[Supplementary material]

The Beixin Culture: archaeobotanical evidence for a population dispersal of Neolithic hunter-gatherer-cultivators in northern China

Guiyun Jin^{1,*}, Songtao Chen², Hui Li³, Xianjun Fan^{2,4}, Aiguo Yang³ & Steven Mithen^{5,*}

¹ Institute of Cultural Heritage, Shandong University, P.R. China

² School of History and Culture, Shandong University, P.R. China

³ Tengzhou Han Dynasty Carved Stone Museum, P.R. China

⁴ Hunan Provincial Institute of Cultural Relics and Archaeology, P.R. China

⁵ Department of Archaeology, University of Reading, UK

* Authors for correspondence: 🖾 gyjin@sdu.edu.cn & s.j.mithen@reading.ac.uk

Recovery methods

The flotation samples averaged 10–20 litres in volume, resulting in a total of 373.5 litres of sediments undergoing bucket flotation at the site. Plant remains were collected using a 0.3mm mesh and dried on site. Each sample was weighed, screened through a 1.0mm and a 0.7mm sieve, and sorted under a binocular stereomicroscope. In most samples, the residues smaller than 0.3mm were not sorted, as preliminary evaluation showed no seeds and fruits were found in these fractions. Charred seeds, fruits and other parts of plants were separated from charcoal, then identified and photographed under Nikon SMZ 1500 microscope with reference to modern comparative collections, Chinese seed atlases (The Editorial Committee 1990) and archaeobotany texts (Liu *et al.* 2008).

Table S1. Plant remains from Guanqiaocunnan.

	Scientific name	Number	Percentage (n=4530)	Samples with plant	Ubiquity (n=38)
Cultigens					
Broomcorn millet	Panicum miliaceum	2944	64.99	36	94.74
Foxtail millet	Setaria italica	1154	25.47	29	76.32
Rice	Oryza sativa	42	0.93	17	44.74
Weedy plants					
Aster family	Asteraceae				
	Siegesbeckia pubescens	1	0.02	1	2.63
Rough cocklebur Xanthium strumarium		7	0.16	3	7.89
Cannabaceae family	Cannabaceae				
	Galium aparine	1	0.02	1	2.63
Caprifoliaceae family	Caprifoliaceae				
	Sambucus williamsii	7	0.16	3	7.89
Goosefoot family	Chenopodiaceae				
	Kochia scoparia	2	0.04	2	5.26
Bean family	Fabaceae				
Soybean	Glycine soja	82	1.81	19	50.00
	Lespedeza bicolor	2	0.04	2	5.26
	Melilotus officinalis	4	0.09	1	2.63

	Scientific name	Number	Percentage (n=4530)	Samples with plant	Ubiquity (n=38)
Mint family	Lamiaceae				
Perilla Perilla frutescens		21	0.46	10	26.32
Grass family	Poaceae				
Crabgrass	Digitaria sp.	11	0.24	10	26.32
Barnyard grass	Echinochloa sp.	9	0.20	9	23.68
Foxtail	Setaria viridis	23	0.51	8	21.05
Knotweed family	Polygonaceae				
Pale smartweed	Polygonum lapathifolium	1	0.02	1	2.63
Tomato family	Solanaceae				
Chinese lantern	Physalis alkekengi	5	0.11	2	5.26
Water plants					
Nymphaeaceae family	Nymphaeaceae				
Gorgon fruit	Euryale ferox	14	0.31	2	5.24
Lythraceae family	Lythraceae				
Water chestnut	<i>Trapa</i> sp.	7	0.16	1	2.63
Fleshy fruit and nuts					
Betulaceae family	Betulaceae				
hazel	Corylus sp.	7	0.16	4	10.53

	Scientific name	Number	Percentage (n=4530)	Samples with plant	Ubiquity (n=38)
Fagaceae family	Fagaceae				
oaks	Quercus sp.	91	2.01	10	26.32
Rosaceae family	Rosaceae				
prunus	Cerasus japonica	25	0.55	3	7.89
Taxodiaceae	Taxodiaceae	20	0.44	1	2.63
Vitaceae	Vitaceae				
Cayratis	Cayratia sp.	1	0.02	1	2.63
Grape	Vitis sp.	5	0.11	2	5.26
Fragments of nuts		32	0.71	9	23.68
Unidentifiable		10	0.22	4	10.53
Total seeds		4258			

Table S2. Radiocarbon dates on charred cereal remains from Guanqiaocunnan site(OxCal v4.2.4 (Bronk Ramsey (2013), using the IntCal13 calibration curve (Reimer *et al.* 2013)).

Lab	Madanial	TT *4	Radiocarbon	Calibra	Calibrated date	
Reference	Material	Unit	date (BP)	1σ (68.2%)	2σ (95.4%)	
BA160669	11 charred broomcorn millet grains	GQCNH3(1)	5430 ± 25	4334–4317 BC (21.0%) 4298–4263 BC (47.2%)	4340–4247 BC (95.4%)	
BA160670	11 charred broomcorn millet grains	GQCNH3(2)	5400 ± 25	4324–4287 BC (42.6%) 4269–4245 BC (25.6%)	4334–4232 BC (94.2%) 4188–4181 BC (1.2%)	
BA160671	One charred rice grain	GQCNH7(1)	5335 ± 30	4239–4224 BC (8.2%) 4207–4161 BC (27.4%) 4131–4071 BC (32.7%)	4260–4050 BC (95.4%)	
BA160672	11 charred foxtail millet grains	GQCNH7(2)	5290 ± 35	4227–4201 BC (13.9%) 4169–4127 BC (22.6%) 4121–4092 BC (14.0%) 4080–4046 BC (17.7%)	4235–4038 BC (91.3%) 4018–3999 BC (4.1%)	

BA160673 I 1 charred foxtail millet grains GQCNH7(3) 5270 ± 30 4225-4205BC (12.0%) 4164 4130 BC (21.6%) 4112-4102 BC (4.7%) 4112-4102 BC (4.7%) 4016-4000 BC (21.6%) 4016-4000 BC (21.6%) 4016-4000 BC (21.6%) 4016-4000 BC (21.6%) 4016-4000 BC (21.6%) 4016-4000 BC (8.3%) 4224 4207 BC (3.0%) 4161-4131 BC (6.4%) 4071-3971 BC (8.2%) 4046-3990 BC (6.82%) 4046-3990 BC (6.82%) 4071-3971 BC (8.2%) 4071-3971 BC (8.1%) BA160675 Three fragments of charred rice grains GQCNH5(2) 5335 ± 30 4239-4224 BC (8.2%) 4131BC-4071BC (32.7%) 4260BC-4050 BC (95.4%) BA160676 Three fragments of charred rice grains GQCNH5(2) 5335 ± 30 4227 4200 BC (15.4%) 4131BC-4071BC (32.7%) 4223-4048 BC (95.4%) BA160676 Three fragments of charred rice grains GQCNH5(3) 5305 ± 25 4227 74200 BC (11.9%) 4233-4048 BC (95.4%) BA160676 Fragments of charred rice grains GQCNH5(3) 5305 ± 25 4227 74200 BC (11.9%) 4233-4048 BC (95.4%)					4005 4005D C	[]
BA160673 11 charred foxtail millet grains 6QCNH7(3) 5270 ± 30 4164-4130 BC (21.6%) 4231-4194 BC (16.0%) BA160673 foxtail millet grains 6QCNH7(3) 5270 ± 30 4164-4130 BC (21.6%) 4231-4194 BC (16.0%) BA160674 foxtail millet grains 6QCNH7(3) 5270 ± 30 4073-4040 BC (21.6%) (79.4%) BA160674 Two fragments of charred rice grains 6QCNH5(1) 5235 ± 25 4046-3990 BC (68.2%) 4224-4207 BC (3.0%) BA160675 Thrce fragments of charred rice grains 6QCNH5(2) 5335 ± 30 4239-4224 BC (82.%) 4046-3990 BC (82.%) 4260BC-4050 BC (95.4%) BA160675 Thrce fragments of charred rice grains 6QCNH5(2) 5335 ± 30 4229-4224 BC (27.4%) 4260BC-4050 BC (95.4%) BA160676 Thrce fragments of charred rice grains 6QCNH5(3) 5335 ± 30 4227-4200 BC (15.4%) 42433-4048 BC (95.4%) BA160676 Three fragments of charred rice grains 6QCNH5(3) 5305 ± 25 4227.4200 BC (15.4%) 4233-4048 BC (95.4%)						
BA160673 11 charred foxtail millet grains GQCNH7(3) 5270 ± 30 (21.6%) 4112-4102 BC (4.7%) 4231-4194 BC (16.0%) 4176-3990 BC (21.6%) BA160674 Two fragments of charred rice grains GQCNH5(1) 5235 ± 25 4046-3990 BC (68.2%) 4224-4207 BC (3.0%) BA160675 Three fragments of charred rice grains GQCNH5(2) 5235 ± 25 4046-3990 BC (68.2%) 4224-4207 BC (3.0%) BA160676 Three fragments of charred rice grains GQCNH5(2) 5235 ± 25 4046-3990 BC (68.2%) 4260BC-4050 BC (64.4%) BA160676 Three fragments of charred rice grains GQCNH5(2) 5335 ± 30 4239-4224 BC (32.7%) 4260BC-4050 BC (95.4%) BA160676 Three fragments of charred rice grains GQCNH5(2) 5335 ± 30 4227-4200 BC (15.4%) 4260BC-4050 BC (95.4%) BA160676 Three fragments of charred rice grains GQCNH5(3) 5305 ± 25 4169-4148 BC (11.9%) 4233-4048 BC (95.4%) BA160676 Fragments of charred rice grains GQCNH5(3) 5305 ± 25 4169-4148 BC (11.9%) 4233-4048 BC (95.4%)						
$ \begin{array}{ c c c c c c c } & 11 \ charred \\ foxtail millet \\ grains & GQCNH7(3) \\ & 5270 \pm 30 \\ & 4112 \ 4102 \ BC \\ & (4.7\%) \\ & 4073 \ 4040 \ BC \\ & (21.6\%) \\ & 4016 \ 4000 \ BC \\ & (21.6\%) \\ & 4016 \ 4000 \ BC \\ & (8.3\%) \\ & 4016 \ 4000 \ BC \\ & (8.3\%) \\ & 4016 \ 4000 \ BC \\ & (8.3\%) \\ & 4046 \ 3990 \ BC \\ & (6.4\%) \\ & 4011 \ 4131 \ BC \\ & (6.4\%) \\ & 4011 \ 4131 \ BC \\ & (6.4\%) \\ & 4011 \ 4131 \ BC \\ & (6.4\%) \\ & 4011 \ 4131 \ BC \\ & (6.4\%) \\ & 4011 \ 4131 \ BC \\ & (6.4\%) \\ & 4011 \ 4131 \ BC \\ & (6.4\%) \\ & 4011 \ 4131 \ BC \\ & (6.4\%) \\ & 4011 \ 4131 \ BC \\ & (6.4\%) \\ & 4011 \ 4131 \ BC \\ & (6.4\%) \\ & 4011 \ 4131 \ BC \\ & (6.4\%) \\ & 4011 \ 4131 \ BC \\ & (6.4\%) \\ & 4011 \ 4131 \ BC \\ & (6.4\%) \\ & 4011 \ 4131 \ BC \\ & (6.4\%) \\ & 4011 \ 4131 \ BC \\ & (6.4\%) \\ & 4011 \ 4131 \ BC \\ & (8.2\%) \\ & 4207 \ BC \ 4161 \ BC \\ & (8.2\%) \\ & 4207 \ BC \ 4161 \ BC \\ & (8.2\%) \\ & 4207 \ BC \ 4161 \ BC \\ & (8.2\%) \\ & 4207 \ BC \ 4131 \ BC \ 4131 \ BC \ 4131 \ BC \ 4131 \ BC \\ & (95.4\%) \\ & 4169 \ 4148 \ BC \\ & (11.9\%) \\ & 4169 \ 4148 \ BC \\ & (11.9\%) \\ & 4135 \ 4000 \ BC \\ & (95.4\%) \\ & 4135 \ 4000 \ BC \\ & (95.4\%) \\ & 4135 \ 4000 \ BC \\ & (95.4\%) \\ & 4135 \ 4000 \ BC \\ & (95.4\%) \\ & 4135 \ 4000 \ BC \\ & (95.4\%) \\ & 4135 \ 4000 \ BC \\ & (95.4\%) \\ & (95.4\%$					4164–4130 BC	
$ \begin{array}{c} {}^{\rm BA160673} \\ {}^{\rm BA160673} \\ {}^{\rm foxtail millet} \\ {}^{\rm grains} \end{array} \begin{array}{c} {}^{\rm GQCNH7(3)} \\ {}^{\rm S270 \pm 30} \end{array} \begin{array}{c} {}^{\rm S270 \pm 30} \\ {}^{\rm H112-4102 BC} \\ {}^{\rm H12-4102 BC} \\ {}^{\rm H176-3990 BC} \\ {}^{\rm H073-4040 BC} \\ {}^{\rm C21.6\%) \\ {}^{\rm H016-4000 BC} \\ {}^{\rm H016-4000 BC} \\ {}^{\rm H016-4101 BC} \\ {}^{\rm H016-4131 BC} \\ {}^{\rm H016-4131 BC} \\ {}^{\rm H016-4131 BC} \\ {}^{\rm H01-4131 BC} \\ {}^{\rm H01-4105 BC} \\ {}^{\rm H01-4105$		11 charred			(21.6%)	4231–4194 BC
$ \begin{array}{ c c c c c c c c c c c c c c c c c c c$	BA160673		GQCNH7③	5270 ± 30	4112–4102 BC	(16.0%)
$\begin{array}{ c c c c c c c c c c c c c c c c c c c$	DA100075			5270 ± 50	(4.7%)	4176–3990 BC
$ \begin{array}{ c c c c c c } \hline & & & & & & & & & & & & & & & & & & $		grams			4073–4040 BC	(79.4%)
$ \begin{array}{ c c c c c } \hline \begin{tabular}{ c c c c } \hline \end{tabular} \\ \hline \end{tabular} \\ \hline BA160674 \\ BA160674 \\ \hline \end{tabular} \\ \hline tabula$					(21.6%)	
$ \begin{array}{ c c c c c } \hline BA160674 & $ $ $ $ $ $ $ $ $ $ $ $ $ $ $ $ $ $ $					4016–4000 BC	
$ \begin{array}{ c c c c c c } \hline BA160674 & $ $ $ $ $ $ $ $ $ $ $ $ $ $ $ $ $ $ $					(8.3%)	
$ \begin{array}{c} \mbox{Two fragments} \\ \mbox{becomessance} \\ \mbox{BA160674} \\ \mbox{BA160674} \\ \mbox{BA160674} \\ \mbox{arred rice} \\ \mbox{grains} \\ \end{array} \begin{array}{c} \mbox{GQCNH5(1)} \\ \mbox{grains} \\ \mbox{arred rice} \\ \mbox{grains} \\ \end{array} \begin{array}{c} \mbox{GQCNH5(2)} \\ \mbox{GQCNH5(2)} \\ \mbox{signals} \\ \mbox{signals} \\ \mbox{signals} \\ \end{array} \begin{array}{c} \mbox{S235 \pm 25} \\ \mbox{signals} \\ \mb$						4224–4207 BC
$ \begin{array}{c ccccccccccccccccccccccccccccccccccc$		Transformersta	GQCNH5①			(3.0%)
$\begin{array}{ c c c c c c c c c c c c c c c c c c c$	DA1(0(74	of charred rice		5235 ± 25	4046–3990 BC	4161–4131 BC
$ \begin{array}{ c c c c c c c c } \hline & & & & & & & & & & & & & & & & & & $	BA1000/4				(68.2%)	(6.4%)
$\begin{array}{ c c c c c c c c c c c c c c c c c c c$						4071–3971 BC
BA160675 Three fragments of charred rice grains GQCNH5(2) 5335 ± 30 (8.2%) 4260BC-4050 BC (27.4%) 4260BC-4050 BC (95.4%) BA160676 grains						(86.1%)
$ \begin{array}{c} BA160675 \\ BA160675 \\ BA160675 \\ BA160676 \\ BA1$					4239–4224 BC	
$\begin{array}{c c c c c c c c c c c c c c c c c c c $		fragments of charred rice	GQCNH5(2)	5335 ± 30	(8.2%)	
$\begin{array}{c ccccccccccccccccccccccccccccccccccc$	DA1(0(75				4207BC- 416 1BC	4260BC-4050 BC
$\begin{array}{ c c c c c c c c c c c c c c c c c c c$	BA100073				(27.4%)	(95.4%)
$\begin{array}{c ccccccccccccccccccccccccccccccccccc$					4131BC- 4071BC	
BA160676 Three (15.4%) BA160676 fragments of charred rice grains 6QCNH5(3) 5305 ± 25 (11.9%) 4233-4048 BC (95.4%) 4135-4090 BC (95.4%) (95.4%) (10.4%) (10.4%) (10.4%)					(32.7%)	
BA160676 Three fragments of charred rice grains GQCNH5(3) 5305 ± 25 4169-4148 BC (11.9%) 4233-4048 BC (95.4%) 4135-4090 BC (95.4%) (95.4%) 4081-4056 BC 4081-4056 BC					4227–4200 BC	
BA160676 fragments of charred rice grains $GQCNH5(3)$ 5305 ± 25 (11.9%) $4233-4048$ BC (95.4%) Image: GQCNH5(3) 5305 ± 25 (11.9%) $4081-4056$ BC				5305 ± 25	(15.4%)	
$\begin{array}{c c c c c c c c c c c c c c c c c c c $	BA160676	Three			4169–4148 BC	
charred rice 4135–4090 BC (95.4%) grains (26.7%) 4081–4056 BC		fragments of			(11.9%)	4233–4048 BC
4081–4056 BC		charred rice	GQCNH5(3)		4135–4090 BC	(95.4%)
		grains			(26.7%)	
(14.2%)					4081–4056 BC	
					(14.2%)	

					3493–3468 BC
				3370–3338 BC	(7.7%)
10 charred BA160677 broomcorn millet grains		QH2(3) 4575 ± 25 (8.3%)	(56.9%)	3375–3329 BC	
	QBQH2③		3207–3195 BC	(60.9%)	
			(8.3%)	3216–3180 BC	
			3148–3143BC	(14.7%)	
				(3.0%)	3159–3123 BC
					(12.1%)

References

BRONK RAMSEY, C. 2013. Oxcal 4.2 manual. Available at:

http://c14.arch.ox.ac.uk/oxcalhelp/hlp_contents.html (accessed 29 September 2020).

The Editorial Committee of Zhongguo nongtian zacao yuanse tupu. 1990. Zhongguo

nongtian zacao yuanse tupu. Beijing: Agricultural Press.

LIU, C.J., G.Y. JIN & Z.C. KONG. 2008. *Archaeobotany: study of seeds and fruits*. Beijing: Science Press (in Chinese).

REIMER, P. *et al.* 2013. IntCal13 and Marine13 radiocarbon age calibration curves 0–50 000 years cal BP. *Radiocarbon* 55: 1869–87. https://doi.org/10.2458/azu_js_rc.55.16947