Journal of Archaeological Science: Reports 14 (2017) 116–126

Contents lists available at ScienceDirect

Journal of Archaeological Science: Reports

journal homepage: www.elsevier.com/locate/jasrep

Stable isotopes and discriminating tastes: Faunal management practices at the Late Bronze Age settlement of Mycenae, Greece

Gypsy C. Price[a,*], John Krigbaum[a], Kim Shelton[b]

[a] Department of Anthropology, Turlington Hall, Room 1350A, University of Florida, PO Box 117305, Gainesville, FL 32611, United States
[b] Nemea Center for Classical Archaeology, Department of Classics, 7233 Dwinelle Hall #2520, University of California, Berkeley, CA 94720-2520, United States

ARTICLE INFO

Keywords:
Carbon isotopes
Nitrogen isotopes
Oxygen isotopes
Late Bronze Age
Mycenaean Greece
Faunal management strategies

ABSTRACT

This research uses stable isotope analyses to identify disparities in management strategies amongst faunal resources consumed in disparate socio-economic sectors of the Late Bronze Age palatial settlement of Mycenae, Greece. δ^{13}C, δ^{15}N, and δ^{18}O data from four species (99 individuals) known to have been purposefully managed during this time period are presented. Data demonstrate species-specific management disparities between consumptive contexts: the exploited *Sus* population shows the most variation, largely predicated on diet, whereas caprines exhibit no inter-context variation, but similar intra-context variation, suggesting ubiquitous access to caprine resources, at least between these two contexts. This study aims to broaden the application of isotope analyses in this region where faunal isotopic data have been largely relegated to constructing baselines for interpreting human isotope data and environmental reconstructions.

1. Introduction

Early Mycenaean states represent the earliest known complex societies on mainland Greece. They have long been a model for studying development in early complex societies. Current models of Mycenaean economies recognize that Mycenaean palaces did not act as the omnipresent hub of economic activity as previously thought (e.g., Bendall, 2007; Finley, 1957, 1999; Killen, 1985, 2008; Snodgrass, 1986), but rather primarily participated in wealth finance to fund prestige building endeavors and perpetuate political power, while remaining largely dependent on non-palatial, staple-based economies to supply subsistence resources to the settlement (e.g., Halstead, 1988, 1992; Galaty and Parkinson, 2007; Nakassis, 2010). These complementary staple and finance systems would have mobilized resources upwards towards palatial settlements in response to political and social strategies institutionalized and perpetuated by the palatial elite (e.g., Aprile, 2013; Earle, 2002; Hruby, 2013; Nakassis et al., 2011; Parkinson et al., 2013; Voutsaki and Killen, 2001).

As discussed by Earle (2002) and illustrated by others (e.g., Dietler, 2001; Halstead and Barrett, 2004; Nakassis, 2010), however, resources are not static – staple goods can be mobilized to serve as wealth finances, creating systems of debt and obligation through non-transferable exchanges such as feasting (e.g., Dietler, 2001; Nakassis, 2010) or fostering ideological institutions through sacrifices to religious or cult deities (e.g., Bendall, 2007). In turn, wealth goods can be exploited as standards of monetary or commercial exchange (e.g., Nakassis, 2010). While staple resources, such as mundane foodstuffs, may generally be considered interchangeable, when involved in acts of commensality, i.e. feasting, the life histories of resources render them non-interchangeable as they have been upwardly converted through a particular set of social interactions (e.g., Appadurai, 1986; Ingold, 2011; Knappett, 2011; Kopytoff, 1986; Renfrew et al., 1974; Renfrew, 2004; Voutsaki, 1997). Thus, when contextualizing resources in a larger political economy, interchangeability based on life histories, as well as application (staple vs. wealth finance), should be considered.

Fauna constitute a unique category of economic resource in that they are ubiquitous in the archaeological record, ranging from domestic assemblages utilized for subsistence to ritualized deposits of burned or otherwise distinguished elements. Domesticated livestock are particularly embedded into the social, economic, and political fabric of early complex societies (e.g., Allentuck, 2013; Greenfield, 2010; Marciniak, 2011; Sherratt, 1983), thus associated management practices are often highly purposeful and enacted with consumption in mind.

Most of what we know about the Mycenaean faunal economy is based on evidence from Linear B tablets, clay slabs upon which administrative matters were recorded in syllabic script (Linear B). Specific livestock demographic information of palatial flocks (including age, sex, and species), discrete quantity measurements (herd size and relative composition), and contextual information (including purpose of use, manner of acquisition, and production targets) are recorded on

* Corresponding author.
E-mail address: gypsycprice@ufl.edu (G.C. Price).

http://dx.doi.org/10.1016/j.jasrep.2017.05.034
Received 22 September 2016; Received in revised form 9 May 2017; Accepted 21 May 2017

tablets (Halstead, 2003; Killen, 1994; Ventris and Chadwick, 1956). Deadstock records (those referring to fauna to be slaughtered) describe fauna as fattened or destined for slaughter for ritual sacrifice or feasting events (Halstead, 2003; Killen, 1994). However, information from Linear B tablets is geographically and temporally restricted, as they have only been recovered from a limited number of administrative centers (predominately Thebes, Knossos, and Pylos) and only record transactions related to regionally limited palatial interests that occurred within months of their deposition (e.g., Finley, 1957; Halstead, 1992). These palatial interests in faunal resources appear to have been highly selective, focusing mainly on domesticated caprines and they relate to the production of secondary products such as wool and labor (e.g., Halstead, 1990, 1992).

As stable isotopes reflect the diet and mobility of fauna during life, characteristics that are a direct result of human intervention in domesticated livestock, they can be used to identify species-specific management strategies in consumed fauna throughout all social, political, and economic strata of a society. This research uses stable isotope analyses to characterize the nature of the upward conversion of faunal resources recovered from disparate socio-economic sectors of early complex societies by identifying disparities in management strategies amongst faunal resources consumed at the palatial site of Mycenae, Greece, during the Late Bronze Age (LBA).

2. Background

2.1. Principles of isotopic analysis

The use of stable isotopes is now routine in studies addressing diet and mobility of fauna (e.g., Balasse et al., 1999; Balasse et al., 2001; Balasse et al., 2002; Finucane et al., 2006; Hobson, 1999; Katzenberg, 1989; Stevens and Hedges, 2004; Thompson et al., 2005; Thornton et al., 2011). Here, carbon ($\delta^{13}C$), nitrogen ($\delta^{15}N$), and oxygen ($\delta^{18}O$) isotopes recovered from bone collagen and bone apatite are presented to assess differences in dietary regimes and mobility in exploited fauna at LBA Mycenae.

$\delta^{13}C$ variation is largely predicated on the different photosynthetic pathway characteristic of resident primary producers, differentiating between C_3, C_4, and CAM plants (DeNiro and Epstein, 1978; Farquhar et al., 1989; Kohn, 2010; O'Leary, 1988; Tieszen, 1991; Tieszen and Boutton, 1989). $\delta^{13}C$ values also help to discern between marine and terrestrial systems (Smith, 1972; Chisholm et al., 1982; Schoeninger and DeNiro, 1984), as well as vary in relation to fluctuations in aridity, temperature, and elevation (Körner et al., 1991; Hartman and Danin, 2010; Kohn, 2010). In temperate climates such as Greece, C_3 plants dominate modern terrestrial flora, while C_4 vegetation is mostly limited to coastal environments. In the context of LBA southern Greece, elevated $\delta^{13}C$ signatures present in exploited fauna are most likely due to the presence of natural vegetation such as *Hyparrhenia hirta*, a native perennial C_4 grass. Though the C_4 cultivar millet is present in northern Greece during the LBA, there is no conclusive evidence to suggest millet cultivation occurred as far south as the Argolid at this time (Halstead, 1995; Petroutsa and Manolis, 2010). Significant access to perennial C_4 grasses, such as *Hyparrhenia*, may indicate less regulated diets and broader foraging regimes for fauna exhibiting elevated $\delta^{13}C$ signatures.

$\delta^{15}N$ values reflect the isotopic composition of the consumers and their diet from primary (plant) producers to consumers along a food chain. $\delta^{15}N$ values may distinguish between leguminous vs. non-leguminous and terrestrial vs. marine diets (DeNiro and Epstein, 1981; Schoeninger et al., 1983; Ingvarsson-Sundstrom et al., 2009), as well as trophic level within a known ecosystem (Schoeninger and DeNiro, 1984; Lee-Thorp et al., 1989; Bocherens et al., 1994). It has been suggested that during the LBA in Greece, legumes were utilized as fodder for domesticated fauna and perhaps planted alongside other crops to increase N_2 levels in soils (Flint-Hamilton, 1999). Thus, elevated $\delta^{15}N$ values may be identifiable in faunal populations exposed to cultivated crops and/or leguminous fodder (DeNiro and Epstein, 1981). Elevated $\delta^{15}N$ values may also be indicative of marine resource consumption. Marine ecosystems typically exhibit higher $\delta^{15}N$ values than do terrestrial fauna due to increased trophic steps in their foodwebs and consumer $\delta^{15}N$ values are enriched by approximately 3‰ in relation to the foods they consume (Schoeninger and DeNiro, 1984). Importantly, $\delta^{15}N$ values vary in relation to aridity and temperature fluctuations (e.g., Hartman and Danin, 2010). Thus, $\delta^{15}N$ values may inform anthropogenic management (such as foddering) and ecological contexts in which fauna were raised (e.g., Bocherens et al., 1994; Triantaphyllou et al., 2008; Ingvarsson-Sundstrom et al., 2009; Frémondeau et al., 2012).

$\delta^{18}O$ values are largely driven by evapotranspiration, the movement of water between terrestrial sources and the atmosphere. Myriad variables influence evapotranspiration and $\delta^{18}O$ values including changes in temperature, latitude, elevation, humidity, amount of precipitation, and distance from geographic origin of water sources (e.g., Sponheimer and Lee-Thorp, 1999). In general, warmer weather conditions result in less negative ('higher') $\delta^{18}O$ values and cooler weather conditions result in more negative ('lower') $\delta^{18}O$ values. In a temperate environment such as modern day Greece, we can expect relatively high $\delta^{18}O$ values in the summer and relatively low $\delta^{18}O$ values in the winter (Bryant et al., 1996; Dansgaard, 1964). Non-human mammalian body water $\delta^{18}O$ values are typically determined by their drinking water, which is composed of unmodified (distilled, boiled, etc.) local meteoric water. Therefore, $\delta^{18}O$ values of mammalian bone are representative of imbibed local meteoric waters and ingested foods, and are thus reflective of the local physical environment and associated climate (e.g., Bryant et al., 1994; Longinelli, 1984; Luz et al., 1984). As $\delta^{18}O$ values also tend to decrease with altitude and distance from bodies of water (e.g., Sharp, 2006), $\delta^{18}O$ values from individuals that live at higher altitudes and further from a body of water may exhibit lower $\delta^{18}O$ values than individuals that do not. Studies of $\delta^{18}O$ in precipitation in Greece corroborate this inference, indicating differences as great as 5‰ between those living in the mountainous interior and those living nearer to the coast (Argiriou and Lykoudis, 2006; Dotsika et al., 2010).

2.2. Archaeological context

The ancient site of Mycenae is located about 90 km southwest of Athens in the northeast Peloponnese (Fig. 1). It spreads across three hills located approximately half a kilometer northeast of the modern village of Mykines. As it stands today, the site largely reflects the height of occupation during the LBA, though the site is known to have been occupied as far back as the early Neolithic (e.g., Wace, 1957). It is composed of a fortified hilltop citadel in which the elite rulers, priests, and priestesses likely resided with their retainers (Fig. 2). Intermittent structural foundations and a network of transportation infrastructure including roads, dams, and bridges, indicate that sprawling residential and industrial districts extend north, northwest, and southwest from the citadel (French et al., 2003; Mylonas, 1966a, 1966b). Samples for this project were chosen from two contexts interpreted to have operated in disparate socio-economic spheres of exchange in the palatial settlement of Mycenae: Petsas House, an industrial and domestic building located downslope from the citadel; and the Cult Center, an ideological complex located within the fortification walls of the citadel.

Petsas House is a predominately LH IIIA 1–2 (1400–1300 BCE) habitation structure with extensive ceramic storage and production elements located downslope from the main citadel at Mycenae (Fig. 3). Petsas House is characterized as "extra-palatial" and "extra-citadel", serving industrial, residential, and storage functions (e.g., Iakovidis, 2001; Papadimitriou and Petsas, 1950; Papadimitriou and Petsas, 1951; Shelton, 2010). While the exact relationship between this structure and the Mycenaean palace is uncertain, it has been suggested that it served