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Dietary reconstruction of the Iron Age population at the Fantzuyuan site, Taiwan, revealed by isotopic analysis on human and faunal bone collagen

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ABSTRACT

In this study, we analyzed the carbon and nitrogen stable isotopic composition of human bone collagen in 33 individuals found at the Fantzuyuan site in Taiwan in order to investigate the dietary patterns of this Iron Age group. Forty-three faunal collagen samples were also analyzed to ascertain the variability of baseline isotopic signatures in the area. Mean $\delta^{13}C$ and $\delta^{15}N$ values of $-12.5 \pm 0.7‰$ and $8.1 \pm 0.5‰$, respectively, were found in 26 human individuals. In conjunction with archaeological evidence, this study showed that human diet at this site derived mainly from terrestrial animals, with a minor component derived from marine shellfish. No significant difference in isotopic compositions was detected between male and female adults or between adults and juveniles. However, six individuals had dietary patterns that were different from others, which probably reveals that they had special social status and/or non-local origins.

1. Introduction

The Iron Age (2000–400 cal. yr BP, Liu, 1999) in Taiwan witnessed the development of complex societies and the construction of dynamic trading networks. During this period, Taiwan was occupied by several regional cultural groups, one of which was the Fantzuyuan (hereafter FTY) cultural group. Archaeological sites belonging to the FTY culture are distributed along the foothills of Houli and Dadu tablelands, as well as over the basins and coastal plains of central Taiwan (Fig. 1), a pivotal region connecting northern and southern Taiwan (Ho, 2003; Liu, 1999). Therefore, investigating social structure and human mobility of the FTY culture can contribute to an increased understanding of material flow, agricultural spread, and relationships between different prehistoric groups both within Taiwan and between Taiwan and adjacent regions.

The FTY culture is characterized by gray-black pottery, iron tools, and foreign trade items, such as glass beads, porcelain, and fired clay artifacts. Based on these findings, it is suggested that the FTY culture may have played an important role in ancient trading networks. For example, iron tools produced in northern Taiwan, as evidenced by iron smelting workshops and large amounts of iron slag (Liu, 2002), appear to have been exchanged and moved through central Taiwan to southern and inland regions (Ho and Yan, 2009). The finding of foreign items also leads to the suggestion of that there was interaction with China or Southeast Asia (Ho and Yan, 2009). With such a context, some scholars suggest that non-locals may have moved or migrated by following material flow to the FTY community (Ho and Yan, 2009). One possible source of evidence for this is that most individuals buried in the FTY culture sites did not have any of their teeth removed. However, one individual buried at the FTY site and another buried at the Luliao site did (Ho et al., 2007; Song, 1962). This feature could imply the special status or non-local origins of these two individuals in the FTY community, though the meaning of the dental extraction remains unclear (Ho et al., 2007). At the FTY site, for example, the location of the teeth ablation of M15 was not in accordance with the typical type, i.e. $2I^2 2C$ type, found in Taiwan (Chiu, 2010). As a result, it cannot be precluded that the teeth were ablated naturally. If this was the case, then there would not be enough evidence to infer that M15 was a non-local individual.

Another important feature of the FTY culture is extended prone burials, and males were buried with their hands placed over their pelvis, while the females and children were buried with both of their arms placed straight by their side (Ho, 1996, 2003). Moreover, certain burials were found with pottery covering the faces of the deceased, for example

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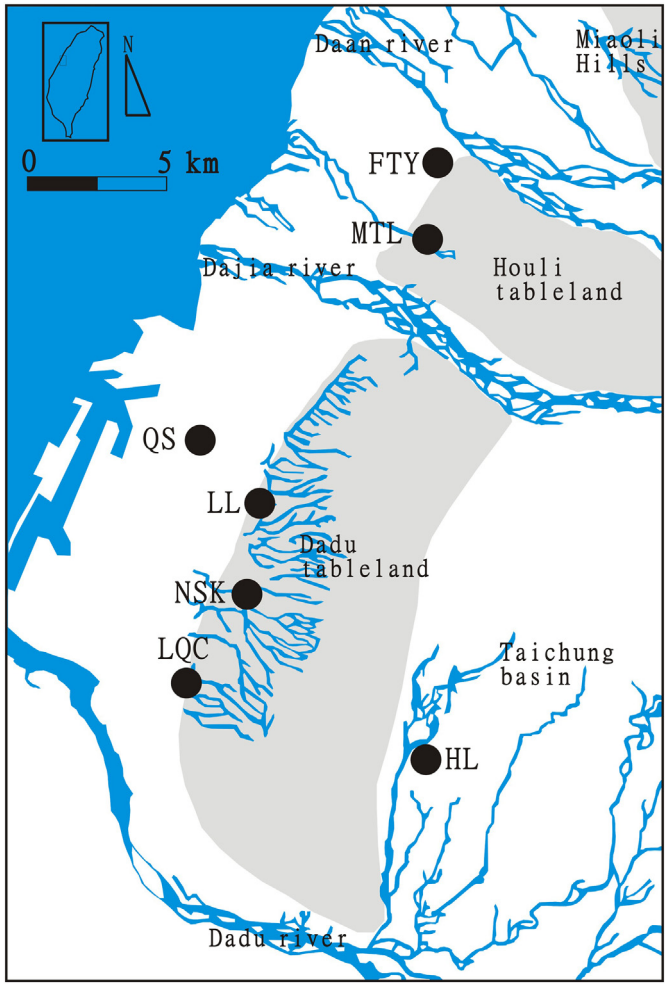

Fig. 1. Archaeological sites relevant to the FTY culture, including Fantzuyuan (FTY), Matoulu (MTL), Qingshui (QS), Longquancun (LQC), Huilai (HL), Luliao (LL), and Nanshikeng (NSK).

one burial at the Matoulu site and two burials at the Huilai site (Ho, 2003; Shih and Song, 1956), probably reflecting special funeral rituals for individuals of high social status (Ho, 2003). These findings lead to the suggestion of that the FTY culture may have been socially differentiated and that males and females/children were treated in different ways.

Except for evidences from burial context and artifact remains, reconstruction and comparison of dietary patterns within a population could provide another line of evidence for social structure and human mobility in FTY culture. One of the methods used to reveal information on paleodietary patterns is stable carbon and nitrogen isotopic analysis applied to human bone collagen (Katzenberg, 2008; Lee-Thorp, 2008). This technique may be able to reveal a pattern of food consumption for an individual over a long period of time, and it has been used to reflect the ways in which members of different social status, gender, and age groups access food (e.g. Ambrose et al., 2003; Kinaston et al., 2013c; Valentin et al., 2006). It may also be possible to detect non-locals whose original diets differed from the dietary patterns of a majority group (e.g. Pollard et al., 2011). Although this technique has been applied widely to reconstruct subsistence activities of ancient groups or specific individuals all over the world, it has not been applied much to Taiwanese archaeological bone remains.

This study presents the application of stable carbon and nitrogen isotopic analysis to human and faunal bones excavated from the FTY site in central Taiwan. The aim of this study was to obtain information on dietary pattern and potential dietary differences between individuals in this Iron Age cultural group. The human skeletons buried at the FTY site were chosen as the material for isotopic analysis because of the large number of burials found at this site (up to 32 burials). Such a large assemblage provides a good opportunity to reconstruct dietary patterns of the FTY culture, to pinpoint potential immigrants, and to understand the social structure by comparing the diets between genders and among different age groups.

1.1. Study site - the Fantzuyuan site

The FTY site, at an altitude of 70 m above mean sea level, is located in the northwest region of the Houli tableland (Fig. 1). The FTY site faces the Daan River on the north and the alluvial plain of the Daan River on the west. The distance from the FTY site to the modern coast is approximately six kilometers. After one human skull and one shell midden were found unexpectedly in 1955 by Dr. Chao-Chi Lin of the Department of Geology, National Taiwan University (NTU), several excavations were undertaken at the FTY site in 1955, 1957, 1961, and 1964. These excavations were led by Dr. Chang-Ju Shih and Dr. Wen-Hsun Song of the Department of Archaeology and Anthropology of NTU.

From the surface downwards, the strata of the FTY site consisted of a gray soil layer, a brown soil layer, and a gravel layer (Shih and Song, 1956; Song, 1962). Shell middens of small size and various shell remains were found at this site. There was also abundant pottery but few stone tools. Other important findings included iron knives, glass bracelets, and 32 burials. Only the context of 16 burials (M1–M16), which were unearthed mainly in gray and brown soil, has been published (Table 1). The 16 individuals included eight male adults, two female adults, three adults with unknown gender, two juveniles, and one individual with unknown information (Ho, 1996). All were interred in extended prone position oriented toward the southeast with no burial goods or coffin pit (Shih and Song, 1956; Song, 1962). No specific data for the burials have been reported so far, but based on pottery characteristics, cultural stratum, and one ^{14}C dating from shell, the site age is estimated to be between 2000 and 400 cal. yr BP (Liu, 1999).

1.2. Archaeological evidence for the paleodiet of the FTY culture

Remains of food uncovered from the FTY site included the bones of deer (*Cervus* sp.), muntjac (*Muntiacus reevesi*), pig (*Sus* sp.), turtle, and fish (Shih and Song, 1956). In addition, twelve species of shellfish have been identified in the FTY middens, of which the most common are Pacific oyster (*Crassostrea gigas*), followed by *Melanoides crenulatus* and *Venerupis variegate* (Shih and Song, 1956). No plant remains have been found at the FTY site so far, limiting our ability to understand which plant foods were consumed as part of the human diet at this site. However, artifacts at this site, such as saddle-shaped stone knives, do provide evidence for plant harvesting (Shih and Song, 1956).

Faunal remains were found at the Luliao site as well, consisting of sika deer (*Cervus nippon taiouanus*), muntjacs (*Muntiacus reevesi*), wild pigs, goats (*Capra* sp.), badgers (*Meles meles*), rats, birds, fish and various shellfish (Ho et al., 2007). The faunal remains found at the Huilai site are dominated by *Cervus* sp., accompanied by muntjacs, pigs, rats, turtles, fish and birds. Some of the fish remains were identified as catfish (Siluriformes), a kind of freshwater fish (Ho and Chu, 2007). Plant remains unearthed at the Huilai site include Zingiberaceae and Pandanaceae, as well as rice grains (Ho and Chu, 2007). Moreover, harvesting tools, such as saddle-shaped stone knives and stone hoes, hunting tools, such as stone arrowheads, and knives for meat and animal bone processing, were found from Huilai (Ho, 2003). Based on these findings, it was assumed that the FTY cultural group practiced hunting, gathering, and maybe rice cultivation (Ho and Chu, 2007).

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