

Original Study

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Charles Franklin Higham*, Fiorella Rispoli

The Mun Valley and Central Thailand in prehistory: integrating two cultural sequences

Abstract: This paper compares the later prehistory in two regions of Thailand. The Mun Valley lies on the eastern side of the Phetchabun Range, the Lopburi Region (LR) to the west. They are linked by a major pass. While the Lopburi area is rich in copper ore, the Mun Valley has none. Quality salt is abundantly available in the Mun Valley but less so in the LR. This study explores the inter-relationships between the areas over a period of 2300 years which sharpens our understanding of both, and presents explanations and possibilities in the context of cultural transmission theories. Neolithic farmers with ultimate origins in China, arrived in the first half of the second millennium BC. Widespread exchange in prestige goods was a factor in the adoption of copper-base metallurgy in the late 11th century BC, when the LR became a producer, the Mun Valley an importer. With the Iron Age, (from about 500 BC), sites grew in size. During the course of this period, gold, silver, agate, carnelian and glass ornaments were ritually placed with dead elites. It is in these powerful and wealthy Iron Age communities that we can identify the early transition into states with population growth, agricultural intensification, conflict and increased production and competition over salt and metal for exchange.

Keywords: Prehistoric Thailand, Neolithic, rice farmers, Bronze Age, cultural transmission, elite exchange, Iron Age, mortuary ritual

Doi: 10.2478/opar-2014-0002

received April 11, 2014; accepted June 02, 2014

Introduction

Given its relatively recent development, the current literature on Mainland Southeast Asian (MSEA) prehistory is weighted in favour of preliminary site reports. However, the publication of a synthesis of over 20 years of research in the Lopburi area (LR) [1], in conjunction with the completion of a similarly lengthy endeavour in the Upper Mun Valley (UMV) of Northeast Thailand (Fig. 1), makes possible a review of their integration over a period of about 23 centuries [2-7].

During the course of approximately 115 human generations, both regions witnessed a series of profound cultural changes. The first was the interaction between long-established hunter gatherers and communities that cultivated rice and/or millet and raised domestic animals. By the 11th century BC, copper was being mined and cast in the LR, while the UMV was an importer of not only metal, but also greatly increased quantities of marine shell and marble ornaments. Six centuries later, both regions came under

***Corresponding author: Charles Franklin Higham:** Department of Anthropology and Archaeology, University of Otago, P.O. Box 56, Dunedin, New Zealand. charles.higham@otago.ac.nz

Fiorella Rispoli: International Association for Mediterranean and Oriental Studies (ISMEO), Via E. Giovenale 88, 00176 Rome, Italy. rispoli.ciarla@gmail.com

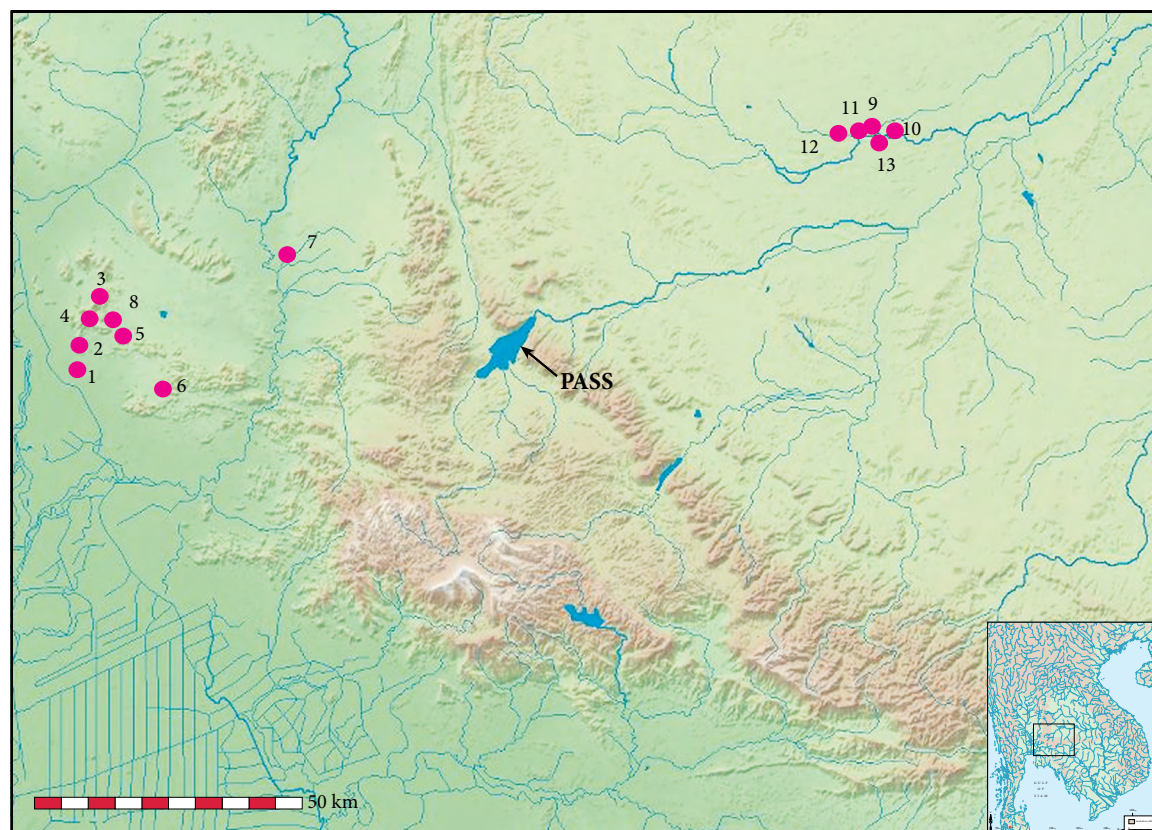


Fig. 1: The location of the two regions and the prehistoric sites. 1. Lopburi, 2. Tha Kae, 3. Non Pa Wai, 4. Nil Kham Haeng, 5. Huai Yai, 6. Khao Sai On, 7. Khok Charoen, 8. Non Mak La, 9. Ban Non Wat, 10. Ban Lum Khao, 11. Noen U-Loke, 12. Non Ban Jak, 13. Non Muang Kao.

the influence of a maritime exchange network, which brought individuals from the Indian subcontinent to Southeast Asia. New technical knowledge, customs, substances, crops and ideas presented themselves to the late Bronze Age communities. At the present state of knowledge, the aim of this paper is to integrate the two cultural sequences into a holistic overview.

However, this cannot be undertaken, other than in a very basic manner, without raising key issues of cultural transmission. One of these is the nature of the adoption of rice and millet cultivation and the raising of domestic animals. Did the initial Neolithic settlement involve a handful of newcomers who introduced new foods that stimulated prestige transmission, as noted by Mills at Zuni Pueblo [8], or was there an influx of a new population leading to integration with the resident hunter gatherers? Exploring what processes contributed to similar forms and motifs on pots between the two areas and further afield calls on the processes involved and illustrated through ethnoarchaeology in the vertical and horizontal transmission of accepted ways to form and decorate ceramics [9-11]. One of the most compelling issues in Southeast Asian prehistory is identifying the origin of metallurgy and understanding how expertise in this demanding *chaîne opératoire* spread so rapidly. What was the social impact of the exchange of copper base prestige items and casting techniques? Were there aggrandiser strategies to acquire the necessary skills, or control the new specialists? [12]. The advent of the Iron Age opened a veritable Pandora's Box of new ideas, crops, prestige goods and technological knowledge as a major maritime trading system exposed Southeast Asian communities to the civilizations of India and China. Documenting the subsequent cultural changes archaeologically is a necessary first step, explaining them through models of horizontal prestige transmission is quite another.

The Environment

The Mun River drains the southern part of the Khorat Plateau. Its many tributaries flow through a gently sloping and broad flood plain, flanked by elevated middle and high terraces. The natural vegetation over much of this area is a dry dipterocarp forest, adapted to the monsoon regime which sees a long dry season with little if any rainfall between November and April, followed by heavy rains for the rest of the year. Forest clearance on the low terrace today permits one crop of rice annually. The natural abundance of food, provided by the fish, shellfish and the wild fauna offers advantages for prehistoric settlement. The Mun River provides a natural trade route that links with the Mekong River to the east and the LR to the west by means of a pass over the Phetchabun Range. This opened access to marine shell resources, and assumed even greater significance with the Bronze Age, because there are copper mines in the LR to the west and Sepon (Laos) to the east. The UMV commands a major source of salt, a vital resource for preserving fish and as a feeding supplement for domestic stock. Finally, the UMV contains deposits of laterite iron ore some of which, to judge from the slag that covers certain prehistoric sites, was of sufficient quality to exploit. The five excavated sites in this region are Ban Lum Khao, Ban Non Wat, Non Ban Jak, Non Muang Kao and Noen U-Loke. The last four are moated, and in close proximity [5,7].

The LR, centred on the confluence of the Lopburi and Pasak rivers, presents a complementary set of assets. It had ready access to high quality marine shell, valued for jewellery during the Neolithic and Bronze Ages. The Khao Wong Prachan Valley is a source of copper ore. Strategically, it lies on the eastern side of the pass that links with the Khorat Plateau, with its many prehistoric settlements that generated demands for exotic goods, including shell and copper. The area has a tropical savannah climate, the mean annual rainfall is 1370 mm and a mean annual temperature of 28.6 °C. Between November and April, evaporation exceeds rainfall. The soil suffers annually from a long period of negative moisture balance. Archaeological surveys and excavations have identified many archaeological sites dating from the late 3rd millennium BC to the Historic Period [13]. Sites surrounded by earth ramparts and moats have been detected from the 1943-1947 Williams-Hunt collection of aerial photographs [14]. They range in size from seven to more than 50 ha and generally display an oval-to-circular shape. Usually located on the fringe of the caliche terraces or in the flood plain, none have been found in the piedmont area with its concentration of copper-smelting sites [15].

The principal excavated sites in this region are Khok Din and Noen Din in the Khao Sai On mineral district [16-17], Pong Manao [18], the large moated-site of Tha Kae (ca. 18 ha) with an uninterrupted sequence from the Neolithic to the Dvaravati period [19-27]. Nil Kham Haeng, Non Mak La and Non Pa Wai in the Khao Wong Prachan Valley [28-31]; Khok Charoen [32-35]; Sab Champa/Sab Lam Yai [36,37]; north-east of the Khao Wong Prachan Valley, Phu Noi [38,39] and Ban Mai Chaimongkol [40,41].

Chronology

The chronological framework for the UMV sites comes from three sets of radiocarbon determinations (Fig. 2). That from Ban Non Wat covers the period from initial Neolithic settlement to the early Iron Age [42]. The Iron Age is dated on the basis of determinations from the site of Noen U-Loke [43]. The determinations from Ban Lum Khao come from late Neolithic contexts. The cultural sequence at Ban Non Wat began with flexed burials dated between 1750-1050 BC. The first settlement of Ban Non Wat by Neolithic rice farmers lasted from the 17th century BC until about 1250 BC. The second Neolithic phase dates from 1250-1050 BC. The initial Bronze Age (BA) followed during the late 11th century, to be followed by a further five BA phases (1000 – 420 BC). The four Iron Age (IA) phases cover the millennium from 420 BC to about AD 600. The chronology of the LR is based on radiocarbon determinations as well as comparisons with the dated phases from other regions [1]. Although there is a broader series of divisions than in the UMV, due to the finely-grained sequence of burial phases at Ban Non Wat, there is a reassuring correspondence.

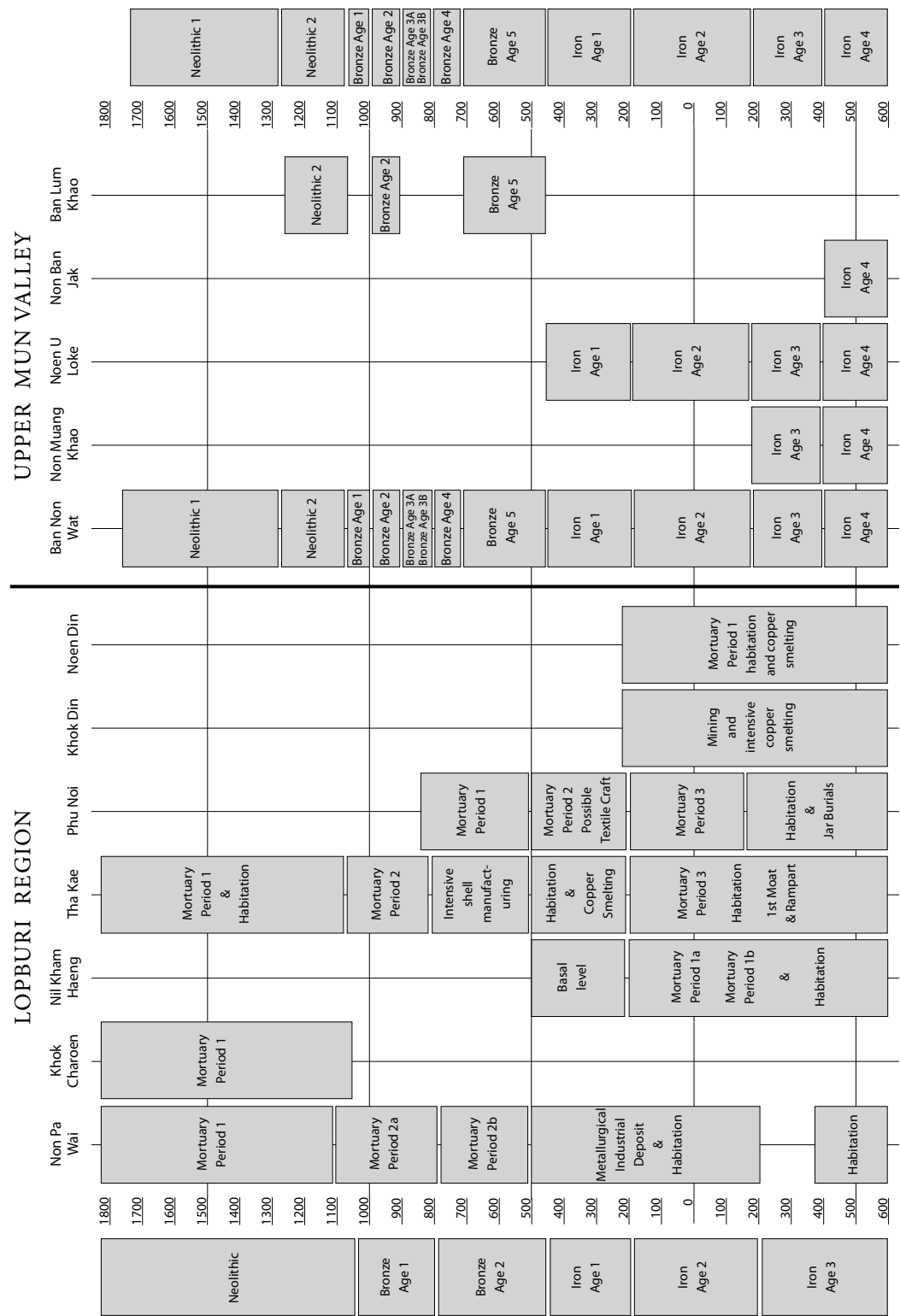


Fig. 2: The chronological relationships between the sites of the Lopburi and Upper Mun valley regions.

Flexed Burials

The indigenous hunter-gatherers of MSEA nearly always interred the dead in a flexed position. At Ban Non Wat, several such burials were associated with offerings unmatched in any of the Neolithic graves, in particular large shell beads [5, figs. 2:2-2:25]. One individual was interred with a pot distinct from Neolithic forms, and another, with a pig's cranium. Relating these to the overall sequence is not easy because there are no cases where the grave of another phase intercuts a flexed burial. However some flexed graves contained bivalve shells and three have been dated from the 18th to the 11th centuries BC. They were thus contemporary with the Neolithic occupation. A test for their separation from the Neolithic inhabitants lies in isotopic evidence for diet. At least two of those tested are distinct in this respect [45]. In Central Thailand, a flexed burial has been reported from Sab Lam Yai [36] and burial 26 at Ban Kao, a Neolithic site located about 100 km west of the LR [46]. There is, therefore, some evidence that the intrusive Neolithic farmers encountered and interacted with indigenous hunter-gatherers.

The First Farmers

The earliest Neolithic contexts in both regions come from sites in which rice or millet were cultivated, and domestic animals maintained. In the UMV, this is seen at Ban Non Wat, while in the LR, the principal settlements are Tha Kae, Khok Charoen and Non Pa Wai. There is no consensus on the timing and origins of Neolithic settlement in MSEA, three contrasting models being current. The first takes note of the recent advances in tracing the origins of the two domesticated plants, rice and millet. Fuller et al. [47] have shown that the domestication of rice was achieved by the 5th millennium BC in the lower Yangtze region, followed by a series of outward thrusts of human expansion one of which reached MSEA. Millet was domesticated in the loess lands of the Yellow River. Pigs, dogs, and probably cattle were domesticated coincidentally with rice and millet. Rispoli [48] and Zhang and Hung [49] have traced the southward expansion archaeologically on the basis of settlements that have yielded the remains of rice, millet, domestic animals, a mortuary ritual involving extended inhumation of the dead accompanied by mortuary offerings, and the decoration of ceramic vessels with incised and impressed patterns.

The earliest Neolithic context in the UMV comes from a cemetery and associated middens at Ban Non Wat. The latter reflect a broad ranging subsistence strategy that involved fishing, shellfish collecting, hunting, and the maintenance of domestic pigs, cattle and dogs. Fragments of rice also survive. The cemetery comprised 31 burials, 17 of which are adults. The prominent orientation of the extended inhumation graves has the head to the north, but one or two were directed south, and one east [50]. Two adults were interred in large, lidded pots [50, figs. 3:16 3:57]. Mortuary offerings were dominated by pottery vessels in six forms, together with pig and fish bones, stone adzes, bivalve shells and a few shell ornaments. Many pottery vessels were ornamented with incised and impressed (I&I) as well as painted designs with parallels at Tha Kae in the LR (Fig. 3). According to the isotopes in the human teeth, rice was prominent in the diet [45].

A second Neolithic phase at Ban Non Wat, dated between 1250-1050 BC, comprises 37 burials, of which 10 are infants. Most adults were orientated with the head to the east, though some were directed to the north and west [51, fig. 4:1]. Mortuary offerings were parsimonious: up to three ceramic vessels, 10 shell beads, and one person with pig bones. Two adults were accompanied by bivalve shells. The ceramic vessels were now undecorated save for cord marking and red slipping. A virtually identical set of burials and mortuary offerings has been identified at the nearby site of Ban Lum Khao, with the same chronological context [2].

The Neolithic in the LR is characterized by small communities of early agriculturalists, who exploited the riverine and mountain environments by intensive gathering of local species. Evidence of early agricultural practices is still elusive, although a few domestic rice husks and rachises were observed in the paste of red-painted potsherds from the Neolithic burials at Tha Kae. Archaeobotanical research carried out on flotation samples from Non Pa Wai in the Khao Wong Prachan Valley has identified millet early in the sequence, with domestic rice being found from the 1st millennium BC [1,52].



Fig. 3: Stemmed bowls with incised and impressed decoration from Ban Non Wat (A-C) and Tha Kae (D-E).

The first two seasons of excavations at the Neolithic site of Khok Charoen revealed a cemetery containing 28 inhumation graves [32]. Most of the dead were placed with the head to the east, though in some cases the orientation was to the north or the southeast. Again, pottery vessels were the dominant mortuary offerings. Bivalve shells, stone adzes and animal bones were also placed in the graves. There was more shell and stone jewellery than at Ban Non Wat, the range including disc beads and trochus shell bangles. The pottery forms show some similarities with Ban Non Wat, while some of the I&I designs are virtually identical, particularly that of a “stylized human” (Fig. 4).

Thirty-five inhumation burials were excavated at Non Pa Wai. Mortuary offerings included ceramic vessels with I&I decoration, disc and H-shaped shell beads, freshwater bivalve shells and stone adzes. Burial rituals at Tha Kae involved both extended supine interment in rectangular graves and lidded jar burials. Most offerings comprise ceramic vessels, polished stone adzes, shell and stone ornaments and freshwater bivalve shells. Personal ornaments parallel those found at Khok Charoen, such as small disk-shaped and H-shaped shell beads, while two disk-shaped pendants made of greyish marble and shell were found respectively at Non Pa Wai and Khok Charoen [32, figs. 11:28, 11:31]. As at Ban Non Wat, some pottery vessels were decorated with the I&I decorative style with geometric and meandering motifs, and by red-painted geometric designs on buff to pale-yellow slip [22] (Figs. 4-5).

The sites in both regions are linked by mortuary behaviour and the subsistence base, but distinguished by some details of their ceramics. In both regions, the dead were interred in extended inhumation graves accompanied by bivalve shells, stone adzes, pottery vessels and food bones. The LR had much easier access to marine shell, and this is reflected in the relative abundance of shell jewellery worn by the dead. There is hardly any evidence for exchange in exotic marine shell in the UMV other than a handful of cowries in two graves.

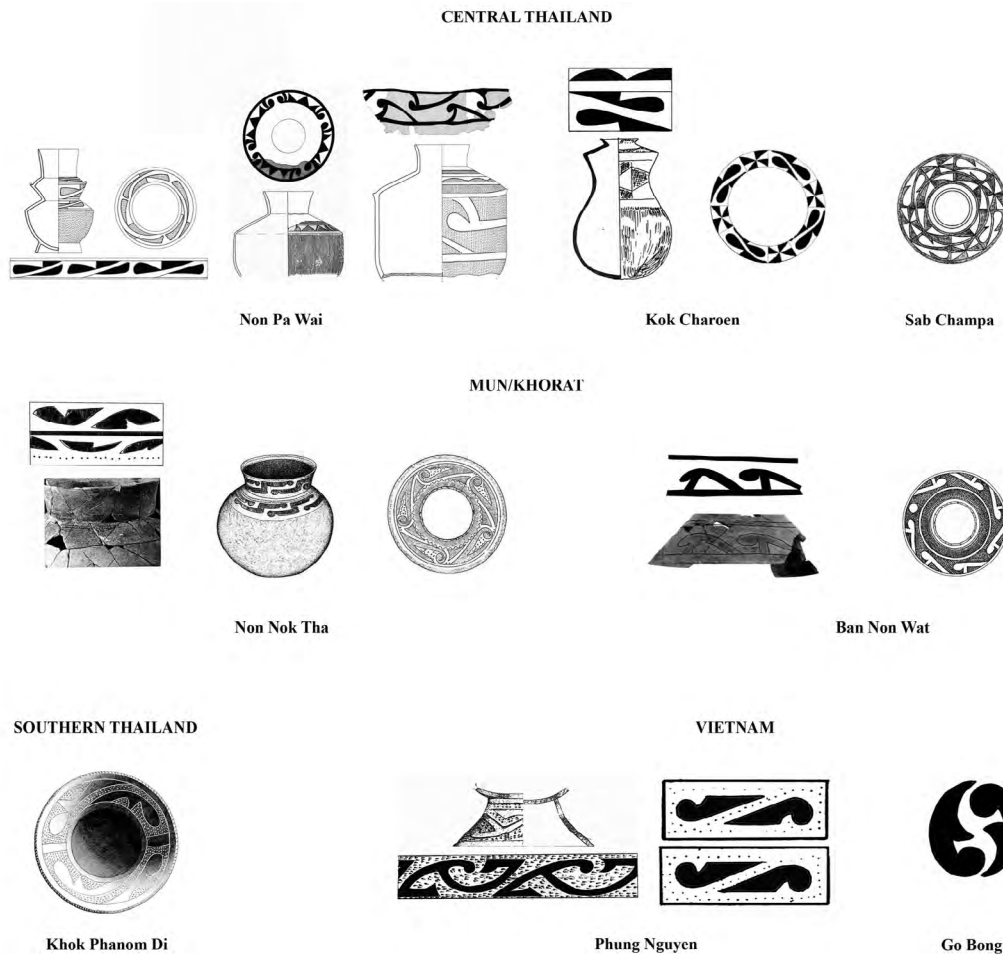


Fig. 4: The stylised human figure motif from early Neolithic sites in Southeast Asia

What do these similarities and differences reflect? A widely stressed indicator of similarity not only between these two regions, but across MSEA as a whole, is the decorative technique of incising and impressing patterns, and the chosen designs (Fig. 5). Ethnoarchaeological research relating decorative techniques to ethnic boundaries does not present a consistent model to work from. Gosselain [9] has demonstrated when comparing ceramic traditions even in closely contiguous territory, that it is the *chaîne opératoire* that is of the greatest significance. He argues against the employment of superficial decoration as a convenient method of identifying cultural boundaries, for ornamental styles that come into the orbit of a potter can be imitated, modified, rejected or manipulated. In the Cameroon, where he studied 21 potting groups divided into seven linguistic traditions, Gosselain found that the most incisive relationship between pottery traditions and ethnicity or linguistic boundaries lay in the forming process of the pot, rather than its decoration. This has been supported by Dietler and Herbich [10] in their study of ceramic traditions of the Kenyan Luo, where they too found that boundaries in style zones today are not a reliable guide to group identity.

On the other hand, Eerkens and Lipo [53] have provided an approach in terms of cultural transmission theory for the rapidity of change in design elements, such as incising and impressing patterns on ceramic vessels, that can help explain how from the same starting point, variation can be manifested. This is applicable to the similarities in techniques and basic designs, but subtle differences in the early Neolithic ceramic forms and decorative designs in their two regions. Wallaert [11], working with the Dii potters of the Cameroon, found extreme conservatism in terms of modes of decoration, and vertical transmission

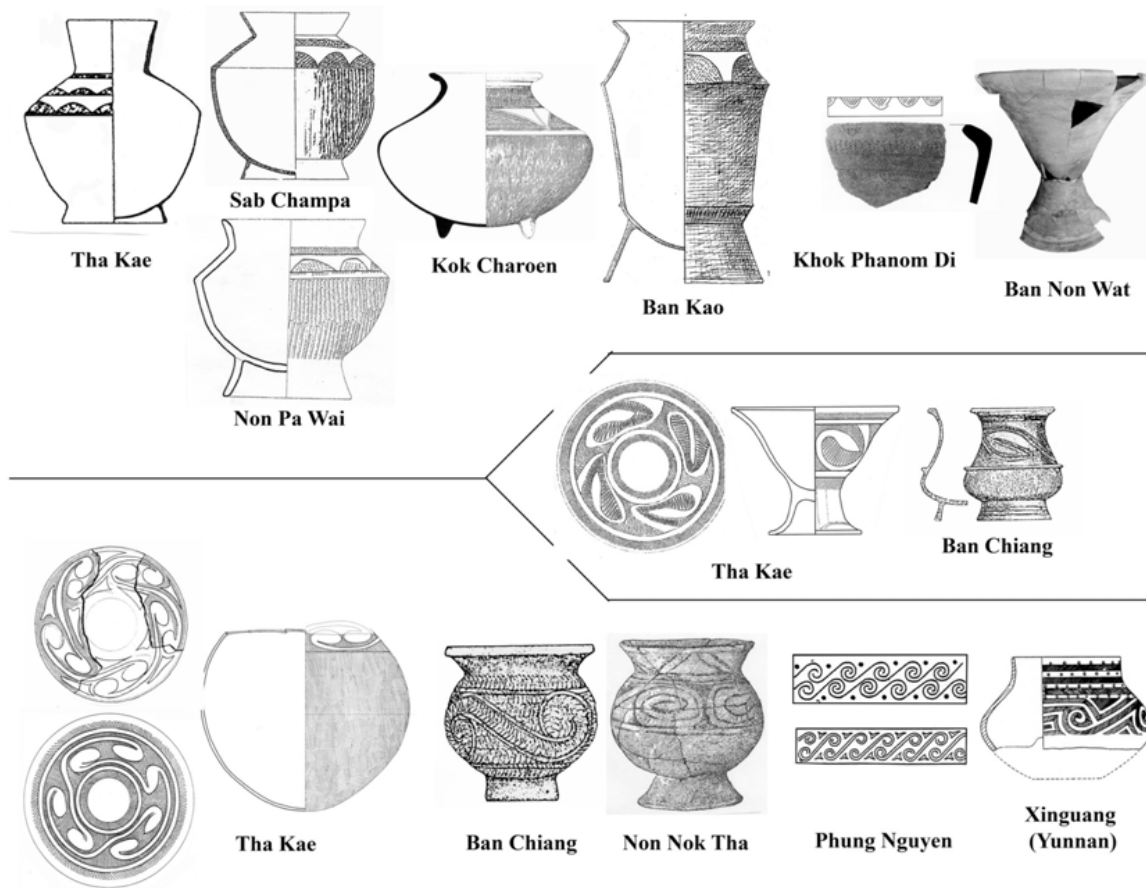


Fig. 5: Motifs impressed and incised on Neolithic ceramic vessels from Southeast Asia and southern China.

from mothers to daughters, while the nearby Fali were more open to innovation. Even the conservatism of the Dii would not resist change: as Hodder [54] has stressed, people do tinker with things. Dietler and Herbich's [10] research among the Luo of Western Kenya has illuminated a quite different system for here, women marrying into a patrilocal community are taught when already adults the arts of pottery making from their mothers in law. When studying a ceramic village in Northeast Thailand in 1970, Higham found that two women from over 100 km away married into the community and brought with them, their preferred techniques, forms and decorative patterns [55]. In an archaeological context, Bentley and Shennan [56], when analysing change over time in the incised and impressed designs on Neolithic *Linearbandkeramik* sites in the Merzbach Valley, found that they could relate designs to specific households.

In comparing the earliest identified Neolithic occupation of our two regions, therefore, we stress first, similarities in the mixed subsistence base of rice cultivation and the maintenance of domestic animals combined with hunting, collecting and fishing. The second set of parallels is found in the mortuary rituals that involved extended inhumation accompanied by pottery vessels, bivalve shells, shell beads and stone adzes. Subsistence and treatment of the dead in lowland riverine habitats during the first half of the second millennium BC denote a completely new chapter, archaeologically speaking, in the prehistoric sequence of both regions. This we interpret most parsimoniously as reflecting settlement of both by farmer communities whose ultimate ancestors lived in the Yangtze and Yellow River valleys. At least the DNA from the Man Bac Neolithic population in northern Vietnam links some individuals with the Yangtze Neolithic site of Weidun [57]. It is most unlikely that we have encountered the earliest Neolithic sites in either region and it remains conceivable that earlier settlements once identified will reveal a closer similarity between all aspects of behaviour that is archaeologically visible. Later differences in preferred ceramic forms and decorative motifs would then reflect divergence as the vertical transmission of accepted norms involved innovations

over time that departed from the original homogeneity. Alternatively, different groups who followed different pathways south from an ultimately common origin might be in question. It is commonplace in such situations to cite future research as the means to clarify these possibilities. The incised and impressed designs vary between regions but still display a common syntax and in some instances, identical motifs. A recent approach by Buckley [58] in his Bayesian analysis of warp ikat textile designs in island Southeast Asia has concluded that they have a common mainland ancestor. A similar programme of research on mainland Neolithic ceramics could be equally revealing.

The Initial Bronze Age (1050-850 BC)

The BA in the UMV is documented at Ban Lum Khao and Ban Non Wat [2,6]. There are six phases, two are represented at the former site, all six at the latter. BA1 (1050-1000 BC) at Ban Non Wat comprises seven inhumation burials. The adults were now orientated with the head to the south, and there was a marked increase in the quantity of mortuary offerings when compared with the preceding Neolithic. Adults were now associated with between 11 and 14 ceramic vessels. The round-based vessels followed in the tradition of the Neolithic pots in terms of form and surface finish, but were much more precisely executed (Fig. 6).

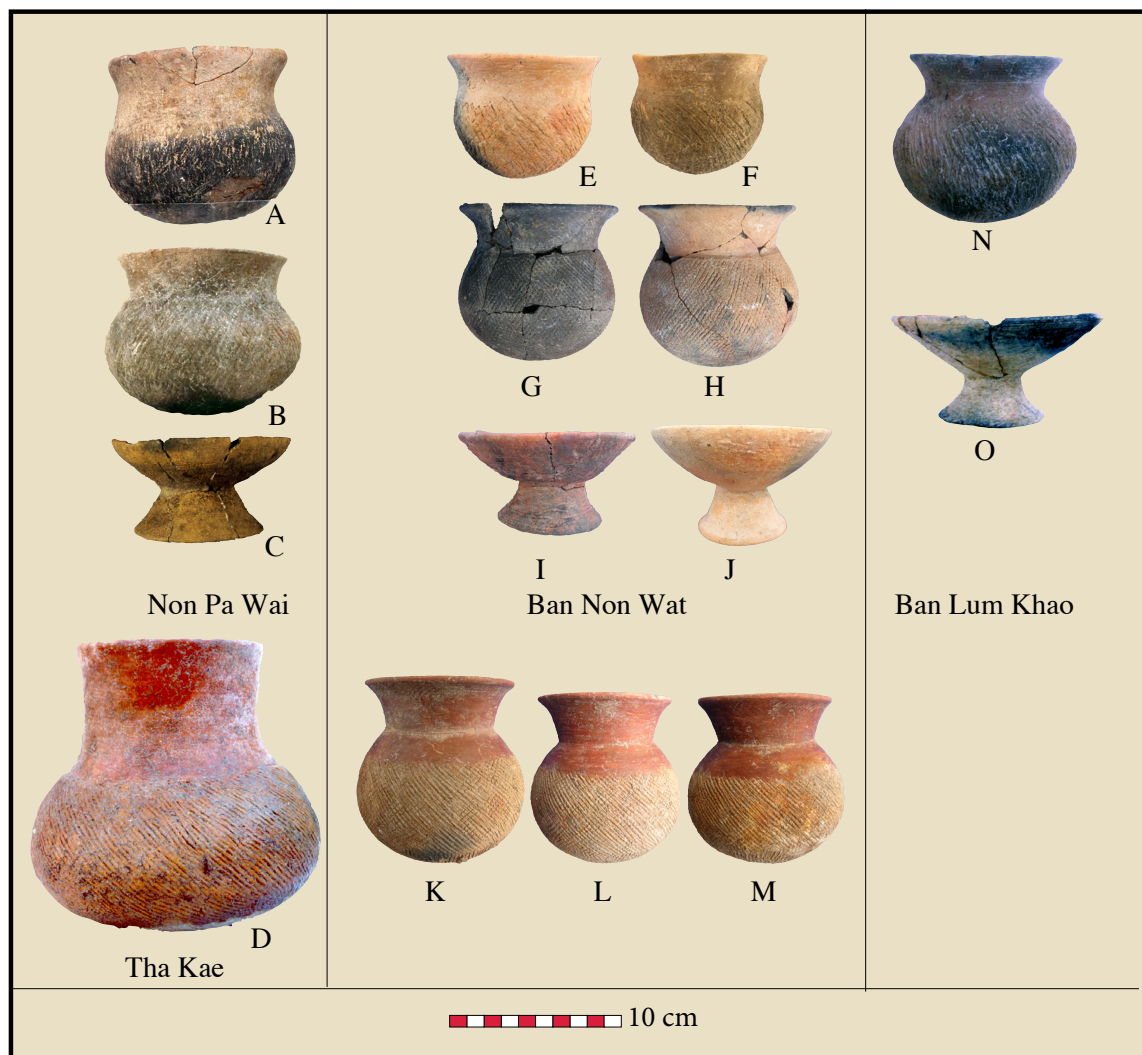


Fig. 6: Early Bronze Age vessels from the Lopburi area and the Upper Mun Valley, showing common forms and decoration.

Probably exotic shell beads were now much more abundant than hitherto, one young female wearing over 2,000. Marine trochus shell bangles were worn by two individuals, and socketed copper axes were found with two adults, a two year old infant and a child who lived to about 10 years (Fig. 7).

The 11 male, seven female and 15 infant burials from BA2 (1000-850 BC) were interred with wealth unparalleled in MSEA [59]. Socketed copper axes were relatively abundant, and come in three forms. There were also copper-base awls, chisels, anklets and bells. A striking feature was the weight of shell ornaments, including thousands of beads, trochus and tridacna bangles and earrings. One woman wore nearly 20,000 shell beads and another, 43 exotic shell bangles. There were also many exotic marble bangles and earrings. Ceramic vessels were now extraordinarily abundant, the most in any burial being 88 in a grave containing two women. Twenty-two different forms were identified, some of considerable size. It is suggested that social demands for aggrandizer funeral feasts required the innovation by craft potters of new forms to fulfil an increased range of functions. This also stimulated impressive new decorative techniques and motifs. Red painted designs included a stylised human face, spirals, human hands, a row of dancers, as well as patterns elaborated from Neolithic 1 antecedents. In a smaller excavation square about 50 m northeast of the main excavation, BA2 burials were found with markedly poorer mortuary offerings. There were few pots, and limited forms, and no decorative motifs. Thus, for the first time in MSEA, a demarcated BA cemetery for an elite group of individuals, defined on the basis of mortuary wealth, has been identified in a prehistoric site.



Fig. 7: Early Bronze Age moulds and copper base axes from the two regions and from Non Nok Tha in the northern Khorat Plateau.

Evidence for the initial BA in the LR is limited by the few excavated graves. There are two BA phases, dated by a small number of radiocarbon dates. The earlier began around 1100/1000 BC, as suggested by two C14 dates from Non Pa Wai. Here each of two “founder’s burials” contained a pair of clay bivalve casting moulds [28,60,61]. Other burials from the same layer were furnished with copper tools: an axe-adze, a fishhook and a cluster of copper fragments, possibly part of a completely oxidized “blade”.

Although it might seem premature, there is little doubt that the adoption of copper metallurgy presents an ideal case study for the mechanics of cultural transmission. As Eerkens and Lipo [62] have shown, there are several modes whereby technical information can be learned. Smelting copper ore and casting the metal is a highly specialized procedure. It is unlikely to have been successfully transmitted for example, through simple verbal instruction. In both regions, the artefacts cast, particularly the socketed axes, match each other in form and the casting techniques. Moreover, they also include the graves of presumed practitioners interred with crucibles and casting moulds. The transmission of knowledge through visual, verbal and repeated instruction is the most successful means of spreading the techniques involved, and this would require a long period of learning from specialists. Such specialists might have been itinerant, or been adopted into host communities while keeping their skills only for themselves and their descendants through the process of scaffolding [63].

Despite the sparse evidence for the initial BA, there is then, compelling enough evidence to link the two regions on the basis of the copper technology. The bivalve moulds of Non Pa Wai show a marked depression in the flat interior surface intended for casting a blind-socketed axe-adze with convex sides and a gently flaring curved blade, similar to that excavated from the same site and those found from Tha Kae and the BA1 burials at Ban Non Wat (Fig. 7). In particular, the curved blade, the hyperboloid body and the size of the two axes from burial 470 and 572 at Ban Non Wat fit perfectly into the large bivalve moulds from Non Pa Wai. Lead isotope analyses carried out by Pryce on the copper-base axes from Ban Non Wat point to at least three artefacts that were manufactured in the LR [64]. In his analysis of the crucibles and moulds from Ban Non Wat, Cawte [65] has pointed out that they cast a tin bronze. Yet the BA1 and 2 metal artefacts comprise copper. This supports the importation of finished copper items rather than casting on site.

We conclude that copper was mined, smelted and cast in the LR, with finished axes and other products reaching the UMV through an exchange system. It is almost certain, given the geographical location of the LR relative to the seashore and the pass over the Phetchabun Range to the UMV, that the unparalleled number of marine shell bangles and beads were also exchanged along the same route. We lack evidence in the LR for the social organisation that lay behind copper production, except for the possible higher social status granted to the specialised founders. This is seen in the presence of the founder’s graves excavated at Non Pa Wai, which parallel several ‘founder’s burials’ excavated in the Lingnan region of southern China [1] and with the slightly later founder’s grave of Ban Non Wat [66]. In the UMV, however, there is a strong case in favour of elite control of access to exotic valuables, and their immolation as part of complex mortuary rituals over a period of about two centuries. Such elite control could have extended beyond simple access through exchange, to control over expert practitioners. As Olausson [12] has noted with regard to Neolithic Scandinavian flint production, aggrandizers can gain prestige through either possessing personal skill, or controlling the output of highly-skilled craft workers.

The Later Bronze Age

In the UMV, there are four phases in the later Bronze Age, designated BA3A, 3B, 4 and 5. BA3A (850-800 BC) graves were orientated to the northeast, but otherwise individuals were just as well endowed with mortuary offerings as during BA2. There were seven female, five male and one infant burial. A measure of their wealth is represented by the 65 trochus marine shell bangles and five copper base anklets worn by one man, 24,000 shell beads with a woman, and 30 copper base bells with an infant less than a year old at death [6].

Phase 3B (800-750 BC) saw graves continuing on the same orientation, but with a steep reduction in mortuary wealth despite the range of mortuary offerings being similar to preceding phases. With BA4 (750-600 BC), burials were orientated with the head slightly to the west of north. The relative poverty of the

mortuary rituals continued, but similar beads and shell and marble bangles continued to be worn. Pottery vessels continued to have red slip on the upper part of the body, and cord marking below, although the number of forms decreased, and surviving earlier forms were modified. Copper-base artefacts, however, became very rare. That copper-base axes and ornaments were cast at Ban Non Wat during this period is demonstrated by the presence of a founder's burial, interred with two sets of bivalve moulds for casting axes, and 25 “concertina moulds” to cast bangles [66].

BA5 (600-420 BC) again saw burials oriented just to the west of north. Graves remained poor. There were changes in the form of pots but not in the surface treatment. It was during this phase that the dead began to be buried with spindle whorls and caches of grey clay. The latter is still used as a medium for dying fabric or as a mordant, and associated as it was with spindle whorls, it is highly likely that the late BA community was heavily involved in the production of fabric. Spindle whorls were present in earlier Bronze Age contexts, but their placement in graves came late in the sequence.

In the LR during the local BA2 (800-500 BC), there were several innovations in the pottery typology together with the full establishment of copper-base metallurgy [1]. The prevailing ceramic ware is by now pale yellow-to-buff in colour, while the most prevalent decoration consists of decorative bands of red slip applied on the rim, neck and/or the pedestal of the pots. Particularly in the northern LR, a globular-to-ovoid jar with a high, slightly flaring collar and short truncated conical pedestal became common. These are decorated at the shoulder with an applied cordon that underlies the join of the upper portion of the pot (neck/shoulder) highlighted by a decorative coat of red slip, and the lower, cord-marked portion of the body. Globular pots with an inverted rim decorated by a large band of red slip are also quite frequent.

The growth in craft production is represented at Tha Kae BA2 by thick lenses of shell jewellery manufacturing debris, including semi-finished bracelets and beads, rejected fragments, as well as many complete pieces. The main industry was based on the exploitation of the *Tridacna* sp. bivalve shell, of which medium sized species (40-60 cm) like *Tridacna crocea* and *Tridacna squamosa*, were most probably collected from the Gulf of Thailand, whose northernmost limit was then closer to the LR [67, fig. 6]. The complex manufacturing cycle has the characteristics of an industry performed by well skilled, possibly full time, craftsmen (Fig. 8) [1,19]. Evidence of shell/tridacna on-site production has also been noticed at Huai Yai [68] and at Non Mak La [69]. We can thus hypothesise that the production of shell jewellery was a speciality of the LR.

T-section and ellipse-section bracelets of stone (marble and green/grey calcareous stones) have been commonly found, the former being ubiquitous at most of BA sites in the LR. They are found at Phu Noi, Non Pa Wai and Non Mak La. While so far we have very elusive evidence of T-section stone bracelet manufacturing in the LR, several debris fragments from ellipse-sectioned stone bracelets were recovered at Tha Kae and Huai Yai, in association with the shell jewellery debitage.

In considering the nature of the relationship between the two regions during the later BA, the possibility of immigration to the UMV is most unlikely. As King et al. [45] have shown, strontium isotopes have failed to identify likely migrants. Moreover, there is underlying continuity in mortuary rituals and ceramic styles from the early to the later BA. As with the early BA, there was a distinction between the evidence for production and consumption between the two regions. Whereas copper was mined and most probably cast into ingots in the LR, the quantity of bivalve moulds, crucible fragments and occasional furnace for liquefying metal at Ban Non Wat signals the presence of local founders. This is demonstrated beyond reasonable doubt by the grave of a metal worker [66].

Further evidence of the technological link between the two regions is the continued similarity in the typology of the blind-socketed axe-adzes with convex sides and gently curved blade. In particular, the elliptical section of the blind sockets mirror the use of flattish suspended mould-plugs. Several tens in the LR [1] and hundreds of ceramic mould plugs in the UMV [4] were found in Iron Age contexts, but as they clearly match the blind sockets of the BA axe-adzes, indicating that they were also employed by BA founders (Fig. 9). This method of casting can be traced back to the Erligang metallurgical tradition of the mid 2nd millennium BC in the Central Plains of China [70, figs. 1.27-1.28, tav. 1.I; 71].

The manufacture of marine shell and stone ornaments was also centred in the LR, but not in the UMV where shell and stone jewellery continued to be worn, albeit in greatly reduced quantities. The establishment



Fig. 8: Marine shell ornaments were manufactured in the Lopburi area and worn by Bronze Age men, women and children in the Mun Valley.

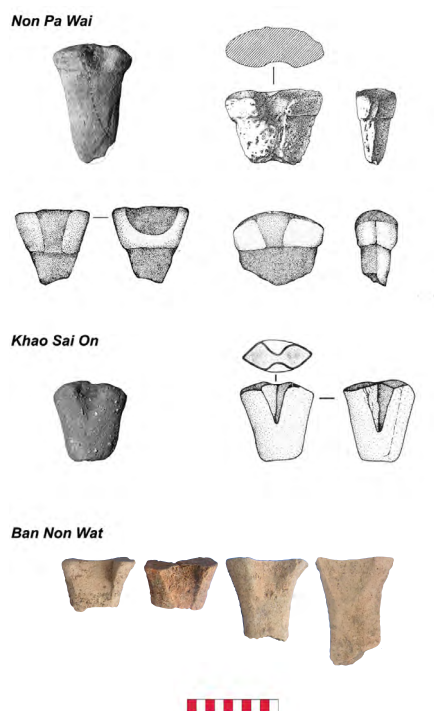


Fig. 9: The mould plugs for casting socketed copper-base axes from sites in the Lopburi and Upper Mun River areas. Scale 5 cm.

of an interaction sphere that linked the two regions is indicated by the distribution of these exotic valuables whose origins lie in the copper deposits of the Khao Wong Prachan Valley and the seas to the south. What is less clear, is whether or not there was a reciprocal flow from the UMV to the LR. The prime candidate is salt, a highly valued resource abundant in the UMV.

A more subtle relationship is also seen in the ceramic repertoire, particularly in surface finishing and forms. We note the common use of decorative bands of thick red burnished slip on the neck in contrast to the buff/pale yellow/light orange body of the pot, and the production of footed open bowls and globular-necked vessels with a distinctive criss-cross cord marks. At Phu Noi and Non Pa Wai, the practice to place footed open bowls in the graves persists, but now the internal surface of these bowls is invariably covered by red slip that externally underlies the rim, just as in the pottery at Ban Non Wat BA3 and Ban Lum Khao.

Identifying the social interactions that might underlie this general similarity in surface finish and form is not straightforward, and this is emphasized by what would be needed to retrofit modern ethnographic information on ceramic traditions to the prehistoric Thai situation. One fact, however, is clear. Surface finish and form are not in themselves, sufficient to sustain a model of interaction. The first priority is to reconstruct the entire *chaîne opératoire* of the manufacturing process, and this is best done by first identifying the manufacturing centres [9]. In both areas, BA occupation contexts include the mushroom shaped anvils used to form pots by the paddle and anvil technique. Doubtless, pots were made at Bronze Age Ban Non Wat, and the forms were modified with time. There are several mechanisms whereby a general similarity in pot forms and finish in the two regions could have been established. One is the movement of potters themselves, bringing their own manufacturing methods and preferred styles. At least for the upper Mun sites so far examined, the isotopes suggest that immigration was not common. The second is that pots were traded, and then copied in the recipient potting communities. As Vincent has shown, exchange of pottery vessels, and their contents, took place in both Neolithic and Bronze sites he has examined [72,73]. In the present early stage of enquiry, the general similarity is best seen as an aspect of the exchange relationships that brought individuals and artefacts together into an interaction sphere and not as a means of establishing any form of ethnic divisions or links.

The Iron Age

The transition into the Iron Age (IA) took place as a maritime trade network was established that linked MSEA with India and China. While never of a colonial nature, this contact introduced new ideas, new foods and technologies with the potential to stimulate rapid prestige-based and horizontal cultural transmission. Thus a long tradition of Indian expertise in iron forging and the manufacture of hard stone and glass ornaments reached coastal ports in MSEA, clearly seen at the 4th century BC urban centre of Khao Sam Kaeo on the eastern coast of peninsular Thailand. Bellina [74] has concluded that Indian specialists established themselves there and manufactured jewellery to satisfy the local elite. Making carnelian beads, to take one of the many new forms of ornament that appeared with the early Iron Age, is not any easily learned procedure [75], and there is a strong likelihood that craft specialists from India came to Southeast Asia to set up workshops. The site has certainly provided evidence for the local manufacture of glass and hard stone beads, the presence of Indian and Chinese ceramics, the forging of iron and the casting of bronzes. Sites on the Phu Khao Tong on the opposite shore of the peninsula have furnished Indian fine ware ceramics, hard stone beads, glass ornaments and even a short text in the Tamil language [76]. It is therefore a tenable hypothesis that knowledge of the properties of iron reached MSEA through the aegis of this new maritime exchange network.

Iron smelting and forging spread rapidly and had a profound impact on communities in the UMV and the LR. Iron ore is more widely available than the ores of copper or tin, and the first evidence for iron artefacts in the UMV dates to the 5th century BC. All four IA phases in the UMV are represented at Noen U-Loke, while only IA4 is documented at Non Ban Jak. A small square at Non Muang Kao revealed IA3-4 occupation floors and burials [77]. The largest sample of IA1 burials comes from Ban Non Wat, with 57 male, 34 female, 18 adult and 33 infant graves [43]. These present a seamless transition from the BA5 interments

[44], and fall into two groups. One had the head orientated to the north, the other to the south with no evidence for a sequence between the two [7]. However, the density and number of graves suggest that many generations were involved [43]. Ceramic vessel forms continued unchanged from the late BA, as did the provision of spindle whorls and grey clay [78]. Iron mortuary offerings included socketed spears, billhooks, hoes, bangles and kits of small tools including knives and awls. The disposition of potsherds suggests that the dead were interred within tree trunk coffins.

Bronze was far more abundant than in the late BA. We find children wearing bangles and anklets cast by the lost wax method. The latter contained clay balls in the hollow interior that would have resonated when the child moved [7, figs. 15:6, 15:12]. Three people were accompanied by socketed spears with an iron blade and a bronze haft. There are rare bronze arrowheads, and two thin socketed bronzes of unknown function. Lead was found as a film over what look like clay cores for casting an axe socket, as if a lost lead technique was used. The burials also contained rare glass earrings and carnelian and agate beads, indicating that these exotic ornaments reached Ban Non Wat contemporaneously with iron [43].

The initial IA at Noen U-Loke is represented by seven graves [7,43]. There are similarities and some differences between their contents and those from Ban Non Wat. Both contain iron ornaments and iron spears. The pottery vessels are similar in form, and like Ban Non Wat, they contained fish skeletons. Bronze bangles and spears were present at Noen U-Loke but there were no glass or hard stone ornaments. However, a pair of shell discs on either side of the skull of burial 28 suggests that studs were now being inserted in the ear lobes. Later examples at this site were made of bronze, silver and gold.

The second to fourth phases of the IA in the UMV are best represented at Noen U-Loke [3]. During IA2 (200 BC-AD 200), two groups of burials were found, one of which was probably the earlier and certainly the poorer in terms of mortuary offerings. The first glass beads were found with the former, together with bronze finger rings. The later graves were filled with rice, and the dead were now accompanied by long carnelian beads, agate beads and pendants, strings of glass beads, and bronze finger and toe rings. One person wore a bronze spiral ornament on the head. No iron and very few pots were found.

During IA3 (AD 200-400) at Noen U-Loke, mortuary wealth reached its zenith [43]. The burials were now laid out in clusters on a chequerboard pattern. Most adults and some infants were interred within graves filled with rice, and in some cases, lined and capped with clay. Three of the four clusters contained at least one individual of outstanding mortuary wealth. The richest was a rice-filled grave containing the remains of a 35-40 year-old man. At least eight pottery vessels were present, and more may well lie beyond the excavated area. Many glass beads were associated and an iron knife was found over the left wrist. Bronzes were abundant: three belts, 150 bangles, 124 finger rings and four toe rings. He wore silver ear coils covered in gold foil, two agate pendants and two bimetallic bronze and iron rings.

The man in burial 69 lay in a rice-filled grave filled with four pottery vessels. Bronzes included two large, circular ear plugs, four bronze belts, 20 bangles, 124 finger rings and 34 toe rings. Four bimetallic rings were also recovered, together with an iron point or arrowhead. Another man was associated with a socketed iron ploughshare (Fig. 10).

Women were buried with similar wealth. One was interred with a necklace comprising 68 gold and many agate beads and two agate pendants. Four pottery vessels lay beyond the cranium. Her bronze ornaments comprised two ear spirals, 38 or more bangles, 64 finger rings and nine toe rings. She also wore a silver finger ring on her left hand and a silver toe ring on the left foot. An iron knife blade covered in the remains of fabric lay on her left arm, and there was a bimetallic ring under her head [3, fig. 11:5].

Infants of this phase were provided with burials involving exotic mortuary offerings and rituals that involved placing them in lidded vessels, on occasion filled with rice. Burial 80 was found in a bed of rice. It wore 17 bronze bangles and 15 anklets. A necklace with agate and glass beads was found, and a spindle whorl lay by the right hand [3, fig. 11:12].

The IA 4 cemetery at Noen U-Loke, dated within the period AD 400-600, involved graves in rows rather than nucleated groups, and a modest contraction in wealth. Nevertheless, there was still an appreciable quantity of bronze offerings. One man wore 22 bangles, 59 rings and an ear-coil on each ear. Bimetallic rings continued to be favoured, two being located by his upper left leg, and two more by the right shoulder

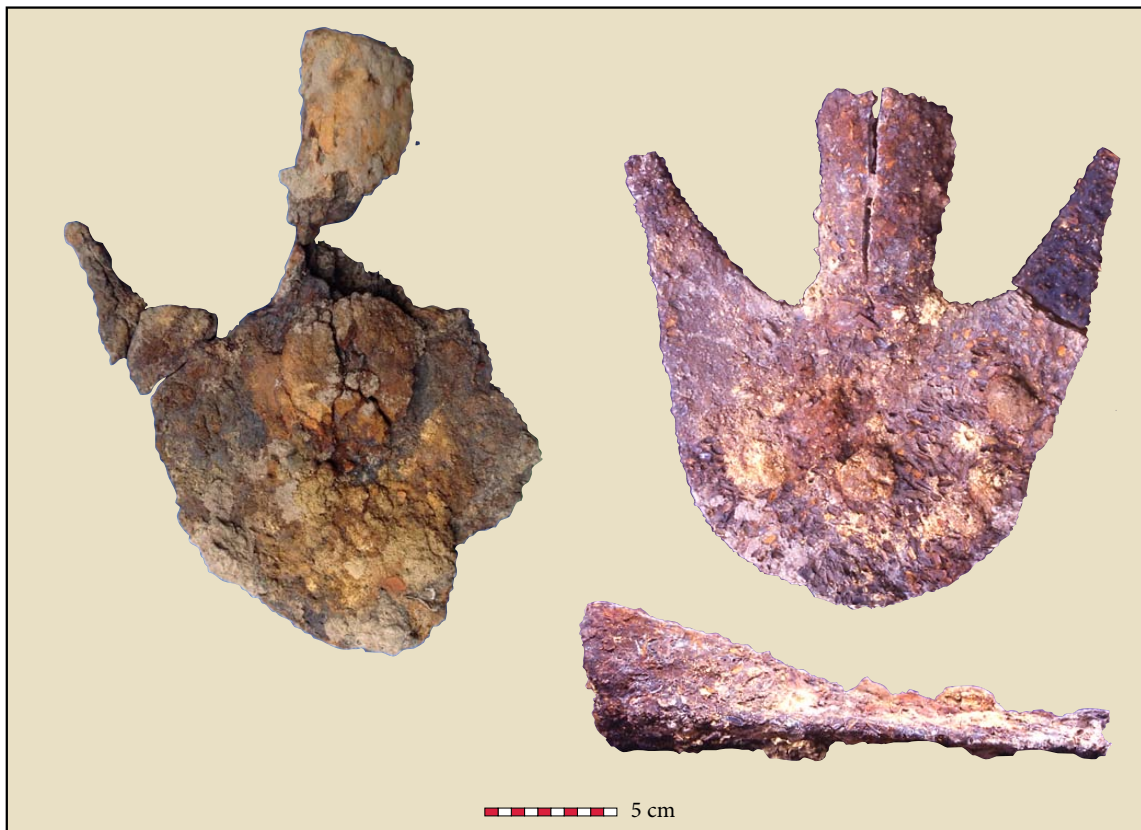


Fig. 10: Iron ploughshares from Non Ban Jak and Noen U-Loke.

[3, fig. 16.2]. A woman was relatively poor, being accompanied by two fragmented pottery vessels, a bronze bangle, six rings on the fingers of the left hand and eight toe rings. An iron knife blade and sickle were also recovered.

Infants were normally interred in large and impressive lidded pots, but one newly born infant, unusually, was laid out in the same manner as adults, with the head orientated to the north. The skeleton lay parallel with the shed antler. Other grave goods comprised 33 bronze bangles, five bronze anklets, a bronze earring and a bimetallic ring in the area of the skull.

One of the most revealing of the IA4 burials was that of a young man buried prone with an arrowhead lodged in his spine. He wore a bronze bangle on each arm, two bronze rings on the right hand finger and a bronze earring. This was the period when moats and banks continued to be constructed, and to judge from the proliferation of iron projectile points, conflict between rival settlements flared.

At Ban Non Wat, Non Ban Jak and Non Muang Kao, this late IA phase was represented by similar burials. All three sites lay in close proximity and were secured behind broad moats and banks. They all contained plastered clay floors, charred wooden sleeper beams and fragments of wattle and daub walls [79, fig. 23:7]. This is most clearly seen at Non Ban Jak where walls and floors were superimposed over each other, always on the same orientation. Houses were separated by a town lane and one room, possibly a ritual chamber, contained three burials, while lidded pots had been placed in the corners. The lowest house had been destroyed by a conflagration that preserved the charred cooking area replete with hearth, pottery vessels in position, and large quantities of rice. This house covered an earlier ceramic kiln for firing Phimai Black pottery vessels, some of which still lay within, together with an iron ploughshare (Fig. 10).

Noen U-Loke and Ban Non Wat also incorporated butchering floors where domestic animals were slaughtered [80]. A pound for securing domestic cattle and water buffaloes was found at Ban Non Wat. There are areas where iron smithing if not smelting took place, and much evidence for bronze casting in the

form of broken crucibles and moulds. The number of spindle whorls indicates that spinning and weaving cloth were undertaken. Finally, many UMV sites are surrounded by small and steep-sided salt making mounds.

Several significant emergent properties are thus identified. Banks were built to encircle the sites and retain water in moat/reservoirs [81]. Iron ploughshares and sickles evidence intensification of rice cultivation, now almost certainly in fields demarcated by bunds to retain rainwater. Those adjacent to the sites could also have been irrigated. Weaponry proliferated, and some individuals were interred with considerable wealth denominated in exotic gold, silver, glass, carnelian, agate and bronze. There were specialist potters, to judge from the eggshell-thin fine ceramics now fired in closed kilns, weaving was undertaken and salt manufactured [82].

In the LR, the advent of the IA is marked by a steep increase in the intensive exploitation of the local resources, mainly evidenced by the 5 ha of copper smelting debris that accumulated at Non Pa Wai, as well as by the many smaller smelting sites near copper bearing outcrops south and west of the Khao Wong Prachan main copper source. Ore, slag, crucibles, ingot moulds, bivalve moulds and mould plugs fill the IA1 layer (ca. 500-200 BC) at Non Pa Wai together with occupational markers, such as potsherds and animal bones. Cattle are rarely found, pigs and dogs were managed as a major food source, together with wild species common to disturbed habitats, such as fields and secondary forest [83, pp.160-163, figs. 163-165]. This bioarchaeological picture sustains geomorphological data that point to an increase of forest clearance in LR during the early IA, possibly due to the need of fuel for metallurgical activities as well as to opening fields for agriculture [15, p.168, fig.1,]. Banks and moats/reservoirs were constructed round settlements located on river terraces at the confluence of waterways or inside river meanders to provide access to water transport, a constant water supply for the fields and defence. The trend in innovation is also apparent in ceramic production; particularly in the manufacturing technique: mastery of the paddle-and-anvil construction allowed building large pots characterized by distinctively thin walls.

Copper production at Non Pa Wai involved casting copper ingots, socketed tools and ornaments. Tens of thousands of cup and conical ingot moulds were recovered from the thick layer at Non Pa Wai [28, fig.11]. Small copper-base ingots are known from Non Mak La [84, p.18, fig.15] and Tha Kae, suggesting that copper circulated in ingot form. Numerous relatively small ceramic bivalve moulds of rectangular and “duckbill-like” shape have also been excavated at Non Pa Wai and Non Mak La, characterized by rather shallow casting impressions [1].

From ca. 200 BC a steady acceleration in copper smelting is evidenced by the rapid deposition of crushed ore and slag across 4 ha at Nil Kham Haeng and, on a minor scale, at Khok Din. In the same sites these layers were interleaved with living surfaces bearing post-holes (Fig. 10), animal bones, potsherds and some burials. The copper-base products included socketed, cordiform implements recovered from burials, often near the head of the deceased, in clusters as a kind of cache as if originally contained in a fabric bag (Fig. 12). Similar cordiform implements have been excavated at Tha Kae and Noen Din [17, p.328, fig. 20]. At Phu Noi, in the northern area of the LR, the IA is represented by a large cemetery characterized by clusters of tightly superimposed graves. No iron implements were found, but the evidence for metal is provided by several fragments of corroded bronze wire bracelets, and by two large armbands of multiple tin-alloyed copper bangles, very thin and flat in section [1].

Spinning and weaving are evidenced in the terracotta spindle-whorls as mortuary offerings: at Tha Kae, terracotta spindle whorls with attached iron spindles were found [85]. Clay was also used to fashion ear plugs, a form of ornaments never encountered in the Neolithic or Bronze Ages, but with a long ancestry in India [25].

The IA cemetery at Tha Kae dates between the end of the local IA 2 (200 BA-200 AD) and IA 3 (200-500 AD). Although already heavily looted at the time of the excavation, the few burials saved from looters illuminate several social details of that community. The graves were laid out in at least two parallel rows oriented north to south that evidence a well organized perception of the ‘ritual’ space, possibly determined by kinship ties. This is also suggested by several ‘multiple burials’, consisting of individuals stacked sequentially within the same narrow and deep vertical burial-pit. Cast copper/bronze ornaments from the LR in general include rings,

toe-rings and bracelets. At Tha Kae these last were both plain narrow band-shaped as well as heavy, thick band-shaped bracelets, one of which was embellished by two parallel, interlaced full-round braids, which go in opposite directions cast by the lost wax casting technique. There are too few excavated burials (11 IA burials and 4 IA jar-burials) to allow a detailed mortuary analysis, and no major difference in the assortment of the burial offerings has been noticed between those interred in one row. However, the mortuary offerings reveal Indian influence, including imported or, most probably, locally imitated carnelian, banded-agate and serpentine beads associated with opaque Indo-Pacific glass [1]. Two types of gold bead, quasi-lenticular and prismatic in shape, were found from the same upper horizon of the IA deposit at Tha Kae.

Indian influence is also seen in the carved paddle technique, with parallels in ceramic vessels from Indian sites such as Arikamedu (Tamil Nadu) and Sonkh (Uttar Pradesh), both dated to the end of the 2nd century BC [23, pp.146-149]. At Tha Kae, new ceramic forms also appear, one of which is closely comparable to the Indian 'carinated rimless handi' [23, pp.164-167].

Different types of heavy iron implements (e.g., socketed hoes, Fig. 15, and spades, axes and 'points', tanged sickles, possibly spindles, tanged knives and spear-points) were regularly interred as grave goods, including three bent (or ritually killed) iron tools as the ones excavated at Pong Manao [86]. Towards the end of the IA in the LR, between the 4th and the 6th century AD, the scope of human activity expansion is well represented at Tha Kae by the construction of a second, larger moat and rampart coeval with the dumping of habitation rubbish. Plastered floors, in association with wattle and daub structures, make their appearance (Fig. 11).



Fig. 11: Occupation areas in the Mun Valley and the Lopburi area reveal superimposed clay floors. Above, late Iron Age Non Ban Jak and below, Nil Kham Haeng.

A relevant marker of the already established contact with the Indian subcontinent in the LR is provided by the discovery of several skin-rubbers at Tha Kae, Non Pa Wai, Phu Noi and Nil Kham Haeng from contexts datable between the 3rd and the 5th century AD [23, pp.168-175; 24, 26].

Relationships During The Iron Age

Of the two regions, the LR is closer to the maritime centres, and was probably a conduit for the movement of new and exotic forms of personal ornament into the UMV. The glass, gold, carnelian and agate beads are virtually identical in both regions (Fig. 12).

Ritual and domestic innovations also moved in parallel. Houses comprised clay plastered floors and sleeper beams that anchored wattle and daub walls. Many of the UMV sites were now encircled by banks and moats. At Noen U-Loke, five moats extended over a distance of 200 m. Construction took place during the first five centuries AD, the period of outstandingly wealthy IA3 burials.

The surge in copper production in the LR dovetails with the weight of bronze ornaments worn by the dead at Noen U-Loke. The lost wax casting technique was deployed, and ceramic mould plugs are common to both regions. Spindle whorls attest to the production of yarn and presumably, weaving. Indian inspired skin rubbers appear on both sides of the Petchabun Range. There are also parallels in iron weaponry and tools.

The bronze industry saw not only increased production, but also similar casting techniques. Mould plugs in the LR are identical with those from Ban Non Wat. Thin cordiform bronzes of unknown function are known from surface findings at sites in the area of Ban Phu Wisat and Ban Phu Wa villages, in the Nakhon Sawan Province [13, pp. 182, 189] and at Ban Non Wat, burial 482 [87, p. 198]. Evidence of seriously long distance inter-regional contact is also suggested by the virtually identical cordiform implements from Nil Kham Haeng and those in the Hejiashan hoard in the northern part of Yunnan province, in Southwest China [61, pp. 320-321, fig. 17]. A further parallel is seen in the form of an arrowhead in a mould from Pong Manao, and an identical example from Ban Non Wat (Fig. 13), while a man at Noen U-Loke was found wearing 75 bronze bangles on each arm, an almost corresponding number of identical bangles adorned each arm of the individual buried in grave 7 at Phu Noi [3, pp. 214-215; 1, p. 140, fig. 22] (Fig. 14).

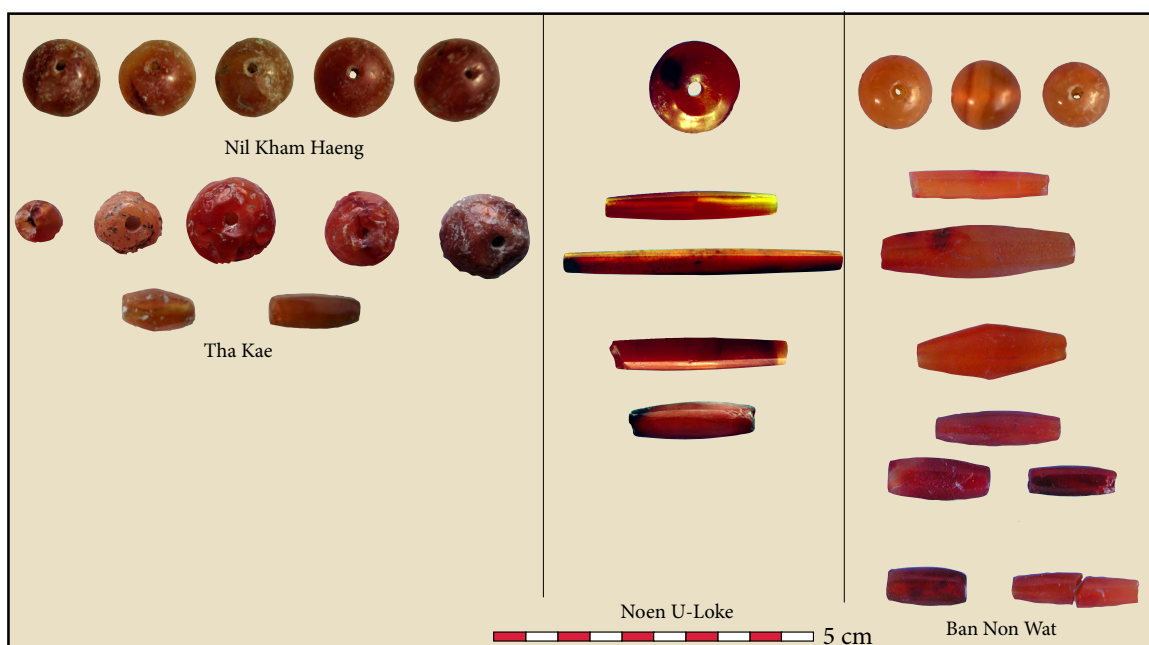


Fig. 12: Carnelian beads from Iron Age contexts in the Lopburi region and the Upper Mun Valley.



Fig. 13: Iron Age ceramic moulds from Lopburi sites and corresponding cast artefacts from Ban Non Wat.



Fig. 14: Bronze bangles from Noen U-Loke burial 14 (above) and Phu Noi burial 7.

We suggest that the virtually identical sets of exotic ornaments in glass, gold, carnelian and agate worn in both regions reflects the intensification of elite exchange. The mining and consumption of copper base artefacts also dovetail. In the LR, not only was much more ore mined, but it was processed more efficiently before smelting in order to secure a greater yield of copper. The hundreds of ingot moulds and on rare occasions, the actual ingots, indicate the development of a major item to feed into exchange networks. In the UMV, we find many bivalve moulds, mould plugs and crucibles that reveal the presence of foundries. The elites invested in bronzes to display their status. One man at Noen U-Loke wore 150 bangles, many rings and three belts, weighing more than all the bronzes from the preceding six phases of the Bronze Age at Ban Non Wat. Knowledge transfer and innovation, seen for example in the lost wax castings and ceramic mould plugs, must have involved close contact between or the movement of specialists.

Iron smelting and forging likewise was adopted virtually simultaneously in both regions, and the artefacts include knives and axes, hoes and sickles for domestic and agricultural use. Thus the Tha Kae hoes can be compared to those found at Noen U-Loke and Ban Non Wat [88, p. 434, cat. 524] (Fig. 15). Spears and arrowheads indicate a rise in conflict. Two ploughshares from the UMV sites point to a profound change in agriculture that took place at the same time as the construction of banks and moat/reservoirs round the settlements. A buffalo drawn plough can bring far more land under cultivation than a man wielding a hoe. This would enable the production of wealth measured in quantities of rice above subsistence requirements, some of which was invested in complex mortuary rituals at Noen U-Loke and Ban Non Wat, where graves were filled with rice.

Rispoli et al. [1, p. 102] have adopted the term localization to the multi-faceted cultural changes that took place with the development of the maritime trade network [89]. Horizontal transmission within the established interaction sphere saw the adoption of iron technology, acceptance of new exotic valuables, water control, agricultural innovation, even methods of personal hygiene. This defines “a dynamic cultural process in which elements of a distinct exotic culture are independently selected, elaborated upon and

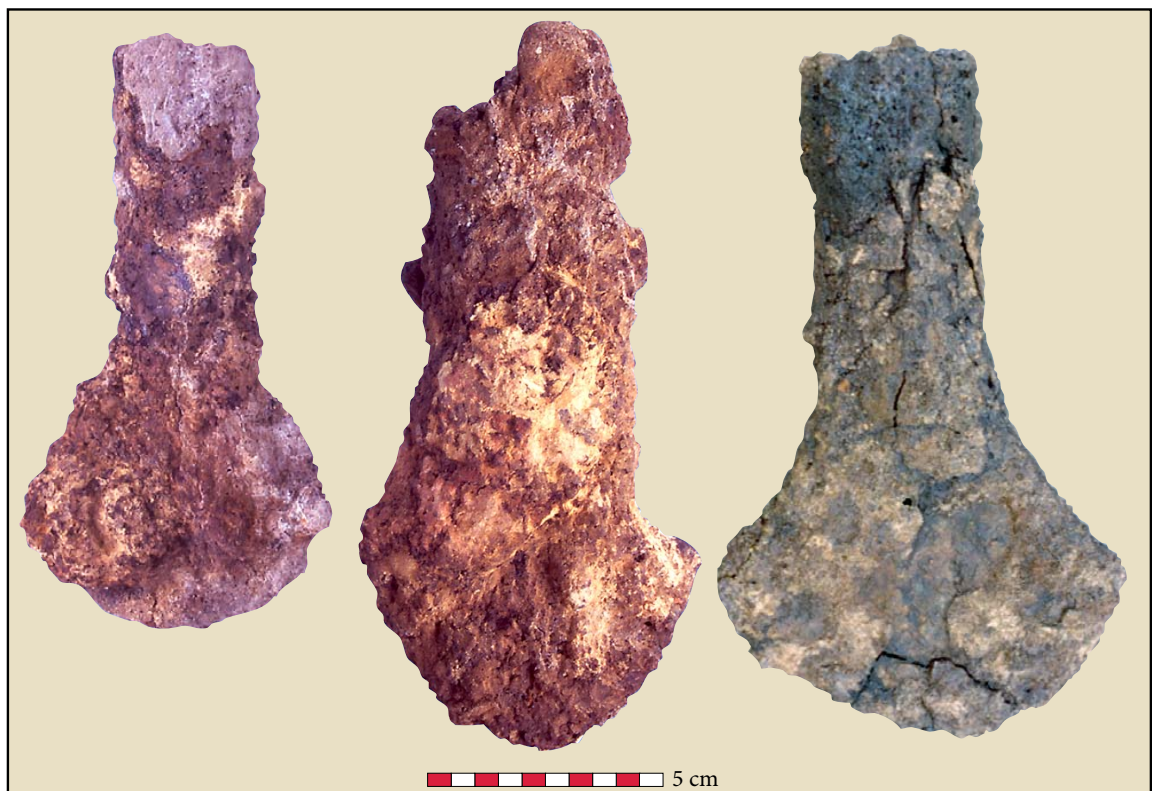


Fig. 15: Iron hoes from Noen U-Loke and Ta Kae (far right).

manipulated to fit the needs of a receptive local culture” [1, p. 150]. It was not restricted to the Central Plain of Thailand despite its proximity to the sea: there is a mirror-like match in many aspects of behaviour – technological, economic and social – that link the LR and the UMV. These emergent properties took place in the absence of isotopic evidence for immigration [90]. They are defined in terms of intensive rice cultivation, conflict, burgeoning exchange in exotic valuables, the marshalling of labour for major constructions and veneration of ancestors contributed to the historic sequel in both areas, the emergence of city states.

Summary and Conclusions

The Phetchabun Range divides two regions endowed with complementary resources. The UMV commands a bottleneck as a pass opens access to the extensive lowlands of the Khorat Plateau. To this day, villagers are able to produce a surplus of salt, a commodity in demand as a condiment, as a medium for preserving wet season fish for consumption during the long dry season and a supplement to domestic animal feed. The LR incorporates one of the few known sources of copper ore exploited in Southeast Asia in antiquity. Having ready access to the Gulf of Siam, it was also a natural location for the manufacture and exchange of marine shell ornaments, one of the dominant raw materials for the exotic valuables that reflected high status during the Bronze Age. The culmination of over 20 years of archaeological research in both regions, incorporating precise radiocarbon chronologies for key sites, has permitted a consideration of the two regions in combination.

In both, there is fleeting evidence for the presence of indigenous hunter-gatherers. In the early 2nd millennium BC, prehistoric occupation involved the foundation of settlements in low-lying, marshy habitats where rice, and in the LR millet, were cultivated, and domestic pigs, dogs and cattle were maintained. Despite many decades of searching for evidence in favour of an indigenous transition to the domestication of plants and animals, none has been found. Nor is one likely. From their initial expansion out of Africa, the hunter-gatherers of MSEA enjoyed a benign climate and naturally productive environment for at least 2,500 generations. Several groups of hunter gatherers survive in remote forests to this day, and the motivation to change is hard to identify. However, the long passage of domesticating rice in the Yangtze Valley has been documented, and the expansion of farming communities is being traced. The same may be said for the domestication of millet in the Central Plains of China.

We therefore favour an exotic ancestry for the first Neolithic settlement. This is currently dated specifically in the 17th century at Ban Non Wat, and more generally in the first half of the second millennium BC. There are similarities in the archaeological record in both regions beyond basic subsistence. The dead were interred in a supine, extended position with mortuary offerings centred on pottery vessels, animal bones, stone adzes, shell ornaments and bivalve shells. Lidded pots contained the remains of infants, and at Ban Non Wat, two adults. While the forms of some of pottery vessels found in both areas present similarities, there are robust parallels in the modes of decoration: both painting and incising and impressing similar designs. Rather than a homogeneous deluge of Neolithic rice farmers into MSEA, bringing with them a uniform package, we visualise a series of trickles, following different routes, and bringing with them a similar, ultimately related set of cultural variables. In this interpretation, initial settlement of both regions might have involved the same people during the centuries preceding the first available evidence, followed by diverging but ancestrally related ceramic preferences. The two regions could equally well have been first occupied by already distinct ethnic groups. Although there is little evidence for embedded social distinctions based on differential mortuary wealth over the six or seven centuries of Neolithic occupation, embryonic recognition of individual achievement is noted in the very wealthy burial 4 at Non Pa Wai [1, p. 158]. This finding is matched by the incredible wealth of a woman interred in burial 15 at the site of Khok Phanom Di at the same juncture [91]. In both cases, the individual was probably a skilled potter, judging from a clay anvil among the mortuary offerings.

This situation developed dramatically with the Bronze Age. We trace the origins of metallurgy through the ramifying exchange networks that linked MSEA and Southern China during the last few centuries of the 2nd millennium BC. The burial of founders, interred with their moulds and castings, suggests that

specialists in the complex procedures involved were establishing themselves across a broad area. In the LR, this saw the initiation of mining, smelting and casting. In the UMR, copper imports were added to the shell and marble ornaments that were prized by new aggrandizing elites. The two regions were components of an interaction sphere involving exotic valuables, but probably also communication between potters, for there are similarities in the syntax of ceramic forms and ornamentation that are unlikely to have occurred independently.

Fundamental cultural changes took place during the millennium of the Iron Age. Already by the 4th century BC, coastal communities were participating in an extensive and complex maritime exchange system that brought exotic goods and ideas from India and China. This translated into first a trickle and then a surge in new exotic valuables reaching both regions: glass, agate and carnelian came first, to be followed by silver and gold. In the LR, more efficient smelting techniques contributed to a quantum leap in the amount of copper circulating. Part of this output ended as ornaments worn in the UMR. Knowledge of iron smelting and forging spread rapidly, and in both regions, it was used in conflict, display and agriculture. Mortuary behaviour developed in parallel, with hollowed trees serving as coffins within structured cemeteries. Lidded pottery vessels served ritual functions in both regions (Fig. 16). Houses were constructed along the same principles within settlements ringed by similar banks and moat/reservoirs. Fundamental changes in agriculture involved plough agriculture, fixed fields, and quite possibly, irrigation, leading to the potential to accumulate surplus wealth on the part of those with preferential land ownership. The agents of these changes can be discerned in the opulent graves at Noen U-Loke, and the substantial residences at Non Ban Jak. These emergent properties, it is concluded, fuelled the rapid crystallisation of early states during the 6th century AD.

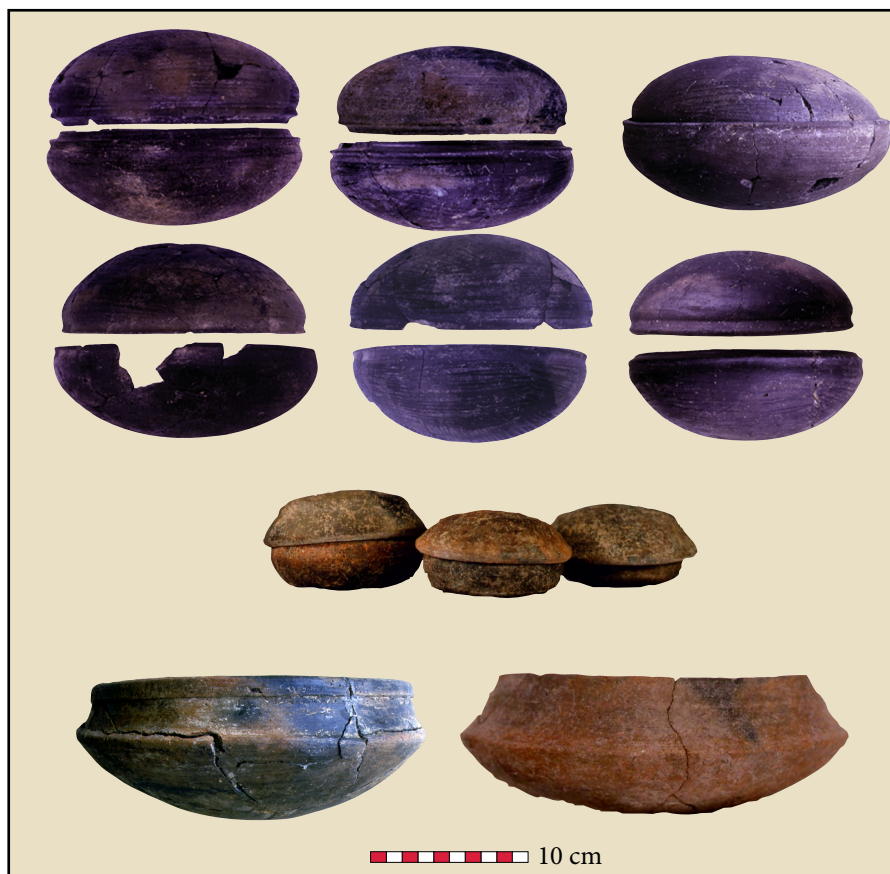


Fig. 16: Lidded ceramic vessels placed together with no clear association with burials are found in both the Upper Mun and the Lopburi areas. Upper two rows, Noen U-Loke, lower rows, Tha Kae.

Acknowledgements: The research undertaken in the Mun Valley was funded by the Marsden Fund of New Zealand, The Australian Research Council in a grant to Dr. D. O'Reilly and Dr. L. Shewan, and Earthwatch and its research corps under permits granted by the National Research Council of Thailand and the Thai Fine Arts Department. The radiocarbon determinations were undertaken by Professor T.F.G. Higham, and human remains were analysed by Associate Professor N.G. Tayles, Dr. K. Domett and Dr. S. Halcrow. C.H. acknowledges the cooperation of his two co-directors in the field, Dr. R. Thosarat and Dr. A. Kijngam.

The LoRAP research activities -co-directed by R. Ciarla and S. Natapintu (1988-2005) and by R. Ciarla and Pakpadee Yukongdee (2006-2014)- gratefully acknowledge its funding Institutions: the Italian Ministry of Foreign Affairs, the Italian National Research Council, the Italian Institute for Africa and the Orient, the 'G. Tucci' National Museum of Oriental Art and the International Association for Mediterranean and Oriental Studies-ISMEO. The TAP archaeological research -co-directed by V.C. Pigott and S. Natapintu - was funded by: the National Science Foundation, the National Geographic Society, the American Philosophical Society, the American Council of Learned Societies/Luce Foundation, the Pennsylvania University Museum and the Northern Kentucky University. Both projects operated under the permits granted by the National Research Council of Thailand and the Thai Fine Arts Department. A special and heartfelt acknowledgement is addressed to Ajarn Surapol Natapintu, Ms Manita Kuenkhan, Ms Pakpadee Yukongdee and Ms Poonsri Jaebkaew for their kind and endless help and cooperation.

References

- [1] Rispoli, F., Ciarla, R., Pigott, V.C., Establishing the prehistoric cultural sequence for the Lopburi region, Central Thailand, *Journal of World Prehistory.*, 2013, 26(2), 101-171
- [2] Higham C.F.W., Thosarat, R. (Eds.), The origins of the civilization of Angkor. Volume 1. The excavation of Ban Lum Khao., Bangkok: The Fine Arts Department of Thailand, <http://www.oxbowbooks.com/oxbow/catalogsearch/result/?q=9781782977964>, 2005
- [3] Higham C.F.W., Kijngam, A., Talbot, S. (Eds.), The origins of the civilization of Angkor. Volume II. The excavation Noen U-Loke and Non Muang Kao., Bangkok: The Fine Arts Department of Thailand, <http://www.oxbowbooks.com/oxbow/the-origins-of-the-civilization-of-angkor-volume-2-44287.html>, 2007
- [4] Higham C.F.W., Kijngam, A. (Eds.), The origins of the civilization of Angkor. Volume III. The excavation Ban Non Wat: Introduction., Bangkok: The Fine Arts Department of Thailand, <http://www.oxbowbooks.com/oxbow/the-origins-of-the-civilisation-of-angkor-volume-3-44288.html>, 2009
- [5] Higham C.F.W., Kijngam, A. (Eds.), The origins of the civilization of Angkor. Volume IV. The excavation Ban Non Wat: The Neolithic occupation, Bangkok: The Fine Arts Department of Thailand, <http://www.oxbowbooks.com/oxbow/the-origins-of-the-civilization-of-angkor-volume-4-44289.html>, 2011
- [6] Higham C.F.W., Kijngam, A. (Eds.), The origins of the civilization of Angkor. Volume V. The excavation Ban Non Wat: the Bronze Age., Bangkok: The Fine Arts Department of Thailand, <http://www.oxbowbooks.com/oxbow/the-origins-of-the-civilization-of-angkor-volume-44290.html>, 2012
- [7] Higham C.F.W., Kijngam, A. (Eds.), The origins of the civilization of Angkor. Volume VI. The excavation Ban Non Wat: the Iron Age., Bangkok: The Fine Arts Department of Thailand, <http://www.oxbowbooks.com/oxbow/the-origins-of-the-civilization-of-angkor-volume-44291.html>, 2012
- [8] Mills, B.J., Colonialism and cuisine. Cultural transmission, agency and history at Zuni pueblo. In: Stark, M.T., Bowser, B.J., Horne, L. (Eds.), *Cultural transmission and material culture. Breaking down boundaries.*, Tucson: University of Arizona Press, 2008, 245-262
- [9] Gosselain, O.P., Social and technical identity in a clay crystal ball, In: Stark, M.T. (Ed.), *The archaeology of social boundaries.*, Washington: Smithsonian Institution Press, 1998
- [10] Dietler, M., Herbich, I., Habitus, techniques, style: an integrated approach to social understanding of material culture and boundaries, In: Stark, M.T. (Ed.), *The archaeology of social boundaries.*, Washington: Smithsonian Institution Press, 1998
- [11] Wallaert, H., The way of the potter's mother. Apprenticeship strategies among Dii potters from Cameroon, West Africa, In: Stark, M.T., Bowser, M.T. (Eds.), *Cultural transmission and material culture. Breaking down boundaries.*, Tucson: University of Arizona Press, 2008
- [12] Olausson, D.J., Does practice make perfect? Craft expertise as a factor in aggrandizer strategies., *Journal of Archaeological Method and Theory*, 2008, 15, 28-50
- [13] Fine Arts Department of Thailand, *Archaeological sites in Thailand*, Vols. 1 and 2, Bangkok: Archaeological Division Publication No. 6, Thai Fine Arts Department, 1988
- [14] Williams-Hunt, P., Irregular earthworks in Eastern Siam: an air survey., *Antiquity*, 1950, 24, 30-37

- [15] Cremaschi M., Ciarla, R., Pigott, V.C., Palaeoenvironment and late prehistoric sites in Central Thailand, In: Glover, I. (Ed.), *Southeast Asian Archaeology 1990.*, Hull: Centre for Southeast Asian Studies, University of Hull, 1992
- [16] Ciarla, R., A Preliminary Report on Lo.R.A.P. archaeological excavations at prehistoric Khao Sai On, Lopburi Province, Central Thailand., *East and West*, 2007, 57 (1-4), 395-401
- [17] Ciarla, R., The Thai-Italian Lopburi regional archaeological project excavation at Khao Sai On-Noen Din. Preliminary Report., *East and West*, 2008, 58 (1-4), 313-336
- [18] Natapintu, S., The contribution of archaeology to the improvement of life quality at Ban Pong Manao village, Lopburi Province, Central Thailand In: I. Piovano, I. (Ed.), *La cultura Thailandese e le relazioni Italo–Thai.*, Torino: Centro Studi Medio ed Estremo Oriente, 2005
- [19] Ciarla R., The Thai-Italian archaeological project: preliminary results, In: Glover, I.C. (Ed.), *Southeast Asian archaeology 1990.*, Hull: Centre for Southeast Asian Studies, Hull, 1992
- [20] Ciarla, R. Lopburi regional archaeological project. In: Ministero degli Affari Esteri (Ed.), *Missioni archeologiche Italiane. La ricerca archeologica, antropologica, etnologica.*, Roma: Ministero Affari Esteri, 1998
- [21] Rispoli, F., Preliminary report on the pottery from the 1989 excavation season at Tha Kae, Op. 1 Square A', In: Glover, I.C., *Proceedings of the 3rd ASEAAWE Conference.*, Hull: Centre for Southeast Asian Studies, University of Hull, 1992
- [22] Rispoli, F. Late-third/early second millennium BC pottery traditions in Central Thailand: some preliminary observations in a wider perspective, In: Ciarla, R., Rispoli, F. (Eds.), *South-East Asian Archaeology 1992. Proceedings of the fourth international conference of the European Association of South-East Asian Archaeologists Rome.*, Serie Orientale Roma, Vol. 77, Istituto Italiano per l'Africa e l'Oriente, 1997
- [23] Rispoli, F., *Ad occidente è l'India. Alla ricerca delle radici del processo di indianizzazione nella Thailandia Centrale.*, Ph.D. thesis, Istituto Universitario Orientale, Naples, 1997, (in Italian)
- [24] Rispoli, F., I levigatoi/skin rubbers della Valle del Chao Phraya (Thailandia Centrale), In: Fontana, M.V., Genito, B. (Eds.), *Studi in onore di Umberto Scerrato per il suo settantacinquesimo compleanno.*, Naples: Istituto Universitario Orientale, 2004
- [25] Rispoli, F., To the west and India, In: Callieri, P., Filigenzi, A. (Eds.), *Studi onore di Maurizio Taddei.*, *East and West*, 2005, 55, 243-264
- [26] Rispoli, F., Terracotta ear-studs and skin-rubbers: looking for the roots of Indianization in Central Thailand, In: Piovano, I. (Ed.), *Cultura Thailandese e le relazioni Italo-Thai.*, Torino: Centro Studi Medio Estremo Oriente (CESMEO), 2005
- [27] Rispoli, F., Ciarla, R., Natapintu, S. The archaeological project and its implications, In: Italian Embassy and Silpakorn University, (Ed.), *First international conference on Italian-Thai studies: from the late nineteenth century to the present.*, Bangkok: National Museum, 1997
- [28] Pigott, V.C., Weiss, A.D., Natapintu, S., The archaeology of copper production: excavations in the Khao Wong Prachan Valley, Central Thailand, In: Ciarla R., Rispoli, F. (Eds.), *South-East Asian archaeology 1992.*, *Proceedings of the fourth international conference of the European Association of South-East Asian Archaeologists*, Rome: Serie Orientale Roma., Vol. 77, Istituto Italiano per l'Africa e l'Oriente, 1997
- [29] Pigott, V.C., Prehistoric copper mining in the context of emerging community craft specialisation in northeast Thailand, In: Knapp, A.B., Pigott, V.C., Herbert, E.W. (Eds.), *Social approaches to an industrial past: The archaeology and anthropology of mining.*, London: Routledge, 1998
- [30] Pigott, V.C., Reconstructing the copper production process as practiced among prehistoric mining/metallurgical communities in the Khao Wong Prachan Valley of central Thailand., In: Young, S.M., Pollard, M., Budd, P., Ixer, R. (Eds.), *Metals in antiquity.*, Oxford: British Archaeological Report (International Series) 792, 1999
- [31] Pigott, V.C., Ciarla, R., On the origins of metallurgy in prehistoric Southeast Asia: the view from Thailand, In: La Niece, S., Hook, D., Craddock, P. (Eds.), *Metals and mines.*, *Studies in archaeometallurgy*, London: British Museum, 2007
- [32] Ho, C.M.W., The pottery of Kok Charoen and its farther context., Ph.D. thesis, University of London, London, 1984
- [33] Loof-Wissowa, H.H.E., Hill of prosperity: state-of-the art of the publication of Khok Charoen site, Lopburi Province, Thailand., *Bulletin of the Indo-Pacific Prehistory Association*, 1997, 16, 199-211
- [34] Watson, W., Khok Charoen and the early metal age of Central Thailand, In: Smith, R.B. and Watson, W. (Eds.), *Early Southeast Asia.*, New York: Oxford University Press, 1979
- [35] Watson, W., Loof-Wissowa, H.H.E., The Thai-British archaeological expedition: a preliminary report on the work of the first season., *Journal of the Siam Society*, 1967, 55, 237-262
- [36] Malaipan, V. The excavation at Sab Champa, In: Smith, R.B., Watson, W. (Eds.), *Early South East Asia.*, Oxford: Oxford University Press, 1979
- [37] Veeraprasert, M.S. Etude archéologique sur le site de Sab Champa., M.A. thesis, Université de la Sorbonne Nouvelle, Paris, 1981-82, (in French)
- [38] Natapintu, S., Current archaeological research in Central Thailand with special reference to the site of Phu Noi, Lopburi Province, In: Ciarla, R., Rispoli, F. (Eds.), *South-East Asian Archaeology 1992. Proceedings of the fourth international conference of the European Association of South-East Asian Archaeologists.*, Rome: Serie Orientale Roma, Vol. 77, Istituto Italiano per l'Africa e l'Oriente, 1997
- [39] Ciarla, R., The Thai-Italian al archaeological project: a survey of fifteen years of activities, In: Piovano, I. (Ed.), *La cultura thailandese e le relazioni Italo-Thai.*, Torino: Centro Studi Medio ed Estremo Oriente, 2005

- [40] Onsuwan Eyre, C., Excavation of Ban Mai Chaimongkol, Nakhon Sawan Province, Central Thailand: A study of site stratigraphy, chronology and its implications for the prehistory of Central Thailand., MA thesis, University of Pennsylvania, Philadelphia, 2000
- [41] Onsuwan Eyre, C., Prehistoric and proto-historic communities in the Eastern Upper Chao Phraya River valley, Thailand: analysis of site chronology, settlement pattern and land use., PhD thesis, University of Pennsylvania, Philadelphia, 2006
- [42] Higham, C.F.W., Higham, T.F.G., A new chronological framework for prehistoric Southeast Asia, based on a Bayesian model from Ban Non Wat., *Antiquity*, 2009, 82, 125-144
- [43] Higham, C.F.W., The Iron Age of the Mun Valley, Thailand., *The Antiquaries Journal*, 2011, 91, 101-144
- [44] Higham, C.F.W., the adult male burials and other adults of Iron Age period 1, northern group. In: Higham, C.F.W., Kijngam, A. (Eds.), *The origins of civilization of Angkor. Vol. VI. The excavation of Ban Non Wat Part Four: The Iron Age, summary and conclusions.*, Bangkok; The Thai Fine Arts Department of Thailand, 2012
- [45] King, C.L., Bentley, R.A., Higham, C.F.W., Tayles, N., Viðarsdóttir, U.S., Layton, R., et al., Economic change after the agricultural revolution in Southeast Asia?, *Antiquity*, 2014, 88, 112-125
- [46] Sørensen, P., Hatting, T., *Archaeological investigations in Thailand: The archaeological materials from the burials.*, Copenhagen: Munksgard, 1967
- [47] Fuller, D.Q., Sato Y-I., Castillo, C., Qin, L., Weisskopf, A.R., Kingwell-Banham, E.J. et al., Consilience of genetics and archaeobotany in the entangled history of rice., *Archaeological and Anthropological Science*, 2010, 2, 115-31
- [48] Rispoli, F., *The incised and impressed pottery of mainland Southeast Asia: following the paths of Neolithization.*, East and West, 2007, 57, 235-304
- [49] Zhang, C. and Hung, H-C., The emergence of agriculture in southern China., *Antiquity*, 2010, 84, 11-25
- [50] Higham, C.F.W., Wiriayaromp, W. Neolithic phase 1, In: Higham, C.F.W., Kijngam, A. (Eds.), *The origins of the civilization of Angkor. Volume IV. The Oxavation Ban Non Wat: the Neolithic occupation.*, Bangkok: The Fine Arts Department of Thailand, 2010
- [51] Higham, C.F.W., Wiriayaromp, W. Neolithic ceramic motifs, In: Higham, C.F.W., Kijngam, A. (Eds.), *The origins of the civilization of Angkor. Volume IV. The Excavation Ban Non Wat: the Neolithic occupation.*, Bangkok: The Fine Arts Department of Thailand, 2010
- [52] Weber, S., Lehman, H., Barela, T., Hawks, S., Harriman, D., Rice or millets: early farming strategies in prehistoric central Thailand. *Archaeological and Anthropological Sciences.*, 2010, 72 (2), 79-88
- [53] Eerkens, J.W. and Lipo, C.P., Cultural transmission, copying errors, and the generation of variation in material culture and the archaeological record., *Journal of Anthropological Archaeology*, 2005, 24, 316–334
- [54] Hodder, I., *Entangled. An archaeology of the relationships between humans and things.*, Chichester: Wiley-Blackwell, 2012
- [55] Calder, A.M., *Cracked pots and rubbish tips: An ethnoarchaeological investigation of vessel and sherd distribution in a Thai-Lao village.*, MA thesis, Otago University, New Zealand, 1972
- [56] Bentley, A., Shennan, S.J., Cultural transmission and stochastic network growth., *American Antiquity*, 2003, 68, 459-485
- [57] Shinoda, K. Mitochondrial DNA of human remains at Man Bac. In: Oxenham, M., Matsumura, H., Nguyen, D.K. (Eds.), *Man Bac. The Excavation of a Neolithic Site in Northern Vietnam. The Biology.*, Terra Australis, 2010, 33, 95-116
- [58] Buckley, C.D., Investigating cultural evolution using phylogenetic analysis: the origins and descent of the Southeast Asian tradition of warp ikat weaving., *PLoS ONE*, 2012, 7(12): e52064. doi:10.1371/journal.pone.0052064
- [59] Higham, C.F.W., *The Bronze Age of Southeast Asia: new insight on social change from Ban Non Wat.*, *Cambridge Archaeological Journal*, 2011, 21(3), 365-389
- [60] Pigott, V.C., Natapintu, S., *Archaeological investigations into prehistoric copper production: the Thailand Archaeometallurgy Project 1984–1986*, In: Maddin, R. (Ed.), *The beginning of the use of metals and alloys.*, Cambridge, Mass: MIT Press, 1988
- [61] Ciarla, R., Rethinking Yuanlongpo: the case for technological links between the Lingnan (PRC) and Central Thailand in the Bronze Age., *East and West*, 2007, 57 (1-4), 305-328
- [62] Eerkens, J.W., Lipo, C.P., 2007. Cultural transmission theory and the archaeological record: providing context to understanding variation and temporal changes in material culture., *Journal of Archaeological Research*, 2007, 15, 239-274
- [63] Ferguson, J.R. The when, where and how of novices in craft production., *Journal of Archaeological Method and Theory*, 2008, 15, 51-67
- [64] Pryce, T.O., Brauns, M., Chang, N., Pernicka, E., Pollard, M., Ramsey, C. et al., Isotopic and technological variation in prehistoric Southeast Asian primary copper production., *Journal of Archaeological Science* 2011, 38, 3309-3322
- [65] Cawte, H. The copper base industry., In: Higham C.F.W., Kijngam, A. (Eds.), *The Origins of civilization of Angkor. Vol. V. The excavation of Ban Non Wat Part Three: The BronzeAge*, Bangkok: The Thai Fine Arts Department of Thailand, 2012
- [66] Higham, C.F.W., *Recasting Thailand. New discoveries at Ban Non Wat.*, *Current World Archaeology*, 2008, 31, 38-41
- [67] Negri, M.P. An experimental mapping method by means of fossil mollusk faunas: The Holocene Thai paleogulf., *Bollettino della Società Paleontologica Italiana*, 2009, 48 (1), 41-50
- [68] Natapintu, S., *Current research on ancient copper-base metallurgy in Thailand*, In: Charoenwongsa, P., Bronson, B. (Eds.), *Prehistoric Studies: Stone and Metal Ages in Thailand.*, Bangkok: Thai Antiquity Working Group, 1988

- [69] Pigott, V.C., Natapintu, S., Excavations at Non Mak La, Lopburi Province, Central Thailand, Ms. on file Internal Report submitted to the Thai Fine Arts Department on Fieldwork conducted in 1994 by the Thailand Archaeometallurgy Project, Philadelphia, 1997
- [70] Ciarla, R., Interazioni culturali e tecnologiche tra Cina meridionale e Sudest asiatico continentale tra la fine del II millennio a. C. e l'inizio del I millennio a C.: la dispersione meridionale della tecnologia del rame/bronzo., PhD thesis Università Ca' Foscari, Venezia, 2013, (in Italian)
- [71] Higham C.F.W., Ciarla, R., Higham, T.F.G., Kijngam, A., Rispoli, F. The establishment of the Bronze Age in Southeast Asia., *Journal of World Prehistory*, 2011, 24(4), 227-274
- [72] Vincent, B.A., *Prehistoric Ceramics of Northeast Thailand.*, Oxford, British Archaeological Reports (International Series), 461, 1988
- [73] Vincent, B.A., *Khok Phanom Di: The pottery.*, London, Research Report of the Society of Antiquaries of London LXX, 2004
- [74] Bellina B., *Cultural exchange between India and Southeast Asia. Production and distribution of hard stone ornaments (VI c. BC– VI c. AD).*, Editions de la Maison des Sciences de l'Homme, with the participation of l'Ecole Française d'Extrême-Orient and Epistèmes, Paris, 2007
- [75] Roux, V., David, E., Planning abilities as a dynamic perceptual-motor skill: An actualist study of different levels of expertise involved in stone knapping. In: Roux, V., Bril, B. (Eds.), *Stone knapping: The necessary conditions for a uniquely hominin behaviour.*, Cambridge: McDonald Institute, 2005
- [76] Bellina, B., Silapanth, P., Chaisuwan, B., Thongcharoenchaikit, C., Allen, J., Bernard, V. et al., The development of coastal polities in the upper Thai Malay Peninsula, In: Revire, N., Murphy, S.A. (Eds.), *Before Siam was born.*, Bangkok: River Books, 2014
- [77] O'Reilly, D.J.W., The discovery of clay-lined floors at an Iron Age site in Thailand – preliminary observations from Non Muang Kao, Nakhon Ratchasima Province., *Journal of the Siam Society*, 1997, 85, 133-150
- [78] Cameron, J., The spinning tools, In: Higham C.F.W., Kijngam, A. (Eds.), *The origins of civilization of Angkor. Vol. VI. The excavation of Ban Non Wat, Part Four: The Iron Age, summary and conclusions.*, Bangkok: The Thai Fine Arts Department of Thailand, 2012
- [79] Chetwin, J. N., The remains of wattle and daub structures, In: Higham C.F.W., Kijngam, A., Talbot S. (Eds.), *The origins of civilization of Angkor. Vol. II. The excavation of Noen U-Loke and Non Muang Kao.*, Bangkok: The Thai Fine Arts Department of Thailand, 2007
- [80] Iseppu, A. The Iron Age occupation in layer 3, In: Higham, C.F.W., Kijngam, A. (Eds.), *The origins of the civilization of Angkor. Volume VI. The excavation Ban Non Wat: the Iron Age.*, Bangkok, The Fine Arts Department of Thailand, 2012
- [81] McGrath, R.J., Boyd, W.E. The chronology of the Iron Age 'moats' of northeast Thailand., *Antiquity*, 2001, 75, 349-360
- [82] Rivett, P., Higham, C.F.W., The archaeology of salt production, In: Higham, C.F.W., Kijngam, A., Talbot S. (Eds.), *The origins of civilization of Angkor. Vol. II. The excavation of Noen U-Loke and Non Muang Kao.*, Bangkok: The Thai Fine Arts Department of Thailand, 2007
- [83] Pigott, V.C., Mudar, K.M., Agelarakis, A., Kealhofer, L., Weber, S.A., Voelker, J.C., A program of analysis of organic remains from prehistoric copper-producing settlements in the Khao Wong Prachan Valley, Central Thailand: a progress report, In: Bacus, E.A., Glover, I.C., Pigott V.C. (Eds.), *Uncovering Southeast Asia's past: Selected papers from the 10th international conference of the European Association of Southeast Asian Archaeologists.*, Singapore: National University of Singapore Press, 2006
- [84] Pigott, V.C., Reconstructing the copper production process as practiced among prehistoric mining/metallurgical communities in the Khao Wong Prachan Valley of central Thailand, In: Young, S.M., Pollard, M., Budd, P., Ixer, R. (Eds.), *Metals in antiquity.*, Oxford: British Archaeological Report (International Series) 792, 1999
- [85] Cameron, J., Iron and cloth across the Bay of Bengal: new data from Tha Kae, central Thailand., *Antiquity*, 2011, 85, 559-567
- [86] Natapintu, S., personal communication.
- [87] Higham, C.F.W., The material culture, In: Higham, C.F.W., Kijngam, A. (Eds.), *The origins of civilization of Angkor. Vol. III. The excavation of Ban Non Wat. Part I: introduction.*, Bangkok: the Thai Fine Arts Department, 2009
- [88] Connelly, R., The iron and bimetallic artefacts, In: Higham C.F.W., Kijngam, A., Talbot S. (Eds.), *The Origins of civilization of Angkor. Vol. II. The excavation of Noen U-Loke and Non Muang Kao.*, Bangkok: The Thai Fine Arts Department of Thailand, 2007
- [89] Brown, R.L., *The Dvaravati wheels of the law and the Indianisation of Southeast Asia.*, Studies in Asian Art and Archaeology, 1995, 18, New York: E.J. Brill
- [90] Cox, K., Bentley, R.A., Tayles, N.G., Buckley, H.R., MacPherson, C.G., Cooper, M.J., Intrinsic or extrinsic population growth in Iron Age Northeast Thailand? The evidence from isotopic analysis., *Journal of Archaeological Science*, 2011, 38, 665-681
- [91] Higham, C.F.W., Thosarat, R., *The excavation of Khok Phanom Di: Volume VII. Summary and Conclusions.*, London: The Society of Antiquaries of London, 2004