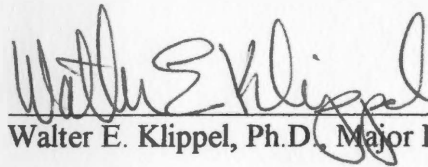


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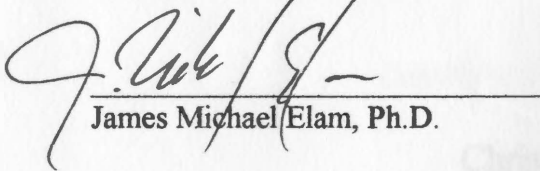


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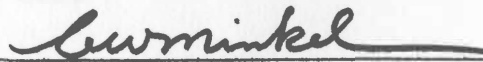


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Associate Vice Chancellor, and
Dean of the Graduate School.

Estimating Sex and Weight of *Odocoileus virginianus* (Whitetail deer)

with Implications to Human Status at Toqua

A Thesis Presented for the

Master of Arts Degree,

The University of Tennessee, Knoxville

Christian DeForest Davenport

May 1999

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DEDICATION

This thesis is dedicated to all those people who have helped me throughout the years. To those instructors who seemed more like friends than conveyors of knowledge, for without their help and encouragement, I would not be where I am today.

ACKNOWLEDGMENTS

I owe many people thanks for their help on this paper. First and foremost my parents for never doubting in my abilities and always encouraging me to reach for my goals. My fiancé for all those nights of listening to me rant and rave about dead deer and statistics. Dr. Walter E. Klippel who has provided endless amounts of guidance during my years at the University. Dr. Paul Parmalee who has taught me the art of fine scrutiny and how to identify something by the way it feels. Dr. James (Mike) Elam who has taught me not to fear statistics by helping me to understand my output and has introduced me to aspects of archaeology I have never thought about. Ms. Ann Read who took many hours of her own time to help me refine the statistical analysis in this report. Sean Coughlin for not only helping me collect my data but checking the grammar and spelling on numerous copies of this paper. Beth Maney and Wendy Goodman who both proof read many drafts of this thesis. Mike Ruddell who has taught me the importance of persistence and an appreciation for Pleistocene faunas. Russ and Julie Townsend who provided endless hours of needed distractions. I would like to thank the rest of the people who have helped me over the years at UT. Furthermore, I would like to thank the many folks from Adams Taxidermy and Deer Processing in Powell, Tennessee, since they let me interrupt them during their busiest time of year so I could collect my data. Lastly, I thank all the hunters who got up at the crack of dawn to get their deer for without them I would still be at step one.

ABSTRACT

Whitetail deer (*Odocoileus virginianus*) was one of the prevalent food resources of human beings in both prehistoric and early historic North America (Smith 1975). This paper shall explore deer selection by prehistoric hunters through analysis of deer remains from Toqua (40MR6). Toqua is a multicomponent site spanning from the late Mississippian (AD 1200-1600) through the historic Overhill Cherokee Period (AD1600-1800) in Tennessee (Polhemus 1987: 1246). Previous work done by Bogan (1980), demonstrated a status related distribution not only between species but also within species at this site. This is typified by the presence of axial portions of whitetail deer that were clustered around high status areas such as mounds and courtyards while appendicular portions tended to cluster near single dwellings. Findings indicate that there was a culturally imposed biased distribution of deer parts across the site. Given this, there may have also been cultural factors involved in the selection process based on the size or sex of the deer. Traditional methods of sexing deer remains relied on the presence or absence of antlers or the pubis, however, these elements seldom survive intact in the archaeological record. Because of this fact, two nontraditional elements for estimating the sex and weight for North American whitetail deer were employed: the first cervical vertebra (atlas) and the distal humerus. While these elements seem unlikely candidates for estimating sex and weight, they have been successfully employed in Europe with many species.

The first requirement to properly carry out this study was the metric evaluation of skeletal elements from a sample of modern whitetail deer of known sex and weight. Both simple and multiple regression clearly demonstrate a linear relationship of these element's size to live weight (R squared values of .80). Statistical logistics allowed for the accurate estimation of sex upwards of 70% of the time. Based on the favorable control sample results, this method was applied to analyze the deer remains from Toqua. The archaeological data indicates that there was a preference for large male deer by prehistoric peoples. Furthermore, there was also a trend for even larger deer being taken in the historic periods.

TABLE OF CONTENTS

CHAPTER	PAGE
1. INTRODUCTION	1
Bogan's Findings	2
Selectivity	3
The European Explanation	8
Inferring Status in Archaeological Record from Faunal Remains	9
Summary	11
Goals	12
2. METHODOLOGICAL BACKGROUND	13
Methodology	20
Control Sample	22
Atlas Control Sample Results	30
Humerus Control Sample Results	35
Blind Test of Control Sample Results	38
Summary	39
3. CULTURAL CHRONOLOGY	40
Mississippian Period	40
Dallas Phase	41
Overhill Cherokee	42

TABLE OF CONTENTS (CONT.)

CHAPTER	PAGE
4. TOQUA	44
Status at Toqua	45
Summary	46
5. SUBSISTENCE STRATEGIES AT TOQUA	47
Dallas Subsistence at Toqua	47
Cherokee Subsistence	48
The Skin Trade	49
Summary	52
6. DISCUSSION OF THE ARCHAEOLOGICAL SAMPLE	54
Atlas Results	54
Distal Humerus Results	54
7. DISCUSSION OF RESULTS	56
Selection and Taphonomic Explanations	56
Ethnohistoric References for Selection	58
Implications to Cherokee Selection	59
European Explanation Revisited	61
Summary	62
8. CONCLUSIONS	64
REFERENCES	67
APPENDICES	79
VITA	100

LIST OF FIGURES

FIGURE		PAGE
1	von den Driesch's Atlas Measurements	24
2	Additional Atlas Measurements	25
3	von den Driesch's Distal Humerus Measurements	27
4	Additional Distal Humerus Measurements	28

Chapter 1

Introduction

One of the main goals of archaeology is to understand past lifeways. One way of obtaining this goal is to infer past economic processes. This can involve the study of hunting practices and foodways of the past. Traditionally, these studies have focused on three factors. First, what species were hunted. Second, what habitats were being exploited and lastly, which seasons within the given environment were resources being acquired (e.g. Parmalee, Paloumpis and Wilson 1972; Guilday, Parmalee and Tanner 1962).

Focus has shifted from these factors to addressing hunting selection and the implications of specific animal choice (e.g. Beauchamp 1993). This type of inquiry can provide insight into the technological, political, and economic aspects of a past culture.

This idea was previously stated by Cleland:

Instead of observing animal bones from archaeological sites as a segment of a larger surrounding natural community we must find significance in the fact that their bones also represent a series of culturally determined choices. The people who killed the animals chose them within a technological, socio-political, and ideological framework [1966: 38].

While zooarchaeologists have established the fact that Native Americans were indeed selecting for various types of animals (i.e. deer, turkey and raccoons) (e.g. Styles

1981; Theler 1987; Bogan 1980), it has not been determined if Native Americans were selecting for one particular sex or size class. The inquiry of food movements and differential access to animal products within a site is also lacking (Zieder and Arter 1996).

Towards this end, zooarchaeological studies have not extensively addressed the role technology, socio-political, and economic factors play in the selection of game. The operating premise of this paper is that prehistoric peoples were active and selective hunters by nature and that animal products were distributed along status lines. This pattern did not change until the adoption of firearms in the Historic Period.

Bogan's Findings at Toqua

Much of the material drawn for this study comes from the many works done by Bogan (1976, 1980, 1982). Bogan (1980, 1982) examined the faunal material from Toqua (40MR6), a Dallas Phase Mississippian site located along the Little Tennessee River. In this analysis he attempted to accomplish two things. The first was to contrast and compare subsistence strategies of a prehistoric ranked society and a historic tribe exploiting the same geographic area (Bogan 1980: 16). The second aspect Bogan addressed was an apparent uneven distribution of animal remains across Toqua. Bogan's (1980) analysis suggests a status related pattern of faunal remains. This pattern indicated that the socio-political elite received choice cuts of meat, while lower status individuals received lesser quality cuts or portions. Since the access to animal protein appears to have been controlled, there may also have been a controlling factor in the sex or size of

animal within that distribution. This thesis will build from Bogan's findings by examining the game selection strategies that went into producing this observed pattern.

Selectivity

The idea of selective hunting is one of those touchy subjects for archaeologists because it is difficult to prove beyond the shadow of doubt. Nowhere has this been more eloquently inferred than by O'Connell who stated "Hunter-gather prey selection, transport and tactics are said to be less understood than those of the non-human predators..." (O'Connell 1993: 175). Certainly, we as analysts do accept the fact that some animals were indeed selected for by past peoples. One need not look any further than the vast quantities of literature on domestication of animals from sheep and goats to guinea pigs to see some animals were selected for while others were not. I will not address the issue of animal domestication further, for it is outside the scope of this paper.

The classic example of game selection during the historic period from the New World concerns the various animals that were taken for the hide trades. These "trade" animals include, but are not exclusive to, deer, raccoon, beaver and buffalo. However, when we talk about game selection by prehistoric peoples, it is considered risky since it is so hard to prove.

In distant prehistory, we know of and accept a handful of sites where one specific genus of animal was selectively hunted. These sites include many bison jump sites in the West such as the Garnsey Bison Kill site (Speth 1983). There are also isolated cases involving selection of extinct megafauna (Anderson and Sassman 1996). Generally,

these ideas are not challenged because they have been limited to specific events at specific sites. The conclusions presented herein about game selection are also site specific but, the methodology can be applied to other sites.

It is widely accepted that certain animals, generally deer, raccoon and turkey, were continuously hunted by prehistoric peoples in the eastern woodlands (Theler 1987). We also know from works by Stiner (1991) and Munson (1991) that there is a cultural preference in game selection since past peoples generally selected for prime age individuals as evidenced by the underrepresentation of young and old individuals at archaeological sites. Therefore, if there is selection for species as well as for age classes who is to say there is not also a selection preference for one sex or size over another?

The idea of selectivity has met with resistance because of the negative stigma of the Optimal Foraging theory (Davis 1987). Simply, this theory states that a given animal (in this case humans) will exploit those resources which can be extracted with the least expenditure of energy and the largest return (Rapport 1971; Styles 1981; Charnov 1976; and Pyke, Pulliam and Charnov 1977). If this theory were true, all animals would have an equal chance of being taken and, as previously discussed, this is not the case. While some animals certainly were taken opportunistically, this likely would not have provided the bulk of the diet. Furthermore, the Optimal Foraging model does make some sense when one accepts two facts: first, people are generally lazy and second, the researcher is placing his or her own judgment on what is the least expenditure of energy for hunting (Styles 1981).

Thus, selectivity flies in the face of being “optimal” since the hunter is expending more energy for less return. It is also accepted by anthropologists that present day hunters and gatherers only spend a few hours a day acquiring food. Given that modern hunters and gatherers are not always on the edge of starvation, it is unlikely that hunters and gatherers of the past were either. Thus, it should not be considered risky to assume people of the past also had the luxury of being selective. There are instances such as starvation where any and all animals were taken, but known cases of starvation are few and far between in the archaeological record (White 1992). One such case is the Mancos site in Colorado where, under starvation conditions, humans were killed, boiled in clay pots and evidently eaten (White 1992). Starvation conditions should be even more rare in the Southeast, given that seasons are generally not extreme in intensity or duration.

This brings us to the next point of examining the different techniques of hunting and how they fit in the selection process. In the prehistoric and early historic periods, there are generally three types of hunting methods for medium and large sized game. These techniques are drives (by fire, water, jumps, or into box canyons), stalking and ambush (Munson 1991: 143).

Drives offer game selection after the fact. Every animal has an equal chance of being selected for, since the whole group (males, females, young and old) has been killed. Stalking, on the other hand, involves selecting an individual animal on the basis of some cultural factor. To illustrate this, it is necessary to define the difference between what I am calling active versus passive hunting.

Stalking by my definition, is a four-staged process which I term active hunting. The first stage requires prediction of where a prey species will be located. The second stage involves searching those specific locations to establish whether or not game is indeed present. Third, is the act of stalking the prey, and the last, taking the shot. If the animal is missed this process must be repeated all over again. The results of this method should more closely represent a cultural produced game selection pattern.

Ambush hunting is less complex than stalking. Here the hunter has a priori knowledge of where game is going to be located. The hunter places himself in that spot and surprises the game. Game taken using this method should more closely represent a noncultural game selection pattern in that the old, young, males and females should all be present. Selection can still occur using this method if two or more deer are present (Munson 1991: 144). Thus, by my definition, ambush hunting relies on the game to come to the hunter instead of the hunter actively hunting and pursuing the game. This is what I refer to as passive hunting.

Passive hunting is exemplified by the Garden Hunting Hypotheses (Neusius 1996). There are three points to Garden Hunting Hypotheses. First, certain species of animals prefer open environments like fields. Second, the animals that frequent these fields are one of the main sources of meat of a given culture. Third, the scheduling of garden planting was more important than the hunting of game.

The second point of the above theory has implications that are far reaching since the premise behind this is "...non-selective garden hunting is a low cost and low-risk means of acquiring meat" (Neusius 1996: 276). Put simply, any animal that comes to eat

the cultivated crops ends up as the food for humans. This idea lends itself nicely to the Optimal Foraging idea since, once again, the only animals taken are those that come for the crops. Thus the hunter expends little energy while receiving a large payoff in the form of usable animal products. I would argue that the Garden Hunting Hypotheses represents a more supplementary hunting method than a main supplier of animal products. Certainly nuisance animals like the occasional deer that raided the maize fields were dispatched. However, not all animals can be said to have been taken opportunistically. It is unlikely this method alone would supply enough animal products to sustain a population of considerable size.

To narrow the scope of this section, when dealing with deer hunting strategies in North America, there is debate between those who say Native Americans took any animal they came across and those who say they were only selecting for large deer. On the side of non-selection are McGinnes and Reeves (1957) and Gramly (1977). McGinnes and Reeves compared prehistoric deer kills to modern kills and concluded “deer were taken regardless of age, sex or condition” (1957: 4). Gramly researched the Huron, stating: “The Huron hunted deer with no restriction on age or sex” (1977: 603). Therefore, by my definition, the Huron should be non-selective in nature and likely relied on ambush or drive style hunting.

On the side of selection is Elder (1965) and McClure (1990). Elder states: “The low percentages of fawns in the Indian kill is evident that they were voluntarily and effectively employing conservation measures sparing the fawns to turn into better hides and more meat.” (1965: 369). While this statement is based on age classes, one can also

look at this statement in respect to body size and weight. I disagree with “the Native American as conservationist” concept. However, I do agree there is a cultural aspect for selection of mature animals. McClure implies a selection bias in the Ohio deer trade based on sex of the deer. He states: “Buckskins (male deer hides) were preferred over doeskins (female deer hides)” (1990: 118). So, by my definition, these would be selective hunters likely relying on stalking methods or possibly some form of selective ambush style.

The European Explanation

When dealing with a complex society, (i.e. that has large population and is rank stratified; typical of Mississippian culture) the Optimal Foraging model is inappropriate to address subsistence strategies. This is due to the fact that hunting probably contributed a minor amount of sustenance relative to agricultural practices. Unfortunately, a subsistence strategy model, incorporating the ideas of limited hunting relevant to this type of society has not been developed.

A model based on Medieval Europe with its laws limiting hunting may be applicable to the Mississippian culture. What makes this model more relevant is the fact that during the Medieval Period in Europe, there was a large population which was socially stratified (almost a caste society). The social structure of the time was comprised of an elite class (nobles), and a non-elite class (serfs and peasants). Historical records indicate that elites were the leaders and thinkers of the society while the serfs and peasants comprised the agrarian basis of the socioeconomic system. During the medieval

period in Europe, historical documents also indicate that only high status individuals like nobles were allowed to hunt and consume wild game (Grant 1984: 183). Archaeological data supports the documentary evidence since the remains of large wild game animals, like deer, tend to cluster around high status areas like castles and manors (Grant 1984).

In North America during the Mississippian and Proto-historic periods, a similar pattern may have existed where deer remains cluster around high status areas. However, given Bogan's (1980) data, the difference in game animal distribution, relative to status, seemed to pertain only to selective parts of the animal, in this case deer. It is very unlikely, given the nature of status differentiation during these periods, that only high status personages could hunt or consume wild game, particularly whitetail deer.

Inferring Status in the Archaeological Record from Faunal Remains

The underlying premise on how zooarchaeologists infer status difference is most clearly stated by Reitz and Zierden:

Animals used as food obviously represent a nutritional role. However, food consumption is also a cultural behavior. As a result it has deeper cultural meaning. These meanings are seen by others by which foods are eaten and which are avoided. Thus the relationship that exists between food, status, and wealth is complicated [1991: 397].

With this cultural and nutritional relationship in mind, inferring status from the archaeological record is difficult but can be successfully completed. Reitz and Zierden

(1991) address the differences in status between several different households throughout Charleston, South Carolina. They defined status as “one groups position relative to other groups which is governed by social rules and economic wealth” (Rietz and Zierden 1991: 391). Employing this definition, they clearly demonstrated that it is possible to examine issues of status through examining differences in faunal remains from many sites. This will be the definition of status employed in this study.

In a somewhat extreme case of status differences, ethnohistoric documents have been used to show there was a difference in how meat was distributed between white plantation owners and slaves. “Since planters preferred such cuts as hind limbs, shoulders, and tenderloins they usually gave the “offal” - the viscera, head, necks, backbones, tails and lower legs to the slaves” (Otto 1984: 144). This was later confirmed in the archaeological record (Otto 1984: 145). Contrary to what one would expect, the archaeological record also revealed that wild game such as deer, alligator and marine turtles were also enjoyed by the plantation owners while the slaves lived off smaller animals found in the surrounding tidal marshes (Otto 1984: 146). Again Otto’s (1984) report demonstrates selection for some animals is controlled by status.

Though not truly relative to this paper, I include how physical anthropologists infer status. Their work is often closely linked to zooarchaeology, not only by the nature of the material that is examined but also by the types of questions they try to answer. Bioarchaeologists have ascribed status differences between individuals on the basis of skeletal pathologies” (Larsen 1997: 54; Powell 1988). Examples include Mississippian sites like Dickson mounds, Moundville and Pete Klunk mounds (Larsen 1997: 54; Powell

1988). At these sites, it is suggested there is a link between individual health and nutritional intake resulting in the formation of enamel hypoplasia.

Comparisons of individuals of high, intermediate and low status reveal a clear link between social position and stress experiences: high status individuals have the lowest prevalence of hypoplasia and low status individuals have highest prevalence of hypoplasia. Thus, during the years of growth and development of human dentition, higher status individuals enjoyed better health than lower status individuals [Larsen 1997: 54].

If hypoplasia is indeed caused by a lack of high quality food stuffs, then we would expect meat with its high protein ratios to be highly sought after and controlled by high status individuals.

Summary

To summarize, zooarchaeologists are trying to infer more and different types of cultural behavior from the same amount of faunal material. Examples of this include questions of game selection, distribution of meat portions within a specific site, and differential access to animal products. Of key importance to this report is that it is possible to address status rankings of humans by examining the types and amounts of animal remains present.

Goals

This study looks at two new methods for estimating sex and weight of whitetail deer in order to address three questions. First, in a stratified prehistoric society, was game selection influenced by higher status individuals who may have obtained deer of different sex or size compared to their lower status counterparts? Second, was there an active or passive hunting strategy employed at Toqua? Third, how was deer selection influenced by the introduction of new domestic animals, firearms and the deer hide trade? These questions will be addressed using zooarchaeological data from Toqua (40MR6), a multicomponent site with Dallas Phase Mississippian and historic Overhill Cherokee occupations.

Chapter 2

Methodological Background

Estimating the amount of biomass/live weight of an animal is important to archaeologists. It helps estimate the contribution that different species made to human existence at a site. This in turn allows archaeologists to better address questions of population size, length of occupation, population health and economic patterns.

Smith (1975b: 101) noted “The size of a deer was controlled by several factors including sex, environment and amount of available food.” This was later reiterated and expanded upon by Reitz and Ruff (1994: 699) who stated “Body size is complex, it is not only controlled by several genes but is also controlled by sex of the animal, environmental conditions, and availability of food.” For the moment, let us address these factors and see which ones are within the researcher’s control and which are not. Again, the factors controlling body size are genetics, environmental conditions, availability of food and sex of the animal.

Advanced molecular genetics is a relatively new field. Though someday it may be possible to estimate size and weight (among other things) from a fragment of bone, at this time it is beyond most in the field. To accurately perform a genetic study a control population of whitetail deer would be needed so gene transference and mutation rates could be established. If this were not enough, one would also need to “decipher” the DNA code of the whitetail deer for each given region of the country. This is well beyond the scope of this paper and will not be addressed further.

Estimating environmental conditions is well within the researcher's control. One should, from modern deer populations, be able to estimate an average weight of an adult deer within the site's geographical setting. This would include accounting for the affects of the Bergmann and Allen rule over time. However, extending modern conditions and size into the past has problems.

Estimating how much actual food was available at one specific moment in time is difficult though not impossible. Again, borrowing from physical anthropology, bone chemistry of individual remains are being used to reconstruct individual diets of the past (Antoine, *et.al* 1988; Safont *et.al* 1998). A similar study could be performed on deer, though again, this is outside the scope of this study. Lastly, it is also known that the sex of deer clearly affects its weight. This fact will be discussed in more detail later.

Since all these factors affect the relative size and weight of a whitetail deer, it is necessary to accurately account for as much of this variation in live weight as possible. Generally, there are three methods of calculating live weights of animals from archaeologically recovered faunal material. These are weighing, inferring a standard weight for each genus and measuring the remains. All of these methods have been used with varying degrees of success.

The first method involves weighing the archaeological material and calculating a total weight from the sample. This work was pioneered by Cook and Treganza (1950). However, with mineral replacement and weathering over time, bone weights can be altered making this method inappropriate (Lyman 1994: 419).

The second method, inferring a standard weight for each genus was developed by White (1953). This involves two steps. The first step is estimating the minimum number of individuals (MNI). This done by matching paired elements together and counting half of them to arrive at the minimum number of individuals. The second step involves inferring an average weight for the each genus regardless of element size or state of epiphyseal fusion. This method was thoroughly embraced until Grayson (1984) clearly demonstrated the inherent flaws of using MNI. This left zooarchaeologists with an inability to accurately estimate live animal weights. However, archaeologists still wanted to know how much biomass was at a site at a given time. This sentiment is best stated by Reitz, *et.al*:

Archaeologists need a more accurate way to estimate meat yield and total body weights from zooarchaeological remains. Accurately estimating meat has important applications in documenting human variability in several areas. Reliable estimates of meat weight are needed when evaluating the relative contribution of a species to a diet as well as when reconstructing subsistence strategies. Such estimates can also be combined with information about calories, vitamins and minerals to assess the nutritional base of an archaeological population and can be used in ecological models such as Optimal Foraging Theory and Central Place Theory [1987: 304].

With the advent and plethora of personal computers, a third method of calculating live animal weight was developed. This involves mathematical regression models that can estimate the weight of a specific animal by measuring its bone size (e.g. Oetelaar

1981: 54). This method is referred to as allometric regression/scaling or morphometric scaling.

The underlying concept for any zooarchaeological allometric scaling study is that mature or larger animals should have greater bone mass when compared to smaller similar aged individuals within the same genus or species. This principle is known as Wolf's Law. Wolf's Law assumes that bones adapt genetically and environmentally to the stresses placed upon them (Ruff 1994: 253). As physical characteristics such as weight or height increase within an individual, so must its skeleton increase to withstand the new strains placed upon it.

Allometry is also useful in zooarchaeology because it does away with the problem associated with White's (1953) method in that allometry does not rely on average animal weights or minimum number counts. Rather, this method provides an estimate for an individual animal and not for total meat weight of a taxon (Grayson 1984: 173; Lyman 1979). This is more clearly stated by Reitz, *et.al*:

The use of allometry is not only more sound biologically but it also eliminates the need to determine an "average" size for each taxon.... The ability to more accurately reconstruct the size range of animals recovered in a midden provides better information about dietary contributions. It also enables analysts to do the estimate body size of some animals to reconstruct the location, technology and season of capture [1987: 306].

Allometric regression attempts to account for the changes in one variable in relation to constant changes in the continuum of size grades of individual specimens (Gould 1966; Smith 1980).

The preferred formula for allometric scaling is $Y = aX^b$ (Gould 1966; Smith 1980 and Reitz, *et.al* 1987); however, a linear relationship formula can also be used $Y = a + bX$. Regardless of which formula is utilized, scaling of morphometric data has been used in many cases (Davis 1977; Emerson 1978; Hesse and Wapnish 1985; Kohler 1993; Patterson 1998; Purdue 1980, 1986, 1987, 1989, 1991; Rietz 1994; Reitz and Ruff 1994;).

For the purpose of this study, a combination of the two formulas was chosen for simplicity. The variables Y and X are the dimensions of a given object. Y is the unknown variable (in the case of this study, biomass/live weight) and X is the independent variable (in the case of this study, the actual measurement of the bone).

This type of work is exemplified by the works of Patterson (1998); Purdue (1980, 1986, 1987, 1989, 1991); Purdue and Reitz (1993); Reitz and Ruff (1994); Emerson (1978) and McMahon (1975). In these examples, allometry is used on various bones, from the astragalus to the scapula, to examine the change in size of individual animals over time in various areas of the New World.

With all the above choices of bones that have been shown to accurately estimate weight, what is the advantage to adding two more bones to the list? The answer is: since zooarchaeologists cannot predict which bones or which parts of which bones are going to be recovered, it becomes important to be able to regress weight on any, and

all, bone(s). While this study will not fill in all the blanks, it will provide measures for two more postcranial elements. That is why the atlas and the distal portion of the humerus were chosen. With this said, it is necessary to discuss why estimating the sex of a whitetail deer is important.

As both Smith (1975b) and Reitz (1994) stated, there is a direct correlation between the size of an animal's bones and the animal's sex. Thus, to more accurately estimate an animal's weight, one must try to estimate an animal's sex. In dealing with living specimens, estimating sex is not difficult with large mammals like whitetail deer, however, in the archaeological record, with its normal fragmentary nature, this simple act is next to impossible.

Traditional procedures of estimating sex from archaeological remains have primarily relied on two different methods. The first method is dependent upon the recovery of complete skulls of animals that have either horns or antler pedicels. Animals can be sexed by either the presence or absence of these elements or by the relative size of the horn core itself, given the fact that males tend to have larger horns than females (Davis 1987: 44; Boessneck 1970; McDonold 1981). However, complete skulls are seldom recovered from archaeological contexts (Davis 1987: 44; Lyman 1994: 223; Binford 1981: 106). The second method to estimate sex is examining the physical characteristics of the pubis (Taber 1956; Edwards, *et.al* 1982). However, like the skull, seldom does a complete pubis survive in the archaeological record (Davis 1987; Lyman 1994). Because of the lack of survivability of these elements, other elements for estimating sex are needed. Since most animals display some degree of sexual

dimorphism, it stands to reason that there is a metric relationship between an animal's sex and the size of its skeleton. Various skeletal elements in combination with metric evaluation have been used both in the New World and the Old World to estimate an animal's sex. Grigson (1982) determined the difference between cows, bulls and steers using the metacarpal. Fock (1966) determined sex within certain breeds of cattle. Wilson (1982) gives a list of various skeletal elements that have been used to sex and age animals in Europe. McDonald (1981) determined the sex of different species and subspecies of bison by measuring various parts of the skull. Bossneck (1970) estimated the sex of sheep and goats using various bones. Davis (1977) determined the sex of gazelle using the width of the metacarpal's distal condyles. So, clearly by using metric evaluations sex can be estimated accurately. This brings us to the issue of why accurately estimating sex is important.

The answer to this question has already been partially revealed in the previous pages dealing with estimating an animal's weight. It was discussed that an animal's weight is going to be partially dictated by its sex this is due to the fact there tends to be pronounced sexual dimorphism between the sexes of most animals. Therefore, if one is going to accurately estimate the weight of an animal, one should also account for its sex. On a more culturally oriented note, when trying to address prehistoric economic patterns, knowledge of an animal's sex is important to estimate the contribution that sex made to the diet and economy of the past.

Estimating sex will not only be important in this study for more accurately estimating weight, but will also be important to determine if game selection was in some

way influenced by the sex of the animal. Lastly, estimating sex will offer insight into the question of whether one sex preferred over another by different status groups in the past. With this said, it is necessary to discuss the methods applied in this study to ascertain if the atlas and distal humerus were suitable for estimating the sex and weight of *Odocoileus virginianus* (whitetail deer).

Methodology

This study employs two new allometric means of estimating sex and weight of *Odocoileus virginianus* from the first cervical vertebra and the distal humerus. This species was chosen over others because it was one of the main food animals prehistorically as well as in the early historic period through out the Americas (Larson 1980: 16; Smith 1975b: 100). This species should lend itself well to this kind of study since regardless of age class, males are larger than females (Smith 1975a: 33).

The first cervical vertebra was chosen for several reasons. First, it is one of the easiest vertebra to be identified from the spinal column. Second, the atlas was generally spared during butchering. Support for this comes from Waselkov's statement: "...the neck was severed at the fifth or sixth cervical vertebrae." (1978: 88). This would have spared the atlas from being chopped or crushed during initial processing. Many deer heads were collected and processed for my study. The atlas survived intact because it was protected by the back of the skull and mastoid regions while the axis was usually chopped or sawn midway between either end. Lastly, the first cervical vertebra may

seem like a strange choice to estimate sex, however, it has been used elsewhere as Smith states:

Variations in morphological characteristics of the first cervical vertebra have been used to determine the sex of a number of species of deer in the Old World but the applicability of the method to the genus *Odocoileus* has not been established [1975a: 32].

Following Smith's statement, whitetail deer should lend itself well to this type of study. When one thinks about it logically, male whitetail deer should have larger cervical vertebrae when compared to female. The larger vertebrae in males are necessary to support the head and antlers which they use to fight with during rut. This physical stress and strain causes the vertebrae to develop larger surface areas to support the increased muscle mass in the region of the neck.

References are made to European researchers using the atlas to discriminate between male and female mammals. However, these references could not be obtained by the author. In the 28 years since Smith's (1975b) article, no work has been done in the United States to explore this topic.

One of the objectives of this study is to demonstrate that the atlas is effective for estimating sex and weight in deer. Standardized measurements were taken following von den Driesch's (1976) guide for animal bone measurements, to allow for replication by other zooarchaeologists. Five more measurements were added to these to determine if the diameter of the vertebral canal reflects sexual dimorphism.

The humerus should also be useful for estimating sex and weight. A heavier animal should indeed have heavier limb bones to support its weight. Thus, knowing the degree of sexual dimorphism, and that males carry their weight in the fore quarters and females on the hind quarters (Jacobson and Klippel 1998), this should make the humerus larger in males when compared to similar aged females. Much like the atlas, European researchers have determined mammal sex based on the distal humerus (Davis 1987: 37; Hesse 1984). However, little has been done in the United States using this bone to estimate sex.

Standardized measurements using von den Driesch (1976) were taken for the distal humerus. Like the study of the atlas, using these measurements allows zooarchaeologists to replicate this study. Two more measurements were added following Hesse's (1984) and Davis' (1987) methods.

Control Sample

To insure these measurements accurately estimate sex and weight, a control population of whitetail deer of known sex and weight was employed. This sample is housed at the University of Tennessee Comparative Vertebrate Osteology Collection. Most of the whitetail deer in the collection are road-kill does and a few bucks. More bucks with complete data were obtained from a local butchery /taxidermy establishment, Adams Taxidermy and Deer Processing, Powell, Knox County, Tennessee. These deer required further processing which entailed skinning, defleshing and simmering off the remaining flesh. A total of 58 atlases were obtained (males n=34, females n=24) (See

appendix 1) and a total of 27 humeri were obtained (males n=14, females n=13) (See appendix 2). Measurements were taken using von den Driesch to allow easy replication (Figure 1): GB= Greatest breadth over the wings, GL= Greatest length, BFCR= Cranial articular surface, BFCD= Caudal articular surface, GLF= Greatest length between BFCR and BFCD, LAD= Length of the dorsal arch and H= Height.

In addition to von den Driesch measurements, four more measurements were employed (Figure 2); these were the VFHP= Vertebral Foramen Height Proximal (cranial end), VFWP= Vertebral Foramen Width Proximal (cranial end), VFHD= Vertebral Foramen Height Distal (caudal end), VFWD= Vertebral Foramen Width Distal (caudal end). These measurements were added to see if the diameter of the vertebral canal reflects differences in weight. With the measurements of the atlas covered, we can now move on to the second bone of this study, the distal end of the humerus.

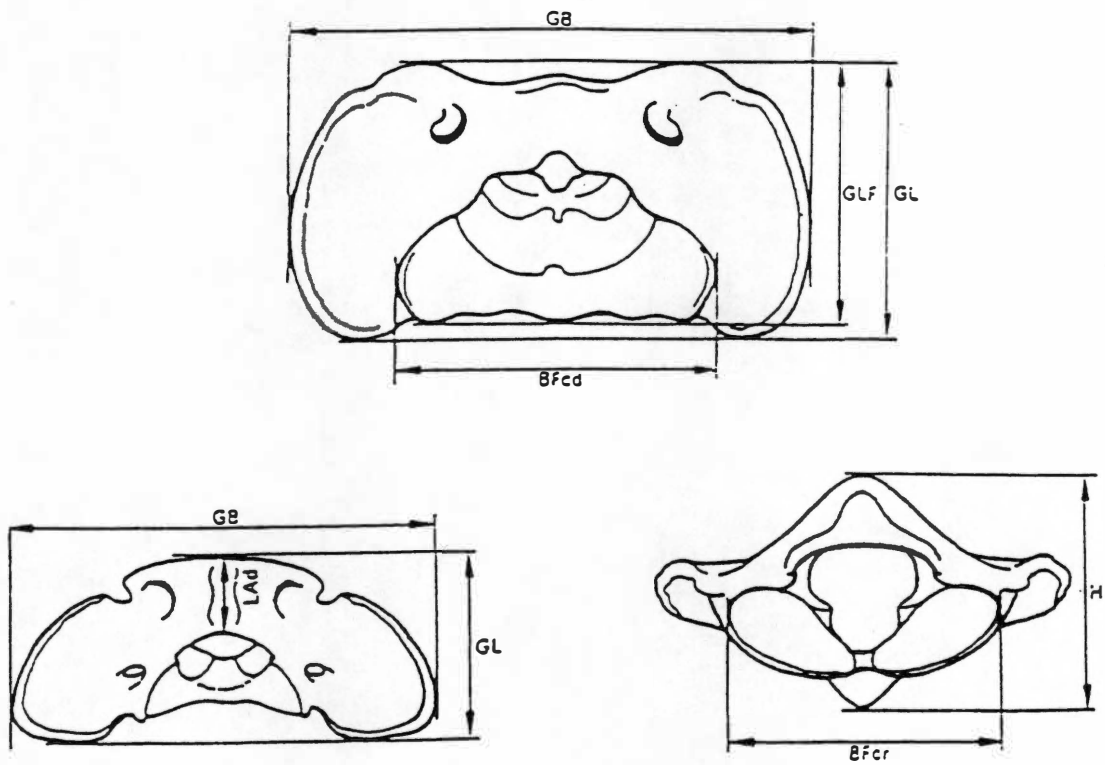
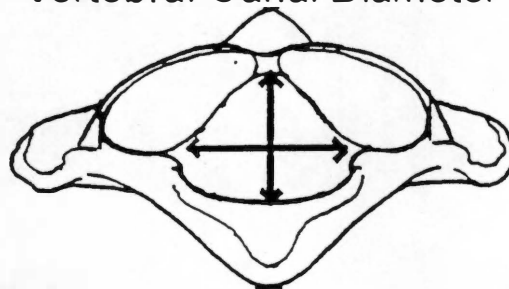
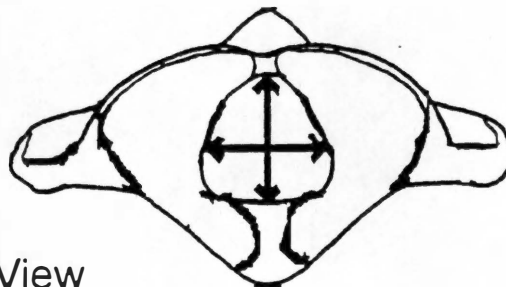


Figure 1
von den Driesch Atlas measurements
(Modified from von den Driesch)

Vertebral Canal Diameter



Cranial View



Caudal View

Figure 2
Additional Atlas Measurements

Like the atlas, the humerus may seem like a poor choice to estimate sex and weight. The humerus, however, survives in the archaeological record so frequently that it makes a logical choice to try to estimate sex and weight. Again, measurements were taken from von den Driesch (Figure 3). Specifically BD = Greatest Breadth of the distal end and BT= Greatest Breadth of the trochlea. Two more measurements added (Figure 4): TH= Total Trochlea height and GTH= Greatest Trochlea Height. This was to see if these areas were responding in some way to weight.

With the measurements of both the atlas and distal humerus complete the results were entered into several statistical programs. As stated in the beginning of this study, a combination of the more complex exponential model and simple linear model for regressing weight was employed. This was done for the sake of mathematical elegance (simplicity) since the complex model first requires a log transformation of the raw data, then multiplying the constant by the slope, next multiplying the previous sum by the known variable. This results in a exponential outcome graphically represented by a curvilinear line. The model employed for this study also requires the raw data be converted to a natural log scale to reduce the affect of comparing measurements made in millimeters to those of pounds. However, this is where the two methods diverge. Instead of multiplying the data further, a simple regression model is employed to estimate weight. This is justified because, as discussed in the literature, culturally produced faunal assemblages generally display a characteristic prime dominate distribution (Cleland and Kearney 1976; Smith 1975a; Stinner 1991; Munson 1991). This type of distribution is comprised of few young or very old animals.

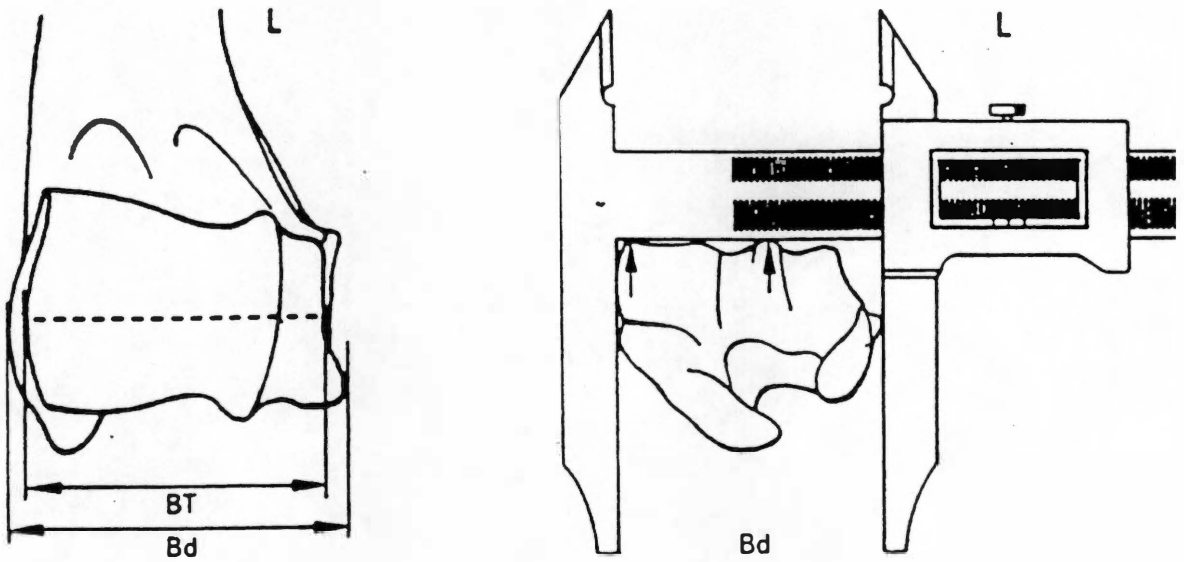
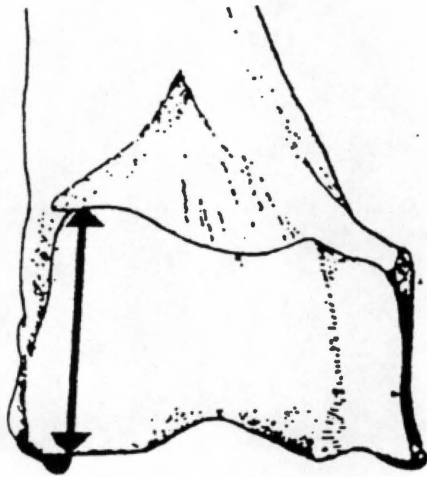


Figure 3
von den Driesch Distal End of the Humerus
(Modified von den Driesch)

**Modified
From Davis 1987**

**Total Trochlea
Height**



**Greatest Trochlea
Height**

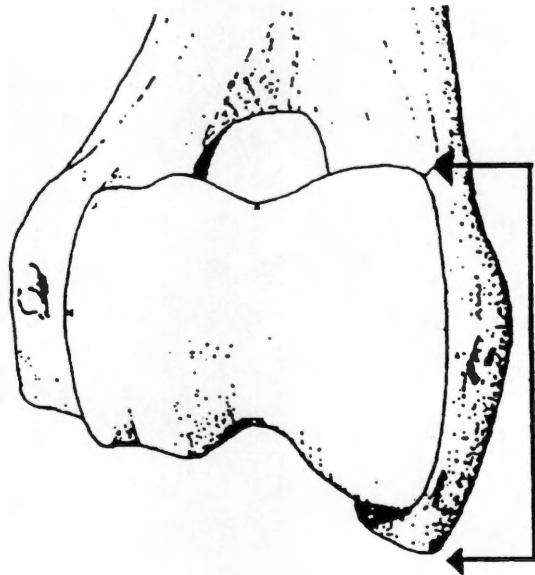


Figure 4
Additional Measures of the Distal End of the Humerus

Furthermore, it would be safe to say that there is generally a correlation between age and size. Thus, those animals in the archaeological record would also be of “average” adult size. Average adult size in this case is relative to the geographic locality of the given site. This is due to the fact that the average whitetail deer in Maine would be on the extremely large size when compared to the deer in Tennessee. Taking this a step further and equating age classes with the physical size of the animal, the young and thus small animals are absent. This means the lower tail of curvilinear distribution created by the complex model can be ignored. Second, following the same lines of reasoning, we would expect few individuals to fall on the upper (heavy) tail because few old, very large animals are going to occur in nature. Thus, the upper tail of weight distribution can also be ignored. With this said, the trimmed curvilinear line resembles a straight line distribution. Following mathematical logic (calculus), any points within a curve of a greater population are going to appear as a straight line. Thus, a linear regression can be employed.

The main point here is, as analysts, we are only “seeing” a small section of the larger distribution. As a result, the part of the curve we are “seeing” more closely resembles a linear regression instead of a curvilinear regression. Thus, linear regression is appropriate, although one could use the exponential method of weight prediction if a scatter plot displays clustering on either end of the distribution.

This procedure was performed on both the atlas and humerus control samples. Those specimens which were missing a weight were also measured and plugged into the regression formula to derive a weight for them. This demonstrated that the model

worked because the unknowns were not clustered on one end of the distribution or for that matter the unknowns were not scattered throughout the curve. This was to “test” the regression formula to see how well it could estimate weight. Before going on to discuss the control sample results, it should be noted that **these findings are regionally specific to East Tennessee and to apply the results of this study to another area, without the use of a control sample for that region, could lead to incorrect conclusions.**

Atlas Control Sample Results

The results for the atlas control group are encouraging. First, it was found that sex and weight could be determined accurately from the atlas. The formula for estimating sex was derived from the control sample using a stepwise regression with weight correlated against all the variables. This method was employed because it determines which variables account for the most variation within a sample. This resulted in eight variables that could be used to estimate sex. These variables are log of LAD, log of H, log of BFCR, log of BFCD, log of GLF, log of VFWD, log of VFHP and Log of FH. These variables were then placed into a Fisher’s linear discriminate function test.

The Fisher test uses linear combinations of discriminating variables to determine group differences and partitions. This is accomplished by maximizing group differences while minimizing variations within the groups (Klecka 1980: 43; Kachigan 1986: 305; Thomas 1986: 291). The formula for this is as follows:

$$h_k = b_{k0} + b_{k1}X_1 + b_{k2}X_2 \dots + b_{kp}X_p$$

“ h_k is the score for group k , the b 's are the coefficients that need to be derived” (Klecka 1980: 43). This formula is calculated for each group to be classified. For this study, the grouping k would be either male or female deer, the b 's would be measurements of either the atlas or distal humerus. Fisher's formula can also be used to determine which group an unknown most likely belongs to. The formula is as follows:

$$b_{ki} = (n - g) \sum_{j=1}^p a_{ij} X_{jk}$$

Thus b_{ki} is the coefficient for variable i in the equation corresponding to group k , and a_{ij} is an element from the inverse of the within-groups cross products matrix. To this a constant is added:

$$B_{k0} = -.5 \sum_{j=1}^p B_{kj} X_{jk}$$

Stated more simply, sex is estimated in this test by calculating a score for both the male and female formulas while inserting the values from the archaeological sample. The results are two numerical scores. The higher score is the sex to which the unknown element most likely belongs.

The seven constants of Fisher's formula derived for estimating sex in this study control population are as follows:

$$\text{Males} = -948.912 + 218.544(\log \text{BFCR}) + 397.911(\log \text{H}) - 119.297(\log \text{GB}) + 438.377(\log \text{VFWD}) - 316.735(\log \text{LAD}) + 23.970(\log \text{FH}) - 29.58(\log \text{VFHP})$$

$$\text{Females} = -884.499 - 202.362(\log \text{BFCR}) + 373.339(\log \text{H}) - 111.999(\log \text{GB}) + 455.944(\log \text{VFWD}) - 309.214(\log \text{LLAD}) + 27.208(\log \text{FH}) - 66.611(\log \text{VFHP})$$

This formula produced a canonical correlation of .698 which predicted sex from the control samples accurately 90.2% of the time. To get values for all seven of these variables is rare, so a five variable model was also derived.

$$\text{Males} = -818.996 + 283.669(\log \text{BFCR}) + 401.495(\log \text{H}) - 231.410(\log \text{GL}) + 34.812(\log \text{FH}) - 27.235(\log \text{VFHD})$$

$$\text{Females} = -755.796 + 272.934(\log \text{BFCR}) + 385.727(\log \text{H}) - 224.811(\log \text{GL}) + 38.001(\log \text{FH}) - 26.140(\log \text{VFHD})$$

This formula produced a canonical correlation of .663 which predicted sex from the control samples accurately 90.0% of the time. There is little decrease in this model's power, thus, it is preferred given its mathematical elegance. With this in mind, and knowing the atlas does not usually survive intact in the archaeological record, a three variable model was used with the archaeological data.

$$\text{Males} = -676.480 + 185.024(\log \text{BFCR}) + 171.6122(\log \text{H}) + 2.566(\log \text{FH})$$

$$\text{Females} = -816.693 + 177.018(\log \text{BFCR}) + 161.874(\log \text{H}) + 6.664(\log \text{FH})$$

This formula produced a canonical correlation of .661 which predicted sex from the control samples accurately 84.0% of the time. Even with this three variable model, some of the required variables needed to be predicted from other variables that were present.

This could be performed due to the high amount of intercorrelation of variables (see Appendix 3). Intercorrelation results from the fact that all the variables are measuring roughly the same thing: the rough size of vertebra in relation to biomass of the individual.

Though this three variable model was used for this study, a single variable model was also developed.

$$\text{Males} = -626.814 + 320.540(\log \text{BFCR})$$

$$\text{Females} = -571.369 + 306.026(\log \text{BFCR})$$

This formula produced a canonical correlation of .627 which predicted sex from the control samples accurately 83.0% of the time. In practice, this formula would be the easiest to use since BFCR survives frequently in the archaeological record.

Since sex could be determined from the atlas, weight regression formulas are sex specific with the best single variable model for females being the Log of Greatest Breadth (LGB). The formula is as follows:

$$\text{Log weight} = -7.48 + 2.83(\text{LGB})$$

This formula produced an R-square value of .90.

The best single variable model for males is the Log of Height (LH). The formula is as follows:

$$\text{Log weight} = -5.92 + 2.92(\text{LH})$$

This formula produced an R-square value of .82.

These are not the only variables or combinations of variables that can be used.

An all subsets regression was run with weight regressed to all possible combinations of variables (see Appendix 4). To summarize the findings of Appendix 4, any combination of two variables for females and three for males will result in R-square values of .90.

Thus, a researcher can be 90.0% sure that the predicted weight is accurately represented.

I am including a generic weight regression formula which does not take sex into account. These formulas would be unreliable to estimate weight for an individual deer. However, this formula could be useful for analyzing a general sample of deer by examining the sample to demonstrate whether the specimens cluster in one region or if there is a continuum of evenly distributed weights.

$$\text{Log weight} = -5.412 + 1.247(\text{LGL}) + -.525(\text{LVFHP}) + 1.775(\text{LH})$$

This formula produced an R-square value of .89.

Like the other formulas for predicting weight, the fewer the variables the better.

So, a two variable model was also developed:

$$\text{Log weight} = -5.67 + 1.375(\text{LGL}) + 1.292(\text{LH})$$

This formula produced a R-square value of .87.

With such a high R-square value, it makes more sense to use the model with less variables. Again, I must stress the fact that these models should only be used to demonstrate trends in weight for samples within a specific site.

To summarize, skeletal structures adapt to the stress of their environment. This stress differs between male and female deer, thus allowing sex to be determined. Ultimately, weight can be determined by employing a simple linear regression. With this in mind, we can move on to address the applicability of estimating sex and weight from the humerus.

Humerus Control Sample Results

Sex could be determined from the distal end of the humerus within the control sample. The formula for estimating sex was derived from the control sample using a stepwise regression with sex correlated against all the variables. Therefore all variables could be used to estimate sex. These variables are log of GTW, log of GTH, log of GH, log of GW. These variables were then placed into a Fisher's linear discriminate function test.

$$\begin{aligned} \text{Males} = & -1236.633 + 674.616(\log \text{GTW}) + 255.510(\log \text{GTH}) - 160.013(\log \text{GH}) \\ & - 39.882(\log \text{GW}) \end{aligned}$$

$$\begin{aligned} \text{Females} = & -1178.659 + 672.251(\log \text{GTW}) + 253.179(\log \text{GTH}) - 155.466(\log \text{GH}) \\ & - 57.803(\log \text{GW}) \end{aligned}$$

This formula produced a canonical correlation of .581 which predicted sex from the control samples accurately 78.6% of the time. With this four variable model, some of the variables needed to be estimated from other variables that were present. This could be safely done since all variables are highly intercorrelated with one another (See appendix 5). We could stop at this point and move on to estimate weight, however, seldom would all of these osteological points survive in the archaeological record. So it was decided that a reduced variable model was needed. When examining the results from the stepwise selection procedure, it was found that the variable GW was the most significant measure and accounted for the most variation.

$$\text{Males} = -889.675 + 530.346(\log \text{GW})$$

$$\text{Females} = -832.324 + 512.959(\log \text{GW})$$

This formula produced a canonical correlation of .579 which predicted sex from the control samples accurately 78.6% of the time. Even with this single variable model, sometimes GW needed to be estimated from other variables that were present. This single variable model has the same prediction value as the full model. Therefore, mathematical elegance dictates its use. Since sex could be determined from the humeri, weight regression formulas are sex specific with the best single variable model for females being the Log of Total Height (LTH). The formula is as follows:

$$\text{Female Log weight} = -6.52 + 3.65(\text{LGB})$$

This formula produced an R-square value of .55.

The best single variable model for males is the Log of Total Width (LTW). The formula is as follows:

$$\text{Log weight} = -16.24 + 5.87(\text{LTW})$$

This formula produced an R-square value of .95.

This raises an interesting problem. While sex can be predicted, the sex specific weight regression formulas are paradoxical. Weight regressed for females resulted in an R-square value that is little better than guessing. Males, on the other hand, produce an R-square value of .95. I can only speculate on the reasons for this. However, it has been asserted that since male whitetail deer carry most of their weight on the forequarter (Jacobson and Klippel 1998), the male humerus might be more sensitive to changes in size and weight and as a result it scales better when compared to females. Another explanation of this problem could be that my control sample is in some way biased. However, statistically speaking, the data for both males and females is normal and shows no outliers. As a result sex can indeed be determined in the control sample from the distal humerus however, sex specific weight regression models are poor predictors. As a result of this fact, one should estimate sex through the logistic model but a generic regression model for estimating weight should be employed.

The best single predictor for weight from the humerus is the Log of Trochlea Width (LTW)

$$\text{Log weight} = -7.59 + 3.43(\text{LTW})$$

This produced an R-square value of .79.

The best two variable multiple regression model for weight is the Log of Trochlea Width by the Log of Trochlea Height

$$\text{Log Weight} = -10.34 + 1.48(\text{LTW}) + 3.21(\text{LTH})$$

This produced an R-square value of .81.

An all subset regression was performed on the humerus data (See Appendix 6). Simple linear regression was used instead of the multiple regression model because the difference between the two models R-square values is minor. Also it is better to use the fewest variables possible when dealing with the archaeological record to maximize the number of measurable elements in a sample.

Blind Test of Control Sample Results

A blind test was performed to test the results of the control sample. The test was performed by employing specimens in the University of Tennessee Vertebrate Comparative Osteology Collection (see appendix 7 for the atlas data and see appendix 8 for the humerus data). The specimens used in the blind test were not employed in the development of the various regression model formulas.

The overall results were mixed. The atlas blind test predicted sex correctly 80% of the time. Though 100% correct prediction would be ideal, the results for the atlas are still quite good (see appendix 9). With a larger control sample size I would predict correct sex estimation to increase to the low to mid 90 percentile range.

The humerus blind test predicted sex correctly 68% of the time. However, it predicted all specimens as male (see appendix 10). There were more males than females in the blind test (roughly 2:1 ratio). Because of this I would argue that predicting sex from the distal humerus to be poor at best. Perhaps with a larger control sample, this measure could be used. However, until that time predicting sex cannot be done.

Summary

In summary both sex and weight prediction for the atlas can be accomplished with statistical significance from the control sample. Blind testing also demonstrated the ability to accurately estimate sex. Sex can also be estimated from the distal humerus with statistical significance from the control sample. However, from the blind test it is clear the formula overestimates the number of male deer. Furthermore sex specific weight regressions also have problems. As a result of these problems a generic weight regression, regardless of sex, was employed for the humerus.

With both atlas and humerus control group formulas accounted for and the results of the data covered, we can move on to discuss the implications of these data and examine the archaeological sample from Toqua. Toqua is a multicomponent site spanning the Dallas Phase of the Mississippian Period through the Historic Cherokee. This will require the examination of several issues: the general background of the Dallas Phase peoples and Cherokee culture, the physical description of the Toqua site, and how the deer hide trade impacted local deer populations and human cultures.

Chapter 3

Cultural Chronology

The socio-political and economic factors were radically different throughout time at Toqua as it changed from a prehistoric ranked society to a historic tribe. Thus it is necessary to discuss the implications of the individual cultural components which make up the archaeological record. To do this chapter is divided into three subsections: 1) the Mississippian Period 2) Dallas Phase of the Mississippian Period and 3) Historic Overhill Cherokee.

The Mississippian Period

Smith, defines the Mississippian as:

Those prehistoric human populations existing in the eastern deciduous woodlands during the time Period A.D. 800-1500 that had a ranked form of social organization, and developed a specific complex adaptation to linear, environmentally circumscribed flood plain habitat zones.... This adaptation involved maize horticulture and selective utilization of a limited number of species groups of wild plants and animals that represented dependable, seasonally abundant energy sources that could be exploited at a relatively low level of energy expenditure [1975b: 486].

Of particular importance is the inferred ranked form of social organization and the selective utilization of species by Mississippians. The level of sociopolitical complexity associated with Mississippian cultures in the Southeast is the chiefdom

(Hudson 1976: 95; Zeder and Arter 1996: 319; Bogan 1980: 14). Given this fact, there are elite and non-elite individuals. “The clearest evidence of the authority of the southeastern chiefs was their demonstrated ability to command stores of food and clothing and numerous labor parties required by the Spanish to continue their explorations” (Powell 1988: 18). This quote helps to establish the fact that there was some form of social ranking, and access to animal products was controlled. The Mississippian Period in Tennessee is well represented from numerous sites across the state. From East Tennessee, Lewis and Kneberg (1946) argued for a linear succession of the Mississippian Period to the late prehistoric and historic archaeological cultures. Within this succession is the Hiwassee Island, Dallas, Mouse Creek and Cherokee cultures. This report concentrates on Dallas Phase and Cherokee cultures.

Dallas Phase

According to Schroedl (1986), the Dallas Phase of the Mississippian Period existed from A.D. 1200-1600. As defined by Lewis and Kneberg (1946: 10), the Dallas Focus is a Middle Mississippian Culture confined to East Tennessee along the Tennessee River and its tributaries.

The Dallas Phase consisted of compact interval settlements in the Ridge and Valley area (Polhemus 1987: 1246). Dallas villages are characterized by large sites with earthen mounds as well large and small log structures, with a palisade around the perimeter (Polhemus 1987: 15; Schroedl 1986: 128). Few of these towns had more than one mound or more than one structure on a mound (Polhemus 1987: 1246). Like other

Mississippian cultures, it is thought that sociopolitical structure of the Dallas culture was ranked in some form (Polhemus 1987: 15). However, Keel (1976) and Dickens (1976, 1979) suggest that Dallas peoples were the prehistoric counterpart of historic Overhill Cherokee.

Overhill Cherokee

The Cherokee nation occupied 40,000 square miles. Population sizes and duration of occupation varied from settlement to settlement (Schroedl 1986: 5). A general description of an Overhill Cherokee town is provided by Schroedl (1986: 128) as follows: “The Overhill Cherokee towns were characterized by widely dispersed paired winter-summer structures and no palisades, a village plaza, and large public town houses but not built on the mounds.”

There is some debate on the exact arrival of the Cherokee in the area. It was originally proposed that the Cherokee arrived in the Tennessee region around the 13th century. However, Lewis and Kneberg (1946) suggest that they arrived later to the region and replaced the Mouse Creek and Dallas peoples (Schroedl 1986: 7). Keel (1979) suggests a continuous lineage from Dallas Phase to the Historic Cherokee, this assumption being based on ceramic types which displayed continuity throughout time.

Regardless of when the Cherokee came into the area, European contact with the Cherokee occurred very early. First contact was likely made in 1540 by DeSoto's expedition. This was later followed by the Juan Pardo expedition which may have made it as far north as present day Knoxville, Tennessee (Schroedl 1986: 7). There was then a

100 year period of no European contact with the Cherokee until the late 1670s when James Needham and Gabriel Arthur left the Virginia Colony and traveled south into the Cherokee territory. However, it was not until the 1700s that traders established and sustained contact with the Overhill Cherokee (Schroedl 1986: 7). This was a very stressful time for the Cherokee since their culture and tribal lands were constantly being encroached on by white settlers (Ford 1982).

After the French and Indian War, the Cherokee were faced with tremendous pressures from the Virginia and Carolina colonies. This led to increased competition for resources and a dependence on European material culture (Schroedl 1986: 13). After the American Revolution, Cherokee political, economic, and military power were greatly reduced.

Chapter 4

Toqua

Toqua was chosen for this study because of Bogan's (1980) Dallas phase inferences which suggested elites had differential access to animal products. This inference made it a prime candidate to test if there was also a differential selection of game on the basis of sex or weight. The later Cherokee occupation allowed contrasts and comparisons to be made with the earlier Dallas occupation and to see how technological changes affected game selection.

Toqua was of great importance to further understanding past lifeways of East Tennessee because it was a relatively undisturbed multi-mound and village Dallas Phase site with later historic Cherokee occupations. The Toqua site is a multicomponent village and mound complex located on what was the first terrace of the Tennessee River, Monroe County, Tennessee. The first documented investigation of Toqua was conducted by John W. Emmert in 1884 for the Bureau of Ethnology under Cyrus Thomas (Polhemus 1987; Bogan 1980). In the mid 1970s, salvage archaeology investigations were undertaken to record as much data as possible before the site area was flooded by the Tennessee Valley Authority's (TVA) Tellico Project.

Structurally, Toqua is composed of two palisade walls, two earthen mounds, 110 structures and 1,502 features located within the walls (Bogan 1980: 12). The site was divided into six areas: West Village, North Village, Mound A, Mound B, East Village Midden and East Village. "The Dallas village at Toqua was approximately 500,000 square feet in size and had been enclosed on three sides by a trench-type palisade.

Mound 'A' exhibited nine construction phases, each with its own burial phases" (Bogan 1980: 12). It has been suggested that these dual mounds may be significant as an identification of local or district centers of a larger chiefdom (Polhemus 1987: 1246). Not much is known about the transitional period between Dallas and the Cherokee periods. However, at some point Toqua lost its political power and by historic times Chota-Tanasee was the seat of political power (Newman 1977).

In the Historic Period (ca 1600s), Toqua was one of 60 Overhill Cherokee settlements in what was part of the northern extent of the Cherokee Nation (Schroedl 1986: 5-7; Polhemus 1987: 12). The most dense area of historic Cherokee occupation at Toqua occurred east of Mound A beyond the major Dallas village midden.

Status at Toqua

Because of the cultural makeup of Toqua, status estimation is primarily concerned with the Dallas Phase peoples. This is for several reasons. Foremost, the Cherokee were egalitarian in nature so one would not expect much difference between individual households. Second, not all of the Cherokee features were excavated at the site. Status, for the Dallas Phase at Toqua, was determined much like status observed at other archaeological sites, by looking at the structure's physical locations within the site. Mounds and plazas are considered high status areas because of the amount of labor that went into creating them. Thus, a structure's proximity to a mound or central plaza partially determined its rank. Rank for individuals within Toqua was determined by the following criteria:

Ranking of individuals at Toqua was determined by the types and amount of grave goods that are associated with burials as well as the placement of the grave (mound versus village). Furthermore status should also be reflected in differential access to foodstuffs; nutritional stresses and dietary differences... patterning of faunal remains should also reflect differential access to food and to raw material resources [Polhemus 1987: 20].

Summary

Important to this study is the idea of differential access to foodstuffs and dietary differences based on status lines during the Dallas Phase. Since the Cherokee were egalitarian, there should be no difference in distribution of material goods within this group. However, we expect there to be a difference between Dallas and Cherokee peoples.

Chapter 5

Subsistence Strategies At Toqua

Before interpreting game selection it is necessary to understand the subsistence strategies that produced the archaeological assemblage at Toqua. It is generally believed that subsistence changes are the result of over exploitation of the physical environment. However, it has been suggested subsistence changes may be more the result of social, political or technological changes and not changes in the physical environment (Styles 1981). Understanding these latter changes is important since all three occurred at Toqua.

First, socio-cultural changes occurred across North America as Native American populations decreased due to introduced European diseases. As a result, those who survived became more isolated and long-standing infrastructures collapsed. Second, the inhabitants of Toqua (the Dallas Phase peoples) went from a ranked society to an egalitarian tribe (the Cherokee) (Polhemus 1987; Schroedl 1986). Lastly, there was an exponential jump technologically from the spear and bow to dependence on the gun by the Cherokee. All of these factors effect game selection at Toqua.

Dallas Subsistence at Toqua

Dallas Phase settlements are generally located within the Ridge and Valley geographic area. This is a highly productive ecotone which provided Dallas societies with a plethora of food resources (Bogan 1980). All classes of animals were recovered from the Dallas Phase at Toqua. "The vertebrate fauna is comprised of about 480 species,

including 18 introduced, 7 extirpated and 2 extinct species” (Bogan 1976: 14). However, Bogan (1976) only considered 12 of these species to have been food animals. Like most prehistoric sites across the country, whitetail deer supplied most of the meat to the diet. Support for this statement comes from the over 3000 whitetail deer remains that could be positively identified from Toqua (Bogan 1980; 1982). Remains of smaller mammals like squirrels and rabbits were also recovered from this site, but these taxa likely played a more supplementary role in the prehistoric diet (Bogan 1982: 309).

According to Bogan’s findings, low status individuals at Toqua received less whitetail deer protein than high status individuals (Bogan 1980: 44; 1982: 312). It is inferred that low status individuals made up for this lack of protein by diversifying their selection of game, since the greatest species diversity was located in the East Village midden. This was considered a low status location (Bogan 1982: 309).

Cherokee Subsistence

The Europeans found the Cherokee to be an egalitarian society (Bogan 1980: 14). The Cherokee lived in extended families that were matrilineal in descent (Perdue 1989: 16). Prior to the arrival of the Europeans, the most important game to the Cherokee was also whitetail deer (Perdue 1989: 18; Bloom 1942: 326). However, there is also mention of bear, bison, elk, hares, raccoon, squirrels, beavers, ground hogs, wild fowl and insects being exploited (Bogan 1976: 34). Winter was the preferred season for hunting and a hunting party would generally be gone for several months at a time (Perdue 1989: 18).

According to Perdue (1989) these hunting parties may have traveled as far west as the Mississippi River.

An Overhill Cherokee subsistence pattern from Citico during the Federal Period provides insight into the Cherokee acceptance of Euro-American domesticated animals and the shrinking role of native species. Deer, bear and turkey continued to be used, but pig was by then the main meat staple of the diet (Bogan 1980: 173). The depletion of wild game during this time period was a factor of the Cherokee becoming involved with European trading. By the early 19th century, Cherokee subsistence was rapidly transformed to near total dependence on domestic animals.

The Skin Trade

Deer hide was originally used by the Native Americans to manufacture clothing, cover dwellings and for camouflage (McGinnes and Reeves 1957: 5). In later historic periods, it was used by Europeans for similar purposes. "In historic times it was the preferred material for close fitting riding breeches worn by fashionable gentlemen on both sides of the Atlantic" (McClure 1990: 118).

It is generally accepted that the Cherokee adopted Euro-American material culture fairly quickly, including firearms and domestic animals (Riggs 1987: 1). However, the Cherokee had no form of hard currency, so the only way to obtain these goods was through trade and barter. One of the main forms of trade was the deer hide. Deer skins were one of the first export goods of this country. This is because deer were

the only large animal in the eastern woodlands in sufficient numbers with a hide large enough for clothing.

The way the deer trade worked was that, for example, merchants in London would extend credit to the merchants in Charleston, South Carolina. In turn merchants in Charleston would credit traders with goods. Following this, the trader would give trade goods to the Indian hunters who would acquire the skins. These skins were then exchanged for more goods. All of this trade was based on credit and dependent on the following year's successful hunt; this has been cited as the main factor in cultural change for Native Americans (Baden 1983: 10). One of the best sources of information and examples of this come from the many historical records of the Creeks.

The economy of the Lower Creeks of this Period (1690-1715) were commencing a relationship with the deerskin trade that ultimately placed the Indians in a position dependent upon the English for guns, knives, clothing and many kinds of ornamental nonessentials (Mason 1963: 67).

Deer hunting was the only way an individual Indian could reap the Europeans to his friends and relatives, ceaseless and unrelenting consumers. The Indians had no other means of access to the trade... (Mason 1963: 70).

Although these quotes are not about the Cherokee, they do illustrate the previous point that the Cherokee like the Creek were in an endless loop of hunting deer for trade goods.

Narrowing the focus in returning to Toqua, during 1707 the British and French were trying to control the southern frontier. During this time, trade with the Indians was highly regulated, including that involving ammunition. This hindered the deer trade drastically since without lead shot and gunpowder to propel the shot, the gun was useless. This regulation lasted until 1756 when Fort Loudoun was built on the Little Tennessee River. British officers and soldiers then became frequent visitors along the Little Tennessee River (Schroedl 1986: 11). Trade at this time was undoubtedly increasing. Rothrock states that “Fort Loudoun in 1756 promised to improve, and for a while did improve, the state of trade in the Overhills” (Rothrock 1929: 17). This likely included the trading of livestock such as pigs, chickens, cows and horses in exchange for goods and land. This would surely have an impact on the types of deer and numbers of deer that were taken during this transitional Period.

In 1708, the governor of North Carolina reported an average of at least 50,000 skins exported annually to England (Rothrock 1929: 10). It is likely that half of these skins came from the Cherokee Nation (Rothrock 1929: 10). By 1725, some 200,000 skins were leaving Charleston annually (McClure 1990: 116). In 1775, the [Overhill] Cherokee produced 3,500 skins while the whole Nation likely produced 25,000 skins (Rothrock 1929: 10). With these kinds of export numbers, one would expect an increase in deer taken with disregard to age, size, and sex by the Overhill Cherokee.

If the Cherokee were indeed taking deer regardless of sex, this activity should be reflected in the archaeological record. Following Gramly’s (1977) article, for the Huron to obtain 62,000 hides would require 13,800 square miles be hunted heavily with no

restriction on age or sex of the deer taken (Gramly 1977: 603). However, McClure (1990: 123) has suggested, based on the deer hide trade in Ohio, that buckskins (male deer hides) were preferred over doeskin (female deer hides); "...the hide trade favored mature bucks over does and fawns, as apparently it did, the deer population of the Ohio Valley may have sustained significant hunting pressures with a catastrophic plummet in numbers." If this is true, it would not be unreasonable to expect a similar sexual selection bias in the Southeast. We know there was an uneven distribution of deer remains at Toqua status. What we do not know is if there was an uneven distribution of deer on the basis of size or sex.

Elder (1965) examined prehistoric versus historic deer exploitation and noted that there were two different age curves in deer taken from the prehistoric and historic period site respectively. He attributes this to the possession of guns and horses obtained through barter. These acquisitions in turn increased hunting territories leading to increased hunting pressures due to commercial opportunities (Elder 1965: 369). The reports noted above clearly suggest that selection for size (age) was being practiced.

Summary

The important players in this thesis are the Dallas Phase peoples of the greater Mississippian Period and the Historic Period Overhill Cherokee. There are three questions of particular importance to this study: 1) Did game selection differ by status during the Dallas Phase 2) was there a biased distribution of sex and weight of whitetail deer across Toqua, and 3) was there a selection for a specific size or sex of deer for the

deer hide trade by the Cherokee? To address these questions requires examining the archaeological record.

Chapter 6

Discussion of the Archaeological Sample

Atlas Results

As one would expect, not many deer atlases survived intact and only 11 could be analyzed (see appendix 11). Five came from high status Dallas Phase areas but only 4 could be measured. Results indicate that all the atlases were likely from male deer. These deer had an average weight of 161 lbs. Seven came from low status Dallas Phase, but only 5 could be measured. Again, results indicate that all the atlases were likely from male deer. These deer had an average weight of 187 lbs. Only 2 atlases came from historic Overhill Cherokee contexts. Results indicate they were likely from male deer. These deer had an average weight of 123 lbs. An ANOVA was performed to test if the atlas mean weights were different between status groups. There was no statistically significant difference between Dallas or Cherokee status areas.

Distal Humerus Results

The distal humerus survived more frequently than the atlas (see appendix 12). A total of 95 deer humeri were analyzed. All weights were estimated from the measurements of trochlea width. Low status Dallas Phase areas contained 39 humeri; the mean weight of the deer from this area, based on distal humeri measurements, was 103 lbs. High status Dallas Phase areas contained 59 humeri; the mean weight of the deer from this area, based on distal humeri measurements, was 107 lbs. Historic Cherokee

areas contained 18 humeri; the mean weight of the deer from this area, based on the distal humeri measurements, was 162 lbs.

An ANOVA was performed to test the humeri mean weights to see if there was a statistical difference between the different groups. There was no significant difference between high and low status Dallas areas at Toqua. However, those from the historic Cherokee occupation were found to be statistically different at the .05 level than those from the Dallas areas. The difference indicates the Cherokee were consistently selecting for heavier deer than their predecessors.

Chapter 7

Discussion of Results

There are several possible explanations as to why the distribution of faunal remains cluster differently around the Dallas areas at Toqua. One explanation is that the archaeological record is biased. This is not very likely since most of the Dallas areas at the site were excavated and analyzed. Another explanation comes from early ethnographic references stating Mississippian elite were capable of controlling vast quantities of foodstuffs (Hudson 1976). Normally this kind of statement would go unsupported, however, Bogan's works (1980 and 1982) add some validity to this statement.

Selection and Taphonomic Explanations

There are also possible taphonomic explanations as to why only large males might be in the archaeological record. Parmalee (1965), from his analysis of the Tick Creek cave site fauna, was one of the first to address the idea of selection. He states: "The preponderance of females among adults today probably reflects the hunting system in which males are selectively hunted; it is doubtful if prehistoric man practiced selective hunting of bucks" (Parmalee 1965: 28). Parmalee (1965) also notes that only 18 females and 72 males were recovered in the Archaic period while 34 females and 100 males were represented in the Woodland Period. This converts to four males to each female in the Archaic Period and roughly three (2.94) males for each female in the Woodland Period.

If we accept the fact that half the female remains did not survive for whatever reason, that still leaves a 2 to 1 preference for males. This is not the only place where a preference for males has been seen. Waselkov (1977: 84) states that, "from sites in southwestern Virginia there is also a high preference for males."

Game selection on the basis of sex has been addressed, but not directly tested on Mississippian sites. Smith (1975a) had a similar distribution as found by Parmalee. He, like Parmalee, explained this distribution in terms of being an artifact of taphonomic and utilitarian needs, not as active selection by Native Americans and not a cultural active selection for males. Smith states:

This seeming selection for male deer over female deer is most likely not a result of hunters preference but rather a biases introduced by two factors. Female skulls fragment because of their delicate nature unrecognizable from the battering they would receive from extraction [of the brain].. Male antlers had a utilitarian practicality and thus would be more likely to be brought back [1975a: 33].

Deer in the Southeast usually do not attain a maximum weigh of the northern subspecies so they could be carried back in their entirety to a base camp. Thus, no elements should have been left at the kill site. Some support for the entire deer carcass being returned to base camp comes from White's (1953: 337) article stating that "small animals like deer and antelope were carried back to base camps for butchering." Furthermore, from my own examination of the deer remains from Toqua all skeletal elements are present, thus indicating the carcass was brought back to the site as a whole

unit. Second, one can not deny the importance of antlers as a tool resource to Native Americans. However, brains were used in the tanning of hides, thus female skulls would have just as much “value” as male skulls for that purpose. As stated previously, this study does not rely on the presence of the skull, so it does not have the same limitations that Parmalee and Smith encountered.

Ethnohistoric References for Selection

Finally, there are ethnohistoric references which may be applicable to this question. Read (1971: 70) states, that the “greater the dependence of a group on a particular animal, the greater the likelihood that the bones of this animal occasionally represent ceremonial use”. Early Cherokee cultures and Dallas Phase cultures had a great dependence on whitetail deer, and we know that the deer was predominant in Cherokee ceremonial use (Mooney 1982). References of particular importance to this study center around the Creek, but it is reasonable to assume that similar cultural traditions existed with the Cherokee.

The first buck killed each season was sacrificed as a religious offering and hunters awarded the choicest parts of meat to the fire. Adair noted they [the Creeks] commonly pull their new-killed venison (before they dress it) several times through smoke and flame of the fire, both by of the way sacrifice and to consume the blood, life or animal spirits of the beast... and they sacrifice in the woods the milt or a large piece of fat of the first buck they kill, both in the summer and winter hunt; and frequently the whole carcass... [Braund 1993: 64].

This could be one possible explanation on why predominately large deer were recovered from the Cherokee areas at Toqua. The certainty of this statement is more confident when applied to the Cherokee but this may be applicable to the Dallas Phase peoples as well.

Implications to Cherokee Selection

There are several possible explanations as to why the Cherokee may have been selecting for larger deer as compared to their predecessors. One explanation of why the Cherokee were taking larger deer has nothing to do with the Cherokee, but rather that the archaeological sample is biased. This idea cannot be addressed at this time, since Toqua is now submerged below the present day Tellico Reservoir.

A second explanation for why the Cherokee were selecting larger deer comes from historical references. During transition between Dallas Phase societies (16th century) and the beginning of the Historic Cherokee (17th century), a great tragedy occurred. Millions of Native Americans succumbed to diseases introduced by Europeans during that time period. This had an unseen affect as the human populations dropped across the country. The land abandoned as a result of human population reduction was well suited for whitetail deer. This in turn caused a deer population explosion (Braund 1993: 61). These increased numbers of deer supported the extensive deer hide trade that was developing at this time in Colonial America. Uerperman (1998) suggested that the newly open land allowed individual deer to reach unprecedented size for the Southeast, since the deer had access to previously unavailable food resources. However, if one

thinks about this, the entire deer population of the Southeast, including the very young through the very old, were available to the Cherokee hunters of the time. Therefore, if selection was not taking place, why are only the large male deer showing up in the archaeological record? Where are the fawns and does? Logically, large male deer were being actively sought and taken. Munson came to a similar conclusion from sites across eastern North America (1991: 143).

A third explanation for larger deer being taken by the Cherokee is due to the acquisition of the gun. Firearms appear to have been adopted early on by the Cherokee, since, by the 1700s, contacts with the Overhill Cherokee indicated they possessed Spanish firearms (Rothrock 1929: 5). There was undoubtedly a change in game selection from traditional hunting with traps and bows and arrows to the introduction of firearms. It is likely that with the use and acceptance of the firearms, Native Americans could be more selective on the number and types of deer taken.

A fourth explanation is the introduction and continual use of domestic animals for meat. However, these Euro-American staples were not immediately accepted by the Cherokee (Bogan 1980; Newman 1979). Newman (1979: 102) states that domestic animals were not raised for meat until the mid-18th century. Newman (1979: 103) attributes these two factors to the following: "First they generally believed they would inherit the physical appearance of the animals they ate. It is likely that given the choice between a sleek swift deer and a sluggish wallowing pig, the Cherokee would have chosen the deer." This is further supported by Goodwin (1977), who was addressing changes in Cherokee culture prior to 1775.

He who feeds on venison is, according to their physical system, swifter and more sagacious than a man who lives on the flesh of the clumsy bear, or helpless dunghill fowls, the slow-footed tame cattle to the heavy wallowing swine [Adair in Williams 1966: 139].

The reason that domestic animals were finally accepted was the lack of deer due to their population reduction from the deerskin trade (Newman 1979: 103). Since deer were the main traditional food staple, when they became less available it would have been advantageous for the Cherokee to supplement their diet with domestic animals. Thus, those deer that were taken by the Cherokee after the mid-18th century more likely represent an attempt to maintain traditional lifestyles instead of daily subsistence.

The European Explanation Revisited

This study employed a modified Medieval European subsistence model for addressing the faunal distribution at Toqua. This may or may not be a relevant model to use. There are no New World subsistence strategies available to explain the workings of large complex societies which are rank stratified, typical of Mississippian culture.

As stated in the beginning of this study, during the Medieval Period in Europe only high status nobles were allowed to hunt and consume wild game. This is seen archaeologically as well with wild game remains clustering around high status dwellings (Grant 1984: 183). Bogan (1980) demonstrated that deer elements clustered differently around high status areas when compared to the rest of Toqua. His information combined with this study's suggests the elite Mississippians were not only receiving different

portions of deer but these portions are representative of large deer as well. This is very similar to the results of the European model. However, it would be wrong to suggest only high status Mississippians were allowed to hunt since, ethnohistoric records indicate large hunting parties went out on regular basis (Braund 1993). Also, with the absence of domestic animals to supplement the diet, the majority of the population would have difficulty supporting itself. However, Styles (1981) demonstrated that fish remains and not deer remains make up the bulk of several Woodland assemblages from Illinois. Though strictly speculative at this time, maybe what we are seeing during the Mississippian and Woodland periods are low status individuals supplementing their diet with aquatic resources while elites are getting more terrestrial resources like deer.

Summary

Food consumption can be symbolic in nature. I would tentatively put forth that what we are “seeing” at Toqua are male deer being brought back whole and consumed in a cultural/ritualistic controlled fashion with the elite getting choice parts. The first line of evidence comes from the fact that the elite Mississippians controlled food stuffs. Bogan’s (1980; 1982) study of body part representation supported this idea when he concluded that less desirable portions of deer were present and located in low status areas at Toqua. This is similar to Grant’s (1984) European findings. A second line of evidence is supported by ethnographic records that deer were ritualistically treated by the Creeks and Cherokee. Support for this inference comes from Goodwin (1977) and Braund (1993). They relate ethnohistoric evidence of a cultural preference for not only

deer over domestic animals but a preference for male deer. This study similarly suggests a selection preference for large male deer.

Chapter 8

Conclusions

The overall purpose of this study was to address hunting selection and how it related to human status through time at a single site. To accomplish this it was necessary to choose an animal that was widely exploited in the both the historic and prehistoric past of eastern North America. This was the easiest step of the study for no animal was exploited more than whitetail deer.

The next step was to decide on selection criteria that would be visible in the archaeological record. Sex and weight was chosen since these characteristics should have left their marks on the skeleton. Biomechanical studies have established there is a positive correlation between an animal's weight and the size of its skeleton. Sexual dimorphism studies have demonstrated that male animals tend to be larger than females. It would stand to reason that any bone should reflect the sex and weight of the individual.

Allometric studies of whitetail deer have already been performed on certain bones with great success. Instead of re-testing these studies, other bones were chosen. This is justified because zooarchaeologists cannot predict which bones or which parts of which bones are going to be recovered. The bones were chosen on the basis of one of two criteria. First, the bone needed to reflect sexual dimorphism. Second, the bone needed to survive in the archaeological record. The atlas was chosen because of personal observations made in regard to the range of variation in size. The distal humerus was chosen because it often survives intact in the archaeological record.

With the bones selected for this study, it was necessary to determine if they did or did not demonstrate an allometric relationship with sex or weight. This required the use of standardized measurements and a control sample of deer of known sex and weight for both the atlas and humerus. Without this step it would be impossible to tell if the results were accurate or not. Based on a modern sample, regression formulas were derived to sex and weight.

To ensure the accuracy of the sex prediction formulas, a blind test was employed. This entailed collecting another data set in which sex was known. The results from the control sample were employed on the new data set to see if they correctly estimated sex. The results of the blind test were mixed.

The results of the blind test on the atlas vertebrae were encouraging. Sex was correctly estimated 80% of the time, validating the use of the formulas to estimate sex. Results on the humeri were classified as male, but this was clearly not the case. Thus, sex cannot be accurately predicted from the distal humerus.

The scope of this study did not permit creating a blind test for estimation of weight. However, estimating weight from the control sample resulted in R-square values of .82-.89 for the atlas and .79 for the humerus. Taking these at face value, weight can be accurately obtained from the allometric regressions.

By applying the above methodology to the archaeological sample from Toqua. The questions of game selection and human status were addressed. It was inconclusive if high status individuals were or were not receiving different sized deer when compared to their low status counterparts. However, a status difference is suggested by Bogan's (1980,

1982) findings resulting from the differential distribution of deer remains across the site. Second, the faunal remains from Toqua indicate an active game selection as proposed by Elder (1965) and McClure (1990), instead of a passive one. Support for active game selection is evident by the preference for male deer at Toqua regardless of status or time period. Third, it appears that selection for large deer in the Historic Period (Cherokee), was strongly influenced by the deer hide trade. This is a reasonable conclusion since deer were larger during this period when compared to deer from the Mississippian Period Dallas Phase. This is likely the result of the introduction of domestic animals and the introduction of the firearm which provided a steady source of food. Regardless of time period or element used, there was a selection for large animals.

The methodological results of this study demonstrate that weight and sex can be predicted from postcranial elements for whitetail deer from East Tennessee. This is by no means a definitive study, and several aspects may be improved. These would include a larger sample of deer with known weights from different age ranges and sizes for both sexes. The second area of improvement would be the employment of a blind test to check the weight regression formulas. Third, other multicomponent sites should be looked at to see if there is indeed a selection for large male deer. Lastly, this methodology should be applied to other deer samples from around the country.

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APPENDICES

Appendix 1 Atlas Control Sample

SPEC#	SEX	WGHT	GB	GL	BFGD	BFCR	GLF	LAD	H	VFWP	VFHP	VFWD	VFHD	FH
7915	F	123	74.6	63.3	47.1	49.9	46.8	23.3	35.8	16.7	25.8	23.8	24	6.2
6543	F	144	80.8	68.3	50.4	48.5	54.9	26.7	41.2	19.2	26.1	25.2	27.5	7.2
7272	F	125	79.7	67.8	44.3	50	52.8	24.4	39	18.3	26	24.5	23.7	6
7413	F	89	66	51.4	42.1	45.4	47.1	19.3	34.6	16.2	24.5	21.8	22.6	6.1
6596	F	98	70.3	57	44	44.5	52.3	26.1	35	12.5	23.6	23.6	23	6.8
6534	F	67	66.4	54.1	40.2	42.4	46	24.2	30.9	13.7	20.2	20.3	20.3	5
7081	F	50	62	47.6	39.7	43.7	44.9	22.3	30.3	15.6	26	21	21	7
7080	F	75	69.5	53.5	47.2	42.3	50.6	27.5	34.6	16.2	24.8	22.4	23.5	7
8120	F	107	68.4	55	45	46.3	48	22	31.2	14	27.6	21	23.8	7.1
6784	F	64	59.9	47.2	42.9	42.2	44.9	20	32.5	16.5	22.8	23.2	22.7	5.8
7652	F	49	54.1	49.5	38.2	43	43.1	16.7	30.5	23.6	16.2	22.1	21.7	6.6
6730	F	22	44	32	31	34.8	35.6	13.7	25.9	15.3	18.9	17.9	18.6	5.8
6559	F	104	76	67.2	45.3	44.8	49.5	26.2	37	18	26.4	23.6	23.6	7.3
7407	F	34	49.4	41.6	36.2	43.1	40.4	17.7	29.8	15.6	21.5	19.4	21.2	5.9
26	F	58	48	36	38	44.8	43.1	17	30.2	17.1	23.9	21	21.1	5.9
27	F	100	64.8	54	45.3	45.3	49.5	22.6	31.7	13.4	22	19.1	22	5.7
28	F	60	59.7	52.8	45.4	41.9	48.3	19.3	33.1	15.8	21.8	21.7	21.3	5.6
29	F	60	59.3	45.8	38.6	43.4	39.8	17	29.8	13.2	22.1	22.1	21.7	5.6
30	F	122	73	64.3	44.8	46	54.1	24.5	24.6	15.1	22.5	22.5	23.3	7.3
31	F	44	49.9	43	36.5	41.8	37.7	16.3	28.9	13.2	21.4	17.3	17.8	6.5
32	F	90	65.1	51.6	44	48.2		24.8	35.6	17.2	26.2	24.6	24.7	7.1
675	F	60	51.5	41.6	35.5	40.9		16.2	27.8	13.8	22	14.5	20	5.1
7078	M	129	83	68.5	51.2	53.6	51.8	24	40.3	16.6	34.8	25	25.5	7.3
8129	M	176	96.5	75.5	50	50.6	58.3	33.3	41.3	14.5	25.7	20	21.5	8.5
7268	M	74	59.7	49	39.5	45.8	46.7	18.8	32.7	12.8	24	20.7	20	8.3
6664	M	104	74.2	60.6	47	50.4	52.4	24.1	38	19.1	29.6	21.7	22.7	6.2
1	M	142	75		50.5	50.1				19.5	25.6	24.9	23.8	6.2
2	M	191	86.4	67.8	49	51	56.7	27.7	41.2	15.7	49.3	23.7	23.7	5.5
4	M	137	99.9	74.9	65	54.8	62.1	29.4	43.4	20	32.1	28.9	28	8
20	M	130	81.2	71.4	51.5	53.5	55.3	27.1	39.4	19.2	29	27.5	26.7	7.1
5	M	128	93.8	77.1	54.4	50.2	54.4	30	39.4	17.2	27.8	24	24	5
25	M	114	67.2	53.4	45.4	42.6	52.1	21.6	39.4	18.3	22.8	25.8	23.8	7.2
9	M	136	80.9	65.6	51.8	51	57.8	27	39.7	18	23.3	26.7	27.3	6.1
16	M	99	61.9	49.6	49.8	43.4	60.1	21.3	35.6	18.8	24.2	25	23.4	4.7
17	M	128	83	66.7	56.2	50.9	53.9	26	41.1	17.8	24.7	26.5	25.8	4.2
1	M	74	64.4	56.6	52.6	43.7	46.9	23.4	36	17.2	24.4	26.9	23.1	4.3
6	M	122	73	67.2	46	47.1	54.4	25.3	37.8	18.5	24.3	23	21.7	6.1
19	M	135	86.3	68.4	55.4	54.6	61.3	25.6	41.2	19.1	24.8	25.8	24.4	5.7
8	M	107	67.5	59.9	48	46.8	55.8	25.8	40.7	19.1	23.8	24.5	24.5	6.5
10	M	117	77.3	58.9	46.6	45.4	57.3	27.2	38.3	17	23.7	25.6	23.9	4.7
32	M	70	60.8	50	44.5	43.3	45.9	18	32.2	15	24.8	23.2	23.3	5.3
33	M	128	78	70	50.6	51.5	60.3	26.4	39	16.2	25.3	24.7	25.1	8.2
34	M	71	65.2	56.3	50	44.2	48.1	19.2	34.9	14.3	28	24	23.7	6.5
35	M	80	69.5	57.4	53	46.5	52.5	24	35.6	16	23.8	24.2	24.9	5.6
36	M	175	103.9	88.2	56.9	57	61.8	31	43	20.2	28.2	26.9	26.9	8.2
37	M	110	77.2	64.9	49.5	50.5	50.9	25.9	38.9	14.6	25	26.2	25.2	7.3
38	M	160	88.3	69.5	51	53.7	56.9	27	41.6	17	29	25	28.1	6.5
39	M	52	55.1	45	37.2	46	40	18	28.1	13.9	23.2	20	20.5	5.7
40	M	120			51	49	54.3	26.9	41	13.9	47.2	27.9	27.3	7.1
41	M	90	65	55.9	44.3	47.2	49.5	21.3	34.8	13	26.5	24	25	5.2
42	M	124	79.8	66	56.2	53.1	55.9	28	39.7	17	24.3	24	23	5.8
43	M	108	72.6	57	51.8	45.9	48.5	38	37	17.2	24.7	25.9	24.3	5.9
44	M	61	60.3	49.4	48.8	41	44.1	18	33.3	16.9	22.4	22	22.8	5.2

SPEC# = Specimen Identification Number
Sex = F = Female M = Male
Wght= Weight in LBS
GL= Greatest Length
GB = Greatest Breadth
BFCR = Cranial Articular Surface
BFGD = Caudal Articular Surface
GLF= Distance between BFCR and BFGD

LAD= Length of Dorsal Arch
H = Height
VFHP= Vertebral Foramen Height Proximal
VFHD= Vertebral Foramen Height Distal
VFWP= Vertebral Foramen Width Proximal
VFWD= Vertebral Foramen Width Distal
FH=Maximum Length of Transverse Foramen Height

Appendix 2
Humerus Control Sample

Spec#	Sex	Weight	BT	BD	TH	GT
7915	F	123	34.2	20.5	26.8	40.2
6543	F	144	38.2	23.8	31.3	42.8
7272	F	125	34	21.3	25.8	38.5
7413	F	89	31	20.4	25.8	33.7
6596	F	98	34.3	20.1	26.9	39.1
6534	F	67	31.8	18.3	24	18.3
7081	F	50	30.7	19.2	24.2	34.1
7080	F	75	37.8	22.1	27.8	41.3
8120	F	107	32.8	20	25.9	36.5
7269	F	92	31.9	19.9	25.8	34.2
8784	F	72	31.4	18.2	23.5	33.7
7852	F	49	30.5	17.5	23.2	32.7
7407	F	50	30	18.3	22.5	33.4
5	F	60	32	18	22	34.9
9	F	95	34	20.9	28	38.7
4	F	50	29	19	23	31.3
3	F	50	30	19	24.7	35.3
8	F	90	34	21	27.2	37.9
6	F	130	35.8	21.3	28.8	37.9
7	F	122	33	19.2	27	34.9
7078	M	129	38	22	30	42.2
13	M	168	37.2	22	29	42.2
8129	M	176	37	21.8	28.9	41.4
14	M	70	31.2	19	26.3	34.9
7268	M	74	33.8	20.3	25.8	35.5
6664	M	104	34.6	21.7	28	37.9
1	M	110	35.4	21.7	29.2	41.8
2	M	191	38.6	23.5	30.5	43.3
10	M	180	38.2	21.9	30.3	42
22	M	108	35.2	23.8	30.2	42.3
15	M	98	34.8	20.7	29.1	39.8
16	M	75	30.5	20.1	25.1	33
17	M	175	37	22	31	42
18	M	179	38	24.3	31	43
12	M	165	37	23.1	29	40
11	M	185	38	21.4	28.9	42.9
19	M	169	37	21	28.2	38.1
20	M	100	34.1	22	27.1	38
21	M	92	34	20	27	37.2

SPEC# = Specimen Identification Number

Sex = F = Female M = Male

Wght= Weight in LBS

BT= Breadth of the Trochlea

BD = Breadth of the Distal End of the Humerus

TH= Total Height

GT= Greatest Height

Appendix 3 Atlas Correlation Matrix

Pearson Correlation Coefficients / Prob > |R| under Ho: Rho=0
/ Number of Observations

	LGL	LBFCR	LBFCD	LGLF	LLAD	LH
LGL	1.00000 0.0 48	0.83594 0.0001 48	0.87603 0.0001 48	0.85172 0.0001 45	0.84325 0.0001 48	0.89697 0.0001 48
LBFCR	0.83594 0.0001 48	1.00000 0.0 51	0.74877 0.0001 51	0.84341 0.0001 46	0.79346 0.0001 50	0.87526 0.0001 50
LBFCD	0.87603 0.0001 48	0.74877 0.0001 51	1.00000 0.0 51	0.75775 0.0001 46	0.69823 0.0001 50	0.80374 0.0001 50
LGLF	0.85172 0.0001 45	0.84341 0.0001 46	0.75775 0.0001 46	1.00000 0.0 46	0.87349 0.0001 46	0.89808 0.0001 46
LLAD	0.84325 0.0001 48	0.79346 0.0001 50	0.69823 0.0001 50	0.87349 0.0001 46	1.00000 0.0 50	0.82494 0.0001 50
LH	0.89697 0.0001 48	0.87526 0.0001 50	0.80374 0.0001 50	0.89808 0.0001 46	0.82494 0.0001 50	1.00000 0.0 50
LVFHP	0.40718 0.0041 48	0.43473 0.0014 51	0.34615 0.0128 51	0.42463 0.0033 46	0.28305 0.0464 50	0.48332 0.0004 50
LVFWP	0.57859 0.0001 48	0.51871 0.0001 51	0.57295 0.0001 51	0.51075 0.0003 46	0.48934 0.0003 50	0.58324 0.0001 50
LVFHD	0.69673 0.0001 48	0.78989 0.0001 51	0.63720 0.0001 51	0.74411 0.0001 46	0.65435 0.0001 50	0.80215 0.0001 50
LVFWD	0.74434 0.0001 48	0.83493 0.0001 51	0.71481 0.0001 51	0.74648 0.0001 46	0.66829 0.0001 50	0.80680 0.0001 50
LFH	0.27445 0.0591 48	0.07993 0.5772 51	0.26394 0.0613 51	0.17482 0.2452 46	0.22105 0.1229 50	0.21492 0.1339 50

Appendix 3 (Cont.)

Correlation Analysis

Pearson Correlation Coefficients / Prob > |R| under Ho: Rho=0
/ Number of Observations

	LVFHP	LVFWP	LVFHD	LVFWD	LFH
LGL	0.40718 0.0041 48	0.57859 0.0001 48	0.69673 0.0001 48	0.74434 0.0001 48	0.27445 0.0591 48
LBFCR	0.43473 0.0014 51	0.51871 0.0001 51	0.78989 0.0001 51	0.83493 0.0001 51	0.07993 0.5772 51
LBFCD	0.34615 0.0128 51	0.57295 0.0001 51	0.63720 0.0001 51	0.71481 0.0001 51	0.26394 0.0613 51
LGLF	0.42463 0.0033 46	0.51075 0.0003 46	0.74411 0.0001 46	0.74648 0.0001 46	0.17482 0.2452 46
LLAD	0.28305 0.0464 50	0.48934 0.0003 50	0.65435 0.0001 50	0.66829 0.0001 50	0.22105 0.1229 50
LH	0.48332 0.0004 50	0.58324 0.0001 50	0.80215 0.0001 50	0.80680 0.0001 50	0.21492 0.1339 50
LVFHP	1.00000 0.0 51	0.02065 0.8856 51	0.51003 0.0001 51	0.42952 0.0017 51	-0.00021 0.9988 51
LVFWP	0.02065 0.8856 51	1.00000 0.0 51	0.45755 0.0007 51	0.52090 0.0001 51	0.20430 0.1504 51
LVFHD	0.51003 0.0001 51	0.45755 0.0007 51	1.00000 0.0 51	0.85234 0.0001 51	0.10416 0.4670 51
LVFWD	0.42952 0.0017 51	0.52090 0.0001 51	0.85234 0.0001 51	1.00000 0.0 51	0.16522 0.2466 51
LFH	-0.00021 0.9988 51	0.20430 0.1504 51	0.10416 0.4670 51	0.16522 0.2466 51	1.00000 0.0 51

LGB= Log of Greatest Breadth, LGL = Log of Greatest Length,
LBFCR = Log of Cranial Articular Surface, LBFCD = Log of Caudal Articular Surface
LGLF = Log of Greatest Length Between the Cranial and Caudal Articular Surfaces
LLAD = Log of Dorsal Arch, LH = Log of Height
VFHP = Vertebral Foramen Height Proximal, VFWP = Vertebral Foramen Width Proximal
VFHD = Vertebral Foramen Height Distal, VFWD = Vertebral Foramen Width Distal
LFH = Maximum Length of Transverse Foramen

Appendix 4
All Subsets Regression of the Atlas

Female Log weight Regressed to the Log of All Subsets

N = 18 Regression Models for Dependent Variable: LWGHT

In R-square Variables in Model

1	0.9081692	LGB
1	0.8981503	LGL
1	0.8749897	LBFCR
1	0.8137933	LGLF
1	0.7612057	LBFCR
1	0.7538803	LH
1	0.6860909	LVFWD
1	0.6575195	LLAD
1	0.5058374	LVFHD
1	0.4144724	LVFWP
1	0.1557984	LFH
1	0.0074837	LVFHP

2	0.9341820	LGB LBFCR
2	0.9338188	LGL LBFCR
2	0.9288696	LGB LBFCR
2	0.9254855	LGL LVFHP
2	0.9243177	LGB LLAD
2	0.9217996	LGB LGL
2	0.9185690	LBFCR LBFCR
2	0.9133695	LGB LVFHD
2	0.9126928	LGB LVFWD
2	0.9117356	LGB LVFHP
2	0.9117024	LGL LVFWP
2	0.9105276	LGL LVFWD

3	0.9600452	LGB LBFCR LLAD
3	0.9518335	LGL LBFCR LVFHP
3	0.9499929	LGL LVFHP LVFWD
3	0.9473870	LGB LBFCR LBFCR
3	0.9469452	LGL LBFCR LLAD
3	0.9408686	LGL LBFCR LBFCR
3	0.9402142	LGB LBFCR LVFHP
3	0.9393619	LGB LBFCR LLAD
3	0.9393101	LGB LBFCR LVFHD
3	0.9388137	LGB LGL LBFCR
3	0.9375978	LGB LBFCR LGLF
3	0.9368330	LGL LBFCR LFH

4	0.9793871	LGL LBFCR LLAD LVFHP
4	0.9733093	LGB LBFCR LLAD LVFHP
4	0.9728937	LGB LBFCR LLAD LVFHD
4	0.9670764	LGB LBFCR LLAD LVFWD
4	0.9653815	LGB LGL LBFCR LLAD
4	0.9638975	LGB LBFCR LBFCR LLAD

Appendix 4 (Cont.)

Female Log weight Regressed to the Log of All Subsets

In	R-square	Variables in Model
4	0.9638886	LGB LBFCR LGLF LLAD
4	0.9627646	LGB LBFCR LLAD LH
4	0.9617783	LGB LBFCR LLAD LVFWP
4	0.9606390	LGB LBFCR LLAD LFH
4	0.9600464	LGL LLAD LVFHP LVFWD
4	0.9573788	LGL LBFCR LBFC D LVFHP

5	0.9895032	LGB LGL LBFCR LLAD LVFHP
5	0.9885897	LGL LBFCR LGLF LLAD LVFHP
5	0.9806649	LGB LBFCR LGLF LLAD LVFHP
5	0.9806196	LGL LBFCR LLAD LH LVFHP
5	0.9803428	LGL LBFCR LLAD LVFHP LVFWD
5	0.9802722	LGL LBFCR LLAD LVFHP LVFHD
5	0.9801618	LGL LBFCR LLAD LVFHP LVFWP
5	0.9796600	LGB LBFCR LGLF LLAD LVFHD
5	0.9796222	LGL LBFCR LBFC D LLAD LVFHP
5	0.9794690	LGL LBFCR LLAD LVFHP LFH
5	0.9794056	LGB LBFCR LLAD LVFHP LVFWP
5	0.9780012	LGB LGL LBFCR LLAD LVFHD

6	0.9953650	LGB LGL LBFCR LGLF LLAD LVFHP
6	0.9911207	LGL LBFCR LGLF LLAD LVFHP LVFWP
6	0.9902233	LGB LGL LBFCR LLAD LVFHP LVFHD
6	0.9901102	LGB LGL LBFCR LLAD LVFHP LVFWP
6	0.9896712	LGB LGL LBFCR LBFC D LLAD LVFHP
6	0.9895474	LGB LGL LBFCR LLAD LVFHP LVFWD
6	0.9895071	LGB LGL LBFCR LLAD LVFHP LFH
6	0.9895054	LGB LGL LBFCR LLAD LH LVFHP
6	0.9891268	LGL LBFCR LGLF LLAD LVFHP LFH
6	0.9889796	LGL LBFCR LGLF LLAD LH LVFHP
6	0.9887351	LGL LBFCR LBFC D LGLF LLAD LVFHP
6	0.9887128	LGL LBFCR LGLF LLAD LVFHP LVFHD

7	0.9965924	LGB LGL LBFCR LGLF LLAD LVFHP LVFHD
7	0.9961575	LGB LGL LBFCR LGLF LLAD LVFHP LVFWD
7	0.9954948	LGB LGL LBFCR LGLF LLAD LVFHP LFH
7	0.9954790	LGB LGL LBFCR LBFC D LGLF LLAD LVFHP
7	0.9954427	LGB LGL LBFCR LGLF LLAD LH LVFHP
7	0.9953883	LGB LGL LBFCR LGLF LLAD LVFHP LVFWP
7	0.9928994	LGL LBFCR LGLF LLAD LVFHP LVFWP LFH
7	0.9923455	LGL LBFCR LBFC D LGLF LLAD LVFHP LVFWP
7	0.9913993	LGL LBFCR LGLF LLAD LVFHP LVFWP LVFWD
7	0.9911246	LGL LBFCR LGLF LLAD LVFHP LVFWP LVFHD
7	0.9911210	LGL LBFCR LGLF LLAD LH LVFHP LVFWP
7	0.9911014	LGB LGL LBFCR LLAD LVFHP LVFWP LVFHD

8	0.9966982	LGB LGL LBFCR LGLF LLAD LVFHP LVFHD LFH
8	0.9966869	LGB LGL LBFCR LGLF LLAD LVFHP LVFHD LVFWD

Appendix 4 (Cont.)

Female Log weight Regressed to the Log of All Subsets

In	R-square	Variables in Model										
8	0.9966829	LGB	LGL	LBFCR	LBFCR	LGLF	LLAD	LVFHP	LVFHD			
8	0.9965932	LGB	LGL	LBFCR	LGLF	LLAD	LH	LVFHP	LVFHD			
8	0.9965924	LGB	LGL	LBFCR	LGLF	LLAD	LVFHP	LVFWP	LVFHD			
8	0.9962544	LGB	LGL	LBFCR	LGLF	LLAD	LVFHP	LVFWP	LVFWD			
8	0.9962359	LGB	LGL	LBFCR	LGLF	LLAD	LVFHP	LVFWD	LFH			
8	0.9961798	LGB	LGL	LBFCR	LBFCR	LGLF	LLAD	LVFHP	LVFWD			
8	0.9961600	LGB	LGL	LBFCR	LGLF	LLAD	LH	LVFHP	LVFWD			
8	0.9956443	LGB	LGL	LBFCR	LGLF	LLAD	LVFHP	LVFWP	LFH			
8	0.9956381	LGB	LGL	LBFCR	LBFCR	LGLF	LLAD	LVFHP	LFH			
8	0.9956137	LGB	LGL	LBFCR	LBFCR	LGLF	LLAD	LVFHP	LVFWP			

9	0.9968126	LGB	LGL	LBFCR	LBFCR	LGLF	LLAD	LVFHP	LVFHD	LFH		
9	0.9967763	LGB	LGL	LBFCR	LGLF	LLAD	LVFHP	LVFHD	LVFWD	LFH		
9	0.9967416	LGB	LGL	LBFCR	LBFCR	LGLF	LLAD	LVFHP	LVFHD	LVFWD		
9	0.9967341	LGB	LGL	LBFCR	LGLF	LLAD	LVFHP	LVFWP	LVFHD	LFH		
9	0.9967119	LGB	LGL	LBFCR	LBFCR	LGLF	LLAD	LVFHP	LVFWP	LVFHD		
9	0.9966984	LGB	LGL	LBFCR	LGLF	LLAD	LH	LVFHP	LVFHD	LFH		
9	0.9966964	LGB	LGL	LBFCR	LGLF	LLAD	LVFHP	LVFWP	LVFHD	LVFWD		
9	0.9966915	LGB	LGL	LBFCR	LGLF	LLAD	LH	LVFHP	LVFHD	LVFWD		
9	0.9966881	LGB	LGL	LBFCR	LBFCR	LGLF	LLAD	LH	LVFHP	LVFHD		
9	0.9965934	LGB	LGL	LBFCR	LGLF	LLAD	LH	LVFHP	LVFWP	LVFHD		
9	0.9965056	LGB	LGL	LBFCR	LGLF	LLAD	LVFHP	LVFWP	LVFWD	LFH		
9	0.9963683	LGB	LGL	LBFCR	LBFCR	LGLF	LLAD	LVFHP	LVFWP	LVFWD		

10	0.9971095	LGB	LGL	LBFCR	LBFCR	LGLF	LLAD	LVFHP	LVFWP	LVFHD	LFH	
10	0.9969402	LGB	LGL	LBFCR	LBFCR	LGLF	LLAD	LVFHP	LVFWP	LVFWD	LFH	
10	0.9968618	LGB	LGL	LBFCR	LGLF	LLAD	LVFHP	LVFWP	LVFHD	LVFWD	LFH	
10	0.9968528	LGB	LGL	LBFCR	LBFCR	LGLF	LLAD	LVFHP	LVFHD	LVFWD	LFH	
10	0.9968165	LGB	LGL	LBFCR	LBFCR	LGLF	LLAD	LH	LVFHP	LVFHD	LFH	
10	0.9967957	LGB	LGL	LBFCR	LBFCR	LGLF	LLAD	LVFHP	LVFWP	LVFHD	LVFWD	
10	0.9967790	LGB	LGL	LBFCR	LGLF	LLAD	LH	LVFHP	LVFHD	LVFWD	LFH	
10	0.9967507	LGB	LGL	LBFCR	LBFCR	LGLF	LLAD	LH	LVFHP	LVFHD	LVFWD	
10	0.9967387	LGB	LGL	LBFCR	LGLF	LLAD	LH	LVFHP	LVFWP	LVFHD	LFH	
10	0.9967124	LGB	LGL	LBFCR	LBFCR	LGLF	LLAD	LH	LVFHP	LVFWP	LVFHD	
10	0.9966980	LGB	LGL	LBFCR	LGLF	LLAD	LH	LVFHP	LVFWP	LVFHD	LVFWD	
10	0.9965776	LGB	LGL	LBFCR	LBFCR	LGLF	LLAD	LH	LVFHP	LVFWP	LFH	

11	0.9972110	LGB	LGL	LBFCR	LBFCR	LGLF	LLAD	LVFHP	LVFWP	LVFHD	LVFWD	
										LFH		
11	0.9971437	LGB	LGL	LBFCR	LBFCR	LGLF	LLAD	LH	LVFHP	LVFWP	LVFHD	LFH
11	0.9970526	LGB	LGL	LBFCR	LBFCR	LGLF	LLAD	LH	LVFHP	LVFWP	LVFWD	LFH
11	0.9968662	LGB	LGL	LBFCR	LGLF	LLAD	LH	LVFHP	LVFWP	LVFHD	LVFWD	LFH
11	0.9968597	LGB	LGL	LBFCR	LBFCR	LGLF	LLAD	LH	LVFHP	LVFHD	LVFWD	LFH
11	0.9967966	LGB	LGL	LBFCR	LBFCR	LGLF	LLAD	LH	LVFHP	LVFWP	LVFHD	
										LVFWD		
11	0.9957401	LGL	LBFCR	LBFCR	LGLF	LLAD	LH	LVFHP	LVFWP	LVFHD	LVFWD	
										LFH		
11	0.9922279	LGB	LBFCR	LBFCR	LGLF	LLAD	LH	LVFHP	LVFWP	LVFHD	LVFWD	

Appendix 4 (Cont.)

Female Log weight Regressed to the Log of All Subsets

In	R-square	LFH Variables in Model
11	0.9919827	LGB LGL LBFCR LBFC D LLAD LH LVFHP LVFWP LVFHD LVFWD LFH
11	0.9861472	LGB LGL LBFCR LBFC D LGLF LLAD LH LVFWP LVFHD LVFWD LFH
11	0.9815352	LGB LGL LBFC D LGLF LLAD LH LVFHP LVFWP LVFHD LVFWD LFH
11	0.9675905	LGB LGL LBFCR LBFC D LGLF LH LVFHP LVFWP LVFHD LVFWD LFH

12	0.9972435	LGB LGL LBFCR LBFC D LGLF LLAD LH LVFHP LVFWP LVFHD LVFWD LFH

Appendix 4 (Cont.)

Male Log weight Regressed to the Log of All Subsets

N = 28 Regression Models for Dependent Variable: LWGHT

R-square Variables in Model
In

1	0.8322990	LH
1	0.7999999	LGB
1	0.7830531	LLAD
1	0.7525036	LGL
1	0.7426627	LGLF
1	0.3638845	LBFC
1	0.3037604	LBFCR
1	0.2595191	LVFWP
1	0.2322045	LVFWD
1	0.1951232	LVFHD
1	0.1848399	LVFHP
1	0.1253212	LFH

2	0.8754444	LGB LH
2	0.8701799	LGB LGLF
2	0.8700103	LLAD LH
2	0.8651233	LGL LH
2	0.8623882	LBFCR LH
2	0.8623033	LGLF LH
2	0.8602295	LH LVFWP
2	0.8576772	LGL LGLF
2	0.8499483	LH LVFHP
2	0.8483224	LH LVFHD
2	0.8419136	LGLF LLAD
2	0.8410343	LH LVFWD

3	0.9340490	LGB LBFCR LH
3	0.9152505	LGB LBFCR LGLF
3	0.9138382	LGL LBFCR LH
3	0.9042266	LBFCR LLAD LH
3	0.9000946	LBFCR LGLF LH
3	0.8977498	LLAD LH LVFWP
3	0.8966385	LGLF LH LVFWP
3	0.8947916	LGB LGLF LH
3	0.8913640	LGLF LH LVFHP
3	0.8913524	LGLF LLAD LVFWP
3	0.8911921	LGL LBFCR LGLF
3	0.8896052	LGB LGLF LVFWP

4	0.9583607	LGB LBFCR LGLF LH
4	0.9444226	LGL LBFCR LGLF LH
4	0.9408167	LGB LBFCR LH LVFWP
4	0.9359695	LGB LBFCR LH LFH
4	0.9352630	LGB LBFCR LLAD LH
4	0.9346674	LGB LBFCR LH LVFHD

Appendix 4 (Cont.)

Male Log weight Regressed to the Log of All Subsets

R-square Variables in Model

In

4	0.9341556	LBFCR LGLF LH LVFWP
4	0.9341053	LGB LBFCR LBFC D LH
4	0.9341015	LGB LBFCR LH LVFWD
4	0.9340593	LGB LGL LBFCR LH
4	0.9340512	LGB LBFCR LH LVFHP
4	0.9310384	LBFCR LLAD LH LVFWP

5	0.9700461	LGB LBFCR LGLF LH LVFWP
5	0.9631326	LGL LBFCR LGLF LH LVFWP
5	0.9605682	LGB LBFCR LGLF LH LFH
5	0.9599207	LGB LBFCR LGLF LH LVFHP
5	0.9585834	LGB LBFCR LBFC D LGLF LH
5	0.9585625	LGB LGL LBFCR LGLF LH
5	0.9585215	LGB LBFCR LGLF LLAD LH
5	0.9584105	LGB LBFCR LGLF LH LVFWD
5	0.9583889	LGB LBFCR LGLF LH LVFHD
5	0.9546741	LBFCR LGLF LLAD LH LVFWP
5	0.9488936	LGL LBFCR LGLF LH LVFHP
5	0.9472817	LGL LBFCR LGLF LH LFH

6	0.9722755	LGB LBFCR LGLF LH LVFWP LFH
6	0.9706867	LGB LBFCR LGLF LH LVFHP LVFWP
6	0.9705856	LGB LGL LBFCR LGLF LH LVFWP
6	0.9703380	LGB LBFCR LGLF LLAD LH LVFWP
6	0.9702679	LGB LBFCR LBFC D LGLF LH LVFWP
6	0.9700822	LGB LBFCR LGLF LH LVFWP LVFHD
6	0.9700462	LGB LBFCR LGLF LH LVFWP LVFWD
6	0.9662005	LGL LBFCR LGLF LH LVFWP LFH
6	0.9649393	LGL LBFCR LGLF LH LVFHP LVFWP
6	0.9640812	LGL LBFCR LGLF LLAD LH LVFWP
6	0.9637153	LGL LBFCR LBFC D LGLF LH LVFWP
6	0.9635023	LGL LBFCR LGLF LH LVFWP LVFHD

7	0.9735085	LGB LBFCR LGLF LH LVFHP LVFWP LFH
7	0.9734236	LGB LGL LBFCR LGLF LH LVFWP LFH
7	0.9723385	LGB LBFCR LBFC D LGLF LH LVFWP LFH
7	0.9723108	LGB LBFCR LGLF LLAD LH LVFWP LFH
7	0.9722789	LGB LBFCR LGLF LH LVFWP LVFHD LFH
7	0.9722779	LGB LBFCR LGLF LH LVFWP LVFWD LFH
7	0.9712635	LGB LGL LBFCR LGLF LH LVFHP LVFWP
7	0.9710403	LGB LGL LBFCR LBFC D LGLF LH LVFWP
7	0.9709377	LGB LBFCR LGLF LLAD LH LVFHP LVFWP
7	0.9708424	LGB LBFCR LBFC D LGLF LH LVFHP LVFWP
7	0.9707927	LGB LBFCR LGLF LH LVFHP LVFWP LVFHD
7	0.9706870	LGB LBFCR LBFC D LGLF LLAD LH LVFWP

8	0.9748476	LGB LGL LBFCR LGLF LH LVFHP LVFWP LFH
8	0.9736776	LGB LGL LBFCR LBFC D LGLF LH LVFWP LFH

Appendix 4 (Cont.)

Male Log weight Regressed to the Log of All Subsets

In	R-square	Variables in Model
8	0.9735603	LGB LBFCR LGLF LH LVFHP LVFWP LVFHD LFH
8	0.9735199	LGB LBFCR LBFCD LGLF LH LVFHP LVFWP LFH
8	0.9735153	LGB LBFCR LGLF LH LVFHP LVFWP LVFWD LFH
8	0.9735143	LGB LBFCR LGLF LLAD LH LVFHP LVFWP LFH
8	0.9735090	LGB LGL LBFCR LGLF LLAD LH LVFWP LFH
8	0.9734311	LGB LGL LBFCR LGLF LH LVFWP LVFHD LFH
8	0.9734254	LGB LGL LBFCR LGLF LH LVFWP LVFWD LFH
8	0.9724047	LGB LBFCR LBFCD LGLF LLAD LH LVFWP LFH
8	0.9723432	LGB LBFCR LBFCD LGLF LH LVFWP LVFHD LFH
8	0.9723410	LGB LBFCR LBFCD LGLF LH LVFWP LVFWD LFH

9	0.9750707	LGB LGL LBFCR LGLF LLAD LH LVFHP LVFWP LFH
9	0.9749819	LGB LGL LBFCR LBFCD LGLF LH LVFHP LVFWP LFH
9	0.9748545	LGB LGL LBFCR LGLF LH LVFHP LVFWP LVFHD LFH
9	0.9748478	LGB LGL LBFCR LGLF LH LVFHP LVFWP LVFWD LFH
9	0.9737215	LGB LGL LBFCR LBFCD LGLF LLAD LH LVFWP LFH
9	0.9736842	LGB LGL LBFCR LBFCD LGLF LH LVFWP LVFHD LFH
9	0.9736802	LGB LGL LBFCR LBFCD LGLF LH LVFWP LVFWD LFH
9	0.9735728	LGB LBFCR LBFCD LGLF LH LVFHP LVFWP LVFHD LFH
9	0.9735703	LGB LBFCR LGLF LLAD LH LVFHP LVFWP LVFHD LFH
9	0.9735700	LGB LBFCR LGLF LH LVFHP LVFWP LVFHD LVFWD LFH
9	0.9735315	LGB LBFCR LBFCD LGLF LLAD LH LVFHP LVFWP LFH
9	0.9735304	LGB LGL LBFCR LGLF LLAD LH LVFWP LVFHD LFH

10	0.9751499	LGB LGL LBFCR LBFCD LGLF LLAD LH LVFHP LVFWP LFH
10	0.9751024	LGB LGL LBFCR LGLF LLAD LH LVFHP LVFWP LVFWD LFH
10	0.9750707	LGB LGL LBFCR LGLF LLAD LH LVFHP LVFWP LVFHD LFH
10	0.9749884	LGB LGL LBFCR LBFCD LGLF LH LVFHP LVFWP LVFHD LFH
10	0.9749824	LGB LGL LBFCR LBFCD LGLF LH LVFHP LVFWP LVFWD LFH
10	0.9748638	LGB LGL LBFCR LGLF LH LVFHP LVFWP LVFHD LVFWD LFH
10	0.9737375	LGB LGL LBFCR LBFCD LGLF LLAD LH LVFWP LVFWD LFH
10	0.9737371	LGB LGL LBFCR LBFCD LGLF LLAD LH LVFWP LVFHD LFH
10	0.9736842	LGB LGL LBFCR LBFCD LGLF LH LVFWP LVFHD LVFWD LFH
10	0.9735910	LGB LBFCR LBFCD LGLF LLAD LH LVFHP LVFWP LVFHD LFH
10	0.9735830	LGB LBFCR LBFCD LGLF LH LVFHP LVFWP LVFHD LVFWD LFH
10	0.9735760	LGB LBFCR LGLF LLAD LH LVFHP LVFWP LVFHD LVFWD LFH

11	0.9751772	LGB LGL LBFCR LBFCD LGLF LLAD LH LVFHP LVFWP LVFHD LVFWD LFH
11	0.9751500	LGB LGL LBFCR LBFCD LGLF LLAD LH LVFHP LVFWP LVFHD LFH
11	0.9751271	LGB LGL LBFCR LGLF LLAD LH LVFHP LVFWP LVFHD LVFWD LFH
11	0.9749994	LGB LGL LBFCR LBFCD LGLF LH LVFHP LVFWP LVFHD LVFWD LFH
11	0.9737406	LGB LGL LBFCR LBFCD LGLF LLAD LH LVFWP LVFHD LVFWD LFH
11	0.9735957	LGB LBFCR LBFCD LGLF LLAD LH LVFHP LVFWP LVFHD LVFWD LFH
11	0.9718572	LGB LGL LBFCR LBFCD LGLF LLAD LH LVFHP LVFWP LVFHD LVFWD LFH
11	0.9695416	LGL LBFCR LBFCD LGLF LLAD LH LVFHP LVFWP LVFHD LVFWD LFH

Appendix 4 (Cont.)

Male Log weight Regressed to the Log of All Subsets

In	R-square	Variables in Model
		LFH
11	0.9658556	LGB LGL LBFCR LBFCD LGLF LLAD LH LVFHP LVFHD LVFWD LFH
11	0.9467049	LGB LGL LBFCR LBFCD LLAD LH LVFHP LVFWP LVFHD LVFWD LFH
11	0.9385013	LGB LGL LBFCR LBFCD LGLF LLAD LVFHP LVFWP LVFHD LVFWD LFH
11	0.9361450	LGB LGL LBFCD LGLF LLAD LH LVFHP LVFWP LVFHD LVFWD LFH
12	0.9752020	LGB LGL LBFCR LBFCD LGLF LLAD LH LVFHP LVFWP LVFHD LVFWD LFH

Appendix 5 Humerus Correlation Matrix

Correlation Analysis

4 'VAR' Variables: LTW LTH LGW LGH

Simple Statistics

Variable	N	Mean	Std Dev	Sum	Minimum	Maximum
LTW	39	3.5291	0.0836	137.6	3.3499	3.6533
LTH	39	3.0283	0.0823	118.1	2.8622	3.1739
LGW	39	3.2960	0.0962	128.5	3.0910	3.4468
LGH	39	3.6339	0.0967	141.7	3.4532	3.7705

Pearson Correlation Coefficients / Prob > |R| under Ho: Rho=0 / N = 39

	LTW	LTH	LGW	LGH
LTW	1.00000 0.0	0.86061 0.0001	0.88018 0.0001	0.93023 0.0001
LTH	0.86061 0.0001	1.00000 0.0	0.91772 0.0001	0.88437 0.0001
LGW	0.88018 0.0001	0.91772 0.0001	1.00000 0.0	0.89849 0.0001
LGH	0.93023 0.0001	0.88437 0.0001	0.89849 0.0001	1.00000 0.0

LTW = Log of Trochlea Width, LTH = Log of Total Trochlea Height
 LGW = Log of Greatest Trochlea Width, LGH = Log of Greatest Trochlea Height

Appendix 6 All Subset Regression of the Humerus

Female Log weight Regressed to the Log of All Subsets

N = 20 Regression Models for Dependent Variable:
LWGHT

Number in Model	R-square	Variables in Model
1	0.79902186	LGH
1	0.57577880	LTH
1	0.51125278	LGW
1	0.47364964	LTW

2	0.81085938	LTW LGH
2	0.80948346	LTH LGH
2	0.80391624	LGW LGH
2	0.59293923	LTH LGW
2	0.58485325	LTW LTH
2	0.51998141	LTW LGW

3	0.81542963	LTW LTH LGH
3	0.81090427	LTW LGW LGH
3	0.81047876	LTH LGW LGH
3	0.59301744	LTW LTH LGW

4	0.81594130	LTW LTH LGW LGH

Male Log weight Regressed to the Log of All Subsets

N = 19 Regression Models for Dependent Variable:
LWGHT

Number in Model	R-square	Variables in Model
1	0.95650459	LTW
1	0.80689004	LGW
1	0.70119967	LGH
1	0.59534027	LTH

2	0.95753894	LTW LGW
2	0.95722917	LTW LTH
2	0.95677106	LTW LGH
2	0.80916661	LGW LGH
2	0.80826395	LTH LGW
2	0.71417032	LTH LGH

3	0.95768787	LTW LTH LGW
3	0.95756706	LTW LGW LGH
3	0.95722992	LTW LTH LGH
3	0.80956897	LTH LGW LGH

4	0.95780542	LTW LTH LGW LGH

LTW = Log of Trochlea Width, LTH = Log of Total Trochlea Height
 LGW = Log of Greatest Trochlea Width, LGH = Log of Greatest Trochlea Height

**Appendix 7
Atlas Blind Test Data**

SPEC#	SEX	GB	GL	BFGD	BFCR	GLF	LAD	H	VFWP	VFHP	VFWD	VFHD
2603	F	47.8		38.4	44.6	42.7	16.8	30.5	16.8	23.7	21.3	20.9
3537	F	64.5	54.4	44.7	45.3	49.3	22.4	31.4	13	21.6	18.7	22.2
420	F	59.5	53	45.7	21.9	47.9	18.9	32.7	16.1	22.5	22.5	21.6
5761	F	58.9	46.1	38.4	43.6	40.5	17.3	30	12.2	21.7	21.7	22
7920	F	73.3	63.7	45	46.1	53.8	23.9	34.9	15	22.7	22.7	22.9
1386	F	50.4	42.8	36.8	42	37.5	16.6	29.3	13.4	21.6	16.9	18.3
7768	F	65.4	51.3	44.4	47.9		23	34.5	17.4	25.8	23.6	23.7
675	F	51.5	41.6	35.5	40.9		16.2	27.8	13.8	22	14.5	20
4912	M	61.2	49.6	44.7	23.9	46.2	18.2	32.5	14.5	25	23	23.5
2690	M	78.2	70.3	49.6	51.3	59.3	26.8	38.6	15.9	25.6	24.9	25.1
7917	M	64.9	55.7	50.4	43.6	47.6	19.5	33.5	13.9	27.7	22.5	23.9
8159	M	68.9	57	52.9	46.8	52.4	23.6	34.9	16.1	24.4	24.2	25.6
7079	M	105	87.6	57.2	57.3	61.5	30.6	42.9	19.8	28	27.4	27.4
7916	M	77.2	64.9	49.5	50.5	50.9	25.9	38.9	14.6	25	26.2	25.2
7082	M	87.9	70.5	50.9	54.1	57.6	27.4	42.6	17.4	28.5	25.4	27.7
7711	M	54.6	45.4	36.7	46.2	40.4	17.9	27.6	14.4	22.9	20.2	20.5
7937	M	65.1	56	44	47.4	48.9	20.8	35	23.3	25.7	24.3	25.2
7626	M	80.1	66.2	52.6	52.7	56.4	28.2	40.2	16.6	23.9	23.7	23.2
7936	M	59.9	48.9	49	41.3	43.7	18.4	34.1	17.4	21.8	21.3	23.1
424	M	71.9	57.3	51.3	46.4		38.3	37.3	17	24.4	25.4	24.6

Spec# = Specimen Identification Number VFHP = Vertebral Foramen Height Proximal
 GL = Greatest Length VFHD = Vertebral Foramen Height Distal
 GB = Greatest Breadth VFWP = Vertebral Foramen Width Proximal
 BFCR = Cranial Articular Surface VFWD = Vertebral Foramen Width Distal
 BFGD = Caudal Articular Surface FH = Maximum Length of Transverse Foramen
 GLF = Distance between BFCR and BFGD

Appendix 8 Humerus Blind Test Data

Spec#	Sex	BT	BD	TH	GT
2603	F	32	18	22	34.9
7920	F	34.4	21.1	28	39.3
1368	F	28.5	18.8	22.7	31.6
420	F	30.2	18.6	24.4	35.5
7918	F	33.7	20.8	26.9	38.2
5760	F	36.1	21.5	26.6	38.4
5782	F	33	18.9	27.3	35.4
2609	M	36.9	21.6	28.6	42.5
4912	M	30.9	19.1	26	34.7
7079	M	38	22	30	42.2
7916	M	34.9	23.5	30	42
7082	M	34.6	20.5	28.9	39.5
7711	M	30.3	19.8	25	33.4
7885	M	36.9	22.5	31.4	41.8
7626	M	38.1	23.9	31.2	43.2
2328	M	37.2	22.7	29.5	40.5
424	M	37.8	21.7	28.5	42.6
8159	M	36.7	21.2	28.5	38.6
7917	M	33.9	21.6	26.8	38.2
7687	M	34.1	20.3	27.1	36.6

SPEC# = Specimen Identification Number

Sex = F = Female M = Male

BT= Breadth of the Trochlea

BD = Breadth of the Distal End of the Humerus

TH= Total Height

GT= Greatest Height

Appendix 9

Atlas Blind Test Results
Fisher Discriminate Function Test
Female = -571.396+306.026(log of BFCR)
Male = -626.814+320.54(log of BFCR)

ID#	Sex	Female Score	Male Score	Predicted
2603	Female	545.004	542.534	Female
2609	Male	623.327	624.571	Male
7711	Male	531.327	528.02	Female
4912	Male	591.495	591.23	Female
7916	Male	622.709	623.924	Male
7917	Male	626.223	629.7	Male
420	Female	598.265	598.321	Male
7920	Female	593.542	593.374	Female
424	Male	633.64	635.373	Male
7626	Male	641.298	643.395	Male
7936	Male	619.602	620.67	Male
3537	Female	591.495	591.23	Female
7937	Male	586.664	586.17	Female
8159	Male	643.039	645.218	Male
5761	Female	545.004	542.534	Female
7668	Female	589.434	589.071	Female
675	Female	520.974	517.364	Female
7079	Male	666.955	670.268	Male
7082	Male	631.244	632.864	Male
1386	Female	531.98	528.892	Female

		Number Correct	Percent Correct
Males	12	9	0.8
Females	8	7	
Total	20	16	

Appendix 10

Humerus Blind Test Results

Fisher Discriminate Function Test

Female = $-632.324 + 512.959(\log \text{ of greatest width})$

Male = $-689.657 + 530.346(\log \text{ of greatest width})$

ID#	Sex	Female Score	Male Score	Predicted
7920	Female	1050.86	1057.36	Male
420	Female	998.7	1003.4	Male
5760	Female	1038.98	1045.08	Male
7711	Male	967.42	971.09	Male
5762	Female	997.25	1001.93	Male
7082	Male	987.01	991.34	Male
4912	Male	1053.47	1060.05	Male
2603	Female	989.96	994.39	Male
424	Male	1092.22	1100.12	Male
7856	Male	1082.5	1090.07	Male
7916	Male	1084.95	1092.6	Male
7626	Male	1099.4	1107.54	Male
7917	Male	1036.3	1042.31	Male
7687	Male	1014.35	1019.61	Male
1368	Female	939	941.71	Male
7918	Female	1036.3	1042.31	Male
2328	Male	1066.29	1073.31	Male
2609	Male	1091.02	1098.88	Male
7079	Male	1087.38	1095.12	Male
8159	Male	1041.64	1047.83	Male
		Number Correct	Percent Correct	
Males	13	13	0.68	
Females	6	0		
Total	19	13		

Appendix 11 Archaeological Atlas Data

SPEC#	STAT	GB	GL	BFGD	BFCR	GLF	LAD	H	VFWP	VFHP	VFWD	VFHD	FH
4081	1		64.2	52.3				38.3	20.7	29.8	24.5	24.6	3.9
4062	3		61.9	47.7	39.5		25	37.2				21.8	
4063	3		69.2	51.8								23.7	6
4064	2				46							23.7	6
4065	2		63.4	50				37.7					7.3
4066	2		75.7	52.6	42.8		27.5	43.3	16.3	26.2	25.7	24.2	6.8
4087	2		77.1	52.4				43.9		26.3	16.9		7.4
4088	2		69.4	86.3				40.4					6.2
4089	2		67	52.5				39	17.9	24.6			6.5
40810	2		81.7	50.9	49.6			45.8	17.5	25.6	28.9	26.4	8.5
40611	0	94.1	74.3	52	50	59.5	27.8	41.6	15.3	26.9	23.3	26.5	6
40612	1		77.4	55.9			27	44	27	25.8			8.5
40613	1				51.6						26.4		8.4
40614	1		78.1	56				44.3			25.6	24.9	9
40615	1		74.1	56.4			35.6	42.6	29.6	18.9			6.4
40618	2		73.8	51.4	45.3	52	26	42.4	18	27.2	25	25.9	8.8
40617	2		73.1	53.8	52.2	54.1	31.5	42.2			21.4	24.7	6.8
40618	1		68	49.7	45.1	51.7	31.4	40	20	26.6	24.8	22.4	9.5

SPEC# = Specimen Identification Number

LAD= Length of Dorsal Arch

Stat= 1= High Status, 2= Low Status, 3= Cherokee, 0=unknown

H = Height

GL= Greatest Length

VFHP= Vertebral Foramen Height Proximal

GB = Greatest Breadth

VFHD= Vertebral Foramen Height Distal

BFCR = Cranial Articular Surface

VFWP= Vertebral Foramen Width Proximal

BFGD = Caudal Articular Surface

VFWD= Vertebral Foramen Width Distal

GLF= Distance between BFCR and BFGD

FH=Maximum Length of Transverse Foramen

Appendix 12 Archaeological Humerus Data

Spec#	Status	BT	BD	TH	GT	Spec#	Status	BT	BD	TH	GT
406103	2	34.5	28.9	34.5	40.3	4069	2		30.1	37.9	42.3
40660	3	38.3	31.8		40	40610	2			35.5	
40661	3		29.8		39.7	40611	2	33.5			40.8
40662	1	33.1	27	32.5	36	40612	2	35.8	29	33.5	37.8
40663	1	32.6	27.7	32	31	40613	2	31.7	25	31.1	35.2
40664	1	33.1	27	36.8	31	40614	2	32.9	27.9	35.4	37.2
40665	1	31.6	26.2		34.6	40615	1	31.2	26.7		36.8
40666	1	32.3	26.2	31.6	37.9	40616	0	36.7	29.6	37.2	40.4
40667	1	34	27.6	33.8	37.4	40617	1	29.8	25.6	33.7	34.3
40668	1	36.5	30.5	32.2	41.5	40618	1	34.5	29.3		38.3
40669	2	36.3	30	36	41.9	40619	3	35.8	25.8	37.3	40.1
40670	2	32.1	26	31	36.2	40620	3		25		32.9
40671	2	34	27.5	37	31.6	40621	3		27.7	35.6	36
40672	2	34	27.5	37	31.6	40622	1		29.4	34.7	39.6
40673	2	38.1	31.2	38.5	41.7	40623	1	36.2	29.4	34	39.2
40674	2	34.2	26.4	34.4	37.1	40624	1	37.7	33	39.6	44
40675	2	37	29.7		42.8	40625	3		31	38.9	41.2
40676	2	38.8	32.6	37.6	43.6	40656	2	31.3	26.5	35	
40677	2	36.6	29.7	36.6	41.7	40657	2	36			43.4
40678	0	33.7	26.8	32	36.8	40658	2	34.9	28.6		38
40679	0	37.6	30.4	39.5	42.3	40659	2	33.2	26.1		37.8
40680	2	36.7	29.5	36.5	43.5	406104	0	33.9	27.7	33.7	36.9
40681	2	35.4	30.4	35.1	42	40626	3	34.3			41.6
40682	2	36	29.6	35.5	43	40627	3	35.4	26.2	33.3	39.3
40683	2	36	29.6	35.5	42	40628	3		26.4		34.9
40684	2	32.4	25.3		33.3	40629	3	33	26.6	33.7	35.2
40685	2	34.9	27.8	34.8	43	40630	1	35.3			
40686	1	37.5	31.7	37.5	43.3	40631	1	34.8	28.4	38	39.5
40687	1	32.8	26.2	32.6	36	40632	1	33.5	28	35.7	36.2
40688	1	34	27.7	33.9	39.9	40633	0	32.6	27.5	32.2	36.1
40689	1	36	28.1	33.5	38.4	40634	0	31.8	26.9	31.4	36.8
40690	1	38.7	33.1	39.3	43.5	40635	2		25.7	32.6	33.9
40691	3		25.7	31.6	37.9	40636	2	34.2	28.4		37.7
40692	1	34.6	27.7	36.7	44.4	40637	1	35.6	29.2	34.4	41.2
40693	1	36.4			49.2	40638	3	31.9			42.7
40694	1	33.3	26.5	34.4	35.4	40639	3	34.8	30.2	33.5	40.8
40695	1	32.5	25.6	30.8	35.4	40640	3	28.9	32.6	33.3	39
40696	1	37.5	30	33.5	42	40641	3	36.6	28		39
40697	1	34.7	25.9	33.1	38.5	40642	1	30.3	25.7	29.3	37.4
40698	1	35.8	29.2	32.2	37.8	40643	1	28.5	27.8	32.7	32
40699	0	32.9	27.2	32.2	37.2	40644	2	31.2	25.7	30.3	33.8
406100	1	36.8	28.8	37.5	40.6	40645	2	31.7	28	35.4	40
406101	1	35.6	28.3	33.5	33.9	40646	2	32.9	27.5	31.8	37.9
406102	2	36.2	27	33.8	41	40647	2	34.7	29.3	34.8	39.3
4061	2	32.6	19	25.3	33.7	40648	2	29.6	37.7	37.6	42
4062	0		21.5		28	40649	2	36.5	31.5	40.1	43.3
4063	0		20.5		26.6	40650	2	36.5	29	35.3	41.2
4064	1	31.8	27.3	34.5	38	40651	2	32.9	27.3	40.7	37.8
4065	1		24.6	28.2	36	40652	2	25.7	26.2	31.7	37.3
4066	1	34.2			41.5	40653	2	33.6	26.9	33.9	36
4067	2	37.2	29.6	37	42.7	40654	2	24.1	25.8	34.2	36.5
4068	1	32.7	26.6	34.2	37.2	40655	2	40	33		43.3

SPEC# = Specimen Identification Number

BD = Breadth of the Distal End of the Humeru

STATUS = 1 = High, 2 = Low, 3 = Cherokee, 4 = Unknown

TH = Total Height

BT = Breadth of the Trochlea

GT = Greatest Height

VITA

Christian DeForest Davenport was born on March 5, 1970, in Baltimore, Maryland. However, he spent his early childhood in Duxbury, Massachusetts. At age seven, he moved back to Maryland. At this time, he joined a local archaeology group. In the fall of 1988, Christian graduated from Centennial High School in Howard County, Maryland. In the summer of 1989, he was chosen from 1,200 applicants to study, work and dive with the Cousteau Society the Channel Islands in California.

In the spring of 1989, he entered Howard County Community College, Maryland, where he was a General Studies Major. This is where Christian had his first anthropology course. After a year's at study Howard County Community College, Christian was accepted into the undergraduate program of studies at Franklin Pierce College in Rindge, New Hampshire.

While at Franklin Pierce, he majored in Anthropology and was awarded the Outstanding Sophomore in Anthropology in 1991. In his senior year, he was awarded the Anthropology Award. Then in 1993, he graduated magna cum laude.

While applying to graduate school, he worked for various Cultural Resource Management Groups throughout the Mid-Atlantic and New England Regions. In 1994, he was accepted into the Anthropology Department of the University of Tennessee, Knoxville. At this time, under Walter E. Klippel, Ph.D., he became interested in zooarchaeology. He was awarded graduate assistantships in 1994 and 1995. Christian was granted a Master of Arts degree in Anthropology in May 1999.