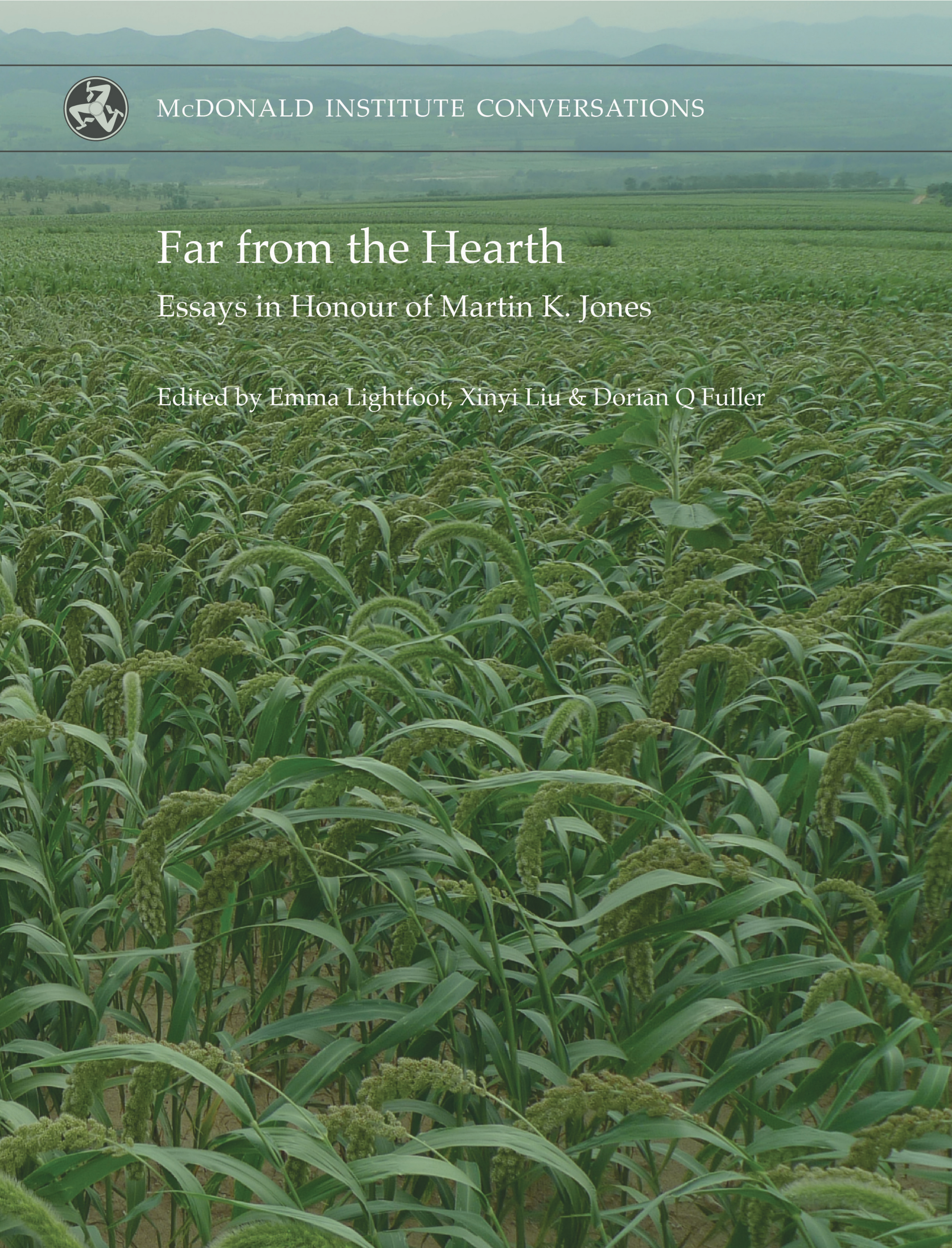
McDONALD INSTITUTE CONVERSATIONS

Far from the Hearth

Essays in Honour of Martin K. Jones

Edited by Emma Lightfoot, Xinyi Liu & Dorian Q Fuller



Far from the Hearth

(Above) Martin Jones at West Stow, 1972 (with thanks to Ian Alister, Lucy Walker, Leonie Walker, and West Stow Environmental Archaeology Group); (Below) Martin Jones in a millet field, Inner Mongolia, 2010. (Photograph: X. Liu.)

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Cover image: *Foxtail millet field near Xinglonggou, Chifeng, China, photographed by Xinyi Liu, September 2014.*

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Acknowledgements

The initial idea of editing this volume grew out of a conversation between Xinyi Liu and Graeme Barker at St John's College, Cambridge in June 2016. The editors subsequently discussed the provisional layout of the volume. By April of the following year, our list of agreed contributors was complete. Abstracts followed, and the chapters themselves soon after. First of all, the editors would like to pay tribute to our 36 authors, whose excellent work and timely contributions made it all possible.

For the last two-and-a-half years, the volume has been known as 'Fantastic Beasts' in order to keep it a secret from Martin. As we enter the final stage, we wish to extend our thanks to all who have ensured Martin remains blissfully unaware, including Lucy Walker, and we offer her our sincere thanks. We are extremely grateful to Harriet Hunt, Diane Lister, Cynthia Larbey and Tamsin O'Connell, who are kindly organizing the gatherings to mark Martin's retirement and the publication of this volume.

With respect to the volume's production, we would like to thank the McDonald Institute for Archaeology Research for financial support. The McDonald Monograph Series Editor James Barrett oversaw and encouraged all aspects of this project, and we offer him sincere thanks. We would also like to acknowledge the support of Cyprian Broodbank, not least for allowing us to host the workshop at the institute, but also for his encouragement throughout all phases of the volume's implementation. Particular thanks must go to several key individuals: Anne Chippindale, Ben Plumridge, Emma Jarman, Simon Stoddart and Samantha Leggett. Finally, we are also grateful to the anonymous reviewers who recommended changes that have greatly enhanced the final version of this volume.

Xinyi Liu, Emma Lightfoot and Dorian Fuller
August 2018

Foreword

The 28-year term of Martin Jones as the first George Pitt-Rivers Professor of Archaeological Science witnessed, and in part created, a transformation in the fields of environmental and biomolecular archaeology. In this volume, Martin's colleagues and students explore the intellectual rewards of this transformation, in terms of methodological developments in archaeobotany, the efflorescence of biomolecular archaeology, the integration of biological and social perspectives, and the exploration of archaeobotanical themes on a global scale. These advances are worldwide, and Martin's contributions can be traced through citation trails, the scholarly diaspora of the Pitt-Rivers Laboratory and (not least) the foundations laid by the Ancient Biomolecules Initiative of the Natural Environment Research Council (1989–1993), which he chaired and helped create. As outlined in Chapter 6, Martin's subsequent role in the bioarchaeology programme of the Wellcome Trust (1996–2006) further consolidated what is now a central and increasingly rewarding component of archaeological inquiry. Subsequently, he has engaged with the European Research Council, as Principal Investigator of the Food Globalisation in Prehistory project and a Panel Chair for the Advanced Grant programme. As both practitioner and indefatigable campaigner, he has promoted the field in immeasurable ways, at critical junctures in the past and in on-going capacities as a research leader.

The accolades for Martin's achievements are many, most recently Fellowship of the British Academy. Yet it is as a congenial, supportive—and demanding—force within the Pitt-Rivers Laboratory that the foundations of his intellectual influence were laid. Here, each Friday morning, the archaeological science community would draw sticks to decide who would deliver an impromptu research report or explore a topical theme. Martin is among the most laid-back colleagues I have worked with, yet simultaneously the most incisive in his constructive criticism. As a provider of internal peer-review he was fearless without being unkind. The themed Pitt-Rivers Christmas parties were equally impactful—on one occasion Alice Cooper appeared, looking ever so slightly like our professor of archaeological science.

Martin's roles as a research leader extended to several stints as head of the Department of Archaeology, chairing the Faculty of Archaeology and Anthropology and serving as a long-term member of the Managing Committee of the McDonald Institute for Archaeological Research. Having started his professional career as an excavation-unit archaeobotanist in Oxford, he was a long-standing proponent of the highly successful Cambridge Archaeological Unit. In the wider collegiate community, he is a Fellow (and was Vice-Master) of Darwin College and was the staff treasurer of the Student Labour Club. In all roles he fought valiantly and often successfully for the interests of his constituency. His capacity to fight for deeply held priorities while recognizing the value of diverse perspectives was of utmost importance. His nostalgic enthusiasm for the debate with archaeological science that was engendered by the post-processual critique is one signal of an underlying appreciation of plurality. His active support for the recent merger of the Divisions of Archaeology and Biological Anthropology, within our new Department of Archaeology, is another. As a scientist (Martin's first degree, at Cambridge, was in Natural Sciences) he values the peer-reviewed journal article above all scholarly outputs, yet has authored as many highly regarded books as a scholar in the humanities. His *Feast: Why humans share food* has been translated into several languages and won Food Book of the Year from the Guild of Food Writers. He views academia and society as a continuum, campaigning for archaeobotanical contributions to global food security (e.g. by promoting millet as a drought-resistant crop) and working with world players such as Unilever to encourage archaeologically informed decisions regarding food products.

That Martin's achievements and influence merit celebration is clear. That his colleagues and students wish to honour him is equally so. Yet does the McDonald Conversations series publish *Festschriften*? This is a semantic question. As series editor I am delighted to introduce a collection of important papers regarding the past, present and future of archaeobotany, representing its methodological diversity and maturity. That this collection concurrently pays respect to a treasured colleague is a very pleasant serendipity.

Dr James H. Barrett

Chapter 17

When and How Did Wheat Come Into China?

Zhijun Zhao

Introduction

Wheat has its origin in the Fertile Crescent in West Asia. Remains of the earliest wheat have been excavated from the archaeological sites of the EPPNB period (Early Pre-Pottery Neolithic B), which is dated to 10,500–9500 BP (Weiss & Zohary 2011). *Triticum monococcum* (einkorn wheat) and *T. turgidum* (emmer wheat) are two varieties of the earliest domesticated wheat. About 8000 years ago, *T. turgidum* was introduced into the river valley between the northern Iranian plateau and southeastern Caspian Sea, and hybridized with local *Aegilops tauschii* (Tausch's goatgrass), which gave birth to a new cultivated variety that is widely planted and used today—*T. aestivum*, which is also called common wheat or bread wheat (Zohary & Hopf 2000).

Wheat gradually spread to become the main crop in the regions of the major ancient civilizations, including the Mesopotamian civilization in the Euphrates and Tigris valleys, the ancient Egyptian civilization in the Nile Valley, the ancient Indian civilization in the Indus Valley and the ancient Greek and Roman civilizations, which were all established on the basis of agricultural production with wheat as the main crop.

In Central Asia, the eastward spread of wheat was very slow. According to archaeological findings, wheat had already spread into the southwestern areas of Central Asia, such as the northern slopes of Kopet-Dagh in Turkmenistan, as early as 7000 years ago (Harris 2010), but only moved eastward to East Asia thousands of years later. There were many reasons for this hindrance of the eastward spread of wheat, among which the different climates of western and eastern Asia should be the main factor. The birthplace of wheat, West Asia, enjoys a Mediterranean climate with hot, dry summers, and cold, damp winters, with frequent rainfall in winter and spring. However, East Asia, including China, the Korean Peninsula and the Japanese archipelago, enjoys an East Asian monsoon climate with hot, wet summers, cold, dry winters, and frequent rainfall in summer. The difference in rainy seasons had a great impact on the growth of wheat. As a winter crop, wheat is sown in autumn and harvested in summer. Water is needed in spring, the growing season for wheat, but rain is scarce in East Asia at this time. For example, in the vast areas of northern China, it is said that rain in spring is as precious as oil. The lack of water is not conducive to the jointing and filling of wheat in the growing season, while the frequent rain in summer also affects its maturation and harvest. Under these conditions, East Asia is actually not suitable for growing wheat unless irrigation is used. Therefore, climatic differences in western and eastern Asia are the main reason for the very gradual eastward spread of wheat.

According to historical documents, however, wheat continued to spread eastward, reaching the middle and lower reaches of the Yellow River, which was the core area of ancient Chinese civilization. Gradually replacing such local crops as foxtail millet (*Setaria italica*) and broomcorn millet (*Panicum miliaceum*), wheat became the major crop of dry-land farming in northern China, leading to China's current agricultural production pattern of rice in the south and wheat in the north. Thus, it follows that in spite of the fact that wheat did not originate in China, the time when it was introduced into China, the route it took to enter China, the method of its spread in China and its impact on ancient Chinese civilization are all important issues deserving serious attention.

In this chapter, archaeological remains of wheat are studied using the methods of archaeobotany so as to explore the time and routes of the introduction of wheat into China. Specifically, the credibility and reliability of the dates of unearthed remains of early wheat are assessed, thereby determining the time of its introduction into China. This will involve integrating archaeological materials concerning wheat found in different regions and synthesizing the environmental characteristics and cultural traditions in ancient China. The means and routes of wheat's transmission into China will be explored, especially to the core region of Chinese civilization, namely, the middle and lower reaches of the Yellow River.

Archaeological data collected in the last century

For the time when wheat spread into China, some clues can be found in historical documents. For example, an ancient historical text, in the chapter 'Duke Cheng of Lu (590–573 BC)' in *Zuo Zhuan* 左传 (Zuo Qiuming's commentary on *Spring and Autumn Annals*), compiled in the early fourth century BC, records that '周子有兄而无慧, 不能辨菽麦, 故不可立' [the brother of Zhou Zi is not qualified to be a king, because he is not intelligent enough to distinguish soybean and wheat]. It is clear from this document that wheat was widely grown in northern China during the Eastern Zhou period (770–256 BC). In addition, Chinese characters relating to wheat have been identified in China's earliest written artefacts, the so-called oracle bone inscriptions (inscriptions on bones or tortoise shells) dating from the period of the late Shang Dynasty, roughly 1200–1050 BC. For example, though the two characters *lai* 来 and *mai* 麦 have been explained as Triticeae crops, the former is regarded as denoting wheat and the latter barley (Song 2002). The character referred to wheat originally, but later was used as a word meaning 'come'. Some scholars thus believe that this indicated that wheat came (来) from regions outside China (Ho 1985), though other scholars hold different views (Luo 1990). At all events, the Chinese character in the oracle bone inscriptions clearly confirms that wheat had already entered China no later than the Shang period (before 3000 years ago).

These are the earliest historical records about wheat. To trace any further into the past requires archaeological findings that precede these historical documents, that is, archaeological materials dated to earlier than 3000 years ago. This is the chronological demarcation line for the discussion of the present study.

The most direct archaeological evidence for when the introduction of wheat occurred should come from the remains of ancient wheat found during archaeological research. The fact is, though, that only in rare cases is wheat preserved in cultural deposits, because the plant as an organic material tends to rot away. Unlike other archaeological remnants, wheat grains are too small to be observed by the naked eye, with the result that it is very difficult to find any wheat remains by means of the usual methods employed in archaeological excavation. Despite this, there were still some reports of wheat remains in archaeological excavations in the previous century. Archaeological sites where remains of early wheat from 3000 years ago were discovered include the Donghuishan site in Minle County, Gansu Province (Gansu Provincial Institute of Cultural Relics and Archaeology and Northern Archaeology Laboratory of Jilin University 1998), the Zhaojialai site in Wugong County, Shaanxi Province (Institute of Archaeology, Chinese Academy of Social Sciences 1988), the Diaoyutai site in Bo County, Anhui Province (Anhui Museum 1957), the Haimenkou site in Jianchuan County, Yunnan Province (Preparatory Office of Yunnan Museum 1958), the Changguogou site in Shannan in Tibet (Fu 2001), the Gumugou site in Lop Nor (Wang 1983), the Lanzhouwanzi site in Balikun County (Wang *et al*. 1985) and the Wubao Tomb in Hami in Xinjiang Uygur Autonomous Region (Xinjiang Institute of Cultural Relics and Archaeology 1992) (Table 17.1).

It should be noted that most of these wheat remains were discovered by chance, and there is a fair margin of doubt about the period and species that they belong to, provoking some debate. For example, the ceramic pot in which the wheat remains were found unearthed at the Diaoyutai site was initially considered to date to the Late Neolithic, about 4000 years ago, but was subsequently identified as a relic of the Western Zhou period (1046–771 BC: Yang 1963). Another example is that, although there is agreement on the age of the wheat remains found at the Zhaojialai site (Longshan period, *c*. 4300–3800 BP), the determination of their species requires further research. It was reported that the wheat remains from this site were actually found in the traces of some plant stems present in the mud used to daub a wall (Huang 1991). However, it is difficult enough to identify the species of fresh stems of most crops based on appearance, let alone the impressions of stems left in such material.

The most influential and controversial of such wheat remnants discovered in the twentieth century are those unearthed at the Donghuishan site located in the Hexi Corridor 河西走廊, Gansu Province. Li Fan was the first to research those wheat remains. Based on the wheat grains he collected at the site in 1985 and 1986, he identified them as *Triticum aestivum* and *T. compactum* and determined that the wheat grains dated to 5000±159 cal. BP, based on radiocarbon dating analysis of bulk samples (black carbon soil) collected from the site (Li *et al*. 1989). Since Li Fan is a well-known agronomist rather than archaeologist, his identification of the wheat species is credible, but the methods he used to collect the samples of plant remains and to assess their date require further confirmation by professional archaeologists.

In 1987, a combined archaeological team from the Gansu Institute of Archaeology and the Archaeology Department of Jilin University officially began excava-

Table 17.1. *Early wheat remains in last-century archaeological discoveries.*

Site	Location	Finds	Relative date	Absolute age BP	Dating material/method	References
Donghuishan	Minle County, Gansu Province	charred wheat grains	Siba	5000±159	soil/ conventional	Li *et al.* 1989
Donghuishan	Minle County, Gansu Province	charred wheat grains	Siba	3770±145	charcoal/ conventional	Gansu Provincial Institute of Cultural Relics and Archaeology and Northern Archaeology Laboratory of Jilin University 1998
Donghuishan	Minle County, Gansu Province	charred wheat grains	Siba	4230±250	wheat grain/ conventional	
Zhaojialai	Wugong County, Shaanxi Province	wheat straw impression	Longshan	c. 4300–3800	–	Huang 1991
Zaojiaoshu	Luoyang City, Henan Province	wheat grains	Erlitou	3660±150	charcoal/ conventional	Cultural Relics Team of Luoyang 2002
Haimenkou	Jianchuan County, Yunnan Province	ears of wheat	late Neolithic	c. 3500	–	Preparatory Office of Yunnan Museum 1958
Changguogou	Shannan County, Xizang (Tibet) Autonomous Region	wheat grains	Neolithic	3370	charcoal/ conventional	Fu 2001
Gumugou	Lop Nor, Xinjiang Uyghur Autonomous Region	wheat grains	–	3765–3925	coffin, sheepskin and blanket/ conventional	Wang 1983
Lanzhouwanzi	Balikun Coungty, Xinjiang Uyghur Autonomous Region	charred wheat grains	–	3285	wood and fur/ conventional	Wang *et al.* 1985
Wupu Tombs	Hami City, Xinjiang Uyghur Autonomous Region	wheat grains	–	3260–2960	charcoal/ conventional	Wang 1983

tion of the Donghuishan site. The results obtained by the team show that the site belongs to the Siba culture (Gansu Provincial Institute of Cultural Relics and Archaeology and Northern Archaeology Laboratory of Jilin University 1998, 131–2), an Early Bronze Age culture in the Hexi Corridor dated from 3900 to 3400 years ago. Therefore, the date of the Donghuishan site determined by archaeologists based on excavation was over 1000 years later than that of the wheat remains at the site identified by Li Fan. Even more complicated are the two radiocarbon dating results published in the appendix of the official archaeological report (Gansu Provincial Institute of Cultural Relics and Archaeology and Northern Archaeology Laboratory of Jilin University 1998, 190). The calibrated result of the radiocarbon age of charcoal samples with clear acquisition layer was 3770±145 cal. BP, which was precisely in the period of the Siba culture. However, the conventional radiocarbon age of charred wheat collected from the Siba cultural layer was 4230±250 BP, which seemed to be closer to Li Fan's assessment. These contradictory radiocarbon dating results added to the confusion over the age of the wheat remains found at the Donghuishan site, leading to further academic debate (Li & Mo 2004).

In 2005, a joint team consisting of Chinese and American archaeologists made a special trip to the Donghuishan site. Using the flotation technique, more remains of wheat and barley were discovered. Based on over 10 series of charred wheat samples selected through flotation, the age of this newly unearthed wheat was directly dated using the AMS (accelerator mass spectrometry) dating technique by the Radiocarbon Laboratory of Peking University. The calibrated results indicated that most wheat samples were dated from 3600 to 3400 BP (Flad *et al*. 2010). In recent years, new sampling and dating by Chinese and Australian scholars have determined that the calibrated results of radiocarbon dating age were in a range from 3800 to 3500 BP (Dodson *et al*. 2013). These new data irrefutably prove that the cultural deposits and remains of wheat from the Donghuishan site are from the period of the Siba culture, and their absolute age was around 3600 BP. As a result, this archaeological problem, which had been confusing academic circles for years, was finally solved.

Table 17.2. *Early wheat remains with only relative ages.*

Sites	Location	Acquisition methods of wheat remains	Relative age	Presumed absolute age BP	Basis for the presumed age	References
Liangchengzheng	Rizhao City, Shandong Province	archaeological excavation	Longshan	*c*. 4300–3800	feature of the cultural remains in the site	Crawford *et al*. 2004
Jiaochangpu	Liaocheng City, Shandong Province	archaeological excavation	Longshan	*c*. 4300–3800	feature of the cultural remains in the site	Zhao 2004
Zhaogezhuang	Yantai City, Shandong Province	archaeological excavation	Yueshi	*c*. 3839–3627	radiocarbon dating results of other materials	Jin *et al*. 2010
Maan	Zhangqiu City, Shandong Province	archaeological excavation	Yueshi	*c*. 3800–3600	feature of the cultural remains in the site	Chen & Guo 2009
Daxinzhuang	Jinan City, Shandong Province	archaeological excavation	Shang	*c*. 3600–3000	feature of the cultural remains in the site	Chen & Fang 2008
Yuhuicun	Bengbu City, Anhui Province	archaeological excavation	Longshan	*c*. 4300–4140	radiocarbon dating results of other materials	Yin 2013
Xijincheng	Bo'ai County, Henan Province	archaeological excavation	Longshan	*c*. 4300-3800	feature of the cultural remains in the site	Chen *et al*. 2010
Wangchenggang	Dengfeng County, Henan Province	archaeological excavation	Late Erlitou	*c*. 3640–3520	radiocarbon dating results of other materials	Zhao & Fang 2007
Wadian	Yuzhou City, Henan Province	archaeological excavation	Longshan	*c*. 4260–4150	radiocarbon dating results of other materials	Liu & Fang 2010
Baligang	Dengzhou City, Henan Province	archaeological excavation	Late Longshan	*c*. 4300–3800	feature of the cultural remains in the site	Deng & Gao 2012
Xinzhai	Xinmi City, Henan Province	archaeological excavation	Xinzhai Phase	*c*. 3910–3830	radiocarbon dating results of other materials	Zhao 2011
Erlitou	Yanshi City, Henan Province	archaeological excavation	Phase IV of Erlitou	*c*. 3510–3480	radiocarbon dating results of other materials	Zhao 2015
Zhouyuan	Fufeng City, Shaanxi Province	archaeological excavation	Pre-Zhou	*c*. 3080–2870	radiocarbon dating results of other materials	Zhao & Xu 2004
Xishanping	Tianshui City, Gansu Province	Profile sampling in environmental survey	–	*c*. 4650	presumption of deposition rate of sediments of profile	Li *et al*. 2007
Fengtai	Huzhu County, Qinghai Province	archaeological excavation	Kayue	*c*. 3200–2800	feature of the cultural remains in the site and radiocarbon dating results of other materials	Zhao 2004

New archaeobotanical data

Flotation is currently the most effective way to obtain ancient plant remains from archaeological excavations. Since the beginning of this century, flotation has been vigorously promoted and popularized in Chinese archaeology, making it much easier to find ancient plant remains in the process of excavation. It has now been used at hundreds of archaeological sites, resulting in the discovery of a large number of charred

Table 17.3. *Directly dated early wheat remains.*

Site	Location	Acquisition methods of wheat remains	Calibrated results of ^{14}C dates (cal. BP)	Dating materials	Laboratory/ method	References
Zhaojiazhuang	Jiaozhou County, Shandong Province	archaeological excavation	4411–4158	wheat grains	Peking University/ AMS	Jin *et al*. 2008
Dinggong	Zouping County, Shandong Province	archaeological excavation	4150–3929	wheat grains	Poznan University/ AMS	Long *et al*. 2018
Dinggong	Zouping County, Shandong Province	archaeological excavation	4143–3903	wheat grains	Poznan University/ AMS	Long *et al*. 2018
Huoshiliang	Jinta County, Gansu Province	profile sampling on cultural layer	4085–3845	wheat grains	Oxford/AMS	Dodson *et al*. 2013
Ganggangwa	Jinta County, Gansu Province	profile sampling on cultural layer	3976–3709	wheat grains	Oxford/AMS	Dong *et al*. 2014
Donghuishan	Minle County, Gansu Province	profile sampling on cultural layer	3829–3488	wheat grains	Oxford/AMS	Dodson *et al*. 2013
Donghuishan	Minle County, Gansu Province	profile sampling on cultural layer	3573–3402	wheat grains	Peking University/ AMS	Flad *et al*. 2010
Jinchankou	Datong County, Qinghai Province	archaeological excavation	3980–3720	wheat grains	Beta/加速器	Dong *et al*. 2014
Aiqingya	Gangcha County, Qinghai Province	profile sampling on cultural layer	3406±49	wheat grains	Beta/加速器	Chen *et al*. 2015
Xiariyamakebu	Dulan County, Qinghai Province	profile sampling on cultural layer	3316±69	wheat grains	Peking University/ AMS	Chen *et al*. 2015
Shuangerdongping	Ledu County, Qinghai Province	profile sampling on cultural layer	3251±88	wheat grains	Peking University/ AMS	Chen *et al*. 2015
Xiaohe Tombs	Lop Nor, Xinjiang Uyghur Autonomous Region	archaeological excavation	3640–3370	wheat grains, millet grains and tips of animals' ears	Peking University/ AMS	Xinjiang Institute of Cultural Relics & Archaeology 2007
Xintala	Heshuo County, Xinjiang Uyghur Autonomous Region	profile sampling in environmental survey	3677–3830	wheat grains	Oxford/AMS	Zhao *et al*. 2012

plant remains of great value to Chinese archaeological research (Zhao 2014). These plant remains also include ancient wheat, providing new evidence with which the introduction of wheat into China can be explored (Zhao 2009).

According to incomplete statistics, there have been dozens of cases of discoveries of early wheat remains reported or formally published in this century. In contrast to the findings from the previous century, the remains of wheat discovered in this century have three distinctive characteristics. First, instead of being found by chance, they have been mostly acquired deliberately through flotation or sieving during archaeological excavations or field investigations. Second, some geologists and biologists have participated in this process and in research on these early wheat remains. Finally, with increasingly advanced radiocarbon dating technology, especially improvements in the AMS dating technique, a single grain of wheat now qualifies as a dating sample (see Liu *et al*. 2016, for a review of direct wheat dates). In addition, thanks to China's growing economy, adequate research funds have meant that such samples can be tested by radiocarbon laboratories at home and abroad, resulting in a stream of relatively accurate dating data.

These early wheat remains have been acquired in two different ways. Some have been discovered in deposits at archaeological sites through standard excavation. These remains usually corresponded to specific cultural layers, though highly specific dating of them is absent in most cases. The relative age of the wheat is basically calculated based on the cultural features of the site or on the dating of other samples excavated from the same layers, such as charcoal, animal bones, fur and even bulk samples. On the other hand, some have been acquired from profile sediments or cultural deposits through environmental observation or archaeological investigation. Although these remains may not be clearly located in archaeologically attested cultural contexts, they mostly have reliable dating data gained from direct AMS dating.

According to the statistics in Table 17.2, with the exception of those found at Xishanping in Gansu Province, early wheat remains with only relative dating were all obtained through standard archaeological excavation. Based on their relative age determined by cultural periodization, the earliest date from the Longshan period, from 4300 to 3800 years ago, while some belong to the Erlitou culture, from 3800 to 3500 years ago. According to the statistics in Table 17.3, those early wheat remains with direct dating data were obtained through both archaeological excavation and profile sampling during investigation (Chen *et al*. 2015). With the exception of those from Zhaojiazhuang site and Dinggong site in Shandong Province, the samples tested by AMS dating all come from no earlier than 4000 years ago. Among these two sets of statistics, Xishanping, Zhaojiazhuang and Dinggong are special cases and deserve further analysis.

Although the wheat remains from Xishanping in Gansu Province were gained from sediment profiles through environmental observation, the age of the wheat was based on speculation due to the lack of direct AMS dating of the grains unearthed. According to the original report:

> Twenty samples with the thickness of 10–15 cm and weighing approximately 80 kg were acquired from a 650-cm-thick sedimentary section. Various archaeological remains were then extracted through sieving and flotation. Wheat was detected in the top profile of the eight samples, with an earliest date of 4650 cal. BP. (Li *et al*. 2007)

After being published, the report immediately attracted wide attention due to the relatively early dating, and has been cited as data relating to the earliest wheat in China in many relevant papers.

However, the question remains concerning how the date 4650 cal. BP was obtained, and how accurate and reliable it is. Tables in the original report offered eight radiocarbon dating results in which the date of 4650 cal. BP was not included. The eight dated samples mainly consisted of charcoal (six samples), a rice grain and a millet grain (*Setaria italica*), but these samples contained no wheat grains. Clearly, no AMS dating was carried out on any unearthed wheat in this research, and thus the date of the wheat found at Xishanping must have been calculated based on the relative age of the layer from which it was discovered. In which layer, then, was the wheat actually found? What was the basis of the determination of the layer's age? The eight sets of age data in the report all corresponded to the layer depth of the sedimentary sections, yet, other than recording that wheat was discovered in the top eight samples, the report does not refer to the layer depth in which it was found, making it impossible to identify the age.

The only information of reference value in the report is the relative dates in the pollen spectrum, which was calculated based on deposition rate of sediments. The period between the two relative dates of 4600 and 4500 corresponded to the layer depth of 200 cm, which was roughly the position where the 'top eight samples' with wheat were unearthed. Thus, the date of the wheat remains unearthed at Xishanping was calculated based on the depth of the sedimentary section, the dates of which were determined by the deposition rate of the corresponding section. Clearly, due to this lack of credibility, the relative dating obtained through this method could only serve as a reference, rather than as firm data for the earliest wheat in China.

In contrast, the wheat remains unearthed at Zhaojiazhuang and Dinggong in Shandong Province were acquired from archaeological excavation, and have provided data based on direct age dating. According to the original report (Jin *et al*. 2008; Long *et al*. 2018), both Zhaojiazhuang and Dinggong included cultural deposits from the Dawenkou and Longshan periods. By means of the application of flotation during the archaeological excavations, rich charred plant remains were obtained that include wheat grains from both sites. After analysis using the AMS dating method, the conventional radiocarbon age of the wheat grains from the Zhaojiazhuang site was determined to be 3905±50 BP (Jin *et al*. 2008), and the calibrated result was 4411–4158 cal. BP. There are two radiocarbon dates of wheat grains from the Dinggong sites (Long *et al*. 2018). One is 3705±35 BP (4150–3929 cal. BP); the other is 3680±35 BP (4143–3903 cal. BP). Therefore, combining both the clear archaeological cultural background and accurate dating data, the wheat remains from Zhaojiazhuang and Dinggong are highly credible and of great research value.

In summary, based on analysis of the ages of early wheat remains unearthed from over 30 archaeological sites listed in Tables 17.1 to 17.3, wheat had already been introduced into China by 4000 years ago, and was widely planted in northern China. According to the dates of the wheat remains from Zhaojiazhuang

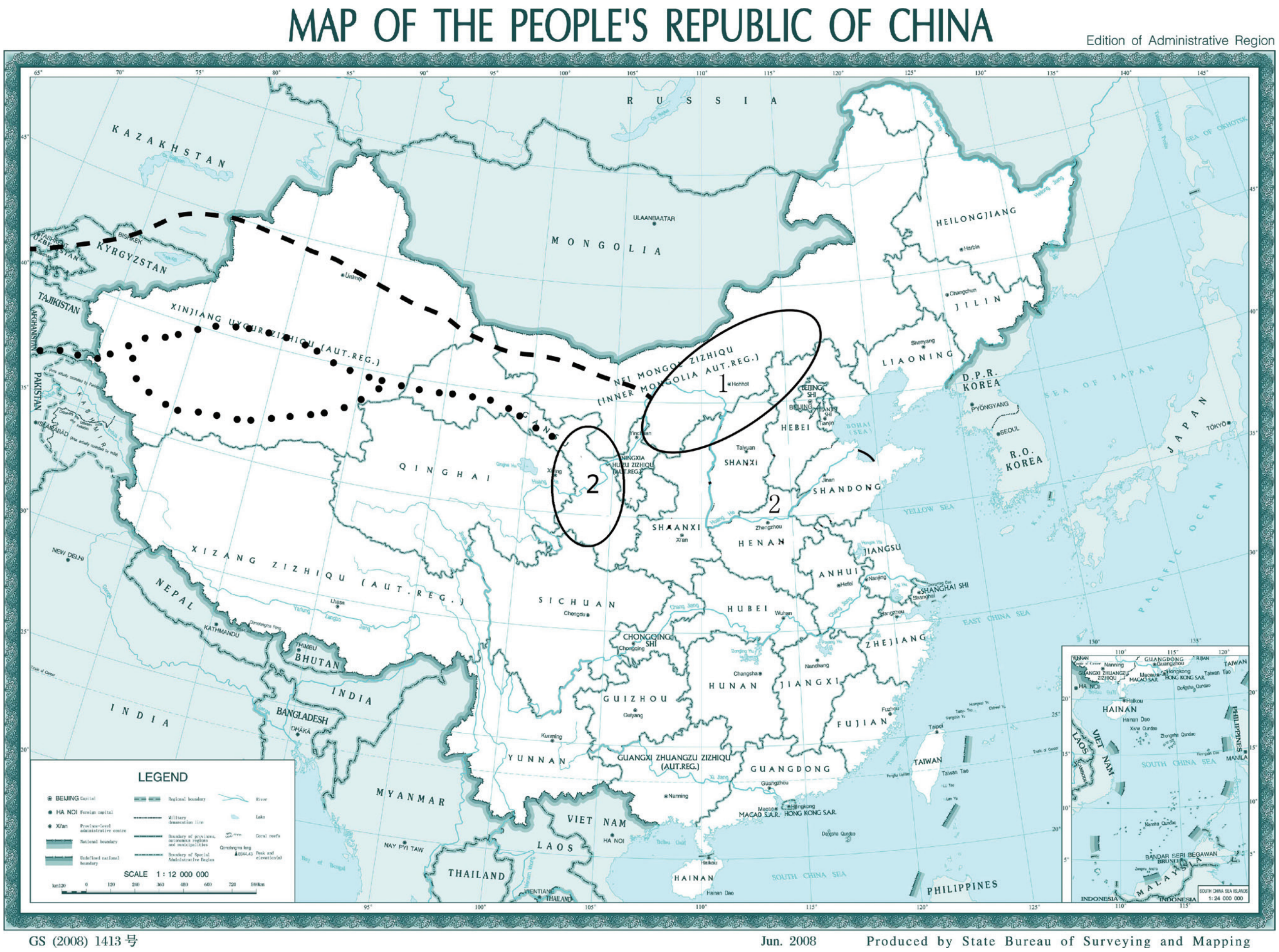

Figure 17.1. *The potential routes for the spread of wheat into China: (1) Northern Cultural Zone; (2) The western part of the Loess Plateau. The dashed line indicates the Steppe Route and the dotted line indicates the Oasis Route.*

and Dinggong sites in Shandong Proivince, it is likely that wheat entered China as early as a time period between 4500 and 4000 BP.

Multiple routes for the introduction of wheat

As stated above, there are more than 30 archaeological sites in China that contain wheat remains of an early period, that is, over 3000 years ago. These sites are mainly distributed along a belt of terrain stretching for several thousand kilometres from the Tianshan Mountains in the west to the Shandong Peninsula in the east. This belt is located at approximately 34–46°N latitude (Figure 17.1). According to the features of its ecological environment and the archaeological division of cultural regions, it included three regions: from east to west, the Haidai Region, Central China Region and Northwest Region.

The Haidai Region refers to the areas where the Dawenkou culture (*c*. 6000–4300 BP) and Haidai-Longshan cultures (*c*. 4300–3800 BP) of the Neolithic period and the Yueshi culture (*c*. 3800–3600 BP) of the Bronze Age flourished. It basically embraces today's Shandong Province and northern parts of Anhui Province and Jiangsu Province (Luan 1997). Archaeological sites within the Haidai Region include: Zhaojiazhuang in Jiaozhou (Jin *et al*. 2008); Dinggong in Zouping (Long *et al*. 2018); Liangchengzhen in Rizhao (Crawford 2004); Jiaochangpu in Liaocheng (Zhao 2004); Zhaogezhuang in Yantai (Jin *et al*. 2010); Ma'an in Zhangqiu (Chen & Guo 2009); and Daxinzhuang in Jinan (Chen & Fang 2008), all located in Shandong Province, and Yuhuicun in Bengbu (Yin 2013), located in Anhui Province. The importance of the wheat remains found at Zhaojiazhuang and Dinggong has already been stated. The findings from Liangchengzhen, Jiaochangpu and Yuhuicun also deserve proper attention, because charred wheat grains have been found at all three sites belonging to the Longshan culture (*c*. 4300–3800 BP), although no direct dating data has been published.

The Central China Region refers to the Zhongyuan-Longshan culture of the Neolithic period and the Erlitou culture of the Bronze Age in the middle Yellow River area, which is the core area for the formation of Chinese civilization. This region generally covers today's Henan Province and the southern parts of Shanxi Province and Hebei Province. Archaeological sites in the region where early wheat remains have been unearthed using flotation in recent years include: Wangchenggang in Dengfeng (Zhao & Fang 2007); Xijincheng in Bo'ai County (Chen *et al*. 2010); Wadian in Yuzhou (Liu & Fang 2010); Baligang in Dengzhou (Deng & Gao 2012); Xinzhai in Xinmi (Zhao 2011); and Erlitou in Yanshi (Zhao 2015), all located in Henan Province. The most noteworthy of these sites are Xijincheng, Wadian and Baligang, because charred wheat grains belonging to the Longshan culture (*c*. 4300–3800 BP) have been excavated at these three sites. The wheat remains found at the Wadian site were delivered to a radiocarbon dating laboratory for dating, as yet without satisfactory results. The tests indicated that the date of the wheat was evidently later than the Longshan period, and further analysis and verification are required.

The Northwest Region covers a vast territory of complex geographical units, involving the upper Yellow River area, the Hexi Corridor and most parts of Xinjiang region. Wheat remains from an early period found in the Northwest Region have been obtained mainly through environmental and archaeological investigation, and most of them have direct dating data. The sites in which these wheat remains have been unearthed are mainly distributed across three areas, that is, the eastern part of Qinghai Province, the Hexi Corridor in Gansu Province and the eastern part of Xinjiang region; their chronology falls between 4000 to 3500 years ago. Important sites here include Jinchankou in Datong County of Qinghai Province (Dong *et al*. 2014), Huoshiliang and Ganggangwa in Jinta County of Gansu Province (Dodson *et al*. 2013). The direct dating data for the charred wheat grains found at these three sites reaches or approaches 4000 BP, the earliest absolute chronological data obtained so far, besides Zhaojiazhuang and Dinggong in Shandong Province.

Wheat was introduced to China from West Asia through Central Asia. Therefore, the Northwest Region seems to be most closely related to the route along which wheat came to China. Correspondingly, in historical times, especially since West Han Dynasty (202 BC–AD 8), the major channel of cultural exchange between East and West was the so-called Silk Road, and the Hexi Corridor was a key section of this route. In addition, the Northwest Region is where early wheat remains have been most commonly found, which easily leads to the conclusion that wheat was brought to China by that route. Therefore, it seems that wheat spread from Central Asia, crossed the Oasis Route along the northern and southern sides of Tarim Basin in southern Xinjiang region, passed down the Hexi Corridor and the Wei River valley to the Central China Region, and finally arrived in the Haidai Region.

However, the distribution of archaeological sites in which early wheat remains around 4000 years old have been unearthed does not show a west-to-east spreading pattern, since they have been found in all three regions: the Northwest Region in the west, Central China Region in the middle and the Haidai Region in the east. Moreover, the earliest wheat remains of highest reliability found so far were unearthed at the Zhaojiazhuang and Dinggong sites, which are located in the Shandong Peninsula, right at the eastern end of this belt of terrain. Therefore, whether wheat simply followed the route of the Silk Road to China from the west requires rethinking.

In fact, the Silk Road was not the only channel for exchange between the cultures of the East and West in ancient times. There were other routes at different times, such as the Maritime Silk Road, the Southern Silk Road and the Eurasian Steppe Route. The latter is an ancient route that stretches along the Eurasian Steppe, linking East and West. The channel extends from the Greater Khingan Mountains in Northeast Asia to the Carpathian Mountains in Central Europe, passing through the Mongolian Plateau, south Siberia, Central Asia and the northern part of Western Asia to Central Europe. This Eurasian Steppe Route, the main part of which is vast, flat prairie presenting no difficulties in overcoming natural barriers, serves as a natural corridor linking the cultures of East and West.

As mentioned earlier, wheat reached Central Asia about 7000 years ago and continued spreading eastwards to East Asia, including China. Therefore, the starting point for this propagation of wheat should be Central Asia. The region that connects to Central Asia is the eastern part of the Eurasian Steppe, including south Siberia, the Sayan-Altai-Tianshan Region and the Mongolian Plateau. Archaeological discoveries have verified that by 5600 to 3400 years ago, several early cultures of the Bronze Age were widely distributed across the eastern part of Eurasian Steppe, such as the Afanasevo, Okunyev, Chemurchek, Seima-Turbino and Andronovo cultures (Lin 2014; Table 17.4). These Bronze Age cultures scattered over the vast steppes may not have been successive, yet they share common cultural features, such as bronze accessories with animal designs and bronze daggers, and a mixed type of economic production and lifestyle combining

Table 17.4. *List of archaeological cultures in the Central Asian Steppe.*

<table>
<tr><th>South Siberia</th><th>Sayan-Altai</th><th>Altai-Tianshan</th></tr>
<tr><td>Afanasevo Culture, c. 3600–2500 BC</td><td>Afanasevo Culture, c. 3600–2500 BC</td><td>Afanasevo Culture, c. 3600–2500 BC</td></tr>
<tr><td rowspan="2">Okunyev Culture, c. 2100–1800 BC</td><td>Chemurchek Culture, c. 2500–2100 BC</td><td>Chemurchek Culture, c. 2500–2100 BC</td></tr>
<tr><td rowspan="2">Seima-Turbino Culture, c. 2200–1700 BC</td><td>Okunyev Culture, c. 2100–1800 BC</td></tr>
<tr><td>Seima-Turbino Culture, c. 1800–1700 BC</td><td>Seima-Turbino Culture, c. 1800–1700 BC</td></tr>
<tr><td>Andronovo Culture, c. 1600–1400 BC</td><td>Andronovo Culture, c. 1600–1400 BC</td><td>Andronovo Culture, c. 1600–1400 BC</td></tr>
</table>

animal husbandry and farming. This shows that these early bronze cultures interacted closely, making possible cultural exchanges on the Eurasian Steppe and ensuring smooth communication between cultures of East and West.

During about the same period, namely 5000 to 3000 years ago, archaeology has revealed a special complex of cultures in northern China (Su & Yin 1981) known as the Northern Cultural Zone (Yang 2004) or Northern Zone (Watson 1971). The scope of this zone varies at different times, but basically it is a strip from northeast to southwest around the line where the Great Wall now runs, including the south and north of the Yanshan Mountains, the north of Shanxi Province, the southern part of Inner Mongolia, the north of Shaanxi Province and the Hetao area. What is noteworthy is that the Northern Cultural Zone falls exactly at the ecologically sensitive zone, called ecotone, of the transition from the semi-arid zone to arid zone in northern China. This zone is suitable for both agriculture and animal husbandry. In other words, the Northern Cultural Zone in archaeology coincides with the ecotone between agriculture and animal husbandry.

The Northern Cultural Zone is sandwiched in between the Bronze Age cultures on the steppes and the agricultural cultures around the middle and lower reaches of the Yellow River. Thus the zone, apart from the cultural features peculiar to it, such as large earthen pots with snake design (west) and pottery with decorative patterns of the Chinese character 'zhi' (之) (east), also possessed characteristics of Early Bronze Age cultures on the steppes, such as bronze daggers, bronze accessories with animal designs and horn-shaped eared cups, as well as features of ancient cultures around the middle and lower reaches of the Yellow River, such as painted and corded pottery.

Lin Yun notes that many typical bronze wares of the Early Bronze Age cultures on the Eurasian Steppe first arrived in the Northern Cultural Zone in China, and then spread to the middle and lower Yellow River areas. For example, bronze daggers, tube-holed axes and bow-shaped tools, artefacts typical of the Northern Cultural Zone, unearthed from Shang Dynasty sites, can be traced back to the Bronze Age cultures on the Eurasian Steppe (Lin 1987). Hence, it can be seen that the Northern Cultural Zone played an important role as a medium for cultural communications between the Early Bronze Age cultures on the Eurasian Steppe and ancient cultures in the region of the middle and lower reaches of the Yellow River.

In summary, the most likely way that wheat spread to China is the Eurasian Steppe Route; about 7000 years ago, wheat was brought to Central Asia from West Asia and spread gradually eastwards, becoming the staple crop of early agricultural production in river valleys in Central Asia. Around 5000 years ago, wheat cultivation was adopted by the Early Bronze Age cultures in the eastern part of the Eurasian Steppe, which were characterized by a mixed production pattern of animal husbandry and farming, with wheat as one of the crop varieties. Due to frequent contact between these Early Bronze Age cultures on the steppe, wheat quickly spread eastwards, through the Sayan-Altai-Tianshan Region to the Mongolian Plateau, where it was adopted by the Northern Cultural Zone in the south of the plateau. Since the connection between the Northern Cultural Zone and ancient cultures around the middle and lower reaches of the Yellow River is longitudinal, the direction of the spread of wheat took a turn south, and reached the middle and lower Yellow River areas along multiple river valleys, such as those of the Luan River, Sanggan River/Yongding River and Yellow River on both sides of the Hetao area. It is significant to note that this route is driven by cultural factors rather than population migration.

Early cultures of the East and West communicated in a variety of ways, and the routes along which wheat travelled to China were not limited to the Eurasian Steppe Route. As mentioned early, wheat remains around 4000 years old were found at several sites near the Hexi Corridor in Gansu Province, such as the Huoshiliang site and Ganggangwa site in Jinta County, which means early wheat appeared in the Northwest Region through the Oasis Route at the same time as it did in the Northern Cultural Zone through the Steppe Route. This means that it left Central Asia, crossed Pamir to the Tarim Basin, followed the Oasis Route on the northern and southern extremes of the Taklimakan Desert, and passed down the Hexi Corridor to the Loess Plateau. This Oasis Route is basically the same as the famous Silk Road of later history.

However, recent archaeological findings reveal that the Loess Plateau might be the destination of the eastward spread of wheat through the Oasis Route, that is, wheat entering China through the Oasis Route was likely to stop in the western part of the Loess Plateau after passing down the Hexi Corridor. For example, no evidence of early wheat dated to before 3000 years ago has been found in the Guanzhong Plain of Shaanxi Province, which is located between the Northwest Region and the middle and lower reaches of the Yellow River, although archaeological work is well developed in this area. Moreover, the early wheat remains found through archaeological excavations in Northwest Region are often accompanied by barley remains, and in some cases the barley remains are even more abundant than wheat remains in the assemblages of plant remains recovered. However, no barley remains dated before 3000 years ago have been found in the middle and lower Yellow River area. It has been proposed that the introductions of wheat and barley into central China might be distinct in both time and space (Liu *et al*. 2017). This evidence might suggest that wheat introduced into China through the Oasis Route reached only the western part of the Loess Plateau, and did not continue to spread eastward to the middle and lower Yellow River area, the core area of ancient Chinese civilization.

Conclusion

I met Martin Jones for the first time in 2004 in Beijing. That was about the time when application of the flotation technique in China had just taken off. During the last 15 years or so, flotation programmes have fundamentally transformed our understanding of early agricultures of this country, with a growing mass of archaeobotanical data, including substantial number of wheat remains recovered. According to statistics, there are over 30 archaeological sites where early wheat remains have been discovered. The application of AMS dating on such unearthed wheat grains has provided reliable data to explore the time when wheat entered into China. Following comprehensive analysis of excavated early wheat remains, the conclusion is that wheat had already been introduced into China no later than 4000 years ago.

Wheat entered China by more than one route. Analysis of the distribution of archaeological sites where early wheat remains have been found indicates that early wheat in the middle and lower reaches of the Yellow River and in Northwest Region may have been introduced by two different routes: the Steppe Route and the Oasis Route. As for the former, from Central Asia, wheat entered the eastern Eurasia Steppe. With the close connection among Bronze Age cultures on the grassland, early wheat moved eastward and was adopted in the Northern Cultural Zone in China after being introduced into the Mongolian Plateau. Finally, wheat was spread into the middle and lower reaches of the Yellow River along river valleys. As for the Oasis Route, from Central Asia, wheat crossed the Pamir Mountains and entered the Tarim Basin. From there it passed along the oases on the northern and southern extremes of the Taklimakan Desert, finally reaching the Loess Plateau through the Hexi Corridor. Note that the Oasis Route for the spread of wheat ended in the western part of the Loess Plateau.

These spreading routes and means are only hypothetical, as archaeological materials are still insufficient to be absolutely conclusive. Early wheat remains have not yet been discovered in the Northern Cultural Zone in China or the eastern foot of the Pamir Mountains, something that requires further great efforts in archaeology, especially in archaeobotany. In the past decade, Martin Jones has played an important role in contextualizing the archaeobotanical data from East Asia in a global framework, often in an inquisitive manner of building hypotheses and asking new questions. For these years, he has been working closely with Chinese archaeobotanists and contributing significantly to the recent flourishing.

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