Differential identifiability between chosen North American gallinaceous skeletons and the effect of differential survivorship

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Abstract. Differential identifiability – the variation in the ease with which skeletal parts can be identified in samples of their bones – affects the presence and abundance of gallinaceous birds reported in the zooarchaeological record. In this paper, I examined how the distinctiveness of morphological characters among 27 fossil classes of the gallinaceous birds: Bobwhite Colinus virginianus; Ruffed Grouse Bonasa umbellus; Prairie Hen Tympanuchus cupido; and Wild Turkey Meleagris gallopavo may limit the researcher’s ability to identify an archaeological bird bone specimen. The results and discussion: 1) demonstrate that the morphology of bird bones may limit taxonomic distinctions even at the high taxonomic levels of order and subfamily; and 2) present three patterns relating the differential identifiability of fossil classes to their differential survivorship. Awareness of the effects of these two factors potentially increases researchers’ ability to explain the occurrence and abundance of “rare” bird taxa in the archaeofaunal record.

Key words: gallinaceous birds, differential survivorship, skeletal identification.

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I. INTRODUCTION

Identification is, of course, the foundation on which all subsequent analysis rest (LAWRENCE 1973, as cited by PARMALEE 1977).

Differential identifiability – the variation in the ease with which skeletal parts can be identified in samples of their bones – affects the presence and abundance of gallinaceous birds reported in the zooarchaeological record. The differential identifiability of bone elements (e.g., femur) or portions (e.g., distal end or epiphysis) is dependent on the existence of intrinsic characters or the "attributes which are inherent to the organisms themselves" (WILEY 1981: 115). Archaeologists too recognize that although a bone element and portion is “recognizable” the lack of diagnostic characteristics often prevents an identification to taxon (WHITE 1952; HARGRAVE 1972; LYMAN 1979; HARGRAVE & EMSLIE 1979; SHIPMAN 1981; EMSLIE 1984; PARMALEE 1985; REA 1986). Archaeological reports of animal remains tend to neglect detailing how identifications are made (DRIVER 1992; BUTLER & LYMAN 1995). JONES & LEONARD (1989) and BOBROWSKY & BALL (1989) warn that classification schemes and methods of identification must be defined, clearly standardized, and recognized by all
researchers; otherwise quantitative measures will misrepresent the archaeological material under study. Moreover, it is equally important for analysts to recognize their own limitations in identifying different taxa, to be humble enough to ask other specialists for assistance, and to be conservative when differential identifiability occurs in their samples.

When comparing archaeofaunas, researchers compensate for this bias by distinguishing different levels of identifiability (LYMAN 1979) (Table I). Recognizing how misidentifications can result in the misinterpretation of animal use by Native Americans, I adopt a “conservative approach” to identifying remains (DIRRIGL 1991). This approach considers only positive identifications. I transpose any questionable identification based on the concept of closest or next higher taxonomic category. If an animal is identified as possible or ? or cf. at a given level (e.g., *Meleagris gallopavo*?), I change the animal’s identification to the closest or next higher taxonomic category (i.e., a Massachusetts, USA specimen of *M. gallopavo* could be transposed to Subfamily: Meleagridinae. However, because only a single species of *Meleagris* is extant, I would record the next higher taxonomic category of Order: Galliformes).

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Table I

Levels of identifiability for animals (modified after LYMAN 1979)

For birds, the similarity of appearance of skeletons hinders taxonomic identifications of species. Thus, archaeologists may resort wrongly to assuming that large bird bones are of Wild Turkey *Meleagris gallopavo*, even when analysts caution that the bones of Wild Turkey and other birds appear similar (HARGRAVE & EMSLIE 1979). This practice leads to specimens being misidentified in museum collections, reports, and publications.

My recent reexamination of remains identified as Wild Turkey *Meleagris gallopavo* for the Calf Island Site, Massachusetts (LEUDTKE 1980) demonstrates this problem. In a sample of bones recognizable as diaphysis long bone fragments, the previous identification of numerous small fragments to Wild Turkey is questionable because the specimens lack diagnostic characteristics for identification at the levels of family, genus, or species. In my conservative approach, I would not assume that
the fragments “must belong” to a turkey because other bones were identified to this species. The resulting published number of identified specimens (LEUDTKE 1980) is therefore misrepresented not by the fault of the author, but perhaps by the analysts of the animal remains not recognizing the problems caused by differential identifiability. As part of my research program, I have worked toward awakening the archaeological community of the Northeast United States to similar case studies involving problems of identification among both invertebrate and vertebrate remains (DIRRIGL 1993a, 1993b).

The absence of comparative studies of bird osteology and the lack of skeletal specimens in scientific collections is problematic for zooarchaeologists who identify animal remains from archaeological contexts and study prehistoric bird hunting by Native Americans. In the Northeast, as well as other areas, archaeofaunal samples differ in their preservation and representation of bird remains (DIRRIGL 1991). The high fragmentation of remains and few recognizable skeletal elements commonly associated with northeastern samples often limits making identifications using diagnostic osteological characters (cf. ZIEGLER 1973; WATSON 1979; LYMAN 1979, 1987).

Current state of research in the Northeast United States

Gallinaceous birds are no exception. Archaeological evidence indicates that Wild Turkey *Meleagris gallopavo* and Ruffed Grouse *Bonasa umbellus* comprise a major part of the northeastern avian archaeofaunal record (STEADMAN 1988; DIRRIGL 1991; FUNK 1993) although the survival of body parts varies among samples. Based on its frequency, archaeologists suggest that wild turkey played important role in the prehistoric diet of Northeast Native Americans (RITCHIE 1965; RITCHIE & FUNK 1973; GRAYSON 1974; FUNK 1976, 1993; NEUMANN 1989).

I agree with these researchers, having found similar animal use patterns (DIRRIGL 1991). However, the under-representation of other gallinaceous bird species (e.g., Bobwhite *Colinus virginianus* and Heath Hen *Tympanuchus cupido cupido*) in the archaeological record does not suggest that other gallinaceous bird species were any less important. For example, in my database of over 100 archaeofaunal samples from New England and New York, only three Massachusetts sites contain the bones of the extinct Heath Hen. It is incorrect to use this information to assume that the Heath Hen was less important to diet and bird use than Wild Turkey. Clearly, cultural and non-cultural factors (SCHIFFER 1987; LYMAN 1995) may account for the absence.

I propose that research reports about the presence of different types and abundance of gallinaceous birds are dependent upon “differential identifiability” – the variation in the ease with which skeletal parts can be identified in samples of their bones. This ease may, therefore, be one bias accounting for the commonality of some species and the rarity of others. LYMAN (1995) provides the best discussion of the complex determination of why a specific animal is absent in the archaeological record. He reports that the misidentification of animal remains is potentially a sixth reason that evidence of a particular taxon is absent in reports and museum collections.

Differential identifiability is also dependent on the differential loss of specimens (GRAYSON 1991) that results from taphonomic biases such as density-mediated attrition (LYMAN et al. 1992). Whereas other studies of density-mediated attrition include similar comments, the assessment of the potential effects is lacking (LYMAN 1984; KREUTZER 1992). DIRRIGL (1998, 2001) demonstrated that the skeletal elements and portions of gallinaceous birds differ in their bone mineral density (BMDa and BMDv). My examination of paleontological and archaeological samples of gallinaceous bird remains demonstrated that density-mediated attrition accounted at least, in part, for the differential survivorship of skeletal parts.

With this project, I examine how the differential identification of bird bone potentially affects the reports of gallinaceous birds in samples of their bones. Clearly, the inherent problems of identifying bird bones indicate that an examination of differential identifiability among gallinaceous birds is warranted. I also examine the relationship between the identification/representation of fossil classes and density-mediated attrition using DIRRIGL (1998, 2001). Until these biases are consid-
erected, it may be premature to develop cultural criteria to distinguish birds hunted by the prehistoric peoples of the Northeast United States similar to those proposed for the Southwest (Senior & Pierce 1989).

Acknowledgments. I am grateful to George Clark (University of Connecticut) for his mentoring and careful review throughout this project. The use of skeletal specimens required loans through several institutions, and the generous cooperation of the following individuals is merited: Joseph Bopp (New York State Museum, Biological Survey); Charles Dardia (Cornell University, Division of Biological Sciences); Robin Panza (Carnegie Museum of Natural History); Mark Robbins (University of Kansas, Museum of Natural History); Fred Sibley (Peabody Museum of Natural History, Yale University); and Paul Sweet (American Museum of Natural History). Additional assistance with archaeological collections was provided by Lisa Anderson (New York State Museum), Susan Bruce (Peabody Museum of Archaeology and Ethnology, Harvard University), Eric Johnson (Massachusetts Historical Commission), Barbara Leudtke (University of Massachusetts, Boston), and Stephen Warfel and Janet Johnson (State Museum of Pennsylvania, Section of Anthropology). Teikyo Post University provided travel support to present this paper at the IV International Meeting of the ICAZ Bird Working Group in Kraków, Poland. Finally, I am grateful for the editorial comments and corrections offered by the anonymous reviewers of this paper. An inherent limitation in my review and presentation is my inability to read non-English written works.

II. MATERIALS AND METHODS

Zooarchaeologists should identify to a particular taxon only those bones which can unquestionably be assigned to it (Driver 1992: 43).

Bird identification and phylogenetic study relies on combining relationships derived from genetic sequence data, observable external characters (e.g., feather pattern and color), ecological characters (e.g., territory), vocalization, and lastly osteological or myological characteristics (Bledsoe 1988; Hughes 1996; Ellsworth et al. 1996). Studies of bird osteology focus on the comparative material from museum specimens to identify macroscopic diagnostic characters. Interested analysts of gallinaceous bird bones should consult the references listed in Dirrigl (1998: Table 4.2) or Zooarchaeology Home Page (www.zooarchaeology.com).

This study examines the differential identifiability among the appendicular skeletal elements of Bobwhite Colinus virginianus Linnaeus, 1758, Ruffed Grouse Bonasa umbellus (Linnaeus, 1766), Prairie Hen Tympanuchus cupido (Linnaeus, 1758), and Wild Turkey Meleagris gallopavo Linnaeus, 1758 using annotated descriptions presented in Dirrigl (1998). The development of this study is based on Woolfenden (1961) for waterfowl and Gilbert et al. (1981), Hargrave (1972), Hargrave and Emslie (1979), Holman (1961, 1964), and MacDonald (1992) for gallinaceous birds. In Dirrigl (1998), I limited my presentation to the characteristics and fossil classes most useful to identification rather than the development of full zoological diagnoses. My results annotated the skeletal characteristics reported by Gilbert et al. (1981) for Anseriformes (A. platyrhynchos) and Galliformes (C. virginianus, B. umbellus, M. gallopavo and T. cupido). The descriptions in Dirrigl (1998) are provided to assist archaeologists, many who use this classic reference regularly, with identifying bird remains.

Importantly, my treatment is not meant to be a definitive resource for identification. Only through examining and comparison with several well-prepared museum specimens, should identifications be determined. This practice will also allow the archaeologist to become familiar with the variation in skeletal morphology that is present intraspecifically and interspecifically. For example, I found variation among the proximal femur, proximal ulna, and proximal scapula between specimens of T. cupido not previously reported by Allen (in Gross 1928). A future project will review these finding for the subspecies of T. c. cupido.
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My descriptions do not include size differences similar to GILBERT et al. (1981). Whether size is used to identify one gallinaceous bird from another is a matter of choice by the faunal analyst. Although I do not report size differences, in some circumstances taxonomic separation is appropriate. For example, the proximal radii of Galliformes are indistinguishable morphologically, but the recovery of a large, broad gallinaceous specimen would most likely be M. gallopavo. In making such a decision, the faunal analyst must heed the cautionary notes provided by avian osteologists HARGRAVE 1972; HARGRAVE & ESMILIE 1979; STEADMAN 1980.

Thus, similar to MACDONALD (1992:315), I focused on identifying “non-metric traits” or qualitative structural differences rather than morphometric data (cf. MCKUSICK 1986). I chose not to study morphometric differences for several reasons. First, the lack of complete skeletons and the availability of specimens for loan (e.g., Prairie Hen) hindered any morphometric study. Second, although bird morphometric studies (e.g., CRACRAFT 1968, 1976) are useful in assessing the size and shape of skeletal elements among taxa, LOUGHEED et al. (1991: 436) caution about measurement errors and the “problem variables” existing among them. Third, morphometric data may not always provide dependable criteria for making taxonomic distinctions between bird species (cf., Podicipediformes (grebes) examined by BOCHENSKI 1994 and LIVEZEY & STORER 1992). Lastly, the utility of skeletal measurements, such as those presented by GILBERT et al. (1981), is limited in the Northeast United States where bird remains are recovered most often as fragmented pieces.

I utilized the osteological terminology presented by BAUMEL et al. (1993) and GILBERT et al. (1981) to compare intrinsic, morphological characters (i.e., structural attributes sensu WILEY (1981: 319-322)) exhibited by birds. I adopted WILEY’s (1981: 115-119) view of characters as features that exhibit systematic relationships among organisms. Characters that are useful to identification are those that: (1) vary between taxa; (2) vary in a correlated, coherent manner; and (3) do not vary environmentally (WILEY 1981: 319). I examined macroscopic morphological characters among the appendicular skeletons of dried museum specimens lacking muscle or ligaments. Additionally, I used the glossary of anatomical terminology presented in BORROR et al. (1976) and SCHWARTZ (1995) based on the references presented therein.

My study only considered the osteological characters of males for several reasons. DIRRIGL’s (1998, 2001) study of mineral bone content and density necessitated examining males because of the presence of medullary bone in females, which is lost and gained with egg laying (TAYLOR et al. 1971; SIMKISS 1975; DACKE et al. 1993). JOHNSGARD (1973: 87, Table 18) reports that adult males comprise over half of the present populations of gallinaceous birds, and it is likely that males would be well represented in prehistoric cultural deposits. Whenever possible, several specimens of each taxa were examined following the recommendations of BOCHENSKI & TOMEK (1995) and STEADMAN (1980). A skeletal element is a discrete anatomical unit that includes portions and features. I studied the appendicular elements commonly found in northeastern archaeofaunal samples based on DIRRIGL (1998) and considered by researchers to be most useful taxonomically: humerus, carpometacarpus, coracoid, tarsometatarsus, femur, tibiotarsus, and scapula (BLEDSOE 1988). Although the ulna and radius may be considered less useful (BLEDSOE 1988), I also examined these elements. Because the fibula of gallinaceous birds is fused with the tibiotarsus and is found regularly broken on both museum and archaeological specimens, I avoided its description.

For each element, I noted the differences in osteological characters for the proximal, medial, and distal portions. Following HOLMAN (1961, 1964), osteological characters exhibiting no differences were not included in the descriptions. Comparing gallinaceous bird bones to mallard (Anseriformes: Anas platyrhynchos), I examined the differential identifiability among the two bird orders: Galliformes to Anseriformes. The decision to compare these two orders is based on the common ancestry reported by DZERZHINSKY (1995), although debate about this relationship continues (ERICSON 1996). Using the information from DIRRIGL (1998, 2001) for areal and volumetric bone mineral density (BMDa and BMDv), I also discuss the effect of differential survivorship on the reporting of the skeletal parts relating to their differential identifiability.
III. RESULTS AND DISCUSSION

If the major goal of zooarchaeological analysis is calculation of relative frequency of species, some species will be more abundant simply because their skeletons are more easily identified (Driver 1992: 41).

Identification biases of archaeological artifacts and ecofacts (see review by Schiffer 1987: 362) can be attributed to the ability, training, and experience of analysts and the condition of the specimens they examine. Interanalyst biases toward identifying zooarchaeological specimens demands attention (Lyman & O’Brien 1987; Driver 1992). To demonstrate the differential identifiability of diaphysis long bone fragments, I recommend that the beginning analyst smash specimens of gray squirrel \textit{Sciurus carolinensis} and Mallard \textit{A. platyrhynchos}, mix them in a box, and attempt to sort among the two species. The problem encountered for a basic interclass determination of mammals from birds becomes apparent.

Hillson (1992: 5-6) describes the basic steps for identification: (1) “Decide which bone in the body it is from, and which fragment of that bone it is”; (2) “Decide which side of the body it is from”; (3) “Assess its size and robustness”; and (4) “Look for detailed points of anatomy to amend finer distinctions that are possible.” This is similar to Driver’s (1992) notion that the identification of vertebrates relies on descriptions of species, element, and part of element (i.e., portion). Furthermore, the characteristics of size, shape, structure or combinations thereof for skeletal remains recovered from archaeological sites can limit identification (Shipman 1981). Those “distinctive skeletal elements” (Shipman 1981: 126), which allow for identification beyond the class level, can be ranked in order of identification utility to zooarchaeologists (Lyman 1979).

The annotated osteological descriptions for gallinaceous birds in the Northeastern United States are presented fully in Dirrigl (1998). Using this information, Table II presents the identifiability of the fossil classes described. A pattern of differential identifiability is apparent. The proximal humerus (PHU) followed by the proximal femur (PFE) and proximal coracoid (PCO) offer the highest levels of identifiability (Table III). Those fossil classes providing moderate identifiability include the distal femur (DFE), tibiotarsus (DTI), humerus (DHU), and ulna (DUL) and the proximal scapula (PSC). Although the medial tarsometatarsus (MTA) provides identifiability to the species level, this is only possible when a specimen of adult male with a spur cone is preserved. Several fossil classes are indistinguishable even at the taxonomic level of order, medial tibiotarsus (MTI), ulna (MUL), radius (MRA), and scapula (MSC) and distal scapula (DSC). The preservation of these less distinguishable bones would inhibit a faunal analyst to identify them as Anseriformes or Galliformes.

The results of this study demonstrate that the morphology of bird bones may limit taxonomic distinctions even at the higher levels of order and subfamily. For several fossil classes, only identification among Anseriformes and Galliformes may be possible. Of the twenty-seven fossil classes between one species of Anseriformes (\textit{A. platyrhynchos}) and four species of Galliformes, I found forty-four percent to be in this category. When these fossil classes preserve, the zooarchaeologist is unable to distinguish between the gallinaceous species, except for the larger specimens representing \textit{M. gallopavo}.

The survivorship of gallinaceous bones depends on their aerial (BMDa) and volumetric (BMDv) bone mineral density (Dirrigl 1998; 2001). When the potential effect of differential survivorship is related to the differential identifiability of fossil classes, the zooarchaeologist’s ability to discriminate bone specimens between different native gallinaceous birds occurring in the Northeast to species is limited.

Three patterns for the fossil classes examined emerge; the second and third patterns are more common than the first.
Table II

Levels of identifiability for 27 fossil classes of Gallinaceous birds, in order of identifiability from most to least, using LYMAN (1979) and HOLMAN (1961, 1964). Abbreviations are as follows: D (Distal), M (Medial), and P (Proximal). The last two letters correspond to the first two letters of the skeletal element (e.g., FE for Femur). Fossil classes for which Order is blank would be at LYMAN’s level of 3C (class). Classification follows the American Ornithologists’ Union (1983).

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Abbreviations are as follows: D (Distal), M (Medial), and P (Proximal). The last two letters correspond to the first two letters of the skeletal element (e.g., FE for Femur).
1. A fossil class having a high level of identifiability tended to have a high potential for survival

For example, the proximal coracoid provides identifiability among the orders Anseriformes and Galliformes and between Galliformes. This fossil class contained high levels of bone mineral density for *C. virginianus* (ranking 16 BMDa and 19 BMDv of 20 fossil classes). Additionally, the bone mineral density of the proximal coracoid ranked high for *B. umbellus* (ranking 26 BMDa and 25 BMDv of 26 fossil classes), and *T. cupido* (ranking 25 BMDa and 24 BMDv of 26 fossil classes). Although the proximal coracoid of *M. gallopavo* tended to rank lower than the other gallinaceous birds (15 BMDa and 14 BMDv of 28 fossil classes), this element falls within those considered most dense (DIRRIGL 1998: 81).

2. A fossil class having the highest level of identifiability tended to have a low potential for survival

This proposition is based on the assumption that bones with the highest bone mineral density levels are most likely to survive the non-cultural taphonomic or attritional processes described by SCHIFFER (1987), BEHRENSMEYER (1991, 1993), and LYMAN (1994). For example, the proximal humerus exhibited a high level of identifiability, but differs in its potential survivorship between Galliformes. Of the twenty fossil classes measured in DIRRIGL (1998, 2001), the proximal humerus of *C. virginianus* is low ranking (6.5 BMDa and 5 BMDv). For *B. umbellus* and *T. cupido*, it ranks similarly (12.5, 11 BMDa and 5, 5 BMDv respectively) for 26 fossil classes. However, the proximal humerus of *M. gallopavo* is also low ranking for BMDa (8) and low for BMDv (1) out of 28 fossil classes. A similar pattern emerges for the proximal femur, which has high identifiability but low ranking survivorship, except that for the BMDa of *C. virginianus* and *M. gallopavo* it ranks moderately or higher (10 and 19 respectively). A plausible explanation for this exception is that the proximal femur for these two gallinaceous birds is not pneumatic, therefore measuring high in bone mineral density.

3. A fossil class having a low identifiability tended to have a high potential for survival

For example, the medial portions of the tibiotarsus and ulna do not provide identifiability among the orders Anseriformes and Galliformes. Yet, these fossil classes contain high levels of bone mineral density, except for the medial ulna of *C. virginianus* (BMDa low ranking = 8.5). The medial radii of Galliformes are also indistinct, however, this fossil classes is low ranking in BMDa (9.5 for *B. umbellus*; 5.5 for *T. cupido* and 7 for *M. gallopavo*) and high ranking in BMDv (21 for *B. umbellus*; 25 for *T. cupido* and 24.5 for *M. gallopavo*). Whether the medial radius is considered similar to the medial tibiotarsus and ulna in its identifiability and survivorship depends on which measure of bone mineral density is considered the best predictor for survivorship (DIRRIGL 1998, 2001).

Table III

Overall order of identifiability by element. “Best” elements for identification in bold face. Abbreviations as in Table II

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<thead>
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<tr>
<td>Tibiotarsus</td>
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<tr>
<td>Humerus</td>
<td>PHU&gt;DHU&gt;MHU</td>
</tr>
<tr>
<td>Coracoid</td>
<td>PCO&gt;DCO&gt;MCO</td>
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<tr>
<td>Tarsometatarsus</td>
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<td>Ulna</td>
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</table>
IV. CONCLUSION

The ability of a researcher to identify a particular archaeological bone specimen to a taxon is dependent on both taphonomy and the osteology of animals. This study expands on earlier concepts of differential identifiability (c.f., LYMAN 1979; LYMAN & O’BRIEN 1987) by examining how the distinctiveness of avian macro-osteological characters among 27 fossil classes may limit the identification of Bobwhite *C. virginianus*; Ruffed Grouse *B. umbellus*; Prairie Hen *T. cupido*; and Wild Turkey *M. gallopavo*. The results suggest that the morphology of bird bones may limit taxonomic distinctions even at the high taxonomic levels of order and subfamily. Finally, my research demonstrates how the rarity of an identified species is considered to be a function of the fossil classes surviving density-mediated attrition (DIRRIGL 1998).

REFERENCES


Differential identifiability of gallinaceous skeletons


