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Human diets during the social transition from territorial states to empire: Stable isotope analysis of human and animal remains from 770 BCE to 220 CE on the Central Plains of China

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ABSTRACT

Chinese history from the Eastern Zhou to the Han Dynasty (770 BCE to 220 CE) witnessed a social transition from conflicting territorial states to a prosperous empire. This study investigates the effects of social changes on human diet using stable isotope analysis. Human remains (n = 134) and contemporary faunal remains (n = 14) from three sites located on the Central Plains of China were analyzed, and the results have shed light on human diets in the two different eras. Most individuals of the Eastern Zhou had diets based on millet and a limited amount of animal protein. The poor ate a significant amount of wheat, which may have been a response to the food pressures of their urban environment. Wheat consumption in the Han Dynasty increased significantly, likely in response to a population increase during the early imperial period, and patterns of animal protein consumption also differed from that of the Eastern Zhou. Status-related dietary variation in the two eras was reflected in the amount of wheat eaten rather than animal protein consumption. The dietary changes seen likely reflect both adaptive strategy and active change, and seem to have benefited human health in the following dynasties. The results also indicate that significant wheat consumption started in the lowest social classes, suggesting a bottom-up mode for the adoption of wheat into human diets of the area.

1. Introduction

Stable isotope studies in recent years have shown growing interest in the diets of historical populations, particularly those of imperial societies. Research on both New World and European empires has revealed a variety of dietary patterns and adaptive strategies, reflecting different natural and sociocultural circumstances (e.g. Killgrove and Tykot, 2013; Redfern et al., 2012; Somerville et al., 2013; Williams and Murphy, 2013). These discoveries have not only shed light on the dietary behaviour of different imperial societies but have also triggered curiosity about diet in other ancient empires. China is of particular interest as the locus of the first empire to be established in East Asia, a system which would endure for over two millennia.

The Eastern Zhou Dynasty (东周), divided into the Spring and Autumn Period (春秋) (SAP, 770-481 BCE) and the Warring States Period (战国) (WSP, 480–221 BCE), witnessed a social transition from territorial states to a prosperous empire in ancient China, involving significant changes in politics, society, and scholarship (Qian, 2005, pp. 3–5). The transition also involved both a high frequency of wars (Editorial Board, 1985, p. 3; Military Museum of China, 1994, pp. 21–118; Wang and Qi, 2013), and a series of reforms implemented in different states to logistically support these conflicts, consequently boosting regional economies (Qian, 2005, p. 4). The following early imperial dynasties of the Qin (秦, 221–207 BCE) and Han (汉, 206 BCE–220 CE) benefited from these changes. After the powerful but short-lived Qin, the Han developed into a flourishing eastern empire, playing an important role in ancient world history. While benefiting from the achievements of the previous era, the early imperial period also displayed substantial cultural differences (Lewis, 2007). Details of China's history from the Eastern Zhou to the Han Dynasty can be found elsewhere in both English (e.g. Hsu, 1965; Loewe and Shaughnessy, 1999, pp. 450–659; Twitchett and Loewe, 1986, pp. 20–376; Li, 2013, pp. 162–282) and Chinese (e.g. Bai, 1994, pp. 359–565; Bai, 1995, pp. 173–449; Fan, 1995, vol. 1: pp. 105–275; Fan, 1995, vol. 2: pp. 3–205; Lu, 1992, pp. 330–380).

In China there have been a number of studies focusing on diet in the Eastern Zhou and Han Dynasties (e.g. Yin, 1997; Chen, 2007), most of which are descriptive works based on ancient texts or material remains recovered by archaeologists. However, the biases of historical documents and the fragmentary nature of archaeological remains leave much space unexplored, especially in the interactions between socio-economic changes and human diet. Using stable carbon and nitrogen isotope values of human and faunal remains from the two different

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periods as its primary evidence, this paper will investigate how the complex social context of conflicting territorial states affected the diets of ordinary individuals, and whether the significant differences between the Eastern Zhou and Han eras altered human diets.

2. Background

By the Eastern Zhou period ancient China had long had a diversified agricultural system. Results of archaeological flotation analyses suggest that several staple crops, including millet, rice, wheat, barley, sorghum, and soybean, had been grown in China since the Neolithic (An, 1988; Chen, 1990, pp. 23–51; Kong et al., 2003). Despite ongoing debates over the origins of some species, cultivation of all these crops in the Eastern Zhou and Han Dynasties is undisputable except for sorghum, which should be excluded from the list based on the most recent evidence (Liu et al., 2012). The importance of these crops in northern China during the eras in question, though, varied.

Historical documents indicate that millet was the major grain in the north during the Eastern Zhou era (Qian, 2009; Hsu, 1984a). It has been further suggested that millet was the only important grain grown in the north before the SAP, and that other grains were widely grown only after the WSP (Qian, 2009). Although rice was grown at some sites in the north from early times (e.g. Weisskopf, 2010), it is unlikely to have been common due to environmental constraints. It may have been available, though not widely, for commoners in the Eastern Zhou (Qian, 2009), when it was likely sold at a high price (Hsu, 1984b). Wheat does not seem as important as millet in documents of the Zhou era, but the situation appears to have changed in the Han Dynasty. Opinions on the importance of wheat in the Han Dynasty differ, with some suggesting that it was widely planted and elevated to a position equal to millet, while others argue that it was still less important than millet (for a review see Zhou and Garvie-Lok, 2015). The remains of barley have occasionally been discovered together with wheat in northern China starting in Neolithic times, but at a very low frequency except for some north-western sites (Jin, 2007; Liu and Chen, 2012, p. 94; Chen et al., 2015). The low general frequency of archaeological and literary evidence for barley in comparison to wheat indicates that it was of much less importance than the latter; this was still true in recent traditional society (e.g. Simoons, 1990, p. 74). The importance of soybean has also been debated. Some experts believe that it was a staple crop, though inferior to millet, in earlier Zhou times (Song, 1987; Gu, 1992; Yang, 2000), and that it probably gained a status equal to millet during the WSP (Song, 1987; Yang, 2000). Others argue that soybean might only have served as a staple food in barren regions (Hsu, 1984a), or might have actually been eaten as a vegetable supplementary to grains (Knechtges, 1997).

Knowledge on the animal proteins consumed in Zhou times is based mainly on ancient texts referring to nobles' lives. Species consumed by Zhou nobles include both domesticated (e.g. cattle, sheep, pig, dog, and chicken) and wild animals (e.g. bear, deer, rabbit, and game birds), as well as aquatic species such as fish, turtles, and shellfish (Hsu, 1984b; Knechtges, 1986). Among these, fish are depicted as being of particular importance in the nobles' diet (Chang, 1977, p. 11). However, the most common animal proteins in Zhou times were likely pork, dog, fish, chickens and their eggs, and turtles (Hsu, 1984b; Knechtges, 1997). The animal proteins available to Han people did not differ from those of the Zhou era based on funerary art. Kitchen scenes depicted in funerary paintings and reliefs suggest that Han people consumed both terrestrial and aquatic animals, including pigs, sheep, cattle, dogs, rabbits, birds, and fish (for review see Yü, 1977; Yang, 1991). Pottery figurines of cattle, sheep, dogs, pigs, chickens, ducks, fish, turtles, and many other animals are frequently discovered in Han tombs (Jiang, 2011; Wei, 2014), suggesting that these animals were all potential meat resources. However, the most common meat sources in this era might have been pigs, dogs, and chickens, which every household was encouraged to raise (Ban, 1962, p. 1120).

3. Methodological background

The theory of stable isotope analysis in dietary reconstruction is briefly introduced in this section; more details are available in reviews such as Lee-Thorp (2008) and Katzenberg (2008).

Experimental feeding studies indicate that bone collagen $\delta^{13}C$ primarily reflects dietary protein $\delta^{13}C$ because collagen synthesis tends to draw on dietary amino acids, so the carbon incorporated into collagen is preferentially derived from consumed protein (Hare et al., 1991; Ambrose and Norr, 1993; Tieszen and Fagre, 1993; Jim et al., 2004). These studies have also shown that when the diet is adequate in protein, collagen $\delta^{13}C$ is primarily determined by dietary protein $\delta^{13}C$ and often falls about 5‰ above it. This approximation is most accurate when diets are monoisotopic, with similar $\delta^{13}C$ values in both protein and carbohydrate components, such as a diet based on C_3 grains and meat of animals feeding on C_3 plants (for review see Kellner and Schoeninger, 2007). Studies of a variety of ecosystems suggest that the enrichment value of 5‰ between dietary protein $\delta^{13}C$ and human bone collagen $\delta^{13}C$ is reliable in most cases, and it is often assumed in dietary studies of archaeological populations (Katzenberg, 2008; Lee-Thorp, 2008).

Stable nitrogen isotope ($\delta^{15}N$) values display a stepwise enrichment of 3‰ to 5‰ from one trophic level to the next along the food chain (DeNiro and Epstein, 1981; Schoeninger and DeNiro, 1984; Sealy et al., 1987; Bocherens and Drucker, 2003). A recent controlled dietary study on humans suggests that diet-to-collagen $\delta^{15}N$ enrichment for humans ranges up to 6‰ (O'Connell et al., 2012). Comparisons of $\delta^{15}N$ values between humans and coexisting animals provide information on the trophic level position of humans in their local food web and the likely importance of potential meat resources. In addition, $\delta^{15}N$ variation among populations and individuals may reflect their differences in trophic level and animal protein consumption, which can be further interpreted as reflecting differences in social status. It is worth noting that this application depends on the assumed diet-to-collagen $\delta^{15}N$ fractionation value. Taking the above studies into account and considering the potential pitfalls of underestimating the fractionation value (Hedges and Reynard, 2007), a midpoint value of 4.5‰ seems acceptable and will be assumed for the current study.

Human and ecosystem $\delta^{15}N$ values are subject to other factors, including local aridity and an organism's health and nutritional status, that might affect the interpretation of data (for a detailed review see Waters-Rist and Katzenberg, 2010). These complicate archaeological $\delta^{15}N$ analysis, but also greatly expand its potential for the investigation of diet and health over the life course in past populations.

4. Material and methods

4.1. Material

This study begins with the Central Plains (mainly referring to the current Henan Province) of northern China (Fig. 1), which were the main political centre during the period in question, witnessing many of its major changes (Liu, 2006). We sampled 134 human and 14 faunal remains from three sites in close proximity within this area, two (ancient Xinzheng City and Tianli) dating to the Eastern Zhou and one (Xuecun) dating to the Han Dynasty (Fig. 1).

4.1.1. Ancient Xinzheng City

Ancient Xinzheng City (郑韩故城) is located within the urban area of present-day Xinzheng (新郑) City, Henan province. Details on the history of this city can be found elsewhere (Ma, 1978; Shi, 1998; Li, 2005; Tao, 2008). The human remains chosen for the current study are from two cemeteries exposed during 2003–2005 salvage excavations. Typological analysis of the funerary objects suggests that the earliest might be slightly earlier than the beginning of the Eastern Zhou in 770 BCE and the latest do not postdate the unification in 221 BCE (Fan and Xu, 2007, pp. 136–140).