On Chronology-Building for Central Thailand through an Attribute-Based Ceramic Seriation

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ARCHAEOLOGICAL KNOWLEDGE HAS INCREASED about the prehistory and early history of Thailand during the past several decades, frequently as the result of major long-term archaeological research projects. Numerous problems have been pursued that include changes in subsistence, settlement pattern, technology, sociopolitical organization, trade, and the nature of foreign influence (Anderson 1987; Bayard 1972; Bhumadhon 1999; Bronson 1979; Charoenwongsa 1982; Gorman 1971; Higham 1998; Higham and Kijngam 1984; Mudar 1993; Natapintu 1988*a*; Nitta 1991; Santoni et al. 1990; Shoocongdej 2000; White and Pigott 1996; Wilen 1986–1987). These ambitious studies have, however, been hampered by lack of fine-grained chronologies, and 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 insufficient 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. This paper improves the cultural chronology for central Thailand by applying a quantitative seriation method to a number of late prehistoric and early historic period (c. 2000 B.C.–A.D. 500) assemblages from central Thailand.

There are several reasons to pursue ceramic chronology in central Thailand. First, a large number of ceramic materials have been discovered through systematic surveys and excavations during the past two to three decades. With an adequate sample of ceramics from a number of sites, it is worthwhile to conduct such ceramic studies. It should be noted also that the cost of radiocarbon dating is often prohibitive for Thai scholars, and that relative dating—so long as it can be anchored into some stratigraphic, dated sequences from systematic excavations—provides a viable strategy for building regional chronologies. Second, those ceramic collections exhibit enough stylistic and technological variation to indicate their potential for ceramic seriation. Third, radiocarbon dating in this area has been rare and presents potential pitfalls; ceramic chronology is another way to elucidate the temporal dimension of the archaeological record. Seriation helps to

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date surface collections, where the only absolute dating technique available is thermoluminescence, and this strategy is both expensive and not yet proven. Seriation is useful for assessing the age and significance of archaeological sites before we excavate them. Finally, as noted earlier, little work of this sort has been done in Thailand relative to that productively followed in many parts of the world. Exploratory research presented here is intended to begin to fill this archaeological gap.

Much recent archaeological research in Thailand has focused on topics such as settlement patterns (Higham and Kijngam 1984; Mudar 1993), the development of early metallurgy (Natapintu 1988*a*; Pigott and Natapintu 1988), trade–exchange patterns (Welch 1989; White and Pigott 1996), and cultural interaction (Lertrit 2002). Careful reconstruction of the chronology of sites and regions has been of secondary significance. Complicating matters further is the fact that scholars from different fields such as art history, history, and epigraphy have developed their own chronologies based on evidence specific to their fields. The result, noted by Bellwood (1992), Higham (1989, 1996), Hutterer (1982:563), and Miksic (1995), 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 is thus worth pursuing. It is believed that this 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.

In addition, much archaeological work in Thailand is done in a "salvage" context or in association with monument stabilization that does not receive much analysis or detailed reporting, and does not even have associated radiocarbon dates (e.g., Fine Arts Department 1991, 1997; Sri Thep Historical Park 1995; Yukongdi and Pantukowit 1995). Furthermore, almost all of the "salvage" and restoration work has focused on historic sites, in partial response to the promotion of tourism in the country.

The particular period of time, 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.

THE STUDY REGION AND PERIOD

This paper provides a chronological sequence for 16 prehistoric and early historic period assemblages from central Thailand (Fig. 1). Additional studies of the assemblages are beyond the scope of this study, but researchers can use the sequence to look for other changes in material culture, site characteristics, and settlement pattern of these or related sites. It is hoped that researchers can also

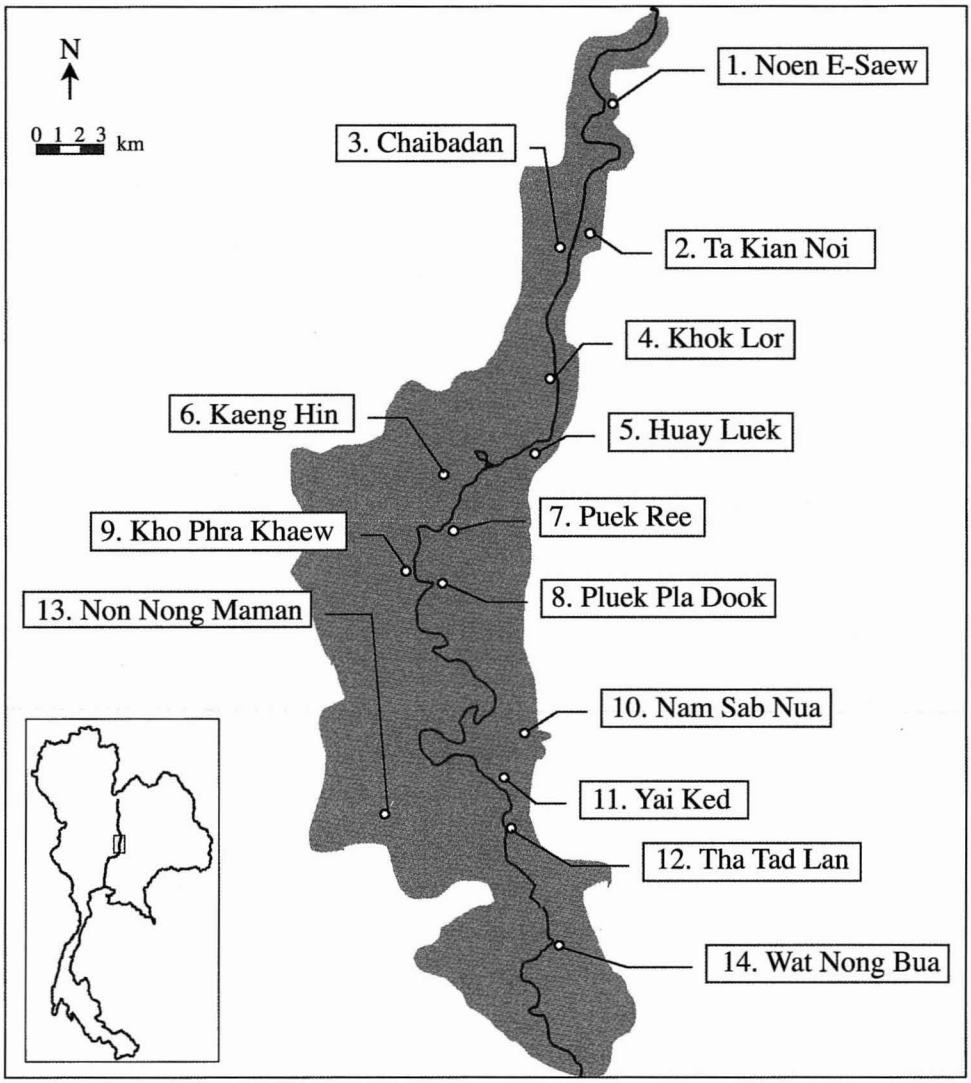

Fig. 1. Location of archaeological sites included in this study (adapted from Fine Arts Department 1997:17).

extend pottery attribute 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 (Fig. 1) were selected for this study. These assemblages were excavated in 1996–1997 by Puranrak, 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 (Puranrak 1996*a*, 1996*b*, 1996*c*, 1996*d*, 1996*e*, 1996*f*, 1996*g*, 1996*h*, 1996*i*, 1996*j*, 1996*k*, 1996*l*, 1997*a*, 1997*b*, 1997*c*, 1996*d*, 1997*e*, 1997*f*, 1997*g*). 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. These assemblages were analyzed during the summers of 1999 and 2000.

The ceramic assemblages from recent archaeological salvage projects in the Pa Sak River valley in the Central Plain of Thailand were chosen 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 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 early historic period (2000 B.C. to C. 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 Dvaravati period (sixth to tenth centuries A.D.). This period saw a number of new developments such as adoption of certain foreign characteristics, expansion of trade networks, 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). Changes also occurred in subsistence patterns from hunting, collecting, and early plant domestication to intensive rice cultivation (e.g., Bronson and Dales 1972; Mudar 1995; Natapintu 1995). Evidence for the formation of a settlement hierarchy (Mudar 1999) also suggests that important sociopolitical reorganization occurred during this time.

Obtaining a more precise understanding of the timing of these developments and their interrelationships will enhance our ability to study and understand the evolution of these early complex societies.

Fourth, although a number of archaeological studies have been conducted in the central region for more than two decades (see, for example, Bhumadhon 1999; Ciarla 1992; Daeng-iet 1978; Ho 1984; Koraneekij 1995; Mudar 1993, 1999; Office of Archaeology and National Museums 1997; Sillapee 1985; Siripanich 1985; Wales 1969), 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. No fine-grained internal chronology exists for this interval of several thousand years, not even a generally accepted subdivision of it into two or three well-accepted periods.

This paper provides two primary contributions. First, it makes a methodological contribution by demonstrating the utility of the seriation technique. Second, it makes a substantive contribution by providing a better time line for tracking important changes in Thailand's prehistoric and early historic past.

THE DATABASE

This paper focuses on the seriation of ceramic assemblages using non-metric attribute data, rather than typological data. 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). This is hampered by the lack of reference to a well-established ceramic typology in central Thailand and the lack of radiocarbon dates. 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 were sufficiently large to identify the presence or absence of the targeted attributes. 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, were recorded. The majority of the sherds recorded were larger than 2 cm.

It should be noted that the numbers of sherds in the existing collections differ from those recorded by the Puranrak in their site reports, which present these data typologically. It is found that there were some inconsistencies in number of sherds in collections and number of sherds mentioned in the site reports. In most cases, the number of sherds in the existing collections was slightly larger than those in the site reports, perhaps because some sherds were broken during transportation from the sites in Lopburi Province to storage rooms in Ayutthaya Province. However, this study relied on existing collection for the number of sherds from each provenience and site.

Table 1 presents the total number of sherds from each site that were used in this analysis. A disparity exists in sample size between collections. This is an irre-

TABLE 1. COLLECTIONS INCLUDED IN THE ANALYSIS

ASSEMBLAGE	CONTEXT	TOTAL PLAIN SHERDS	TOTAL DECORATED SHERDS	TOTAL SHERDS
Chaibadan-phase I	Habitation	7891	4683	12,574
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
Kho Phra Khaew	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		32,978	20,272	55,056

Note: Assemblages are placed in alphabetical order.

solvable issue here because the data used in this study were derived from limited excavations. The best way to control for such variability in sample size was to use only sherds from similar contexts (habitation contexts) in each of the 14 sites.

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) identified temporal changes in the relative frequency of forms of whole vessels (n = 102) excavated in 1982 from the stratified site of Tha Kae (three cultural layers and eight stratigraphic layers) in the Lopburi region. While pedestaled bowls dominated the collection in the beginning of the late prehistoric period, large bowls, jars, and pots with vertical necks were more common in the late prehistoric period. The "Dvaravati pottery" types, such as kettles, lamps, and pots with wide rims and acute carination, were dominant in the early historic period. However, the Pa Sak ceramic collection used in this study contains few whole vessels. Therefore, the study concentrated on attributes commonly observable on sherds.

Nine variables were recorded as decorated body sherds, including cord-marking, incising, excising, stamping, slipping, burnishing (polishing), hand-kneading, and multidesigning (see Fig. 2). These attributes represent three different surface treatments. Cord-marking is deemed to be a secondary forming technique. Slipping and burnishing (polishing) are considered surface finishing techniques. Finally, incising, excising, stamping, and hand-kneading are deemed decorative. Some of the most meaningful attributes involve multiple design element like SPID (scale pattern impressed decoration) (see e.g., Ha Van Tan 1985; Rispoli 1992, 1997).

These attributes are relatively common and showed enough interassemblage 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, it was then assigned to the multidesign category. Additional attributes (such as punching and appliqué), although recorded, were discarded because they were too rare. These sherds were excluded from the analysis. A description of each attribute included in this study is as follows:

Plain (Pn): Sherds without any decorations on either the exterior or interior surfaces.

Cord-marking (Cm): Sherds with impressed traces of cord or rope marks on the surface, regardless of pattern, size, and orientation of the design (Silapee 1985:46).

Incising (Ic): Sherds with incised designs (such as a line) deliberately done by free-hand incising using a sharp tool such as a knife blade, finger nail, or pointed stick (cf. Shepard 1956:195–203).

Excising (Ec): Sherds with excised designs that appear as grooves or channels on the exterior surface of sherds (see Bronson 1976:124).

Slipping (Sl): Sherds decorated with a type of liquid suspension of fine clay and water finished by dipping the vessel into the slip or by dipping wet hands into the slip and smoothing it over the vessel surface (Bronson 1976:129; Rice 1987:482). This attribute was restricted to red and/or white slipped sherds.

Stamping (St): Sherds with stamped designs on the exterior surface. The stamped

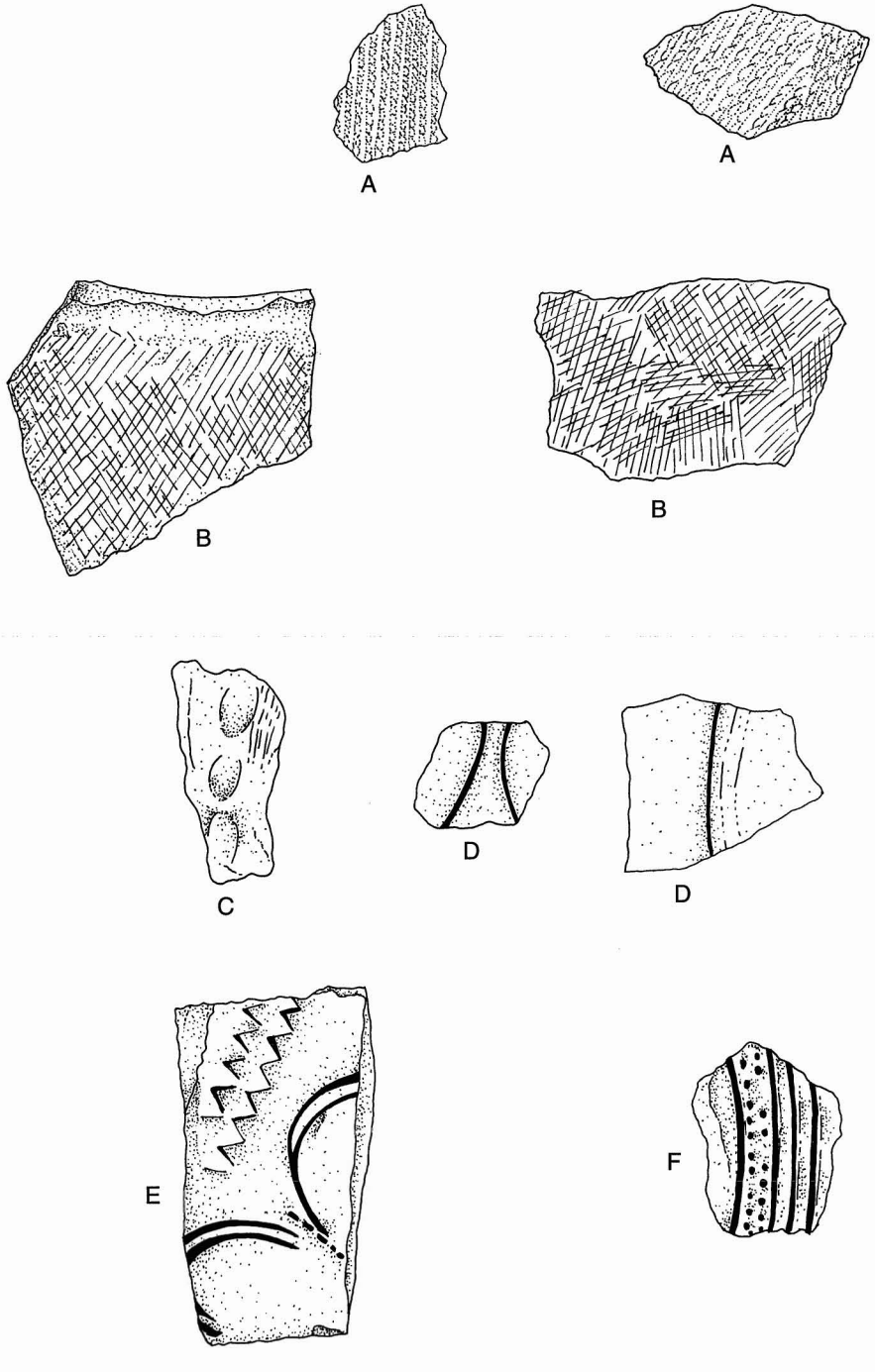

Fig. 2. Surface-treatment attributes included in this study: a: cord-marking; b: incising; c: hand-kneading; d: excising; e: stamping; f: multidesign.

designs were executed by using stamping tools such as wooden paddles bearing carved designs, continuous roulettes, and rocker roulettes (Shepard 1956:194).
Polishing (Pl): Sherds with a glossy surface as a result of polishing, burnishing, or rubbing, usually by using a pebble or a hard stone (cf. Ho 1984:40; Kramer 1997:69).
Hand-kneading (Hk): Sherds with hand-impressed designs. It is believed that the design was finished by finger-kneading leather-hard clay to make a series of rows or lines of large dots.
Multidesign (Md): Sherds bearing more than one of the surface treatments described above.

This study is primarily concerned with intersite chronology, rather than with temporal intrasite relationships. The sherds are primarily classified into assemblages on the basis of stratigraphy and the similarity of associated artifacts. Layers in some sites were lumped together based on assemblage similarity. The result is a total of 16 ceramic assemblages: 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, Kaeng Hin, Ko Phra Khaew, Khok Lor, Nam Sab Nua, Noen E-Saew, Non Nong Maman, Pluek Pla Dook, Puek Ree phase 1, Puek Ree phase 2, Ta Kian Noi, Tha Tad Lan, Wat Nong Bua, and Yai Ked. These assemblages represent the major or the initial occupation layers of each of the sites. It should be remembered that assemblages derived from stratigraphic layers that were disturbed by recent natural and human activities, most of which are uppermost layers, were not included in this study.

CHARACTERISTICS OF THE ASSEMBLAGES

The sherds used in this study derived 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 relatively small samples in some cases. 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 four test units of 2-by-2 and 3-by-3 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, Kho Phra Khaew, Ta Kian Noi, and Tha Tad Lan).

The paucity of whole or reconstructible vessels in the archaeological assemblages precluded reliance on vessel form as a ceramic attribute, 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 proven to be true in central Thailand where Mudar (1993:98) found that her rim profiles did not consistently correlate with particular body shapes. To be safe, this paper does not incorporate vessel form as an additional attribute for seriation.

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 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 the 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 domestic when 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 stone, spindle whorl) and, in some sites, postholes.

Given that the ceramic assemblages are fairly large, time and financial constraints did not permit me to conduct additional attribute measurements such as fabric, temper, and metric variables (e.g., thickness, width, length, vessel proportions, and geometric shapes). These attributes may have distinctive temporal distributions. It is hoped that these attributes will be measured more fully in future studies.

METHODS OF STUDY

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

After that, the assemblages were seriated using correspondence analysis (CA). Correspondence analysis is a multivariate analytical technique that shows promise for use in assemblage seriation. This technique displays 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 (Clouse 1999; Duff 1996; Heidke and Miksa 2000; Lipe and Ortman 2000; Ortman 1995). The CA is used in this study as an exploratory method to help order the Southeast Asian ceramic assemblages.

Results of analysis were cross-checked with stratigraphic information where available. Temporal indicators such as index pottery, as well as radiocarbon dates, associated with the assemblage or similar one located outside the study area in central Thailand were also employed to cross-check results. A rank-order correlation analysis was used to compare the seriation-based sequence with 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 tech-

TABLE 2. SURFACE TREATMENT ATTRIBUTES OF PLAIN AND DECORATED BODY SHERDS BY ASSEMBLAGES

	VARIABLE									
ASSEMBLAGE	PN	CM	IC	EC	ST	SL	PL	HK	MD	ROW TOTALS
Chaibadan-phase I	7891	2381	499	53	542	49	1149	0	10	12,574
	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*
Kho Phra Khaew	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	29,848	13,955	1961	114	2211	123	1326	28	554	50,120
	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.

nique that has been shown to be successful in dealing with frequency data matrices (Bolviken et al. 1982; Ortman 1995; Shennan 1997).

Surface treatment frequency distributions are presented in Table 2, which cross-tabulates attributes by assemblages for the decorated and undecorated 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 information.

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
Kho Phra Khaew	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

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 percentages of plain sherds show 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. This analysis focuses primarily on CA of surface treatment attribute counts since this analysis seemed to work better than did that for the percentages. 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 and Figure 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.

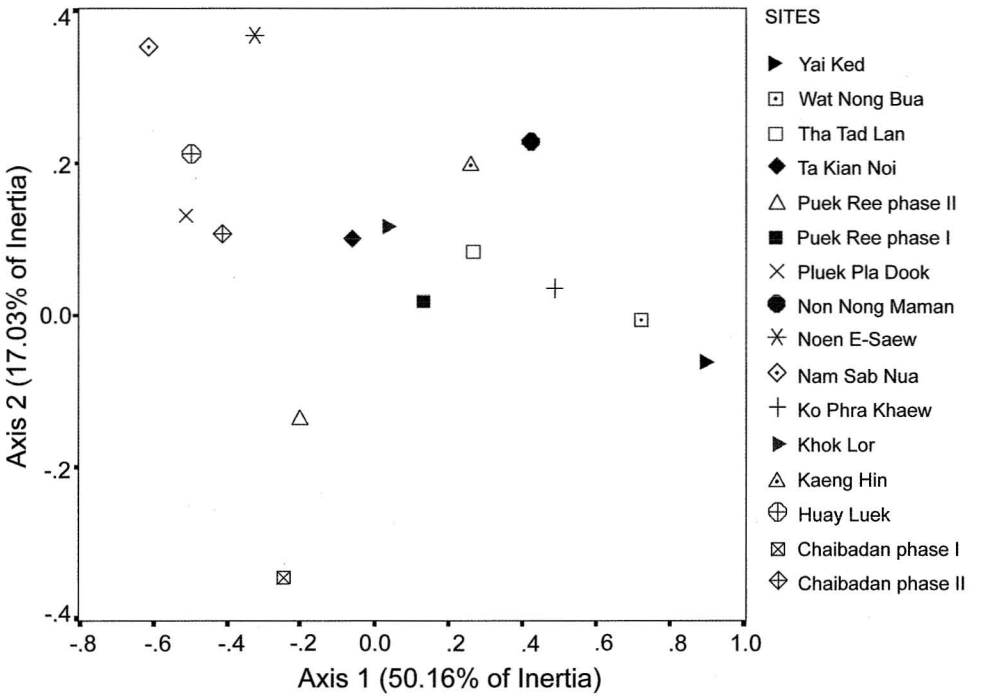

Fig. 3. Correspondence analysis plot of counts of surface-treatment attributes.

On the other hand, some inconsistencies are 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 the 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 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. Noen E-Saew is located at the extreme northern limit of the study area (see Fig. 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 the suggested chronological order. Figure 3 also shows two outliers in overall pattern (Chaibadan phase I and Puek Ree phase II). This result may be related to the unusually high amount of polished and stamped sherds. It should be remembered that Chaibadan and Puek Ree are relatively larger and were more intensively excavated than other sites included in this study. In this view, more sherds decorated with stamping and polishing techniques were uncovered for some reason (e.g., contact with nearby communities, such as Sab Champa, where stamped and polished sherds were found in great quantity [Lertrit et al. 2002]).

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
Kho Phra Khaew	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	Kho Phra Khaew
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**

The percentage distribution of surface-treatment attributes is shown in Figure 4. When Noen E-Saew is omitted for reasons discussed earlier, the patterning of incised and stamped attributes is well ordered. The anomalously high percentage of stamped-decoration sherds from Puek Ree phase II deserves to be noted. This also depresses the percentage of the other attributes. However, there are no firm grounds at present to doubt its chronological position. It appears that Axis 1 of the CA has achieved an ordering for most of the surface-treatment attributes that approximates the desired "battleship curve" shape.

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 seven chronological ranks as shown in Table 5. Kendall's tau beta shows a relatively strong and significant correlation 0.526 ($p = 0.007$; also see Fig.5*a*) between these ranks and the placements for these assemblages on Axis 1 of the CA, implying that the Axis 1 score reflects a chronological sequence of assemblages. This is further supported by the horseshoe-shaped trend in the distribution of assemblages and surface-treatment attribute counts as illustrated in Figure 6. The horseshoe-shaped pattern is very characteristic of CA (Baxter 1994; Madsen 1988; Shennan 1997). The statistical results also show that Noen E-Saew is an outlier (Fig. 5*a*). On the other hand, the Axis 2 scores (Fig. 5*b*) are unrelated to the "traditional" chronology (Kendall's tau beta = 0.009, $p = 0.963$). This indicates that the Axis 2 scores, which account for only 17.03 percent of the inertia, in any case, do not reflect chronology.

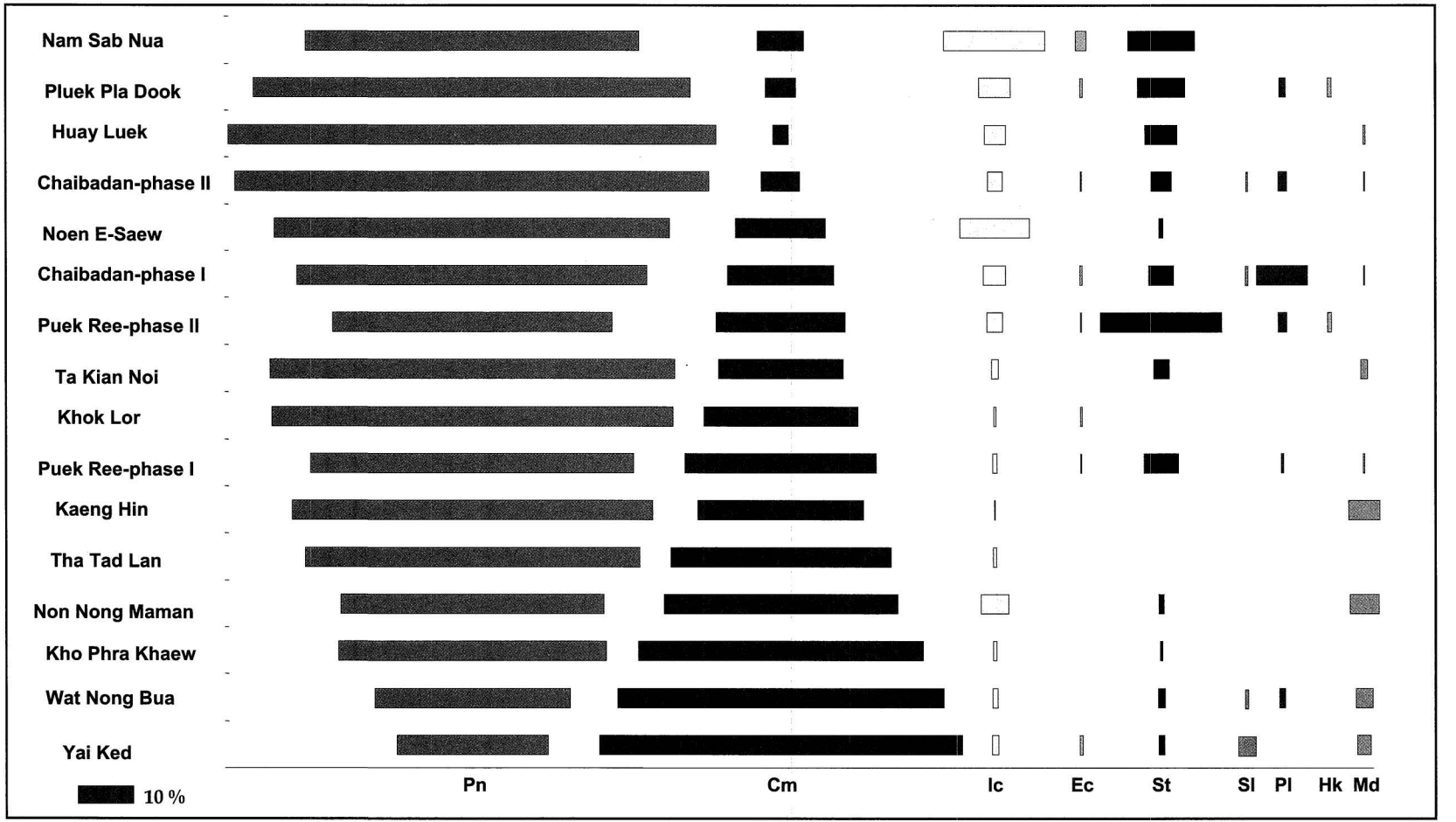

Fig. 4. Percentages for surface-treatment attributes in assemblages ordered by their placement on Axis 1 of the correspondence analysis (early sites at bottom).

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
Kho Phra Khaew	Late Prehistoric?	3
Puek Ree-phase I	Iron Age	2
Chaibadan-phase I	Iron Age	2
Puek Ree-phase 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

Combining results of correspondence analysis of surface-treatment attributes, archaeological artifact correlation, stratigraphic information, and regression analysis produces a chronological ordering of assemblages from the Pa Sak River valley. This chronology is divided into three periods as Early, Middle, and Late (Table 6). The 16 assemblages were collapsed into three periods because considering this as a sequence of 16 assemblages may be 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 is done, a more conservative ordering of these assemblages is favored. It appears that the ordering of assemblages crosscuts older traditional periods (i.e., Neolithic and Bronze Age). This problem is acknowledged; however, based on seriation results and archaeological data, it is suggested that these older periods conflate 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 coexistence 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 in central Thailand, particularly as these changes affected rural populations who produced the assemblages studied here. This is to say that, at the village or household level, most people of the Neolithic and Bronze Age in the area lived rather similar lives. To fully examine this argument, analysis of additional data is needed from different areas of the sites, including burials and elite–public precincts.

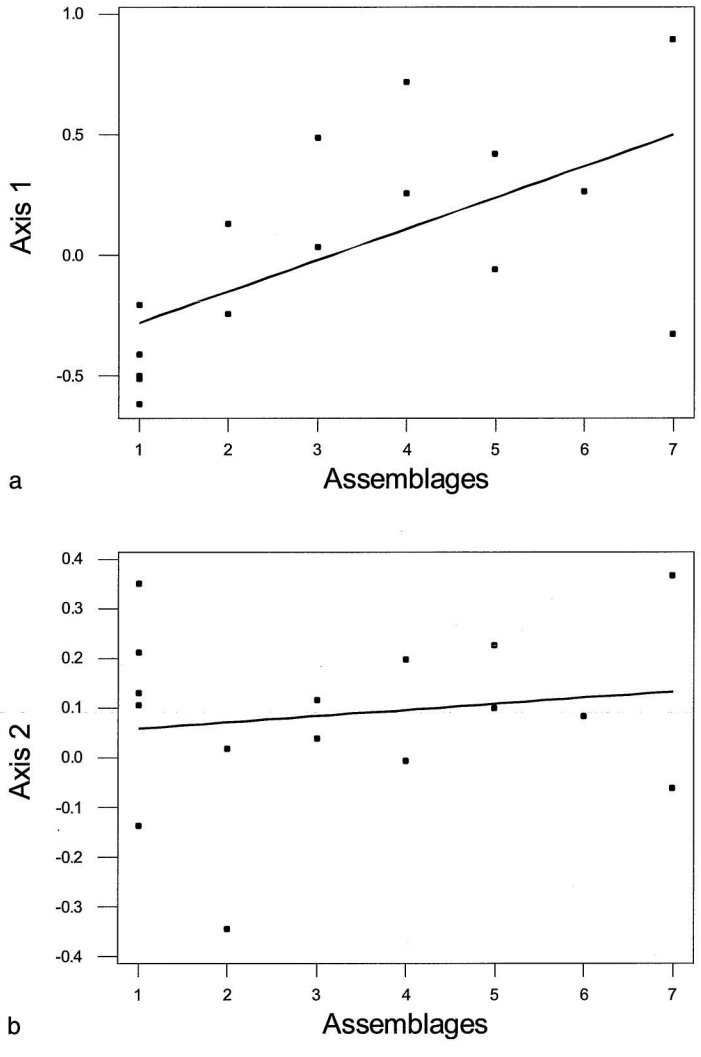

Fig. 5. Linear regression plots of the relationship between "traditional" placement of assemblages (horizontal axes) and Axis 1 (a) and Axis 2 (b) of CA-ordered assemblages based on surface-treatment attribute counts.

It should be noted that Noen E-Saew is removed from consideration in this section due to the problematic nature of the assemblage, as discussed earlier. This does not mean that Noen E-Saew is considered less important archaeologically than other assemblages. If Noen E-Saew must be included in this proposed chronology, it would be put in the Early period.

Early Period

The line dividing the Early period from the Middle Period is not clear-cut. The drop in frequency of cord-marked and incised sherds was used as an ending point.

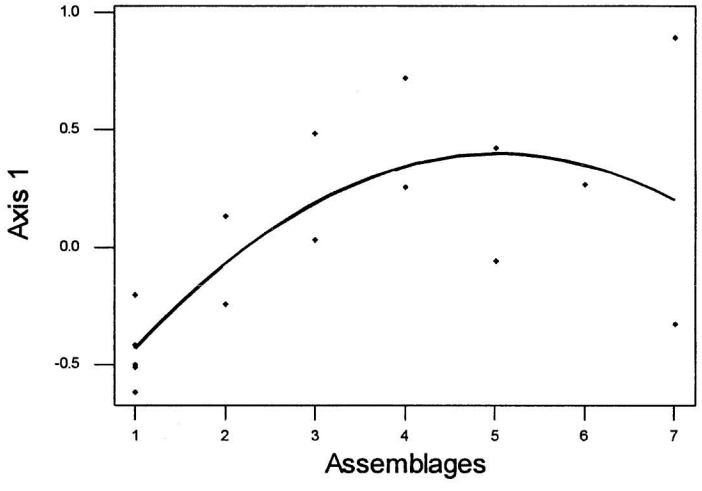

Fig. 6. Quadratic regression plot of correlation between seven rank-ordered assemblages and CA scores from Axis 1 of surface-treatment attribute counts.

Sites assigned to this period include Yai Ked, Wat Nong Bua, Kho 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-marked and plain sherds. Two different directions of surface-treatment attribute

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
Kaeng Hin	Early
Tha Tad Lan	Early
Non Nong Maman	Early
Kho Phra Khaew	Early
Noen E-Saew*	Early
Wat Nong Bua	Early
Yai Ked	Early

* The placement of Noen E-Saew in the Early period is not based on the CA of surface treatment attributes.

distribution are observed. It is shown in Figure 7 that plain surfaces were less popular than cord-marking at the beginning of the period. As time passed, plain surfaces 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. It should be noted that both attibutes were always present to some extent in the Early period assemblages. 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 appears at the beginning of the period but then disappears. 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 punctate-incising style, which may be related to Rispoli's (1997) SPID that is found throughout Mainland Southeast Asia from northern Viet Nam, Northeast and central Thailand, Burma, Malaysia, and into Island Southeast Asia. The incised, punctate style of decoration was largely documented in late Neolithic and early Bronze Age sites (c. 2000–1400 B.C.) (e.g., Bellwood 1978:166–173, 1992:127; 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 and incorporates sites that fall within both the Neolithic and the early Bronze period. Artifacts such 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 coexisted with bronze artifacts, seen in the assemblages of Wat Nong Bua and Non Nong Maman.

The Middle Period

The Middle 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 found at a relatively low frequency (but still in larger frequencies than other attributes) and reached its peak at the middle of the period. (It should be noted that, to some extent, this is the result of the anomalous character of Puek Ree phase II, which has a high frequency of stamped sherds and a correspondingly low frequency of plain sherds.) The excising attribute made a return in this period. However, its frequency distribution does not show a remarkable change over time. Unlike excising, stamping reemerged 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 exca-

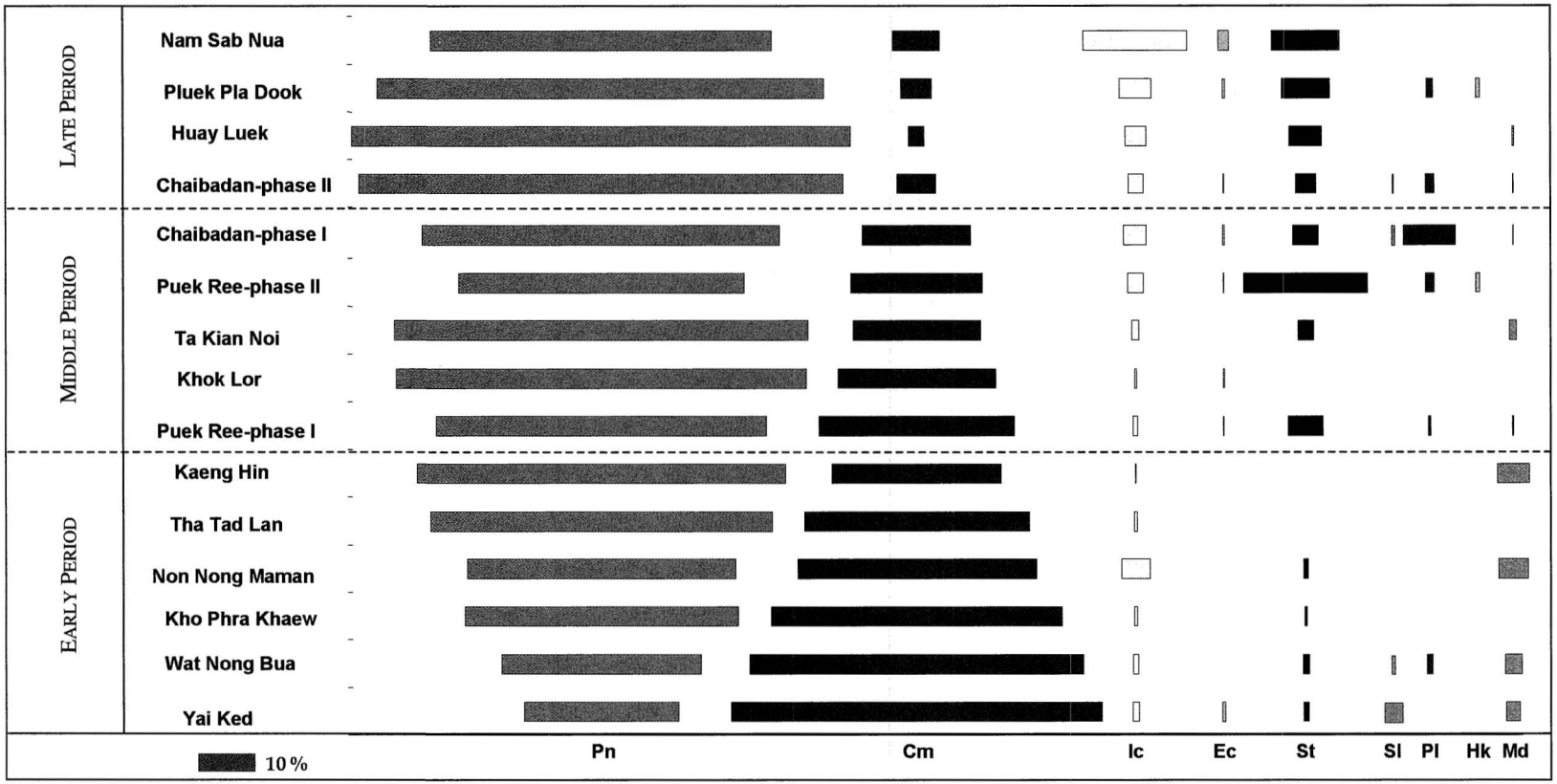

Fig. 7. Proposed chronology for the Pa Sak River valley. Sites in each period are ordered on the basis of Axis 1 scores of CA of surface-treatment attribute counts.

vated in central and northeastern Thailand (see, for example, Aussavamas 1999; Natapintu 1988*b*; O'Reilly 1997; Phetyoi 1995; Siripanich 1985; Welch and McNeil 1990). Inventory of complete and reconstructible burial vessels from the Pa Sak Valley sites (Chaibadan and Puek Ree) shows that the majority of the vessels (64 percent, N = 114 from Chaibadan; 70 percent, N = 20 from Puek Ree) were surface-polished.

Archaeologically, this period covers the transitional period from the Bronze to Iron Age. It is attested by the appearance 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 (Mankong 1989; Natapintu 1995; Siripanich 1985).

The Late Period

This period can also be linked to the Middle period in terms of surface treatment attribute distribution. No clear break occurred in the frequency distribution of plain, cord-marking, incising, and stamping attributes. Incising and stamping are represented in 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. 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 (Nakhon Sawan), Donglakorn (Nakhon Nayok), Ku Bua (Ratchaburi), Ku Muang (Singburi), Nakhon Pathom or Nakhon Chaisri (Nakhon Pathom), Sab Champa (Lopburi), U Ta Pao (Chainat), U Thong (Suphanburi), and Wang Pai (Lopburi). Previous site reports provide frequency data on stamped sherds from Dvaravati sites in central Thailand (Bronson 1976; Indrawooth 1985; Lertrit et al. 1984; Meekaew 1998; Nilakul 1985; Wilaikaew 1991). Stamping that appears in the Late period may also correlate well with the southern intrusion of the Han empire (c. 300 B.C.–A.D. 200) and the appearance of Han stamped ceramics in Cham sites (A.D. 100–300) in south-central Viet Nam (see, for example, Glover and Yamagata 1995, 1998; Prior 1998). This is not to say, however, 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. Late period incising in the Pa Sak River valley ceramics resembles the shoulder decoration on spouted vessels found in the Mekong Delta during this period (Malleret 1960; Stark 2000). 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 dominate *all* Late period assemblages in especially striking contrast to the Early

period. 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), as recently dated by Bronson and White (1992:499). This period is marked by the appearance of carinated pots, glass beads, and, in fewer cases, spouted pots, which coexisted with iron artifacts and exotic objects such as gold and ivory.

DISCUSSION

The study has shown that ceramic seriation (attribute-based seriation in this particular case) can be useful in constructing local chronologies. This research has attempted to refine the chronological sequence of archaeological sites in the Pa Sak River valley in central Thailand that date from c. 2500 B.C. to c. A.D. 500. Ceramic assemblages from 14 sites excavated by Puranrak, an archaeological contract company, during 1996–1997, were seriated and a cultural sequence is proposed 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.

Previous archaeological research in central Thailand has not placed a high priority on the construction of cultural chronologies. In particular, using ceramics to develop refined chronologies has not been a primary focus for earlier scholars, although a few archaeologists (e.g., Mudar 1993; Natapintu 1995; Rispoli 1992, 1997) working in the area have demonstrated their interest in defining temporal sequences through the analysis of stylistic change in ceramics.

The decision to focus on ceramic assemblage seriation was stimulated by a comment from Mudar (1993:217–218) who called for the refinement of the ceramic sequence using well-provenienced and well-dated excavated ceramic samples from central Thailand.

Attribute data rather than typological data were used in order to maintain a high degree of consistency in the analysis. Given that sherds rather than whole vessels constitute the majority of ceramic assemblages and sherds are difficult to assign to particular types on the basis of form, function, or other morphological categories, an attribute-based seriation was alternatively chosen. Many advocates of attribute-based approaches (e.g., Hegmon 1991; Le Blanc 1975; Marquardt 1978; Ortman 1995; Plog and Hantman 1986) argue that it is often impossible to assign individual sherds to types. In Southeast Asia, types are traditionally defined on the basis of whole vessels (e.g., Bayard 1977; Debreceny 1998). In this particular case, attribute-based seriation might be more appropriate than type-based seriation, even though the research actually ends up with units that are *de facto* types. 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 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 exploratory data analysis suggested 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. The CA results were compared 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 Early phase or period is generally marked by high percentages (ranging from 27 to 69 percent) of plain and cord-marking styles of surface decoration. Incised and punctate design, described as "multidesign," in this period is also present in small but significant numbers (3–6 percent) of sherds. Incising, excising, polishing, and stamping account for less than 3 percent in each assemblage of the period. This period is then named "Yai Ked phase" after the site of Yai Ked, which marks the bottom rank in my chronological sequence.

The Middle phase or period features the fluctuating but still high frequency of cord-marked (20–45 percent) and plain sherds (50–70 percent). Note the decrease of cord-marking during this period. Stamped sherds show an increased frequency (4–20 percent). This period can be called the "Ta Kian Noi phase" because the site of Ta Kian Noi appears in the middle of this phase.

The Late phase or period is notable for an increasing number of sherds with incising (18 percent at the highest) and stamping (12 percent at the highest) attributes. Cord-marking reduces to the range of only 3–8 percent. It is called here the "Nam Sab Nua phase" after the site which marks the end of the sequence.

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 the construction of chronological sequences. Seriation helps us to (relatively) date sherds (rather than whole vessels) that dominate surface assemblages. The seriation technique also provides us with a more systematic approach to studying technological differences in whole vessels, and allows us to link sherds to whole vessels more effectively.

As successfully applied elsewhere (e.g., Bech 1988; Bolviken et al. 1982; 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). Results of CA surface-treatment attribute plots

display a slight horseshoe shape in the placement of assemblages on the first two axes (Fig. 6). However, a CA will often, but not always, produce a horseshoe-shaped distribution of sites and variables when these data represent a seriation. 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, pers. comm. 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 the utility of this approach, application of this ceramic-based methodology is 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 may place the assemblages in the wrong order if the data are derived from sites that are located in different geographic areas. A seriation can thus confuse chronological and cultural variability. Noen E-Saew appears to be part of a different system, and thus falls 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 this study further suggest that some stylistic variation in archaeological ceramics, 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 at ceramic seriation in Thailand in general and in central Thailand in particular. This research has now contributed to that research avenue. Though the research is successful in several respects, it has been constrained by several factors and has raised some questions that need to be answered in future research. Four recommendations for future research follow.

1. Additional temporally sensitive attributes should be explored. Past research 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 similar analytical techniques. Results of the seriations could provide clues to the understanding of temporal development in central Thailand as a whole. The areas pertinent to ceramic seriations are those specified by Bhumadhon (1999), Ho (1992), and Natapintu (1995) as the Maenam Bangkham Basin, Khao Heng Talat, Khao Samphot, Khao Pho Kha, and the Takhli-Khok Samrong Undulating Terrain. These geographically restricted areas may have been occupied by people of different prehistoric and early historic cultural traditions (e.g., Vallibhotama 1986, 1992). Ceramic seriations may help

prove or disprove the statement, as seriation can potentially illustrate the effects of geographic or ethnic boundaries 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 multicomponent 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 in 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, sociopolitical organization, and so on.

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ABSTRACT

This paper seeks to build a chronology for the prehistoric period and the early historic period of central Thailand. Sixteen ceramic assemblages from 14 prehistoric and early historic archaeological sites in the Pa Sak River valley (of central Thailand) were examined using an attribute-based seriation method. Body sherds were included in the study and the attributes selected for this study are those of surface-treatment attributes. Correspondence analysis was used to seriate the 16 ceramic assemblages. Findings from this study suggest that surface-treatment attributes are temporally sensitive. The proposed chronology is thus based primarily on results of correspondence analysis of surface treatment. The final arrangement of the ceramic

assemblages corresponds closely to broad archaeological periods proposed previously by Southeast Asian archaeologists. The results of correspondence analysis, however, provide a finer-scaled chronology for the study area. This research thus contributes to a better understanding of chronological development in the Central Plain of Thailand in general and in the Pa Sak River valley in particular. The research shows the significance and efficacy of attribute-based seriation and correspondence analysis as an exploratory multivariate method in the chronological placement of archaeological assemblages in Thailand and, by extension, in Southeast Asia. KEYWORDS: Southeast Asia, central Thailand, Pa Sak River valley, prehistoric and early historic periods, ceramic seriation, correspondence analysis.