	10175				1
266	12	0109	008	3	1	008	124	10591	10219	10175	10228	10271	10163	10286				1
267	12	0208	005	3	1	008	124	10648	10250	10180	10236	10292	10160	10294				1
268	12	0310	021	3	1	008	124	10591	10205	10171	10198	10256	10154	10181				1
269	12	0310	022	3	1	008	124	10641	10241	10193	10230	10291	10160	10190				1
270	12	0310	023	3	1	008	124	10660	10253	10196	10236	10300	10274	10190				1
271	12	0103	004	3	1	009	001									70800	70590	4
272	12	0103	004	3	1	009	001	70580										5
273	12	0103	006	3	1	009	001										70660	4
274	12	0104	082	3	1	009	001									70852	70570	4
275	12	0104	083	3	1	009	001									71130	70670	4

MEASUREMENTS - OPOVO

OBS	SITE	UNIT	BONENUM	FORMAT	CLASS	SPECIES	ELEMENT	MEAS1	MEAS2	MEAS3	MEAS4	MEAS5	MEAS6	MEAS7	MEAS8	MEAS9	MEAS10	LINENUM
276	12	0104	083	3	1	009	001	70700										5
277	12	0107	003	3	1	009	001									70790	70530	4
278	12	0107	003	3	1	009	001	70600										5
279	12	0103	010	3	1	009	020									10281		1
280	12	0103	010	3	1	009	020							10156				2
281	12	0105	088	3	1	009	020							10675	10391		10158	1
282	12	0105	088	3	1	009	020	10078						10159	10180			2
283	12	0105	113	3	1	009	020						10640				10156	1
284	12	0105	113	3	1	009	020	10087						10190	1			2
285	12	0105	175	3	1	009	020									10308		1
286	12	0105	175	3	1	009	020								10144			2
287	12	0203	004	3	1	009	020									10267		1
288	12	0203	004	3	1	009	020		10388					10170	10158			2
289	12	0209	012	3	1	009	020					11121	11420	10681	10290	10405	10161	1
290	12	0209	012	3	1	009	020	10085	10439				10389	10203	10196			2
291	12	0107	018	3	1	009	036				10197	10315	10210	10235				1
292	12	0206	002	3	1	009	036				10198	10321	10223	10231				1
293	12	0104	006	3	1	009	038							10295	10249	20295		1
294	12	0106	009	3	1	009	038							10293	10267	10246		1
295	12	0206	011	3	1	009	038				20315	10413						1
296	12	0304	002	3	1	009	039				10282	10264					10650	1
297	12	0304	009	3	1	009	046		10319	10267								1
298	12	0104	023	3	1	009	074			10420		10202						1
299	12	0104	154	3	1	009	076						10292	10224				1
300	12	0105	036	3	1	009	079	10300	10280	10164	10179	10290						1

MEASUREMENTS - OPOVO

OBS	SITE	UNIT	BONENUM	FORMAT	CLASS	SPECIES	ELEMENT	MEAS1	MEAS2	MEAS3	MEAS4	MEAS5	MEAS6	MEAS7	MEAS8	MEAS9	MEAS10	LINENUM
301	12	0208	008	3	1	009	079	10338	10326	10187	10197	10196						1
302	12	0209	015	3	1	009	079	10295	10282	10160	10170	10289						1
303	12	0105	041	3	1	009	080	10668	10208									1
304	12	0105	047	3	1	009	080	10651	10215									1
305	12	0203	022	3	1	009	095	12165			10221	10222	10137		10120	10214	10116	1
306	12	0105	056	3	1	011	054	10674	10073									1
307	12	0106	056	3	1	011	054	10686	10075									1

Appendix 3: Ljuljaci

Ljuljaci, near Kragujevac (site #20) (*site number - sonda number - excavation unit number)	Computer Code*
Sonda 6a, povrsini sloj, izrabi se na ? ,Box 7	20-16-99
Sonda 6a, os 1, CM 6E (9/8/76), Box 7	20-16-01
Sonda 6a, os 2, ispod kamena, CM 17e, Box 25	20-16-02
Sonda 6a, os 3, CM 56E (14/8/76), Box 31	20-16-03
Sonda 6a, os 3, izvan lepa, Box 26	20-16-33
Sonda 6b, povrsinski sloj, CM 2E, 1E, (9/8/76), Box 7	20-26-01
Sonda 6b, os 3, CM 14E (10/8/76), Box 25	20-26-03
Sonda 6b, os 4, CM 43E, 54E (12,13/8/76), Box 7	20-26-04
Sonda 6b, os 5, CM 48E (13/8/76), Box 7	20-26-05
Sonda 6b, ukop za stubove, CM 85, Box 29	20-26-98
Sonda 7, os 1, CM 16E, 21, 22E(9/8/76, 10/8/76), Box 3	20-07-01
Sonda 7, os 2, CM 67E (16/8/76), Box 31	20-07-02
Sonda 7, os 3, CM 68E (16/8/76), Box 29	20-07-03
Sonda 7, os 4, CM 75A, 62E (23,16/8/76), Box 34	20-07-04
Sonda 7, os 5, CM 89E (19/8/76) Box 3	20-07-05**
Sonda 7, os 6, CM 97E (20/8/76) Box 28	20-07-06
Sonda 7, povrsini sloj, CM 65E (16/8/76), Box 26	20-07-99
Sonda 7a, os 1, CM 23E (10/8/76), Box 7	20-37-01
Sonda 7a, os 3, CM 90E (19/8/76), Box 20	20-17-03
Sonda 7a, os 4, CM 91E (19/8/76), Box 17	20-17-04
Sonda 7b, povrsini sloj, CM 47E, Box 26	20-27-99
Sonda 7b, os 1, CM 49E (18/8/76), Box 31	
Sonda 7b, os 2, CM 74E (17/8/76), Box 24,31	20-27-02
Sonda 7b, os 3, CM 75E (17/8/76), Box 18	20-27-03
Sonda 7b, os 4, CM 92E (19/8/76), Box 5	20-27-04
(**includes some of Sonda 7a, os 4 material as well.)	
Sonda 8, os 1, CM 26E, 42E (11,20/8/76), Box 7, 31	20-08-01
Sonda 8, os 2, CM 39E (12/8/76), Box 31	20-08-02
Sonda 8, os 2, zone 2, CM 45E (13/8/77), Box 25	20-08-22
Sonda 8 or 8c?, os 2, jugoistocno profirenje, nivo podnice, CM 28 or 27A (16/8/76), Box 14	20-38-02
Sonda 8, os 3, zone 2, CM 51E, 55E (13/8/76), Box 18	20-08-23
Sonda 8, os 4, zone 1, CM 77E ( ), Box 7	20-08-04
Sonda 8, os 5, uz ?, CM 100E (21/8/76), Box 20	20-08-05
Sonda 8, os 6, CM 101E (21/8/76), Box 17	20-08-06
Sonda 8, os 5?, CM 14E, 33E (11/8/76), Box 25	20-18-05
Sonda 8, os 7, CM 109, 112 (23, 24/8/76)Box 25	20-08-07
Sonda 8, os 7, zone 2, CM111E, 109E(24,23/8/76), Box 25	20-08-27
Sonda 8-8a, ispod opt, CM 113 (24/8/76), Box 25	20-08-99
Sonda 8-8a, os 4-6, zone 2, CM99E, Box 11	20-c8-24
Sonda 8a, os 2 (17/8/76), Box 33	20-18-02
Sonda 8a, os 3, CM 70E (18/8/76), Box 25	20-18-03
Sonda 8a, os 2, istocno profirenje, CM9A (17/8/77), Box 12	20-18-32
Sonda 8a, os 3, zone 2, CM 72E (18/8/76), Box 17	20-18-23
Sonda 8a, os 4, zone 2, CM 79E (18/8/76), Box 35	20-18-24

Ljuljaci cont:

Sonda 8a, os 5, zone 1, CM 80, 86 (18,19/8/76), Box 9	20-18-05
Sonda 8a, os 5, zone 2, CM 81E (18,19/8/76), Box 9,25	20-18-25
Sonda 8a, os 6, zone 1, CM 87E, 88E (19/8/76), Box 17	20-18-16
Sonda 8b, os 3, (23/8/77), Box 34	20-28-38
Sonda 8b, os 3, u nivo i oko nivoa kucne konstrukcije, CM 67E (23/8/77), Box 19	20-28-03
Sonda 8b, os 4, CM 69A, Box 4	20-28-04
Sonda 8b, os 5, CM 78A, (24/8/77), Box 34	20-28-05
Sonda 8b, os 6, uz nivoa kuce uz severni profil (24/8/77), Box 34	20-28-06
Sonda 8c, os 3, jugoistocno profirenje, CM 13A (17/8/77), Box 14	20-38-03
Sonda 8c, os 4, zone 1, CM 70A (23/8/77), Box 12	20-38-04
Sonda 8c, os 7, CM 81, 81A (24/8/77), Box 14	20-38-07
Sonda 9, os 1, CM 25E (11/8/76), Box 7	20-09-01
Sonda 11, os 1, CM 83E (19/8/76), Box 11	20-11-01
Sonda 11, os 3, CM 94E ( ), Box 11	20-11-03
Sonda 11, os 4, CM 95E (20/8/76), Box 31	20-11-04
Sonda 11, os 5, CM 96E,104E (20,21/8/76), Box 20	20-11-05
Sonda 11, os 6, CM 105 (21/8/76), Box 26	20-11-06
Sonda 11, os 6, iz ugao, CM 107 (23/8/76), Box 25	20-11-66
Sonda 12, os 1, CM 2A (15/8/77), Box 35	20-12-01
Sonda 12, os 2, CM 5A, 20A (15,16/8/77), Box 30,33	20-12-02
Sonda 12, os 2, zone 1, CM 19 (16/8/77), Box 10	20-12-12
Sonda 12, os 3, CM 3A (17/8/77), Box 13	20-12-03
Sonda 12, os 3, zone 1, CM 4A (17/8/77), Box 27	20-12-13
Sonda 12, os 3-4, CM (/8/77), Box 16,22	20-12-34
Sonda 12, os 4, CM 6A (17/8/77), Box 33	20-12-04
Sonda 12, os 4, zone 1, CM 25A,29A (18/8/77), Box 8,6	20-12-14
Sonda 12, os 4, istocno profilog, CM 46 (20/8/77), Box 20	20-12-24
Sonda 12, os 5, zone 1, CM 34A (19/8/77), Box 10	20-12-05
Sonda 12, os 5, zone 2, CM 27A (18/8/77), Box 13	20-12-25
Sonda 12, os 6, zone 1, CM 55A (/8/77), Box 1	20-12-06
Sonda 12, os 7, CM (25/8/77), Box 23	20-12-07
Sonda 12, os 8, iz severni i zapadni profil ako nivoa kuce (uz kuce), (25/8/77), Box 32	20-12-08
Sonda 12, os 9, (26/8/77), Box 32	20-12-09
Sonda 13, os 2, CM 31A (18/8/77), Box 30,6	20-13-02
Sonda 13, os 4, zone 1, CM 38A (19/8/77) Box	20-13-04
Sonda 13, os 4, zone 2, CM 39A (19/8/77) Box 12	20-13-24
Sonda 13, os 5, zone 1, CM 55A (20/8/77), Box	20-13-05
Sonda 13, os 5, zone 2, CM 56A (20/8/77), Box 30	20-13-25
Sonda 13, os 6, zone 1, CM 57A (20/8/77), Box 6	20-13-06
Sonda 13, os 6, zone 2, CM 58A (20/8/77), Box 34	20-13-26
Sonda 13, os 7, zone 1, CM 55A (20/8/77), Box 4	20-13-27
Sonda 13, os 7, zone 2, CM 60A, 64A (20,22/8/77), Box 13	20-13-07
Sonda 13, os 8, zone 2, CM 73A, Box 1	20-13-08

Ljuljaci cont:

Sonda 14, os 2, CM 42A (19/8/77), Box 14	20-14-02
Sonda 14, os 3, CM 43A,51A (19,20/8/77), Box 8	20-14-03
Sonda 14, os 4, zone 1, CM 54A (20,23/8/77), Box 14,34	20-14-04
Sonda 14, os 4, CM 75A (23/8/77), Box 34	20-14-14
Sonda 14, os 5, CM 77A (23/8/77), Box 10	20-14-05
Sonda 14, os 5, zone 1, CM 76A (23/8/77), Box 10	20-14-05
Sonda 14, os 6, CM 88A (/8/77), Box 15	20-14-06
Sonda 14, os 7, CM 89a (24/8/77), Box 14	20-14-07
Sonda 5, os 17 (1965)	20-05-17

Number of bone fragments per excavation unit - Ljuljaci:

A -B	No.
05-17	27
07-01	84
07-02	9
07-03	138
07-04	109
07-05	51
07-06	29
07-99	7
08-01	47
08-02	4
08-04	29
08-05	19
08-06	54
08-07	18
08-22	7
08-23	123
08-24	30
08-27	14
08-99	4
09-01	6
11-01	28
11-03	33
11-04	11
11-05	35
11-06	6
11-66	4
12-01	13
12-02	47
12-03	35
12-04	6
12-05	32
12-06	118
12-07	150
12-08	50
12-09	42
12-12	10
12-13	67
12-14	58
12-24	28
12-25	25
12-34	27
13-02	86
13-04	90
13-06	21
13-07	79
13-08	50
13-24	90
13-25	10
13-26	8
13-27	45

A-B	No.
14-02	40
14-03	92
14-04	46
14-05	73
14-06	216
14-07	8
16-01	1
16-02	4
16-03	9
16-33	2
16-99	5
17-03	27
17-04	30
17-25	2
18-02	22
18-03	34
18-05	41
18-16	30
18-23	26
18-24	98
18-25	103
18-32	21
26-01	4
26-03	1
26-04	82
26-05	8
26-98	4
27-01	24
27-02	117
27-03	52
27-04	138
27-99	4
28-02	3
28-03	70
28-04	29
28-05	17
28-06	5
28-38	8
37-01	3
38-02	45
38-03	46
38-04	38
38-07	9
Total	3,772

A-Sonda number
B-Otkop sloj number
No-Number of bone fragments

MEASUREMENTS - LJULJACI SLOJ

OBS	SITE	UNIT	BONENUM	FORMAT	CLASS	SPECIES	ELEMENT	MEAS1	MEAS2	MEAS3	MEAS4	MEAS5	MEAS6	MEAS7	MEAS8	MEAS9	MEAS10	LINENUM
1	20	1406	086	3	1	005	036				10391			10361				1
2	20	1207	004	3	1	001	038						10176	10334	10315	10280	10160	1
3	20	0701	005	3	1	001	039				10310	10285					20165	1
4	20	2804	013	3	1	001	057				10192	10135						1
5	20	1405	005	3	1	001	066		10264	10227		10133	10083					1
6	20	0701	036	3	1	004	001				70480	10498	10400					1
7	20	2702	077	3	1	004	001				72210	10806	10602					1
8	20	1824	066	3	1	004	001	10725										1
9	20	1824	066	3	1	004	001								10278	10230		1
10	20	3802	017	3	1	004	001								10290	10222		1
11	20	1203	001	3	1	004	001						10920					1
12	20	1406	083	3	1	004	001				71840	10625	10493					1
13	20	1703	018	3	1	004	020								10272	10216		1
14	20	3802	016	3	1	004	020										10320	1
15	20	3802	016	3	1	004	020	10137										2
16	20	1406	087	3	1	004	020	10167										2
17	20	1406	087	3	1	004	025							11545	10984	10560	10416	1
18	20	2604	007	3	1	004	027			11121			10596					1
19	20	1207	003	3	1	004	036				10479	10622	10536	10445				1
20	20	0701	048	3	1	004	038							10686	10528	10555		1
21	20	1704	001	3	1	004	038								10917			1
22	20	2704	005	3	1	004	038							10570	10530	10547		1
23	20	1825	001	3	1	004	038							11212	11088	11060		1
24	20	1209	001	3	1	004	038							11218	11092	11070		1

MEASUREMENTS - LJULJACI SLOJ

OBS	SITE	UNIT	BONENUM	FORMAT	CLASS	SPECIES	ELEMENT	MEAS1	MEAS2	MEAS3	MEAS4	MEAS5	MEAS6	MEAS7	MEAS8	MEAS9	MEAS10	LINENUM
25	20	1209	002	3	1	004	038							10681	10633			1
26	20	1403	004	3	1	004	038							10654	10582			1
27	20	0703	016	3	1	004	039				10793	10730					10373	1
28	20	2799	001	3	1	004	039				10716	10667						1
29	20	1825	004	3	1	004	039				10780	10714						1
30	20	1206	036	3	1	004	039								10656	10622		1
31	20	1306	001	3	1	004	039								10700	10680		1
32	20	1306	001	3	1	004	039	10394										2
33	20	1308	005	3	1	004	039										10398	1
34	20	1214	018	3	1	004	040			10555		10320						1
35	20	1406	091	3	1	004	040			10620		10437						1
36	20	2704	021	3	1	004	057	11810			20475	20300	10271		10190	10555	10292	1
37	20	2805	001	3	1	004	057				10574	10340	10325					1
38	20	3807	001	3	1	004	057				10573	10331						1
39	20	1213	010	3	1	004	057	11670			10543	10325	10306		10200	10686	10290	1
40	20	1403	015	3	1	004	057					10346	10334		10217			1
41	20	1406	027	3	1	004	057				10567	10332	10318		10190			1
42	20	1406	088	3	1	004	057									10627	10296	1
43	20	1406	109	3	1	004	057				10556							1
44	20	2698	001	3	1	004	066		10663	10521								1
45	20	2704	048	3	1	004	066		10618	10460								1
46	20	1206	032	3	1	004	066		10695	10510		10420	10220					1
47	20	1306	005	3	1	004	066		10843	10610								1
48	20	0705	009	3	1	004	074								10820			1

MEASUREMENTS - LJULJACI SLOJ

OBS	SITE	UNIT	BONENUM	FORMAT	CLASS	SPECIES	ELEMENT	MEAS1	MEAS2	MEAS3	MEAS4	MEAS5	MEAS6	MEAS7	MEAS8	MEAS9	MEAS10	LINENUM
49	20	1209	023	3	1	004	074					10433						1
50	20	1406	082	3	1	004	074								10850			1
51	20	0705	010	3	1	004	076						10865	10703				1
52	20	0824	001	3	1	004	076			10857					10850			1
53	20	2803	008	3	1	004	076						10850	10640				1
54	20	1302	030	3	1	004	076						10568	10420				1
55	20	1306	007	3	1	004	076						10608	10463				1
56	20	1307	004	3	1	004	076						10565	10407				1
57	20	0823	069	3	1	004	079	10580	10544	10322	10325	10378						1
58	20	1101	001	3	1	004	079	10890	10822	10520	10525	10584						1
59	20	1214	029	3	1	004	079	10688	10555	10332	10335	10400						1
60	20	1307	005	3	1	004	079	10582	10543	10332	10236	10371						1
61	20	1406	034	3	1	004	079	10627	10554	10347	10351	10407						1
62	20	1825	020	3	1	004	080	11309	10397									1
63	20	1307	006	3	1	004	087	10553	10510									1
64	20	0701	012	3	1	004	095				10446	20415						1
65	20	1825	006	3	1	004	095	12180			10436	10433	10252		10223	10517	10280	1
66	20	1206	004	3	1	004	095	11975			10428	10428	10434		10220	10538	10295	1
67	20	1214	027	3	1	004	095				10398		10240		10220			1
68	20	1225	005	3	1	004	095				10397	10377						1
69	20	1304	012	3	1	004	095								10315	10690	10486	1
70	20	1307	007	3	1	004	095				10508	10451						1
71	20	0804	006	3	1	004	122	10483	10273	10234	10157	10277	10148	10188				1
72	20	1824	012	3	1	004	122	10775	10397	10350	10406	10493	10260	10295				1

MEASUREMENTS - LJULJACI SLOJ

OBS	SITE	UNIT	BONENUM	FORMAT	CLASS	SPECIES	ELEMENT	MEAS1	MEAS2	MEAS3	MEAS4	MEAS5	MEAS6	MEAS7	MEAS8	MEAS9	MEAS10	LINENUM
73	20	1825	033	3	1	004	122	10587	10348	10295	10332	10370	10216	10235				1
74	20	3803	002	3	1	004	122	10703	10373	10314	10358	10395	10227	10270				1
75	20	3804	015	3	1	004	122	10514		10260	10352		10166	10185				1
76	20	1207	009	3	1	004	122	10743	10423	10370	10397	10397	10263	10289				1
77	20	1208	002	3	1	004	122	10756	10424	10380	10492	10482	10270	10316				1
78	20	1209	015	3	1	004	122	10543	10284	10248		10336						1
79	20	0701	025	3	1	004	124	10745		10320	10370	10415	10222	10252				1
80	20	0704	021	3	1	004	124	10826	10426	10330	10358	10453	10235	10164				1
81	20	0804	007	3	1	004	124	10555	10257	10227		10302	10175					1
82	20	0824	004	3	1	004	124	10718	10278	10315	10338	10373	10241	10260				1
83	20	0824	003	3	1	004	124	10734	10365	10313	10350	10362	10211	10244				1
84	20	2803	016	3	1	004	124	10814	10410	10347	10420	10420	10260	10280				1
85	20	1103	005	3	1	004	124	10754	10390	10340	10345	10407	10233	10270				1
86	20	1105	002	3	1	004	124	10810	10425	10327	10400	10454						1
87	20	1214	023	3	1	004	124	10752	10463	10405	10427	10455	10264	10303				1
88	20	1405	007	3	1	004	124		10437	10382	10427		10292	10313				1
89	20	0701	026	3	1	004	125		10468									1
90	20	1307	046	3	1	005	091	10772	10114									1
91	20	0705	030	3	1	005	001									11390	11275	3
92	20	0705	030	3	1	005	001	10858	10542	10420	10461	10253						4
93	20	1704	013	3	1	005	001				10307	10286						4
94	20	2704	065	3	1	005	001				10341	10206						4
95	20	0804	021	3	1	005	001			10385								4
96	20	1805	023	3	1	005	001	10728			10370	10168						4

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OBS	SITE	UNIT	BONENUM	FORMAT	CLASS	SPECIES	ELEMENT	MEAS1	MEAS2	MEAS3	MEAS4	MEAS5	MEAS6	MEAS7	MEAS8	MEAS9	MEAS10	LINENUM
97	20	1825	048	3	1	005	001				10459	10191						4
98	20	1825	042	3	1	005	001		10488	10389								4
99	20	2803	027	3	1	005	001				10454	10194						4
100	20	3807	002	3	1	005	001		10446	10358								4
101	20	1105	012	3	1	005	001				10424	10206						4
102	20	1324	038	3	1	005	001		10524	10378			10311					4
103	20	1324	037	3	1	005	001	10784			10398	10223						4
104	20	1402	012	3	1	005	001				10444	10190						4
105	20	1304	028	3	1	005	001				10364	10203						4
106	20	1307	019	3	1	005	001						10131					4
107	20	1602	001	3	1	005	020		10198									2
108	20	1602	001	3	1	005	020						10414					3
109	20	0701	041	3	1	005	020		10143									2
110	20	0701	041	3	1	005	020						10294					3
111	20	0706	020	3	1	005	020		10170									2
112	20	0706	020	3	1	005	020						10370					3
113	20	1725	001	3	1	005	020		10194									2
114	20	1725	001	3	1	005	020						10423					3
115	20	2703	030	3	1	005	020									10711		1
116	20	2703	030	3	1	005	020		10160									2
117	20	2703	030	3	1	005	020						10346					3
118	20	0801	038	3	1	005	020		10192									2
119	20	0801	038	3	1	005	020						10476					3
120	20	0807	006	3	1	005	020		10155									2

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OBS	SITE	UNIT	BONENUM	FORMAT	CLASS	SPECIES	ELEMENT	MEAS1	MEAS2	MEAS3	MEAS4	MEAS5	MEAS6	MEAS7	MEAS8	MEAS9	MEAS10	LINENUM
121	20	0807	006	3	1	005	020						10308					3
122	20	1816	021	3	1	005	020		10202									3
123	20	1816	021	3	1	005	020						10442					3
124	20	1824	044	3	1	005	020				10585							3
125	20	1824	044	3	1	005	020					10113	10187	10180				3
126	20	1105	006	3	1	005	020		10168									3
127	20	1105	006	3	1	005	020						10345					3
128	20	1202	026	3	1	005	020					10337						3
129	20	1202	029	3	1	005	020		10185									3
130	20	1202	029	3	1	005	020						10470					3
131	20	1203	002	3	1	005	020										10612	1
132	20	1203	002	3	1	005	020	10388										1
133	20	1206	015	3	1	005	020										10755	1
134	20	1206	015	3	1	005	020	10404		10760	11214							3
135	20	1206	015	3	1	005	020	10762				10320	10420	10363				3
136	20	1206	002	3	1	005	020			10835	11220							3
137	20	1206	002	3	1	005	020	10800				10324	10438	10310				3
138	20	1206	018	3	1	005	020										10796	1
139	20	1206	018	3	1	005	020	10465		10742								3
140	20	1206	018	3	1	005	020	10787				10330	10415	10257				3
141	20	1206	048	3	1	005	020		10162									3
142	20	1206	048	3	1	005	020						10352					3
143	20	1325	008	3	1	005	020		10167									3
144	20	1325	008	3	1	005	020						10365					3

MEASUREMENTS - LJULJACI SLOJ

OBS	SITE	UNIT	BONENUM	FORMAT	CLASS	SPECIES	ELEMENT	MEAS1	MEAS2	MEAS3	MEAS4	MEAS5	MEAS6	MEAS7	MEAS8	MEAS9	MEAS10	LINENUM
145	20	1327	016	3	1	005	020			10753								2
146	20	1327	016	3	1	005	020	10254				10309	10823	10325				3
147	20	1212	001	3	1	005	020					10335	10422	10302				3
148	20	1213	041	3	1	005	020			10665								3
149	20	1213	041	3	1	005	020					10290	10415					3
150	20	1213	042	3	1	005	020				11210							3
151	20	1213	042	3	1	005	020					10366	10417	10420				3
152	20	1207	013	3	1	005	020		10293									1
153	20	1207	013	3	1	005	020						10387					2
154	20	1207	006	3	1	005	020	10896				10322						3
155	20	1207	008	3	1	005	020					10315	10403	10353				3
156	20	1209	031	3	1	005	020									10643		1
157	20	1209	031	3	1	005	020		10154									2
158	20	1209	031	3	1	005	020						10306					3
159	20	1214	011	3	1	005	020										10553	1
160	20	1214	011	3	1	005	020	10475		10400	10596							2
161	20	1214	011	3	1	005	020					10108	10210	10200				3
162	20	1214	040	3	1	005	020		10165									2
163	20	1214	040	3	1	005	020						10355					3
164	20	1224	011	3	1	005	020		10281									2
165	20	1224	011	3	1	005	020						10415					3
166	20	1234	001	3	1	005	020				11432							2
167	20	1234	001	3	1	005	020	10803				10330	10393	10377				3
168	20	1234	002	3	1	005	020				11297							3

MEASUREMENTS - LJULJACI SLOJ

OBS	SITE	UNIT	BONENUM	FORMAT	CLASS	SPECIES	ELEMENT	MEAS1	MEAS2	MEAS3	MEAS4	MEAS5	MEAS6	MEAS7	MEAS8	MEAS9	MEAS10	LINENUM
169	20	1234	002	3	1	005	020	10832				10327	10403	10375				3
170	20	1234	003	3	1	005	020	10815				20348						3
171	20	1234	005	3	1	005	020					10310	10426	10428				3
172	20	1234	004	3	1	005	020	10767				20315						3
173	20	1234	006	3	1	005	020	20863				20280		20398				3
174	20	1234	010	3	1	005	020					10352	10445	10420				3
175	20	1234	011	3	1	005	020			10800								3
176	20	1234	011	3	1	005	020					10321	10375	10350				3
177	20	1234	012	3	1	005	020			10780								3
178	20	1234	012	3	1	005	020					10320	10397	10398				3
179	20	1234	013	3	1	005	020					10320						3
180	20	1234	014	3	1	005	020					10325	10390	10371				3
181	20	1304	027	3	1	005	020		10177									3
182	20	1304	027	3	1	005	020						10366					3
183	20	1306	016	3	1	005	020		11360									3
184	20	1306	016	3	1	005	020					10312		10391				3
185	20	1403	036	3	1	005	020		10210									3
186	20	1403	036	3	1	005	020						10475					3
187	20	1406	092	3	1	005	020		10279									3
188	20	1324	035	3	1	005	026							10450				1
189	20	2704	001	3	1	005	036				10261							1
190	20	1209	004	3	1	005	036				10352	10520	10418	10374				1
191	20	1601	001	3	1	005	038							10448	10554	20515		1
192	20	1704	005	3	1	005	038							10617	10493	10570		1

MEASUREMENTS - LJULJACI SLOJ

OBS	SITE	UNIT	BONENUM	FORMAT	CLASS	SPECIES	ELEMENT	MEAS1	MEAS2	MEAS3	MEAS4	MEAS5	MEAS6	MEAS7	MEAS8	MEAS9	MEAS10	LINENUM
193	20	2701	004	3	1	005	038							10588	10474	10566		1
194	20	2702	004	3	1	005	038							10542	10457			1
195	20	0823	002	3	1	005	038							10550	10450	10548		1
196	20	1104	001	3	1	005	038								10455			1
197	20	1202	003	3	1	005	038							10423	10360	10411		1
198	20	1213	003	3	1	005	038						10230	10522	10429	10535		1
199	20	0701	017	3	1	005	039				10418	10418					10310	1
200	20	0703	009	3	1	005	039				10415						20287	1
201	20	0703	006	3	1	005	039				10415						10292	1
202	20	0703	004	3	1	005	039								10455			1
203	20	0703	004	3	1	005	039	10331										2
204	20	2701	002	3	1	005	039				10415							1
205	20	0823	009	3	1	005	039				10390						10264	1
206	20	0823	006	3	1	005	039				10420						10290	1
207	20	1825	007	3	1	005	039				10427						20324	1
208	20	2803	005	3	1	005	039				10413						10285	1
209	20	3803	003	3	1	005	039				10421						10290	1
210	20	1202	014	3	1	005	039				10295						10216	1
211	20	1202	001	3	1	005	039				10425		10260				10283	1
212	20	1205	002	3	1	005	039								10366	10333		1
213	20	1205	002	3	1	005	039	10271										2
214	20	1206	029	3	1	005	039				10318	10318					10210	1
215	20	1212	003	3	1	005	039				10307						10214	1
216	20	1402	002	3	1	005	039				10383						10256	1

MEASUREMENTS - LJULJACI SLOJ

OBS	SITE	UNIT	BONENUM	FORMAT	CLASS	SPECIES	ELEMENT	MEAS1	MEAS2	MEAS3	MEAS4	MEAS5	MEAS6	MEAS7	MEAS8	MEAS9	MEAS10	LINENUM
217	20	1208	003	3	1	005	039								10464	10382		1
218	20	1208	003	3	1	005	039	10320										2
219	20	1224	005	3	1	005	039										10290	1
220	20	1224	006	3	1	005	039				10330						10232	1
221	20	1307	029	3	1	005	039				10436						10313	1
222	20	1403	049	3	1	005	039				10431						10288	1
223	20	1405	002	3	1	005	039				10303						10202	1
224	20	2604	010	3	1	005	040			10555		10341						1
225	20	2702	009	3	1	005	040			10484		10228						1
226	20	0822	003	3	1	005	040					10298						1
227	20	0823	001	3	1	005	040			10494		10307						1
228	20	1802	002	3	1	005	040			10590		10296						1
229	20	1825	008	3	1	005	040			10549		10285						1
230	20	3803	005	3	1	005	040					10230						1
231	20	1203	006	3	1	005	040					10293						1
232	20	1206	005	3	1	005	040			10522		10305						1
233	20	1206	008	3	1	005	040					10206						1
234	20	1206	026	3	1	005	040					10266						1
235	20	1213	009	3	1	005	040			10685		10312						1
236	20	1224	003	3	1	005	040			10440		10228						1
237	20	1224	004	3	1	005	040			10524		10280						1
238	20	1307	030	3	1	005	040					10325						1
239	20	1405	003	3	1	005	040					10224						1
240	20	2604	035	3	1	005	053	10748	10138									1

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OBS	SITE	UNIT	BONENUM	FORMAT	CLASS	SPECIES	ELEMENT	MEAS1	MEAS2	MEAS3	MEAS4	MEAS5	MEAS6	MEAS7	MEAS8	MEAS9	MEAS10	LINENUM
241	20	0823	095	3	1	005	053	10750	10137									1
242	20	1327	007	3	1	005	053	10808										1
243	20	1403	023	3	1	005	053	10763										1
244	20	1404	003	3	1	005	053	10720	10223									1
245	20	2604	009	3	1	005	054	11009		10277	10207	10273	10250	10160	10227			1
246	20	0704	002	3	1	005	054	10212	10176	10219	10226	10150	10205					1
247	20	2702	034	3	1	005	054	10967	10251	10190	10238	10240	10140	10205				1
248	20	2702	038	3	1	005	054		10227			10250						1
249	20	1324	029	3	1	005	054	10788		10180	10148		10195	10150				1
250	20	1207	076	3	1	005	054			10188			10186					1
251	20	1203	011	3	1	005	055			10228			10233					1
252	20	1213	039	3	1	005	055	10235	10200	10222								1
253	20	1207	075	3	1	005	055			10219			10236					1
254	20	2604	034	3	1	005	056	10670	10153									1
255	20	1404	036	3	1	005	056	10768	10162									1
256	20	2703	024	3	1	005	066		10522	10425								1
257	20	1825	046	3	1	005	066		10530	10460								1
258	20	1206	019	3	1	005	066		10345	10285								1
259	20	1306	004	3	1	005	066		10496	10414								1
260	20	0703	059	3	1	005	075	10436	10327									1
261	20	0703	056	3	1	005	075	10468	10330									1
262	20	1324	028	3	1	005	075	20489	10344									1
263	20	2604	017	3	1	005	076						10385	10356				1
264	20	0701	054	3	1	005	076				10206		10378	10336		10203		1

MEASUREMENTS - LJULJACI SLOJ

OBS	SITE	UNIT	BONENUM	FORMAT	CLASS	SPECIES	ELEMENT	MEAS1	MEAS2	MEAS3	MEAS4	MEAS5	MEAS6	MEAS7	MEAS8	MEAS9	MEAS10	LINENUM
265	20	0703	061	3	1	005	076						10352	10303				1
266	20	0704	007	3	1	005	076						10410	10353				1
267	20	0706	005	3	1	005	076						10430	10366				1
268	20	0805	003	3	1	005	076						10433	10376				1
269	20	0806	004	3	1	005	076						10300	10283		10198		1
270	20	1803	008	3	1	005	076						10490	10350				1
271	20	1816	003	3	1	005	076						10415	10356				1
272	20	1825	002	3	1	005	076						10392	10346				1
273	20	3802	005	3	1	005	076						10420	10474				1
274	20	1105	011	3	1	005	076						10396	10345				1
275	20	1206	021	3	1	005	076					10252	10377	10303	10084			1
276	20	1208	024	3	1	005	076				10245		10364	10320		10185		1
277	20	1214	004	3	1	005	076						10413	10380				1
278	20	1304	008	3	1	005	076						10415	10367				1
279	20	1304	007	3	1	005	076						10425	10372				1
280	20	0701	015	3	1	005	079	10642	10475									1
281	20	0701	055	3	1	005	079	10538	10483									1
282	20	0704	024	3	1	005	079	10488	10442									1
283	20	0704	026	3	1	005	079	10558	10496									1
284	20	1825	015	3	1	005	079	10566	10503									1
285	20	3802	001	3	1	005	079	10540	10476									1
286	20	1206	009	3	1	005	079	10538	10472									1
287	20	1214	005	3	1	005	079	10490	10453									1
288	20	1302	009	3	1	005	079	10425	10385									1

MEASUREMENTS - LJULJACI SLOJ

OBS	SITE	UNIT	BONENUM	FORMAT	CLASS	SPECIES	ELEMENT	MEAS1	MEAS2	MEAS3	MEAS4	MEAS5	MEAS6	MEAS7	MEAS8	MEAS9	MEAS10	LINENUM
289	20	1404	025	3	1	005	079	10550	10483									1
290	20	0703	050	3	1	005	080	10972	10289									1
291	20	0703	031	3	1	005	080	11015	10296									1
292	20	1704	002	3	1	005	080	11099										1
293	20	1823	007	3	1	005	080	10956										1
294	20	1824	008	3	1	005	080	11192	10302									1
295	20	1324	013	3	1	005	080	11079	10297									1
296	20	1403	012	3	1	005	080	11087	10280									1
297	20	2604	039	3	1	005	094	20850	10138									1
298	20	2604	037	3	1	005	094	10206	10167									1
299	20	0823	099	3	1	005	094	10893	10132									1
300	20	0706	024	3	1	005	114		10226									1
301	20	0706	024	3	1	005	114						10428					2
302	20	2703	014	3	1	005	124	10746	10350	10300	10326	10485	10213	10257				3
303	20	1326	007	3	1	006	001	10171										1
304	20	1326	007	3	1	006	001									10187		3
305	20	1308	023	3	1	006	001	11785	11576					10820	10645	10905	10500	1
306	20	1308	023	3	1	006	001			10827	10290	10563	10155	10426	10582			2
307	20	1308	023	3	1	006	001	10167	10070	10162				10190	10143			3
308	20	1308	023	3	1	006	001	10620									10250	4
309	20	1308	023	3	1	006	001	11065	10366	10705	10774	10655	10825	10090	10130	10240	10340	5
310	20	2604	020	3	1	006	020	10378	10330	10212	10086							2
311	20	0704	038	3	1	006	020										10322	1
312	20	0704	038	3	1	006	020					10190						2

MEASUREMENTS - LJULJACI SLOJ

OBS	SITE	UNIT	BONENUM	FORMAT	CLASS	SPECIES	ELEMENT	MEAS1	MEAS2	MEAS3	MEAS4	MEAS5	MEAS6	MEAS7	MEAS8	MEAS9	MEAS10	LINENUM
313	20	2702	067	3	1	006	020							10755	10702	10665	10333	1
314	20	2702	067	3	1	006	020	10378	10334	10203		10202						2
315	20	2702	067	3	1	006	020										10204	3
316	20	2703	032	3	1	006	020							10750	10673	10624	10375	1
317	20	2703	032	3	1	006	020	10300	10252			10208						2
318	20	2703	032	3	1	006	020									10185	10192	3
319	20	2704	053	3	1	006	020										10344	1
320	20	2704	053	3	1	006	020			10206	10083	10208						2
321	20	1324	043	3	1	006	020			10207	10083							2
322	20	1306	018	3	1	006	020										10335	1
323	20	1306	018	3	1	006	020					10187						2
324	20	1306	018	3	1	006	020										10223	3
325	20	1308	024	3	1	006	020							10784			10320	1
326	20	1308	024	3	1	006	020			10190	10075	10180						2
327	20	1308	024	3	1	006	020									10174	10243	3
328	20	1308	024	3	1	006	020			10144								4
329	20	1403	050	3	1	006	020										10338	1
330	20	1403	050	3	1	006	020			10216	10087							2
331	20	1405	017	3	1	006	027	10482		10297			10215	10184	20353			1
332	20	0823	054	3	1	006	036				10235	10395	10252	10176				1
333	20	1802	012	3	1	006	036					10288	10250	10197				1
334	20	1824	031	3	1	006	040		10148	10214	10173	10140						1
335	20	1825	035	3	1	006	074			10382	10175	20165						1
336	20	0703	023	3	1	007	038							10703	10694			1

MEASUREMENTS - LJULJACI SLOJ

OBS	SITE	UNIT	BONENUM	FORMAT	CLASS	SPECIES	ELEMENT	MEAS1	MEAS2	MEAS3	MEAS4	MEAS5	MEAS6	MEAS7	MEAS8	MEAS9	MEAS10	LINENUM
337	20	2704	006	3	1	007	038								10727			1
338	20	1207	002	3	1	007	038							10760	10708	10791		1
339	20	0701	004	3	1	007	039								10733			1
340	20	0703	001	3	1	007	040			10663		10537						1
341	20	1206	033	3	1	007	057	12080			10470	10312	10320		10208	10474	10345	1
342	20	2704	015	3	1	007	076							10407				1
343	20	1214	030	3	1	007	076						10809	10492				1
344	20	0703	025	3	1	007	079	10630	10591	10536	10648							1
345	20	1405	043	3	1	007	079	10612	10645	10577	10608							1
346	20	0701	013	3	1	007	095	12530			10535	10460	10236		10260	10524	10340	1
347	20	1206	080	3	1	008	001	10700										3
348	20	2703	035	3	1	008	020										10331	1
349	20	2703	035	3	1	008	020	10150										2
350	20	1403	047	3	1	008	020	10155										2
351	20	1832	001	3	1	008	036				10358	10601	10492	10395				1
352	20	2803	002	3	1	008	036				10452			10510				1
353	20	2803	003	3	1	008	036				10362	10606	10450	10410				1
354	20	1405	028	3	1	008	036					10670	10521	10488				1
355	20	1406	093	3	1	008	036							10445				1
356	20	1824	027	3	1	008	038							10648	10575	10650		1
357	20	1824	025	3	1	008	038							10620	10574	10614		1
358	20	1201	001	3	1	008	038							10623	10555			1
359	20	2604	002	3	1	008	039								10540	10529		1
360	20	2604	002	3	1	008	039	10363										2

MEASUREMENTS - LJULJACI SLOJ

OBS	SITE	UNIT	BOMENUM	FORMAT	CLASS	SPECIES	ELEMENT	MEAS1	MEAS2	MEAS3	MEAS4	MEAS5	MEAS6	MEAS7	MEAS8	MEAS9	MEAS10	LINENUM
361	20	0703	003	3	1	008	039				10582	10556					10311	1
362	20	2702	011	3	1	008	039				10643	10603					10332	1
363	20	2703	003	3	1	008	039								10580	10566		1
364	20	2703	003	3	1	008	039	10412										2
365	20	2704	011	3	1	008	039				10561	10530						1
366	20	1823	001	3	1	008	039				10596	10559					10338	1
367	20	1824	016	3	1	008	039				10636	10574					10346	1
368	20	1824	017	3	1	008	039				10653	10613					10366	1
369	20	1824	019	3	1	008	039				10635	10607					10347	1
370	20	3802	007	3	1	008	039								10580	10529		1
371	20	1324	003	3	1	008	039				10602	10554					10327	1
372	20	1309	003	3	1	008	039								10531	10505		1
373	20	1308	003	3	1	008	039	10384										2
374	20	1406	010	3	1	008	039				10616	10574					10324	1
375	20	0703	002	3	1	008	040		10705	10504	10473	10297						1
376	20	0823	056	3	1	008	040				10328							1
377	20	1823	002	3	1	008	040					10238						1
378	20	1824	015	3	1	008	040		10861	10613	10542	10370						1
379	20	1824	018	3	1	008	040					10345						1
380	20	0703	039	3	1	008	057								10235	10495	10312	1
381	20	0705	017	3	1	008	057									10481	10317	1
382	20	0823	067	3	1	008	057									10480	10294	1
383	20	1824	004	3	1	008	057								10226	10483	10316	1
384	20	3802	003	3	1	008	057									10424	10280	1

MEASUREMENTS - LJULJACI SLOJ

OBS	SITE	UNIT	BONENUM	FORMAT	CLASS	SPECIES	ELEMENT	MEAS1	MEAS2	MEAS3	MEAS4	MEAS5	MEAS6	MEAS7	MEAS8	MEAS9	MEAS10	LINENUM
385	20	1101	008	3	1	008	057									10489	10209	1
386	20	1208	001	3	1	008	057									10434	10296	1
387	20	1406	030	3	1	008	057									10466	10318	1
388	20	1406	031	3	1	008	057									10588	10315	1
389	20	2702	048	3	1	008	066		10623	10552								1
390	20	1802	001	3	1	008	066		10643	10524								1
391	20	2702	023	3	1	008	074								10648			1
392	20	2702	031	3	1	008	076						10546	10421				1
393	20	1825	014	3	1	008	076						10520	10372				1
394	20	3803	001	3	1	008	076						10547	10414				1
395	20	1104	002	3	1	008	076						10516	10394				1
396	20	1202	002	3	1	008	076						10593	10410				1
397	20	1324	010	3	1	008	076			10673					10623			1
398	20	0705	014	3	1	008	079	10601	10570	10336	10340	10380						1
399	20	0705	013	3	1	008	079	10581	10545	10316	10321	10349						1
400	20	2702	028	3	1	008	079	10608	10560	10328	10340	10384						1
401	20	2702	020	3	1	008	079	10627	10584	10342	10358	10400						1
402	20	1824	013	3	1	008	079	10605	10568	10345	10352	10365						1
403	20	1106	001	3	1	008	079	10684		10342		10400						1
404	20	1206	012	3	1	008	079	10592	10550	10305	10335	10355						1
405	20	1304	011	3	1	008	079	10634	10590	10350	10365	10390						1
406	20	1703	001	3	1	008	080	11325	10410									1
407	20	1824	002	3	1	008	080	11180	10350									1
408	20	1824	014	3	1	008	087	10419	10412									1

MEASUREMENTS - LJULJACI SLOJ

OBS	SITE	UNIT	BONENUM	FORMAT	CLASS	SPECIES	ELEMENT	MEAS1	MEAS2	MEAS3	MEAS4	MEAS5	MEAS6	MEAS7	MEAS8	MEAS9	MEAS10	LINENUM
409	20	2702	003	3	1	008	095								10248	10487	10295	1
410	20	0805	001	3	1	008	095									10406	10280	1
411	20	1206	013	3	1	008	095								10244	10476	10300	1
412	20	1307	009	3	1	008	095									10426	10272	1
413	20	1406	078	3	1	008	095								10236	10488	10307	1
414	20	2704	034	3	1	008	122											1
415	20	1824	006	3	1	008	122	10560	10224	10181	10255	10277	10167	10187				1
416	20	1213	014	3	1	008	122	10587	10235	10194	10224	10282	10161	10187				1
417	20	1225	002	3	1	008	122	10602	10245	10180	10224	10300	10257	10182				1
418	20	2704	033	3	1	008	124	10447	10212	10164	10195	10254	10147	10158				1
419	20	0804	005	3	1	008	124	10633	10241	10186	10224	10286	10170	10198				1
420	20	1214	007	3	1	008	124	10647	10240	10200	10223	10317	10160	10173				1
421	20	0701	035	3	1	009	001										70820	4
422	20	0701	035	3	1	009	001	70880										5
423	20	1703	005	3	1	009	020									10290		1
424	20	2698	002	3	1	009	057								10092	10220	10148	1
425	20	1406	045	3	1	009	076				10162		10272	10206		10133		1
426	20	1405	021	3	1	014	001									10533		2
427	20	0802	001	3	1	014	020	10720										3
428	20	1405	020	3	1	014	020								10666			3
429	20	1326	001	3	1	014	038							10840	10607	10544		1
430	20	0703	092	3	1	014	055	10931	10214									1
431	20	1825	032	3	1	014	092	10756	10167									1
432	20	0701	019	3	1	014	093	10807	10213									1

MEASUREMENTS - LJULJACI SLOJ

OBS	SITE	UNIT	BONENUM	FORMAT	CLASS	SPECIES	ELEMENT	MEAS1	MEAS2	MEAS3	MEAS4	MEAS5	MEAS6	MEAS7	MEAS8	MEAS9	MEAS10	LINENUM
433	20	0703	015	3	1	015	039				10124						10085	1
434	20	0824	005	3	1	016	020							10448	10442		10244	1
435	20	0824	005	3	1	016	020			10178	10075							2
436	20	0824	005	3	1	016	020										10172	3

APPENDIX 4: LIVADE UNIT CODE AND MEASUREMENTS

Livade: Unit Code

Livade, Mala Vrbica - 1980

Code	No. Frags.	Description
100100	64	sonda 1, entire trench except jama 1, 2a and 2b
100101	6	sonda 1, objekat (jama-pit) 1
100102	16	sonda 1, objekat (jama-pit 2a) 3
100103	34	sonda 1, objekat (jama-pit 2b) 3 (pits 2a lies within 2b, but the material was not well separated. They belong to the same temporal ceramic horizon.)
100200	103	sonda 2, entire trench, except jama 1
100201	4	sonda 2, jama 1
100300	52	sonda 3, entire trench except for jama i otkop sloj 1 and 2
100301	15	sonda 3, o.s. (= otkop sloj) 1 i 2
100302	7	sonda 3, jama iz profila
100400	154	sonda 4, entire trench
100500	86	sonda 5, jama 1
100600	46	sonda 6, entire trench except jama 1
100601	9	sonda 6, jama 1

100602		sonda 6, jama 1
100603		sonda 6, jama 1
100701	13	sonda 7, entire trench
100900	133	sonda 9, entire trench except jama 1
100901	13	sonda 9, jama 1
101200	42	sonda 12, entire trench except jama 1
101291	10	sonda 12, jama 1

Livade, Mala Vrbica - 1981

101101	7	sonda A1, cs I
101102	24	sonda A1, cs II
101103	13	sonda A1, cs III
101104	11	sonda A1, cs 4
101105	17	sonda A1, cs 5
101199	3	sonda A1, A2, B1, B2 - sloj nivelacije
101201	5	sonda A2, cs I
101202	18	sonda A2, cs II
101203	21	sonda A2, cs III
101204	50	sonda A2, cs 4
101205	??	sonda A2, cs 5
101206	4	sonda A2, cs VI
1012 1	27	sonda A2, cs V, jama 1
1012 2	17	sonda A2, cs 4 i 5 jama 2
101401	9	sonda A4, cs 1
101402	42	sonda A4, cs 2
101403	30	sonda A4, cs 3
101404	18	sonda A4, cs 4

101405	15	sonda A4, cs 5
101406	1	sonda A4, cs 6
101499	3	sonda A4, A5, B4, B5 - sloj nivelacije
101501	1	sonda A5, cs 1
101502	28	sonda A5, cs 2
101503	46	sonda A5, os 3
101504	38	sonda A5, cs 4
101505	37	sonda A5, cs 5
101506	3	sonda A5, os 6
102101	12	sonda B1, cs 1
102102	53	sonda B1, cs 2
102103	61	sonda B1, os 3
102104	42	sonda B1, cs 4
102105	4	sonda B1, cs 5
102106	28	sonda B1, os 5 i 6, jama
102201	4	sonda B2, cs 1
102202	24	sonda B2, cs 2
102203	23	sonda B2, os 3
102204	15	sonda B2, cs 4
102205	4	sonda B2, cs 5
102206	43	sonda B2, cs 5 i 6, jama
102401	4	sonda B4, cs 1
102402	33	sonda B4, cs 2
102403	22	sonda B4, os 3
102404	29	sonda B4, cs 4
102405	9	sonda B4, cs 5, bez objekat

102406	2	sonda B4, cs 6
102501	0	sonda B5, cs 1 (no bones)
102502	15	sonda B5, cs 2
102503	26	sonda B5, cs 3
102504	11	sonda B5, cs 4
102505	27	sonda B5, cs 5
104101	7	sonda D1, cs 1
104102	13	sonda D1, cs 2
104103	21	sonda D1, cs 3
104104	19	sonda D1, cs 4
104105	??	sonda D1, cs 5
1041 4	8	koncentracija u D1 i E1, os 4
104199	4	sonda D1, D2, E1, E2 - sloj nivelacije
104201	30	sonda D2, os 1
104202	??	sonda D2, cs 2
104203	37	sonda D2, cs 3
104204	37	sonda D2, os 4
104204	11	sonda D2, cs 5
1042 4	92	sonda D2, cs 4, koncentracija školke od t1E2, 1.10 m.
104401	4	sonda D4, cs 1
104402	12	sonda D4, cs 2
104403	0	sonda D4, os 3, no bones
104404	10	sonda D4, cs 4
104499	10	sonda D4, D5, E4, E5 - sloj nivelacije
104501	2	sonda D5, cs 1

104502	5	sonda D5, os 2
104503	26	sonda D5, os 3
104504	28	sonda D5, os 4
104505	20	sonda D5, os 5
105101	9	sonda E1, os 1
105102	4	sonda E1, os 2
105103	25	sonda E1, os 3
105104	11	sonda E1, os 4, 5, i 6 - koncentracije lepa bliza kontrolnom stubu
105105	13	sonda E1 i E2, os 5 i 6 - jama uz istočnom profil
105106	9	sonda E1, os 4, 5 i 6 - objekat sa lepom blizi istočnom profil
105201	5	sonda E2, os 1
105202	6	sonda E2, os 2
105203	39	sonda E2, os 3
105204	??	sonda E2, os 4
105205	14	sonda E2, os 5
1052 4	??	sonda E2, os 4 - iz grupacije uz jugoistočne ugao
105401	3	sonda E4, os 1
105402	10	sonda E4, os 2
105403	0	sonda E4, os 3, no bones
105404	19	sonda E4, os 4
105501	4	sonda E5, os 1
105502	16	sonda E5, os 2

105503	15	sonda E5, cs 3
105504	8	sonda E5, cs 4
105505	8	sonda E5, cs 5
1055 5	8	sonda E5, cs 4 i 5, objekat sa lepom

MEASUREMENTS - LIVADE OTKOP SLOJ

OBS	SITE	UNIT	SONENUM	FORMAT	CLASS	SPECIES	ELEMENT	MEAS1	MEAS2	MEAS3	MEAS4	MEAS5	MEAS6	MEAS7	MEAS8	MEAS9	MEAS10	LINENUM
1	10	1504	012	3	1	001	001	10398	10280									5
2	10	0300	012	3	1	001	036				10180							1
3	10	1501	001	3	1	001	038							10293	10267	10240		1
4	10	4504	012	3	1	001	038						10257	10245	10211			1
5	10	5502	004	3	1	001	039				10306	10286						1
6	10	1404	009	3	1	001	057				10220	10160	10137					1
7	10	4504	004	3	1	001	057	11067			10209	10148	10114		10081	10232	10146	1
8	10	4102	002	3	1	001	095				10186	10182	10108					1
9	10	0300	009	3	1	002	039				10323						10170	1
10	10	2502	003	3	1	002	039				10284	10277						1
11	10	0200	035	3	1	002	057								10079	10221	10146	1
12	10	0200	035	3	1	002	057		10102	10100	10028							1
13	10	0701	001	3	1	003	020							10654	10453	10305	10228	2
14	10	0701	001	3	1	003	020	10085	20681				10313	10235	10182			1
15	10	0900	061	3	1	003	020										10232	2
16	10	0900	061	3	1	003	030	10090										1
17	10	0200	041	3	1	003	030									10245		2
18	10	0200	041	3	1	003	030							10220	10170			1
19	10	0400	018	3	1	003	030									10270		2
20	10	0400	018	3	1	003	030							10233	10185			1
21	10	0400	078	3	1	003	030							20728	10502	20220	10233	2
22	10	0400	078	3	1	003	070	10081						10225	20160			1
23	10	0400	017	3	1	003	076				10186		10263	10205				2
24	10	0301	002	3	1	004	001										11251	2

MEASUREMENTS - LIVADE OTKOP SLOJ

OBS	SITE	UNIT	BONENUM	FORMAT	CLASS	SPECIES	ELEMENT	MEAS1	MEAS2	MEAS3	MEAS4	MEAS5	MEAS6	MEAS7	MEAS8	MEAS9	MEAS10	LINENUM
25	10	0301	002	3	1	004	001	10765	10522									3
26	10	0301	002	3	1	004	001								10293	10200		5
27	10	2204	004	3	1	004	001								10285	10217		5
28	10	2505	018	3	1	004	001								10281	10202		5
29	10	4203	004	3	1	004	001	10756										3
30	10	4203	004	3	1	004	001								10283	10196		5
31	10	0900	059	3	1	004	020								10820		20350	1
32	10	0200	045	3	1	004	020										10320	1
33	10	0200	045	3	1	004	020	10152										2
34	10	1402	029	3	1	004	020								10790		10340	1
35	10	1402	029	3	1	004	020	10152						10482				2
36	10	1503	001	3	1	004	020									10495		1
37	10	1503	001	3	1	004	020								10348			2
38	10	2404	004	3	1	004	020										10434	1
39	10	2404	004	3	1	004	020	10218										2
40	10	2503	016	3	1	004	020								10830		10362	1
41	10	2503	016	3	1	004	020	10145										2
42	10	4204	015	3	1	004	020										10355	1
43	10	4204	015	3	1	004	020	10160										2
44	10	4504	019	3	1	004	020										10342	1
45	10	4504	019	3	1	004	020	10232										2
46	10	0200	015	3	1	004	026									10132	10168	3
47	10	0400	039	3	1	004	036				20462							1
48	10	0400	040	3	1	004	036				10349							1

MEASUREMENTS - LIVADE OTKOP SLOJ

OBS	SITE	UNIT	BONENUM	FORMAT	CLASS	SPECIES	ELEMENT	MEAS1	MEAS2	MEAS3	MEAS4	MEAS5	MEAS6	MEAS7	MEAS8	MEAS9	MEAS10	LINENUM
49	10	0400	045	3	1	004	038				10474							1
50	10	0200	008	3	1	004	036				10331							1
51	10	4103	015	3	1	004	038									11130		1
52	10	1200	003	3	1	004	039			10775						10325		1
53	10	1200	004	3	1	004	039									10425		1
54	10	0100	009	3	1	004	039				10835						10453	1
55	10	1505	004	3	1	004	039				10669	10619					10350	1
56	10	2203	001	3	1	004	039				10774	10693					10395	1
57	10	2203	002	3	1	004	039				10793	10737						1
58	10	2206	011	3	1	004	039						10425		10763	10776	10436	1
59	10	2206	011	3	1	004	039	10470	10250									2
60	10	2405	001	3	1	004	039				10841	10782					10442	1
61	10	0300	008	3	1	004	040		10816	10682	10445	10381						1
62	10	2203	003	3	1	004	040					10632						1
63	10	0400	002	3	1	004	057						20360		10239	10680	10343	1
64	10	0400	004	3	1	004	057				10559	10349						1
65	10	0400	003	3	1	004	057					10300	10272		10201			1
66	10	0300	010	3	1	004	057						10341		10197			1
67	10	2103	020	3	1	004	057				10540		10367		10220	10660	10340	1
68	10	0300	014	3	1	004	068		10625	10662	10438	10184						1
69	10	2404	002	3	1	004	068		10791									1
70	10	2103	006	3	1	004	074			10396	10427	10376						1
71	10	2103	002	3	1	004	074					10596						1
72	10	0900	037	3	1	004	075						10460	10364				1

MEASUREMENTS - LIVADE OTKOP SLOJ

OBS	SITE	UNIT	BOMENUM	FORMAT	CLASS	SPECIES	ELEMENT	MEAS1	MEAS2	MEAS3	MEAS4	MEAS5	MEAS6	MEAS7	MEAS8	MEAS9	MEAS10	LINENUM
73	10	0300	002	3	1	004	076				10255		10644	10500		10390		1
74	10	0600	007	3	1	004	076						10580	10400				1
75	10	1202	003	3	1	004	076						10624	10500				1
76	10	1404	003	3	1	004	076					10348	10567	10431				1
77	10	1506	001	3	1	004	076						10764	10540				1
78	10	2102	001	3	1	004	076				10304		10520	10363				1
79	10	2404	001	3	1	004	076					10334	10535	10494				1
80	10	2502	001	3	1	004	076						10533	10398				1
81	10	4505	012	3	1	004	076					10380	20585	10433	10213			1
82	10	5404	001	3	1	004	076				10398		10618	10467		10277		1
83	10	0900	001	3	1	004	079	10573	10533	10315	10365	10343						1
84	10	0100	015	3	1	004	079	10634	10583	10343	10351	20390						1
85	10	1503	003	3	1	004	079	10620	10548	10341		10395						1
86	10	2103	025	3	1	004	079	10556	10516	10313	10313	10360						1
87	10	4502	001	3	1	004	079	10640	10580	10342		10410						1
88	10	0200	027	3	1	004	087	10505								10428		1
89	10	4203	003	3	1	004	087	10596	10572									1
90	10	1200	020	3	1	004	095	12275			10500	10455	10262		10235	10590	10310	1
91	10	0200	023	3	1	004	095				20399	20323						1
92	10	0400	005	3	1	004	095								10231	10514	10300	1
93	10	0400	001	3	1	004	095									10567	10303	1
94	10	1503	002	3	1	004	095				10408	10386	10228					1
95	10	1203	017	3	1	004	D20										10347	1
96	10	1203	017	3	1	004	020	10161										2

MEASUREMENTS - LIVADE OTKOP SLOJ

OBS	SITE	UNIT	BONENUM	FORMAT	CLASS	SPECIES	ELEMENT	MEAS1	MEAS2	MEAS3	MEAS4	MEAS5	MEAS6	MEAS7	MEAS8	MEAS9	MEAS10	LINENUM
97	10	5504	002	3	1	004	132	10540	10285	10234		10303	10158					1
98	10	2404	003	3	1	004	124	10580		10251	10293	10358	10285	10209				1
99	10	2505	009	3	1	004	124	10728	10357	10301	10340	10391	10211	10244				1
100	10	4102	004	3	1	004	124	10591		10225	10257	10324	10168	10186				1
101	10	4504	015	3	1	004	124	10599	10281	10243	10258	10306	10280	10210				1
102	10	4505	013	3	1	004	124	10605	10268	10215	10238	10325	10175	10215				1
103	10	5205	006	3	1	004	124	10768	10331	10265	10295	10377	10207					1
104	10	5203	001	3	1	004	124	10729	10315	10272	10302	10356	10198	10242				1
105	10	5203	003	3	1	004	124	10610	10262	10223	10260	10308	10180	10203				1
106	10	0200	049	3	1	005	001		10450									4
107	10	1104	001	3	1	005	001						10280					4
108	10	2502	004	3	1	005	001		10356	10290								4
109	10	4203	010	3	1	005	001						10359					4
110	10	0900	069	3	1	005	020									10664		1
111	10	0900	069	3	1	005	020		10153									2
112	10	0900	069	3	1	005	020						10328					3
113	10	0900	068	3	1	005	020									10792		1
114	10	0900	068	3	1	005	020		10350									2
115	10	0900	068	3	1	005	020						10151					3
116	10	0400	074	3	1	005	020		10158									2
117	10	0400	073	3	1	005	020						10333					3
118	10	0300	041	3	1	005	020		10165									2
119	10	0300	021	3	1	005	020						10330					3
120	10	0300	022	3	1	005	020		10170									2

MEASUREMENTS - LIVADE OTKOP SLOJ

OBS	SITE	UNIT	BONENUM	FORMAT	CLASS	SPECIES	ELEMENT	MEAS1	MEAS2	MEAS3	MEAS4	MEAS5	MEAS6	MEAS7	MEAS8	MEAS9	MEAS10	LINENUM
121	10	0300	022	3	1	005	020						10343					3
122	10	0400	074	3	1	005	020			10410	10593							3
123	10	0400	074	3	1	005	020					10130						3
124	10	1104	002	3	1	005	020				10592							3
125	10	1104	002	3	1	005	020					10140	10232	10172				3
126	10	1204	006	3	1	005	020					10312						3
127	10	1499	002	3	1	005	020									10672		1
128	10	1499	002	3	1	005	020		10157									2
129	10	1499	002	3	1	005	020						10352					3
130	10	1504	010	3	1	005	020									10661		1
131	10	1504	010	3	1	005	020		10151									2
132	10	1504	010	3	1	005	020						10338					3
133	10	1504	011	3	1	005	020									10685		1
134	10	1504	011	3	1	005	020		10144									2
135	10	1504	011	3	1	005	020						10327					3
136	10	1504	008	3	1	005	020					10285						3
137	10	1505	019	3	1	005	020										10492	1
138	10	1505	019	3	1	005	020	10367		10441								2
139	10	1505	019	3	1	005	020					10110	10332	10284				3
140	10	2104	012	3	1	005	020		10150									2
141	10	2104	019	3	1	005	020						10345					3
142	10	2503	014	3	1	005	020									10696		1
143	10	2503	014	3	1	005	020		10165									2
144	10	2503	014	3	1	005	020						10347					3

MEASUREMENTS - LIVADE OTKOP SLOJ

OBS	SITE	UNIT	BONENUM	FORMAT	CLASS	SPECIES	ELEMENT	MEAS1	MEAS2	MEAS3	MEAS4	MEAS5	MEAS6	MEAS7	MEAS8	MEAS9	MEAS10	LINENUM
145	10	4203	012	3	1	005	020		10154									2
146	10	4203	012	3	1	005	020						10362					3
147	10	4503	007	3	1	005	020			10440	10680							3
148	10	4503	007	3	1	005	020					10130	10238	10210				3
149	10	4503	014	3	1	005	020					10125						3
150	10	5103	006	3	1	005	020		10164									3
151	10	5103	006	3	1	005	020						10390					3
152	10	0900	026	3	1	005	036							10240				1
153	10	0400	041	3	1	005	036				10214							1
154	10	0300	011	3	1	005	036				20255							1
155	10	0301	008	3	1	005	036							10471	10395	20345		1
156	10	1503	004	3	1	005	039							10353	10296	10345		1
157	10	2102	018	3	1	005	039							10543	10431	10528		1
158	10	0200	013	3	1	005	039				10295						10198	1
159	10	0400	036	3	1	005	054				10390						10259	1
160	10	4203	015	3	1	005	035				10285						10210	1
161	10	1505	003	3	1	005	040					10227						1
162	10	2505	003	3	1	005	040					10194						1
163	10	1402	024	3	1	005	054	10647	10225	10174	10210	10214	10118	10185				1
164	10	0400	047	3	1	005	066		10349	10314	10256	10155						1
165	10	1203	003	3	1	005	066		10293	10292								1
166	10	1404	001	3	1	005	066		10300	10300								1
167	10	0701	004	3	1	005	076						10297	10196				1
168	10	0200	016	3	1	005	076						10303	10270				1

MEASUREMENTS - LIVADE OTKOP SLOJ

OBS	SITE	UNIT	BOMENUM	FORMAT	CLASS	SPECIES	ELEMENT	MEAS1	MEAS2	MEAS3	MEAS4	MEAS5	MEAS6	MEAS7	MEAS8	MEAS9	MEAS10	LINENUM
169	10	1505	025	3	1	005	076					10256	10404	10350		10197		1
170	10	1505	023	3	1	005	076						10298	10260				1
171	10	4104	002	3	1	005	076						10395	10356				1
172	10	4204	003	3	1	005	076						10400	10358				1
173	10	0100	016	3	1	005	079	10410	10382									1
174	10	5402	002	3	1	005	079	10456	10401									1
175	10	0300	019	3	1	006	001									10144		2
176	10	0300	019	3	1	006	001			10174								3
177	10	1204	004	3	1	006	001									10178		3
178	10	1204	004	3	1	006	001	10188	10078									3
179	10	0900	056	3	1	006	020				11200			10782	10704	10659	10343	1
180	10	0900	056	3	1	006	020	10371	10315	10205		10208	10085	10056			10140	2
181	10	0900	056	3	1	006	020		10260							10200		3
182	10	0900	056	3	1	006	020	10217										4
183	10	0400	019	3	1	006	020							10685	10653	10615	10350	1
184	10	0400	019	3	1	006	020			10193		10190						2
185	10	0400	019	3	1	006	020										10196	3
186	10	0400	083	3	1	006	020					10272		10650	10600	10548	10228	1
187	10	0400	083	3	1	006	020											2
188	10	1503	016	3	1	006	020							10648	10645	10610	10323	1
189	10	1503	016	3	1	006	020	10345	10305	10210	10083	10205						2
190	10	1503	016	3	1	006	020									10175	10183	3
191	10	2206	015	3	1	006	020							10730	10710	10652	10354	1
192	10	2206	015	3	1	006	020	10367	10315	10225	10082	10206						2

MEASUREMENTS - LIVADE OTKOP SLOJ

OBS	SITE	UNIT	RENUM	FORMAT	CLASS	SPECIES	ELEMENT	MEAS1	MEAS2	MEAS3	MEAS4	MEAS5	MEAS6	MEAS7	MEAS8	MEAS9	MEAS10	LINENUM
193	10	2206	015	3	1	006	020									10170	10205	3
194	10	2206	014	3	1	006	020							10762	10715	10694	10360	1
195	10	2206	014	3	1	006	020	10373	10314			10210						2
196	10	2206	014	3	1	006	020									10205	10236	3
197	10	2402	001	3	1	006	020							10740	10695	10646	10325	1
198	10	2402	001	3	1	006	020	10391	10330	10210	10077							2
199	10	2402	001	3	1	006	020										10207	3
200	10	4203	002	3	1	006	020	10313			10199	10080						2
201	10	4203	002	3	1	006	020										10192	3
202	10	2206	001	3	1	006	036					10243	10220	10148				1
203	10	2206	003	3	1	006	038						10110	10284	10222	10218	10108	1
204	10	0900	043	3	1	006	076						10185	10132				1
205	10	0200	024	3	1	006	076						10190	10154				1
206	10	0900	027	3	1	007	036							10447				1
207	10	1405	001	3	1	007	066		10810	10605								1
208	10	2103	021	3	1	007	066		10660	10590								1
209	10	0200	029	3	1	007	095											1
210	10	2203	004	3	1	007	095				10477	10430						1
211	10	1504	004	3	1	008	020							11258	10828	10520	10334	1
212	10	1504	004	3	1	008	020	20160						10425	10347			2
213	10	5205	001	3	1	008	036							10383				1
214	10	5404	006	3	1	008	076					10663	10585	10470				1
215	10	1102	002	3	1	008	098							10655	10602	10621		1
216	10	1503	006	3	1	008	039				10633	10600					10358	1

MEASUREMENTS - LIVADE OTKOP SLOJ

OBS	SITE	UNIT	BOMNUM	FORMAT	CLASS	SPECIES	ELEMENT	MEAS1	MEAS2	MEAS3	MEAS4	MEAS5	MEAS6	MEAS7	MEAS8	MEAS9	MEAS10	LINENUM
217	10	2103	003	3	1	008	039				10581	10582					10347	1
218	10	4104	001	3	1	008	039				10607	10557					10322	1
219	10	5205	002	3	1	008	039								10580	10560		1
220	10	1505	005	3	1	008	040					10326						1
221	10	4203	009	3	1	008	040					10376						1
222	10	1505	020	3	1	008	057				10453	10337						1
223	10	2403	001	3	1	008	057									10440	10301	1
224	10	4402	001	3	1	008	057				10538	10348						1
225	10	1404	005	3	1	008	076					10300	10514	10403				1
226	10	2104	005	3	1	008	076						10605	10490				1
227	10	1505	021	3	1	008	079	10574	10568	10314	10342	10377						1
228	10	5404	004	3	1	008	079	10481	10533	10320	10305	10360						1
229	10	4203	006	3	1	008	080	10988	11053									1
230	10	1204	001	3	1	008	095						10270		10258	10480	10310	1
231	10	2203	005	3	1	008	095				10395	10465						1
232	10	2102	004	3	1	008	122	10633	10254	10198	10237	10291	10183	10206				1
233	10	2103	010	3	1	008	122	10596	10221	10177	10210	10280	10154	10175				1
234	10	2102	005	3	1	008	124	10663	10246	10189	10230	10300	10174	10186				1
235	10	2103	034	3	1	008	124	10608	10226	10176	10213	10256	10168	10181				1
236	10	2402	003	3	1	008	124	10565	10217	10176	10214	10251	10160	10187				1
237	10	5203	002	3	1	008	124	10635	10256	10204	10258	10304	10170	10191				1
238	10	5203	015	3	1	008	124	10632	10242	10180	10226	10297	10168	10188				1
239	10	2203	010	3	1	008	035							10286	10262	10287		1
240	10	2206	034	3	1	011	091	10619	10074									1
241	10	2206	033	3	1	011	092	10638	10057									1

MEASUREMENTS - LIVADE PITS

OBS	SITE	UNIT	BONENUM	FORMAT	CLASS	SPECIES	ELEMENT	MEAS1	MEAS2	MEAS3	MEAS4	MEAS5	MEAS6	MEAS7	MEAS8	MEAS9	MEAS10	LINENUM
1	10	5105	001	3	1	004	001								10292	10283		5
2	10	1291	001	3	1	004	020							11165	10720	10432	20310	1
3	10	1291	001	3	1	004	020	20120						10473	10330			2
4	10	2106	017	3	1	004	020							11492	10921	10570	10415	1
5	10	2106	020	3	1	004	020	10161						10515	10440			2
6	10	1291	003	3	1	004	079		10605	20365	10382	10437						1
7	10	2106	010	3	1	004	124	10714	10337	10286	10316	10348	10228	10250				1
8	10	5105	004	3	1	005	076						10400	10355				1
9	10	2106	013	3	1	005	079	10528	10480									1
10	10	2106	016	3	1	006	020							10820			10367	1
11	10	2106	016	3	1	006	020					10194						2
12	10	2106	016	3	1	006	020								10265		10209	3
13	10	5105	002	3	1	006	040					10117						1
14	10	2106	021	3	1	008	020									10506		1
15	10	12 2	004	3	1	003	124	10630	10242	10177	10227	10290	10165	10284				1
16	10	12 2	005	3	1	003	124	10622	10243	10190	10231	10282	10163	10187				1
17	10	5105	002	3	1	004	124	10633	10252	10190	10231	10303	10180	10200				1

MEASUREMENTS - LIVADE FEATURES

OBS	SITE	UNIT	BONENUM	FORMAT	CLASS	SPECIES	ELEMENT	MEAS1	MEAS2	MEAS3	MEAS4	MEAS5	MEAS6	MEAS7	MEAS8	MEAS9	MEAS10	LINENUM
1	10	5105	002	3	1	005	035				10350	10495	10400					1

APPENDIX 5: NOVAČKA ĆUPRIJA UNIT CODE AND MEASUREMENTS

Novačka Ćuprija: Unit Code

A. Pit 2 - nw and sw quadrat of sonda 23, most of sonda 31 and part of sonda 41 (Early Bronze Age)

A1. Slcj units above, but contemporary witn pit 2 - possible extensions:

052313

052314

052318

052319

052320

052325

052326

052327

052328

052329

054103

054104

054105

054106

A2. Pit 2 units:

052331

052332

052333

052334

052335

052336

052337

052338

052339

052340

053103

053104

053105

053106

053107

053109

053110

053111

053112

053113

053114

053115

053116

053117

053118

053119

053120

053121

053122

053127

053128

053129

053130

053136

054107

054108

054109

054110

054111

B. Pit 1 - northeast quad of sonda 23 (Early Bronze Age)

B1. Sloj above pit 1, contemporary with pit units:

052315

052316

052321

B2. Pit 1 units:

052341

052342

052343

052344

052345

052346

052347

C. Pit 3 units - Sonda 41 (Early Bronze Age):

054113

054115

D. Urn and associated units in sonda 24, se quad (Late Bronze Age; B2/D-Ha A):

052404

052409

052416

052418

052419

052420

052421

052422

052423

052424

052427

052430

052431

E. Late Bronze Age (Iransitional Iron Age - Gava?) surface in sondas 25 and 42:

052509

052513

054207

054208

054209

054210

054211

054214

054217

054222

F. Eneolithic (Baden-like) units, Sonda's 3, 9, 22, and 40 (only slightly earlier than the pit complex in sondas 23/31/41:

050304

050308

050309

050310

050311

050312

050313

050904

052211

052216

052218

054011

054012

054013

054014

054015

054016

054017

054018

054019

054020

MEASUREMENTS - NOVAČKA ĆUPRIJA - BADEN SLOJ

OBS	SITE	UNIT	BONENUM	FORMAT	CLASS	SPECIES	ELEMENT	MEAS1	MEAS2	MEAS3	MEAS4	MEAS5	MEAS6	MEAS7	MEAS8	MEAS9	MEAS10	LINENUM
1	05	0304	008	3	1	001	036							10193				1
2	05	4015	004	3	1	001	057				10207	10142						1
3	05	2216	003	3	1	001	062				10105							1
4	05	2211	001	3	1	001	063	10215	10109	10088	10096							1
5	05	4011	002	3	1	001	064	10272	10203	10073								1
6	05	0304	009	3	1	003	057				10198							1
7	05	0304	001	3	1	003	066		10280	10257								1
8	05	0304	010	3	1	003	095				10175							1
9	05	0304	011	3	1	003	095				10180							1
10	05	0304	007	3	1	004	001						20563		10374	10313		3
11	05	2216	001	3	1	004	020								20870			1
12	05	2216	001	3	1	004	020							10515				2
13	05	4011	001	3	1	004	076						20632					1
14	05	4013	001	3	1	004	095								10600	10333		1
15	05	0304	002	3	1	004	122	10544	10297	10245	10270							1
16	05	0304	003	3	1	004	122	10557	10306	10263								1
17	05	0308	001	3	1	004	122	10543	10285	10254	10255							1
18	05	0308	002	3	1	004	122	10571	10277	10231	10232							1
19	05	4015	002	3	1	004	122	10497	10240	10187	10220							1
20	05	0904	001	3	1	005	020							11095	10909	10539	10455	1
21	05	0904	001	3	1	005	020	10334	10148							10397	10400	2
22	05	0904	001	3	1	005	020						10291					3
23	05	4015	013	3	1	005	063	10134	10081	10079	10077							1
24	05	0904	004	3	1	005	076				10202		10307					3

PLEASE NOTE:

Page(s) not included with original material
and unavailable from author or university.
Filmed as received.

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MEASUREMENTS - MEASUREMENTS FROM NOVAČKA ĆUPRIJA PITS (1, 2, 3)

OBS	SITE	UNIT	BONENUM	FORMAT	CLASS	SPECIES	ELEMENT	MEAS1	MEAS2	MEAS3	MEAS4	MEAS5	MEAS6	MEAS7	MEAS8	MEAS9	MEAS10	LINENUM
1	05	4113	004	3	1	001	001									10721		3
2	05	4113	004	3	1	001	001	10210	10176									4
3	05	4110	004	3	1	001	036						10290	10217				1
4	05	3106	003	3	1	001	038							10264	10251			1
5	05	3107	029	3	1	001	038						10178	10292	10279			1
6	05	3107	030	3	1	001	039	11530			10317	10286	10091		10313	10230		1
7	05	3107	025	3	1	001	057				10234	10166						1
8	05	4110	006	3	1	001	057				10225	10159						1
9	05	3103	002	3	1	001	063	10210	10100	10095	10088							1
10	05	3114	003	3	1	001	074			10437		10198						1
11	05	4110	002	3	1	001	079	10293	10278	10271								1
12	05	2333	003	3	1	001	095						10120		10095	10222		1
13	05	3127	007	3	1	003	001		10396									3
14	05	3122	001	3	1	003	020				11224			10754	10468	10292	20183	1
15	05	3122	001	3	1	003	020	10055	10350					10220	10170			2
16	05	4115	002	3	1	003	020									10330		1
17	05	4115	002	3	1	003	020							10250				2
18	05	2341	001	3	1	003	057	11286			10213		10142		10095	10256		1
19	05	3109	016	3	1	003	076						10278					1
20	05	3127	008	3	1	003	001				10202	10073						1
22	05	4107	013	3	1	003	010	10078										2
23	05	3117	002	3	1	003	124	10273	10124	10087	10086							1
24	05	3109	004	3	1	004	020								10838		10352	1

MEASUREMENTS – MEASUREMENTS FROM NOVAČKA ĆUPRIJA PITS (1, 2, 3)

OBS	SITE	UNIT	BONENUM	FORMAT	CLASS	SPECIES	ELEMENT	MEAS1	MEAS2	MEAS3	MEAS4	MEAS5	MEAS6	MEAS7	MEAS8	MEAS9	MEAS10	LINENUM
25	05	3109	004	3	1	004	020	10144										2
26	05	3119	001	3	1	004	020	10751										3
27	05	3112	002	3	1	004	02D									10495		1
28	05	2333	001	3	1	004	036					10684	10568	10432				1
29	05	4107	004	3	1	004	036				10352		10431	10345				1
30	05	4108	001	3	1	004	036				10241							1
31	05	3103	001	3	1	004	040		10740	10463	10394							1
32	05	3107	002	3	1	004	040				20760	20730						1
33	05	3110	004	3	1	004	051	10388										1
34	05	2340	001	3	1	004	057								10190	10508		1
35	05	3127	001	3	1	004	057								10260	10523		1
36	05	3105	002	3	1	004	063		10315	10255	10382							1
37	05	2344	001	3	1	004	066		20780	20593								1
38	05	3107	028	3	1	004	070					10487	10255	11300				1
39	05	3107	016	3	1	004	076						10631					1
40	05	3110	003	3	1	004	076						10611					1
41	05	3105	001	3	1	004	079	10692	10615	10386	10350	10404						1
42	05	3107	020	3	1	004	079	10632		10350	10333							1
43	05	3107	019	3	1	004	080		10370									1
44	05	3109	001	3	1	004	080		10380									1
45	05	3107	017	3	1	004	087	10468										1
46	05	3109	003	3	1	004	087	10546										1
47	05	3107	027	3	1	004	095									10582		1
48	05	3110	001	3	1	004	095				10478		10251					1

MEASUREMENTS - MEASUREMENTS FROM NOVAČKA ĆUPRIJA PITS (1, 2, 3)

OBS	SITE	UNIT	BONENUM	FORMAT	CLASS	SPECIES	ELEMENT	MEAS1	MEAS2	MEAS3	MEAS4	MEAS5	MEAS6	MEAS7	MEAS8	MEAS9	MEAS10	LINENUM
49	05	4113	002	3	1	004	095									10533		1
50	05	4113	002	3	1	004	095	10309										2
51	05	3105	006	3	1	004	020										10216	1
52	05	3105	006	3	1	004	020	10112										1
53	05	2333	002	3	1	004	122		20291	10237	20304							1
54	05	2337	002	3	1	004	122	10502	10256	10206	10236							1
55	05	2345	001	3	1	004	122	10534	10198	10212	10234							1
56	05	3107	021	3	1	004	122	10540	10327	10283	10304							1
57	05	3109	002	3	1	004	122	10541	10285	10233	10255							1
58	05	4110	001	3	1	004	122	10550	10320	10251								1
59	05	2339	003	3	1	004	124	10554	10293	10242	10275							1
60	05	3107	022	3	1	004	124		10248	10197								1
61	05	3107	023	3	1	004	124	10600	10296	10233								1
62	05	3119	002	3	1	004	124	10622	10340	10277	10306							1
63	05	4108	002	3	1	004	124	10586	10253	10220	10248							1
64	05	4107	005	3	1	004	125	10397	10321	10243	10267							1
65	05	2347	010	3	1	005	001	20650										4
66	05	3105	007	3	1	005	020		10156									2
67	05	3105	007	3	1	005	020						10371					3
68	05	3107	003	3	1	005	020		10193									2
69	05	3107	003	3	1	005	020						10330					3
70	05	3107	004	3	1	005	020					10117						3
71	05	3107	005	3	1	005	020				20690							3
72	05	3107	005	3	1	005	020					10117						3

MEASUREMENTS - MEASUREMENTS FROM NOVAČKA ĆUPRIJA PITS (1, 2, 3)

OBS	SITE	UNIT	BONENUM	FORMAT	CLASS	SPECIES	ELEMENT	MEAS1	MEAS2	MEAS3	MEAS4	MEAS5	MEAS6	MEAS7	MEAS8	MEAS9	MEAS10	LINENUM
73	05	3106	002	3	1	005	038							10417	10315			1
74	05	2345	002	3	1	005	040			10375	10305							1
75	05	3112	005	3	1	005	054			10151								1
76	05	3107	026	3	1	005	063	10245		10136	10129							1
77	05	2337	001	3	1	005	066		10354	10315		10262			10405			1
78	05	2341	002	3	1	005	066		10384	10340								1
79	05	3105	004	3	1	005	066		10352	10309								1
80	05	3114	001	3	1	005	066		10310	10278		10233	10144	10640				1
81	05	3105	003	3	1	005	076						10299					1
82	05	2332	003	3	1	005	080		10236									1
83	05	2337	003	3	1	005	104					10161						1
84	05	3111	001	3	1	006	001							10594		10170	10450	2
85	05	3111	001	3	1	006	001	10174	10099	10168	10121	10136	10069	10090				3
86	05	2344	006	3	1	006	020	10304	10257	10195	10071	10181					10094	2
87	05	2344	006	3	1	006	020			10140								3
88	05	2344	007	3	1	006	020			10164								3
89	05	4110	013	3	1	006	056	10495	10074									1
90	05	4110	014	3	1	006	094	10607	10069									1
91	05	4113	008	3	1	006	105	10602	10077									1
92	05	4110	012	3	1	006	001	10167	10076									3
93	05	2339	004	3	1	007	038							20720	20710			1
94	05	4109	001	3	1	007	039								10722	10631		1
95	05	3117	001	3	1	097	020									10229		1
96	05	3117	001	3	1	097	020							10208	10195			2

MEASUREMENTS - NOVAČKA ĆUPRIJA - SLOJ ABOVE PITS

OBS	SITE	UNIT	BONENUM	FORMAT	CLASS	SPECIES	ELEMENT	MEAS1	MEAS2	MEAS3	MEAS4	MEAS5	MEAS6	MEAS7	MEAS8	MEAS9	MEAS10	LINENUM
1	05	2320	030	3	1	003	020										10209	1
2	05	2320	030	3	1	003	020	10086										2
3	05	2328	003	3	1	003	020									10281		1
4	05	2328	003	3	1	003	020								10185			2
5	05	2313	033	3	1	003	076						10253					1
6	05	2316	001	3	1	003	d20										10207	1
7	05	2316	001	3	1	003	d26	10070										2
8	05	2321	008	3	1	003	d20	10081										2
9	05	2327	001	3	1	003	d20										10200	1
10	05	2327	001	3	1	003	d20	10074										2
11	05	4106	001	3	1	003	d20										10222	1
12	05	4106	001	3	1	003	d20	10079										2
13	05	4106	002	3	1	003	d20										10234	1
14	05	4106	002	3	1	003	d20	10080										2
15	05	2320	005	3	1	004	001						10783	21052	10313	10295		3
16	05	2325	002	3	1	004	001	10827										3
17	05	2318	017	3	1	004	020									10470		1
18	05	2318	017	3	1	004	020								20350			2
19	05	2318	001	3	1	004	001						10377					4
20	05	2325	001	3	1	004	036				10493	10619	10525	10460				1
21	05	2320	001	3	1	004	039				20522	20480	10126	10590				1
22	05	2320	004	3	1	004	039						10200	11000	20610	10543		1
23	05	2325	004	3	1	004	063	10332	10259	10196	10196							1
24	05	2329	008	3	1	004	063	10350	10282	10224	10212							1

MEASUREMENTS - NOVAČKA ĆUPRIJA - SLOJ ABOVE PITS

OBS	SITE	UNIT	BONENUM	FORMAT	CLASS	SPECIES	ELEMENT	MEAS1	MEAS2	MEAS3	MEAS4	MEAS5	MEAS6	MEAS7	MEAS8	MEAS9	MEAS10	LINENUM
25	05	2318	007	3	1	004	066		10610	10513		10320	10200	10920				1
26	05	2318	008	3	1	004	066		10532	10435								1
27	05	2319	001	3	1	004	066		10650	10568		10324	10204	10910				1
28	05	2320	002	3	1	004	076				10238		10517	10396				1
29	05	2320	003	3	1	004	076			20810								1
30	05	2321	001	3	1	004	076						10586					1
31	05	2320	008	3	1	004	079			10359	10346							1
32	05	2320	009	3	1	004	079	10653	10600	10357		10430						1
33	05	2320	010	3	1	004	079	10710	10645	10430	10420	10470						1
34	05	2318	016	3	1	004	080		20380									1
35	05	2321	002	3	1	004	087	10531										1
36	05	2318	004	3	1	004	095						10274		10256	10595		1
37	05	2318	005	3	1	004	095				10538							1
38	05	2320	011	3	1	004	122	10543	10260	10233	10260							1
39	05	2318	002	3	1	004	124	10636	10322	10298	10343							1
40	05	2318	003	3	1	004	125	10403	10337	10281	10306							1
41	05	2318	011	3	1	005	020									10624		1
42	05	2318	011	3	1	005	020		10331									2
43	05	2318	011	3	1	005	020						10150					3
44	05	2318	012	3	1	005	020			10881								1
45	05	2318	012	3	1	005	020		10157						10490			2
46	05	2318	012	3	1	005	020						10349					3
47	05	2318	014	3	1	005	036				20240							1
48	05	2316	025	3	1	005	040			10360		10291						1

MEASUREMENTS - NOVAČKA ĆUPRIJA - SLOJ ABOVE PITS

OBS	SITE	UNIT	BONENUM	FORMAT	CLASS	SPECIES	ELEMENT	MEAS1	MEAS2	MEAS3	MEAS4	MEAS5	MEAS6	MEAS7	MEAS8	MEAS9	MEAS10	LINENUM
49	05	2316	026	3	1	005	040			10343		10293						1
50	05	2318	015	3	1	005	040			10368		10213						1
51	05	2329	002	3	1	005	040			10386		10209						1
52	05	2315	002	3	1	005	054		10773		10126	10155						1
53	05	2329	001	3	1	005	066			10305			10110	11060				1
54	05	2314	001	3	1	005	079	10410	10375									1
55	05	2318	021	3	1	006	001									10164		2
56	05	2321	007	3	1	006	076						10202					1
57	05	2313	001	3	1	007	054				10472	10320						1

MEASUREMENTS - NOVAČKA ĆUPRIJA URN AND LBA FLOOR

OBS	SITE	UNIT	BONENUM	FORMAT	CLASS	SPECIES	ELEMENT	MEAS1	MEAS2	MEAS3	MEAS4	MEAS5	MEAS6	MEAS7	MEAS8	MEAS9	MEAS10	LINENUM
1	05	2431	001	3	1	001	079		10246	10154	10450							1
2	05	2509	015	3	1	003	020									10198		1
3	05	2509	015	3	1	003	020							10207	10185			2
4	05	2509	017	3	1	003	120	10070										2
5	05	2430	002	3	1	004	063	10380	10279	10210	10247							1
6	05	2418	001	3	1	004	076						10560					1
7	05	2430	001	3	1	004	079	10686	10552	10337	10338	10380						1
8	05	2513	001	3	1	004	122	10624	10364	10315	10332							1

Appendix 6: Crkvina

MEASUREMENTS - CRKVINA PIT

OBS	SITE	UNIT	BONENUM	FORMAT	CLASS	SPECIES	ELEMENT	MEAS1	MEAS2	MEAS3	MEAS4	MEAS5	MEAS6	MEAS7	MEAS8	MEAS9	MEAS10	LINENUM
1	01	0106	011	3	1	001	036				10193	10340	10257	10211				1
2	01	0107	022	3	1	001	074			20382		10202						1
3	01	0106	013	3	1	003	02D		10655									2
4	01	0107	019	3	1	003	038						10134		10284			1
5	01	0107	027	3	1	003	057				10210							1
6	01	0203	002	3	1	003	062				10098							1
7	01	0207	002	3	1	003	062				10148							1
8	01	0107	026	3	1	003	076						10256					1
9	01	0202	003	3	1	003	079					10160						1
10	01	0202	002	3	1	004	062		10286	10252								1
11	01	0201	001	3	1	004	079					10352						1
12	01	0107	023	3	1	004	087	10475										1
13	01	0207	001	3	1	004	122		10303	10264	10275							1
14	01	0103	014	3	1	005	063	10214	10158	10133								1
15	01	0105	003	3	1	005	063	10194	10143	10127	10116							1
16	01	0106	014	3	1	005	064	10274	10256	10103								1
17	01	0107	028	3	1	005	064	10290	10269	10089								1
18	01	0107	025	3	1	006	038							10292				1

Appendix 7: Sarina Medja, Vrbica and Vecina Mala

Sarina Medja (site #17)	computer code*
Sonda A/2-A/3, pit 1 (Objekat 1)	17-02-01
Sonda B3, pit 2 (Objekat 2)	17-03-02
Sonda ?, pit 3 (Objekat 3)	17-00-03
Vecina Mala (site #18)	
Sonda 1A, pit (jama)	18-01-01
Vrbica (site #19)	
Sonda 1, pit (jama)	19-01-01
Sonda 1, surface surrounding pit (slightly earlier date than pit, but same basic ceramic chronology).	19-01-02

(*site number-sonda number-excavation unit or pit number)

MEASUREMENTS - SARINA MEDJA PITS

OBS	SITE	UNIT	BONENUM	FORMAT	CLASS	SPECIES	ELEMENT	MEAS1	MEAS2	MEAS3	MEAS4	MEAS5	MEAS6	MEAS7	MEAS8	MEAS9	MEAS10	LINENUM
1	17	0201	002	3	1	001	020	11655	11700	10520	11125	11174	11342	10663	10476	10320	10228	1
2	17	0201	002	3	1	001	020	10091	10363	10606			10357	10242	10158			2
3	17	0201	022	3	1	001	020	21530	21610	10433	11120	11064	11233	10770	10455	10215	10215	1
4	17	0201	022	3	1	001	020	10091	11345	10756	10643		10362	10217	10150			2
5	17	0201	028	3	1	001	020							10670	10460	10215	10212	1
6	17	0201	028	3	1	001	020	10090					10370	10238	10141			2
7	17	0201	115	3	1	001	026		10596	10480		10428		10338				1
8	17	0201	007	3	1	001	027	10534	10498	10408	10332	10420	10231	10212	10455			1
9	17	0201	149	3	1	001	027	10553	10584						10454			1
10	17	0201	024	3	1	001	031	10875	10862	20755	10300	10135						1
11	17	0201	139	3	1	001	031				10240	10123						1
12	17	0201	084	3	1	001	036				10195	10318	10157	10210				1
13	17	0201	086	3	1	001	036						10265	10234				1
14	17	0201	074	3	1	001	036				10204	10309	10235	10204				1
15	17	0201	083	3	1	001	036					10322	10248	10209				1
16	17	0201	070	3	1	001	038				10434							1
17	17	0201	005	3	1	001	039	11405			10396	10261	10155		10291	10232	10155	1
18	17	0201	005	3	1	001	039	10180	10007									2
19	17	0201	012	3	1	001	039	11500			10302	10274	10151		10300	10233	10160	1
20	17	0201	012	3	1	001	039	10183	10084									2
21	17	0201	006	3	1	001	040	21650				10180						1
22	17	0201	013	3	1	001	040		10360	10347	10223	10168						1
23	17	0201	013	3	1	001	057				10227	10170	10125		10096	10256	10165	1
24	17	0201	012	3	1	001	057		10116	10110								2

MEASUREMENTS -- SARINA MEDJA PITS

OBS	SITE	UNIT	BONENUM	FORMAT	CLASS	SPECIES	ELEMENT	MEAS1	MEAS2	MEAS3	MEAS4	MEAS5	MEAS6	MEAS7	MEAS8	MEAS9	MEAS10	LINENUM
25	17	0201	116	3	1	001	057	11250			10239	10173	10137		10093	10254	10156	1
26	17	0201	116	3	1	001	057		10117	10112								2
27	17	0201	022	3	1	001	066					10160	10093					1
28	17	0201	156	3	1	001	066					10151	10105					1
29	17	0201	159	3	1	001	066					10155	10115					1
30	17	0201	019	3	1	001	066					10167	10118					1
31	17	0201	155	3	1	001	066		10299	10238								1
32	17	0201	014	3	1	001	074			10460		10209			10377	10466		1
33	17	0201	008	3	1	001	074								10367	10464		1
34	17	0201	001	3	1	001	076	11915		10374	10135		10222	10195	10390	10114		1
35	17	0201	073	3	1	001	076	12010			10140		10262	10216		10170		1
36	17	0201	071	3	1	001	076	11995		10423	10139		10264	10214	10367	10121		1
37	17	0201	072	3	1	001	076				10140		10267	10190		10112		1
38	17	0302	016	3	1	001	076			10308					10251			1
39	17	0201	011	3	1	001	079	10281	10272	10164	10176	10286						1
40	17	0201	131	3	1	001	080	10567	10190									1
41	17	0201	132	3	1	001	080	10563	10198									1
42	17	0201	021	3	1	001	134	10355	10121	10096	10114	10140	10070	10090				1
43	17	0201	112	3	1	001	134	10364	10139	10105	10124	10144	10080	10103				1
44	17	0201	113	3	1	001	134	10360	10115	10096	10110	10144	10073	10088				1
45	17	0003	019	3	1	001	134	10348	10112	10191	10105	10128	10176	10096				1
46	17	0003	021	3	1	002	079	10289				10179						1
47	17	0201	015	3	1	003	001			10214								3
48	17	0201	009	3	1	003	001		10436									3

MEASUREMENTS - BARINA MEDJA PITS

OBS	SITE	UNIT	BONENUM	FORMAT	CLASS	SPECIES	ELEMENT	MEAS1	MEAS2	MEAS3	MEAS4	MEAS5	MEAS6	MEAS7	MEAS8	MEAS9	MEAS10	LINENUM
49	17	0201	009	3	1	003	001				10187	10116						5
50	17	0302	042	3	1	003	001				10188	10120						5
51	17	0201	164	3	1	003	020		10340						10146	10130		2
52	17	0201	018	3	1	003	066		10310	10235								1
53	17	0201	045	3	1	004	020										10340	1
54	17	0201	045	3	1	004	020	10150										2
55	17	0302	046	3	1	004	020	10125										2
56	17	0201	003	3	1	004	026		10742	10226	10665		10700					1
57	17	0201	036	3	1	004	036					10580	10476	10430				1
58	17	0201	035	3	1	004	040			10515		10304						1
59	17	0201	040	3	1	004	057				10510	10295						1
60	17	0201	119	3	1	004	057				1	10302						1
61	17	0302	021	3	1	004	057				10578	10331						1
62	17	0201	117	3	1	004	095					10415						1
63	17	0201	050	3	1	004	122	10510	10384	10235	10268	10297	10176	10206				1
64	17	0201	051	3	1	004	122	10508	10377	10239	10266	10280	10171	10206				1
65	17	0201	105	3	1	004	122	10522	10256	10206	10245	10261	10153	10191				1
66	17	0201	107	3	1	004	122	10525	10268	10237	10173	10295	10172	10210				1
67	17	0201	109	3	1	004	122	10525	10220	10385	10259	10291	10160	10191				1
68	17	0201	106	3	1	004	122	10524	10250	10206	10249	10290	10156	10193				1
69	17	0302	068	3	1	005	020	10345										2
70	17	0302	017	3	1	005	076						10302	10277				1
71	17	0302	018	3	1	005	076						10277	10236				1
72	17	0302	038	3	1	006	020	10370	10310									2

MEASUREMENTS - SARINA MEDJA PITS

OBS	SITE	UNIT	BONENUM	FORMAT	CLASS	SPECIES	ELEMENT	MEAS1	MEAS2	MEAS3	MEAS4	MEAS5	MEAS6	MEAS7	MEAS8	MEAS9	MEAS10	LINENUM
73	17	0302	038	3	1	006	020			10195						10195	10226	3
74	17	0302	006	3	1	006	038						10133	10312	10341			1
75	17	0201	023	3	1	009	038							10307	10263	10253		1

MEASUREMENTS - VRBICA

OBS	SITE	UNIT	BONENUM	FORMAT	CLASS	SPECIES	ELEMENT	MEAS1	MEAS2	MEAS3	MEAS4	MEAS5	MEAS6	MEAS7	MEAS8	MEAS9	MEAS10	LINENUM
1	19	0101	009	3	1	004	020			20970		12300		11248	10798	10461	10338	1
2	19	0101	008	3	1	004	020	10135		11370			10653	10414				2
3	19	0101	005	3	1	004	087	20471	20483									1
4	19	0101	015	3	1	005	039				10284	10204					10203	1
5	19	0101	014	3	1	008	057								10190	10431	10284	1

MEASUREMENTS - VECINA MALA

OBS	SITE	UNIT	BONENUM	FORMAT	CLASS	SPECIES	ELEMENT	MEAS1	MEAS2	MEAS3	MEAS4	MEAS5	MEAS6	MEAS7	MEAS8	MEAS9	MEAS10	LINENUM
1	18	0101	007	3	1	001	066		10270	10220		10129	10081					1
2	18	0101	017	3	1	004	039								10670	10643		1
3	18	0101	017	3	1	004	039	10370										2
4	18	0101	022	3	1	004	122	10535	10290	10219	10263	10324	10155					1
5	18	0101	028	3	1	005	092			10176	10145		10227	10125				1
6	18	0101	027	3	1	005	093			10163	10145		10250	10135				1
7	18	0101	038	3	1	006	020				11151	11074	11144	10754	10730	10683	10365	1
8	18	0101	038	3	1	006	020	10390	10349			10213					10105	2
9	18	0101	038	3	1	006	020	10491	10215	10175					10248	10205		3
10	18	0101	005	3	1	007	066		10656	10586		10429	10256					1
11	18	0101	013	3	1	008	057						10240		10255	10429	10392	1

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