4 Local Perspectives: Archaeobotanical Studies in Yunnan

4.1 Prehistorical Sites in Yunnan: An Introduction

A recent publication has indicated Yunnan, Tibet, and Xinjiang are the provinces in China with the lowest reported prehistorical archaeological site density (quantified to less than 1:1,000 km^2; see Guojia 2001 in Hosner et al. 2016). This analysis was based on data compiled in the *Zhongguo Wenwu Dituji* 中国文物地图集 (Atlas of Chinese Cultural Relics), a series published by the Chinese Bureau of Cultural Relics between 1989 and 2014, which provides maps of known archaeological sites in each Chinese province at the time of publication. Hosner et al. (2016) note that provinces with fertile loess soils and good water resources, such as Shandong and Shaanxi, have among the highest reported site density (45:1,000 km^2 and 30:1,000 km^2, respectively). The authors of the study attribute these differences to the contrasting topographic features of the regions. Although the rugged landscape of Yunnan and Tibet, along with the arid environment of Xinjiang, may have limited prehistoric occupation, it is also important to consider that the shorter history of archaeological research in these provinces could have contributed to the lower number of known sites at the time of the Atlas publication. In addition to this, archaeological research in China historically focused on Shandong and Shaanxi, while excavations

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in other provinces like Yunnan have been primarily driven by rescue campaigns related to infrastructure projects, such as the construction of motorways and railways. When taking this into account, the differences in prehistorical site density are not surprising. However, the data presented in Hosner et al. (2016) has discrepancies with that listed in the Atlas; it considers a lower number of sites than those reported in the Atlas (279 vs. 546) and groups together substantially different sites in a single category of 'undistinguished Neolithic cultures'. Pleistocene early hominid sites, such as the *Homo erectus* Yuanmou man (*Yuanmouren* 元谋人), dating to ca. 1,700,000 years ago (Zhu et al. 2008), are grouped with sites dating from the ninth millennium BCE, which represent *H. sapiens* hunter-gatherer groups. These are also combined with sites that were re-dated to the Bronze Age before the publication of the study (for example Yeshishan 野石山 and Qinghuadong 清华洞, dated to ca. 1300-900 BCE; Liu, Sun 2009; Min et al. 2013). Although the Atlas classifies sites according to their chronology (Palaeolithic, Neolithic, and Bronze Age)[1] and provides information on whether these were settlements or cemeteries, many of the reported sites are 'locations with evidence of' lithics or bronze artefacts (*shiqi/qingtong chutu dian* 石器/青铜出土点). Archaeological research undertaken in the two decades since the publication of the Atlas has refined the chronology of known prehistoric sites in Yunnan. This prompts caution when making direct inferences from the data compiled in the Atlas without examination of the most recent archaeological findings in the region (Dal Martello 2022).

4.2 Before Sedentism: Evidence of Plant Use in Early Holocene Yunnan

An overview of the origins of agricultural practices would be incomplete without mentioning the time period that preceded them, often referred to as the Palaeolithic Age (*Jiushiqi Shidai* 旧石器时代), indicating the period prior to the Neolithic Age (*Xinshiqi Shidai* 新石器时代). In Chinese archaeology this classification is adapted from categories developed in the nineteenth century in European Prehistoric Archaeology, originating from the Three-Age System – a theory commonly attributed to Christian Jürgensen Thomsen (1788-1865; see Rodden 1981; Trigger 2006, 121-9). Thomsen theorised a Stone, Bronze, and Iron Age on the basis of raw material changes in prehistoric artefacts from the then Danish Museum of Northern Antiquities (now Danish National Museum). John Lubbocks (Lord Avebury; 1834-1913) in his book *Pre-historic Times* (1865), further elaborated upon Thomsen's classification by dividing the Stone Age into the Palaeolithic (or Archaeolithics, meaning Old Stone) Age and the Neolithic (New Stone) Age, each characterised by distinct lithic tool production technology – usually describes as chipped vs. ground or polished (see Trigger 2006, 147-8).

1 Sites listed in the Atlas include Palaeolithic (n=27), Neolithic (n=314) and Bronze Age sites (n=205; see Guojia 2001, 54-5).

Simplifying, in current Chinese archaeological literature[2] Palaeolithic sites indicate seasonal campsites, caves or open air sites, which are characterised by flaked/chipped stone tools and/or microblades, absence of domesticated plants or animals and generally absence of pottery remains (with some exceptions).[3] Neolithic sites indicate settled villages (and cemeteries) with evidence for domesticated plants and animals, intensive production of pottery, but no metal artefacts (Yan 2008). Broadly speaking, in China sites dated to ca. 20000-6500 BCE are classified as Palaeolithic sites; sites dating to 6500-2000 BCE are considered Neolithic sites (Liu, Chen 2012). However, this chronology has been established based on archaeological data from the Central Plains. With the expansion of archaeological research in other regions, chronological variations in local development have become increasingly evident. Recognising the limitations of these terms but acknowledging their widespread use in Chinese archaeological reports, I refer to Palaeolithic and Neolithic sites in line with published conventions in Chinese literature. More specifically, I use the term Palaeolithic to refer to pre-agricultural sites. To avoid confusion, all sites mentioned in text will also be presented with their absolute chronology at first mention.

2 Although some scholars have raised questions about the usefulness and suitability of applying such categories to classify Chinese material, this classification is widely employed in both Chinese and English language academic literature on Chinese archaeology. For example, Liu and Chen (2012) monograph *The Archaeology of China* has the subheading *From the Paleolithic to the Early Bronze Age*; the first volume of an important publication series by the Institute of Archaeology of the Chinese Academy of Social Sciences summarising archaeological data in China is titled *Zhongguo Kaoguxue: Xinshiqi Shidai Juan* 中国考古学: 新石器时代卷 (Chinese Archaeology-Neolithic Archaeology; Zhongguo 2010). It is standard practice to title archaeological excavation reports with indication of Palaeolithic/ Neolithic/ Bronze Age before the site name, a quick search of the terms on CNKI (Chinese Network Knowledge Infrastructure, a search engine for academic publications in China) gives numerous yearly reports titled that way: `https://cnki.net/index/`.

3 Ceramic production was considered strictly linked with sedentism and as such seen as a foundational element of the so-called Neolithic Age. This view was challenged after the discovery of several sites in South China with evidence of ceramic technology before any attested sedentism and/or presence of domesticated plants (see, for example, Xianrendong 仙人洞, Yuchanyan 玉蟾岩, and Zengpiyan 甑皮岩; Wu et al. 2012; Boaretto et al. 2009; Yuan 2013). Some scholars proposed that pottery in South China emerged along with collecting and cooking wild rice (e.g., Higham, Lu 1998; Liu 2008). This view was supported by the retrieval of rice phytoliths at these sites; however, the reliability of the identification and the provenance of the remains has been questioned. Other scholars have suggested that ceramic containers were more generally used to store and cook (boil) food from local foraged resources to increase digestibility. For example, nuts need a soaking period to remove toxins (Lu 1999, 124; Pearson 2005; Fuller, Castillo 2016). Meat from freshwater gastropod shells is also more easily extracted through cooking, and finds of crushed shells at sites without pottery, as opposed to whole shells at sites with pottery seem to support this view (Lu 2010, 2012).

Table 11 Radiocarbon dated Palaeolithic sites in Yunnan with indication of chronology, lithic industry, faunal, and floral remains if available. Lithic tools categories after Huan et al. 2024. See Figure 18 for location of sites

Site	Chronology	Lithic tools	Faunal remains	Floral species	References
Xiaodong cave 硝洞 (Discovered 1981 Exc. 2008, 2015)	43-24 k y BP Oldest site with Hoabinian tools to date	Hoabinian complex; (Ridge-hammer percussions)	*Rhinoceros sinensis, Selenarctos thibetanus, Macaca* sp., *Cervus unicolor*, *Muntiacus* sp., *Bos gaurus, Hystrix brachyuran yunnanensis*	-	Ji et al. 2016a; Zhang 2016
Yushuiping cave 玉水坪 (Discovered 1984 Exc. 1988, 2005)	38-17 k y BP	Core-flake tools; Cobbles	*Rhinoceros* sp., *Cervus* sp., Bovidae, *Leprus* sp., *Ursus* sp.	-	Yunnan, Nujiang, Lanping 2020
Longtanshan 龙潭山 (Discovered 1975 Exc. 1982)	31-29 k y BP	Core-flake tools	*Rhinoceros sinensis,* Bovidae, *Cervus* sp., *Sus* sp.	-	Hu 1977; Qiu, Zhang, Hu 1985
Laohu cave 老虎 (Discovered 1987 Exc. 2005)	30-18 k y BP	Cobbles; Core-flake tools	Unspecified	-	Zhu, Ji 2010
Dedan cave (Discovered 1950s Exc. 2018-22)	(35-)18 k y BP	Hoabinian complex	Unspecified	-	Wu et al. 2022a
Naminan cave 娜咪囡 (Discovered 1997 Exc. 1997-8, 2010-11)	20-10 k y BP	Cobbles; Core-flake tools	Unspecified invertebrate and vertebrate animals, including fish, amphibians, and mammals	Phytoliths: Palm, Panicinae, Eragrostioideae, Arundiaceae/ Bambusoide	Ruan 2021; Zhang, Wang, Gao 2022
Maludong (Red deer cave)[4] 马鹿洞 (Exc. 1989, 2008-11)	18-13 k y BP	Cobbles; Core-flake tools	Large mammals, *Macaca* sp., *Axis yunnanensis*	-	Curnoe et al. 2015; Ji et al. 2016b; Zhang et al. 2022b

4 Despite earlier claims of hominid fossils showing a mixture of archaic and modern features, genomic analyses indicate that human bones from Maludong are anatomically modern humans.

Site	Chronology	Lithic tools	Faunal remains	Floral species	References
Fodongdi cave 佛洞地 (Exc. 2016-17)	18-13 k y BP	Hoabinian complex; Core-flake tools; Microliths; (Ridge-hammer percussions)	Fish: *Cyprinus,* *Ctenopharyngodon,* *Barbodes, Carassius;* Amphibians: *Anura, Cynops*; Reptiles: Testudoformes, Lacertiformes, Serpentiformes; Small and large mammals: Erinaceidae, Chiroptera, *Macaca,* *Semnopithecus,* Hystricida, Rhizomyidae, Sciuridae, Cricetinae, *Castor;* Felidae, Canidae, *Meles, Porcula,* Cervidae, Bovinae, Caprinae, Birds and invertebrates	Pollen: *Pinus,* *Dendrocalamus,* *Aphanamixis,* *Gleditsia,* *Gigantochloa,* *Cyclocarya paliurus,* *Dipterocarpus,* *Cyclobalanopsis,* *Ailanthus,* *Toona,* *Cyclobalanopsis,* *Quercus,* *Phoenix,* *Celtis, Juglans,* *Cerasus,* *Bromus,* *Plantago, Vitis*	Gao et al. 2023; Huan et al. 2024
Zhangkoudong cave 张口洞 (Discovered 1989 Exc. 1990; 2003)[5]	14.9-9.8 k y BP	Core-flake tools (Ridge-hammer percussions)	Boars, rhinos, deer, dogs	-	Hu 1995; Gao 2004
Tangzigou 塘子沟 (open air site) (Discovered 1987 Exc. 2003, 2006)	10-8 k y BP	Cobbles; Core-flake tools; microliths	Small cervids, large cervids, bovids, micromammals: Murids, Rhizomyids, Scuirids, Hystricids	-	Jin et al. 2012; Zhou et al. 2020; Zhu et al. 2020
Dabanqiao cave 大板桥 (Discovered 1989 Exc. 1989)	10-8 k y BP	Microliths; Core-flake tools	Gastropoda: *Margaya* ssp. Fish, Birds, Mammals: *Rattus* sp., *Vulpes vulpes,* *Aonyx cinerea,* *Felis bengalensis,* *Panthera* sp., *Sus* sp., *Muntiacus reevesis,* *Cervus* sp., Bovinae	-	Yang 1993

5 Gao 2004 mentions plant remains but no formal report has been published.

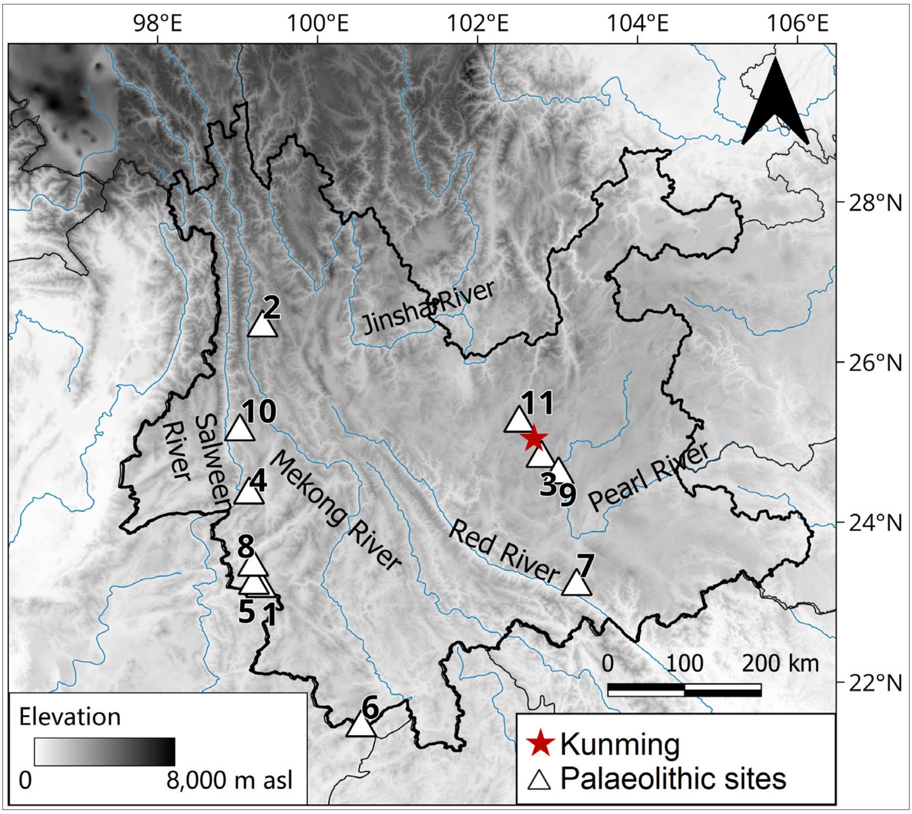


Figure 18 Palaeolithic sites mentioned in text: 1. Xiaodong; 2. Yushuiping; 3. Longtanshan; 4. Laohu; 5. Dedan; 6. Naminan; 7. Maludong; 8. Fodongdi; 9. Zhangkoudong; 10. Tangzigou; 11. Dabanqiao. Made by the Author with QGIS 3.28.5-Firenze, Natural Earth and EROS Digital Elevation basemap, U.S. Geological Survey

Of the 27 Palaeolithic sites listed in the Atlas, 17 had been excavated by the time of its publication and several new sites have been discovered or systematically investigated since.[6] Most sites dating to the late Pleistocene and early Holocene in Yunnan (ca. 40,000-8,000 years ago) are cave sites located close to water reservoirs. At present, eleven sites have been dated through radiocarbon dating methods and provide a chronological framework for the occupation of Yunnan during this period **[fig. 18] [tab. 11]**. This shows anatomically modern humans inhabiting Yunnan as early as 43,000 years ago, as evidenced by *Homo sapiens* remains from Xiaodong 硝洞 (Ji et al. 2016a). Palaeolithic research in Yunnan places greater emphasis on the study of human remains or lithic tools production technology; while animal resources are sometimes found and reported, almost no information is available on the plant species that may have been exploited for food by these groups. An exception to this is the pollen study undertaken at Fodongdi 佛洞地 (Gao et al. 2023; Huan et al. 2024), and the phytolith study at Naminan 娜咪囡 (Ruan 2021; Zhang, Wang, Gao 2022). These studies help reconstruct the environment during the occupation of the sites; however, they don't provide

6 See Ji, Ma 2005; Qi, Dong 2006; Li 2015; Ji et al. 2016a; 2016b; Wu et al. 2022a; 2022b; Gao et al. 2023; Huan et al. 2024; Zhang et al. 2024.

indication on whether people exploited these floral resources. Plant use at these Palaeolithic sites is inferred through the analysis of the lithic toolkit **[tab. 11]**. Hoabinhian tools are reported at sites located along the Mekong Basin, spanning across Yunnan and present-day mainland Southeast Asia. In Yunnan, Hoabinhian tools have been reported from Xiaodong (Ji et al. 2016a; Zhou et al. 2024), Dedan (Wu et al. 2022a), and Fodongdi (Gao al. 2023).[7] The discovery of Hoabinhian tools at Xiaodong has provided new support for the theory of a Hoabinhian homeland in present-day Yunnan (a theory known as 'Chinese Hoabinhian Homeland'; see Van Heekeren 1972; Wu et al. 2022; Zeitoun, Forestier, Nakbunlung 2008), or, at the very least, suggests a much broader distribution of Hoabinhian-like tool-producing groups in Southwest China than previously hypothesised.[8] The Hoabinhian technocomplex typically includes unifacial flaked tools and large cores ('sumatraliths') that have been suggested to be correlated to clearing tropical (and sub-tropical) forest vegetation (e.g., Gorman 1971). Based on this, scholars have inferred people living in these humid tropical forests practiced a broad-spectrum subsistence.[9] According to palaeoenvironmental reconstructions, many areas of Yunnan up to 2,000 m asl in elevation were dominated by plant taxa that produced edible acorns (i.e. *Cyclobalanopsis, Castanopsis, Lithocarpus*; see Ch. 3). These provide highly nutritious food that could easily serve as starchy staples for hunter-gatherer groups. Of note, according to the authors of the systematic subsistence study done at Tangzigou 塘子沟, one of the few known open-air sites dated to this period in Yunnan, people were not under resource stress (Jin 2010; Jin et al. 2012). Large numbers of animal bones, including cervids, bovids, and micro-mammals have been documented during excavation. There were no signs of intensification in the exploitation of animal resources, suggesting people at Tangzigou engaged in broad-spectrum subsistence.

In North China, use-wear analyses on grinding slabs (mortars and pestles) recovered from early Neolithic sites have demonstrated that these tools likely had a multi-use function purpose, being used for processing wild plant, such as acorns,[10] rather than domesticated cereals, as previously hypothesised. This interpretation is supported by the apparent lack of convincing domesticated plant remains from these sites (Liu 2008; Liu et al. 2010; Lu 1999, 60-1). Recent archaeological investigations in Guangdong and Guangxi provinces (as well as mainland Southeast Asia)[11] have revealed large groups of foragers inhabiting these regions in the millennia preceding the emergence of cereal-based agriculture. These groups exploited local wild resources (see § 2.4.4), and grinding stones have been retrieved at sites dating to the ninth to seventh millennia BCE in Guangxi (Xie 2022). Here, grinding stones have been interpreted as evidence of local (wild) plant

7 Further sites along the Mekong in modern Yunnan sharing a similar lithic industry are listed in a preprint article (Wu Y. et al. 2023), however these lack certainty of chronology.

8 Ji et al. 2016a; Li Y.H. et al. 2020; Zhou 2021; Zhou et al. 2024.

9 For a recent discussion of Hoabinhian terminology and limits on Hoabinhian lithic classifications see Shoocongdej 2022. On Hoabinhian and more broadly hunter-gatherers in Southeast Asia see Higham 2013; 2024.

10 For example, hackberry seeds, identified as *Celtis bungeana* and *C.* cf *koraiensisseeds* have been retrieved from Burial 4 in Donghulin (Hao, Xue, Cui 2008).

11 For a review of subsistence before cerealiculture in South China see Zhang, Hung 2012; in Southeast Asia see Higham 2014.

processing. Interestingly, grinding stones decline from sites in mainland Southeast Asia after the appearance of domesticated crops (see § 5.3; Wang W. et al. 2022). Although direct evidence of ancient plant remains is mostly lacking, the emergence of pottery in South China has been linked to the boiling of wild plant, so to increase their digestibility.[12] Since most of these sites have been excavated before the introduction of flotation techniques, the absence of plant remains should not surprise (however, flotation is still rarely conducted during the excavation of Palaeolithic sites). Some authors argue that the abundant tropical and sub-tropical vegetation provided ample resources to fulfil the subsistence needs of hunter-gatherer populations, and that cultivation practices began only after the migration of farming populations from elsewhere (Liu, Chen 2012, 73). The general lack of a clear evidence for a Palaeolithic-Neolithic transition during the Holocene in regions such as Southwest China reinforces this hypothesis. However, the current lack of evidence may be largely due to the insufficient scope of systematic archaeological investigation.

12 Lu 1999, 124; Pearson 2005; Fuller, Castillo 2016; see Ch. 4 fn. 3.

4.3 Archaeological Sites from the Third Millennium BCE and the Beginning of Farming

Although two of the earliest known flotation studies in China were carried out in the Yunnan, at Mopandi and Shifodong (Zhao 2003a; 2010b; see § 1.3); prior to 2009, most of the known ancient plant remains derived from chance findings. This changed after the 2007-08 excavation of Haimenkou, when systematic flotation was undertaken across the whole site, and especially after the publication of the updated *Field Work Archaeology Protocol* in 2009 (Guojia 2009), which mandated flotation during all archaeological excavations (see § 1.2.3.2). Since then, flotation has become standard practice in archaeological excavations in Yunnan. This has resulted in a wealth of archaeobotanical data from over twenty sites for the time period considered in this book **[tab. 12] [fig. 19]**. In this chapter I review archaeological data for sites in Yunnan that provide evidence for ancient plant remains, with a focus on macro-botanical data, including both remains systematically collected through flotation and those handpicked. Only sites for which systematic archaeobotanical studies have been undertaken will be described in detail in text. Isotope studies will also be mentioned, as they can provide complementary data to the macro-botanical dataset. Information on all mentioned sites is listed in Table 12, and their location is illustrated in Figure 19.

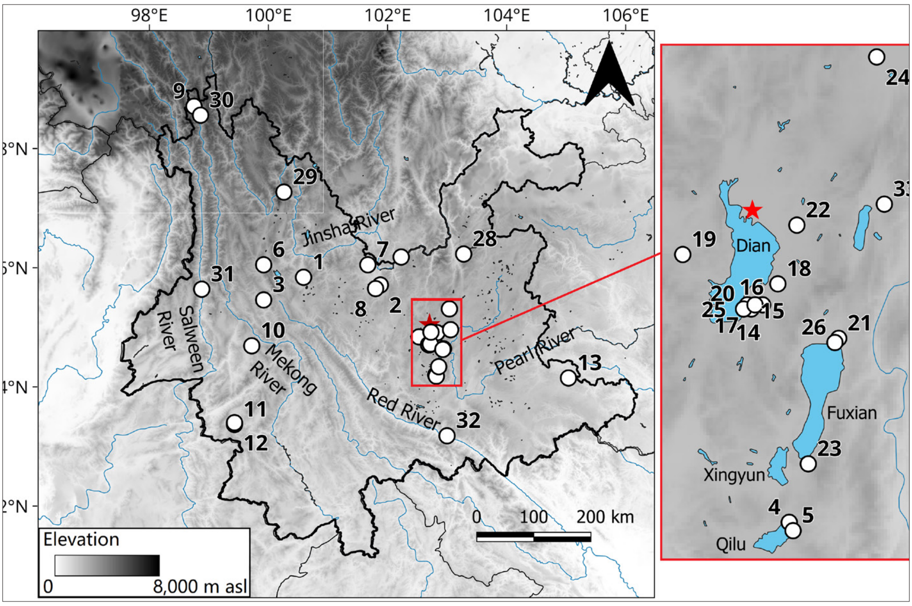


Figure 19 Map showing location of sites in Yunnan with evidence for ancient plant macro-botanical remains and sites with isotope studies mentioned in text. 1. Baiyangcun; 2. Dadunzi; 3. Xinguang; 4. Haidong; 5. Xingyi; 6. Haimenkou; 7. Mopandi; 8. Mopanshan; 9. Zongzan; 10. Yingpanshan; 11. Shifodong; 12. Nanbiqiao; 13. Dayingdong; 14. Gucheng; 15. Shangxihe; 16. Hebosuo; 17. Shizhaishan; 18. Anjiang; 19. Dayingzhuang; 20. Xiwangmiao; 21. Xueshan; 22. Xiaogucheng; 23. Guangfentou; 24. Qujing Dongjia; 25. Jinshashan 26. Jinlianshan; 27. Jiangxifen; 28. Yubeidi; 29. Gaozhai; 30. Adong; 31. Shilinggang; 32. Mayutian; 33. Shamaoshan. Made by the Author with QGIS 3.28.5-Firenze, Natural Earth and EROS Digital Elevation basemap, U.S. Geological Survey

Table 12 Archaeological sites in Yunnan dating between the third millennium BCE to the early first millennium CE with evidence for ancient plant remains. Both sites with systematic flotation (indicated by Latin names of plants) and chance findings (indicated with common English name of plants) are included. Modified after Dal Martello 2022, Table 1

Site (Location)	Exc. Date Exc. Area/ Est. site size	Chronology	Features	Material Culture	Plant Remains	Faunal Remains	References
Baiyangcun 白羊村 Middle Jinsha River, Binchuan county	1973-74; 2013-14 390 m²/ 10~20 ha	2650-1690 cal BCE (charred seeds)	29 houses (wattle-daub) 39 hearths 290 pits 56 burials (shaft pit/ urn) Unspecif. no. of living floors	Ceramics: Impressed/ incised, Baiyangcun type Lithics: Ground, polished Perforated knives	*Oryza sativa, Setaria italica, P. miliaceum, Echinochloa* sp., *Glycine soja, Vigna* sp., *Cajanus* sp., *Cucumis* cf *melo, Melia azerdach, Euryale ferox, Juglans* sp., *Vitis* sp., *Crataegus* sp., *Perilla* sp., *Lycium* sp., Peach? [Isotopes] Predominantly C_3 in the early phase	Pig, Cattle, Goat/sheep, Wild boar, Black bear, Deer	Yunnan 1981; Yunnan Kaogu 2014; Dal Martello et al. 2018; Dal Martello 2020; Ma et al. 2022a
Dadunzi 大墩子 Middle Jinsha River, Yuanmou county	1972-73; 1999; 2010 1985 m²/ 1.6 ha	2200-1610 cal BCE (charred seeds)	61 houses (wattle-daub/ semi-subterr./ stilt) 5 hearths 25 pits 2 sacrificial pits 98 burials (shaft pit, urn, stone cist)	Ceramics: Impressed/ incised, Dadunzi type Lithics: Ground, polished Grinding stones; perforated knives	*Oryza sativa, Setaria italica, P. miliaceum, Vigna* sp., Cucurbitaceae	Pig, Dog, Cattle, Goat/sheep, Chicken, Muntjac, Deer Lacustrine resources	Kan 1977; Yunnan Kaogu 2009; Jin et al. 2014a; Jin et al. 2014b; Li et al. 2016
Xinguang[13] 新光 Upper Mekong River, Yongping county	1993-94 1000 m²/ 3~8 ha	2620-1780 cal BCE (charred peat)	21 pits 6 houses (Semi-subterr./ wattle-daub) 1 moat 7 hearths	Ceramics: Impressed/ incised, Xinguang type (red paint) Tools: Ground, polished Perforated knives	Charred rice grains from G3	Deer, Horse teeth?	Yunnan 2002; Yao 2010

13 Yao (2010) lists the following plants for Xinguang: rice, millet, and wheat; however, no mention of these remains is found in the Chinese reports of Xinguang.

Site (Location)	Exc. Date Exc. Area/ Est. site size	Chronology	Features	Material Culture	Plant Remains	Faunal Remains	References
Haidong 海东 (shell mound) Qilu Lake, Tonghai county	1988-89 372 m²/ 0.3~0.85 ha	3090-2200 cal BCE (human bone)	40 hearths 30 burials (shaft pit)	Ceramics: Corded ware, Shizhaishan (Neolithic) type Lithics: Ground Harvesting knives?	Rice?	Lacustrine resources: tortoise shells, and other unspecified animal bones	He 1990; Xiao 2001; Zhang, Hung 2010; Yao 2010
Xingyi 兴义 Phase II (shell mound) Qilu Lake, Tonghai county	2015-16 190 m²/ 5.2 ha	2900-2300 cal BCE (human and animal bones, wood charcoal)	12 burials (Shaft pit; urn)	Ceramics: Corded ware, Haidong (Neolithic) type Tools: Unspecified Harvesting knives?	No seeds retrieved in the samples [Isotopes] Predominantly C_3, Increase in C_4,	Bovid, Cervidae Abundant freshwater resources: *Margarya* sp.	Yunnan 2017; Zhang 2017; Ma et al. 2024
Xingyi 兴义 Phase III (shell mound) Qilu Lake, Tonghai county	2015-16 190 m²/ 5.2 ha	1800-1300 cal BCE (human and animal bones, wood charcoal)	47 floors 18 houses (Semi-subterr.; stilt, pavilion houses) 24 burials (Shaft pit; urn) 16 pits 4 streets 2 ditches 1 walled structure	Ceramics: Corded ware, Xingyi type Lithics: Steppe style stone adzes	*Setaria italica, P. miliaceum, Oryza sativa, T. aestivum, Glycine max, Fagopyrum esculentum, Perilla frutescens*	Pig, Bovid, Bird, Cervidae Abundant freshwater resources: *Margarya* sp.	Yunnan 2017; Zhang 2017; Ma et al. 2024
Haimenkou 海门口 Phase I Middle Jinsha River, Jianchuan county	1957; 1978; 2007-08; Ongoing 1350 m²/ 5~10 ha	1600-1450 cal BCE (charred seeds)	Unknown no. of houses (wood pile- stilt), pits, hearths	Ceramics: Incised/ impressed, Baiyangcun type Lithics: Polished Half-moon shaped knives	*Oryza sativa, Setaria italica, P. miliaceum, Chenopodium* sp., *Fagopyrum* cf *esculentum, Cannabis* sp., *Prunus* cf *persica, Prunus* cf *armeniaca, Quercus* sp.	Sus domesticus Ovis/Capra sp., *Canis familiaris, Bos gaurus, Cervus unicolor, Sus scrofa, Axis porcinus, M. muntjak, M. berezovskii, Macaca* sp., *Ursus* sp., *Lepus* sp., *Volpe* sp.	Yunnan 1958; Xue 2010; Jin 2013; Li, Min 2014; Wang 2018; Xue et al. 2022

Site (Location)	Exc. Date Exc. Area/ Est. site size	Chronology	Features	Material Culture	Plant Remains	Faunal Remains	References
Haimenkou 海门口 Phase II, III Middle Jinsha River, Jianchuan county	1957; 1978; 2007-08; Ongoing 1350 m²/ 5~10 ha	1450-400 cal BCE (charred seeds)	Unknown no. of houses (wood pile-stilt), pits, hearths	Ceramics: Incised/ impressed, Haimenkou type Lithics: Polished Bronze objects (mould casting)	*Oryza sativa,* *Setaria italica,* *P. miliaceum,* *Chenopodium* sp., *Triticum aestivum,* *Hordeum vulgare,* *Fagopyrum* cf *esculentum,* *Cannabis* sp., *Prunus* cf *persica,* *Prunus* cf *armeniaca,* *Quercus* sp., *Vitis* sp., *Perilla* sp. Uncharred aquatic species (e.g., *Butomus, Najas, Ranunculus*)	Sus domesticus Ovis/Capra sp., *Canis familiaris,* *Bos gaurus,* *Cervus unicolor,* *Sus scrofa,* *Axis porcinus,* *M. muntjak,* *M. berezovskii,* *Macaca* sp., *Ursus* sp., *Lepus* sp., *Volpe* sp.	YPM 1958; Xue 2010; Jin 2013; Li, Min 2014; Wang 2018; Xue et al. 2022
Mopandi 磨盘地 Middle Jinsha River, Yongren county	1983; 2001 340 m²/ 0.8 ha	1400 BCE (assoc.)	2 houses (wattle-daub) 1 hearth 17 postholes 1 ditch 7 burials (stone cist)	Ceramics: Incised/ impressed, Caiyuanzi type Lithics: Ground, polished Perforated knives	Rice	Pig, Cattle, Goat/sheep, Dog, Chicken, Deer, Muntjac	Yunnan 2003; Zhao 2003a
Mopanshan 磨盘山 Middle Jinsha River, Yuanmou county	2012-13 116.5 m²/ 0.9 ha	'Neolithic' (assoc.)	4 burials (Shaft pit, Stone cist) 41 houses (Semi-subterr.; Stilt houses) 30 pits 1 ditch 1 kiln 9 floors	Ceramics: Unspecif. Lithics: Perforated stone knives	Acorns? Millets? (broomcorn, foxtail?), Rice?	Bovid, Caprine, Dog, Pig, Bird	Kang 2013; Yunnan Kaogu 2013
Zongzan 宗咱 Upper Mekong River, Weixi county	2013 1600 m²/ Unspecif.	2000 BCE-200 CE (assoc.)	45 walled structures 1 ditch 1 pit	-	Buckwheat? (dated to Western Zhou dyn., 1045-771 BCE)	Cattle, Sheep, Deer, Pig, Monkey, Black bear	Yang 2014; Li 2016; Chen, Chen, Zhu 2019
Yingpanshan 营盘山 Upper Mekong River, Changning county	1990 50 m²/ 1 ha	1800 BCE (assoc.)	1 House (Semi-subterr.?) 2 Hearths	Ceramics: Unspecif. Lithics: Polished Perforated knive	Rice	Not reported	Xiang et al. 2015; Xiao 2006; Geng, Li, Zhang 1990

Site (Location)	Exc. Date Exc. Area/ Est. site size	Chronology	Features	Material Culture	Plant Remains	Faunal Remains	References
Shifodong 石佛洞 (Cave site) Middle Mekong River, Gengma county	1982; 2003 750 m²/ 0.3 ha	1400-1100 BCE (assoc.)	Several hearths	Ceramics: Incised/ impressed, Shifodong type Lithics: Polished	*Oryza sativa, Setaria italica Chenopodium* sp., *Tamarindus* cf *indica,* Indet. tree legume, Indet. fruits	Pig, Dog, Cattle, Deer, Horse? Indet. birds/ fish species	Kan 1983; Liu, Dai 2008; Yao 2010; Zhao 2010b; Dal Martello 2020
Nanbiqiao 南碧桥 (Cave site) Lower Mekong River	1982 Unspecif./ 0.3 ha	1250-970 BCE (assoc.)	-	Ceramics: Incised/ impressed, Shifodong type	Rice	-	Kan 1983; An 1999
Dayingdong 大阴洞 (Cave site) SE Yunnan, Guangnan county	2017-18 300 m²/ 1500 m²	1400-1100 cal BCE (human bones)	12 pits 17 burials	Ceramics: Corded ware, Black polished pottery Lithics: Ground	Charred rice found in a pit [Isotopes] C_3	Not reported	Yunnan Kaogu 2018; Zhao et al. 2022
Toujushan 头咀山 Xingyun Lake, Jianchuang county	1961 Unspecif.	‘Neolithic’ (assoc.)	Unspecif.	Ceramics: Neolithic (Dian) type Lithics: Polished	Rice	Not reported	Ge 1978
Gucheng 古城 (古城村) (shell mound) Dian Lake, Jinning county	2012 (survey); 2020-22 (exc.) 16,500 m²/ 2.7 ha	Shang dyn. 1600-1050 BCE (assoc.)	111 burials (81 shaft pit; 30 urn) 1 house (Semi-subterr.)	Metal agricultural tools	Wild local plants (Grape, Peach, Apricot, Chinese Hawthron)	Sambar, Deer, Muntjac Gastropod, Shells	Yao, Jiang 2012; Yunnan Kaogu 2024a; 2024b
Shangxihe, Yi area 上西河乙区 (shell mound) Dian Lake, Jinning county	2014; 2016-17 500 m²/ 1.6 ha	1212~1081 - 380~209 cal BCE (charred seeds)	40 houses (Semi-subterr.; pile-dwelling) 470 pits 12 wells 62 ditches 3 burials (vertical shaft pit)	Ceramics: Dian type Tools: Agricultural tools Unspecif. metal artefacts	Rice, Wheat, Fruits	Not reported	Yao A. et al. 2020; Yunnan, Chicago 2019; Yunnan Kaogu 2017a; Yang et al. 2017

Site (Location)	Exc. Date Exc. Area/ Est. site size	Chronology	Features	Material Culture	Plant Remains	Faunal Remains	References
Hebosuo 河泊所 (shell mound) Dian Lake, Jinning county	2014; 2016-17; 2021-22 12.5 m²/ 31 ha	900-109 cal BCE (charred seeds)	13 Houses (Semi-subterr.; pile-dwelling) 33 burials (Shaft pit, urn) 4 pits 1 ditch	Ceramics: Dian type Metal agricultural tools	*Oryza sativa, Triticum aestivum, Setaria italica, P. miliaceum, Fagopyrum esculentum, Cerasus* sp., *Zanthoxylum, Bungeanum* Uncharred aquatic species (i.e., *Potamogeton, Najas*)	Pig, Cattle, Dog, Sheep, Deer, Fish, Birds, Reptiles, Gastropod shells	Yao, Jiang 2012; Yao et al. 2015; Yang 2016; Yunnan, Chicago 2019; Yao A. et al. 2020; Yang et al. 2023
Gucheng 古城 (古城村) (shell mound) Dian Lake, Jinning county	2012 (survey); 2020-22 (exc.) 16,500 m²/ 4~10 ha	900-530 cal BCE (charred seeds)	21 houses (14 Semi subterr.) Unspecif. no. of pits, floors	Ceramics: Unspecif. Metal agricultural tools	*Triticum* sp., *Oryza sativa, Setaria italica,* Pea? Uncharred aquatic species (i.e., *Potamogeton, Najas*)	Domestic mammals Large quantities, of gastropod shells	Yao, Jiang 2012; Yunnan Kaogu 2024a; 2024b
Shizhaishan 石寨山 Dian Lake, Jinning county	1953; 1955; 1958; 1960; 1996 504.3 m²/ 0.05? ha	Dian to Western Han periods 779-488 cal BCE (charred seed)	86 burials (shaft pit: supine extended large graves have wooden coffins)	Ceramics: Incised/ Impressed, Dian type Casted bronze tools and weapons; drum-shaped cowrie shell containers in elite burials	*Triticum* sp., *Oryza sativa, Setaria italica* Uncharred aquatic species (i.e., *Potamogeton, Najas*)	-	Yunnan 1963; Yao, Jiang 2012
Anjiang[14] 安江 (shell mound) Dian Lake, Jinning county	2008; 2010-11 (survey); 2020-21 (exc.) 4000 m²/ 4 ha	Dian to western Han periods 770-430 cal BCE (charred seeds)	42 postholes 3 shell deposits Unspecif. no. of pits	Ceramics: Dian type	*Oryza sativa, Triticum aestivum, Hordeum vulgare, Setaria italica, P. miliaceum, Chenopodium* sp. (aquatic species; i.e., *Potamogeton, Najas*)	Cattle, Water buffalo, Pig, Dog, Deer, Felidae, Other mammals	Yao et al. 2015; Yunnan Kaogu 2024c
Dayingzhuang 大营庄 (shell mound) Dian Lake, Xishan county	2017 500 m²/ 10 ha	750-390 cal BCE (charred seeds)	35 pits 4 houses (Pavillion structure) 5 rivers 2 floors 5 *jicao*	Ceramics: Dian type Small bronze dagger	*Oryza sativa, Setaria italica, Triticum aestivum, Hordeum vulgare, Chenopodium* sp., *Zantoxhylum* sp., *Castanea* sp.	Unspecif.	Dal Martello, Li, Fuller 2021

14 The site is referred to by Anjiang North (Anjiang Bei) 安江北 in the most recent report by the Yunnan Provincial Institute of Cultural Relics and Archaeology (see Yunnan Kaogu 2024c).

Site (Location)	Exc. Date Exc. Area/ Est. site size	Chronology	Features	Material Culture	Plant Remains	Faunal Remains	References
Xiwangmiao 西王庙 Dian Lake, Jinning county	2014; 2016 81 m²/ Unspecif.	800-109 cal BCE (charred seeds)	8 houses (Semi-subterr.; wattle-daub) 22 pits; 4 ditches	Ceramics: Dian type Lithics: Grinding stones Bronze knives	Rice, Wheat, Millets, Soybean	Cattle, Sheep, Pigs, Dogs, Horses, Gastropods, Turtle, Birds, Deer	Yang et al. 2019
Xueshan 学山 Dian Lake, Chengjiang county	2006; 2009; 2010-11 2335 m²/ 1.5 ha	Dian period 800-300 BCE (assoc.)	29 houses (Semi-subterr./ wattle-daub) 260+ burials Unknown no. of pits 1 sacrificial pit?	Ceramics: Dian type	*Triticum aestivum, Oryza sativa, Setaria italica, P. miliaceum, Hordeum vulgare, Glycine max, Lens culinaris, Vigna* sp.*, Fagopyrum esculentum, Zanthoxylum* sp., Fruits, Acorns [Isotopes] C_3 dominant; one individual mixed C_3/C_4	*Margarya melanioides*	Wang 2014; Wu, Jiang, Feng 2010; Wang et al. 2019; Wang et al. 2022
Xiaogucheng 小古城 (shell mound) Dian Lake, Chenggong county	2007-08; 2010-11 Unspecif./ 5~10 ha	800-670 cal BCE (wood charcoal)	Wooden 'palisade'	Ceramics: Dian type	*Oryza sativa,* Panicoideae, Verbenaceae, *Polygonum* sp. Aquatic species, *Ranunculus* sp., *Rumex* sp.	Gastropod shells	Yao et al. 2015
Guangfentou 光坟头 (shell mound) Fuxian Lake, Jiangchuan County	1984; 2011-12 600 m²/ 1.7 ha	Dian period (Spring-Autumn to Western Han) 700- 300 BCE (assoc.)	26 houses (Semi-cript) 30 pits 11 floors	Ceramics: Dian type Metal objects production centre	*Triticum aestivum, Oryza sativa, Setaria italica, Hordeum* sp.*, P. miliaceum, Chenopodium* sp.*, Duchesnea indica, Perilla frutescens, Ziziphus spinosa*	Cattle, Dog, Pig, Horse?, Sheep/goat, Deer, Bear, Rats, Porcupine, Rabbit	Yunnan 2013; Li, Liu 2016
Qujing Dongjia Village[15] 曲靖董家村 Dian Basin Qujing county	1982 n/a	700-300 BCE (assoc.)	Pit	-	Rice	-	Li, Li 1983

15 Also known by locals as Macaodong 马槽洞 or Biankukeng 蝙库坑.

Site (Location)	Exc. Date Exc. Area/ Est. site size	Chronology	Features	Material Culture	Plant Remains	Faunal Remains	References
Jinshashan 金砂山 Dian Lake, Jinning county	1999-2000; 2014-15; 2016 Unspecif.	Dian-Han period 800BCE-200 CE (assoc.)	84 burials (Vertical shaft pits; Some with sacrificial pits and burial chambers) 12 pits 2 ditches	Ceramics: Dian type Metal agricultural tools	Wheat, Nuts Flot. results unpublished	Unspecif.	Kaogu 2015; Yunnan Kaogu 2015; 2017b
Jinlianshan 金莲山 Dian Lake, Chengjiang county	2006; 2008-09 Over 600 m²/ Unspecif.	500-400 BCE (human bones)	265 burials (shaft pits)	Ceramics: Dian type Grinding stones Perforated knives	[Isotopes] C_3 prevalence (rice?); C_4 secondary	Not reported	Zhang 2011; Jiang et al. 2011
Jiangxifen 江西坟 Middle Jinsha River, Wuding county	2018-19 12,000 m²/ Unspecif.	900-400 BCE (human and animal bones)	530 burials (stone cist; shaft pit) 13 pits 1 floor 17 ditches	Ceramics: Impressed/ incised	*Oryza sativa, Setaria italica* [Isotopes] mixed C_3/C_4 one individual predominant C_3	Pig, Bovid	Yunnan Kaogu 2019; Lu et al. 2021
Yubeidi[16] 玉碑地 Bingu (Lower Jinsha River), Dongchuan County	1988; 2013 300 m²/ 1.8 ha	Dian period (Spring Autumn to Western Han) 700-300 BCE (assoc.)	15 houses (Semi-subterr.) 49 pits 6 burials (urn) Unknown no. of floors and postholes	Ceramics: Dian type Metal agricultural tools	*Oryza sativa, Setaria italica, Triticum aestivum, Glycine max, Zantoxhylum bungeatum, Chenopodium* sp., *Morus alba* Fruits, Tubers	Unspecif.	Huang 1990; Jiang, Zhu 2014 Yang 2016; Yang, Jiang, Chen 2020
Gaozhai Upper Jinsha River, Yulong county	2020 n/a	850-450 BCE (human bones)	4 burials (Stone cist)	Bronze knives	[Isotopes] Primarily C_3	Not reported	Ma et al. 2022b; Lu et al. 2023
Adong NW Yunnan, Deqing County	2020 n/a	750-450 BCE (human bones)	Unspec. no. of burials (Stone cist)	Bronze knives	[Isotopes] Mixed C_3/C_4	Not reported	Ma et al. 2022b; Lu et al. 2023

16 Previously referred to as Yingpancun 营盘村.

Site (Location)	Exc. Date Exc. Area/ Est. site size	Chronology	Features	Material Culture	Plant Remains	Faunal Remains	References
Shilinggang 石岭岗 Middle Salween River, Lushui county	2003; 2013-14 500 m²/ 10 ha	723-339 cal BCE (charred seeds)	42 burials (shaft pits) 4 pits 4 floors 2 houses (wattle and daub?) Burnt soil	Ceramics: Dianbian type	*Oryza sativa, Setaria italica, Zanthoxylum bungeanum, Perilla frutescens, Rhus chinensis* [Isotopes] mixed C_3/C_4; Tubers, roots, Acorns, Palms	Pig, Goat, Cattle, Dog, Deer	Li et al. 2016; Zhang et al. 2017; Ren et al. 2017
Mayutian 麻玉田 Red River, Yuanjiang section	2006; 2010 1325 m²/ Unspecif.	570- 440 BCE (human bones)	21 burials (Vertical shaft pits)	Ceramics: Mayutian type Metal artefacts, spearheads and axes	[Isotopes] Mixed C_3/C_4	Not reported	Xiao, Wan 2013; Zhang et al. 2014
Hebosuo 河泊所 (shell mound) Dian Lake, Jinning county	2014; 2016-17; 2021-22 12.5 m²/ 31 ha	202 BCE- 220 CE (charred seeds)	2 foundations 1 house (semi-subterr./ pile-dwelling) 1 road 375 pits 65 ditches 7 wells 1 river 31 burials (Vertical shaft pits) 14 dust heaps 6 floors 5 hard surfaces 6 ceramic heaps	Ceramics: Dian type, some Han objects	*Oryza sativa, Triticum aestivum, Setaria italica, P. miliaceum, Glycine max, Vigna angularis, Fagopyrum esculentum*, *Vitis vinifera, Crataegus cuneata, Chenopodium* sp., *Zantoxhylum bungeatum*, *Lagenaria* sp., *Prunus persica, Prunus salicina, Prunus cerasus, Choerospondias axillaris*	Not reported	Yao, Jiang 2012; Yao et al. 2015; Yang 2016; Yunnan, Chicago 2019; Yao A. et al. 2020; Yang et al. 2023; Jiang et al. 2023
Shamaoshan 纱帽山 Lake Yangzong, Yiliang county	1989 2,100 m²/ Unspecif.	250 BCE- 55 CE (human bones)	57 burials (vertical shaft-pits)	Ceramics: Dian type, some Han objects Metal weapons, buckles	[Isotopes] Predominantly C_3	Not reported	Zhang et al. 2012; Wu et al. 2019

4.3.1 Baiyangcun

Baiyangcun is located on the banks of the Binju River, which flows into the Jinsha River, in Binchuan county, northwest Yunnan **[fig. 19]**. Radiocarbon dating on charred seeds retrieved through flotation during the 2013 excavation established that Baiyangcun was occupied between 2650-1700 BCE (Dal Martello et al. 2018; Appendix 4). Both rice and millet have been reported since the lowest occupation layers, directly dated to 2650 BCE (Dal Martello et al. 2018, Dal Martello 2020). The occupation of the site has been further divided in two phases; phase I dating between 2650-2450 BCE, and phase II, dating between 2200-1700 BCE. Based on differences in ceramic typology, phase II was divided in two periods (Min Rui, pers. comm. September 2016), with a proposed phase III dating between 2000-1700 BCE (Dal Martello et al. 2018). The reasons why the site was briefly abandoned and then re-occupied between phase I and phase II are still unclarified. Baiyangcun has been among the most cited sites in Yunnan Archaeology since its discovery in 1972 and excavation between November 1973 and January 1974 (Yunnan 1981). Finds of rice remains (presumably silicified rice husks and panicles) were reported in less than half of the excavated pits during the first excavation season.[17] This was taken as evidence that Yunnan may have been the centre for rice domestication, a theory that is now no longer supported by the archaeological and archaeobotanical evidence (see § 2.2.1.1; see also below).

Information on the archaeological material is available from the first excavation (Yunnan 1981), and a preliminary report on the second season has been published on the official website of the Yunnan Provincial Institute of Cultural Relics and Archaeology (Yunnan Kaogu 2014). Both settlement and cemetery areas have been excavated. Features unearthed include at least 29 houses, 290 pits, over 50 burials, and numerous 'hearth' features. The preliminary report of the second excavation season distinguishes open air hearths (*huotui* 火堆; n=11), fire pits (*huotang* 火塘; n=4), and 'stove', indicated with the term *zao* 灶 (n=1; Yunnan Kaogu 2014); however, these have been grouped together in Table 12. At Baiyangcun, houses are wattle and daub structures with poles around the foundation perimeter; oval or rectangular pits with irregular openings have been documented around the houses. Chronologically, earlier houses present a groove along the foundation perimeter where poles were placed; later houses have poles dug straight into the ground. Burials are mostly primary inhumation in vertical shaft pits with the deceased placed in extended or flexed supine position, mostly without any funerary object. Urn inhumation of new-borns and infants and a few secondary and multiple burials have also been reported. A peculiar characteristic of Baiyangcun burials is the removal of the skull from some of the secondary interments. Scholars have suggested this custom may be tied with ancestral worship (Zhao, Zhu, Min 2016; Zhang, He 2022).

The ceramics at Baiyangcun are characterised by coarse/sandy pottery (*jiashatao* 夹砂陶) mostly brownish/dark-coloured (*he* 褐), and secondarily greyish or reddish in colour, vessels are produced with the coil technique, and are decorated with the so-called 'incised/impressed' style (*kehuawen* 刻划纹), characterised by geometrical and dotted designs (Rispoli 2007). The ceramic assemblage comprises *guan* 罐 and *gang* 缸 type vessels

17 The first excavation report states: "*Yuanxing jiaoxue ershiwu ge.* […] *tiantu songruan, neihan huibaise de liangshi fenmo yu daohe, daogan henji* 圆形窖穴二十五个 。 […] 填土松软，内含灰白色的粮食粉末与稻壳、稻秆痕迹。" (25 round-shaped pits. […]. Filled soil soft, it contained greyish grain powder and impressions of rice husks and stalks; Yunnan 1981, 352); "(*wu) guwu, guohe baiyangcun yizhi qingli zao, wanqi de jiaoxue sishiba ge, qizhong ershisan ge jiaoxue nei tiantu zhong huibaise de liangshi fenmo yu daoke, daogan henji (dai jianding). T4 chutu guohe yimei, jing zhongguo kexueyuan yichuan yanjiusuo li lu tongzhi jianding ke 'yunnan shan tao' (zhengshi xueming daiding*). （五）谷物、果核 白羊村遗址清理早、晚期的窖穴四十八个，其中二十三个窖穴内填土中灰白色的粮食粉末与稻壳、稻杆痕迹 （待鉴定）。T4出土果核一枚， 经中国科学院遗传研究所李璐同志鉴定可' 云南山桃' （正式学名待定）。" (5-Cereals and Fruits. Among the 48 early and late phase pits excavated at Baiyangcun, the soil of 23 contained greyish grain powder and impressions of rice husks and stalks (awaiting identification). A peach stone was found in Trench no. 4; Li Lu Comrade from the Institute of Genetics, Chinese Academy of Sciences has identified it as 'Yunnan Mountain peach' (scientific name awaiting determination)"; Yunnan 1981, 365).

(Yunnan1981, 362, fig. 16).[18] Guan jars have an ovoid body, restricted neck, and outward protruding lips. Gang jars present a round base, cylindrical body that expands greatly towards the shoulders, and are generally larger in size than *guan* vessels **[fig. 20]**. Guan jars are considered suitable for cooking through boiling, while *gang* jars are often described as used for storing grains. Gang round base suggests that if these were indeed used for storing cereals, they would be partially buried in the ground or be placed on a support. Other ceramic artefacts include typical daily objects that can be used for drinking or eating, such as *bo* 钵 bowls, *pen* 盆 plates/basins, and, in the upper layers, so-called *ye* vessels have also been recovered **[fig. 20]**.

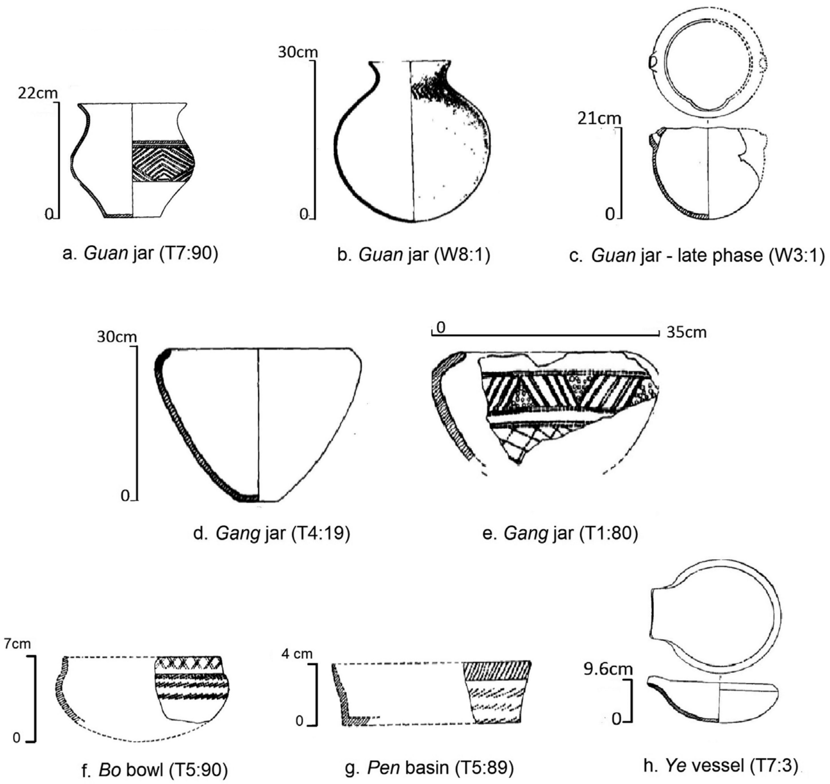


Figure 20 Examples of ceramic vessels from Baiyangcun. Redrawn from Yunnan 1981, adapted from Dal Martello 2020

Ye vessels are shallow dishes with a spout. The 1981 report states that vessels suitable for pouring liquids (identified by having a spout) increase in quantity during the second phase. It is worth noting, however, that vessels at Baiyangcun (and other sites discussed here) are classified based on conventional descriptive categories based on their shape, and no scientific studies have been undertaken so far to confirm their actual use. Of interest is the retrieval of two ceramic 'feet' (*qizu* 器足) from the first phase of occupation. They are made of reddish-coloured coarse pottery, pointy and

18 1 to 7 for *guan*, and 9, 15 for *gang*; some examples have been illustrated in Figure 20.

elongated, undecorated. This indicates that some vessels at Baiyangcun had feet; however, the fragmentary nature of the remains prevents us from fully understanding the type of vessel to which they were attached. Ground and polished stone tools, including serrated and perforated knives, have been reported through the sequence. Knives recovered at Baiyangcun include both rectangular and half-moon shaped blades. These are usually interpreted as suitable for harvesting cereals, such as rice and millet, at the panicle or slightly lower (see § 2.3.2.2). This would allow the collection of straws too, which may have been used as animal fodder or construction material (Bray 1984, 323-31; Thompson 1996). Their retrieval is seen as evidence of agricultural practices.

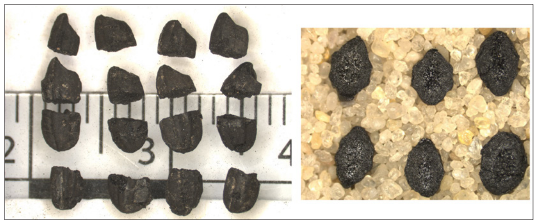
Systematic archaeobotanical sampling across the whole stratigraphic sequence and features was undertaken during the 2013 excavation of the site. The study of flotation samples not only confirmed the presence of rice, but also revealed a variety of other species, both domesticated and wild, that were potentially exploited by the Baiyangcun people **[fig. 21]**. These include foxtail and broomcorn millets, soybean, *Vigna* and *Cajanus* legumes, foxnut (*Euryale ferox*), goji berry (*Lycium* sp.), melon (*Cucumis* cf *melo*), chinaberry (*Melia azerdach*), walnut (*Juglans* sp.), hawthorn (*Crataegus* sp.), and wild grape (*Vitis* sp., Dal Martello 2020) **[fig. 21]** **[tab. 12]**. Peach stones have been reported from the 1981 excavation (see fn. 17); however, systematic flotation revealed no peach remains. A large amount of *Echinochloa* sp. grains have also been reported. Seven *Echinochloa* species are currently documented in Yunnan (Chen, Philipps 2006), including the cultivated *frumentacea* and *esculenta*,[19] all but one presenting a wetland habitat. It is not clear when and how this species was domesticated and used in the past (see § 2.4.2.2); however, *Echinochloa* is also known to be a rather difficult to extirpate irrigated rice field weed. At Baiyangcun, seeds of *Echinochloa* are present in high quantity, but contextual analyses were inconclusive in determining whether they were associated with cereal crops or weed species (Dal Martello 2020). Therefore, it is difficult to establish whether this plant was cultivated on its own or if it became incorporated in the archaeobotanical assemblage by infesting rice fields (and being accidentally collected during harvest). If so, the combined presence of *Echinochloa* and other typically wetland rice weeds, such as *Fimbristylis* sp., *Polygonum persicaria*, and *Schoenoplectus macronatus*, would indicate that rice at Baiyangcun was cultivated in a wet regime (Dal Martello et al. 2018). The presence of both rice and millet, along with the site's location in a valley surrounded by high mountains, suggests that rice was cultivated near the river, likely irrigated by seasonal flooding, while millet was grown on the surrounding slopes. Only 89 wild-type rice spikelet bases have been reported compared to the 1,714 domesticated-type found in the archaeobotanical assemblage. This indicates that rice at Baiyangcun was fully domesticated. Morphometric measurements on rice grains demonstrate a predominance of <2 grain length/width ratio (Dal Martello et al. 2018), which is considered indicative of *japonica* variety, based on established ratio differences between *indica* and *japonica* in previous studies (Castillo et al. 2016; Fuller, Harvey, Qin 2007; Harvey 2007).

19 The two cultivated *Echinochloa* species are known in Chinese as *hunan baizi* 湖南稗子 (*E. frumentacea*), and *zisuibai* 紫穗稗 (*E. esculenta*). In Yunnan, *Echinochloa* is also used to produce a local alcoholic beverage (D.Q. Fuller, pers. comm. 2017).

Figure 21 Ancient seeds from Baiyangcun, 2013 excavation. Black lines indicate 1 mm scale. a. Rice – *Oryza sativa*; b. Rice spikelet bases, domesticated-type; c. Foxtail millet – *Setaria italica*; d. Broomcorn millet – *Panicum miliaceum*; e. *Echinochloa* sp.; f. Foxnut – *Euryale ferox*; g. Soybean – *Glycine max*; h. *Vigna* sp.; i. *Cajanus* sp.; j. Acorn type A; k. Acorn type B; l. Wild grape – *Vitis* sp.; m. Hawthorn – *Crataegus* sp.; n. Possible melon – *Cucumis* sp.; o. *Fimbristylis* sp.; p. *Polygonum persica;* q. *Schoenoplectus macronatus*. © Author, modified from Dal Martello 2020

Of great interest is the retrieval of 'cracked' rice grains **[fig. 22]**. These have been retrieved especially from floor contexts, indicated in the excavation records as *huodongmian* 活动面 (activity floor). *Huodongmian* are most likely house floors for which the perimeter could not be individuated, and therefore archaeobotanical finds from such contexts may be related to cooking activities. According to charring experiments on rice grains, if grains are broken before charring, the fracture surface becomes glossy and bulges after charring (Lian 2015). This is the case for the cracked grains recovered at Baiyangcun, and if confirmed, it would suggest that people were pounding and cracking the grains before cooking them. This is an unusual find and it is currently difficult to determine what types of meals may have been prepared by cracking rice grains. Some charred lumps of organic materials were recovered in the flotation samples; SEM (Scanning

Electron Microscopy) examination established these were not charred food byproducts, but instead they were cracked rice grains agglomerates **[fig. 23]**.



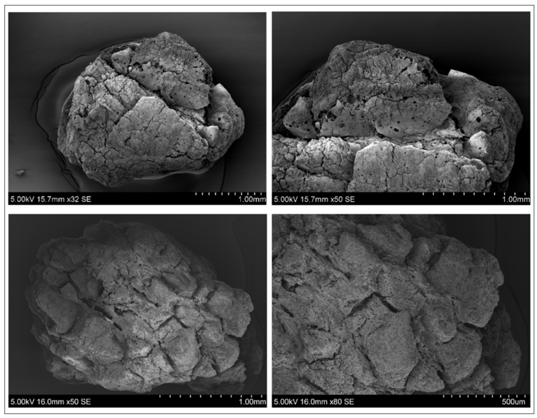


Figure 22
Cracked rice grains at Baiyangcun from context F11. © Author, modified after Dal Martello 2020 figs 5.16-17

Figure 23
SEM pictures of cracked rice grain lumps from context layer 18; right images show close up of left pictures. © Author, modified after Dal Martello 2020, fig. 5-15

Chronologically, cereals are predominant over all other types of plant species in all three phases of occupation. According to macro-botanical remains, rice and millets constitute the basis of the agricultural system. Rice, although maintaining its overall prominence, decreases in favour of millet in phase II. Legumes, fruits and nuts, although accounting for a small proportion in the overall assemblage, show an increase in the second phase. This may be due to changing climatic conditions across the third to second millennia BCE, especially the drying monsoon. Palaeoenvironmental reconstructions (see Ch. 3) indicate that, at the time of Baiyangcun occupation, precipitation in the area may have been as much as 20% higher than today (est. 680 mm versus present day ca. 565 mm). This would not have been sufficient to support the rainfed cultivation of rice, and the retrieval of typically irrigated rice weed species confirms that rice was cultivated in a wet regime. The drying climate during phase II may have caused uncertain rice harvests and pushed people to increase millet cultivation (Dal Martello et al. 2018).

In addition to archaeobotanical studies, stable isotope analyses have been undertaken on human and animal bone collagen from material derived from the second excavation. The results of the study show that people had a predominantly C_3 diet for all time periods (Ma et al. 2022a). One individual was sampled for phase I (ca. 2750-2350 BCE, $\delta^{13}C$ value −17.8‰) compared to twenty from the 'later phase' (ca. 1750-1250 BCE; $\delta^{13}C$ average value −18.9‰ ± 0.4‰). It is important to note that most of these individuals date to later than the last phase from which we have direct archaeobotanical remains (dating to ca. 2200-1700 BCE; see above), with only one possibly dating to the cusp of the transition from phase III to the 'later phase' (ca. 1740-1630 BCE). Isotopes on two pigs from the later phase showed they predominantly fed on C_3 plants ($\delta^{13}C$ average value –20.4‰). This suggests that both people and domestic animals fed on either rice or local wild resources, assuming a scarcity of natural C_4 plants in the background vegetation. Subtropical and tropical regions today are characterised by C_3 dominant vegetation. However, numerous edible tropical grasses and sedges are C_4, and today Yunnan has a high diversity of C_4 grasses compared to other provinces in China (Zhang A. et al. 2023; Wang 2006), therefore, caution is needed when inferring the specific plants that constituted ancient diets, as many plants other than cereals are edible and have C_3 and C_4 signatures. Authors of the isotope study suggest that millet was not cultivated for food at Baiyangcun, and its presence in the archaeobotanical assemblage may indicate it was used as animal fodder or for ritual purposes. However, this contrasts with the results from the two sampled pigs, which fed on C_3 plants rather than millet – a crop that, if used as animal fodder, would be unlikely to appear charred in the archaeobotanical records alongside rice grains. The macro-botanical evidence from Baiyangcun shows that millet grains are ubiquitous and associated with rice from domestic contexts. This would suggest both crops were seen as food resources. The lack of a C_4 signature in both humans and animals could be due to the fact that most of the sampled individuals date to a later phase for which available macro-botanical remains are available. A phase during which the site may have been used a cemetery only, for people residing elsewhere. Given the uneven sample size, as well as the absence of a baseline for herbivores, needed to understand the background vegetation, it is difficult to fully assess the diet composition of ancient Baiyangcun people and further data is needed to confirm a millet production decline as hypothesised by Ma et al. (2024). Moreover, the one individual sampled for phase I (from which we have direct archaeobotanical remains) may also have been an outsider, or someone belonging to a special group with differing eating habits, which would explain the discrepancies between the macro-botanical and isotope data. In addition to plant cultivation, at Baiyangcun hunting and animal husbandry may have both been practiced, as evidenced by the presence of pigs, cattle, goats/sheep, wild boars, black bears, and deer (Yunnan 1981).

According to a survey carried out after the end of the second excavation, Baiyangcun is estimated to be between 10-20 hectares in size (Min Rui, pers. comm. April 2018). Although there are currently no ancient population estimates for Yunnan, similar studies undertaken at other Neolithic sites in China proposed an estimate of 50/53 people per hectare for rice producing sites (Sun 2013, 563; Liu 2004, 79), and about half for sites based on millet farming (Carlstein 1980; see also Qin, Fuller 2019). If applicable to Yunnan, this estimate would suggest a population of 500-1000 people living at ancient Baiyangcun.

4.3.2 Dadunzi

Dadunzi is located on the northern bank of the Longchuan River, a tributary of the Jinsha River, in Yuanmou county, northwest Yunnan **[fig. 19]**. The site was discovered in 1972 and excavated for a first time across 1972-73, with successive excavations conducted in 1999 and 2010. In 1972, greyish powder and charred rice grains had been reported (Kan 1977).[20] Based on radiocarbon dating on charred seeds retrieved through flotation in 2010, Dadunzi was occupied between 2200-1610 BCE (Li et al. 2016; Jin et al. 2014a; 2014b). According to the report from the first excavation (the only one published so far; Kan 1977), Dadunzi material culture shows strong affinities with that of Baiyangcun. Of the 61 houses uncovered, most are of the wattle and daub type, with a few semi-subterranean and stilt houses. The cemetery included vertical shaft pit burials, urn (for infants), and stone cists burials.[21] The deceased were placed in a variety of positions, including extended, flexed, supine, and prone; about half of the burials had ceramic vessels and other small objects. Dadunzi ceramic vessels are made of coarse pottery, handmade, and decorated with incised/impressed geometric designs. Vessel types include *guan* jars, which are fairly similar to those unearthed at Baiyangcun, and other utilitarian vessels, described in the report as suitable for cooking and eating (e.g., *hu* 壶 flasks, *ping* 瓶 bottles, *bei* 杯 glasses, *bo* bowls). A peculiar shape not encountered at Baiyangcun is the so-called 'ring-foot' (*quanzuqi* 圈足器). This indicates a round and hollow pedestal. Such a pedestal may have been used as a base for other vessels. Of note is the retrieval of a small 'chicken'-shaped ceramic pot (*jixinghu* 鸡形壶) from a burial. This is only 12 cm tall; the vessel is shaped so that the beak of the chicken serves as spout. The surface of the chicken-pot is decorated with incised lines (to resemble feathers?), and three rows of circular studs are placed on the back of the bird; two more studs are placed on the mouth of the vessel, probably to resemble the bird's eyes (Kan 1977, 70). Lithic tools from Dadunzi include half-moon shaped and perforated knives, grinding stones, and other tools suitable for cultivation activities. Three stone stamps show a square grid pattern on one surface; such stamps may have been used to impress the decoration on the pottery vessels; but this hypothesis needs further research. Finally, 69 knives made of freshwater shells have been reported, most are fragmented but two whole ones show small, drilled holes in the middle.

The archaeobotanical samples collected in 2010 revealed an assemblage dominated by cereals, specifically rice and millets (Jin H.T. et al. 2014a; 2014b). Foxtail (n=1136) and broomcorn millet (n=228) grains were much more numerous than rice grains (n=78); however, the samples contained a staggering 3,520 domesticated-type rice spikelet bases. Although rice grains are present in lower quantities than millet, the high presence of rice spikelet bases indicate that rice was locally cultivated. Other edible species include potentially edible *Vigna* and Cucurbitaceae seeds, but these are present in negligible quantities compared to cereal grains (Jin H.T. et al. 2014a; 2014b). Seeds of *Digitaria* sp., *Setaria* sp., *Chenopodium* sp., *Fimbristylis* sp., and

20 The original report states: "*H1 chutu daliang huibaise de hecao lei yezi, guke fenmo, K7 de san ge taoguan nei, jun faxian daliang de dalei tanhua wu. Jing zhongguo kexueyuan zhiwu yanjiusuo jianding, huibaise fen lishu hezhang lei (ru daozi) fenmo. Jing chubu jianding, guan nei de gulei tanhua wu shi jingdao* H1出土大量灰白色的禾草类叶子、谷壳粉末, K7的三个陶罐内, 均发现大量的答类炭化物。经中国科学院植物研究所鉴定, 灰百色粉隶属禾章类(如稻子)粉末。经初步鉴定、罐内的谷类炭化物是粳稻。" (A large quantity of greyish grass powder and leaves was unearthed in H1. Large numbers of charred grains were found inside three ceramic jars recovered in K7. The Institute of Botany of the Chinese Academy of Sciences identified the remains as Poaceae, most likely rice grains of the *japonica* type; Kan 1977, 70-1).

21 Only the total number of excavated graves is reported from the 2010 excavation, and no quantitative information is known on the different types of graves unearthed in this occasion.

Scirpus sp. have also been reported (Jin H.T. et al. 2014a). The presence of both wetland and dryland cultivation weeds suggests that people at Dadunzi were cultivating along a vertical gradient, presumably planting rice in the lowlands close to the river, and moving onto the slopes for millet fields, similar to the mixed farming system attested at Baiyangcun. No systematic zooarchaeological study has been undertaken at Dadunzi yet, but a similar suite of animals to that found at Baiyangcun has been reported, with the addition of lacustrine resources, which may indicate fishing was an important component of the economy.

4.3.3 Xingyi Phases I, II

Xingyi 兴义 is a large shell-midden site located on the shore of Qilu Lake, south from the Dian Lake **[fig. 19]**. Excavations in 2015-16 revealed an over 9 m deep archaeological deposit, and radiocarbon dates individuated three phases of occupation: phase I ca. 5500-3350 BCE; phase II ca. 2950-2350 BCE; phase III ca. 1850-1350 BCE (Ma et al. 2024). No full report has been published yet, but features from phase II include 12 burials, the deceased placed in flexed position, and 3 pits (Yunnan 2017). Xingyi ceramics are decorated with corded patterns (*shengwen* 绳纹), described as Haidong style (see below), and the most prevalent vessel type is the wide-mouthed, high-neck *guan* jar. Corded ware is specific to Neolithic sites located in the Dian Lake Basin during this millennium (Yao 2010). This indicates two different cultural traditions and presumably groups inhabited northwest and central Yunnan at the time, represented in this book by Baiyangcun (and possibly Dadunzi) with incised/impressed ceramics in northwest Yunnan, and Xingyi/Haidong with corded ware in the Central Lakes area of Yunnan. At Xingyi, extremely abundant lacustrine resources have been reported, particularly *Margarya* sp. (a freshwater gastropod), suggesting significant exploitation of the lake during the occupation of the site.

Although archaeobotanical samples were collected from all phases, no seeds were retrieved from the first two phases, possibly due to the poor preservation of organic remains given the shell midden nature of the site (Ma et al. 2024). Archaeologists that excavated the site suggest that the first phase represent the transition from a 'pre-agricultural' to a settled agricultural lifestyle. Stable isotope analysis on human and animal bones was undertaken to investigate Xingyi's people diet. Two individuals were sampled for phase I and showed a predominantly C_3 diet ($\delta^{13}C$ average value –19.2‰), which the authors of the study have interpreted as consistent with wild plants foraging or possibly rice consumption. However, this is based on only two individuals (one adult and one infant), a too small sample size to make broad inferences. Since no archaeobotanical remains were retrieved from this period, the results cannot be correlated with specific evidence that would clarify which species were exploited and whether they were wild or domesticated, collected or cultivated. Given the absence of macro-botanical remains, rice consumption at Xingyi during the earliest phases of occupation remains, as yet, an unproved hypothesis. Wild rice was present throughout this region at the time (see Ch. 3), however, in cases where systematic archaeobotanical studies have been conducted (such as at Baiyangcun, see § 4.3.1), wild rice appears in negligible quantities in the overall archaeobotanical assemblage, possibly indicating that its wild collection was not practiced by local groups, and the C_3 signature detected at Xingyi may refer instead to local wild plants. More evidence, specifically archaeobotanical remains, is needed to clarify this issue.

Fourteen individuals were sampled for phase II. The results show an increase in C_4 plants intake ($\delta^{13}C$ values range from –18.9 to -12.6‰, average value –16.8‰), which the authors of the study interpret as evidence of millet consumption. While direct evidence for millet consumption in the form of charred millet grains is presently missing, the absence of C_4 isotopic signature from the earlier period would support such an interpretation. Data on ancient herbivores at the site indicate a low natural presence of C_4 plants in the background vegetation of Qilu Lake at the time of Xingyi's occupation (Ma et al. 2024, 108).[22] However, given the lack of macro-botanical remains, it is difficult to fully establish what plant resources were consumed by Xingyi's inhabitants, and whether isotope differences indeed relate to a change in subsistence from rice (or rather other local wild resources; see above) in phase I to millet in phase II, as suggested by Ma and colleagues (Ma et al. 2024). It is also worth noting that several shellfish species have a C_4 signature, which could skew the isotope data. More data is needed to clarify the diet composition of the early occupation of Xingyi.

4.3.4 Other Third Millennium BCE sites

In a summary about agricultural dispersal to South China by Zhang and Hung (2010) (handpicked) rice remains from Haidong 海东, a shell midden site located not far from Xingyi **[fig. 19]**, were described as the earliest attested at the time in Yunnan (Zhang, Hung 2010, 15).[23] Human bones from the site were directly dated to ca. 3090-2200 BCE (Yuan et al. 1994). Excavated features include 30 burials, which were mostly shaft pits with the deceased placed in a flexed position. Ceramics from Haidong are characterised by cord-impressed decoration (He 1990, Yao 2010). The same type of ceramic remains have been reported from third millennium BCE layers at Xingyi. A tortoise shell and high quantities of lacustrine mollusc shells were also found at Haidong **[tab. 12]**. However, both the original report on Haidong's discovery (He 1990), and the article cited by Zhang and Hung (Xiao 2001) do not mention rice grains from the site. An article about early agriculture in Yunnan authored by A. Yao (2010) and summarising plant remains from sites in Yunnan does not list Haidong among the sites with rice remains. At present the presence of rice at Haidong is unclear but given the great similarity and proximity of Haidong to Xingyi, we may assume that people at Haidong had access to similar wild plant resources as those attested from Xingyi, but this needs to be confirmed with future flotation studies.

In 1993, charred rice grains were found at the bottom of an ancient ditch (G3) at Xinguang, a site located in the upper Mekong Basin, in northwest

22 The reconstruction of a C_3 based background vegetation is based the C_3 predominant diet of herbivores from the site (attested with stable isotopes studies). This contrasts with other studies (e.g., Zhang et al. 2023; Wang 2006) which instead reconstruct a high diversity of C_4 grasses in Yunnan compared to other provinces in China.

23 Zhang and Hung state that "in Yunnan, the earliest rice remains belong to the Shizhaishan Neolithic phase in the Lake Dian region, dated to 3100-2450 cal BC at Haidong" (Zhang, Hung 2010, 15).

Yunnan **[fig. 19]**.[24] The site was occupied between, ca. 2620-1780 BCE (Yunnan 2002). Features unearthed include 4 wattle and daub houses, 2 semi-subterranean houses, 21 irregularly shaped pits, and 3 ditches. The ceramic assemblage from Xinguang is vastly similar to that from Baiyangcun. Ceramic pots at Xinguang are handmade with coarse pottery, have a greyish-coloured surface, and are decorated with incised/impressed geometric designs. At Xinguang, the most prevalent vessels are *guan* jars with flat bases, round bellies, and outward protruding lips. The report states that ceramic sherds from the lowest levels show occasional traces of red paint. Lithic implements perforated knives, and grinding stones (Yunnan 2002). Preliminary data from Xinguang suggest its inhabitants were sedentary agriculturalists cultivating rice. Yao (2010) lists rice, millet and wheat at Xinguang, but the original excavation reports do not mention millet and wheat. Therefore, the presence of these two cereals needs to be confirmed with future studies.

4.4 The First Bronze Implements and the Arrival of Wheat and Barley

4.4.1 Haimenkou Phases I, II

Haimenkou is located in the Jinsha Basin, in Jianchuan county, northwest Yunnan. The site was excavated in 1957, in 1978, and in 2007-8, when archaeobotanical samples were collected. At present, the site is still undergoing excavation as part of Sichuan University Archaeology Field School Program (J.X. Song, pers. comm., 2023). It is estimated to be as large as 5 to 10 hectares (Min 2009a; 2009b). Extensive radiocarbon dating on charred seeds in conjunction with changes in material culture identified three phases of occupation: phase I (Neolithic) ca. 1600-1450 BCE, phase II (Neolithic/Bronze Age Transition) ca. 1450-1100 BCE, phase III (Bronze Age) ca. 800-400 BCE (Li, Min 2014). Metal objects were found in layers from phases II and III, and these are the earliest metal artefacts recovered in Yunnan today. After the site was abandoned, it was submerged and preserved by waterlogging. This resulted in excellent preservation of organic remains, including whole wooden poles and hundred thousand of plant remains (see below). Due to this unparalleled preservation, Haimenkou was included in the *Year 2008 10 Best Archaeological Discoveries of China* (2008 *Nian Quanguo Shida Kaogu Xin Faxian* 2008 年度全国十大考古新发现; PKU 2009).

Features unearthed at Haimenkou include an unspecified number of rectilinear pile dwellings, or elevated wattle and daub houses (Min 2009a; 2009b). Ceramic tiles have been reported. The wooden poles increase significantly in number in the second phase, indicating an expansion of

24 “G3 *dibu caji daode tanhuadao biaoben, jing yunnansheng nongkeyuan cheng kansheng jiaoshou jianding shi daogu lei. You jing jiangsusheng nongye kexueyuan zhang linghua tongzhi jianding, renwei ‘cong zhiwu danbaishi de xingzhuang laikan, yingdang shi gengxing dao’*” “*G3*底部采集到的碳化稻标本，经云南省农科院程侃声教授鉴定是稻谷类。又经江苏省农业科学院张陵华同志鉴定，认为‘从植物蛋白石的形状来看，应当是粳型稻’” (Charred rice specimens were collected from the lower layer of G3, Prof. Cheng Kansheng from the Yunnan Academy of Agricultural Sciences identified it as ancient rice. Further identification by Comrade Zhang Linghua of the Jiangsu Academy of Agricultural Sciences stated “from the perspective of the phytolith morphology, it should be *japonica* type rice”; Yunnan 2002, 226).

the settlement. Phase I ceramics were handmade with mostly incised/impressed geometric decorations. The majority had a coarse pottery of greyish/dark surface colour, with some vessels having fine polished black pottery. Generally speaking, vessels appeared fired at high temperature. The most common vessel type are *guan* jars; however, these are rather small in size, and many are fragmented and lack the bottom section **[fig. 24]**. In phase I, several ring-foot pedestals (similar to those found at Dadunzi) have been reported, but they disappear in phase II (Yunnan, Dali 2009; Min 2009b). During phase II, red-coloured surface vessels and painted ceramics appear, high-neck and double-handled *guan* jars increase, and some vessels are made of fine pottery (*nizhitao* 泥质陶), but these are always minor compared to those made of coarse pottery. The Haimenkou ceramic vessels were decorated with incised/impressed triangles, zigzags, lozenges and other simple geometrical elements that show affinities with ceramic decoration traditions from third millennium BCE Northwest China (mostly referring here to Gansu and Qinghai provinces, Xiao 1995). High-neck and double-handled *guan* jars are considered diagnostic of Northwest China Neolithic Cultures (those from Gansu and Qinghai), and their increase at Haimenkou is seen as evidence of cultural connections, through either trade or migrations of Neolithic populations from that region (see below; Wang 2018). Pottery fishnet weights have been reported, and this may indicate that fishing had a role in the overall economy. Tools from Haimenkou include perforated stone knives and other stone implements that may be associated with agricultural or deforestation activities. The overall number of stone tools rises considerably in phase II, which has been correlated with increased deforestation, as indicated by the greater number of wooden beams in this phase. Metal objects were reported from the first two excavation seasons, but no stratigraphic information was provided. According to the 2007-8 campaign, copper/bronze and iron objects were recovered from layer 6 (see Li, Min 2014 for composition analyses of metal artefacts unearthed at Haimenkou, and Liu et al. 2021b for a more recent analysis and dating of the objects). Metal artefacts form Haimenkou are small tools, such as knives, chisels, awls, sickles **[fig. 25]**. A small bell (3.8 cm long and 2.6 cm wide) and three bracelets are the only non-utilitarian metal objects reported so far from Haimenkou. The bell has a simple cylindrical shape with a round hook at the top; two circular holes at the top and a larger eight-shape hole are present on one side of the bell (Min 2009b) . In addition to metal artefacts, stone casting moulds for producing metal hatchets have been retrieved **[fig. 25]**, and this indicates that the metal objects were manufactured locally (Xiao 1995).

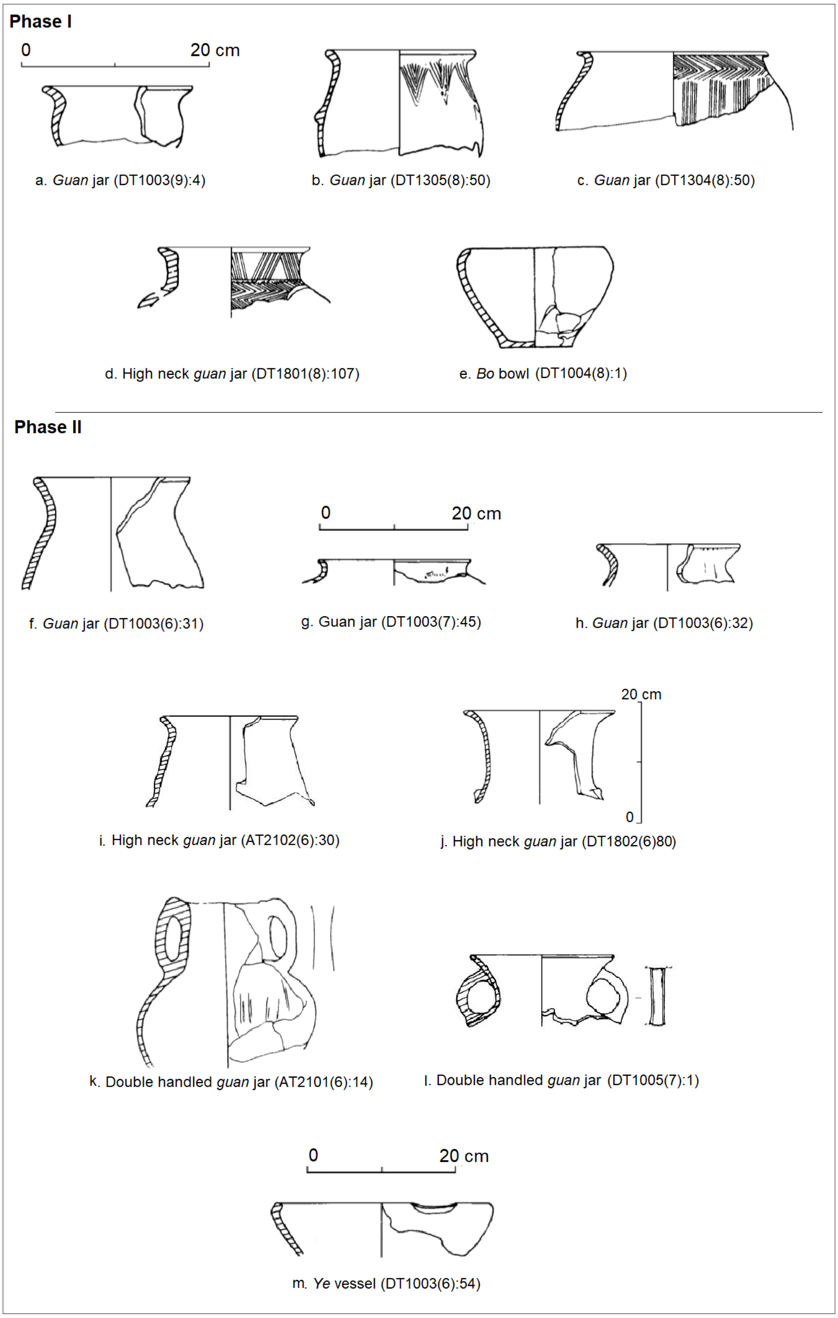


Figure 24 Examples of ceramic vessels from Haimenkou. Phase I indicates objects from layers 10-8; Phase II indicates objects from layers 7-6. Redrawn from Yunnan et al. 2009, modified from Dal Martello 2020

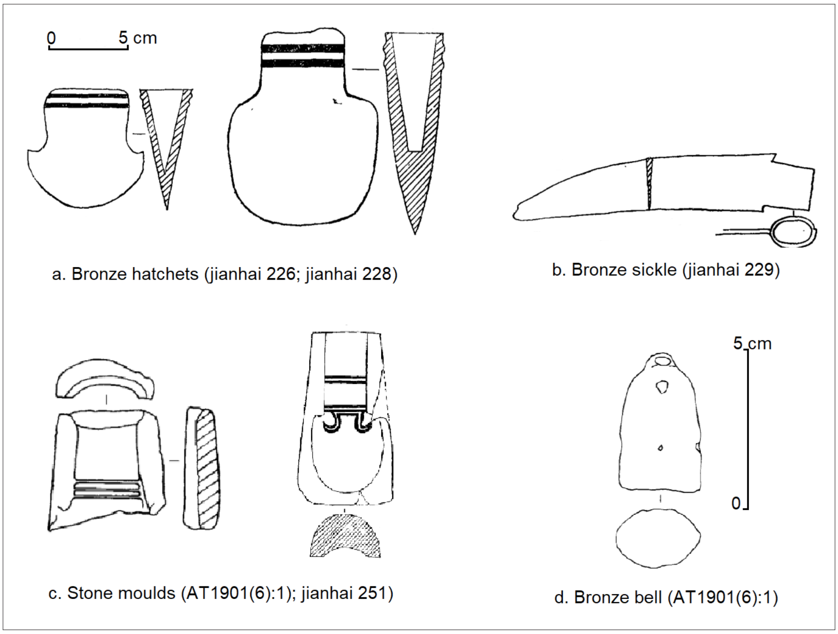


Figure 25 Examples of bronze and stone artefacts from Haimenkou. a.-c. redrawn from Xiao 1995; d. redrawn from Yunnan et al. 2009; modified from Dal Martello 2020

The archaeobotanical remains from Haimenkou have an unparalleled level of preservation, with over 117,000 individual plant remains retrieved (Xue et al. 2022). In phase I, cereals include rice and (foxtail) millet. In phase II, low numbers of seeds of wheat (*Triticum aestivum*) and barley (*Hordeum vulgare*) have been reported **[fig. 26]**. Wheat seeds have been directly dated to ca. 1500-1400 BCE,[25] at present, this is the earliest report of wheat in Yunnan. Barley seeds are present in much lower quantities compared to wheat grains (Xue et al. 2022). One seed of buckwheat (*Fagopyrum* cf *esculentum*) has been reported from each phase. Other species that may have been exploited for food include *Chenopodium album*, soybean, peach and apricot (*Prunus persica*, *P. armeniaca*), foxnut, wild grape, and possible raspberry (*Rubus* sp.). *Chenopodium* seeds were found in high concentrations in cereal-rich samples; the quantity of *Chenopodium* seeds exceeded that of any other species in some of the samples (Xue et al. 2022; Dal Martello 2020). This suggests that *Chenopodium* was exploited, possibly as food (Xue et al. 2022). Finally, *Cannabis sativa* – probable hemp seeds were found. Comparative morphometric studies on modern and archaeological cannabis seeds indicate that at Haimenkou this plant may have been cultivated either for psychoactive purposes and for oil/fibre or possibly both (Dal Martello et al. 2023b). Over 700 seeds of cannabis have been found in one sample, suggesting this crop was stored individually. This further supports the exploitation of this plant for human use. A textile fragment and a rope bundle

25 Although 11 wheat grains were found in samples from phase I layers, direct radiocarbon dating furnished a date congruent with phase II, indicating those 11 grains were intrusive (Xue et al. 2022).

have been reported from the 2007-08 excavation; however, the fibres have not been identified (Xue et al. 2022).

In addition to charred remains, waterlogged plant seeds have also been retrieved from layer 6 upward. These are believed to derive from the rising of the ancient underground water levels, which sealed the site underwater and allow the excellent preservation of organic remains seen at the site. Waterlogged remains include mostly seeds of wild aquatic species such as *Butomus* sp., *Najas* sp., and *Ranunculus* ssp. It has been inferred that waterlogged remains relate to post-depositional processes, and as such they have been excluded from quantitative analyses in previous studies (Xue et al. 2022).

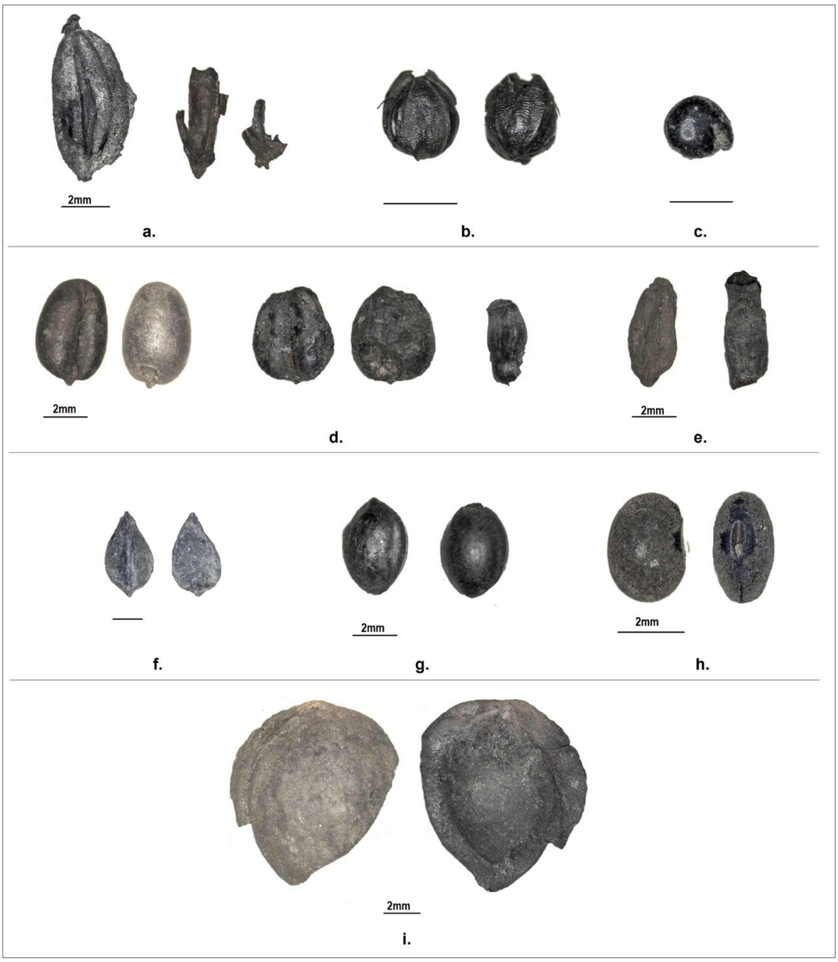


Figure 26 Ancient seeds from Haimenkou, 2008 excavation. Black lines indicate 1 mm scale. a. Rice – *Oryza sativa* and spikelet bases; b. foxtail millet – *Setaria italica*; c. *Chenopodium* sp.; d. Wheat – *Triticum aestivum* grain and rachis; e. barley – *Hordeum vulgare* grain and rachis; f. Buckwheat – *Fagopyrum* cf *esculentum* grain; g. *Cannabis* sp. grain; h. Soybean – *Glycine* cf *max* grain; i. *Prunus* sp. © Author, modified from Dal Martello 2020

A systematic study on the faunal remains collected during the 2007-08 excavation reported the presence of both domesticated and wild taxa, including pigs (*Sus domesticus,* the most prevalent species), goat/sheep (*Ovis*/

Capra sp.), dogs (*Canis familiaris*), and potentially gaurs (*Bos gaurus*), which may have been under human management (Wang 2018). Today gaurs are found confined to southern Yunnan, and gayal (*Bos frontalis*, domesticated gaur) is sporadically attested in Northeast India and Myanmar.[26] Gaur's presence at second millennium BCE northwest Yunnan indicates their distribution in the past was much more widespread than it is today. This may provide clues for understanding their domestication. Another interesting feature of the animal assemblage is an increase in goat/sheep remains in phase II.

The appearance of wheat and barley, the expansion of the settlement, the increase in sheep/goat remains, along with rise artefacts associated with Neolithic Northwest China (Gansu/Qinghai) at Haimenkou from ca. 1400 BCE have been taken as evidence of strong cultural connections or even migrations of Majiayao populations from the north (see below).

4.4.2 Xingyi Phase III

Phase III of Xingyi has been radiocarbon dated to ca. 1750-1250 BCE (Ma et al. 2024). Features unearthed from phase III include 47 floors, 18 houses, 24 burials, 16 pits, 4 streets, two ditches, and one walled structure (Yunnan 2017). The most prevalent vessels in the ceramic assemblage are flared rim *guan* jars and spouted vessels. These have a greyish-coloured surface; only the top section of the pots is decorated in what is described as Xingyi style. Foot-ring ceramic supports, bronze objects, and moulds were also unearthed. Among the lithic implements, knives and grindstones are reported, but no further details about the objects have been published (Yunnan 2017).

Both archaeobotanical and isotope studies are available from this time. Macro-botanical remains include seeds of foxtail and broomcorn millets, rice, wheat, one buckwheat seed, soybean, and *Perilla frutescens* seeds (Ma et al. 2024). Although acorns were not retrieved in the archaeobotanical samples, acorn presence is mentioned in the preliminary excavation report (Yunnan 2017); at present it is unclear which phase acorns belong to. Analyses on carbon isotope from human bone collagen show the widest range compared to the previous two periods ($\delta^{13}C$ values comprised between –18.9‰ and –12.6‰; average value –15.9‰). However, this is based on 12 samples, all from infants. Sampled pigs show a C_4 rich diet ($\delta^{13}C$ range from –18.3‰ to –13.5‰; Ma et al. 2024). This wide range possibly indicates a mixed C_3/C_4 diet; this is corroborated by the presence of rice, wheat and millet in the macro-botanical assemblage. The authors of the isotope study suggest that compared to phases I and II, inhabitants of Xingyi in phase III practiced "a more integrated plant and animal agriculture" (Ma et al. 2024, 111). While an agriculture subsistence is well supported for phase III – through both macro-botanical and isotope data – the absence of macro-botanical data for the first two phases, along with the small sample size for phase I, means that evidence for farming prior to phase III is currently lacking. Therefore, at present caution is warranted in inferring an agricultural subsistence for the earlier phases, and further data is needed to explore this issue.

26 Simoons, Simoons 1968; Shaller 1967; Larson, Fuller 2014; Murphy, Fuller 2018.

4.4.3 Other Second Millennium BCE Sites

Other sites for which we have information, either macro-botanical remains or data from stable isotopes, are Mopandi and Mopanshan 磨盘山 in the wider Jinsha River Basin; Toujushan on the shores of Xingyun Lake, in central Yunnan;[27] Yingpanshan, Shifodong, and Nanbiqiao in the middle-lower Mekong River Basin, and Dayingdong 大阴洞, in southeastern Yunnan close to Guizhou Province **[fig. 19] [tab. 12]**.

Mopandi was excavated in 2001; one context was floated after excavation, providing evidence for rice at the site (Zhao 2003a). Mopandi is a settlement site with wattle and daub structures similar to those found across northwest Yunnan in this period. Ceramic vessels are handmade with reddish, coarse pottery. The most prevalent vessel type are *guan* jars with outward protruding lips and flat bases. Some pots are decorated with incised/impressed geometric designs. Although no systematic study has been undertaken on the animal species, pig, cattle, and sheep/goat bones were reportedly found at the site. A section of the cemetery was also excavated, this was located on the slopes, although the skeletal remains were not well preserved. Mopanshan is only 3 km from Dadunzi; it was excavated in 2012-13, and at present only preliminary reports have been published. According to these reports, Mopanshan is a settlement characterised by semi-subterranean and stilt houses, vertical shaft pits and stone cists burials. These varieties in house and burial structures may indicate different phases of occupation, or diversified customs within the people living at the site. Preliminary archaeobotanical analysis attests the presence of acorns, millets, and rice. The presence of pig bones further suggests a settled agricultural lifestyle. Both Mopandi and Mopanshan sites have been dated by association to the second half of the second millennium BCE.

Yingpanshan is located in the middle Mekong Basin; it was excavated in 1990, and it was reported that a 8 to 10 cm thick layer (estimated to weigh 7,000 g) of charred rice grains was found clustered on a corner of a semi-subterranean house, under which there were fragments of a (storage) basket (Xiang et al. 2015, 41). No further information is available about the site.

Shifodong is a cave-site located in the middle Mekong Basin, further south from Yingpanshan and close to the Myanmar border **[fig. 19]**. Shifodong was excavated in 1982 and in 2003, when several hearth-like features were found inside the cave. Archaeologists working at the site inferred that the hearth structures may indicate a division of the internal space for specialised use (Liu, Dai 2008). One context was floated after excavation and the extracted material sent for identification to Prof. Zhao Zhijun (Istitute of Archaeology, Chinese Academy of Social Sciences). The retrieved macro-botanical remains comprised of rice grains, a great quantity of rice husks, few foxtail and broomcorn millets grains, *Chenopodium* sp. grains, seeds of possible cf. *Tamarindus indica* (Dal Martello 2020, albeit this have been identified

27 The exact location of Toujushan is unknown since the original report did not contain a map and did not provide further information beyond its location in the surrounding of the Xingyun Lake; for this reason, the site has not been included in Figure 19.

via photographs only and needs future confirmation)[28] **[fig. 27]** and another unidentified tree legume, and some possible fruit stones (Zhao 2010b). The ceramic assemblage at Shifodong is characterised by a large quantity of *fu* 釜 cauldrons (these are large vessels with unrestricted openings, usually a flat base, and wide shoulders. *Fu* cauldrons are considered suitable for cooking), *guan* jars, *bo* bowls, *bei* drinking cups, and *pen* plates/basins. Ceramic vessels at Shifodong are decorated both with incised/impressed and corded designs. Incised/impressed decorations show a strong resemblance with earlier Yunnan incised/impressed pottery style, as well as contemporaneous Southeast Asian ceramics (see Ch. 5); however, no in-depth report on the objects unearthed at Shifodong has been published yet (Kan 1983; Liu, Dai 2008).

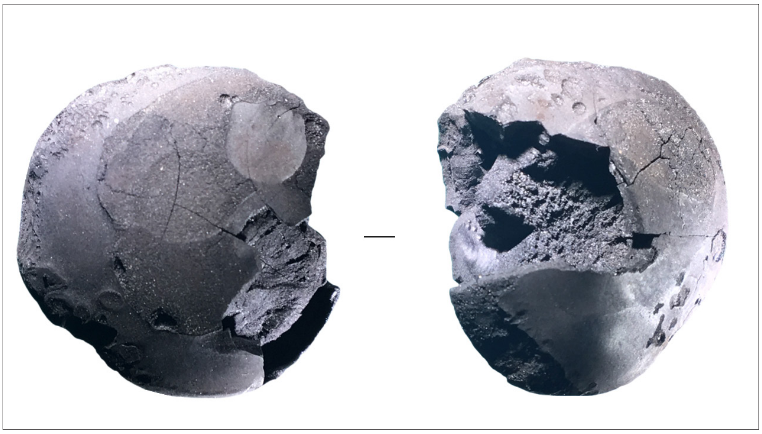


Figure 27 Seed of possible tamarind (cf. *Tamarindus indica*) from Shifodong. Seed stored at the Archaeobotany Laboratory at the Institute of Archaeology, Chinese Academy of Social Sciences. © Author, modified after Dal Martello 2020, fig. 8-4

Nanbiqiao is a cave site located close to Shifodong with which it shares similarities in material culture (Yao 2010). Charred rice grains were reported during its excavation in 1982, but no further information is available.

Finally, Dayingdong is a cave site in southeastern Yunnan, which was excavated in 2017-18 (Yunnan Kaogu 2018). Inside the cave the archaeologists found 12 pits, and 17 burials. Burials included both primary and secondary interments, and the deceased were placed both in flexed and extended positions. According to radiocarbon dating on human bones, the site was occupied in the second half of the second millennium BCE. Charred rice grains have been reported, and isotope analyses on human bones evidenced a predominantly C_3 diet ($\delta^{13}C$ range from –20.2‰ to –17.5‰; Zhao et al. 2022; Zhang Y. et al. 2024).

28 The retrieval of seeds of possible tamarind is interesting as this species was thought to be native to Africa and only recently introduced to India. Recent archaeological work in India has found possible tamarind wood remains (dating to ca. 1300 BCE at Narhan in the middle Ganges), this, together with with linguistic data, indicate a much earlier spread (Asouti, Fuller 2008; Fuller 2007). However, there are also a variety of local tree legume species which may produce similar seeds (i.e., *Parkia* ssp. present in Yunnan, and *Dialium indum* present in broader Southeast Asia), therefore tamarind presence in Yunnan needs to be confirmed.

4.5 Archaeobotany of the Dian Kingdom

The number of sites with evidence for plant remains dating to the first millennium BCE is higher compared to the previous two millennia, most of which cluster in the Central Lakes region and are culturally connected with the Dian Kingdom (see below). There may be several reasons for this increase in the number of sites, one being that the area around the Dian Lake and Kunming, the capital city of Yunnan, has seen more infrastructural development in the last decades compared to other areas of the province, leading to a greater number of archaeological sites being investigated. Another reason being the recent academic focus on understanding the Dian Kingdom through systematic surveys of the Dian Basin, which led to the individuation (and subsequent excavation) of sites relating to this period. Finally, given that these sites have been excavated within the last 15 years, thus after the introduction of mandatory archaeobotanical sampling and analysis (see § 1.2.3.2), this results in a greater number of sites with systematic archaeobotanical studies and radiocarbon dating compared to the previous two millennia.

Archaeological sites dating to the first millennium BCE from the Dian and Central Lakes basins belong to the Dian 滇 Culture (previously known as Shizhaishan Culture or Shizhaishan Culture Complex), today also referred to as the Dian Kingdom. The Dian Culture was discovered in 1955 with the excavation of the Shizhaishan cemetery. Here, in grave M6, a gold seal bearing the inscription 'Seal of the King of Dian' (*Dianwang zhi Yin* 滇王之印) was buried together with cowrie shell containers and 166 small jade plaques, interpreted by local archaeologists as intended for making a funerary suit (Allard 1999, 79). Based on this find, scholars have identified the Shizhaishan people with 'the southwestern Barbarians', which were described by Sima Qian in Chapter 116 *Xinan Yi Liezhuan* 西南夷列傳 (The Southwestern Barbarians) of the the *Shiji* (Watson 1971). According to Sima Qian, the southwestern barbarians were sedentary agriculturalists cultivating rice. He also stated that Zhuang Qiao 莊蹻, a general from the Chu State, fought the Dian in 279 BCE and upon his return home was blocked by the Qin armies and thus went back to Yunnan, adopted local customs and established himself as King thanks to the strength of his troops (Sun, Xiong 1983, 244). Further accounts tell that in 122 BCE the Dian captured and detained Han envoys who were trying to reach Bactria through India (Allard 1998; 2006). Finally, in 109 BCE, during the reign of Emperor Wudi (*Han Wudi* 漢武帝), Han armies conquered the Dian and established the Yizhou prefecture, ending the Dian reign (see § 4.6; for a summary of textual records referring to the Dian see Allard 1998).

Dian sites cluster around the Dian Basin and the Central Lakes region in eastern Yunnan **[fig. 19]**. West from Kunming, the Dian Lake (*Dianchi* 滇池) is the sixth largest freshwater reservoir of China, with an area of 312 km^2, average depth of 5.7 m, reaching up to 8 m in the deepest point. A few km south from it, smaller lakes constitute the Central Lakes region, which include Fuxian 扶仙, Xingyun 星云 and Qilu 杞麓 lakes. Altogether, these lakes sit right in the middle of the Yungui Plateau, at altitudes ranging between 1,885 and 1,900 m asl. Today this region presents a monsoonal, humid, and subtropical climate, mild weather year-round, and an average annual precipitation of ca. 1,000 mm. This makes the area extremely productive for agriculture and up to four harvests per year are documented, making it among the most productive regions of Yunnan. The main plant species cultivated today include rice, wheat, rapeseed and broadbean (NBS 2024). Climate conditions stabilised to those attested today around the first millennium BCE (see Ch. 3), which means that the Dian Basin has offered conducive conditions to intensive cultivation for well over two thousand years. In addition to this, the Dian Basin is also strategically located at the intersection of the Yangzi, Pearl and Red River basins, providing connection routes in and out of Yunnan, which link Central China with Southeast Asia and beyond. This makes it an important region for understanding the history of long-range connections in broader East Asia.

Recent archaeological work has individuated numerous cemeteries that are culturally associated with the Dian. According to radiocarbon dating, the Dian Culture flourished between the eighth and the first centuries BCE, although archaeological work at the site of Shangxihe 上西河 suggests that the origin of the Dian may extend back in time to the tenth or twelfth century BCE (Yao A. et al. 2020, see below). The Dian Culture is famous for lavish bronze artefacts found in 'elite' burials, namely drums and drum-shaped cowrie shell containers from deposits dating after the sixth century BCE.[29] These are stylistically strikingly different from bronze vessels from both Shang and Zhou dynasty traditions in the Central Plains and the Sanxingdui Culture in Sichuan. The tympanum and sides of the Dian drums, and the top of the cowrie shell containers have elaborated, realistic scenes depicting battles, rituals with music and dance, tribute offerings, and weaving activities (Allard 1998, 334). Some scholars interpret these scenes as the celebration of the deceased life achievements (Yao 2016). It is important to note that the number of 'elite' graves accounts only for a small percentage of all the graves in any given Dian cemetery, for example at Shizhaishan they constitute only 1% of the total excavated graves (although many of the Shizhaishan graves were damaged, either by later graves or illicit digging, Yao 2016). This highlights that the Dian were a strongly hierarchical and stratified society. Other bronze artefacts commonly found in Dian cemeteries include small (animal and human) figurines, armour pieces, weapons, buckles and plaques (some decorated with precious stones), and musical instruments. Metal composition analyses on over 500 bronze artefacts from Dian sites show these were made of tin bronze alloys or pure copper, with very little or no lead present. Manufacturing processes included hot forging for small tools and weapons, casting for elaborated scenes on cowrie shell containers, and tinning and gilding were also sometimes used. Yunnan is rich in geological resources, including copper, gold, lead, silver and tin deposits (Zaw et al. 2014). It is inferred that bronzes recovered from Dian sites were locally produced and a few specialised bronze production sites have been individuated. For example, at Guangfentou 光坟头 there is evidence for smelting, melting and casting bronzes (see below). Metal composition analyses established that artefacts found at the Shizhaishan and Lijiashan 李家山 cemeteries were most likely produced at Guangfentou (Zou et al. 2017). Stable isotope studies on Dian metal artefacts indicate strong consistency among the objects retrieved in the Dian Basin, and this

29 Some scholars individuate in the Dian the origin of Dong Son drums in northern Vietnam (Calo 2014; Han 2004). Beyond Shizhaishan, other Dian cemeteries with the richest graves found so far include third century BCE Lijiashan 李家山 and first century CE Tianzimiao 天子庙 (Yao 2016).

is indicative of short-range metal exchange networks between the sites (Pryce et al. 2022)

Only few settlements have been individuated so far, many of which were investigated between 2008 and 2012 during the joint Sino-American survey of the Dian Basin, known as the Dian Heartland Survey Project, led by the Yunnan Provincial Institute of Cultural Relics and Archaeology, and the Department of Anthropology at the University of Toronto. The principal aim of the project was to understand the settlement pattern of the Dian.[30] Two main large settlement sites were investigated, Hebosuo 河泊所 and Xiaogucheng 小古城. Smaller sites located in their surrounding were also surveyed. The majority of the available archaeobotanical data for the Dian Kingdom comes from settlements individuated during these surveys, when flotation samples were taken from exposed profile sections (see below). At these sites, no palaces or defensive structures have been unearthed so far, although material culture points to a great importance of warfare, attested by the prevalence of weapons and warfare scenes. Differently from the bronze artefacts retrieved from cemeteries, metal objects from Dian settlements are usually small utilitarian tools, such as axes, arrowheads, daggers, and personal accessories such as bracelets.

4.5.1 Hebosuo

Hebosuo is a large settlement site located 650 m from the southeastern shore of the Dian Lake, 60 km from Kunming, and only one km south from the important Dian cemetery of Shizhaishan **[fig. 19]**. It is estimated to be 31 hectares in size at its apex and considered the most important among sixteen other settlement sites in the area, all contemporaneous to Hebosuo, which constitute the so-called Hebosuo cluster (Yao A. et al. 2020). Subsequent archaeological surveys recorded at least 34 settlements in the southeastern area of the Dian Basin, with settlements located close to each other at distances ranging between 750 m to 1,000 m (Yao et al. 2020). Archaeologists excavating the site hypothesise that people buried at Shizhaishan cemetery may have lived at Hebosuo. According to radiocarbon dating, Hebosuo was occupied continuously from the ninth century BCE until a few centuries after the Han conquest of the Dian (see below). The site was excavated in 2014, in 2016-17, and in 2021-22. Dian features unearthed at Hebosuo include semi-subterranean houses or possibly pile-dwellings (see below), 18 vertical shaft pit burials, and 13 urn burials. Grave goods include numerous small bronze artefacts, such as arrowheads, rings, bracelets, and belt hooks. The ceramic assemblage is mostly comprised of undecorated *guan* jars and *pen* basins; some vessels have simple impressed/incised geometric decorations. Of interest is the retrieval of ceramic fishing net weights, indicating fishing was practiced by the Hebosuo people.

Preliminary archaeobotanical samples collected during the 2012 survey attested the presence of uncharred plant remains from stratified cultural layers at the site (Yao, Jiang 2012). Plants retrieved in that occasion include *Potamogeton*, *Najas*, Characeae, Cyperaceae, *Myriophyllum*, *Rumex* and *Juncus* species, which are indicative of a possible marshy environment. This

30 Yao, Jiang 2012: Yunnan Meiguo 2012; Yunnan, Meiguo, Meiguo 2014; Yao et al. 2015.

led scholars to hypothesise that houses were pile-dwelling structures, similar to those depicted in Dian bronze artefacts (Yao, Jiang 2012). Systematic archaeobotanical samples collected during subsequent excavations revealed an agricultural assemblage dominated by rice, followed by wheat and millets during the Dian period. Other cultivated resources include buckwheat, Sichuan pepper (*Zanthoxylum bungeatum*), and possibly managed cherry fruit (*Cerasus* sp.), which was among the 8 retrieved waterlogged remains from this period (Yang et al. 2023; Yang 2016). An interesting feature of the archaeobotanical assemblage from Hebosuo is the high quantity of charred charcoal fragments, which are positively correlated with charred seed presence. This may suggest that seeds entered the archaeological record most likely by people routinely burning their domestic waste, such as food left-over or crop processing byproducts (Yang et al. 2023). The most prevalent species of agricultural weeds retrieved in the Dian samples include *Polygonum lapathifolium* (syn. *Persicaria lapathifolium*), which is known today to infest rice or other irrigated crop fields but also surviving some dry periods, therefore, we cannot infer the extent or presence of rice irrigation practices at Hebosuo.

4.5.2 Dayingzhuang

Dayingzhuang 大营庄 is a shell mound settlement site located 13 km from the northwestern shore of Lake Dian **[fig. 19]**. It was excavated in 2017 due to the imminent construction of a tobacco factory. Radiocarbon dating on charred seeds show that Dayingzhuang was occupied between ca. 780-390 BCE (Dal Martello, Li, Fuller 2021). Features unearthed at Dayingzhuang include 35 pits, 4 houses, 2 living floors, 1 hearth, and 5 wall foundations. Of note, 5 paleochannel deposits (*hedao* 河道) were individuated, and these have been identified as the ancient vestiges of modern Tanglang 螳螂 River, which today flows just a few km west from the site and stabilised its course around Han times (Li X.R., pers. comm. April 2018). The Tanglang flows into the Jinsha River and connects the Dian Basin to northwest Yunnan. It is believed that Dayingzhuang was a connection hub between the two regions.

Two type of house structures have been attested at Dayingzhuan; pavilion-like structures in the lowest levels, and wattle and daub in the upper levels. Ceramics from Dayingzhuang include utilitarian shapes such as *fu* caludrons, *bo* bowls, *pen* plates, and *guan* jars. These were made of coarse, reddish or greyish pottery, and decorated with simple incised, comb or corded patterns. The lithic artefacts retrieved include axes, adzes, grindstones, and other daily objects. Although metal slags have been found at Dayingzhuang, only a small number of metal objects were retrieved during excavation, these included a dagger and a bracelet.

The organic remains preservation at the site was rather poor. Charred remains of cereal retrieved include wheat, rice, millets and barley. Wheat and rice are the two prevalent species, with a higher quantity of seeds found compared to other cereals. Among the two, wheat was present in higher numbers than rice, but rice was more ubiquitous across the samples. The bulk of wheat grains derives from one individual context: *hedao* 1, where over 300 charred wheat grains have been found (Dal Martello, Li, Fuller 2021). In addition to cereals, soybean, possible Sichuan pepper, chestnut – *Castanea* sp., foxnut, and other unidentified acorns have been found in the archaeobotanical assemblage. This indicates people at Dayingzhuang relied both on the cultivation of domesticated crops and the collection of local wild resources. Seeds of field weeds are not numerous. Typical dryland species, which may be associated either with millet or wheat cultivation, include *Chenopodium* sp., *Pennisetum* sp., and *Vicia* sp.; along with typical wetland species, which may be associated to rice paddies, such as *Alisma* sp. and *Schoenoplectus* sp. (Dal Martello, Li, Fuller 2021). In addition to macro-botanical studies, phytoliths covering the whole stratigraphic sequence were collected to investigate the cultivation ecology of the crops grown at Dayingzhuang. Results from the phytoliths analysis showed that the area around Dayingzhuang was heavily deforested by the time the site was occupied. Phytoliths also indicated a shift from a dry to a wet environment at the end of the occupation sequence; however, since phytolith samples were not crop dominant, it was not possible to determine whether this shift was due to a change in crop irrigation practices or more broadly to environmental fluctuations. Regardless of the issue of irrigation, the archaeobotanical assemblage from Dayingzhuang illustrates a dualistic nature of the agricultural system at the site. At the time of the occupation, the climate and environment were similar to those of today. It is thus hypothesised that year-round cultivation of winter wheat and summer rice and/or millet would have already been feasible. Given the proximity of different vertical zones, it seems plausible that the people at Dayingzhuang were cultivating rice near the lake and moved to higher elevations to grow dryland crops. In doing so, the inhabitants of Dayingzhuang would have maximised their available resources, potentially intensifying agricultural production through year-round cultivation (Dal Martello, Li, Fuller 20021). Beyond plants, pigs, cattle, horses, deer, fish bones, and a thick deposit of *Margarya melanioides* shells, indicate that people most likely raised domesticated animals and exploited the nearby lake resources (Li X.R. pers. comm. April 2018).

4.5.3 Xueshan

Xueshan 学山 is situated on the shores of Fuxian Lake, ca. 60 km south of Kunming city **[fig. 19]**. It was excavated in 2006, 2009, and 2010-11, and the site has been dated by cultural association to the Dian Culture (Yunnan Kaogu 2011). 29 houses were excavated during the last excavation season. These are mostly semi-subterranean structures and have been classified according to their size into large (30 m^2) and small houses (10 m^2; Yunnan Kaogu 2011). The houses were orderly built along roads (Wang T. et al. 2022). A small bronze arrowhead was found inside a house. The ceramic assemblage from Xueshan is characterised by *guan* jars, *pen* basins, and *fu* cauldrons. The vessels are made of coarse pottery of reddish (*pen* basins) and greyish (*guan* jars and *fu* cauldrons) colour, all decorated with simple geometric designs. Of note is the retrieval of several *zhan* 盏 bowls; these are small, shallow and mostly undecorated vessels described as tempered with rice remains (Wu, Jiang, Feng 2010). At Xueshan, several ceramic 'feet' were reported, but these are too fragmented to reconstruct the vessel type they represent.

Archaeobotanical samples collected in 2011 showed a cereal-based assemblage containing, in order of prominence, wheat (n=7,481), rice (n=3,783), and both foxtail (n=209 and broomcorn (n=50) millet grains. Seven grains of barley were also reported. In addition to cereals, other species reported include 149 seeds of buckwheat, 7 seeds of possible Sichuan pepper (reported as *Zanthoxylum* sp.), 63 seeds of soybean, *Vigna* sp. (Wang 2014; Wang Q. et al. 2019). Finally, 16 lentil seeds have also been reported from Xueshan (Wang Q. et al. 2019), referred to as *Lens culinaris* (*bingdou* 兵豆; see Wang 2014, 17, tab. 2.2) in the text, but indicated in Chinese as *bingdoushu* 兵豆属 – which translates to *Lens* sp. – in the photo (Wang 2014, 50 colour plate 2, fig. 2). It is difficult to ascertain a positive identification from the photos. Lentils were domesticated in Southwest Asia (Zohary, Hopf, Weiss 2012), from there the crop spread to South Asia, where lentil seeds are reported from Harappan sites and sites in Uttar Pradesh from the second millennium BCE.[31] At present there are no known reports of ancient lentil seeds in China dating to the first millennium BCE, and although a southern route of dispersal via India is likely (since lentil does not tolerate high altitudes and high latitudes), this may be dated to a later period than the Dian and further research is needed to clarify this question.

Isotope analyses on the dentinal collagen of 19 individuals demonstrated that they had a predominantly C_3 diet ($\delta^{13}C$ values range from –18.9‰ to –17.8‰), except for one individual which showed a mixed C_3/C_4 signature ($\delta^{13}C$ –14.1‰; Wang T. et al. 2022). This means that people at Xueshan likely had a diet based on wheat and rice, which are both C_3 plants. This is in line with the macro-botanical evidence. Starches and phytoliths were also extracted from the dental calculus; the results indicate the presence of rice phytoliths, and Triticaceae, possible millet, rice, buckwheat, and possible yam or other tuber starch grains (Wang T. et al. 2022). However, there is currently a lack of established identification criteria, and some authors raise questions regarding the reliability of these methods to reconstruct past diet due to potential cross-contamination issues.

4.5.4 Guangfentou

Guangfentou is located on the northeast shore of the Xingyun Lake, only 2 km south from Fuxian Lake **[fig. 19]**. It is a shell mound settlement that was discovered in 1984 and excavated in 2011-12. The site has been dated through cultural association to between the Spring and Autumn to Western Han periods (ca. 700-300 BCE). Features unearthed include 26 semi-subterranean houses, 11 living floors, and 30 pits. Metal slags recovered during excavation, along with the site's location at only 3 km from copper mines suggest Guangfentou was a specialised metal production centre. Although no precise workshop area has been individuated during excavation, scholars suggest that smelting was the main activity conducted at the site; refining and casting may also have been undertaken (Zou et al. 2017). Scholars further suggest that metal artefacts from Shizhaishan and Lijiashan graves may have been produced here (Zou et al. 2017). The ceramic assemblage from Guangfentou is characterised by reddish and brown/dark vessels with simple decorations; vessel types include *fu* cauldron, *guan* jars, and *bo* bowls and *pen* plates.

31 Saraswat 1993a; 1993b; Fuller 2003; Pokharia 2008; Kingwell-Banham 2019.

Archaeobotanical samples collected in 2011-12 revealed a mixed agricultural system based on wheat, which was the predominant species among the cereals, rice, and millets; 8 grains of barley were also found. Rice spikelet bases attest to the local cultivation of rice. Numerous seeds of field weeds were reported, including *Digitaria sanguinalis, Setaria virids, Vicia sepium, Fimbristylis dichotoma,* and *Echinochloa crus-galli*; these are in line with the reconstructed mixed farming system (Li, Liu 2016). Among them, 5,301 seeds of *Chenopodium album* were the most abundant across all other plant species retrieved, including cereals (wheat, for example, included 523 whole seeds, and 456 fragmented ones; Li, Liu 2016, tab. 2). Authors of the study categorised the *Chenopodium* as a weed rather than a potential food source, but the staggering amount of seeds may indicate that it was cultivated independently as a crop and exploited as a food resource (Li, Liu 2016). Other potentially edible species include possible Indian strawberry (*Duchesnea indica*), *Perilla frutescens*, and wild jujube *(Ziziphus spinosa*), but these are present in rather low numbers.

Bones of cattle, dogs, pigs, horses, deer and bears, along with a high quantity of freshwater gastropod shells have been included in the preliminary report, but no systematic study on these remains has been conducted yet.

4.5.5 Yubeidi

Yubeidi 玉碑地 is located in the middle Jinsha Basin, in north Yunnan **[fig. 19]**, it was previously referred to as Yingpancun 营盘村, where a layer of carbonised rice grains had been reported during the 1987-88 excavation of the site (Huang 1990). It was excavated in 2013 and dated by cultural association between the Spring and Autumn to the Western Han periods (700-300 BCE; Yang 2016). Features uncovered include 15 semi-subterranean houses, 49 pits, and 6 urn burials. Some of the pits contained large quantities of charred rice; the walls of these pits were plastered in red clay, which may suggest that they were underground storage deposits for cereals. Agathe and turquoise ornaments were interred in some of the graves. Bronze artefacts recovered from Yubeidi are mostly small, utilitarian objects such as arrowheads, needles and fishhooks, knives; some perforated stone knives have also been reported. Due to the numerous metal slags and ore fragments retrieved during excavation, local archaeologists suggest Yubeidi was a metalworking production centre (Jiang, Zhu 2014).

Rice, foxtail millet, and wheat seeds have been recovered through flotation in 2013. However, only 8 grains of wheat have been retrieved compared to the 2,452 rice grains (and 510 rice spikelet bases), and 229 foxtail millet grains. This may indicate that wheat was not an important component of the agricultural system at Yubeidi, but it could also relate to preservation and/or sampling biases. Other edible resources include soybean, Sichuan pepper, possible white (silkworm) mulberry (*Morus alba*), and unidentified fruits and tubers; however, only a few seeds of these other edible species have been reported (Yang 2016; Yang, Jiang, Chen 2020). Based on the 8 *Morus alba* seeds from Yubeidi we cannot conclusively infer silk production; historical sources indicate that sericulture was practiced in Yunnan at least from the Eastern Han Dynasty period (25-220 CE); however, mulberry fruits can also be fermented to produce brews or provide animal fodder; further investigation will clarify its use at Yubeidi (Yang, Jiang, Chen 2020).

4.5.6 Haimenkou Phase III

Archaeobotanical samples from Haimenkou phase III (ca. 800-400 BCE) had a much lower seed density compared to previous periods. This may be attributed to environmental and taphonomic factors. Ceramic vessels from this period have been fired at much lower temperatures compared to the previous two phases. In phase III, ceramics are similar to those attested in phase II (see § 4.4.1), there is an increase in number of red painted double-handled *guan* jars, in addition to the previously attested types (*bo* bowls, *pen* basins, *gang* jars, *fu* cauldrons, *ye* vessels), however, there is a decrease in firing temperature compared to the previous phases (see Min 2009a; 2009b). There are no new species retrieved in the archaeobotanical samples from phase III, but there is a marked increase in dryland crop (wheat and millet), compared to phases I and II. This may indicate a drying of the environment; however, the much poorer preservation conditions of the organic remains from this phase makes it difficult to confirm whether changes in crop abundance relate to dietary shifts or taphonomic factors. A recent genomic study on six individuals from Haimenkou (radiocarbon dated to ca. 1200-900 BCE) has demonstrated close genetic affinity with Late Neolithic agricultural populations from the Upper Yellow River Basin (Tao et al. 2023). According to this study, the six sampled individuals shared 90% of their ancestry with Late Neolithic Yellow River (millet) agriculturalists. This suggests that the expansion of the settlement in phase II, at least in part, may derive from migrating populations from Northwest China (Majiayao, ca. 3000-2000 BCE, distributed in modern Gansu and Qinghai provinces), which themselves originated from the expansion of Late Yangshao millet farmers (ca. 5000-3000 BCE; Tao et al. 2023, 4999). This could also explain the decrease of rice and increase in millet attested in this period. Finally, it may also indicate that the potential route through which agriculture spread to Yunnan followed the eastern Tibetan Plateau rim and was driven by migrating millet farmers that adopted rice during their expansion (Tao et al. 2023, 4999, see Ch. 5).

4.5.7 Shilinggang

Shilingang 石岭岗 is the only site located on the middle Mekong River with archaeobotanical study undertaken for this time period **[fig. 19]**. Direct radiocarbon dating on charred rice grains dated the occupation of the site to between the late eighth and the fourth centuries BCE (Li et al. 2016). No excavation report has been published yet but information on past subsistence is derived from flotation and isotope studies. Archaeobotanical samples were not rich in plant remains. Crops include rice, foxtail millet, and a suite of dryland weed species, including *Eleusine indica, Setaria viridis,* and *Vicia sepium*. Moreover, seeds of Sichuan pepper, *Perilla frutescens,* and *Rhus chinensis*, which has some medicinal properties, were also reported (Li et al. 2016). Beyond macro-botanical remains, stable isotopes and dental calculus from humans buried at Shilingang were analysed (Ren et al. 2017). Stable isotopes on 16 individuals indicated a mixed C_3/C_4 diet ($\delta^{13}C$ values range from –19.5‰ to –16.3‰), possibly with a slightly higher consumption of C_3 (Ren et al. 2017), presumably derived from rice as attested by the macro-botanical remains. Carbon isotope values on herbivores (deer) indicated they fed on

C_3 plants ($\delta^{13}C$ values range from –25.9‰ to –19.9‰), and therefore we can infer a C_3 dominant background vegetation. Starches and phytoliths were extracted from human dental calculus and the results indicate the presence of rice phytoliths, and starches of millets, tubers, roots, acorns and palms (Zhang N.M. et al. 2017). However, the reliability of such studies is still not completely demonstrated due to possible cross-contamination issues.

4.5.8 Other First Millennium BCE Sites

Further sites with archaeobotanical remains retrieved from flotation (albeit not systematically collected) associated with the Dian Kingdom include Shizhaishan, Shangxihe, Xiwangmiao 西王庙, and Jinshashan 金砂山, Gucheng 古城 (also known as Gucheng Village, *Guchengcun* 古城村), and Anjiang 安江 **[fig. 19] [tab. 12]**. At these sites, flotation samples were collected during surveys from one or two individual contexts from exposed profiles, therefore, the information we have does not represent systematic studies but can nevertheless indicate broad presence of plant species.

Shangxihe is located 280 m east from Hebosuo, one of the sixteen smaller sites in the Hebosuo cluster. Direct radiocarbon dating indicates the site was occupied from the twelfth to the third century BCE, and metal work has been attested from at least the eleventh/tenth century (Yao A. et al. 2020). Today this is the earliest known site related to the Dian. Successive excavation in 2014, and 2016-17 revealed a large settlement comprised of 40 houses (semi-subterranean or pile-dwelling), 470 pits, numerous wells and ditches, and three vertical shaft pit burials with the deceased placed in flexed, supine position **[tab. 12]**. Small bronze and copper implements have been reported. The ceramic assemblage shows strong similarities in pottery types with other settlement sites in the Dian Basin (Yunnan Kaogu 2017a; Yang et al. 2017). Since no full excavation report has been published, we don't know how the features unearthed related with the chronology and potential phases of occupation. Preliminary flotation samples collected during a survey attested the presence of both rice and wheat (Yao A. et al. 2020), further flotation samples have been collected during systematic excavation, but full results have not been published yet (Yang W., pers. comm. 2023).

Shizhaishan cemetery has undergone five seasons of excavation, but flotation was not carried out during any of the seasons. Possible rice husks tempered ceramic vessels are mentioned in the first report (Yunnan 1963); however, during the Dian Heartland Project, a small flotation sample was collected from a stratified cultural layer. The sample included seeds of rice, wheat and millet (*Setaria italica*; Yao, Jiang 2012).

Xiwangmiao is located only 600 m southeast from Hebosuo. It was excavated in 2014 and 2016; it has been dated by radiocarbon dating on unspecified material to ca. 1200-550 BCE (Yang et al. 2023). Features unearthed include semi-subterranean and wattle and daub houses; pits and ditches. Flotation samples attest to the presence of rice, wheat, foxtail millet, soybean and Sichuan pepper, but no full report has been published yet (Yang, Jiang, Cheng 2020). Given its close chronological occupation and location proximity to Hebosuo, we can infer that people at the two sites conducted a similar subsistence.

The site of Jinshashan is located 2.2 km from the present-day shore of the Dian Lake, and only 1.5 km from Shizhaishan. The site was excavated in 1999-2000, in 2014-15, and a large grave (M190) was excavated in 2016 (Yunnan Kaogu 2017b). Over 80 graves have been excavated so far and dated by cultural association to the Dian to Han periods (Yunnan Kaogu 2015). Based on the high presence of objects buried in the graves, which included jade artefacts, Jinshashan is considered a cemetery where members of the Dian elite were buried. M190 was particularly rich and notably included a clay seal, this indicates that the owner of the grave had a high rank (Yunnan Kaogu 2017b). Burials dated to the Dian period are mostly vertical shaft pits; however, burials dated to the Han period are underground structures with walls and tiles and have sacrificial pits at the entrance of the burial chamber (Yunnan Kaogu 2017b). Preliminary mention of flotation samples' results indicates the presence of wheat and nuts at the site (Kaogu 2015).

Located only 8 km east from the large shell-mound of Hebosuo, the site of Gucheng was initially discovered in 2008, excavation was conducted between 2020-22 (Yao, Jiang 2012; Yunnan Kaogu 2024a; 2024b). Two periods of occupation have been determined, dated by cultural association to ca. between twelfth and third centuries BCE. Direct radiocarbon dates on charred seeds collected during the Dian Heartland Survey furnished a date of 900-530 BCE (Yao, Jiang 2012). The 2020-22 excavation revealed a large cemetery (dating to the twelfth-tenth centuries BCE) with 81 shaft pits and 31 urn graves. Most of the deceased were placed in the extended supine position. Only one house was reported from this phase. Generic wild animals and plants are mentioned as present in this period (Yunnan Kaogu 2024a; 2024b). 21 semi-subterranean houses, with a minority showing evidence of foundation or posts have been unearthed from the Warring State period layers. According to the preliminary report, domestic mammals and agricultural crops, including rice, wheat, and pea increase in this period (Yunnan Kaogu 2024a, 2024b). A small flotation sample collected during the Dian Heartland Archaeology Survey Project provided evidence for rice, wheat, and millet (Yao, Jiang 2012). Albeit possible pea seeds (referred to as *wandou* 豌豆) have been reported by more recent flotation studies (Yunnan Kaogu 2024a). However, their identification and time period need confirmation, as they are quite large in size, which most likely indicates a much more recent age than the Dian occupation of the site (Yang W., pers. comm. 2025). Pea (*Pisum sativum*) was domesticated in Southwest Asia (Zohary, Hopf, Weiss 2012) and spread to South Asia by the second millennium BCE, when pea seeds are reported from Harappan sites and sites in Uttar Pradesh.[32] Although possible pea seeds have also been reported from southern Tibet at the end of second millennium BCE[33] (see § 5.2; which may hint to a dispersal route via the Himalayas), the current lack of data from northeast India and the presence of securely identified pea seeds from Wupaer in Xinjiang, dating to 1400-400 BCE (Yang Q. et al. 2020), and slightly earlier from Tasbas (1500-1300 BCE, Spengler, Frachetti, Doumani 2014) currently suggests a northern route of dispersal to China for this plant, but more evidence is needed to confirm this hypothesis.

Anjiang, or Anjiang North, is a small shell mound site located on the eastern side of Dian Lake at less than 10 km northeast from Hebosuo. The

32 Saraswat 1993a; 1993b; Fuller 2003; Pokharia 2008, Kingwell-Banham 2019.

33 Possible pea seeds have been reported for example from Changguogou/'Phreng-po-lung 昌果沟, on the southern Tibetan Plateau, dating to 1500-1200 BCE (Fu 2001; d'Alpoim Guedes et al. 2013a; Gao et al. 2020b; see § 5.2), at comparable dates of the reported finds from Xinjiang.

site was initially reported during the Dian Heartland Archaeology Survey Project (Yao et al. 2015) and subsequently excavated in 2020, when part of the settlement was unearthed (Yunnan Kaogu 2024c). During the survey an exposed profile was cleaned and partially excavated to previously unexposed depths, flotation samples were taken both from the exposed pit and from a well located off-site 300 m west of the mound (Yao et al. 2015). The samples provided evidence for rice, wheat, barley and broomcorn millet grains. Plant remains from the off-site well included wild species, such as *Chenopodium* sp., *Cyperacea* sp., *Potamogeton* sp., *Characea* sp., *Najas* sp., *Salvinia* sp., all apart from *Chenopodium* indicating a paddy environment (Yao et al. 2015). In 2020, further flotation samples were collected during excavation, but no report has been published yet.

Xiaogucheng is a large shell mound site located on the northeastern shore of the Dian Lake. A small section of the site was investigated during the Dian Heartland Survey, and it revealed a wooden palisade structure surrounded by shells (Yao et al. 2015). Flotation samples collected in that occasion contained rice grains, and large quantities of seeds of weed species. Wild species included Verbanaceae, *Polygonum* sp., *Amarantus* sp., and typical paddy field weeds such as *Rumex* sp. and *Ranunculus* sp. (Yao et al. 2015). It has been hypothesised that the structure unearthed was related to the processing of rice after its harvest.

One last location worth mentioning is a pit found in the vicinity of the Batatai 八塔台 cemetery during its 1982 excavation (Yunnan Kaogu 2016), when the surrounding area was surveyed for cultural remains. A large pit with ancient rice was discovered in the vicinity of the modern-day village of Dongjia, which was referred to by locals as Macaodong 马槽洞 or Biankukeng 蝙库坑 (Li, Li 1983). The estimated area of the charred rice layers was 4-5 m^2 in area and between 1 to 3 m in depth. No other cultural artefacts were found in the pit. Presently, it is unclear how this related to the Batatai cemetery.

Outside the Dian Basin, the site of Zongzan 宗咱, in the upper Mekong Basin, has been dated by association to 2000 BCE-200 CE **[fig. 19] [tab. 12]**. It is included here as preliminary archaeobotanical report only mentioned buckwheat seeds from layers dated to between the fifth and third centuries BCE (Li 2016). Ceramic artefacts show affinities with incised/impressed traditions such as that from Baiyangcun but given the presumed long chronology of the site and lack of further information, we cannot determine the role of buckwheat at the site.

4.5.9 Dietary Evidence from Isotopes

In addition to macro-botanical studies, numerous isotope studies have been undertaken from sites in Yunnan dating to the first millennium BCE, these include Jiangxifen 江西坟, Gaozhai, and Adong, in northwest Yunnan; Jinlianshan 金莲山, in the Dian Basin; and Mayutian 麻玉田, in southeastern Yunnan **[fig. 19]**.

At Jiangxifen 530 burials were excavated in 2019. These were radiocarbon dated on human bones between the ninth and fifth centuries BCE (Lu et al. 2021). 65 individuals and two pigs were samples for stable isotopes analyses. The results indicated that most people had a mixed C_3/C_4 diet ($\delta^{13}C$ values range from –18.6‰ to –9.4‰; average value –14.2‰). The two sampled pigs show a C_3 signature ($\delta^{13}C$ median value –19.5‰). A small flotation study conducted retrieved rice (n=83), and foxtail and broomcorn millet grains (n=11), thus indicating that pigs likely foraged in the forest (consuming locally available wild C_3 resources) and humans fed on both rice and millets, possibly giving pigs C_3 food too.

Gaozhai is located in the Jinsha basin, further upstream from Jiangxifen. Here, 4 stone cist tombs have been excavated in 2020, and radiocarbon dating on human bones indicate the people buried in them lived between the ninth to the fifth centuries BCE (Lu et al. 2023). Isotope analyses show a primarily C_3 diet ($\delta^{13}C$ median value −18.4‰ ±0.4‰; Lu et al. 2023). Animal bones found in the graves were also sampled, and their isotope signature was similar to that of humans. This could mean they fed on either rice or wheat, or both, since by the time of Gaozhai occupation wheat and rice were available in the Jinsha basin.

Adong is located in the very northwestern section of Yunnan, close to a modern Tibetan village in Deqin county. In 2020 some tombs were found and dated to the eighth to fifth century BCE (Lu et al. 2023). Three individuals were sampled for carbon isotope studies. The analyses indicate that two of the sampled individuals had a mixed C_3/C_4 diet ($\delta^{13}C$ values range from −15.7‰ to −15.2‰) and one had a primarily C_3 diet ($\delta^{13}C$ values range from −18.5‰ to −17.8‰). In the absence of macro-botanical remains we cannot conclusively determine which were the plants people buried at Adong consumed.

Jinlianshan is a site located close to Xueshan in the Dian Basin; it was excavated in 2006, and in 2008-09. The site has been dated through radiocarbon dating on human bones to between the eighth and sixth centuries BCE, although according to the artefacts unearthed, the cemetery was used until the Eastern Han period (25-220 CE). 265 graves have been excavated. Objects buried in the graves include metal spearheads, buckles, and undecorated pottery *guan* jars, among other artefacts (Jiang et al. 2011). Stable isotope analyses on human bones attest to a C_3 predominant diet ($\delta^{13}C$ values range from −19.3‰ to −18.2‰), which has been interpreted as derived from rice consumption (Zhang 2011). However, a C_3 signature could also derive from wheat, which was the prevalent species retrieved through flotation at the nearby and contemporaneous site of Xueshan.

Mayutian is located on the northern bank of the Yuanjiang River, an affluent of the Red River, in the very south of Yunnan. It was discovered and excavated in 2006, and in 2010. A total of 21 burials were unearthed, although human bones were not well preserved. Bronze spearheads and axes were the most frequent type of metal artefact buried in the graves. Ceramic vessels were mostly undecorated *guan* jars. An isotope study was conducted on human bones and human tooth enamel. The results indicate that people buried at Mayutian had a mixed C_3/C_4 diet ($\delta^{13}C$ values range from −12.04‰ to −6.33‰; average value −9.14‰ ±1.6‰; Zhang X.X. et al. 2014). The lack of macro-botanical remains limits our understanding of which plant species contributed to the diet.

4.6 Agriculture and the Han Conquest of the Dian

According to the *Shiji*, Han armies conquered the Dian in 109 BCE and established the Yizhou prefecture 益州 (or Yizhou commandery) after which they restored the Dian King and gave him seals (Watson 1971, 285). According to the *Han Shu* 漢書 (The Book of Han) after establishing the Yizhou Prefecture, the Han divided it into counties and undertook a census (Sun, Xiong 1983, 247). There were at least seven major uprisings against the Han between 105 BCE and 176 CE, and during the reign of Wang Mang 王莽 (45 BCE-23 CE) the Han abolished local royal titles (Allard 1998). An increase in Han style artefacts is attested after the first century CE, when bronze censers, lamps, ceramic models of daily scenes, such as cultivated fields and animal pens, are retrieved in much higher quantities than the previous centuries (Allard 2006).[34] By the second century CE, most of the graves were Han style brick tiled structures covered by mounds. This indicates that Han customs became widespread more than a century and a half after the Han conquest of the region (Allard 2006, 248-9).

4.6.1 Hebosuo

Although initially thought to become secondary after Han conquest, excavations in 2016 revealed both Dian and Han remains, indicating that the site was continuously occupied from ca. 1200 BCE to ca. 220 CE. Further excavations in 2021-22 found a stash of over 2000 bamboo and wooden slips and 837 clay seals. The slips detailed government policies, dates and locations; the seals bear inscriptions such as *Yizhou Taishou Zhang* 益州太守章 (Seal of the Governor of Yizhou) and *Tonglao Cheng Yin* 同劳丞印 (Seal of the Deputy of Tonglao; see Jiang et al. 2023). This led archaeologists to identify Hebosuo with the Yizhou Commandery (or Prefecture), described in Han textual sources as an important settlement and administrative centre for the southern regions (Yang et al. 2023; Jiang et al. 2023). One large structure was excavated in Han layers, and Han artefacts were retrieved between layers 16 and 7. These include corded decorated tiles, a typical Han style chariot implement known as *gegongmao* 盖弓帽, numerous coins bearing *wuzhu* 五銖 (produced from 118 BCE and in use until the end of the Eastern Han Dynasty in 220 CE; Yang et al. 2023), and a small bronze bell. The bell has a curved opening, a trapezoidal body, a flat top with a hanging round loop, and raised knobs on the surface. These findings all support the increased incorporation of Hebosuo people into the Han administration.

The archaeobotanical samples retrieved from the Han layers have a high presence of rice remains. The extremely high quantity of rice spikelet bases is a strong indication of local cultivation of this species, and the predominance of wetland type weeds, including *Schoenoplectus juncoide*s, *Scirpus triqueter*, *Bulbostylis* sp., *Eleocharis* sp., and *Potamogeton* sp., suggests that rice was cultivated in a wet regime. Historical sources document irrigation was practiced in the north-eastern area of the Lake Dian by 16 CE (Yao et al. 2015), however, archaeological data to confirm this is currently still lacking (see for example Dal Martello, Li, Fuller 2021).

34 Before Han conquest, Han style objects have been reported from less than 5% of the graves. This may indicate they were gifts (Allard 2006).

Other crops attested at Han Hebosuo include both wheat and millet; however, wheat remains in the Han period are lower than those attested in the Dian period. Some authors have suggested this represent flavour preferences of the incoming Han population, among which wheat is never documented to gain a prominent role (Yang et al. 2023). In the Central Plains it is only after the Han Dynasty that wheat became predominant (Boivin, Fuller, Crowther 2012; Deng et al. 2020). During the Han period, there is an increase in presence and variety of plant taxa not previously recorded at the site. These include soybean and adzuki bean (*Vigna angularis*), Sichuan pepper, grape (indicated as *Vitis* sp. in the table, but as *Vitis vinifera* in text),[35] hawthorn (*Crataegus cuneata*), and Indian strawberry (*Duchesnea indica*; Yang et al. 2023). The charred assemblage also contained a few fragments of unidentified fruits and/or nut species and tubers. Waterlogged remains were also retrieved from the Han layers at Hebosuo, and these include seeds of bottle gourds (*Lagenaria* sp.), stones of peach (*Prunus persica*), possible cherry (*Prunus cerasus*), Japanese plum (*Prunus salicina*), and indeterminate *Prunus* stones, as well as *Rubus* seeds. Some handpicked plant remains were also collected during excavation, including possible hog plum remains (*Choerospondias axillaris*; Yang et al. 2023). While the decrease in wheat may indicate Han preferences, the increase in fruit remains may indicate the development of fruit trees management practices. The management of fruit trees is thought to development after cereal agriculture, and to be associated with urbanisation (Fuller, Stevens 2019; Dal Martello et al. 2023a). Overall plant density in the archaeobotanical assemblage also increased in the Han period.[36] This has been interpreted as evidence for an intensification of agricultural production, which could have been driven by the population increase linked with the Han arrival (Yang et al. 2023). Records in the *Hou Han Shu* 後漢書 (Book of the Later Han) document 2000 hectares of land not previously cultivated were cleared for agriculture during the Protectorate of Wen Qi in the Wang Mang period (ca. 19 CE; Yang et al. 2023). This seems to be supported by the increase in charcoal fragments in the Han dated archaeobotanical samples at Hebosuo. Palaeoclimate reconstructions on Dian Lake sediments also attest to an increase in charcoal signature in the first century CE, possibly derived from an increased fire activity to clear the forest vegetation (Xiao et al. 2020).

35 The most recent evidence indicates a dual origin for table and wine grape, happening around the ninth millennium BCE in western Asia and the Caucasus (Dong et al. 2023). According to the *Shiji* by Sima Qian, grapes would have reached China from a region possibly situated in the Fergana Valley, in modern Uzbekistan, around the second century BCE (Jiang et al. 2009). At present, the earliest attested archaeobotanical evidence for domesticated grape (*Vitis vinifera*) in China comes from the site of Yanghai, in Xinjiang, dating to the third century BCE (Jiang et al. 2009). No photos are available of the *Vitis* seeds from Hebosuo, so it remains unclear whether these represent a local wild grape species (attested at earlier sites in Yunnan, such as at Baiyangcun) or domesticated grape, which, if confirmed, would imply a rather early dispersal of the plant to Southwest China.

36 According to Yang et al. (2023, 18), cereal crops increase from 90 to 92.5% of the total recovered archaeobotanical remains, overall density of archaeobotanical remains increases from 29.8 to 124.3 grains/floated L of soil.

4.6.2 Shamaoshan

Shamaoshan 纱帽山 is a cemetery site located on the eastern shore of the Yangzong Lake, only 30 km away from Xueshan **[fig. 19]**. Radiocarbon dates on human bones indicate the site was used between ca. 250 BCE to 55 CE (Zhang et al. 2012). A total of 57 graves have been excavated. The graves had a northwest-southeast orientation, and were mostly single interments, with the deceased placed in extended supine position. Numerous joint graves were present, showing both primary and secondary interments. Burial goods included mostly bronze tools and weapons, such as spears, swords, axes, daggers, which were minimally decorated or undecorated (Zhang et al. 2012). The type of objects at Shamaoshan indicate a non-elite group within the Dian. There is a slight increase in Han-style objects from the upper layers (Wu et al. 2019). Stable isotopes were measured from tooth enamel extracted from 18 individual; the results indicate a predominant C_3 diet ($\delta^{13}C$ values range from −24.7‰ to −23.1‰; Wu et al. 2019), which may derive from rice and/or wheat consumption. Both species have been documented archaeobotanically from earlier sites in the region, including at the nearby Xueshan site.

4.7 Summary

Prior to 2009, flotation studies in Yunnan were scarce. Knowledge on past subsistence derived from handpicked material (mostly rice grains) from sites such as Baiyangcun. Systematic archaeobotanical sampling was conducted at Haimenkou during its 2008-09 excavation. Flotation analyses at the site revealed excellent preservation conditions of ancient plant remains and a high potential for this type of study in Yunnan. Since then, flotation has been carried out at all newly excavated sites; archaeobotanical reports are now available from around fifteen sites, more data is available from stable isotope study in bone collagen **[tab. 12]**. This greatly expanded our understanding of early plant use in Yunnan.

Palaeonvironmental reconstructions along with the examination of stone toolkits from Palaeolithic sites provide insights into the hunter-gathering lifestyle of groups inhabiting Yunnan in the late Pleistocene/early Holocene. These groups possibly collected local wild resources, such as tropical acorns, roots, and tubers. However, specific evidence supporting these inferences remains scarce. Domesticated cereals appear in northwest Yunnan from at least 2650 BCE, as attested through direct radiocarbon dating of charred millet and rice grains at Baiyangcun (Dal Martello 2020). Although a study argued for rice and millet presence inferred through isotope analyses on human bones collagen at Xingyi possibly from ca. 2900 BCE (Ma et al. 2024), conclusive evidence about farming at the site prior to the second millennium BCE is lacking. While Li et al. (2016) proposed an initial stage of farming in Yunnan based on rice cultivation only, it remains to be determined whether C_3 consumption at Xingyi prior to 2900 BCE results from rice or local wild resources. At present, mixed farming systems incorporating millet and rice cultivation, are the first attested farming systems in the province, dating back to at least the first half of the third millennium BCE **[fig. 28]**. Weed species associated with rice at Baiyangcun suggest the crop was cultivated in a wet regime. At Baiyangcun, the retrieval of *Euryale* and other acorns suggests that even after the development of farming, the collection of local wild resources continued to play a role in the overall economy. The scarcity of fruits, nuts and other economic species beyond cereals implies that these resources were either collected and consumed off-site or played a secondary role to cultivated plants in the overall diet. Pigs have not been reported at sites prior to Baiyangcun (Yunnan 1981) and clearly domesticated pigs were the most numerous faunal species at Haimenkou (Wang 2018); their presence indicates they were introduced to the region together with domesticated crops, and animal husbandry developed alongside farming. However, large quantities of lacustrine resources (*Margarya* sp. shells) at Xingyi and wild animal bones presence at Baiyangcun indicates that fishing and hunting were also practiced. It remains unclarified what role, if any, pre-existing hunter-gatherer populations played in the emergence of agriculture in Yunnan. More research is needed to understand whether they were replaced by incoming farmers or adopted agricultural crops themselves.

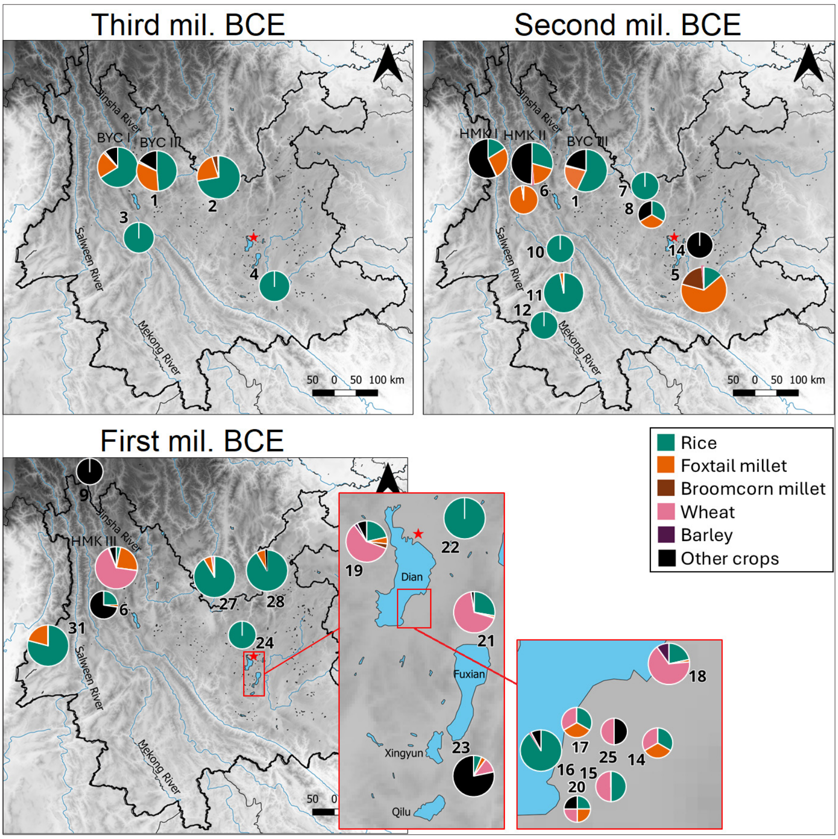


Figure 28 Crop ratios from sites in Yunnan dating to between the third and first millennia BCE as evidenced from macro-botanical remains; smaller pie charts indicate handpicked/unsystematic flotation remains. For seed counts and sources see Appendix 4. Sites numbered as in Figure 19: 1. Baiyangcun; 2. Dadunzi; 3. Xinguang; 4. Haidong; 5. Xingyi; 6. Haimenkou; 7. Mopandi; 8. Mopanshan; 9. Zongzan; 10. Yingpanshan; 11. Shifodong; 12. Nanbiqiao; 14. Gucheng; 15. Shangxihe; 16. Hebosuo; 17. Shizhaishan; 18. Anjiang; 19. Dayingzhuang; 20. Xiwangmiao; 21. Xueshan; 22. Xiaogucheng; 23. Guangfentou; 24. Qujing Dongjia; 25. Jinshashan 27. Jiangxifen; 28. Yubeidi; 31. Shilinggang. Made by the Author with QGIS 3.28.5-Firenze, Natural Earth and EROS Digital Elevation basemap, U.S. Geological Survey

Agricultural systems in Yunnan expand around the mid-second millennium BCE with the arrival of wheat and barley, two crops originally domesticated in Southwest Asia. Wheat grains have been directly dated to ca. 1400 BCE at Haimenkou, in northwest Yunnan (Xue et al. 2022) **[fig. 28]**. The route(s) through which wheat and barley spread to China is still debated (see § 2.5.2). The appearance of these two species at Haimenkou, at the same time as a sudden increase in houses, an increase in goat/sheep remains (Wang 2018), and innovations in material culture (the emergence of metallurgy) suggests contacts and possibly migrations of agro-pastoral populations from Northwest China (mostly from Gansu and Qinghai, Min 2009a; 2009b). This view is substantiated by strong ceramic affinities and by recent genomic data, albeit from individuals from later periods (1200-900 BCE). The results showed that sampled individuals from Haimenkou shared 90% of their ancestry with late Neolithic Yellow River farmers (Tao et al. 2023), whose expansions in the fifth millennium BCE brought to the development of agriculture in Northwest China (see § 5.2) and thus migrated from there to northwest Yunnan at the end of the second millennium BCE. The presence of goat/sheep bones at Baiyangcun (albeit their domestication status has not been ascertained, contrarily to goat/sheep bones from Haimenkou which appeared domesticated; see Wang 2018), however, indicates that connections with the eastern part of Northwest China may predate the occupation of Haimenkou, but it remains to be confirmed whether agriculturalist migrations from modern Gansu and Qinghai were also responsible for the establishment of agricultural systems in the millennium prior the occupation of Haimenkou. It also remains uncertain if population growth at Haimenkou relates to agricultural innovation, or if trade and exchange played a role. An alternative view is that barley diffused separately via a southern route, through the Himalayas, supported by modern barley landraces genetic studies and direct dating of barley at sites along the southern Himalayas (see § 2.5.2). This cannot find confirmation due to the presently patchy archaeobotanical data in East India, Tibet and Myanmar. In Yunnan, there is also no reported wheat and/or barley from sites dating prior to Haimenkou, although this may change with the increased application of flotation techniques in archaeological excavations across the province. Their concurrent presence at Haimenkou indicates the crops spread to Yunnan together and thus favour a single dispersal route of both crops to Yunnan. Their incorporation in the cultivation systems of Yunnan, however, was slow, and at late second millennium BCE Haimenkou, rice and millet continue to be the predominant species. Seeds of *Chenopodium album*, a plant today sparsely grown and consumed for its leaves and grains by groups in Taiwan and on the Tibetan Plateau, have been retrieved in high quantities from the Haimenkou samples. *Chenopodium* seeds were strongly associated with cereals in domestic contexts, which indicates the plant was possibly exploited as food. The species is highly tolerant to unfavourable environmental conditions, needs little water, and can withstand low temperatures (see § 2.4.2.3). Its cultivation may indicate a worsening of the environmental conditions at the site, which may have affected cereal harvests. Other species attested include buckwheat, soybean, peach and apricot fruits, wild grape, and cannabis. *Cannabis* at Haimenkou may have had a multi-function use as medicinal and textile plant (Dal Martello et al. 2023b). Beyond Haimenkou, few other sites have been systematically investigated from this period, but overall the archaeobotanical data shows a diversification in number of species present, now including a greater number of legumes (e.g., soybean, cf. tamarind), fruits (e.g., peach, apricot, grape, perilla), and other economic species (e.g., cannabis). This indicates a diversification of the productive economy in Yunnan in the second millennium BCE.

The first millennium BCE in Yunnan is characterised by the establishment of the Dian polity, which flourished in the Dian Basin until 109 BCE, when, according to historical sources, the Han established control over the region. In this period, wheat cultivation becomes more widespread and even predominant at some sites, such as Dayingzhuang and Xueshan (Dal Martello, Li, Fuller 2021; Wang Q. et al. 2019). However, wheat uptake does not substitute previously cultivated crops, such as rice and millet, which continue to be cultivated alongside wheat (with varying degrees of importance in different areas of Yunnan) **[fig. 28]**. This indicates that the availability of new crops, rather than replacing pre-existing systems, allowed the expansion of the agricultural production, a strategy most likely facilitated by the peculiar vertical zonation of Yunnan. In the first millennium BCE, environmental and climatic conditions in Yunnan were close to those of today, albeit highly fluctuating. Today, the Dian Basin and Central Lakes region have mild weather year-round, average winter temperatures of 10°C degrees. This is the most productive area of the province. The co-existence of lowlands and highlands at close distance would have provided environmental conditions suitable to grow crops with different watering and temperature needs, by establishing fields at different levels of the landscape. The presence of summer and winter crops at Dian sites suggest that, already during the Dian, agricultural production was undertaken year-round, taking full advantage of water-rich lowlands and nearby drier highlands. Rice could have been grown in the summer months in the lowlands close to the water reservoirs, and millet in the nearby slopes, where it would rotate with winter wheat. Cereal cultivation was complemented by the cultivation of legumes such as soybean, possibly buckwheat, along with a modest contribution from wild resources, including local fruits and nuts. Although possible lentil seeds have been reported from Xueshan (Wang Q. et al. 2019; Yunnan Kaogu 2024a), their identification needs to be further confirmed. Lentil (and pea) have been found from Harappan sites and sites in Uttar Pradesh from the second millennium BCE,[37] as well as in northeast India between the second and first millennium BCE.[38] Prior to that, lentil (and pea) have been reported from sites in southern Central Asia, including at several sites in Pakistan dating to after the fifth millennium BCE.[39] Between the third to second millennia BCE, both lentil and pea are a common occurrence at sites in modern Turkmenistan (e.g.,

37 See for example 1993a; 1993b; Fuller 2003; Pokharia 2008, Kingwell-Banham 2019.

38 For example, both lentil and pea have been found at Chirand ca. 2100-1300 BCE (Vishnu-Mittre 1972) and lentil has been reported from Wari-Bateshwar, in Bangladesh, in the first millennium BCE (Rahman et al. 2020).

39 These include, for example, lentil at fourth millennium BCE Shahi Tump I and Miri Qalat (Desse et al. 2008; Tengberg 1999); pea and lentil at fourth to third millennia BCE Harappa (e.g., Weber 2003), third millennium BCE Miri Qalat (Tengberg 1999), and other sites (e.g., Vishnu-Mittre, Savithri 1982; Costantini 1990).

Gonur Depe, Togolok 1, Adji Kui 1, and Chopantam),[40] and both species have been found at Shortugai, in Afghanistan, also dating to between the third and second millennium BCE (Willcox 1991). These crops originate from Southwest Asia and reports from early sites in China are scarce. Possible pea seeds have been reported from the end of second millennium BCE in southern Tibet (see § 5.2, see also Ch. 4 fn. 33), from Wupaer in Xinjiang, dating to 1400-400 BCE (Yang Q. et al. 2020), and slightly earlier at Tasbas (1500-1300 BCE, Spengler, Frachetti, Doumani 2014). More research is needed to confirm the timing and route(s) through which these legumes spread to China.

Outside of the Dian Basin, we see a preference of rice at sites located deep in river valleys (such as Shilingang on the Mekong Basin, and Yubeidi on an affluent of the Jinsha River) **[fig. 28]**, and fishing was particularly important at lacustrine sites, such as Haidong and Xingyi. The fluctuating climate of the first millennium BCE may have had a role in preserving a highly mixed subsistence system such as outlined above in Yunnan, while the variety of landforms may have facilitated the local diversification of agricultural systems based on rice only or on the mixed cultivation of seasonally different crops.

Archaeobotanical data from Han period is scarce, but samples from Hebosuo show continuity in subsistence strategies, with a potential expansion in the consumption of fruit and nut species (Yang et al. 2023). This may represent a change in flavours brought by the arrival of the Han or the beginning of fruit trees management in the province. This continuity may also result from specific limitations posed by local soils and environments. As we have seen, a mixed system based on the rotation of wetland and dryland crops is well-suited to the rugged landscape of Yunnan, where lowland plains provide rich water resources to sustain rice paddy cultivation, while the adjacent highlands offer ideal conditions for growing millet and wheat. Yang et al. (2023) suggested that the continuity of agricultural systems after the arrival of the Han derives from their efforts to avoid disrupting pre-existing cultivation systems, thereby preventing local upheavals and maintaining their political control over Yunnan (Yang et al. 2023, 71). An intensification of the agricultural production during the Han period is attested by the overall increase in relative proportion of cereal crops and density of charcoal fragments (indicative of increased fire activity) in the archaeobotanical assemblage at Hebosuo (Yang et al. 2023). Rice production may have been intensified with the development of irrigation or other water management practices. Historical records indicate that irrigation was practiced in the north-eastern area of the Lake Dian at least from 16 CE (Yao et al. 2015); however, current archaeobotanical data has not conclusively determined whether irrigation began earlier or it developed following the Han arrival to the region.

40 For Gonur Depe see Miller 1993; Sataev and Sataeva 2014; Togolok 1 see Billings et al. 2022; Adji Kui see Spengler et al. 2018, Chopatam see Spengler et al. 2014.