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CHAPTER 7 Conclusions and Future Work

7.1 Conclusions

The goals and research topics outlined in Chapter 1 have been investigated and successfully completed as a result of this thesis research. In particular, this thesis represents one of the largest and most detailed investigations of paleodiet in China using the technique of stable isotope ratio analysis. This thesis focused on time periods and cultures that were previously underrepresented, in the literature such as the early Bronze/Iron Ages to the Qin Dynasty (221-206 BC). Further, this thesis found new evidence concerning dietary patterns, social stratification (or lack thereof), animal husbandry practices and human mobility during these formative pre-Qin Empire periods. The key findings and their importance in terms of the research questions discussed in Chapter 1 are summarized below.

7.2 Nancheng

At the Proto-Shang site of Nancheng, my research was focused on three main topics: Reconstructing the human diet and animal husbandry patterns to better understand the type of animal protein consumed; examine if different dietary patterns can be linked to sex, age and burial direction/position in the population and to determine if dietary differences existed based on perceived social status, as inferred from the type of grave goods recovered.

In terms of the first research question, my thesis found that the nearly all of the individuals studied had a relatively homogenous diet that was exclusively focused on C4 resources (millets). Only a single individual (M70) consumed a diet that was a mixture of C3/C4 resources. In contrast to the archaeological evidence (different burial position and orientation), individual M70 was determined to most likely not have been a migrant based on the $\delta^{34}$S result, which was similar to the general population and domestic animals at the site. This example highlights the important information that can be revealed as a result of using $\delta^{34}$S measurements on Chinese skeletal collections. In addition, it was found that the Nancheng population had a diet that was predominately based on
pigs, cattle and possibly dogs. An interesting and important finding was that the sheep/goats were not being consumed in significant amounts by the humans, and were thus likely kept for their secondary products such as wool. This pattern of sheep/goat animal husbandry is similar to the findings at Liuzhuang as well as other sites from this period in north China and may reflect a general pattern where sheep/goats were prized and raised nearly exclusively for their wool production.

At Nancheng, significant isotopic patterns directly related to sex, age and burial direction/position were not observed, but when age and sex were compared together, males older than 40 years had significantly lower $\delta^{13}$C values compared to the males below the age of 40 years. This finding could be related to the possible elevated status of older males in this Proto-Shang community or reflect labor divisions between younger and older males, but more research on this topic is necessary in the future. In addition, individuals buried with more or higher quality grave goods were not found to have different diets compared to individuals buried with fewer or common grave goods. Thus, it appears that the social stratification, which is prevalent during later periods (Shang and Zhou Dynasties), is not present at the Nancheng site, and that in general, the entire community was eating a similar and homogenous diet.

7.3 Xishan

At the Late Western Zhou to Warring States Period site of Xishan the following research questions were investigated: were the human diet and animal husbandry practices related to nomadic pastoral activities, agriculture or a mixture of both practices?; did individuals with more or higher quality grave goods have different diets?; were there dietary differences related to status differences between tomb owners and sacrificial victims?; and were there dietary differences between males and females?

The isotopic results of this thesis determined that millet was a significant dietary resource for the Xishan population, but that the individual diet was diverse and spanned the range of nearly complete C$_3$ to C$_4$ diets. Interestingly, a linear trend ($R^2 = 0.62$) was discovered in the human $\delta^{13}$C
and $\delta^{15}$N values which paralleled the isotopic results of the animals at the site. However, most of the humans plot with or were only slightly elevated in $\delta^{15}$N compared to the animals. Surprisingly, this indicates that these wild and domestic animals were not regularly consumed by the humans but likely used for their labor, secondary products or sacrificial importance. Thus, my thesis work supports the views of the archaeologists and excavators, and indicates that the early Qin were a settled rather than a nomadic/pastoral based society.

At Xishan, high status individuals (based on grave goods) were found to have significantly higher $\delta^{15}$N results compared to the low or middle status individuals, and this seems to reflect more pork consumption in their diets. No definitive differences were found between tomb owners and their sacrificial victims, but I acknowledge that the number of individuals was small and that the collection was not complete so further research on this topic is necessary in the future. However, females were found to have elevated $\delta^{13}$C and $\delta^{15}$N values compared to the males. This is evidence that the females consumed a diet with more millet and pork while the males ate diets that were a mixture of C$_3$/C$_4$ resources including wild animals. Still, caution is necessary with this interpretation as many of the skeletons could not be identified based on sex.

### 7.4 Qin Shi Huang Mausoleum

For the humans and animals from the Liyi and Shanren sites, that are associated with the Qin Shi Huang Mausoleum, the following research topics were addressed in this thesis: Reconstruction of the diet of these two population to determine if there were differences between these two groups and reviewing the previously published isotopic literature from north and south China to better understand the diets and geographical origins of the individuals found at the Liyi and Shanren sites.

My thesis research determined that the Liyi workers consumed a diet that was composed of predominately millets and/or domestic animals fed millets. However, the prisoners from Shanren had a significantly different diet that was a mix of C$_3$ and C$_4$ foods with possibly less domestic animal protein consumption. Comparison of these results to the previously published research from north and south China suggests that the Shanren individuals may have originated from southern
China. Specifically, these prisoners appear to have originated from the ancient Chu state, located in modern day Hubei Province and parts of Hunan and Anhui Provinces, and this discovery agrees with the historical sources and mtDNA evidence.

7.5 Millet Consumption in Northern China

In this thesis, the isotopic results highlight that the majority of individuals from these three study sites had diets that were predominately based on millet. This supports past archaeological work that millet was the typical dietary preference in much of northern China from the late Neolithic to the Qin Dynasty. In particular, at the Nancheng site, the results agree with both the archaeological and literature evidence that millet was the most dominant grain for human diet or for animal fodder during late Neolithic period. Thus, my thesis work revealed that the Proto-Shang had a similar dietary tradition to the inhabitants of the Central Plains when they migrated from the north of China. At the Xishan site, the results indicate that millet farming was very important to the early Qin population in northwest China during the Western Zhou to Eastern Zhou period. This work supports the view that the early Qin were a more settled and agriculture based society at the Xishan site, rather than a nomadic and pastoral based society. On the Guanzhong Plain, where the Liyi and Shanren sites are located, the isotopic results confirm that millet still occupied an important position as a staple food during the Qin Dynasty, even though alternative crops such as wheat, rice and soybean were readily available during this time. Thus, the four sites studied here demonstrate that millet was still an extremely important component to the diets of the inhabitants of northern China during the early Bronze Age to the Qin Dynasty.

7.6 Choices of Animal Protein in the Human Diets

The isotopic results showed that the populations at these three sites consumed varying amounts of domestic animal protein. At both the Nancheng and Xishan sites, pigs were the dominant source of animal protein, but cattle and likely dogs were also consumed to a lesser extent. However, the isotopic results suggest that other animals such as sheep/goats and deer were not regularly eaten, but most likely used for their secondary products, labor or as sacrificial offerings. Further, the
Nancheng site shows strikingly similar animal husbandry patterns compared to other contemporary sites such as Liuzhuang and Xinzhai, which may reveal a common animal husbandry strategy during the terminal Neolithic or Chalcolithic period in the Central Plains of China. For the Xishan site, the results indicate that the early Qin population adopted and exploited a stockbreeding and animal husbandry regime that was influenced by the pre-existing nomadic populations of the central Gansu region. During the Qin Dynasty, the townspeople at the Liyi site, consumed a significant amount of animal protein, but the lack of faunal remains makes it difficult to comment on the preferred species that were consumed. In contrast, the prisoners from the Shanren site were found to have likely consumed significantly less animal protein from domestic animals and possibly only ate wild game.

7.7 Social Status

When it was possible, links between the isotopic results and: sex, age and social status were investigated at all the sites presented in this thesis. At the Nancheng site, no significant correlations between diet and burial direction/position or social status (based on the type of grave goods) were found. This is possible evidence that dietary social stratification had yet to be established during the transformative Proto-Shang period of China. In contrast, my thesis result showed that high status individuals had significantly elevated $\delta^{15}$N results compared to the low or middle status individuals at the later site of Xishan. This might indicate that high status individuals were having more animal protein in their diets compared to the common people. In addition, significant differences in both mean $\delta^{13}$C and $\delta^{15}$N values were also found between males and females at Xishan. This suggests that females were consuming a diet that was mainly based on millet and pork while the males had more diverse diets that were a mix of C$_3$ and C$_4$ plants and different animals, both wild and domestic. Further, four cases of human sacrifice were analyzed at the Xishan site, and the results indicate that it might be possible to identify the social rank or identity of these individuals. However, due to the very small sample size, caution is needed in the interpretation of these findings. At the Liyi and Shanren sites, isotopic differences related to social class and geography were found. The Liyi individuals were local worker at the Qin Shi Huang Mausoleum whereas the Shanren individuals were prisoners or slaves (buried in a mass grave and
in iron shackles). The large isotopic differences between the two groups suggest that the Shanren individuals were possibly from another part of China (likely the south), and had diets with decreased amount of millet and domestic animal protein. Thus, the large isotopic differences in carbon, between populations of north and south China, make it possible to track the migration of individuals between these two regions. This finding will be of great importance for future isotopic research on Chinese skeletal materials.

7.8 Limitations of this Thesis and Future Research

While this thesis presented some of the largest isotopic studies on Chinese materials to date, there are limitations that can be highlighted and discussed in relation to this current work. The work present here was focused on bone collagen, and tooth enamel apatite and dentine serial sections were not studied. This was due to the fact that it can be very difficult gain access to human remains for isotopic analysis or other archaeological science techniques in China. Many archaeologists, excavators and museum curators are unfamiliar with this type of research in China and are reluctant to provide materials for sampling. I encountered this firsthand when I was trying to obtain materials for this thesis. In particular, teeth are even more difficult to obtain for sampling than bones, and this is one of main reasons why I was not able to sample teeth as part of this thesis. Ideally, it would be beneficial in the future to compare isotopic studies of teeth (apatite and dentine serial sections) with the bone collagen results to create more detailed dietary life histories and mobility patterns for the individuals of these population.

In addition, to the animals that were sampled as part of this thesis, it would be ideal to isotopically analyze plant, bird and fish specimens from these sites. However, this was not possible as these plant and smaller faunal remains were not saved during the excavation process at these sites. This is an unfortunate reality of archaeological research here China where the value of these remains have been overlooked in the past. However, archaeological research and excavation techniques have improved significantly over the past decade and now more attention is being focused on these archaeobotanical and smaller zooarchaeological remains. However, there is still more work to be done about educating the archaeological community about the value of these items, and I hope to be able to sample these remains as part of future isotopic research projects here in China.
One of the most promising areas of future isotopic research for Chinese archaeological collections is that of $\delta^{34}$S analysis. While the sulfur results presented for the Nancheng site in chapter 4 of this thesis are some of the first for a Chinese archaeological site, only a small number of humans ($n=12$) and animals ($n=20$) provided enough collagen for analysis. Thus, it would be important to try and do a larger number of $\delta^{34}$S measurements at the Nancheng site. In addition, it would be good to isotopically analyze the Xishan remains for sulfur to see if there were also differences related to status and/or sex. At the Liyi and Shanren sites, $\delta^{34}$S analysis would be ideal to confirm if the Shanren individuals were originally from the south of China. Thus, the combined analysis of carbon, nitrogen and sulfur isotope ratios would be able to provide important new information about the lives and histories of the Shanren prisoners. Finally, other sites with large collections of human remains that have been analyzed for sex, age and social rank should be examined in China. In particular, it would be important to do a diachronic study of different sites within a region to see when and how social stratification as related to human diet was established. I hope that my work presented in this thesis will encourage these types of new and exciting investigations.