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# What the pig ate: A microbotanical study of pig dental calculus from 10th–3rd millennium BC northern Mesopotamia

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ABSTRACT

One of the main questions that zooarcheologists have attempted to answer in their studies of ancient agropastoral economies relates to animal diet. Starch granules and phytoliths, which derive from the plant foods consumed over the course of an animal's life, become imbedded in dental calculus and thus offer direct clues about diet. In this paper, we investigate pig diet with an eye toward understanding husbandry strategies in northern Mesopotamia, the region in which pigs were first domesticated, from the Epipaleolithic though the Early Bronze Age. Our data reveal that pigs consumed an assortment of plant foods, including grasses, wild tubers, acorns, and domestic cereals. Although poor preservation plagued the identification of plant microremains at Epipaleolithic (10th millennium cal. BC) Hallan Çemi, the identification of a diet based on tubers and grasses matches models of wild boar diet. Pigs at 6th millennium Domuztepe, 5th millennium Ziyadeh, and 4th millennium Hacinebi consumed cereals, particularly oats (*Avena* sp.) and barley (*Hordeum* sp.), as well as wild plant food resources. Several of the cereal starch granules showed evidence of cooking, indicating that pigs had access to household refuse beginning at least in the late Neolithic. Moreover, calculus from morphologically wild specimens also contained cooked cereal grains. This points to a close relationship between wild boar populations and human settlements in the Neolithic and beyond. Preservation was poor for 3rd millennium sites in the study, including Atij, Raqa'i, Ziyadeh, and Leilan, but the available data suggest that pigs ate oats, barley and other Triticeae (the tribe that includes wheat, barley, and goatgrass), and other grasses. This may represent foddering practices in the Early Bronze Age.



## 1. Introduction

The reconstruction of ancient animal management practices from archeologically-recovered assemblages of bones and teeth is a major topic of zooarcheological research (e.g., Crabtree, 1990; Halstead, 1996; Mengoni Goñalons, 2007; deFrance, 2009; Arbuckle, 2012; Stiner et al., 2014). While animal diet is one of the most critical aspects of animal husbandry, reconstructing it archeologically remains difficult. Diet is particularly interesting with respect to pigs, which are omnivorous and can thrive on a variety of foods. For this reason, numerous researchers have attempted to reconstruct pig diets in the ancient past (Wilkie et al., 2006; Mainland et al., 2007; Vanpoucke et al., 2009; Lösch et al., 2006; Masseti, 2006; Hamilton et al., 2009).

Ethnographic evidence suggests that pig diets vary considerably under different husbandry regimes, the latter of which range from allowing pigs to forage their own food to provisioning pigs with agricultural and household waste (Hide, 2003; Albarella et al., 2011; Halstead, 2011). Under intensive husbandry regimes, pigs are provisioned with food, often household refuse ("slop"). Under more extensive regimes, they are allowed to forage their own food, often rooting for tubers and nuts, such as acorns.

In this paper, we analyze plant microremains (i.e., starch granules and phytoliths) obtained from the dental calculus of archeologically recovered pigs' teeth in order to reconstruct their diets at six sites in northern Mesopotamia from the Epipaleolithic through the Early Bronze Age. Northern Mesopotamia is the region that stretches across modern-day southern Turkey, Syria, and northern Iraq (Fig. 1) and was the location in which pigs were first domesticated. Our diachronic analysis of pig diets aims to understand how ancient husbandry and feeding practices evolved over time from the period immediately before domestication until the rise of the first cities in the region.

## 2. Pig husbandry in northern Mesopotamia

Pigs and their progenitors, wild boar (*Sus scrofa*), have a long history with humans in northern Mesopotamia. Epipaleolithic hunter-gatherers preyed upon wild boar. This predatory relationship intensified over time, and evidence from Cyprus suggests that people brought pigs and other animals to the island by boat in the 10th millennium cal. BC (Vigne et al., 2009). Domestication, by which we mean the

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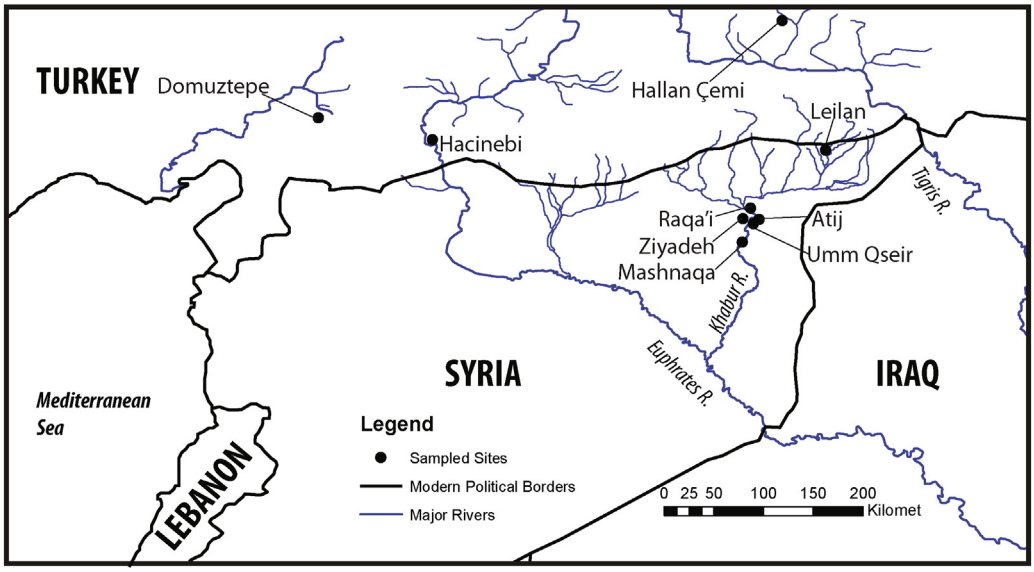


**Fig. 1.** Map of northern Mesopotamian sites included in this study.

accumulation of morphological traits in response to human management, began in the 9th millennium cal. BC (Ervynck et al., 2001; Zeder, 2011; Peters et al., 2013). The precise manner in which pig domestication occurred is unclear, but it appears to have been a long process in which certain populations slowly adapted to human niches after the advent of plant agriculture (cf. Larson and Fuller, 2013). The initial husbandry strategies appear to have been extensive, in the sense described in the Introduction. Ervynck et al. (2001) who examined the pig remains from Çayönü, argue that extensive husbandry practices led to a slow process of pig domestication.

In the millennia following the Neolithic, pigs were crucial, if often secondary, components of the animal economies of northern Mesopotamia and typically make up 10–20% of the faunal remains recovered from archeological sites (Vila, 1998). Complex societies emerged in the 4th millennium cal. BC, and full-fledged urban societies appeared in the middle of the 3rd millennium (Ur, 2010; Stein, 2012). How did pig husbandry change in these periods?

Ongoing research is attempting to answer this question to document the changes in pig management practices in northern Mesopotamia from the Neolithic through the Early Bronze Age, a period defined by the development of complex societies and urbanism (Price, 2016). Understanding pig diets is an important component of this research. As discussed in the Introduction, the pig feeding regimes vary markedly between extensive and intensive husbandry systems, and thus determining what the pigs ate in ancient northern Mesopotamian settlements will help us identify husbandry practices more generally.

## 3. Dietary reconstruction through dental calculus

Dental calculus is mineralized plaque that accumulates on the surface of a tooth at the base of a living plaque deposit. It forms dense accumulations on the buccal surfaces of molars (molars are not constantly growing) close to salivary glands, especially in the context of a high-starch diet and a lack of dental hygiene (Hillson, 1996). Because it is a mineralized deposit, it survives well in archeological contexts (Lieverse, 1999).

Starch granules and phytoliths preserve within calculus deposits in both human and animal teeth (Lalueza Fox and Pérez-Pérez, 1994; Middleton and Rovner, 1994; Scott Cummings and Magennis, 1997). These microremains are incorporated into plaque and, eventually, calculus via the food an animal consumes and are thus direct indicators of the plant foods in an animal's diet. In the past two decades, archeologists have successfully reconstructed ancient diets in a diverse number of contexts, including those of Neanderthals (Henry et al., 2011), 18th century farm animals (Middleton and Rovner, 1994), 10th through 6th millennium Andeans (Piperno and Dillehay, 2008), 3rd millennium BC agriculturalists in the Khabur River valley (Henry and Piperno, 2008), and Pleistocene fauna (Asevedo et al., 2012). It is important to note that pig and human dental calculus differ in crystalline makeup — the former comprising primarily calcite and the latter comprising primarily hydroxyapatite (Weaver, 1964). However, microfossils are still incorporated into this crystalline matrix.

It is important to recognize that dental calculus accumulates naturally over the course of an animal's life, though the rate of accumulation is variable and contingent on a number of factors. As a result, it is impossible to determine when within the lifetime of an animal a specific plant microremain was ingested. Starch granules and phytoliths in dental calculus represent a palimpsest of feeding events, or in the case of pigs, rooting. Dental calculus may be uncommon in archeological and modern pigs due to their young age of slaughter (Anthony, 1946), but it is not unheard of in archeological contexts (Middleton and Rovner, 1994; Albarella et al., 2006).

Based on the sites examined in this study, which we detail in the next section, we pose several questions. First, what were the diets of Epipaleolithic wild boars, which may have been attracted to human settlements such as Hallan Çemi, but were otherwise not managed? Did the diets of wild boar change over time in response to increased human population density? Second, what were the diets of early domestic pigs at sites such as Domuztepe? Third, how did the diets of domestic pig change during the emergence of complex societies in the 4th and 3rd millennia at sites such as Hacinebi, Atij, Ziyadeh, Raqa'i, and Leilan?

## 4. Faunal collections analyzed and their paleoenvironmental contexts

We collected and analyzed samples of dental calculus obtained from pig teeth from several sites spanning the 10th through 3rd millennia cal. BC in northern Mesopotamia. We visited the following institutions: the Smithsonian Institution (Hallan Çemi, Raqa'i, Atij, Ziyadeh, Umm Qseir), the Oriental Institute at the University of Chicago (Hacinebi), the Kahramanmaras Archaeological Museum in Turkey (Domuztepe), and Harvard University (Leilan).

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