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Ancient Maya turkey husbandry: Testing theories through stable isotope analysis

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ABSTRACT

Large gaps exist in our knowledge of ancient Maya turkey husbandry and management. Among the questions still needing to be addressed are: 1) when and where was the non-local Wild Turkey (*Meleagris gallopavo*) introduced to and adopted by the ancient Maya, and 2) did the ancient Maya also rear captive or tame populations of the indigenous Ocellated Turkey (*Meleagris ocellata*)? In this paper, we assess the potential of stable isotope analysis to address these questions. We employ stable carbon ($\delta^{13}C$) and nitrogen ($\delta^{15}N$) isotope analysis to determine whether wild and husbanded turkeys in the Maya region can be distinguished based on their diets. Strontium isotope analysis ($^{87}Sr/^{86}Sr$) is also used to distinguish between *M. gallopavo* individuals that were imported from central/northern Mexico, and those raised on-site in the Maya lowlands. The results indicate that stable isotope analysis is a promising and underutilized method for testing theories regarding ancient Maya turkey husbandry.
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1. Introduction

The Wild Turkey (or common turkey) (*Meleagris gallopavo*) is the only large-bodied domestic animal used by the pre-colonial Maya besides the dog (*Canis lupus familiaris*), and the only vertebrate domesticated in Mesoamerica. To better understand how managed or domesticated resources were integrated into ancient Maya subsistence, ritual and political economies, we must first understand the process and extent of Maya turkey husbandry and domestication. The subject is only recently gaining traction in Mesoamerica and the Maya world (Thornton et al., 2012; Thornton and Emery, 2015; Lapham et al., this volume; Manin, Cornette and Lefèvre, this volume; Martinez Lira and Valadez, this volume) despite broad interest in the domestic dog in Mesoamerica (Blanco et al., 2006; Götz, 2008; Valadez Azúa et al., 2006, 2013), and the domestic turkey in the American Southwest (e.g., Badenhorst et al., 2012; Grimstead et al., 2014; Lipe et al., 2016; McCaffery et al., 2014; McKusick, 2001; Munro, 2006, 2011; Newbold et al., 2012; Rawlings and Driver, 2010; Speller et al., 2010). In Mesoamerica, where the timing of domestication and the possible trade of turkeys are unclear, the lack of osteological markers distinguishing domesticated from wild birds is significantly problematic. Understanding Maya turkey use is complicated by the fact that, in this area, domesticated *M. gallopavo* is found alongside the local, wild Ocellated Turkey (*Meleagris ocellata*). Although the latter is not domesticated today, ornithologists and zooarchaeologists have debated whether it too was managed by the pre-Colonial Maya through captive rearing and breeding (Hamblin, 1984; Masson and Peraza Lope, 2008; Pohl and Feldman, 1982; Pollock and Ray, 1957; Steadman, 1980). Both birds are found in Maya archaeological contexts related to food and ritual, and although they are easily distinguished based on their plumage, distinguishing between them osteologically is extremely difficult especially when dealing with highly fragmented or eroded skeletal remains (Bochenski and Campbell, 2006; Emery et al., this issue; Steadman, 1980). For this reason, many Maya zooarchaeological studies only identify turkeys to the genus level (*Meleagris* sp.). Distinguishing domestic, captive-reared and wild individuals within a species using zooarchaeological specimens is equally (or even more) problematic (Breitburg, 1988; Munro, 2006).

In view of the difficulties attendant on morphologically distinguishing the two species of Mesoamerican turkey, and also wild from domesticated/husbanded birds, we assess the potential for stable isotope and ancient DNA analysis to address these issues and elucidate the complex history of ancient Maya turkey husbandry and domestication. Specifically, we employ ancient DNA analysis to taxonomically identify individuals as *M. gallopavo* or *M. ocellata*, stable carbon ($\delta^{13}C$) and nitrogen ($\delta^{15}N$) isotope analysis to distinguish between wild and husbanded turkeys of either species based on their diets, and strontium isotope analysis ($^{87}Sr/^{86}Sr$) to determine if *M. gallopavo* specimens in the Maya region were imported from central Mexico shortly before death, or raised on-site in the Maya Lowlands, which would indicate early Maya experiments with turkey domestication. Isotopic studies have been used previously to document turkey domestication in the

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American Southwest (Grimstead et al., 2014; McCaffery et al., 2014; Rawlings and Driver, 2010), but similar methods have not yet been widely applied in Mesoamerica.

This paper presents the results of our experimental use of these methods on archaeological turkey specimens from the Maya region. The results indicate that stable isotope analysis is a promising and underutilized method in Mesoamerica for identifying: (1) wild versus captive-reared turkeys, (2) the habitats where wild turkeys were hunted, and (3) whether the earliest domestic turkeys that arrived in the Maya Lowlands were reared on-site or imported from central Mexico. The isotope data also provide comparative data for archaeologists working on similar datasets from the American Southwest and elsewhere (e.g., Morris et al., this issue), and thus contribute to an overall understanding of the history of turkey use, husbandry and domestication in the ancient Americas.

1.1. Mesoamerican turkeys

The South Mexican subspecies of the wild turkey (*M. g. gallopavo*) was first domesticated outside the Maya cultural region in central Mexico (Monteagudo et al., 2013; Speller et al., 2010). The timing of Mesoamerican wild turkey domestication is still unclear, but the process of domestication was likely underway by the first half part of the Preclassic or Formative period (1800 BCE–250 CE) (Thornton and Emery, 2015; Valadez Azúa, 2003:74; Valadez Azúa and Arrellín Rosas, 2000). Despite the antiquity of turkey husbandry and domestication in northern Mesoamerica, zooarchaeological evidence previously suggested that domestic turkeys were not introduced to or adopted by the ancient Maya until the Postclassic period (1000–1519 CE) (Götz, 2008; Hamblin, 1984). An earlier introduction, however, is suggested by the recent identification of non-local domestic turkeys at the Late Preclassic (250 BCE–250 CE) Maya site of El Mirador located in Petén, Guatemala (Thornton et al., 2012). This finding indicates that some domestic turkeys reached the Maya region several centuries earlier than previously thought, although their widespread adoption and use as a subsistence resource may have occurred much later.

Understanding the adoption and use of domestic turkeys in the Maya region is further complicated by the presence of the indigenous Ocellated Turkey (*Meleagris ocellata*), which is native to Mexico's Yucatan Peninsula and northern Belize and Guatemala. Although Ocellated Turkeys have never been classified as domesticated, previous research suggests that Postclassic Maya populations reared Ocellated Turkeys in captivity alongside or instead of domestic turkeys at certain sites (Hamblin, 1984; Masson and Peraza Lope, 2008; Pohl and Feldman, 1982; Pollock and Ray, 1957). This practice would situate Ocellated Turkeys among a suite of wild taxa that was occasionally managed or reared by ancient Mesoamerican societies, as is still done today (Pohl, 1977), including macaws (*Ara* sp.), parrots (Psittacidae), quail (*Colinus* sp.), rabbits (*Sylvilagus* sp.), white-tailed deer (*Odocoileus virginianus*), peccaries (Tayassuidae) and large felids (e.g., *Puma concolor*, *Panthera onca*) (Corona Martínez, 2002, 2013; Hamblin, 1984; Lapham et al., 2013; Sugiyama et al., 2015; Valadez Azúa, 1993, 2003; White et al., 2004). The extent of these practices is unclear, as is whether the captive animals were maintained for subsistence as well as for elite display and ceremonial purposes, but regardless, Ocellated Turkey husbandry would not be out of place within this cultural framework.

1.2. Stable isotopes and turkey domestication

Because the two species of turkey are so difficult to tease apart osteologically, and because both species may have been reared in captivity or hunted in the wild, we require an alternative method to distinguish wild from managed or husbanded turkeys in Mesoamerica. We argue that stable isotope analysis provides such a tool. We hypothesize that greater maize (*Zea mays*) consumption by domestic/captive-reared turkeys of either species will distinguish them isotopically from wild turkeys. We also predict that strontium isotopes will provide a means of determining whether the early examples of *M. gallopavo* in the Maya region represent locally reared animals, or individuals that were imported from their native range in central/northern Mexico shortly before death.

1.2.1. Reconstructing turkey diet: stable isotope analysis ($\delta^{13}C$ and $\delta^{15}N$)

When animals are brought under human control, their diet changes due to their feeding in a more conscripted region, or the consumption of human provided fodder. These dietary shifts may be studied through stable carbon ($\delta^{13}C$) and nitrogen ($\delta^{15}N$) isotope analysis since these isotopes serve as proxies for paleodiet (Ambrose and DeNiro, 1986; Lee-Thorp et al., 1989; Schoeninger and DeNiro, 1984). Isotopic shifts associated with animal husbandry and domestication have been identified previously for Old World taxa including sheep, goats, pigs and cattle (Albarella et al., 2006; Balasse and Ambrose, 2005; Makarewicz and Tuross, 2012; Minagawa et al., 2005; Noe-Nygaard et al., 2005), and in Mesoamerican dogs, deer, rabbits, and captive reared predators (Somerville, 2015; Sugiyama et al., 2015; Tykot et al., 1996; White et al., 2004). At archaeological sites in the American Southwest, stable isotope analysis has similarly documented rearing of both domestic turkeys (McCaffery et al., 2014; Rawlings and Driver, 2010) and captive scarlet macaws (*Ara macao*) (Somerville et al., 2010) based on their extensive consumption of maize (*Zea mays*).

To date, stable isotopes have not been widely applied to the study of Mesoamerica turkey husbandry, but similar dietary shifts associated with human provided fodder are expected. As in the American SW, maize is the most important agricultural crop grown in Mesoamerica. High maize consumption is detectable in both humans and animals within the region because maize utilizes the C4 or Hatch-Slack photosynthetic pathway, resulting in higher (less negative) $\delta^{13}C$ (average $\delta^{13}C = -12.5‰$) than most other plants including trees, shrubs, root crops and forbs, which utilize the C3 or Calvin-Benson photosynthetic pathway, (average $\delta^{13}C = -27‰$) (Smith and Epstein, 1971; van der Merwe, 1982). As the agricultural staple, maize was likely provided directly or indirectly (via household waste) to animals raised within human settlements. This is confirmed through ethnographic data (Götz and Garcia Paz, this volume), as well as isotopic evidence for C4-based diets in archaeological Maya dogs and the occasional captive-reared white-tailed deer (White et al., 2001, 2004). Similarly, at the non-Maya site of Teotihuacan in central Mexico, isotopic analysis indicates C4-based diets for captive-reared turkeys (Morales Puente et al., 2012), rabbits (Somerville, 2015), eagles, pumas and wolves (Sugiyama et al., 2015). Domestic or captive-reared turkeys in the Maya region are therefore expected to exhibit elevated $\delta^{13}C$ indicative of significant maize consumption.

In the wild, both species of Mesoamerican turkey (*M. gallopavo* and *M. ocellata*) have a varied, omnivorous diet including fruits, flowers, seeds, nuts, insects, terrestrial gastropods, small lizards, and the leaves of shrubs, forbs and grasses (Hurst, 1992; Leopold, 1959; Williams et al., 2010; Márquez-Olivas et al., 2005). The majority of foods consumed by wild turkeys are C3 plants (e.g., fruits, shrubs, nuts, flowers and some grasses), but they also consume maize when it is available on the landscape (McRoberts, 2014; Leopold, 1948; Stearns, 2010). Other C4 plants potentially consumed include wild or domestic amaranth (*Amaranthus* sp.), and various species of tropical grasses (e.g., *Paspalum conjugatum*). Consumption of CAM (Crassulacean Acid Metabolism) plants could also elevate wild turkey $\delta^{13}C$ (Edwards and Walker, 1983). CAM plants available to turkeys include bromeliads and cacti (e.g., *Opuntia* sp., *Yucca* sp.), but none of these are known to contribute significantly to the diet of wild Mesoamerican turkeys (Baur, 2008; Leopold, 1959; McRoberts, 2014; Márquez-Olivas et al., 2005). Although wild foraging turkeys in Mesoamerica may consume C4 and CAM plants that elevate the $\delta^{13}C$ recorded in their skeletal tissues, the overall expectation is that domestic and captive-reared turkeys will exhibit higher $\delta^{13}C$ than their wild

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