UNIVERSITY OF ALBERTA

AN ANALYSIS OF THE ANIMAL REMAINS FROM FOUR MIDDENS AT THE LATE ROMAN RURAL VILLA SITE OF SAN GIOVANNI DI RUOTI

BY

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The undersigned certify that they have read, and recommend to the Faculty of Graduate Studies and Research for acceptance, a thesis entitled AN ANALYSIS OF THE ANIMAL REMAINS FROM FOUR MIDDENS AT THE LATE ROMAN RURAL VILLA SITE OF SAN GIOVANNI DI RUOTI submitted by MICHAEL MACKINNON in partial fulfillment of the requirements for the degree of MASTER OF ARTS.

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ABSTRACT

An analysis of the animal remains from four middens at the late Roman rural villa site of San Giovanni di Ruoti provides significant results with which to derive interpretations about i) biases, forces, and processes affecting the recovery and nature of the sample, and ii) the economy and diet of the occupants at the site. In terms of the former, these analyses support the efficacy of screening, and address the issues of controlling taphonomic and methodological biases. In terms of the latter, a variety of domestic and wild animal species are represented in the sample, none of which are atypical to the geographic area. A surplus of domesticates predominates; pigs are the most abundant, followed by caprines, cattle, equines and pets. Their analysis reveals that pig raising and pork production were important activities at the site. The occupants exploited herds of pigs, which were kept in neighboring forests, in efforts to fulfill Imperial tax demands. Live and butchered pigs of all ages were exported. Similarly, caprines of all ages were slaughtered and presumably exported. However, their importance in the diet and economy at the site decreases through time, largely due to an increase and intensification of pig husbandry. The evidence suggests that small-scale, short-distance transhumance was practised. Cattle, contributed little to the economy and diet. Finally, the presence of wild species, including deer, rabbit, boar, and bear lends support to the idea that hunting occurred, however this too appeared to have dwindled in importance later in time, again at the expense of pig raising. The faunal evidence supports the argument that San Giovanni was a wealthy villa and production center, linked in a market exchange type of economic system.

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List of Abbreviations

The following abbreviations are used in the body of text to denote references to classical literary works:

Apicius De Re Coq.	Apicius, De Re Coquinaria
Cato De Agri Cult.	Cato, De Agri Cultura
Col. De Re Rust.	Columella, De Re Rustica
Hor. Carm.	Horace, Carmina
Hor. Sat.	Horace, Satires
Palladius Opus Agric.	Palladius, Opus Agriculturae
Pliny Nat. Hist.	Pliny, the Elder, Historia Naturalis
Var. De Agri Cult.	Varro, De Agri Cultura

The following abbreviations are used in the body of the text to denote techical terms used in faunal analyses

NISP	Number of Identifiable Specimens (Identifiable Bones)
MNI	Minimum Number of Individuals
ID	Identifiable Bone (same as NISP in this case)
UNID	Unidentifiable Bone
RF	Relative Frequency
MNE	Minimum Number of Elements
MAU	Minimum Animal Units
TMAU	Total Minimum Animal Units
MGUI	Modified General Utility Index
MUI	Meat Utility Index
dp4	fourth deciduous premolar
M1	first permanent molar
M2	second permanent molar
M3	third permanent molar

CHAPTER 1

INTRODUCTION: OVERALL OBJECTIVES

The analysis of faunal remains from ancient sites is an essential component in any multidisciplinary archaeological venture. Through a study of the bone remains recovered from a site, the faunal analyst or zooarchaeologist is able to provide information pertinent to the interpretation of past human lifeways and activities. This information can range from determining the abundance of species present at the site to determining the specific roles animals played in the ancient economy, geographic area, or culture. In addition, it is information that may not be available from the analysis of other ecofacts or artifacts. Thus, any complete archaeological study attempting to understand past human cultures should incorporate a faunal analysis if bone remains are recovered.

In recent years, considerable research has been devoted to faunal analyses. Researchers have realized that much information can be extracted from animal bones recovered from archaeological sites, and several have published extensive volumes on this subject (Chaplin, 1971; Cornwall, 1974; Davis, 1987; Grayson, 1973; 1984; Hesse and Wapnish, 1985; Klein and Cruz-Uribe, 1984; McCormick, 1982; Payne, 1972a; Ryder, 1969). Methodologies are becoming increasingly standardized. The chief aim of any faunal analysis should be the identification of as many bones, and fragments of bones, as possible into their anatomical elements and into zoological species (Grigson, 1978:122). Often this can be enhanced with information derived from osteological evidence of age, sex, and size. Reference skeletal collections and manuals (Boessneck, 1969; Schmid, 1972; Silver, 1969; Wilson et al., 1982) may assist in classification. With this information, relative numbers of different species can be assessed either from calculations of the minimum numbers of individuals of the different species (MNI), or a count of the total number of bones of each species (NISP), or a calculation of the relative frequency of species (RF), or from methods involving weights of bones. The degree of fragmentation (Watson, 1972), the role of taphonomic factors (Brain, 1981; Gifford, 1981; White and Hannus, 1983), the significance of recovery methods (Cockerham and MacKinnon, 1991; Payne, 1972b), as well as cultural practices of the people who formed the deposit, are all factors to consider before interpretations can be made.

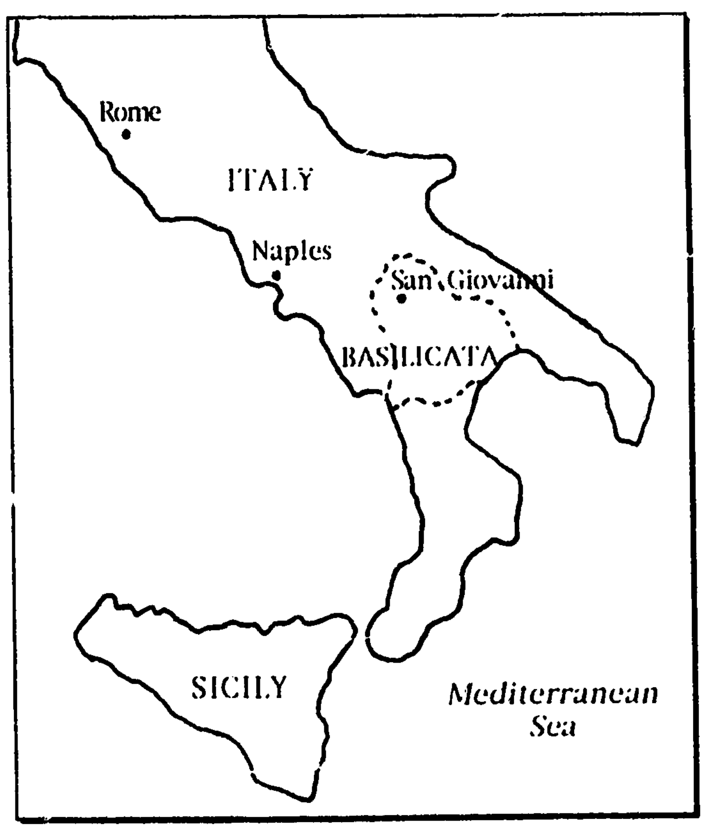
The interpretation of animal bone material should not be attempted unless, and until, all the basic data have been evaluated and the findings made available, otherwise its validity is suspect (Grigson, 1978:125). Owing to the statistical and scientific nature of the data, hypotheses about the sample can often be tested. In some cases provisional conclusions are all that can be derived. Other times the data may conform to a previous model (Clark, 1987). Sometimes the data may be arranged to devise a model, which itself may be widely applicable (Clarke, 1972).

Topics for interpretation are numerous, and will depend on the goals of the researchers. Environments may be reconstructed based on the ecology of the various species represented. Evidence for settlement and seasonality may be discerned based on the spatial distribution of the bones and a firm knowledge of cultural and animal behaviours. The relationship of the animals with humans can be analyzed to provide economic information. Here, one might assess the role of domestic and wild species in the economy, provided clearly defined criteria are used to establish the wild/domestic status. Issues of trade, choice of species, and the use of animals and their products can also be investigated. Often animals were consumed; thus issues of butchery and the contribution of meat to the diet become important to interpret. Bone technology is another topic, which is particularly important when discussing cultures which made bone tools. Pathological incidence and abnormalities may be topics of significance, especially if diseases were endemic or epidemic.

The diversity of topics presented supports the argument that the information derived from the interpretation of animal bones is a vital component to any archaeological analysis. The importance becomes even more significant when faunal samples are compared through time and space. Without their analysis our knowledge of animal ecology and human culture, from its prehistoric beginnings to modern times worldwide, would be incomplete.

My research will present a detailed faunal analysis of the animal bone remains recovered from four middens at San Giovanni di Ruoti, a late Roman farm site in southern Italy. The location of the site is shown in Figure 1. Through an analysis of the recovered faunal material, I quantify and interpret the mammalian contribution to the economy and diet of the fifth and early sixth century occupants at this site.

Figure 1: Location of San Giovanni



Archaeological excavations at San Giovanni were carried out from 1977 to 1984 primarily by student groups from the University of Alberta under the direction of Alastair M. Small and Robert J. Buck. D. Gentry Steele, now at Texas A&M University, was director of the zooarchaeological analysis. The investigators were especially interested in studying the economy of this ancient Roman farm complex, and made every effort to collect biological and environmental data from the site. Faunal remains were collected during all seasons of excavation. As the numbers of accumulated elements soared into the tens of thousands, and combined weights surpassed 200 kg, the sheer magnitude of the sample suggested that much information could be gained from its analysis.

A variety of publications concerning the excavation results, the architecture, the environment, and other aspects of and issues regarding the site have already been published (Buck and Small, 1980; Buck et al., 1979; Freed, 1985; Gualtieri et al., 1983; Small, 1978, 1979, 1980, 1981, 1985; Small and Buck, 1978, 1982, 1983, forthcoming; Small et al., 1985). However, the faunal sample has not as yet been fully studied. Previous analyses did not incorporate the whole sample: Steele (1983) studied only parts of two middens, whereas Assad (1986) focused on a taphonomic analysis of the pig remains. The bird remains are presently being studied by Ann Eastham in England. Mollusk and gastropod remains have been classified and studied by David Reese and Martin Bishop, respectively. This left the entire collection of mammalian, reptilian, fish, and amphibian remains available for study, and of these, the mammals dominated and necessitated analysis.

My original intention had been to do a full analysis on the entire sample of mammalian bones from all periods of occupation at the site. However, it was realized that this was too large an undertaking at this level, and I have therefore limited this study to the mammalian bones from four middens dating to Period 3, the last period of occupation at the site. These middens produced the greatest quantities of faunal remains from any contexts over the entire site, regardless of occupation period. The analysis of this still quite large sample should provide important, and statistically significant, results and information about the economy and diet of the occupants in Period 3.

San Giovanni is an archaeological site of the historical period, therefore information pertaining to the role of mammals in Roman farming practices can be derived from ancient literary records, particularly the agricultural accounts of the Roman writers Cato, Varro, Columella, Pliny the Elder, and Palladius. Additional information can be extracted from the legal recordings in the Theodosian Code (Buck, 1983), and from the recipes of Apicius (Flower and Rosenbaum, 1958). Yet even amalgamated these sources are far from complete, and inherent biases impede an unquestionable acceptance of their dicta. The agricultural writers are selective in their recordings, which in turn are derived from ethnocentric and area-specific vantage points. Law codes are essentially prescriptive rather than descriptive. Clearly then, the credibility of these sources is suspect. My quantitative study of the mammal remains from the four late Roman period middens at San Giovanni will provide a basis from which to derive comparisons between the theory as presented in these ancient literary records and the actual and quantifiable practice as revealed through faunal analyses. Thus, clarifying the gulf between theory and practice concerning the role of mammals in Roman farm-villa economy and diet will be addressed in this analysis and developed further.

Despite their recognized value, faunal studies of Roman period sites in Italy have not been abundant. Although faunal remains from Roman period sites in England have received intense analysis, for a variety of reasons classical archaeologists working in Italy have often focused their research on the analysis of architectural and artifactual remains. Perhaps they relied on the classical literature to provide economic information. If collected at all, faunal remains were principally used to construct lists of species represented. Some reports attempted to quantify the remains, however, in most cases the faunal report was relegated to a small and insignificant appendix.

Recently, faunal analyses of Roman period sites in Italy have received greater attention. A variety of good and extensive reports and books are available which cover a range of urban and rural sites (Barnish, 1987; Barker, 1976; 1977; 1978; 1982; Bökönyi, 1990; Cartledge, 1981; Greene, 1986; Hesse and Wapnish, 1987; King et al., 1985; Potter, 1987; Steele, 1983; Watson; 1992). The results and conclusions are important to the growing body of knowledge about the Roman diet and econony, however many of these reports may not have enough statistical content about the age, sex, and quantity of animal species represented to satisfy the zoologist and anthropologist. It is my goal to address this concern in my analysis of the sample of faunal remains from San Giovanni.

CHAPTER 2

BACKGROUND: SOUTHERN ITALY, LUCANIA, AND SAN GIOVANNI DI RUOTI

2.1 Environmental History

One cannot attempt to analyze or interpret any artifactual or ecofactual component from an archaeological site in ignorance of the environmental and cultural context of the period and area. In no sub-discipline of archaeology is the incorporation of this knowledge so vital as within zooarchaeology. Animals are affected to varying degrees by the physical, geographical and social environments. Physical factors such as climate and geography often act as restrictors of animal habitats, simply because most species physiologically function optimally within given temperature ranges and geographic landscapes. Similarly, humans may act as restrictors of animals through their efforts to control and exploit species. Human influence becomes particularly important when one studies the effects of farming, husbandry, and other anthropogenic factors and practices on animal populations, primarily domestic ones, but not necessarily only these. Each archaeological site has a unique combination of these physical and social factors which affects the animal population, thus any sample of faunal bones studied from any site needs to address these physical and social factors in order to place analyses and interpretations into perspective. The purpose of this chapter is to briefly discuss the climate, geography, and socio-political, economic and cultural history of southern Italy, in general, and the region of Basilicata (which corresponds broadly to ancient Lucania), and the site of San Giovanni di Ruoti, in specific. This is important to understand because the regional and local environments, both climatic and cultural, could have strongly affected the character of animal husbandry practised by the Roman occupants and agriculturists at San Giovanni.

Although climatic conditions throughout the peninsula vary depending on latitude and altitude, modern Italy typically experiences a Mediterranean climate, characterized by mild, wet winters and hot, dry summers. However, in many regions of Basilicata , including Ruoti, this typical climate is somewhat modified by altitude and, to an extent, by the inland position of the area (Campbell, forthcoming). Because of these factors, Ruoti generally experiences slightly cooler mean annual temperatures and reduced mean precipitation than the average values recorded for the region of Basilicata, where seasonal temperatures range from 20-24° C in summer to 0-4° C in winter, and average seasonal precipitation from 10-50 mm in summer to 75-100 mm in winter (Atlante Enciclopedico Touring, 1986). The microclimate of Ruoti likely bears closest resemblance to the neighboring area of Potenza. Thus, after correcting for altitude and geographic differences, the mean annual temperature at Ruoti will be close to 12°C, and the mean annual precipitation will be 850-900 mm (Campbell, forthcoming). These statistics can generally be extrapolated back to the Roman period with minor variations. Thus, for the purposes of this thesis it will be assumed that climatic conditions in Roman Lucania and modern Basilicata were, and generally are, meteorologically similar.

The modern province of Basilicata, along with the northern portion of Calabria, comprises most of the ancient land of Lucania (Smith, 1854).

Geographically, Lucania extended from the Tyrrhenian Sea on the west to the Gulf of Taranto on the east and was bounded by the ancient lands of Samnium and Apulia on the north and northeast, Campania on the northwest, and the land of the ancient Bruttians (part of modern Calabria) on the south (Smith, 1966:206). The physical landscape is diverse. The Apennine mountains are the dominant physical landform and they transverse the whole of Lucania, being more mountainous on the western side. However, lowland areas are prevalent near the coasts. Numerous rivers and their tributaries carve the landscape.

Traditionally a certain notoriety characterized the mountainous areas of Lucania, which were, and often still are, considered "one of the wildest regions of Italy" (Smith, 1966:209). Extensive forests blanket the landscape. The vegetation of the lowlands consists primarily of various grasses on lush plains and forests monopolized by oaks. The lower montane regions are dominated by lower beech forests with oak and chestnut. The upper montane zones contain upper beech forests with firs and pines (Campbell, forthcoming). It is believed that the forests of the Roman period were more extensive and denser than those in modern Basilicata, owing to a history of disturbance caused by logging and clearance at least over the last 100-200 years, a process which is well-documented for the area (Tichy, 1957). References to bears (Horace, Carm. 3. 4. 18, among others) and wild boars (Horace. Sat. 2. 8. 6) document the existence of these animals within Lucanian forests. Today, however, these animals are extremely rare or extinct in this heavily deforested area.

2.2 Socio-political History

The socio-political history of Lucania includes episodes of migration, war, subjugation, peace and settlement. The earliest historic occupation of the area, dating to before 500 BC, was a mixture of Greek colonists around the coast and Lucanian people in the interior. In the last five centuries BC, these people experienced severe political and social upheavals including the three Samnite wars, the Second Punic War (with divided alliances), and the Social War. Each episode caused considerable economic, environmental, and social stress and unrest. The Social War of 90-88 BC in particular, "gave the final blow to the prosperity of Lucania" (Smith, 1966:208), a process further hampered by the involvement of the Lucanians on the losing side of the civil war between Marius and Sulla immediately following the Social War. In the end, after much strife, the Lucanians surrendered and were enfranchised into the Roman culture and government, the last of them around 84 BC. The slave revolt of 73-71 BC further damaged Lucania. From then on, however, peace was generally maintained, despite minor political and administrative changes, including the implementation of direct taxation in kind under the Roman emperor, Diocletion, until the fifth century AD. At this time, political, economic, and social problems wreaked ubiquitous havoc in the western Roman world. While Lucania suffered under the Visigothic assault of AD 410, some economic prosperity, in isolated regions was enjoyed within Lucania after this time. Finally, in AD 476 Roman Lucania came to an end with the collapse of the Roman empire in the west. In the subsequent rule of the area under Ostrogothic kingdoms, conditions were at first relatively peaceful until the outbreak of the Gothic wars in AD 536-553. It is possible that the firing and final abandonment of San Giovanni was an incident of one of the many episodes of unrest during these Gothic wars.

2.3 Economic History

Just as the socio-political history underwent changes through the ages in Lucania so did the economic history of the area. The ancient economy of southern Italy has always been dominated by rural farming and husbandry activities. Indeed, the importance of the land was fundamental to the Roman economy. A brief account of Roman farm complexes, and farming and husbandry activities is therefore necessary in order to place my study of the faunal remains of the Period 3 midden deposits from San Giovanni into proper perspective.

Roman period farm complexes varied in size and scale of activity. Some were vast and elaborate estates while others were simple working farms with small residential structures. Survey work around Ruoti revealed that a range in scale of sites and settlements existed in the area (Small, 1991; Roberto and Small, forthcoming). The early villa at San Giovanni, "which appears to have been fairly typical of the villas in the mountainous interior of Italy" (Roberto and Small; forthcoming) measured approximately 4,000 m^2. This is within the 2,001 - 5,000 m^2 size range characterizing the villas of the region (Roberto and Small, forthcoming). In addition to villas of this size, large villas or villages, measuring between 5,001 and 10,000 m^2, were also recorded. Smaller farm complexes (less than 2,000 m^2), were likely common (Percival, 1976:56), and probably were so throughout the Roman period, especially in more remote mountainous regions. However, they appear to have been rare in the Ruoti region on the basis of the survey results (Small, 1991). San Giovanni was a moderate to large sized villa throughout its occupation.

Due to the political and social problems in southern Italy near the third century BC, the Roman government confiscated large parts of land from the native tribes (Small, 1978:197). The general belief has been that this confiscated land was rented to wealthy individuals, who acquired large tracts of land, constructed massive rural villas and farming complexes, and converted much of the arable land into pasturage for their profitable ranching activities. These large farming and ranching complexes, or *latifundia*, forced many small-scale farming operations into decline. In this process large sections of land were bought by these wealthy farmers, while smaller farm complexes were amalgamated into the estates and holdings of the rich. The rural countryside became progressively depopulated as fewer but larger farming estates were established and destitute farmers migrated to urban centers. The formation of these large estate complexes has been traditionally argued to be the primary factor causing widespread economic decline and depopulation of the southern Italian countryside (Small, 1978: 197), including Lucania.

Recent archaeological investigations, however, have provided evidence refuting the idea that *latifundia* were the primary source of agricultural products throughout the Roman occupation of southern Italy. It is now believed that settlement in small and moderate sized farms, rather than large ranches, was widespread in the Hellenistic and early Roman imperial periods, over many areas of Italy (Small, 1978:197), including the mountainous regions of central and southern Italy (Frank, 1933: 175). In a study of sixteen of these Roman villa farm complexes in Basilicata, including San Giovanni, Buck and Small (1980) noticed that:

> the location of these villas indicates that they concentrated on a combination of agriculture with a forest economy appropriate for the keeping of large herds of swine and local flocks of sheep and goats. Whether wide-scale transhumance formed any part of this economy must be considered very doubtful. The remoteness of the villas from major centres may explain why they are sited close to reasonably important routes giving ready access to more distant markets (Buck and Small, 1980:564).

It is quite probable that the villa at San Giovanni conforms more to this type of farm and economic base, prevalent throughout southern Italy from the first century AD through the sixth century AD than to the large ranch estates with their predominantly transhumant economic patterns.

2.4 Farming History and Practices

Farming practices during Roman times are documented in the writings of the classical agronomists, including Cato, Varro, Columella, Pliny the Elder, and Palladius. Additional information is found in modern studies (Frank, 1933; White, 1970). Combined, these sources provide a general picture of farming and husbandry practices which acts as a framework from which to compare results obtained from faunal studies at specific sites. The following brief discussion of Roman farming practices will center on animal husbandry practices and the role of animals in the rural-farm culture and life, issues that are directly relevant to faunal analyses.

Which animals were kept, raised, or exploited by Roman farmers depended heavily upon a complex interaction of cultural and physical factors. As in any economic system, the farmer wanted to maximize gains and minimize costs. Thus, the role of animals in the economy varied depending on the geographic area, nature and scale of the farm, and sociocultural dicta. Rural Lucanian farms raised and exploited domestic animals including pigs, sheep, goats, cattle, horses, asses, mules, and poultry. In addition, wild resources such as boars, bears, birds, tortoises, and other animals were available.

Cattle and oxen were indispensable working and draft animals on Roman farms. Large-scale cattle raising ranches were restricted to well-irrigated lowland valleys outside the Lucanian region. Some species raised on these ranches were intended primarily for slaughter, others were milked for cheese production. However, unlike today, cow's milk was not the primary Italian milk resource (White, 1970:206). Another resource produced by these animals, manure, was utilized as a fertilizer. In Lucania, it appears that the principle role fulfilled by cattle and oxen was as draft animals to pull plows; therefore at least two animals were needed. Aside from this purpose cattle probably did not contribute much to the rural farm economy.

Like cattle and oxen, horses were also work animals, although their role on the farm was limited. Instead, horses were used for more prestigious duties including military activities, rapid travel, chariot racing and riding during hunting. Mules, on the other hand, were important to the farming industry, especially on large estates where they were often used as pack animals or harnessed to pull carts (Hyland, 1990:35, 72). Asses and donkeys performed similar duties but were often overburdened and harshly treated in comparison to mules (Hyland, 1990:36). Consumption of horses and related species was frowned upon during the Roman period.

Sheep were an important resource in southern Italy where high altitude and low rainfall promoted production of the best wool. Sheep raising systems were perhaps the most variable, ranging from nomadism, to free range and transhumance, to folding and stall feeding (White, 1970:302). In many cases, sheep were incorporated into intercultivation systems where they fed and fertilized in and among the olive and vine plantations. Since wool was the primary resource, the maintenance of the quality of the flock was essential. Milk and cheese were also important, the latter a means of converting surplus milk into a marketable commodity. Mutton came principally from slaughtered and sacrificed lambs, but it rarely surpassed wool as the primary resource from sheep during Roman times.

Goats, like sheep, were also raised in high and dry areas, although they were best pastured in rough wooded districts (White, 1970:313). A threefold exploitation of milk, meat, and skins/hair, in that order, was practised. Goats produced abundant quantities of milk, double that of cattle when the size factor is controlled (White, 1988:235). This milk was preferred for drinking and cheese manufacturing during Roman times.

The herding of sheep and goats in transhumant flocks has frequently been believed to be the dominant husbandry activity in southern Italy throughout the Roman period (Barker and Grant, 1991; Brunt, 1971; Frayn, 1984; Stevens, 1966; among others). In this pastoral type of economic system sheep and goats would be wintered at lower elevations and moved to higher pastures for summer grazing. The adaptability of these animals to mountainous habitats, such as those found in regions of Lucania and within the Apennines, where much of the land is extremely poor, combined with the profitable resources marketable from their exploitation, made the transhumant herding of sheep and goats an efficient venture, especially in southern Italy.

Pigs were the major supplier of meat, meat products, and lard in the Roman period (Barker, 1985; Davies, 1971; among others) and it was generally commonplace that most farms raised some swine that could live on scraps and refuse (Frank, 1933:168; White, 1970:316). The primary criterion in Roman Italy for larger herding operations, appears to be the association of forests or woods which provided the proper food source, namely acorns and other mast from trees such as oak and beech. References noting the training of swine to come to the sound of a horn for feeding (White, 1977:82), suggest that herds were left to roam the open country rather than being penned. Apparently this practice of herding swine was seasonal (Parain, 1966), for "when foraging in the woods was over, these swine were fed acorns, beans, and if the price permitted, some barley" (Frank, 1933:167).

Poultry farming was also important, and could be undertaken almost anywhere. Chickens reproduced quickly and surplus stock was sold or slaughtered. Eggs were essential to the Roman diet. Although poultry were generally attended to by the already busy women, or housewife, on the farm (Ghigi, 1939:11), the fact that a reasonable profit could be maintained without a great deal of upkeep and effort prompted many farmers to keep at least a small collection.

Bee keeping, the housing of birds in special aviaries, storing fish in constructed fishponds, and the keeping of exotic animals were all considered to be specialized farming practices. Generally these activities catered to an elitist market concerned with conspicuous consumption.

Finally, before leaving domestic animals, mention should be made of those animals kept as pets, primarily dogs and cats. Farm dogs fulfilled a variety of roles depending on the breed. These ranged from hunting and tracking prey, to guarding and rounding up flocks of sheep, to watching and protecting houses, to drawing small carts, to acting as faithful friends and companions (Toynbee, 1973:109). Cats, on the other hand, had limited roles on the farm. Their primary function was to catch mice and other vermin around the villa (Toynbee, 1973:88).

Wild animals were normally captured or killed during hunting ventures. Sport hunting was an extremely popular activity during the Roman period, especially among the wealthy rural population, who could afford such a luxury, and had villas near forests (Anderson, 1985) Within these forests a variety of game was hunted, including wild boars, stags, hares and rabbits. Bears, wolves, and other threats to flocks and/or crops were also hunted, although generally out of necessity rather than for sport (Anderson, 1985). During the early empire, hunting on foot was customary; however, by the late empire the tradition of hunting on horseback was more firmly established (Anderson, 1985).

With these general principles concerning the physical, social, economic, and cultural, construct and history of the Roman empire and the region of Lucania outlined, we can now narrow the focus and concentrate specifically on the site of San Giovanni and the faunal sample recovered there.

2.5 The Site

San Giovanni (ca. 40° 44'N; 15° 40'E) is located near the small town of Ruoti, just northwest of Potenza, in the Lucanian Uplands of the southern Apennines. It is situated on a southward facing slope ca. 670 meters above sea level, overlooking the Fiumara di Avigliano, a tributary of the Sele River which flows towards the Tyrrhenian Sea (Small, 1985). The elevation of the site places it within the transition zone between Mediterranean and lower montane life zones (Campbell, forthcoming). As a result, the climate can vary from almost true Mediterranean to montane depending on meteorological fluctuations. The mean annual temperature, close to 12°C, is recorded as averaging mild conditions in the summer and frequent cold conditions in the winter; the frost-free period should be close to 200 days (Campbell, forthcoming). However, much seasonal and annual variation is possible owing to the geographic position of the site within transitional ecological and environmental zones. The soils of the San Giovanni vicinity mimic this variability and are composed of clays and silts with limestone outcrops nearby (Small, 1981). Finally, in terms of vegetation, the area supports mixed agriculture and viticulture, and extensive oak and beech forests still exist at higher elevations.

The occupation of the site extends from the end of the first century BC to about AD 550. Its initiation coincides with the restoration of stable government under Augustus. From that time a series of rural villa complexes characterize the various periods of occupation. The destruction of the last of these villas signals the final demise of the site. It may possibly be linked with rampant destruction in Lucania during the Gothic Wars in the decade following AD 540 (Small et al., 1985). Whatever the case, San Giovanni was not reoccupied after being abandoned around AD 550.

The occupation at the site has been subdivided into several periods based on changes in the architecture and structure of the villa complexes, substantiated by changes in material goods, especially pottery. Three periods of occupation, (Period 1, 2, and 3), which include various phases of villa construction and/or renovation and development (the villas of Period 1; Period 2A, 2B, 2C; Period 3A, 3B) are noted. Periods 1 and 2 and associated villa structures will only be discussed briefly. However, the two occupation phases of Period 3, denoted Period 3A and Period 3B, will be discussed in detail because they provide chronological and cultural contexts for the midden deposits analyzed here.

2.5.1 The Period 1 Villa

The Period 1 villa was occupied continuously from around 30 BC to AD 221. The exact layout is difficult to determine because subsequent construction in later periods destroyed much of it. This villa was probably a one-story structure (Small et al., 1985), part of which was arranged in the shape of a "U" which bordered a central courtyard, opening to the northwest (Small et al., 1985).

Unfortunately, very little is known about the function of most of the villa rooms, particularly those to the east of the central courtyard, which were radically altered or obscured by the villas of later periods. However, a kitchen and several storage rooms have been identified, as well as a water mill for agricultural processing (Small and Buck, forthcoming). The "overall impression given by the artifacts is that the villa as a whole was a rather modest establishment, comparable to many others built in the remoter parts of the Italian countryside in the early empire" (Small et al., 1985:8).

Although modest architecturally, the villa probably had important economic functions which were likely based on agriculture, husbandry, and the exploitation of the surrounding forest. To ensure profit, the owners must have "invested considerable funds in the property, and must have required some staff to operate the villa" (Small, 1985:175). As is the case in many Roman rural villas, the functional and domestic quarters were separated.

2.5.2 The Period 2 Villa

Over a century of abandonment separates the end of Period 1 from the beginning of Period 2. This second villa, dated from about AD 350 to AD 400, underwent three construction phases which greatly altered the previous structure (Small, 1985). Many of the Period 1 rooms were modified and reoccupied. In addition, extensive reconstruction occurred in the eastern part of the complex, whereas some demolition was carried out in the western area (Small et al., 1985). Internal modifications included new clay floors in most rooms (Small et al., 1985).

The central courtyard continued to be used as a yard but now contained an impressive tank in the center and several large dolia, or huge storage pots, in the southwest corner (Small et al., 1985).

The construction of a bath suite in combination with the discovery of imported North African fine ware ceramics (Freed, 1985), glazed window glass, and other rare, imported or valuable artifacts including marine oysters, suggests some degree of prosperity and comfort was available in the Period 2 villa.

2.5.3 The Period 3A Villa

There is no evidence indicating a break in occupation between Period 2 and Period 3 (Small et al., 1985). It could be that there was a brief period of abandonment which was unrecognizable archaeologically. It was not uncommon in fourth century Italy to have abandoned villas repaired for occupation (Small et al., 1985). Whatever the case, the Period 3 villas were the most impressive of all those at San Giovanni.

Period 3 is divided into Period 3A (AD 400 to AD 460) and Period 3B (AD 460 to about AD 550) based on extensive phases of rebuilding. Expansive construction and remodeling characterized the Period 3A villa. During Period 3A all but a few of the rooms from Period 2 were destroyed and the few remaining rooms were incorporated into the new structure which had an apsidal building, a new bath and a series of rooms with two stories (Small et al., 1985). Impressive wealth is attested by the architectural and artifactual evidence.

2.5.4 The Period 3B Villa

Of all the villa complexes constructed at San Giovanni, that of Period 3B is the largest and most impressive. Many additions and alterations occurred to the villa which nearly doubled in size over Period 3A. Earthquake destruction was probably the impetus for this phase of rebuilding (Small et al., 1985).

The function of many of the rooms in the Period 3B villa is distinguishable based on artifactual, structural, and feature clues. It was a two story complex; the upstairs rooms were the principal living areas (Small et al., 1985). A large apsidal room in an upper story was likely a reception hall. Many ground floor rooms served as storage areas. Several others, one with a mosaic floor, were probably dining areas and related service rooms. Still others probably functioned as housing stalls and stables for animals, since they had drains, floors of <u>opus signinum</u>, and wide doorways and corridors to facilitate access.

The Period 3B structure underwent several modifications and changes during its occupation. These involved abandonment of many of the rooms, particularly in the vicinity of the animal housing area, where subsequent midden materials accumulated. These changes indicate a period of decline prior to final abandonment (Small et al., 1985:34). A dwindling resident population and the poor quality of some of the later structural work indicate a lack of resources (Small et al., 1985). The site was finally abandoned around AD 550 when the apsidal hall was burnt.

2.6 The Middens

A midden has been defined as "a heap or stratum of refuse (broken pots and tools, ashes, domestic or food remains, etc.) normally found on the site of an ancient settlement" (Bray and Trump, 1988: 157). Essentially middens are garbage dumps. The varied, concentrated, and often abundant accumulation of artifacts and ecofacts contained within them makes middens a particularly valuable resource for increasing sample sizes and limiting biases in archaeological studies. In addition, tight chronological control is generally attained, since these deposits are usually spatially restricted, with clear definition, and often include enough artifacts and ecofacts that can be accurately dated.

Middens containing vast amounts of bones are especially important to faunal studies for several reasons. First, they often provide enough debris and material to afford a statistically significant sample size for analysis. Second, their accumulation is frequently attributed to animal processing and domestic waste. In other words, the materials within provide direct indications of ancient diets and economic patterns of the occupants at the site. They are often intentional accumulations of trash made by the inhabitants, as opposed to random and haphazard scatters of material that litter other regions of the site. Finally, bones within middens are generally well-preserved, owing to the fact that often they accumulate and are subsequently buried in a relatively short time. Thus, post-depositional loss of materials is generally not as pronounced as among other less protected archaeological deposits.

A total of nine middens was excavated at San Giovanni and their location is shown in Figure 2. Middens 1 and 2 date to Period 3A, whereas Middens 3, 4, 5, 6, 7, 8, and 9 were deposited during Period 3B. Dating of the middens is based on ceramic materials. Because of the continuous change in the form of the villa complexes at the site, owing to phases of construction, occupation, and destruction, it is unknown if the lack of middens from Periods 1 and 2 is due to destruction by later periods of occupation, including Period 3, or if Period 1 and Period 2 trash was disposed of in some other way.

Only Middens 1,4,5, and 7 were used in my analysis. These produced the greatest accumulation of bone materials that could be securely dated, and appeared to be free from contamination, thus making them ideal for study because these biases could be controlled. The remaining middens produced only small amounts of faunal materials. It was felt that their inclusion was not necessary to obtain a clear economic and dietary picture of Period 3, simply because they did not contain large enough samples. The faunal samples from Middens 1, 4, 5, and 7 provided an important chronological control from which to draw cultural comparisons or contrasts because they could be separated into Periods 3A and 3B.

Figure 2: Location of San Giovanni Middens

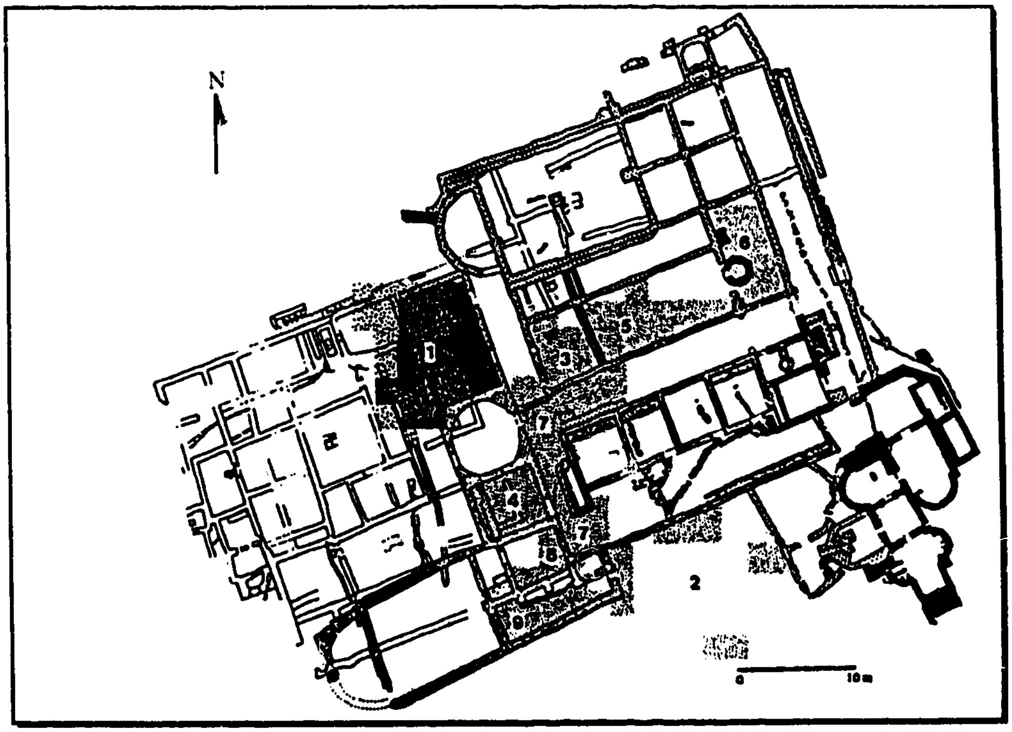


Table 1 records basic information about the approximate spatial area and volume. Soil analyses were performed for several contexts and layers within middens 4 and 5. These results, given in Appendix A, suggest a uniform midden soil type. The soil within the middens was generally dark in colour, often greasy and crumbly in texture, and moderately alkaline. Nitrogen levels were relatively low, but the levels of other inorganic minerals were relatively high. It is assumed that the pedology of each midden was similar, however this remains to be tested.

Table 1: Area and Volume of Middens 1, 4, 5, and 7

Midden	Period	Approx. Area(m^2)	Approx. Volume(m^3)
1	3A	116	17.1
4	3B	68	6.5
5	3B	50	11.5
7	3B	84	18.9

2.7 The San Giovanni Faunal Sample

2.7.1 Recovery

Faunal remains were collected from the entire area of excavation. Recovery methods included trench collection based on visual inspection, and screening. The relative merits and disadvantages of each of these techniques among archaeological excavations is well documented (Payne, 1972b; Thomas, 1969; Steele, 1983). Some authors (Payne, 1972b; Thomas, 1969; among others) have discussed the failure of visual inspection techniques in the recovery of small, inconspicuous elements and fragments, which subsequently may bias the sample towards an over representation of larger species. They assert that the primary benefit of sieving and screening deposits is to eliminate this bias and produce a more representative sample.

Steele (1983), on the other hand, expresses confidence in the success of visual trench inspection techniques in recovering small bone elements and fragments, provided the excavators are aware, informed of osteological morphologies, meticulous, and vigilant. He cites the recovery of hundreds of chicken bones, smaller bird bones, and bones from small field mice and moles without the use of screens as partial proof of his methods. A further study revealed there was no great difference in the relative frequencies of animals of comparable sizes picked visually from trenches and recovered from screens. He thus upheld his contention that visual inspection for bone at San Giovanni has not significantly skewed the recovery of domestic animals (Steele, 1983:77).

Despite the results of Steele's experiments, parts of the midden deposits from San Giovanni were screened through 5mm and 2.5mm screens. The dense concentration of faunal materials in the dark, organically-rich, and often greasy, soil matrices warranted such an action, especially when great control was required in extracting every bit of material from these dumps. Fortunately, the rich, black, crumbly soil could be put through even the finer mesh with ease as long as it was reasonably dry. In addition, some contexts from within midden deposits were floated in efforts to extract the maximum amount of environmental information within strict controls. In all cases, the entire midden was excavated, except Midden 5 due to time constraints.

Attempting to quantify the volume of soil in the middens and the proportion of that screened and floated is problematic. In some cases the volume of soil screened and floated was recorded. However, this was unsystematic. In the post-excavation analysis several layers in various parts of these middens were combined when they were determined to be contemporaneous. Often some layers from the middens were screened but other contemporaneous layers of the same midden midden not. In other cases, varying proportions of the soil from a given layer was screened. Since the midden deposits were not systematically screened, statistical analyses of the recovered remains are difficult to apply.

Without complete records of the volume of soil within the middens and the quantity screened it is necessary to reconstruct rough models of the middens and their associated layers in efforts to estimate soil volumes. Spatial dimensions of each midden were obtained from the site map, and depth from section plans. Very rough three-dimensional models of the four middens were constructed based on the limited information available, which were then used to estimate the volume of soil within each midden. Similar models and soil volume estimates were derived for unquantified screened layers. The final results, presented in Table 2, are the estimated volumes of the amount of soil comprising the midden, and the proportion which was screened.

Table 2: Volume of Soil and Portion Screened in Four Midddens

Midden	Total Volume of Soil (m^3)	Volume of Soil Screened (m^3)	Percent Screened
1	17.1	1.6	9.4
4	6.5	2.3	35.4
5	11.5	3.1	27.0
7	18.9	1.9	10.0

2.7.2 Preparation for Analysis

Following recovery, the faunal material excavated at the site was prepared for analysis. Cleaning, identification, and cataloging were the first steps in this process. Most of the samples of bones from the middens had already undergone these steps by Steele and Assad. However, some contexts or parts of contexts from within some middens had faunal materials yet to be sorted, identified, and cataloged. I combed through the entire sample to recover these, subsequently preparing them for analysis, and incorporating them into the appropriate midden classifications. All identifications were done in consultation with reference skeletons and informative manuals (including Boessneck, 1969; Chaplin, 1971; Olsen, 1968, 1973, 1982; Schmid, 1972; among others). Where possible each specimen was identified to species level, however for some elements, genus, family, order, class, or even generalized groupings such as medium-sized mammal were all that could be attributed.

The majority of the faunal remains from the four midden deposits had been sorted into identifiable (ID) and unidentifiable (UNID) categories by previous investigators. Each of these ID bones had been labeled with a catalog number containing its unit/grid provenience, layer number, and consecutive, ordinal designation. I cataloged newly processed elements in the same manner.

The cataloged information recorded in the data listings included taxa, element type, side of the specimen, sex, age, and a description of the specimen. In many cases the taxon and element were the only information recorded, which unfortunately limited the value of the data. Information on the side, sex, and age of the specimens was not always possible to determine. To extract more information from the sample, I utilized schemes of aging pig and caprine mandibles and mandibular teeth to enhance the limited statistics listed for the ages of these animals. In addition, some elements from the sheep/goat taxon were further distinguished as to species and/or sex. Finally, the elements were reviewed to check for the presence and location of cut, cleaver, or saw marks left by butchery practices, as well as other types of pre- and post burial modifications caused by human, animal, or natural agents. My aim was to obtain as much relevant information as possible per element using a combination of information recorded within the data lists coupled with my further checks and observations.

Unfortunately, one problem limited accomplishing this goal fully. Most of the elements listed in the data lists recorded by previous zooarchaeologists could be actually found within the sample of San Giovanni faunal remains shipped to Edmonton from Texas A&M University. However, some listed elements could not be found, specifically, many of the pig teeth and/or bones from Middens 1, 4, 5, and 7. Some other elements from several other taxa were also not located. Fortunately, the information provided in the data lists was generally complete for most of these "missing elements" and their absence did not hinder my analysis significantly. The greatest difficulty was the fact that I could not double check, measure, or critically inspect these elements. Thus, my procedures to sex and age missing elements, particularly mandibles and mandibular teeth, could not be performed for them.

The information for each element listed in the data lists, as well as new recordings and extra information on the previously studied materials which I added based on my studies, were entered into the Excel spreadsheet program. This enabled me to sort, list, and group the elements readily, based on any number of criteria.

2.7.3 Methods of Quantification

The initial stage of a faunal analysis is to quantify the already identified and cataloged bones. In recent years much attention has been given to methods of quantifying faunal remains. Several methods and variations of these are utilized, including (i) Number of Identifiable Specimens (NISP), (ii) Minimum Number of Individuals (MNI), (iii) Relative Frequency (RF), and (iv) systems of weighing.

The NISP is the total number of elements of each species or taxonomic group in the faunal sample, regardless or side, age, and sex. It is simply a count of the number of fragments of each taxon's element of study in the sample. There are many problems with this method (as discussed in Grayson, 1984: 16-92; Klein and Cruz-Uribe 1984: 24-38). In general, NISP values are particularly vulnerable to effects and degrees of fragmentation in the sample, which are different for each animal and site. Fragments are usually ignored or treated the same as whole bones. As a result NISP will often exceed the actual number of individuals considerably because its calculation does not discriminate between the bones of the same or a different carcass. Therefore one could easily count the same animal several times. NISP also automatically weights a species according to the number of quantifiable bones in its skeleton. Animals with more identifiable parts will usually be over-represented, and vice versa for animals with fewer identifiable parts (Daly, 1969). Furthermore, it gives larger values for taxa tending to reach the site whole than for those butchered elsewhere and reaching the site in parts. Despite these criticisms, NISP may be an adequate measure to demonstrate the rank order of species abundance and broad patterns in the assemblage profile (Winder, 1991:116). Since I was dealing principally with mammals, all of which generally contain the same number of identifiable bones (except for minor dental differences), I chose NISP as a quick and efficient indicator of species abundance and rank.

The MNI calculation is based on the most commonly retrieved element of each taxon in the sample. In its traditional form (Klein and Cruz-Uribe: 1984) it is a raw count of the number of individuals necessary to account for all the identifiable bones. Often it incorporates information on the age and sex of the animals, in efforts to accurately categorize individuals and avoid unnecessary overestimation (often the case with NISP) or underestimation (often the case with MNI's that do not use age and sex subcategories) of species. Various modifications of the MNI method have been proposed over the years (Binford, 1978, 1981, 1984, 1988; Bökönyi, 1970; Casteel, 1977a, 1977b; Chaplin, 1971: 70-75; Grayson, 1973, 1978, 1979;), including methods that incorporate procedures for matching paired elements, and integrate the Lincoln (or Peterson) index (Fieller and Turner, 1982; Krantz, 1968; Poplin, 1976; Wild and Nichol, 1983; Winder, 1991).

The assumption is that MNI numbers reflect original kill ratios, without the interdependence difficulties inherent in NISP values. However, other biases are encountered. Any count of a particular bone that has, as a result, been artificially increased relative to other less biased bones will skew MNI numbers (Gilbert and Singer, 1982:32). Furthermore, MNI counts are subject to the problem of aggregation, wherein they vary depending on how the faunal material from a given site is divided into smaller aggregates, based on temporal or spatial factors (Grayson, 1984:29). Despite these problems MNI values were calculated for the San Giovanni fauna. The sample is large, thus those modifications to the MNI method attempting to correct for this bias were not used. It was felt the problem of aggregation would be controlled by treating each midden and its layers as a single unit. The same procedure was followed in the separation of phases. The possibility that materials may have been mixed among the three Period 3B middens or that differential deposition of carcass pieces occurred among them was entertained. They are not separated by great distances, and could very well contain different elements from the same animal. Thus, Period 3B MNI counts are not simply a sum of the Middens 4, 5 and 7 MNI counts. Unfortunately, the problem of artificial increment of some bones relative to others cannot be controlled fully, and thus remained a bias.

The MNI method chosen is one of the more common and conservative measures and follows principles outlined in Klein and Cruz-Uribe (1984). It incorporates information on the age and sex of the animals and side (either left or right) of the element, where possible. Attempts were made to match fragments from single elements, to pair elements which were likely from the same animal, and to fit loose teeth into appropriate mandibles or maxillae, in efforts to avoid counting the same animal twice. The majority of MNIs were derived from dental elements, of which pig and sheep/goat dominated. It was felt that a scheme for aging these teeth would be beneficial for separating these taxa into smaller aggregate groups, wherein MNIs could be calculated based on each developmental stage represented. This method was not feasible for all taxa. However, efforts were made to broadly age elements from other taxa where possible, and this information was taken into account when MNIs were calculated. Age related changes in bone morphology, size, and fusion of epiphyses were the criteria used to demarcate representative elements into juvenile, immature or adult categories, which in turn formed aggregate groups from which to derive MNI counts. The total MNI for each taxon was the sum of all the separate MNIs from each aggregate age group or developmental stage for that particular taxon. The formula employed was MNI= *max. (L, R)*. In cases where the side was indeterminate I allocated equal numbers to each side. No overlap among age group or developmental stage was tolerated. In this way, the problem of counting elements from the same animal which as a factor of differential growth may lie in separate age groups or developmental stages was controlled.

Binford (1978, 1981, 1984) substitutes Minimum Number of Elements (MNE) and Minimum Animal Units (MAU) for NISP and MNI calculations. These are related to the other quantifying methods. However, "they are specifically designed for the study of skeletal part representation, rather than taxonomic abundance *per se* " (Ringrose, 1993:129). The MNE is simply the NISP calculated for each skeletal part. The difference is that an attempt is made to match fragments in order to minimize the chance of counting the same bone (or bone-part) twice. In this way, MNE allows for fragmentation, while NISP does not. The MAU is a normed version of the MNE. It is obtained by dividing the MNE by the number of that skeletal part in living animals, for example 2 in the case of paired elements (right and left side), or 4 in the case of metapodials (right and left, front and back legs).

Binford's methods were not used in this report for a variety of reasons. First, correct matching could not be achieved for all elements. Second, while MNE and MAU lend themselves readily to the quantification of limb and long bone elements it was unclear how to deal with loose teeth, as well as jaw bones with and without attached teeth. Teeth comprised the majority of my sample. Third, my primary goal, at this point, was to understand taxa abundance and representation rather than skeletal part representation (the exception being the section on butchery and resource exploitation). Finally, these methods are not practised (as yet) in Classical archaeological projects.

The other modification of the MNI incorporates principles derived from the Lincoln (or Peterson) index and is described more fully elsewhere (Fieller and Turner, 1982; Krantz, 1968; Poplin, 1976; Turner and Fieller, 1985; Wild and Nichol, 1983; Winder, 1991). This method proposes that *LR/P* (*L*= number of lefts, *R* = number of rights, *P* = population) is an estimate of the number of animals in the Death Assemblage, based on that skeletal element (Ringrose, 1993:128). In theory this method offers the best estimate of the actual assemblage of living animals, which is the primary reconstructive goal of many faunal analysts. However, in practice this method contains many biases. The multiplicative nature of it means that it is more vulnerable than other methods to any kind of misidentification, especially in pairing and fragmentation (Ringrose, 1993:129). Transport of elements to and from the site presents further complications. Finally, the method can become highly complicated mathematically (Winder, 1991), and thus is generally avoided. It still remains to become widely accepted. For these reasons, I did not choose to use this method in my analysis.

The RF method first developed by Perkins (1964), and later modified by Gilbert, Singer and Perkins (1981), and Chase and Hagaman (1987) is infrequently used, except in certain institutes. Some authors (including Chase and Hagaman) refer to it as the Total Minimum Animal Units or TMAU. Whatever the term, it is essentially a NISP count in which at least two corrections have been made. First, the recovery frequency of each bone type is divided by the number of times it occurs in the skeleton, thus averaging left-right distributions. Second, the sum of these corrected frequencies is divided by the number of different bone types recovered, thus leveling the advantage a species might gain by having more of its skeletal parts represented (Gilbert, Singer and Perkins, 1981:87). However promising, RFs were not calculated for the San Giovanni sample for several reasons. First, like NISP it cannot discriminate between bones of the same or a different carcass. Second, mammals were the focus of the study, thus the first dividing factor, the total number of quantifiable bones occurring normally in the skeleton, would be generally the same. Similarly, the total number of quantifiable bone types is normally equal, at least for the principal taxa represented, whereas other taxa are represented by rather few bone elements. Finally, the method is not universally practised or popular. Thus, for these reasons it is neither adequate nor possible to try to make an RF estimate of the San Giovanni material.

Finally, a method of weighing categorized groups of bone has been practised (Casteel, 1978). This approach uses skeletal weight to estimate dietary contribution based on allometric relationships between body size and body proportions (Jackson, 1989; Reitz et al., 1987) It presumes the weight of archaeologically recovered bone to be in some way physiologically related to the mass of muscle and other tissue it supported. Binford (1978, 1981) developed the Modified General Utility Index (MGUI), which was later reworked and clarified by Lyman (1985, 1992) and also Metcalfe and Jones (1988) who proposed the new label, Meat Utiity Index (MUI). These methods were not used in this analysis for several reasons. First, missing elements could not be measured or weighed, thus the sample would be incomplete. Second, it is suggested that this method, as presently used with fragmentary remains, may not provide a dependable characterization of the relative contributions of identified taxa (Grayson, 1979; Jackson, 1989). Regression equations have not been fully developed for all animal species, and vary among individuals within a specific taxon. Furthermore, they are all based on modern breeds (Hale et al., 1985; Prange et al., 1979), and have been shown to respond differentially to sample size (Jackson, 1989:607). Third, MGUIs and MUIs have often been applied to remains from early hominid sites, in efforts to distinguish hominid transport and carnivore kill sites, with much controversy (Grayson, 1989; Lyman, 1985, 1992). As far as I am aware, they have never been applied in studies of Roman period sites and their inclusion in this report would likely bring unnecessary confusion. Finally, an illustrative rank of the estimated meat contributed by the principal taxa represented rather than an exact quantification of available meat contributed by all taxa was the primary focus of my dietary research. Therefore, to achieve this, the system of meat weight estimation based on MNI weight conversions (Smith, 1975; White, 1953) was used.

Much discussion of the merits and shortcomings of all of these methods is available. NISP and MNI values are by far the most universally practised and popular of all the methods. Suffice it to say that, when used in conjunction, NISP and MNI values provide a good indication of species/taxa abundance in faunal analyses. Both were used in my analysis of the San Giovanni faunal material from Middens 1, 4, 5, and 7. Overall, the focus was to obtain a clear picture of the relative contribution of the taxa represented which will reflect and approximate the actual representation of the taxa in the economy and diet at San Giovanni.

CHAPTER 3

RESEARCH OBJECTIVES AND METHODOLOGY

Now that the faunal sample from the four Period 3 middens has been set into its physical and cultural context, my specific research objectives may be presented. These, and the methodologies used to answer them, will be discussed under the following headings:

- Sampling and Recovery
- Species Representation and Quantification
- Age and Sex Distributions
- Butchery and Resource Exploitation

3.1 Sampling and Recovery

Any faunal sample is more fully understood when it is interpreted in light of the sampling and recovery procedures. The middens have already been examined to estimate the volume of soil removed and the proportion screened. The screened and unscreened volumes were further studied to determine the type and quantity of bone represented in each. Advocates for screening claim this method allows for the recovery of a greater quantity of bones from smaller species, and a greater number of tiny unidentifiable bone fragments. Classifying the amount of bone retrieved, the NISP/taxon, the number of unidentifiable fragments, and the corresponding weights of each of these, according to screened or unscreened volumes, enabled me to test if a significant difference in bone recovery existed between these two methods.

3.2 Species Representation and Quantification

Identification of the species present was based on the inclusion of representative skeletal elements or bone fragments within the sample. A list of species present was constructed and compared with those from other Roman period sites to check for similarities and gross discrepancies.

The quantification of the species represented was performed at several levels. NISP and MNI calculations (described above), and percentage values based on them, were used throughout. Preliminary tables and figures present calculations for general class categories (mammal, bird, fish, reptile, amphibian), for each midden, and their designated phase (Midden 1 = Period 3A; Middens 4, 5, and 7 = Period 3B). Subsequent tables and figures present NISP, MNI, and percentage values for more specific taxonomic categories, and between wild and domestic mammalian (including amphibian and reptilian) taxa. These procedures enabled me to order the taxa present in terms of numeric abundance, in efforts to decipher the relative importance of each to the economy and diet at the site. I was able to see which species (or taxa) dominated, by how much, and determine if statistically significant differences existed among middens and between phases. The numeric representation of the various classes, taxa, and species facilitated comparisons of their relative abundance within the sample.

Ideally in any faunal analysis, standard measurements of all measurable bones should be taken and recorded in metric units, the goals being to determine if species, or sexes within species, fall within marked size ranges, or if size differences exist among species separated in time or space. Often, however, sample sizes are too small to allow any significant analyses of these measurements to be performed, or time limitations do not permit the measuring of all elements. Therefore, I chose to perform metrical analyses of the fourth deciduous mandibular premolar (dp4), and first, second, and third permanent mandibular molar (M1, M2, M3) teeth of pigs recovered from the four middens. Length, anterior width, and posterior width, as defined in Appendix H, were measured using digital calipers for each of these teeth, where possible. Only complete teeth were considered, regardless of side. An earlier study noted that there is minimal to no indication of sexual dimorphism in tooth lengths and widths from species of pigs (Payne and Bull, 1988:31), thus these measurements can generally be used to reliably separate wild and domestic individuals. In addition, tooth widths and lengths are relatively stable (widths moreso than lengths), and show no significant change related to age. Furthermore, residual individual variability is generally low. These facts promote the reliable use of tooth lengths and widths to indicate wild or domestic status of pigs. My goal was to determine if clusters of measurements form when graphed in scatterplots, which might be attributable to significant size differences between wild and domestic pigs within the San Giovanni sample. Classical literature contains references to wild boars and domestic pigs in Lucania. A morphometrical analysis of the teeth will allow me to determine the proportions of each of these species at San Giovanni.

3.3 Age and Sex Distributions

3.3.1 Aging

Any evidence for the age of bones, teeth, or antlers at death was recorded. The sources of evidence included rates of suture fusion, tooth eruption and wear patterns, development of muscle scars, and so on. I primarily used rates and patterns of tooth eruption and wear to age mammal species within my sample. This approach was restricted to schemes devised for pigs, and caprines (combined sheep and goat category) because these two taxa dominate the mammalian contribution, and have adequate sample sizes of dental elements. They also represent very common domesticates which have the potential to be an important mammalian contribution to the economy and diet. In isolated cases, information gained from the presence of unfused epiphyses, or morphological differences in the surface texture, particularly the roughened appearance of the surface of juvenile and fetal bone, or marked size differences in the bone, was used to broadly age individuals.

The age of death of each of the pig or caprine fragments is based upon the developmental state of eruption and wear of the mandibular teeth. Of these teeth, I used the incisors and canines rarely among pigs, and almost never among caprines, simply because they are less reliable indicators of age than premolars and molars. Premolar and molar teeth have distinct eruption and wear phases that can be readily designated into chronological brackets. It should be noted that specific ages for time of death cannot be established. The reason for this "is that different breeds mature at different rates and it is not known which breeds were being raised in southern Italy during this time" (Steele, 1983:79). Whatever the breed, they were probably slower to mature than more modern breeds since the latter have likely been genetically selected through the ages to mature and breed rapidly. In order to address this complication, the samples were divided into groups of individuals that appear to be in one of a number of distinct developmental stages at the time of death. Nine stages were recognized for pig mandibular teeth, and eight for caprines. The criteria demarcating each of these stages and the results of their manipulation will be discussed separately for the two taxa used - pigs and caprines.

3.3.1.1 Pigs -Aging

The dental criteria used to characterize each developmental stage based on the eruption and wear of pig mandibular teeth are presented in Appendix B. These are generally the same as those used in a preliminary analysis by Steele (1983) who states...

> The first stage represents an animal that was newborn, or possibly even fetal. The eighth stage represents an animal which has reached early adulthood. A modern pig with the teeth in this stage of development is usually around two to three years of age. The ninth and final stage represents an animal which has been mature for a long enough period for the animal's last molar, which had erupted at maturity, to exhibit extensive wear. A pig from a modern breed showing equivalent wear of the last molar should be well in excess of four years (Steele, 1983:80)

However, they have been enhanced by my inclusion of incisor and canine teeth.

3.3.1.2 Caprines - Aging

The dental criteria used to categorize each developmental stage based on the eruption and wear of the mandibular teeth of caprines are described in Appendix C. Far more extensive aging schemes and reference codes for the eruption and wear of the mandibular cheek teeth of sheep and goats are described elsewhere (Grant, 1982; Payne, 1987). These were thought to be too detailed for my purposes, therefore I devised my own system of developmental stages based on the information in these and other (Schmid, 1972; Silver, 1969) sources. Although age equivalents cannot be exactly determined for each of the eight stages, the approximate ranges based on modern breeds of sheep and goats are as follows: Stage 1, prenatal; Stage 2, birth - 0.5 year; Stage 3, 0.5 - 1.5 years; Stage 4, 1.5 - 2.5 years; Stage 5, 2.5 - 3.5 years; Stage 6, 3.5 - 4.5 years; Stages 7 and 8, over 4.5 years.

3.3.2 Sexing

Sexual data were recorded where possible, based on distinct morphological and size differences among the representative bones, which are characteristic of sexual dimorphism. In most cases the fragmentary nature of the bone hinders this analysis. However, some elements may be readily sexed providing key pieces are recovered.

3.3.2.1 Pigs - Sexing

It is possible to estimate the sex of pigs on the basis of canines. The morphology of the mandibular and maxillary canines of mature male and female pigs is sufficiently different to allow their separation. Male maxillary canines are large, open rooted teeth with deep grooving, whereas those of females are much smaller, stout teeth which are double rooted with a closed root canal in the adult sow. Male mandibular canines are moderately large, open-rooted teeth that are sub-triangular in shape. Female mandibular canines, on the other hand, have a crown that is a little smaller than that of males, but the root is deeply grooved and the root canal closed. They appear more squarish in cross-section. In addition, in the absence of canine teeth, one can determine the sex of pig mandibles and maxilla fragments on the basis of size and shape of the canine alveolus.

3.3.2.2 Caprines - Species Separation and Sexing

The morphological similarities between sheep and goats often force them to be grouped into the encompassing taxon "caprine" for analysis. However, there are some osteological differences that allow the separation of the species (Boessneck, 1969). Similarly, osteological differences between the sexes, particularly pronounced in the pelvis, allow them to be separated in some cases (Boessneck, 1969). The major difficulty in distinguishing species and sexes of caprines is that this depends on slight morphological differences in certain regions of certain bones. The fragmentary nature of faunal samples often does not lend itself readily to such specificity. Regardless, some information can be gained from an application of these criteria to the caprine bones of my sample.

Age and sex distributions among the mammals in the San Giovanni sample offer clues about the husbandry and animal rearing schemes practised at the site. Information about the age and sex of the animals being slaughtered provides insight into how, if at all, the animals were raised, and possibly how they were used in the diet and economy. A preponderance of the remains of young male mammals of a particular species, over other sexes and age classes, informs us that the species in question probably made an important contribution to the diet and economy, since young males are expendable (not required for reproduction), and often more palatable. Alternatively, a sample showing a more even balance between the sexes represented, with individuals surviving to older ages (a more natural death profile), may indicate the importance of the exploitation of secondary mammalian resources such as milk, wool, skins, hides, and manure, rather than meat, to the economy.

3.4 Butchery and Resource Exploitation

This is a complex topic because there are many factors that affect the availability of different kinds of meat or resources and the decisions made by the producers and consumers. Huelsbeck (1991) discusses these. One prime factor is choice (Huelsbeck, 1991:64). In many cases the occupants of the site prefer certain meats for consumption and export others as part of an economic or trade system. Depending on external or internal demands and choices they may choose to utilize local environments or intensify butchery practices. A series of social, economic, political, and preferential factors must be considered in determining the pattern of butchery and resource exploitation. However, central to all this is an analysis of cut and saw marks on the elements themselves, to determine frequencies. Which animals and which elements show butchery marks? How does this pattern compare with contemporary sites? What resources or types of meat were favoured based on the frequency of butchery marks? These are several of the questions that can be answered from an analysis of butchery marks and practice.

Although Binford's MNE and MAU methods might have been more appropriate measures of skeletal part representation, neither was used in my study of butchery and resource exploitation, for various reasons outlined earlier.

Resource utilization and exploitation was addressed through a study of elemental representation and meat yields. Certain areas of the mammalian skeleton are associated with prime meat cuts. These include the forequarters (scapula and humerus), and the hindquarters (innominate and femur). These regions are the tastiest and meatiest portions of the animal. Mid-limb areas, around the radius, ulna, tibia, and fibula, are secondary cuts which produce a poorer quality meat than that associated with prime cuts. Lower limb areas are the poorest cuts of meat. Here meat is sparse and not as palatable as elsewhere. Finally, the head region, while not producing high-quality cuts of meat, does contain the brain and tongue which can be eaten.

Aside from the cuts, the amount and quality of meat per animal also varies depending on the species. A cow produces more meat than a pig, and a pig more than a chicken. It is simply a matter of size and weight. An estimate of the amount of meat represented within the sample may be calculated by multiplying MNI values by the weight of meat per unit animal for each species. Meat estimates assist in eliminating biases that may occur when one attempts to standardize the dietary worth of the species represented in the faunal sample.

The combined information obtained from butchery and meat yield studies can assist in answering certain questions about the economy and culture at the site. A surplus of animals and meat beyond the dietary requirements of the estimated population at the villa [20-30 people (Small, Campbell, personal communication)] implies a connection with an outside market where excess goods could be sold, given, or traded. Quantifying this surplus, and determining exactly what was exported are topics of consideration. If transport of whole animals occurred at San Giovanni then one would expect to find few bone remains among the sample since live animals or whole carcasses would be removed to markets. Alternatively, absence of bones could represent a relatively poor contribution of animals to the economy, or simply indicate that excavations failed to unearth the remains which may have been deposited outside the area. In that case, unless other indications, such as large stable or stall complexes, or an abundance of harnessing devices or other animal related artifacts, are discovered, it may be difficult to discern the exact significance of a lack of animal bones.

On the other hand, if select pieces of meat were exported from San Giovanni then one would expect the recovered sample to display a majority of certain elements, probably those related to poor meat areas such as the skull, and limb extremities. In this context, the absence of bones associated with primary cuts would indicate that these animals were likely selectively chosen and butchered at the site in preparation for export.

Finally, if processing and curing of meat off the bone occurred at the site prior to export, one might expect the sample to display a more balanced representation of elements, since only the meat and not the associated bones would be exported. In addition, one might expect a greater accumulation of tools for skinning the animals and cutting the meat, as well as areas to dry and salt or smoke the meat.

CHAPTER 4

RESULTS

4.1 Sampling and Recovery Procedures

Figures 3 and 4 depict the total number of pieces of bone collected/m^3 and the NISP/m^3 for the screened and unscreened portions of each midden. The numbers within the bars are the total number of bones (Figure 3) and the NISP (Figure 4) per unit volume of screened or unscreened soil from each midden.

Figure 3: Total Number of Bone Pieces Collected/m^3 of Screened and Unscreened Portions of Four Middens

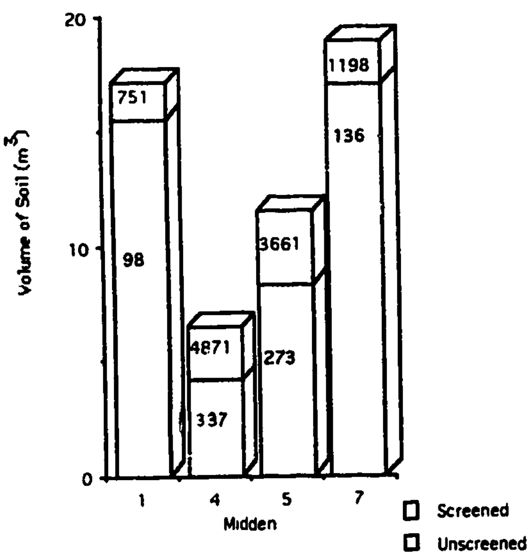
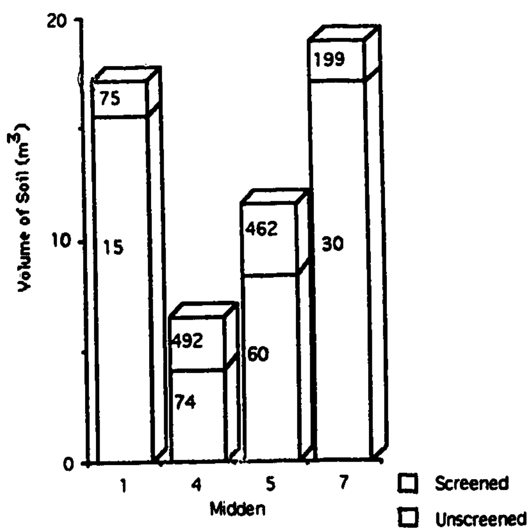


Figure 4: NISP/m^3 of Screened and Unscreened Portions of Four Middens



Overall, the screened contexts produced a significantly greater number of bone pieces and NISP per unit volume of soil than the unscreened contexts. This is expressed as a ratio in Table 3.

Table 3: Number of Bones and NISP from Screened Contexts/ Unit Bone and Unit NISP from Unscreened Contexts

MIDDEN	Number of Bones from Screened Context/ Bone from Unscreened Context	NISP from Screened Context/ NISP from Unscreened Context
1	7.7 / 1	5.0 / 1
4	14.5 / 1	6.6 / 1
5	13.4 / 1	7.7 / 1
7	8.8 / 1	6.6 / 1

These results show that screening does increase the sample size immensely, for both the number of bone pieces and elements collected and the NISP. Furthermore, the information in Table 3 suggests that, in terms of total number of bones collected, Middens 4 and 5, are closely related. Similarly, Middens 1 and 7 are also more closely related than either is to Midden 4 or 5. However, similar ratios among all middens occur when NISP values are compared. The differences in the number of pieces collected may be explained in terms of the degree of fragmentation. Perhaps Middens 4 and 5 were subject to forces or activities that caused a greater degree of fragmentation among the bones, thus boosting the number of pieces to larger proportions than Middens 1 and 7. Their deposits were more concentrated, thus more fragments were collected per unit volume of soil, and more fragmentary tiny pieces were collected from screened contexts. The similarities among the NISP ratios in Table 3 may be explained in terms of the capacities of the faunal analyst, and the representation of identifiable bone elements and fragments. Certain elements and fragments are more easily identified, whereas some fragments can never be accurately identified to specific levels. It is likely that these factors would be held constant regardless of the midden analyzed. It is assumed there would be an equal chance of identifying fragments and elements in all four middens whatever the recovery method employed, since this is contingent on the incorporation of recognizable morphological characteristics on each specimen which allows it to be accurately identified by the analyst. Thus, any sample containing all bones fragmented beyond recognition would not be able to include any NISP values.

Figure 5: NISP and UNID Count in Four Middens

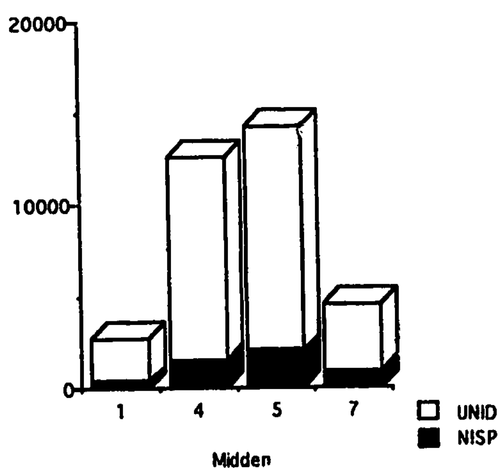


Figure 6: NISP and UNID Weights in Four Middens

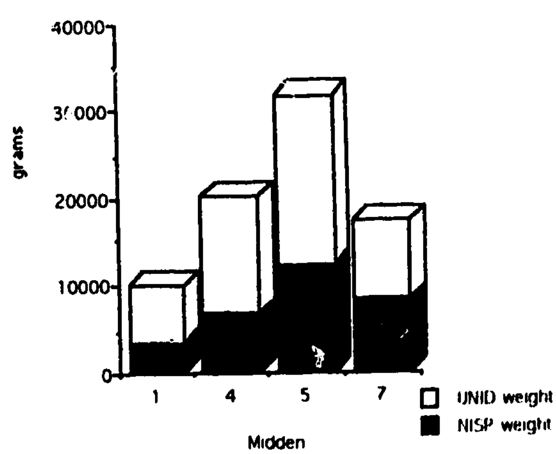
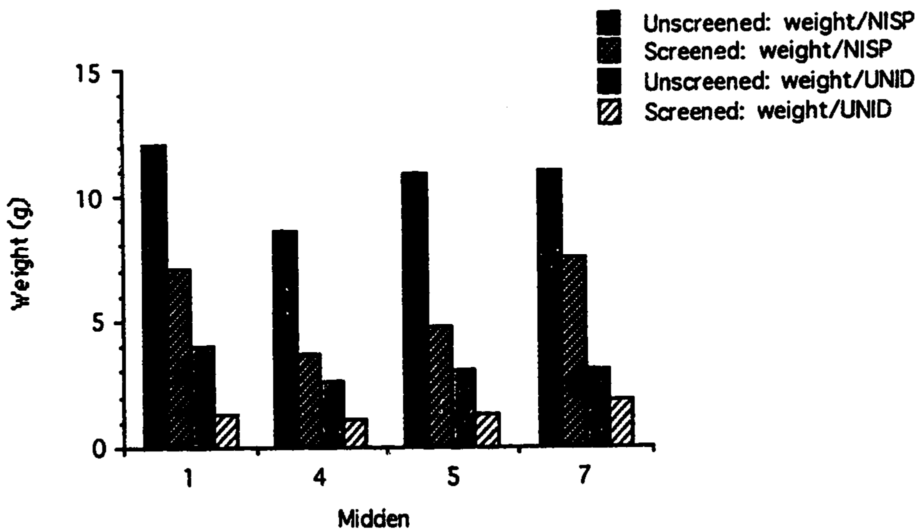


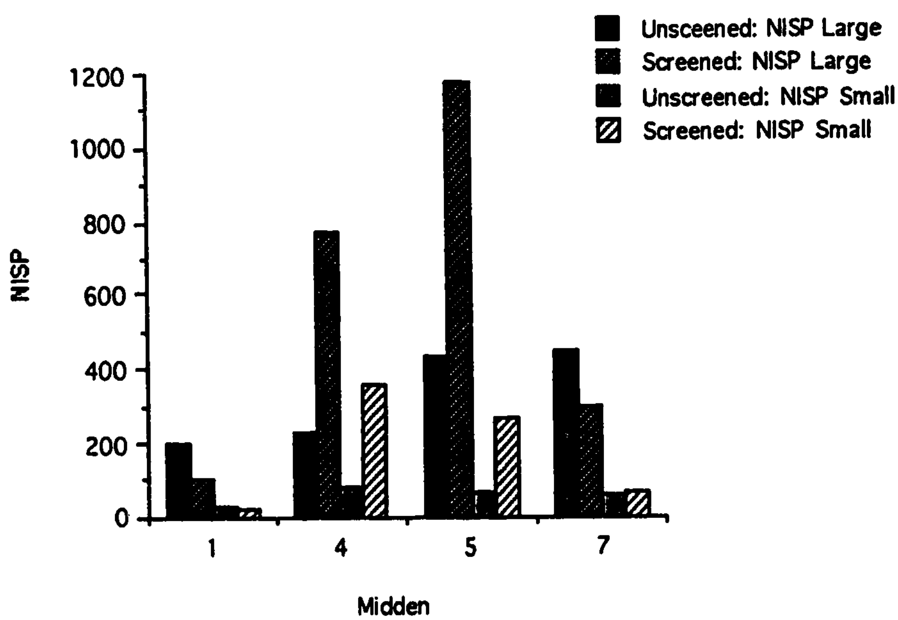
Figure 5 displays the total count of NISP and total count of the number of unidentifiable bones recovered from the four middens. The number of unidentifiable pieces and fragments clearly outnumbers the total NISP. This is not uncommon; many faunal reports (including Steele, 1983, on San Giovanni) calculate similarly low percentages of the contribution of NISP to the total bone count. However, when the weights of each category are recorded and displayed (Figure 6), it is evident that the total weight of all the NISP contributes a larger portion of the overall weight of bone accumulated. Again this is common among faunal analyses. Identifiable bone specimens are commonly large or whole skeletal pieces with a greater weight than the often tiny and light-weight unidentifiable fragments.

Figure 7: Average Weight/Identifiable (NISP) and Unidentifiable Bone (UNID) from Screened and Unscreened Contexts in Four Middens



When the average weight per bone is recorded for identifiable and unidentifiable bone from screened and unscreened portions a consistent pattern develops, for which there is no significant difference among middens. Figure 7 shows that in all middens, on average, identifiable bones from unscreened contexts were the heaviest, followed by identifiable bones from screened contexts, then unidentifiable bones from unscreened contexts, and finally, the lightest bones: unidentifiable bones from screened contexts.

Figure 8: NISP for Large and Small Animal Taxa from Screened and Unscreened Contexts in Four Middens



It has generally been suggested that screening enables the archaeologist to recover a greater number of bones from smaller animals. The idea has been that tiny elements and fragments, which can easily go unnoticed during trench excavation will be captured in screens. Figure 8 depicts the NISP distributions for small and large animals from screened and unscreened portions of the middens. Large animals are arbitrarily those species larger than a typical "loaf of bread", whereas small animals generally fall below this designation. Middens 4 and 5 exemplify that screening is integral to the recovery of the smaller animals. Although about one quarter to one third of the soil in these middens was screened, on average a much greater accumulation of NISP from smaller animals was encountered. On the other hand, since less than 10% of the soil was screened from Middens 1 and 7, it is not unlikely that screening here did not produce a comparative trend for small animal recovery. Regardless, screening did assist in the recovery of smaller animals in Midden 7, and to a lesser extent in Midden 1, since the small animal NISP/screened volume values are about double what would be expected if screening had no effect on recovery.

4.2 Species Representation and Quantification

4.2.1 Identification and Quantification

Identification and quantification results shown in Appendix D reveal that mammals dominate, over all other classes of vertebrates represented, in terms of NISP and MNI values and associated percentages for all of the four middens (1, 4, 5, 7) and both phases of occupation (3A and 3B). Percentages are presented to display trends and facilitate overall comparisons, regardless of the scale of operation suggested by the NISP and MNI values for each midden or phase. Table 4 , below, summarizes this information for Periods 3A and 3B.

Table 4: NISP and MNI/ Class of Animal in Periods 3A and 3B

	PERIOD 3A				PERIOD 3B			
CLASS	NISP	%	MNI	%	NISP	%	MNI	%
Mammal	319	91.4	35	87.5	3442	80.6	181	73.3
Bird	29	8.3	4	10.0	804	18.8	63	25.5
Fish	1	0.3	1	2.5	10	0.2	1	0.4
Reptile					10	0.2	1	0.4
Amphibian					6	0.1	1	0.4
TOTAL	349		40		4272		247	

Although sample sizes for MNI values are much smaller than those used for NISP statistics, there do not appear to be major discrepancies between their corresponding percentage calculations. This may suggest that both NISP and MNI values are reliable indicators of quantity for my chosen sample of study, at least within the same midden or phase. However, this is not the case among middens and between phases when chi-square (X^2) values are calculated. The chi-square statistic is employed as a nonparametric test for significant differences between and among populations (Sokal and Rohlf, 1973).

"Significant" is here denoted at the probability level of less than 0.05 ($p<0.05$); "highly significant" corresponds to $p<0.01$. A X^2 value of 9.39 denotes a significant difference in the NISP and MNI ratios among middens. Similarly, a X^2 value of 10.83 denotes a significant difference between the NISP and MNI ratios per phase. Significantly more MNI are obtained from the NISP sample in Period 3A than in Period 3B. Whether this is due to a greater degree of fragmentation in the bone from Period 3B, or a more even representation of skeletal elements in Period 3B, or a greater accumulation of those elements used for MNI calculation in Period 3A, or a combination of all of these, cannot be determined. In any case, this difference does necessitate the comparison of NISP and MNI values throughout.

Appendix D and Table 4 show that, on average, mammals account for roughly three-quarters of all combined NISP and combined MNI recordings for middens and phases. Midden 1 (= Period 3A), has the greatest percentage of mammals (91.4%, based on NISP; 87.5%, based on MNI), yet it has the smallest sample size of all middens. Middens 4, 5, and 7 (= Period 3B), on the other hand, all have lower percentages for mammals; Midden 4, the lowest (70.9%, NISP; 62.3% MNI). In these three, it is evident that other classes of vertebrates contribute a large comparative percentage. Again this is most noticeable in Midden 4, where avifauna account for over 25% of all vertebrates represented. In addition, fish, reptiles, and amphibians, are represented in greater quantities, although combined they still account for less than 1% of the total NISP.

Table 5 breaks down the vertebrate classes represented in Table 1 into more specific taxonomic categories, and displays the respective NISP and MNI values for each of these, for each midden. A more detailed account of this is given in Appendix E. Table 5 shows that a variety of taxa are represented within each midden. Taxa common to all include pig, sheep/goat, cattle, chicken, other birds, lagomorphs, and rodents. Of all these, pig, sheep/goat, and chicken account for the vast majority of NISPs and MNIs.

This report is primarily concerned with the mammalian component of the sample. Appendices F and G respectively display the NISP and MNI values, and their corresponding percentages, for the mammalian (plus amphibian and reptilian) taxa represented among the four middens from Periods 3A and 3B at the site. It was felt this more detailed analysis of the mammalian material contained in the middens would indicate which animals were consumed most frequently, which were domesticated and kept, or commonly raised, on the site, and which were wild. These appendices divide the mammalian taxa into domestic and wild categories to assist in analysis.

Table 5: NISP and MNI/Taxa in Four Middens

TAXON	MIDDEN 1 NISP	MIDDEN 1 MNI	MIDDEN 4 NISP	MIDDEN 4 MNI	MIDDEN 5 NISP	MIDDEN 5 MNI	MIDDEN 7 NISP	MIDDEN 7 MNI
Pig	183	12	714	39	1325	65	506	25
Sheep/goat	86	13	219	21	202	24	156	20
Cattle	22	2	54	2	80	3	80	3
Equids	5	1			1	1	3	1
Red deer	3	1			4	1	2	1
Roe deer	1	1					1	1
Dog			6	1				
Cat					2	1	3	2
Lagomorph	3	1	1	1	15	3	2	1
Chicken	20	2	360	39	263	18	75	7
Other birds	9	2	50	2	36	2	20	2
Bat					1	1		
Rodent	11	2	11	2	5	1	16	4
Porcupine					1	1		
Bear	2	1						
Mouse	1	1	5	3	6	1		
Mole					1	1		
Shrew/vole							1	1
Rat			1	1	1	1		
Frog			3	1	1	1	2	1
Tortoise					9	1	1	1
Fish	1	1	5	1			5	1
Other	2		6		3		9	
TOTAL	349		1435		1956		882	

A glance at Appendices F and G reveals that a variety of domestic and wild mammals are represented at the site. Remains of domestic mammals are the most common, and are represented by 6 taxa. These include bones from pig, sheep, goat, cattle, equines (indeterminate whether they are horses, mules, or asses), cat, and dog. Wild mammals, including red deer, roe deer, bear, lagomorph (including rabbit and hare), bat, mouse (dormouse and field mouse), porcupine, mole, rat, shrew or vole, as well as small rodents and insectivores of indeterminate species, are also represented (13 taxa in total), but they account for a much smaller portion of the total NISP and MNI calculations. Indeed, as Table 6 below shows, wild animals (including frog and tortoise) comprise less than 10% (in most cases less than 5%) of the total NISP, in each midden and phase. However, their representation significantly increases when MNI values are compared. In this case, wild mammals account for between 10% and 20% of the total MNI. This apparent abundance may be misleading, since even one fragment accounts for an MNI for the taxon in question. Overall, Tables 5 and 6 reveal that there are fewer fragments of bones from wild animals, however these are dispersed among a greater number of taxa. This is most evident in Midden 5, which has double the number of wild taxa represented over domestic ones. However, while Midden 5 may have the greatest variety of wild taxa represented, it is Midden 1 (= Period

3A) which contains the highest percentage of wild mammal remains. Whether this is due to cultural practices, or is a factor of the sample size, cannot be determined without ambiguity, and will be discussed later.

The dominance of domestic mammals warrants their separation for further study. Remains of pigs, sheep and goats (treated as one taxon due to morphological similarities), and cattle are sufficiently plentiful in most cases to allow for their independent analysis. Age, sex, and butchery data become more statistically significant when sample sizes are large. This is the case for these three taxa, especially pig. Table 6 summarizes the NISP and MNI and percentage components for these three domestic taxa, other domesticates, and wild animals. Full statistics for all taxa are presented in Appendices F and G.

Table 6: NISP and MNI/Mammalian Taxa in Four Middens and Two Phases

TAXON	MIDDEN1		MIDDEN 4		MIDDEN 5		MIDDEN 7		PERIOD 3A		PERIOD 3B	
	NISP	%	NISP	%	NISP	%	NISP	%	NISP	%	NISP	%
Pig	183	57.5	714	70.4	1325	80.1	506	85.5	183	57.5	2545	74.0
Sheep/goat	86	27.0	219	21.6	202	12.2	156	20.2	86	27.0	577	16.7
Cattle	22	6.9	54	5.3	80	4.8	80	10.3	22	6.9	214	6.2
Other Domesticates	5	1.6	6	0.6	3	0.2	6	0.8	5	1.6	13	0.5
Wild animals	21	6.6	21	2.1	44	2.7	25	3.2	21	6.6	90	2.6
	MNI	%	MNI	%	MNI	%	MNI	%	MNI	%	MNI	%
Pig	12	34.3	39	54.9	65	61.3	25	41.0	12	34.3	100	54.9
Sheep/goat	13	37.1	21	29.6	24	22.6	20	32.8	13	37.1	52	28.6
Cattle	2	5.7	2	2.8	3	2.8	3	4.9	2	5.7	6	3.3
Other Domesticates	1	2.8	1	1.4	2	2.0	3	4.9	1	2.8	4	2.1
Wild animals	7	20.0	8	11.3	12	11.3	10	16.4	7	20.0	20	11.0

To facilitate comparisons, the NISP and MNI percentages for Period 3A and 3B are visually depicted in Figures 9, 10, 11, and 12.

Figure 9: NISP/Taxa in Period 3A

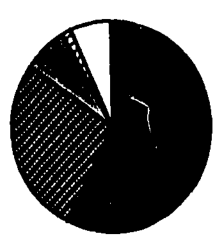
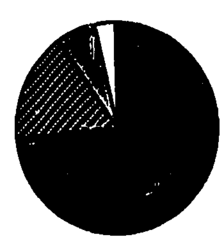


Figure 10: NISP/Taxa in Period 3B



■ Pig ▩ Sheep/goat ▦ Cattle ▨ Other Domesticates □ Wild Animals

Figure 11: MNI/Taxa in Period 3A

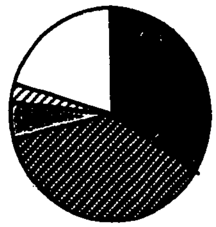
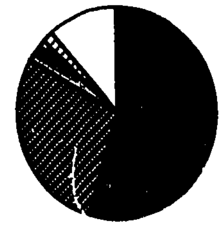


Figure 12: MNI/Taxa in Period 3B



It is apparent from Table 6 and Figures 9 and 10 that the remains of pigs dominate the sample in terms of NISP, in all middens and both phases. The percentages range from 57.5% in Midden 1 to 79.6% in Midden 5. Caprine remains, on the other hand, follow a reverse pattern. They range from the highest percentage, 27%, in Midden 1, through to the lowest percentage, 12.2%, in Midden 5. Thus, where the NISP values for pig are high, those for caprines are low, and vice versa. This may indicate an economic system that dictates an inverse relationship of these two taxa. One may flourish at the expense of the other. These general results accord with those obtained by Steele (1983) in an analysis of partial samples from Middens 1 and 4. In both studies it is noted that the percentage of pig NISP, as a total of all NISP, increased from Period 3A to Period 3B. However, my results show a greater percentage of pig NISP in the earlier period (57.5% as opposed to Steele's 40%), and a less significant increase into the later period (16.2% increase as opposed to Steele's 25% increase in pig NISP).

The MNI values in Table 6 and Figures 11 and 12 offer slightly different results than the corresponding NISP values. When MNI values are compared with the corresponding NISP values for the principal domestic species, it is evident that, on average, the percentage of pigs represented drops about 20%, while that of sheep and goats increases approximately 10%, regardless of midden or phase. Overall, domestic animals seem much less important in the economy/diet when the NISP and MNI statistics in Table 6 are compared. On the other hand, MNI percentages for wild animals increase immensely over their corresponding NISP percentages. Thus, the MNI values and percentages in Table 6 suggest that sheep and goats fulfilled a much larger role, and pigs a comparatively smaller role, in the economy/diet at the site, while wild species contributed a substantial component. This is most evident in Midden 1 (Period 3A), where MNIs for pigs and caprines are roughly equal, with each taxon contributing approximately a third of the total MNI represented. Wild species here account for a fifth of the total MNI represented. In Period 3B, however, the MNI percentage value for pigs increases by over 20%, most of which is at the expense of wild species of animals.

Overall, the results from Table 6, Figures 9-12, and Appendices E, F and G suggest that the vast majority of NISP and MNI values obtained from this sample of animal bones comes from domestic mammals. Of these, pigs generally dominate in both statistics, for all middens and phases, except in the MNI values for Midden 1 and Period 3A. In fact, a X^2 value of 3.98 ($p=0.05$) denotes a significant difference between the pig and other domesticate MNIs between the two phases. The data support the argument that pigs fulfilled a much more pronounced role in the economy/diet of Period 3B.

4.2.2 Morphometric Analysis of Pig Dentition

The results of the morphometric analysis of the pig teeth are presented in Figures 13-16 and Appendix H. Figures 13, 14, 15, and 16 plot the lengths (L) of each mandibular tooth (dp4, M1, M2, and M3) against the anterior width (WA) and posterior width (WP) where recorded. For control purposes, several previously recorded measurements from known wild or domestic pigs (Payne and Bull, 1988) were included within each plot. These allowed me to easily distinguish clusters of wild and domestic pigs on the plots, which are marked by boxes. Specifically, all wild individuals marked in Figures 13, 14, and 15 are control specimens from outside the San Giovanni sample. In addition, several points centered within the domestic cluster depicted in Figures 13-16 are from control specimens of domestic pigs. The exact position of these points is not a key issue in this analysis. They span the range of lengths and widths represented by the San Giovanni sample. They were only included as general guides for the San Giovanni measurements. Full statistics for the L, WA, and WP of the four types of teeth used including sample size, range, mean, and standard deviation are presented in Appendix H.

Figure 13: L and WP Measurements in Mandibular dp4 of Pigs

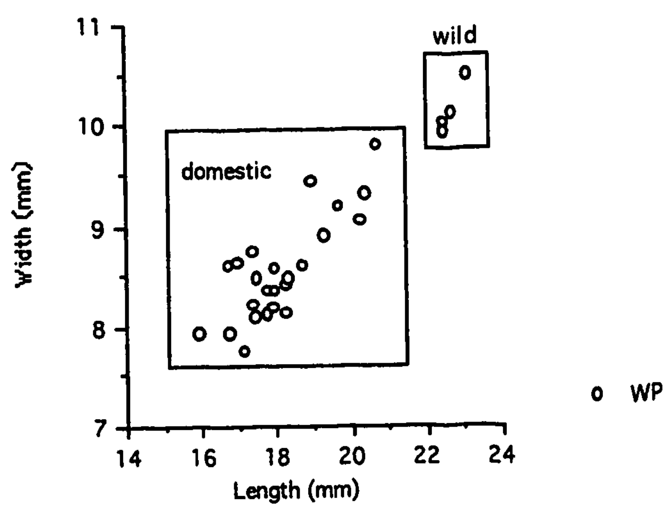


Figure 14: L, WA, and WP Measurements in Mandibular M1 of Pigs

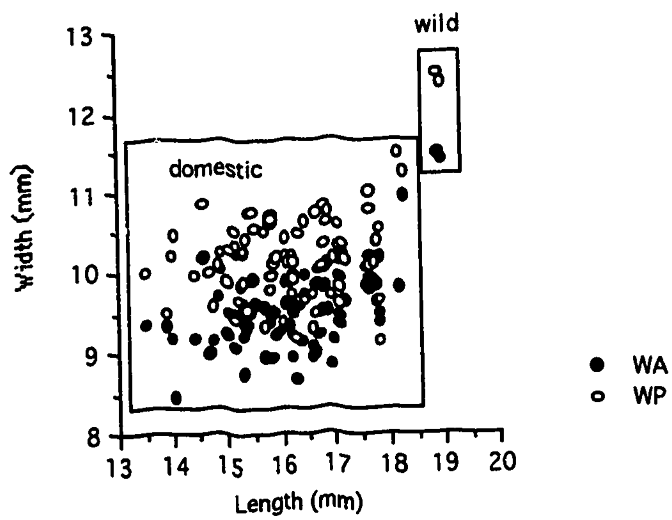


Figure 15: L, WA and WP Measurements in Mandibular M2 of Pigs

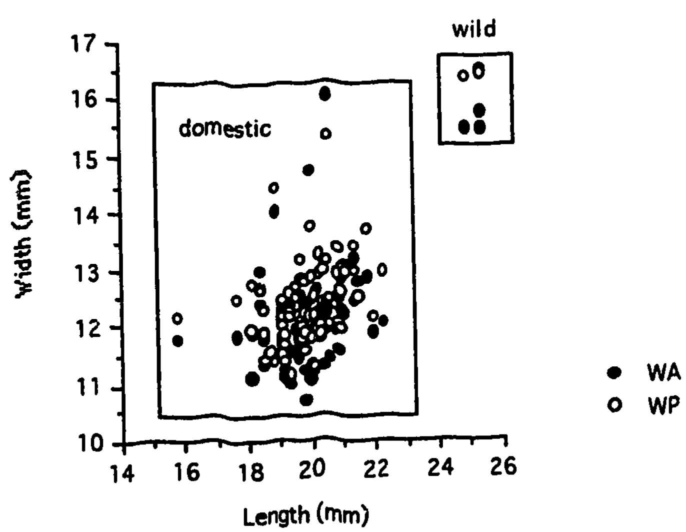
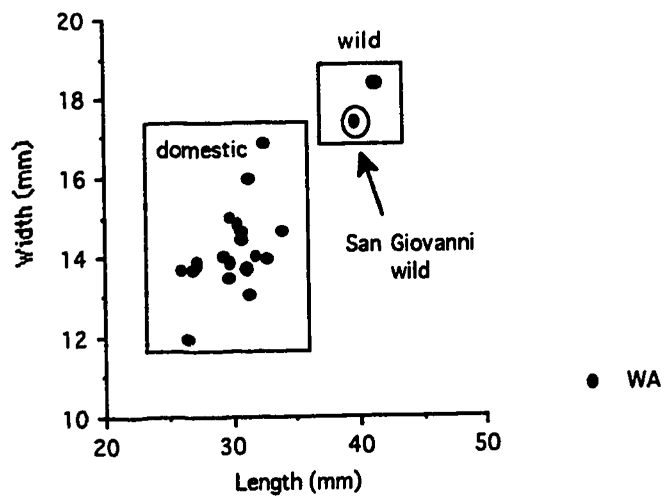


Figure 16: L and WA Measurements in Mandibular M3 of Pigs



It is clear from the figures that practically all the San Giovanni pig teeth are from domestic individuals. The only unmistakably wild individual from the site is represented by a large M3 which is circled in Figure 16.

Table 7 ranks the mean lengths of mandibular M3s from breeds of pigs (*Sus scrofa*) collected from several sites. Full statistics for these sites are presented in Appendix I.

Table 7: Mean Lengths of Mandibular M3s from Wild and Domestic Pigs

Site or Source	Pig Type	Mean Length of M3 (mm)
Seeberg, Burg.-Süd	wild	43.7
Kizilcahaman	wild	41.1
Modern Kurd	wild	40.6
Algerian	wild	40.0
San Giovanni	wild	39.6
Mugharet el'Aliya	wild	36.8
Jarmo ceramic	wild	36.8
Argissa Bronze Age		33.4
Banahilk		31.7
Schola Praeconum	domestic	30.4
Mikulcice	domestic	30.3
San Giovanni	domestic	29.8

The results show that there is a clear difference in length between the mandibular teeth of wild and domestic pigs. Unfortunately the exact dividing line between the two could not be discerned due to the insecurity in assigning a pig type for the M3 mean length for the Argissa and Banahilk sites. Given the data in Table 7 it is likely that the pigs at these sites were transitional, semi-domesticated breeds. The San Giovanni domestic pigs are not significantly different from the Schola Praeconum and Mikulcice domestic pigs, at least in terms of M3 lengths. Similarly, the San Giovanni wild individual is not significantly different from other wild pig M3 mean lengths displayed. Although not depicted, the WA means for M3, incompletely presented in Appendix I, also allow ..ne clear separation between wild and domestic pigs. Once again, the San Giovanni pigs fall within the recorded ranges for each.

4.3 Age and Sex Distributions

4.3.1 Pigs - Aging

The results of the pig aging analyses are presented in Table 8, Figures 17, 18, 19, 20 and Appendix J. Appendix J presents the complete statistics for NISP and MNI assigned to each dental developmental stage within each midden and phase. In addition, calculations of the percentage of individuals surviving to the next developmental stage are presented. Table 8 shows the NISP, MNI, and corresponding statistics of percent surviving for each developmental stage for the two phases. Figures 17, 18, 19, and 20 are plots of the these survivorship statistics.

Table 8: Developmental and Survivorship Statistics for Period 3A and 3B Pigs

	DEVELOPMENTAL STAGE									TOTAL
	1	2	3	4	5	6	7	8	9	
PERIOD 3A										
NISP	2	0	3	2	4	17	13	11	3	55
% surviving	96.3	96.3	90.8	87.2	80.0	49.0	25.3	5.3	0.0	
MNI	1	0	1	1	1	3	2	2	1	12
% surviving	91.7	91.7	83.3	75.0	66.7	41.7	25.0	8.3	0.0	
PERIOD 3B										
NISP	0	8	37	54	68	133	102	53	7	462
% surviving	100	98.3	90.3	78.6	63.9	35.1	13.0	1.5	0.0	
MNI	0	2	8	10	13	26	24	13	4	100
% surviving	100	98.0	90.0	80.0	67.0	41.0	17.0	4.0	0.0	

Appendix J and Table 8 show that pigs were killed at all stages of life, from birth through adulthood, but equal numbers did not perish at each stage. It appears that the majority of the sample was killed during developmental stages 5 through 8. Steele (1983:80), observes a similar pattern. He states that "animals killed at this time were reaching their point of skeletal maturation" (Steele, 1983:80). Furthermore, "animals killed before these stages were killed before full body size had been attained, and animals killed (after stage 8) had long since ceased to gain in most body dimensions" (Steele, 1983:80). A X^2 value of 0.021 (p=0.05) denotes that there is no significant difference between the NISP and MNI ratios between phases, thus either may be used with confidence when comparing survivorship statistics per phase.

Figure 17: Survivorship of Pigs Based on NISP Counts in Four Middens

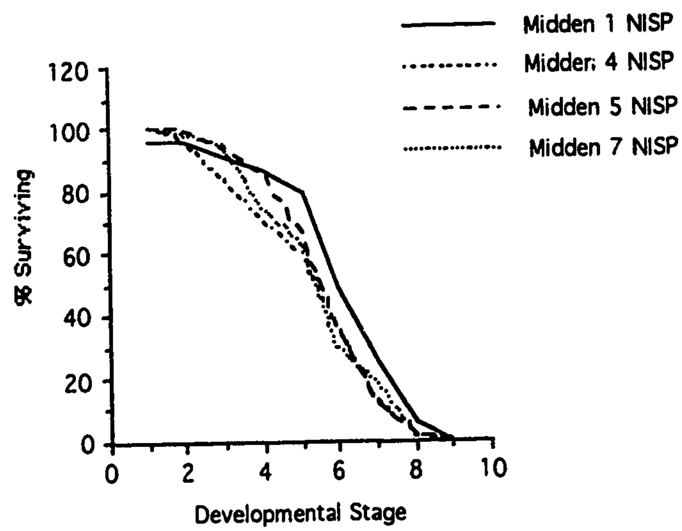


Figure 18: Survivorship of Pigs Based on MNI Counts in Four Middens

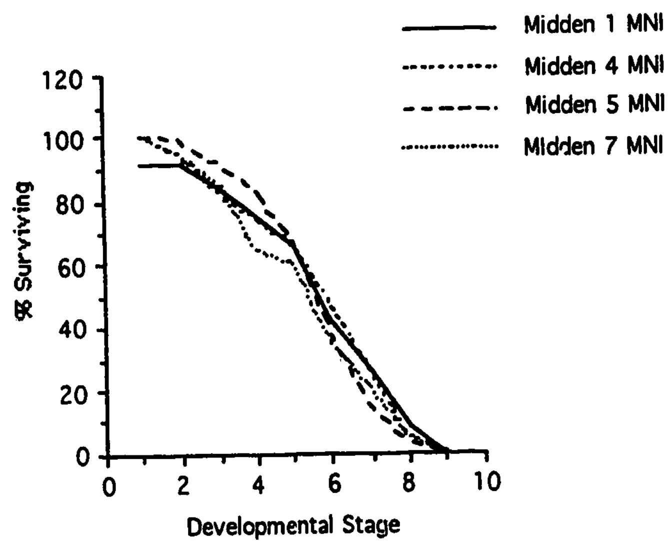


Figure 19: Survivorship of Pigs Based on NISP Counts in Periods 3A and 3B

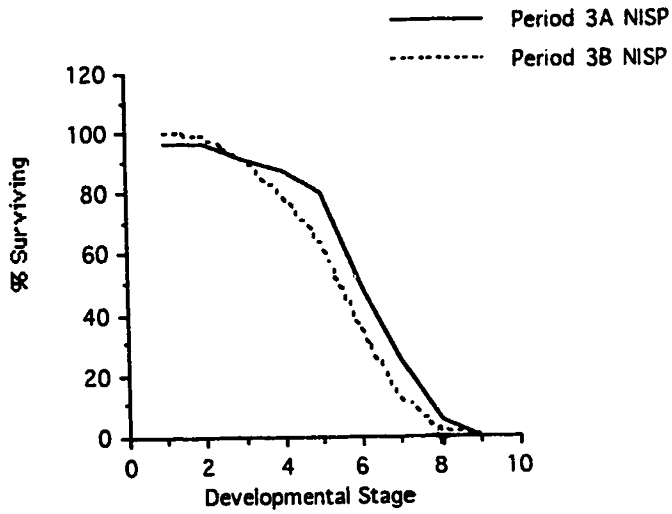
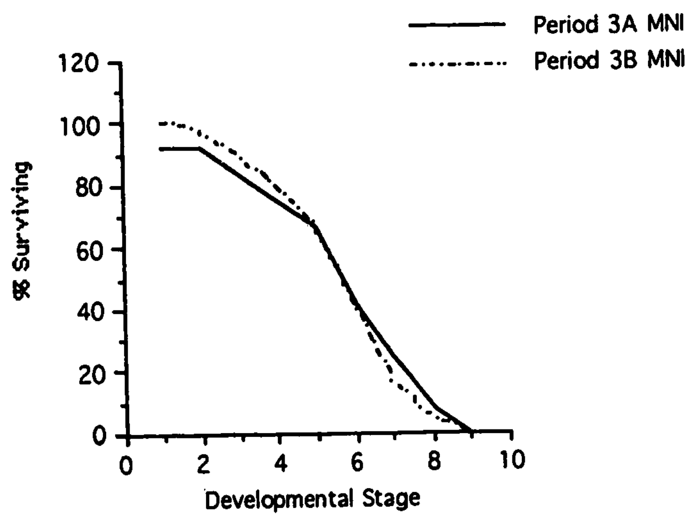


Figure 20: Survivorship of Pigs Based on MNI Counts in Periods 3A and 3B



The survivorship curves, Figures 17-20, mimic the information presented in Appendix J, and Table 8. These curves plot the relative percentage of the total sample of pigs which survived through time. Figures 17 and 19 use the NISP derived percentages, and Figures 18 and 20, the MNI derived percentages. If most of the pigs died, or were killed, very early in life, then the plotted lines would drop down the graph rapidly. On the other hand, if animals were allowed to reach maturity before they were killed, then these plotted lines would parallel at, or very near, the 100% line until stages 8 and 9 were reached, at which point they would drop rapidly (Steele, 1983:80). Neither of these idealized scenarios is depicted in the figures. Rather, it appears that pigs were killed during all stages of life. The largest portion died during developmental stages 5 through 8, where the graphs have the steepest downward slope.

A comparison of these survivorship curves and the statistics presented in Appendix J, and Table 8 suggests that there is a difference in survivorship between the middens and phases represented. Midden 1 (= Period 3A) appears to contain a larger percentage of pigs that survived to later developmental stages than Middens 4, 5, and 7 (= Period 3B), when Figures 17 and 19 are analyzed. The indication from a visual inspection of these NISP plots is that relatively more younger pigs were being slaughtered during the later phase of occupation than during the earlier. However, caution should be exercised. The corresponding MNI plot in Figure 20 does not show any great difference between the survivorship curves for Periods 3A and 3B, thus indicating that there was no change in slaughtering practices between the two phases. In addition, regardless of figure, the sample size is much smaller in Period 3A than in Period 3B (on average 1/8th the size), and thus may be more susceptible to sampling biases, which could cause its distribution to be skewed. Finally, when the NISP totals are amalgamated into two categories, young pigs (Stages 1-4) and old pigs (Stages 5-9), and phases compared, a X^2 value of 2.28 ($p=0.05$) denotes that there is no significant difference in survivorship between the two phases. Thus, despite visual indication suggesting the contrary, statistical tests support the hypothesis that slaughtering practices did not change significantly between phases, at least in terms of the ages of pigs at death.

4.3.2 Pigs - Sexing

Table 9 documents the identity, by sex, of all the pig canines recovered from the four middens and two phases. The final columns give the male/female ratio based on MNI calculations for maxillary and mandibular canine teeth respectively.

Table 9: Pig Sex Identification Based on Canine Teeth

MIDDEN	Maxillary MNI male/female	Mandibular MNI male/female
1	4 / 3	4 / 3
4	5 / 5	10 / 6
5	21 / 14	36 / 24
7	6 / 7	14 / 5
PERIOD		
3A	4 / 3 = 1.33 / 1	4 / 3 = 1.33 / 1
3B	30 / 23 = 1.30 / 1	59 / 35 = 1.69 / 1

In most cases it appears that males were slaughtered more frequently. This is particularly evident when mandibular canines are studied. Here, in all middens and phases, male canines are more plentiful than those of females. The ratios vary, however. On the basis of mandibular canines, it appears that far more males were killed in the Period 3B middens, than in Period 3A. In support, a X^2 value of 7.052 ($p=0.01$) denotes a highly significant difference between the male/female ratio between phases.

The evidence of the maxillary canines is less conclusive, and a X^2 value of 0.286 ($p=0.05$) shows no significant difference between male/female ratios between phases. Overall, it appears that male maxillary canines are more abundant than those of females. There is, however, less of an imbalance in the representation of sex. In Midden 7, females even outnumber males.

To gain a better understanding of the age of those canines that had been sexed, rough age categories were developed and where possible the sexed canines were placed in appropriate age brackets. The permanent canines were used, thus all individuals had passed the level of development associated with its eruption, which occurs around 8-12 months in modern pigs (Schmid, 1972). Age classes were developed based on the assumption that the canine teeth of older pigs would be larger and exhibit more wear than those of younger pigs. The classification was based on the comparative morphology of complete canine teeth from both sexes. Although some fragmentary pieces could be sexed, if these were too small, or lacked the distal end of the canine tooth which revealed information about wear and was a good indicator of overall size, they were not used in this aging analysis. It should be stressed that the aging demarcation was a highly subjective exercise. Specific ages, or extensive developmental stages (see Appendix B), could not be accurately determined. Instead, the primary purpose was to broadly categorize the sexed canines into young, middle, and old age classes. Because Midden 1 (=Period 3A) contained so very few canine teeth it was thought that any comparison of pig age and sex ratios between phases would be riddled with biases. Therefore, the sample was pooled for all middens and phases. In addition, only NISP counts were recorded. Insufficient information regarding the side of each canine inhibited the determination of accurate MNI values. Table 10 presents the ratio of the number of mandibular and maxillary canines per sex and age class.

Table 10: Number of Canine Teeth/ Sex and Age Class among Fully Mature Pigs

	Mandibular Canines		Maxillary Canines		Ratio Male/Female	
AGE CLASS	Male	Female	Male	Female	Mand. C.	Max. C.
Young	33	5	17	2	6.6 / 1	8.5 / 1
Middle/Old	17	28	10	12	1 / 1.6	1 / 1.2
Very Old	0	5	0	0	0 / 5	0 / 0

These results suggest that far more males than females were being slaughtered at younger ages, and that far more females than males survived to older ages.

4.3.3 Caprines - Aging

The results of the aging processes for the caprine mandibles and mandibular teeth are presented in Appendix K, Table 11, and Figures 21, 22, 23 and 24. Appendix K gives the NISP, MNI values and their corresponding survival percentages for each of the four middens and two phases studied. Table 11 duplicates this information for each phase. Figures 21 and 23 are plots of the percent of individuals surviving, (the NISP values), for each midden (Figure 21) and phase (Figure 23). Figures 22 and 24 are similar survivorship plots, using MNI based percentages.

Table 11: Development and Survivorship Statistics for Period 3A and 3B Caprines

	DEVELOPMENTAL STAGE								TOTAL
	1	2	3	4	5	6	7	8	
PERIOD 3A									
NISP	0	3	0	5	6	10	5	0	29
% surviving	100	90.0	90.0	72.4	51.7	17.2	0.0	0.0	
MNI	0	2	0	2	2	4	3	0	13
% surviving	100	84.6	84.6	69.2	53.8	23.1	0.0	0.0	
PERIOD 3B									
NISP	4	29	20	23	36	31	11	16	170
% surviving	97.6	80.6	68.8	55.3	34.1	15.9	9.4	0.0	
MNI	3	9	7	9	8	8	3	5	52
% surviving	94.3	76.9	63.5	46.2	30.8	15.4	9.6	0.0	

An analysis of Appendix K and Table 11 reveals that sheep and goats were killed, or died, at all stages of development. However, depending on the phase, from one-half to two-third of deaths appear to occur after Stage 4, when the complement of adult dentition was erupting or in wear. Selective slaughter of older individuals is suggested. A X^2 value of 0.455 (p=0.05) denotes that there is no significant difference between NISP and MNI derived statistics between the two phases, thus either may be used with confidence.

Figure 21: Survivorship of Caprines Based on NISP Counts in Four Middens

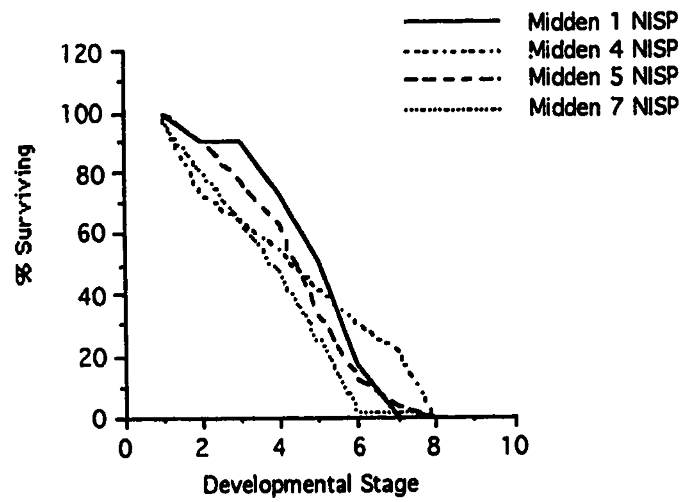


Figure 22 Survivorship of Caprines Based on MNI Counts in Four Middens

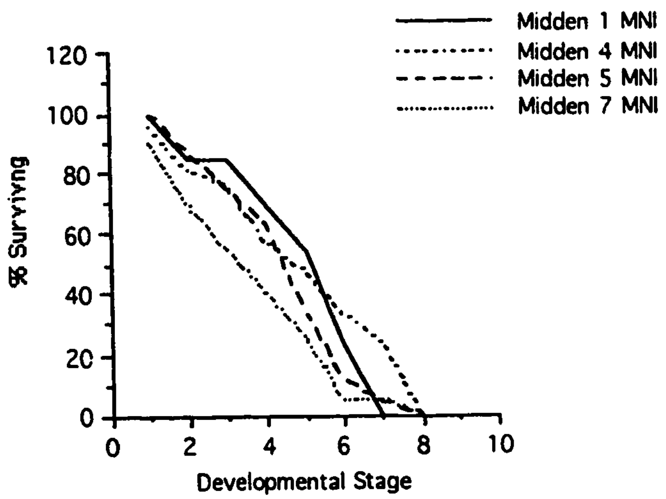


Figure 23 Survivorship of Caprines Based on NISP Counts in Periods 3A and 3B

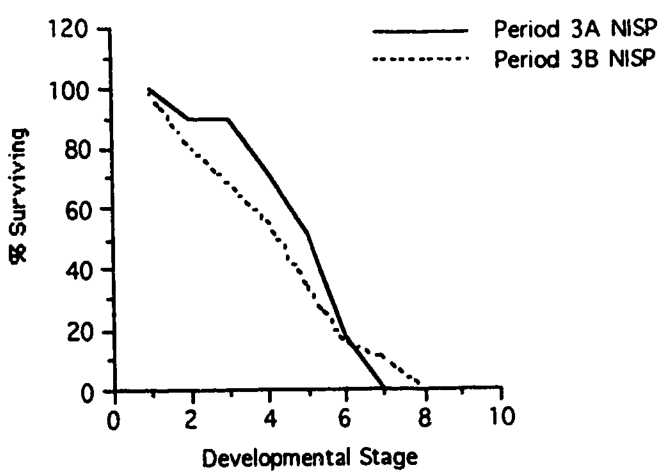
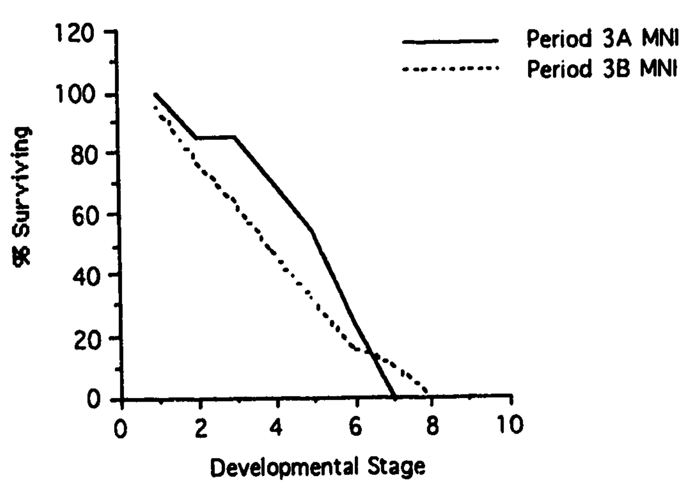


Figure 24: Survivorship of Caprines Based on MNI Counts in Periods 3A and 3B



The survivorship curves, Figures 21-24, better illustrate these concepts. A comparison of all figures reveals that there does not seem to be any great discrepancy between the graphs based on NISP or MNI derived values. Their shapes are very similar. In all cases the slope of the lines declines throughout the developmental stages indicating that sheep and goats were dying at all stages of development. However, if there is any rapid decline in the slope it usually occurs between Stages 4 and 6, indicating that a slight majority of animals were killed when they were between approximately 2 and 4 years of age.

Comparing the individual plots for the two phases, on the other hand (Figures 23 and 24), reveals that a greater percentage of caprines survived to older ages during Period 3A than Period 3B. This probably indicates that relatively more younger animals were being slaughtered during the later phase of occupation than during the former. When NISP statistics are amalgamated into two categories, Stage 1-4 and Stage 5-8, and compared between phases, the corresponding X^2 value of 2.976 is significant at the 0.08 level. Although not significant at the standard 0.05 level, this value does offer support that a marked difference between sheep/goat slaughtering practices exists between phases. Specifically, a proportionally greater number of younger individuals were more selectively slaughtered during Period 3B.

4.3.4 Caprines - Species Separation and Sexing

According to Boessneck's (1969) methods for distinguishing sheep and goats morphologically, 15 sheep and 3 goats are represented. I distinguish between sheep and goats only in this section. Elsewhere in my analysis the separation of these two species has not been considered. These are only minimum values; no system has been developed as yet to accurately determine the species of each bone identified as caprine. What is perhaps more important is the ratio of the two species derived from these figures. Assuming minimal sampling and preservation biases and that represented elements come from different animals, these figures suggest that about five times as many sheep were kept than goats. Because of its small size, this sample does not afford conclusive proportions. It appears that more of the caprine sample derives from sheep than from goat.

Information on the sex of the sheep and goats represented in the sample is very limited, and is based on the morphological differences in the pelvis of male and female animals (Boessneck, 1969). Unfortunately, only 11 pelvic pieces were identified and of these only 4 could be accurately sexed. Midden 1 produced a female sheep and a female goat; Midden 7 produced 2 female sheep. In all cases the bones had fused epiphyses and were large enough to be those of adults. These data suggest that older female sheep were kept at the site, possibly fulfilling some selective role in the economy. Unfortunately, sample sizes are too small to allow estimation of differences between phases.

4.4 Butchery, Resource Exploitation and Diet

4.4.1 Butchery and Resource Exploitation

The principal information about butchery is shown in Appendices L, M, N, and Table 12. Appendices L, M, and N list the NISP and MNI values based on the region and quality of cut for pigs, caprines, and cattle, respectively. These taxa were chosen because they are the most frequent domestic animal taxa represented at the site. This information is summarized in Table 12.

In Table, 12 and Appendices L, M and N some attempt has been made to counter an undoubted bias in the material. It is evident that in all cases, isolated teeth heavily weight the "Head" category, especially in NISP calculations. Often, the durability of teeth allow them to be more frequently preserved through time than other skeletal elements. In addition, combined deciduous and permanent dentition within a single animal can number up to 72 teeth; thus sheer numbers favour their recovery over paired long bone elements. It is likely the case that a single head would separate into a large number of cranial and dental elements after deposition. The MNI values should assist in controlling these biases, and may provide a more realistic representation of abundance. Whatever the case, a review of these results shows that all body parts are generally represented for each taxa, and all have been butchered into smaller fragments. Midden 1 (=Period 3A) has the greatest number of gaps, signifying missing elements. Whether this is the result of cultural practices, or simply a matter of poor representation in a small sample, cannot be determined. The latter explanation may have some merit, because in the other middens, all with much larger sample sizes, all elements are normally represented.

Table 12 lists the NISP and MNI statistics for the four butchery regions, among pigs, sheep/goats, and cattle between the two phases.

Table 12: Elemental Distribution in Pigs, Caprines and Cattle in Periods 3A and 3B

	PERIOD 3A		PERIOD 3B	
	NISP	MNI	NISP	MNI
PIG				
Head	148	12	2130	100
Primary Cuts	13	4	162	19
Secondary Cuts	6	2	116	12
Limb/extremities	15	2	190	9
CAPRINE				
Head	59	13	415	52
Primary Cuts	6	2	37	5
Secondary Cuts	13	3	70	9
Limb/extremities	6	1	59	4
CATTLE				
Head	3	1	70	6
Primary Cuts	5	1	21	3
Secondary Cuts	5	2	25	4
Limb/extremities	9	1	89	4

Although all parts of the body are generally represented for the three taxa, the distribution of elements differs among them. Pigs and caprines show the greatest number of NISP and MNI values for the head region, in most cases far exceeding the combined NISP and MNI values of the remaining three categories. Primary cuts are generally represented more frequently than secondary cuts among pigs, but the reverse appears so for caprines which show a predominance of secondary cuts over primary ones. The Limb/Extremities category is much more variable, and is generally dominated by metapodials or phalanges. Cattle, on the other hand, show a more even distribution among the four categories, for each phase, at least when MNI values are compared. There does not appear to be any selective disposal of cattle remains which may have caused an imbalance in the representation of elements.

Tests of significance among the representation of butchery regions between phases were performed using the NISP values. Unfortunately the MNI values were too low (except among pigs) to afford valid testing. As previously mentioned the NISP values may not be as accurate a representation of the actual population totals as the MNI values therefore caution must be exercised in interpreting the following X^2 recordings. The X^2 values of 0.959 and 1.453 ($p=0.05$ in both cases) denote no significant difference between butchery elemental representation between phases for pig and sheep/goat respectively. The X^2 value of 1.195 ($p=0.05$) for pig MNI is also insignificant. A similar test using cattle produced a X^2 value of 6.988, itself insignificant at the 0.05 level, but significant at the 0.10 level. Of these three principal domesticates it appears that cattle butchery may represent the only change in butchery practices between phases, at least when elemental ratios are compared. In terms of actual numbers of animals butchered, the data clearly indicate that many more pigs, caprines, and cattle were slaughtered during Period 3B.

A substantial proportion of the bones showed signs of having been cut or sawn. No attempt was made to systematically study the incidence of butchery marks because the entire analyzed sample could not be found, and the recordings in the data lists were not sufficiently explicit. However, Assad (1986:134) noted that 24% of the pig remains, 20% of the caprine remains, and 54% of the cattle remains from a sample in midden 5, had some evidence of either cut or saw marks, and also noted an important bias in butchery mark distribution. It appears that a majority of the cut and saw marks occurred on longbone diaphyses, ribs, and vertebrae, all of which could not be identified to species level because of their generalized or indistinctive shape (Assad, 1986:130,132). This inability to identify these elements to a more specific taxon would bias the interpretation of certain aspects of a faunal or taphonomic analysis, including elemental presence, and more importantly, interpretations of butchering practices (Barker, 1978).

4.4.2 Diet

Table 13 simplifies dietary analyses by presenting the NISP and MNI values for animals which were likely eaten. The separation here is between domestic animals (pig, sheep/goat, cattle) and wild animals (red deer, roe deer, and lagomorph). It is assumed, based upon the paucity of references in classical culinary literature, that the remaining taxa were infrequently consumed, if at all. They have been left out of Table 13.

Table 13: NISP and MNI for Consumed Domestic and Wild Taxa

	PERIOD 3A		PERIOD 3B	
	NISP	MNI	NISP	MNI
DOMESTIC	291	28	3336	159
WILD	7	4	25	6

The log likelihood ratio (G), a similar nonparametric statistic to X^2, but more accurate if too many (generally over 25%) of the cell expected frequencies are less than 5, was used to determine if a significant difference in the wild and domestic food remains existed between Periods 3A and 3B. A G value of 5.81 (p=0.05) shows a highly significant difference between wild and domestic NISP ratios between the two phases. A similar calculation using MNI statistics produced a G value of 3.43. Although not as significant as the corresponding NISP derived G value, this is significant at the 0.07 level. It can be stated, therefore, that a significant difference exists between the proportions of consumed wild and domestic taxa between the two phases. It is evident from these data that the Period 3A occupants ate a greater proportion of wild animals, and fewer domesticates, than the Period 3B occupants. However, in both phases it is clear that domestic animals provided the vast majority of the meat.

Appendix O lists the meat, and live weight calculations for the four principal meat taxa in each midden and phase; a portion of this has been included as Table 14 below. Lagomorphs have been excluded because they contribute a very small portion of meat in comparison to the larger animals. Red and roe deer are combined in the "Deer" taxon. The live weight and meat weight estimates are based on mature modern breeds, therefore calculations are meant only as a rough guide. These estimates were taken from King et al.'s (1985) work at Settefinestre, a Roman site in Etruria dating to the first century BC. It was thought these values would provide the best comparative data for the San Giovanni estimates. No attempt has been made to distinguish variations in meat yield values based on age or sex, thus the recorded amounts will likely be higher than the representative amounts they estimate. Nevertheless, regardless of midden or phase it is evident that pigs dominate in terms of both live weight and meat weight. The smallest amount of meat from pigs is from Midden 1 which potentially produced an estimated 756 kg. This figure is still, though minimally, in excess of the combined sheep/goat and cattle total amount of meat. Middens 4, 5, and 7 show a clear dominance of pig meat over others; so much so, that in Period 3B pigs account for over twice as much meat as sheep/goat, cattle and deer combined.

Table 14: Meat Weight Estimates for Pigs, Caprines, Cattle and Deer in Periods 3A and 3B

	PERIOD 3A		PERIOD 3B	
	Total Meat Weight (kg)	%	Total Meat Weight (kg)	%
Pig	756.0	42.0	6300	68.6
Sheep/Goat	357.5	19.9	1430	15.6
Cattle	385.0	21.4	1155	12.6
Deer	300.0	16.7	300	3.3

Although sheep and goats may dominate the MNI values for Period 3A, Table 14 shows that they only contribute roughly 20% of the total meat. This suggests that exploitation of their secondary resources, including milk and wool was important to the economy, and their meat perhaps less important in the diet and economy. Wild resources, of which deer are the meatiest, do not appear to form a large component of the dietary meat yield. Their numbers are consistent between Periods 3A and 3B, which may indicate consistency in the nature and incidence of hunting activities and/or a consistency in the size of the deer population. On the other hand, considering the difference in the sample sizes between phases, it appears that venison contributed more meat to the Period 3A diet. Finally, the importance of cattle as meat providers is shown for both phases. However, as much more meat is yielded from a single cow or bull than from several caprines or pigs, one must judge MNI values cautiously when discerning dietary contribution. Meat yields, on the other hand, may offer a more reliable indication of this.

CHAPTER 5

DISCUSSION

The results presented above allow a number of specific and general conclusions to be drawn. Specifically, information about the representation, quantification, age, sex, and butchery of the mammal species in the sample from Period 3A and Period 3B middens can be discerned. On a general level, inferences about the economy of the villa and the diet of the occupants can be made.

5.1 Biases and Limitations

Before interpretations can be put forward, research limitations must be addressed. The majority of these relate in some way to the reconstructive nature of faunal studies, which often assume or neglect certain aspects or issues of importance simply because information is absent, sparse, or too complex. Maltby (1981:167) states...

> The number of bones of each species represented is dependent upon the method of quantification used, excavation techniques, preservation conditions, discard practices, butchery practices, redistribution of the carcasses and the ages of the animals exploited. All of these processes impede the translation of faunal data into realistic statistics of species present. To understand bone samples better, we have to take all these factors into consideration...

Efforts have been made to standardize and explain each of these biases as they relate to the San Giovanni faunal material. These will be discussed under three categories:

Taphonomy
Sampling and Recovery
Quantification

5.1.1 Taphonomy

An earlier analysis (Assad, 1986) discussed preservation, taphonomic, and butchery effects, particularly as they relate to the pig remains from the site. It is often suggested or assumed that broken bones in faunal samples are the result of cultural activities such as butchering, marrow extraction or bone grease processing (Bökönyi, 1984; O'Connor, 1982; Prummel, 1975). Although most of the San Giovanni bones are broken, no substantial evidence exists to suggest this resulted solely from cultural activities. Assad identified modifications on bones, such as gnaw marks, etching, breakage, and burning, and attributed these to various taphonomic agents and forces, such as carnivores, rodents, and physical or chemical weathering processes. She concluded that there is (i) "little difference in the overall frequencies of occurrence of the...taphonomic categories examined" (Assad, 1986:83), and (ii) "no visible patterning in the distribution of any modification or group of modifications for any particular element" (Assad, 1986:106). These results, coupled with the commonality of soil type among the middens (Appendix A), suggest taphonomic uniformity. Preservation and taphonomic differences among the four middens in my sample, therefore, are assumed to be minimal.

5.1.2 Sampling and Recovery

Careful excavation techniques, employing screens, should limit biases inherent in recovery. The results of my sampling and recovery analyses show that overall, screened contexts produced more bones per unit volume of soil than unscreened contexts. Screening is a highly effective and integral measure in the recovery of small bones, be they tiny unidentifiable fragments or elements from small or inconspicuous animals. However, it is also effective in the recovery of identifiable bones from larger animals. It is likely that the greater number of bones recovered during screening relative to trench inspection methods lends itself readily to a relatively greater number of both identifiable and unidentifiable bone fragments being recorded from screened contexts. Whatever the case, the fact that screening was not employed in a systematic or ubiquitous manner is one uncontrollable bias which should be taken into consideration before a discussion of the represented taxa ensues. Considering the care in excavating as noted by Steele (1983), it is unlikely that this bias has significantly or drastically skewed the relative frequencies of the domestic mammalian taxa, all of which are medium to large sized animals.

The results relating the average weight of NISP and UNID bone among screened and unscreened contexts revealed a consistent pattern. The order of categories from average heaviest to average lightest is: unscreened NISP, screened NISP, unscreened UNID, and screened UNID. This pattern clearly shows that, on average, identifiable bones are larger and heavier than unidentifiable bones, which is a principle frequently dismissed as common sense. However, this pattern also ranks both NISP and UNID from screened contexts as lighter in weight than their contemporaries from unscreened contexts. Again, this asserts the efficacy of screening over visual trench inspection techniques in obtaining tiny and inconspicuous bones and fragments.

Finally, the sampling and recovery analyses reveal similarities among the middens irrespective of the actual taxa represented within them. The plots for Middens 1 and 7, depicted in Figures 2 - 7, closely resemble one another. Similarly, the plots for Middens 4 and 5, depicted in Figures 2 - 7, are generally alike. Whether these parallels are due to correlations in the amount of soil screened within each midden (Middens 1 and 7: <10% screened; Middens 4 and 5: >25% screened), or due to size differences among them (Middens 1 and 7 are the largest in terms of space and volume), or due to functional differences among them, cannot be fully ascertained. It is likely all of the factors contributed in some degree to this separation. The fact that Middens 4 and 5 are contained within rooms, whereas Middens 1 and 7 were spread over larger areas with few or no confining limits or walls, suggests a spatial distinction between these two related groups. This could very well have a cultural significance, in which case the taxa and element representations may be related to functional differences among the middens. The occupants may have preferred to dispose of refuse in an abandoned room, inside the villa, which may explain why more refuse was thrown into Middens 4 and 5. In turn, perhaps the occupants preferentially disposed of selective refuse in certain middens. However, arguing against the idea of functional differences characterizing the middens is the apparent homogeneity in taxa and element content among them. All certainly contained domestic and butchery refuse which may be used to reconstruct the diet and economy of the site. Since they are all middens it is likely that their respective functions were not significantly different. Homogeneity is further suggested by the similarity among the survivorship plots for pigs (Figures 16 and 17) and caprines (Figures 20 and 21) for each midden. Whatever the case, the sampling and recovery analyses suggest that caution should be employed in comparing the results of all the middens.

5.1.3 Quantification

The methodology used for quantifying species which combined NISP and MNI calculations, both of which incorporated information on aging and sexing of species, should limit problems of quantification.

In conjunction, these sources of information applied to the faunal sample from San Giovanni should provide the proper context in which to make interpretations about the representation and quantity of species present, and derive conclusions about the diet and economy of the site.

5.2 Interpretations of the Faunal Sample

5.2.1 Introduction

The results of the taxa representation and quantification reveal that a wide range of domestic animals, including pig, sheep/goat, cattle, equids, dog and cat, was present at the site during Period 3. Domesticates were the most common animals kept or brought to the site. Based on the compact design of the building it appears that the majority of these animals were housed outside the immediate villa complex. Some stables and/or pens are distinguished among the rooms in the Period 3A and Period 3B villa, however, they are too few in numbers, and too limited in size, to support the entire sample of live domesticated animals suggested by the NISP calculations. On the basis of MNI values one may argue that those animals represented from within the middens could have been housed in the pens and stables at the site. For example, the minimum number of 100 pigs, spread out over the 90 year occupation span in Period 3B, correlated with around one pig/year. Surely one pig could have been housed annually at the site. However, this rationalization is unjustified for several reasons. First, these middens do not represent the entire amount of faunal material collected at the site and it is possible that many more animals are represented from within specific occupation phases. After all, MNI values solely record the absolute minimum number of animals represented from bone elements only. Second, the size and wealthy nature of the villa suggests that farming and husbandry activities practised were very profitable. Exploiting one penned animal/year could hardly bring such riches. Third, classical literature references numerous instances of, and procedures for, raising large herds and flocks of animals. Fourth, the farmer probably wished to maximize herd and flock sizes to increase profit as well, a practice which would further elevate their populations. Rapidly increasing numbers of animals would create great demands for available housing; the farmer would have to find alternate shelter. Fifth, it was generally common practice to allow these animals free pannage in forests, or to herd them in transhumant flocks, rather than to keep them contained in pens. Such is the traditional type of animal husbandry still widely practised in southern Italy today. Finally, the faunal sample from San Giovanni is very large; the largest of any recovered from any Roman rural site in southern Italy. In terms of sheer numbers and volumes it is comparable with that recovered from excavations at the massive villa at Settefinestre (King et al., 1985). Surely a sample of such magnitude must suggest a surplus of animals was raised, far beyond the carrying capacity of the pens and stables at the site. Thus, on the basis of this information it appears more likely that these stables housed horses and cattle, larger animals typically reserved for specialized work or transport purposes. These animals, particularly horses, may require greater attention devoted to maintenance, grooming, and training (White, 1970:291) which might prompt the owner/farmer to pen them in stables for greater control. In addition, if cattle and equids were used as work animals around the farm, one would want to keep them under close surveillance to avoid theft and rustling or attacks by wild animals. The ancient authors offer extensive accounts about the care of horses and working oxen (Palladius, Opus Agric. 4; Pliny, Nat. Hist. 8; among others), and suggest they be kept on the farm. Whatever the case, this does not preclude the use of these rooms as temporary shelters for other domesticates. Palladius (Opus Agric. 3.155.1079) notes that pregnant sows should be housed in sties during spring when they are birthing. Sheep may require temporary housing during shearing periods in the spring. Finally, pet animals, including dogs and cats, may have made their home in these pens as well. Overall though, the fact that the numbers of animals far exceeded the available housing and stall space on the farm suggests that animal resources contributed a major component to the economy of the villa, and that many of these were kept outside the immediate farm site. Caprine and dog footprints on tiles suggest at least these animals were loose around the farm. It does not appear that the villa occupants kept and raised domesticated animals solely for their own immediate consumption. Instead, a surplus of domestic animals is suggested.

The range of domestic animals present is typical of Roman period farmsites as well as "non-transient subsistence and mixed economy farms throughout Europe and North America" (Steele, 1983:81). The threefold exploitation of pigs, caprines, and cattle appears to have persisted through the ages in this region, and indeed throughout the entire Roman world. G. Salinardi (1973), stressed the importance of these three species to the rural diet and economy in Ruoti. He further commented that in 1945 he ran a farm which if excavated today would contain the same general range and frequency of animals as at Roman period San Giovanni, specifically a preponderance of pigs and a high number of chickens. Other domesticated animals, equids, dogs, and cats are generally universal throughout the Roman world and are represented at a vast number of Roman archaeological sites.

5.2.2 Wild Species

A wide range of wild species is represented in the sample. The remains of red deer, roe deer, lagomorphs, and possibly bear in the refuse suggest that these wild animals were hunted. All, including wild boar, are documented in the ancient literary accounts of Roman hunting practices and in Pliny's record of species (Nat. Hist., 8). Stag, boar, and hare hunting were particularly popular during the late Roman period. At Ruoti, these animals could be hunted in the local forests that existed around the site.

The role of hunting seems to change between Periods 3A and 3B. Significantly more wild animals, especially larger and meatier species like deer, are represented in Midden 1, than among the other middens. Assuming sampling biases are minimal, perhaps the occupants of the Period 3A villa had a greater penchant for wild game in their diet, or could afford more time to pursue hunting activities. Given the architectural and artifactual evidence for wealth, it is unlikely the occupants were forced to hunt for subsistence. Evidence suggests that the increase in the frequency of domestic animals was at the expense of wild game. Perhaps the Period 3B farmers were exploiting the forests more intensively as habitat or food for their increasing stocks of domestic animals, which subsequently forced many of the indigenous wild game away.

The remaining wild species represented in the Period 3 middens are likely either intrusive animals or small pests that were killed around the site. Moles, mice, rats, and other rodents are particular threats to crops. Palladius mentions methods for their extermination (Opus Agric. 1. 130-131. 907-931). Overall though, these species of rodent-size or smaller wild animals are too uncommon to suggest any purposeful hunting or capture by the occupants for dietary or economic exploitation. It does appear, however, that a greater number of them were recovered in the Period 3B middens, possibly because a greater portion of these middens was screened. On the other hand, their increased presence may signify that crop husbandry was intensified at this time, as more crops would tend to attract more rodents. The clearing of forests for agricultural or grazing land would force many rodents to find new shelters, many of which would be closer to human settlements. The several specimens of dormice in the sample would particularly favour a domestic surrounding. Overall, the presence and diversity of these species of rodents lends further support to the reconstruction of the environment surrounding the site as forested, since many of these species survive best in that type of habitat. It is unlikely that agriculture, if it was intensified, was done to such a marked degree as to cause complete deforestation during Period 3B.

5.2.3 Domestic Animals

The prevalence of domestic animals in the middens attests to their importance in the diet and economy of the occupants. Pigs and caprines appear to have been the most common domesticates, cattle and equids occur less frequently, while dog and cat are the least frequent.

Interpretations drawn from the representation and quantification of these domestic animal remains should be done in light of the function of the middens, and the size of the samples. Certainly a large part of the recovered bone came from animals consumed at the site, but other remains may be from animals slaughtered for export. In both cases, however, the emphasis is on dietary consumption. Thus, the low frequency of cattle and equids may simply indicate that these species were not commonly eaten. Dogs and cats were not consumed during Roman times. The single dog in Midden 4 was likely a breed which would have assisted in hunting and tracking prey, or guarding and rounding up stock. After its death it was probably simply discarded on the midden heap, as were the cats in Midden 5 and 7, whose function in life was probably to catch mice and rodents around the farmstead. There is a correlation of the increased frequency of cats in Period 3B with an increase in the number of mice and rodents. Thus, one may infer that an augmented agrarian economy at this time attracted more vermin which subsequently forced the occupants to combat these pests with cats. Alternatively, the increase may simply be a result of a smaller sample size recovered from Period 3A, or a more restrictive deposition in Midden 1. This same argument may explain why equid remains are so infrequent in this sample of middens; perhaps, the remains of equids were disposed of elsewhere. Although the exact species of equid could not be determined based on the limited remains, the presence of spurs, feeding oats and stables suggests that some horses were kept. Horses, in particular, were prized animals during Roman times, and it is likely that they would be rare finds at a farmstead. They served no purpose there other than for riding (White, 1988 :235) and even then their use was restricted. According to the Theodosian Code [9.30. 1-4 (364-390)] riding horses was prohibited in southern Italy in the fourth century except for governors, veterans, decurions, and swine collectors, so as to discourage brigandage. In addition, the poor representation of horse in many Roman period sites, including San Giovanni, may simply be the result of its declining importance as a meat producing animal. Few horse bones have been found in British Roman period deposits in assemblages derived mainly from butchery waste, and records of butchery on horse bones are rare (Maltby, 1981:184). None of the equid bones in the San Giovanni sample showed evidence of butchery marks and is is unlikely that a whole dead individual would be discarded in these middens which contained mainly food and processing waste.

5.2.3.1 Cattle

The relatively low frequency of cattle warrants more extensive discussion, since cattle were certainly consumed during this period. At San Giovanni, it appears that cattle were not a preferred food. The ancient agronomists suggest that cattle were used strictly as draft animals, primarily to pull plows, and were rarely eaten unless they met an untimely death or came to the end of their working life. The absence of immature cattle in this sample supports the interpretation that they were being utilized for purposes other than meat. They were likely not part of any large-scale breeding and slaughtering economy. In addition, if these cattle were bred for draft, they would have been poor producers of milk, which may explain the Roman preference for sheep and goat milk.

Overall, NISP percentages of cattle remain fairly consistent throughout Periods 3A and 3B. However, a comparison of MNI percentages suggests that cattle played a lesser role in Period 3B. It may be that an increase in the role of pigs at this time (note the percentage changes for NISP and MNI), corresponded with a decrease in the agrarian economy of this region. However, if this were the case, one would have to explain the increase in rodents and vermin differently. Nevertheless, fewer fields to tend would limit the value of working cattle, and perhaps a smaller number of cattle would be raised and kept on the farmstead. Cattle were very expensive to keep (Brothwell, 1988:257), and likely would not be kept in any kind of surplus unless necessity demanded. Comparison with the botanical data is necessary to test this hypothesis. Unfortunately, only qualitative studies of these remains have been performed thus far (Costantini, 1983); no statistics have been presented to estimate the actual quantities of each plant species in the diet and economy.

The results of the elemental distribution analysis for cattle suggest that these bones came from animals killed and consumed at the site. The fairly even MNI representation among the various categories suggests that whole animals were butchered at the site for consumption by the occupants. It appears that they made use of all parts and did not selectively butcher certain regions for sale or export. The large number of teeth and phalanges of cattle, relative to the other cattle bones, which is likely coincident with the NISP comparison approaching significant levels, may indicate differential preservation and recovery. These are the most numerous and durable of all cattle elements, thus sheer numbers favour their recovery.

The meat yield analysis shows that whereas cattle do not dominate in numbers, those represented produced a substantial amount of meat. If these meat yields statistics are representative in some way of the local diet, then it appears that beef contributed about one-fifth of the meat to the diet in Period 3A and approximately one-eighth of the meat to the diet in Period 3B. The lower contribution of beef to the Period 3B diet may relate in some way to their apparent decline in numbers between the two phases. It has previously been suggested that their role in agriculture became overshadowed by husbandry of pigs. The same may be true concerning their dietary contribution as well.

Finally, it is not surprising that over half of the cattle remains show evidence of cut and saw marks. Cattle are large animals and would have to be butchered into smaller pieces for consumption. The multitude of cut and saw marks may indicate several attempts, and several cuts had to be made to break the skeletal parts into manageable components. Again, this would be expected since cattle bone is thicker than that of other, smaller domesticates.

5.2.3.2 Caprines

After pig, sheep and goats are the second most commonly represented species in the middens, and probably the most difficult to interpret. Lack of definitive information about the exact species, age, and sex of these caprines, coupled with fluctuating NISP and MNI statistics between middens and phases, compounds this problem. In addition, the relative frequency of this, and all, taxa as they relate to the overall economy and diet at the site must be interpreted with caution, since it is contingent on taxa deposition within the middens. Deposition in the middens is assumed to reflect discard from consumed animals. Those caprines represented in the middens were all ultimately killed for their meat. However, if sheep and goats were not preferred table fare, then their remains would not be abundant in the middens, similar to the case with cattle. Sheep, in particular, could be under-represented in the middens if they were used primarily for wool and milk, rather than raised and slaughtered at younger ages and in great numbers specifically for their meat. It is with this reservation that the role of caprines in the economy and diet of Period 3 San Giovanni will be discussed.

The results of the analyses of caprines reveal several points. First, although the actual numbers and percentages vary between middens, on average it appears that caprines are less common in the middens from Period 3B than in Midden 1 from Period 3A. Second, more sheep than goats were identified based on the presence of diagnostic features on certain elements; therefore, it seems likely that most of the caprine bone sample derived from sheep. Third, more females than males are represented. Fourth, caprines were killed at all stages of development, however most (approaching significant proportions), appear to have been killed at an older age in Period

3A than in Period 3B. Fifth, the distribution of elements produces a peculiar pattern wherein the remains associated with secondary cuts, limb extremities, and the head region dominate over those associated with primary cuts. Furthermore, it is a pattern that remains consistent within and between both phases. Finally, the estimated contribution of meat from these taxa decreases from around 20% of the total meat in Period 3A to approximately 15% in Period 3B. Combined, what do these results tell us about the role of caprines in the economy and diet at the site?

Traditionally, rural southern Italy has been considered prime territory for the transhumant herding of sheep and goats (Semple, 1932:324). The data from San Giovanni support this to some extent. Caprines comprise from one-fifth to one-third of the quantified mammal component, depending on the midden and phase, suggesting that caprines fulfilled an important role in the economy and diet of the occupants. There does not appear to be enough stall space at the farmstead to house these, thus it is likely they were kept outdoors. The hoof-prints in tiles attest to this. Perhaps they were herded as transhumant flocks. However, the relatively low frequency of caprines compared to pigs probably means that transhumance was practised on a minimal scale and over short distances. A small-scale, short-distance transhumant operation might afford the farmer time to attend to other resources and animals, since he would never be too far from the farm. In addition, numerous strategies and resources available, including local woodland, scrubland and undrained land, as well as cultivation of fodder crops and the rotation of fields, would enable the farmer to keep the flocks near the farm all year round.

Attempting to quantify and qualify the exact role of this pastoral component in the San Giovanni economy is problematic. The incidence of transhumance in Roman Italy "is far more complex and interesting than it at first appears" (Thompson, 1988:214). The topic must now be considered in light of other determining factors such as economics, politics, and archaeological and ethnographic analogies. G. Barker (1991) has been instrumental in trying to understand the role of transhumance in archaeological and ethnographic contexts. His research provides a framework within which to qualify and quantify transhumance as revealed by the San Giovanni samples.

Barker's ethnoarchaeological study of transhumant practices in the Cicolano mountains in Italy concluded that regardless of flock size, distances covered and patterns of movement, universal similarities in husbandry patterns existed. All flocks were almost entirely composed of female animals, with only around 5% male; clearly females were favoured for propagation of the species and milk exploitation (Barker, 1991:72).

The age at death of the animals depended on the economic and dietary importance of their primary and secondary resources to the culture (Barker, 1991:73). Mature flocks signified that milk, cheese and wool were favoured. Females could contribute more, thus efforts were likely directed to keep them healthy. This would be expected to correlate with an abundance of implements and vessels associated with spinning, weaving, milking, or other resource processing, depending on where exactly these activities occurred. Shearing is a lowland activity, therefore one might expect to find its associated technology absent in the upland settlements where the transhumant flocks generally spent the summer months. On the other hand, meat, particularly that derived from young lamb, if popular, could skew death profiles to include a majority of immature and young individuals generally under one year of age (Barker, 1991:73,75). If this were the case, then young males would be readily expendable. In the archeological record one would now expect to find a greater accumulation of butchery tools in association (again depending on where this activity occurred), if meat and hides were primarily exploited. Theoretically it should be possible then to relate the ages of the bones from the site to the type of exploitation practised, although S. Payne (1973) has pointed out that often flocks are not usually kept for a single product, particularly in subsistence economies.

Although by no means conclusive, the caprine remains from San Giovanni suggest that some degree of pastoralism was practised. Females dominate that portion of the sample which could be accurately sexed. They were likely kept to older ages in efforts to exploit their supplies of wool and milk. It seems unlikely, however, that San Giovanni served as a major center for shearing, spinning, and weaving. The site is not located in a lowland area conducive for shearing, and loom weights and spindle whorls were extremely rare finds. Instead, it appears that the site may have been a transitional area between lowland and higher montane regions, where flocks would have rested in their transhumant journeys. The site lies within the lower montane zones, and quality grazing land is located on elevated slopes and fields within 5 km. of the site. That the flocks were mainly sheep is not unique. Brothwell (1988:258) claims that in Roman Italy sheep were preferred to goats; the latter were generally reported to be less profitable to the farmer, more difficult to handle in large numbers, and more destructive of the vegetation.

The results of the caprine aging analyses do not readily fall into any ideal pattern. If exploitation of secondary resources was important, one would expect to find a majority of elderly ewes and rams in the middens. Most of these would have reached at least stage 6 in my developmental scheme and survivorship curves illustrated in Figures 20 - 23 would hover near the 100% line before declining rapidly after stage 6. They do not. Nor do the graphs display evidence for extensive culling of young immature animals; in this case the curve would slope rapidly during Stages 1 through 4. Rather the steady decline through all stages of development suggests that caprines of all ages were killed and consumed at the site. It appears that neither meat nor milk nor wool could be considered the principal resource exploited from caprines at San Giovanni, but rather a combination of all three. It is likely that mature individuals, would be primarily used for milk and wool, but slaughtering for meat could be practised as well. Meat from caprines comprised a small, but consistent, part of the diet. This seems odd, considering that caprines, like cattle, were not principally, nor universally, bred for food during Roman times, and according to G. Salinardi (1973), this tradition continued into modern times as well. Young individuals were often slaughtered for festive or sacrificial occasions, and old ones were eaten upon their death. However, references in the literature to the slaughtering of individuals of all ages are absent.

What is even more peculiar is that the remains of bones associated with secondary cuts of meat predominate over those associated with primary cuts. Assuming that there is some cultural and economic significance to this distribution, rather than simply a result of differential discard, preservation or retrieval biases, we must assume that prime cuts of mutton were exported.

The abundance of elements associated with the head region lends support to the hypothesis that a fair number of caprines were slaughtered at the site. Both primary, and to a lesser extent secondary, cuts may have been cured, or otherwise preserved, and sold or distributed away from the site, and the remains from the head may have been discarded along with the kitchen refuse into the middens. It is unknown to what extent the head and brains of caprines were consumed by the Romans.

The evidence suggests that as the relative percentage of sheep and goats decreased from Period 3A to Period 3B so did their role in the economy and diet. In terms of diet, it appears the proportion of mutton to other meats in the diet dropped by about 5%. In terms of economics, it appears that wool and milk were relatively less important commodities during Period 3B. Age profiles show that a smaller percentage of individuals survived to mature ages at this time, perhaps indicating that caprines were no longer as valued for their secondary resources. Thus, while the economic role of caprines may have diminished in Period 3B, relatively more may have been slaughtered for meat, even though overall the contribution of mutton to the diet in Period 3B decreased.

5.2.3.3 Pigs

It is clear that pigs were by far the most important animals at San Giovanni. In all middens, regardless of phase, they account for over half, and in most cases over two-thirds, of the total NISP. The MNI values for pigs are comparably high, though not as high. This may, in part, be due to the significant rise in MNI values for caprines, as already discussed. Whatever the case, the abundance of pig remains is still extremely informative. The primary role pigs assumed in the diet and economy of the villa cannot be overstated.

The results of the analyses of pigs reveal several key points worth reviewing. First, NISP and MNI figures suggest that pigs contributed the majority of the faunal remains. Their relative numbers appear to increase, in some cases over 20%, between the Period 3A midden and any of the three middens from Period 3B. Second, this increase is also seen in a comparison of meat yields. Pork accounts for a majority of the total meat yielded in Period 3A, and an even greater majority during Period 3B. Third, survivorship curves show that pigs were killed at all stages of development Here, the NISP survivorhip curve seems to indicate that relatively more young pigs may have been slaughtered during Period 3B than Period 3A. However, statistical tests reveal that there is no significant difference in culling and slaughtering of young (Stage 1-4) and old (Stage 5-9) pigs between the two phases. Fourth, regardless of midden or phase, it appears younger males were slaughtered preferentially over females of all ages, and older males. Females, on the other hand, appear to have been slaughtered at older ages. Significantly more males, compared to females, were slaughtered in Period 3B than in Period 3A, but only when mandibular canines are assessed. Finally, the skeletal remains from the head and primary cuts of meat are represented to a greater extent than bones associated with secondary cuts and limb extremities. However, there is no significant difference in butchery practices between phases.

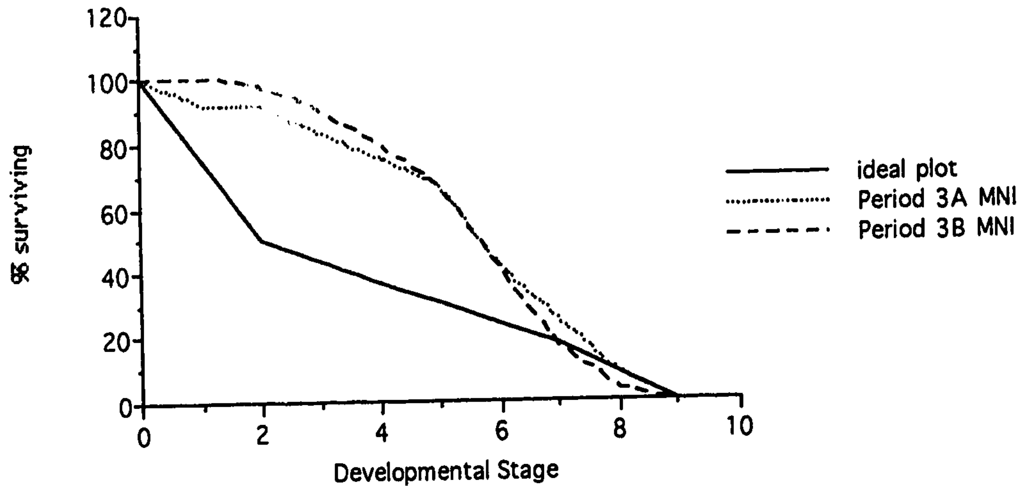
The species of pig utilized at San Giovanni was likely a local breed of dark-skinned pigs rather than the typical white and pinkish breeds common there today. This dark-skinned breed has longer legs, is thinner and leaner, and matures at a relatively later age than the white breed (Aherne, personal communication). They are generally very small, perhaps half the size of wild boar, but breed more rapidly than the latter (Clutton-Brock, 1981:74). According to G. Salinardi (1973), the breed of white pigs was not introduced to the Ruoti area until the mid-nineteenth century, coincident with a trend in deforestation. The dark-skinned breed was allowed free pannage in the forest, where it fed on insects, rodents, and vegetative mast, but the white breed was penned. Oak and beech forests are the dominant tree form in the area today, and probably were even more extensive during Roman times. This type of forest produces excellent forage for pigs. Clearly then, the availability of prime forest as habitat for these pigs was conducive to the exploitation of this animal.

The sex and age at death of the pigs is informative, but problematic. To begin with, it appears that selective slaughtering of young males as represented in Tables 8 and 9, accords with the Roman dietary preference for suckling pig. This practice would be efficient as well. A few adult males would be vital to perpetuating the stock, but too many would be redundant. Fussell (1972:34) states that among Classical farms in Western Europe ten boars were generally sufficient to serve one hundred sows, and herds ranged from 100 to 150. One would expect that if pork was a popular meat, as it was throughout late antiquity, then young suckling male pigs would be more prevalent in the retrieved faunal samples since the people would spare the females for propagation.

The information extracted from San Giovanni does not quite document these ideal conditions fully. Yes, young males dominate, but not to the extent expected in a truly efficient economy. If we assume the 1:10 ratio of males: females is ideal, and that each of these 10 mature females produces a brood of 6 piglets, 3 male and 3 female (based on Palladius's brood size estimates Opus Agric. 3. 156. 1086), then we would expect culling to display a pattern wherein 27 of the 30 newborn males would be killed during immaturity, and 30 of the 30 newborn females would be allowed to reach maturity. For control, the oldest male and ten of the oldest females would also be killed. Thus ratios of 28:10, or nearly 3:1, for male: female deaths would be obtained. Assuming enough space and food was available for the steadily increasing stock, a bimodal survivorship curve showing three times as many immature deaths as old age deaths, and no death in between would result from these ideal conditions,

The assumptions of this ideal scenario are its ultimate downfall. To maintain stable numbers in the herd of pigs, a balance of females and males would have to be killed during middle age to account for the new males and females being born. Most of these would be middle-aged females, and ideally in the above described situation 18 would need to be killed. If all stock was culled and slaughtered at the site then equal representation of males and females would be expected. In addition, if close and efficient control was practised the survivorship curve would tend to display an idealized distribution, depicted in Figure 25.

Figure 25: Idealized Pig Survivorship Plot Compared to that from Periods 3A and 3B at San Giovanni



This is not the case for the San Giovanni sample, as shown by the comparative MNI plots in Figure 25. Pigs appear to be have been kept to older ages, and extensive slaughter is suggested to have occurred during middle ages, between Stages 4 to 6. The sex ratios show a dominance of males. However, the 7:1 ratio of younger males to younger females as suggested in Table 10, is far in excess of the 3:1 idealized ratio explained above. Furthermore, far more older males are represented than would be expected under ideal circumstance. Why so many discprecancies?

A number of suggestions may be put forward to explain the deviation of San Giovanni pigs from idealized situations. Perhaps the simplest explanation is sample bias. It is possible that female canines may have been missed in the recovery and screening process because they are smaller teeth. Additionally, perhaps more of them existed as unrecognizable fragmentary pieces. Maybe, for some unknown reason, the part of the sample of female canines was simply unexcavated or was destroyed by taphonomic processes or agents. These explanations seem unlikely: since the entire middens were excavated meticulously, and teeth are perhaps the most durable of all skeletal elements. Therefore, we must look to a cultural explanation to explain the results.

The best explanation for the age and sex distributions of the pigs from San Giovanni is a cultural one that integrates many factors. Steele (1983) discussed this in his earlier analysis of a part of the San Giovanni faunal sample.

> The fact that pigs were killed at all stages of development would suggest that the animals were under close enough human control (either penned, herded or otherwise closely watched) for the animals of all ages to be selected for slaughter. Similarly, the higher frequency of males being slaughtered locally suggests a degree of control of the domesticate. It may be that females were left for brood stock or herded elsewhere for slaughter and the males may have been slaughtered locally because they were more difficult to herd, raised for lard, or for some other unperceived reason. (Steele, 1983:82).

The exact degree of control over the pigs is difficult to estimate. It would appear they were kept in a casual fashion, and were not restricted to pens. No evidence of feeding yards or housing pens large enough to support the great numbers of pigs represented has been recovered at San Giovanni. Thus, it is unlikely that tightly controlled, large-scale pig farming was an important practice at the farm. It appears more likely that the pigs were allowed to range freely in the local forested areas where they could feed themselves. No strict regime of care or feeding would be necessary, leaving the residents time to devote to other agricultural and husbandry activities. Efforts would probably be made to cull and slaughter males, particularly young ones, since these provided the tastiest cuts of meat, and were readily expendable. However, this pattern may not have been followed faithfully and other pigs, regardless of age or sex, may have been culled and slaughtered, perhaps in order to hastily fulfill quotas of consumption, sale, or export. Harvesting may have included the killing of a number of mature males, perhaps incorporated into a sport-hunting scenario. Whatever the case, the point is that the culling and slaughtering of pigs in this manner would explain why so many males were allowed to reach maturity. The occupants were not keeping them in confined places, like pens or yards, and were thus not concerned with such matters as male fighting and the cost of raising economically useless animals. Without the tight degree of age and sex control, often practised in pig-farming economies, the San Giovanni pig populations were able to live and die along more natural lines.

The harvesting of pigs in the forest, conjures up images of wild boar hunting. This sport was popular during Roman times, and may in fact influence the statistics presented for the pig sample from San Giovanni. Another explanation for the male bias in the pig sample is that some of these were wild or feral boars. However, only one mandibular M3 from the sample of pig teeth measured distinguishes a wild boar. Thus, on the basis of this evidence it is more likely that the male pigs represented are domesticates.

Domestication cannot be definitely proven at this point, however it seems highly probable. First, the presence of tooth-crowding in some of the dentitions indicates pig-keeping may have occurred. Domestication usually results in a decrease in the overall size of the species which often leads to dental crowding (Clutton-Brock, 1981:24). Measurements of mandibular teeth fall within the documented limits for those of domesticated pigs (Payne and Bull, 1988); only one tooth (a third mandibular molar) is unmistakeably that from a wild, and probably male, pig. Second, domestic pigs, like cattle and caprines, but very much unlike wild pigs, often congregate in large herds (Clutton-Brock, 1981:74); thus it is unlikely such a large sample of pigs would incorporate a vast quantity of wild individuals. Collective slaughter would be easier than individual killing. Finally, on the basis of classical literary references and historical documents, domestication is likely.

Despite these factors suggesting domestication, it is also possible that other male pigs from the San Giovanni middens indicated by their canine teeth but not by their mandibular teeth, represent wild/feral animals which were hunted for sport, or for some other reason. Unfortunately, the dividing line between domestic and wild pigs is narrow, and not readily discernible using morphological and morphometrical studies of skeletal elements. Pliny (Nat. Hist., 8. 79. 210) comments on the practice of inter-breeding wild and domesticated pigs during Roman times, thus further melding the line of discrimination between the two types. Perhaps the occupants did not really distinguish between wild or domestic species, but rather enjoyed the hunting activity for its own merit. Assuming these pigs were not totally docile they would still present some challenge to the hunter. If boar hunting was a special activity at this villa which attracted wealthy clients from outside areas, then most would probably be content with any kill they made. Inexperienced hunters would probably not know the difference between a truly wild or domestic boar. Rather, the whole hunting routine would simply be a part of a ploy to publically display wealth in a conspicuous manner.

Regardless of the manner in which they were kept and caught, the subsequent butchery of the pigs at San Giovanni may provide further insight into the economy and diet of the occupants. To begin, it is not surprising that they are the most frequent animals butchered, or that they show the greatest percentages of meat represented: pork was the main meat of the Romans. The butchery process was probably quite uniform. Those marked for slaughter were likely restrained or driven to a confined space, stunned or slit in the throats, allowed to bleed to death, scalded to facilitate skinning and dehairing, then cut or sawn into the desired pieces (Aherne, personal communication). It is likely that all parts of the animal were utilized in some manner, the majority probably consumed.

In her analysis, Assad (1986:119) noted that cut and saw marks among pig bones were placed in efforts to separate and dismember the skeletons into desired sections and remove muscle from the bones. This procedure is attributed to the Romans by Columella (Luff, 1982). The cut marks were probably caused by knives, fine-toothed saws or other sharp instruments. Several iron blades have been found at the site (Small and Buck, forthcoming). "It does not appear that the butchering caused severe damage, unless the bones were destroyed from unrecognized actions of the butchering process" (Assad, 1986:119).

The distribution of pig elements at San Giovanni suggests that all parts of the pig carcass were utilized. However, it does not appear that whole animals were consumed at the site, otherwise one would expect, assuming no recovery biases, a more equal representation of all skeletal elements regardless of their grade of cut. Instead, the sample suggests that a surplus of pigs were raised. If the occupants were slaughtering pigs solely for domestic consumption at the site then one would not expect to find so many missing skeletal elements. The skewed representation of skeletal elements in the San Giovanni pig sample suggests that at least some cuts were exported. Head elements are the most common, followed by primary cuts, but secondary cuts and limb extremities are also well represented. The frequency of head bones is particularly striking. It may have been that the occupants were processing cuts of meat, and exporting these, which left the heads as waste. Alternatively, the heads may have been a valuable resource, which was deliberately reserved for processing and/or consumption at the site. There is mention of roasting wild boar in the ancient literature (Pliny, Nat. Hist., 8. 78. 213). Perhaps the occupants entertained clients or guests quite frequently, and provided a special feast serving boars head. Although specific mention of this is absent in the classical literature, it is likely that if one was hunting and wished to conspicuously display the catch of the day, then the roasted head would certainly be an obvious and visually stimulating marker. In this way, the large number of mature males represented in the sample could be explained, and the occupants could still export the remaining cuts from these hunted boars, thereby explaining the lower comparative frequency of these elements.

Another explanation for the preponderance of head elements in the sample of pigs at San Giovanni may be due to the manufacturing of sausages at the site. The occupants could have exported primary and secondary cuts of pork but kept the relatively meatless and cumbersome heads for sausage materials. Apicius (De Re Coq. 2.5.1) lists a recipe for sausages which combines eggs and brains. In addition, although his popular Lucanian sausage recipe does not specify which cut of pork was required (De Re Coq. 2.4), it is possible that butchers used meat from the heads of pigs for this purpose. Assad (1986:123) further comments, "there are enough cut and saw marks on the cranial bones to suggest that the muscle was removed on at least some skulls prior to cooking". Whatever the case, the frequency of head and foot parts of the carcass, within the middens, correlates well with what we know from the ancient literary references about the consumption of pork. Although these parts of the carcass may not be universally popular today, it is noted that "the haute cuisine of imperial Rome presents an astonishing array of recipes based on the pig; there is scarcely any part of the carcass that did not provide the basis for some gourmet's delight...Pliny alone mentions fifty such recipes" (White, 1970:321). In Roman Italy, all parts of the pig were consumed either as pork, ham, sausage or lard. Sausage making would be a very economical way of dealing with the otherwise less palatable or preferred parts of the pig, including the head.

In modern Ruoti, some parallels exist which may support the interpretations presented above. Salinardi (1973) claimed that today pigs are still the main source of meat in the Ruoti region. Most of these are young male pigs which have been fattened quickly and slaughtered at under a year old. The farmer would try to have two litters from the breeding females per year, in autumn and spring. Brood sows were kept for 5 - 6 years. He further stated that although most of the pig produce was consumed locally, the area was renowned for its sausage.

That pigs continued to be the primary source of meat throughout the occupation phases at the site is undeniably true. Their contribution to the diet at San Giovanni increases over 20% from Period 3A to Period 3B, and has been reported to have reached even higher percentages (up to 80%) in Ruoti since that time (Salinardi, 1973). Today, however, the percentages are much smaller (Small, personal communication). It is probable, in the absence of modern concentrated foods, that ancient pigs required a longer period to fatten properly. Therefore, most of these Roman pigs would have been older than a year before slaughter. This may account, in part, for the older ages represented in the survivorship curves. Uninfluenced by human culture, it is likely that only one litter per sow per year was the norm (Aherne, personal communication). But, Palladius stated that sows breed from 2 - 7 years, and litter every four months (Opus Agric. 3. 153. 1065). Furthermore, he stated that if you eat or sell the piglets, thereby limiting the number of newborns, the sooner the mother will breed again, and the stronger she will be (Opus Agric. 3. 153. 1065-1086).

On the other hand, there is one modern practice in pig husbandry that does not directly parallel the situation revealed for San Giovanni. Specifically, Salinardi (1973) claimed that in addition to meat, pigs were also raised for lard. These were primarily males and castrated males which were killed at two years. Both castration and lard production do not appear to be common practices at San Giovanni.

Lard and marrow were probably not valuable products from the San Giovanni pigs. Assad (1986:106) noted that carnivore activity, rather than deliberate breakage by humans, was primarily responsible for the piecemeal destruction of the San Giovanni pig sample. In addition, the fact that overall these pigs were much leaner than modern commercial breeds (Aherne, personal communication), limits their potential for lard.

It is also unlikely that castration was commonplace (Aherne, personal communication), if the pigs were kept in a rather casual fashion. Until further data are collected, it is unknown how the osteology of castrated pigs differs from that of males or females, or what the canine morphology of castrate pigs is like. It is possible that a proportion of the males in the sample could include castrates. One would prefer to have docile castrated males, rather than territorial and ferocious uncastrated males. However, the work involved in castrating males would probably not be worth the effort, unless lard was the principal commodity exploited from the pig population, which it was not. Overall, castration seems highly unlikely considering the Roman penchant and demand for pork over lard.

When all the results of the pig analyses are considered together, it appears that pigs were important animals to the economy and diet of the occupants. There is sufficient evidence to suggest that a surplus was raised for a market economy. The most obvious market, based on literary and archaeological evidence is Rome itself. "We know that the region of Lucania surrounding the farmstead was heavily taxed for pork products during the period of occupation of the farmsite" (Steele, 1983:82). Guilds of pork suppliers who organized the purchase and transport of pigs and pig products to Rome from various regions as far away as southern Italy are described in the Theodosian Code of 438 AD (Codex. Theod. 14.3, 14.4, and 14.7). Faunal evidence from archaeological excavations within Rome, including the Schola Praeconum (Barker, 1982), and Palatine East (MacKinnon, 1992), indicates that pigs may have been the most commonly consumed meat in Rome during this period. It seems likely that San Giovanni was part of this market economy system dealing in swine, since it appears to have produced a surplus of pigs, beyond the dietary needs of the occupants.

San Giovanni can be labeled as a production center in a market exchange type of economic system. The excess of butchery elements, and an unnatural herd structure, both respresented in the pig sample, are two criteria which accord with Clark's (1987:191) description of such a site. However, while it is easy to identify San Giovanni as a production center, it is difficult to quantify and qualify its role based on the faunal sample alone. If animals were driven to Rome from Lucania on the hoof, then their bones would be absent from the site. On the basis of the smaller frequency of remains from female pigs, compared to males, it is possible that a proportion of sows was driven to outside markets even as far away as Rome. Ancient documents attest to this practice but they do not state which sex was preferred, if a discrimination was made. If sufficient food and water were available along the route then journey times and tissue shrinkage could be greatly reduced (Aherne, personal communication). On the other hand, if cuts of meat were processed at the site, and either salted, smoked, made into sausages, or otherwise butchered or preserved, then an excess of butchered elements would be represented. It is probable that both of these systems were practised at San Giovanni. The abundance of butchered pig remains from the Period 3B middens, however, may suggest that processing cuts at the site was more important to the economy at that time, than during Period 3A. Perhaps the farmsite played a greater role in fulfilling the demands of local and regional markets with cuts of pork at this time.

It appears that the role of pigs in the economy of the farm increased dramatically during this phase, at the expense of all other domestic and wild animal resources. The exact significance of the economic interaction between rural and urban sites as revealed through comparative faunal analyses is a topic that deserves further study if we are to ever quantify and qualify the roles of these centers of production and consumption

CHAPTER 6

SUMMARY AND CONCLUSIONS

Archaeological excavation at the Roman rural villa of San Giovanni has produced a substantial sample of faunal remains. The majority were collected from four middens dating to two occupation phases (Period 3A = AD 400 to AD 460; Period 3B = AD 460 to AD 550). A statistical analysis of the mammalian bone from these middens provides significant results from which to derive interpretations about i) biases, forces and processes affecting the recovery and nature of the sample, and ii) the economy and diet at the site.

Analyses reveal the importance of distinguishing and controlling all biases that may skew representations in any faunal sample. Taphonomic factors, recovery and sampling methods, and quantification procedures should be clearly outlined, for each can affect the cultural interpretations made on the sample. This has been performed for the San Giovanni material.

Sampling and recovery methods were studied as they relate to the faunal sample. Analyses have revealed the importance of using screens in the recovery of bone. In all middens screening resulted in the recovery of significantly more bone. Screening is vital for the revovery of small fragmentary pieces and bone and tiny elements from smaller species. The results of the sampling and recovery analyses further reveal that sample similarities existed between Middens 1 and 7, and between Middens 4 and 5, regardless of the taxa represented within each.

A variety of domestic and wild mammalian taxa was represented, among them, pig, sheep/goat, cattle, equids, dog, cat, red deer, roe deer, bear, bat, porcupine, rat, mice, and various rodents and small insectivores. All of these are typical of the area during the Roman period, and all are mentioned in the Classical literature.

Pigs are the most abundant taxon represented. Their analysis reveals several important points. First, the number and relative proportion of pigs increased significantly from Period 3A to Period 3B, indicating a concentration on, and intensification of, pig husbandry during the later phase. Second, despite literary references alluding to the popularity of wild boar hunting in this area, dental evidence indicates that the vast majority of the bones recovered were from domesticated pigs. Third, dental criteria also show that male pigs outnumbered females by ca. 1.3 to 1. Finally, while pork was the most important meat in the diet, evidence of the slaughtering of pigs at all ages indicates that the traditional dietary penchant of the Romans for suckling pig was not a viable option for the site occupants. The evidence supports the argument that the pigs were raised in a rather causal fashion, which did not require extensive care and vigilance by the farmer. The herds were kept in neighboring forests, where they were allowed to feed freely. The occupants exploited these large herds in efforts to fulfill Imperial tax demands for pork. The unequal sex ratios suggest that some pigs, mainly females, were driven to urban markets, including Rome. On the other hand, the skewed representation of skeletal elements, and distribution of butchery marks indicate that some processing of carcasses occurred at the site, presumably for export to local or regional markets.

Caprines are the second most abundant taxon represented at the site. Again several points are noteworthy. First, caprines are common in Period 3A, but significantly less so in Period 3B. Their numbers appear to have dwindled, likely due to the increase in pigs during the later phase. Second, sheep preponderate over goats, and females over males. This accords with typical profiles among transhumant flocks. Transhumance is further suggested by the lack of adequate stall and pen space at the site. Third, caprines were killed at all stages of development. This suggests that both primary and secondary resources were utilized, perhaps in equal proportions. Milk and wool were valuable commodities at the site. However, sheep and goats were also butchered for their meat, some of which may have been processed at the site and transported elsewhere. Finally, the diminishing importance of caprines in the diet and economy between the two phases suggests that small-scale, short-distance transhumance was likely practised. The site is located in a transitional region between lowland and higher montane regions. It is likely it served as a resting area for flocks, rather than as a home base, or shearing center . Yet, despite areas of favourable geography in proximity and a traditional belief promoting southern Italy as prime territory for the raising of sheep and goats, pastoralism was probably never the dominant mode of husbandry at San Giovanni. Caprines always undershadowed pigs in terms of economic and dietary importance.

Cattle are the third most abundant taxon represented, but compared to pigs and caprines, they are very infrequent finds. Cattle were not the preferred food fare at the site; those few cattle represented are likely work animals which were consumed after they had lived to an elderly age and were becoming inefficient.

Other domesticants are extremely rare in the middens. Dogs, cats, and equines appear to have contributed little to the economy.

The remains of wild animals are also infrequently represented in the middens. Many of these were hunted and all could have lived in the nearby forested regions. Of these, it appears that deer (both red and roe) contribute the greatest quantity of meat to the diet - a contribution more pronounced during Period 3A. It is possible that the emphasis on pig and pork production during Period 3B occurred at the expense of hunting. Nevertheless, the presence of such a diverse range of wild species implies that the villa was a wealthy structure, occupied or visited by elites who revelled in the joys of hunting.

In conclusion, the analysis of the faunal remains from four middens at the Roman rural villa of San Giovanni di Ruoti has revealed important economic and dietary information which could not be obtained from any other type of analysis or extrapolated from any Classical literary account. It has clarified our understanding of rural life and culture in Roman Italy. However, in doing so the rural economy did not operate in isolation. It was tied in various ways to the larger urban economy. Much work still remains to be done in deciphering the intricacies of both Roman rural and urban sites and their economic relations. It is hoped that my research on the ancient economy and diet at San Giovanni di Ruoti will provide a valuable foundation for the future research of rural-urban economic comparisons, correlations, and connections, not only in Roman Italy but throughout the Roman Empire.

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Appendix A: Analysis of Soils from Contexts in Two Middens

Context	Midden	pH	N	Ph	K	Ca	Mg	Zn	Fe	Mn	Cu	Organics
CK20/DA21-428	4	8 mod. alk.	low	>150 very high	288 high	>4000 very high	395 high	>2.00 high	>20.0 high	10 high	2	>7.0%
DE28/DF29-555	5	8.1 mod. alk.	low	>150 very high	284 high	>4000 very high	350 high	>2.00 high	>20.0 high	9.3 high	2	4.30%
DK28/EA29-580	5	8 mod. alk.	low	>150 very high	236 high	>4000 very high	365 high	>2.00 high	>20.0 high	6.1 high	2	6.40%

all values expressed in parts/million (PPM) unless otherwise noted

Appendix B: Pig: Developmental Stages

This table provides a description of the state of tooth eruption and wear characteristic of the nine developmental stages identified for the pig mandibles and mandibular teeth recovered from Middens 1, 4, 5, and 7. The key to symbols used is as follows:

dc = deciduous canine
di = deciduous incisor [first (di1); second (di2); third (di3)]
dp = deciduous premolar [second (dp2); third (dp3); fourth(dp4)]
C = permanent canine
I = permanent incisor [first (I1); second (I2); third (I3)]
P = permanent premolar [second (P2); third (P3), fourth (P4)]
M = permanent molar [first (M1); second (M2); third (M3)]

Stage 1: dc, di3, dp4 unerupted or in process of erupting, but not in occlusal position.

Stage 2: dc and di3 are slightly worn. dp4 is in occlusal position, but with no or minimal wear. di1, di2, dp2, dp3, and M1 are unerupted.

Stage 3: dc and di3 are moderately worn. di1, di2, dp2, and dp3 are erupting and may show slight wear if in occlusion early. dp4 is exhibiting slight wear on the occlusal surface. M1 is erupting but not in occlusal position.

Stage 4: dc and di3 are heavily worn. di1, di2, dp2, dp3, and dp4 exhibit moderate wear on the surface. M1 is in occlusal position and exhibits slight wear. C, I1, I3, and M2 are unerupted.

Stage 5: dp2, dp3 and dp4 are very worn with none of the cusps identifiable. di2 is moderately to heavily worn. C, I1, and I3 are erupting and have replaced dc, di1, and di3 respectively. M1 shows slight to moderate wear. M2 is erupting, but not in occlusal position.

Stage 6: P2, P3, and P4 have replaced dp2, dp3, and dp4 respectively. C, I1, I3, and M2 show slight wear. M1 is worn. M3 is erupting but not in occlusion. di2 is heavily worn.

Stage 7: I2 has replaced di2, and may show some wear. C, P2, P3, and P4 exhibit slight to moderate wear. I1 an I3 show moderate wear. M1 is worn flat on the occlusal surface. M2 shows moderate wear, but the apices of the cusps still project above the occlusal plane. M3 is in occlusal position, but shows only minimal wear.

Stage 8: Moderate to heavy wear if shown on C, I1, I2, I3, P2, P3, and P4. M1 is worn virtually to the gum line. M2 is worn to a flat occlusal plane. M3 exhibits slight to moderate wear.

Stage 9: M3 is worn to a flat occlusal plane.

Wear stages based on information contained in Schmid (1972); Steele (1983); Wilson et al. (1982).

Appendix C: Caprine: Developmental Stages

This table provides a description of the state of tooth eruption and wear of the eight developmental stages identified for the caprine mandibles and mandibular teeth from Middens 1, 4, 5. and 7. The key to the symbols used is as follows:

di = deciduous incisor [first (di1); second (di2); third (di3)]
dp = deciduous premolar [first (dp1); second (dp2); third (dp3)]
I = permanent incisor [first (I1); second (I2); third (I3)]
P = permanent premolar [first (P1); second (P2); third (P3); fourth (P4)]
M = permanent molar [first (M1); second (M2); third (M3)]

Stage 1: Fetal or newborn in beginning stages of deciduous dentition. No wear on any teeth.

Stage 2: Deciduous dentition erupted and in occlusion. di1, di2, dp1, dp2, and dp3 exhibit slight to moderate wear. di3 is slightly worn. M1 is erupting.

Stage 3: Early stages of eruption for I1 and M2. Heavy wear on remaining deciduous teeth. M1 slightly worn.

Stage 4: Deciduous dentition exfoliated. di3 may still be present but is heavily worn. Early stages of eruption for I2, P2, P3, and possibly M3, with pointed forms for all.

Stage 5: I3 has replaced di3. Early stages of eruption for P4. M3 erupting and approaching occlusion position. I1, I2, P2, P3, M1, and M2 show early stages of slight wear. Cemento-enamel junction on all cheek teeth plainly visible.

Stage 6: Slight to moderate wear on I1, I2, P2, P3, M1 and M2. P4 and M3 exhibit slight wear.

Stage 7: Moderate to heavy wear on I1, I2, P2, P3, M1, and M2. Moderate wear on P4 and M3.

Stage 8: Pronounced heavy wear on all teeth, with the exception of P4 and M3 which show moderate to heavy wear.

Wear stages were developed based on information contained in Grant (1982); Payne (1987); Schmid (1972).

Appendix D: Class Representation

	MIDDEN 1		MIDDEN 4		MIDDEN 5		MIDDEN 7		*PERIOD 3A*		*PERIOD 3B*		COMBINED	
CLASS	NISP	%	NISP	%	NISP	%	NISP	%	*NISP*	*%*	*NISP*	*%*	NISP	%
Mammal	319	91.4	1017	70.9	1646	84.2	779	88.3	*319*	*91.4*	*3442*	*80.6*	3761	81.4
Bird	29	8.3	410	28.6	299	15.3	95	10.8	*29*	*8.3*	*804*	*18.8*	833	18.0
Fish	1	0.3	5	0.3			5	0.6	*1*	*0.3*	*10*	*0.2*	11	0.3
Reptile					9	0.5	1	0.1			*10*	*0.2*	10	0.2
Amphibian			3	0.2	1	0.1	2	0.2			*6*	*0.1*	6	0.1
TOTAL	349		1435		1955		882		*349*		*4272*		4621	

CLASS	MNI	%	MNI	%	MNI	%	MNI	%	*MNI*	*%*	*MNI*	*%*	MNI	%
Mammal	35	87.5	71	62.3	106	82.8	61	83.6	*35*	*87.5*	*181*	*73.3*	216	75.3
Bird	4	10.0	41	36.0	20	15.6	9	12.3	*4*	*10.0*	*63*	*25.5*	67	23.3
Fish	1	2.5	1	0.9			1	1.4	*1*	*2.5*	*1*	*0.4*	2	0.7
Reptile					1	0.8	1	1.4			*1*	*0.4*	1	0.3
Amphibian			1	0.9	1	0.6	1	1.4			*1*	*0.4*	1	0.3
TOTAL	40		114		128		73		*40*		*247*		287	

Appendix E: NISP and MNI Values/ Taxon and Midden

TAXON		MIDDEN 1		MIDDEN 4		MIDDEN 5		MIDDEN 7	
		NISP	MNI	NISP	MNI	NISP	MNI	NISP	MNI
Pig	*Sus sp.*	183	12	714	39	1325	65	506	25
Sheep/goat	*Ovis sp./Capra sp.*	86	13	219	21	202	24	156	20
Cattle	*Bos sp.*	22	2	54	2	80	3	80	3
Equids	*Equus sp.*	5	1			1	1	3	1
Red Deer	*Cervus elaphus*	3	1			4	1	2	1
Roe Deer	*Capreolus capreolus*	1	1					1	1
Dog	*Canis sp.*			6	1				
Cat	*Felis sp.*					2	1	3	2
Lagomorph	*Lepus sp.*	3	1	1	1	15	3	2	1
Chicken	*Gallus sp.*	20	2	360	39	263	18	75	7
Other birds	Aves	9	2	50	2	36	2	20	2
Bat	Chiroptera					1	1		
Rodent	Rodentia	11	2	11	2	5	1	16	4
Porcupine	*Hystrix cristata*					1	1		
Bear	*Ursus sp.*	2	1						
Mouse	*Apodemus sp./Glis sp./Mus sp.*	1	1	5	3	6	1		
Mole	*Talpa sp.*					1	1		
Shrew	Soricidae							1	1
Rat	*Rattus sp.*			1	1	1	1		
Frog	*Bufo bufo*			3	1	1	1	2	1
Tortoise	*Testudo hermanni*					9	1	1	1
Fish	Osteichthyes	1	1	5	1			5	1
Misc.	[illegible]	2		6		2		9	
TOTAL		349		1435		1955		882	

Appendix F: NISP Statistics

TAXON	MIDDEN 1		MIDDEN 4		MIDDEN 5		MIDDEN 7		*PERIOD 3A*		*PERIOD 3B*	
	NISP	%	NISP	%	NISP	%	NISP	%	*NISP*	*%*	*NISP*	*%*
Pig	183	57.5	714	70.4	1325	80.1	506	65.5	*183*	*57.5*	*2545*	*74.0*
Sheep/goat	86	27.0	219	21.6	202	12.2	156	20.2	*86*	*27.0*	*577*	*16.7*
Cattle	22	6.9	54	5.3	80	4.8	80	10.3	*22*	*6.9*	*214*	*6.2*
Equids	5	1.6			1	0.1	3	0.4	*5*	*1.6*	*4*	*0.1*
Dog			6	0.6							*6*	*0.2*
Cat					2	0.1	3	0.4			*5*	*0.1*
Red Deer	3	0.9			4	0.2	2	0.3	*3*	*0.9*	*6*	*0.2*
Roe Deer	1	0.3					1	0.1	*1*	*0.3*	*1*	*0.0*
Lagomorph	3	0.9	1	0.1	15	1.0	2	0.3	*3*	*0.9*	*18*	*0.5*
Bat					1	0.1					*1*	*0.0*
Rodent	11	3.4	11	1.1	5	0.3	16	2.1	*11*	*3.4*	*32*	*0.9*
Porcupine					1	0.1					*1*	*0.0*
Bear	2	0.6							*2*	*0.6*		
Mouse	1	0.3	5	0.4	6	0.3			*1*	*0.3*	*11*	*0.3*
Mole					1	0.1					*1*	*0.0*
Shrew							1	0.1			*1*	*0.0*
Rat			1	0.1	1	0.1					*2*	*0.1*
Frog			3	0.3	1	0.1	2	0.3			*6*	*0.2*
Tortoise					9	0.5	1	0.1			*10*	*0.3*
TOTALS												
Domestic	296	93.4	993	97.9	1610	97.3	748	96.8	*296*	*93.1*	*3351*	*97.4*
Wild	21	6.6	21	2.1	44	2.7	25	3.2	*21*	*6.6*	*90*	*2.6*
GRAND TOTAL	317		1014		1654		773		*317*		*3441*	

Appendix G: MNI Statistics

TAXON	MIDDEN 1 MNI	MIDDEN 1 %	MIDDEN 4 MNI	MIDDEN 4 %	MIDDEN 5 MNI	MIDDEN 5 %	MIDDEN 7 MNI	MIDDEN 7 %	*PERIOD 3A MNI*	*PERIOD 3A %*	*PERIOD 3B MNI*	*PERIOD 3B %*
Pig	12	34.3	39	54.9	65	61.3	25	41.0	*12*	*34.3*	*100*	*54.9*
Sheep/goat	13	37.1	21	29.6	24	22.6	20	32.8	*13*	*37.1*	*52*	*28.6*
Cattle	2	5.7	2	2.8	3	2.8	3	4.9	*2*	*5.7*	*6*	*3.3*
Equids	1	2.8			1	1.0	1	1.6	*1*	*2.8*	*1*	*0.5*
Dog			1	1.4							*1*	*0.5*
Cat					1	1.0	2	3.3			*2*	*1.1*
Red Deer	1	2.8			1	1.0	1	1.6	*1*	*2.8*	*1*	*0.5*
Roe Deer	1	2.8					1	1.6	*1*	*2.8*	*1*	*0.5*
Hare	1	2.8	1	1.4	3	2.8	1	1.6	*1*	*2.8*	*3*	*1.7*
Bat					1	1.0					*1*	*0.5*
Rodent	2	5.7	2	2.8	1	1.0	4	6.6	*2*	*5.7*	*4*	*2.2*
Porcupine					1	1.0					*1*	*0.5*
Bear	1	2.8							*1*	*2.8*		
Mouse	1	2.8	3	4.2	1	1.0			*1*	*2.8*	*4*	*2.2*
Mole					1	1.0					*1*	*0.5*
Shrew							1	1.6			*1*	*0.5*
Rat			1	1.4	1	1.0					*1*	*0.5*
Frog			1	1.4	1	1.0	1	1.6			*1*	*0.5*
Tortoise					1	1.0	1	1.6			*1*	*0.5*
TOTALS												
Domestic	28	80.0	63	88.7	94	88.7	51	83.6	*28*	*80.0*	*162*	*89.0*
Wild	7	20.0	8	11.3	12	11.3	10	16.4	*7*	*20.0*	*20*	*11.0*
GRAND TOTAL	35		71		106		61		*35*		*182*	

Appendix II: Data on Mandibular Teeth Measurements in Pigs

	N	Range in mm.	mean	std. dev.
dp4				
L	24	15.91 - 20.68	18.14	1.22
WP	24	7.93 - 9.79	8.55	0.51
M1				
L	79	13.52 - 18.28	16.14	1.09
WA	79	8.47 - 10.96	9.55	0.45
WP	79	9.16 - 11.52	10.14	0.48
M2				
L	73	15.76 - 22.27	19.8	1.07
WA	73	10.68 - 16.02	12.04	0.83
WP	73	11.14 - 15.30	12.38	0.73
M3 (domestic)				
L	16	25.84 - 33.88	29.83	2.51
WA	16	11.92 - 16.82	14.04	1.1
M3 (wild)				
L	1	39.64		
WA	1	17.34		

L = the greatest length of the enamel crown, taken along the mesio-distal axis. Once teeth are in wear, L is generally at or close to the occlusal plane; if the shape of the crown is irregular, L is measured as a maximum projection.

WA = the maximum width of the anterior part of the enamel crown, taken at right angles to the tooth's mesiodistal axis. WA is usually at or very close to the cervical margin of the crown. If the shape of the tooth is very irregular, WA is measured in projection.

WP = the maximum width of the posterior part of the enamel crown otherwise measured in the same way as WA.

Appendix I: Comparative M3 Data for Pigs

SITE or SOURCE		L				WA			
		N	Range in mm.	x	s	N	Range in mm.	x	s
Kizilcahaman	wild	5	39.7 - 42.8	41.1		5	17.7 - 19.5	18.3	
(Payne and Bull, 1988)									
Mikulcice	domestic	1191		30.3	2.37	1200		14.8	0.9
(Kratochvil, 1981)									
Mugharet el 'Aliya	wild	6	35.0 - 38.6	36.8	1.46				
(Gilman, 1975)									
Algerian wild	wild			40					
(Pomel, 1896)									
Modern Kurd wild	wild	11	37.4 - 44.0	40.6	2.05				
(Hole et al., 1969)									
Jarmo ceramic	wild	3	35.8 - 38.1	36.8					
(Hole et al., 1969)									
Seeberg, Burg.-Sud wild	wild	20	40.0 - 49.0	43.7	6.78				
(Boessneck et al., 1963)									
Banahilk		5	28.7 - 34.0	31.7	4.06				
(Hole et al., 1969)									
Argissa Bronze Age		6	32.0 - 37.0	33.4	3.24				
(Milojcic et al., 1962)									
Jericho	wild		37.0 - 43.7						
(Clutton-Brock, 1979)									
Schola Praeconum	domestic	9	28.3 - 34.0	30.4	2.05				
(Barker, 1982)									
San Giovanni	domestic	16	25.84 - 33.88	29.83	2.51	16	11.92 - 16.82	14.04	1.1
San Giovanni	wild	1		39.64		1		[illegible].34	

Appendix J: Pig: Development and Survival Statistics

	DEVELOPMENTAL STAGE									
	1	2	3	4	5	6	7	8	9	
MIDDEN 1										
NISP	2	0	3	2	4	17	13	11	3	} 55 NISP
% surviving	96.3	96.3	90.8	87.2	80.0	49.0	25.3	5.3	0.0	
MNI	1	0	1	1	1	3	2	2	1	} 12 pigs
% surviving	91.7	91.7	83.3	75.0	66.7	41.7	25.0	8.3	0.0	
MIDDEN 4										
NISP	0	6	21	22	16	40	38	18	2	} 163 NISP
% surviving	100.0	96.3	83.4	70.0	60.1	35.6	12.3	1.2	0.0	
MNI	0	2	5	3	3	8	8	8	2	} 39 pigs
% surviving	100.0	94.9	82.1	74.4	66.7	46.2	25.6	5.1	0.0	
MIDDEN 5										
NISP	0	1	14	21	46	75	58	26	4	} 245 NISP
% surviving	100.0	99.6	93.9	85.3	66.5	35.9	12.2	1.6	0.0	
MNI	0	1	4	5	9	17	14	6	2	} 58 pigs
% surviving	100.0	98.3	91.4	82.8	67.2	37.9	13.8	3.4	0.0	
MIDDEN 7										
NISP	0	1	2	11	6	18	6	9	1	} 54 NISP
% surviving	100.0	98.1	94.4	74.1	63.0	29.6	18.5	1.9	0.0	
MNI	0	1	2	4	1	5	3	3	1	} 20 pigs
% survivng	100.0	95.0	85.0	65.0	60.0	35.0	20.0	5.0	0.0	

PERIOD 3A										
NISP	*2*	*0*	*3*	*2*	*4*	*17*	*13*	*11*	*3*	*} 55 NISP*
% surviving	*96.3*	*96.3*	*90.8*	*87.2*	*80.0*	*49.0*	*25.3*	*5.3*	*0.0*	
MNI	*1*	*0*	*1*	*1*	*1*	*3*	*2*	*2*	*1*	*} 12 pigs*
% surviving	*91.7*	*91.7*	*83.3*	*75.0*	*66.7*	*41.7*	*25.0*	*8.3*	*0.0*	
PERIOD 3B										
NISP	*0*	*8*	*37*	*54*	*68*	*133*	*102*	*53*	*7*	*} 462 NISP*
% surviving	*100.0*	*98.3*	*90.3*	*78.6*	*63.9*	*35.1*	*13.0*	*1.5*	*0.0*	
MNI	*0*	*2*	*8*	*10*	*13*	*26*	*24*	*13*	*4*	*} 100 pigs*
% surviving	*100.0*	*98.0*	*90.0*	*80.0*	*67.0*	*41.0*	*17.0*	*4.0*	*0.0*	

Appendix K: Caprine: Development and Survival Statistics

	DEVELOPMENTAL STAGE								
	1	2	3	4	5	6	7	8	
MIDDEN 1									
NISP	0	3	0	5	6	10	5	0	} 29 NISP
% surviving	100.0	90.0	90.0	72.4	51.7	17.2	0.0	0.0	
MNI	0	2	0	2	2	4	3	0	} 13 sheep/goats
% surviving	100.0	84.6	84.6	69.2	53.8	23.1	0.0	0.0	
MIDDEN 4									
NISP	2	15	5	6	8	7	6	13	} 62 NISP
% survivng	96.8	72.6	64.5	54.8	41.9	30.6	21.0	0.0	
MNI	1	3	1	4	2	3	2	5	} 21 sheep/goats
% surviving	95.2	81.0	76.2	57.1	47.6	33.3	23.8	0.0	
MIDDEN 5									
NISP	0	6	7	8	17	12	5	2	} 57 NISP
% surviving	100.0	89.5	77.2	63.2	33.3	12.3	3.5	0.0	
MNI	0	3	3	3	7	5	2	1	} 24 sheep/goats
% surviving	100.0	87.5	75.0	62.5	33.3	12.5	4.2	0.0	
MIDDEN 7									
NISP	2	8	8	9	11	12	0	1	} 51 NISP
% surviving	96.1	80.4	64.7	47.1	25.5	2.0	2.0	0.0	
MNI	2	4	3	3	3	4	0	1	} 20 sheep/goats
% surviving	90.0	70.0	55.0	40.0	25.0	5.0	5.0	0.0	
PERIOD 3A									
NISP	*0*	*3*	*0*	*5*	*6*	*10*	*5*	*0*	*} 29 NISP*
% surviving	*100.0*	*90.0*	*90.0*	*72.4*	*51.7*	*17.2*	*0.0*	*0.0*	
MNI	*0*	*2*	*0*	*2*	*2*	*4*	*3*	*0*	*} 13 sheep/goats*
% surviving	*100.0*	*84.6*	*84.6*	*69.2*	*53.8*	*23.1*	*0.0*	*0.0*	
PERIOD 3B									
NISP	*4*	*29*	*20*	*23*	*36*	*31*	*11*	*16*	*} 170 NISP*
% surviving	*97.6*	*80.6*	*68.8*	*55.3*	*34.1*	*15.9*	*9.4*	*0.0*	
MNI	*3*	*9*	*7*	*9*	*8*	*8*	*3*	*5*	*} 52 sheep/goats*
% surviving	*94.3*	*76.9*	*63.5*	*46.2*	*30.8*	*15.4*	*9.6*	*0.0*	

Appendix L: Pig: Element Distribution

	MID. 1		MID. 4		MID. 5		MID. 7		*P3A*		*P3B*	
	NISP	MNI	NISP	MNI	NISP	MNI	NISP	MNI	*NISP*	*MNI*	*NISP*	*MNI*
HEAD												
cranial	4	2	23	4	74	?	13	2	*4*	*2*	*110*	*?*
premaxilla & maxilla	8		27		39		10		*8*		*76*	
mandible	15		74		92		35		*15*		*201*	
deciduous teeth	24		105		178		77		*24*		*360*	
incisors	40	12	84	39	291	65	99	25	*40*	*12*	*474*	*100*
canines	33		57		173		53		*33*		*283*	
premolars	10		66		145		39		*10*		*250*	
molars	14		110		198		68		*14*		*376*	
TOTALS	**148**	**12**	**546**	**39**	**1190**	**65**	**394**	**25**	***148***	***12***	***2130***	***100***
PRIMARY CUTS												
scapula	6	4	28	5	36	?	23	?	*6*	*4*	*87*	*?*
humerus	6	4	19	5	22	10	12	5	*6*	*4*	*53*	*19*
innominate	1	1	5	3	2	1	1	1	*1*	*1*	*8*	*4*
femur			5	3	7	3	2	1			*14*	*5*
TOTALS	**13**	**4**	**57**	**5**	**67**	**10**	**38**	**5**	***13***	***4***	***162***	***19***
SECONDARY CUTS												
radius			7	3	9	5	4	2			*20*	*7*
ulna	4	2	12	5	13	5	10	4	*4*	*2*	*35*	*12*
tibia			5	2	5	2	9	3			*19*	*7*
fibula	2	1	5	2	23	7	14	4	*2*	*1*	*42*	*11*
TOTALS	**6**	**2**	**29**	**5**	**50**	**7**	**37**	**4**	***6***	***2***	***116***	***12***
LIMB EXTREMITIES												
metapodial					5	2	2	1			*7*	*2*
metacarpal	3	2	13	4	13	3	16	2	*3*	*2*	*42*	*7*
metatarsal	4	1	15	4	15	4	16	4	*4*	*1*	*46*	*7*
calcaneus	2	2	8	3	6	3	5	3	*2*	*2*	*19*	*9*
astragalus			3	2	2	2					*5*	*4*
phalanges	6	1	35	2	17	1	15	1	*6*	*1*	*67*	*4*
carpals			1	1							*1*	*1*
tarsals			2	1	1	1					*3*	*1*
TOTALS	**15**	**2**	**77**	**4**	**59**	**3**	**54**	**3**	***15***	***2***	***190***	***9***

Appendix M: Caprine: Element Distribution

	MID. 1		MID. 4		MID. 5		MID. 7		*P3A*		*P3B*	
	NISP	MNI	NISP	MNI	NISP	MNI	NISP	MNI	*NISP*	*MNI*	*NISP*	*MNI*
HEAD												
horn	1	1	3	2	8	3	3	2	*1*	*1*	*16*	*6*
cranial	1	1	1	1	4	1			*1*	*1*	*5*	*2*
premaxilla & maxilla	1				1		1		*1*		*2*	
mandible	8		21		16		18		*8*		*55*	
deciduous teeth	3		20		13		12		*3*		*45*	
incisors	5	13	12	21	11	24	5	20	*5*	*13*	*28*	*52*
premolars	7		29		21		14		*7*		*64*	
molars	33		68		82		53		*33*		*203*	
TOTALS	**59**	**13**	**154**	**21**	**156**	**24**	**106**	**20**	***59***	***13***	***415***	***52***
PRIMARY CUTS												
scapula	2	2	9	2	4	3	1	1	*2*	*2*	*14*	*5*
humerus	2	2	2	1	3	2	5	3	*2*	*2*	*10*	*4*
innominate	2	2	3	2	1	1	5	1	*2*	*2*	*9*	*4*
femur					2	1	2	2		*1*	*4*	*2*
TOTALS	**6**	**2**	**14**	**2**	**10**	**3**	**13**	**3**	***6***	***2***	***37***	***5***
SECONDARY CUTS												
radius	2	2	11	3	10	6	11	3	*2*	*2*	*32*	*9*
ulna	1	1	5	2	2	1	9	2	*1*	*1*	*15*	*4*
tibia	8	3	9	2	10	8	3	2	*8*	*3*	*22*	*9*
fibula	2	1							*2*	*1*		
TOTALS	**13**	**3**	**25**	**3**	**22**	**8**	**23**	**3**	***13***	***3***	***70***	***9***
LIMB EXTREMITIES												
metapodial			5	2	3	1	4	1			*12*	*3*
metacarpal	2	1	1	1	2	1	4	2	*2*	*1*	*7*	*3*
metatarsal	2	1	3	2	9	2	3	1	*2*	*1*	*15*	*3*
astragalus												
calcaneus			1	1	2	2	4	2			*7*	*4*
phalanges	2	1	11	1	4	1	2	1	*2*	*1*	*17*	*2*
carpals			1	1	3	1					*4*	*1*
tarsals												
TOTALS	**6**	**1**	**22**	**2**	**23**	**2**	**17**	**2**	***6***	***1***	***59***	***4***

Appendix N: Cattle: Element Distribution

	MID. 1		MID. 4		MID. 5		MID. 7		*P3A*		*P3B*	
	NISP	MNI	NISP	MNI	NISP	MNI	NISP	MNI	*NISP*	*MNI*	*NISP*	*MNI*
HEAD												
horn					2	1					*2*	*1*
cranial					1	1	1	1			*2*	*1*
premaxilla & maxilla			1								*1*	
mandible			5		7		4				*16*	
deciduous teeth			1		1		6				*8*	
incisors	2	1		2	2	2	1	2	*2*	*1*	*3*	*6*
premolars	1		3		5		2		*1*		*10*	
molars			10		10		8				*28*	
TOTALS	**3**	**1**	**20**	**2**	**28**	**2**	**22**	**2**	***3***	***1***	***70***	***6***
PRIMARY CUTS												
scapula			1	1	4	2	3	1			*8*	*3*
humerus	1	1			2	1	2	1	*1*	*1*	*4*	*2*
innominate	3	1	1	1	1	1	1	1	*3*	*1*	*3*	*1*
femur	1	1			3	2	3	1	*1*	*1*	*6*	*3*
TOTALS	**5**	**1**	**2**	**1**	**10**	**2**	**9**	**1**	***5***	***1***	***21***	***3***
SECONDARY CUTS												
radius	1	1	2	1	1	1	5	3	*1*	*1*	*8*	*4*
ulna	3	2	1	1	3	2	4	2	*3*	*2*	*8*	*4*
tibia	1	1	4	1	4	2	1	1	*1*	*1*	*9*	*3*
fibula												
TOTALS	**5**	**2**	**7**	**1**	**8**	**2**	**10**	**3**	***5***	***2***	***25***	***4***
LIMB EXTREMITIES												
metapodial			1	1	7	2	2	1			*10*	*3*
metacarpal			2	1	3	2	1	1			*6*	*3*
metatarsal			1	1	4	3	2	1			*7*	*4*
astragalus	1	1			1	1			*1*	*1*	*1*	*1*
calcaneus	1	1			1	1	4	2	*1*	*1*	*5*	*3*
phalanges	6	1	19	2	11	2	26	2	*6*	*1*	*56*	*3*
carpals			1	1	2	2					*3*	*2*
tarsals	1	1							*1*	*1*		
TOTALS	**9**	**1**	**24**	**2**	**29**	**2**	**36**	**2**	***9***	***1***	***89***	***4***

Appendix O: Meat Weight Estimates

		MID. 1	MID. 4	MID. 5	MID. 7	P3A	%	P3B	%
PIG									
	MNI	12	39	65	25	12		100	
	Total Meat Weight (kg)	756	2457	4095	1575	756	42.0	6300	68.6
	Live Weight (kg)	1080	3510	5850	2250	1080		9000	
SHEEP/GOAT									
	MNI	13	21	24	20	13		52	
	Total Meat Weight (kg)	357.5	577.5	660	550	357.5	19.9	1430	15.6
	Live Weight (kg)	715	1155	1320	1100	715		2860	
CATTLE									
	MNI	2	2	3	3	2		6	
	Total Meat Weight (kg)	385	385	577.5	577.5	385	21.4	1155	12.6
	Live Weight (kg)	700	700	1050	1050	700		2100	
DEER									
	MNI	2		1	2	2		2	
	Total Meat Weight (kg)	300		150	300	300	16.7	300	3.3
	Live Weight (kg)	600		300	600	600		600	

Pig: live animal weight = 90 kg; meat weight = 70%
Sheep/Goat: live animal weight = 55 kg; meat weight = 50%
Cattle: live animal weight = 350 kg; meat weight = 55%
Deer: live animal weight = 300 kg; meat weight = 50%

Live and meat weight estimates from King et al. (1985)