Subsistence Strategies at the Zencor Site (33FR8)
A Faunal Analysis of a Late Woodland Site

THESIS

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By

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Abstract

The Zencor site, a Late Woodland site, is located on an eastern terrace of the Scioto River within the southern boundary of the Columbus city limits. The site was originally investigated by Raymond Baby of the Ohio Historical Society in 1957 and 1958. The site was initially identified as a year-round settlement, but the radiocarbon dates suggest that the site was occupied intermittently throughout the Late Woodland as a seasonal occupation. An extensive investigation of over 10,000 animal bone fragments was performed on the faunal assemblage of the Zencor Site, incorporating the entire site, and revealing distinct subsistence patterns at the Late Woodland site. The data analysis suggests a high dependence on deer and wild turkey, including marrow utilization. The faunal record also indicates a lack of aquatic remains. The faunal record was compared to Reidhead’s (1981) linear model for the Late Woodland diet to determine if the inhabitants of Zencor were attempting to optimize their diet. The faunal analysis suggests that Late Woodland people were occupying Zencor intermittently during the winter and fall seasons and optimizing the available faunal resources.
Dedication

This document is dedicated to my parents.
Acknowledgments

Special thanks must be extended to the Ohio Historical Society for the loan of the faunal collection and field notes from the Zencor site. I would also like to thank Martha Otto, Jeb Bowen, Linda Pansing, and Bill Pickard for their continued support. I also would like to thank my advisor Dr. Richard Yerkes for his guidance and insight as well as Drs. Julie Field and Robert Cook for their help as members of my defense committee. In addition, I would like to thank Dr. Clark Spencer Larsen and my fellow students for their suggestions and advice on earlier drafts of this paper. Special thanks must be extended Dr. Paul Thacker of Wake Forest University for his continued support.

I would like to thank my mother, father, brothers, sisters, nieces and nephews for their constant encouragement in not only this thesis, but also all other obstacles I have encountered in my life. Finally, thank you Carolyn, for being the rock in which the seas of doubt crash and break.
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Chapter 1:
Investigating Prehistoric Social Behavior through Faunal Remains

Although investigations of archaeological faunal collections and human subsistence span the twentieth century, the breadth of research undertaken recently is considerable. From ethnoarchaeological observations into caribou butchery (Binford 1981) to the effects of a catastrophic volcanic eruption on cervid remains (Lyman 1982), the diversity of this research remains as significant as the quantity. Archaeologists working throughout North America identify general subsistence patterns through investigations of remains and gain insights into the corresponding cultural traditions (Lapham 2005; Reidhead 1981).

Subsistence and settlement strategies can be inferred from the food represented by faunal remains left at prehistoric sites. Faunal remains can provide data that can be used to measure human diet breadth and understanding behavioral trends in prehistory (Sutton and Arkush 2006). Specifically, some of the important questions answered through faunal analysis include:

“Which taxa were regularly eaten, rarely eaten, and never eaten and why? Which taxa contributed most to the prehistoric diet? When were particular taxa hunted? How much food did different taxa provide? Were particular age groups or one sex of a taxon preferred over others? Did age, sex, or individual selection vary intertaxonomically? Where were food animals hunted and how were they hunted?” (Lyman 1982:335)
Archaeologists also seek to understand who was involved in animal procurement in order to offer insight into division of labor based on age or sex, what combinations of foods were preferred, as well as indications of differential access (Redding 2002).

Unfortunately, subsistence strategies in the Late Woodland period in central Ohio are not as well understood as in other regions, since only a limited number of faunal analyses have been conducted. In addition, the understanding of settlement patterns during this period has come under contention (Clay and Creasman 1999). The study of faunal material from the Late Woodland Zencor site in central Ohio can provide insights into diet, subsistence strategies, and settlement patterns during this period (AD 400-1000). This thesis investigates these topics through an analysis of the organization of faunal remains, including the location, abundance, and condition of animal bones in the deposits at Zencor. Specifically, the quantification of taxa based on the number of identified species (NISP), as well as the minimum number of individuals (MNI) was conducted in order to provide an accurate measure of the taxonomic composition at Zencor. Lastly an age profile of the ancient deer (Odocoileus virginianus) population was generated by the application of dental aging indices to the assemblage of mandibles. Analyses such as these can indicate shifts in subsistence practices that may be important to understanding the cultural transition from the Middle to Late Woodland periods. This analysis is intended to determine whether the inhabitants at Zencor’s primary objective in their food procurement was to minimize labor in the production of a nutritionally optimal diet. The faunal evidence will be tested by comparing the data with an optimal foraging model put forth by Van Reidhead (1981) for the Leonard Haag Late Woodland site in the
Ohio Valley region. As a result of my analyses, I contend that food procurement strategies at Zencor during the Late Woodland placed particular importance on large mammal species, specifically deer (*Odocoileus virginianus*), and minimally utilized resources from the Scioto River, such as fish and beaver. Based on the optimal foraging model put forth by Reidhead for a Late Woodland site, the Zencor analysis shows few similarities with the optimal strategy for food procurement. Instead, the faunal record suggests that the Zencor site was inhabited during the fall and winter seasons. Furthermore, this thesis suggests that the human group inhabiting the Zencor site possibly actively modified their local environment by managing certain vertebrate resources. Management simply refers to the voluntary use of restraint in the harvesting of certain age groups, specifically older deer (5 ½ years and older), to maintain a healthy deer population in balance with the habitat (Miller and Marchinton 1995). Such management would have maintained demographic conditions that are more typical when herds are managed by natural conditions, which provide for a nutritionally as well as socially healthy deer population. Though the faunal record does not provide specific data on herd structure, the deer kill ratios at Zencor suggest that the hunted deer population possessed a more balanced age structure, with a higher ratio of older deer when compared to modern, unmanaged deer populations. The focus on juvenile deer ensures a population that best suits the deer sociobiology.

Despite possible sample bias favoring larger mammal species due to a lack of screening or flotation during excavation, the faunal remains at the site possess important implications for prehistoric Native American environmental adaptations and social organization, especially in the transition from the Middle to Late Woodland. Through
deer management and more intensified horticultural practices, the populations of the mid-
Ohio valley shifted their attention from intricate mound building and long distance trade
networks of the preceding Middle Woodland period, to an intensification of subsistence
and food processing strategies that characterize the Late Woodland.

In 1957 and 1958, Raymond Baby of the Ohio Historical Society initiated
excavations at a Late Woodland site situated several hundred yards west of South High
Street south of downtown Columbus, Ohio, along the edge of a terrace just east of the
Scioto River. The property was previously known as the old Marion Farm, and had been
purchased by the Zenith Trading and Holding Company. In light of impending
development, Baby wanted to test the site, which he labeled Zencor prior to its
destruction (Mays and Baby 1958; Potter 1966). The excavations were exploratory and
designed to reveal information about the embankment as well as the village area. Two
long trenches were dug through the site. The following season both trenches were
extended considerably (Potter 1966). The Baby excavations uncovered postmolds of at
least three habitation areas as well as a significant amount of faunal remains, which will
be analyzed in this thesis (Potter 1966).
Chapter 2:
Change in Subsistence and Settlement Patterns in Southern Ohio

The appearance of the archaeological phenomenon known as Hopewell from 100 B.C. to A.D. 400, as well as its disappearance, remains the focus of numerous debates in archaeology (Dunnell and Greenlee 1999; Emerson, McElrath, Fortier 2000). The Hopewell of the Middle Woodland are known for their large-scale geometric earthworks, hilltop enclosures, and complex burial mounds. The large quantity and aesthetic qualities of the grave offerings interred in these burial mounds provide an example of the considerable extent of the Hopewell Interaction Sphere (Caldwell 1964; Hall 1997: 155-157). Most burials include finely crafted objects, made from exotic materials obtained through interregional trade. Marine shells from the Gulf of Mexico, mica and quartz crystals from the southern Appalachians, and grizzly bear teeth and obsidian from the Rocky Mountains indicate the extent of the trade networks (Hall 1980; Dunnell and Greenlee 1999). Many archaeologists consider the archaeological manifestations of the Hopewell period as evidence of the first cultural climax for Midwestern prehistory (McElrath, Emerson, Fortier 2000). Cultural artifacts and mortuary ritual characteristic of the Hopewell period arise intermittently throughout the Eastern Woodlands, and two regions particularly associated with this complex are in Illinois and Ohio (McElrath, Emerson, Fortier 2000). However, most researchers note that in south and central Ohio the complex of Hopewell cultural characteristics are most prominent (Fitting 1978, Lepper 2005).
Profound differences in the archaeological records of the Middle and Late Woodland periods signify the end of Hopewell society patterns ca. A.D. 400. These differences are so definitive that while the former is referred to as a ‘high culture’ (Griffin 1943:211) and even a ‘flamboyant explosion’ (Prufer 1964:63), the latter is a ‘good and gray’ culture (Williams 1963:297) and a ‘colorless interval’ (Dunnell and Greenlee 1999; also see Hall 1980; Seeman 1992; Yerkes 1988, 2006). The perceived difference between them stems from divergent archaeological features. During the Late Woodland large earthworks and hilltop enclosures disappear from the record, and mounds, where present, are small and lack the elaborate cultural remains that were readily present in the Middle Woodland (McElrath, Emerson, Fortier 2000). These changes form the basis for the idea that the Late Woodland represents a collapse of Hopewell culture (Dunnell and Greenlee 1999). Yet, was this indeed a collapse, or a transition into a more productive society? If so, what caused this transition in Hopewell society? Archaeologists have addressed these questions with models that attempt to explain the Middle to Late Woodland transition. The following is an overview of the evidence drawn from southern Ohio, which incorporates the Zencor site.

The Late Woodland in Southern Ohio

Compared to the expansive mounds and earthworks of the Hopewell in the Middle Woodland, the archaeological record of the Late Woodland is dramatically less visible (McElrath, Emerson, Fortier 2000). Yet, the emergence of cultural resource management-driven archaeology as well as an increased interest in the development of
tribal societies has increased the number of recorded Late Woodland sites in Southern Ohio (Seeman and Dancey 2000) (Figure 1). In light of this new evidence, a clearer picture of prehistoric life in the Late Woodland has emerged.

Figure 1 - List of Late Woodland sites in the mid-Ohio valley (Seeman and Dancey 2000: 587)
Though dating the period still presents some problems, uncalibrated radiocarbon dates from Late Woodland sites range from A.D. 541 to A.D. 1005, which makes this period relatively brief in the mid-Ohio Valley (Figure 2). The material culture of the period includes well-developed lithic, ceramic, bone, and fiber industries. Lithic core-and-bladelet industries, which were common during the Middle Woodland (Yerkes 2003), disappear in the Late Woodland when there are only bifacial chipped stone industries (Seeman 1992). In addition, Late Woodland ceramics contrast significantly with those of the previous Middle Woodland period, as thin, cordmarked, and coarse grit tempered forms appear in the archaeological record (Potter 1966). These changes in the archaeological record from the Middle Woodland to the Late Woodland demonstrate the discontinuity between the two cultural traditions.
Figure 2 - Radiocarbon record for selected Late Woodland mid-Ohio valley sites
(Seemand and Dancey 2000:588)

Though the data indicates that the Hopewell culture increased their commitment to obtaining and consuming local seed-bearing plants when compared to the earlier Early Woodland period, the available evidence suggests that the Late Woodland period in the mid-Ohio valley is particularly characterized by an intensification of subsistence and food processing activities (Seeman and Dancey 2000; Abrams 2009). Strong evidence of forest clearing, more uniform ceramics, earth-oven cooking technology, chipped stone technology, and an increase in local chert tool production support this hypothesized change (Wymer 1987; Potter 1966, Seeman 1992). Although cultivated plants show
evidence towards morphological change towards domestication, no unequivocal sign of an increase in starchy seed collection is present during the period in Ohio (Wymer 1992, but see Braun 1988, for contrary data from Illinois). In addition, Late Woodland peoples focused on hunting deer, and there is some evidence of increasing hunting pressure over time in the increase of bone abundance found in archaeological deposits of the period (Shott et al. 1993:20). At the Late Woodland Turpin site, located in southeast Ohio, large mammals such as deer contributed more than 90 percent of the fauna exploited (Theler and Harris 1988). In contrast, aquatic resources, which were intensively exploited in other areas such as the Lower Illinois Valley by the beginning of the Late Woodland period, show the opposite trend in the mid-Ohio Valley, even though many sites were ideally situated to exploit such resources (Styles 1981; Theler and Harris 1988).

Related to the focus on deer hunting is the emergence of the bow and arrow during the Late Woodland. The bow and arrow provided technical superiority when compared to the earlier spearthrower, yet came with more demanding production skills and increased maintenance costs (Hall 1980). Specifically, the bow and arrow provided greater range, higher velocity, greater accuracy, and a more rapid rate of fire. In addition, the bow could be employed from a greater variety of positions, allowed the hunter to carry more ammunition, and required less learning time (Seeman 1992). Yet, bows and arrows possess more components than spearthrowers, and require a wider range of raw materials for manufacture. In addition, a higher skill level was necessary in the manufacturing process, and increased maintenance costs associated with bow and arrow usage include a higher rate of arrow loss, and lower impact shock (Hall 1980).
coupled with changes in food procurement and processing strategies, the adoption of the bow and arrow suggest an intensification of subsistence practices.

In the Middle Woodland, Hopewell communities were made up of single or multiple family households scattered across the landscape, but concentrated around centrally located burial mounds and ceremonial precincts (Dancey and Pacheco 1997). What some see as nucleated, year-round settlements supplanted and replaced these earlier smaller, more dispersed settlements homesteads during the Late Woodland (Figure 3; Dancey 1996; Yerkes 2005, 2006). Yet, the concept of a nucleated village generally connotes the presence of a sedentary site occupied throughout the year, with areas including well-defined house structures, activity areas, and communal areas, the locations of which remain constant through periods of demolition and rebuilding (Smith 1978). The Late Woodland sites, particularly those found in mid-Ohio valley such as Zencor, show no substantial domestic facilities (Clay and Creasman 1999). This has led some archaeologists to question the idea of nucleated villages in the Late Woodland, arguing instead that these sites were seasonally occupied (Clay and Creasman 1999). This thesis attempts to contribute to this discussion through the use of the optimal foraging model of nutritional optimization for the Late Woodland put forth by Van Reidhead.
Figure 3 - Size of Late Woodland sites in the mid-Ohio Valley (Seeman and Dancey 2000:592).

Modeling Late Woodland Subsistence in Southern Ohio

Borrowed from ecology, optimal foraging models have been applied to several modern and prehistoric societies to predict how subsistence resources will be used (Kelly 1995). The optimal foraging models approximate the decision-making process that a forager makes based on the assumption that the goal of foraging is to maximize the
overal energy-return rate (Kelly 1995). Reidhead utilized a linear programming model to analyze the changes in subsistence strategies at the Leonard Haag site from the Late Woodland to the Fort Ancient period. Linear programming is preferred as while many optimal-foraging models use only energy as their currency, linear programming can simultaneously evaluate diets in terms of an array of dietary elements (Reidhead 1981). Linear programming models predict diets based on the intersection of linear constraint lines, which are determined by several physiological, anatomical and energetic characteristics of the foragers (Belvovsky 1986).

Reidhead used linear programming is that it was necessary to generate a nutritional model which demonstrates the resource mix which must have been used to minimize costs in the attainment of a specified level production. In achieving this goal, the Late Woodland people of the Leonard Haag site were faced with a set of limited resources of variable nutritional value. The task, therefore, is to simulate the decisions which must have been made regarding the allocation of those resources in meeting the hypothetical goals of the Late Woodland populations (Reidhead 1981). A test of nutritional optimization through linear programming is made possible by two conditions. First, the subsistence patterns of the Late Woodland and Fort Ancient peoples who inhabited the Leonard Haag Site may be reconstructed using the faunal and floral remains from the site. Secondly, models of nutritional optimization may be generated using linear programming and the availability of resources, nutrient value of resources, and resource costs, which would specify the quantities of resources that would have been used by the Leonard Haag inhabitants had their goals been to minimize labor, while still providing the basic nutritional requirement (Reidhead 1981:2).
Based on these conditions, Reidhead produced a floral and faunal database for the Leonard Haag site based on the potential resources available for a site in its location. These resources were then ranked according to their nutrition factors and the labor required to procure such resources for both each season and the entire year to create a model of resource optimization (Reidhead 1981). With this information, the actual subsistence records at the Leonard Haag site were then compared to the model in order to determine whether or not there is evidence of nutritional optimizing strategies for the Late Woodland and Fort Ancient periods (Table 1). Reidhead suggested that the inhabitants of Haag site were not orienting their animal procurement activities toward nutritional optimization in the Late Woodland in a strict sense, and that other considerations were of importance in shaping production decisions as they related to animal utilization (Reiadhead 1981:405). Such a process may be applied to the faunal record of the Zencor Site. The Leonard Haag and Zencor site show many similarities; both are situated above the floodplain of a river, are large habitation sites, and date to the Late Woodland Period (Reidhead 1981). As a result, it may be assumed that the faunal resources available to the inhabitants of the Leonard Haag site are similar to those available to the Zencor population. Therefore, the Late Woodland optimization model put forth by Reidhead may be utilized in the analysis of the Zencor faunal record.

In order to determine whether the inhabitants at Zencor practiced nutritional optimizing practices in procuring fauna depends upon a comprehensive analysis of the faunal record at the Zencor Site. This thesis seeks to add to the ever-growing information on the Late Woodland in the mid-Ohio Valley.
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Table 1 - Late Woodland optimum foraging model created by Reidhead compared to the Leonard Haag fauna rank ordered by contribution to diet (Data from Reidhead 1981: 401).
Chapter 3:
A History of Excavation and Exploration at the Zencor Site

The Zencor site is located 4 ¼ miles (6.4 km) south of downtown Columbus in the Marion Township of Franklin County, Ohio. The site is situated several hundred yards west of South High Street along the edge of a terrace just east of the Ohio-Erie canal and the Scioto River, on property now owned by the Zenith Trading and Holding Company (Figure 4; Goodman 1957). The site is along the edge of a terrace just east of the Ohio-Erie canal and the Scioto River, located in the Wisconsin till plain and the soils are fertile and well-drained. The site itself is situated in Wea silt loam, a well-drained fertile soil found on stream terraces and glacial outwash areas. Directly to the east of the site, within half a kilometer, is an extensive slight rise that is classified as Kendallville silt loam. This rise is also well-drained, especially when compared to the Celina silt loam which borders the rise on the east (Wymer 1987: 101).

Dr. Raymond Baby’s Ohio Historical Society excavations of the Zencor site in 1957 were exploratory and designed to reveal information about the embankment as well as the village area. Therefore, baby excavated two long trenches at the site (Figure 5; Goodman 1957). Excavation measurements were not metric. The first trench was 150 feet in length and placed near the western edge of the embankment and just north of the southern property line of the Zencor housing division. This trench was oriented north to south. This first trench uncovered a number of features, including three human burials
and several postmolds (Figure 6). The second test unit was 100 feet in length and oriented east to west, and was located 304 feet northwest of the first trench (Figure 7). Each trench was excavated in two levels, the first level incorporating the plow zone and going to an average depth of six inches (Goodman 1957). The second level of each unit contained dark earth, fire cracked rock, and the majority of occupational debris, and this level reached an average depth of four inches, ending once a yellowtilly clay subsoil was reached (Figure 8).

In the second year of excavations in 1958, the trenches were extended considerably to encompass more of the habitation area (Mays and Baby 1958). The southern end of the first trench was extended east to west by strip excavating another habitation area and uncovering postmolds of at least two houses that had a circular arrangement, 25 to 36 feet in diameter, with an overlapping wall that may have served as an entrance. In addition, the western end of the second trench was extended through stripping, uncovering the postmolds of at least one house structure (Mays and Baby 1958).

Martha Potter Otto, director of the Department of Archeology at the Ohio Historical Society continued excavations in the area between 1981-1983 (Potter 1982). Although the northern portion of the site was destroyed due to development, the southern third of the site was preserved due to its incorporation in the Scioto Trails School grounds. As a result, the site was maintained as a green space, adjacent to the houses built for the Zencor subdivision. Martha Potter Otto continued excavations in alignment with the location of Baby’s first trench, oriented north to south.
Results of Excavations

Both areas uncovered by Baby’s excavations revealed at least two habitation areas, as well as numerous oval and circular pits, located in and around the housing structures. The village refuse and midden contained great quantities of animal bone, mussel shells, lithic material, including projectile points and numerous worked tools, and ceramic sherds. Despite the amount of cultural refuse collected from the site, there is no indication of screening or the use of floatation techniques during the excavations, potentially creating a discrepancy between larger and smaller artifacts and faunal materials (Mays and Baby 1958). Nevertheless, the excavations produced approximately 10,000 bone fragments that encompass the faunal sample that this thesis addresses. Martha Otto’s excavations uncovered a few scattered postmolds and refuse pits, which also contained several human burials. Feature 5 in particular, represents an extensive section of the site, possibly representing several pits adjoining each other, and has yielded a significant quantity of ceramics, animal bone, fish and shellfish remains (Potter 1982). In addition, Otto recognized that the site may have been encircled by a semicircular embankment measuring approximately nine hundred feet long, which partially enclosed the site area on the southeast, east, and northeast sides (Figure 9). The addition of earth by the inhabitants suggests that the embankment may have been used for defense (Potter 1966). Six radiocarbon dates were taken from the Zencor site. Table 2 and Figure 10 illustrate the range of six the dates from the site as they span the entire Late Woodland period. These radiocarbon dates indicate that the faunal remains in this thesis may have been deposited during several occupation episodes. Feature 2, which contained a
substantial number of elements, has a C14 date that is an "outlier," (AD 1025-1154) which falls in the Late Prehistoric period. In addition, Feature 6 would date to the terminal Late Woodland (AD 778-941), but there are no radiocarbon dates for Feature 1 or 3. The dates range from the early Late Woodland through to after the period, suggesting that rather than a relatively short year-round occupation at a Late Woodland village, Zencor may have faunal remains from several occupations, perhaps during the colder months of the year. Such an occupation is suggested by Theler and Harris (1988), for the Turpin site, and is contrary to the year-round settlement pattern that was previously indicated. An investigation into the faunal sample at Zencor may reveal more about the occupation pattern.

The ceramic collection for the Zencor site, along with ceramics from other Late Woodland sites formed the basis of Martha Potter Otto’s Masters thesis at Ohio State (Potter 1966). The ceramics from Zencor were classified as grit tempered, cordmarked Late Woodland types, including the Cole variety or sub-type. However, further research suggested that the Late Woodland period actually incorporated a more refined series of temporal and associated cultural phases than the broad Cole Culture designation. In response to this research, some of the Zencor sherds were reclassified as early Late Woodland Newtown types (Seeman 1992).

Due to the extensive plant community still present along the bluff edge and slope of the site, a vegetation survey was conducted on along a path that led from the sharp bluff adjacent to the site and along the terrace immediately above the Scioto River (Wymer 1987). Although the list of plants taken in the survey is only a crude index of the diversity of species in the area, the majority of the taxa recorded are typical of
disturbed areas, and indicate the extent of land modification in the area. Therefore, this transect demonstrates that more arid-adapted taxa tend to occupy the bluff face and more moist-adapted species inhabit the alluvial soils along the river’s edge. In addition to this vegetation survey a comprehensive paleoethnobotanical record was created along with several other central Ohio sites (Wymer 1987). This record indicates that the life-history and habitat characteristics of the plants identified at the Zencor site show a picture of an active interaction between the humans and their environment. Weedy plants such as bedstraw (*Galium aparine*), vervain (*Verbenaceae sp.*), and ragweed (*Ambrosia artemisiifolia*) grew in and around the house structures and along paths within the living space, while shrubby areas of hazelnut (*Corylus cornuta*), elderberry (*Sambucus nigra*), raspberry (*Rubus idaeus*), sumac (*Rhus coriaria*), and other genera grew in abandoned garden plots and along openings in the forest. Such garden plots, when left in fallow, may have provided for an accessible location for firewood from the trees that matured in these areas (Wymer 1987).

A preliminary faunal analysis was performed on the remains by Jeb Bowen of the Ohio Historical Society. The analysis incorporated several 5 x 5 foot units from the first trench excavated by Baby, and three pit features, and shows a wide variety of faunal species present at the site, with deer being the most abundant. Bowen also aged deer mandibles in his report, a technique that this thesis continues with the rest of the site’s faunal record (Bowen 2005).
Remaining Questions

The Zencor site, and particularly the faunal record, provides a unique opportunity to understand the subsistence strategies of the Late Woodland populations in the mid-Ohio valley. Along with the paleoethnobotanical record, a complete faunal analysis of the Zencor record may reveal relationships between the patterns in horticultural practices and hunting strategies and whether the Zencor inhabitants optimally utilized these resources. Specifically, a faunal analysis may show the specific vertebrate species that the Zencor population utilized to compliment their horticultural practices and whether their procurement practices were intended for nutritional optimization. In addition, the faunal record may provide further insight into the layout of features and habitation areas at the site and even reveal insight into whether the site was used as a seasonal occupation or a year-round settlement. Finally, a complete age profile of deer based on the aging the available mandible remains may demonstrate both the type of deer population being hunted as well as whether the Zencor inhabitants practiced some sort of deer management through the voluntary use of restraint in hunting specific ages of deer.
Figure 4 - Map of southwest Columbus, Ohio with Zencor site indicated (Wymer 1987; 97).
Figure 5 - Layout of Zencor Site with excavation indicated (Courtesy of Martha Otto, Ohio Historical Society).
Figure 6 - Trench #1 layout at the Zencor Site (Courtesy of Martha Otto, Ohio Historical Society).
Figure 7 - Trench #2 layout at the Zencor Site (Courtesy of Matha Otto, Ohio Historical Society).
Figure 8 - Vertical profile of Square R1 of Trench #2, demonstrating level depth (Goodman 1957).
Figure 9 - Aerial photograph of Zencor Site showing the location of the ditches defining the settlement space. Baby excavations are located within the ditch (Seeman and Dancey 2000; 596).
<table>
<thead>
<tr>
<th>Lab Number</th>
<th>Square</th>
<th>Level</th>
<th>BP</th>
<th>Dev</th>
<th>Conventional Radiocarbon Age ± 1σ calibration ranges (Calib6.01)</th>
<th>2σ calibration ranges (Calib6.01)</th>
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<td>Feature 5 pit</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>start-end (% under curve)</td>
<td>start-end (% under curve)</td>
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<td>SMU-1964</td>
<td>3L3</td>
<td>35-40 cm</td>
<td>1448</td>
<td>40</td>
<td>AD 590-645 (95), AD 585-589 (5%)</td>
<td>AD 548-656 (100%)</td>
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<td>3L3</td>
<td>40-45 cm</td>
<td>1330</td>
<td>60</td>
<td>AD 648-721 (75), AD 741-770 (25%)</td>
<td>AD 602-784 (93), AD 787-826 (5), AD 840-863 (2%)</td>
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<tr>
<td>Beta-4349</td>
<td>3L3</td>
<td>50-55 cm</td>
<td>1200</td>
<td>60</td>
<td>AD 768-894 (87), AD 716-744 (13%)</td>
<td>AD 682-905 (87), AD 912-970 (13%)</td>
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<td>AD 569-777 (100%)</td>
<td>AD 546-897 (98), AD 922-942 (2%)</td>
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<td><strong>T-test:</strong> different at 0.05; T = 12.2, X² = 5.99 (2 df)</td>
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<td>12or9R3</td>
<td>70-80 cm</td>
<td>1435</td>
<td>80</td>
<td>AD 543-666 (100%)</td>
<td>AD 428-714 (97), AD 745-767 (3%)</td>
<td>Wymer 1987</td>
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<td>Beta-4350</td>
<td>6R0</td>
<td>25-30 cm</td>
<td>1170</td>
<td>50</td>
<td>AD 778-897 (88), AD 922-941 (12%)</td>
<td>AD 766-986 (95), AD 711-746 (5%)</td>
<td>Wymer 1987</td>
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<td>Feature 2 pit</td>
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<tr>
<td>Beta-4347</td>
<td>0</td>
<td>30-35 cm</td>
<td>950</td>
<td>50</td>
<td>AD 1076-1154 (73), AD 1025-1055 (27%)</td>
<td>AD 1013-1208 (99.4), AD 998-1003 (&lt;1%)</td>
<td>Wymer 1987</td>
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<tr>
<td><strong>Sum. Prob.</strong></td>
<td><strong>Zencor all Features, six dates</strong></td>
<td></td>
<td></td>
<td></td>
<td>AD 564-725 (58), AD 727-888 (42%)</td>
<td>AD 534-984 (84), AD 1016-1173 (16), AD 467-481 (&lt;1%)</td>
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Table 2- Conventional and calibrated radiocarbon dates from the Zencor site (Wymer 1987).
Figure 10- Calibrated radiocarbon date ranges and summed probabilities at the 68.3% (1σ) confidence interval for six samples from the Zencor site. The calib 6.01 program and IntCal09.14 curve were used. Note that the summed probabilities for the six dates span the entire Late Woodland period. See Table 2 for details.
Faunal remains are an important source of data that can help archaeologists reconstruct some of the daily activities of ancient people. Previous populations used many animals in a variety of different ways, and faunal remains are present in most archaeological sites. Faunal remains can provide information about subsistence strategies, hunting methods, site function, as well as interaction with their surrounding environment (Sutton and Arkush 2006). Faunal remains may also provide information about group diet and site layout (Reitz and Wing 1999). Zooarchaeologists deduce this information through taxonomic identification using a comparative faunal collection as well as through the aging of deer mandibles and quantitative statistical methods, such as number of identified specimens (NISP) and the minimum number of individuals (MNI) in the faunal collection (Grayson 1984; Elder 1965; Theler and Harris 1988).

Zooarchaeologists may disagree over analytic methods and their implications, but they agree that the best way to identify ancient bones, teeth, and shells, is with reference to comparative collections that contain skeletons of multiple individuals of varying sex and ontogenetic age, but each of known taxonomic identity (Lyman 2005). Previously analyzed animal bone comparative collections from sites in the same region are ideal for several reasons. First, the faunal remains in the collection are likely to be similar to the fauna being analyzed. In addition, the bones in the comparative collection are likely to
be similar morphologically to the faunal remains to be studied (Hesse and Wapnish 1985). As a result, uncertainties resulting from comparing a recent skeletal form from a distant or unknown locale to ancient samples are circumvented. Finally, the criteria of identification can be employed consistently throughout the faunal research (Hesse and Wapnish 1985). The faunal comparative collection in Richard Yerkes’ Archaeology Lab at Ohio State University provides a bone reference collection, with a large white-tailed deer sample that is crucial in the analysis of the faunal remains at the Zencor site.

The principal tool used by the modern game biologist to evaluate hunting intensity is the age composition of the kill, determined by examination of the deer jawbone and comparison with a standard set of deer mandibles (Miller and Marchinton 1995). Criteria for age-classes are based on premolar replacement, third molar eruption, and degree of enamel wear, as initially established by Severinghaus (1949). Zooarchaeologists similarly employ this mandible aging technique when addressing the faunal record (Elder 1965; Parmalee 1965; Lapham 2005). However, there are some possible sources of error. Since deer mandibles from the archaeological record could have been the result of hunting throughout the year, they are more difficult to age than contemporary samples that result from a brief, fall hunting period. This produces a possible error of a year either way in classifying some mandibles, but it does not introduce a consistent bias, and each mandible remain is therefore placed with the age-class it most resembles (Elder 1965). In addition, the faunal record is usually not stratified sufficiently for any one year's harvest to be distinguishable. As a result the age profile of a deer population at an
archaeological site must extends over a considerable number of years and is thus an average sample (Parmalee 1965).

The basic quantification units used in the statistical analysis of the faunal record are the number of identified specimens (NISP) and the minimum number of individuals (MNI). For many years, the number of identified specimens per taxon was used as the standard measure of taxonomic abundance within the archaeological faunal record (Grayson 1984). In a given faunal collection bones are identified, numbers of identified specimens per taxon determined, and the NISP values themselves used to examine changing taxonomic frequencies through time and across space (Grayson 1984). Yet, the NISP method has encountered a number of criticisms. First, the number of identified specimens (NISP) are affected by butchery patterns, so that differences in specimen counts per taxon may simply reflect the fact that some animals were recovered from the site of the kill, while other were butchered on the spot with only selected portions retrieved (Binford 1981). In addition, the use of NISP assumes that all specimens are equally affected by decomposition through time. In other words, differential preservation affects the number of identifiable specimens per taxon, so that the numbers identified by an archaeologist at the time of analysis may possess an unknown relationship to the numbers originally deposited. However, NISP fails to take differential preservation into account (Watson 1972). Finally, numbers of identified specimens have been criticized as a result of the potential interdependence of the units being counted. There is no way of demonstrating which fragments of bones and teeth necessarily came from different individuals across an entire faunal assemblage, and therefore no way of resolving the
patterns of specimen interdependence that affects many specimen samples (Grayson 1984). In order to deal with these sources of error, many researchers have used the minimum number of individuals per taxon technique (MNI) as an alternative in the quantification of taxonomic abundances within faunal collections (Grayson 1984; also see Klein and Cruz-Uribe 1984:24-38).

The potential effect of interdependence on specimen counts suggests that an alternative unit of measurement not affected by this problem should be used for the quantification of taxonomic abundances within vertebrae faunas. The minimum number of individuals (MNI) measurement possesses such a quality. MNI is determined by separating the most abundant element of the species found into right and left components and using the greater number as the unit of calculation (White 1953). Minimum numbers of individuals determined in this way would seem to possess a number of advantages over specimen counts. Specifically, the numbers determined for any given faunal aggregate are all independent of one another (Grayson 1984). On the other hand, minimum numbers of individuals possess values that are in part determined by the choices made by the analyst concerning how faunal material should be aggregated prior to minimum number calculation. As a result, when a researcher studies minimum number values, that person is studying not only taxonomic abundances, but also the decisions made concerning aggregation (Grayson 1984).

In short, specimen counts are affected by the problem of interdependence, but are unaffected by aggregation, while minimum numbers are in part determined by aggregation but, within aggregates, each minimum number is independent of every other
(Binford 1981). Yet, used together, as employed in this thesis, both the number of identified specimens and the minimum number of individuals may produce an ordinal scale for the distribution of taxonomic abundances at the Zencor site.

**The Zencor Faunal Sample**

As stated previously, there is no indication of screening in the field notes for the excavations at the Zencor site in 1957 and 1958. As a result, faunal remains were probably recovered by hand during excavation, which would make large animal and bone remains more likely to be recovered. Since the Zencor excavations, archaeologists have stressed the importance of screening at archaeological sites (Watson 1972). In addition, flotation techniques have been employed during excavations in order to recover microscopic animal remains and to create a more accurate faunal description. Samples collected without screening will contain primarily large specimens compared to those collected with screening (Watson 1972). Without screening or flotation, some small species of fish, birds, reptiles, amphibians, and mammals may be missed entirely, resulting in a miscalculation of the relative importance of different animals and even the development of an incorrect subsistence model (Grayson 1984). The use of fine-mesh screens and flotation has become commonplace for the recovery of small taxa or small elements (Lyman 2005). In addition, it must be noted that there are continued disparities between the field notes and the information available for the faunal remains. These disparities are more prevalent in the field notes from 1958, as the excavations were
extended beyond the initial trenches. Although more rigorous screening techniques were not employed at the excavations of the Zencor site, and the field notes show disparities, definite results may still be deduced from the faunal record.

**Process of Identification**

The initial step taken in the analysis of the faunal remains from each level from the Zencor site was sorting of the remains into general categories. First, the faunal elements were separated into cranial, postcranial, and unknown categories. The postcranial bones were then separated into categories of large tubular bones, small tubular bones, flat bones, irregular bones, and unknown. Care was taken to keep all the materials from the same analytical unit together. The same process is repeated with any invertebrates. After this process, the process of identification was simple due to the comprehensive comparative collection and complementary faunal identification reference publications. The taxonomically unidentified archaeological specimen was compared with comparative specimens and publications until the best match was found (Lyman 2005). Often the closest match was obvious, and the unknown specimen was identified as belonging to the same taxon as the known comparative specimen. If no identification was possible, the faunal element was labeled as unidentified.

The next step taken was the identification skeletal elements. First, identification was made to the specific bone of which the fragment is a part of, such as right humerus, left radius, etc. The second component was the description of the part of the bone
recovered. Long bone elements were identified to three types: fragments of the proximal end, fragments of the distal end, and fragments of the shaft (Figure 11; Reitz and Wing 1999). Once these classifications and identifications were completed, all of the data were recorded into an Excel spreadsheet program, where they were analyzed to discern general trends.
Figure 11 - Flow chart of the process of sorting in animal bone research (Hesse and Wapnish 1985: 572).
Deer Aging by Tooth Wear and Replacement

White-tailed deer (*Odocoileus virginianus*) represent a significant resource in the mid-Ohio valley, and as a result these remains provide important insights into the subsistence strategies of Zencor’s inhabitants. The age of deer may be estimated through careful examination of certain remains in the faunal collection (Weiss 2004). Although it is possible to use body size and shape to estimate the age of deer, this technique is not employed in this thesis, as physical development between deer of the same age is significantly affected by nutrition and genetics. As an alternative, this study utilizes deer mandible remains from the Zencor faunal collection to determine age. The teeth on each side of an adult mandible consist of three incisors, one canine, three premolars, and three molars (Miller and Marchinton 1995). The eruption and wear on the premolars and molars are normally used to determine age (Kroll 1991). Fawns are born with three deciduous premolars. All permanent teeth are acquired by 18-24 months of age, depending on geographic location and health of the deer (Miller and Marchinton 1995). Since most deer are born in the late spring or early summer, ages are usually assigned in increments of half years. The analyses in this thesis employ these temporal units.

According to aging indices, if the complete mandible possesses fewer than five teeth, (e.g., three deciduous premolars and two fully erupted molars), the deer is less than one year of age and is classified as a fawn (Figure 12; Kroll 1991). This age class is also distinguished by the small size of the mandible. If the deer is not classified as a fawn, the last (fourth) premolar is examined. In fawns and yearlings, there are three cusps on the
fourth (last) deciduous premolar (Weiss 2004). If the last premolar possesses three
distinguishable cusps, the deer is classified as a yearling and is about one and a half years
of age. In addition, if the deer has three deciduous premolars and two fully erupted
molars, it is classified as a yearling. Deer with jaws where the fourth (last) premolar does
not have three cusps have had their deciduous premolars replaced by permanent teeth
with two cusps. They are usually older than a yearling (Miller and Marchinton 1995).
The deciduous premolars generally are replaced by permanent teeth with the normal two-
cusp structure between 18-30 months of age. After this process, aging older deer depends
upon the three permanent premolars and three permanent molars (Kroll 1991).

All mammal teeth have two layers, an inner core of brownish dentine surrounded
by a hard white enamel layer (Kroll 1991). The teeth become increasingly worn as the
deer ages, and since the cusps are cone shaped, wear reduces dentine incrementally. The
relative amount of dentine exposed is used as an indicator of age in older deer (Weiss
2004). If the last (fourth) premolar has only two cusps and is stained, the deer is not a
yearling. In this case, comparing the relative widths of dentine and enamel on the tongue
side of the jaw for the first molar is utilized (Weiss 2004). If the dentine is not wider than
the enamel, wear has not progressed and the animal is classified as two and a half years
old. If, however, the first molar shows considerable wear, the deer is older than two and
a half years. As a result, the next oldest tooth, the second molar, is examined. If the
dentine is not wider than the enamel layer, the animal is three and a half years old. If the
dentine is wider than the enamel, the last molar is examined using the same criteria (Kroll
1991). If the cusps of the molar are sharp, with dentine thinner than the enamel, the deer
is four and a half years of age. If not, the deer is at least five and a half years old. In this situation, if the first molar has become so worn that little enamel remains in the center of the tooth, the deer is six and a half years old. If not, the deer is five and a half years of age (Weiss 2004). This process provides a complete aging technique for deer mandibles.
White-tailed deer are best aged using the tooth wear and replacement method of Severinghaus (1949). Generally, deer are aged in one of seven categories: fawn, yearling, 2½-year-old, 3½-year-old, 4½-year-old, 5½-year-old, and 6½ years old and older. Courtesy Institute for White-tailed Deer Management and Research, College of Forestry, Stephen F. Austin State University. All other rights reserved.

Figure 12 – Mandible examples of deer at certain ages (Miller and Marchinton 1995; 28).
Chapter 5:  
Understanding Importance of Animal Fauna at the Zencor Site

Approximately 10,000 pieces of bone were recovered from the Baby excavations of the Zencor site. A total of over 6,500 faunal remains were identified to the species level from the collection (Table 3). Both the number of identified specimens (NISP) and the minimum number of individuals (MNI) were calculated for each element at the Zencor site. Minimum number of individuals for the various taxa recovered from the Zencor site was calculated by counting the most frequently occurring skeletal element of a taxon, after dividing the elements into rights and lefts, if applicable, and taking into account the portions of bones present. The MNI values were calculated for each square of the two trenches as well as each feature within the Zencor site. This may have resulted in an overestimation of large animals such as deer, since communal sharing of these animals may have occurred, and the bones of a single animal dispersed over a large area. Though both the NISP and MNI may not provide ratio scale measures of taxonomic abundance, minimum numbers and specimen counts may provide valid ordinal level measures of taxonomic abundance for the Zencor site (Grayson 1984). The faunal analysis provides evidence for a significant dependence upon one particular faunal resource; white-tailed deer. The abundance of deer remains at the site provide a window into not only the subsistence patterns of the Late Woodland population, but can also
include information about hunting practices and age preference, site formation and occupation, butchering techniques, and even symbolic behavior.

**Mammals**

As a group, mammals were the most significant subsistence resource for the Zencor occupants. The percentage of identified mammal remains, compared with those of birds, turtles, and fish, ranged from 73 percent for MNI to nearly 90 percent for the NISP. From the total number of identified specimens, deer remains represent over 87% of the total assemblage of identified remains (Figure 5.2). Through calculating the MNI for the Zencor site, the total percentage of white-tailed deer in the assemblage is still significant (see Figure 5.1), but is reduced to a little over 55% (Figure 5.3). In addition, the percentage of minimum number of individuals of other mammal taxa, such as fox and squirrel, increases in the assemblage. Several other mammal species were identified in the assemblage, including elk (*Cervus canadensis*), raccoon (*Procyon lotor*), squirrel (*Citellus* spp.), fox (*Urocyon cinereoargenteus*), mink (*Mustela vison*), skunk (*Mephitis mephitis*), bobcat (*Lynx rufus*), and domestic dog (*Canis familiaris*). Due to the low numbers of these mammals in the faunal sample recovered at the Zencor site, there appears to have been little or no specialized or selective hunting efforts expended to obtain these other animals. Instead, they were taken as abundance and availability dictated. None of the remains of the eight other mammal species identified in the faunal record accounted for more than six percent of the total. The killing of an occasional elk
or fox would have provided a considerable amount of meat at the time, but the apparent infrequency of such kills limited their importance as a regular food source.

The abundance of white-tailed deer remains identified from the Zencor site allows for a wider range and more intensive suite of analyses. The MNI value of 289 deer is based on the sum of the totals calculated for each feature. This, however, may be an overestimation for reasons discussed earlier. A more conservative MNI may be deduced from the total number of deer elements identified from the entire site (Table 4). Based on the most abundant element, the right tibia, a more conservative and possibly more accurate MNI for deer is 102. In addition, the presence of all deer body parts suggests that entire carcasses were returned to the Zencor site for butchering. Of the 5,976 deer elements, few possessed noticeable butchering marks. Butchering marks occurred on a few distal ends of humeri, on several naviculo-cuboids and vertebra, as well as on a few tibiae and ulnae. In addition to the butchering marks, three bone awls were identified from the assemblage, indicating that at least some deer bone was incorporated into the Late Woodland toolkit.

A total of sixty-six of the one hundred and five mandibles were assigned to a relative age range (Table 5). A majority of the mandibles were younger than three years of age (Figure 15), which suggests that certain ages of deer were selected during hunting. The lack of a frontal skull remains with attached antlers makes the seasonal dating of the site difficult. However, while some archaeologists consider this as a seasonal indicator, Smith (1975) notes that the only seasonal determination that researchers may deduce from the antlers of deer is the following: antler presence suggests that deer were killed
during the period from May to February, and if the antlers are shed the deer were killed
during the period from January to May. However, the presence of young deer mandibles
suggests that the site would have been occupied between November and March,
assuming that the fawns had been born in either May or June. Finally, the abundance of
both distal and proximal end bone fragments (Figures 16 and 17) from the long bones
that yield the highest amount of marrow (Figure 18) suggests that bone marrow was
utilized at the Zencor site to supplement the diet (Higgins 1999). There is an absence of
distal and proximal femur bone fragments in the assemblage, possibly due to the fact that
it is the longest bone and is more likely to break.

The distribution of mammal remains in Trench #1 reveal that these animals were
discarded mainly in designated pit features (Figure 5.10). The south part of the trench
uncovered a number of postholes, suggesting that there may have been a structure in this
area. As a result, the presence of mammal remains in this area is limited, with the
majority of the remains contained in Feature #1, a debris pit found in squares 5L1 and
10L1. In addition, the extension of Trench #1 in the excavations of 1958 uncovered a
larger habitation area to the west of the trench. The field notes suggest that the habitation
area lacked significant amounts of mammal remains, except in a number of features
surrounding the area (Mays and Baby 1958).

In Trench #2 there was a general dearth of mammal remains, with the only
Feature #6 containing a significant amount of identifiable fragments (Figure 5.11). The
west side of the trench uncovered a number of postholes, suggesting again that there may
have been structures in the area. As seen in both habitation areas surrounding Trench #1,
the area in and near the possible structures is relatively lacking in mammal remains, with most of the remains concentrated in a number of features.

Deer remains were numerous throughout the site but were also concentrated in features. Specifically, towards the center of Trench #1 a number of features were excavated, including a burial pit that contained three human burials. Along with the burials, a significant amount of deer remains were found in Features #2 and #3, with a lesser amount of other mammal remains, such as grey fox, included. Based on the count of right tibia fragments, Feature #2, contained approximately thirteen deer (Table 6). The feature also contained every type of element, suggesting that whole deer were discarded in the area. The abundance of deer remains in close proximity to human burials suggests that they may have been interred together. This practice has been noted in a number of other Late Woodland Sites in the area (Seeman and Dancey 2000).

**Birds**

A total of 576 bird bone fragments were identified from the Zencor faunal assemblage all designated to the wild turkey (*Meleagris gallopavo*). Wild turkey constitutes the next abundant taxa in the faunal record, but only accounts for 8.4% of the total assemblage. In the MNI calculation, the minimum number of turkey increases their contribution to 16% of the assemblage, showing a relative increase in the importance of turkey for the ancient population at the site. The wild turkey may have provided a valued diet supplement because of its size and availability throughout the year. A wide variety
of turkey elements were identified from the faunal record, suggesting that, like deer, the
turkey was returned to the Zencor site for butchering. A turkey humerus was identified
which contained cut marks near the proximal end. As with the mammal remains, the
turkey bone fragments were concentrated in the pit features found throughout the Zencor
site, with at least two turkeys present in the before mentioned Feature 2.

**Reptiles**

A total of 58 reptile fragments were identified from the Zencor faunal record.
Box turtle (*Terrapene ornate*), snapping turtle (*Chelydra serpentine*), and painted turtle
(*Chrysemys picta*) are represented in the collection, as well as trace amounts of frog
remains. Turtle and frog, were identified to species, but are listed in Table 5.1 by a
general taxa category. Of the reptile elements identified, turtle carapace was the most
abundant, with only trace amounts of frog remains found. The relatively low numbers of
reptile remains may be the result of a lack of screening from excavations at the site.
Also, it is possible that the frog remains may be from individuals which inhabited the
area and died there, rather than individuals that contributed to the Zencor human
population’s diet. As with the mammal remains, the reptile bone fragments were
concentrated in the pit features found throughout the Zencor site.
Aquatic Resources

Fish also provided occasional supplements to the basic diet of deer meat. Possibly affected by the lack of screening during excavations, the remains of only 5 fish were identified at the Zencor site. Fish elements comprise less than two percent of all the bone remains, and the quantity of meat derived from this group of animals would have been negligible. Shells of the terrestrial gastropod species *Amblema plicata* were also identified from the site. Though shell elements comprise a larger percentage of the faunal record (2 percent MNI) their contribution would have been minimal. The Scioto River and the associated floodplain may have been an ideal area to utilize such aquatic resources. Considering the long period of occupation at the Zencor site, the small number of fish indicates that this resource was not utilized. As with the mammal remains, the fish bone fragments were concentrated in the pit features found throughout the Zencor site.

Summary

A large and varied faunal assemblage was recovered from the Zencor site. The calculation of minimum numbers and specimen counts provide valid ordinal scale measures of taxonomic abundance for the Zencor site, indicating that deer and turkey contributed the most to the Zencor diet, with fifteen other species contributing small amounts. The faunal materials were mostly contained in features that surround various
occupational areas. Significantly, Feature #2 and Feature #3 possessed complete bodies of deer directly adjacent to three human burials. Based on the faunal analysis, the foraging pattern was directed toward the utilization of deer, with aquatic resources playing a limited role. The importance of white tailed deer is also indicated by the use of deer bone to create tools, evidence of the utilization of bone marrow from deer remains, and the possible association of deer remains with human burials. In addition, the aging of deer remains demonstrates that certain age ranges were represented in the faunal record. In summary, the large amount of deer remains as well as turkey elements identified from the site suggests that deer and wild turkey played an important role, not only in Late Woodland diet, but also in the society. As a result, a discussion of the significance of deer may provide yet another clue into the Middle to Late Woodland transition.
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<th>NISP - Percentage</th>
<th>MNI</th>
<th>MNI - Percentage</th>
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</tr>
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<td>6</td>
<td>1.54</td>
</tr>
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<td>5</td>
<td>1.54</td>
</tr>
<tr>
<td>10. Dog</td>
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<td>0.01</td>
<td>5</td>
<td>0.96</td>
</tr>
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<td>0.77</td>
</tr>
<tr>
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<td>3</td>
<td>0.58</td>
</tr>
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<td>14. Frog</td>
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<td>0.01</td>
<td>4</td>
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<td>15. Bobcat</td>
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Table 3 - NISP and MNI totals for identified remains per taxa. Taxa ranked based on NISP.
Figure 13 - Percentage of NISP for each taxa identified.

Figure 14 – MNI percentage for each identified taxa.
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<td>72</td>
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<td>67</td>
<td>105</td>
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<td>Incisor</td>
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<td>0</td>
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<td>25</td>
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<tr>
<td>Molar</td>
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<td>102</td>
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<td>Illium</td>
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Table 4 - Summary of left and right deer elements for the Zencor Site.
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Table 5 - Totals and percentage for aged deer mandibles.

Figure 15 – Percentage of deer within the five age-range categories.
Figure 16 – End bone fragment totals for both proximal and distal ends of deer long bones.

Figure 17 – End bone fragment totals for deer long bones.
Figure 18 – Average marrow return rate for each deer long bone (Madrigal and Holt 2002; 750).
Figure 19 – NISP abundance for all taxa for each square and feature of Trench #1 and surrounding Area B (courtesy of the Martha Otto, Ohio Historical Society).
Figure 20 - NISP abundance for all taxa in each square and feature of Trench #2 and surrounding Area A (map courtesy of the Martha Otto, Ohio Historical Society).
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<td>Axis</td>
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</tr>
<tr>
<td>Vertebra</td>
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<td>0</td>
</tr>
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<td>Naviculo Cuboid</td>
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</tr>
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<td>Long Bone</td>
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</tr>
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Table 6 – Summary of deer elements from Feature #2.
Chapter 6:
Resource Dependence at the Zencor Site

The identification and quantification of faunal remains at the Zencor site indicate that during the Late Woodland period the population depended on at least fifteen animal species. However, two taxa dominate the assemblage: white-tailed deer and wild turkey. Of these, white-tailed deer provided the most important vertebrate resource. This section compares the faunal analysis results to the subsistence patterns at corresponding sites in the southern Ohio. In addition, this section explores the traits and behavior of white-tailed deer and the potential relationship that emerged between deer and human populations during the Late Woodland period.

Subsistence in Southern Ohio

The available evidence suggests that the Late Woodland period in the mid-Ohio Valley is characterized by an intensification of subsistence and food processing strategies (Seeman and Dancey 2000). The Zencor faunal collection, although potentially affected by previously discussed behavioral and excavation factors, follows this distinct pattern of increased food processing strategies as exemplified by evidence of bone marrow utilization and the increased dependency on only a few faunal resources. At Late
Woodland sites throughout southern Ohio, native peoples focused on deer, and there is some evidence of increasing hunting pressure over time (Shott et al. 1990). At the Late Woodland Turpin site, located in southeast Ohio, large mammals such as deer contributed more than 90 percent of the fauna exploited (Theler and Harris 1988). In contrast, aquatic resources, which were intensively exploited in other areas such as the Lower Illinois Valley by the beginning of the Late Woodland period, show the opposite trend in the mid-Ohio Valley, even though many sites were ideally situated to exploit such resources (Styles 1981; Theler and Harris 1988). At Turpin, aquatic resources accounted for less than two percent of the assemblage. Since field screening occurred during the excavation at the Turpin site, this assemblage provides a critical comparison to the Zencor faunal assemblage. Despite the lack of screening and flotation, the results of faunal analyses from Zencor indicate a similar trend to that occurring at Turpin. Again, Zencor follows this regional trend, as aquatic resources account for less than two percent of the entire assemblage, even though the site is situated upon a bluff of the Scioto River, which would have been an optimal spot for exploiting aquatic resources. An investigation into the optimal foraging model developed by Reidhead for a site comparable to the Zencor site may provide insights into the procurement practices of the Zencor inhabitants.

In comparing the rank order from the faunal record of the Zencor site with the optimal foraging model produced by Reidhead, there are few similarities that appear (Table 7). Although deer is rank high in both the model and the faunal record, wild turkey shows a higher rank in the Zencor fauna than should be expected if the inhabitants
were optimizing their diet. The most significant disparity between the model and the observed faunal record is the under representation of aquatic resources in the faunal record, which were ranked very high in Reidhead’s Late Woodland optimization model. All aquatic resources are rank lower in the faunal record than expected, with the largest disparity present by fish, which are relatively absent from Zencor. This disparity is significant based on the abundance of these resources in the area surrounding Zencor. It is probable that during the Late Woodland, low water levels during the late summer and early fall period made efficient mussel collection possible on a regular basis (Reidhead 1981). Furthermore, of all the faunal groups available in the vicinity of the Zencor site, the sum of the fish populations in the river, streams and backwater lakes presented the greatest biomass as well as the greatest potential for support of human populations and the relative absence of these resources in the faunal record presents significant questions.

This result may be explained in a variety of different ways. First the comparison may indicate that the Zencor site inhabitants were not pursuing an optimizing strategy in their use of animal resources. If this line of reasoning is followed, since aquatic resources were not utilized at the Zencor site, despite their nutritional return, the inhabitants could not have been achieving optimization, or minimizing labor in the production of a nutritionally adequate diet. Alternatively, the faunal sample identified from the Zencor site may not accurately represent the actual subsistence practices of the Late Woodland, thus skewing the results. The condition of the faunal record has been discussed previously and a significant under representation of fish resources may be the result of the lack of screening during excavations, and this explanation remains a very
real possibility. Yet, the presence of a similar trend at Turpin, in which screening was present, suggests that screening at Zencor would have yielded the same results. On the other hand, the types of fish procured may have had a cartilaginous skeleton, which cannot be expected to preserve as well as other animal bones, leading to further potential error in the faunal sample at both Zencor and Turpin (Reidhead 1981).

The final explanation for such a disparity in the optimization model and the observed faunal record is that the Zencor site may have been inhabited during seasonal periods of the year, rather than year-round. As mentioned previously, the radiocarbon dates for the Zencor site suggest that instead of representing a relatively short year-round occupation of the Late Woodland, the site may be the result of several occupations, perhaps during the colder months of the year. The faunal results suggest that at least juvenile deer were procured during the fall and for both deer and turkey are highest during the fall and winter months (Table 8). Furthermore, procuring fish would have been more costly in the fall and winter months than in the summer and spring. Reidhead suggests that fishing can be eliminated as viable procurement activity for the people of the Late Woodland as a result of the costs (Reidhead 1981). The earliest efficient fishing may have begun only in the middle to the late spring during the spawning period (Reidhead 1981: 115). If Zencor can be regarded as a seasonal site, as the radiocarbon dates show, the absence of fish resources may reflect seasonal procurement practices, suggesting that Zencor may have only been inhabited during the fall and winter months. This may also explain the relative abundance of deer and wild turkey in the faunal record at Zencor, and further strengthens the argument that the site served as a seasonal
occupation rather than a year-round settlement. Again this corresponds with the trend observed at Turpin, further questioning the perceived settlement patterns of the Late Woodland (Theler and Harris 1988).

Distribution of faunal remains throughout the site may reveal further information into the settlement patterns present at Zencor. Despite the elaborate display of mortuary practices in southern Ohio during the Middle Woodland, ceremonialism in the Late Woodland placed much less emphasis on human burials. At several sites, including the Zencor site, human remains appear in village midden deposits, apparently not positioned in any designated cemetery area. For example, fifteen burials were recovered from the Childers site, and all seem to be placed in the village middens (Schott et al. 1993). At the Zencor site, four human burials were uncovered adjacent to two features that contained a significant amount of faunal remains, specifically deer bones, suggesting that these humans were placed in the village midden. Though faunal remains at Zencor are concentrated in pit features, the appearance of human burials in such close proximity to a significant amount of faunal material may indicate the lack of a well defined trash area that remains constant throughout the occupational period, which contradicts the definition of a nucleated settlement. This disparity further questions the settlement pattern previously associated with the Zencor site.

Extensive research was performed on the deer remains due to their abundance in the Zencor faunal record. Despite the stated evidence showing the importance of deer in the Zencor diet of the Late Woodland society, a closer analysis of deer sociobiology
demonstrates an even more important role of deer for the ancient population of the Zencor site.
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<td>2. Deer</td>
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<td>2. Turkey</td>
</tr>
<tr>
<td>5. Box Turtle</td>
<td>5. Raccoon</td>
<td>5. Turtle</td>
</tr>
<tr>
<td>8. Raccoon</td>
<td>8. Fish</td>
<td>8. Squirrel</td>
</tr>
</tbody>
</table>

Table 7 – Rank order of animals from optimal foraging model for Late Woodland and the observed results from the Leonard Haag site and the Zencor site based on meat weight. No waterfowl remains were recovered at Zencor (data from Reidhead 1981: 401).
<table>
<thead>
<tr>
<th></th>
<th>Deer</th>
<th>Turkey</th>
<th>Elk</th>
<th>Fish</th>
<th>Mussels</th>
<th>Turtle</th>
</tr>
</thead>
<tbody>
<tr>
<td>Summer</td>
<td>138</td>
<td>158</td>
<td>189</td>
<td>153</td>
<td>66</td>
<td>110</td>
</tr>
<tr>
<td>Fall</td>
<td>255</td>
<td>342</td>
<td>291</td>
<td>153</td>
<td>66</td>
<td>110</td>
</tr>
<tr>
<td>Winter</td>
<td>198</td>
<td>342</td>
<td>245</td>
<td>153</td>
<td>66</td>
<td>110</td>
</tr>
<tr>
<td>Spring</td>
<td>125</td>
<td>226</td>
<td>125</td>
<td>153</td>
<td>66</td>
<td>110</td>
</tr>
</tbody>
</table>

Table 8 – Calories available for each season for animals found at Zencor (data from Reidhead 1981: 293-297).

**Deer Sociobiology**

Before discussing deer sociobiology, this thesis must re-approach the previous results of the deer mandible age estimations from the Zencor site. At first glance, a focus on hunting younger deer may suggest that hunting occurred with little consideration of the potential impact to the surrounding habitat or deer populations. Yet, an analysis of current deer management techniques shows that this may not be the case. A high percentage of the population at Zencor were two to three years old, with successively older age classes contain progressively fewer animals. Figure 21 shows the population age structure of harvested deer from managed deer populations, which is visually similar to the data from the Zencor faunal analysis. The standard deviation for these deer population values is relatively low, with the greatest amount of deviation present in the one and a half to three year age range (Table 9). In addition, a chi-square test indicates
that the values for each deer population are statistically not significant from each other (Table 10). By comparison, age profiles exhibited by contemporary samples from Iowa and Missouri in which any sex or age of can be legally collected more closely resembles what is called a catastrophic mortality profile (Figure 22). This profile is modeled on the age distribution of animals that occurs when an entire living population is killed in a single catastrophic event (Klein and Cruz-Uribe 1984). The resulting distribution has successively older age classes that contain progressively fewer animals. The natural structure of a deer population also conforms to this distribution (Emerson 1980). The relationship of contemporary managed populations and the Zencor population distribution suggests that the Zencor inhabitants may have practiced at least some form of management by focusing their hunting on prime age ranges to ensure an optimal deer population. Yet, certain processes may have also affected the population distribution in the Zencor faunal record.

Archaeologists have hypothesized that prime-age dominated mortality profiles can result from any number of factors, including complimentary strategies of deer predation among human hunters and predators such as wolves, differential butchering and processing of juvenile animals (Speth 1983), and differential scavenging by carnivores (Lapham 2005). The hypothesis that Native American populations has a greater opportunity to harvest prime aged deer because carnivores such as wolves had killed many of the youngest, oldest, or weakest animals, may be a possible explanation for the age structure for Zencor. Yet, the absence of wolf remains at Zencor suggests that the wolf population in the area was small enough to not significantly affect the deer age.
structure. In addition, the possibility that differential processing of fawns results in a mortality profile dominated by prime-aged deer is not supported by the Zencor faunal record because deer in the earliest age range account for twenty-four percent of the mandibles aged. The third argument, which concludes that carnivore gnawing causes greater attrition of mandibles from fawns than adult deer because their bones are more fragile, and thus creating an under representation of juvenile animals in archaeological mortality profiles, is also not supported by the faunal record at Zencor (Lapham 2005). Of the aged mandibles at Zencor, none show signs of carnivore gnawing. In addition, carnivore gnawing is also infrequent in the entire faunal assemblage. In light of this new information, a closer investigation of deer behavioral patterns may show the importance of deer population management.

The basic social unit in female deer populations consists of a matriarch doe, several generations of her daughters, and fawns that share an ancestral link (Miller, Marchinton, Ozonga 1995). Bucks leave these matriarchal groups during their first or second year and many establish new home ranges. Typically bucks join male groups composed of several compatible but unrelated bucks (Jacobson 1995). A strict dominance hierarchy usually is central in the social lives of whitetails. In both sexes, physically and behaviorally mature individuals can suppress the reproductive performance of younger individuals (Jacobson 1995). Among females, dominance closely relates to age, as older matriarchs tend to occupy the best habitat and posses the highest fawn-rearing success (Miller, Marchinton, Ozonga 1995). In contrast, dominance in males is determined primarily by age, size, and strength. Where they exist, physically
superior and behaviorally mature bucks (3 and a half years of age) typically dominate younger bucks and do most of the breeding (Weiss 2004).

Figure 21 – Population age structure of harvested areas from two deer management groups and Zencor site (data from Miller and Marchinton 1995;30).
Table 9 – Percentages for population age structures and the standard deviation (data from Miller and Marchinton 1995;30).

<table>
<thead>
<tr>
<th>Age</th>
<th>Texas Parks and Wildlife Department</th>
<th>Temple-Inland Clubs</th>
<th>Zencor Site</th>
<th>Standard Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 - 1.5</td>
<td>28</td>
<td>24</td>
<td>24</td>
<td>2.3</td>
</tr>
<tr>
<td>1.5 – 3</td>
<td>28</td>
<td>27</td>
<td>40</td>
<td>7.2</td>
</tr>
<tr>
<td>3 - 4.5</td>
<td>23</td>
<td>15</td>
<td>19</td>
<td>4</td>
</tr>
<tr>
<td>4.5 - 5.5</td>
<td>8</td>
<td>7</td>
<td>12</td>
<td>2.6</td>
</tr>
<tr>
<td>&gt;6</td>
<td>7</td>
<td>6</td>
<td>3</td>
<td>2</td>
</tr>
</tbody>
</table>

Table 10 – Chi Square test for Zencor and managed deer populations (data from Miller and Marchinton 1995;30).

**Test Statistics**

<table>
<thead>
<tr>
<th></th>
<th>Deer Pops.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chi-Square</td>
<td>1.800^a</td>
</tr>
<tr>
<td>df</td>
<td>11</td>
</tr>
<tr>
<td>Asymp. Sig.</td>
<td>.999</td>
</tr>
</tbody>
</table>

^a. 12 cells (100.0%) have expected frequencies less than 5. The minimum expected cell frequency is 1.3.

Table 10 – Chi Square test for Zencor and managed deer populations (data from Miller and Marchinton 1995;30).
Figure 22 - Population age structure of harvested areas from two open seasons and the Zencor site (data from Elder 1964:368).

Considering the normal whitetail social organization, populations that are dominated by young individuals and which also have skewed sex ratios have significant problems. Under normal conditions, mature bucks maintain a ritualized breeding system (Jacobson 1995). These bucks dominate younger males and the select numbers of dominant bucks in an area have preferential breeding rights, which maintain genetic health as the best adaptive bucks contribute more to the genetic makeup of the next generation (Weiss 2004). In deer populations in which few, if any, mature bucks remain, the breeding system breaks down and becomes a frenzied scramble competition among the young bucks to breed with any available doe in the area. The behavioral patterns that
help to mold the genetic makeup of the herd are discarded in exchange for a system that results in little if any selectivity for adaptive traits (Miller, Marchinton, Ozonga 1995). In addition, mature bucks tend to suppress the aggression and breeding competition among young bucks (Marchinton et al 1990). This effect caused by the presence of mature bucks and their dominance results in lowered testosterone levels in the younger bucks. These physiological changes generally minimize weight loss and allow young bucks to grow to greater sizes before assuming breeding responsibilities (Miller, Marchinton, Ozonga 1995). Without these mature bucks, younger males may compete effectively for breeding opportunities, but they cannot afford such energy expenditure if they are to reach their maximum potential (Weiss 2004).

Based on these behavioral factors in deer populations, the kill ratios that favor younger deer at Zencor suggests that the inhabitants may have practiced at least some sort of deer management. By focusing on younger deer, the Zencor inhabitants, either intentionally or inadvertently, maintained the optimal deer population and genetic makeup. By managing the deer population, the Zencor inhabitants would have benefitted from their actions, by harvesting optimal deer populations each year. This evidence correlates with the horticultural practices indicated at the site, which show a picture of an active interaction between the humans and their environment. The paleoethnobotanical record shows that the Zencor inhabitants focused on optimizing their horticultural practices to maximize their production. In addition, by leaving certain areas fallow for grazing, the Zencor inhabitants provided rich browsing areas for the deer populations (Wymer 1987), increasing the productivity of their most important faunal resource while
assuring that these populations made the site part of their home-range. If Zencor represents a seasonal settlement that was inhabited in the fall and winter, these subsistence practices may indicate nutritional optimization on a seasonal basis. With the evidence of deer management and the intensification of horticultural practices at the Zencor site, a closer investigation of the settlement pattern at Zencor and in southern Ohio may be discussed.
Chapter 7:  
The Late Woodland – A Transitional Period

Between A.D. 400 and 600, Ohio Valley Woodland societies changed a great deal. No longer were complex earthworks built or exotic goods traded. Many causes for these changes have been proposed; some suggest that the Hopewell cultural pattern declined or broke down. More recently, archaeologists have cited a trend during this period toward larger numbers of people living in large nucleated sites that may have been supported by raising plants and depending on local faunal resources, most importantly deer. Yet, other researchers have questioned this claim, citing the lack of presence and robustness of architecture and the redundant use of certain landscapes as evidence to the contrary. The Zencor site remains at the center of this debate. Though initially identified as a nucleated, year-round settlement inhabited during the early part of the Late Woodland, the radiocarbon dates indicate a range of dates spanning throughout the period, suggesting the site was a seasonal occupation. The faunal remains indicate that white-tailed deer and wild turkey were an integral piece of the subsistence patterns. In comparison with Reidhead’s optimization model for a nucleated Late Woodland site, the Zencor faunal record shows few similarities, with a significant under-representation of aquatic resources. Yet, deer and wild turkey, the most abundant remains at Zencor, would have provided a high nutritional output during the fall and winter seasons.
Furthermore, the faunal analysis shows possible active management of deer populations, in which hunters exhibited voluntary restraint in the harvesting of certain age groups.

The combination of the faunal evidence as well as the radiocarbon dates suggests that rather than a nucleated year-round settlement, Zencor represents a site seasonally occupied throughout the Late Woodland period during the fall and winter months. As a result, the ‘beef’ that is sought for substantial evidence of large nucleated Late Woodland sites is not to be found at Zencor. This indicates an inherent plasticity in social groupings in the southern Ohio Late Woodland, which strongly reflects a residentially mobile lifestyle and a tendency to cluster on occasion without nucleation (Clay and Creasman 1999). This type of social structure would have resulted in high fluidity in the size and composition of households and multihousehold residential groups, varying in response to local social and economic conditions. No doubt more faunal and paleoethnobotanical evidence from other Late Woodland sites is needed to further establish this trend, but if the evidence holds true, the Zencor settlement pattern may change the outlook of the period as the good and grey period. Each aspect of the Late Woodland in southern Ohio must be revisited in relation to a residentially mobile lifestyle as shown in the Middle Woodland period.
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