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A new system for computing dentition-based age profiles in *Sus scrofa*

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ABSTRACT

Reconstructing demographic profiles is valuable for revealing animal exploitation strategies at archaeological sites. For pig (*Sus scrofa*), the method presented by Grant (1982) demonstrates a promising technique for estimating age through dental wear pattern analysis. Grant's study is, however, limited as it requires complete or nearly complete mandibles, exclusively uses mandibular teeth, and offers only a relative scale for aging. While some work has been done to establish useful age classes based on tooth eruption and wear patterns in *S. scrofa*, a systematic study producing a standardized and comprehensive methodology for using tooth wear to age pigs remains to be conducted.

The study presented here is part of ongoing research aimed at developing new methods for the construction of *S. scrofa* demographic profiles based on *both* dentition and long bone fusion. In this paper, we present the results of a study of eruption and wear patterns in a large modern assemblage of wild boar which provides the basis for a new method for constructing pig harvest profiles and addresses some of the most serious limitations of Grant's earlier study. The utility of this method in detecting subtle differences in pig prey/harvest profiles is demonstrated through its application to three Near Eastern archaeological assemblages from three distinct time periods: Bronze Age Tell Leilan, Halafian Banahilk, and Epipaleolithic Hallan Çemi, where residents likely employed widely different pig exploitation strategies. The results of these case studies demonstrate the ability of this method to reliably reconstruct age demography and distinguish age profiles between sites with different animal procurement strategies. This method provides a standardized means of collecting accurate and reliable age data crucial in examining patterns of past pig exploitation.

1. Introduction

Reconstructing the demographic profiles of faunal remains from archaeological sites is essential for revealing the nature of past animal exploitation strategies. Previous work on a wide diversity of species has shown that construction of demographic profiles based on both dental eruption and wear and long bone fusion is a powerful tool for detecting a wide variety of anthropogenic and non-anthropogenic factors that structure prey populations in the past (Davis, 1983; Klein, 1982; Payne, 1973; Stiner, 1990; Zeder, 1991 to name just a few). Demographic profiles have also proven especially useful in tracking the process of animal domestication (Hole et al., 1969; Hesse, 1978; Zeder and Hesse, 2000). Emphasizing the human behavior behind animal procurement, demographic profiles for age and sex composition of harvested animals are capable of revealing subtle patterns in human animal management strategies not visible when utilizing other markers of domestication such as morphology or genetics. Instead, they provide a flexible medium that is capable of documenting even incipient or intermediary episodes in the continuum of human intervention from hunting to herding (Zeder, 2006a).

The sequence and rates of both long-bone fusion and dental eruption and attrition have been used successfully to reconstruct such age profiles at archaeological sites (Ervynck, 1997; Ervynck et al. 2001; Fandén, 2005; Hongo and Meadow, 1998; Hole et al. 1969; Magnell, 2005; Payne, 1973; Rolett and Chiu, 1994; Zeder, 2006a,b). For domestic caprines (Greenfield and Arnold, 2008; Zeder, 2006c) and gazelle (Munro et al. 2009) there has been significant success in calibrating both fusion and dental techniques, establishing age classes with meaningful and useful definitions that can be applied to archaeological assemblages.

These methods have also been applied to pig (*Sus scrofa* spp.) remains, and a quick inspection of the literature reveals a healthy amount of work towards establishing similarly useful methods for constructing demographic profiles in this important species,

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especially methods focusing on dental criteria (Anezaki, 2009; Bull and Payne, 1982; Carter and Magnell, 2007; Grant, 1982; Hongo and Meadow, 1998; Magnell, 2002; Matschke, 1967; Rolett and Chiu, 1994). The problem with these studies is not that the existing body of work is insubstantial or unreasonable, but rather how little these studies agree with one another, and how often they fail to provide an adaptable method that can be confidently reproduced with diverse assemblages from widely differing cultural contexts.

What these studies do have in common is their use of the method introduced by Grant (1982), which serves as their foundation for documenting pig dental wear-patterns. While these efforts at constructing methods for computing dentition based demographic profiles for pig have benefited from this landmark work, they have also inherited some of the limitations of Grant's method. Principle among these is that the method can only be applied to complete, or nearly complete, mandibles dramatically limiting the sample size of ageable remains. Moreover, the method was developed for use on exclusively mandibular and not maxillary dentition, another limitation that reduces sample size. Finally, the method uses only a relative, or floating, scale for aging specimens that is unanchored to the animal's actual age of death (Grant, 1982).

In marked contrast to the focus on developing dentition based demographic profiles in pigs, there has been little parallel attention to the development of aging methods based on pig long bone fusion sequences. While Payne and Bull's study of a population of wild Turkish boar brought new rigor and resolution to computing long bone fusion based pig demographic profiles (Bull and Payne, 1982), most archaeozoologists still turn to the early work of Silver (1969) and Habermehl (1975) to affix long bone fusion age profiles, despite their partial reliance on 19th century data of uncertain origin or accuracy (Legge, 2013).

The study presented here is part of ongoing research aimed at developing new methods for the construction of both domestic and wild *S. scrofa* spp. demographic profiles based on *both* dentition and long bone fusion. In this paper, we present the results of a study of eruption and wear patterns in a large modern assemblage of wild boar which provides the basis for a new method for constructing pig harvest profiles and addresses some of the most serious limitations of Grant's earlier study. The utility of this method in detecting subtle differences in pig prey profiles is demonstrated through its application to three archaeological assemblages from sites whose residents likely employed widely different pig exploitation strategies. Ultimately, this study seeks to move closer to the realization of a comprehensive and definitive methodology for collecting accurate and reliable age data that is crucial to examining patterns of archaeological pig exploitation.

2. Method: a revision

2.1. The modern sample

The modern specimens utilized in this study derive from the Zoology Department of the Field Museum of Natural History in Chicago (FMNH), the Division of Mammals of the National Museum of Natural History in Washington (NMNH), and Sebastian Payne's personal collection of Turkish wild boar utilized in the original 1982 study (Bull and Payne, 1982). A total of 91 corresponding maxillae and mandibles were analyzed for this study, including 46 females, 39 males, and 6 specimens of undetermined sex (Table S1). The specimens analyzed in this sample have a wide distribution across Eurasia. FMNH specimens are primarily comprised of Near Eastern wild boar, with some Indian and Chinese specimens, as well as one Polish wild boar included. These animals were collected by various collectors and expeditions—including the Street Expedition to Iran in 1968, the Field Museum's Near Eastern Expedition in 1934, the Braidwood archaeological expeditions in Iraq and Iran in the 1950s and 1960s, and the Roosevelt and Faunthorpe expeditions to India in the 1920s. NMNH specimens are comprised of mostly Chinese wild boar from expeditions in the early and mid 19th century by A.C. Sowerby and D.C. Graham. The Payne specimens were all collected during the winter of 1974–1975 from forests around Kızılcahamam in central Anatolia in Turkey (Bull and Payne, 1982); this large sample of specimens from a single population mitigates problems that might arise from using animals from a wide geographic range such as those studied here from NMNH and FMNH collections. All animals were identified as wild *S. scrofa* based on information from the expeditions, collectors, and context of locale. Age at death information was not provided for any of the specimens in this sample, and skulls showing wear due to pathologies were not included in the final dataset.

Additionally, the sample was limited to wild boar to control for effects of different nutrition regimes or improved breeding programs on the timing and sequence of tooth eruption and wear in domestic pigs. At least in regards to eruption, however, a recent review of pig molar eruption studies by the late Tony Legge shows that claims of accelerated dental development in domestic pigs may not be entirely substantiated (Legge, 2013). As for the scoring of attrition patterns, we expect that the sequence of wear scores and the resulting age classifications will not vary despite differences in diet and nutrition, because these are shaped by the morphology of pig jaws and the mechanics of how pigs chew, which do not change. The timing of these age classes to absolute ages as well as the duration of a given age class may vary by region and diet, but the relative sequence should remain the same. Thus, while the ages tied to age classes may not agree across wild and domestic pigs, the relative order and composition (i.e. the scores of individual teeth that compose an age class) should. A systematic study of such differences in well-documented modern specimens would provide much needed empirical rigor to the anecdotal or purely hypothetical conjectures about the varying impact of factors like region and diet on tooth wear in pigs and other mammals that cloud the current literature on the subject (see discussion in Moran and O'Connor, 1994).

2.2. New rules

For this study we devised a scoring system for individual teeth—from **0** (pre-developmental absence) through **19** (heaviest wear) (Table 1 and Fig. 1). This system captures the complete history of a tooth, from prior to its emergence (score **0**), through its formation (**1**–**3**), eruption (**4**–**6**), and duration of use throughout the animal's life (**7**–**19**). Finding a close correspondence between visible wear patterns on the modern sample and Grant's tooth wear stages (**a**–**n**), we adapted Grant's drawings of wear stages to characterize wear patterns on teeth following the complete eruption of the tooth (**7**–**19**) (1982:94). Scores for earlier developmental and erupting phases of teeth (**0**–**6**) were compiled from studies conducted in both archaeology and animal sciences on timing and identifying distinct developmental stages of pig teeth (Carter and Magnell, 2007; Matschke, 1967; Bull and Payne, 1982; Tucker and Widowski, 2009).

These individual scores can be grouped into broader categories (Table 1): **0**–**3** for teeth that are either unerupted or forming in the jaw, **4**–**6** for teeth that are in various stages of eruption, **7**–**9** for teeth that are in light stages of wear with only small amounts of dentine exposed on cusps, **10**–**12** for moderate wear stages in which progressively more dentine is exposed, **13**–**16** for heavy wear in which large areas of exposed dentine are ringed by thin margins of enamel, and **17**–**19** which represent teeth with little or no enamel left on occlusal surfaces to teeth in which the crowns are