

Archaeobotanical evidence reveals the early history of the sacred lotus (*Nelumbo nucifera*) usage in China

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Abstract

Although archaeobotanical data of sacred lotus (*Nelumbo nucifera*) recovered from the sites in China had increased in recent years, the early history of human usage ways of this plant has received less attention. In this study, we collated and reevaluated all published macro-botanical data of lotus from China during 9000 – 1100 BP. The present findings suggest that Neolithic rice growers living in the middle and lower Yangtze and Yellow River basins had made extensive use of lotus roots and seeds as a supplementary starch-based food for subsistence. Furthermore, the medicinal and cultural use of the sacred lotus appears to have developed with the rise of China's urban aristocracy from the mid-Warring States to the Late Tang Dynasty period. Our study provides the basis for further telling the story of the Chinese people's long-term interaction with the plants of sacred lotus.

Introduction

The sacred lotus (*Nelumbo nucifera*) is a typical wetland perennial herbaceous plant with a wide geographic distribution in southeastern Asia (Li et al., 2014a, b; Lin et al., 2019). It has been mainly cultivated in China, Japan, India and Iran (Hayes et al., 2000; Guo, 2009; Liu et al., 2016), and also in some tropical and warm areas of the northern part of Australia (Lin et al., 2019). Apart from *N. nucifera*, *Nelumbo lutea*, native to North America, is another species of the genus *Nelumbo* on Earth that has been extensively exploited by human beings (He et al., 2010). Existing ethnobotanical records suggest that the seeds and tuberous rhizomes of the American lotus (*N. lutea*) have been used for diet, medical and cultural symbolic purposes amongst the Native American tribes before European contact (Swan, 2010).

In Asia, the close relationship between humans and the sacred lotus (*N. nucifera*) has a long history as well. According to *Shi Jing* (the Book of Odes, written during the 11th -6th century BC), poetic language was used to describe the sacred lotus as a symbol of the elegant feminine by the Chinese of the pre-Qin era (Zhou, 2010). As the rhizomes and seeds of lotus are rich in a variety of nutrients, such as carbohydrates, minerals and proteins, etc, without any toxic materials (Mahmoudi et al., 2020; Zaidi and Srivastava, 2019), this plant can be easily served as starchy foods and vegetables by early residents living in the wetland environments of southeastern Asia. Archaeologists have found at least 77 carbonized lotus rhizomes and 2 seeds of *N. nucifera* at the Jiahu site in the Huai River Basin, revealing that the earliest Neolithic societies settling in the central plains of China had already collected a considerable amount of lotus rhizomes and seeds as a kind of supplementary food during 7000 – 5500 BC (Zhao and Zhang, 2009; Zhang et al., 2018).

Different organs of *N. nucifera* are also recognized as valuable to the Traditional Chinese Medicine (TCM) long before (see Table 1). Today, the rhizomes of lotus is effective in treating urinary problems, neurological difficulties and skin allergies (Li et al., 2014). The lotus flowers consists of microfibers and other minerals and vitamins has been used to treat gastrointestinal, cholera, digestive problems (Fatima et al., 2018; Gomes et al., 2018). Lotus seeds are useful in the treatment of some cancers, insomnia, bleeding and leprosy (Arooj et al., 2021). Lotus leaves can be used to stop bleeding (Li et al., 2016). Additionally, lotus has been chosen for water treatment and environmental purification in many modern cities, because of its visible role in water purification and pollution reduction (Lin et al. 2019).

Previous scholars have examined the history and culture of lotus utilisation in China by analysing historical documents and image materials relating to the sacred lotus (e.g. Rawson, 1984; see Fig. 1), by contrast, archaeobotanical evidence that directly records the long-term interactions between humans and sacred lotus in early China has been long overlooked. Scattered macro-botanical records of sacred lotus have been published in Chinese journals, but are not easily accessible for a wide audience. We therefore re-evaluated and investigated all macro-botanical evidence of sacred lotus (*N. nucifera*) found at archaeological sites in China dating to around 9000 – 1100 BP. Combined with relevant archaeological findings recovered from the same sites, our study contributes to the scientific knowledge on the human usage ways of sacred lotus in early China in a long-term archaeological context.

Table 1
Utilization of *Nelumbo nucifera* in Traditional Chinese Medicine (TCM)

Medicinal Parts	Medical Classics	Written Time	Illness/Usage	Reference
Lotus rhizome	Shennong's Classic of Materia Medica ()	221 BC-AD 220	Sweet in taste and mild in nature. Mainly used to nourish the spirit, benefit the vitality and remove all diseases. take it for a long time to make the body lighter and younger, and to prolong life without hunger	Sun and Sun 1991
Lotus rhizome	Variorum of Shennong's Classic of Materia Medica ()	AD 456-536	The juice of lotus rhizome can detoxify <i>Shewang</i> (extract of <i>Kusnezoff Monkshood</i>) and crab poison	Tao, 1985
Lotus rhizome	Materia Medica of Rihuazi ()	AD 907-960	Lotus rhizome can resolve postpartum blood stasis, can be eaten uncooked; Pound and apply to the wound caused by metal instruments and bone and joint Injuries, can stop the sudden pain; Steamed and boiled to eat, can enhance appetite	Chang, 2015
Lotus bud	Materia Medica of Rihuazi ()	AD 907-960	It can calm the heart and keep the face from aging	Chang, 2015
Lotus rhizome	Materia Medica of Yunnan ()	AD 1578	Take more to moisten the intestines and lungs and to produce fluids	Lan, 1977
Lotus flower	Materia Medica Category ()	AD 1578	Promote blood circulation and stop bleeding, remove rheumatism, clear the heart and cool the blood, and relieve heat and toxicity	Li, 2014
Lotus seed	Materia Medica Category ()	AD 1578	Nourish the heart, benefit the kidneys, tonify the spleen, and astringent to the intestines	Li, 2014
Lotus stamen	Materia Medica Category ()	AD 1578	Clear the heart, benefit the kidneys, astringent to sperm, stop bleeding, relieve summer heat and annoyance, promote the production of body fluid to quench thirst	Li, 2014
Lotus leaf	Materia Medica Category ()	AD 1578	Clear summer heat and dampness, raise the Yang and stop bleeding, lose weight and slim the body	Li, 2014
Lotus rhizome	Materia Medica Category ()	AD 1578	Stop bleeding, disperse blood stasis and relieve heat and toxicity	Li, 2014
Lotus petiole	Materia Medica Category ()	AD 1578	Clear and remove summer heat, promote the circulation of Qi and body fluid, dip fire and clear the heart	Li, 2014

Material And Method

We aimed to collate all published macro-botanical data of *N. nucifera* found at the archaeological sites in the present boundary of China. We used Google scholar and the China National Infrastructure Database (<http://www.cnki.net>) to search '*Nelumbo nucifera*', 'lotus', 'site' and 'China' in English and Chinese academic literature. From each search result, we extracted the archaeological information of sites including the geographic coordinates and cultural chronology or dating data of the sites, the number and available photography of these macro-fossils of *N. nucifera* as well as artifacts with lotus-shaped image and other macro-botanical remains unearthed from the same archaeological contexts.

Results

We have found archaeobotanical data of *N. nucifera* from 13 archaeological sites and burials in China from the early Neolithic time (7000 BC) to the late period of Tang Dynasty (AD 618–907). All of these sites have been mapped in the Fig. 2. Moreover, we have re-analyzed archaeological findings of other plant macro-fossils and artifact with lotus-shape images from the same site to further identify the temporal changes of the usage of *N. nucifera* by ancients in China. The chronological framework in the present study follows the results provided by the generally accepted date range of the early Neolithic to Tang Dynasty period (7000 BC - AD 907). Detailed archaeological information of these sites, archaeobotanical findings and artifacts with lotus-shaped image recovered from these studied sites is detailed in Table 2 and illustrated in Fig. 3 and Fig. 4.

Table 2
Archaeobotanical discoveries of *Nelumbo nucifera* in China and other archaeological information from the same site

Site	Cultural period	Age	Preserve condition	Archaeological context	Cultural Relics with lotus - shaped images	Dominated cereal remain/ Major agricultural economy	Other plant foods	References
Jiahu site	Peiligang Culture	7000 - 5500 BC	77 lotus roots; 2 lotus nuts	Pits	No	<i>Oryza sativa</i>	<i>Quercus</i> spp.; <i>Trapa</i> spp.; <i>Euryale ferox</i> ; <i>Carya cathayensis</i> ;	Zhao and Zhang, 2009; Zhang et al., 2018
Hujiawuchang site	Lower Zaoshi Culture	5800 - 5000 BC	3 lotus nuts	Cultural layers (T101, T102)	No	Rice agriculture	<i>Armeniaca mume</i> ; <i>Amygdalus davidiana</i> ; <i>Cerasus pseudocerasus</i> ; <i>Diospyros kaki</i> ;	Wang and Zhang, 1993
Nantunling site	Beixin Culture	5000 - 4500 BC	1 lotus nut	Pit	No	<i>Panicum milaceum</i> Rice agriculture	No	Chen, 2007
Tianluoshan site	Memudu Culture	5000 - 4500 BC	9 lotus nuts	T103 ; T305H36; T104H29	No	<i>Oryza rufipogon/sativa</i>	<i>Trapa</i> ; <i>Quercus</i> ; <i>Euryale ferox</i> ; <i>Cyclobalanopsis</i> ; <i>Lagenaria</i> ; <i>Armeniaca mume</i> ; <i>Amygdalus davidiana</i> ; <i>Choerospondias axillaris</i> ; <i>Diospyros</i> ;	Zheng et al., 2011
Dongshancun site	Maijiabang Culture	5000 - 4000 BC	2 lotus nuts	T2006	No	<i>Oryza sativa</i>	<i>Trapa natans</i> ; <i>Euryale ferox</i> ; <i>Lagenaria sciceraria</i> ; <i>Armeniaca mume</i> ; <i>Amygdalus persica</i> ; <i>Prunus</i> cf. <i>salicina</i> ; <i>Cerasus</i> sp.; <i>Crataegus</i> sp.;	Qin, 2016
Dahecun site	Yangshao Culture	4000 - 3000 BC	2 lotus nuts	House No.2 (F2)	No	Unclear Millet agriculture?	<i>Glycine</i> ;	Li et al., 2001

Site	Cultural period	Age	Preserve condition	Archaeological context	Cultural Relics with lotus - shaped images	Dominated cereal remain/ Major agricultural economy	Other plant foods	References
Jiangzhuang site	Liangzhu Culture	3300 - 2300 BC	Lotus nuts, number unclear	Pits	No	<i>Oryza sativa</i> <i>Setaria italica</i>	<i>Glycine max;</i> <i>Lagenaria;</i> <i>Cucumis melo;</i> <i>Trapa; Euryale ferox;</i> <i>Diospyros;</i> <i>Choerospondias axillaris;</i> <i>Armeniaca vulgaris;</i> <i>Amygdalus persica;</i> <i>Ziziphus;</i> <i>Quercus;</i>	Wu et al., 2019
Liangzhu site (Zhongjiagang)	Liangzhu Culture	3300 - 2300 BC	1 broken lotus nut	Cultural layer	No	<i>Oryza sativa</i>	<i>Trapa natans;</i> <i>Euryale ferox;</i> <i>Lagenaria sciceraria;</i> <i>Lagenaria;</i> <i>Cucumis melo;</i> <i>Diospyros kaki;</i> <i>Armeniaca vulgaris;</i> <i>Armeniaca mume;</i> <i>Amygdalus persica;</i> <i>Prunus salicina;</i>	Wu, 2019
Chu tomb No.1 of Jiuli	Middle Warring States Period	Around 350 BC	Many lotus roots, number unclear	Tomb No. 1	No	Rice agriculture	<i>Ziziphus jujube;</i> <i>Castanea mollissima;</i> <i>Cucumis melo;</i>	Xiong, 2011
Wangshanqiao Tomb No.1	Middle Warring States Period	Around 350 BC	Two seedpods with lotus nuts	East chamber of the tomb	No	Rice agriculture	<i>Zanthoxylum bungeanum;</i> <i>Zingiber officinale;</i> <i>Angelica sinensis;</i> <i>Ziziphus jujube;</i> <i>Castanea mollissima;</i> <i>Quercus sp.;</i>	Sheng et al., 2019

Site	Cultural period	Age	Preserve condition	Archaeological context	Cultural Relics with lotus - shaped images	Dominated cereal remain/ Major agricultural economy	Other plant foods	References
Chu tomb No.2 of Baoshan	Middle Warring States period	Around 330 BC	About 12 lotus roots	Full of two bamboo crates in the Tomb No. 2	No	Rice agriculture	<i>Zanthoxylum bungeanum;</i> <i>Zingiber officinale;</i> <i>Castanea mollissima;</i> <i>Trapa bispinosa;</i> <i>Ziziphus jujube;</i> <i>Diospyros kaki;</i> <i>Eleocharis dulcis;</i> <i>Armeniaca vulgaris;</i> <i>Pyrus;</i>	Chen, 1988
Han tomb No.1 of Mawangdui	Early Western Han Dynasty	Around 160 B.C.	Many lotus roots, number unclear	Inside a lacquered ware in the south cabin of the coffin in the Tomb No.1 (M1)	No	Rice agriculture <i>Triticum aestivum</i> <i>Hordeum vulgare</i> <i>Setaria italica</i> <i>Panicum miliaceum</i>	<i>Zanthoxylum bungeanum;</i> <i>Zingiber officinale;</i> <i>Glycine max;</i> <i>Phaseolus angularis;</i> <i>Cucumis melo;</i> <i>Pyrus pyrifolia;</i> <i>Prunus mume;</i> <i>Myrica rubra;</i> <i>Malva verticillata;</i> <i>Brassica cernua;</i> <i>Ziziphus jujube;</i> <i>Cannabis sativa;</i> <i>Hierochloe odorata;</i> <i>Alpinia officinarum;</i> <i>Cinnamomum chekiangense;</i> <i>Magnolia denudata;</i> <i>Ligusticum cf. jeholense;</i> <i>Asarum forbesii;</i> <i>Eupatorium fortunei;</i>	HAC and IBCAS, 1978
Shuiqiushi's tomb	Tang Dynasty	A.D. 901	5 lotus nuts,	Inside the coffin	Yes	Rice agriculture	No	The Mingtangshan Archaeological Team, 1981; Zhejiang Provincial Institute of Cultural Relics and Archaeology, 2012

Discussion

In this study, by re-examining the macro-botanical data of sacred lotus (*N. nucifera*) recovered from 13 archaeological sites and burials in the middle and lower Yangtze and Yellow River plains from the early Neolithic to late Tang Dynasty period, we can begin to piece together a more

complete picture of the long-term interaction between those plain dwellers and the sacred lotus during 9000 – 1100 BP. To date, archaeologists have found a considerable quantity of lotus roots and nuts from 8 Neolithic sites (Table 2). All of the sites where these fossils of lotus were found are located within the current natural distribution of *N. nucifera* in East Asia (see Fig. 2; Li, et al., 2016). Apart from the sacred lotus remains, other two kinds of aquatic plant food remains such as *Trapa* and *Euryale* have been also commonly discovered at the sites of Jiahu, Tianluoshan, Dongshancun, Jiangzhuang and Liangzhu during 9000 – 4300 BP, revealing the diversity of wetland starchy foods exploited by these early rice-based agriculturalists from different cultural territories (see Table 2; Fuller and Qin, 2010). As the sacred lotus is an important starchy plant resource in wetland ecosystems (Guo, 2009), the widespread use of that plant likely improved food security and enhanced the resilient subsistence strategies of ancient inhabitants in wetland environments.

Interestingly, we find that a large number of archaeobotanical remains of the lotus (*N. nucifera*) in later historical periods have all been found in tombs (Table 2), dating back to the Warring States period (475 – 221 BC). Previous research has suggested that belief in the afterlife among the Chinese noble groups in the Classical period led to the arrangement of burial objects in tombs in imitation of real-life (Luo, 2005; Liu, 2007). In such a cultural phenomenon, it seems that these nobles sought to establish a sensory and spiritual connection with their ancestors through the use of different luxury foods, such as spices, fruits and herbs, in rituals like the funerals (Sterckx, 2011). Echoing this previous understanding of the cultural use of plants, the greater variety of macrofossils of the sacred lotus, including roots, seeds and seedpods, recovered from the noble burials of the Chu State in the southern part of Bronze Age China suggests that the lotus may have been used to meet the multiple needs of the aristocratic urban societies (Fuller and Stevens, 2019).

Specifically, in the Chu tomb No.2 of Baoshan in Hubei Province, neatly arranged lotus roots were found at two bamboo sachets () in the east chamber where burial objects and containers with fruits and other foods were buried with the tomb owner (Chen, 1988). In addition, at least two seedpods with lotus nuts were recovered from the Wangshanqiao Tomb No.1 at Jingzhou around 350 BC, the first discovery of such plant remains in China (Sheng et al., 2020), indicating that these Bronze Age Chu nobles may have been familiar with the value of lotus seedpods. Considering that some typical spice plants, such as *Zanthoxylum bungeanum* and *Zingiber officinale*, were also found alongside the remains of lotus in the burials of Chu nobles (Table 2), it suggests that the sacred lotus may also have been part of the luxury plant package used by these Bronze Age urban nobles in southern China (Fuller and Stevens, 2019). In this context, we believe that it is not sufficient to interpret the appearance of lotus remains recovered from the burials of Chu nobles during this period as the remains of plant food that these ancients consumed to survive.

Furthermore, in the No. 1 Han tomb at Mawangdui in Hunan Province from the mid-Western Han dynasty (202 BC – 8 AD), archaeologists have found a large number of burial objects, including a considerable amount of fruit, spices, herbs and pieces of sacred lotus (HAC, 1978), which provides us details to depict the luxurious lifeways of the tomb owner, Xin Zhui, the wife of the prime minister of the Changsha state () in the southern Han empire, during her lifetime. As shown in Fig. 3f, the slices of lotus root found in the lacquered tripod of that noblewoman excavated from tomb No.1 at Mawangdui indicate a deeper understanding of the cooking of lotus in the Han Dynasty. Additionally, the image of the lotus in a pond became one of the common subjects in the Han dynasty portrait stones and was widely used as decoration in high-class tombs (Xia, 1996; see Fig. 1). This suggests that the image of the lotus may have begun to be imbued with more cultural ideas at this time and served as an important element in the typical landscape setting of the carved artwork of the Han Dynasty (Liu, 1991), highlighting the leisure life of aristocratic societies in early China.

After the Han Dynasty, only five well-preserved remains of lotus nuts were excavated from Shuiqiushi's tomb of the late Tang Dynasty period (Zhejiang Provincial Institute of Cultural Relics and Archaeology, 2012). This is partly due to the current neglect of archaeobotanical studies of the dynamic period of China by scholars. Shuiqiushi is the mother of Qian Liu (), who was the first King of the Wuyu State of the Five Dynasties period of China (907–978 AD). In Shuiqiushi's tomb, over 100 pieces of high-grade ceramics, gold and silver, jade, lacquer and other precious relics were unearthed, showing the luxury of her aristocratic life (ZPICRA, 2012). Several lotus-shaped or lotus-patterned artifacts were found at that burial, such as a small silver Cup-and-saucer, which is beautifully decorated with a convex lotus seedpod in the center of the saucer, and five lotus leaves on the rim, depicting a realistic and lifelike image of fish swimming in a lotus pond (Fig. 4). More importantly, the charred lotus nuts were the only plant remains recovered from the Shuiqiushi's tomb (Table 2). Combined with the exquisite burial object relating to the lotus mentioned above, it is clear that Shuiqiushi had a special fondness for that plant. In consideration of the historical tradition of the Wu-Yue royal family's reverence for Buddhism (Xue, 2013), and the cultural intimacy between the lotus and Buddhism (Lai and Wang, 2017), it can be argued that, in addition to its original dietary and medicinal uses, the lotus may have been given a new cultural connotation under Buddhist influence in the late Tang dynasty in the area of Wu Yue and its influence continues to the present.

Conclusion

By revisiting and analyzing the macro-botanical data of sacred lotus (*N. nucifera*) excavated from archaeological sites in China, we have constructed a broad history of the human usage of sacred lotus by humans from 9000 to 1100 BP. The results suggest that while the sacred lotus was initially used extensively by early rice farmers as supplementary food, from the Bronze Age onwards in China the use of that plant gradually went beyond dietary use to a form of plant use that encompassed multiple uses and multiple cultural connotations. Nonetheless, more systematic research into the archaeobotanical remains of the sacred lotus found in different archaeological contexts in dynastic China is necessary for us to gain a comprehensive understanding of the details of the cultural use ways of lotus and the trajectory of long-term human-lotus interactions.

Declarations

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Figures

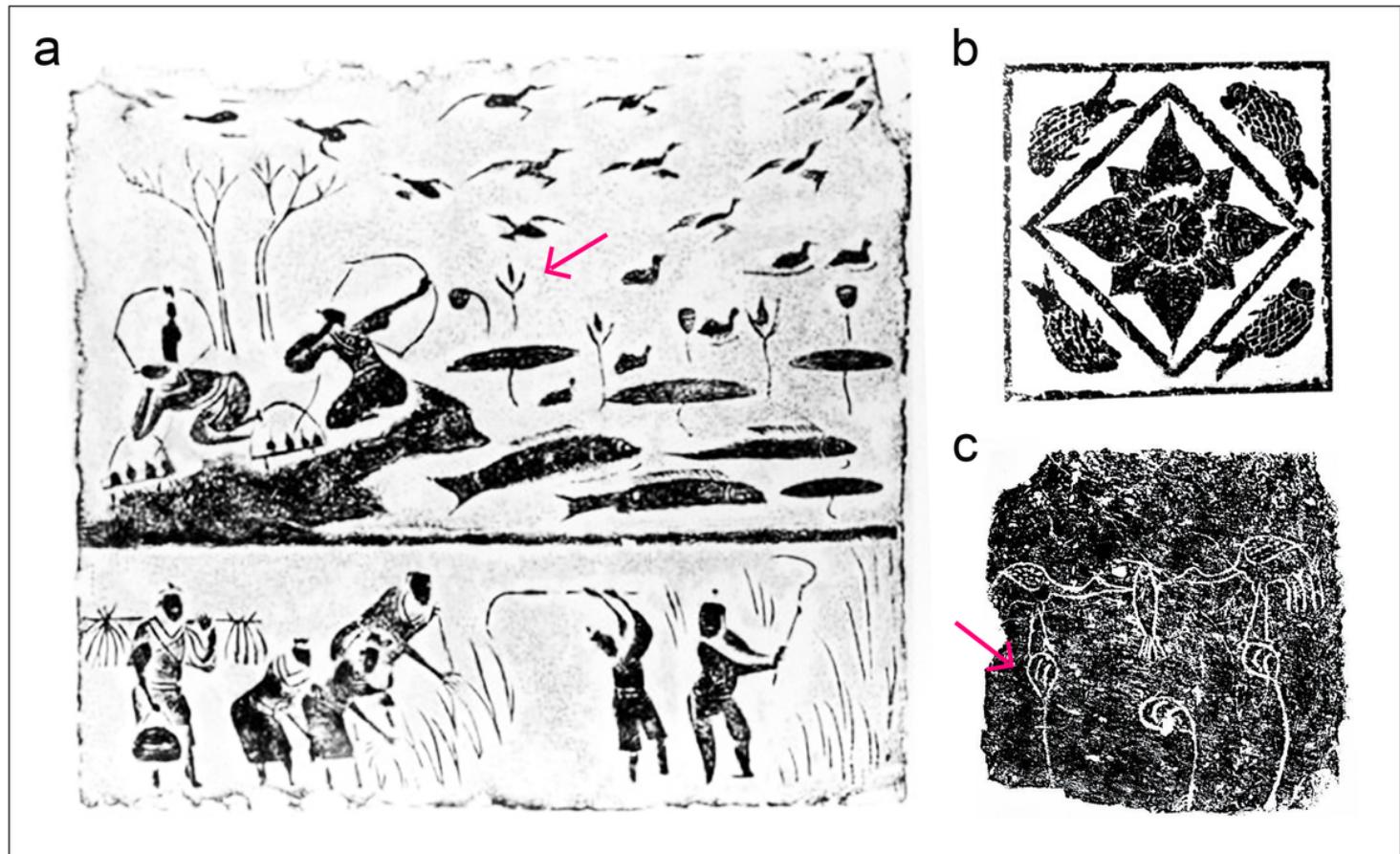


Figure 1

Han Dynasty (202 BC-220 AD) portrait stones with lotus shaped images (redrawn after Xia and Lin, 1996)

a: *Fishing and hunting in the lotus pond* collected from Peng County, Sichuan Province;

b: *Four Fish and Lotus Pattern* excavated in Xuzhou City, Jiangsu Province;

c: *Two cranes holding fish and lotus flowers* excavated in Xio County, Anhui Province.

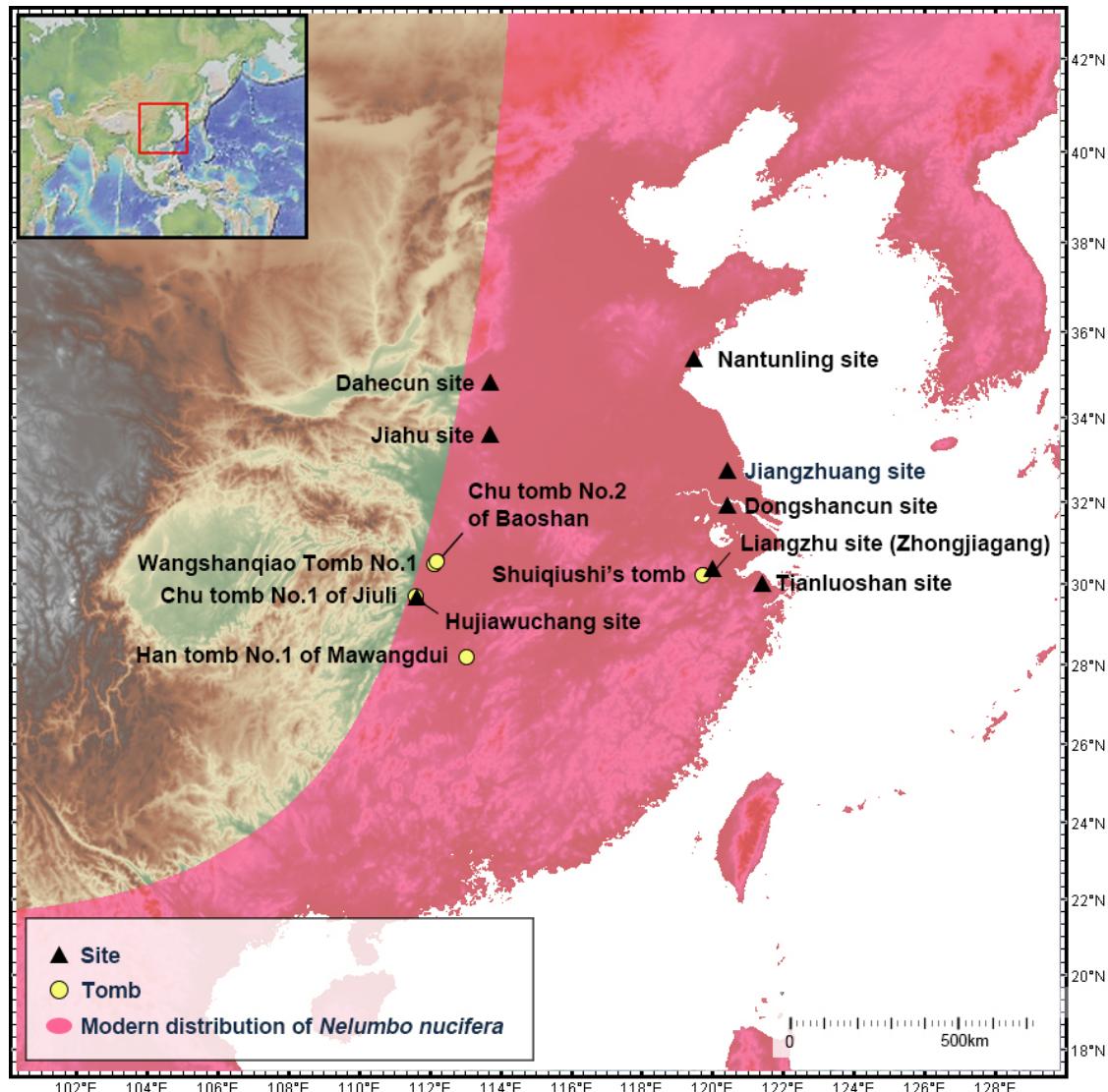


Figure 2

The map of the sites within macro-botanical discoveries of *Nelumbo nucifera* in China (the modern distribution of *N. nucifera* is redrawn after Li et al., 2016)

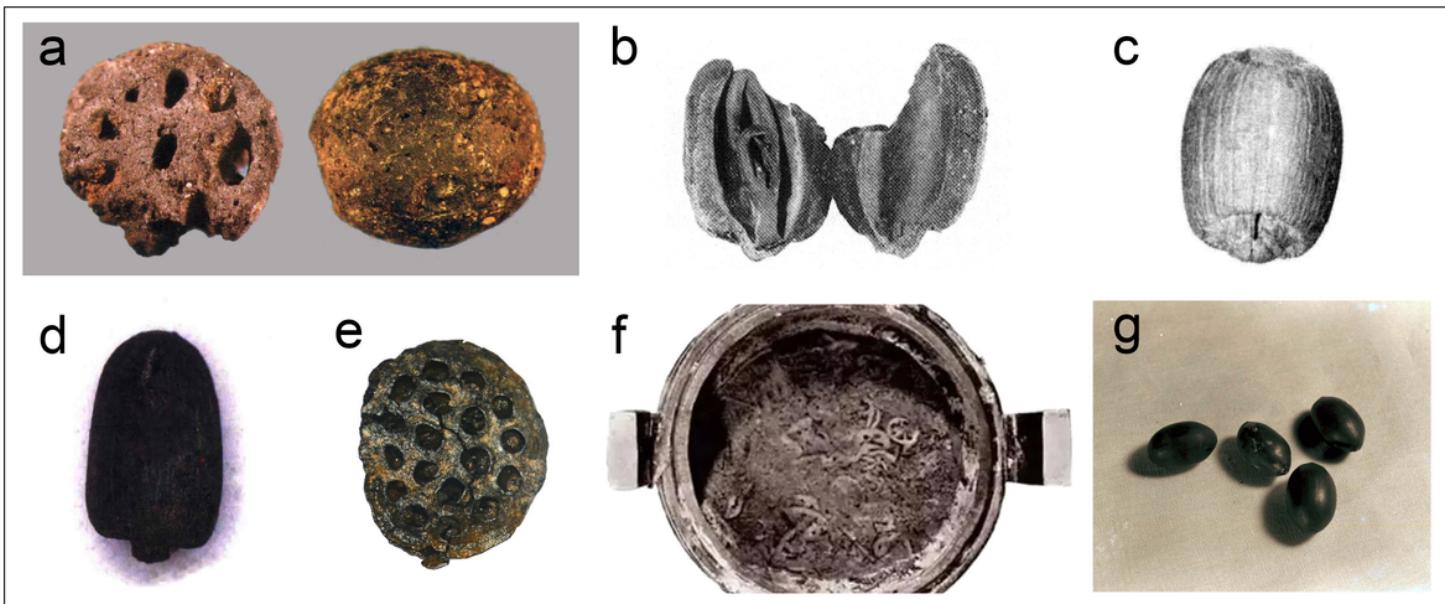


Figure 3

Discoveries of *N. nucifera* in recovered from sites in early China (redrawn after Zhao and Zhang, 2009; Chen, 2007; Zheng et al., 2011; Qin, 2016; Sheng et al., 2020; HM and IACAS, 1973; ZPICRA, 2012).

- a: lotus root and nut from the Jiahu site;
- b: lotus nut from the Nantunling site;
- c: lotus nut from the Tianluoshan site;
- d: lotus nut from the Dongshancun site;
- e: lotus seedpod from the Wangshanqiao Tomb No.1;
- f: slices of lotus roots recovered from container in the Han tomb No.1 of Mawangdui;
- g: lotus nuts from Shuiqiushi's tomb

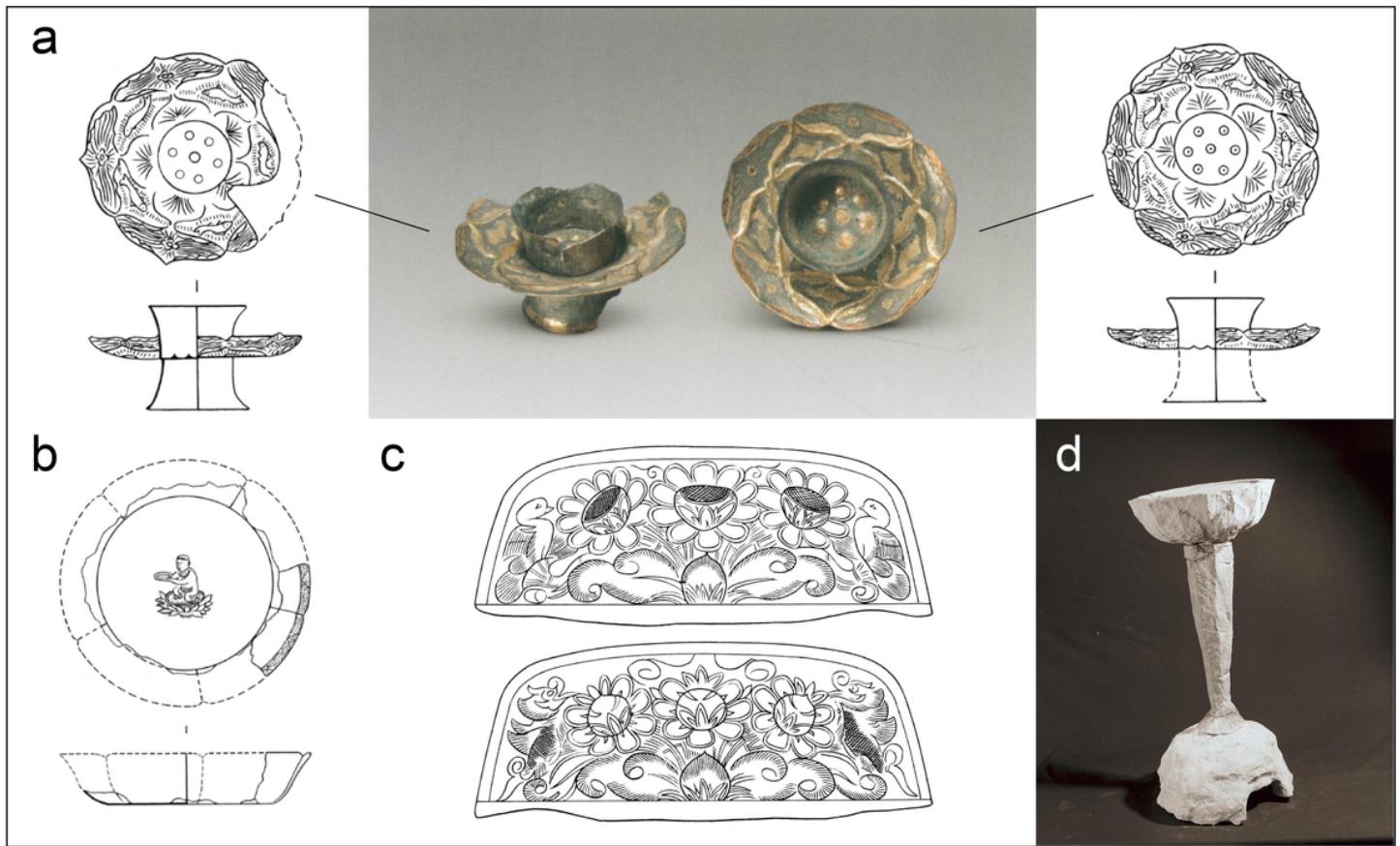


Figure 4

Artifacts with the element of lotus in Shuiqiushi's tomb (redrawn after ZPICRA, 2012)

- a: Small Silver Cup-and-saucer (M24:31-2, 32-2);
- b: Silver Plate with a Mouth Rim in the Shape of Mallow Petals (M24:95);
- c: Jade comb back decorated with lotus (M24:78);
- d: Lotus-shaped Stone Lampstand (M24:3)