

Teak Log Coffin Head Styles in Northern Thailand: Time Sequencing with Dendrochronology

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ABSTRACT: This paper reports the chronology of the styles of the log coffin heads from Bo Krai Cave and Ban Rai Rockshelter in northern Thailand using tree-ring data. This is the first attempt to apply dendrochronology in archaeology fields for age determination, which otherwise only C-14 has been used. The study was undertaken to test the hypothesis that the styles of the coffin heads became increasingly complex over time. At Bo Krai Cave, 71 wood samples were taken from 36 log coffins and 3 supporting posts. At Ban Rai Rockshelter, 116 wood samples were taken from 27 log coffins and 26 supporting posts. Analysis of the wood samples showed that Bo Krai Cave was used as a burial site continuously with log coffins of the same styles over a relatively long period. This means that the people of the Log Coffin Culture probably used multiple log coffin styles continuously and simultaneously. At Ban Rai Rockshelter, the crossdating of the wood samples showed that this area was used as a burial site episodically over several periods. The chronology of the log coffin head styles again indicated that different styles were used simultaneously. Therefore, the chronology of log coffins in this area does not support the concept of a development from simple to complex styles. The simultaneous use of different coffin styles suggests that the style may be related to the status of the buried individuals or their ethnic affiliation rather than indicating cultural changes over time.

KEYWORDS: Dendrochronology, teak (*Tectona grandis* L.), log coffins, Thailand.

INTRODUCTION

Mae Hong Son Province is located in northern Thailand. Many of the caves and rockshelters in this area have been continuously settled since prehistoric times. One of the main archaeological features of these caves is their log coffins. A local culture used elaborated log coffins in its burial ceremonies. These log coffins were typically made of teak logs split into halves and both halves were dug-out inside. One half was the lower portion and the other was a cover. Both the lower portion and the cover had two ends, called heads, while were decorated with carvings of different styles. A striking feature of these carvings is the head-like shapes which can be categorized into two basic types. One type was simple — it has no facial features, merely a head-like shape. In contrast, the complex type has animal-like features.

Previous archaeological research has been conducted in Pang Mapha, Mae Hong Son Province by Chester Gorman¹. He excavated Spirit Cave, on the Kong River approximately 40 and 30 km from Ban Rai Rockshelter and Bo Krai Cave, respectively. Gorman found some “large boat-shaped coffins” and commented

on their approximate age, but did not report the wood species. His primary focus was on the early agricultural practice in Southeast Asia.

In 1987, research on the log coffin culture in Pang Mapha, Mae Hong Son Province (primarily examining their sizes) was carried out by the Fine Arts Department². In 2000, Dilokwanich et al.³ compiled a cave database in Pang Mapha, Mae Hong Son Province. An interdisciplinary highland archaeological project was conducted by Shoocongdej et al.^{4,5} to examine the relationship between humans and environmental change. More germane to our research, Treerayapiwat⁶ carried out an analysis of the styles of the log coffins in many caves in Pang Mapha. He examined the size and shape of the head of the log coffins and divided the styles into 12 types (Table 1). Krajaechan⁷ studied other archaeological artifacts associated with the log coffins at Ban Rai Rockshelter.

Log coffins made from teak—a tropical tree species that forms clear annual growth rings—can be studied by means of dendrochronology⁸⁻¹⁴. This method provides solid, detailed information on the relative ages of various samples, allowing an analysis of the relationship between coffin head styles and their ages.

Therefore we decided to use tree-ring analysis to test whether or not the log coffin head styles developed sequentially.

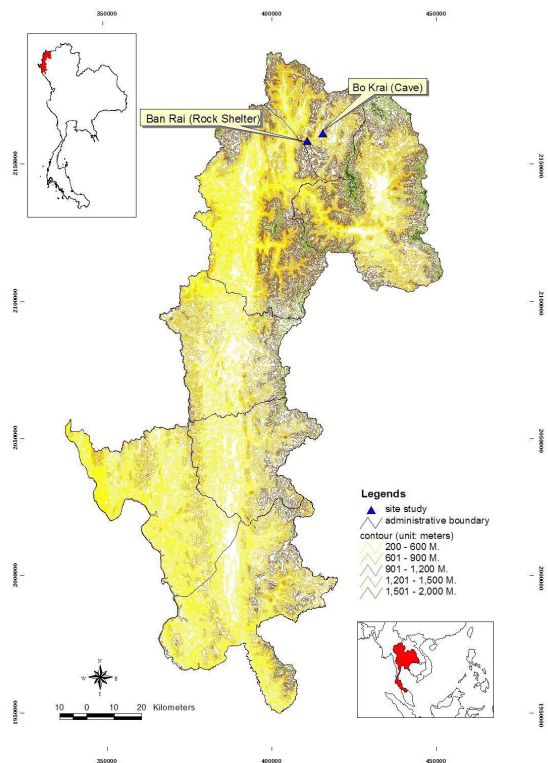


Fig 1. Study areas.

Prior Studies of Log coffin Culture in Southeast Asia

Gorman^{1,15,16} was the first American archeologist to excavate Spirit Cave in Pang Mapha district, Mae Hong Son Province. The cave is located about 60 km from the city center of Mae Hong Son Province, near Ban Rai Rockshelter and Bo Krai Cave. His objective was to reconstruct and examine human agricultural patterns during the late Pleistocene and early recent period of Southeast Asia prehistory. His results provide the most detailed chronology yet available from Spirit Cave of flora macrofossils dating from 11,000 years B.P.

Using radiocarbon dating, Gorman divided the contents of Spirit Cave into two culture levels. Cultural Level I is best described from its lithic component as “Hoabinhian”. The second culture level is “Hoabinhian plus new technological introduction (adze, pottery, slate knives)” which consisted of the above layer.

In Spirit Cave, Gorman also found log coffins but he gave them very little analysis. As he described, “large boat-shaped coffins were erected on scaffolds in the lower, middle, and upper cave”. He did not identify the wood species. However in the soil layer he found at

least one coffin that could be dated from 8,806-7,622 years B.P. (corrected date).

Grave et al.¹⁷ and Grave¹⁸ worked in Pang Mapha, Mae Hong Son Province. He took at least eight samples from log coffins from various caves. His radiocarbon-dated (AMS) samples ranged between $2,080 \pm 60$ to $1,240 \pm 90$ B.P. Therefore other researchers have generally inferred that these dates apply to log coffins at other sites in Pang Mapha, Mae Hong Son Province.

Recently, Treerayapiwat¹⁹ reported the pattern of habitation and burial activity at Ban Rai Rockshelter, using precise excavation techniques. He divided its culture into the Pre-Log Coffin Culture and Log Coffin Culture. The Pre-Log Coffin Culture was dated between 12,500 to 8,000 B.P. by C-14 and the artifacts consisted of variety of lithic material and faunal remains. The Log Coffin Culture was between 2,100 to 1,200 B.P. using the Grave’s radiocarbon dating method, and the artifacts in this culture were potsherds and iron tools.

Of further interest is the excavation of Ongbah Cave, by Sørensen²⁰. Ongbah Cave is located at long. $98^{\circ} 57' E$, lat. $14^{\circ} 41' N$ in the hills of Kanchanaburi Province, about 150 km west of Bangkok. Sørensen, a Danish archaeologist, aimed to make a compilation of all prehistoric iron implements from Thailand by giving a brief description and evaluation of two small collections which were excavated by Thai-Danish prehistoric Expeditions in 1960-62 and 1965-66. The collections were from Kanchanaburi Province; one from Ongbah Cave on the Khwae Yai River and the other from Bang Site, Ban Kao, on the Khwae Noi River. Sørensen’s report noted some 90 “wooded coffins” from the Ongbah’s collections. The coffins were boat shaped, being in fact simple and ordinary dug outs. At both ends they had stylized animal heads, the horns of which may have acted as handles. Usually the coffin consisted of only half a trunk with a cover of plait Boards. None of the coffins discovered was completely intact — all had been damaged by looters. In some of the coffins a few human bones were left. Wood samples were recognized as *Dalbergia* sp., and C-14 dating yielded a result of $2,180 \pm 100$ years B.P.

A boat-shaped log coffin has also been found in Semporna, Sabah²¹. The ancient log coffin was found to be disturbed and no human skeletal remains or burial items were found inside the coffin. The coffin was in good condition and was probably made from a single hardwood log cut into halves. The crescent-shaped lid was carved in the shape of a buffalo head. Te-Kun²² reported that in Iron Age burials at Niah, he found cliff caves that accommodated small wooden-lidded dug-out boats, placed on posts, to receive human remains. In the Philippines, Tenazas²³ described a boat-coffin made of two parts carved out of certain species of hard wood. The lower portion was semi-circular in

cross-section. The lid or cover was carved like a saddle with ends curving upwards. Lizard heads and a crocodile motif decorated the projecting ends of the lids seen in several Bohol, Cebu and Rombron sites. In China, Chang²⁴, and Wei I and Natchamnong²⁵ reported that a boat coffin was found during the excavation of a Bronze Age site at Pao-lun-yuan, Chao-hua, and Szechwan.













The log coffins in other areas appear to have served as ceremonial burial vessels. The meaning behind the various shapes of the log coffin heads remains unknown; perhaps they reflected societal beliefs, the status of the deceased, or the skill of those persons who made log coffins. Despite many studies about log coffins, none

has used dendrochronology knowledge to examine their development.

Study Sites

This study focused on two sites: Bo Krai Cave and Ban Rai Rockshelter. Both are in Pang Mapha district, Mae Hong Son Province (Fig. 1). Because environmental conditions are an important influence on tree growth and tree-ring width, trees that grow under the same or similar environmental conditions at the same time will have similar ring patterns. In addition, both sites have a lot of log coffins that show variation in the styles of coffin heads. This variation is necessary for the study of evolution and the relationship of the log coffin styles.

Table 1. The styles of log coffin heads from Bo Krai Cave and Ban Rai Rockshelter⁵

Style	Image	Description	Piece of log coffin heads	
			Bo Krai	Ban Rai
1A		A long piece of solid wood with a curve at the end.	4	6
1B		A short piece of solid wood with a curve at the end.	7	8
2A		A long piece of square solid wood, curved at the end, with a flat back and a small hole.	26	18
2B		A short piece of square solid wood with a curved end and flat back.	1	7
2C		A short piece of square solid wood with a curved end and a pierced flat back.	2	2
3A		Solid wood carved to look like a pig's head.	2	-
3C		Solid wood carved to look like the head of small four-legged animal: cat, barking deer.	25	-
4B		A flat piece of solid wood, turned up at the top. Always found in combination with style 3C.	20	-
5B		A sharp topknot of solid wood.	1	-
6C		A short piece of solid curved wood. Similar to 1B style but smaller and more slender.	1	-
5D		Two topknots of solid wood with cut between them	1	-
10		Simple head without any sculpture.	2	-

Note: The lower part /cover part of each log coffin has two heads (top and down).

Bo Krai Cave is located at lat.19°32'39" N, long. 98°14'04" E, in the hills, at approximately 933 m above sea level. The site is approximately 300 m above the Nam Lang plain, the closest community, which is located south of the cave. The entrance of which faces to the north is about 4 m wide and 2 m high.

Ban Rai Rockshelter is located at lat.19°31'12" N, long. 98°10'53" E, under a large overhanging rock. It contains a large number of log coffins and some spectacular wall paintings. The site is approximately 793 m above sea level and 150-200 m above the Nam Lang plain. This Rockshelter is about 105 m wide, 142 m long. The entrance of the Rockshelter faces north and averages approximately 30 m high. Because of its location (lower and closer to the plain) and a bigger entrance, Ban Rai Rockshelter could have been used by more people and more often than Bo Krai Cave. Therefore, a large number of log coffins was found at this site. However, there was less variety of coffin head styles here than that at Bo Krai Cave.

The forms of the coffin heads were arranged into 12 groups by Treerayapiwat²⁶ based on the decorative styles and size of the coffin ends. Similar styles were arranged into sub-sets using geometric models to show relatedness and given alphabetic labels for the designs (Table 1). Five styles of coffin heads (1A, 1B, 2A, 2B and 2C) were found at both sites, while seven other styles were found only at Bo Krai Cave.

MATERIALS AND METHODS

The wooden materials for dendrochronological dating were collected from teak log coffins and supporting posts. At Bo Krai Cave, a total of 71 samples was taken from 36 lower portions and covers of log coffins and 3 supporting posts. At Ban Rai Rockshelter, a total of 116 samples was taken from 27 lower portions and covers of log coffins and 26 supporting posts. The specimens were collected using an engine-driven increment borer. After the samples were removed, the bore-holes were filled with small pieces of hardwood to prevent deterioration of the coffins.

The samples were glued on to supporting wood bases and their surfaces smoothened by sanding with a rotary-sanding tool until the annual ring borders became visible. The tree-ring widths were measured to the nearest 0.01 mm, using a moving stage and microscope interfaced to a computer that served as data recorder and editor. Within-tree radii were cross-checked for measurement errors. The data were verified by crossdating. Crossdating of different samples was conducted exclusively on the light table with plotted raw tree-ring series and with the cores under a binocular microscope. In order to identify locally absent or false rings, eliminate measurement errors and ensure dating

accuracy, the quality of crossdating was repeatedly checked with the COFECHA program²⁶. Problematic samples, such as samples with false rings or a distorted growth pattern, were deleted from the data set.

Firstly, samples from the same coffins were crossdated. Then samples from different styles of coffin heads were crossdated. Finally, the ring-width patterns of samples from Bo Krai Cave and Ban Rai Rockshelter were crossdated.

RESULTS AND DISCUSSION

Bo Krai Cave chronological series

Bo Krai Cave consists of 3 chambers with the largest chamber at the entrance and the smallest one the furthest back. In the first chamber, the log coffins were placed on three pairs of supporting posts. Other log coffins in the second and the third chamber were placed directly on the ground. All lids or covers had been removed from the lower portions of the coffins and had been placed close by. However, the covers were matched with the lower portions using the size and the style of the coffins. The majority of the log coffins at Bo Krai Cave was 0.3 m in width and 2.5 m in length. They were smaller than log coffins in other caves but there are more coffin head styles here than that at other sites.

First wood samples were taken from a lower portion of a coffin and from the matching cover for cross dating to confirm the correct matching. Also, at the beginning, the wood samples were separated from each chamber. At the end, the samples were divided into 5 chronology series of teak log coffins. However, only one chronology series, which had the largest number of samples were used to report in this paper. The Bo Krai chronological series was constructed from 30 samples taken from 12 lower portions and covers of log coffins and 3 supporting posts. They demonstrate 5 coffin head styles. The location of the sample collection is illustrated in Fig. 2. The longest ring sequence from this group is 222 rings.

Table 2 demonstrates the correlation between each sample from Bo Krai Cave. Fig. 3 shows the selected cross-date teak tree-ring series of log coffins from 14 series.

From these results, it was surmised that chamber 3, the farthest back, at Bo Krai Cave was probably used as a burial area before chambers 1 and 2. At Bo Krai Cave, log coffin head styles 2A and 2C from chamber 3 predated the 1A style and more complex styles from dendrochronological dating in this series. However, methodological problems include the number of rings lost and lack of information on the time between log harvest and use. The result is further compromised because the experience of other laboratories suggests that reliable crossdating should not be expected for sequences of less than 40 years²⁸ and perhaps should

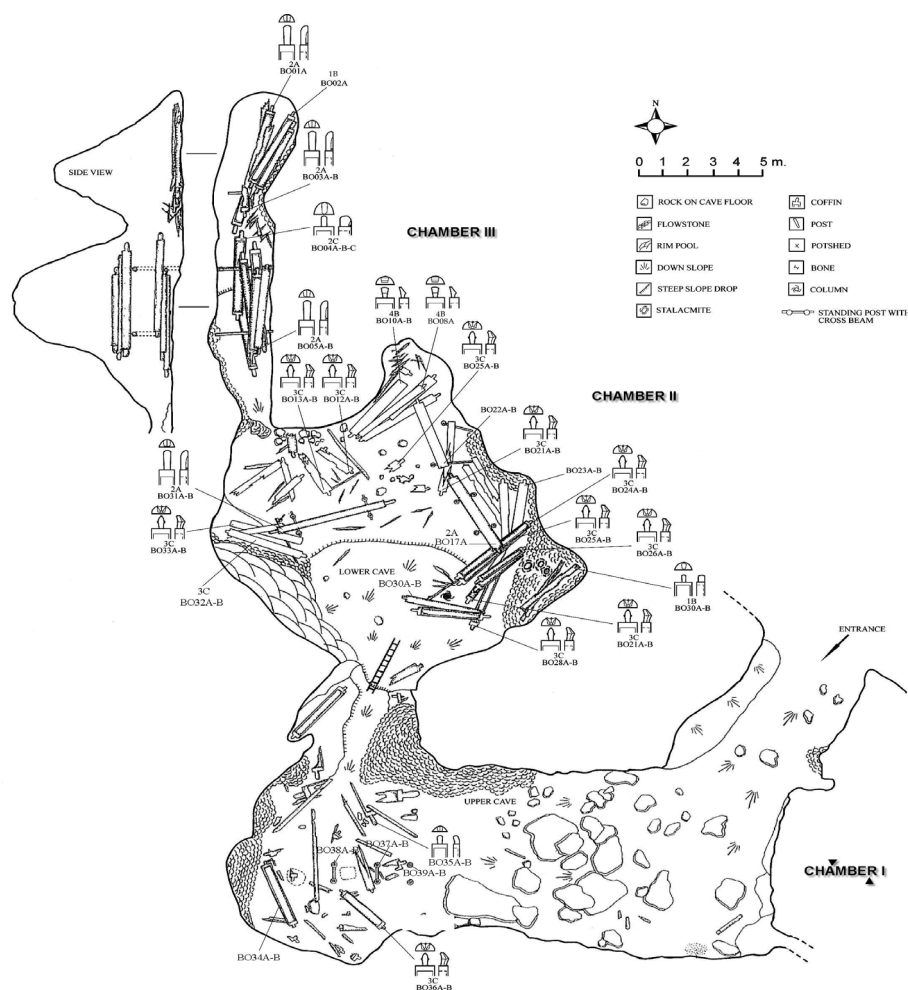


Fig 2. Sample collection for the dendrochronological series from Bo Krai Cave ²⁷.

be more than 60 years for trees in certain subtropical zones. Finally, there is no teak tree-ring chronology in this area for absolute (as opposed to relative) dating.

Our crossdating analysis of these teak log coffin samples suggests that people of the Log Coffin Culture used different head styles in the same period. It is possible that each community had a specialist for wood carving and the coffin style depended on his experience. Or perhaps the log coffin styles 1A, 2A — both very simple styles and more abundant than the others — were used for commoners.









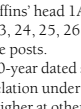
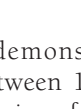
It seems unlikely that the people in that culture reused old log coffins if the burial culture was highly respectful of its ancestors. With plenty of teak trees in the surrounding those people had enough resources to consume and would not have been hard-pressed to recycle burial materials. This same fact also argues against the possibility that the tree were cut elsewhere (far away enough to have significantly different climate and therefore tree-ring pattern) and transported to the site.

Ultimately, the tree ring analysis lends support to the notion that complex coffin head styles were made over a wide period at Bo Krai Cave.

Ban Rai Rockshelter chronological series

The log coffins at Ban Rai Rockshelter averaged 0.5 m in width and 5-7 m in length. Each log coffin was placed on three pairs of supporting posts (Fig. 4). Some of the coffins and the supporting posts were not in good condition. Most of them were damaged by cutting, fire, moisture and insects. Usually the supporting posts were made with teak trees as well, but smaller in diameter than the log coffins. Seven chronology series were constructed from the log coffins from Ban Rai Rockshelter. However, results from only one series, which had the largest number of samples were reported. The Ban Rai Rockshelter chronology series was constructed from 10 samples taken from 4 lower portions and covers of log coffins. The location of the sample collection is illustrated in Fig. 4. The longest ring sequence from this group is 169 rings.

Table 2. Descriptive statistics for the Bo Krai chronological series (BO: Bo Krai)

Seg Series	Style	Time_span	0	20	40	60	80	100	120	140	160
			39	59	79	99	119	139	159	179	199
BO01A		8	58	.50	.49						
BO03A		15	58	.58	.66						
BO03B		15	42	.53							
BO04A		1	31	.45							
BO04B		3	51	.59	.36A						
BO04C		26	52	.50							
BO18A		18	116	.60	.67	.51	.45B	.42B			
BO18B		9	116	.68	.70	.58	.38B	.39			
BO20A		12	104	.58	.55	.48	.43	.44			
BO20B		11	91	.47	.43	.37	.31A				
BO21A		43	142			.59	.61	.56	.46	.45	
BO21B		51	138			.63	.47	.42	.70		
BO22A		83	164					.52	.37	.41	.26A
BO22B		47	132			.51	.57	.44	.55		
BO23A		13	135	.27B	.37A	.24A	.37	.36A	.37		
BO23B		21	134		.48	.37	.28B	.21B	.38		
BO24A		93	196					.33A	.29B	.49	.56
BO24B		95	222					.35A	.48	.71	.79
BO25A		96	193					.37	.41	.44	.66
BO25B		101	198						.37	.32B	.47
BO26A		34	157		.48	.47	.25A	.14B	.48	.53	.64
BO26B		35	159	.33A	.37	.37	.26A	.41	.50		
BO29A		11	114	.56	.58	.46	.47B	.33A	.43	.50	
BO29B		21	155		.78	.65	.55	.38B	.27A	.40	
BO37A1		29	61		.41						
BO37A2		27	45		.62						
BO38A1		55	115			.57	.56	.55			
BO38A2		55	121			.56	.54	.38	.31A		
BO39A1		58	86			.59					
BO39A2		58	92			.45					

Note BO01 and BO03 have log coffins' head 2A style.
 BO04 has log coffins' head 2C style.
 BO18 has log coffins' head 1A style.
 BO20, 21, 22, 23, 24, 25, 26 and 29 have log coffins' one end 3C style and one end 4B style.
 BO37, 38, 39 are posts.
 Correlation of 40-year dated segments, lagged 20 years
 Flags : A = correlation under 0.3665 but highest as dated;
 B = correlation higher at other than dated position

Table 3 demonstrates the best correlation coefficient between 10 samples from one of the 7 chronology series of the log coffins from Ban Rai Rockshelter. Fig. 5 shows the relation of relative dated and crossdated tree-ring series of the coffins from Ban Rai Rockshelter.

The result of this series shows the overlapping ages of log coffins decorated at the ends in simple style. The ages of the 2A and 2B styles of log coffin can be overlapped in the same range in this series. The log coffins BR32 and BR39 were damaged but it looks like the 1A style. From this series it can be inferred that the

style of log coffin heads in the area probably did not evolve over time.

However, the dendrochronological dating of coffin head styles between Bo Krai Cave and Ban Rai Rockshelter shows very low correlation. The low correlation could be caused by a small numbers of samples, the difference of growth patterns of trees between the two sites caused by microclimate differences, and the possibility of different occupation times at these sites. (Trees were cut at different times).

Even though teak trees can have clear ring widths², working with living teak is hard and time consuming.

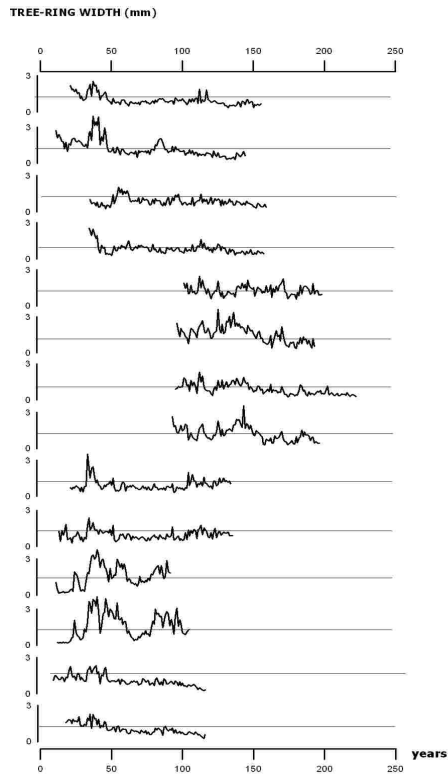


Fig 3. Selected crossdated tree-ring series of the Bo Krai coffins from 14 series.

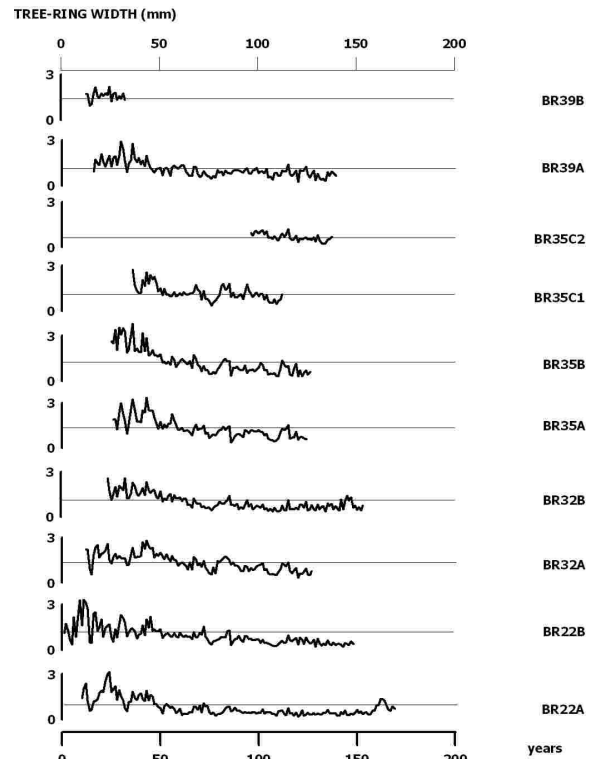


Fig 5. Crossdated tree-ring series of the Ban Rai coffins from 10 series.

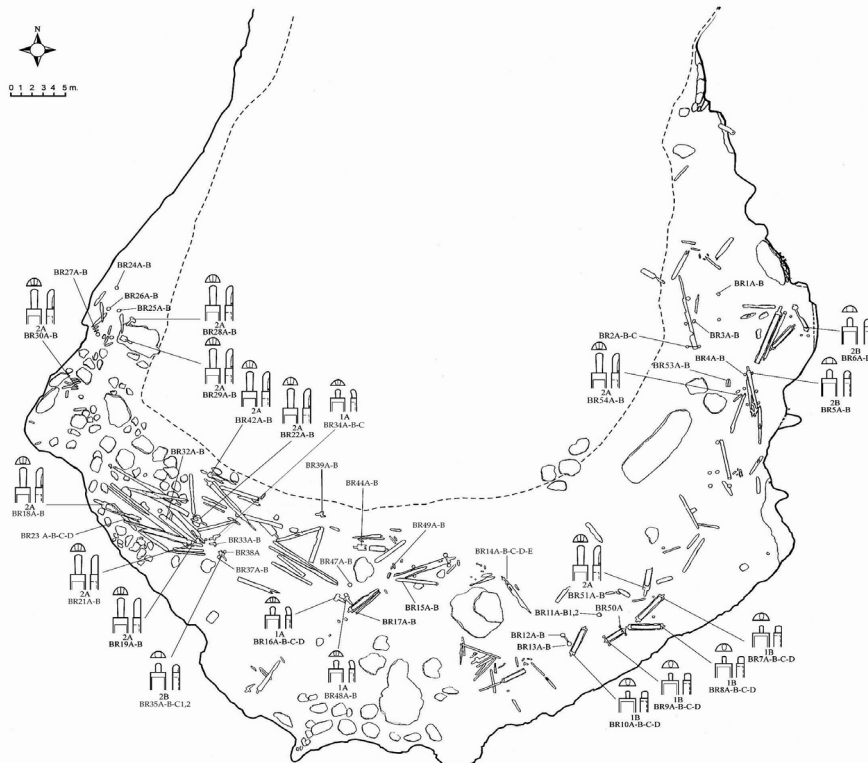
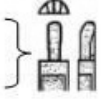
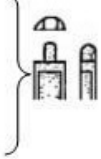
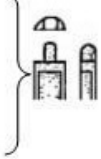


Fig 4. The sample collection for dendrochronological series from Ban Rai Rockshelter²⁷.

Table 3. Descriptive statistics for the Ban Rai chronological series (BR: Ban Rai)

Seq Series	Style	Time_span		0	20	40	60	80	100	120
				39	59	79	99	119	139	159
BR22A		10	169	.63	.64	.58	.38	.42	.50	.32A
BR22B		1	148	.66	.65	.74	.79	.73	.69	.62
BR32A		12	127	.66	.51	.60	.69	.71	.80	
BR32B		23	153		.61	.62	.58	.58	.60	.37B
BR35A		26	124		.71	.64	.66	.74	.71	
BR35B		25	126		.70	.72	.68	.67	.56	
BR35C1		36	112		.66	.67	.67	.71		
BR35C2		96	137					.79	.81	
BR39A		16	139	.64	.66	.64	.51	.50	.80	
BR39B		12	32	.77						

Note BR22 has log coffins' head 2A style.
 BR35 has log coffins' head 2B style.
 The head of log coffin code BR32 and BR39 unidentified head style.
 Correlation of 40-year dated segments, lagged 20 years.
 Flags : A = correlation under 0.3665 but highest as dated;
 B = correlation higher at other than dated position

Seasons in subtropical zones are not regular. Temperature is not significantly different from season to season. Tree-ring width, although clear, is not symmetrical in all directions, and therefore dendrochronology in subtropical rain forests is difficult^{30,31}. Working with subfossil teak in this study is equally, if not even more, difficult. However, interest in climate patterns in subtropical zones is increasing. Therefore many dendrochronologists are investigating tree growth in this area, for example Stahle et al.³², Buckley et al.³³, D'Arrigo et al.³⁴, Fichtler et al.³⁵ and Hua et al.³⁶. Some success has been achieved in constructing a teak tree-ring chronology in northern Thailand, which includes teak from Mae Hong Son Province³⁷⁻³⁹. However those sampling sites were rather far away from the sites of this study. The first extended teak chronology was constructed by Pumijumnong (not published) by using living teak trees from Nam Gut, Mae Hong Son Province and teak stumps cut during the first official teak concessions at Ban Nam Gut, Mae Hong Son Province. The overlapping period of those living teak trees and floating index from the stumps is 60 years, which is nowhere near as ancient as the log coffin cultures. Therefore, C-14 is still needed to provide a rough age of log coffin culture. However, work needs to be continued to extend the tree ring index as far back as possible for benefits not only in dendrochronology fields but also in other fields such as archaeology.

RECOMMENDATIONS

The reliability of dendrochronological results depends on the number of samples collected. Therefore, the results of the current study may have more validity and reliability if additional samples can be collected from the coffins in these same archaeological sites in Pang Mapha district, Mae Hong Son Province.

During the data collection, there were many problems resulting from tourists visiting the archaeological sites and moving the coffins around. It is recommended that future researchers should carefully plan to collect detailed data from coffins to avoid confusion caused by recent repositioning of the coffins, and to educate people in the community about the importance of the log coffins at these archaeological sites, in order to preserve the archaeological record.

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