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Taphonomy, diversity, and seasonality of Cashie Phase faunal assemblages from the Jordan's Landing Site, 31Br7, North Carolina

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Paul Parmalee, Jefferson Chapman

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Walter E. Klippel

Dr. Walter E. Klippel, Chairman

We have read this thesis
and recommend its acceptance:

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Date August 22, 1991

Taphonomy, Diversity, and Seasonality of Cashie Phase Faunal Assemblages from the Jordan's Landing Site, 31BR7, North Carolina

A Thesis
Presented for the
Master of Arts
Degree
The University of Tennessee, Knoxville

John E. Byrd
December 1991

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ABSTRACT

This study provides an evaluation of the faunal remains from the Jordan's Landing Site (31Br7) and inferences concerning subsistence of the Cashie Phase occupants of the site. There are no previous studies of subsistence for Cashie Phase sites. The Cashie Phase has a temporal placement of 800-1600(?) AD, and is located in the Inner Coastal Plain of North Carolina. Prehistoric Cashie culture has been identified as the precursor to that of the Tuscarora groups of the Historic Period.

Jordan's Landing is a village site on the Roanoke River near Williamston, N.C.. The village was situated on a sandy loam ridge next to the confluence of a small stream and the river. Faunal remains from four features belonging to the Cashie Phase were analyzed for this thesis.

Taphonomic analysis of the assemblages reveals a variety of agents that have acted on the skeletons. Human processing resulted in smashed, burned, and cut bone fragments. Canids were active in the village, having ravaged many of the specimens. The low percentage of small and medium size mammals as well as reptiles, amphibians, and fish in Feature 1, an open ditch, probably results from canid activity. The remaining three features, which were closed after filling, contain significantly greater percentages of the smaller fauna. A large number of deer phalanges as well as several whole, unscathed bones indicate that there was a large quantity of deer remains deposited in the ditch relative to the number of dogs that had access to the carcasses.

Species diversity in the four assemblages is explored. There are 38 species represented in the entire sample and the reciprocal Simpson's Index value is 14.32.

Seasonality of the village is explored by examining mammal remains in Feature 1. Evidence of deposition in all four seasons is found, though strongest for summer and spring. It is inferred that the village was not entirely abandoned in the winter.

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CHAPTER 1

INTRODUCTION

General

The purpose of this thesis is to examine faunal remains from the Jordan's Landing Site (31Br7) with the intent of making inferences concerning subsistence of the Cashie Phase occupants of the site. Systematic analyses of faunal remains from Cashie Phase sites have not been conducted, and as a result the information reported here serves as an initial observation of animal remains recovered from a Cashie Phase village.

Cashie Phase culture has been identified as the prehistoric antecedent to the culture labeled "Tuscarora" in the Historic Period (Phelps 1983). Ethnohistoric sources provide some information concerning Tuscarora subsistence as has been outlined by Boyce (1978). The historic Tuscarora were agriculturists who also engaged in hunting and gathering. There was reputedly (Lawson 1967) an annual cycle which included whole villages moving to hunting quarters in late fall (Boyce 1978), but there is presently little evidence indicating that this was a pervasive pattern among the Tuscarora. Lawson's (1967) account does not specify who was inhabiting the single winter quarter he observed near the Falls of the Neuse in 1701, but he does mention visiting a village nearby that was abandoned with the exception of old women. Though he passed several more villages on his way down the Neuse River, no information as to whether they were populated or not was offered. Throughout the year, deer, bear, beaver, and other mammals were hunted as a protein source. Herring and sturgeon were taken in weirs, nets, and with clubs in the spring during their spectacular spawning runs. Hickory nuts, wild parsnips, and wild turnips have been mentioned as wild plant foods (Boyce 1978).

The majority of ethnohistoric sources concerning the Tuscarora date to no earlier than the early 17th century, and thus must be used with caution in making inferences concerning subsistence in the prehistoric period. Potential problems in using these anecdotal accounts include misunderstandings of the various species the writers refer to and failure to recognize changes in subsistence after contact with Europeans. An example of the former is Lawson's (1967) statement that "trout" were taken in "fresh streams." This would certainly not be brook trout nor sea trout in Inner Coastal Plain freshwater rivers and streams. There is no way to determine which species of fish Lawson refers to, and such circumstances raise doubts about other field identifications made by early colonists. The latter problem mentioned above can be illustrated by Lawson's (1967) observation that the Carolina Indians were raising peaches. Peaches are not native to North America and thus must have been obtained in trade, possibly via the Spaniards with whom the Tuscarora were rumoured to have trade relations with early in the Colonial Period (Parramore 1982). How long the Tuscarora had been raising peaches is unknown, but by the turn of the eighteenth century they were apparently standard fair.

The rapid changes that Tuscarora culture must have undergone throughout the seventeenth and eighteenth centuries present excellent research problems for anthropologists, as they offer an opportunity to study mechanisms of culture process. There are many questions that should eventually be addressed concerning such changes and processes. However, Tuscarora culture change in the historic period cannot be intelligently understood in the absence of knowledge of the prehistoric culture. Archaeological research of the Cashie Phase is the only means of obtaining reliable knowledge of prehistoric Tuscarora culture, and is a prerequisite to any meaningful studies of culture process. The research presented in this thesis does not base any assumptions on information obtained from ethnohistoric literature, but rather regards the faunal materials from Jordan's Landing as a starting point in the study of subsistence during the Cashie Phase.

Chapter 2 discusses the methods employed in the identification of the animal remains in four assemblages, each recovered from a separate feature. A description of each of these features appears below. The representation of taxa in the respective assemblages is discussed in Chapter 2.

Most analyses of archaeological faunal assemblages are prone to error resulting from a variety of biasing factors. Examples of such factors include excavation and recovery techniques and taphonomic agents of attrition. Before any further analysis was conducted, the four assemblages used in this thesis were first examined for signs of taphonomic agents. The philosophy concerning the use of taphonomy is simply that sources of bias in the data should be identified a priori, so that expectations of bias can be explicitly outlined before making inferences from the data. Therefore, results from the taphonomic analysis are presented in Chapter 3.

The diversity of the prey species exploited by the villagers is examined in Chapter 4. It is of fundamental importance to understand whether subsistence practices concentrated on some few species or were more diversified, including a large number of species in the diet. Diversity measures provide a standard means by which assemblages can be compared.

The seasons of occupation of the village are examined in Chapter 5. It has been hypothesized that the village was not completely abandoned during the year, but rather was inhabited by at least some villagers yearround. This hypothesis gains plausibility from the density of the archaeological materials recovered from the midden, which suggest that the site was much more than a seasonal camp. The Tillet Site (31Dr35), located on Roanoke Island, has been recognized as a Colington Phase seasonal village and contains on average 36 sherds per 10 centimeter level in a 2 X 2 meter square in the midden (Phelps 1984). The midden at Jordan's Landing has rendered on average several hundred sherds per level in a 2 X 2 meter square. Excavation techniques at the two sites are comparable. An alternative hypothesis is that the village was abandoned in winter as was possibly common practice in the Historic Period (Boyce 1978).

The Cashie Phase

The Cashie Phase has been defined and described by Phelps (1983). The temporal placement of the phase is in the Late Woodland Period, beginning approximately A.D. 800 and lasting until the mid-1600's, when Cashie manisfestations are recognizable historically as "Tuscarora". The phase ends with the dramatic changes introduced to the Tuscarora by the impact of colonizing Europeans.

The geographic distribution of Cashie Phase culture falls in the Inner Coastal Plain of present-day North

Carolina, stretching from the western estuarine border to the fall line, between the Roanoke and Neuse Rivers (Phelps 1983). This region today contains some of the richest agricultural lands in the state. Other resources of the region include the following: deciduous forest containing nuts, grapes, and other edible plants as well as an abundance of wildlife; rivers, streams, and swamps providing habitat for fish, mussels, and other aquatic resources. The settlement pattern generally consists of small villages, located on sandy loam ridges along the major rivers, often near the confluence of a small stream (Phelps 1983). Other types of settlements include homesteads, seasonal camps, and perhaps temporary villages used as "winter hunting quarters" (Phelps 1983). While the use of "winter hunting quarters" by the Tuscarora has been documented in the historic period (Lawson 1967; Boyce 1978), it is unclear if these temporary villages were a traditional practice inherited from Cashie culture, or rather the product of the fur trade vigorously pursued with the colonists (Boyce 1978). One prehistoric Cashie Phase site located on the Tar River near the fall line is a candidate for one of these winter hunting quarters, but awaits further analysis (Phelps 1983).

The Jordan's Landing Site, 31Br7

The Jordan's Landing site is located on the Roanoke River below Williamston, N.C., about 30 miles above where the river meets the Albemarle Sound. The village was situated on a sandy loam ridge on the north bank of the river, occupying about three acres (Phelps 1983). A small creek drains a swamp on the northeast side (see Figure 1.1). Though excavation has not been so extensive as to reveal details of intrasite patterns, some information is available. The village is roughly oval, and bounded on the north and west sides by a ditch, which apparently resulted from removal of dirt used to bank the base of a palisade. There are a variety of pits and hearths distributed on the west and north sides of the site and a number of burials concentrated on the southeastern side (Phelps 1983).

The immediate environment around the site contains several microhabitats (see Figure 1.1). The higher ground is dominated by deciduous climax forest or, as the case may be, fields cleared for agriculture or in some state of succession. There are also lowland deciduous forest closer

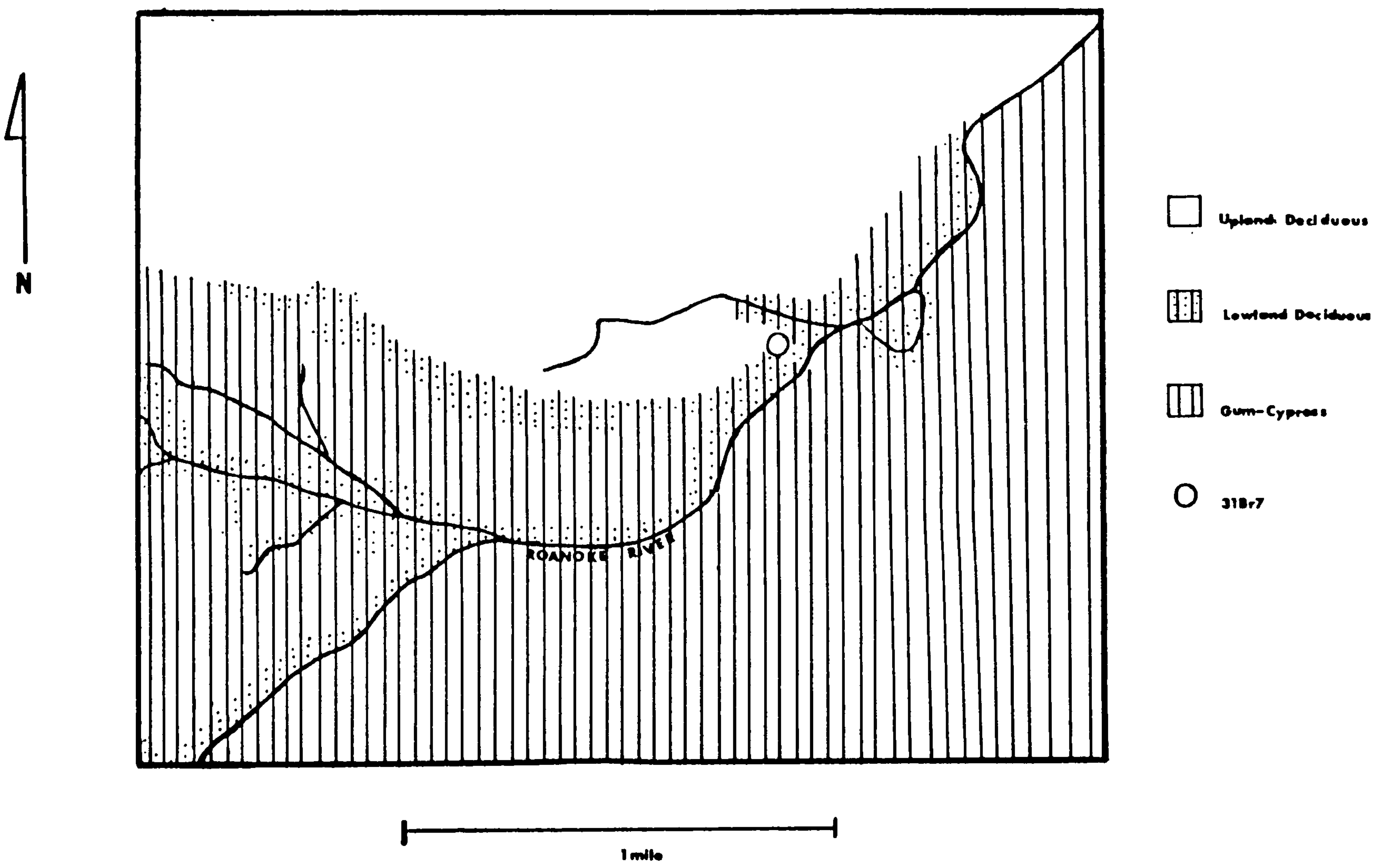

Figure 1.1: The Site Locality at Jordan's Landing.

to the river and creek, as well as natural levee communities near the river's edge. In the vicinity of the mouth of the creek occurs a gum-cypress forest, dominated by baldcypress and water tupelo gum.

Gum-cypress forest is also found upstream on the north shore, and directly across from the site on the south side, seemingly thriving in the floodplains created by bends in the river. Oxbows are also found in the vicinity, one occurring within one quarter mile of the site.

The dominant soil series located on and around the site are as follows: Wickham Series, found on the higher ground; Chewacla Series, found at river's edge (U.S. Department of Agriculture 1990). The Wickham fine sandy loam is identified as "prime farmland" (U.S. Department of Agriculture 1990).

The four faunal assemblages enlisted for this study originate from four features belonging to the Cashie Phase component at 31Br7. Descriptions of these features are given below, along with accounts of the recovery methods employed in the field and any sampling schemes used in obtaining the assemblages for study.

Perhaps the most impressive feature yet observed at Jordan's Landing is Feature 1, the ditch that flanks the north and west sides of the village (see Figure 1.2). As mentioned above, the ditch probably served as a borrow pit for banking the village palisade. Indeed, it does follow the palisade post molds in a broad arc. Eventually another function was assumed for this feature. As Phelps (1983) describes it, "..quite literally it was the village dump, identifiable from the first basketloads to the final overflow at the top." Cashie ceramics found in abundance throughout this feature establish its origin during the Cashie Phase. Although only a section of Feature 1 has been excavated to date, there are tens of thousands of animal bone fragments along with a plethora of other refuse from the village that have been recovered.

Feature 1 was excavated in arbitrary 10 centimeter levels with a detailed plot drawn at each level. The standard screen size used was 1/4", though a large number of random samples (in 5 gallon buckets) was taken and washed through a 1/16" screen. The state of preservation of most materials in the ditch can be considered excellent, which is remarkable given the acidity of the soils (pH 4.5-6.0) found on the site (U.S. Department of Agriculture 1990). There is some variability in the condition of the faunal remains.

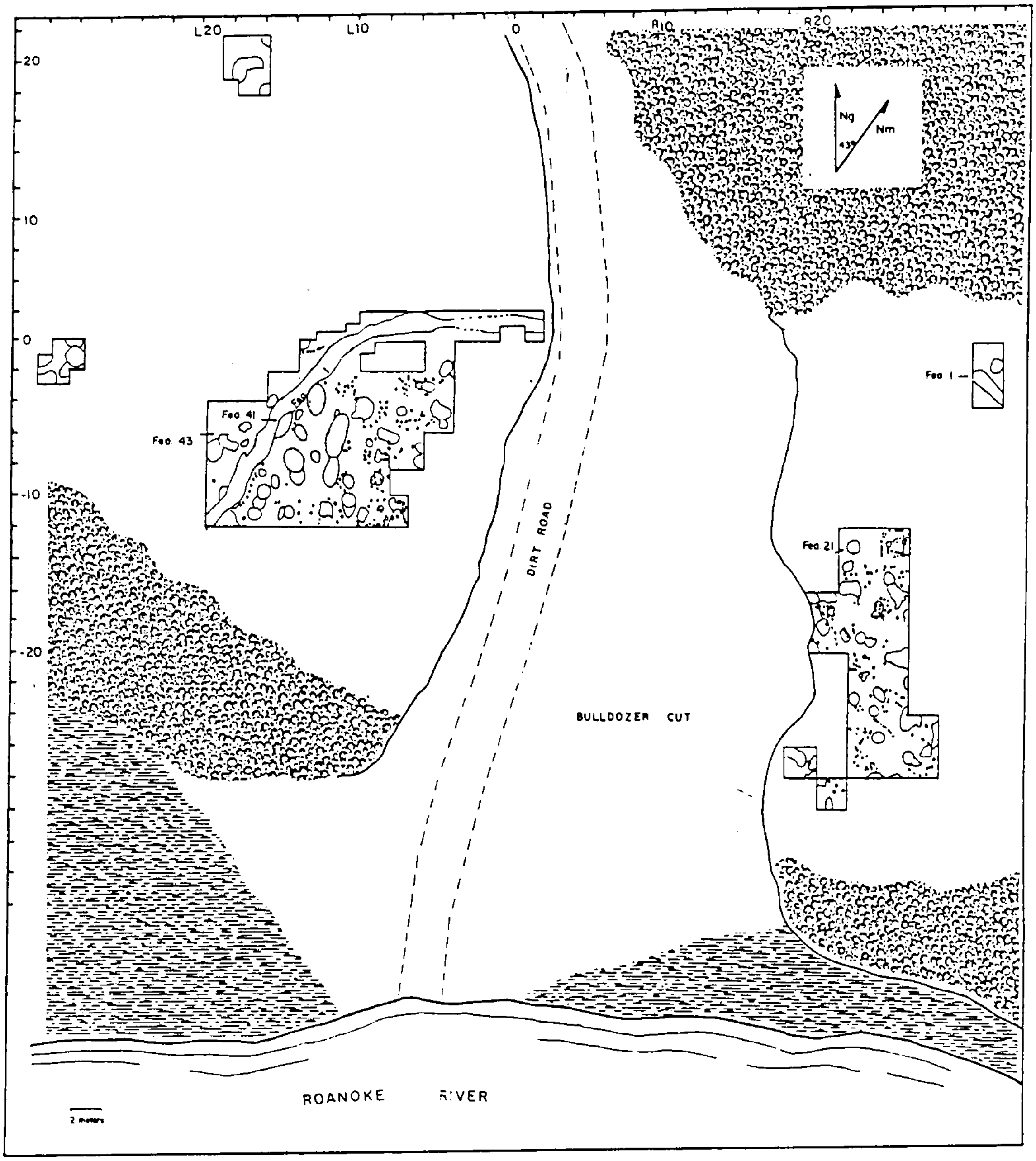

Figure 1.2: The Jordan's Landing Site Showing Excavation Areas.

Differential weathering is an obvious source of some of this variability. Other sources are discussed in Chapter 3.

The analysis of all animal remains from Feature 1 is beyond the scope of this thesis. Therefore, a sample of faunal remains from the two meter square unit, OL2, was deemed appropriate for this study, as it lies in the approximate center of the ditch and provides a cross-section from top to bottom of the feature. Henceforth, any reference to the Feature 1 assemblage is a reference to the OL2 sample.

Feature 21 is a small, circular pit feature located on the east side of the site (see Figure 1.2). It is interpreted as a cooking pit, and interestingly, has two post molds located at opposing ends on the perimeter. A large Cashie sherd was discovered near the bottom of the feature, placing it with the Cashie Phase component. The feature has been radiocarbon dated at A.D. 1425 ± 70 (UGa-1086) (Phelps 1983). The contents of the feature are predominately mussel shell (much of it badly eroded), with strong representation of fish as well (see Table 2-1). Excavation of the feature was as a single unit. Plots were drawn at surface and at base. All fill was washed through 1/16" screens. The entire assemblage from

Feature 21 was analyzed. Features 41 and 43 are located on the west side of the site, adjacent to the ditch. Both are interpreted as hearths and share many characteristics. The shape of each is oblong. The depths are between 30 and 40 centimeters. Materials found in these features include fire-cracked rock, fired clay lumps, Cashie ceramics, fish bone, mussel shell (some badly eroded), and other animal remains. The large quantity of refuse situated above the burned materials in these features along with the small percentage of burned bone fragments (see Chapter 3) indicate that these pits were secondarily filled. The deposition was rapid, if not all at once, evidenced by the *Sciurus* remains in Feature 43. A radius in Plot Level 2 articulates with an ulna in Plot Level 1 and teeth from the base of the pit belong to the jaws discovered in Plot Level 1. It is likely that these cavities were simply utilized as trash pits after their service as hearths had ended (David S. Phelps, personal communication). Both features were excavated in arbitrary 10 centimeter levels with plots drawn at each level. All materials were washed through 1/16" screens. The entire faunal assemblages from Features 41 and 43 were analyzed.

CHAPTER 2

FAUNAL ANALYSIS OF THE FOUR ASSEMBLAGES

General

The animal remains from Features 1, 21, 41, and 43 were graciously loaned to the author by Dr. David S. Phelps of the Archaeology Laboratory, Institute for Historical and Cultural Research, East Carolina University. Identification of vertebrate remains were done in the Zooarchaeology Laboratory, Department of Anthropology, University of Tennessee, Knoxville. The skeletal collections of the Zooarchaeology Laboratory proved to be more than adequate for the task, there being a series of comparative specimens for every species encountered in the assemblages. The Pelecypod fauna was identified in the Malacology Laboratory, Frank H. McClung Museum, University of Tennessee, Knoxville, under the patient supervision of Dr. Paul W. Parmalee.

Notes on Methods of Analysis

Often when one reviews data in faunal reports it is not clear how certain bones or bone fragments were identified to the reported taxa. For example, a squirrel femur labeled as *Sciurus carolinensis* begs the question as to whether or not it might be *Sciurus niger*, which is morphologically nearly identical to the gray squirrel. Some analysts might assign the femur to one of these species based on size, as it is true that fox squirrels are often larger than gray squirrels. However, it is also true that the sizes of individuals in the two species overlap. It is important to make known to the reader how such difficult determinations are made, so that he or she will be aware of uncertainties in the reported data. All *Sciurus* bones assigned to species in Table 2-1 contained the maxillary toothrow (or at least the alveoli) which can be accurately identified to species. Below are comments on how the identifications reported in this thesis were made, including discussion of some of the more difficult assignments.

Table 2-1 lists the minimum number of individuals (M.N.I.) and the number of identified specimens (N.I.S.P.) for all taxa with representation in the four assemblages. Generally, bone fragments were identified as precisely as possible, often assigned to the species level. A great many fragments could not be assigned to a species, but could be placed in a genus or higher taxonomic category. The mammals were divided into large (deer, bear, wolf), medium (beaver, raccoon, squirrel), and small (voles, moles) size categories. Not all taxonomic groups can be considered equally identifiable among the fragments. This disparity is partly due to differential taphonomic histories (see Chapter 3) and to the limited skills of the analyst. For example, a majority of the fish remains are vertebrae, which is probably a result of the vertebrae having a greater inherent ability to survive attrition than the bones of the skull. Most fish vertebrae can be assigned to their respective Families, based on overall shape (including processes) and sculpturing, but few species have vertebrae sufficiently distinctive to allow the author to confidently identify them further. Thus, for the Class Osteichthyes in Table 2-1, a high percentage of the N.I.S.P's reported are at the Family level.

A result of the conservative approach adopted here is that many fragments that are recognized as likely to belong in a species are left out. An important example of this situation is the many ungulate bone mid-shaft fragments that are most likely white-tailed deer, but are not placed in the species because they lack a morphological trait that removes all doubt. It would cause a serious observer-created bias in the taphonomic analysis to simply ignore these fragments, so a popular convention has been adopted to solve this dilemma. The "cf." appearing before the species name indicates that the species designation of those fragments is most likely correct, but not unquestionable.

The Pelecypod fragments present a problem in quantification: there are several bags of rubble that represent the remains of hundreds of shells. No satisfactory means of tabulating this rubble was discovered. The 100+ number that appears with taxa in Features 21, 41, and 43 is necessarily ambiguous. Suffice it to say that large numbers of mussel shells were deposited in these features.

TABLE 2-1: Faunal Remains from Features 1, 21, 41, and 43 at the Jordan's Landing Site.* **

Species	Plot Level				
	1	2	3	4	5
Feature 1					
Phylum Chordata					
Subphylum Vertebrata					
Class Mammalia					
Large size Mammalia					
Odocoileus virginianus	95(4)	112(4)	71(2)	13(2)	21(2)
c.f. *O. virginianus*	1	9	8	3	3
Ursus americanus	6(1)	2(1)	1(1)		1(1)
c.f. *Canis lupus*			1(1)		
Unidentified Large size Mammalia:	275	144	130	6	
Medium size Mammalia					
Lynx rufus	1(1)				
Urocyon cinereoargenteus			2(1)		
Castor canadensis	2(1)	2(1)	2(1)		
Procyon lotor	12(2)	6(2)	14(2)	2(1)	3(1)
Didelphis marsupialis	9(2)	2(1)	8(1)	2(1)	
Ondatra zibethica	1(1)	1(1)	2(1)		
Sylvilagus floridanus	2(1)	1(1)	1(1)		
Sciurus sp.	4(1)		4(1)	9(1)	4(2)
Mephitis mephitis	2(2)				
Unidentified Medium size Mammalia:	28	8	3	1	
Class Aves					
Meleagris gallopavo	1(1)	5(1)	8(2)		2(1)
Unidentified Anserinae:			1(1)		
Unidentified Aves:	20	1	9		2
Class Reptilia					
Order Testudines					
Chelydra serpentina	8(2)	17(2)	19(3)	27(1)	7(1)
Terrapene carolina	4(1)	3(1)	6(1)	14(1)	1(1)
Pseudemys sp.	1(1)	2(1)			2(1)
Unidentified Testudines:	358	83	142	40	23

TABLE 2-1 (continued)

Species	Plot Level				
	1	2	3	4	5
Order Squamata					
Suborder Serpentes					
Agkistrodon piscivorus	4(1)				
Unidentified Viperidae:					1
Elaphe guttata		2(1)	1(1)		
Unidentified Squamata:	5	2			
Class Amphibia					
Rana catesbeiana	1(1)				
Unidentified Amphibia:	16				
Class Osteichthyes					
Superorder Holostei					
Amia calva	22(2)	13(2)	98(12)	19(2)	14(2)
Lepisosteus sp.	16(1)	5(1)	10(1)	9(2)	5(1)
Unidentified Holostei:	14		156	4	
Superorder Teleostei					
Ictaluridae					
Amieurus catus	1(1)			1(1)	
Amieurus natalis					8(1)
Unidentified Ictaluridae:	9			1	
Moronidae					
Morone saxatilis		7(1)	3(1)		
Morone americanus			8(2)		
Unidentified Moronidae:	2				
Unidentified Centrarchidae:	1				
Esocidae					
Esox sp.			1(1)		
Unidentified Teleostei:			98	3	
Unidentified Osteichthyes:	85	8		6	7
Unclassified Vertebrate fragments:	570	237	131	73	74
Phylum Mollusca					
Class Pelecypoda					
Elliptio complanata		3(2)			
Unidentified Pelecypoda:		70+	4		

TABLE 2-1 (continued)

Species	Plot Level 1	2	3	4	5
Feature 21 (no plot levels)					
Phylum Chordata					
Subphylum Vertebrata					
Class Mammalia					
Large size Mammalia					
Odocoileus virginianus	21(2)				
c.f. *O. virginianus*	21				
Ursus americanus	1(1)				
Unidentified Large size Mammalia:	151				
Medium size Mammalia					
Lynx rufus	1(1)				
Procyon lotor	5(1)				
Didelphis marsupialis	12(2)				
Ondatra zibethica	2(1)				
Sylvilagus floridanus	1(1)				
Sciurus sp.	14(2)				
Unidentified Medium size Mammalia:	15				
Class Aves					
Unidentified Aves:	30				
Class Reptilia					
Order Testudines					
Chelydra serpentina	24(2)				
Terrapene carolina	6(1)				
Pseudemys sp.	2(1)				
Unidentified Order Testudines:	434				
Order Squamata					
Suborder Serpentes					
Unidentified Colubridae	23				
Agkistrodon piscivorus	3(1)				
Unidentified Serpentes:	24				
Class Osteichthyes					
Superorder Chondrostei					
Acipenser sp.	2(1)				

TABLE 2-1 (continued)

			Plot Level		
Species	1	2	3	4	5
Superorder Holostei					
Amia calva	78(2)				
Lepisosteus sp.	40(1)				
Unidentified Holostei:	96				
Superorder Teleostei					
Ictaluridae					
Amieurus catus	24(6)				
Amieurus natalis	19(5)				
Unidentified Ictaluridae:	44				
Unidentified Clupeidae:	191				
Centrarchidae					
Lepomis sp.	8(4)				
Micropterus sp.	1(1)				
Unidentified Centrarchidae:	8				
Moronidae					
Morone saxatilis	1(1)				
Unidentified Moronidae:	115				
Esocidae					
Esox sp.	10(1)				
Catostomidae					
Moxostoma sp.	1(1)				
Percidae					
Perca flavescens	4(1)				
Sciaenidae					
Micropogonias undulatus	71(33)				
Anguillidae					
Anguilla rostrata	3(1)				
Unidentified Teleostei:	2886				
Unclassified Vertebrate fragments:	3166				
Phylum Mollusca					
Class Pelecypoda					
Elliptio complanata	100+				
Unidentified Pelecypoda:	?				
Feature 41					
Phylum Chordata					
Subphylum Vertebrata					
Class Mammalia					

TABLE 2-1 (continued)

			Plot Level		
Species	1	2	3	4	5
Large size Mammalia					
Odocoileus virginianus	5(1)	1(1)			
c.f. *O. virginianus*		4	1		
Unidentified Large size Mammalia:	34		6		
Medium size Mammalia					
Procyon lotor	1(1)		1(1)		
Didelphis marsupialis	2(1)				
Ondatra zibethica	2(1)		3(1)		
Sciurus sp.	2(1)	1(1)	1(1)		
(Fired Clay Area A)					
Ondatra zibethica	1(1)				
(Fired Clay Area B)					
Odocoileus virginianus	3(2)				
Unidentified Large size Mammalia:	6				
Procyon lotor	3(1)				
Ondatra zibethica	1(1)				
Sciurus sp.	1(1)				
(North Side of Shell Pit)					
Odocoileus virginianus	4(1)				
c.f. *O. virginianus*	4				
Unidentified Large size Mammalia:	16				
Didelphis marsupialis	3(1)				
Unidentified Medium size Mammalia:	2				
Class Aves					
Meleagris gallopavo	4(1)	1(1)	1(1)		
Unidentified Aves:		3	5		
(North Side of Shell Pit)					
Meleagris gallopavo	2(1)				
Colinus virginianus	1(1)				
Unidentified Aves:	5				

TABLE 2-1 (continued)

	Plot Level				
Species	1	2	3	4	5
Class Reptilia					
Order Testudines					
Chelydra serpentina	7(1)	1(1)	4(1)		
Pseudemys sp.	3(1)				
Unidentified Testudines:	52	24	61		
Order Squamata					
Suborder Serpentes					
Agkistrodon piscivorus		1(1)			
Unidentified Viperidae:	6				
Unidentified Colubridae:	18				
Unidentified Squamata:	1	5	2		
(Fired Clay Area B)					
Terrapene carolina	1(1)				
Unidentified Testudines:	12				
Nerodia sp.	3(1)				
(North Side of Shell Pit)					
Chelydra serpentina	4(1)				
Unidentified Testudines	4				
(South Side of Shell Pit)					
Chelydra serpentina	6(1)				
Unidentified Testudines	14				
Class Amphibia					
Rana catesbeiana	1(1)				
Class Osteichthyes					
Superorder Chondrostei					
Acipenser sp.	2(1)	4(1)			
Superorder Holostei					
Amia calva	15(1)	20(3)	15(1)		
Lepisosteus sp.	22(1)	15(1)	13(1)	1(1)	
Unidentified Holostei:	3				
Superorder Teleostei					
Ictaluridae					
Amieurus natalis	2(1)	10(6)	3(2)		
Amieurus catus	2(1)	2(2)	4(1)		
Amieurus nebulosus			4(2)		
Unidentified Ictaluridae:	19	16	41	1	
Moronidae					
Morone saxatilis	1(1)				

TABLE 2-1 (continued)

Species	Plot Level 1	2	3	4	5
Morone americanus	1(1)	1(1)	2(1)		
Unidentified Moronidae:	7	5			
Unidentified Centrarchidae:	2				
Unidentified Esocidae:	2	2	2		
Unidentified Clupeidae:	27	21	63		
Percidae					
Perca flavescens		4(1)			
Unidentified Cyprinidae:			1		
Anguillidae					
Anguilla rostrata		4(2)	1(1)		
Unidentified Teleostei:			900		
Unidentified Osteichthyes:	596	1100		13	
(Fired Clay Area A)					
Amieurus natalis	1(1)				
Unidentified Osteichthyes:	1				
(Fired Clay Area B)					
Amia calva	2(1)				
Lepisosteus sp.	1(1)				
Esox sp.	4(1)				
Perca flavescens	2(1)				
Unidentified Osteichthyes:	12				
(North Side of Shell Pit)					
Amia calva	28(3)				
Lepisosteus sp.	14(1)				
Unidentified Holostei:	5				
Amieurus catus	2(1)				
Unidentified Ictaluridae:	6				
Micropterus salmoides	2(1)				
Unidentified Teleostei:	28				
(South Side of Shell Pit)					
Amia calva	2(1)				
Anguilla rostrata	1(1)				
Morone saxatilis	1(1)				
Unidentified Osteichthyes:	14				
Unclassified Vertebrate Fragments:	730	300	200		

TABLE 2-1 (continued)

			PLot Level		
Species	1	2	3	4	5
(Fired Clay Area A)					
Unclassified					
Vertebrate Fragments:	4				
(North Side of Shell Pit)					
Unclassified					
Vertebrate Fragments:	110				
Phylum Mollusca					
Class Pelecypoda					
Elliptio complanata	100+				
Feature 43					
Phylum Chordata					
Subphylum Vertebrata					
Class Mammalia					
Large size Mammalia					
Odocoileus virginianus	5(1)	3(1)	4(1)		
c.f. O. virginianus		2	4		
Unidentified					
Large Size Mammalia:	10	11	26		
Medium Size Mammalia					
Procyon lotor	1(1)				
Didelphis marsupialis	1(1)		1(1)		
Castor canadensis			1(1)		
Sciurus carolinensis	4(1)	4(1)	2(1)		
Unidentified					
Medium Size Mammalia:		1	5		
Class Aves					
Unidentified Aves:	8				
Class Reptilia					
Order Testudines					
Terrapene carolina	1(1)	1(1)			
Chelydra serpentina		3(1)			
Unidentified Testudines:		4	7		
Unidentified Squamata:			1		

TABLE 2-1 (continued)

			Plot Level		
Species	1	2	3	4	5
Class Osteichthyes					
Superorder Holostei					
Amia calva	15(2)	5(1)	8(2)		
Lepisosteus sp.	12(1)	47(3)	12(1)		
Unidentified Holostei:		14	3		
Superorder Teleostei					
Ictaluridae					
Amieurus catus	5(1)	5(2)			
Amieurus natalis			4(1)		
Amieurus nebulosus			2(1)		
Unidentified Ictaluridae:	3		2		
Moronidae					
Morone saxatilis	10(1)	3(1)	2(1)		
Morone americanus	2(1)	2(1)			
Sciaenidae					
Micropogonias undulatus			1(1)		
Unidentified Teleostei:	30	53	22		
Unclassified Vertebrate Fragments:		10	29		
Phylum Mollusca					
Class Pelecypoda					
Elliptio complanata	100+		100+		
Ligumia nasuta	2(1)				
Total Fragments		16,779			

* Listed as N.I.S.P., with M.N.I. in parantheses where appropriate.

** References for taxonomy are as follows: mammals, Burt and Grossenheider 1976; birds, Peterson 1980; reptiles and amphibians, Redmond, Echternacht, and Scott 1990; fish, Etnier and Starnes, in press, and Robins, Ray, and Douglass 1986.

TABLE 2-2: Common names of species identified from the Jordan's Landing Site.

Species	Common name
Mammals	
Odocoileus virginianus	white-tailed deer
Ursus americanus	black bear
Canis c.f. *lupus*	gray wolf
Castor canadensis	beaver
Procyon lotor	raccoon
Didelphis marsupialis	opossum
Urocyon cinereoargenteus	gray fox
Lynx rufus	bobcat
Ondatra zibethica	muskrat
Sylvilagus floridanus	eastern cottontail
Sciurus carolinensis	gray squirrel
Sciurus niger	fox squirrel
Mephitis mephitis	striped skunk
Birds	
Meleagris gallopavo	turkey
Colinus virginianus	bobwhite quail
Reptiles	
Chelydra serpentina	snapper
Terrapene carolina	eastern box turtle
Pseudemys sp.	slider
Elaphe guttata	garter snake
Nerodia sp.	water snake
Agkistrodon piscivorus	cottonmouth
Amphibians	
Rana catesbeiana	bullfrog
Fish	
Acipenser sp.	sturgeon
Amia calva	bowfin
Lepisosteus sp.	gar
Amiurus catus	white catfish
Amiurus natalis	yellow bullhead
Amiurus nebulosus	brown bullhead
Morone americanus	white perch
Morone saxatilis	striped bass
Esox sp.	pickerel
Perca flavescens	yellow perch
Lepomis sp.	sunfish
Micropterus salmoides	largemouth bass

TABLE 2-2 (continued)

Species	Common name
Moxostoma sp.	redhorse
Anguilla rostrata	American eel
Micropogonias undulatus	Atlantic croaker
Clupeidae	Herring family
Freshwater mussels	
Elliptio complanata	eastern elliptio
Ligumia nasuta	eastern pondmussel

CHAPTER 3

TAPHONOMIC ANALYSIS OF THE JORDAN'S LANDING ASSEMBLAGES

General

Analysts of archaeological bone assemblages are typically faced with situations where interpretations must be made that are derived from the presence or absence of bones and bone parts. Representation of certain species as opposed to others might suggest certain preferences on the part of the human inhabitants of a site, while the persistent absence of a set of elements from an animal might indicate patterns of treatment of the carcass. However, interpretations based on such information must proceed with caution, as archaeological and fossil bone assemblages are generally subjected to a variety of offences from the time the animal is killed until its remains are recovered (Brain 1976, 1981; Binford 1981; Gifford 1981). Such destructive treatments as gnawing by carnivores, weathering, and chemical attrition can radically alter the relative frequencies of bones and bone parts (Brain 1976, 1981; Behrensmeyer 1975, 1984; Binford 1977, 1981; Gifford 1981).

The study of processes affecting fossil bones and other organic remains before they are recovered has been called "taphonomy" by the paleontologist I.A. Efremov (1940). Efremov (1940) defines taphonomy as "the study of the transition (in all its details) of animal remains from the biosphere into the lithosphere, i.e. the study of a process in the upshot of which organisms pass out of the different parts of the biosphere and, being fossilized, become part of the lithosphere." Taphonomic research utilizes modern, or actualistic experiments (cf. Brain 1976; Binford 1977; Klippel, Snyder, and Parmalee 1987), and thus stands to discover processes that are at work in the contemporary world. Applications of such studies are with sets of remains that often exhibit great depth of time (Gifford 1981). Such applications to fossil or archaeological materials require uniformitarian assumptions (Gifford 1981). Klein and Cruz-Uribe (1984) have questioned the validity of inferring past phenomena using information obtained in the present, pointing out that in modern studies the observer may affect the results, as when one's presence causes bone-collecting carnivores to alter their habits, or when studies are conducted in settings that differ from those in which fossil assemblages accumulated. They add that modern studies can never reproduce the longevity that characterizes the fossil record.

Fortunately, most researchers using taphonomic data do not assume that conditions in the past were exactly as they were in whatever modern experiments were conducted, but rather seek to discover possible explanations for patterns observed in fossil remains by employing information gained through modern studies, such as the differential ability of different bone parts to survive chewing, which has, as much as anything, to do with the inherent qualities of bones (Brain 1976; Binford 1977; Klippel, Snyder, amd Parmalee 1987). While Klein and Cruz-Uribe's points should be given careful consideration, it is reasonable to assume that there are processes to be discovered that are applicable regardless of time.

The role of taphonomic analysis in this study is to examine biases that exist in the data from the four features in the hope of preventing erroneous inferences concerning the behavior of the former inhabitants of the village. Such analysis might also be beneficial in providing information concerning village life not directly relating to human behavior. The approach taken is to first identify potential sources of bias in the assemblages, and then to utilize data from actualistic studies to test hypotheses about those sources.

Taphonomic Agents and Their Effects in the Cashie Phase Bone Assemblages

Every fragment in each of the assemblages from the respective features was analyzed for evidence of possible agents of attrition. Examples of such evidence are cutmarks and percussion scars from human processing (Johnson 1985), dark discoloration from exposure to extreme heat (Shipman et al. 1984), and scoring and pitting from the teeth of canids (Binford 1981).

There is considerable variation in the present condition of the bone fragments both between the four features and within each of them. A continuum from whole and relatively undamaged elements to highly fragmented, burned, and eroded pieces is observed. Such variety suggest that numerous processes have had an effect on the assemblages, and that perhaps some of these processes have not been consistent through time.

That the human occupants who introduced animals into the village altered the condition of the skeletal elements of that fauna is unquestionable. Cutmarks are found on many fragments as listed in Table 3-1. At least some of the bones were subjected to extreme heat, evidenced by the discoloration associated with burning (cf. Shipman, Foster, and Schoeninger 1984). Identifying that damage caused by human treatment of carcasses is difficult, as there is no information outlining prehistoric Tuscarora butchery practices to date. Before data from the assemblages here under study can be used in making inferences concerning such butchery practices, the various non-human agents that have altered the assemblages must be identified and their effects isolated.

Canids as agents of attrition on bone have received an appreciable amount of attention from researchers in taphonomy (cf. Brain 1976; Binford 1977; Klippel, Snyder, and Parmalee 1987). Wolves, which commonly accumulate bone debris in den areas, are known to produce a fairly

TABLE 3-1. Percentage of Bone Fragments Showing Evidence of Taphonomic Agents.

Class	Cutmarks	Burning	Canid Gnawing	Rodent Gnawing
Feature 1				
Mammalia	0.3	9.0	2.4	1.3
Reptilia/ Amphibia	0	7.6	0	0
Osteichthyes	0	0.78	0	0
Aves	0	6.3	0	0
Unidentified	0	3.6	0	0
Feature 41				
Mammalia	0.72	2.0	1.0	0.72
Reptilia/ Amphibia	0	0.88	0	0
Osteichthyes	0	0	0	0
Aves	0	0	0	0
Unidentified	0	1.0	0	0
Feature 43				
Mammalia	1.1	12.8	1.1	2.3
Reptilia/ Amphibia	0	0	0	0
Osteichthyes	0	0.76	0	0
Aves	0	0	0	0
Unidentified	0	5.0	0	0
Feature 21				
Mammalia	0	24.0	1.2	0.40
Reptilia/ Amphibia	0	25.5	0	0
Osteichthyes	0	1.8	0	0
Aves	0	13.0	0	0
Unidentified	0	8.3	0	0

consistent pattern of damage to ungulate skeletons (Binford 1977, 1981; Klippel, Snyder, and Parmalee 1987). The domestic dog has also been studied (cf. Brain 1976; Binford and Bertram 1977; Morey and Klippel in press; Byrd n.d.) and determined to often exhibit similar behavior to that of wolves regarding ungulate bones. There are some notable exceptions, however, which will be discussed below.

The domestic dog, _Canis familiaris_, was common on the prehistoric North American landscape (Haag 1948, Olsen 1985) and dates back to at least 8500 B.C. on this continent (Olsen 1985). That dogs were present at the Jordan's Landing Site during the Cashie Phase is suggested by the gnaw marks observed on bone fragments (see Table 3-1) and is further acknowledged by a dog burial that dates to the Cashie Phase (David S. Phelps, personal communication). Wolves are also represented at the site, as evidenced by the presence of a single radius that was in association with food remains and other garbage. If the village was occupied seasonally, then it is possible that wolves were scavenging the discarded bones during the season when the site was abandoned. With the presence of domestic dogs established and wolves considered a possibility, the next step is to attempt to evaluate what effect the canids had on the assemblages.

An inspection of Table 3-2 reveals some patterns in the survivorship of certain ungulate bone parts among the experimental studies and, most notably, those in Feature 1. The data reported by Brain (1976) are goat bone parts collected from a Hottentot village where humans were smashing, cooking, and chewing the bones before throwing them to their dogs, who subjected the then fragmented elements to further abuse. Because these goat skeletons were first subjected to human attrition processes before being given to the dogs, Brain's data cannot be considered a "pure" representation of what dogs will do to ungulate bones. Klippel, Snyder, and Parmalee (1987) report results from a controlled feeding study involving whole white-tailed deer carcasses and captive gray wolves. In this case, the canids were in an enclosure where their activities could be monitored and no other animals could interfere with the experiment. The resulting data are as close to a pure representation of what wolves will do to ungulate bones as is available to date.

Another controlled feeding study was conducted by Byrd (n.d.) with white-tailed deer carcasses and domestic dogs. One complete deer (#1) skeleton (live weight 66kg) was partially defleshed and offered to three Labrador

TABLE 3-2. Percentage Ungulate Bone Part Frequencies From Experimental Studies* and the Four Features From the Jordan's Landing Site.

	Klippel, Snyder and Parmalee	Brain	Byrd	Features			
				1	41	43	21
M.N.I.	4	64	4	8	2	1	2
Bone part							
cranium	25.0	-	100.0	37.5	50.0	100.0	0
mandible	100.0	91.4	100.0	25.0	0	0	0
atlas	50.0	18.8	-	25.0	0	0	0
axis	25.0	21.9	-	37.5	0	0	50.0
cerv. vert.	15.0	3.8	-	7.5	0	20.0	0
thor. vert.	3.8	2.5	-	10.6	0	0	3.8
lum. vert.	29.2	8.1	-	12.5	0	0	0
innom.	87.5	26.6	100.0	50.0	0	50.0	0
ribs	1.0	10.2	-	2.0	2.0	0	2.0
scapula **	50.0	27.4	28.6	50.0	25.0	0	50.0
P. humerus	25.0	0	0	6.3	0	0	0
D. humerus	87.5	64.0	42.9	62.5	0	0	0
P. rad/ulna	75.0	50.8	14.3	68.8	0	0	0
D. rad/ulna	0	17.2	42.9	18.8	0	0	25.0
carpals	4.2	-	-	8.3	16.7	0	0
P. metacarp.	75.0	25.0	28.6	68.8	25.0	0	0
D. metacarp.***	0	18.0	0	43.8	0	0	25.0
P. femur	25.0	14.1	16.6	6.3	0	0	25.0
D. femur	37.5	7.0	33.3	12.5	0	0	25.0
P. tibia	12.5	10.1	28.6	12.5	0	50.0	0
D. tibia	50.0	56.3	28.6	75.0	0	50.0	0
tarsals	45.0	-	-	30.0	0	20.0	25.0
P. metatar.	87.5	30.4	85.7	87.5	0	50.0	50.0
D. metatar.	12.5	15.6	28.6	43.8	0	0	25.0
phalanges	1.0	2.7	40.0	25.5	6.3	16.7	20.8

* Data obtained from Klippel, Snyder, and Parmalee (1987); Brain (1975); and Byrd (n.d.).

** Scapulae represented in Features by articular ends only.

*** Distal metapodials that could not be designated as metacarpal or metatarsal were tallied and equally divided between the two respective categories.

retrievers, each weighing between 25 and 30 kilograms, for three days. A second deer (#2) (live weight 38kg) was quartered, defleshed, and the head and limbs given to the same three dogs. A third deer (#3) (live weight 40kg) was defleshed and the left front limb given to one dog and the left rear limb given to another. The fourth experiment involved the two dogs mentioned above with deer #3 and a white-tailed deer (#4: live weight 39kg). The deer was defleshed, quartered, and the left front limb along with the right rear limb were boiled for a period of 50 minutes. The two raw limbs were fed to the two dogs separately, the dogs being in different enclosures. Next, the cooked limbs were offered to the dogs, again the dogs being separated. All of the above feeding sessions were controlled. The dogs were in enclosures that were cleaned before experimentation to prevent any debris from covering bone fragments. None of the deer skeletons were left with the dogs for more than three days, a restraint that may have affected the results. The first two deer, which were offered in a larger quantity, would have been further reduced if left with the dogs for a longer period. The last two deer were fed to separate dogs piecemeal, and in each of these feedings the dogs seem to have lost interest in the bones after about 24 hours. Some notable observations that were made during the experiments were that the degree of damage done to the deer bones was directly related to the amount of time the dogs were given access and inversely related to the amount of skeletal material offered to them during a feeding. One might assume that the degree of damage done is directly proportional to the number of dogs, though there is no evidence presented here in support of this assumption. It was also noted that there seems to be no bone part on a deer skeleton that a medium sized dog cannot destroy. When a single limb was fed to a dog, there typically was little left other than small fragments and splinters. In the cases where all four limbs were offered at once, as in the first two experiments, the dogs exhibited preferences for certain parts over others. For example, the proximal humerus, distal radius/ulna, scapula, proximal femur, distal metapodials, and the innominates were attacked immediately. The carcasses were taken away before further selections of parts could be made. It appears that the dogs prefer those bone parts that many researchers (Brain 1976, 1981; Binford and Bertram 1977; Binford 1981) have suggested are less durable.

It seems possible that such preferences are related to ease of crushing for the dogs or possibly to differential nutrient values of various bone parts. The fact that such preferences exist lends support for the supposition that a canid pattern of ungulate bone destruction can be identified (Binford 1981), but the variability that domestic dogs exhibit in their behavior must be appreciated. For example, the ungulate distal humerus has been touted by many as resistent to destruction, indeed even unchewable (Brain 1975), yet the dogs mentioned in the above study can and do crush the distal humerus of the white-tailed deer. It does not seem to be a first choice of bone parts to gnaw on, but if all other bones are absent then it might be destroyed. A distal humerus that was left from the 68kg deer was offered to one of the dogs (25kg) approximately two years after the original experiment. The dog promptly began to gnaw down the bone part even though it was hard, dried, and had seemingly no nutritive value. Morey and Klippel (in press) report similar observations from controlled feeding experiments with a large (32kg) mixed breed dog named Kumba. Various white-tailed deer limb bones were offered to Kumba in quantities varying from whole limbs to single elements. Kumba's destruction of the bones was extreme, mirroring the results reported above when only single limbs were offered to a single dog. In regards to the degree of destruction, Morey and Klippel (in press) state, "[this] underscores the importance of feeding intensity in determining what degree of destruction will be inflicted by a canid. Kumba apparently can destroy any deer long bone she wants to. We suspect that any large, healthy canid can do the same."

If bone part frequencies recorded from the wolf pen experiments reported in Klippel, Snyder, and Parmalee (1987) can be considered a "typical canid pattern" (Morey and Klippel, in press), then the data from the experiments reported above involving the feeding of complete or near complete skeletons (first and second deer) to three dogs are nearly in line with a "canid pattern". Similarities in survivorship between the two are as follows: mandible high, proximal humerus low, distal humerus high, proximal radius/ulna high, distal radius/ulna low, proximal metapodials high, distal metapodials low, both ends of femur low, proximal tibia low, distal tibia high, and phalanges low. As the data are presented in Table 3-2, results from all of Byrd's experiments are combined, creating a picture that is a distortion of the "typical canid pattern". This distortion is caused by the different feeding situations imposed in the experiments which produced radically different results, all attributable to varying "feeding intensity" as suggested by Morey and Klippel in the quotation above. Binford (1977:132) has stated that "only hungry dogs really destroy bones." This clearly is not true. All of the dommestic dogs mentioned in the studies above were well-fed, even during the experiments. There is apparently a highly variable behavioral component to deal with when examining an assemblage that has been altered by domestic dogs.

If, as suggested above, the degree of damage is directly proportional to the number of dogs and the amount of time they are given access, and indirectly proportional to the amount of skeletal material they are given access to, then perhaps models can be derived to deal with this problem. Such models might allow one, for example, to estimate availability of food for a site's human occupants by observing the degree of damage rendered to bone parts in an assemblage, the logic being that the more deer the dogs are given access to (per unit time) the less the proportion of bones the dogs will damage. Of course, one must take into account length of time for access and number of dogs, both of which are virtually impossible to know for a prehistoric site. Also, the question arises as to whether there is appreciable variability in such potentially ruinous variables as individual dog behavior.

The best assemblage for analysis of canid modification of ungulate bone at the Jordan's Landing Site is Feature 1, the ditch that bounds the north and west sides of the village perimeter (Phelps 1983). The ditch was opened by either natural erosion or from borrowing soil to bank the palisade that ran along the inside (Phelps 1983). Its role as a trash dump is plainly evidenced by the quantity of materials contained in it, among which white-tailed deer bones are prevalent. Varying degrees of weathering on the deer bone fragments indicate that some were exposed to the elements more than others. Such variable conditions are expected, given that the materials that ended up in the ditch probably came from a variety of sources, some possibilities being floor sweepings from houses, leftovers from meals, bones that dogs dropped throughout the village, etc.. Table 3-1 list the percentages of all bone fragments in Feature 1 that show evidence of gnawing. The figure of 2.4% for Mammalia (5.0% for white-tailed deer) seems rather low in comparison to the greater than 90% reported for the wolf pen study (Lynn Snyder, personal communication); but this is not surprising given that the deer bones were subjected to some smashing by humans before the dogs had access. The treatment creates more fragments to count for percentages and a smaller proportion of bone parts that would interest a dog. The ungulate bone part frequencies in Feature 1 are listed in Table 3-2 with those from Klippel, Snyder, and Parmalee (1987), Brain (1975), and Byrd (n.d.). Some consistencies in survivorship between Feature 1, Klippel, Snyder, and Parmalee, and Brain are exhibited in the axis, scapula, distal humerus, proximal radius/ulna, and proximal tibia. Close associations between Klippel, Snyder, and Parmalee and Feature 1 but not Brain are seen in the cranium, ribs, carpals, proximal metacarpal, tarsals, and proximal metatarsal, while those between Brain and Feature 1 but not Klippel, Snyder, and Parmalee are evidenced in the atlas and distal radius/ulna (see Figure 3.1). There is no reason at this point to attribute those bone part frequencies that match the "canid pattern" to any cause other than canid attrition. The data from Byrd (n.d.) are not nearly as close to Feature 1 as are those from Brain and Klippel, Snyder, and Parmalee. The most likely explanation for this phenomenon is that the dogs living in the village often had access to more than just the limbs of the animal,

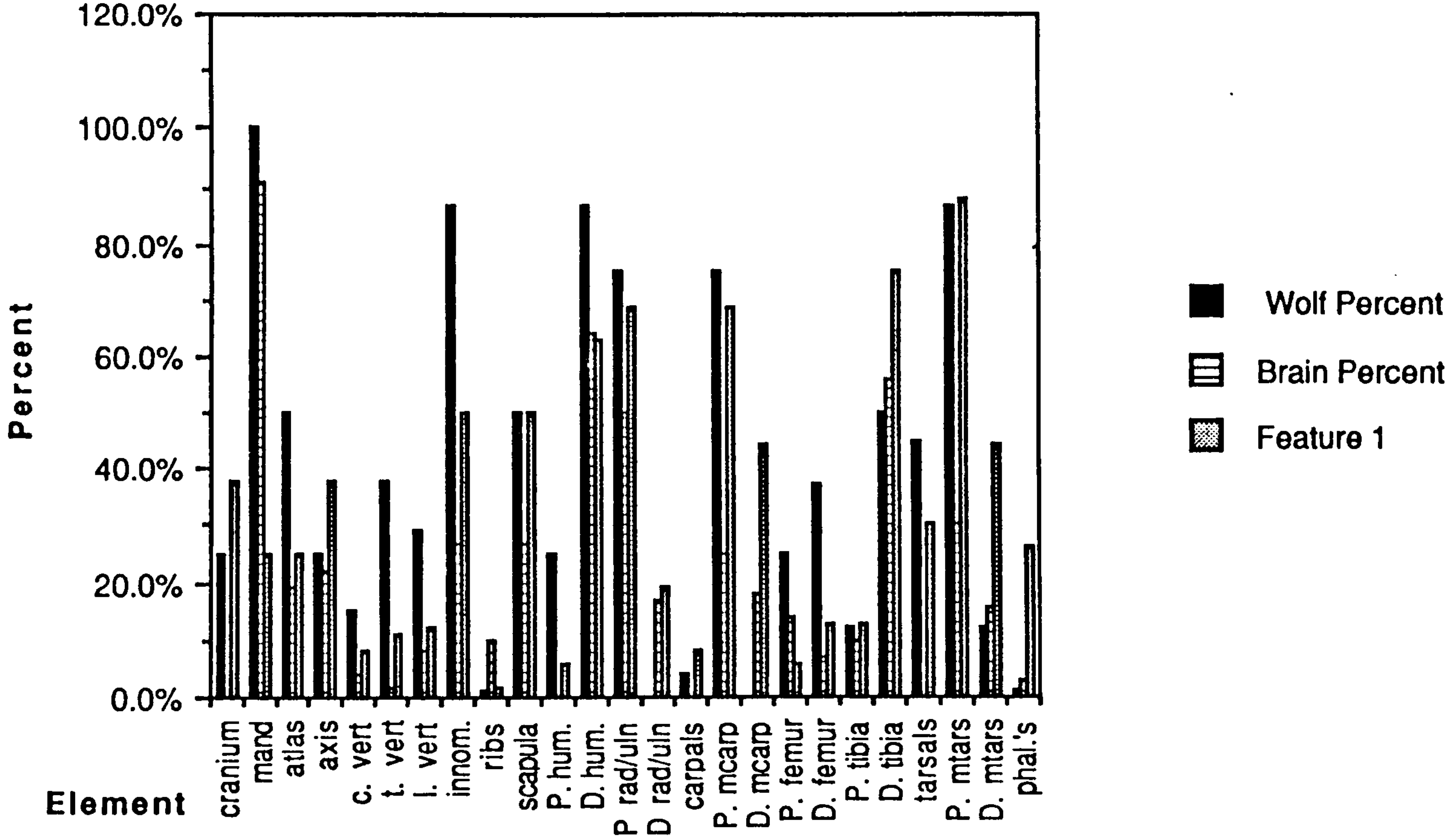

Figure 3.1: Bone Part Frequencies.

as was the case in the wolf pen and Hottentot village studies.

Examination of the bone part frequencies in Feature 1 reveals evidence that there were a large number of deer bone elements available per number of dogs. This evidence includes the relatively low percentage of gnaw marks as well as the similarity of the bone part percentages with those of Klippel, Snyder, and Parmalee and Brain as discussed above. Further indications are the high frequencies of distal metapodials and phalanges and the presence of several whole, unscathed bones. A high recovery of phalanges is reflected in Byrd's data in Table 3-2, which resulted from the dogs' disinterest in the hooves of deer #1 when an entire skeleton was offered to the dogs. Thus, the figure of 40% results from all of the phalanges surviving the one experiment and none surviving the others. If a relatively large number of phalanges made it into Feature 1 unscathed then there are two plausible possibilities, the first being that there were no dogs in the village that could achieve access to those bones. Given the occurrence of gnaw marks on some bone from all the levels in the unit, the second possibility, that there were enough alternative bone elements available to the village dogs to provide them with more desirable choices than the hooves seems likely.

The attempt to isolate the taphonomic overprint in the four assemblages has concentrated thus far on ungulate bone fragments from Feature 1. As it was an "open air" ditch which functioned as a dump, Feature 1 is best suited for such analysis. It probably contains the best general representation of faunal remains from the time in which it was filled. Plus because it was an open ditch, dogs and other animals had prolonged access to the materials it contained. The other three features do not satisfy these same conditions but share certain characteristics that have merits of their own. Features 21, 41, and 43 all contain a great majority of fish bone compared with the other vertebrate classes, there being 82% fish (percentages in reference to N.I.S.P., proportional to all classified bone fragments) in Feature 21, 89% fish in Feature 41, and 70% fish in Feature 43 (see Figure 3.2). Freshwater mussels were also abundantly represented in the three features, but it was impossible to tabulate them in comparable numbers since the shell was largely reduced to rubble. Feature 1 contains 22% fish and 49% mammal of which at least 22% is white-tailed deer. The incidence of canid gnaw marks is

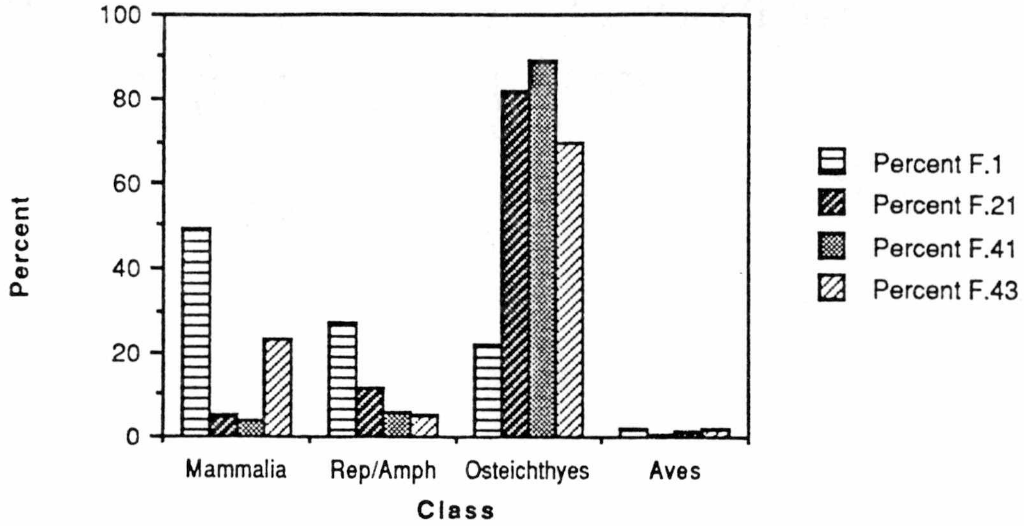

Figure 3.2: Class Percentages (N.I.S.P.) in the Features.

lower in the latter three features than in Feature 1, most likely attributable to the closed nature of Features 21, 41, and 43, which could effectively limit access to dogs once the pits were covered over.

Payne and Munson (1986) have pointed out how smaller mammal skeletons (rabbit size or smaller) can be dramatically affected when consumed by dogs; indeed, they are typically ingested in their entirety, leaving evidence of the animal only in the faeces. Jones (1986) suggests a similar effect for fish when consumed by man, pigs, or dogs. The implications of their findings for the assemblages of concern here are that any medium-to-small mammals and fish that were consumed by dogs (and people?) in the village would not be represented in the features unless the dogs defecated in the pits. As discussed above, there is strong reason to believe that dogs had considerable impact on the Feature 1 assemblage. Thus, it is predictable that Feature 1, the open ditch, should contain proportionally fewer medium mammals, small mammals, and fish than the other three features which were relatively unaccessable to dogs. This is not to say that the ditch originally contained the same proportion of the smaller animals as the other pits, but rather that Feature 1 is more strongly biased against there being representation of the number of individual small animals deposited there originally. Further bias against representation of smaller animals in the ditch results from the sampling procedure: only a fraction of the feature fill was washed through 1/16" screen (see Chapter 1). The percentage of medium-to-small mammals (NISP medium-to-small mammals divided by NISP all mammals X100) in Feature 1 is 10% and the percentage of fish is 22% (NISP fish divided by NISP all vertebrate classes X100). In Feature 21, 20.5% of the remains are medium-to-small mammals and 82% fish. Feature 41 contains 42% medium-to-small mammals and 89% fish, while Feature 43 has 24% medium-to-small mammals and 70% fish.

Another biological agent of attrition in the four assemblages is evidenced by rodent gnawing. Table 3-1 shows that all four features contain fragments that were gnawed by rodents. While rodents are not considered to have seriously damaged the bones on which their gnaw marks appear, the possibility that small bones were carried away must be appreciated.

Once the three pits that are now Features 21,41, and 43 were covered several hundred years ago, the bone and shell fragments within became subject to the chemical environments in the features. The soil is generally acidic, which can have a corrosive effect on bone as well as shell. Indeed, most of the shell in these features is in a highly fragmented, often powdered state. Some valves, however, have persisted in excellent condition. These virtually unharmed valves were seated in locations approximately centered relative to the bulk of shell material, which probably shielded them considerably from surrounding hostile chemical reactions. The condition of the bone fragments is also variable and may be partly affected by their proximity to corroding shell. How many bones and of what type can we expect to have been destroyed in these features?

Determining which patterns in the bone frequency data are attributable to chemical attrition and which to other causes presents somewhat of a problem. The first question which arises is what inherent qualities of bones permit some to survive while others perish? There have been many studies of various properties of bone that are alleged to be related to the differential survivorship we see in the fossil and archaeological records. Many researchers have cited a correlation between survivorship and bone density (Brain 1976; Binford and Bertram 1977; Behrenmeyer 1975; Lyman 1982), and some have tried to show a causal relationship between bone density and survivorship (Lyman 1982). Bone density does not, however, offer a satisfactory explanation for the ability of certain bones and bone parts to persist during processes of attrition when others do not. In the following section bone density models of differential survivorship will be examined and an alternative model proposed. It is hoped that such a model might clarify the taphonomic history of fish remains deposited in the features under study.

Bone Density and Differential Survivorship

Brain (1976) has noted that the proximal and distal ends of goat bones have drastically different capacities to resist crushing, as from the jaws of canids. For example, the proximal humerus is wide, thin-walled, and spongy while the distal end is narrow and compact (Brain 1976). He states that such qualities can be quantified by measuring the specific gravity of each end. Brain describes his method for estimating specific gravity of the opposing ends of the humerus as first cutting the bone in half at a right angle to its axis, and weighing each end. The two ends are next dipped in plasticine to seal off the cavities and any other openings on the shafts and then submerged in water to measure the volume. Specific gravity is then calculated as the ratio of mass to volume (Brain 1976). Brain reports specific gravity estimates for the humerus, radius and ulna, femur, and tibia, all with proximal and distal ends separate and all apparently from a single goat. When the specific gravity estimates of these bone parts are matched against the data from the Hottentot village assemblage, a correlation is observed (Brain 1976).

Lyman (1982) has pointed out that Brain's density measures are not a true specific gravity measure. How one obtains a precise measure of displacement of water by submerging the bone part is not described by Brain. The addition of the plasticine introduces error into the volume, a measurement that is certainly limited in its precision with or without the plasticine. Brain's data must be regarded as somewhat dubious, as the value that is the denominator in the density ratio cannot be relied upon as an accurate measurement. The use of only one representative for each element leaves open the possibility that the data are from an aberrant individual and the correlations are a coincidence.

Binford and Bertram (1977) estimated bone density for three sheep and a caribou. Their method is very similar to that described by Brain (1976), notable exceptions being that here paraffin was used in lieu of plasticine and for paired elements both were measured for each individual and average values reported. Binford and Bertram's method suffers the same ailments as Brain's, and yet the data is used extensively. It seems hazardous to base any interpretations on differences observed between density values for the three sheep, some as small as 0.01, and others as large as 0.68, when the measurement that is the denominator in the density ratio is not very precise. We are also left wondering if there is individual variation in the respective age groups for sheep. Binford and Bertram (1977) acknowledge the need for further study.

Lyman (1982) has conducted an extensive study of the relationship between bone density and survivorship, in which is included a review of attempts to measure the density of bones and bone parts. Lyman observes that Brain's density measures are actually a hybrid of true density, the density of the bone material minus any pore space, and bulk density, the density of the bone including pore space. Binford and Bertram's density estimates are an approximation of bulk density, with the volume of the paraffin coating unaccounted for (Lyman 1982). Both Brain's and Binford and Bertram's density data show correlations with survivorship in the Hottentot village goat sample (Lyman 1982), and Lyman argues that any measure that approximates bulk density will suffice for predicting survivorship. The problem with such techniques for measuring density as employed by Brain and Binford and Bertram is the difficulty in ascertaining whether or not reliable measures are obtained. Lyman's answer to this shortcoming is to measure bone density via photon absorptiometry. He asserts that the photondensitometer can provide one with consistent, well-defined measures of properties of bones. Lyman's measure that is comparable to bulk density is "VD", which, as predicted, shows significant correlations with survivorship in many cases (Lyman 1982).

While correlations can be shown between bone part density and survivorship, a theoretical relationship proves to be more elusive. Binford and Bertram (1977) have formulated an equation that models the destruction of bone as a function of time. They state that the rate of bone destruction is inversely proportional to density, directly proportional to the surface area-to-volume ratio, and directly proportional to the strength of the agent of attrition:

$$dD/dt = a(-S/V)/D$$

where S = surface area, V = volume, D = density, and a = strength of the agent of attrition. In this form, the model seems to be an acceptable representation of attrition, simplified as most models are. Binford and Bertram go on, however, to combine "S/V" with "a" as a constant in the first order approximation:

$$dD/dt = -A/D$$

The reason given for this alteration is that the "surface-to-volume ratio is approximately constant for most bones" (Binford and Bertram 1977:113). As alluded to by Brain (1975, 1981), the surface-to-volume ratio is one quality of bones that can vary dramatically, as with the astragulus and scapula of an ungulate. The ratio S/V cannot reasonably be ignored.

Lyman (1982) proposes a much simpler model relating bone density to survivorship. The model's naive form, basically identifying survivorship as a function of density, is necessary given the purpose for which it was derived: to explore the role of bone density in promoting survival. Though he suggests that bulk density mediates (to some degree) bone part survivorship, Lyman acknowledges the surface area-to-volume ratio as being an important factor and calls for examination of this property (Lyman 1982).

Several researchers have commented on the importance of microarchitecture and design in a bone's ability to resist attrition (Chave 1964; Guthrie 1967; Brain 1976). The shape of a bone, partly genetically predetermined, is greatly influenced during an animal's life by the bone's function (Lanyon and Rubin 1985). The relative amounts of collagen and mineral are also related to function (Lanyon and Rubin 1985). Thus, it is no surprise that many load bearing bones in tetrapods are variations off of a common geometric shape, the cylinder, and vary in response to the particular stresses and strains with which they must contend. In bones bearing "usual loads", the material properties of the tissue are fairly constant (Lanyon and Rubin 1985), whereas bones that have radically different functions, such as deer antlers or the auditory bulla of a whale, may be more variable in their mineral content (Lanyon and Rubin 1985). Adaptive response to stress in what Lanyon and Rubin (1985) call the "traditional" components of the skeleton is "achieved primarily by the regulation of tissue mass and by the adjustment of tissue architecture" (Lanyon and Rubin 1985). There is no reason to expect dramatic variations in density of the tissue among most skeletal elements in an animal, and probably not between comparable elements among many mammals. What does vary is the relative massiveness of bone parts and the manner in which that mass is distributed.

It is proposed here that massiveness and design are the inherent properties of bones that we should examine in the attempt to explain differential survivorship. How can such properties be expressed and quantified? Another look at Binford and Bertram's model reveals one possible solution. The model states that the rate of bone destruction is "approximately inversely proportional to density and proportional to the ratio of surface area to volume" and "proportional to the strength of the agent(a) as measured by soil pH, size of jaw, mass of overburden, and so on, depending upon the context" (Binford and Bertram 1977)(see above for equation form). If we can consider density in this model a bulk density (Lyman 1982), which Binford and Bertram clearly had in mind, then it can be expressed as the mass to volume ratio, the volume including the cavity and any pore space. The model equation might be rewritten as:

$$dD/dt = a(-S/V)/(m/V)$$

where m = mass and all other characters are as defined above. In this form it is plain to see that volume cancels out, leaving the rate of bone destruction being inversely proportional to mass and proportional to the strength of the agent and the surface area, expressed as:

$$dD/dt = a(-S/m)$$

This equation is intuitively pleasing as it has greater potential to approximate the effects of varying distribution of mass in bones or bone parts. Consider that two objects can have equal mass and equal volume, thus equal densities, and yet their mass can be distributed in space in dramatically different ways. For example, a glassmaker might make a window pane with a certain quantity of glass, and then take the same quantity and make a marble. The marble will obviously have a significantly greater ability to resist various abuses, though both objects have equal densities. The rate of chemical reaction between agents in soil and bone is obviously related to surface area: the more bone exposed at one time, the quicker the attrition, and the more bone there is initially (mass), the longer it will survive.

If density is not a property that is of interest in the destruction of bone then why are correlations so often seen between bulk density and survivorship? The answer lies in the relationship between surface area and volume. Table 3-3 lists formulae for surface area and volume of some common geometric shapes. For every shape, there is a direct relationship between surface area and volume which allows surface area to be expressed as a function of volume. Thus, to be related to surface area of a given shape is to be related to volume. It is notable, however, that this relationship is different for each of the different shapes in the table, and would be for any two shapes that are not the same. It is also interesting that at very small values in one dimension, the surface area-to-volume ratio can become quite large, as in the case with cylinders where as they become more disk-like (shorter length) the surface area

TABLE 3-3. Some Properties of Common Geometric Shapes.

Shape	Properties
Sphere	Surface area = 4(pi)rr where r = radius Volume = 4/3(pi)rrr Surface area = 3/rV where V = volume
Cylinder	Surface area = 2(pi)rL + 2(pi)rr where r = radius L = length Volume = (pi)rrL Surface area = 2(1/r + 1/L)V where V = volume
Right Circular Cone	Surface area = (pi)rL + (pi)rr where r = radius L = length Volume = 1/3(pi)rrh where h = height Surface area = [3(1 + r)/rh]V where V = volume

assumes values that are greater and greater relative to the volume. At larger values of the variable, the surface area-to-volume ratio remains smaller. What is of relevance to the issue of bone density is that for bone parts that are of approximately the same shape, for example long bones that are roughly cylinder-like, a bulk density measure will be directly related to the mass/surface area ratio. This explains why significant correlations are seen between bulk density measures and survivorship. The exact manner in which surface area is related to volume for specific shapes varies, and no doubt some variation in the strength of correlations between bulk density and survivorship is attributable to the different shapes of bones.

Bulk density has been shown to have merit as a measure of a bone or bone part's ability to resist attrition when applied to mammals (Brain 1976; Binford and Bertram 1977; Lyman 1982). Despite the fact that differential survivorship of bone parts is not explained by bulk density, significant correlations between this measure and survivorship have been repeatedly demonstrated (Brain 1976; Binford and Bertram 1977; Lyman 1982). However, the shortcomings of models employing bone density measures are revealed when attempts are made to apply such models to bones from species belonging to vertebrate classes other than Mammalia, particularly those that do not possess the hollow cavities typical of many mammal bones. To illustrate this point, density measures were taken on specimens of fish from three species in two families. The gar (*Lepisosteus osseus*) was chosen as a representative of species with what might be considered more "robust" skeletons, while the gizzard shad (*Dorosoma cepedianum*) and the river herring (*Alosa chrysochloris*) represent species with "frail" skeletons. There are obvious differences in the abilities of certain gar and herring bones to survive various forms of attrition; thus, if bone density is a useful measure we should expect to observe variety in the density values of those bones.

Measurement of Bone Density in Three Species of Fish

A technique for measuring specific gravity of substances was employed for obtaining density measures for the fish bone specimens. While density is conceptually defined as the ratio of mass to volume, taking precise and accurate measures of the volume of bones has proven difficult (see discussion in Lyman 1982). To avoid such problems here, specific gravity is measured by recording the dry mass of a bone as well as the apparent mass, or its mass when submerged in distilled water, and calculated as the ratio of the dry mass to the difference between the dry mass and the apparent mass. For purposes in this paper, density is loosely defined as above and specific gravity is considered one type of density measure.

Some practical considerations for this technique are as follows. Since the denominator in the above ratio calls for differences in mass measures, it is imperative that a relatively precise balance be employed. For fish, which typically have individual bones weighing less than 1.0g, a balance reading to 0.0001g has proven to be necessary. The technique also requires that bones be submerged in water in such a manner that a mass can be recorded. Any suspensory apparatus must be accounted for in the model, which might include estimating the effects of surface tension on this apparatus if it is sufficient to introduce an unacceptable amount of error. The water must be distilled and its temperature recorded (the formula relates the density of the material to the density of water at 21.0 degrees celcius).

Any air that is trapped in the specimens must be removed before the apparent mass is measured as air pockets can alter the apparent mass readings.

The balance employed in this analysis was a Mettler HE10 electronic balance which reads to 0.0001g. Accuracy of this balance was checked repeatedly throughout the analysis with secondary standard masses ranging from 0.0505g to 1.0g., and was found to provide consistent readings. A platform was placed underneath the balance (but above the pan) on which a beaker of distilled water could sit without disturbing the readings. Apparent mass measures were accomplished by suspending a wire and a clip holding the specimen from the hook on the balance into the water. The apparent mass of the wire and clip had to be measured and negated in the model. The model, including the apparent mass of the wire and clip, is:

$$\text{specific gravity} = \frac{\text{Mact}}{\text{Mact} + \text{Map} - \text{M'ap}}$$

where Mact is the dry mass of the bone, Map is the apparent mass of the clip and wire, and M'ap is the apparent mass of the clip, wire, and bone. The copper wire used to suspend the clip was thread-like, rendering surface tension negligible. Care was taken never to touch the specimens for fear of leaving grease on the bone or clip.

For every measure of mass, wet and dry, at least three readings were recorded and average values calculated for use in the formula. Multiple readings of the apparent mass of the wire and clip were taken intermittently during the analysis, and an average value used for Map.

Initial experimentation with this technique showed that it is a reliable method for obtaining specific gravity estimates for many materials. For example, a disk of pure aluminum was found to have a density of 2.65 at 23.0 degrees celcius, which compares favorably with the value of 2.69 at 21.0 degrees celcius reported in the Handbook of Chemistry and Physics (Weast 1969). An error of 1.5%, part of which is attributable to the difference in temperature, is acceptable.

Early attempts at obtaining the apparent mass measures for bone specimens met with some difficulty. When the bone was suspended in the beaker, the mass readings began to increase steadily for seconds, sometimes as much as a minute. It was ascertained that air was trapped on and possibly in the specimens. The problem was seemingly remedied (the apparent mass readings no longer increased) by soaking the bones in distilled water for a number of minutes before attempting measurement. Trapped air must be reckoned with as a potential source of error when applying this technique to bones.

Another potential source of error in this experiment is the possible differences in the processing of the fish skeletons used. All specimens measured had been macerated in jars of water and their dried skeletons stored in metal cabinets in the Zooarchaeology Laboratory, Department of Anthropology, University of Tennessee, Knoxville. The length of time spent in jars is unknown, but all specimens have been housed in the cabinets for years.

Results of the experiment are reported as raw data in Table 3-4 with summary statistics in Table 3-5 (see Figure 3.3). Examination of the variation in the raw data reveals some interesting characteristics of density as it can be portrayed by this experiment. First, any statements regarding density measures for particular bone elements must speak of average values, not a single, absolute true density for all such elements of a species or even of some sub-group of a species. In addition, comparisons between most groups of density data must be dealt with statistically (as with the analysis of variance reported in Table 3-6), as many

TABLE 3-4. Density Values for Fish Bone Specimens

Catalog #	Frontal	Opercular	Cleithrum	Vertebrae(2)
Lepisosteus osseus				
LoDr7	1.81	1.62	1.91	1.30
LoDr5	1.86	1.89	1.84	1.20
LoDr26	1.82	1.82	1.84	1.47
LoDr30	1.81	1.86	1.82	1.49
LoDr28	1.61	1.84	1.85	1.39
LoWb31	1.86	1.78	1.87	1.21
LoDr55	1.81	1.84	1.81	1.33
998	1.98	1.95	1.66	1.29
LoDr70	1.83	1.80	1.84	1.43
2660	2.02	1.88	1.72	1.17
LoDr2	1.89	1.92	1.96	1.17
LoDr3	2.04	1.97	1.95	1.41
LoDr40	1.91	1.77	1.90	1.38
Dorosoma cepedianum				
332		1.94	1.81	1.54
337		1.97	1.81	1.30
336		1.97	1.75	1.83
335		1.97	1.68	1.67
334		1.84	1.66	1.34
234		1.95	1.74	1.65
Alosa chrysochloris				
1023		1.89	1.54	1.63
1906		1.82	1.43	1.46
6486		1.80	1.37	1.23
1730		1.97	1.84	1.67

TABLE 3-5. Summary Statistics for Fish Bone Density Data.

Statistic	Frontal	Opercular	Cleithrum	Vertebrae
Lepisosteus osseus (N=13)				
Mean	1.87	1.84	1.84	1.33
Standard Dev.	0.11	0.09	0.08	0.11
Range	0.43	0.35	0.30	0.32
Dorosoma cepedianum (N=6)				
Mean		1.94	1.74	1.56
Standard Dev.		0.05	0.06	0.20
Range		0.13	0.15	0.53
Alosa chrysochloris (N=4)				
Mean		1.87	1.55	1.50
Standard Dev.		0.08	0.20	0.20
Range		0.17	0.47	0.44

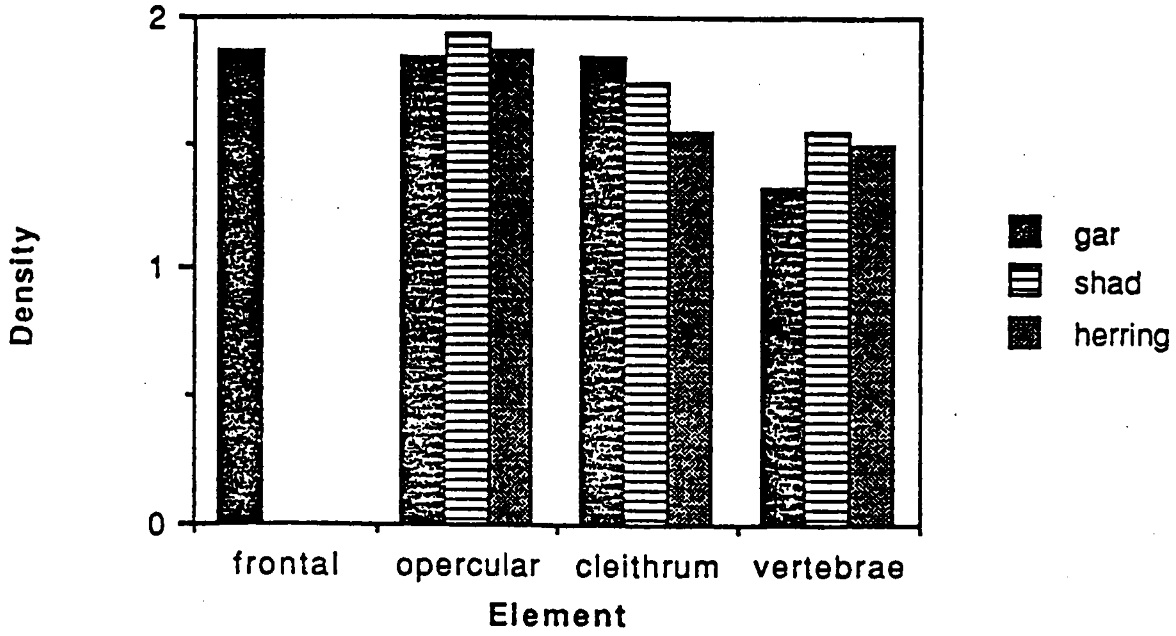

Figure 3.3: Mean Values for Density

(Gar N=13, Shad N=6, Herring N=4)

TABLE 3-6. Analysis of Variance Results.

Species	Source	F value	Prob >F
Lepisosteus osseus	Between frontal, opercular, and cleithrum	0.24	0.7841
Dorosoma cepedianum	Between opercular, cleithrum, and vertebrae	13.78	0.0004
Alosa chrysochloris	Between opercular, cleithrum, and vertebrae	5.50	0.0275
All	Between species, all elements	0.79	0.4554

appear to have values that overlap to a degree that there may be no significant differences among them. One exception is the set of data for gar vertebrae, which is obviously different from the other gar elements measured in that the values for vertebrae are consistently less. For comparisons where differences are not so blatant, an analysis of variance was conducted (Kleinbaum and Kupper 1978; Zar 1984). Table 3-6 lists results of some such analyses. It is apparent that there are no statistically significant differences between the species when data from all available elements are considered collectively. Within the species, significant differences are noted among the elements for shad and herring. Gar show no significant difference among the frontal, opercular, and cleithrum but, as noted above, do show smaller values for the vertebrae.

The issue of whether the species or elements measured exhibit statistically significant differences or not is probably of minute importance in the face of the much larger issue: are there any qualities of density that theoretically promote the resistance of bone to attrition? If there are, are variations on the order of 0.30 in the density values enough to account for differential survivorship? Given that part of the variation is due to "noise" from processing of skeletons, measurement error, etc., the view adopted here is that there is very little in the density of fish bones that is useful in understanding or predicting survivorship.

The Mass/Surface Area Ratio and Fish Bone Survivorship in the Jordan's Landing Assemblage

Density of bones has been argued here not to be a mediating factor in a given bone's resistance to attrition. The success of models employing bone part bulk densities (Brain 1976; Binford and Bertram 1977; Lyman 1982) is attributable to the nature of the bones examined, all being hollow and/or porous, and usually cylinder-like. Such geometric characteristics suggest that there is a strong, definable relationship between volume and surface area. Thus, the mass/surface area ratio is directly related to the mass/volume ratio, which explains the correlations seen in those models that key on mass/volume. For bones that do not have large cavities and/or pore spaces, however, it is predictable that density is not going to prove useful in deriving models to predict survivorship. The density data for fish reported above are a case in point. The analysis of variance results should prohibit any discussion of differences between the Clupeids and gar; but if we forced a comparison of mean values for the opercular (see Table 3-5), to satisfy curiosity, it is seen that the Clupeids have higher densities than do the gar. This is most interesting given that the Clupeid opercular is so frail that it can be crushed under one's small finger while a gar opercular of similar size (equal mass or area) is robust. The critical differences lie in the distribution of mass relative not to volume, but to surface area.

Surface area is no doubt an interesting characteristic of bones. But actually obtaining accurate measures of surface area for objects with complex shapes is problematic, and an efficient, accurate means proves elusive. To explore the importance of the mass/surface area ratio in understanding survivorship, surface area values were estimated for some elements of the Clupeids and gar. The operculars of both groups and the gar frontal were chosen because of their relatively flat shapes. Five specimens from each group were laid on graph paper graduated in millimeters, their outlines traced on to the paper, and surface area estimated by doubling the area within this perimeter. The surface area of the Clupeid vertebral centra were estimated by considering them as cylinders and measuring the radius and length which could be used in the formula for surface area of a cylinder (see Table 3-3). The centra are not actually round, but more elliptical with concavities on each end. The radius measure was taken on the long axis with the intent of obtaining the largest possible value, hopefully compromising the error caused by not accounting for undulations on the surface. At best these measures are rough estimates, but are believed to be close enough to reality to allow some comparison. Table 3-7 lists the values obtained in this analysis. Note the trend of increasing values with increasing Total Length of each fish.

The results in Table 3-7 are useful in understanding the relative frequencies of Clupeid fragments and gar fragments in the Jordan's Landing assemblages. Gar is well represented in all of the features, which certainly reflects in part the abundance of gar in the waterways around the site. The strong representation of gar by a large variety of elements reflects, at least in part, the robusticity of many of the gar elements. Clupeids, in contrast, are

TABLE 3-7. Mass/Surface Area Estimates for Gar and Clupeid Specimens.

Species	Mass/Surface Area (mg/mm x mm) Opercular	Vert.	Frontal	Total Length (cm)
Dorosoma cepedianum	0.143	0.233		19.7
	0.173	0.431		24.0
	0.280	0.474		27.6
Alosa chrysochloris	0.204	0.798		43.0
	0.196	0.647		38.0
Lepisosteus osseus	0.331		0.367	18.0*
	0.339		0.386	18.0*
	0.459		0.495	25.5
	0.768		1.005	117.0
	0.631		0.781	94.0

* Length is an estimate, not based on actual measure of live fish.

represented only in Features 41 and 21 (see Figures 3.4a and 3.4b), and only by vertebral centra (see Figures 3.5a and 3.5b). While the centra are quite abundant, there are no other identifiable elements represented in the features. This is odd given that out of at least 15 species of fish represented in Feature 41, only two have no skull fragments present. Feature 21 has 14 species of fish of which only two have no skull bones represented. Figures 3.5c and 3.5d show the relative representation of gar skull bones and vertebrae. Skull bones from the gar seem to be as resistant to attrition as the vertebrae. Examination of Figures 3.6 and 3.7 reveals that gar opercula have substantially higher values of mass/surface area than do the Clupeids there represented. Figure 3.8 interestingly shows Clupeid vertebrae having substantially higher mass/surface area ratios than the operculars. Figure 3.9 indicates that Clupeid vertebrae are comparable to gar frontals in this measure, and certainly to gar operculars as well. If we, not unreasonably, expect that other Clupeid skull bones have low mass/surface area ratios and that other gar skull bones have high ratios, then it seems that the mass/surface area ratio has some predictatory power in the survivorship of fish bone, as it is indeed correlated with the bone part

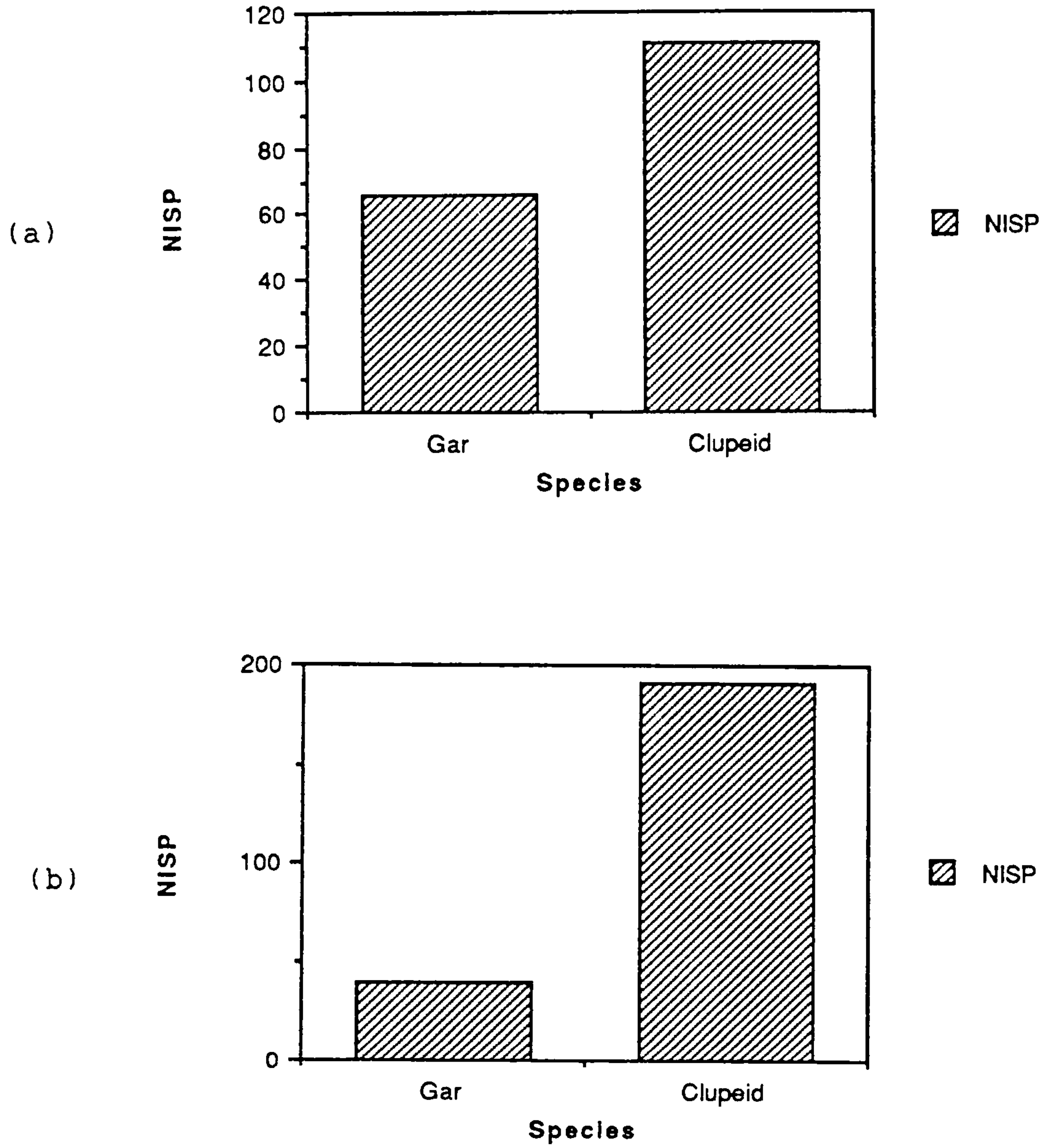

Figure 3.4: Gar and Shad/Herring in Feature 41 (a) and Feature 21 (b).

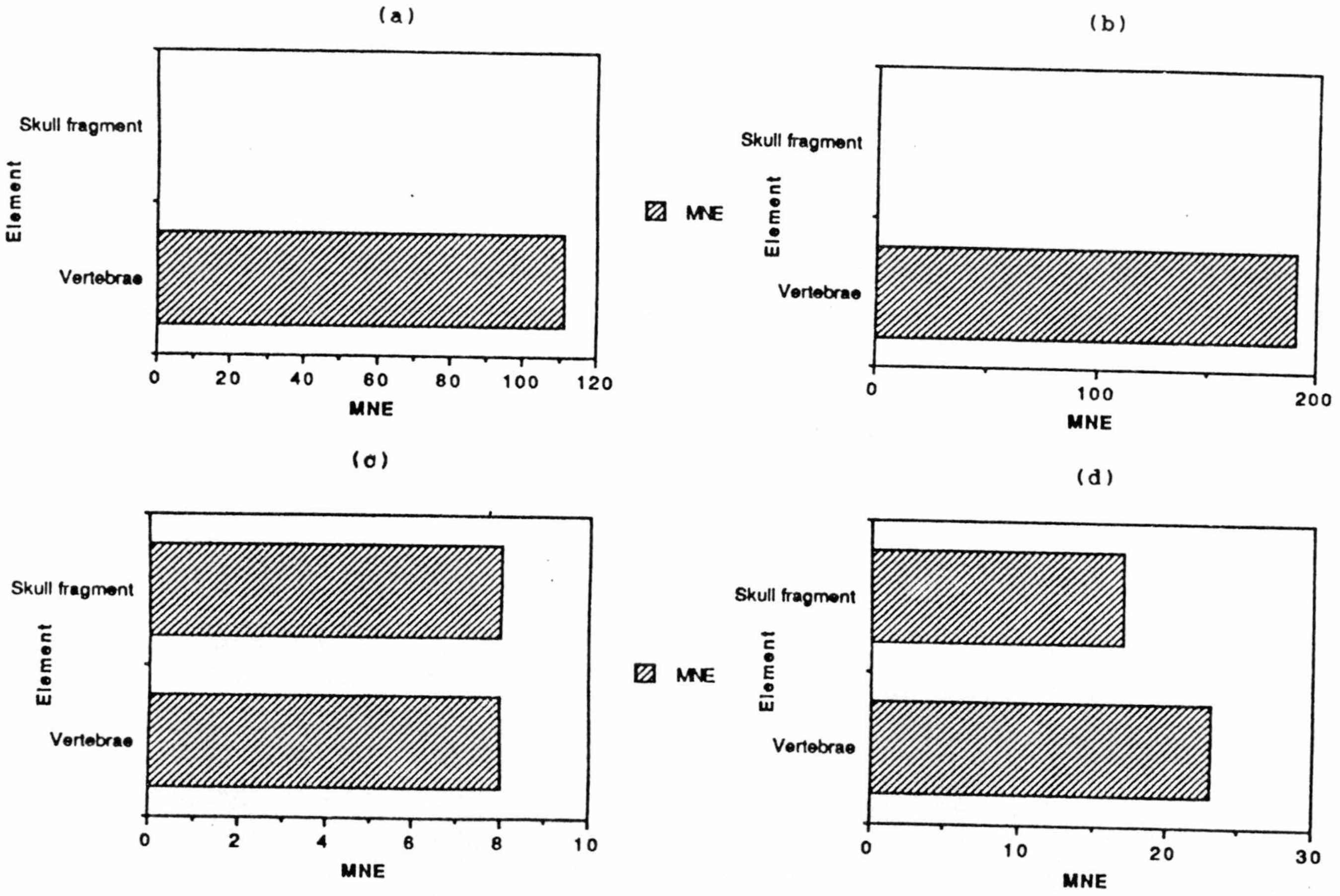

Figure 3.5: Numbers of Clupeid Elements in Feature 41 (a); Numbers of Clupeid Elements in Feature 21 (b); Numbers of Gar Elements in Feature 41 (c); Numbers of Gar Elements in Feature 21 (d).

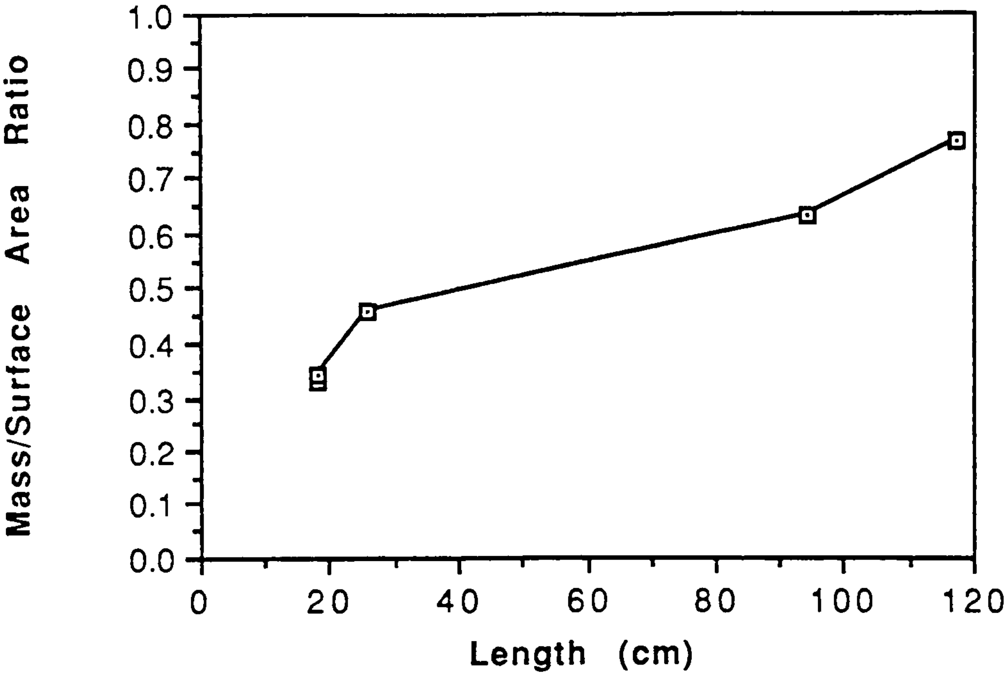

Figure 3.6: Mass/Surface Area Ratios of Opercular for Gar Specimens.

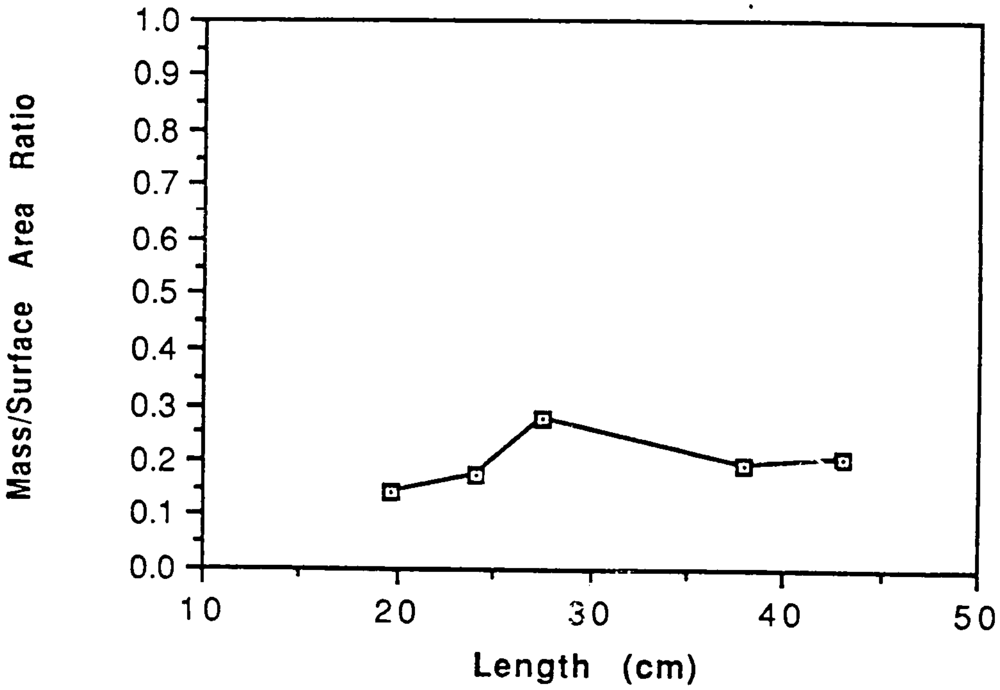

Figure 3.7: Mass/Surface Area Ratios of Opercular for Clupeids.

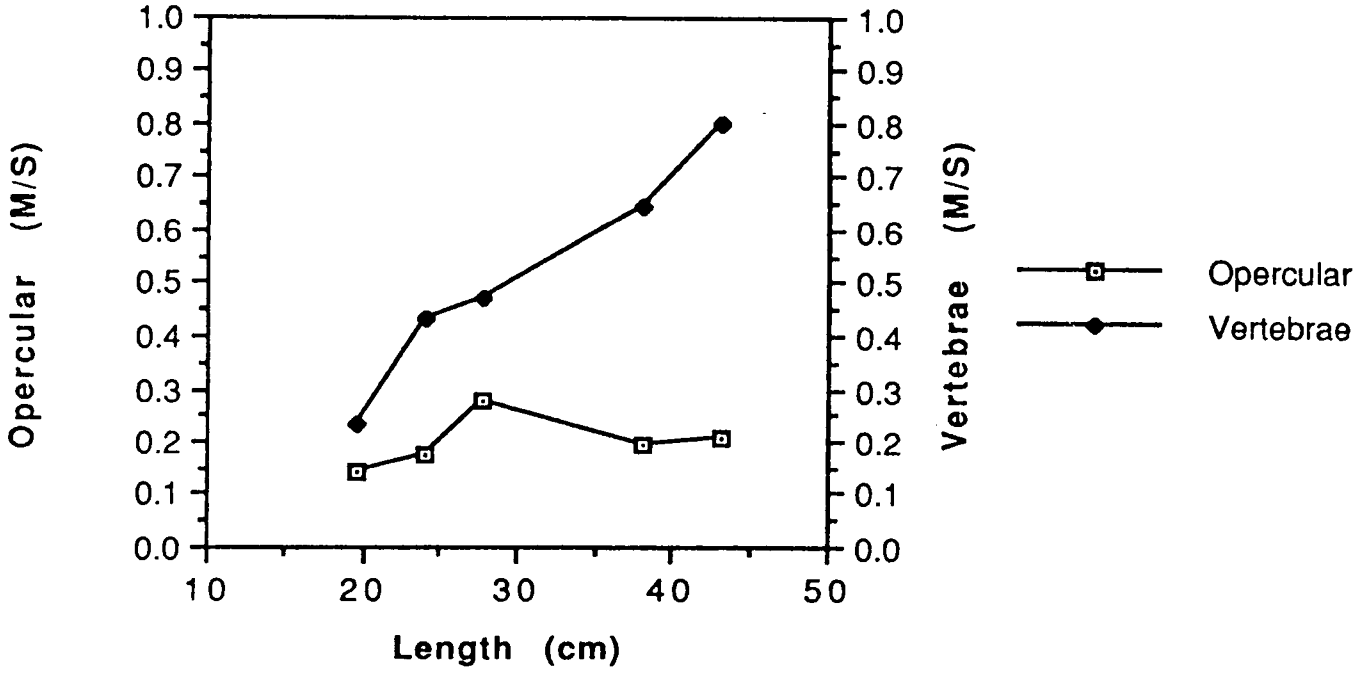

Figure 3.8: Mass/Surface Area Ratios of Opercular and Vertebrae (Clupeids).

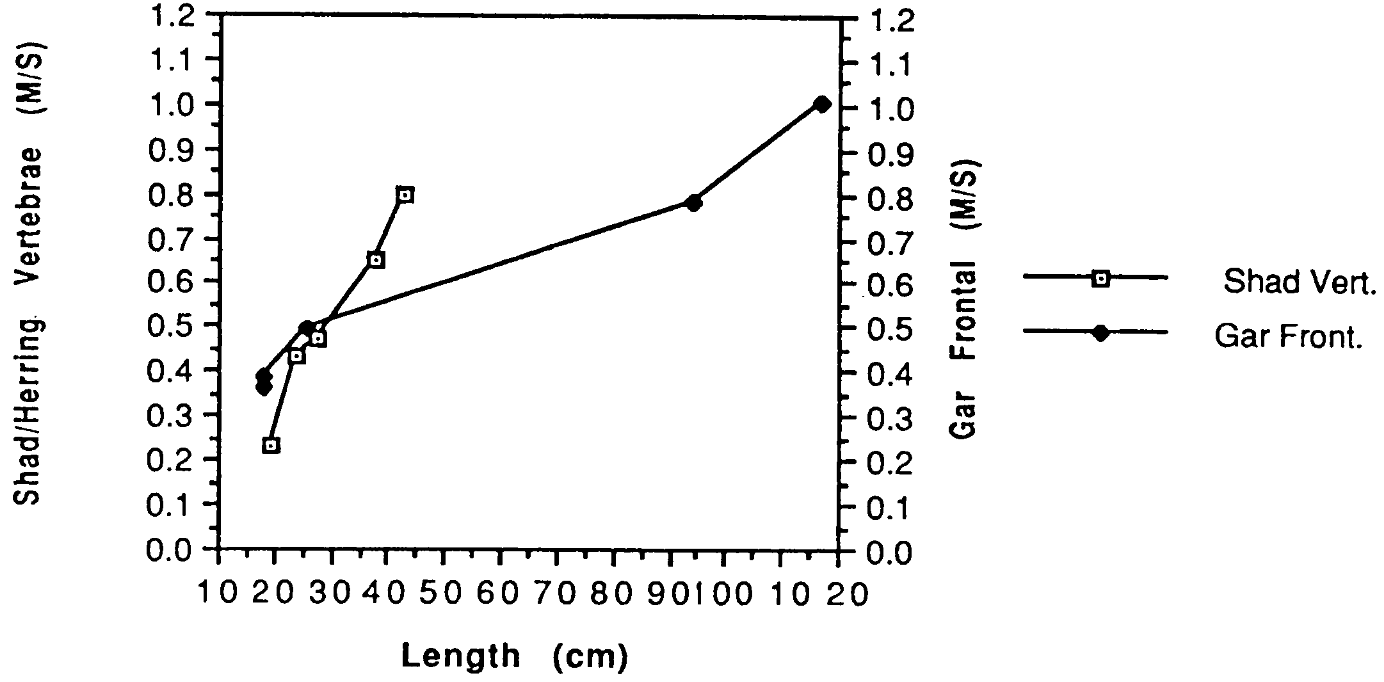

Figure 3.9: M/S for Gar Frontal and Clupeid Vertebrae.

representations in Feature 41. Further, it is conceivable that the distribution of mass relative to surface area has some explanatory power as well.

Summary and Conclusions

The purpose of conducting a taphonomic analysis of the Jordan's Landing assemblages is to isolate a priori any sources of bias introduced by taphonomic agents into the data that affect interpretations of that data.

Domestic dogs are a likely candidate for inflicting the damage seen on many bone fragments, particularly those in Feature 1. The pattern observed on ungulate elements (see Figure 3.1) resembles in many ways those seen in actualistic studies dealing with wolves (Klippel, Snyder, and Parmalee 1987) and domestic dogs (Brain 1976). Representation of bone parts that often do not survive canid attrition (e.g. phalanges) as well as some unscathed complete bones are evidence that either white-tailed deer were exceedingly abundant in the site (and subsequently not totally destroyed by hungry dogs) or there were few dogs operating at the time the ditch was filled. The presence of some complete long bones support the former interpretation, as they indicate that at times the human occupants of the village had no need or desire to extract the marrow.

Small mammal remains are probably underrepresented in Feature 1 due to the ability of humans and dogs to consume them entirely (Payne and Munson 1986). Dogs can be considered less a factor in Features 21, 41, and 43 as they were apparently closed soon after filling. It is probably safe to assume that a similar situation exists for reptile and amphibian remains.

Fish are abundantly represented in Features 21, 41, and 43, and moderately represented in Feature 1 (see Figure 3.2). The bone part frequencies of fish in the ditch has probably been significantly affected by canids as they are known to consume fish in entirety (Jones 1986). The strong representation of gar skull fragments and Clupeid vertebrae in Features 21 and 41 has been suggested to be related to an inherent quality of those bones: the mass/surface area ratio. It is likely that the proportionally high N.I.S.P. for the Holostean fishes is related to their robusticity, while the poor representation of many Teleostean fish bones (particularly skull fragments) is attributable to their more fragile nature. The specific taphonomic agent responsible for destroying these fragile bones is not identified, but strong possibilities are heat from cooking, crushing by humans in mastication, crushing by dogs in mastication, and chemical attrition in the soil. Human cooking and mastication may be the likely agent in the case of the Clupeid skull bones in Features 21 and 41. They are one of the few groups missing skull bones entirely and they have very low mass/surface area values for the opercular and probably for other skull bones as well. Indeed, herring are consumed along the Roanoke River today, often bones and all, as most elements become quite palatable after cooking (save the vertebrae which are swallowed or rejected). It is difficult to imagine humans consuming other fishes whole, particularly those with more massive bones such as the gar. The effects of cooking Clupeids other than the softening effect mentioned above are not known and need to be examined in detail. If the contents of Features 21 and 41 are the remains from stews, then it is possible the Clupeid skull bones were simply boiled away.

It is reasonable to expect Clupeids to often be represented only by vertebrae. The lack of Clupeid remains, including vertebrae, in Features 1 and 43 probably result from no or scant few Clupeids being introduced, the argument being that Clupeid vertebrae are as likely to survive attrition as gar skull plates, which are well represented in all features.

CHAPTER 4

SPECIES DIVERSITY IN THE FOUR FEATURES

General

Diversity is a parameter of ecological communities that has received much attention from ecologists. This descriptive measure is composed of two basic components: the number of species and their relative abundances (Putman and Wratten 1984). Generally, the more species per number of individuals in a community, the more diverse it is; but, the spread of individuals between species must also be considered.

Hill (1973) has discussed several of the popular indices used as diversity measures and concluded that many belong to the same family of mathematical relations. The total number of species, Shannon's index H, and Simpson's index are all simply different powers of the same relation, differing in how they weight rare species. Diversity indices can be thought of as measures of how many species are effectively present when a sample is examined to a certain depth among its rarities (Hill 1973; Putman and Wratten 1984). The total number of species exaggerates rare species by giving them weight equal to the more abundant groups. Simpson's index virtually ignores the rare species giving appreciable weight only to the abundant while Shannon's index H is intermediate between Simpson's index and the total number of species. Hill (1973) notes that Shannon's index H is somewhat ambiguous, a better description being obtained by using the reciprocal of Simpson's index and the total number of species together.

Diversity is of interest in ecological community studies because it can be related to stability, maturity, productivity, evolutionary time, predation pressure, and spatial heterogeneity (Hill 1973). For archaeological faunal assemblages, diversity has a separate purpose, being a parameter that describes the prey exploited by a predator, man. The samples dealt with from archaeological context are never random samples of the community in which the predators operated, and often are not random samples of the fauna exploited, as differential treatment of carcasses and taphonomic pressure can severely bias an assemblage. Any diversity measure of an archaeological faunal assemblage must be accepted a priori as a measure only of that assemblage. Interpretations of the relationship between that diversity measure and the original or true diversity of the prey species must take into consideration the potential sources of bias, such as selective removal of certain species by taphonomic agents.

Diversity of the Cashie Phase Assemblages

The diversity of an archaeological faunal assemblage can be calculated using either the minimum number of individuals (M.N.I.) or the number of identified specimens (N.I.S.P.) for each species, each having unique properties. Grayson (1984) states that N.I.S.P. is the figure to use as it is not subject to the error from improper aggregation as is M.N.I., and because M.N.I. is merely a function of N.I.S.P. This view is rejected here for a number of reasons. First, the problem of aggregation effects is irrelevant for three of the features examined (21, 41, and 43), as they each represent what can be considered a single depositional event. Any error in M.N.I.'s from Feature 1 will reduce the figures, creating a more conservative estimate. Second, the factors affecting N.I.S.P, such as selective bone smashing (large mammals only) and varying numbers of bones for different species, are considerably more distorting than any problems with M.N.I.. The inadequacy of N.I.S.P. can be illustrated by an example that is fictional, but not unrealistic. Consider that a pit is filled with refuse consisting of many fish heads and a severely smashed deer skeleton. The N.I.S.P. may likely give equal or greater weight to the single deer than to the many fish. M.N.I. would recognize the individuals regardless of the processing techniques. N.I.S.P. is also more subject to bias from recovery methods which might favor larger bones and fragments. To state the view adopted here clearly, N.I.S.P. is seen as a function of M.N.I., a relationship that is highly variable as a result of differential processing, taphonomic pressures, bias in recovery methods, and varying numbers of elements for different species.

Table 4-1 lists the total number of vertebrate species and the reciprocal of Simpson's index for each of the four features and for the assemblages considered collectively.

Table 4-1. Species Number and Simpson's Index in the Four Features.

Unit	Species Number	1/Simpson's Index*
Feature 1	26	11.10
Feature 41	25	13.33
Feature 43	16	10.57
Feature 21	28	4.92
All	38	14.34

* Reciprocal of Simpson's Index = 1/[(p1)(p1) + (p2)(p2) + ... + (pi)(pi)] for all species i, where p is the relative abundance of the ith species (Hill 1973).

The M.N.I. was used as the counting unit for each species. Higher taxa that contained fragments, but none that were identified to species, were treated as a single species. For example, there were 111 Clupeid vertebrae in Feature 41 that represent at least two fish and at least one species, and thus were recorded as such. The Class Pelecypoda (Phylum Mollusca) is also represented in great numbers by at least two species in the site, but the large quantity of and extreme damage done to most of the shells precludes a reasonable estimate of the M.N.I.'s for those species. For Features 21, 41, and 43, suffice it to say that there are remains from hundreds of bivalves, most probably belonging to *Elliptio complanata*.

There is some consistency in the number of species in the four features, though Feature 43 contains fewer groups than the others. Many of the same species are shared by all four features; subsequently, considering them all together raises the species number to only 38. The reciprocal of Simpson's index is comparable in three of the features: Features 1, 41 and 43. Feature 21 has a significantly lower value, presumably resulting in part from the strikingly high number of Atlantic croakers. The assemblages collectively have a higher value, reflecting the overall relatively even distribution of individuals among the species.

For sake of comparison, the reciprocal of Simpson's Index was calculated for all of the assemblages collectively using N.I.S.P. which resulted in a value of 8.40. The markedly lower value is explained by the domination of fewer species when comparing fragments. Deer, bowfin, clupeids, and gar have much higher fragment counts than other species, though not the highest M.N.I. values. Taphonomically induced biases probably favor the survival of many of the deer, bowfin, and gar skeletal elements over a number of the other species, particularly the smaller ones (see Chapter 3). Further, treatment of deer carcasses included bone smashing, which has increased the number of fragments identified as deer.

Conclusion

The number of species identified in the four features can be compared with what we might think of as a "baseline" number of species for the geographic locality in which the village once stood. The results of a study of Company Swamp by Laney et al. (1988) provide the figure of 261 vertebrate species present (or likely to be present) in that locality. The similarity of habitat in Company Swamp (e.g. gum-cypress and bottomland hardwood forest) to that of the site location as well as its geographic proximity, being less than 20 miles from Jordan's Landing, qualify the assumption that a similar number existed in the village locality during the Late Woodland Period. Some of the diversity seen in Company Swamp today might result from disturbance (e.g. logging), but land clearing was common practice prehistorically as well. The possibility that some species prehistorically abundant (e.g. wolves, cougars) have disappeared must also be appreciated. Freshwater mussels present somewhat of a problem as they were not discussed in Laney et al. (1988) and species designations in the site assemblages are difficult.

The figure of only 38 species seems rather low when contrasted with 261. However, it is not expected that in so rich an environment that human predators would prey on every animal available. Nor is it expected that the four features examined in this study represent all species utilized by the Late Woodland inhabitants of the village. Of the 38 species in the four assemblages, less than 1/3 (10) are found in all four features. The relatively high value of the reciprocal Simpson's index for the features taken collectively is interpreted as the result of a fairly equitable distribution of individuals among the species. Taphonomic analysis (Chapter 3) indicates that some species such as small mammals, reptiles, amphibians, and fish are underrepresented. This bias most likely serves to decrease the measures of diversity. Given the high diversity of species that are represented, it is concluded that the Cashie Phase villagers exploited a diverse group of prey species.

The number of vertebrate species in the Jordan's Landing assemblages can also be compared to the numbers found in two Colington Phase (see Phelps 1983) sites in the Tidewater region. The Tillet Site (31Dr35) is located at the southern end of Roanoke Island and has been interpreted as a seasonal village occupied by a number of affiliated groups (Phelps 1984). The Kitty Hawk Bay Site (31Dr14) is located on the north shore of Colington Island and has been designated a short-term camp used by no more than a few families at one time (Phelps 1981). Excavation methods are comparable for all the sites (including the use of fine-screens). The Tillet Site assemblage contains remains of 26 species of vertebrates (Runquist 1984; Swift 1984) and the Kitty Hawk Bay Site contains 11 (Runquist 1981; Swift 1981).

CHAPTER 5

SITE SEASONALITY OF THE JORDAN'S LANDING VILLAGE

General

Understanding the seasons in which the Jordan's Landing village was occupied is a fundamental goal in anthropological research of Cashie Phase culture. It is hypothesized that the village was occupied yearround, but this hypothesis is borne out of observations such as the density of archaeological materials which alone do not offer concrete evidence as to the seasons of occupation. Fortunately, evidence from faunal remains in the four assemblages can be employed to address this issue.

The assemblage best suited for a seasonality assessment is that recovered from the ditch, Feature 1, as it contains food remains that were deposited over a period of time as opposed to the remaining three features which were filled relatively quickly, possibly all at once. Test implications of the hypothesis simply call for the observation of evidence of occupation for all four seasons. This evidence can exist in a variety of forms including the age of young-of-the-year animals; dental annuli in mammals (Bourque et.al. 1978); growth rings in fish scales, otoliths, and spines (Casteel 1976; Morey 1983); presence or absence of deer antlers (Davis 1987), etc.. The seasons are defined as: winter, mid-December to February; spring, March to mid-June; summer, mid-June to mid-September; fall, mid-September to mid-December. The analysis begins with mammals, which were no doubt available to the villagers yearround and should show evidence of four seasons, if indeed the hypothesis is tenable. However, if the first sample of mammal remains fails to verify the hypothesis, then other taxa can be examined until the hypothesis is vindicated or left unacceptable due to inadequate sampling. The philosophy adopted here is that yearround occupation can be established by evidence in a single sample. But in order to argue for a seasonal occupation, multiple samples from a variety of sources in the site must be employed, to prove that the lack of evidence for all four seasons does not result merely from a sampling deficiency.

Seasonality of Mammal Remains from Feature 1

Feature 1 contains remains from a number of juvenile individuals of various species. The age in months of each individual can be used to assess season of death by determining the month of birth for the species and adding the age. The result is an estimated season of death. Techniques for aging the animals were obtained mostly from the Wildlife Biology literature. While no single technique is considered to offer extremely accurate results -- they are no doubt compromised by factors such as geographic variation -- they are all assumed accurate enough to place age at death within the three month period required by the test implications of the hypothesis.

Table 5-1 lists evidence from Feature 1, along with the season of death and references for the techniques used to assess that season. Birth periods for all species were

Table 5-1. Evidence for Season of Occupation from Mammal Remains in Feature 1.

Season	Evidence	Reference
Odocoileus virginianus		
Fall/Winter	Antler fused to frontal bone fragment	Severinghaus and Cheatum (1956)
Winter	Distal metacarpal, juvenile (7-9 months)	-
Winter	Distal metatarsal, juvenile (7-9 months)	-
Winter	Mandible with teeth, (7-9 months)	Sevringhaus (1949)
Winter	Calcaneum with half fused epiphysis (20-23 months)	Purdue (1983)
Late Spring/ Summer	Medial phalange with unfused epiphysis (<4 months)	Purdue (1983)
Late Spring/ Summer	Unfused distal femur, juvenile (<3 months)	-
Procyon lotor		
Summer	Left juvenile mandible (2 months)	Montgomery (1964)
Summer	Right juvenile mandible (2 months)	Montgomery (1964)
Summer	Left juvenile mandible (3 months)	Montgomery (1964)
Late Summer/ Fall	Right juvenile parietal (4-8 months)	Junge and Hoffmeister(1980)
Spring	Maxillary fragment with teeth (12-14 months)	Montgomery (1964) Grau et.al.(1970)
Late Winter/ Early Spring	Fragmented skull with teeth (max.-premax. suture, tooth wear, 10-12 months)	Junge and Hoffmeister(1980) Grau et.al.(1970)
Castor canadensis		
Spring	Right frontal, unfused but large size (11-13 months)	Robertson and Shadle (1954)

obtained from Burt and Grossenheider (1976). Ages assigned to specimens appear in parentheses in the "evidence" section of the table.

Several of the specimens assigned to seasons require some clarification. The unfused distal femur of a deer is aged at <3 months, though Purdue (1983) can only place it at <23-24 months. Comparison of this specimen with comparative specimens reveals that it is of the size and state of development of a fawn, less than 3 months of age. The metacarpal and metatarsal fragments were aged similarly, though at 7-9 months. The raccoon right parietal can be aged at <8 months (Junge and Hoffmeister 1980) based on cranial suture obliteration, but this age can be refined somewhat by the size of the bone. A beaver right frontal is aged at <10-12 months (Robertson and Shadle 1954), but this age is refined according to its size relative to comparative specimens.

Conclusion

The evidence listed in Table 5-1 has representation of all four seasons. Given this result, the hypothesis that the village was not seasonally abandoned should be tentatively accepted, based on the seasonality of the mammal remains from Feature 1. Although evidence for winter occupation is more poorly defined than summer and spring, there is clear evidence of winter occupation. If the deer antler was from a winter kill rather than one from a fall, then there might be a void in evidence for fall occupation. Given the evidence of agriculture at the site (Phelps 1983), it is considered highly unlikely that the village would be abandoned before harvest in the fall, and equally unlikely that it would be entirely abandoned for short time periods, as between the harvest and the onset of winter.

Analysis of the remaining features was not conducted in entirety. However, there are some obvious indications as to the seasons in which they were filled. Another fused deer antler was found in Feature 43, strong evidence of fall or winter season. Feature 41 contains a raccoon temporal bone fragment aged at 2-3 months (late spring/early summer) and a distal phalanx from a deer aged at 1-1.5 months (spring). Features 21 and 41 both contain anadromus fishes (clupeids, stripers, and sturgeon) that run the Roanoke River in large numbers in the spring.

CHAPTER 6

DISCUSSION AND CONCLUSIONS

In a review of current research of the Cashie Phase, Phelps (1983) described the subsistence data from the Jordan's Landing site as "typical of a multiple adaptive pattern; maize and beans have been reclaimed from the ditch and hearths, along with charred hickory nutshells, a wide range of fauna including bear, deer, raccoon, possum, rabbit, and other mammals; numerous fish; turtle and terrapin; and turkey and mussel. The wide variety of food resources clarifies the choice of site location where all of these natural foods were available, and arable land for agriculture was also adjacent." At the time of that publication there had been no detailed analysis of faunal remains from any Cashie Phase site, including Jordan's Landing; thus, only general statements were possible. This thesis is the first attempt to create subsistence data that can be utilized to both answer basic questions about the village, such as site seasonality, and provide a basis for the design of more sophisticated subsistence models.

Table 2-1 lists the species observed in the four assemblages. Several of these, including deer, opossum, squirrel, snapping turtle, box turtle, gar, bowfin, white bullhead, yellow bullhead, striped bass, and mussels of the genus *Elliptio*, appear in all four features. It might be hypothesized that these species were available yearround and were a staple in the diet of the villagers. Analyses of assemblages from other Cashie Phase sites can address this issue.

There are indeed a large number of species present in the faunal assemblages examined here. The value of the reciprocal Simpson's Index for all vertebrate individuals in the four assemblages combined, 14.32, indicates that there was not a notable concentration on any single vertebrate species. Of the Pelecypod remains, most appear to be *Elliptio complanata*.

The mammals exploited by the villagers were likely found in any of the microhabitats surrounding the site. It is inferred that venison was in good supply for at least some periods, as evidenced by the occurrence of whole deer long bones and phalanges. Theoretically, these would have been utilized by the villagers and their dogs in times of need (see Chapter 3). The deer populations may well have flourished in the edge habitat created when the fields were cleared for planting, as well as in old fields left to be reclaimed by forest.

Bird remains largely consisted of turkey. Wild turkey are common in the site vicinity today, and prefer the lowland forested areas, usually on Chewacla Series soils (U.S. Department of Agriculture 1990). With the exception of a single bobwhite quail bone, medium and small size birds are entirely lacking in the assemblages. The scarcity of waterfowl remains is surprising. Winter waterfowl populations are high in the Roanoke River watershed today, and were presumably so in the past. The possibility of unknown treatment of the carcass or another taphonomic agent being to blame for the lack of waterfowl remains must be considered, though only negative evidence is available for consideration at this time.

The aquatic resources observed in the site are the most diversified. Reptiles include snapping turtles, cooters, water snakes (<u>Nerodia</u>), and cottonmouth mocasins. Amphibians are represented by the bullfrog. Fish species include a strong representation of the Holostean gar and bowfin. The large proportion of bone fragments recovered belonging to these two species has been suggested to be partly related to their robusticity (see Chapter 3). However, the relatively high M.N.I. estimates must also result from the large number of individuals introduced into the features. It is likely that gar and bowfin were available to the villagers in abundance, particularly in the summer when anaerobic conditions in the shallow waters of the swamps would drive most other species into deeper waters. Gar and bowfin are able to gulp air from the surface. Such behavior would seemingly make them easy targets for gigs. Teleostean fishes that are well represented include several Ictalurids (white bullhead, yellow bullhead, brown bullhead), Clupeids, white perch, striped bass, pickerel, largemouth bass, sunfish, and American eel. There is a large number of Atlantic croaker in Feature 21, somewhat unusual for that stretch of the river (30 miles from Albemarle Sound). The location of the village next to a small stream, as with many of the Cashie Phase villages, may be related to the abundant aquatic resources that cluster near the confluence of such streams with the river.

Though Lawson (1967) and others observed Tuscarora groups establishing winter hunting quarters some distance from their home villages, there is no evidence that the village at Jordan's Landing was seasonally abandoned. It is possible that some parties left the village for extended trips, this being seemingly necessary in order to keep an entire village (small though it may have been) supplied with venison. But there were apparently some individuals remaining behind throughout the four seasons. Further steps in addressing this issue should include seasonality studies of other Cashie Phase villages and seasonal camps.

The information obtained through this study makes possible the formulation of several hypotheses concerning subsistence during the Cashie Phase. It is hypothesized that the location of Cashie Phase villages was generally on arable land (sandy loam ridges) near the confluence of a stream with a river or other stream. This setting was chosen because of its agricultural potential as well as its proximity to excellent habitat for aquatic prey species. The more shallow creeks may also have been necessary for the construction of weirs.

Phelps' (1983) concept of a "multiple adaptive pattern" characterizing subsistence data from Jordan's Landing appears to be tenable. The relatively high diversity of the species exploited by the villagers suggests that a variety of animals were eaten, all accessable in the site locality. It is expected that similarly high diversity values for prey species will characterize other Cashie Phase village sites.

It is hypothesized that the annual cycle during the Cashie Phase was not marked by the movement of whole villages to hunting quarters in the winter, though temporary camps from hunting parties are not ruled out.

There are two major aspects of the subsistence data from Jordan's Landing that should assume key roles in any models of Cashie Phase subsistence. The first is the importance of agriculture, which offered dependable, storable sustenence. The second is the orientation toward aquatic resources, which are so abundantly represented in the Jordan's Landing data. Like the agricultural products, many of the aquatic species were easy to collect, especially given the technology of fish traps, weirs, gigs, and hooks. They were also available to some degree in every season of the year. While the terrestrial species such as the white-tailed deer were obviously of great importance as well, it is suggested here that the exploitation of aquatic resources was a more influential force in Cashie Culture. An obvious example of this influence is the hypothetical placement of villages in locations ideal for taking fish, turtles, etc. as discussed above.

Recommendations for further research include analysis of faunal remains from other Cashie Phase villages to assess seasonality and diversity to compare with that of Jordan's Landing, an assessment of Cashie Phase site types to explore possibilities of seasonal activities such as winter hunting forays, and analysis of faunal remains from any sites other than villages.

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