Late Prehistoric and Early Historic Ceramic Chronology for Central Thailand

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Abstract

This paper attempts to build chronology for the prehistoric period and the early historic period of central Thailand. Ceramic assemblages from archaeological sites in the research area were examined using an attribute-based seriation method. The attributes selected for this study are those of surface treatment attributes. A statistical technique (correspondence analysis) was also used to test the validation of the seriation. Findings from this study suggest that surface-treatment attributes are temporally sensitive. The arrangement of the ceramic assemblages responds closely to broad archaeological periods proposed previously by Southeast Asian archaeologists. This study thus contributes to a better understanding of chronological development in the Central Plain of Thailand in general.

Keywords : Southeast Asia,, Central Thailand, Pa Sak River Valley, Prehistoric and Early Historic Periods, Seriation, Correspondence Analysis.

Introduction

During the past several decades, archaeological knowledge has increased about the prehistory and early history of Thailand, frequently as the result of major long-term archaeological research projects. Numerous problems have been pursued, including changes in subsistence, settlement pattern, technology, socio-political organization, trade, and foreign influence (Anderson 1987; Bayard 1972; Bhumadhon 1999; Bronson 1979; Charoenwongsa 1982; Gorman 1971; Higham 1998; Higham and Kijngam 1984; Mudar 1993; Natapintu 1988a; Nitta 1991; Santoni et al. 1990; Shoocongdej 2000; White and Pigott 1996; Wilen 1986). These ambitious studies have, however, been hampered by lack of fine-grained chronologies, or in some areas, by lack of an ability to place sites and assemblages into any but the most general periods (e.g., prehistoric, Bronze age, Iron age). It appears that not enough attention has been paid to that most basic of archaeological enterprises—developing precise chronologies based on stratigraphy, chronometric dating techniques, and systematic analysis of stylistic change in common artifact types. In this paper, I contribute to an improved cultural chronology for Central Thailand by applying a quantitative seriation method to a number of late prehistoric and early historic period (ca. 2000 B.C.- A.D. 500) assemblages from Central Thailand.

Much of the recent archaeological research in Thailand has focused on topics such as settlement patterns (Higham and Kijngam 1984; Mudar 1993), development of early metallurgy (Pigott and Natapintu 1988; Natapintu 1988a), trade/exchange patterns (Welch 1989; White and Pigott 1996), and cultural interaction (Lertrit 2000). Careful reconstruction of the chronology of sites and regions has been of secondary significance. Furthermore, it appears that scholars from different fields such as art history, history, and epigraphy have also developed their own chronologies based on evidence specific to their fields. The result, as noted by Higham (1989, 1996b), Hutterer (1982 : 563), and Miksic (1995), is that

there is an overlap and contrast in chronological sequences used by those scholars (archaeologists included). Among archaeologists themselves, controversies have risen over the construction of cultural chronologies (e.g., Bayard 1992). The dating problem is not easy to tackle, but it is critical to archaeological research in Thailand, and it is thus worth pursuing. I believe that my research on ceramic chronology can contribute to a better understanding of cultural developments in Thailand in general and in central Thailand in particular.

It also should be pointed out that settlement pattern studies, as well as research on changes in culture and society, require or depend on good chronologies. We cannot convincingly argue that several site types were part of a single land-use pattern, for example, if we cannot show they were contemporaneous.

Importance of the Study

The particular period of time that I am studying, from 2000 B.C. – A.D. 500, begins with the late Neolithic, extends through the Bronze and Iron Ages, and ends at the "dawn" of history with the beginning of the Dvaravati period. This sequence has great anthropological importance for Southeast Asia, because it is during this time that we see the emergence of complex polities and, perhaps, the region's earliest states.

In this paper, I expect to provide a chronological sequence for 16 prehistoric and early historic period assemblages from Central Thailand. Additional studies of the assemblages are outside the scope of this investigation, but I hope in the future, researchers will use my sequence to look for other changes in material culture, site characteristics, and settlement pattern of these or related sites. It is hoped that researchers could also extend my chronology outside the study area to assign a temporal position to other sites in Central Thailand.

Sixteen ceramic assemblages from 14 sites in the Pa Sak River valley in the Central Plain of Thailand (Figure 1) were selected for this study. These assemblages were excavated in 1996-1997 by

Buranrak, a contract company hired by the Fine Arts Department, as part of the salvage project to rescue archaeological sites in advance of the construction of the Pa Sak Dam in Lopburi Province. After the completion of the salvage project, the assemblages were transported to Ayutthaya Province and were curated at the 3rd Office for Archaeology and National Museum in Ayutthaya Province.

I chose the ceramic assemblages from a recent archaeological salvage project in the Pa Sak River valley in the Central Plain of Thailand as a case study on ceramic chronology for several reasons.

First, this is the first time that sites in this area have been intensively and systematically excavated. A relatively large number of pottery sherds were recovered, but little or no detailed analysis has been done. This has provided me with an excellent opportunity to work on a number of collections from a single area.

Second, because the ceramic collections come from the same relatively small area, it is likely that stylistic variation is a product of change through time, rather than being attributable to functional or geographic differences (see Duff 1996; Dunnell 1970; Marquardt 1978; O'Brien and Lyman 1999 for a full discussion of seriation method).

Third, the transition from the prehistoric to the proto-historic period (2000 B.C. to ca. A.D. 500) in Southeast Asia and Thailand witnessed several major changes in sociopolitical organization, settlement pattern, and subsistence strategy. In central Thailand, these changes seem to continue until the early historic period known as the Dvaravati period (6th-10th centuries A.D.). This period saw a number of new developments such as the adoption of certain foreign characteristics, the expansion of trade networks, the sociopolitical reorganization, and the emergence of early urban societies. For example, there was a shift from late prehistoric upland settlements to moated settlements near river valleys in early historic times (see Mudar 1993; Vanasin and Supajanya 1981). There were also changes in subsistence patterns from hunting,

collecting, and early plant domestication to intensive rice cultivation (e.g., Bronson and Dales 1972; Mudar 1995; Natapintu 1995). The formation of a settlement hierarchy (Mudar 1999) is an example of new developments relevant to sociopolitical reorganization during this time.

Fourth, although a number of archaeological studies have been conducted in the Central region for more than two decades (see e.g., Wales 1969; Daeng-iet 1978; Ho 1984; Sillapee 1985; Siripanich 1985; Ciarla 1992; Koraneekij 1995; Office of Archaeology and National Museums 1997; Bhumadhon 1999; Mudar 1993, 1999), there has been a dearth of refined chronological analysis. Given the accepted time span of the late prehistoric and early historic period (2000 B.C.- A.D. 500), it is highly likely that major changes would have taken place as more complex cultures developed. Although many late prehistoric and early historic period sites have been excavated, their temporal placement is often poorly understood. There is no fine-grained internal chronology for this interval of several thousand years.

In summary, this paper provides dual contributions. First, it makes a methodological contribution by demonstrating the utility of the seriation technique. Second, it makes a substantival contribution by providing a better timeline for tracking important changes in Thailand's prehistoric and early historic past.

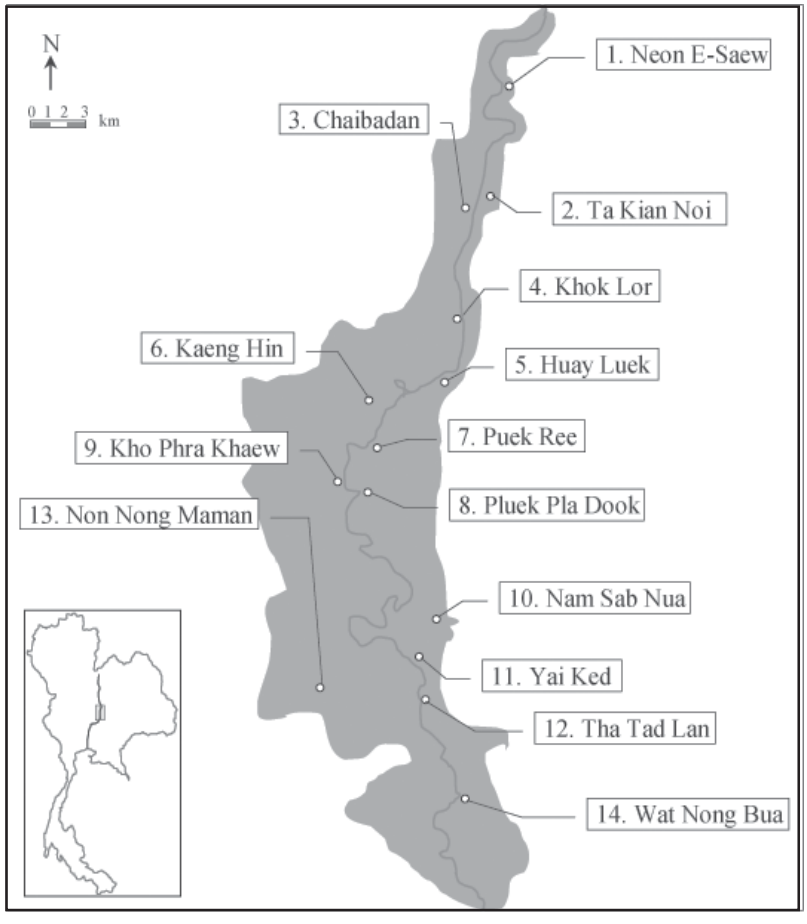

Fig. 1 Location of archaeological sites included in this study (adapted from Fine Arts Department 1997 : 17).

The Database

This paper focuses on the seriation of ceramic assemblages using non-metric attribute data (e.g., surface treatment, form, shape). The attribute data come from decorated and undecorated body sherds. Rim sherds are not believed to be a good indicator of temporal variation because it is difficult to consistently distinguish vessel forms from the rim sherds (see also Lertrit 2001). Therefore, rim sherds are not included in this analysis. Plain sherds

are included in this analysis because of the possibility that their frequency is time sensitive. The decorated body sherds selected for attribute data-recording are large enough to identify the presence or absence of the targeted attributes. I recorded surface attributes for all sherds larger than 2 cm in maximum linear dimension, and also for sherds smaller than 2 cm if they had clearly identifiable attributes. The majority of the sherds I recorded were larger than 2 cm.

I also checked the numbers of sherds in the existing collections against the numbers recorded by the Buranrak in their site reports, which present these data typologically. I found that there were some inconsistencies in the number of sherds in collections and number of sherds mentioned in the site reports. In most cases, the number of sherds in the existing collection was slightly larger than those in the site reports. This is probably because some of the sherds were broken during transportation from the sites in Lopburi Province to storage rooms in Ayutthaya Province, resulting in more fragments of pottery. For this study, I relied on my own analysis for the number of sherds from each provenience and site.

The total number of valid sherds (the sherds that are large enough for study) from each site used in this analysis is presented in Table 1. Both weight and count of decorated body sherds are recorded. Previous studies of ceramic samples from archaeological sites in Thailand have shown that surface treatment attributes, fabric, temper, and vessel form reflect changes through time (cf. Bayard 1977; Mudar 1993 : 95-140; Rispoli 1997; Siripanich 1985). For example, Siripanich (1985) found that relative frequency of forms of whole vessels (n=102) excavated in 1982 from the stratified site of Tha Kae (3 cultural layers and 8 stratigraphic layers) in the Lopburi region changed over time. She found that pedestal bowls dominated the collection in the early period (late Neolithic period), large bowls, jars and pots with vertical neck were more common in the middle period (Metal age), and the “Dvaravati pottery” types such as kettles, lamps, and pots with wide rims and acute carination were dominant in the late period (Early Historical

period). However, in my study, most sites did not yield very many whole vessels. I therefore concentrated on attributes commonly observable on sherds.

The decorated body sherds were recorded for 9 variables, including cord-marking, incising, excising, stamping, slipping, burnishing (polishing), hand-kneading, and multi-designing. These attributes are relatively common and showed enough inter-assemblage variation to suggest that they might be temporally sensitive. Only one attribute was recorded for each sherd. In the instances where more than one attribute appeared on a sherd, I assigned it to the multi-design category. I also recorded additional attributes (such as punching and appliqué) but discarded them because they were too rare. So these sherds were excluded from the analysis.

The sherds are primarily classified into assemblages on the basis of stratigraphy and the similarity of associated artifacts. The result is a total of 16 ceramic assemblages as two sites (Chaibadan and Puek Ree) include more than one ceramic assemblage. The 16 ceramic assemblages consist of Chaibadan Phase 1, Chaibadan Phase 2, Huay Luek, Kaen Hin, Kho Phra Khaew, Khok Lor, Nam Sab Nue, Noen E-Saew, Non Nong Maman, Pluek Pla Dook, Puek Ree Phase 1, Puek Ree Phase 2, Ta Kien Noi, Tha Tad Lan, and Wat Nong Bua. These assemblages represent the major and/or the initial occupation layers of each of the sites. I chose not to include assemblages derived from stratigraphic layers that were disturbed by recent natural and human activities, most of which are topmost layers.

Characteristics of the Assemblages

The sherds used in this study came from test excavations. At most of the sites, looting has destroyed major areas that likely contained abundant ceramics. This situation often forced the excavators to select only "left over" areas for excavations, resulting in some cases in relatively small samples. Sample size is also

affected by the inconsistent scale of test excavation. Some sites (such as Puek Ree and Chaibadan) were relatively intensively excavated (more than 4 test units of 2x2 and 3x3 m), while some were excavated with only one or two test units, resulting in different amounts of sherds. However, sample size is also affected by site size, accumulation rate, and occupation span (e.g., Blinman 2000; Varien and Mills 1997). In general, my sample sizes are adequately large. There are a few that may be suspect because of small samples (such as Khok Lor, Ko Phra Kaew, Ta Kian Noi, and Tha Tad Lan).

Table 1 Collections Included in the Analyses.

Assemblage	Context	Total Plain Sherds	Total Decorated Sherds	Total Sherds
Chaibadan-Phase I	Habitation	7891	4683	**12574**
Chaibadan-Phase II	Habitation	1322	234	**1556**
Huay Luek	Habitation	2000	287	**2287**
Kaeng Hin	Habitation	2350	1288	**3638**
Khok Lor	Habitation	266	104	**370**
Ko Phra Kaew	Habitation	198	215	**413**
Nam Sab Nua	Habitation	989	667	**1656**
Noen E-Saew	Habitation	3719	1530	**5249**
Non Nong Maman	Habitation	838	942	**1780**
Pluek Pla Dook	Habitation	1138	314	**1452**
Puek Ree-Phase I	Habitation	5219	3795	**9014**
Puek Ree-Phase II	Habitation	4188	1054	**5242**
Ta Kian Noi	Habitation	182	71	**253**
Tha Tad Lan	Habitation	220	147	**367**
Wat Nong Bua	Habitation	2017	3751	**7568**
Yai Ked	Habitation	441	1190	**1631**
Total Sherd Counts		**32978**	**20272**	**55056**

Note : Assemblages are placed in alphabetical order.

The paucity of whole or reconstructable vessels in the archaeological assemblages I am working with led me to exclude vessel form, even though this attribute may be temporally sensitive. Although it can be argued that some rim types and body sherds are relevant to certain forms of vessels, it is also possible that rim types represent more than one vessel form or shape. This has been proved to be true in central Thailand when Mudar (1993 : 98) found that her rim profiles could not be related to particular body shapes.

It should be remembered that some surface treatment attributes included in the study (such as slipping, painting, and burnishing) are subject to surface erosion and weathering as a result of exposure and/or cleaning methods used after excavations. The samples used in this analysis are earthenware sherds and some showed evidence of weathering. Presence or absence of painting, slipping, and burnishing was observed by naked eye assisted in some cases by a hand-held lens.

Although a number of burials were excavated at some sites, all the ceramic assemblages used in this study come primarily from one major type of context : the habitation or domestic context. The assemblages are considered as domestic context because they were found in association with a variety of archaeological remains and features such as charcoal, faunal remains, tools for household use (ax, knife, grinding stones, and spindle whorls) and, in some sites, postholes.

Methods of Study

I tabulated selected surface-treatment attributes and used these attributes to characterize assemblage. Attribute-based seriation, rather than type-based seriation, was used for the reasons that attribute data are derived from less subjective definition, including metric and non-metric attributes. Attribute-based seriation may be most appropriate where one can notice change in artifact style at relatively fine-grained level.

After that, I seriated the assemblage using correspondence analysis (CA). Correspondence analysis is a multivariate analytical technique that shows promise for use in assemblage seriation. It is a technique that helps display rows and columns of a two-way contingency table as points in corresponding low-dimensional vector space that are readily interpretable when displayed graphically (Baxter 1994; Bolviken et al. 1982; Greenacre 1994; Madsen 1988). Correspondence analysis (CA) has been widely used in Europe, and has been increasingly employed in American archaeology in the 1990s, especially in ceramic research (Ortman 1995; Duff 1996; Clouse 1999; Heidke and Miksa 2000; Lipe and Ortman 2000).

I checked my results against stratigraphic information where available. Temporal indicators such as index pottery, as well as radiocarbon dates, associated with the assemblage and/or similar one located outside the study area in central Thailand were also employed to check my results. A rank- order correlation analysis was used to compare the seriation-based sequence with a temporal ordering of the sites based on these latter criteria.

Results

The ceramic assemblages were tabulated on the basis of their raw counts and percentage attribute frequency distributions (see Table 2). Then the assemblages were seriated using correspondence analysis (CA), a dimension-reduction technique that has been shown to be successful in dealing with frequency data matrices (Bolviken et al. 1982; Ortman 1995; Shennan 1997).

Cross-tabulations of frequency distribution of surface treatments is presented in Table 2. Table 2 displays the cross-tabulation of attributes by assemblages for the decorated and non-decorated body sherds in my samples. Most assemblages do not contain all observed attributes, and some attributes (slipping, polishing, and hand-kneading) are absent from several assemblages. These less commonly- observed attributes are included in the analysis because they seem to contain temporal distribution.

Plain sherds were included in the attribute matrix. It was first speculated that distribution of plain sherds relative to other attributes would remain largely constant given that plain sherds constitute the majority of total body sherds from almost all assemblages. However, it was found that relative percentage of plain sherds apparently shows a steady change from one assemblage to another through time.

Correspondence analyses of both counts and percents for surface-treatment attributes were performed using the Statistica program. In this analysis, I focus mainly on CA of surface treatment attribute counts since this analysis seemed to work better than did that for the percents. This is probably due to the nature of CA, which emphasizes shape rather than size (Baxter 1994 : 107-139).

The basic results of CA of surface treatment attributes are presented in Table 3. It appears that CA of surface-treatment attribute counts produces a good chronology because the CA of surface treatment counts puts both sites with two phases (Chaibadan and Puek Ree) in their known correct order and the percentage of inertia accounted for by the first axis is greatest in this case. This ordering also helps us to define positive value on Axis 1 as indicating early deposits, and negative values, late deposits.

Second, the order of assemblages, as placed along Axis I in this analysis, is roughly similar to their relative positions based on independent archaeological and stratigraphic information (Table 4). The 16 assemblages (column B in Table 4) were placed in a rough chronological order based on stratigraphy and on the occurrence of artifact types thought to indicate general period or age. We can see from both chronologies that early sites such as Yai Ked, Non Nong Maman, Wat Nong Bua, and Tha Tad Lan are chronologically placed near the positive pole of Axis 1, while sites such as Pluek Pla Dook, Nam Sab Nua, and Huay Luek are at its opposite end, in accordance with their apparently later dates.

Table 2 Surface-Treatment Attributes of Plain and Decorated Body Sherds by Assemblage.

Assemblage	Variable									
	Pn	Cm	Ic	Ec	St	Sl	Pl	Hk	Md	Row Totals
Chaibadan-Phase I	7891	2381	499	53	542	49	1149	0	10	12574
	62.8	*18.9*	*4.0*	*0.4*	*4.3*	*0.4*	*9.1*	*0.0*	*0.1*	*100.0*
Chaibadan-Phase II	1322	106	40	3	56	2	23	2	2	1556
	85.0	*6.8*	*2.6*	*0.2*	*3.6*	*0.1*	*1.5*	*0.1*	*0.1*	*100.0*
Huay Luek	2000	62	87	0	130	0	0	0	8	2287
	87.5	*2.7*	*3.8*	*0.0*	*5.7*	*0.0*	*0.0*	*0.0*	*0.3*	*100.0*
Kaeng Hin	2350	1080	2	0	2	0	0	0	204	3638
	64.6	*29.7*	*0.1*	*0.0*	*0.1*	*0.0*	*0.0*	*0.0*	*5.6*	*100.0*
Khok Lor	266	102	1	1	0	0	0	0	0	370
	71.9	*27.6*	*0.3*	*0.3*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*100.0*
Ko Phra Kaew	198	211	2	0	2	0	0	0	0	413
	47.9	*51.1*	*0.5*	*0.0*	*0.5*	*0.0*	*0.0*	*0.0*	*0.0*	*100.0*
Nam Sab Nua	989	137	300	31	199	0	0	0	0	1656
	59.7	*8.3*	*18.1*	*1.9*	*12.0*	*0.0*	*0.0*	*0.0*	*0.0*	*100.0*
Noen E-Saew	3719	841	655	0	34	0	0	0	0	5249
	70.9	*16.0*	*12.5*	*0.0*	*0.6*	*0.0*	*0.0*	*0.0*	*0.0*	*100.0*
Non Nong Maman	838	747	87	0	15	0	0	0	93	1780
	47.1	*42.0*	*4.9*	*0.0*	*0.8*	*0.0*	*0.0*	*0.0*	*5.2*	*100.0*
Pluek Pla Dook	1138	78	81	7	123	0	16	9	0	1452
	78.4	*5.4*	*5.6*	*0.5*	*8.5*	*0.0*	*1.1*	*0.6*	*0.0*	*100.0*
Puek Ree-Phase I	5219	3087	74	7	555	0	45	4	23	9014
	57.9	*34.2*	*0.8*	*0.1*	*6.2*	*0.0*	*0.5*	*0.0*	*0.3*	*100.0*
Puek Ree-Phase II	1058	487	58	3	460	0	33	13	0	2112
	50.1	*23.1*	*2.7*	*0.1*	*21.8*	*0.0*	*1.6*	*0.6*	*0.0*	*100.0*
Ta Kian Noi	182	56	3	0	7	0	2	0	3	253
	71.9	*22.1*	*1.2*	*0.0*	*2.8*	*0.0*	*0.8*	*0.0*	*1.2*	*100.0*
Tha Tad Lan	220	145	2	0	0	0	0	0	0	367
	59.9	*39.5*	*0.5*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*100.0*
Wat Nong Bua	2017	3374	53	0	70	27	56	0	171	5768
	35.0	*58.5*	*0.9*	*0.0*	*1.2*	*0.5*	*1.0*	*0.0*	*3.0*	*100.0*
Yai Ked	441	1061	17	9	16	45	2	0	40	1631
	27.0	*65.1*	*1.0*	*0.6*	*1.0*	*2.8*	*0.1*	*0.0*	*2.5*	*100.0*
Column Totals	29848	13955	1961	114	2211	123	1326	28	554	50120
	59.6	*27.8*	*3.9*	*0.2*	*4.4*	*0.3*	*2.6*	*0.1*	*1.1*	*100.0*

Pn= Plain; Cm= Cord-marked; Ic= Incised; Ec= Excised; St= Stamped; Sl= Slipped; Pl= Polished; Hk= Hand-kneaded; Md= Multidesign

Row percentage in italic

Table 3 Results of Correspondence Analysis of Surface Treatment Attribute Counts with Sites Sorted in Decreasing Order of Axis 1 Score

Assemblages	Axis 1 (50.16% of Inertia)	Axis 2 (17.03% of Inertia)
Yai Ked	0.894	-0.061
Wat Nong Bua	0.721	-0.006
Ko Phra Kaew	0.486	0.038
Non Nong Maman	0.423	0.227
Tha Tad Lan	0.264	0.084
Kaeng Hin	0.256	0.198
Puek Ree-Phase I	0.132	0.018
Khok Lor	0.034	0.116
Ta Kian Noi	-0.060	0.101
Puek Ree-Phase II	-0.205	-0.136
Chaibadan-Phase I	-0.245	-0.345
Noen E-Saew	-0.327	0.368
Chaibadan-Phase II	-0.414	0.107
Huay Luek	-0.500	0.212
Pluek Pla Dook	-0.513	0.132
Nam Sab Nua	-0.616	0.353

Table 4 Comparison of Suggested Chronological Orderings of Assemblages Based on Correspondence Analysis of Surface Treatment Attributes (A) and Archaeological Artifact Correlation (B).

A	B
Early	**Early**
Yai Ked	Noen E-Saew
Wat Nong Bua	Yai Ked
Ko Phra Kaew	Tha Tad Lan
Non Nong Maman	Non Nong Maman
Tha Tad Lan	Ta Kian Noi
Kaeng Hin	Wat Nong Bua
Puek Ree-Phase I	Kaeng Hin
Khok Lor	Khok Lor
Ta Kian Noi	Ko Phra Kaew
Puek Ree-Phase II	Puek Ree-Phase I
Chaibadan-Phase I	Chaibadan-Phase I
Noen E-Saew	Puek Ree-Phase II
Chaibadan-Phase II	Chaibadan-Phase II
Huay Luek	Huay Luek
Pluek Pla Dook	Pluek Pla Dook
Nam Sab Nua	Nam Sab Nua
Late	**Late**

On the other hand, there are a few inconsistencies evident in Table 4. Noen E-Saew appears to be the assemblage that shows the most serious inconsistency (as it appears "late" in the rank-order based on CA result in column A, but shows up as the earliest assemblage in column B). Based on archaeological evidence, Noen E-Saew is relatively dated to the Neolithic Period on the basis of a lack of bronze artifacts and the presence of polished stone tools. It should be contemporaneous with the site of Yai Ked, given their similarity in artifact classes. There is one reason to believe that data from Noen E-Saew are not completely comparable with data from the other assemblages. The site of Noen E-Saew is located at the extreme northern limit of the study area (see Figure 1), and may belong to a cultural tradition different from the other sites in the analysis. As noted by Dunnell (1970 : 315), a successful seriation should be based on attributes that demonstrate little variation in space. This may be a reason why Noen E-Saew does not fit in the suggested chronological order.

The next step in assessing the validity of this ordering was to calculate rank-order correlation coefficients between the ordering for the assemblages given in Column B of Table 4 and the order of these assemblages on the two axes derived from the CA.

The assemblages in column B of Table 4 were first regrouped into 7 chronological ranks as shown in Table 5. Kendall's tau beta shows a relatively strong and significant correlation 0. 526 (p=0.007) between these ranks and the placements for these assemblages on Axis1 of the CA, implying that the Axis 1 score reflects a chronological sequence of assemblages.

Table 5 The "Traditional" Chronological Rank Order of Assemblages.

Assemblage	Suggested Chronology	Rank
Early		
Noen E-Saew	Neolithic	7
Yai Ked	Neolithic	7
Tha Tad Lan	Late Neolithic	6
Non Nong Maman	Early Bronze Age	5
Ta Kian Noi	Early Bronze Age	5
Wat Nong Bua	Bronze Age	4
Kaeng Hin	Bronze Age	4
Khok Lor	Late Prehistoric?	3
Ko Phra Khaew	Late Prehistoric?	3
Puek Ree-Phase I	Iron Age	2
Chaibadan-Phase I	Iron Age	2
Puek Ree-Phaes II	Early Dvaravati	1
Chaibadan-Phase II	Early Dvaravati	1
Huay Luek	Early Dvaravati	1
Pluek Pla Dook	Early Dvaravati	1
Nam Sab Nua	Early Dvaravati	1
Late		

Note : This "traditional" sequence is based on cross-dating and diagnostic artifacts, not on the CA results.

The Proposed Chronology for the Pa Sak River Valley

Based on the combination of results of correspondence analysis of surface treatment attributes, archaeological artifact correlation, stratigraphic information, and regression analysis, a chronological ordering of assemblages from the Pa Sak River valley is proposed, and divided into three periods as Early, Middle, and Late (Table 6). I collated the 16 assemblages into 3 periods because I am concerned that considering this as a sequence of 16 assemblages maybe overly precise given the general state of knowledge about the period. Obviously, both the 3-way periodization, and the 16-way seriation, need to be tested via radiocarbon dates. Until this done, I favor a more conservative ordering of these assemblages. It appears that the ordering of assemblages crosscuts older traditional periods (i.e., Neolithic and Bronze age). I am aware of this problem, but, based on seriation results and archaeological data, I suggest that these older periods mash considerable continuity of population and culture. This is suggested to me by the fact that several Bronze and Iron-age sites (Chaibadan, Non Nong Maman, Puek Ree, Ta Kian Noi, and Wat Nong Bua) show the co-existence of artifacts characteristic of the Neolithic period (such as polished stone tools) and metal artifacts. This may suggest that no radical/absolute change in cultural materials demarcates one period from another, particularly as these changes affected life of common people on the village level, as in the assemblages studied here.

Table 6 Proposed Chronology and Rank Orders of Assemblages.

Assemblage	Proposed Period
Nam Sab Nua	Late
Pluek Pla Dook	Late
Huay Luek	Late
Chaibadan-Phase II	Late
Chaibadan-Phase I	Middle
Puek Ree-Phase II	Middle
Ta Kian Noi	Middle
Khok Lor	Middle
Puek Ree-Phase I	Middle
Kaen Hin	Early
Tha Tad Lan	Early
Non Nong Maman	Early
Ko Phra Kaew	Early
Noen E-Saew	Early
Wat Nong Bua	Early
Yai Ked	Early

.

Early Period

The line dividing this period from the Middle Period that follows is not clear cut. I use the drop in frequency of cord-marked and incised sherds as an ending point. Sites assigned to this period include Yai Ked, Wat Nong Bua, Noen E-Saew, Ko Phra Khaew, Non Nong Maman, Tha Tad Lan, and Kaeng Hin.

The Early Period is characterized by the relatively high frequency of cord-marked pottery sherds and relatively fewer plain sherds. Other surface treatments such as incising, stamping, and slipping appear but are far less common than cord-marking and plain. Two different directions of surface-treatment attribute distribution are observed. As time passed, it steadily and progressively gained in popularity and its popularity remained quite constant until the end

of the period. On the other hand, a comparatively large number of cord-marked sherds mark the initial portion of this period and then gradually decline over time. Incised decoration appears to be much less popular throughout this period but its distribution pattern is in some respects similar to that of cord-marking (excepting the sharp increase in the Non Nong Maman assemblage). Excising appeared at the beginning of the period but then disappeared. The "multidesign" decoration also appears to be temporally sensitive and to be more common in the Early Period than later. Most of these sherds probably would be described as the punctuate incising style, which may be related to Rispoli's (1997) SPID, that is found throughout mainland southeast Asia from northern Vietnam, northeast and central Thailand, Burma, Malaysia, and into island Southeast Asia. The incised, punctuated style of decoration was largely documented in late Neolithic and early Bronze age sites (ca. 2000-1400 B.C.) (e.g., Bellwood 1978:166-173: Ha Van Tan 1985; O'Reilly 1998; Rispoli 1997: 67-71). Stamping treatment is rare in the Early Period. Incised sherds are present in all assemblages, except at Non Nong Maman.

Based on the other archaeological artifacts from sites in this period, it appears that the time span of the Early Period is quite long, incorporating sites deemed to fall within both the Neolithic and the Early Bronze age. Such artifacts as polished stone tools, spindle whorls, shouldered axes, and stone bracelets are characteristic of Neolithic culture (Higham 1989; Higham and Thosarat 1998). In some cases, these artifacts co-existed with bronze artifacts, as in the sites of Wat Nong Bua and Non Nong Maman.

The Middle Period

This period is more or less a continuation of the Early Period. The overall picture is that this period witnessed a gradual change through time in the frequency distribution of cord-marked sherds. Early in the period, cord-marking was present at a high frequency,

then gradually declined through the end of the period. By contrast, incising started at a low frequency and increased gradually through time. The plain surface treatment fluctuated somewhat through time. It was originally at a relatively low frequency (but still in larger quantities than other attributes) and reached a peak at the middle of the period. The excising attribute made a return in this period. However, the frequency of its distribution does not show a remarkable change over time. Unlike excising, the stamping re-emerged at a rather high frequency and its distribution reflects greater fluctuation. Polishing was more common in this period than in the others, especially toward the end of this period, but it is not present in all assemblages. Polishing or burnishing is a widely documented attribute found on ceramics of Bronze and Iron age sites recently excavated in central and northeastern Thailand (see e.g., Aussavamas 1999; Natapintu 1988b; O'Reilly 1997; Phetyoi 1995; Siripanich 1985; Welch and McNeil 1990).

Archaeologically, this period covers the transitional period from the Bronze to Iron age. It is attested by the presence of new artifact classes such as bronze bracelets, iron axes, and beads. Polished stone tools were found in smaller numbers than in the Early Period. Similar patterns are reflected in archaeological sites located in other areas of central Thailand (Natapintu 1995; Siripanich 1985; Mankong 1989).

The Late Period

This period can also be linked to the Middle Period in terms of the surface treatment attribute distribution. There was no clear break in the frequency distribution of plain, cord-marking, incising, and stamping attributes. Incising and stamping are represented in a generally higher numbers of sherds in assemblages of this period as compared to the previous periods. Stamping exhibits a nice "battleship shaped" distribution pattern; it starts off at a low frequency and then gradually and steadily increases toward the end of the period, with its frequency peak at the end of the period.

It should be noted that stamped sherds are also present in modest percentages in the Middle Period, including the anomalously high percentage from Puek Ree-Phase II. The late popularity of stamping decoration corresponds to the high frequency of stamped ceramics in Dvaravati sites in central Thailand (such as Chansen, Donglakorn, Ku Bua, Ku Muang, Nakhon Pathom, Sab Champa, U Ta Pao, U Thong, and Wang Pai). Stamping that appears in the Late period may also well correlate with the southern intrusion of the Han empire (ca. 300 B.C.- A.D. 200) and the appearance of Han stamped ceramics in Cham sites (A.D. 100-300) in south-central Vietnam (see e.g., Glover and Yamagata 1995, 1998; Prior 1998). This is, however, not to say that the stamping reflects a Chinese intrusion into central Thailand.

The pattern of incising in the Late Period also shows a gradual increase, ending with a sharp increase in frequency represented by the assemblage from Nam Sab Nua. Miriam Stark (personal communication, 2001) notes that Late Period incising in the Pa Sak Valley resembles the shoulder decoration on spouted vessels found in her site (Angkor Borei) in southern Cambodia. This appearance also corresponds well with the Dvaravati incising found in central Thailand (Bhumadhon 1996; Indrawooth 1985).

Cord-marking is much less common in all assemblages of this period compared to those of the previous periods, and shows little fluctuation. Plain ceramics have come to be the dominant portion of all assemblages in striking contrast to the Early Period, especially. Excising, though rare, also appears at a slightly higher frequency through the time span represented by this period.

When viewed against other aspects of the archaeological record for these sites, this period seems to represent the time from the protohistoric to the early Dvaravati period (200 B.C. to A.D. 500) (see Bronson and White 1992 : 499). This period is marked by the appearance of carinated pots, glass beads, and, in fewer cases, spouted pots, which co-existed with iron artifacts and exotic objects such as gold and ivory.

Conclusions and Recommendations

The study has shown that ceramic seriation (attribute-based seriation in this particular case) can be useful in chronology construction. This research has attempted to refine the chronological sequence of archaeological sites in the Pa Sak River valley in central Thailand dating approximately from 2500 B.C. to A.D. 500. Using ceramic assemblages from 14 sites excavated by Buranrak, an archaeological contract company, during 1996-1997, I conducted a ceramic seriation and proposed a cultural sequence for the area. The research has contributed several new research directions to better understand the cultural chronology of central Thailand and other parts of the country.

I used attribute data rather than typological data in order to maintain a high degree of consistency in the analysis. In Southeast Asia, types are traditionally defined on the basis of whole vessels (e.g., Bayard 1977; Debreceny 1998). The attribute-based seriation allows higher resolution for temporal ordering of assemblages/sites because it permits a larger percentage of the ceramics from an assemblage to be used.

In this study, the attribute data are based on both surface treatments. To conduct further analyses, surface treatment attribute data sets were put in separate matrices that included both raw counts and percentages. Plain body sherds were included in the analysis because it appeared that their frequency might be temporally sensitive. Correspondence analysis was employed to discover patterning in these data that contained chronological information. This was successful for surface treatment. This was measured by the success of CA in placing the 16 assemblages in a chronological order that showed good agreement with other chronological evidence. I compared the CA results with a generalized chronology based on other temporally distinctive artifacts from these assemblages. The result of this comparison was a three-phase chronology based on the CA of surface treatment attributes, archaeological artifact correlation, stratigraphic information, and correlation coefficient analysis.

The study finds significant and strong correlations between CA-generated orderings and other "traditional" approaches such as archaeological artifact correlation and stratigraphic position. This suggests that the approach offers archaeologists an empirical means to build a reliable, though relative, temporal sequence whose outcomes can be explicitly evaluated. The selected attributes, particularly the stylistic attributes, are quite general and can be applied to earthenware assemblages throughout central Thailand and perhaps in other regions of mainland Southeast Asia, where earthenware ceramics are commonly found and the stylistic attributes are generally similar. In the absence of and also as a complement to radiocarbon dating, ceramic seriation has much to contribute to construction of chronological sequences. Seriation helps us to (relatively) date sherds (rather than whole vessels) that predominate surface assemblages.

As successfully applied elsewhere (e.g., Bolviken et al. 1982; Bech 1988; Ortman 1995), correspondence analysis has been proven in this particular case to be an efficient exploratory multivariate method for ceramic seriation. The scatterplots derived from the CA are also easy to interpret—usually acceptable seriations are inferred when CA plots exhibit a parabolic distribution (Ortman 1995) or V-shaped formation (Bech 1988). However, a CA will often produce a horseshoe-shaped distribution of sites and variables when these data represent a seriation, but they do not have to. It should be emphasized here that inferring that a seriation is represented in the results is an archaeological and not a statistical problem (Scott Ortman, personal communication, 2001; see also Baxter 1994; Bolviken et al. 1982). In addition, as it appears, CA seems to work better with count frequency data than percent frequency data.

Despite fascinating aspects of these findings, application of such a ceramic chronology method has been constrained by a number of potential limitations. Generally speaking, ceramic seriation is not applicable to every archaeological situation. For example, as shown in the case of the site of Noen E-Saew, this study suggests that seriation tends to place the assemblages in wrong order if the data

are derived from sites that are located in different geographic areas. In other words, a seriation can be interpreted to be chronological when the datasets used in the seriation were chosen from sites in the same geographic region and hence are presumably from the same cultural tradition. Noen E-Saew appears to be part of a different system, therefore falling outside of the parameters that Dunnell (1970) specifies. Results of correspondence analysis also indicate that some attribute data need to be more specifically selected.

The results of my study further suggest that stylistic variation of pottery remains such as the exterior surface treatments used in this study can be used for chronology building at the level of sherds, as well as the level of vessel.

Directions for Future Research

This research represents the first systematic attempt to ceramic seriation in Thailand in general and in central Thailand in particular. My research has now contributed to that research avenue. Though the research is successful in the ways previously described, it has been constrained by several factors and has raised some questions that need to be answered in future research. The recommendations for future research are that :

1. Additional temporally sensitive attributes should be explored. Past researches on ceramic seriation in other parts of the world have identified a variety of attributes that are considered temporal indicators. Among those common attributes are design elements, fabrics, and forming technologies, as well as metric attributes including thickness, width, length, and circumference. It is expected that these attributes are applicable to Southeast Asian and Thai ceramics. Only systematic analysis can determine which of these are good chronological indicators in particular regions and time ranges.

2. Ceramic seriations of assemblages from surrounding areas in central Thailand should be examined using the same or similar analytical techniques. Results of the seriations would provide clues to the understanding of temporal development in central Thailand

as a whole. Ceramic seriations may help prove or disprove the statement, as seriation can potentially illustrate the effects of geographic and/or ethnic as well as temporal differences.

3. Intrasite ceramic seriation should be pursued. It is hypothesized that temporal or functional differences may be reflected by seriation of contextually distinct assemblages from multi-component sites. If it is the case, such information will enhance our ability to study sociocultural change and functional diversity in particular locations.

4. Typological seriation should be undertaken. In some cases, typological data can be used in complement to attribute data for chronology-building. Both approaches are complementary approaches, rather than opposite, and should be attempted to central Thailand. It would be interesting to see whether type-based seriation will produce results comparable to those produced by attribute-based seriation.

Once these basic requirements are carried out, we should be able to go beyond the chronology and use chronological data as a temporal framework for different research topics such as settlement patterns, change in subsistence strategies, socio political organization, and so on

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