



Diet reconstructed from an analysis of plant microfossils in human dental calculus from the Bronze Age site of Shilinggang, southwestern China



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ABSTRACT

The extracted microfossils from the dental calculus of ancient teeth are a new form of archaeological evidence which can provide direct information on the plant diet of a population. Here, we present the results of analyses of starch grains and phytoliths trapped in the dental calculus of humans who occupied the Bronze Age site of Shilinggang (~2500 cal yr BP) in Yunnan Province, southwestern China. The results demonstrate that the inhabitants consumed a wide range of plants, including rice, millet, and palms, together with other food plants which have not previously been detected in Yunnan. The discovery of various underground storage organs (USOs; tubers, roots, bulbs, and rhizomes) and acorns complements the application of conventional macrofossil and isotope studies to understand the diet of the Bronze Age human population of Yunnan. The wide variety of plant foods consumed suggests that the inhabitants adopted a broad-spectrum strategy of gathering food and cultivating crops in northwest Yunnan Province in the late Bronze Age at a time when agricultural societies were developed in the central plains of China.

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1. Introduction

Dietary patterns reflect a variety of natural and cultural circumstances and adaptive subsistence practices, and in addition the reconstruction of the diet of prehistoric humans has attracted increasing interest (e.g. Redfern et al., 2012; Killgrove and Tykot, 2013; Somerville et al., 2013). There have been many studies of human diets and subsistence practices in China. Most of the research has been concentrated in North China and in the middle and lower Yangtze River areas (e.g. Zhang et al., 2003; Fuller et al., 2009; Liu et al., 2013, Liu, 2015; An et al., 2014). However, in the tropical and subtropical areas of China, especially Yunnan, studies

of prehistoric diets and subsistence practice are limited. Due to its relatively remote location, the history of ancient Yunnan is less well-documented than that of other areas of China. The evolution of diet and subsistence practices in Yunnan is not only closely related with the historical development of the central plains of China (e.g. d'Alpoim Guedes, 2011; d'Alpoim Guedes and Butler, 2014), but also has its own unique characteristics (Fang, 2007).

In Yunnan, macrofossil and stable isotope analyses (e.g. Xue, 2010; Xiao and Wan, 2013; Zhang et al., 2014; Li and Liu, 2016; Ren et al., 2017) have provided a limited amount of human dietary information. To get a more complete understanding of subsistence practices, we firstly reconstruct ancient dietary by employing microfossils (starches and phytoithes) recovered from human dental calculus, in Yunnan. Starch grains and phytoliths embedded within dental calculus can survive for thousands of years (Henry et al., 2011), and can provide a direct record of the

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plants consumed by humans (Henry et al., 2011; Barton and Torrence, 2015; Leonard et al., 2015; Tromp and Dudgeon, 2015).

Here, we sampled human dental calculus from the skeletons excavated in tombs at the Shilinggang which was occupied during the late Bronze Age to reconstruct the plant diet and subsistence strategies in Yunnan during the late prehistoric period.

2. Study area and archaeological sites

Shilinggang site (N 25°38'57", E 98°53'16") (Fig. 1) is located on a terrace on the west bank of the middle reaches of Nujiang River in Lushui County, Yunnan. The altitude of the site is 842 m above sea level. The area, which is traversed by numerous mountain ranges, has a subtropical climate with a mean annual precipitation of 977.2 mm, and a mean annual temperature of 20.2 °C (<http://data.cma.cn/site/index.html>). The wide variety of ecological habitats and abundant plant resources in the area provides a broad range of dietary options. At the present day, rice, roots/tubers, maize and buckwheat are the staple crops, and the local people also collect various wild plant foods, including fungi, fruit and flowers (Fang, 2007).

Shilinggang site was discovered in 2003 and was first investigated by the Yunnan Provincial Institute of Cultural Relics and Archaeology and the Nujiang Prefectural Administration of Cultural Relics. It was excavated by the Yunnan Provincial Institute of Cultural Relics and Archaeology in 2013 and 2014. The site is large, with an area of almost 100,000 m², of which only 500 m² have been excavated. A total of 42 graves, 4 pits, 2 areas of human activity, and 2 houses have been excavated. Numerous artifacts have been discovered, such as pottery (including black and grey pottery, red pottery tempered with sand, and pottery shards), stone tools (e.g., net sinkers, axes, knives and arrowheads), bronze tools (e.g., axes,

tomahawks, spears and arrowheads), and iron tools, together with large quantities of human and animal bones (Kang, 2015). The presence of bronze fishhooks and numerous stone net sinkers indicates that fishing was an important subsistence activity at Shilinggang (Kang, 2015). Because of the shortage of flat land at Shilinggang, there was no large settlement and in addition there was no differentiation of the site into discrete areas for farming, habitation and burial.

The excavated archaeological material indicates the occurrence of only a single culture, and Shilinggang is defined as a Bronze Age site by archaeologists (Kang, 2015). Two charred rice seeds and two charcoals have been obtained from the sixth and seventh cultural layer in excavation square TN6W3, the fourth cultural layer in excavation square TN6W2, and the fifth cultural layer in excavation square TN5W3, respectively, for AMS ¹⁴C-dating at Peking University. A detailed map of the excavations is given in Li et al. (2016). Four radiocarbon dates indicate that Shilinggang was occupied between 2730 Cal BP and 2339 Cal yr BP at 2σ (Supplementary Table 1), confirming that it is a late Bronze Age site.

3. Materials and methods

3.1. Studied tooth samples

Samples of dental calculus were taken from 6 individuals, including 2 females, 1 male and 3 unsexed individuals, from tombs M1, M4, M14, M15, M22 and M24 (Table 1). These teeth were sampled because they contained visible calculus deposits. One tooth was taken from each individual for analysis and the teeth were processed separately. All necessary permits for the work were obtained from the Yunnan Provincial Institute of Cultural Relics and Archaeology. Due to the limited number of skeletons from which

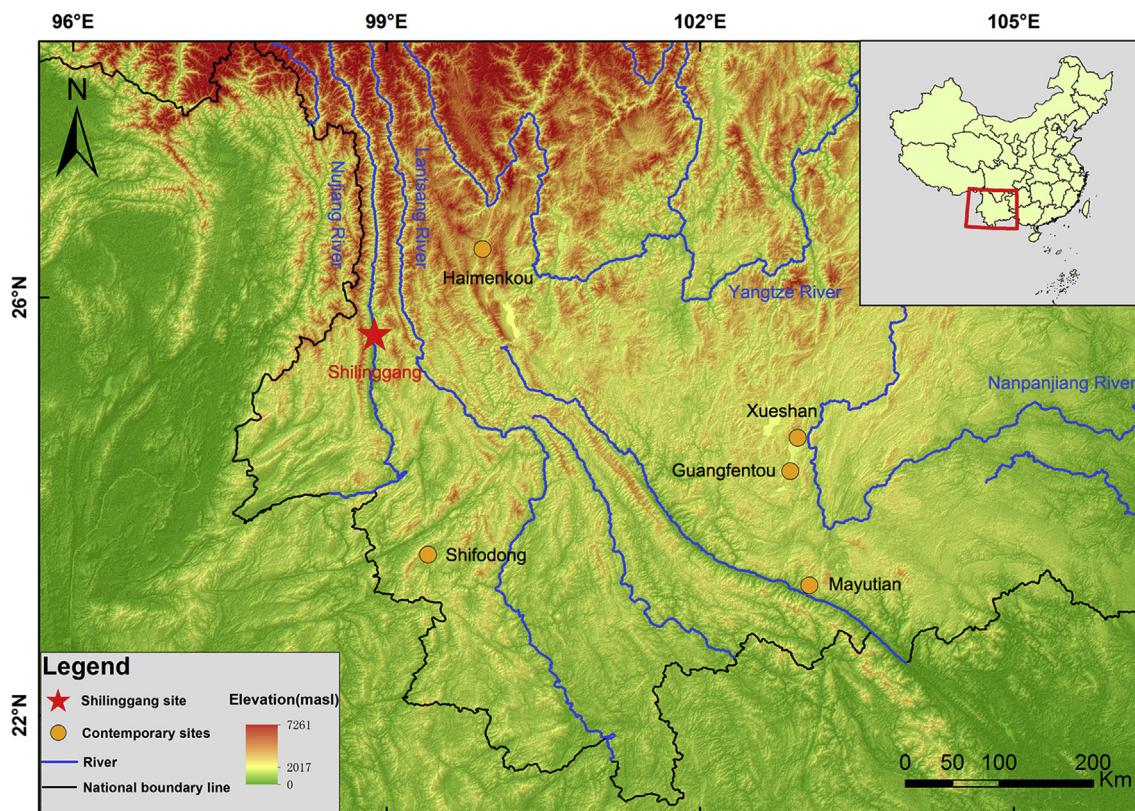


Fig. 1. Location of the study area and archaeological sites mentioned in the text.

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