Abstract

Established radiocarbon and luminescence chronologies indicate a long-term "Hoabinhian" hunter-gatherer occupation of highland northwest Thailand during the terminal Pleistocene (35,000 years ago) to mid-Holocene (5,000 years ago). Here, we reexamine this chronological sequence using new radiocarbon and luminescence analyses from Spirit Cave (*Tham Phi Man*), Steep Cliff Cave (*Tham Pha Chan*) and Banyan Valley Cave (*Tham Pung Hung*) in Mae Hong Son Province. Results indicate that hunter-gatherers exploited this tropical, high-elevation, and ecologically diverse region throughout the terminal Pleistocene, the Pleistocene-Holocene transition, and into the emergence of agricultural lifeways during the Holocene.

Introduction

The highland regions of mainland Southeast Asia are home to some of the oldest and longest records of hunter-gatherer activity. Recent studies from southern China indicate that anatomically modern humans arrived in this region by at least 50,000-45,000 years ago (Sun et al. 2021). The incoming hunter gatherers, using a lithic technocomplex known as the "Hoabinhian" (characterized by unifacially flaked river cobble stone tools, or sumatraliths; Reynolds 1990), continued to occupy the region up until several millennia ago (Forestier et al. 2013; Ji et al. 2016). While the "Hoabinhian" spans 40,000 years of hunter-gatherer activity throughout East and Southeast Asia, we lack fundamental details on variation in the foraging adaptations of its makers in both time and space (White 2011). Re-examination of "Hoabinhian" chronologies in sub-regions, such as highland northwest Thailand, are one way to increase our understanding of these adaptations, especially given that many chronologies currently in use rely on older dates.

Archaeological excavations in 1966 and 1971 at Spirit Cave, Mae Hong Son Province, northwest Thailand (Figure 1), produced several of the first Pleistocene-Holocene transition radiocarbon determinations in northwest Thailand (Gorman 1969, 1970, 1971a). Radiocarbon dates from the nearby Myanmar site of Badahlin Cave (or Padah-Lin), among others, also indicated hunter-gather activity during the transition (Thaw 1971). These radiocarbon records, all derived from caves and associated with the "Hoabinhian" technocomplex, were influential (Reynolds 1990). Finally, hunter-gatherer sites with sumatralith stone tool assemblages that lacked radiocarbon dates, such as Sai-Yok Rockshelter in western Thailand (van Heekeren and

Knuth 1967), had some temporal resolution. In the early 2000s, archaeologists obtained new radiocarbon and luminescence ages that provided further temporal context for hunter-gatherer activities in northwest Thailand (Treerayapiwat 2005; Shoocondej 2006; Marwick 2008). Chronologies from Tham Lod and Ban Rai Rockshelters suggested forager occupations extending into the late Pleistocene, over 30,000 years ago at Tham Lod, but only a sporadic Holocene occupation. Recent analyses show a similar trend: luminescence ages from Badahlin Cave indicate human occupation in the Pleistocene and radiocarbon dates from Doi Pha Kan, Thailand, date to the terminal Pleistocene (Imdirakphol et al. 2017; Schaarschmidt et al. 2019). Evidence for Holocene foragers in northwest Thailand is less well-established.

Here we reexamine the chronologies from three sites in northwest Thailand – Spirit Cave (*Tham Phi Man*), Steep Cliff Cave (*Tham Pha Chan*) and Banyan Valley Cave (*Tham Pung Hung*). We present new dates to investigate whether hunter-gatherers occupied this region of mainland Southeast Asia primarily during the terminal Pleistocene and early Holocene, or if there may also be a long-term Holocene record. Accurately dating these sites is crucial for contextualizing their hunter-gatherer records and further refining our understanding of forager adaptations in mainland Southeast Asia.

Spirit Cave, Steep Cliff Cave and Banyan Valley Cave

As part of his doctoral and post-doctoral research program at the University of Hawai'i at Mānoa, Chester Gorman excavated the sites of Spirit Cave, Steep Cliff Cave and Banyan Valley Cave (Gorman 1963-1964, 1966, 1970, 1971a, 1971b, 1972, 1973). Spirit Cave, a small, shallow site, was excavated twice, once in 1966 and again in 1971 (Figures 2 and S1). Excavation of eight units in the middle cave chamber revealed the presence of five stratigraphic layers (~1m deep in total; see Conrad 2018). Fourteen charcoal specimens collected in 1966 were submitted for radiocarbon analyses (Table 1). Conventional radiocarbon ages suggested a hunter-gatherer occupation between 11,346±560 BP-7397±320 BP. However, in the early 2000s, researchers dated organic resin coatings from two ceramic sherds recovered in surface deposits, or Layer 1 (Lampert et al. 2003, 2004). These resin assays returned relatively late Holocene ages (Table 1). Since Gorman's original date for the early sherds at the site (FSU-317: 7,397±320 BP) suggested an early Holocene appearance of ceramics in mainland Southeast Asia, the resin coating analysis suggested that the original determinations were inaccurate and that the ceramics likely dated to a much later period. This interpretation was contested on stratigraphic grounds (White 2004).

In early 1973, excavations took place at Steep Cliff Cave. Seven excavation units in this shallow rockshelter revealed a deep (~2m in total), fine-grained, loosely compacted and undifferentiated sedimentary deposit. While no stratigraphic profile drawings have been found, surviving site descriptions (Gorman 1973) and photographs (see Conrad 2018; Figures 3 and S2) suggest the presence of five loosely differentiated stratigraphic layers. Radiocarbon analysis of two charcoal specimens returned early- to mid-Holocene ages, but they are in reverse stratigraphic order (Table 1), with the older age, 7497±160 BP stratigraphically higher (in Layer 3) than the younger age, 5178±110 BP (in Layer 4). Gorman never published his final interpretations for this site (see White and Gorman 2004).

Banyan Valley Cave, a large, horizontally deep cave, was excavated periodically throughout 1972 (Gorman 1972; Figures 4 and S3). Eleven excavation units revealed a relatively shallow deposit (~1m deep in total), with internally complex stratigraphy and four identified layers. At Banyan Valley Cave, Gorman radiocarbon dated two charcoal samples and obtained six thermoluminescence measurements on ceramic sherds (Table 1). These ages were internally consistent, with no evidence of stratigraphic mixing, and indicated a mid- to late-Holocene hunter-gatherer occupation beginning at 5358±120 BP and extending until 930±80 BP. A single sherd from Layer 3 returned an approximate age of 2000 BC while a group of five sherds from higher stratigraphic contexts (likely Layers 1-3) returned approximate ages between 900-500 BC. Based on these indirect ages, rice (*Oryza* sp.) spikelets recovered from upper layers at the site – which potentially represented hunter-gatherer exploitation of wild forms (Yen 1977, 1982) – appeared to date to the late Holocene. Reanalysis of a sample of zooarchaeological materials and records from Banyan Valley Cave indicate that Gorman excavated at least seven layers (Conrad 2018). It is possible that an older hunter-gatherer record exists here. Gorman also never published on Banyan Valley Cave (see Reynolds 1992).

Approach and Methods

We obtained 27 new radiocarbon determinations and four luminescence measurements to investigate the hunter-gatherer occupation of northwest Thailand. Samples were selected from curated legacy collections housed at the Penn Museum and the University of Otago. All stratigraphic and contextual information originate from Gorman's published records and unpublished field notes, the latter of which are archived at the Institute for Southeast Asian Archaeology (ISEAA), Penn Museum.

We submitted four freshwater crab (*Indochinamon* sp.) dactyls from Spirit Cave to the University of Waikato Radiocarbon Dating Laboratory (Wk) for accelerator mass spectrometric ^{14}C dating. Twenty-two additional radiocarbon samples, including plant charcoal, mammalian bone apatite (structural carbonate), freshwater pearl mussel (*Margaritifera laosensis*) shell, and rice spikelets (*Oryza sativa*) from Steep Cliff Cave and Banyan Valley Cave were analyzed at the University of Georgia Center for Applied Isotope Studies (UGAMS; see supplemental information [Conrad et al. 2020] for background and methods).

Our analysis includes a discussion on radiocarbon offsets in freshwater crab and mussel samples given their predisposition to assimilate ancient calcium carbonate from dissolving limestone (Zhou et al. 1999; Ascough et al. 2005; Philippsen 2013; Bulbeck 2014). We calculated the freshwater reservoir correction (Culleton 2006) between *M. laosensis*, *Indochinamon* sp. and paired charcoal and bone apatite samples. The reservoir correction is the difference between samples and their pairs by layer (see Stuiver et al. 1986).

Radiocarbon determinations are analyzed and calibrated using the Bchron package in R (Parnell 2014; see Conrad et al. 2020). All radiocarbon dates are standardized to the Libby 5568-year half-life (Godwin 1962; Stuiver and Polach 1977) including all legacy dates. Calibrated age ranges (at 95.4% confidence) were obtained from OxCal v4.4.2 and the IntCal20 atmospheric radiocarbon curve (Reimer et al. 2020).

Finally, four ceramic specimens from Steep Cliff Cave (n=2) and Banyan Valley Cave (n=2) were analyzed by the Luminescence Dating Laboratory at the University of Washington (UW) for optically stimulated luminescence (OSL), thermoluminescence (TL) and infrared stimulated luminescence (IRSL) dating (see Conrad et al. 2020).

Results

Radiocarbon determinations on *Indochinamon* sp. from Spirit Cave (Layers 1, 2, 2a and 4) all date to the early Holocene (Table 2; Figure 5). However, these ages are in reverse stratigraphic order: the oldest sample, at 9839±30 BP, derives from Layer 1 while the youngest, 8551±25 BP, derives from Layer 4. On average, freshwater crab dactyls are 970 years older than their paired charcoal samples, but the importance of this offset is diminished given that the charcoal ages from Spirit Cave are in correct stratigraphic order and provide a clear chronological baseline.

Excluding Gorman's original dates, our new radiocarbon ages at Steep Cliff Cave are bracketed between 11,160±30 BP and 7460±30 BP (Table 2; Figure 6). Analysis of radiocarbon reservoir offsets in *M. laosensis* suggests that these dates are on average 1704 years older than their paired bone apatite and charcoal samples. Accounting for this offset, the earliest age at Steep Cliff Cave is 9960±30 BP. A direct bone apatite radiocarbon determination on a human bone specimen provides the youngest age for our new radiocarbon analysis at 7460±30 BP. One earlier charcoal radiocarbon date of 5178±110 obtained by Gorman is also recorded from this site. Two new luminescence ages on ceramic sherds provided dates of 6390±670 BC and AD 860±50.

Our thirteen radiocarbon determinations from Banyan Valley Cave range between 10,680±30 BP and 2850±25 BP; however, the earliest date for this site is 9270±30 BP when radiocarbon offsets are considered (Table 3; Figure 7). On average *M. laosensis* shells are 2612 years older than their paired bone apatite and charcoal dates. A direct apatite radiocarbon determination on a human bone specimen from Layer 3 returned an age of 6180±30 BP. All three rice spikelet samples, from excavation unit C8, returned ages between 280±20 and 220±20 BP. The rice was re-examined before dating, following current spikelet base identification criteria (e.g., Fuller et al 2009), and was determined to represent domesticated rice; it lacks the awn which is present in all wild rice and the earliest cultivars (Figure 8). Two luminescence ages on a ceramic sherd and ceramic pellet (or bullet – used as a projectile in a pellet bow) provided dates of 2350±230 BC and AD 450±220, respectively.

Discussion

Radiocarbon and luminescence ages obtained from Spirit Cave, Steep Cliff Cave and Banyan Valley Cave provide an important new chronological framework for understanding the lifeways of hunter-gatherers in highland mainland Southeast Asia during the terminal Pleistocene and Holocene.

Of the sites examined, Spirit Cave is the most controversial. While the original sequence was initially accepted by the academic community (Flannery 1973), ages obtained from organic resins on ceramic sherds in the early 2000s cast doubt on the accuracy of portions of the temporal sequence. The argument suggested that because radiocarbon dates from ceramic resins provided late Holocene ages, the bulk of ceramics from Spirit Cave do not date to the early Holocene and the ceramic site chronology was inaccurate (Lampert et al. 2003). This argument was challenged as fieldnotes and site records indicate that the dated sherds (different from subsurface types) were likely recovered from surface contexts and were unrelated to the original hunter-gatherer occupation and the initial appearance of ceramics in deeper layers (White 2004; see also Lampert et al. 2004).

Our new radiocarbon analyses on freshwater crab dactyls support Pleistocene-Holocene transition occupation of Spirit Cave, but not without some caveats. While our results broadly match Gorman's (1970) original sequence, they are in reverse stratigraphic order. This either indicates that the deposits at Spirit Cave are disturbed or otherwise mixed or that the provenience information for these dactyl specimens is inaccurate. Deposits at Spirit Cave are shallow, and there is evidence for prehistoric anthropogenic excavation of pits into underlying layers (Gorman 1970, 1971b). Mixing of the deposits is therefore a realistic possibility (see also Treerayapiwat 2005). However, the curation and storage of the archaeological assemblage from Spirit Cave is also relatively poor (Conrad et al. 2016; Conrad 2018). It is possible that the freshwater crab dactyls were mislabeled, or their provenience information mismatched, during curation.

Whichever process is to blame, our dates clearly support Pleistocene-Holocene transition hunter-gatherer occupation of Spirit Cave. We also argue that the ceramic resin dates are analytically accurate but are representative of much later Holocene human re-use of this site by agricultural societies (i.e., Log Coffin culture). While we were unable to locate, and therefore directly date (using OSL/TL/IRSL) the specific ceramic sherds from Spirit Cave that provided the basis for Gorman's original interpretation, we note that Gorman did observe ceramics on the surface of Layer 2 (Gorman n.d.):

> *Except for where animal disturbance was evident potsherds were limited in the site to the interface of layers one and two. The surface of layer two was closely examined in all of the eleven squares excavated and the same compacted conditions were found to prevail: concentrations of very fragmented pottery were impressed horizontally into this surface just as if the sherds had been broken* in situ *and walked upon for some time. This surface was the living floor circa 6800-5600 B.C. and all of the pottery evidently came into the site at this time.*

This record is significant as we obtained a single luminescence age on a cord-marked ceramic sherd from Steep Cliff Cave at 6390±670 BC (Figure 9) – a date which is within Gorman's original interpretation for the presence of the earliest pottery at Spirit Cave. Cord-marked sherds may represent the earliest form of ceramics that appear in mainland Southeast Asia. Given the inability to re-examine the Spirit Cave specimens, as well as other ages for ceramics obtained in our study (a sherd from Steep Cliff dates to AD 860±50, over 7,000 years later, and a sherd from Banyan Valley Cave dates to 2350±230 BC), further research is required to resolve the question of "Hoabinhian" ceramic use and manufacture during this period.

The dates from the Steep Cliff Cave sequence provide additional evidence of hunter-gatherer occupation in northwest Thailand during the early Holocene. Steep Cliff Cave appears to have a shorter occupation sequence than Spirit Cave. This is further supported by the Steep Cliff Cave faunal assemblage, which suggests that this site was only used as a mass kill hunting location, in which foragers drove large mammals off the cliff face above the site and butchered them on the rockshelter floor (Conrad 2018). This is an unusual hunting behavior in mainland Southeast Asia and suggests that use of Steep Cliff Cave may have involved a component of forager scheduling (e.g., Shoocongdej 2000). Steep Cliff Cave's faunas are dominated by large sized, burnt and cut-marked ungulates.

Our dates also suggest a resolution for the original Steep Cliff Cave chronology issues. Gorman's charcoal radiocarbon determinations for this site, obtained from units E3 and E2 in the northeast where dispersed human remains also occurred (Conrad 2018), were in reverse stratigraphic order. In this study, an apatite date on human bone from D3-2 (immediately adjacent to the source of Gorman's radiocarbon samples) provided the youngest age for site occupation of 7460±30 BP. This bone may indicate the presence of an intrusive human burial. Often the burials dug into earlier hunter-gatherer deposits in cave and rockshelter sites in mainland Southeast Asia are associated with later Holocene groups (Anderson 2005; Shoocongdej 2006; Bulbeck 2014; Lloyd-Smith 2014; Lewis et al. 2015). The relatively early age of this burial suggests this is not the case at Steep Cliff Cave (see also Zeitoun et al. 2013), but it is nonetheless apparent that these deposits have been disturbed.

The dates for Banyan Valley Cave suggest that hunter-gatherers occupied the cave during the same early Holocene period as foragers at Spirit Cave and Steep Cliff Cave, but did so sporadically, and they continued to return to Banyan Valley Cave long after Spirit Cave and

Steep Cliff Cave were no longer in use. The human remains from Banyan Valley Cave date to the early-to-mid Holocene at 6180±30 BP and thus are not intrusive remains from a later Holocene burial. Anthropogenic deposits with artifacts post-dating these remains suggest hunter-gatherers continued to occupy this site until the very recent past (Conrad 2018).

Rice spikelet dates and the luminescence dated clay pellet from Banyan Valley Cave – likely used for hunting arboreal taxa – also suggest late Holocene and historic-era occupation of northwest Thailand cave sites by agricultural populations or hunter-gatherer groups. Banyan Valley Cave thus provides evidence of both hunter-gatherer adaptations during the Holocene and occupation during the transition to agriculture in mainland Southeast Asia.

Conclusions

New radiocarbon and luminescence ages for Spirit Cave, Steep Cliff Cave, and Banyan Valley Cave revise our understanding of human occupation in northwest Thailand in the terminal Pleistocene and Holocene. Our results support the original chronology for Spirit Cave, including possible early "Hoabinhian" ceramics; an early Holocene chronology for Steep Cliff Cave with evidence of hunter-gatherer scheduling and interment activities; and a Holocene chronology for Banyan Valley Cave with evidence of sporadic use of the site, including historic-era activity. Our results do not provide evidence for early agriculture, but rather highlight the significance of northwest Thailand as a center of Pleistocene-Holocene hunter-gatherer occupation in mainland Southeast Asia.

Acknowledgements

Thank you to Lawrence Straus and Sherry Nelson for providing guidance and support during this research. This research could not have been undertaken without the generous support of the Penn Museum, including Marie-Claude Boileau, Anne Brancati, Stephen Lang and Lynn Grant who assisted with the loan of specimens, on-site examinations, and the review of destructive sampling requests through the Scientific Testing Committee. Thank you also to Alex Cherkinsky, Alan Hogg, Erin McClymont, James McDonald, Dave Phillips, Karen Price, Paula Reimer and Meghan Truckey. A special thanks to Douglas Yen for sharing his perspective on the rice spikelets. We are extremely grateful to the Fine Arts Department, Thailand, and former Director-General Mr. Anandha Chuchoti, for supporting this research project. This research was funded by a Quaternary Research Association [14]CHRONO Centre Radiocarbon Dating Award and a National Science Foundation Doctoral Dissertation Improvement Grant (1724202) to C.C. and E.L.J. We thank two anonymous reviewers, and Robert Witcher, for providing invaluable reviews of this manuscript.

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Figure Captions

Figure 1. Map of key sites discussed in text.

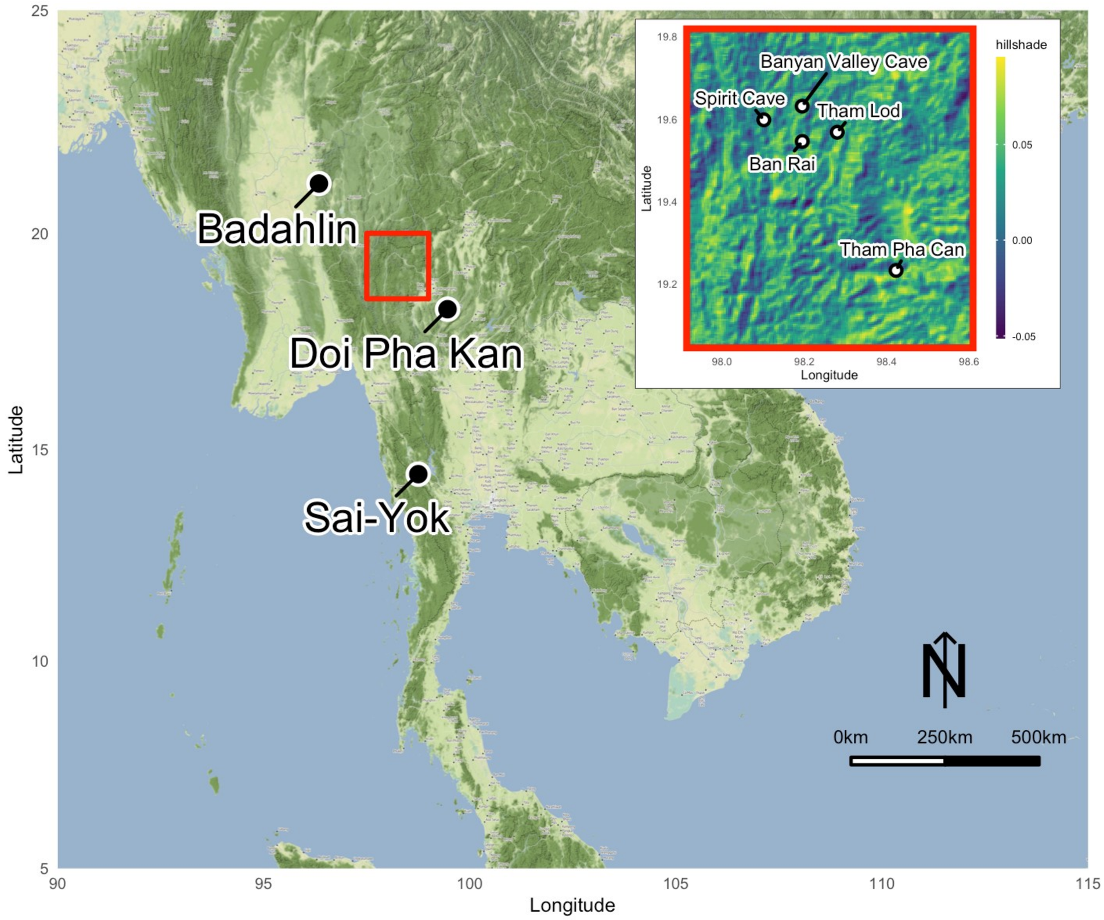


Figure 2. Excavations at Spirit Cave. Courtesy of the ISEAA.

Figure 3. Excavations at Steep Cliff Cave. Courtesy of the ISEAA.

Figure 4. Excavations at Banyan Valley Cave. Courtesy of the ISEAA.

Figure 5. Calibrated radiocarbon age distributions from Spirit Cave.

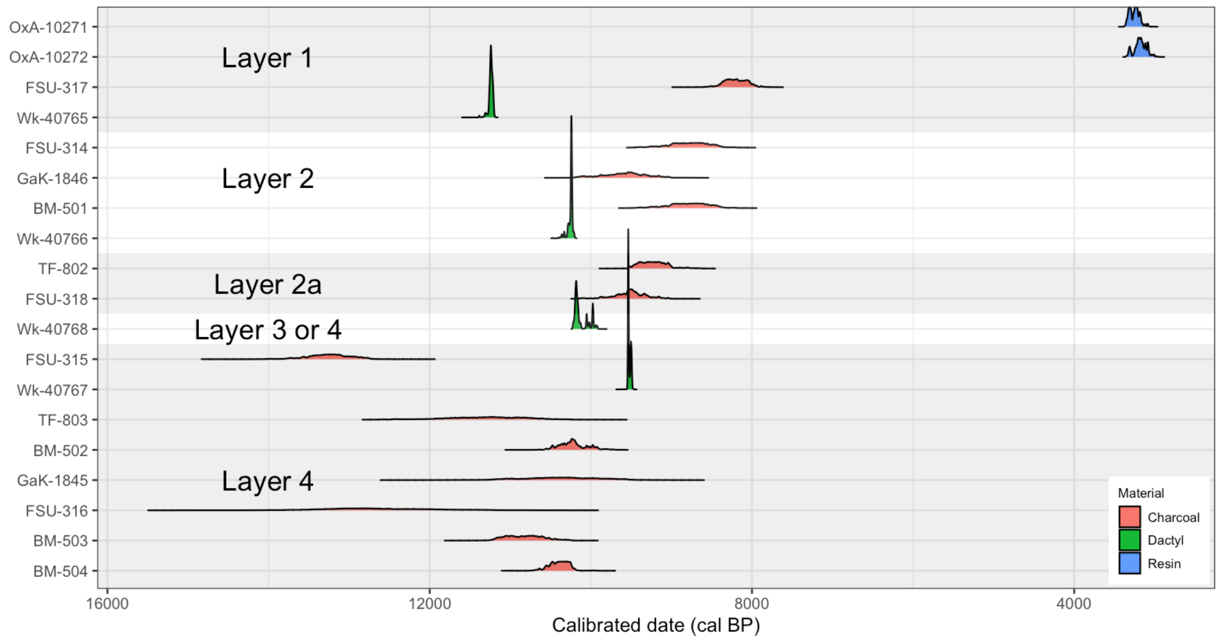


Figure 6. Calibrated radiocarbon age distributions from Steep Cliff Cave.

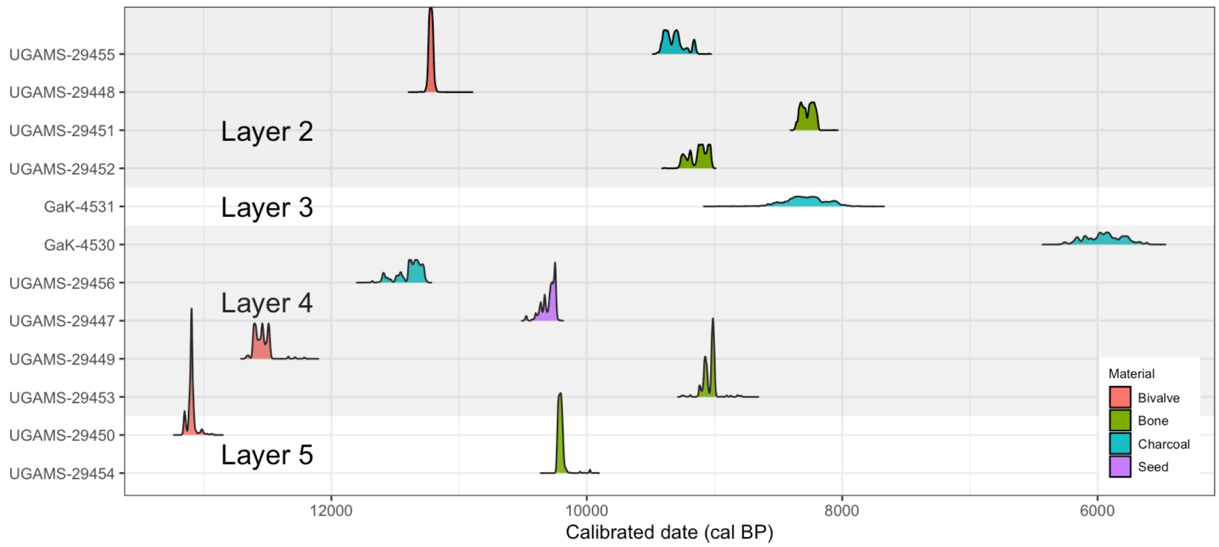


Figure 7. Calibrated radiocarbon age distributions, excluding rice determinations, from Banyan Valley Cave.

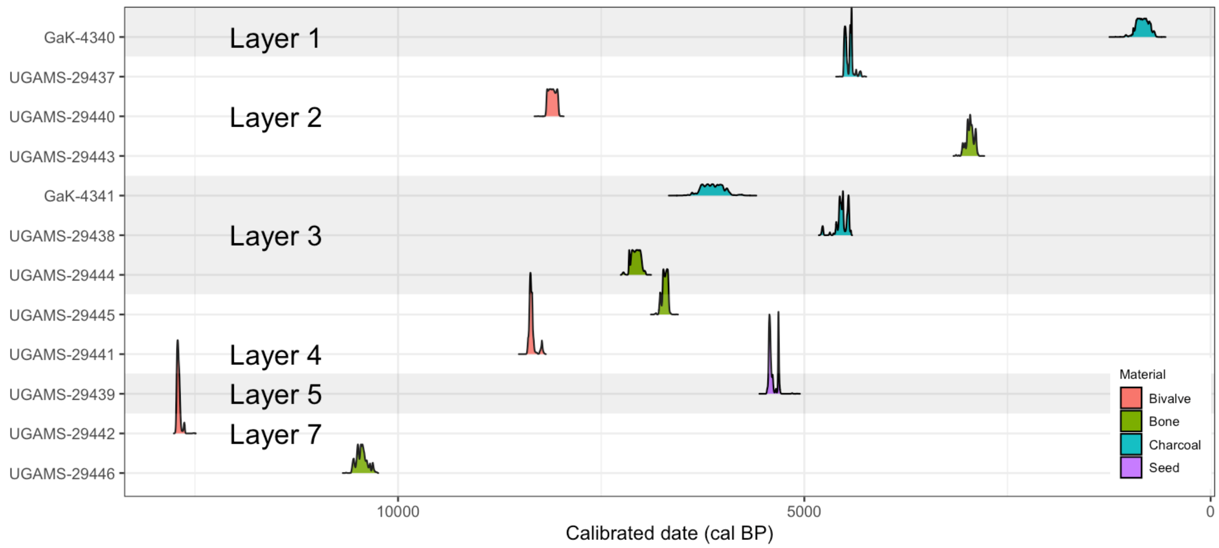
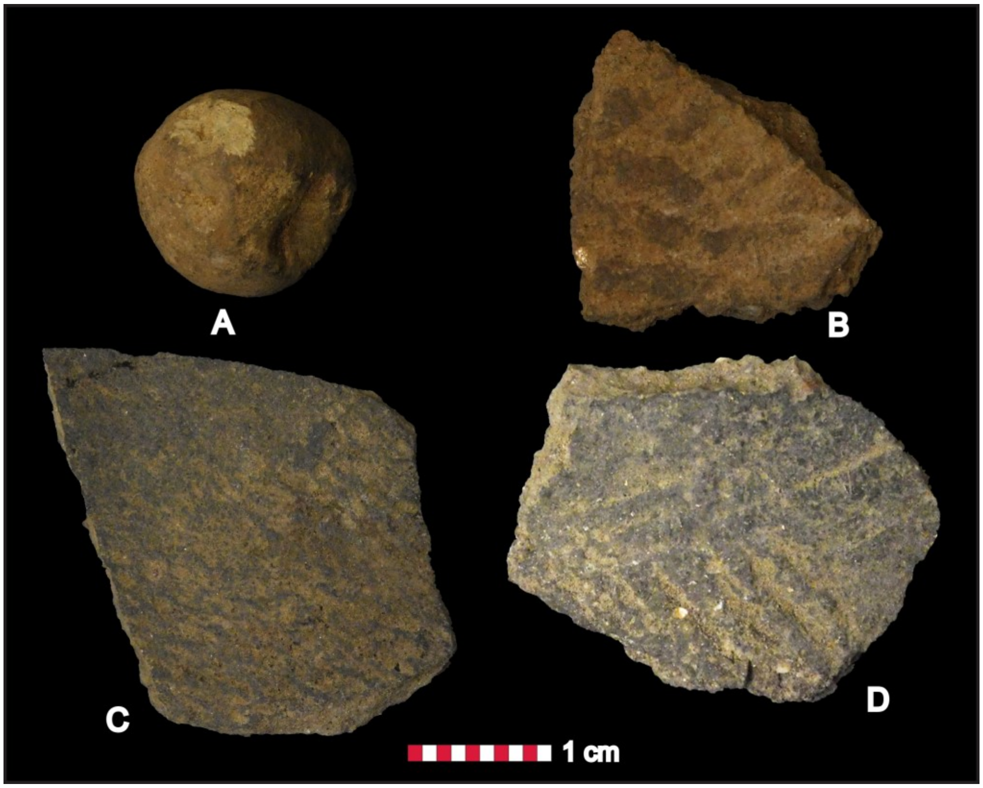


Figure 8. Banyan Valley Cave rice spikelets. At left, two examples of spikelets – note lack of awns (indicating a domesticated variety) and the broad width suggesting also a domesticated length/width ratio. At right, a closeup of a spikelet base demonstrating the torn, domesticated morphology (Photographs: C.C. Castillo).

Figure 9. Dated ceramics: Banyan Valley Cave (A and B), Steep Cliff Cave (C and D). The oldest sherd (D) from Steep Cliff Cave dates to 6390±670 BC.



Tables

Table 1. Original ages from the study sites (see Supplemental Information for references).

Site	Unit	Layer	Material	Type	Age ^{14}C uncal.	± sd	Age ^{14}C cal.	Laboratory Number	References
Spirit Cave	C1-C2	Surface?	Resin coating	^{14}C	3042	37	3362-3151 BP	OxA-10271	1,2,3
	C1-C2	Surface?	Resin coating	^{14}C	2995	40	3339-3008 BP	OxA-10272	1,2,3
	B2-B3	1	Wood charcoal	^{14}C	7397	320	8998-7619 BP	FSU-317	4,5
	A2-B2	2	Wood charcoal	^{14}C	7902	390	9717-7944 BP	FSU-314	4,5
	A2-B2	2	Wood charcoal	^{14}C	8547	200	10,166-9034 BP	GaK-1846	4
	A2-B2	2	Wood charcoal	^{14}C	7907	198	9399-8366 BP	BM-501	6
	B2-B3	2a	Wood charcoal	^{14}C	8265	140	9538-8783 BP	TF-802	7
	B3-B4	2a	Wood charcoal	^{14}C	8517	290	10,249-8724 BP	FSU-318	4,5
	C2	3 or 4	Wood charcoal	^{14}C	11,346	560	15,104-11,884 BP	FSU-315	4,5
	B3	4	Wood charcoal	^{14}C	10,096	310	12,702-10,793 BP	TF-803	4
	C2 (North Wall)	4	Wood charcoal	^{14}C	9073	112	10,565-9895 BP	BM-502	6
	B2-C2	4	Wood charcoal	^{14}C	9177	360	11,396-9478 BP	GaK-1845	4
	B2	4	Wood charcoal	^{14}C	10,896	580	14,306-11,162 BP	FSU-316	4,5
	B3	4	Wood charcoal	^{14}C	Contaminated	-	-	TF-804	8
	B2 (N-W corner)	4	Wood charcoal	^{14}C	9510	160	11,233-10,378 BP	BM-503	6
	B2-C2 (Fire pit)	4	Wood charcoal	^{14}C	9202	106	10,658-10,190 BP	BM-504	6
Steep Cliff Cave	E3	3	Wood charcoal	^{14}C	7497	160	8597-7977 BP	GaK-4531	9,10
	E2	4	Wood charcoal	^{14}C	5178	110	6266-5660 BP	GaK-4530	9,10
Banyan Valley Cave	F4	1	Wood charcoal	^{14}C	930	80	961-682 BP	GaK-4340	11,12
	F4-E4	"Upper ground level 1"	Sherds (n=5)	TL	900-500 BC	NA	-	Oxford	11,13
	D4	3	Wood charcoal	^{14}C	5358	120	6395-5906 BP	GaK-4341	11,12
	F4-E4	"Lower ground level 2"	Sherd	TL	2000 BC	NA	-	Oxford	11,13

Table 2. New ages from Spirit Cave and Steep Cliff Cave. Calibrated ages are corrected for reservoir offsets. [1]See Supplemental Information.

Site	Unit	Layer	Material	Type	δ^{13}C	Age ^{14}C uncal.	± sd	Age ^{14}C cal.	Age (ka)[1]	% Error	Laboratory Number
Spirit Cave	?	1	*Indochinamon* sp.	^{14}C	-11.7±0.2	9839	30	11,313-11197 BP			Wk-40765
	?	2	*Indochinamon* sp.	^{14}C	-13.9±0.2	9106	25	10362-10203 BP			Wk-40766
	?	2a	*Indochinamon* sp.	^{14}C	-13.4±0.2	8965	25	10227-9921 BP			Wk-40768
	?	4	*Indochinamon* sp.	^{14}C	-[1]	8551	25	9546-9487 BP			Wk-40767
Steep Cliff Cave	E3	2	Cord-marked sherd	OSL/TL	-	-	-	-	8.4±0.67	8.0	UW3680
	F3	2	Bamboo charcoal	^{14}C	-27.6	8300	30	9429-9141 BP			UGAMS-29455
	G3	2	*M. laosensis*	^{14}C	-8.7	9800	30	11,252-11,189 BP			UGAMS-29448
	D3	2	*H. sapiens* apatite	^{14}C	-15.6	7460	30	8355-8189 BP			UGAMS-29451
	G3	2	Bovinae apatite	^{14}C	-9.9	8180	30	9270-9017 BP			UGAMS-29452
	G3	4	Bamboo charcoal	^{14}C	-24.7	9960	30	11,609-11,260 BP			UGAMS-29456
	E2	4	Ceramic sherd	OSL/IRSL	-	-	-	-	1.16±0.05	3.9	UW3681
	E2	4	*Canarium* sp.	^{14}C	-25.7	9140	30	10,406-10,230 BP			UGAMS-29447
	G2	4	*M. laosensis*	^{14}C	-8.4	10,510	30	12,661-12,471 BP			UGAMS-29449
	G3	4	Cervidae apatite	^{14}C	-8.3	8100	30	9128-8986 BP			UGAMS-29453
	F3	5	*M. laosensis*	^{14}C	-8.3	11,160	30	13,164-13,003 BP			UGAMS-29450
	F3	5	Bovinae apatite	^{14}C	-4.4	9020	30	10,241-10,171 BP			UGAMS-29454

Table 3. New ages from Banyan Valley Cave. Calibrated ages are corrected for reservoir offsets. [1]See Supplemental Information.

Site	**Unit**	**Layer**	**Material**	**Type**	**$\delta^{13}C$**	**Age ^{14}C uncal.**	**± sd**	**Age ^{14}C cal.**	**Age (ka)[1]**	**% Error**	**Laboratory Number**
Banyan Valley Cave	F4-F5	1	Med. Mammal apatite	^{14}C	-	Failed	-	-	-		UB-26417
	C8	1	*Oryza sativa* spikelet	^{14}C	-26.4	280	20	430-289 BP	-		UGAMS-38826
	C8	2	*Oryza sativa* spikelet	^{14}C	-24.5	220	20	307-11 BP	-		UGAMS-38827
	C8	2	*Oryza sativa* spikelet	^{14}C	-26.4	220	20	307-11 BP	-		UGAMS-38828
	D5	2	Clay pellet (bullet)	TL	-	-	-	-	1.57±0.22	14.1	UW3678
	E5-F5	2	Bamboo charcoal	^{14}C	-25.4	3970	25	4523-4301 BP	-		UGAMS-29437
	F5	2	*M. laosensis*	^{14}C	-8.2	7300	30	8175-8027 BP	-		UGAMS-29440
	E5-F5	2	Lg. Mammal apatite	^{14}C	-25.6	2850	25	3059-2876 BP	-		UGAMS-29443
	F4-F5	2	Med. Mammal apatite	^{14}C	-	Failed	-	-	-		UB-26418
	D5	3	Bamboo charcoal	^{14}C	-29.2	4060	25	4788-4425 BP	-		UGAMS-29438
	F5	3	Ceramic sherd	OSL/TL	-	-	-	-	4.37±0.23	5.3	UW3679
	F5	3	*H. sapiens* apatite	^{14}C	-16.6	6180	30	7165-6965 BP	-		UGAMS-29444
	F4-F5	3	Med. Mammal apatite	^{14}C	-	Failed	-	-	-		UB-26419
	F5	3 (Hearth on 4)	Primate apatite	^{14}C	-13.5	5900	25	6785-6664 BP	-		UGAMS-29445
	F5	3 (Hearth on 4)	*M. laosensis*	^{14}C	-8	7540	30	8410-8217 BP	-		UGAMS-29441
	D4-E4	5	*Canarium* sp.	^{14}C	-25.2	4620	25	5457-5300 BP	-		UGAMS-29439
	E5-F5	7	*M. laosensis*	^{14}C	-4.9	10680	30	12,736-12,625 BP	-		UGAMS-29442
	E5-F5	7	Lg. Mammal apatite	^{14}C	-14.4	9270	30	10,568-10,300 BP	-		UGAMS-29446