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A Study of Communities of Practice in Craft Production from Log Coffin Culture Archaeological Sites in Highland Pang Mapha, Northwestern Thailand

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Abstract

In the late prehistoric and early historic periods (2,120–1,250 B.P.) in highland Pang Mapha, northwestern Thailand, the Log Coffin Culture represented a unique mortuary practice characterized by specific cemetery locations and coffin stylistic variations within a localized region of mainland Southeast Asia. Highland peoples practiced these mortuary patterns for an extended period, indicating that specialized cultural practices were passed between successive generations. This article examines the communities of practice of coffin production to understand how this knowledge transmission occurred over roughly 1,000 years. We conducted a quantitative analysis of 202 coffin heads from four river drainages. Similarities of coffin head proportion and carving techniques suggest that highland peoples shared techniques among craft communities in sub-regional watersheds, including the Lang, Mae Lana and Khong rivers, for generations. The difference in head proportion and surface treatment also suggests that producers conceivably adopted some aspects of traditional techniques and developed individual styles.

Keywords

community of practice – knowledge transmission – craft production – log coffin

1 Introduction

The study of human societies and cultures lies at the heart of archaeology, as it does with other disciplines, such as anthropology, humanities and sociology, though these disciplines focus on different aspects of humanity and its relationship with the broader world. Archaeology is an interdisciplinary field that aims to understand the human past through material culture, including both the tangible objects that people have created, modified, used, and discarded, as well as their meanings (Knappett 2005, 1–10). The topic of knowledge transmission regarding craft production has long been of interest in archaeology. The transmission of craft knowledge is a process of cultural transmission in which information, skills, wisdom, customs and beliefs are shared and acquired from one generation to the next. It is a basis for understanding cultural persistence and change over time (Stark et al. 2008, 1). Archaeologists examine the accumulated material culture of the past to interpret how and why ideas and motor skills are learned and shared among social groups and transmitted within and across generations (Crown 2014, 72; Stark et al. 2008, 1), because the learning and transmission process influences the patterning of material cultural attributes in both time and space (Cordell and Habicht-Mauche 2012, 2; Minar 2001, 381).

As archaeologists are unable to observe human behavior in the past directly, they have applied the concept of the community of practice and ethnoarchaeology to study motor skills through technological and stylistic attributes (e.g., material, form, size, shape, color and so on) of archaeological records (Stark 2006, 23–24). These suggest that people share and adopt knowledge of craft production at different rates. Knowledge is not always directly transmitted from one generation to the next but is transmitted through other processes as well, for example, imitation and exchange. Decision-making of producers generates technological and stylistic variation on temporal and spatial scales.

In mainland Southeast Asia, the Late Prehistoric to Early Historic period (2,120–1,250 B.P.), was characterized by the emergence of complex societies, socio-cultural diversity and political and economic transformations, as shown in the early kingdoms, e.g., Sri Ksetra, Dvaravati (Indrawooth 2005, 68, 105), Champa (Higham 2014, 271) and Haripunjaya (Indrawooth et al. 1993);

metallurgical workshop sites, e.g., Ban Chiang and Noen U-Loke (Higham 2014, 261); and early port settlements, e.g., Srivijaya (Srisuchat 2014, 59), Funan (Manguin and Stark 2022, 637), Khao Sam Kaeo (Bellina-Pryce and Silapanth 2006); and so forth. These developments were associated with the expansion of population, long-distance exchange networks and intensification of agriculture and metal manufacture which led to craft specialization (Favereau and Bellina 2016; Higham 2014). While lowland and coastal areas witnessed the development of early states, chiefdoms, ports and workshops, archaeological records from highland Pang Mapha district, Mae Hong Son province suggest the presence of a more mobile, mixed hunter-gatherer and agricultural society which was largely isolated and is the so-called the "Log Coffin Culture" (Fig. 1).

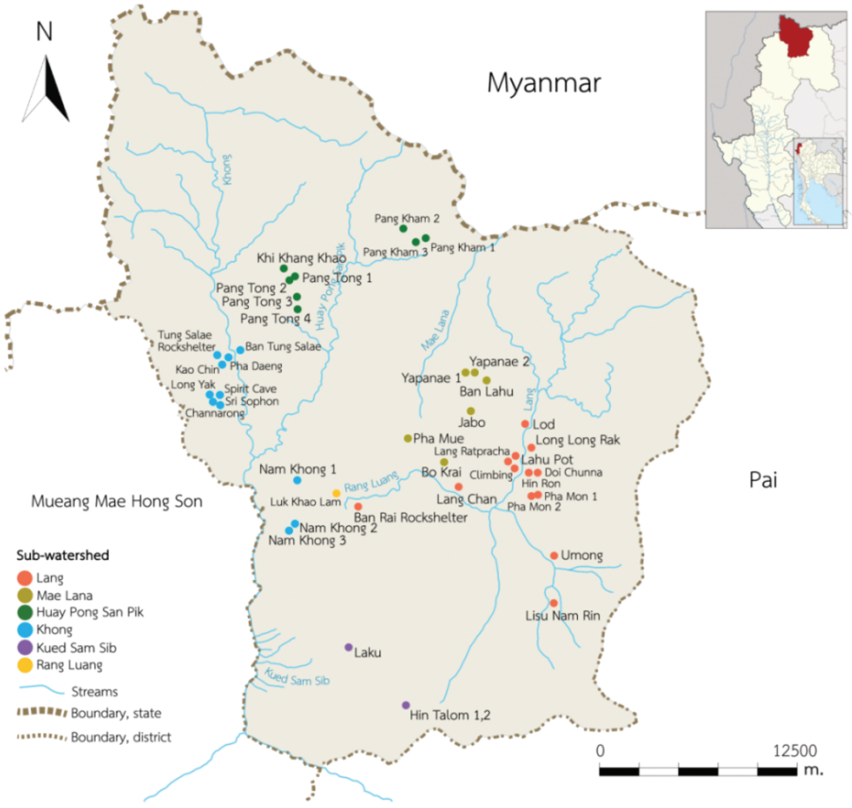


FIGURE 1 Map of the Log Coffin Culture sites in Pang Mapha, Mae Hong Son province, Thailand.
(SOURCE: SURVEY AND CAVE DATABASE MANAGEMENT IN MAE HONG SON PROVINCE PROJECT, AND HIGHLAND ARCHAEOLOGY IN PANG MAPHA, MAE HONG SON, PHASE II PROJECT.)

The term "Log Coffin Culture" is defined by Rasmi Shoocongdej as a unique mortuary practice that involved selecting a karst location for the cemetery and carved coffin styles made from teak trees. Log coffin sites have been discovered in dry caves and rock shelters which were widespread in Pang Mapha (Fig. 2) (Shoocongdej et al. 2021, 483). Each coffin involves the placement of human remains and grave goods which probably represented personal items, household items and food (e.g., earthenware, iron implements, bronze ornaments, woodenware, wickerwork, weaving tools, textiles, glass beads, cowrie shells, and boar, dog and chicken bones) (Shoocongdej 1999, 2016, 15).

Log Coffin Culture peoples were mixed forager-farmer groups who had maintained their traditional subsistence including hunting, fishing and agriculture. They also were part-time artisans who created coffins for their use. Many previous studies (Grave et al. 1994; Niyomkar 1999; Treerayapiwat 2000; Pumijumnong 2007, 2013; Shoocongdej 1999, 2000, 2004, 2007, 2016; Shoocongdej et al. 2021; Wannasri 2006) have demonstrated the ability and knowledge of Log Coffin Culture peoples in using forest resources to produce coffins for ritual activity. They made various styles of coffins and probably shared knowledge and technology of production across five river drainages, as characterized by similarities in the head style of the coffins and radiocarbon dates of coffins. The series of available radiocarbon dates indicates that head styles were continued and changed over time but were not developed into more sophisticated designs. Geometric head types including 1A, 1B, 2A, 2B, 5D and 5F (Fig. 3 & Fig. 4) were normally made in multiple sub-watersheds and were continuously produced over time. Dating back 1,700 years, styles of coffin heads included more stylistic variations. Original designs were continuously preserved, while new designs were created in the Lang sub-watershed. However, earlier studies on the stylistic and technical variation of coffins have mostly focused on the basis of morpho-stylistic similarities of coffin heads,

FIGURE 2 Log coffin sites in Pang Mapha, Mae Hong Son province, Thailand: (a) Ban Rai Rockshelter, (b) Long Long Rak Cave and (c) Bo Krai Cave.
(SOURCE: SAMRIT, CHONCHANOK. 2017. AUTHOR'S PERSONAL COLLECTION.)

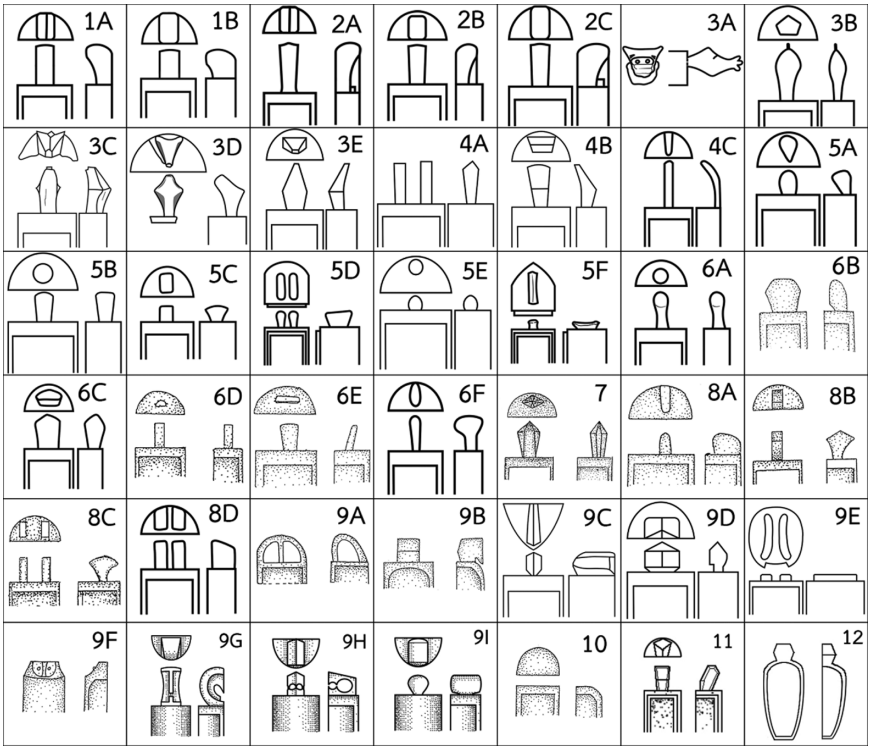


FIGURE 3 Coffin head styles in Pang Mapha, Mae Hong Son province, Thailand. (SOURCE: SURVEY AND CAVE DATABASE MANAGEMENT OF THE MAE HONG SON PROVINCE PROJECT.)

which overlook technique diversity and do not reflect different aspects of knowledge transmission.

This research aims to look beyond the overall similarity of log coffins and to study craft knowledge transmission of an isolated society in the Late Prehistoric to Early Historic period of mainland Southeast Asia. This study examined communities of practice of log coffin production in several attributes, including the size of heads, and the direction and size of gouging on the coffin surfaces. Were the shared head styles made by the shared techniques? How many communities of practice occurred in coffin production? Did producers transmit knowledge between generations? Finally, how was knowledge preserved and adapted through time and space? Here we examine a total of 202 coffin heads from 15 archaeological sites in Pang Mapha district, Mae Hong Son province, using a quantitative analysis of attributes (i.e., the Kruskal-Wallis test).

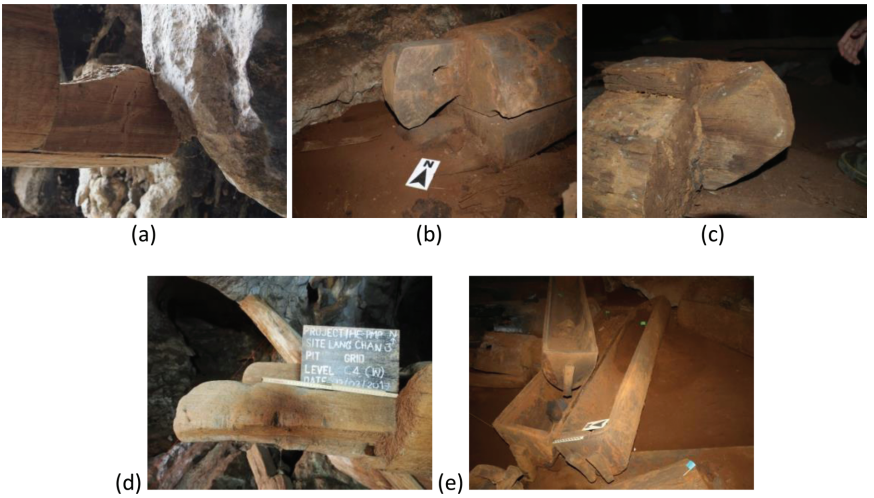


FIGURE 4 Six types of coffin heads were widespread in Pang Mapha: (a) type 1-no holes, (b) type 1-hole, (c) type 2-no holes, (d) type 2-hole, (e) type 5-single head, and (f) type 5-double head.
(SOURCE: SAMRIT, CHONCHANOK. 2017. AUTHOR'S PERSONAL COLLECTION)

This article is divided into five sections. The first introduces the conceptual framework, including communities of practice and ethnoarchaeological research for craft knowledge transmission. The second briefly describes an overview of log coffin production in Pang Mapha to demonstrate the processes of coffin making and various attributes of the coffins. The third provides materials and methods used in this study. The fourth section and final section provide the highlighted findings and the implications of this study in terms of preservation and variation of coffin production in Log Coffin Culture, highland Pang Mapha, Thailand.

2 Conceptual Framework

The study of craft production has been a significant part of archaeological inquiry. Stylistic and technological conceptual frameworks (e.g., the concept of style, the chaîne opératoire concept and the concept of community of practice) are common grounds for interpreting ancient craft productions and relationships among peoples living in a community. Similar patterns of material culture production are related to shared learning contexts (Hegmon 1992, 526) and express coherent underlying perceptions in social groups (David, Sterner, and Gavua 1988, 365). Several producer-groups have distinctive individual

styles (micro-styles) (Hegmon 1992, 526–527), e.g., ceramics production process of mainland Southeast Asia and China present distinctive differences (Cort and Lefferts 2010, 1).

Archaeologists have applied the concept of the community of practice and ethnographic analogy as a cross-cultural comparative study to examine shared traditions and knowledge transmission among social groups in various regions of the world, such as the American Southwest, Southeast Asia and others. These conceptual frameworks provide contexts to explain how knowledge is preserved and changed in ancient craft production.

"Community of Practice" (Lave and Wenger 1991, 29; Wenger 1998, 214) refers to a group with shared ideas and technological traditions achieved through learning motor skills or motor habits in a joint enterprise (Stark 2006, 25; Underhill 2015, 9). The primary use of the concept originated in situated learning theory (Lave and Wenger 1991, 31), which argues that learning is situated in participation of individuals, thereby creating communities of practice in which situated learning is usually unintentional rather than deliberate. Individuals learn together through social interaction, and their identity is subsequently developed (Lave and Wenger 1991, 50; Stark et al. 2008, 5; Wenger 1998, 5). Apprentices begin learning in the early stage and gradually gain expertise if they have more opportunities and engagement to practice in their communities of practice; this process is called "legitimate peripheral participation" (Lave and Wenger 1991, 29).

The foundation of the community of practice and situated learning theory is Pierre Bourdieu's practice theory and the concept of habitus (Bourdieu 1977, 85; Stark 2006, 21). In brief, practice theory emphasizes the routinized

FIGURE 5 Different directions and sizes of gouge texture on the outer surface of the log coffin: (a) along the grain texture, (b) across the grain texture and (c) irregular short gouge texture.
(SOURCE: (A) SAMRIT, CHONCHANOK. 2017. AUTHOR'S PERSONAL COLLECTION. (B) AND (C) SAMRIT, CHONCHANOK. 2018. AUTHOR'S PERSONAL COLLECTION.)

action of individuals as they typically act in everyday life. Habitus is cultural embodiment unconsciously acquired by individuals through socialization in a particular social group (e.g., disposition, habit, skill, behavior and gesture). Therefore, practices are cultural constructions and habitus is constituted and expressed in practice (Bourdieu 1990, 52; Stark 2006, 20–22). In craft communities, producers share a set of production styles and techniques that they have learned and that reflect shared habitus. Routinized action or daily practice leaves patterned traces in this material culture.

In traditional societies, craft production is a main part of everyday life. Several steps of craft production require knowledge, appropriate materials and tools, motor skills, measuring ability and an understanding of the ideological meanings. These processes take a great amount of time and effort to learn. Crown (2014, 74) documented that each stage of craft production, such as pottery, entails necessary skills and knowledge, including preparing workable clay and tempers, using specific tools, modeling, firing, decorating, finishing, taboo and symbolic meanings. Graves (1985, 10) and others (Crown 2014, 75; Sassaman and Rudolphi 2001, 408) suggested that producers learn and practice to earn knowledge, ability, and skills. Children usually learn to make crafts at an early age, initially from same-sex adult producers, such as parents, descendants, relatives, marriage alliances and neighbors. Knowledge and practices are generally learned and shared among participants in social groups. Some routinized actions are used and transmitted across generations. On the one hand, they are distinctive and do not necessarily change in equal proportion in time and space. People are encouraged to modify their traditions through various processes, such as social interaction, decision-making, social organization, migration and more. Stark (2006, 28) also suggests that producers adopt new ideas and techniques at different rates that result in cultural innovation and preservation. The innovations are created through trial and error, thus requiring conscious thought, modification, experimentation and effort.

Graves (1985, 33–34) studied the Kalinga pottery in northern Luzon, Philippines, concluding that pottery of equivalent size and shape often appeared in communities of interacting potters who learned their craft at approximately the same time. Certain younger potters use decoration techniques different from older potters, a trend that spread when many of the older generation quit making pottery. Design similarity is weakly correlated to work groups. Pottery with distinctive decoration represents the decision of producers and individual preferences that are expressed temporally. Similarly, Minar (2001, 392–393) studied the twist directions of cord impressed on the cord-marked pottery of the Navajo, in the southeastern United States. Minar suggested that twist direction was unchanged, given that potters are likely

to conserve the spinning technique that they had learned. In other regions, Gosselain (2008) studied changes of pottery tradition in southern Niger through material gathering and pottery shaping. Gosselain suggested that the decisions of potters about acceptance of new techniques of ceramic production were influenced by spheres of social interaction, such as seasonal migration, family network, economic exchange and others (Gosselain 2008, 167–168, 176).

In addition, Cordell and Habitch-Mauche (2012) concluded that chemical composition and petrographic analyses of glaze-painted and polychrome pottery from the American Southwest revealed that techniques of pottery production were developed over time through the interaction of potters. Communities of potters applied new technologies and new materials to create new styles of ceramics, especially glazed paint and polychrome pottery that occurred through dramatic changes in migration, settlement, exchange and social organization during the 13th to 17th centuries AD.

Stylistic and technological variations are also associated with spatial dimensions. Sassaman and Rudolphi (2001) examined the drag-and-jab decoration of Classic Stallings pottery in the Savannah River region in the United States. They suggest that the decorations are not the same in angle, depth and spacing. The result shows the variation of punctuation decoration technique in each of the three riverine locales and multiple communities of practice (Sassaman and Rudolphi 2001, 409). The similarity of pottery decoration was influenced by cognatic and affinal relations. However, the pottery technology of Classic Stallings could not be sustained over time because of the change in social organization (Sassaman and Rudolphi 2001, 421).

The above research generally indicates that morphological analyses of attributes of the material culture (e.g., form, shape, size, and direction) are an effective tool for examining routinized actions and community of practice. Archaeologists also apply chemical analyses to identify elements and composition of the raw materials involved in the production. Although several pieces of research do not explicitly discuss communities of practice, except Sassaman and Rudolphi (2001), and Cordell and Habitch-Mauche (2012), the research implicitly assumes that similar attributes tend to be created by social groups, particularly kin groups whose participants learn and share traditions in the same period, and they used evidence of shared styles and techniques to define the community of practice. It is noted that material cultures produced by participants of the same community of practice show complete and accurate stylistic features and techniques.

Such research yields fundamental information toward an understanding of cultural preservation and variation. Style and technique, which change for a variety of reasons, all and all tend to be stable throughout a producer's lifetime,

as generational replacement is a long and gradual process. Although a producer generally learns from a teacher and adopts some aspects of the teacher's style and technique, the producer may also develop a different style and technique either because of an expression of self-identity or differences in talent. Each of the different communities of practice in a region is accompanied by micro-tradition or distinctive stylistic and technological feature characteristics, for example Kalinga pottery and Classic Stallings pottery, as mentioned above.

For understanding the preservation and variation of the log coffins of the Log Coffin Culture in Pang Mapha, the archaeological implications drawn from the concept of the community of practice and the ethnoarchaeological case studies are as follows.

(1) Material cultures with similar styles and techniques are produced by the same community of practice, i.e., a group of producers who learn craft production at approximately the same time. Thus, log coffins with equal head shape and size are assumed to be produced by producers who learned coffin production during the same period. Measurement segments of similar head styles were used for ordination and classification of the coffins and compared to radiocarbon dates of the coffin to consider standard and distinct practices.

(2) Material cultures with different styles and techniques are often produced in different locations. Thus, log coffins with different head shapes and sizes are assumed to be produced at different archaeological sites, perhaps by different communities of practices. As such, the shape and measurements of coffin heads found in different archaeological sites were examined for intra- and inter-sub-watershed comparison.

3 Overview of Log Coffin Production in Highland Pang Mapha

In Log Coffin Culture, people participated in a variety of craft productions, including coffins, pottery, iron implement, textile, and basketry. As with all crafts, log coffin production requires knowledge, understanding, skills, materials, and equipment to transform trees into coffins. Log coffins are a distinctive material culture with massive sizes and various styles of heads and are originally placed on the cave floor, some of which are supported by wooden posts and beams or large wooden boards (Niyomkar and Treerayapiwat 2000, 73–91). These log coffins demonstrate the technology and wisdom in the woodworking of the highland population in five sub-watershed locales of the Pang Mapha district.

Coffins were typically made of teak logs (*Tectona grandis* L.), rather than, for example, the lacquer tree (*Gluta usitata* (Wall.) Ding Hou), black plum

tree (*Syzygium cumini* (L.) Skeels), or white meranti (*Shorea talura* Roxb.). These hardwood tree species grow naturally in Pang Mapha, with the teak trunks used for making coffins being common to the flatland areas of the district and northwest Thailand in general. The logs were 100–200 years old when cut down, before being left to dry for at least a year to improve quality and workability. The dried logs were split into halves, both of which were hollowed out with metal tools (Pumijumnong 2007, 235–236). Thus, a log coffin comprised an upper and lower lid. The lengths of the coffins were between 1.2 to 9 meters. Coffins were also built from multiple timbers. This technique requires at least two trunks to make one coffin, particularly small coffins with V-shaped bottom parts and rabbet edges.

Two ends of each coffin lid were carved into different head-like shapes which can be stylistically classified into 42 types based on style and form. The heads of the coffin were generally geometric, some of which resembled animals, human facial features and uncut or plane surfaces. (Niyomkar and Treerayapiwat 2000, 74; Shoocongdej 2007, 863; Wannasri 2006). Head styles were supposed to represent the clan and family of the deceased (Shoocongdej 1999, 2016, 167).

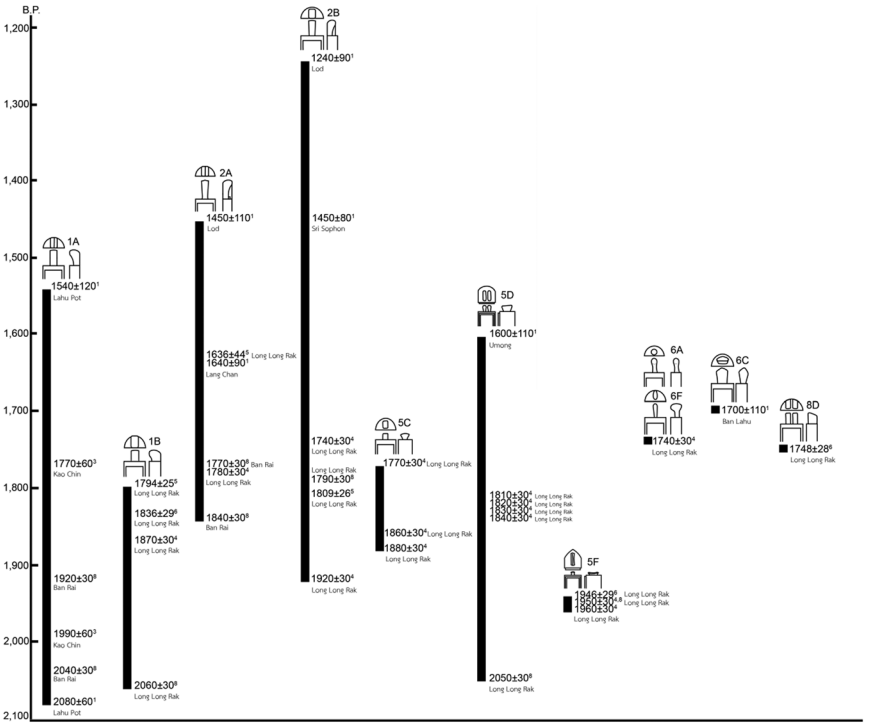
The head and both the inner and outer surfaces of the coffins were carved using gouges or cutting tools with concave blades to shape and remove excess wood (Fig. 4). They were carved along and across the grain in various sizes that left shallow gouges and characteristic textures on the surface. After the carving was completed, coffins were probably finished with lacquer coating (*Gluta usitata* (Wall.) Ding Hou). Multiple layers of lacquer coating were applied to both the inner and outer surfaces of the coffins for sealing and decoration. A small number of coffins were painted with lacquer in black and red geometric designs on their outer surface (Janyaem 2020, 124). Increasingly, lacquer coating was also applied to other consumer goods such as pottery, woodenware, rattan and bamboo wickerwork, and organic thread.

Six head types, including 1A, 1B, 2A, 2B, 5D, and 5F (Fig. 4), are generally presented in several sub-watershed locales, especially Lang, Mae Lana and Khong. Head types 1A, 1B, 2A, and 2B are similar in form, with single long rectangular shapes with rounded corners and one concave side of the head. However, some attributes of the head are different. 1A is short, while 2A is long and has a rectangular ridge with a small square hole. 2B is long and has a ridge without a small hole. These four types are exhibited in larger size coffins than those of 5D and 5F, which have small, round heads. 5D has double parallel heads with concave sides, while 5F has a single head. Coffins with head 5D and 5F were made with a step-shaped recess cut along the edge (i.e., rabbet), which typically forms a match to the edge or tongue of another coffin lid. Both types are usually found with medium size coffins (2 to 5 meters long).

Radiocarbon dates of log coffins have indicated that these six head types continually appeared over time, from 2,080 ± 60 to 1,240 ± 90 years ago. The most apparent types are 1A, 1B, 2A, 2B, 5D and 5F (Fig. 6) (Shoocongdej and Samrit, 2021, 506). With this in mind, this study aims to examine whether these commonly-appearing head types were made using different techniques.

4 Materials & Methods

The research presented here focuses on well-preserved and measurable head types 1, 2 and 5 among log coffins from four sub-watershed locales, including Lang, Mae Lana, Khong, and Kued Sam Sib (Table 1) that are useful for intra and



¹Grave *et al.* 1994 ²Buckley 2002 (Shoocongdej 2003: 102) ³Beta Analytic Inc., (2014) USA (Shoocongdej 2021: 402) ⁴14 CHRONO Centre, Queens University, Belfast (Shoocongdej 2021: 410)
⁵Research Laboratory for Archaeology and the History of Art, University of Oxford (2015) (Shoocongdej 2021: 411) ⁶Beta Analytic Inc., USA (2019) (Shoocongdej 2021: 416)

FIGURE 6 Conventional radiocarbon dates for log coffins.
(SOURCE: HIGHLAND ARCHAEOLOGY IN PANG MAPHA, MAE HONG SON, PHASE II PROJECT AND PREHISTORIC POPULATIONS AND CULTURAL DYNAMICS IN HIGHLAND PANG MAPHA, MAE HONG SON PROVINCE PROJECT.)

TABLE 1 Distribution of the samples

Sub-regional watersheds	Sites	Coffin heads	Sites	Coffin heads
Lang	Ban Rai (BR)	35	Lang Chan (LC)	18
	Lod (LOD)	14	Climbing (CB)	10
	Hin Ron (HR)	3	Long Long Rak (LLR)	63
	Umong (UM)	2	—	—
Mae Lana	Bo Krai (BK)	11	Jabo (JB)	20
	Yapanae 1 (YPN1)	7	Yapanae 2 (YPN2)	2
Khong	Long Yak (LY)	5	Spirit (SPR)	4
	Sri Sophon (SSP)	2	—	—
Kued Sam Sib	Hin Talom 2 (HTL2)	6	—	—
Total		202 heads		

inter-sub-watershed comparison. Sizes of coffin heads were used to investigate communities of practice of coffin production. In all, 202 well-preserved coffin heads from 15 coffin sites in Pang Mapha district, Mae Hong Son province were examined in this study. The distribution of the sample is shown in the following table:

Quantitative testing with a significance level of $p<0.05$ was used to analyze and interpret the data. The Kruskal-Wallis test was used for detecting differences of the head sizes among 15 coffin sites from four sub-watersheds. A p-value of <0.05 indicates a statistically significant difference between sizes of heads.

Surface treatments (both to the inner and outer surfaces), such as direction and size of gouge texture and lacquer coating of coffins, are also considered with the statistical results to examine carving-techniques and the producer group. These methods were applied in investigation of our hypotheses regarding production groups and their different styles and techniques, while quantitative testing was used to perform a more accurate data analysis. The results are then compared with the concept of communities of practice and ethnoarchaeological data, allowing us to interpret archaeological records in terms of preservation and variation of log coffin production in four sub-watersheds.

5 Results & Discussion

This study aimed to investigate communities of practice and transmission of knowledge of coffin production in highland Pang Mapha, Thailand. Based on these aims, this study examined significant differences in the sizes of coffin heads using the Kruskal-Wallis test along with analysis of the gouge texture on the coffin surface, and then compared these to conventional radiocarbon dates of log coffins. The results indicate significant differences in coffin head sizes among intra- and inter-river drainages. However, head sizes do not directly change over time and space.

5.1 *Communities of Practices of Log Coffin Production*

The Kruskal-Wallis test revealed a significant difference, as shown in Table 2. The results suggest that each type of coffin head is not exactly equivalent in proportion. Lang, Mae Lana, Khong, Kued Sam Sib and even intra-Lang producers applied different techniques to create coffin heads in several parts, for example the width of the base and the end part of head type 1-no holes, length of head type 1-no holes, length of the ridge of head type 2, width and length of the hole of head type 2, length of head type 5 and so on. It is noted that the proportions of head type 2-holes are more diverse than head type 2-no holes (Fig. 7).

Additionally, Ban Rai and Long Yak producers generally created larger-sized coffin heads (type 2) than producers from the other sites. It is assumed that the size of the timber used in building a coffin may determine the proportion of the coffin heads. Further study will provide more information with which explore this hypothesis of raw material procurement or forest resource exploitation.

However, the results do not support our hypothesis, as no statistically significant differences were found (Table 2). The findings indicated that producers in multiple sub-watersheds, including Lang Mae Lana and Khong, applied similar proportions to shape coffin heads (e.g., width and length of the hole of head type 1, width or thickness of the ridge of head type 2, length of head type 2, width and length of head type 5, and others).

The findings of this study suggest that coffin production in highland Pang Mapha involved multiple communities of practice (a minimum of 142 groups) that producers participated over time. Each group is characterized by attributes of a coffin such as head style, measurement and carving technique, which the four sub-watersheds shared and applied differently. Highland people clearly applied their own specific ability to perceive or measure elements of the coffins, as well as knowledge of proportions and symmetry.

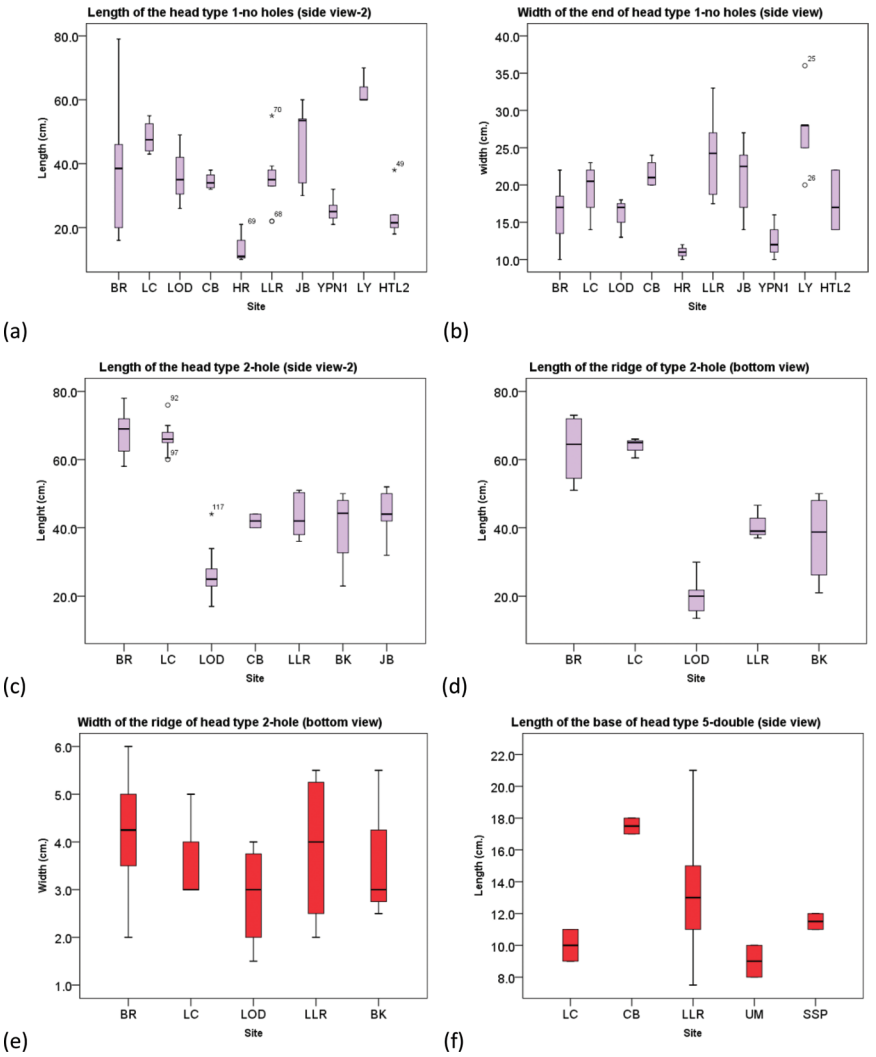


FIGURE 7 Box plot results of the Kruskal-Wallis test for the proportion of coffin heads among log coffin sites: (a) length of the head type 1-no holes (p-value = 0.000), (b) width of the end of head type 1-no holes (p-value = 0.000), (c) length of the head type 2-hole (p-value = 0.000), (d) length of the ridge of head type 2-hole (p-value = 0.002), (e) width of the ridge of head type 2-hole (p-value = 0.488), and (f) length of the base of head type 5-double (p-value = 0.140). The medians are shown as a line in the middle of each box. Boxes represent upper and lower quartiles. The dots and stars indicate outliers. Confirmation of the significant difference of proportion is shown as purple boxes. The significance level is based on a normal distribution assumption.

TABLE 2 Results of the Kruskal-Wallis test

Types	Side (view)	Sites	X^2	df	p
	length-1 (side)	CB, LY, HR, YPN1, JB, HTL2	18.410	5	0.002
	length-2 (side)	BR, LY, LC, HR, CB, JB, LLR, HTL2, YPN1	31.744	9	0.000
1-no holes	width-in (side)	BR, LC, LOD, CB, HR, LLR, JB, LY, HTL2	18.818	8	0.016
(1A, 1B)	width-end (side)	BR, LLR, LY, LOD, CB, HR, JB, YPN1	31.499	9	0.000
	width-in (top)	BR, LY, LC, LOD, CB, LLR, JB, HTL2	22.389	7	0.002
	width-end (top)	BR, LY, LC, HTL2, LOD, LLR, CB, YPN1, JB	29.885	8	0.000
	hole-length	BR, LLR	0.167	1	0.683
1-hole	hole-width	BR, LLR	0.000	1	1.000
	width-in (top)	BR, LLR	0.600	1	0.439
	ridge-length (bottom)	BR, BK, LLR	3.689	2	0.158
2-no holes	ridge-width (bottom)	BR, BK, LLR	2.475	2	0.290
(2B)	length-1 (side)	BR, BK, LLR	5.699	2	0.058
	length-2 (side)	BR, BK, LLR	7.626	2	0.022
	ridge-height (side)	BR, BK, LLR	0.836	2	0.658
	ridge-length (side)	BR, BK, LLR	3.128	2	0.209
	width-end (side)	BR, BK, LLR	7.026	2	0.030
	width-in (side)	BR, BK, LLR	0.994	2	0.608
	width-end (top)	BR, BK, LLR	4.160	2	0.125
	width-in (top)	BR, BK, LLR	4.418	2	0.110
	ridge-length (bottom)	BR, LOD, LLR, BK, LC	16.884	4	0.002

TABLE 2 Results of the Kruskal-Wallis test (*cont.*)

Types	Side (view)	Sites	X^2	df	p
	ridge-width (bottom)	BR, LC, LOD, LLR, BK	3.435	4	0.488
	hole-length	BR, LOD, JB, LC, LLR	22.971	6	0.001
	hole-width	BR, JB, LC	18.930	6	0.004
2-hole	length-low (side)	LC, LOD, CB, JB	13.594	5	0.018
(2A)	length-up (side)	BR, LOD, CB, LLR, BK, JB, LC	36.038	6	0.000
	ridge-height (side)	LOD, JB, LLR	14.560	6	0.024
	ridge-length (side)	LOD, JB, LLR	23.486	6	0.001
	width-end (side)	BR, LC, LOD, CB, LLR, BK, JB	9.253	6	0.160
	width-in (side)	BR, LC, LOD, CB, LLR, BK, JB	8.336	6	0.215
	width-end (top)	LC, LOD, JB	16.745	6	0.010
	width-in (top)	BR, LOD, LC, BK, CB, JB	21.453	6	0.002
1 and 2	hole-length	BR, JB, LLR	24.025	6	0.001
	hole-width	BR, JB	20.111	6	0.003
2-no holes	ridge-length (bottom)	BR, LOD, BK, LC	19.416	4	0.001
& 2-hole	ridge-width (bottom)	BR, LC, LOD, LLR, BK	2.769	4	0.597
(2B, 2A)	ridge-height (side)	BR, LC, LOD, CB, LLR, BK, JB, SPR	14.230	7	0.047
	ridge-length (side)	BR, LOD, LC, LLR, JB	21.448	7	0.003
	length-end (side)	LC, CB, LLR, UM, SSP	10.733	4	0.030

TABLE 2 Results of the Kruskal-Wallis test (*cont.*)

Types	Side (view)	Sites	X^2	df	p
	length-in (side)	LC, CB, LLR, UM, SSP	6.928	4	0.140
	width-end 1 (side)	LC, CB, LLR, UM, SSP	4.604	4	0.330
	width-end-2 (side)	LC, CB, LLR, UM, SSP	7.869	4	0.096
5-single	width (side)	LC, CB, LLR, UM, SSP	7.277	4	0.122
(5D)	length (top)	LC, CB, LLR, SSP	5.570	3	0.135
	length-2 (top)	LC, CB, LLR, UM, SSP	5.301	4	0.258
	width-end-1 (top)	LC, SSP, CB, LLR	9.174	3	0.027
	width-end-2 (top)	LLR, SSP	8.737	4	0.068
	width-in-1 (top)	LC, SSP, CB, LLR	5.410	3	0.144
	width-in-2 (top)	LC, CB, LLR, UM, SSP	7.913	4	0.095
	length-end (side)	CB, LLR	3.208	1	0.073
	length-in (side)	CB, LLR	0.261	1	0.609
	width-end-1 (side)	CB, LLR	0.000	1	1.000
5-dual (5F)	width-end-2 (side)	LC, CB, LLR	3.381	2	0.184
	width (side)	CB, LLR	2.932	1	0.087
	length (top)	LC, CB, LLR	4.692	2	0.096
	width-end-1 (top)	LC, CB, LLR	5.842	2	0.054
	width-in-1 (top)	LLR, LC	4.524	2	0.104

A p-value of <0.05 indicates statistically significant difference between sizes of heads.

Moreover, the different gouge wood textures on the outer and inner surfaces of the coffins may conceivably indicate individual techniques. The morphological analysis of coffins suggests that Lang and Mae Lana producers normally removed excess wood from a coffin with a sharp tool in two directions, including carving along the wood grain and across the wood grain. The gouge textures are 1–3 centimeters in width and 1–15 centimeters in length. The findings may suggest that coffin production requires teamwork, rather than only one producer, and that they applied different sizes of carving tools in different contexts.

5.2 *Preservation and Variation of Log Coffin Production Knowledge*

The coffin carving technique is uncertainly associated with temporal variation due to the insufficient size data and radiocarbon dates of adequate quality coffins. Type 1, 2, and 5 heads were generally created equal in proportion, except for certain parts of the heads. Looking at the well-dated coffins from Long Long Rak, older coffin heads appeared to be larger than younger coffin heads. Coffins existed at approximately the same time and showed equal size. These findings might support the concept of communities of practice and ethnographic information that producers who learned craft production in social groups at approximately the same time reasonably used the same technique and created similar features of material culture.

Radiocarbon dates of the log coffins with head types 1, 2, and 5 suggested that the rectangular shape with rounded corners and the rounded topknot shape heads techniques had probably been adopted over a century prior and were transmitted across generations. The production of head types 1, 2, and 5 was seen significantly more within and across sub-watersheds than the rest of the head styles. The traditional techniques probably initially occurred in Lang settlements and belonged to the first settlers in highland Pang Mapha beginning around 2,080 ± 60 years ago and may have conceivably been carried on until 1,240 ± 90 years ago (Fig. 6).

Between 2,000–1,800 years ago, head styles in Lang, Khong, and Mae Lana continued to be more diverse and reached a high point around 1,700 years ago (Fig. 6). This shift may reflect the migration of populations into the highlands and the adoption of new technology. Radiocarbon dates of human remains from Pang Kham 1 reach back to 1,343 ± 59 and 1,698 ± 59 B.P. (Dilokwanich et al. 2000, 31), suggesting that between 1,600–1,200 years ago people also occupied Huay Pong San Pik. However, stylistic and technical variation gradually declined, whereas typical head styles persisted. Lang and Mae Lana people shared knowledge of coffin production and inhabited these areas for multiple generations. The two major sub-watersheds have seen the discovery

of rare modified human teeth and imported objects from outside, such as bronze objects, a bronze coin,[1] cowries and glass beads.

Conversely, a limited number of coffin head types exited in particular sub-watersheds, including types 2C, 3A, 3C, 3D, 3E, 4A, 4B, 4C, 5A, 5B, 5E, 5F, 6A, 6B, 6C, 6D, 6E, 6F, 7, 8B, 8C, 8D, 9A, 9B, 9D, 9F, 9G, 9H, 9I, 10, 11 and 12. They were shaped in a variety of designs, including geometric design (e.g., trapezoidal shape, match head-like, polygon, etc.), resembling animals (e.g., pig, cat, bird, deer, etc.), a human facial feature, and non-cut or solid. These head types demonstrate that Log Coffin Culture people in five sub-watersheds not only shared and transferred traditional techniques among social groups but also created different styles and proportions of coffin heads. Huay Pong San Pik is represented by specific designs distinct from other river drainages. It is important to note that animal-like designs probably indicated animal symbolism in Log Coffin Culture. Increasingly, a limited amount of two different head-designed coffins were present in Long Long Rak, Ban Rai (type 1-no holes and type 2-holes) and Sri Sophon (type 5C and 9B), while the two ends of a coffin were typically carved into the same head style. The mixed-style head coffin from Long Long Rak dates back 1,900 years. Various styles of coffin heads reflect the cultural diversity of ancient highland populations during the Late Prehistoric to Early Historic period in northwest Thailand.

These findings provide new insight into the craft production of Log Coffin Culture people in that they shared knowledge and techniques among social groups and also modified individual techniques that indicate the decision of producers and individual preferences. However, given our sample limitations, we did not confirm whether Log Coffin Culture people transmitted their knowledge through inheritance, residential proximity, or imitation. Further analyses should focus on well-preserved log coffins from Lang, Mae Lana and Khong. Additional research is also needed to establish size data and radiocarbon dates of the coffins in the rest of the river drainages, including Huay Pong San Pik and Kued Sam Sib.

6 Conclusion

During the Late Prehistoric to Early Historic period (2,120–1,250 years ago), the Log Coffin Culture in Highland Pang Mapha was characterized by a wisdom in

1 The bronze coin with the rising sun and Srivatsa symbol (4th–14th Buddhist centuries), the forms of the auspicious symbols originating in India, which signify abundance and wealth. The auspicious coins were generally found in Dvaravati period archaeological sites in Thailand and other sites in Southeast Asia, i.e., Óc Eo in Southern Vietnam, Sri Ksetra in Myanmar, etc. (Indrawooth 2006, 63–68).

craft production involving multiple communities of practice. Highland people had the ability and knowledge to modify teak from forests to create coffins as a part of shared mortuary ideology. In the craft communities, producers from Lang, Mae Lana and Khong shared knowledge and technology passed down through generations to create their traditional-style coffins. On the other hand, the significant difference in coffin head proportion and surface treatment suggests that producers modified these traditions and devised individual techniques. Technique variation was not, therefore, necessarily related to temporal and spatial scales.

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