1 Studying Humans-Plants Interactions: Methods in Archaeobotany

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1.1 Introduction

Archaeobotany studies the relationship between people and the environment in the past through the analysis of ancient plant remains from archaeological sites (Fuller, Lucas 2014). Archaeobotanists aim to explore all aspects of people-plants interaction. Popular topics in archaeobotanical research include (the list is non-exhaustive)

- investigating the domestication pathways of plant species, both from the biological point of view and the social and cultural developments occurring in societies after the transition to an agricultural economy;
- tracing the dispersal of domesticated plant species outside their native region; reconstructing ancient vegetation and its management;
- plant production for use as fuel and manufacture;
- understanding past social organisation in the production and exploitation of natural resources;
- food production and consumption, including past meal preparation technologies and diets;
- cuisine traditions as basis for social and cultural identities.

According to their size, archaeobotanical remains are grouped into two main categories: macro- and micro-remains. Macro-botanical remains

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indicate seeds, nutshells, fruit stones, wood and wood charcoal fragments.[1] These usually preserve by charring through contact with fire. Other common preservation pathways are waterlogging, when organic remains are sealed in anaerobic conditions, for example through submersion in water, and dessication, happening, where the absence of water restricts the growth of fungal, bacterial and other harmful organisms and resulting in good preservation of organic remains. Finally, ancient plants can also be preserved via mineralisation, which occurs through contact with calcium phosphate ($Ca_3(PO_4)^2$), for example from urine in sewage and latrines. Macro-botanical remains are mostly recovered through flotation, a method further explained below. Micro-botanical remains include phytoliths (silica cells deposited in the soil by the plant during its life cycle), pollen grains, and starches (Pearsall 2015; Fuller, Lucas 2014). Increasingly, other types of evidence are studied in archaeobotanical research, including isotopes, lipids and molecular biomarkers retrieved from organic residues, bones and charred seeds, and more recently paleo-soils (Pearsall 2015). The collection of micro-botanical remains requires a lengthy laboratory procedure, for example for phytoliths, it includes pre-treatment, centrifuging and washing of the soil to extract the micro-material to study. In this book I focus on macro-botanical remains, and therefore the collection and research history of micro-botanical remains is not reviewed here. Readers are referred to Henry (2020) for an introduction to micro-remains in archaeological research, Rosen (1999) and Piperno (2006) for phytoliths; Fiorentino et al. (2015) and Fernandez and Jaouen (2017) for a summary on recent applications of isotope analyses in archaeobotanical research. Readers are further referred to Dal Martello et al. (forthcoming) for an overview of the study of these materials in Chinese Archaeobotany.

To recover macro-botanical remains from archaeological sites, archaeobotanists employ a method called flotation. This methodology was first employed in archaeological contexts in the early 1950s at Tularosa Cave and Higgins Flat pueblo in New Mexico, United States, by Hugh Carson Cutler (1912-1998), who later visited Stuart Streuver (1931-2022) during the Lowillva Project, at the Apple Creek site in Lower Illinois River Valley, and demonstrated the technique, persuading him to undertake it during excavation (Browman 1999; Streuver 1968). The process developed by Culter and published by Streuver was subsequently applied, slightly modified, at the prehistoric site of Ali Kosh in the Deh Luran Plain, in Iran (Helbaek 1969). The methodology was simple and inexpensive, requiring only a container, a sieve or net with small size mesh, and some water. Today, guidelines for archaeological excavations by the Chinese State Administration of Cultural Heritage (*Guojia Wenwuju* 国家文物局; in the past referred to as State Bureau of Cultural Relics) recommend a sieve of 0.2-0.5 mm mesh size (Guojia 2009). Such a small mesh size ensures even the smallest plant remains are recovered. The excavated soil is placed in the container, water is slowly added to it and the soil is gently stirred to allow any organic remains to float to the surface thanks to their lighter weight and more porous density compared to soil. The soil deposits at the bottom of the bucket, while the float is collected on the sieve and poured into a cloth. The sample is labelled, tied securely, and let dry in the shade.

1 The study of charcoal fragments is also referred to as anthracology (*mutanxue* 木炭学/*mutan fenxi* 木炭分析).

Once dried, each sample is processed in a laboratory employing a low-power, binocular microscope; plant remains are extracted, identified, and counted.[2] As highlighted by Streuver (1968, 353), this methodology counteracts the tendency to select for larger remains and it drastically increases the quantity of material retrieved, as it allows the recovery of smaller remains which would otherwise not be clearly visible or retrievable during excavation by sieving only. This was further emphasised by the contrast in the number of remains retrieved before and after the use of flotation at Ali Kosh, with excavators eloquently stating that, while

> according to the 1961 report, plant remains were scarce at Ali Kosh. Nothing could be farther from the truth. The mound is filled with seeds from top to bottom; all that was 'scarce' in 1961 was our ability to find them, and when we added the 'flotation' technique in 1963 we recovered a stratified series of samples totalling 40,000 seeds. (Hole et al. 1969, 24)

A mechanised process of flotation was developed shortly after, with the use of several tanks and a pump (e.g., Limp 1974) and usually referred to as machine flotation. This allows for a quicker and more efficient processing of the soils compared to manual (or bucket) flotation. An early type of flotation machine was developed between the 1960s and the 1970s by Eric S. Higgs (1908-1976), founder of the Cambridge Palaeoeconomy School at Cambridge University in the United Kingdom. Higgs's Palaeoeconomy Research Group popularised flotation across archaeological excavations in Europe and the Mediterranean region.[3] This early type of flotation machine was further developed by the Shell Mound Archaeological Project working in the Green River Area in Kentucky, United States (Watson 1976). 'SMAP-type' flotation machines are today the most used ones worldwide, including in China.

1.2 Archaeobotanical Research in China

1.2.1 Chance Plant Finds and the Theme of the Origins

Until the 1980s, the recovery of plant remains at archaeological sites in China depended upon accidental discovery of high enough quantity and/or large enough plant remains that were visible with the naked eye during excavation (Liu et al. 2008, 8). The identification was then delegated to botanists or agronomists. Some notable examples of such finds include possible foxtail millet grains (described as *su* 粟 – *Setaria italica* in the original report), and alleged cabbage or mustard seeds (*baicai* 白菜 or *jiecai* 芥菜)[4] from two pottery vessels found in a pit at Banpo 半坡, Xi'an, Shaanxi (Zhongguo 1963; Zhao 1983). In 1960, rice remains were reported from Zhujiaju 朱家咀, Hubei (Hubei, Wang 1964). In 1973-74, an impressive quantity of rice husks, rice

2 Although Streuver also described and employed chemical flotation in the lab to further separate charred plant remains from small bones, this type of chemical separation is no longer employed by archaeobotanists today.

3 For early examples of flotation use see Stewart, Robertson 1973; Renfrew 1973; Jarman et al. 1972; Higgs 1972; French 1971.

4 Scholars now prefer to refer to this find with a more generic 'vegetable' seeds (see Zhuang 2020, 616).

grains and acorns were found in pits at Hemudu 河姆渡, Zhejiang (An 1980; You 1976). In 1976-78, during the excavation of the Cishan 磁山 site in Hebei Province, possible foxtail millet grains (referred as *su* 粟 – *Setaria italica*) were found in over 80 storage pits (Sun, Liu, Chen 1981; An 1980, 37; Tong 1984). Here, heaps of 'decayed' small round seeds were found at a depth of between 0.3-2 m (and in few cases deeper than 2 m), which, however, turned into dust shortly after exposure to air (today this find is contested, see § 2.2.3.2.2). Charred remains of possible walnuts, hazelnuts and hackberries were also found in some of the pits (Sun, Liu, Chen 1981). Beyond direct finds of plant remains, the presence of plants at archaeological sites was also attested by grain impressions on ceramic sherds, for example rice grains were identified from ceramic impressions on sherds unearthed at the Yangshao 仰韶 site and at the Yangshao culture site of Xiawanggang 下王岗, in Xichuan, Henan (An 1980, 41; Henan et al. 1999).

Plant remains recovered from archaeological sites were always interpreted as evidence for local cultivation and therefore representing settled agricultural populations. In the absence of plant remains, tools recovered during excavations were used to reconstruct possible agricultural practices. For example, harvesting was inferred through the presence of knives and sickles; spades, shovels and hoes were seen as evidence of land clearance and ploughing, and grinding stones were interpreted as cereal grain processing tools. Their retrieval, therefore, indirectly attested agricultural practices (Zhuang 2020). These early finds were central for the theorisation of a local origin of agriculture in ancient China, through the hypothesised domestication of millet in the North and rice in the broader South,[5] although scholars disagreed on the exact region for rice domestication (see § 2.2.1).

The reconstruction of the origin of agriculture was part of a broader effort by Chinese archaeologists to prove that Chinese civilisation had an indigenous origin, in response to early claims of a Western diffusion. The diffusionist theory was first proposed by Johan Gunnar Andersson (1874-1960) after finding painted ceramics at Yangshao sites in Northwest China. According to Andersson, Yangshao painted ceramics were similar to those found for example at Anau Culture sites in Turkmenistan, or at Trypillia/Tripolje Sites in modern Ukraine.[6] Until last century, Chinese scholars adopted the Marxist unilinear social evolution model as the primary interpretative framework for archaeological material.[7] The Marxist social evolution paradigm was first linked with archaeological evidence by Guo Moruo (郭沫若 1892-1978) in his 1930 book *Zhongguo Gudai Shehui Yanjiu* 中國古代社會研究 (Research on Ancient Chinese Society).[8] The Marxist paradigm stated that ancient societies were initially 'primitive', mobile tribes hunting wild animals and gathering wild plants who evolved into settled agriculturalists, and then transitioned into slavery, feudalism, capitalism and communism in a linear progression. Not only was there a strict dichotomy between mobile

5 Ho 1969; An 1980; Yan 1982a; 1982b.

6 An 1980; on this topic see also Chang 1964; Falkenhausen 1993; Xu 1999. About the Anau Culture see Kircho 2020; on Trypillia Culture see Müller, Rassman, Videiko 2016; Shatilo 2021.

7 Chang 1977a; 1999; Cheng 1965; Yang 1999; Lu 2002.

8 This book was highly influential in the Chinese Academic community and the theoretical paradigm illustrated by Guo became the dominant interpretative framework for archaeological remains after the foundation of the People's Republic of China in 1949.

hunter-gatherer tribes and settled agriculturalists, but the beginning of agriculture was considered as a necessary step for the rise of civilisation; therefore, tracing the origins of agriculture was essential to finding the roots of Chinese civilisation.

1.2.2 Flotation and the Beginning of Archaeobotany

The last two decades of the twentieth century in China were characterised by a general economic and political opening, with a renewed interest in international research. This resulted in a stream of foreign literature being translated into Chinese, presenting newly developed scientific archaeological terminology and methods to Chinese scholars, including those of archaeobotany.[9] This was met with interest especially by those archaeologists investigating the prehistorical period, who had focused on reconstructing the origins of agriculture. The increased interest in early agriculture is exemplified by the foundation of two academic journals entirely devoted to the topic: *Nongye Kaogu* 农业考古 (Agricultural Archaeology), and *Gujin Nongye* 古今农业 (Ancient and Modern Agriculture) founded in 1981 and 1988, respectively (Liu, Fuller, Jones 2015, 313). With regard to the study of macro-botanical remains, four articles are considered seminal for the development of archaeobotany in the country. In 1986, Huang Qixu 黄其煦, an archaeologist from the today Institute of Archaeology at the Chinese Academy of Social Sciences (*Zhongguo Shehui Kexueyuan Kaogu Yanjiusuo* 中国社会科学院考古研究所, henceforth IA-CASS) published in *Gujin Nongye* the article *Kaogu Fajuezhong Huishou Zhiwu Yicun de Fangfa zhi Yi – Paomo Fuxuanfa* 考古发掘中回收植物遗存的方法之——泡沫浮选法 (Flotation: a method for the recovery of plant remains in archaeological excavations), where he described the flotation methodology. In 1989, archaeologist Xiong Haitang 熊海堂 (1951-1994) witnessed archaeologists at Nagoya University, Japan, using a SMAP-type machine to undertake flotation and the same year he published an article in *Nongye Kaogu* describing machine flotation (Xiong 1989). These two articles mark the official start of archaeobotany in the country. In 1992, archaeobotanist Zhao Zhijun 赵志军 described archaeobotanical theoretical principles, field work collection methods and laboratory procedures for macro- and micro-botanical remains, highlighting the need for systematic collection methods in the article *Zhiwu Kaoguxue Gaishu* 植物考古学概述 (Archaeobotany: an overview; Zhao 1992). Zhao's article was particularly important to the field as it was the first to use the term 'archaeobotany' (*zhiwu kaoguxue* 植物考古学; 'plant archaeology', now usually abbreviated as *zhiwu kaogu* 植物考古) **[fig. 2]** instead of the previous 'agricultural archaeology' (*nongye kaogu* 农业考古). *Zhiwu kaogu* became the standard term for referring to the analysis of ancient plant remains from archaeological contexts from that point onward. A few years later, archaeologist Wu Yaoli 吴耀利, who would later become the head of the Prehistoric Archaeology Department at IA-CASS, published the article *Shuifuxuan zai Woguo Kaoguxue Fajuezhong de Yingyong* 水浮选在我国考古学发掘中的应用 (The use of flotation in archaeological excavations in China) and conducted the first known flotation study by a Chinese scholar

9 See Huang 1982, 1986; Jiang 1994a; 1994b; Jiang, Wang 1994; Jin 1999.

in the country during the 1992 excavation of the Lilou 李楼 site, in Henan Province (Wu 1994; Wu, Chen 1994a; 1994b). In this occasion, Wu built three square-shaped sieves each measuring ca. 40 cm in length and width and 6/7 cm in height. Each sieve was fitted with mesh of 1 mm, 1.5 mm, and 2 mm, respectively. Wu noted that through flotation he was able to recover material previously not retrieved, including charcoal fragments, small grains and husks, and rice grains (Wu 1994, 365). Before Wu, Gary Crawford, professor of Archaeobotany at the University of Toronto, Canada, had conducted (bucket) flotation on soil excavated from a house at the Baijinbao 白金宝 site, Heilongjiang, in 1986. Crawford had taught the flotation methodology to Leng Jian 冷健, a team member of the Sino-American project *Investigations into Early Shang Civilization*, led by K.C. Chang (Zhang Guangzhi 張光直; 1931-2001), professor of Chinese archaeology at Harvard University. Leng conducted flotation at several sites in Henan over the course of the project, including at Mazhuang 马庄 (excavated in late 1994), Panmiao 潘庙 (excavated in early 1994), and Shantaisi 山台寺 (excavated in 1995-97). At these sites she found wild and domesticated grasses, possibly millets, and small beans (Murowchick, Cohen 2001). The *Early Shang Civilization Project* didn't just contribute to the development of archaeobotany, but it was also among the first international collaborative projects allowed in China after 1949.[10] In 1999, Anne Underhill, professor of Chinese archaeology at Yale University (then at the Field Museum in Chicago), conducted flotation at the site of Liangchengzhen 两城镇, in Shandong (Crawford et al. 2005). In the early 2000s, Shandong University (*Shandong Daxue* 山东大学) hosted Crawford as Liqing Fellow in Social Sciences, and his stay there contributed to the establishment of Shandong University archaeobotany laboratory (see below). Although the methodologies and sampling strategies used in the above studies were not standardised, they were seminal in the establishment of archaeobotanical laboratories and expansion of the discipline in the following decade. It is important to note, however, that until the 2000s, pollen and phytolith studies were initially more widespread than that of macro-botanical remains, a trend not dissimilar to that attested elsewhere in the world (Pearsall 2015, 4-5).[11] Quaternary paleoecologists were analysing phytolith to investigate rice domestication[12] and pollen to reconstruct ancient vegetation and climate (e.g., Lu, Wang 1989; Wang et al. 1992). Among them Zhou Kunshu 周昆叔, based at the Institute of Geology (now Institute of Geology and Geophysics) of the Chinese Academy of Sciences (IGG-CAS – *Zhongguo Kexueyuan Dizhi yu Diqiu Wuli Yanjiusuo* 中国科学院地质与地球物理研究所), was among the first scholars in China to apply pollen analyses to archaeological contexts (e.g., Zhou 1963; Zhou, Yan, Xie 1975; Zhou, Hu 1988) and became among the most vocal promoters of environmental studies in archaeological research (e.g., Zhou 1993, 2002). Micro-botanical studies would develop alongside macro-botanical research in the following decades and continue to remain an important aspect of archaeobotanical research in China today (Dal Martello et al. forthcoming).

10 In 1991 the ban on international teams working in archaeological excavations in China was lifted, enabling diverse and fruitful collaborations between foreign and Chinese institutions. K.C. Chang, although Chinese by birth, was based at Harvard at the time and his Shang's origin project was able to start thanks to the lift of this ban; Yang 1999).

11 For early studies of pollen grains in China see Ho 1969, 7 fn. 12.

12 Jiang 1994; Gu 1994; Zheng et al. 1994, 1999; Jin 1999, Jin et al. 1999.

1.2.3 Chinese Archaeobotany in the Twenty-First Century

1.2.3.1 The Establishment of Archaeobotanical Laboratories and the Expansion of Archaeobotanical Practice

Archaeobotanical research saw a steady increase from the early 2000s **[figs 2-3]**. After training under the mentorship of leading figures in the field; D.M. Pearsall at Missouri University for his MA, and D.R. Piperno at the Smithsonian Tropical Research Institute for his PhD, Zhao Zhijun returned to China in 1999 and was hired at the IA-CASS. There, he established the first known archaeobotanical laboratory in the country in the Archaeological Sciences Centre (*Keji Kaogu Zhongxin* 科技考古中心) at the IA-CASS and was at the forefront of the popularisation of flotation in the successive decades. In the 2000s, he published numerous articles on archaeobotanical theoretical principles and practical methods (e.g., Zhao 2001; 2003b; 2004a) and summaries on the contribution of archaeobotany to researching early agriculture and the rise of civilisation (e.g., Zhao 2005a; 2005b). He was also among the first to conduct flotation at archaeological sites in Southwest China, including at Mopandi 磨盘地 and Shifodong 石佛洞 in Yunnan, and Yingpanshan 营盘山 in Sichuan (Zhao, Chen 2011).

Shortly after, another archaeobotany laboratory was established at Shangdong University at the (since 2016) Joint International Research Laboratory of Environmental and Social Archaeology (*Huanjing yu Shehui Kaogu Guoji Hezuo Lianhe Shiyanshi* 环境与社会考古国际合作联合实验室), itself nestled within the Eastern Archaeology Research Centre – *Shangdong Daxue Dongfang Kaogu Yanjiu Zhongxin* 山东大学东方考古研究中心). The laboratory is led by Professor of Archaeology Jin Guiyun 靳桂云, a history graduate with a PhD in Quaternary Geology from the IGG-CASS. This laboratory is one of the few in China today that has amassed a modern reference collection that includes comparative modern pollen, phytoliths and macro-botanical remains and equipment for the analysis of all three (Jin, Wang 2006).

In 2008, Professor of Neolithic Archaeology Qin Ling 秦岭 established the Archaeobotany Laboratory at the School of Archaeology and Museology of Peking University (*Beijing Daxue Kaogu Wenbo Xueyuan* 北京大学考古文博学院). Peking University had established a joint research centre with University College London (UCL, UK), named International Centre for Chinese Heritage and Archaeology (ICCHA –*Zhongguo Wenhua Yichan Baohu yu Kaoguxue Yanjiu Guoji Zhongxin* 中国文化遗产保护与考古学研究国际中心). ICCHA aimed at fostering collaborative international research on Chinese archaeology and sponsored scholarly exchange between the two universities. Through ICCHA, in 2004-05 Qin visited UCL to study archaeobotany, and in 2008 Dorian Q. Fuller (professor of Archaeobotany at UCL) went to Peking University to teach a course on the subject. After the establishment of the laboratory, Qin started instructing classes on archaeobotany, both at the undergraduate and graduate levels. Today Peking University is also building an impressive modern reference collection focussing on East Asian plant species (Fuller, pers. comm. 2024).

In the first decade of the twenty-first century, the expansion of archaeobotanical practice was further marked by the publication of two reference books that continue to be used in archaeobotanical training courses today:

- Liu Changjiang 刘长江; Jin Guiyun 金桂云; Kong Zhaochen 孔昭宸(2008). *Zhiwu Kaogu – Zhongzi Guoshi Yanjiu* 植物考古 – 种子果实研究 (Archaeobotany – Research on Seeds and Fruits). Beijing: Science Press.
- Zhao Zhijun 赵志军 (2010a). *Zhiwu Kaoguxue ~ Lilun, Fangfa he Shijian* 植物考古学~理论、方法和实践 (Palaeoethnobotany: Theory, Methods, and Practice). Beijing: Science Press.

These two books cover fieldwork sampling strategies, collection methods, and laboratory techniques while also providing identification keys to the main plant genera and taxa in China.

The establishment of laboratories led to the institutionalisation of archaeobotany as a distinct discipline within archaeological university programs. Trained specialists then went on to work at provincial institutes or establish new laboratories at other universities, thus expanding the teaching and practice of archaeobotany nationwide. Whereas only a handful of scholars were involved in archaeobotany in the early 2000s, today more than 20 universities offer archaeobotanical training, and over 70 specialists are employed at universities, research institutes and museums (Zhao 2022; Dal Martello et al. forthcoming, tab. 1).

1.2.3.2 The Standardisation of Archaeobotanical Practice in Chinese Archaeological Research

After the introduction of archaeobotanical flotation, its application was largely dependent on the interests of the individual archaeologists and specifically tied to the reconstruction of the origins of civilisation. This changed in 2009 when the State Bureau of Cultural Relics (now State Administration for Cultural Heritage) published an updated edition of the *Tianye Kaogu Gongzuo Guicheng* 田野考古工作规程 (Field Archaeology Work Protocol) (Guojia 2009). The first edition was published in 1984 (Wenwuju 1984), and a few years earlier, in 1982, the *Zhonghua Renmin Gongheguo Wenwu Baohufa* 中华人民共和国文物保护法 (People's Republic of China National Legislation for the Protection of Cultural Heritage) was promulgated (last updated in 2017). The two regulated archaeological excavations and the preservation of the national cultural heritage. Their publication is seen as a significant step by the national government in developing a unified approach to archaeological research and advancing the archaeological sciences within Chinese archaeology as a whole. In this regard, the *Field Archaeology Work Protocol* regulated all practical aspects of archaeological field work, providing detailed protocols for conducting archaeological survey and excavation, post-excavation processing and cataloguing of finds (Guojia 2009). The 2009 update included mandating the collection of environmental remains, including archaeobotanical material (21-5). According to the guidelines, each archaeobotanical sample should derive from the flotation of at least 20 l of bulk soil (or any further 5 l increments) and the flot should be collected using a 0.2-0.5 mm mesh sieve. Although these norms are not consistently implemented, there has been a marked increase in published archaeobotanical literature after 2009 compared to previous decades **[figs 2-3]**. Flotation studies, for example, increased from being conducted at only 30 sites by 2005 (equalling to about

5,000 litres of floated soil) to over 70 sites (and over 7,000 litres of floated soil) by 2011 (see Zhao 2005a; 2011). This trend continues today.

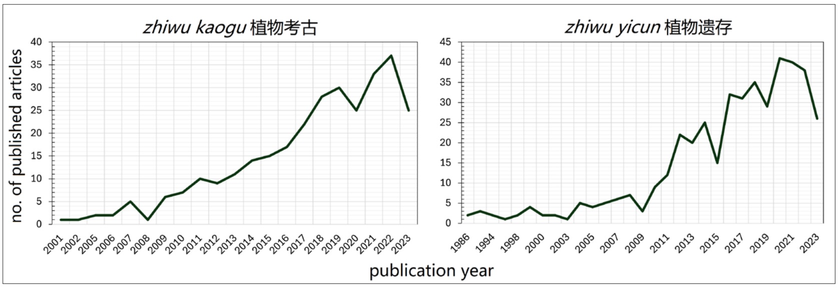

Figure 2 Graphs illustrating publication trends for the terms *zhiwu kaogu* 植物考古 (archaeobotany) and *zhiwu yicun* 植物遗存 (archaeobotanical remains) in Chinese academic publications (articles in journals, Master's theses and PhD dissertations); data from China National Knowledge Infrastructure (Zhongguo Zhiwang 中国知网, `https://cnki.net/index/`)

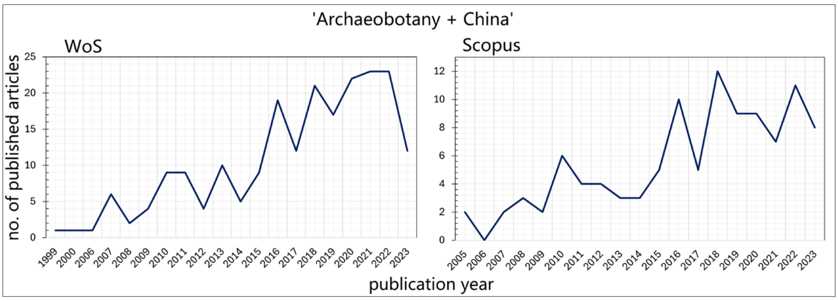

Figure 3 Graphs illustrating publication trends for terms 'archaeobotany' + 'China' in Web of Science (WoS, available at `https://www.webofscience.com/wos/woscc/basic-search`) and Scopus (available at `https://www.scopus.com/search/form.uri?display=basic#basic`), reflecting occurrences in English language publications

Qin Ling and other professors at the School of Archaeology and Museology at Peking University were involved in the updating of the *Field Archaeology Work Protocol*. In June 2009, in conjunction with its publication, Peking University hosted a large training program participated by over 600 archaeologists from provincial archaeological institutes around the country (Flad, Chen 2013). This helped introduce the new protocol and promote a standardised and unified approach to archaeological fieldwork. Peking University continues to train archaeologists employed at the provincial institutes during their yearly field school and the increase attested in publications **[figs 2-3]** may be partly attributed to these training efforts.

In 2012, IA-CASS hosted the first national archaeobotany conference, *Zhongguo Zhiwu Kaogu Xueshu Jiaoliu Yantaohui* 中国植物考古学术交流研讨会 (the Academic Exchange and Seminar on Chinese Archaeobotany), which has since been held almost annually. In 2014, during a conference on rice domestication and the spread of rice agriculture, a national archaeobotanical committee was established as a subsection of the Society for Chinese archaeology (*Zhiwu Kaogu Zhuanye Weiyuanhui* 植物考古专业委员会).[13] Since then, archaeobotanical workshops and symposia are frequently held, highlighting the growth and expansion of archaeobotanical research, both geographically and thematically. These include, for example:

- *Dao de Zhiwu Kaoguxue——Qianyan yu Fansi Xueshu Shalong Huiyi* 稻的植物考古学——前沿与反思学术沙龙会议 (International Workshop: Current Frontiers in the Archaeobotany of Rice), held at Peking University in August 2016;[14]
- Q*ingzang Gaoyuan ji Zhoubian Diqu Zhiwukaogu Guoji Xueshu Yanyaohui* 青藏高原及周边地区植物考古国际学术研讨会 (International Conference on the Archaeobotany of Tibet and the surrounding areas), held at Northwest University, Xi'an, in December 2019;[15]
- *Jiangnan Gudai Zhiwu yu Shehui——Zhiwukaogu Guoji Xueshu Duihua* 江南古代植物与社会——植物考古国际学术对话 (Ancient Plants and Society South of the Yangzi River – International Symposium on Archaeobotany), held at Hangzhou in November 2022.[16]

1.2.3.3 Decentralisation, Internationalisation and Shifts in Research

Between the 1950s and the 1980s, archaeological research was mostly conducted at the national level by either universities or the IA-CASS. At the local level, the government set up cultural relics management committees and museums to oversee archaeological excavations. After the Cultural Revolution (1966-76), these local institutions became units within the local Provincial Institutes of Cultural Relics and Archaeology (*Sheng Wenwu Kaogu Yanjiusuo* 省文物考古研究所, often abbr. *Kaogusuo* 考古所), and have since operated independently from parent museums. By 1990, except for Tibet, all provinces had their own provincial institute for cultural relics and archaeology (Falkenhausen 1995) and some larger provinces also established further institutes at their capital cities, such as the Chengdu Institute for Cultural Relics and Archaeology, which exists alongside the Sichuan one (Flad, Chen 2013, 51). The foundation of provincial institutes was an important shift toward a more decentralised approach to archaeological excavations, planning, and research, as national teams have since needed excavation permits from the institutes to conduct archaeological research in each province (Falkenhausen 1995). After decades of focus in the Central Plains as sole relevant area for the rise of Chinese civilisation, archaeological research now conducted in 'peripheral' areas showed the existence of local ancient cultures, which in turn increased work undertaken in these areas and highlighted the contributions they made to the formation of early Chinese

13 *Daozuo Nongye Qiyuan yu Chuanbo Xueshu Yantaohui ji Zhongguo Kaoguxuehui Zhiwukaogu Zhuanye Weiyuanhui Chengji Dahui* 稻作农业起源与传播学术研讨会暨中国考古学会植物考古专业委员会成立大会 http://www.soaa.zju.edu.cn/wwkg/2011/0922/c44601a1935130/page.htm.

14 *International Workshop Programme: Current Frontiers in the Archaeobotany of Rice:* https://www.ucl.ac.uk/chinese-heritage-archaeology/international-workshop-programme-current-frontiers-archaeobotany-rice.

15 For the conference program see http://www.silkroads.org.cn/portal.php?mod=view&aid=23109.

16 *Ancient Plants and Society South of the Yangzi River – International Symposium on Archaeobotany.* http://www.soaa.zju.edu.cn/2022/1125/c34190a2690957/page.htm.

civilisation.[17] The push for the modernisation of the national infrastructure has led to archaeological excavations being conducted in all provinces and across all time periods resulting in a great expansion of flotation studies, which are now routinely applied during archaeological excavations.

This has led to the expansion of research topics which now include food production, cooking technologies and cuisine identities (e.g., Ritchey et al. 2021; Hastorf 2016; Rowlands, Fuller 2009), and the role of plants and their spread in long-distance migrations and contact (e.g., Stevens et al. 2016; Long et al. 2018; Dodson et al. 2013). Most importantly this has led to the broadening of archaeobotanical research in historical periods.[18] This has allowed for the expansion of archaeobotanical research beyond the realm of the 'five grains' (*wugu* 五穀/五谷, indicating broomcorn and foxtail millet, wheat/barley, (soy)bean, and rice or hemp; see fn. 9 in Ch. 2) and the general focus of archaeobotanical research on staple crops at the expense of other plant categories (Zhao 2009; Zhong 2022). This resulted in a new understanding of the relevance minor crops in past subsistence.[19]

In the last few years, Chinese teams started working in areas outside China's borders, in part due to the political and economic relationships fostered by the Belt and Road Initiative (BRI, *Yidai Yilu* 一帶一路 'One Belt One Road'). As a result, Chinese-led archaeobotanical research has moved into new regions, investigating topics such as the role of long-distance exchange in local subsistence strategies, with a focus on the role of ancient Silk Road routes across Central Asia (Huo 2019; Lu et al. 2016). Chinese-led archaeological excavations are now conducted in some Central Asian countries, for example in Uzbekistan (Chen et al. 2020; Wang J. et al. 2023; Zhou 2024). This has finally taken Chinese archaeobotany in the global research arena, possibly marking the beginning of a golden age of Chinese archaeobotanical studies.

1.3 A Note on Archaeological Excavations and Flotation Studies in Yunnan

In 1920s and 1930s, the Geological Society of China (*Zhongguo Dizhi Xuehui* 中國地質學會) led by Ding Wenjiang 丁文江 (1887-1936; Xia 1960; Ho 1969) conducted several surveys in Yunnan and broader South China with the aim of uncovering prehistorical and early hominid sites in the province. In 1973 the first archaeological training class was undertaken at the site of Dadunzi 大墩子 (Dai 2021), but before the turn of the twenty-first century there was no reported systematic archaeobotanical study done in Yunnan. Discussions about early agriculture derived from chance finds of plant remains, mostly rice grains (either husks or whole grains), or grain impressions on ceramic

17 e.g., Chang 1986; Falkenhausen 1995; Hein 2014; Shelach-Lavi 2009; Sun, Hein forthcoming; Zhang forthcoming.

18 See work done in Xinjiang on Tang Dynasty period (618-907 CE) religious and military sites (e.g., Nong 2024; Yao Y.F. et al. 2020).

19 These include buckwheat (d'Alpoim Guedes et al. 2013a; Hunt, Shang, Jones 2017; Hyslop, d'Alpoim Guedes 2021; Wei 2019; Kryzanska et al. 2021; Tang et al. 2021); peach (Zheng, Crawford, Chen 2014; Dal Martello et al. 2023a); hemp (Dal Martello et al. 2023b; Liu et al. 2022; Long et al. 2016; Sun 2016); osmanthus and foxnut (Tang et al. 2022), and *Chenopodium* (Yang et al. 2009; d'Alpoim Guedes 2013; Gao 2021; Xue et al. 2022; Song et al. 2021).

sherds. Rice grains were reported from (listed in order of excavation) Dadunzi (Kan 1977; 1978); Baiyangcun 白羊村 (Yunnan 1981); Nanbiqiao 南碧桥 (Kan 1983); Xinguang 新光 (Yunnan 2002) and Yingpanshan 营盘山 (Xiao 2006). Rice grain impressions on ceramic sherds were reported from an unspecified site on the eastern shore of the Dian Lake (Huang, Zhao 1959); Shizhaishan 石寨山 (Sun 1956) and Toujushan 头咀山 (Ge 1978). Some of these sites have since been re-excavated and systematic flotation undertaken (see § 4.3). In 2001, Zhao Zhijun floated a sample from Mopandi 磨盘地 (Zhao 2003a) and in 2003 one from Shifodong 石佛洞 (Zhao 2010b). In 2007-08, the first systematic archaeobotanical study was undertaken during the third excavation season of Haimenkou 海门口, in northwest Yunnan (Xue et al. 2022). This marked a flourishing period for archaeobotanical research in the province, with flotation sampling and phytoliths collection during excavation routinely incorporated into all archaeological excavations across Yunnan (Li Xiaorui, pers. comm. April 2018), in line with trends seen for other provinces.