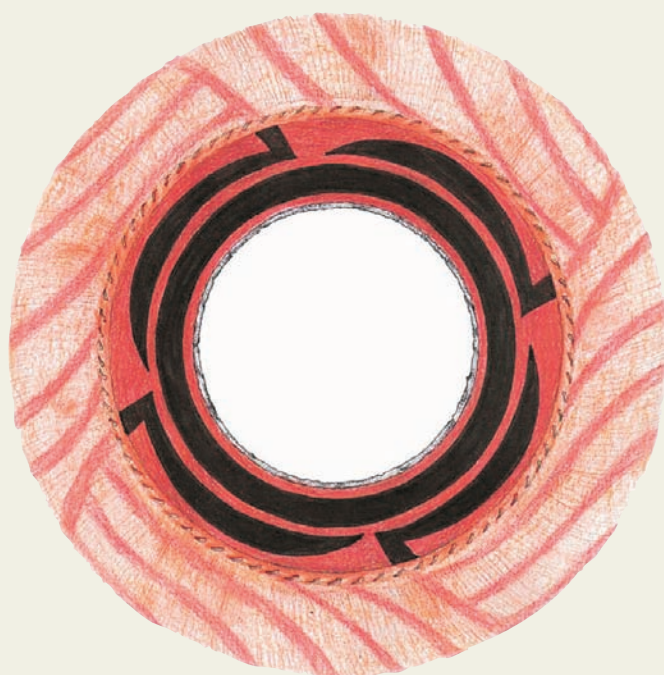


THE ORIGINS OF THE CIVILIZATION OF ANGKOR

VOLUME FOUR

THE EXCAVATION OF BAN NON WAT

PART TWO: THE NEOLITHIC OCCUPATION



The Fine Arts Department, Thailand

THE ORIGINS OF THE CIVILIZATION OF ANGKOR

VOLUME IV

THE EXCAVATION OF BAN NON WAT: THE NEOLITHIC OCCUPATION

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FOREWORD

In 1992, a major research project was initiated in the Amphoe Non Sung, Changwat Nakhon Ratchasima, entitled "The Origins of the Civilization of Angkor". It was conceived by Professor Charles Higham of the University of Otago, New Zealand, and Dr Rachanie Thosarat, of the Thai Fine Arts Department. The Fine Arts Department has been pleased to be associated with this research project and to be able to publish this, the fourth report of a series which promises to contribute a great deal to our understanding of Thai prehistory.

While it might be argued that the upper Mun Valley is relatively remote from the centre at Angkor, two important facts must be stressed. The first is that the Mun Valley, and particularly the area of Phimai, ancient Vimayapura, gave to the kingdom of Angkor its greatest kings in Suryavarman II and Jayavarman VII. These rulers belonged to the Mun Valley dynasty of Mahidharapura. At all times, the Mun Valley was a focus of major cultural developments leading to the early states of Angkor, as seen in the rich prehistoric cultures of the area, the early brick temples of Phimai, Phanom Rung and Phanom Wan, and the number of Chenla period monuments and inscriptions.

It is also noted that in the early 1990s, when this project was being formulated, it was impossible to envisage extensive archaeological fieldwork in Cambodia. The adjacent parts of Northeast Thailand, however, afforded a splendid opportunity to pursue this important topic.

Ban Non Wat is the fourth major excavations undertaken as part of this project, the others being at Non Muang Kao, Ban Lum Khao and Noen U-Loke. It is a site of great importance because of its long occupation period, and the very large area opened by excavation over seven seasons of fieldwork. The site was initially occupied by hunter-gatherers, then by Neolithic rice farmers. By 1000 BC, this community began to cast bronzes, and six centuries later, the first iron was being forged. This volume describes the occupation of Ban Non Wat by a group of probable hunter-gatherers, and the first Neolithic rice farmers. Final reports on either are very rare in Thailand and indeed, in all Southeast Asia. One of the most impressive aspects of this volume in my opinion, is the superb quality of the early Neolithic ceramic vessels, with their distinctive incised, impressed and painted motifs. These have been traced by Dr Warrachai Wiriyaromp to an origin in southern China, bringing the first rice farmers to Ban Non Wat in the 17th century BC.

I congratulate the authors of this volume in maintaining the impressive momentum of their publication series, and look forward to further volumes on the Bronze and Iron Age occupation of this remarkable site.

S. Leyavanija

Dr Somsuda Leyavanija
Director General
Fine Arts Department

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PREFACE

This is the fourth volume reporting on our research project entitled “The Origins of the Civilization of Angkor”. In 1992, when Dr Rachanie Thosarat was appointed to the Phimai office of the Fine Arts Department, we resolved to consider the enigma presented by the many large, moated and banked settlements that are so prolific in the upper Mun Valley. Our initial model saw these sites as dating to the Iron Age, and as such, the immediate precursors to the early states of this area. Our first concern was that the prehistory of this area had been the subject of a lengthy period of research by David Welch and Judith McNeill, and we did not wish to venture into the area where they had been active. With their goodwill, we therefore selected an area immediately to the west of theirs, and began several seasons of site surveys. The moated sites are densely distributed, and we mapped many. In 1995, we decided to begin our excavations at the site of Ban Lum Khao which is, paradoxically, one of the unmoated settlement so far examined. Our choice reflected the clear field evidence for a Bronze Age cemetery, a period we felt it necessary to consider as the precursor to any cultural changes noted in the ensuing Iron Age. Subsequently, we have excavated at Prasat Phimai and the moated sites of Non Muang Kao, Noen U-Loke and Ban Non Wat.

The purpose of this volume, is to report the initial settlement of Ban Non Wat. It is a further step towards the realisation of our goal, to illuminate the prehistoric societies of the upper Mun Valley during the two millennia of cultural changes that led ultimately to the swift transition to the state as represented at Phimai and beyond, to the civilization of Angkor itself. One of the many surprises that we encountered during our excavations, was the presence of burials laid out in a flexed position. This was a widespread practice of hunter-gatherers in Southeast Asia, and we think it likely that a group of hunters and gatherers occupied the area and used the mound of Ban Non Wat as a cemetery. Paradoxically, the radiocarbon determinations for these are contemporary with those of the Neolithic occupation. There are two phases of Neolithic occupation, which began in the 17th century BC and ended about six centuries later. These differ on the basis of the orientation of the human graves and the nature of the mortuary offerings placed with the dead. There is also some evidence for the economy and the technology of the Neolithic inhabitants in the occupation deposits that were not disturbed by the digging of Bronze Age burials.

Future volumes will consider the Bronze and Iron Ages at Ban Non Wat, at which point, we plan to synthesise all our findings made during 12 years of excavations. We are most grateful, therefore, to our colleagues for contributing their current findings in this part of our report series. The identification of the age and sex of the prehistoric individuals whose graves we have excavated has been undertaken by Dr N.G. Tayles and Dr S.E. Halcrow.

Our research at Ban Non Wat proceeded with a permit issued by the National Research Council of Thailand, for which we are indebted. The backing of the Thai Fine Arts Department was also a vital prerequisite to our research. We are most grateful to all our colleagues who worked with us in the field, and who have contributed to this report. Without the good will of the villagers of Ban Non Wat, we could not have worked in their community, and we thank them for their welcome and cooperation. Dr Amphan Kijngam became the co-director of this project in place of Dr Rachanie Thosarat in 2007.

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I INTRODUCTION

C.F.W. HIGHAM

The excavation of Ban Non Wat involved three early phases of occupation. One of these, characterised by a series of flexed inhumation burials associated, could well have involved indigenous hunter-gatherers. This finding reflects the fact that a flexed position recurs in hunter-gatherer sites in Southeast Asia. Moreover, the few artefacts associated with these individuals are not paralleled in any known Neolithic context. The three graves which have been dated fall within the period c. 1600–1100 BC, and were thus contemporary with the Neolithic occupation of this site. There are then two phases of Neolithic settlement. Neolithic 1 involved both occupation deposits, and human graves. The former contained the remains of domestic pigs, cattle and dog as well as a wide range of local hunted mammals, fish and shellfish. The graves contained bodies inhumed in an extended, supine position associated with pottery vessels often decorated with distinctive incised, impressed and painted designs. Two graves differ: adults were interred seated in individual, lidless mortuary vessels.

This Neolithic 1 period of occupation has been dated from the 18th to at least the 14th centuries BC. The third phase, called Neolithic 2, is represented only by graves, since any intact occupation deposits were either located elsewhere on the site, or dispersed when later Bronze Age graves were excavated down into Neolithic layers. During this phase, the orientation of the graves changed and the form and decoration on the associated ceramic vessels underwent a major change: no more incised and impressed designs were encountered. This phase lasted from the 14th to the 11th centuries BC.

Given the few fully-documented Neolithic sites in Southeast Asia, the data from Ban Non Wat are relevant to any consideration of three key issues. The first centres on the origins of the first farmers. The second entails the chronological framework and the third confronts the nature of the transition from hunting and gathering to farming.

Currently there are two principal explanations for the origins of the Southeast Asian Neolithic. The first centres in general on what Bellwood and Oxenham (2008) have termed the Neolithic demographic transition. Specifically in Southeast Asia, it is known as the 'Two Layer' model. This links the archaeological with the linguistic evidence and suggests that human population growth consequent upon the adoption of rice domestication led to a major expansion of rice farmers, emanating ultimately from the Yangtze Valley, into Southeast Asia with a fully developed farming subsistence economy. The indigenous hunter-gatherers were rapidly replaced and played no further

part in cultural development. This model draws on the widespread distribution of Austro-Asiatic languages as well as relationships over a very wide area of Southeast Asia expressed in similar mortuary traditions, the introduction of weaving, the establishment of rice farming and pig husbandry, and closely related techniques for decorating ceramic vessels.

The second model places much greater emphasis on the hunter-gatherers, whose ancestors had adapted to the rich coastal tracts of Southeast Asia over tens of millennia, and whose remains in the interior have been almost exclusively identified in the protected environment of caves and rockshelters. Under this model, the waves of intrusive Neolithic farmers are reduced to a trickle, and had a sharply reduced impact when measured against the adaptability of the indigenous hunter-gatherers to change.

As always, a well-grounded chronological framework is an essential foundation. As will be set out in the concluding chapter, the timing of the establishment of rice domestication in the Yangtze Valley and the demographic expansion thence into Southeast Asia has been more firmly based with the progress of research over the past decade. The research of Fuller and his colleagues has shown that while rice was part of the diet in the Yangtze Valley for millennia from the early Holocene, domesticated rice only became prominent from about 5000 BC, with a further major advance two millennia later (Fuller *et al.* 2009). At Ban Non Wat, the initial Neolithic settlement took place in or soon after the 18th century BC. This broadly equates with a growing consensus that in Southeast Asia, the ingress of rice farmers did not take place significantly earlier than about 2000 BC. I regard chronologies based on charcoal from unidentified trees as being *termini post quem* at best, because of the problems of inbuilt age and the use of mixed samples. The radiocarbon dates for the settlement of An Son, a large Neolithic settlement in Vam Co Dong valley of Southern Vietnam (Fig. 1:1), begin in about 2000 BC and reveal lengthy occupation of at least five or six centuries (Masanari and Dung 2002). Rispoli *et al.* (2009) have proposed that the Neolithic occupation of the central Thai sites of Ta Kae and Non Pa Wai date to the early second millennium BC, broadly equivalent to Ban Non Wat. The radiocarbon determinations from the pioneer excavations at Ban Kao suggest that occupation fell between 2300 and 1500 BC (Sørensen and Hatting 1967). The Neolithic occupation of Ban Chiang and Non Nok Tha present the problem of dating on the basis of AMS determinations from the organic fraction of pottery vessels. This procedure is fraught with pitfalls due to the potential inclusion of old carbon in the clay matrix and

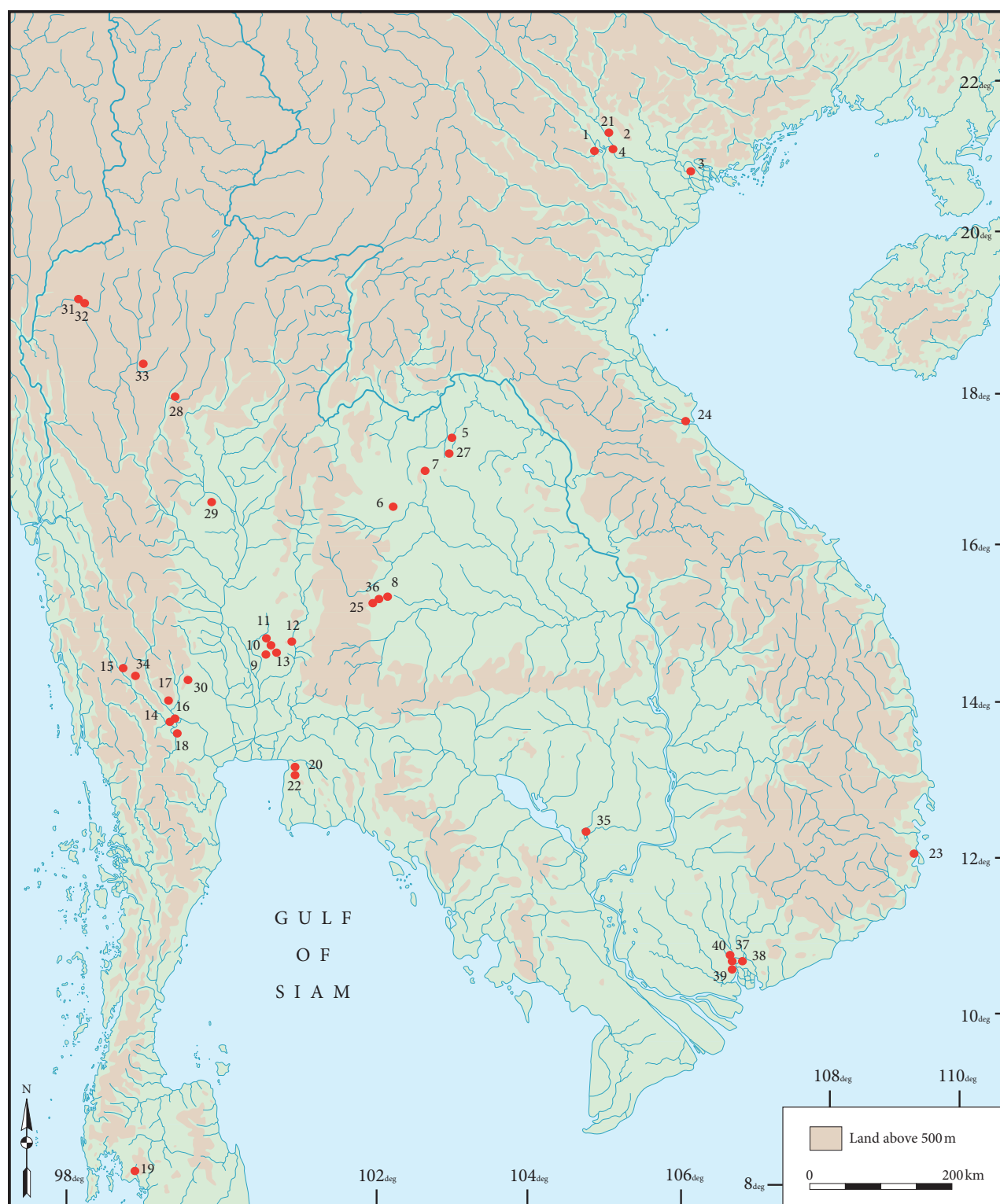


FIG. 1:1 The principal Neolithic and some hunter-gatherer sites in Southeast Asia. 1. Phung Nguyen, 2. Co Loa, 3. Trang Kenh, 4. Lung Hoa, 5. Ban Chiang, 6. Non Nok Tha, 7. Ban Phak Top, 8. Ban Lum Khao, 9. Ban Tha Kae, 10. Non Pa Wai, 11. Ban Phu Noi, 12. Khok Charoen, 13. Huai Yai, 14. Ban Kao, 15. Sai Yok, 16. Nong Chae Sao, 17. Han Songchram, 18. Rai Arnon, 19. Lang Rongrien, 20. Khok Phanom Di, 21. Xom Ren, 22. Nong Nor, 23. Xom Con, 24. Con Nen, 25. Ban Sanuan, 26. Area of Ha Giang, 27. Non Kao Noi, 28. Pratu Pha, 29. Ban Bung Ya, 30. Nong Ratchawat, 31. Spirit Cave, 32. Banyan Valley Cave, 33. Ob Luang, 34. Ongbah, 35. Nong Ratchawat, 35. Samrong Sen, 36. Ban Non Wat, 37. Cu Lao Rua, 38. Cau Sat, 39. Ben Do, 40. An Son

the absorption of carbon from the media used in the firing of the pots. The resulting dates must again, be regarded as *termini post quem*. For Ban Chiang, the initial settlement is dated to later than 2000 BC. The initial Neolithic at Non Nok Tha has provided two determinations based on rice chaff temper: 2307-1858 BC and 1770-1310 BC.

Despite this consensus for the late third to early second millennia BC, there remains an alternative proposed by White (1997). This is based on two radiocarbon determinations from a core taken from the sediments of Lake Kumphawapi. These straddle evidence for a change in the vegetation consistent with land clearance "by cultivating societies" (White 1997:103). No archaeological evidence has ever been found in Southeast Asia for such societies during the 5th millennium BC. However, there is a growing body of evidence that the lowlands of Southeast Asia were occupied then by hunter-gatherers (Higham *et al.* 2010 in press). As is well known, hunter gatherers are giv-

en to firing the natural vegetation. This encourages grass growth in open clearings, which in turn attracts game.

This brings us to the third issue: the nature of the interaction between the intrusive Neolithic people and the indigenous hunter-gatherers. The possible contribution of the latter to the population and society of Southeast Asia after the establishment of rice farming has hardly been considered. Indeed, it has been assumed that hunter-gatherers vanished from further consideration, this despite their continued presence in remote parts of peninsular Thailand. Now, however, new genetic evidence is demonstrating that they provide a substantial proportion of the present gene pool. Moreover, new archaeological fieldwork is beginning to modify and enlarge our appreciation of hunter-gatherer complexity. The contribution of the findings at Ban Non Wat to all three of these issues will be considered after the basic data have been described in the ensuing chapters.

II FLEXED BURIALS

C.F.W. HIGHAM AND W. WIRIYAROMP

Interring the dead in a flexed position is usually identified with the hunter-gatherers of Southeast Asia. One such burial, also in a seated position, was found at the coastal site of Nong Nor (Higham and Thosarat 1998). A flexed skeleton was identified at the Tham Lod rockshelter in Mae Hongson Province, in a Hoabinhian context. It was

associated with a radiocarbon determination of 13,500 BC (Shoocondej 2004, 2008). A further tightly-flexed human burial of an old man in a round pit was found at the Ban Rai rockshelter, also in a Hoabinhian layer, and dating to about 10,000 years ago. This site is only 10 km from Tham Lod (Treerayapeewat 2005, Shoocondej 2004, 2008). At

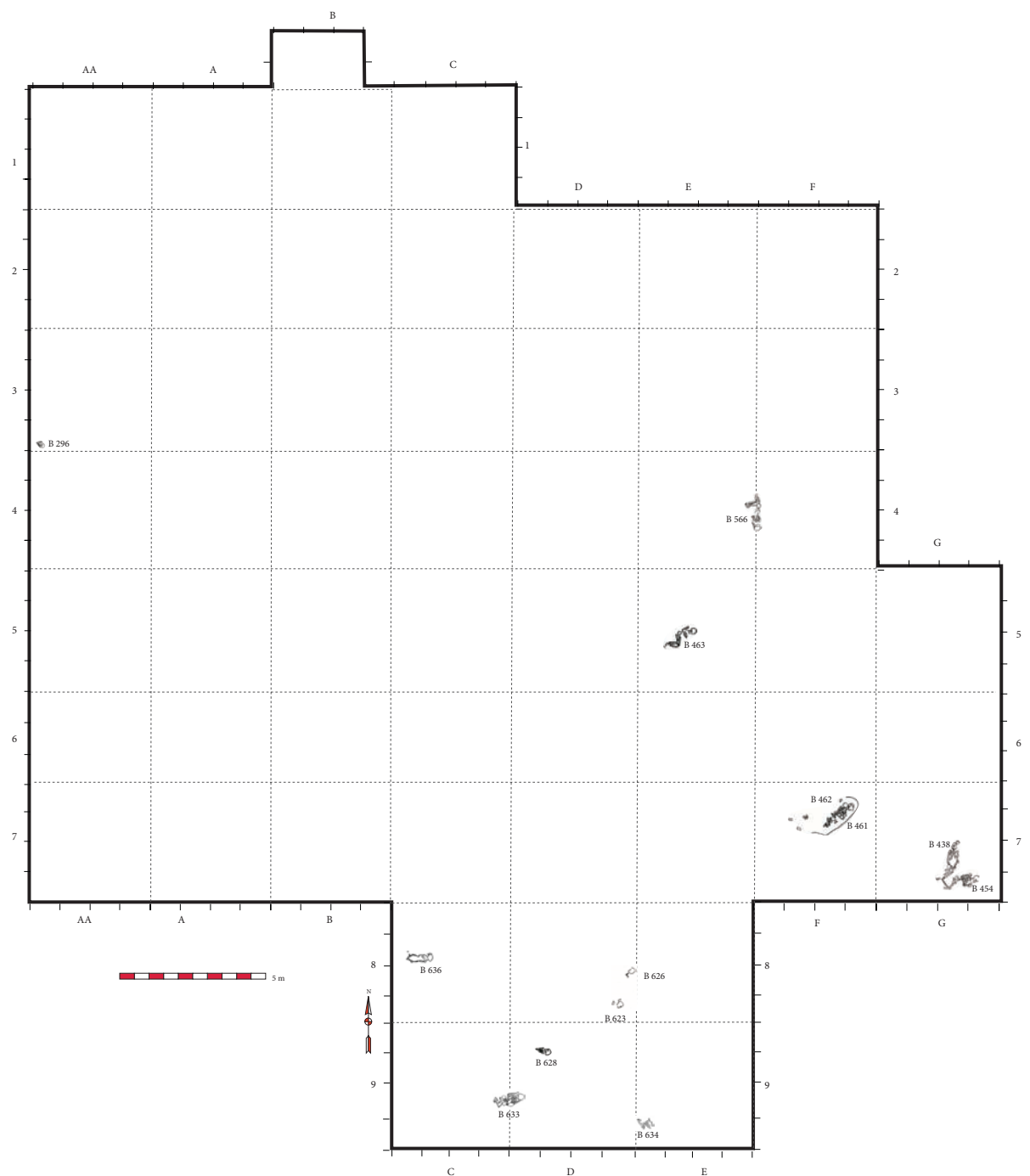


FIG. 2:1 The distribution of flexed burials

Moh Khiew, in peninsular Thailand, Pookajorn has recovered evidence not only for typical Hoabinhian stone tools, but also four inhumation burials, one of which may have been interred in a seated, crouched position. A radiocarbon date suggests that one of the burials is about 25,000 years old (Pookajorn 1992, 1994).

Until the excavation of Ban Non Wat, flexed burials on the Khorat Plateau were barely known. Those uncovered during the excavations of this site are invariably early in the cultural sequence, but the lack of superpositions with other phase interments makes it difficult to place them precisely in the relative sequence. There are at least 12 burials in this group, and possibly one further grave, that of an infant in an extended position, may also belong on the basis of its great depth.

The chronology of this group is known only through radiocarbon determinations from the bivalve shells placed as mortuary offerings (Table 2:1). They evidently



FIG. 2:2 The cranium of burial 463

TABLE 2:1 *The radiocarbon determinations for the flexed burials*

Lab. no.	Burial no.	$\delta^{13}\text{C}(\text{‰})$	Radiocarbon age (BP)	Calibrated date (95% confidence)
OxA-18141	454	-4.61	3362±27	1741-1537 BC
OxA-18142	461	-5.12	3204±27	1521-1423 BC
OxA-15942	438	-5.00	2948±29	1262-1055 BC



FIG. 2:3 Burial 463

fall within the second millennium BC.

In the case of burial 463, the grave was found within the natural substrate with no indication of a grave cutting. The knees were flexed, and the right arm was placed over the chest. The head was tilted slightly upwards and the jaw was closed. No grave goods were found with this individual (Figs. 2:2-3).

Burials 461 and 462 were found together (Figs. 2:4-6). The latter, an infant, lay on its left side with its right arm placed over the adjacent adult. The adult's legs were tightly flexed upwards. A bivalve shell was found to the west of the infant's cranium. Two further bivalves were found well beyond the feet of the adult, together with a pottery vessel. The relationship between these three items and the burials is not clear. The pottery vessel was too fragmentary for reconstruction. It had impressions probably made with

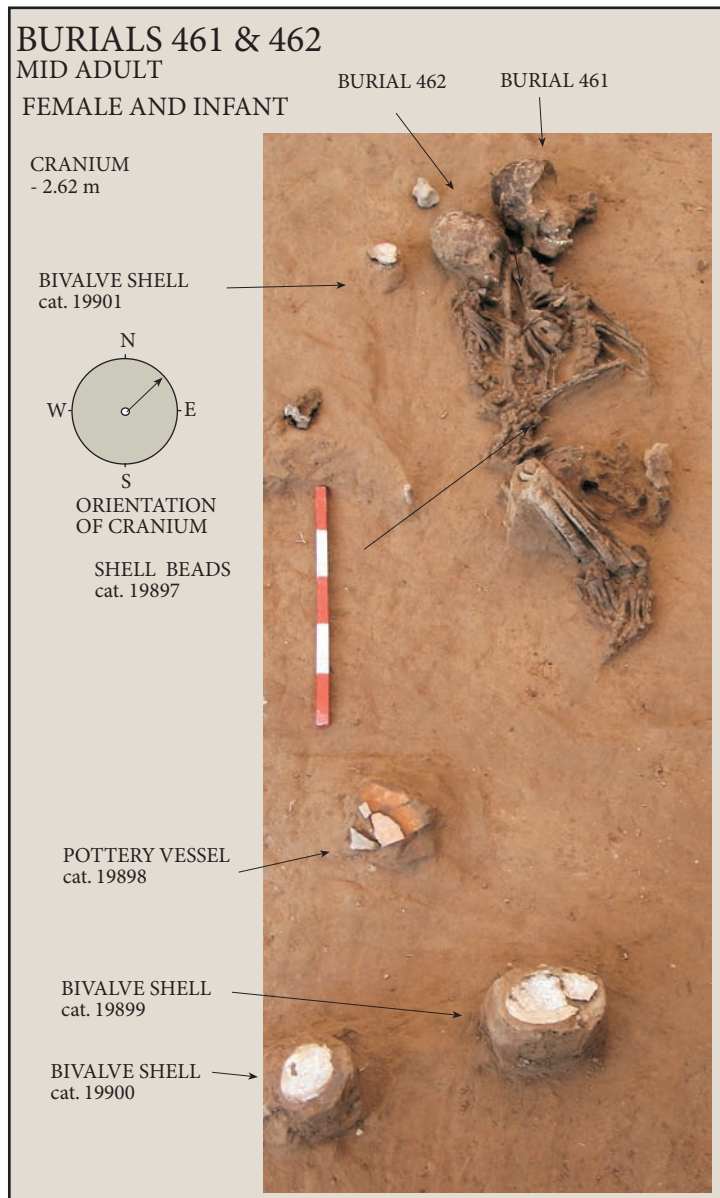


FIG. 2:4 Burials 461 and 462

a thumbnail at the rim and in a band just below the rim, while the rest of the body bears cord marking that was slightly smoothed and embellished with lines. No pottery like this was found in the later Neolithic burials. A total of 238 crudely fashioned shell beads, probably from the marine bivalve *Anadara*, to judge from the ridging still seen on the shell surface, were found over the body of burial 461 (Fig. 2:8). Again, such beads are not known from other Neolithic burials at this site. The cranium of this burial lay at a depth of 2.62 metres below datum in layer 5:1. The bodies were laid out with the head pointing to the north-east. The mouth of burial 461 was slightly open, and the right arm was placed over the chest.

Burials 438 and 454 were also found grouped together

FIG. 2:5 Burial 461, showing the shell beads.
Scale 5 cm

FIG. 2:6 Close up view of burials 461 and 462

(Fig. 2:9). The skull of the former was found in layer 4:9 at a depth of 2.68 m below datum, the skull of the latter was later identified in layer 5:2 at a depth of 2.88 m. They were clearly associated, and probably buried simultaneously. Burial 454, an old adult female, lay on the left side, with the knees flexed and the right arm placed over the chest (Figs. 2:14-15). The head pointed almost to the west. The left arm was bent such that the forearm pointed towards the head with the hand adjacent to the skull. This person wore a necklace of shell beads. The size of the beads suggests that they were fashioned from the tridacna shell, thus indicating a marine source (Fig. 2:16). The shape is rectangular, with the hole bored lengthwise. No similar shells are known to the authors. The large beads were linked with



FIG. 2:7 The ceramic vessel cat. 19898 from burial 461. Note the coarse, smoother cord marking and impressions on the rim



FIG. 2:9 Burials 438 (above) and 454. Scale 20 cm



FIG. 2:8 The shell beads, cat. 19897, from burial 461. Note the ridging, suggesting that they come from the marine species *Anadara*, and the crude manner in which they were finished. Scale 1 cm

small shell disc beads, some of which were found still in place in the threading holes for the large specimens. A bivalve shell had been placed at the left shoulder. Burial 438 lay to the north of burial 454 with the head pointing just east of due north. The knees were flexed and the hands were linked over the lower abdomen (Fig. 2:10). The skull was incomplete. A small globular pottery vessel lay adjacent to the skull. It has a maximum diameter of 11.2 cm, and the surface is plain and smoothed (Fig. 2:11). A bivalve shell was found over the left upper arm (Fig. 2:12). This person wore a shell bead necklace of at least 228 beads (Fig. 2:13). Unlike those from burial 461, they were carefully finished. A stone adze head was found at the left elbow.

Burial 566 was found at a depth of 2.66 m below datum (Fig. 2:17). No grave goods were found with this adult individual. The skeleton was orientated with the head to the south, and it lay beside burial 553, one of the particularly rich Bronze Age individuals in which the bones had been partially disinterred and then reburied in a carefully arranged group.

Only the upper part of the body of burial 296 has survived due to Bronze Age disturbances, but the disposition of the shoulders suggests that it belongs to this group (Fig. 2:18). No mortuary offerings were found in association with this individual.

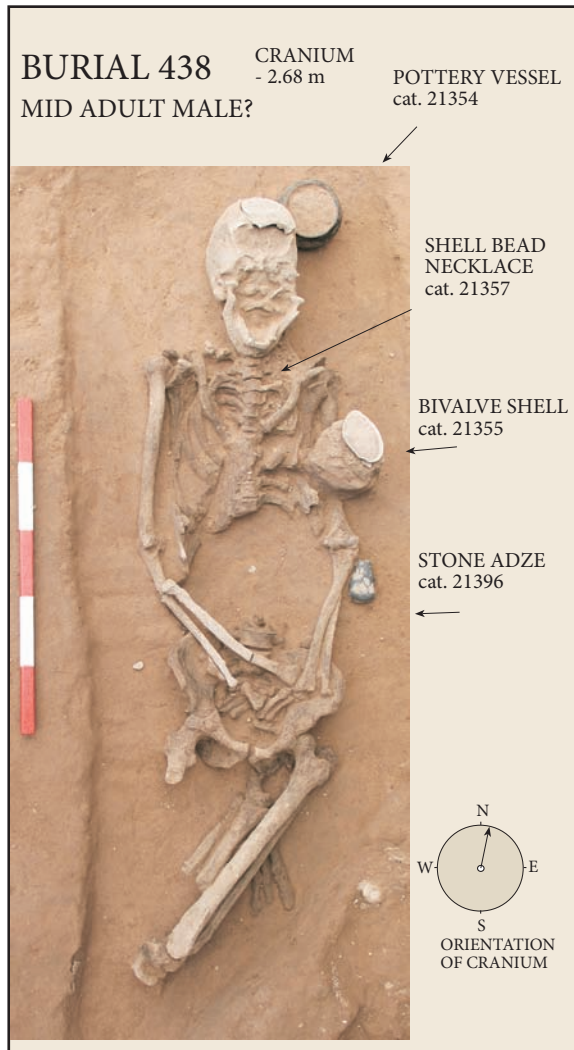


FIG. 2:10 Burial 438

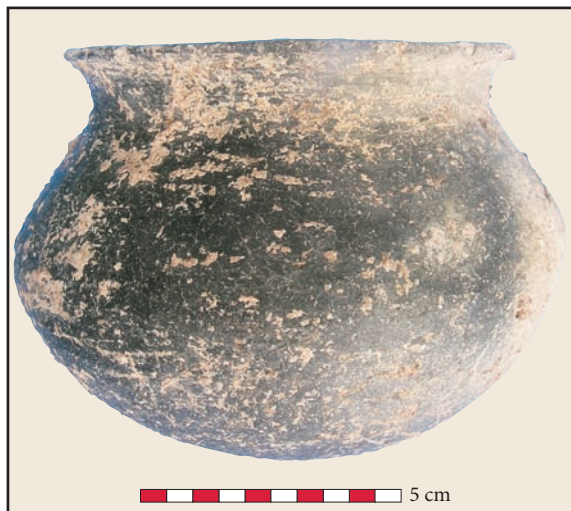


FIG. 2:11 The ceramic vessel cat. 21354 from burial 438



FIG. 2:12 Burial 438, a close up view of the shell disc bead necklace, bivalve shell and stone adze. Scale 10 cm

FIG. 2:13 The shell disc beads from burial 438, cat. 21357.
Scale 1 cm



FIG. 2:14 Burial 454



FIG. 2:15 Burial 454, showing a close up of the head area.
Scale 5 cm



FIG. 2:16 The shell beads from burial 454. Scale 50%



FIG. 2:17 Burial 566

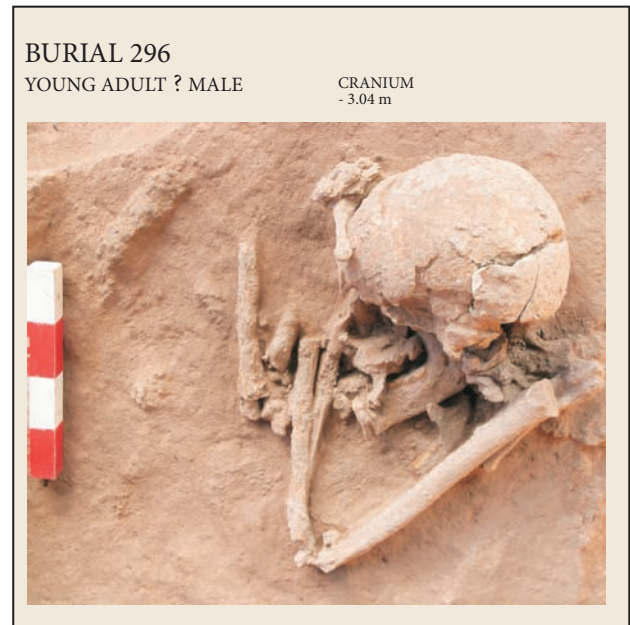


FIG. 2:18 Burial 296



FIG. 2:19 Burial 623

Burial 623, an adult comprises just the cranium and one potsherd that might be associated (Fig. 2:19). It is possibly one of the flexed burials, but this assignment is tentative and reflects its depth.

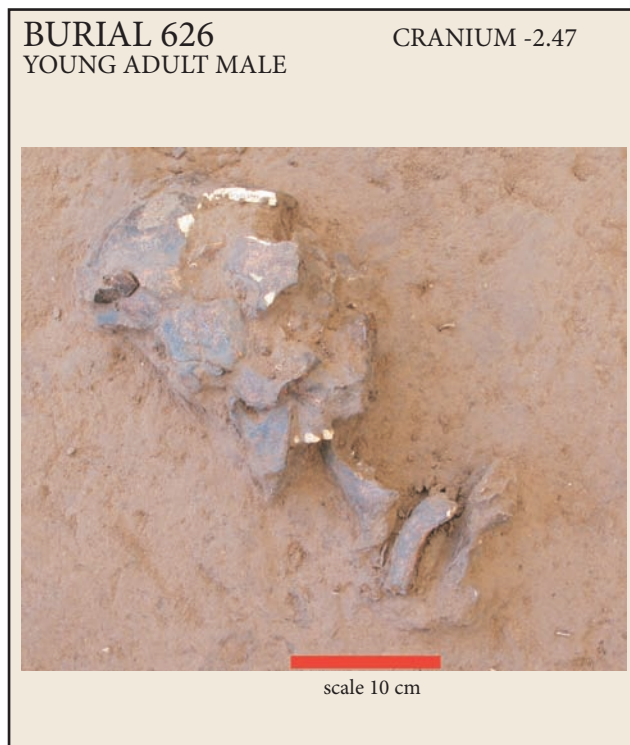


FIG. 2:20 Burial 626

Like burial 623, this adult man was disturbed in prehistory. It lies close to burial 623 at the same depth and the surviving limb bones suggest that it was possibly flexed.



Burial 628 contains the skull and some articulating upper limb bones of an adult probable female (Fig. 2:21). It was found in a line of similar burials in the southern part of the excavated area. A bovid figurine was found in the vicinity of the bones but given the disturbed nature of this burial, the association is not certain (Fig. 2:23).



FIG. 2:23 The clay bovid figurine found with burial 628. Scale 75%

FIG. 2:21 Burial 628



Burial 634 contained the remains of an adult, found deep in layer 5. It has been seriously disturbed in antiquity, and only a few of the bones were found *in situ*.

Fig. 2:22 Burial 634

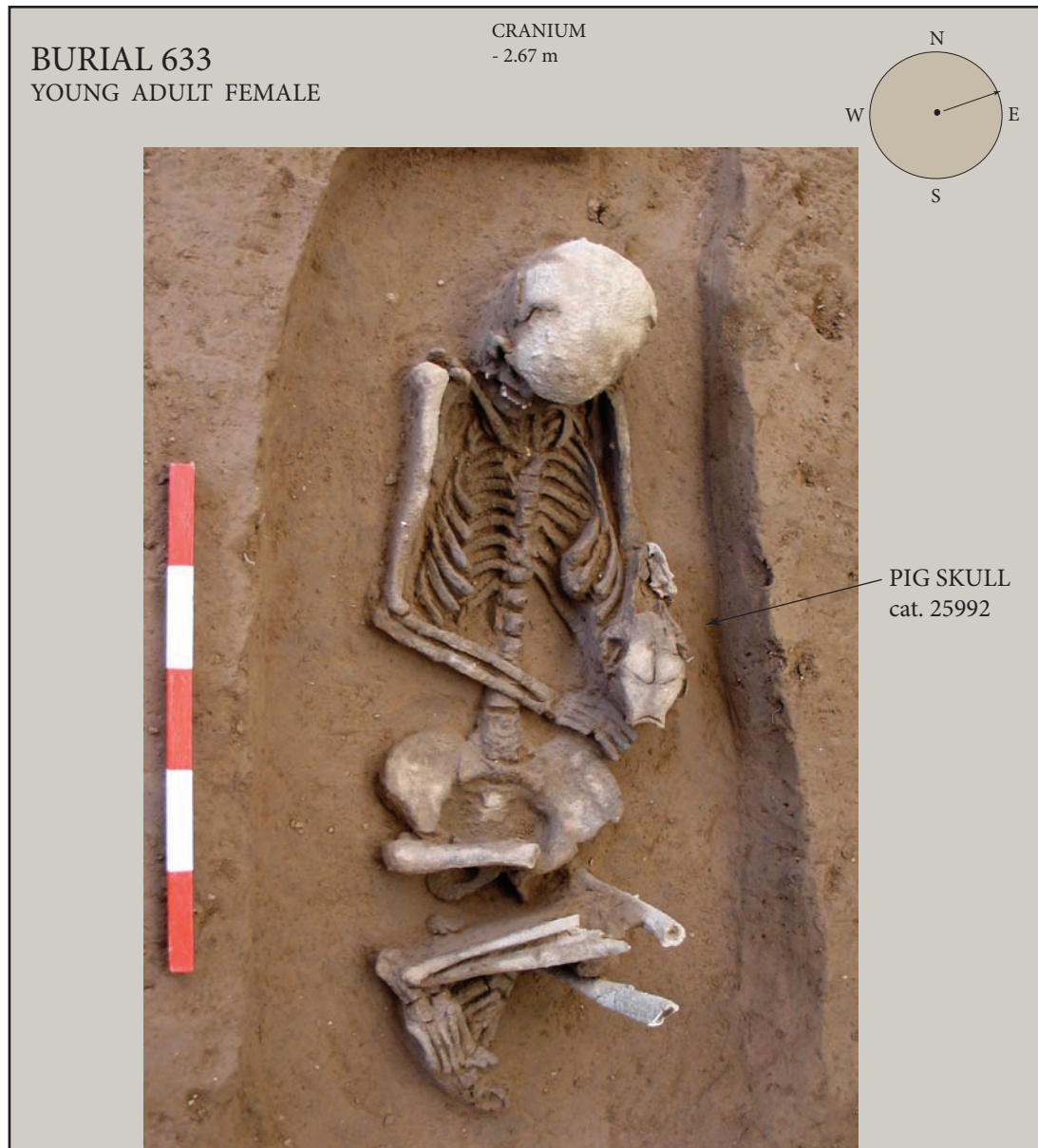


FIG. 2:24 Burial 633

Burial 633 contained the complete skeleton of a young adult woman. She had been interred lying on her back, with the right hand crossed over the abdomen. the legs

were tightly flexed, and the head was elevated as if it had been propped up when buried. The skull of a pig lay over her left hand.

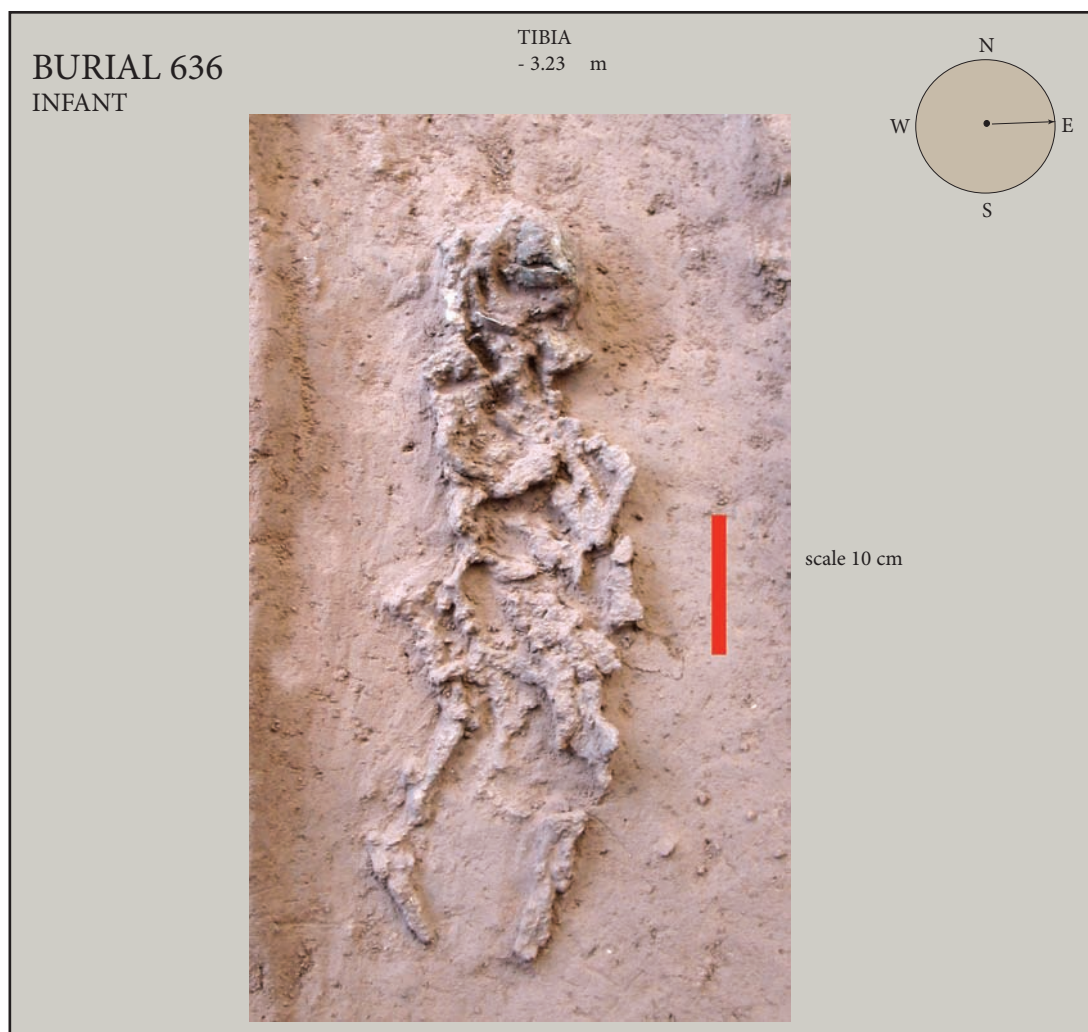


FIG. 2:25 Burial 636

Burial 636 contains the supine skeleton of a newly-born infant. The bones are heavily encrusted and lie in layer 5:6. They are not flexed, but the burial is assigned to this group on the basis of its great depth. It does, however, lie beyond

the feet of burial 250, of Neolithic 1, but is 41 cm deeper. This makes it unlikely that the two are associated, but the possibility cannot be ruled out.

III NEOLITHIC PHASE ONE

C.F.W. HIGHAM AND W. WIRIYAROMP

Neolithic 1 burials concentrate in the western part of the main square (Fig. 3:1). None was found in excavation areas X and Y. The group is defined on the basis of the manner of burial and the associated mortuary offerings. The adult dead were interred in a supine

position, usually with the head pointing to the north. A few burials were orientated to the east or the south. Two adults were placed in a seated position in large, lidded mortuary vessels. Infants were also buried in lidded mortuary vessels. Ceramic vessels were the principal mortu-

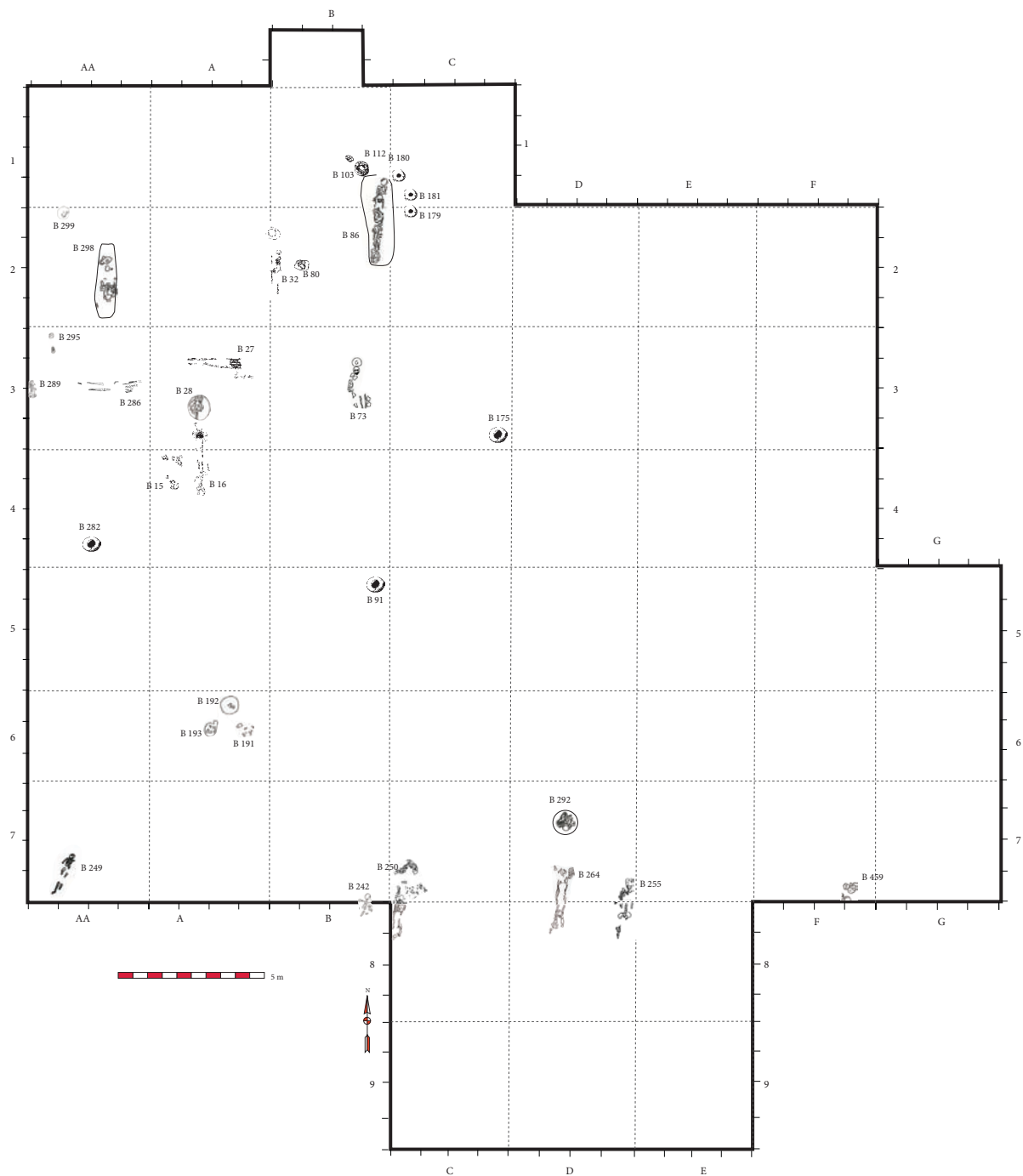


FIG. 3:1 The distribution of Neolithic 1 burials

ary offering. There is a notable rarity of shell jewellery. One person wore shell necklace, and another was found with a single shell bangle. Two individuals were accompanied by cowrie shells. In the case of burial 86, these were pieced and worn as ear ornaments. No such associations suggesting use as jewellery were identified with the five cowrie shells associated with burial 292. Animal offerings were found in the form of pig and fish bones, the latter contained in ceramic vessels. Four stone adzes were also placed with burials.

THE CERAMIC VESSELS

The ceramic vessels have been divided into seven principal forms. Form 1 vases have a cylindrical base, constrained waist and large, flaring upper body. The exterior of the base was embellished with decorative bands usually infilled with punctate or impressed patterns, red paint and burnishing. The upper body was often left burnished and plain, although some vessels had further geometric mo-

TABLE 3:1 *The adult burials of Neolithic 1*

No.	Age	Sex	Orientation	Pots	Pot form						Pig bones	Fish	Shell beads	Stone adze	Shell bangle	Cowrie shell	Bivalve shell
					1	2	3	4	5	6							
15	YA	-	S	4	2	1	-	-	-	-	-	-	-	-	-	-	-
16	YMA	F	N	9	4	1	-	-	-	-	-	-	-	1	-	-	-
27	A	-	E	1	1	-	-	-	-	-	-	-	-	-	-	-	-
28	MOA	M	-	3	-	-	1	1	-	1	-	-	-	-	-	-	-
32	MOA	F	N	2	-	1	1	-	-	-	-	-	-	-	-	-	2
73	O	-	N	3	2	1	-	-	-	-	-	-	-	-	-	-	-
86	Y	M	N	4	2	1	-	-	-	-	3	9	-	-	-	2	3
191	A	M	N	-	-	-	-	-	-	-	-	-	-	-	-	-	-
242	A	F	S	3	2	1	-	-	-	-	1	-	-	-	-	-	-
249	MOA	F	N	-	-	-	-	-	-	-	-	-	-	-	-	-	-
250	OA	M	N	3	2	-	-	-	-	-	1	-	1	-	-	-	1
255	YA	M	N	-	-	-	-	-	-	-	-	-	-	1	-	-	-
264	YA	M	-	2	1	-	-	-	-	-	2	-	-	1	-	-	-
286	YA	F	E	-	-	-	-	-	-	-	-	-	-	-	-	-	-
289	A	-	S	2	2	-	-	-	-	-	1	-	-	1	-	-	-
292	MA	F	-	2	-	-	-	2	1	-	-	-	-	-	1	5	1
459	-	-	-	1	1	-	-	-	-	-	-	-	-	-	-	-	-

TABLE 3:2 *The infant burials of Neolithic 1*

No.	Age	Pottery vessels	Pot form 1	Pot form 2	Pot form 3	Pot form 4	Ivory bead	Fish
80	3 y	2	-	-	1	1	-	-
91	9-12 m	1	-	-	1	-	-	-
103	12-18 m	2	-	1	1	-	-	8
112	premature	1	-	-	1	-	-	-
175	premature	2	-	1	1	-	-	-
179	6 m	3	1	1	1	-	-	-
180	6 m	4	1	1	1	1	-	-
181	3 m	2	1	-	1	-	-	-
192	6-9 m	2	-	1	1	-	1	-
193	6 m	2	-	-	1	1	-	-
282	9 m	2	1	1	-	-	-	-
295	6 m	1	-	-	-	1	-	1
298	2-4 y	3	2	-	-	1	-	-
299	8 y	3	1	1	1	-	-	-

y: year m: month



FIG. 3:2 Ceramic vessels of pot form 1A (A-C), 1B (D-E) and 1C (F-G). A. Cat. 2230, B. cat. 19904, C. cat. 6292, D. cat. 2231, E. cat. 5785, F. cat. 918, G. cat. 15583, H. cat. 25850, I. cat. 25896

tifs incised along the rim. Three sub-forms are suggested. Form 1A has a slightly concave base and a relatively straight contour to its flaring upper body (Fig. 3:2 A-C). Form 1B is broader both in the base and the upper body,

the latter being very slightly convex (Fig. 3:2 D-E) while form 1C has a narrow base and a broad flaring upper body (Fig. 3:2 F-G).

Ceramic form 2 is an open bowl-shaped vessel, usu-

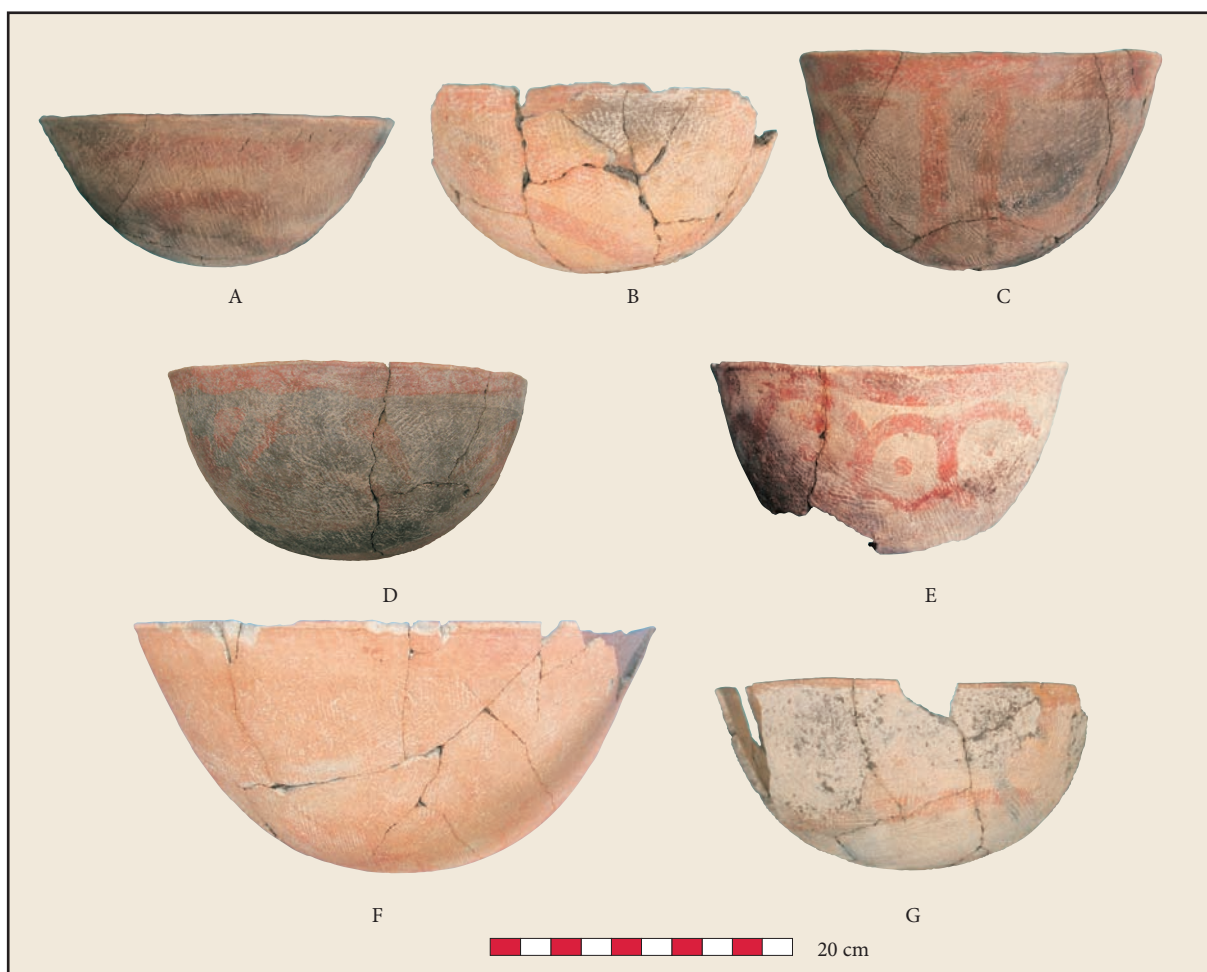


FIG. 3:3. Ceramic vessels of pot form 2. A. cat. 3193, B. cat. 1414, C. cat. 2233, D. cat. 6786, E. cat. 11641, F. cat. 6291 G. cat. 723

ally found employed as a lid to a mortuary jar. The bowls are commonly embellished with designs painted in broad red bands on the exterior, over a cord-marked surface. Interior surfaces are usually painted with a design of parallel, and thinner red bands. The rims are plain but again, enhanced by a red painted band.

Ceramic form 3 is a globular mortuary jar (Fig. 3:4). Five of the specimens, one to accommodate an adult and the other four for infants, were cord marked over most of the body, and the shoulder, demarcated by a raised cordon, was decorated with incised and red painted designs on a burnished panel. The surface of the largest was also painted in large, red, curvilinear designs. Three vessels were cord marked and had a plain everted rim. The last vessel illustrated in figure 3:4 lacks a rim. The body was burnished and two rows of red circles decorate the shoulder.

Form 4 comprises a globular cord-marked vessel with everted rim. These are found in a variety of sizes. Two, for

example, were found placed within adult mortuary vessels, and are small enough to qualify as drinking cups. (Fig. 3:5). Others were larger and come in several slightly differing shapes.

Form 5 is a unique mortuary jar found containing burial 292 (Fig. 3:54). It is very large and deep relative to its width. The shoulder curves in to a small cylindrical neck and the body is cord marked with a preference for vertical strokes. As with burial 28, the side of the vessel was broken in antiquity, presumably to allow the cadaver to be inserted.

Form 6 is a large lid for placing over an adult mortuary jar. The surface finish in the sole example, found with burial 28, is plain (Fig. 3:17).

These pottery vessels reflect a mature and expert tradition of manufacture. They incorporate a range of design motifs which will be set out in more detail in a later chapter.



FIG. 3:4 Ceramic vessels of pot form 3. A. cat. 1039, B. cat. 2209, C. cat. 6290

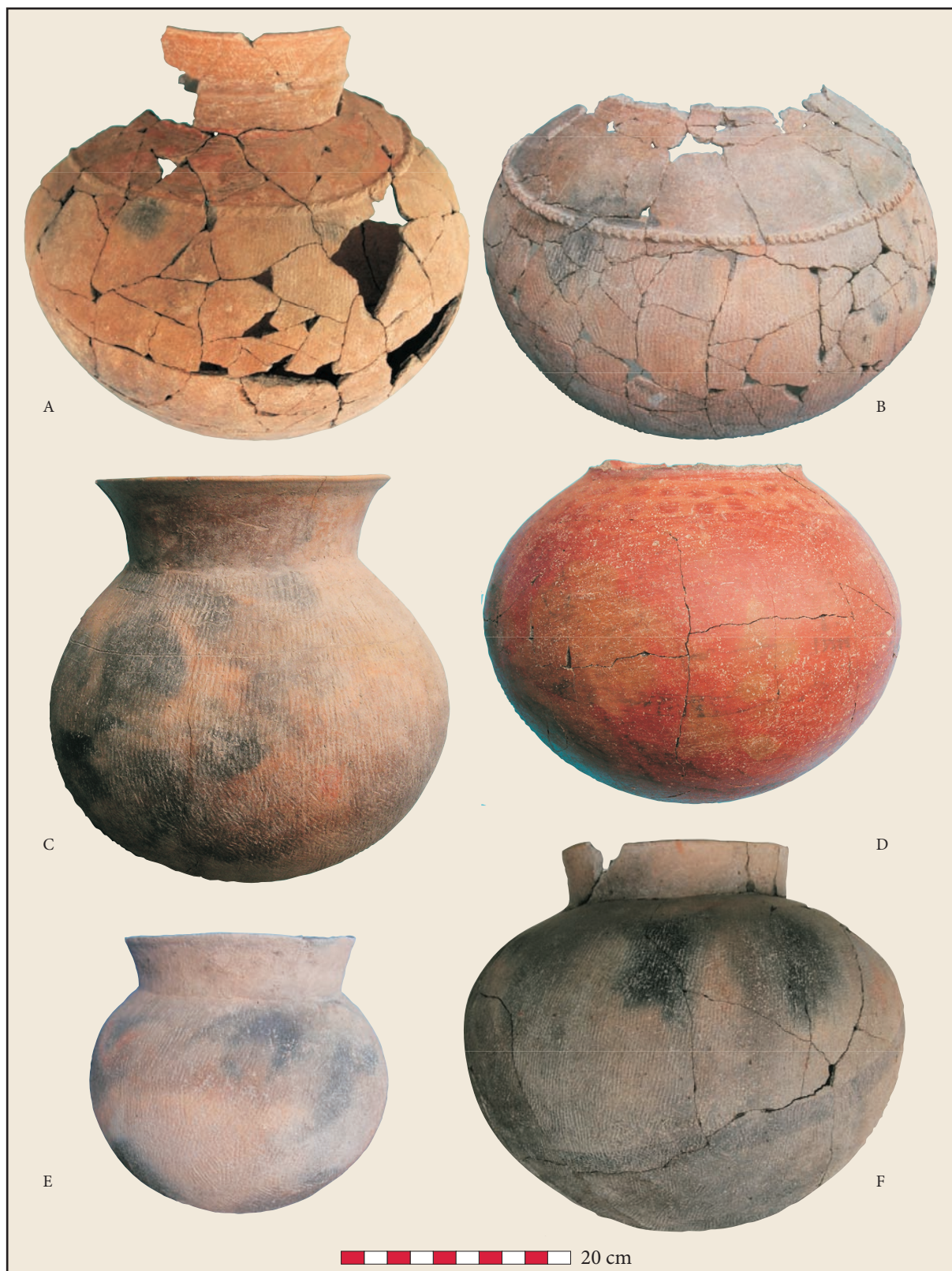


FIG. 3:5 Ceramic vessels of form 3. A. cat. 1376, B. cat. 9141, C. cat. 8863, D. cat. 5784, E. cat. 6787, F. cat. 5782

THE BURIALS

The distribution of Neolithic phase 1 burials is set out in figure 3:1. There is some evidence for patterning. In the northern part of the excavated area, there appears to be a concentration of burials belonging to this phase, including adults and infants. Burial 86, a member of this group, was found with five infant jar burials in an arc round the head area. To the south, there is an isolated group of infant jar burials. Further south, there appears to be a row of adult burials. In addition, there is a handful of scattered infant jar burials. Only burials 15 and 16 were found in close conjunction, with the body laid out with the head in opposite directions. Otherwise, the adult burials appear to be widely spaced one from the other and there is no evidence for disposal in the rows or clusters that developed during the Bronze and Iron ages.

Burial 15, that of a young woman, appears to have been interred in a supine position with the head orientated to the south. The bones were found at a depth of 3 m below datum. The area from the cranium to the radii was disturbed in antiquity. At least four ceramic vessels were associated with the burial (Fig. 3:8). Three cannot be reconstructed, although they were decorated with incised and impressed patterns. Cat. 763 is the base of a form 1 vase which typifies Neolithic 1. This comprises a cylindrical base, usually decorated with incised and impressed patterns. The base narrows before the upper part of the vessel flares outward. In the case of cat. 763, the incised decoration has two major panels. The lower, demarcated by two pairs of incised lines, takes the form of a series of semi-lunates infilled with impressed dots. The upper is much broader, and is again demarcated by incised lines surrounding a deep band of similar incised dots. Cat. 621 is part of



FIG. 3:7 Burial 15, showing the painted pottery vessel cat. 723. Scale 2 cm



FIG. 3:6 Burial 15

the upper section of a similar vessel and is undecorated but smoothed. Cat. 732 is represented only by a sherd, which was cord marked and then painted with red bands. A fourth vessel, cat. 723, is form 2. The cord-marked exterior was painted with broad red bands, while the interior is decorated with red painted, curvilinear designs.

Burial 16 lay alongside burial 15, with the body orientated with the head to the north. It contained a young mid adult probable female (Fig. 3:10). The cranium was encountered at a depth of 3.08 m below datum. The body had been laid supine in the grave, and the jaws were only very slightly apart. Pottery vessels were found round the upper part of the body, and a mass of potsherds lay be-

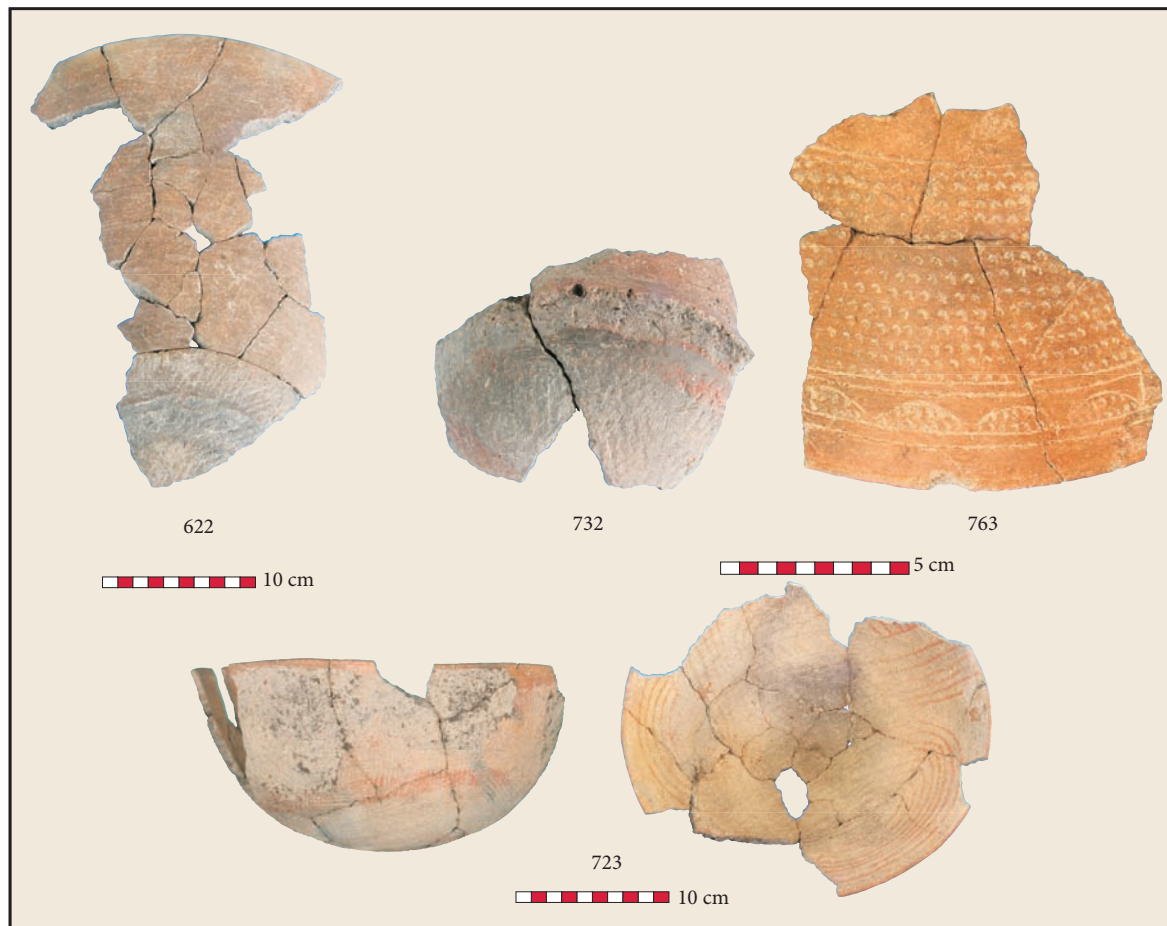


FIG. 3:8 Fragmentary pottery vessels from burial 15. A. cat. 622, B. cat. 732, C. cat. 763, D. cat. 723



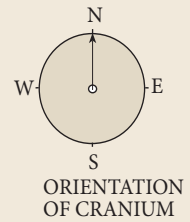
FIG. 3:9 Close up of the decoration on ceramic vessel cat. 762, burial 16

BURIAL 16 YOUNG-MID ADULT PROBABLE FEMALE

CRANIUM
-3.06 m

POTTERY VESSEL
cat. 864

POTTERY VESSEL
cat. 865



POTTERY VESSEL
cat. 866

POTTERY VESSEL
cat. 867

yond the feet. At least nine vessels are thought to be represented (Fig. 3:11). Several of these are form 1 pedestalled vases. Cat. 867 has the typical form of a group B vessel embellished with incised designs incorporating bands of red painted decoration. Cat. 866 at the left shoulder is a form 2 open bowl with a round base and cord marking on the outer body. Cat. 764 is the incomplete base of a form 1 pedestalled vase. The incised and impressed decoration begins, in the upper register, with a broad band of impressed dots defined by two incised lines. There is then a second band of plain finish again set within incised lines. This gives way to third band, again filled with impressed dots, but this band flows into distinctive curvilinear patterns, enhanced by a background of three further plain bands set within incised lines. The small part of the actual base of this vase that is left, indicates a final plain band, its lower limit being marked by a line of red paint.

Cat. 765 is a second such form 1 pedestalled vase, but again it is fragmentary. The upper register comprises a broad band, infilled with small circular impressions that form a curvilinear pattern including at least one spiral. A small plain band within two sets of double incised lines lies below, leading



ADZE cat. 605

POTTERY VESSEL
cat. 764

POTTERY VESSEL
cat. 765

POTTERY VESSEL
cat. 766

POTTERY VESSEL
cat. 762

POTTERY VESSEL
cat. 767

FIG. 3:10 Ban Non Wat burial 16



FIG. 3:11 The pottery vessels interred with burial 16. A. cat. 764, B. cat. 765, C. cat. 762, D. cat. 766, E. cat. 767, F. cat. 866, G. cat. 867

to a third band of decoration, on this occasion impressed in a rocker motif possibly with the edge of a shell. Two

further bands lie below, both relatively thin. One is painted red, the other was burnished.

Cat. 762 is a third form 1 vase. In this instance, both the rim and the base have survived in part. The former is plain and burnished. The latter incorporated a complex incised design, that features the stylized opposed human figure widely employed in Neolithic sites in Thailand (Higham 2004). Cat. 766 comprises two sections of the rim of a form 1 vase, embellished with faint horizontal incised lines. Cat. 767 is a globular cord-marked vessel, with ves-

tiges of red paint on the exterior. A stone adze was found left of the left tibia.

Burial 27 lacks a cranium, probably as a result of the grave being disturbed with the interment of burial 26, a Neolithic 2 burial. The humerus lay at a depth of 3.21 m below datum. The orientation was arranged with the head pointing almost due east. One pottery vessel, which was also found disturbed, has the hallmarks of a Neolithic 1



FIG. 3:12. Burial 16, a close up view of the decoration on pottery vessel cat. 764



FIG. 3:13 The cranium of burial 16. Scale 2 cm



FIG. 3:14 Burial 16 showing pottery vessel cat. 867 under excavation. Scale 2 cm

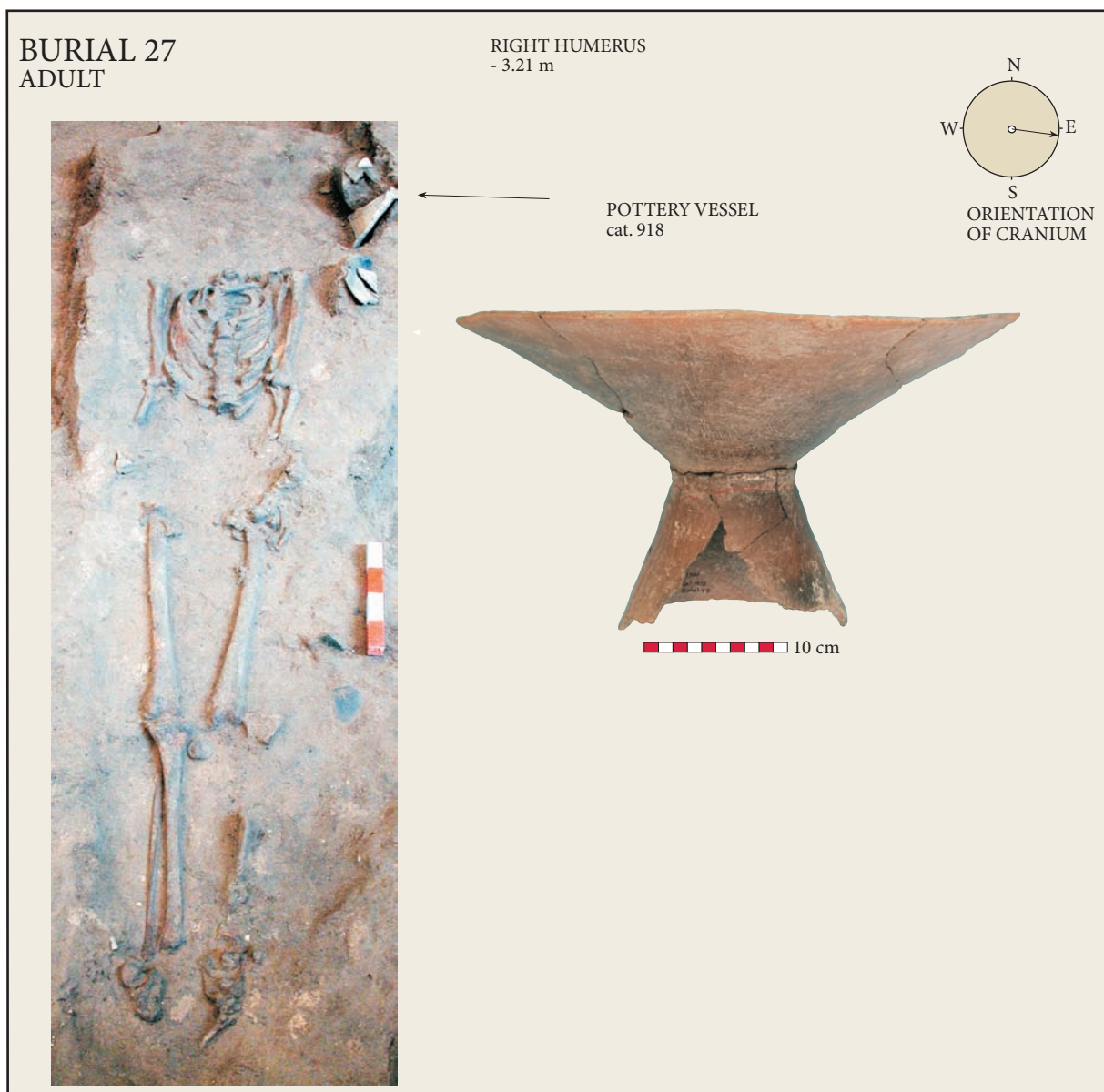


FIG. 3:15 Burial 27

vessel. It has an upper body with a flaring rim, on a cylindrical base, the latter being decorated with thin bands of red paint comprising a curvilinear design. The upper body was cord marked before being enhanced with horizontal impressed lines.

Burial 28 is a remarkable interment, one of only two adult individuals being buried in a lidded mortuary jar (Fig. 3:16-18). This burial has yielded two radiocarbon determinations. The first, derived from charcoal within the mortuary vessel, is 2150-1935 cal. BC. The second comes from the bivalve shell included as a mortuary offering, and is 1499-1407 cal. BC. The latter is preferred since it is most unlikely to have inbuilt age. The skeleton of a mid to old male was found in a seated, crouched posture, with the head slumped over the chest. The hands were crossed and

lay adjacent to a small globular pottery vessel. A bivalve shell was found under the left wrist. Such bivalve shells were to be a recurrent feature of burials at Ban Non Wat during both the Bronze and Iron Ages. The mortuary vessel was complete except that the rim had been removed in antiquity. Most of the body was cord marked, and then embellished with red painted curvilinear bands. A raised cordon demarcated a change in decoration at the uppermost part of the body, where the cord marking and painting were replaced by a broad band of black, burnishing on which a complex series of designs were incised and infilled with red paint. A hole had been created on one side of the vessel, presumably to enable the body to be inserted, for the mouth was not large enough to permit this. The jar was capped by a large ceramic lid, with a plain burnished

BURIAL 28
OLD ADULT MALE

CRANIUM
 -3.27 m

POTTERY VESSEL
 cat. 1039

POTTERY VESSEL LID
 cat. 1038

BIVALVE SHELL
 cat. 1114

POTTERY VESSEL
 cat. 1338

SHELL DISC BEADS
 cat. 1822 n=2

Scale 20 cm



FIG. 3:16 Burial 28. The upper image shows the burial before the removal of the lid

surface, while a very small cup with a plain exterior surface was found beside the man's hands.

Burial 32, that of a mid to old female, was found at a depth of 3.03 m below datum, with the head pointing to

the north (Figs. 3:19-21). The body was laid out supine, but the cranial area was disturbed in antiquity. Charcoal within a lidded ceramic vessel beyond the head has provided a radiocarbon determination of 1603-1373 BC. Two

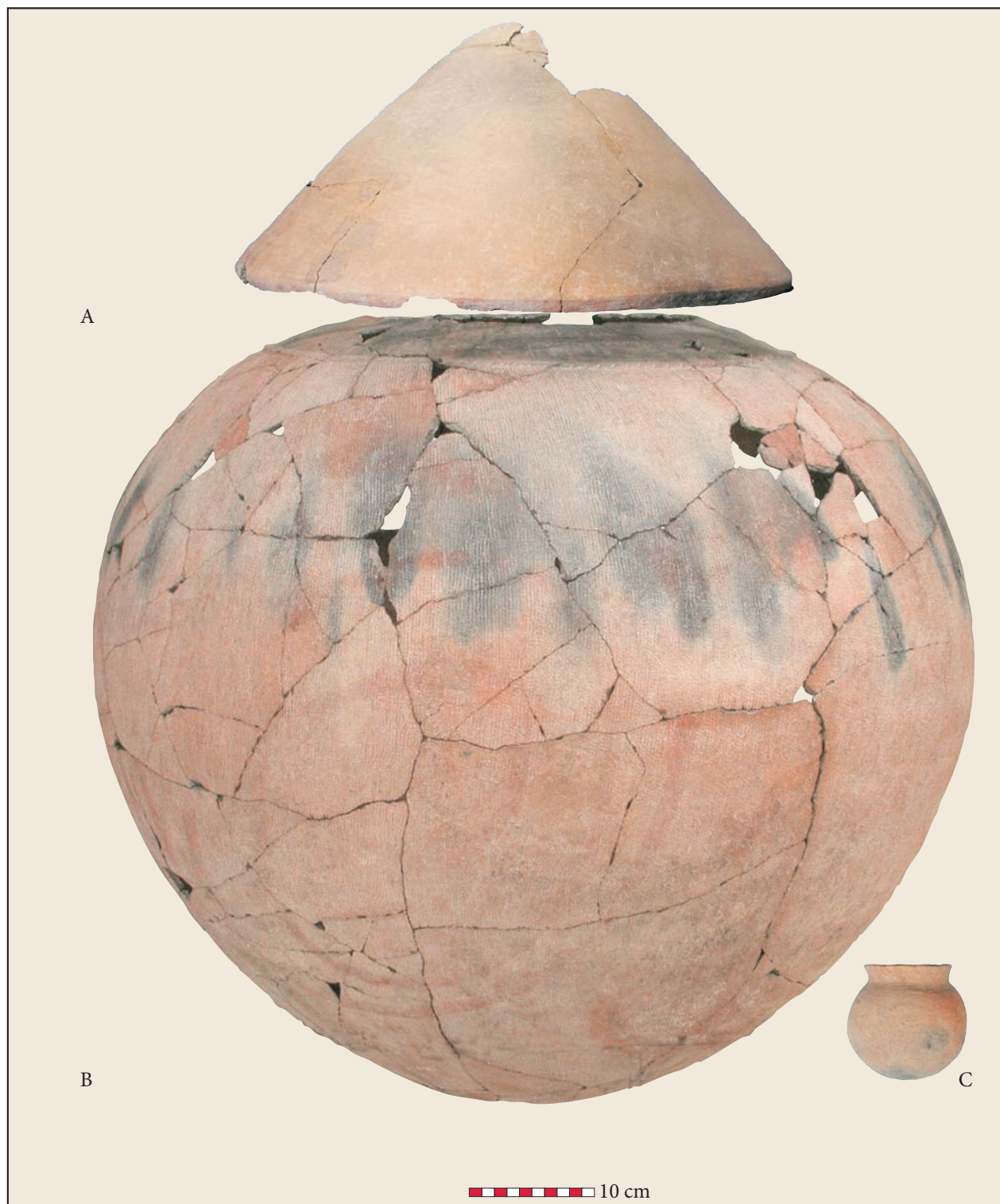


FIG. 3:17 The ceramic vessels from burial 28. A. cat. 1038, B. cat. 1039, C. cat. 1338

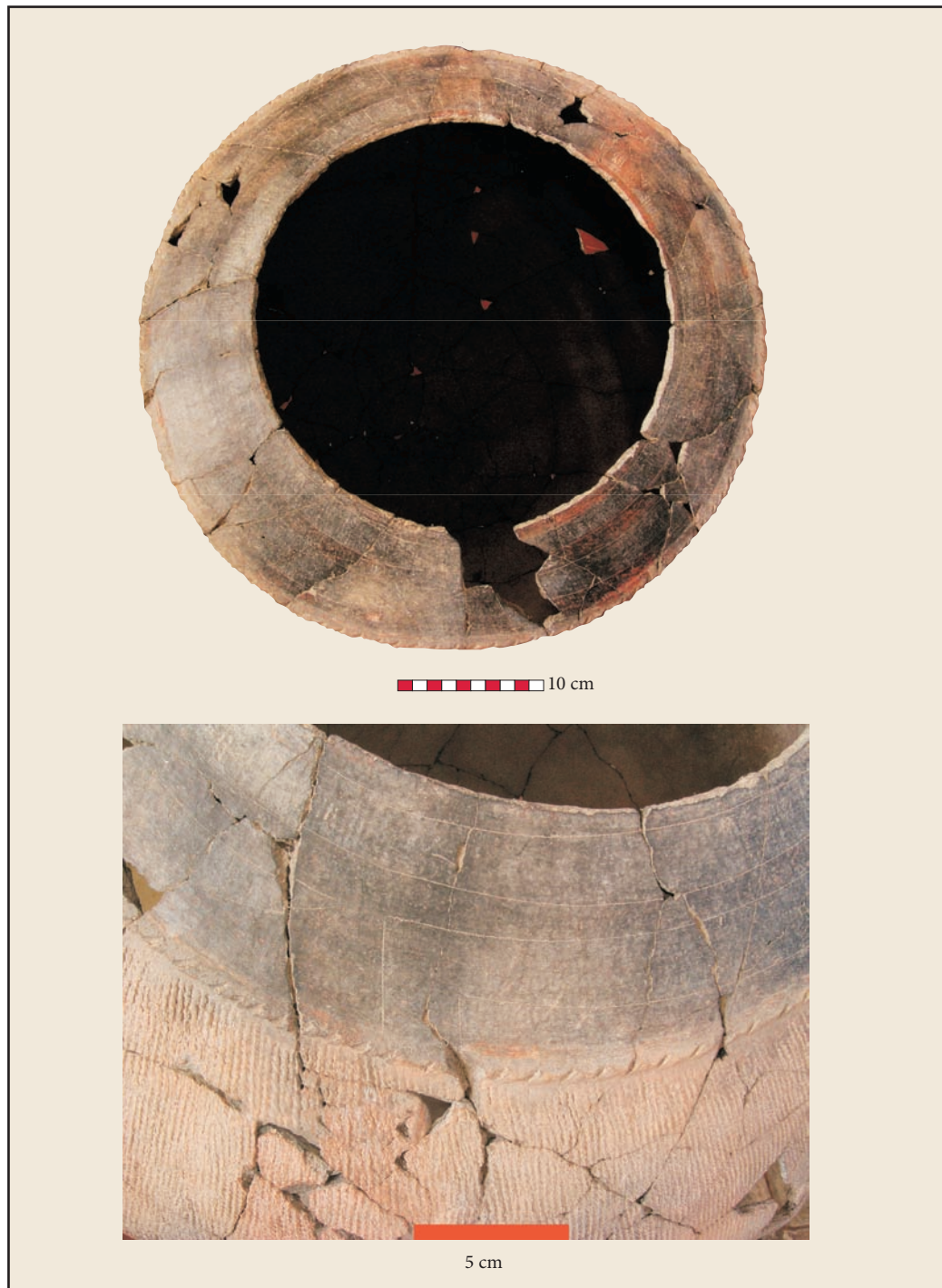


FIG. 3:18 Burial 28, cat. 1039. The upper image shows the decorative band on the shoulder of this mortuary vessel. The lower image provides a close up view of this decoration

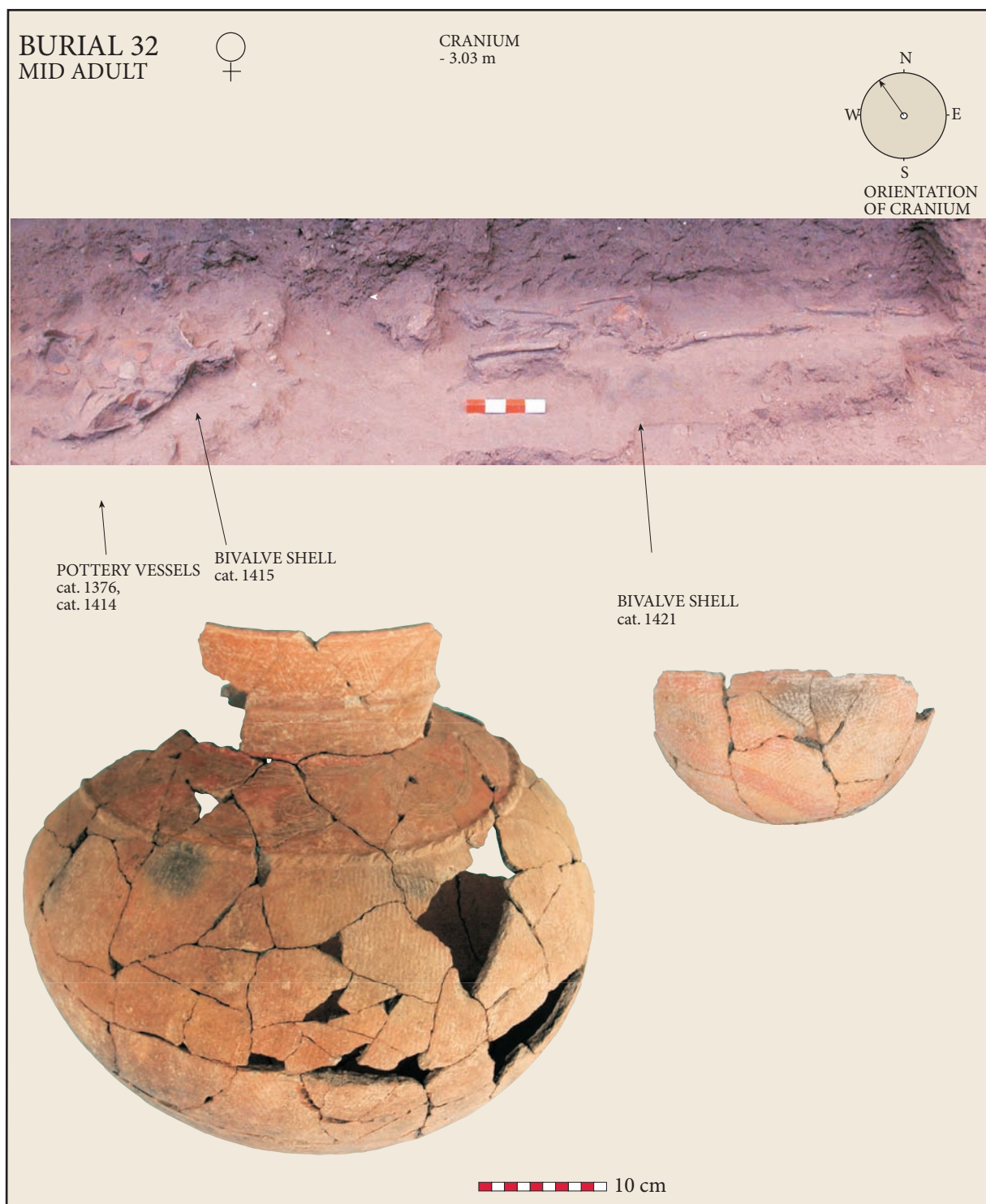


FIG. 3:19 Burial 32

bivalve shells were associated with the skeleton, one beyond the head and the other under the right hand. One of these provided a radiocarbon determination of 1497-1392 BC. The vessel associated with this burial has a cord-marked body under a raised cordon. The shoulder region above this cordon bore an incised and painted spiraliform decoration. The incised spirals were accentuated by a

background of red paint. The outer surface of the rim was decorated with incised wavy lines. A second vessel, cat. 1414, was probably the lid for the main pot. The exterior surface is cord marked and painted in broad red bands. The interior surface was given careful attention with the painting in red pigment of a series of curvilinear designs made up of parallel lines.

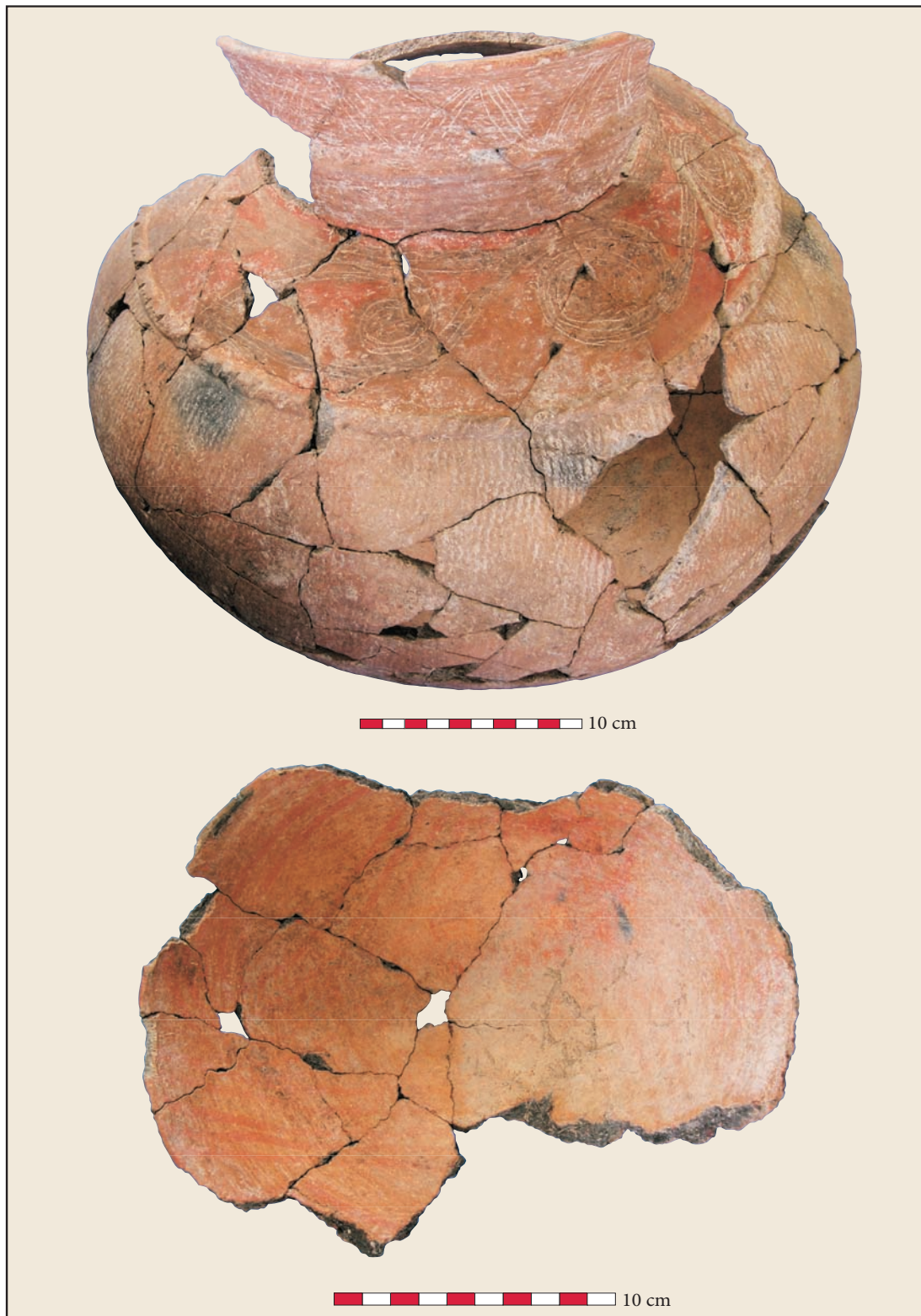


FIG. 3:20 Ceramic vessels from burial 32. Upper, cat. 1376. Lower, cat. 1414

Burial 73 is that of an old adult laid out with the head pointing about 10° from due north (Figs. 3:22-3). Unfortunately a large pit had been cut through the mid part of the skeleton in antiquity, but the cranium survived

intact, and the jaw was found open. The feet were also missing. Three pottery vessels were located with the body, one beyond the head, a second by the right shoulder and the third left of the left tibia. Cat. 3196 is the lower half or



FIG. 3:21 Burial 32, pottery vessel cat. 1376, showing the curvilinear spiral decoration on the shoulder. The arrow points to the charcoal that provided the radiocarbon determination of cal. 1603-1373 BC

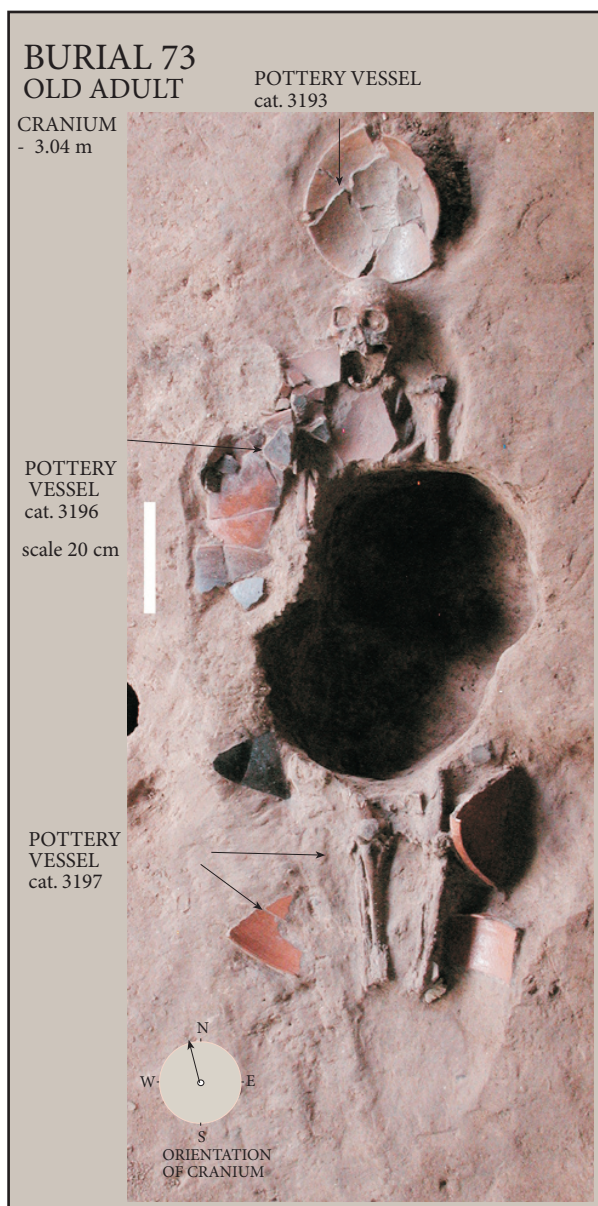


FIG. 3:22 Burial 73

base of a typical form 1 vessel with a broad flaring upper body, although in this case the latter is missing. The pedestal base is decorated with incised bands. In the lower panel, a series of motifs resembling a breaking wave were highlighted by burnishing, and further accentuated by a background of impressed jabs. The upper panel has incised lines infilled with red paint to form a complex design in which the principal motif has a silhouette resembling a whale. This broad band is demarcated above and below by two incised bands infilled with red paint. Cat. 3193 is an open cord-marked bowl with broad red-painted bands on the outer body. The interior was embellished with a pattern of parallel-painted red lines, although the form of the decoration survives only faintly. The remaining vessel is the upper part of a form 1 vessel, the surface of which was burnished with vertical streaks.

Burial 80 contained a three-year-old infant (Fig. 3:24). It was located in square B2 at a depth of 3.05 m below datum. A cord-marked globular vessel was found with the larger mortuary jar. A large sherd from the latter indicated that it was cord marked and decorated with broad red-painted bands.

Burial 86 is one of the richest and most complete of the Neolithic 1 graves (Figs. 3:25-31). A radiocarbon determination from one of the bivalve shells associated with the skeleton as a mortuary offering resulted in a corrected age of 1434-1304 BC. The corpse of a young adult male had been laid out on the back, with the head facing upwards and the arms beside the body. The left ulna was not in anatomical position and the jaw was slightly open. Two cowrie shells, both pierced, were found to the left of the skull, and had presumably been ear ornaments. There were also three bivalve shells associated with the mortuary ritual, one under ceramic vessels beyond the head, one by the right hand and the other to the left of the left ankle. Four ceramic vessels were recovered. One of these, cat. 2233, is a form 2 open bowl, again bearing red painted designs (Fig. 3:29). There are broad red bands over cord marking on the exterior, while the interior bears thinner parallel red-painted lines in a curvilinear pattern.

Cat. 2230 is a form 1A footed vase (Fig. 3:31). The base, as is normally the case with this form, carries the principal decorative motifs. Essentially there are five panels, demarcated by horizontal incised lines. The lowest of these was painted red. A relatively thin burnished band followed, under a series of infilled semi-lunate motifs. This in turn lay under a broad band of impressed circles. The uppermost panel was burnished. The upper body was likewise burnished, and there are faint indications of at least one horizontal band of impressed lines. The interior of the base was painted with a series of broad red bands, but no particular pattern is evident.

The third vessel, cat. 2231, is a form 1B vase (Fig. 3:30). The base was decorated with a distinctive incised motif

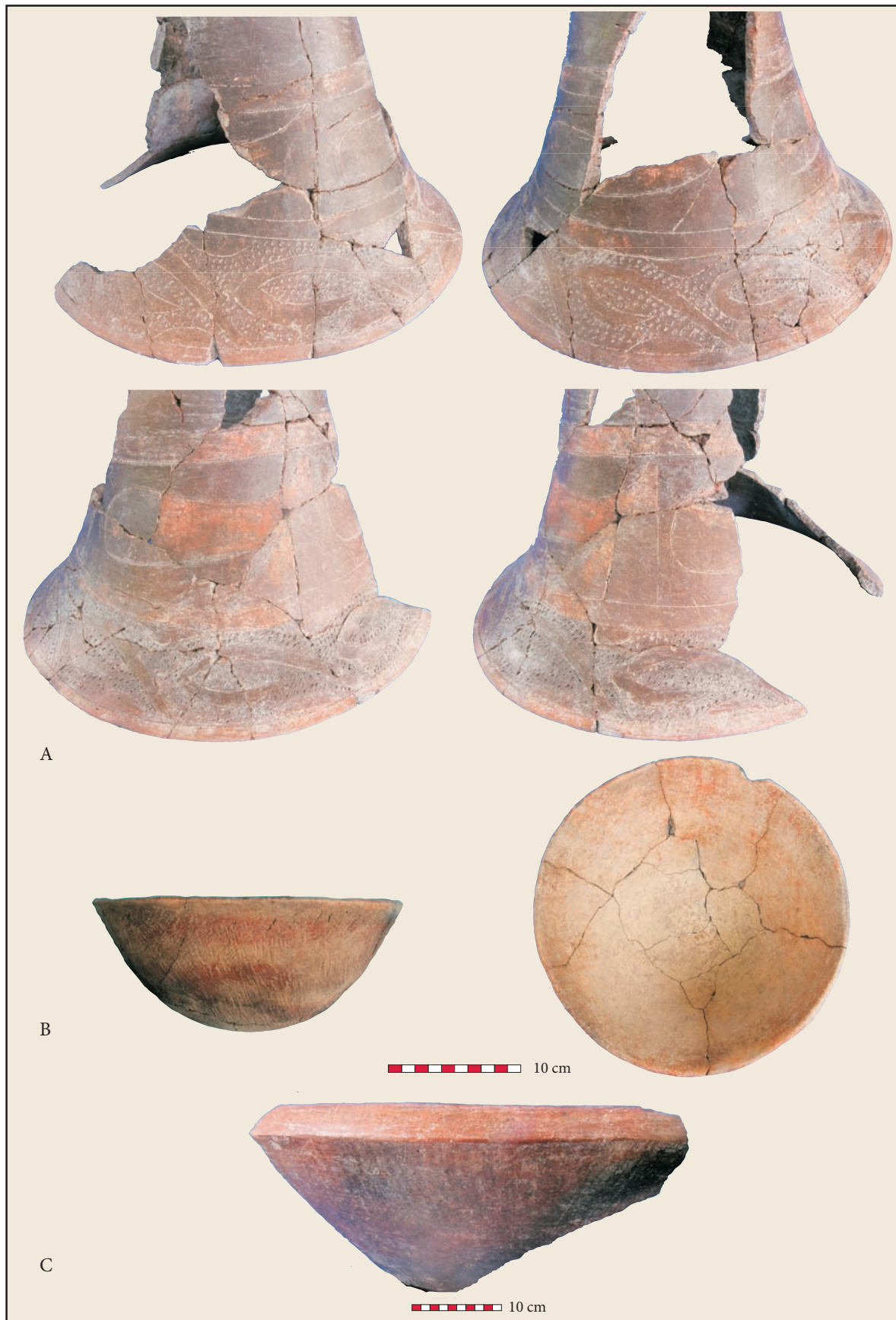


FIG. 3:23 Ceramic vessels from burial 73. A. cat. 3196, showing the complete circuit of the decorated base. B. cat. 3193, C. cat. 3197

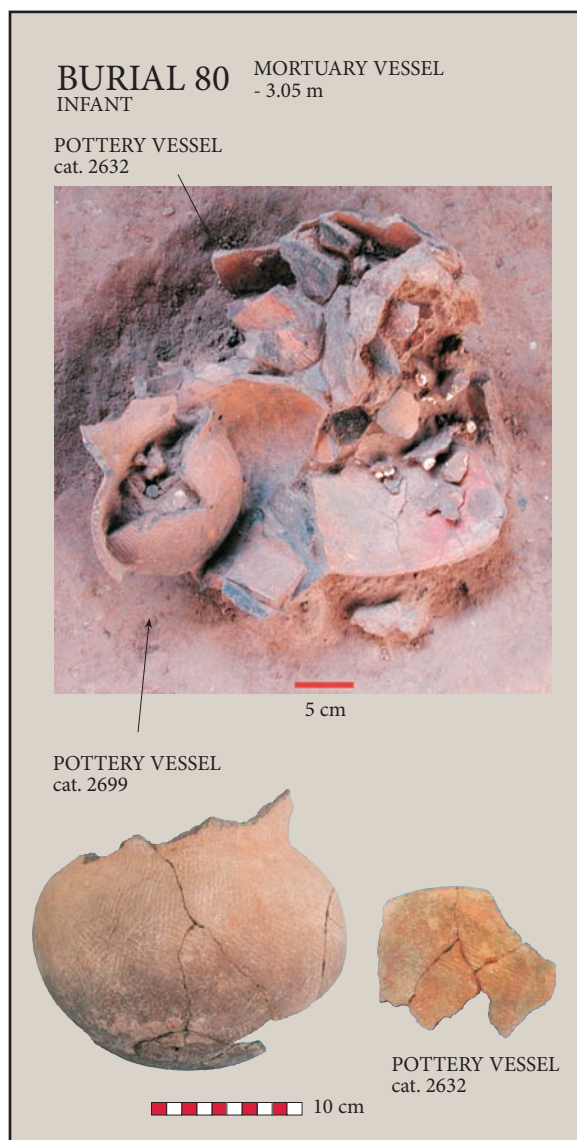


FIG. 3:24 Burial 80

the horizontal component again resembling the outline of a whale or a wing. This motif, also seen on the burial 28 and 103 mortuary jars, was repeated three times. It was highlighted in red paint to a burnished background. The junction between the base and the upper body was accentuated by a band of red paint. The interior of the base was also painted with curved bands of red paint. The fourth vessel survived only in fragments. It is probably of form 3. The base is cord marked with mainly vertical impressions, while the shoulder, above a cordon, was burnished and then decorated with curvilinear motifs executed as red painted, parallel lines. It was located beyond the skull.

Three young pigs were interred with this individual. One skeleton was found over the right tibia, and a second over and beyond the ankles. The pelvis of a pig was also found beyond the head. Finally, a sheet of gastropod shell-

fish had been placed over the body, a practice that was to be matched in a handful of rich Bronze Age burials at a later date. This burial, which extended over 3.6 metres, reveals a complex and ritualised tradition of treating the dead during the Neolithic occupation of Ban Non Wat.

Pot cat. 2231 contained the following fish bones:

Anabas testudineus: 1 l. pterotic; 1 l. & 2 r. cleithrum; 1 l. dentary; 1 r. suborbital (SO₅) = 2

Channa striata: 1 r. epihyal (larger fish); 1 r. pterotic (small fish); 1 l. & 1 r. fragment of cleithrum (ventral); 1 l. maxilla; 1 l. quadrate; 1 l. fragment of palatine = 2

Clarias: sp. 3 fragments of skull; 1 fragment right of coracoid = 1

Hemibagrus nemurus: 1 r. pectoral fin spine with cleithrum = 1

Hemibagrus/Mystus: 1 l. pectoral fin spines = 2

Ompok bimaculatus: 1 l. articular; 1 r. cleithrum = 1

Ompok/Wallago: 1 l. pectoral fin spine

Pot cat. 2233 contained the following fish bones:

Channa sp.: r. articular = 1

Hemibagrus nemurus: 1 l. cleithrum = 1

One further interesting aspect of this burial, is that it was the focus of five infant jar burials, located in a ring round the head area.

Burial 103 is one of the five infant jar burials that encircles the adult burial 86 (Figs. 3:33-4). It contained a 12-18 month-old infant, and was cut in to a Neolithic occupation midden in square B1. The lidded mortuary jar is a replica, on a smaller scale, of that containing burial 28. It has a cord-marked body below a cordon at the shoulder. Above this cordon, the shoulder was burnished, fired to a black colour, and then decorated with incisions infilled with red pigment. While there are similar dark firing clouds on the main part of the body, this vessel lacks the red painted designs seen on the burial 28 mortuary jar.

This pot contained the following fish bones:

Anabas testudineus: 3 r. supracleithrums, 2 l. articulars; 1 r. dentary; 1 r. fragment of preopercular; 1 l. maxilla; 1 l. suborbital (SO₃) = 4

Channa sp.: 1 l. 2 r. quadrate.

Channa micropeltes: 1 l. dentary.

Channa striata: 1 r. lower pharyngeal, 1 l. ceratohyal.

Clarias sp.: 1 l. supraorbital; 1 l. opercular; 1 l. fragment of cleithrum; 1 l. pectoral fin spine.

Monopterus albus: 1 r. ceratohyal.

Hemibagrus/Mystus: 1 l. 2 r. pectoral fin spines.

Ompok/Wallago: 2 r. pectoral fin spines; 1 r. articular.

Burial 112 is also located beyond the head of the adult inhumation burial 86, and is clearly closely associated (Fig. 3:35). The mortuary jar has a cord-marked body, but the shoulder and rim are missing. It contained the skeleton of a late foetal infant.

Burial 175 lay in square C3 layer 5:1, at a depth of 2.95 m from datum to the top of mortuary jar lid (Fig. 3:36). It is isolated from other Neolithic burials. The lid to the mor-

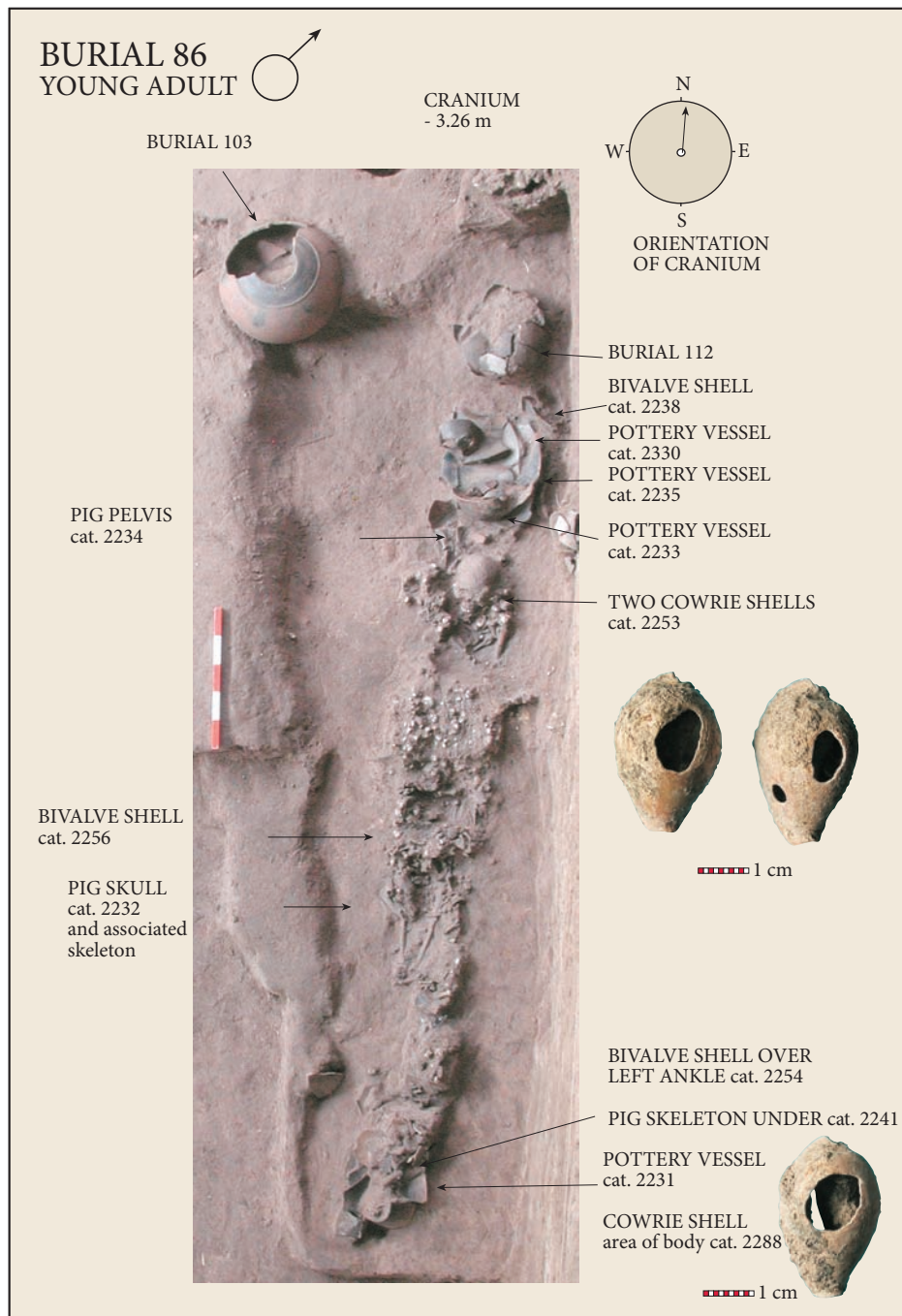


FIG. 3:25 Burial 86

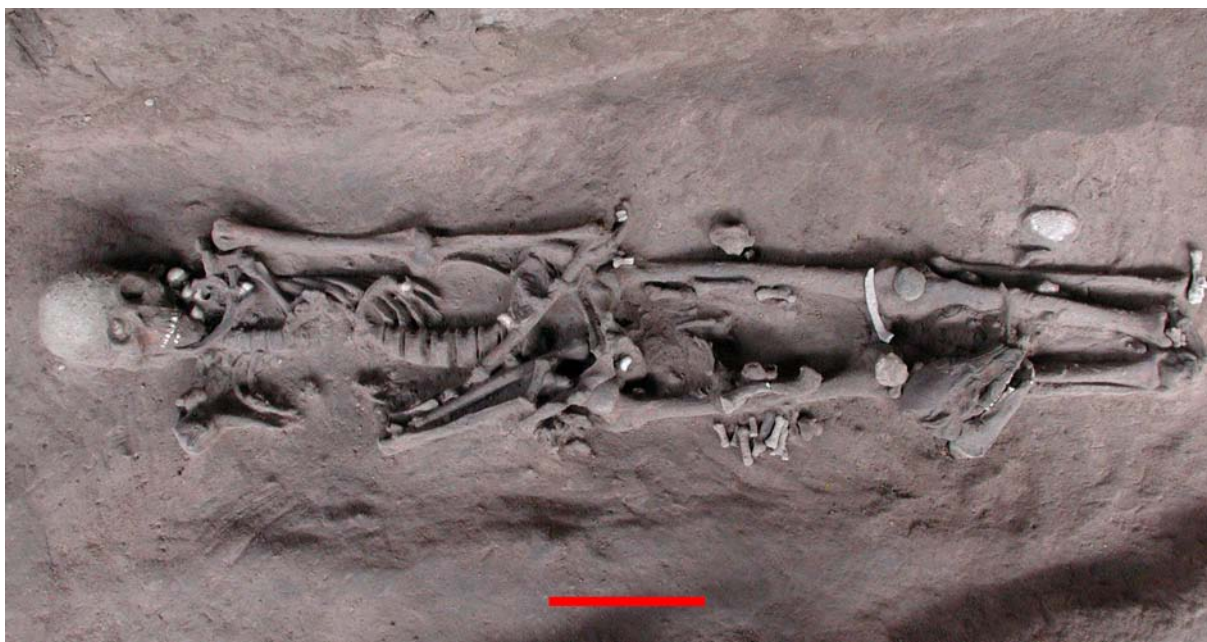
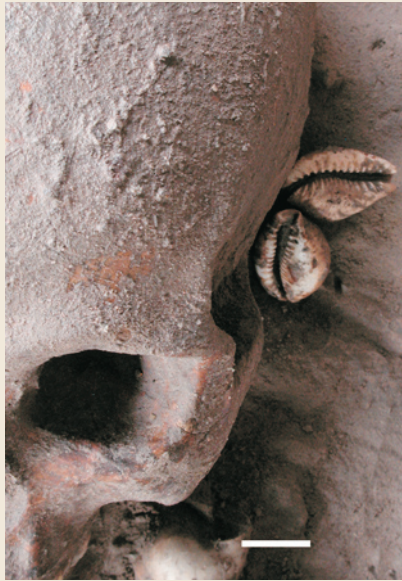


FIG. 3:26 Burial 86 when fully exposed. Note the pig's skull over the right leg. Scale 20 cm



FIG. 3:27 Two of the bivalve shells placed with burial 86. Such shells were placed with the dead throughout the cultural sequence at Ban Non Wat. Their association with individual burials and probable lack of inbuilt age make them acceptable instruments for AMS radiocarbon dating. Scale 2 cm

BURIAL 86



scale 2 cm

COWRIE SHELL EARRINGS cat. 2253



THE CRANIUM, showing the shells placed over the body,
the pottery vessel cat. 2223 beyond and a pig's pelvis, cat 2234



scale 5 cm

THE CERAMIC VESSEL cat. 2231, beyond
the feet



scale 5 cm

PIG CRANIUM cat. 2241

FIG. 3:28 Burial 86: the cowrie shells, pig skull and ceramic vessels

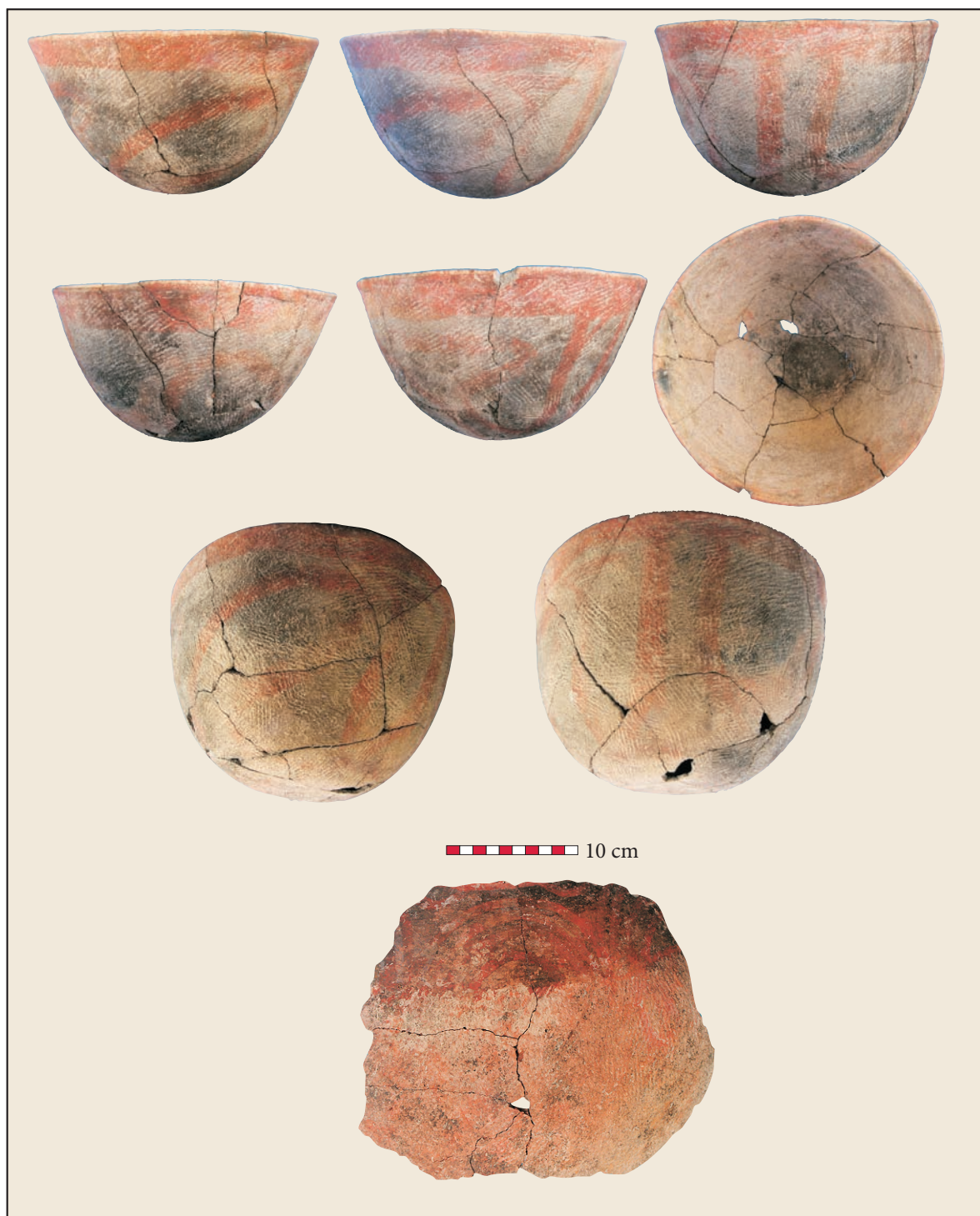


FIG. 3:29 Burial 86, ceramic vessels, cat. 2233 (upper three rows) and cat. 2235



FIG. 3:30 Burial 86, ceramic vessel cat. 2231



FIG. 3:31 Burial 86, ceramic vessel cat. 2230

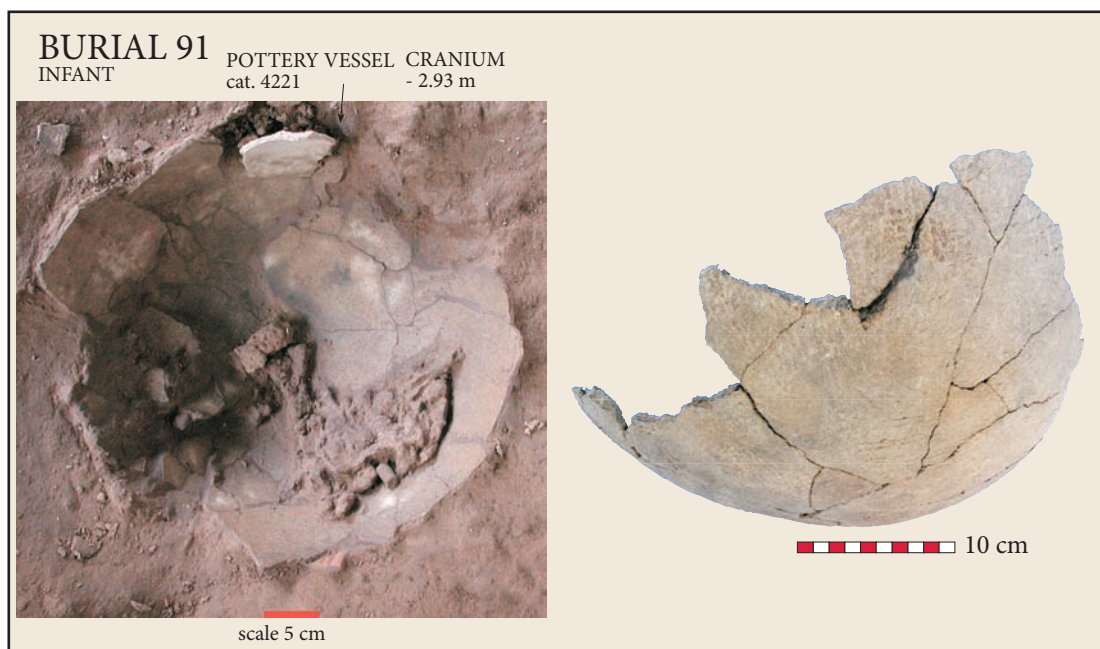


FIG 3:32 Burial 91

Burial 91 contains the remains of an infant who died when aged 9-12 months.



FIG. 3:33 Burial 103

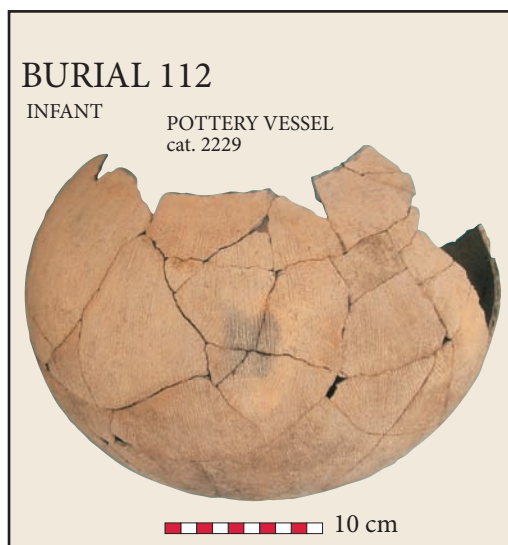


FIG. 3:35 Burial 112

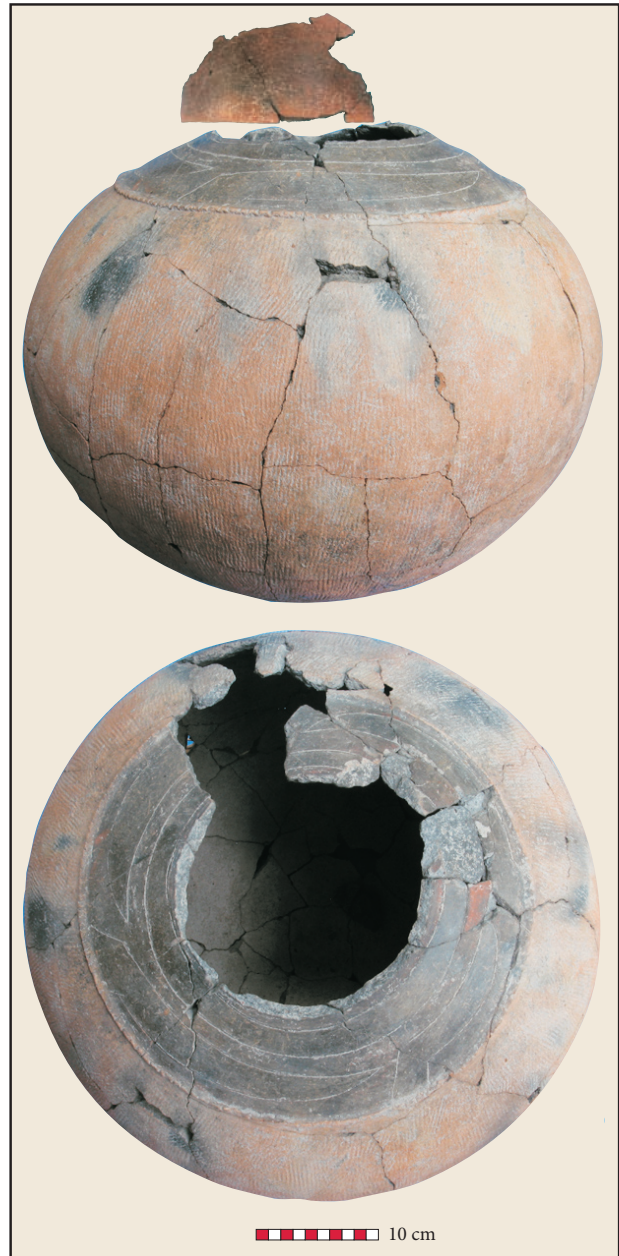


FIG. 3:34 The mortuary jar and lid for burial 103

tuary jar is decorated on the exterior with cord marking and broad bands of red paint. The interior has a complex red painted design of a curvilinear pattern replicated three times. The actual mortuary jar has plain cord marking on the exterior body.

Burial 179 was found as one of five set round the head of burial 86 (Fig. 3:37-8). The c six-month-old infant skeleton within the mortuary vessel lay 3.49 m below datum. A pottery vessel found in a fragmentary condition lay clearly associated with the primary burial jar, which was lidded. Within, the infant was associated with a bivalve shell. The lid to the mortuary jar was decorated on the exterior with broad red painted bands, while the interior had the same set of curvilinear designs as were found on the interior



FIG. 3:36 Burial 175, showing the mortuary jar lid interior with red painted decoration

the lid for burial 175. The burial jar itself was embellished on the exterior with cord marking below a cordon which demarcated the beginning on the shoulder, of a panel the background of which is black burnished. This surface was incised with three concentric bands infilled with red paint. A series of five extensions emerge from the lowest of these, each ending in a sharp point. Cat. 6292, the vessel lying in association, is the typical Neolithic form at this site of

a broad funnel-shaped upper body on a cylindrical base (Fig. 3:39). The base is usually the area to receive most decoration, and in this instance, the lower panel has incised designs infilled with impressed circles. The designs resemble a highly stylised human figure. The incised circles fill the upper panel.

Burial 180, that of a six-month-old infant, was located in square C1 at a depth of 3.32 m below datum (Fig. 3:40). The mortuary jar was covered in cord marking on the exte-

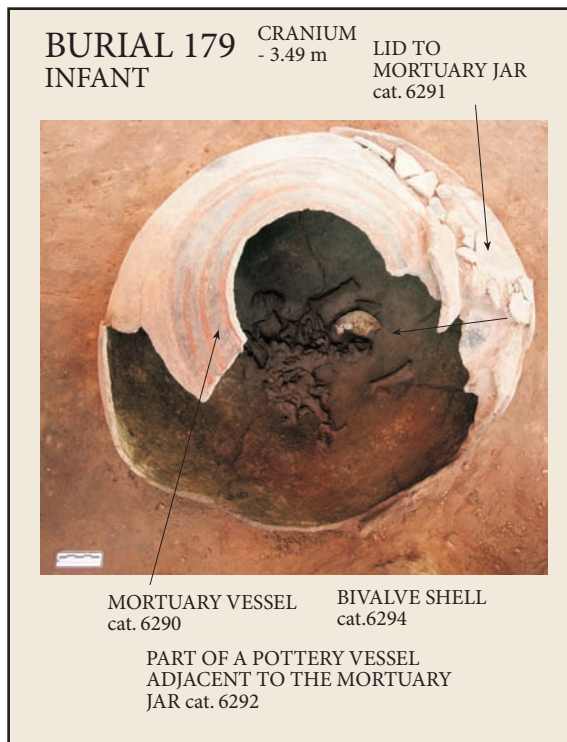


FIG. 3:37 Burial 179

rior, and was associated with a lid and two further vessels. One of these comprised the base of a form 1 pedestalled vase. The motifs included a band of semi-lunates infilled with impressions, and a second band also highlighted by impressions. There was also a small globular vessel, cord marked on the lower half of the body and burnished on the upper.

Burial 181 is the fifth jar burial associated in a circle round the head area of burial 186 (Fig. 3:41). The infant was about 3 months old at death. Its mortuary vessel is bright red with a burnished surface, giving way at the shoulder to two rows of red circles. The rim was removed in antiquity, and a lid covered the mouth of the jar. This lid, remarkably, takes the form of a form 1 footed vase. The decoration on the base comprises a series of horizontal panels, one of which was filled with semi lunates infilled with circular or semi-circular impressions. Two other of the six bands are likewise infilled with impressed circles, the others being burnished. The upper body is also burnished.

A further pot, represented by sherds only, was found lying up against the main vessel, along with an adze, which might be associated. The infant bones were found 3.32 m below datum.

Only fragmentary femora were found in the case of burial 191, an adult male.



FIG. 3:38 Three infant jar burials, cut into an earlier Neolithic midden. From top to bottom, burials 180, 181 and 179



FIG. 3:39 Burial 179 above, and the ceramic vessels from this burial below. Top row, cat. 6291, bottom row, the mortuary jar cat. 6290 and the associated vessel, cat. 6292



FIG. 3:40 Burial 180

Burial 192 was found in square A6 layer 4:8 at a depth of 2.83 m below datum (Fig. 3:42-3). It comprises a lidded burial jar for the interment of an infant aged 6-9 months at death. The lid was of form 3, the exterior being cord marked and painted with broad red bands. The mortuary

jar itself is of form 1. It has the characteristic cord-marked body below a raised cordon at the shoulder. A black burnished band lies between this cordon and the missing rim. It is incised with similar patterns to other vessels of this form. A single bead, perhaps fashioned from ivory, was

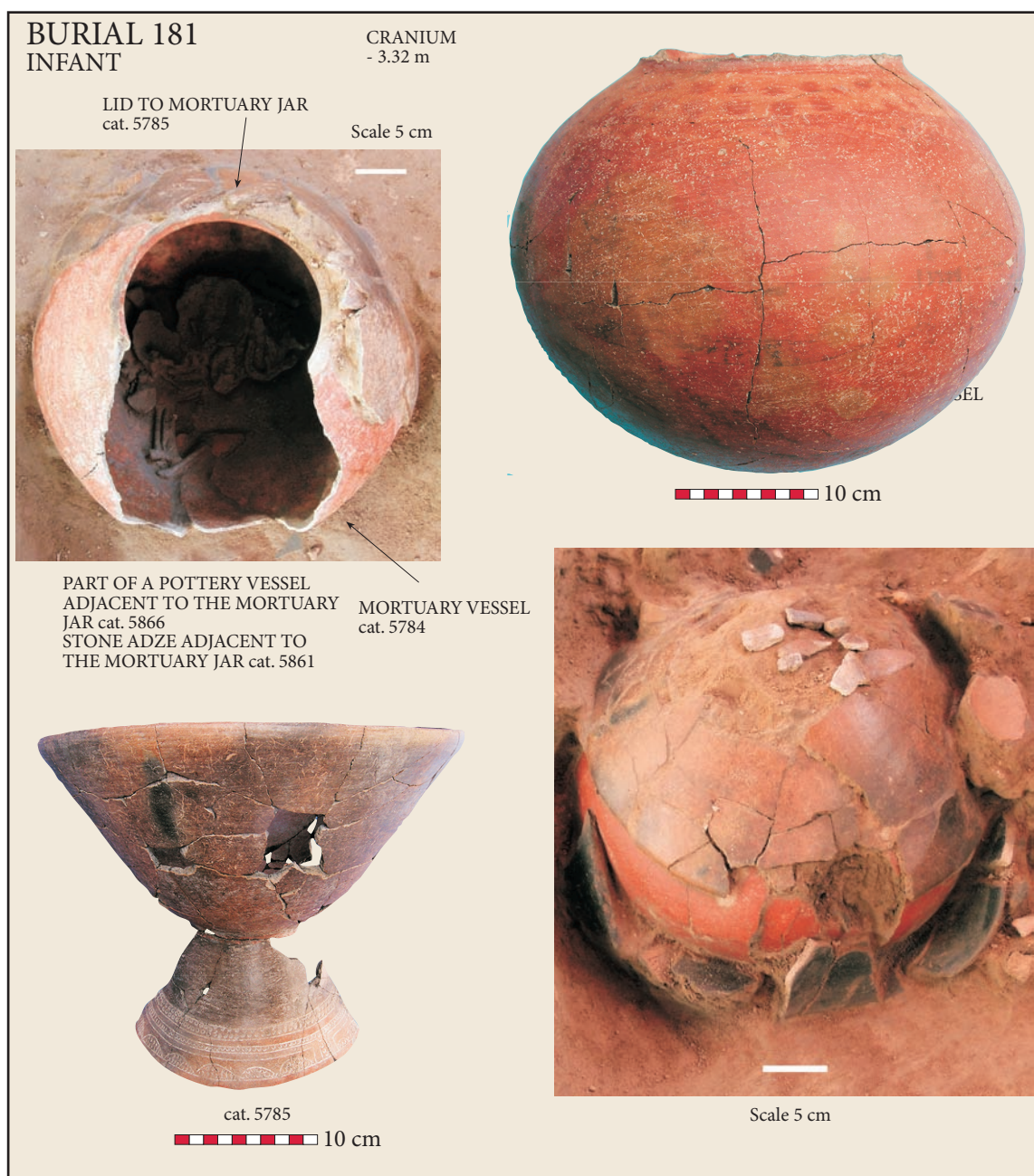


FIG. 3:41 Burial 181

found next to the infant skeleton.

Burial 193 was also found in square A6, layer 4:8 and the infant burial jar lay 2.83 m below datum (Fig. 3:44). The infant was aged approximately six months at death. There was a mortuary vessel, covered with a lid, and associated with two form 1 vessels both in a fragmentary state placed upside down over the lid. The principal vessel

followed the typical Neolithic form, with a cord-marked body and a burnished shoulder, demarcated by a raised cordon. The shoulder was further decorated with incised designs. A grain of rice was found within this vessel.

The base of a third vessel suggested form 1A. It was covered with incised horizontal incised bands incorporating a "whale" motif. The fourth vessel is of form 1A.

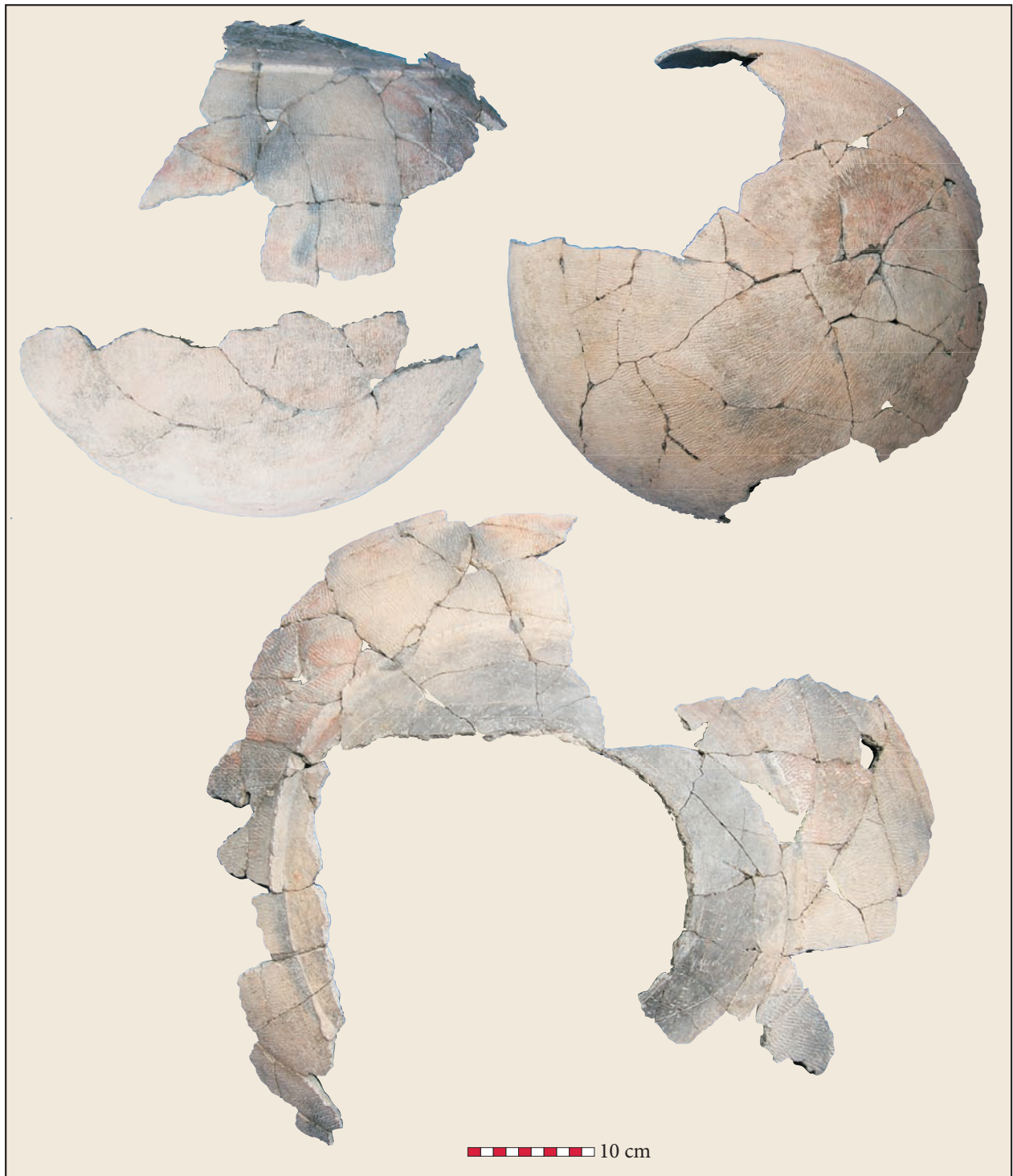


FIG. 3:42 The burial jar cat. 9134 from burial 192

The base was decorated with incised horizontal bands. One of these was then infilled with a pattern of possible highly stylised humans accentuated by impressed circles. A broad upper band was similarly decorated. The upper body was burnished, with a band of cross-hatched incised lines along the rim.

Burial 242 was found in square B7 at a depth of 2.65 m

below datum (Fig. 3:46-7). It is the inhumation grave of a child aged approximately 10 years at death, orientated with the head to the south. Only part of the burial was found in the excavated area. It included the left humerus, scapula and ulna of a pig as a mortuary offering, and at least three ceramic vessels. One of these, a form 2 bowl, was cord marked and then painted with red bands in a

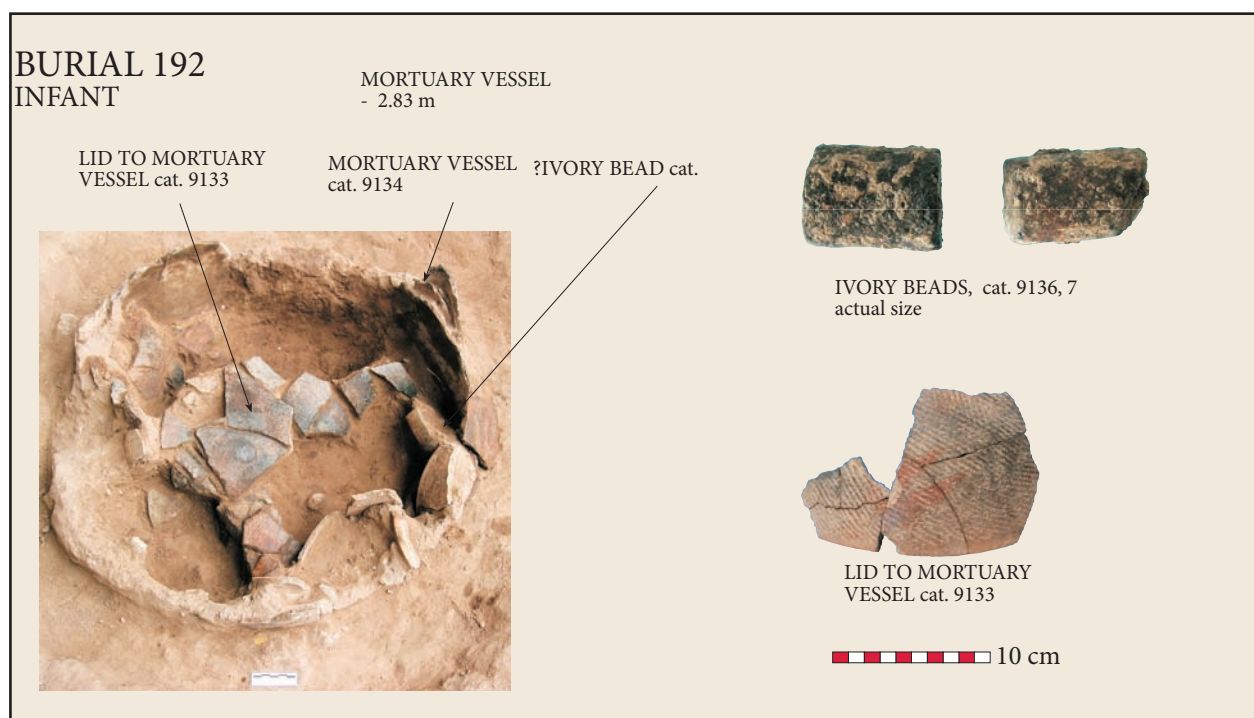


FIG. 3:43 Burial 192



FIG. 3:44 Burial 193

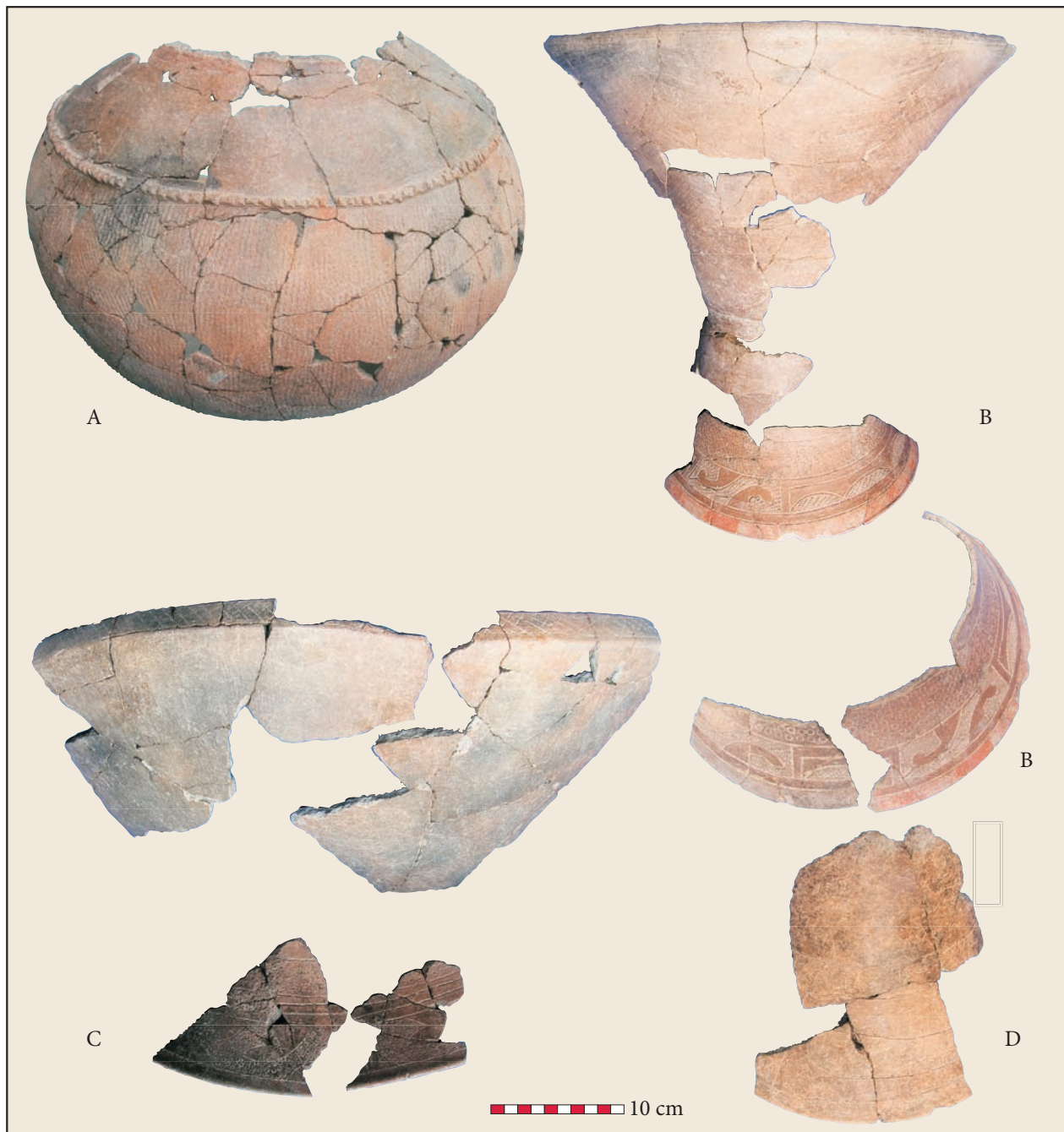


FIG. 3:45 The pottery vessels from burial 193. A. cat. 9141, B. cat. 9139, C. cat. 17735, D. cat. 17736

pattern resembling a human face with eyes. There are also faded red curvilinear lines on the interior of this pot. The other two are form 1C vessels. They were decorated on the rim, one with a series of incised St. Andrew's crosses, while the body bears burnishing strokes. The second has curvilinear incisions along the rim.

Burial 249, that of a mid-adult female, was found in square AA7 layer 4:12, located 2.93 m below datum (Fig. 3:48). No mortuary offerings were found in association. This burial is assigned to the Neolithic solely on the basis

of its depth and orientation.

Burial 250, that of an adult, was located to the east and on the same orientation as burial 242, in square C7. The skeleton was encountered at a depth of 2.81 m below datum (Figs. 3:49-50). The area beyond the upper arms lay beyond the excavated area. This adult was interred with at least two fragmented pottery vessels. One of these (cat. 10302) was a form 1B decorated with incised lines on the basal part, and incised and infilled bands on the upper part of the body. The second (cat. 10301) was also a form

1B vessel. The base began with a red painted band below a band of cross-hatched incisions. The rest of the base was then decorated with incised bands enhanced by red paint that incorporated the "whale" motif. The upper body was burnished, and the rim decorated with incised strokes alternating between an angle of about 45° to the vertical. These lay within two incised horizontal lines. A bivalve shell lay beside the skull and a pig's skeleton was found beyond the head. This person wore a multi-strand shell disc bead necklace that incorporated a large shell barrel bead.

Burial 264, that of an adult, was found in square D7 at a depth of 2.77 m below datum (Fig. 3:52). The body was orientated with the head almost due north. Four postholes had been cut through the grave in antiquity. The corpse was laid out on its back, with the arms running parallel with the trunk. A pottery vessel of form 1A lay beyond the head. The rim was decorated with cross-hatched incision. The skeleton of a young pig were found round and beyond the cranium, by the left femur and running along the right hand side of the body.

Burial 282, that of a nine-month-old infant, was located in square AA4 at a depth of 2.76 m below datum, is a lid-

ded infant jar burial (Figs. 3:53-4). The principal vessel, of which only the lower half survives, has the hallmarks of form 1, in its shape, cord marking and the red design painted in broad bands. This pattern resembles that seen on the jar containing burial 28. Cat. 16644 is of form 2, and was probably the lid that collapsed into the jar after interment.

Burial 286. This young female inhumation burial was found at a depth of 2.79 m in square AA3 (Fig. 3:55). It was orientated with the head directed in an easterly direction, and the grave had been cut into by the Bronze Age burial 28o. It is assigned to the Neolithic on the basis of its depth below datum but there are no mortuary offerings to confirm this ascription.

Burial 289. Only the foot bones of this adult Neolithic burial were found in the excavated area, in square AA3 at a depth of 2.92 m below datum (Fig. 3:56). They were associated with two form 1 vases, found in a fragmentary condition, and the skull and limb bones of a pig. The decoration on the base of vase cat. 16086 follows the syntax of other vessels of this form, in having horizontal bands of impressed and incised decoration. In the case of this example, the principal panel has wavy lines highlighted with



FIG. 3:46 Burial 242

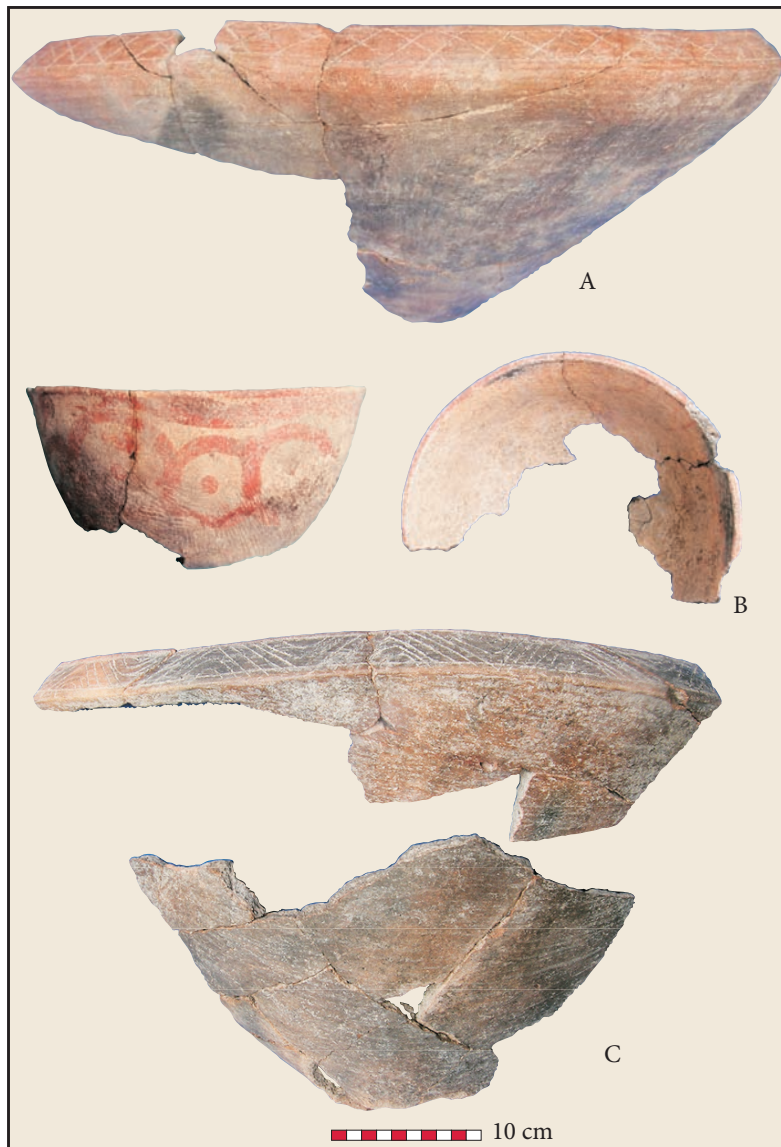


FIG. 3:47 Pottery vessels from burial 242 A. cat. 11762, B. cat 11641, C. cat. 17337

impressions. Further panels are visible, but the pattern is not evident. The second vase was plain and burnished in the upper part, but the base has not survived. A stone adze was also found in the area of the feet.

Burial 292 was found in square D7 (Fig. 3:57). It comprises a jar burial containing the skeleton of a mid adult female. The skull was located at a depth of 3.34 m below datum. The mouth of the mortuary jar was partially covered by the Bronze Age burial 262. The mouth of this very large form 5 vessel had been broken away from the body in antiquity and placed over the body within, together with a large, globular cord-marked pot of form 4. The mortuary jar was also cord-marked all over the exterior surface. Within this jar, the body had been placed in a seated, crouched position with the knees tightly flexed upwards,



FIG. 3:48 Burial 249



FIG. 3:49 Burial 250



FIG. 3:50 The ceramic vessels from burial 250. A, cat. 10301, B cat. 10302 C cat. 25850



FIG. 3:51 Burial 250, showing the necklace of shell disc beads, the bivalve shell and pig's bones. Scale 5 cm

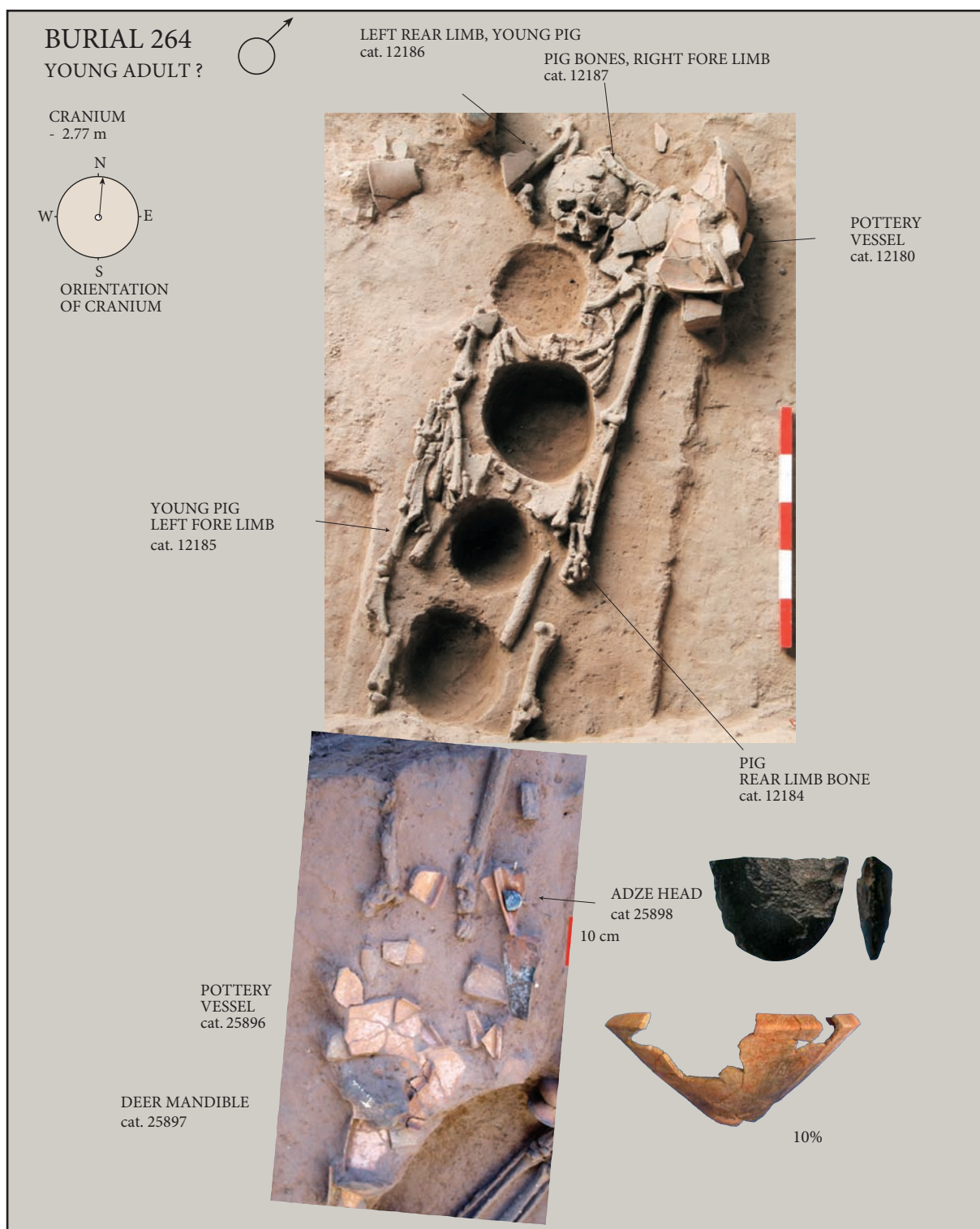


FIG. 3:52 Burial 264

and the arms under the legs. The skull was detached from the vertebral column and lay to the left of the body. As with burial 28, a section at the side of the mortuary vessel had been removed in antiquity, presumably to allow for the introduction of the corpse.

This burial was accompanied by a second, small form 4 vessel placed under the left tibia and fibula (cat. 12325). A shell bangle was found on the left forearm, and five cowrie shells were associated. One was found adjacent to the bangle and under the face, and the second was under the

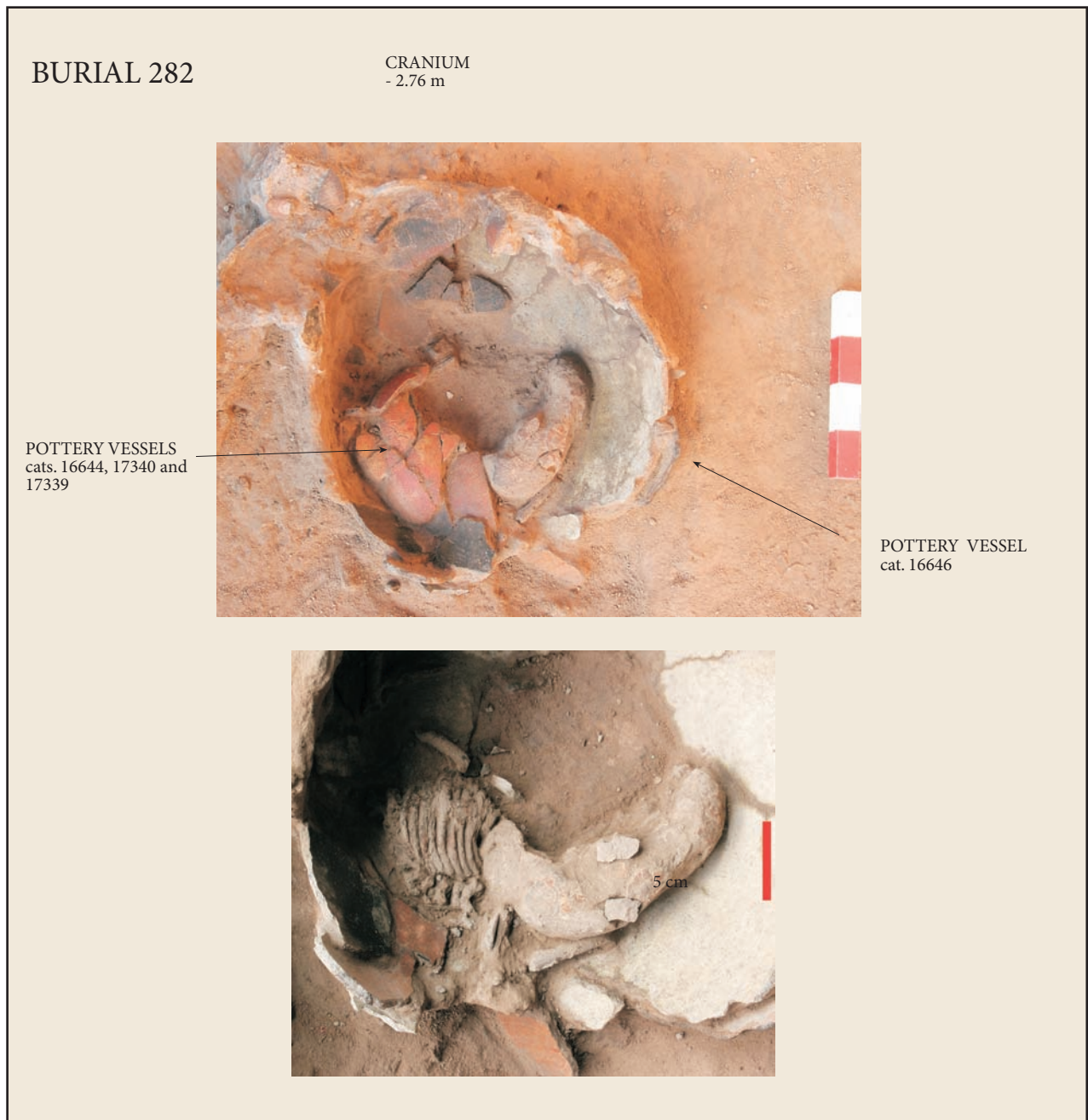


FIG. 3:53 Burial 282

left scapula near the chin. The third lay beside the small pottery vessel under the left tibia, and the last cowrie shell was recovered while cleaning the bones in the site laboratory. A bivalve shell was also placed as a mortuary offering.

Burial 295 in square AA3 comprises the burial of a six-month-old infant, with the head orientated to the southwest (Fig. 3:58). It was found 3.14 m below datum. A ceramic vessel was placed beyond the feet. It was cord

marked below the carinated shoulder and plain and smoothed. This pot contained the basioccipital bone of *Channa striata*.

Burial 298 was found in square AA2 at a depth of 3.14 m below datum. The grave, orientated with the head to the north, contained the cranium and teeth of a 2-4 year-old infant. Three ceramic vessels were associated (Figs. 3:59-60). Two were placed beyond the head, the other to the south of the body. Two of these vessels involved a broad



FIG. 3:54 The pottery vessels from burial 282. A. cat. 16646, B. cat. 16644



FIG. 3:55 Burial 286



FIG. 3:56 Burial 289

and flaring upper body on top of a cylindrical support. The rim was enhanced by incised cross-hatched lines, while the surviving part of one of the cylindrical bases bore incised curvilinear lines. The third comprised a small cord-marked vessel with an everted lip.

Burial 299 is an infant jar burial, found at a depth of 3.23 m in square AA2 (Fig. 3:61). Only the base of the mor-

tuary vessel survives, and it was cord marked. The lid is plain, and part of a pottery vessel was found adjacent to the mortuary jar. It is the conical base of a form 1 pot, with faint incised lines on the exterior surface.

Burial 459 involves a single Neolithic ceramic vessel (Fig. 3:62). It was found in square F7 at a depth of 2.57 m below datum, adjacent to the edge of the excavated

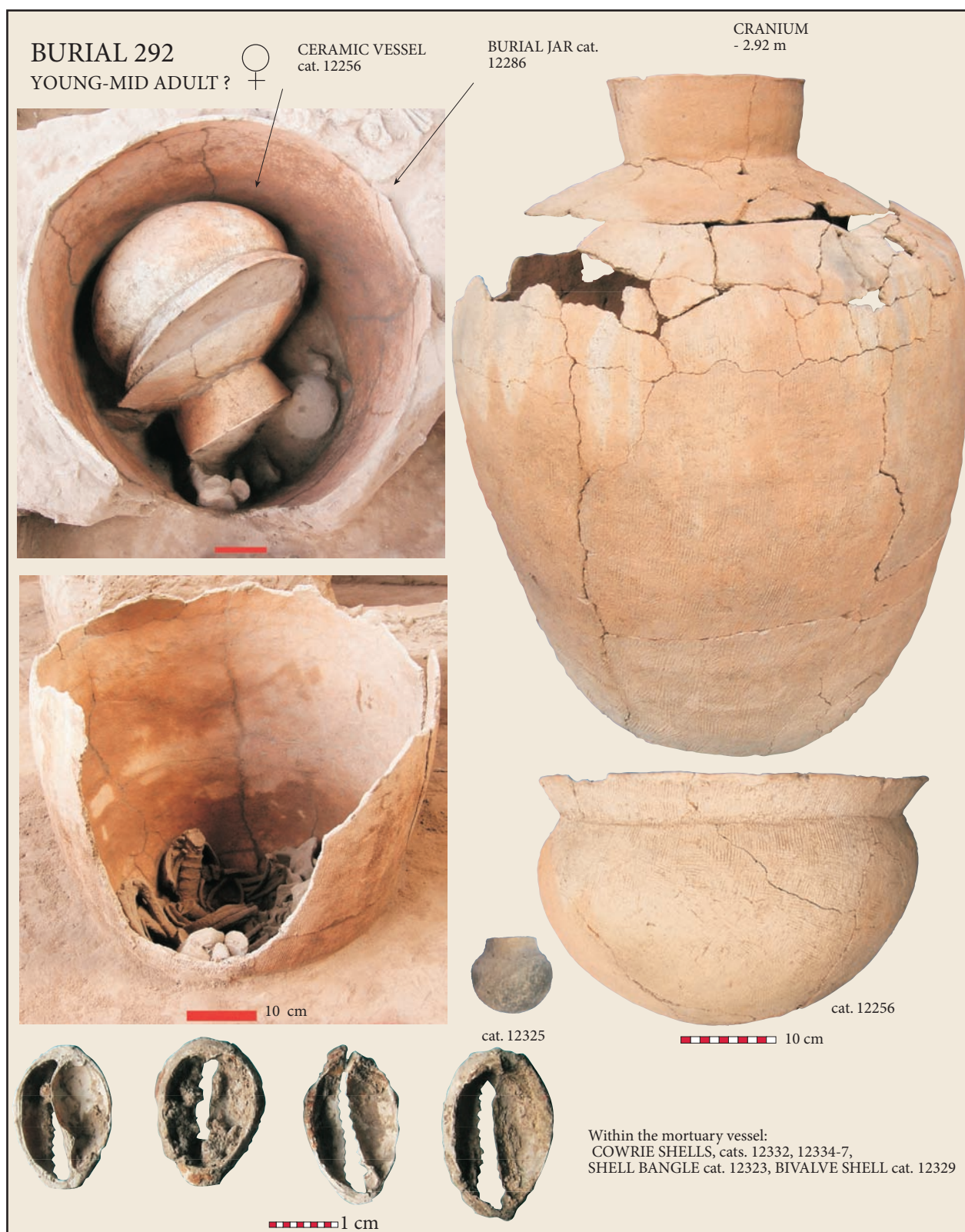


FIG. 3:57 Burial 292

area. No human bones were found, and if indeed this is a burial and not a pottery vessel unassociated with any mortuary activity, it seems likely that the body is located to the south. The vessel is a complete example of the Neolithic 1 form with a narrow waist, a broad flaring rim and a cylindrical base. The latter is decorated on the exterior with incised designs infilled with impressed circles. The lower panel incorporated a human-like figure linked with semi-circles. The upper panel is a band infilled with hollow circles. The human-like figure is paralleled at other sites, including Khok Phanom Di (Higham 2004), where the example from mortuary phase 7 dates to about 1600-1500 cal. BC. The interior of the base was painted with six red strokes, all ending in the centre with a red circle

enclosing a cross.

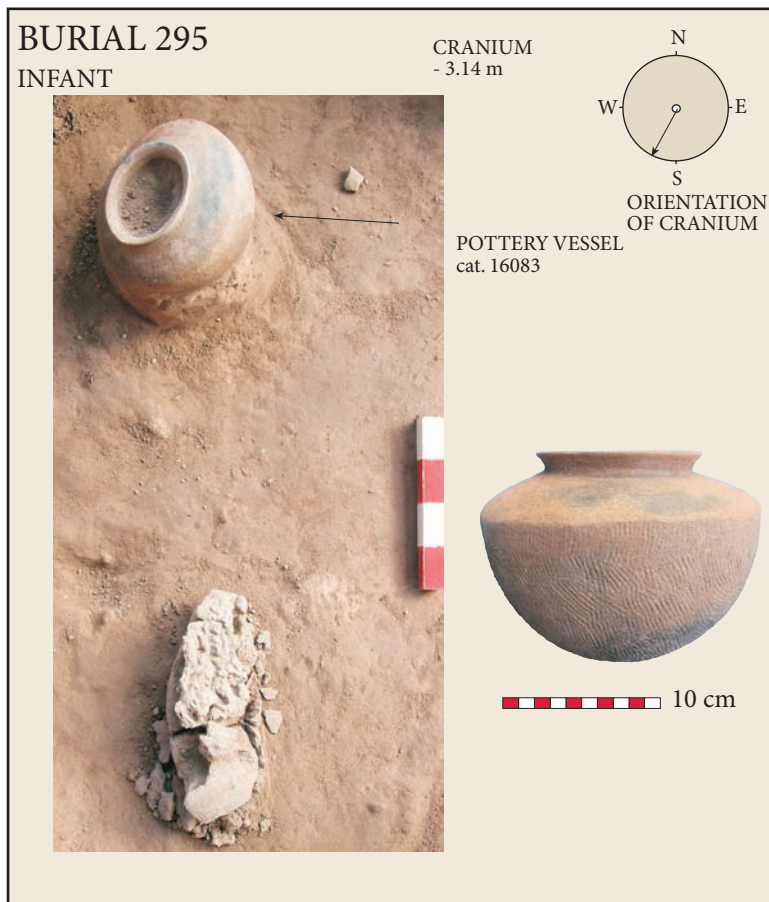


FIG. 3:58 Burial 295

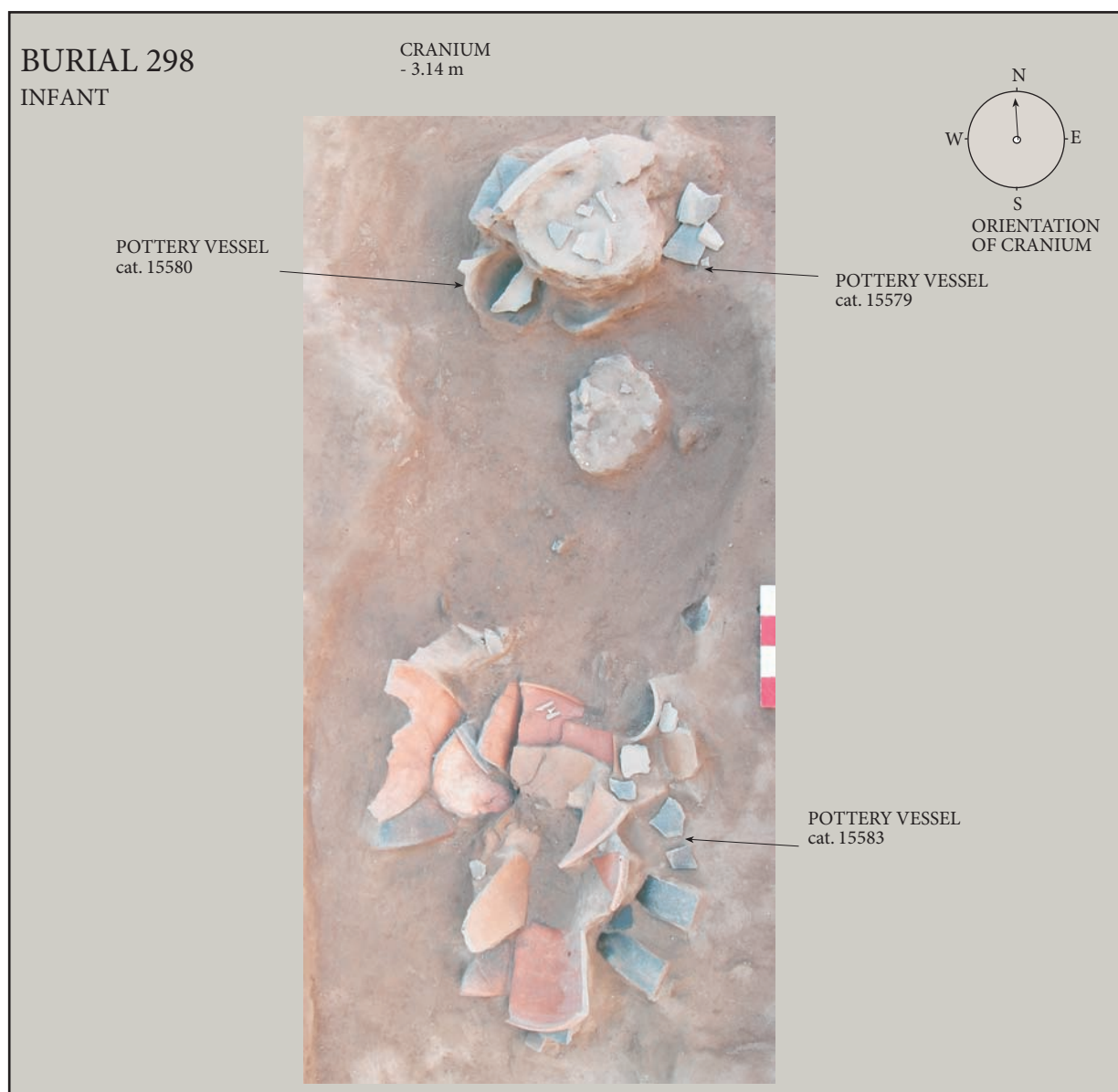


FIG. 3:59 Burial 298



FIG. 3:60 Burial 298, the ceramic vessels



FIG. 3:61 Burial 299 with associated ceramic vessels. A. cat. 15575, B. the mortuary vessel cat. 15578, C. cat. 15582

SUMMARY

The Neolithic 1 burials are found over much of the excavated area, and their distribution suggests that there might have been a northwestern and a southern group. Both include men and women. The former group contains most of the infants, which with one exception, were interred in lidded jars. There is no obvious distinction in the items buried with men and women. They share the presence of pig's bones, cowrie shells, bivalve shells and the main form of ceramic vessel. One man was interred in a lidded jar, as was one woman. Most were buried on a north to south axis, with the head pointing to the north.

Infants were found in the same form of burial jar as the adult male in burial 28, but other infant jars were cord marked and of a different shape. Apart from the pottery vessels and one ivory bead, infants were not accompanied by any offerings.

Infants and children account for 45% of the sample of Neolithic 1 individuals. This is a high figure relative to the Bronze Age, but not unusual in prehistoric populations. Some infants were buried in close proximity to adults, as with burial 86, which had five infant jar burials disposed round the head. Others, however, were more isolated. This stresses the value of opening a large area, for more constrained excavations would have provided an erroneously low figure for infants in the sample as a whole.



FIG. 3:62 Burial 459, ceramic vessel cat. 19904

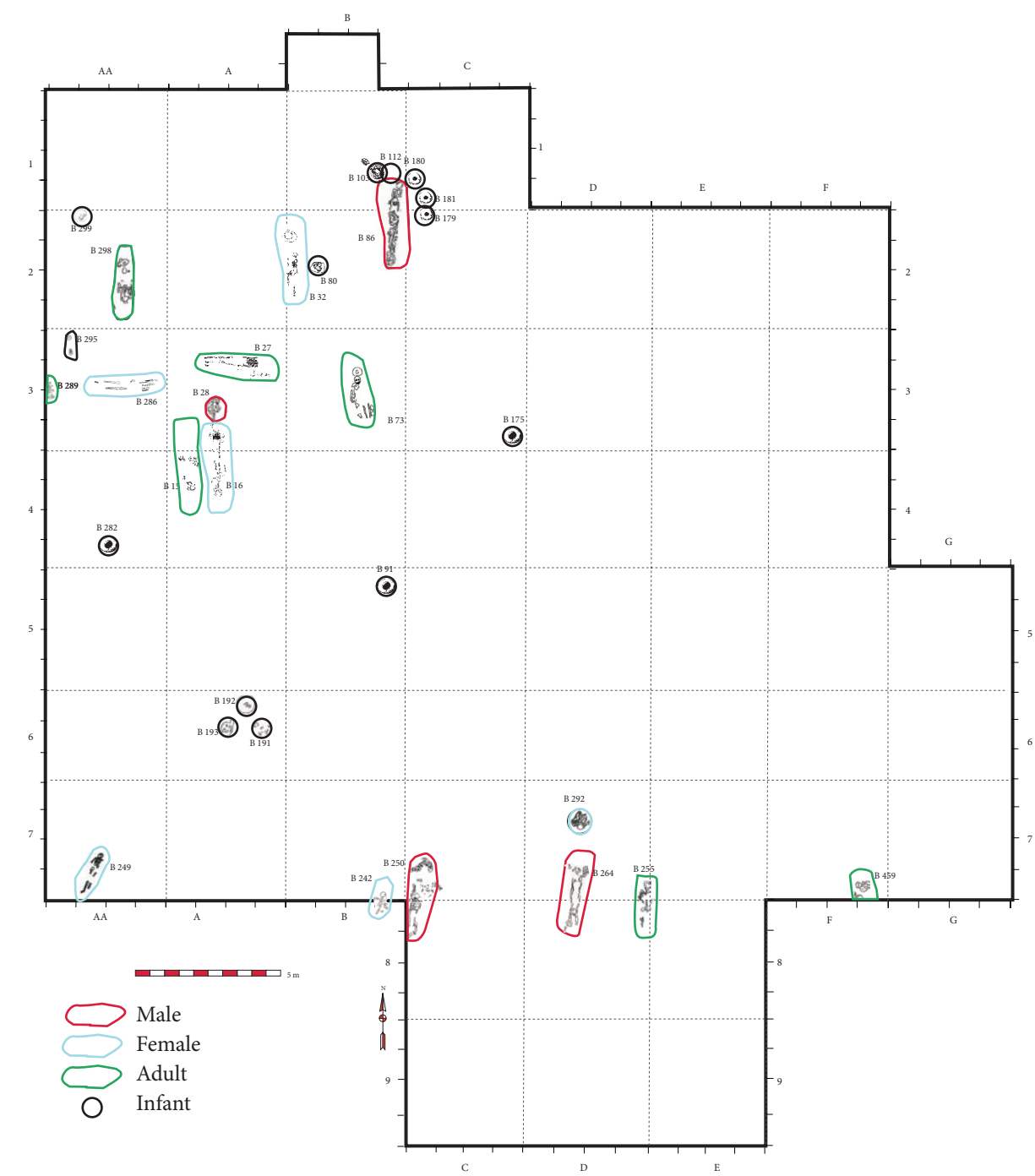


FIG. 3:63 The distribution of Neolithic 1 burials according to sex

IV NEOLITHIC PHASE TWO

C.F.W. HIGHAM AND W. WIRIYAROMP

INTRODUCTION

This group of Neolithic 2 burials is characterised by interment with little more than one or two ceramic vessels that are normally globular in form, and cord marked. One of these vessels, however, bore red-painted

ornamentation and another had a burnished upper body. Some of these burials could belong to group 1, but have been assigned to this group on the balance of evidence (Fig. 4:1). Where there is a stratigraphical relationship, these are later than Neolithic 1 burials, and earlier than those confidently ascribed to the Bronze Age on account

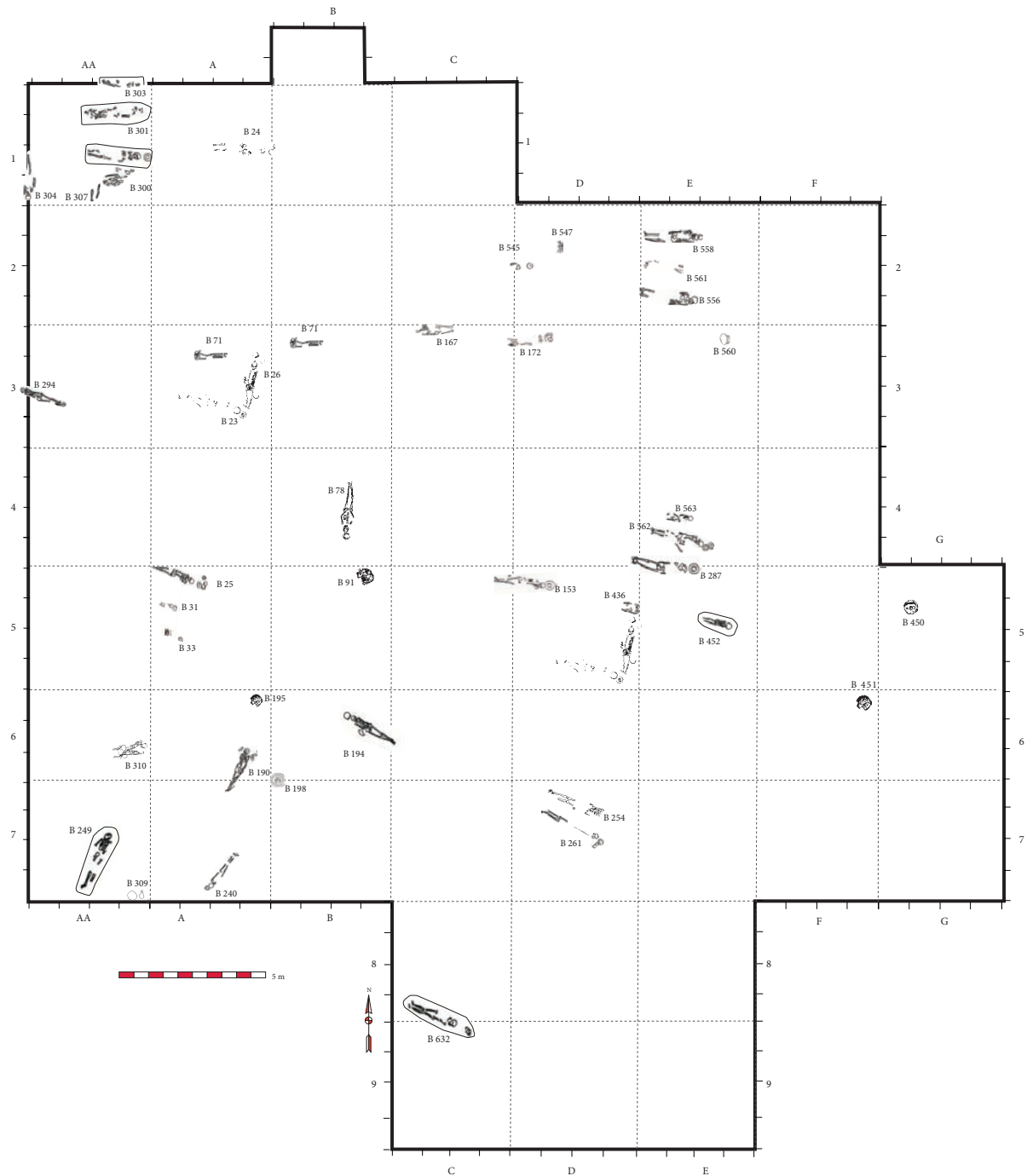


FIG. 4:1 The distribution of Neolithic 2 burials



FIG. 4:2 The ceramic vessels from Neolithic 2 burials. A. cat. 915, B. cat. 916, D. cat. 884, E. cat. 793, F. cat. 917, G. cat. 1424, H. cat. 1425, I. cat. 1426, J. cat. 1343, K. cat. 3690, L. cat. 11072, M. cat. 12253, N. cat. 13762, O. cat. 16141 burial 294, P. cat. 15098, Q. cat. 12254

of the presence of their bronze mortuary offerings.

A similar series of burials was encountered at the nearby site of Ban Lum Khao, where they were dated slightly later than 1280-1300 BC (Higham and Thosarat 2005). At Ban Non Wat, a radiocarbon determination from charcoal within a mortuary vessel resulted in a dated range of 1524-1412 cal. BC. A second determination for this period comes from a bivalve shell placed as a mortuary offering with burial 31, which is 1263-1056 cal. BC.

The preferred orientation of the corpse was with the head to the east, although some burials were oriented to the south, west or north. Apart from one or two cord-marked vessels placed beyond the head or feet, one adult

was interred with pig bones in the head area and two others were associated with bivalve shells. Two further individuals wore waistbands fashioned from long shell beads.

In almost every respect, these burials contrast with those from Neolithic phase 1. They were usually interred on a different orientation. The ceramic vessels are distinct in form but similar in terms of fabric. There is none of the flamboyant painted, incised and impressed decoration. The shell beads are different in form and location on the body. Detailed further examination of the skeletal remains are expected to illuminate this contrast further. Infant burials account for 26.3% of the sample. This compares

TABLE 4:1 *The adult burials of Neolithic 2*

No.	Age	Orientation	Sex	Pottery vessels	Pig bones	Fish	Bivalve shell	Shell bead
23	YA	E	-	2	-	-	-	5
24	MA	E	M	2	-	-	-	4
25	MOA	E	M	3	2	-	-	1
26	YA	N	F	4	-	1	-	-
71	O	E	F	-	-	-	-	-
78	OA	S	F	1	-	2	-	-
153	MOA	E	F	1	-	-	-	-
167	A	W	F	1	-	-	-	-
172	A	E	F?	1	-	2	-	-
190	YA	N	F	2	-	-	-	-
194	YA	-	F	2	-	-	-	-
240	-	SW	-	1	-	-	-	-
261	MA	E	M	2	-	-	-	-
286	YA	E	F	-	-	-	-	-
287	O	E	F	1	-	-	-	-
294	OA	W	F	1	-	-	-	-
300	OA	E	F	1	-	-	-	-
301	OA	E	M	-	-	-	1	-
303	A	-	M	-	-	-	-	-
304	MA	S	M	-	-	3	-	-
436	MA	E	M	-	-	-	-	-
545	O	E	M?	1	-	-	-	-
547	MA	E	M?	-	-	-	-	-
556	YMA	E	F?	-	-	-	1	-
558	OA	E	M?	1	-	-	-	-
561	OA	E	F?	-	-	-	-	-
562	MOA	E	M	1	-	2	-	-
632	YA	E	M	1	-	-	-	-

TABLE 4:2 *The infant burials of Neolithic 2*

No.	Age	Pottery vessels	Pot form 1	Pot form 2	Pot form 3	Pot form 4	Pot form 5	Bivalve shell
31	3 y	1	-	-	1	-	-	1
33	15-18 m	1	-	-	-	-	-	-
91	9-12 m	1	-	-	1	-	-	-
195	7-9 m	2	-	-	1	1	-	-
198	-	1	-	-	1	-	-	-
307	child	-	-	-	-	-	-	-
450	0	2	-	1	1	-	-	-
451	30 w	1	-	-	1	-	-	-
452	2 y	-	-	-	-	-	-	-
563	child	-	-	-	-	-	-	-



FIG. 4:3 Burials 26 (upper), and 23, showing the probable severing of the ankle bones of burial 26 (arrowed) with the interment of burial 23

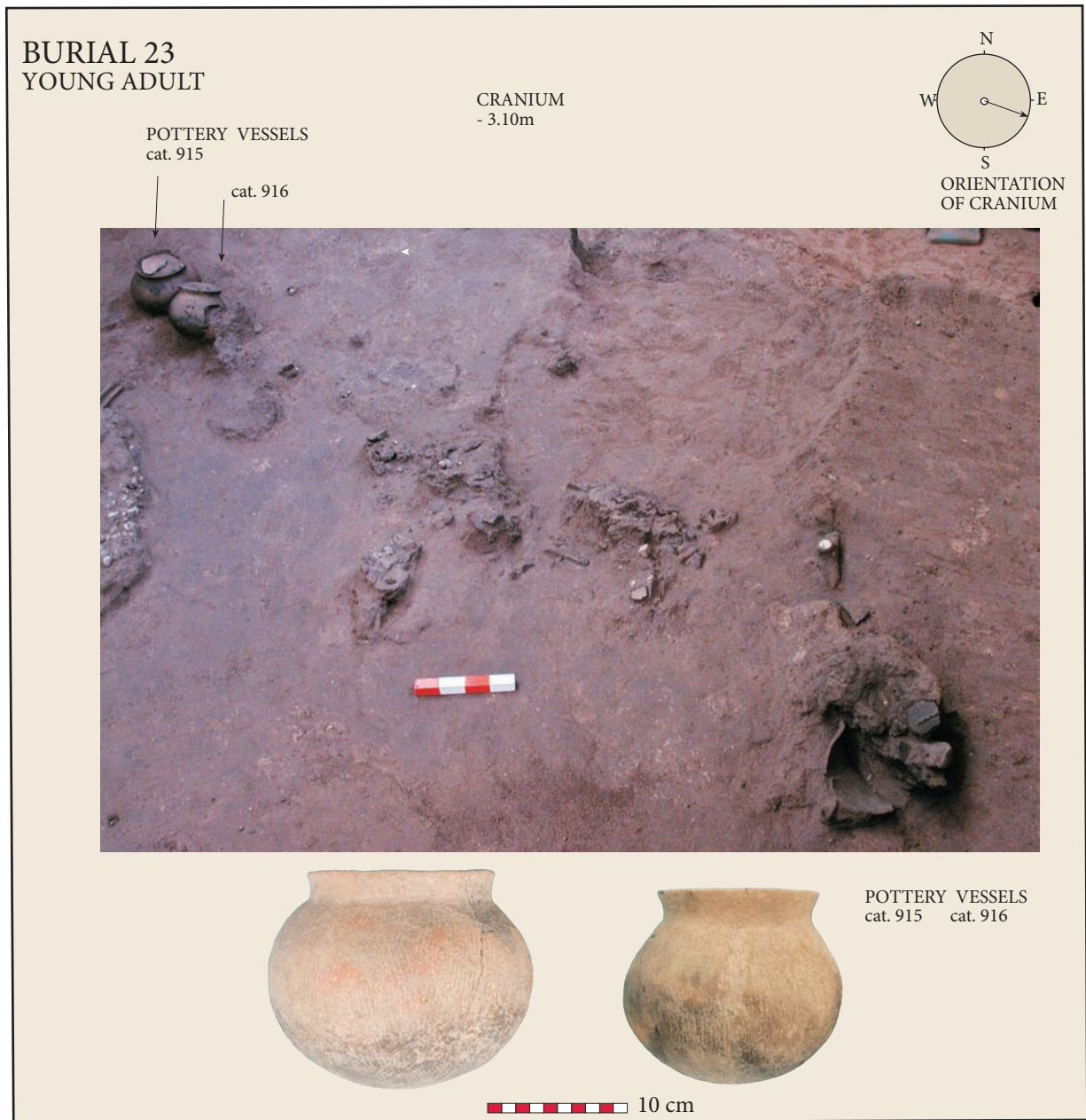


FIG. 4:4 Burial 23

Burial 23 was found in square A3 at a depth of 3.10 m below datum. The young adult skeleton was very disturbed in antiquity, part of the skull lying adjacent to globular

cord-marked vessels. The orientation of the body saw the cranium pointing to the east. It is considered likely that this burial severed burial 26 at the ankles.

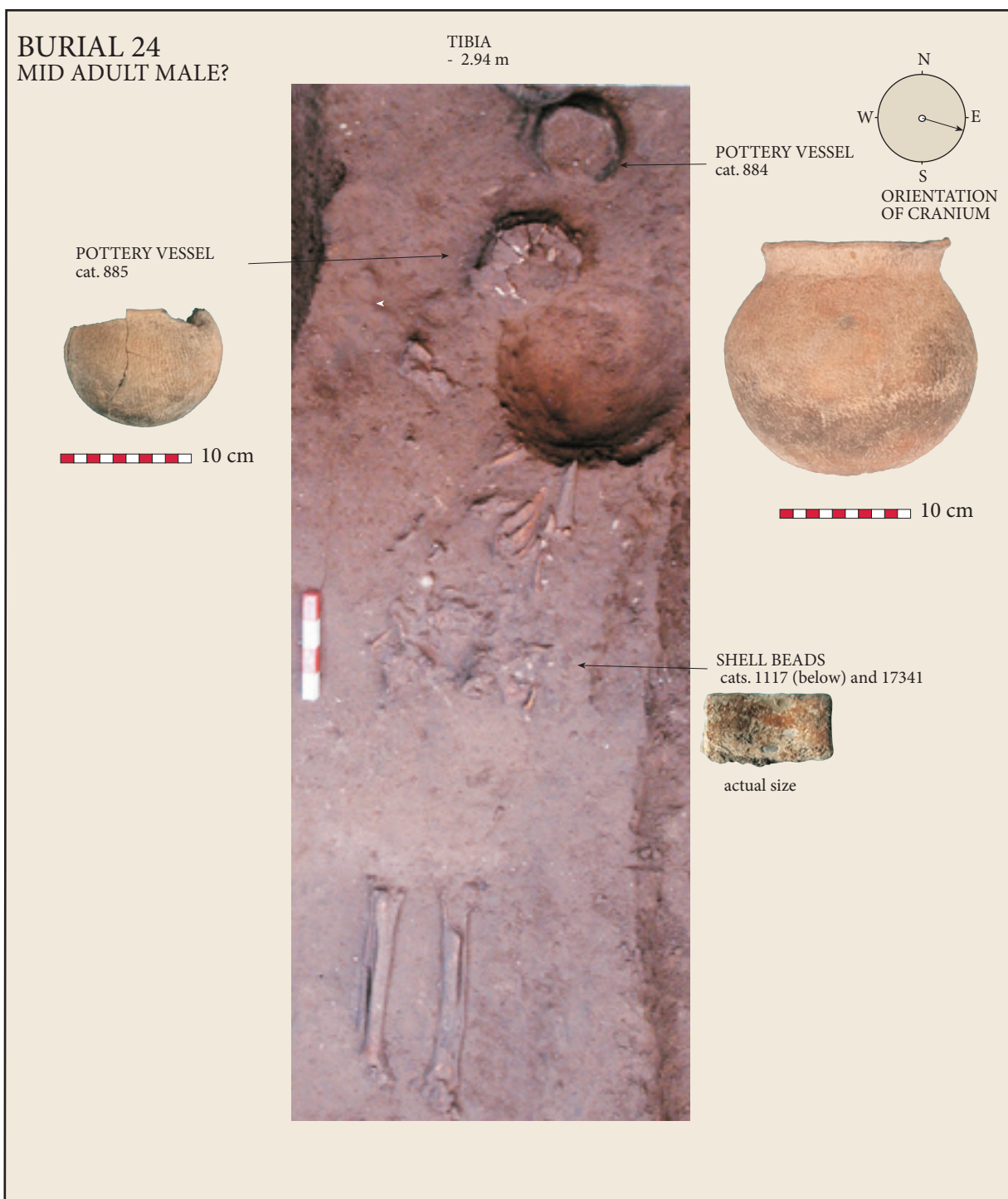


FIG. 4:5 Burial 24

Burial 24 was found at a depth of 2.94 m in square A1. The mid adult probable male was orientated with the head pointing to the east. A large posthole dug through the upper part of the body had damaged the cranium, beyond

which lay two globular cord-marked pottery vessels. The femora had also been cut through in antiquity. Long shell beads were found in the area of the waist.

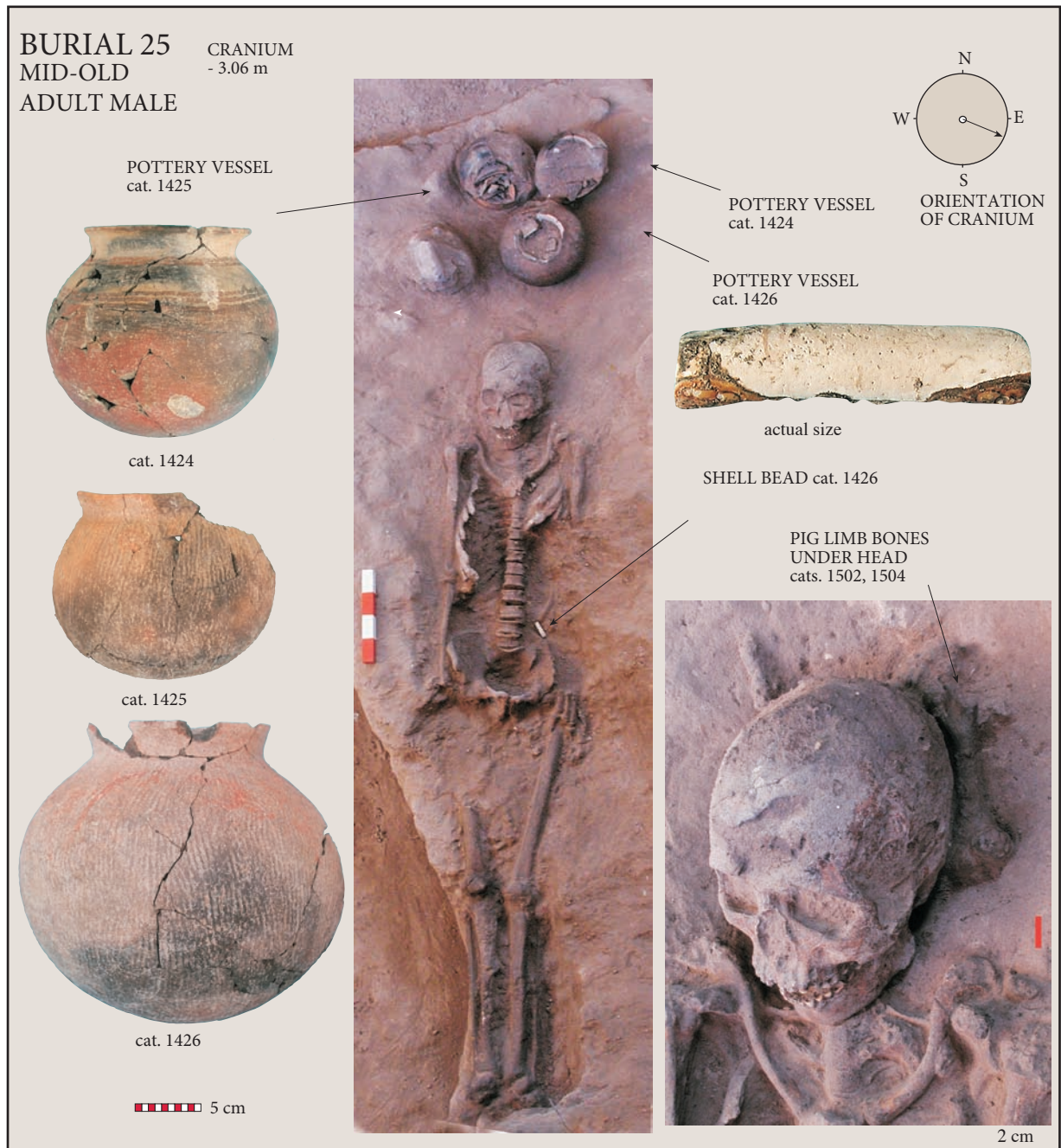


FIG. 4:6 Burial 25

Burial 25 was found in square A4 at a depth of 3.06 m below datum. The body was orientated with the head to the east. It was accompanied by three pottery vessels, all placed beyond the cranium. Two of these are globular cord-marked pots, one of which was further decorated with red painted lines on the upper part of the body. The

third vessel was red slipped on the lower part of the body, above which were two sets of parallel wavy horizontal red lines with a fifth such line on the rim itself. A long shell bead was found by the left forearm, and the skull lay on the right fore limb of a young pig.

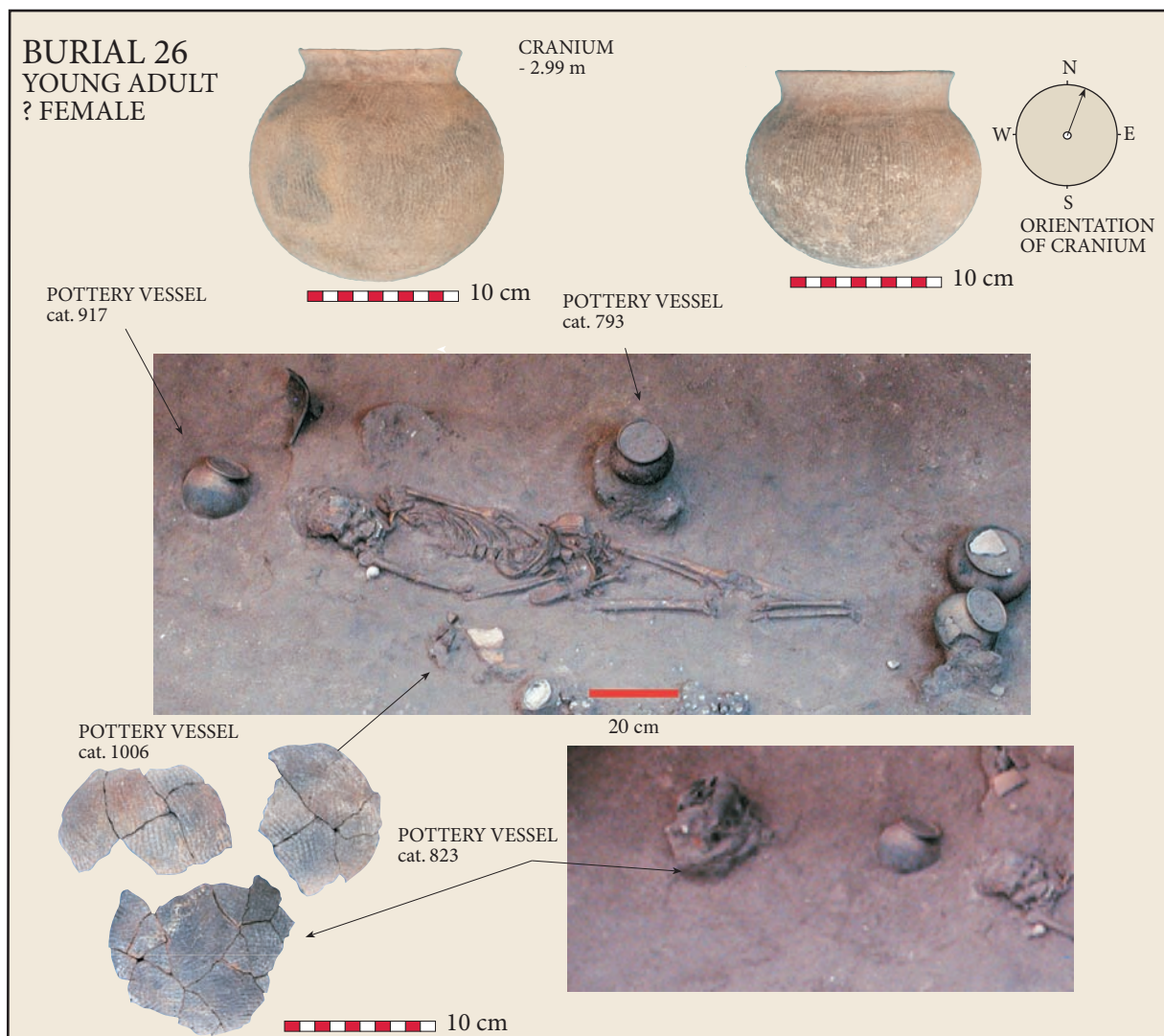


FIG. 4:7 Burial 26

Burial 26 was found at a depth of 2.99 m below datum in square A3. It was probably later than burial 23, since the ankle area of the grave was cut through with the interment of the latter. The body was laid on a northerly direction, and was associated with four pottery vessels. The two that can be reconstructed were globular and cord marked over the outer body.

Pot cat. 823 contained a fragment of cleithrum from *Hemibagrus* or *Mystus*



FIG. 4:8 Beatrice Hudson uncovering burial 26

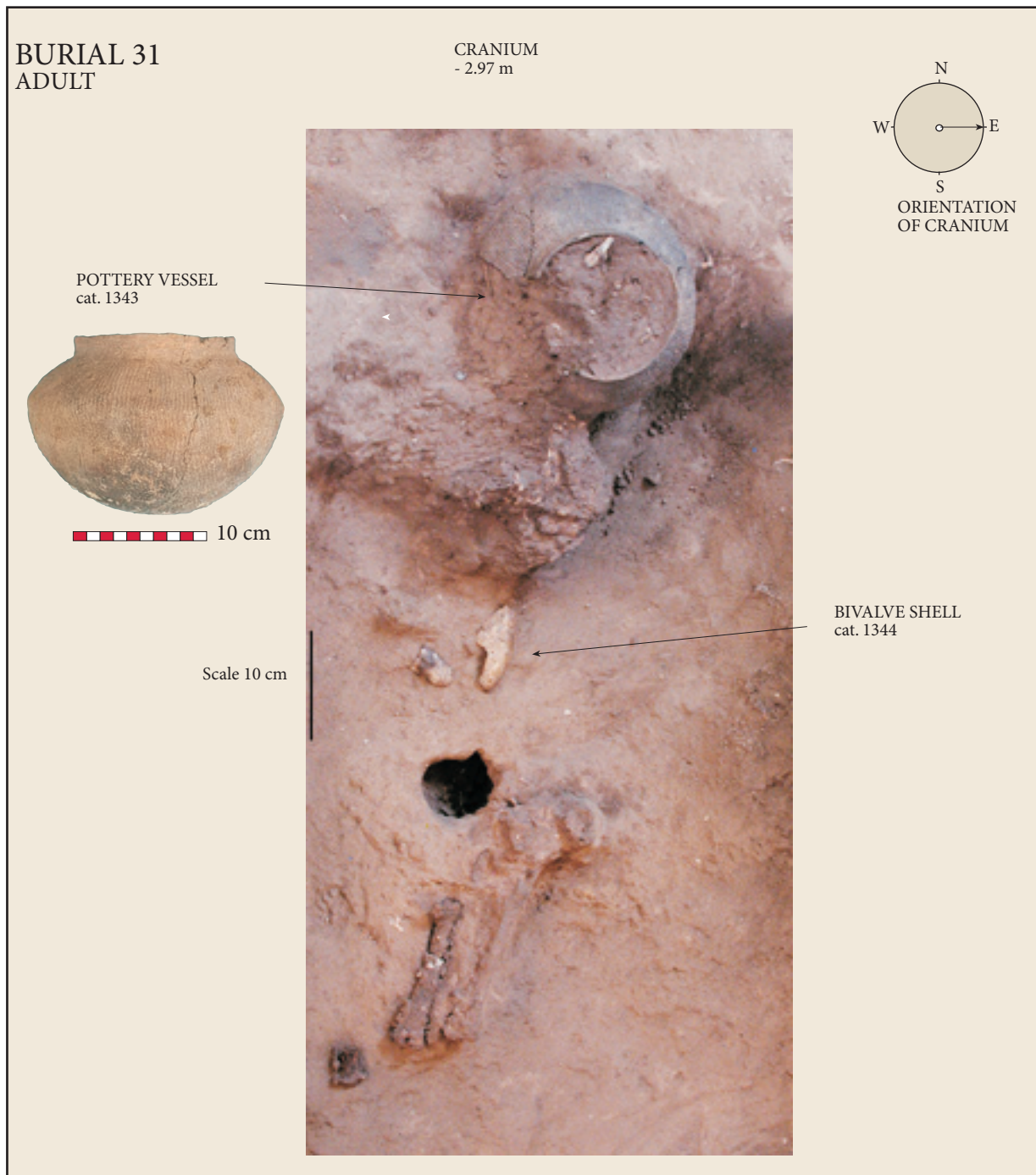


FIG. 4:9 Burial 31

Burial 31, a 3-year-old child burial in square A5, was found at a depth of 2.97 m below datum. The body was orientated with the head pointing to the east. The human remains were found in a fragmentary condition, and were associ-

ated with one ceramic vessel, a globular cord-marked pot placed beyond the head. A bivalve shell was placed to the left of the cranium.

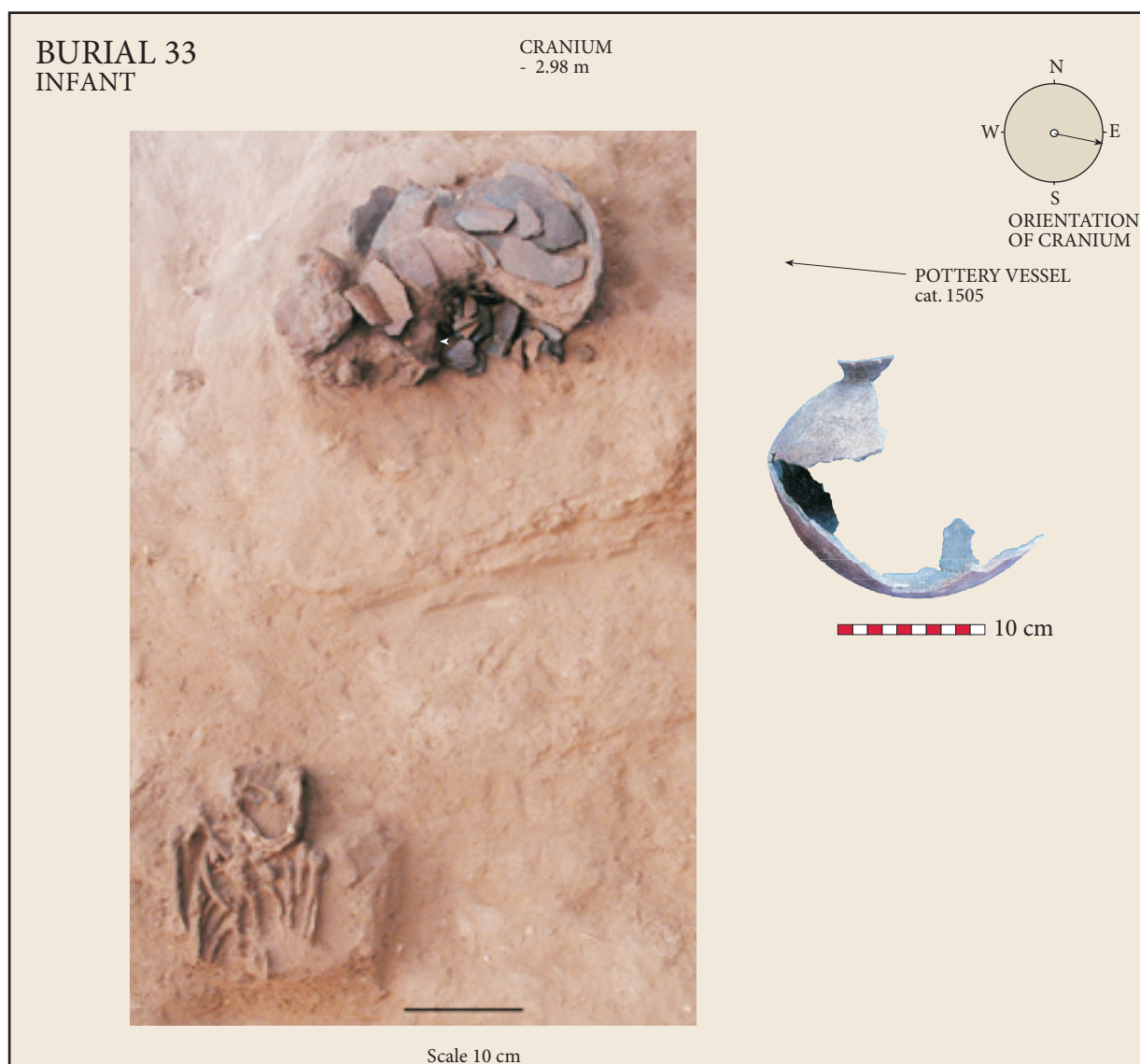


FIG. 4:10 Burial 33

Burial 33 is that of a 15-18-month infant found at a depth of 2.98 m below datum, and orientated with the head pointing in an easterly direction. It was only partially present

due to disturbance in antiquity, and was accompanied by a fragmentary pottery vessel beyond the head.

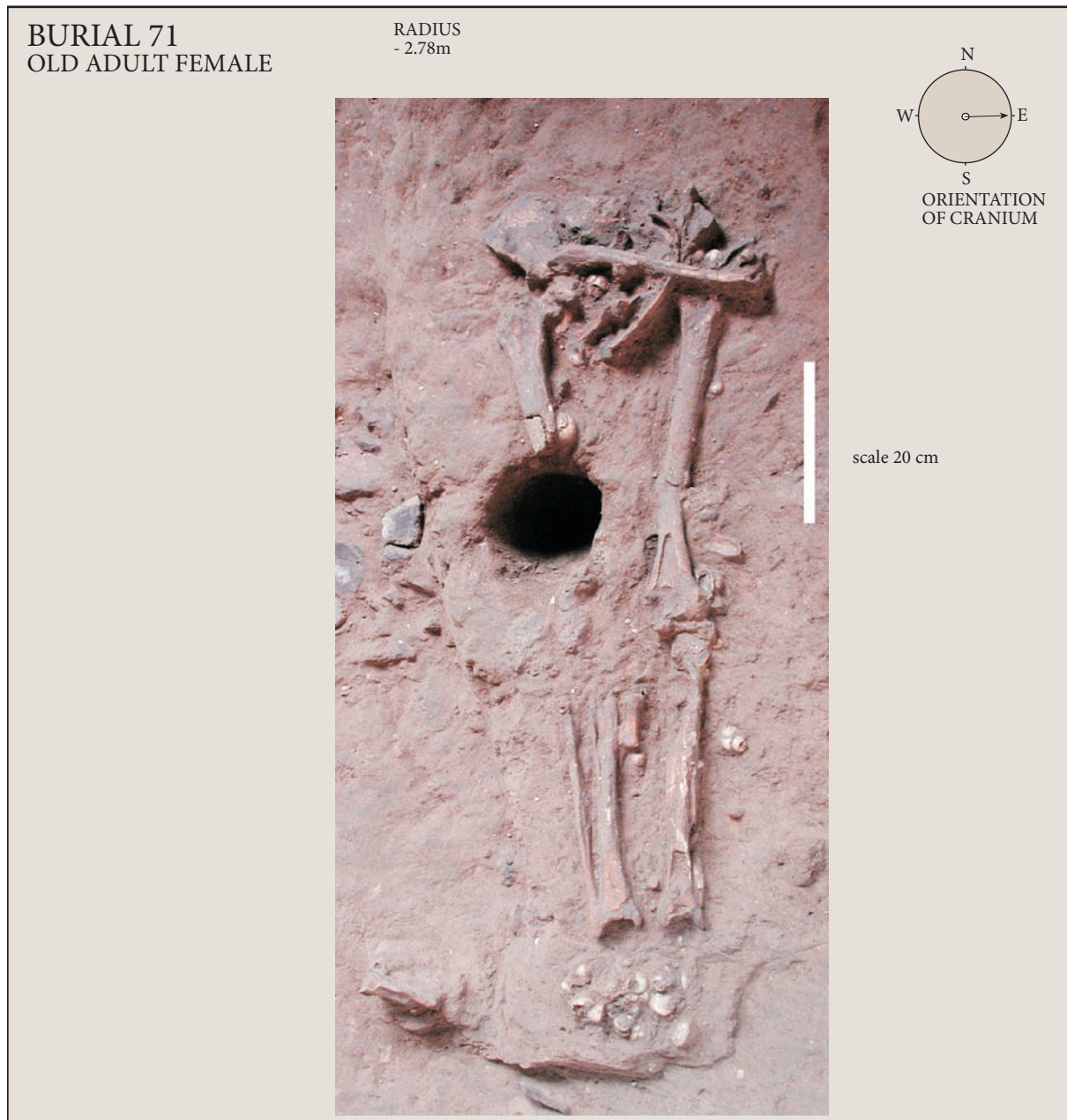


FIG. 4:11 Burial 71

Only the depth and orientation of this burial suggest that it belongs to Neolithic 2. The remains of an old adult female were present only from the lower abdomen to the

tibiae, found in square B3 at a depth of 2.84 m below datum. The body was orientated with the head directed in an easterly direction.

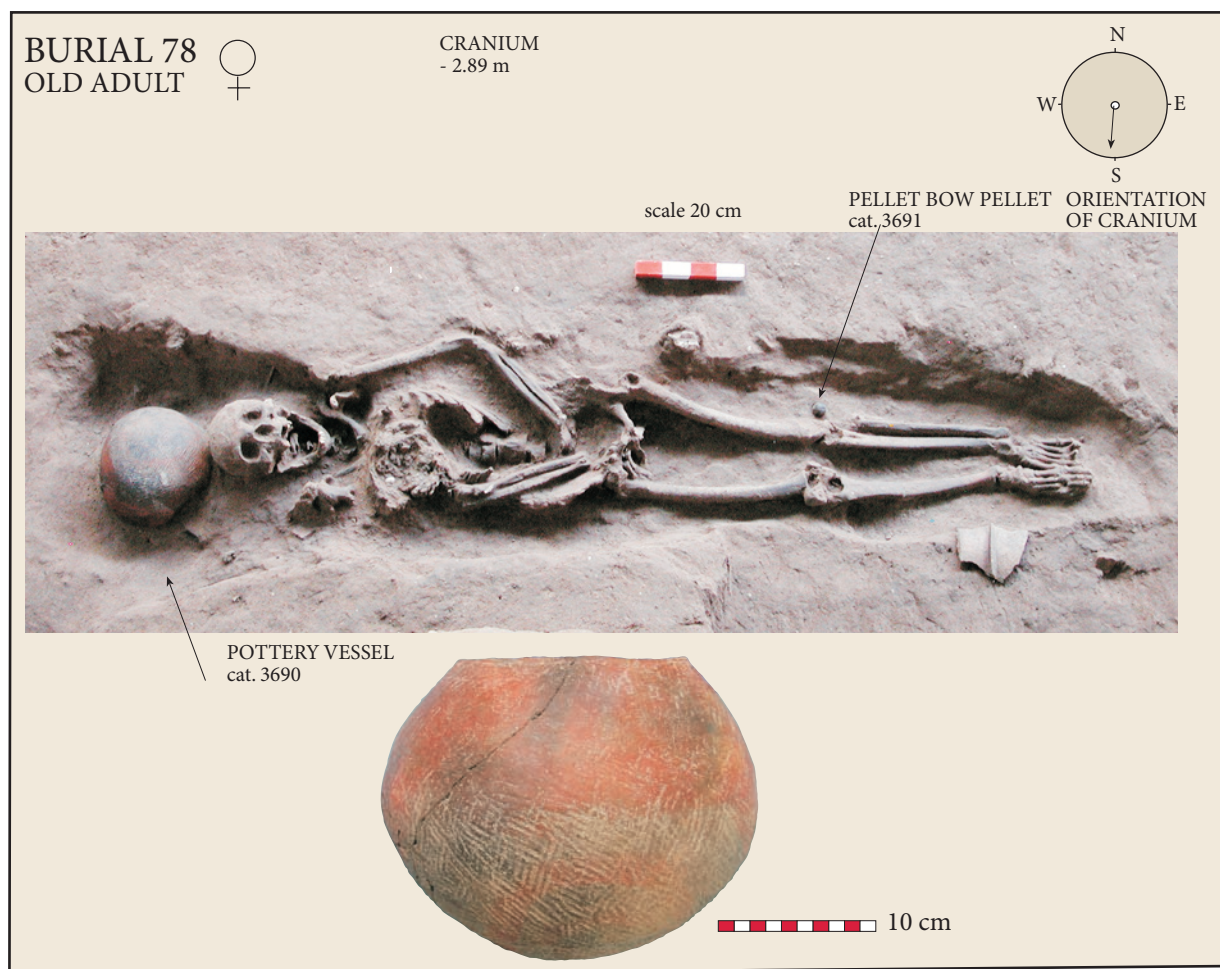


FIG. 4:12 Burial 78

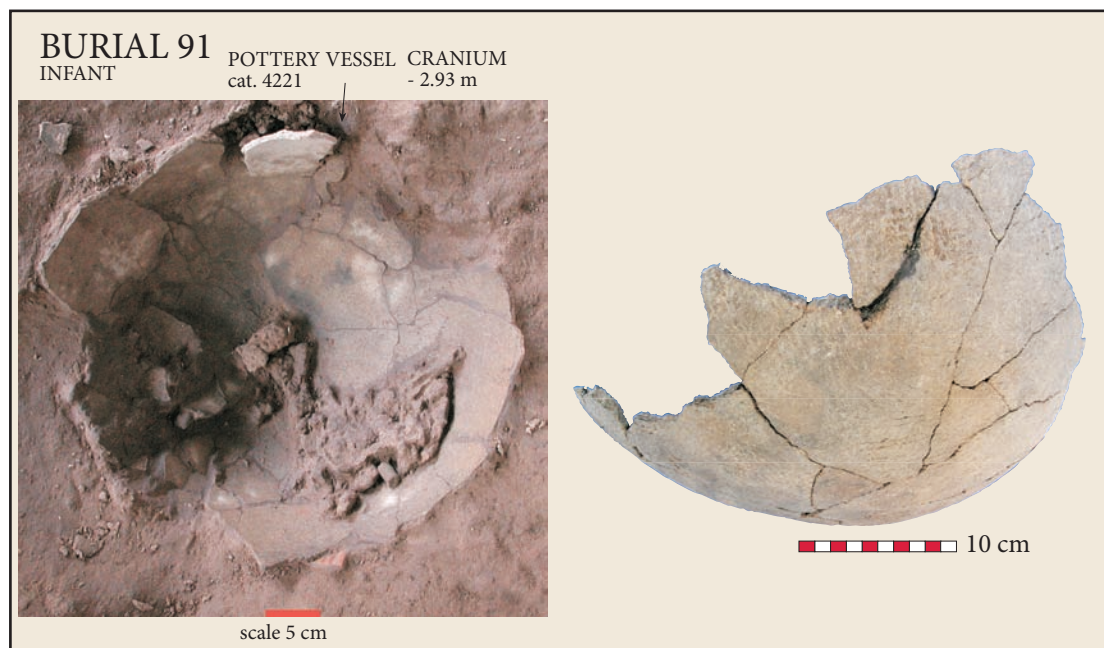


FIG. 4:13 Burial 91

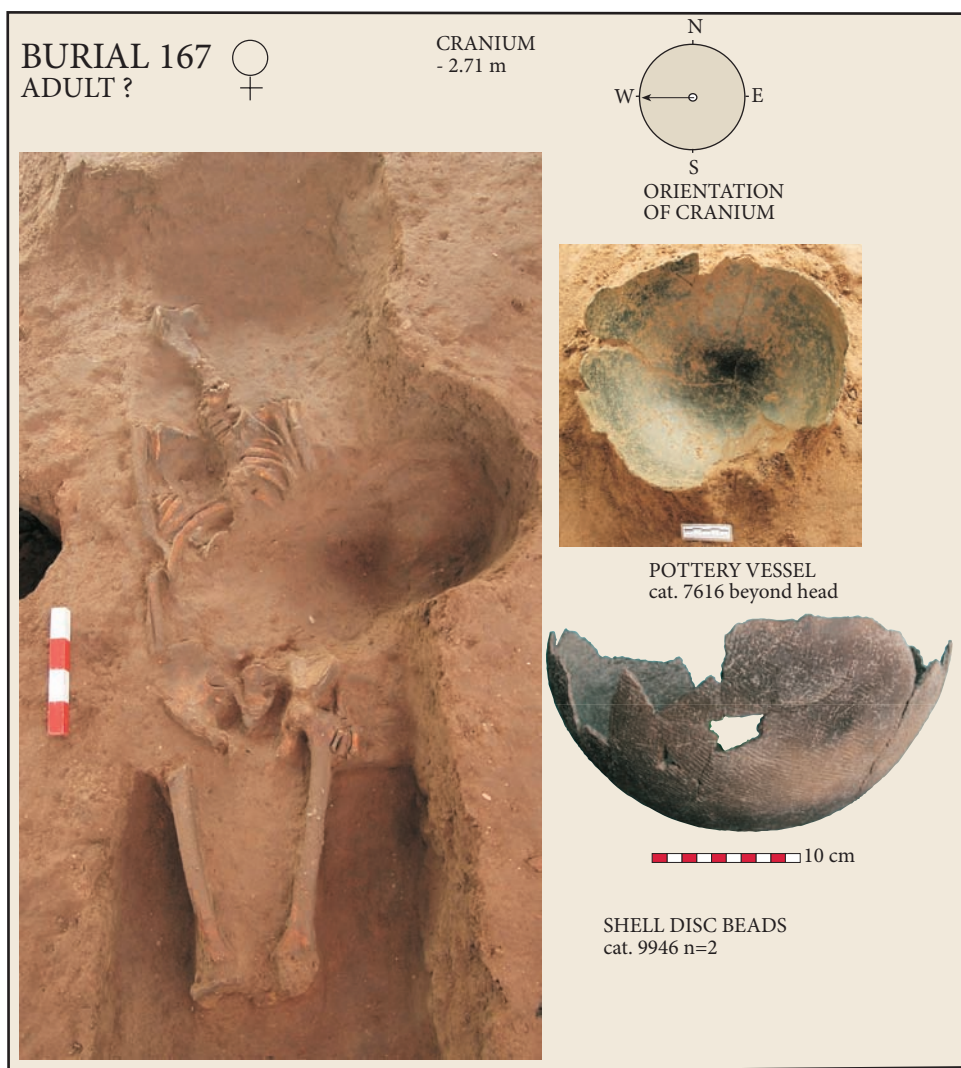
Burial 78, the grave of an old adult female, was found at a depth of 2.89 m below datum in square B4. The body was orientated with the head pointing in a southerly direction. The jaw was open wide, and the hands were crossed over the abdomen. A globular pottery vessel, shorn of the rim in antiquity, had been placed upside down beyond the cra-

nium. It was cord marked over the lower half of the body, and burnished on the upper half. A pellet bow pellet was present beside the left knee and bivalve shell of the species *Hyriopsis bialatus* had been placed inside the pottery vessel together with the subopercular of *Anabas testudineus* and the pectoral fin spine of *Clarias* sp.



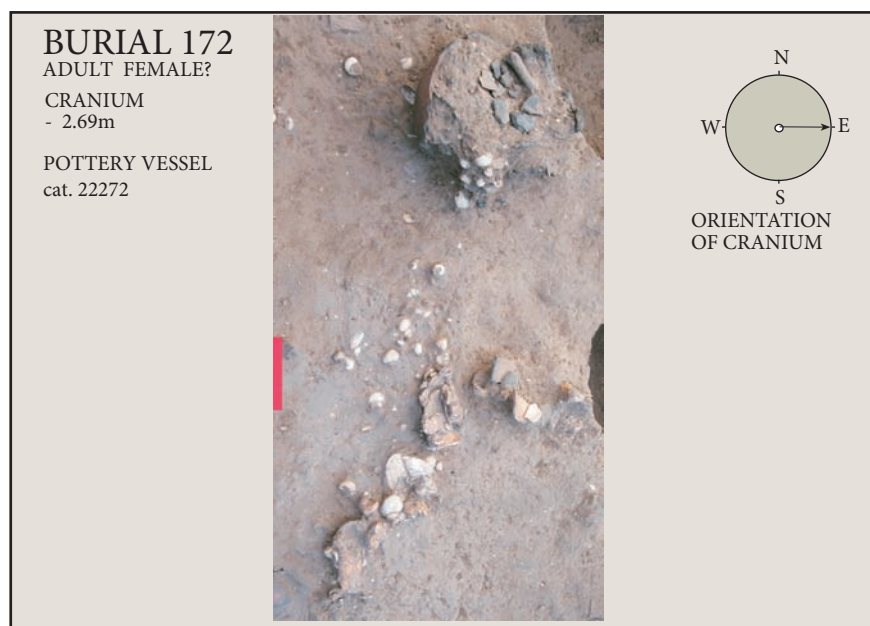
Burial 153 was found stratified below burials 270 and 279, both of which belong to the Bronze Age. Found over two seasons at a depth of 2.54 m below datum in squares C5 and D4, the mid-old adult female was orientated with the head pointing to the east. A single ceramic vessel was found immediately beyond the cranium. The jaw was wide open, but the middle part of the body was missing.

FIG. 4:14 Burial 153



The status of burial 167, an adult female, is equivocal. It is orientated with the head to the west, and was found at a depth of 2.71 m below datum. It was disturbed in antiquity, and the base of a cord-marked, globular ceramic vessel was in place beyond the head. This disposition suggests ascription to Neolithic 2, but a fragment of copper based metal in the grave fill was also found. Its presence alone does not require its being placed with Bronze Age graves, due to the possibility of later excavation down to this level, particularly given the clear evidence for disturbance.

FIG. 4:15 Burial 167



Burial 172, that of an adult female, survived in a very fragmentary condition. It was found at a depth of 2.69 m, and was orientated with the head pointing to the east. The fragmentary pot found with this person contained 11 fish vertebrae, a left fragment of dentary, left maxilla and two right epiphyseal bones of *Channa striata*. There was also the pectoral fin spine of *Hemibagrus* or *Mystus*.

FIG. 4:16 Burial 172

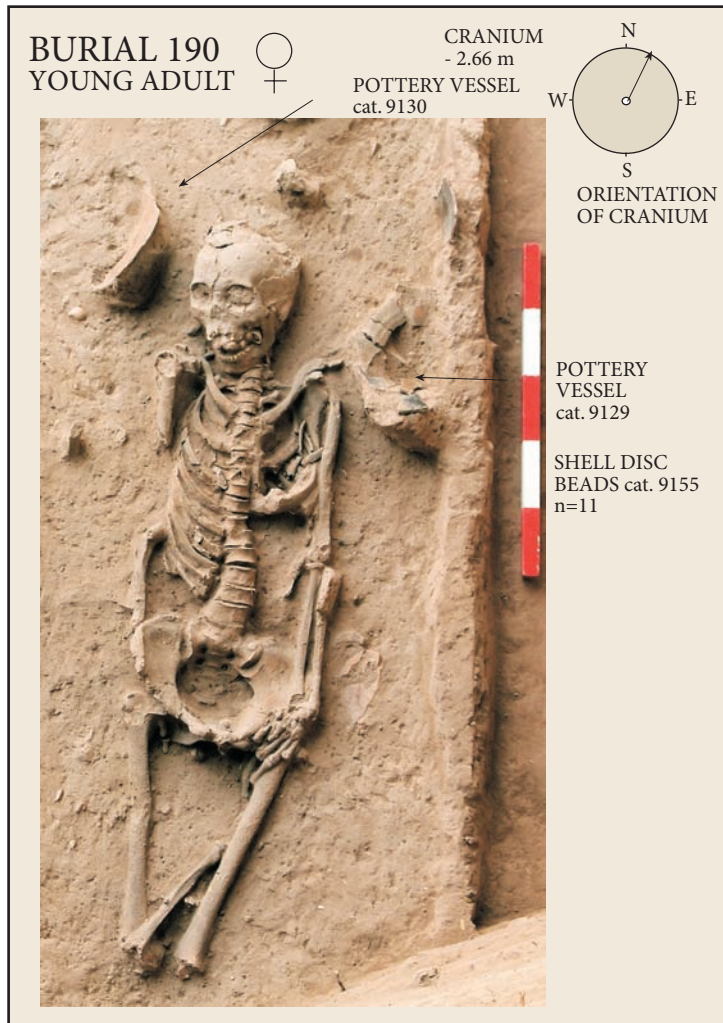
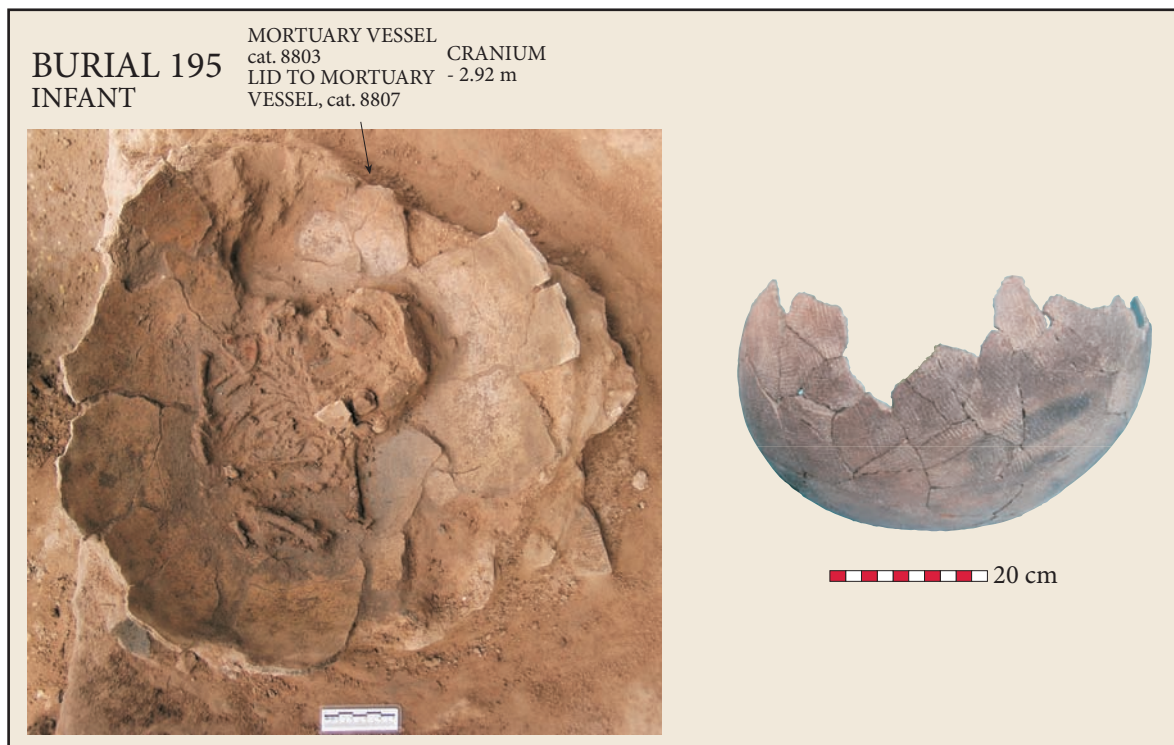


FIG. 4:17 Burial 190

Burial 190, a young adult female, was found in square A6 at a depth of 2.66 m below datum. The adult skeleton lay supine, with the arms running parallel with the body and the jaws slightly open. The head was orientated 20° to the east of due north. Two very fragmentary cord-marked vessels were present, one to the right of the cranium, the other at the left shoulder.

Burial 195 was found in square B6 at a depth of 2.92 m below datum. It is a further lidded jar burial containing the skeleton of an infant who died when about 7 to 9 months at death. The mortuary vessel was not found complete, only the lower part of the body, which was cord marked, being recovered. Some sherds representing, probably, the lid, were also present. A sample of charcoal was recovered within this mortuary jar, the radiocarbon determination being 1524-1412 cal. BC.

FIG. 4:18 Burial 195



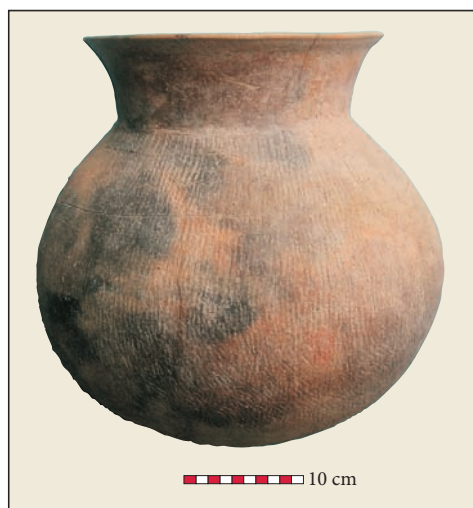


FIG. 4:19 Burial 198, cat. 8863

Burial 198 was found at the junction of layers 4 and 5 at a depth of 2.92 m below datum. It is a complete ceramic vessel containing the skeleton of an infant (cat. 8863). The vessel was cord marked, with a plain everted neck. A band of straight and wavy incised lines enhanced the shoulder.

Burial 240, located in square A7, was laid out supine, with the arms beside the body and the jaw slightly open. It was orientated with the head pointing southwest, at a depth of 2.67 m below datum. The single ceramic vessel associated with this adult was placed just beyond the head. It is a globular form, cord marked over the body with a plain everted rim.

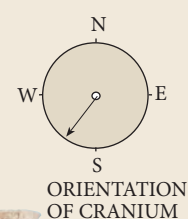
FIG. 4:20 Burial 240

BURIAL 240 ADULT



CRANIUM
- 2.67 m

POTTERY VESSEL
cat. 11072



10 cm



5 cm

SHELL DISC BEAD cat. 11076

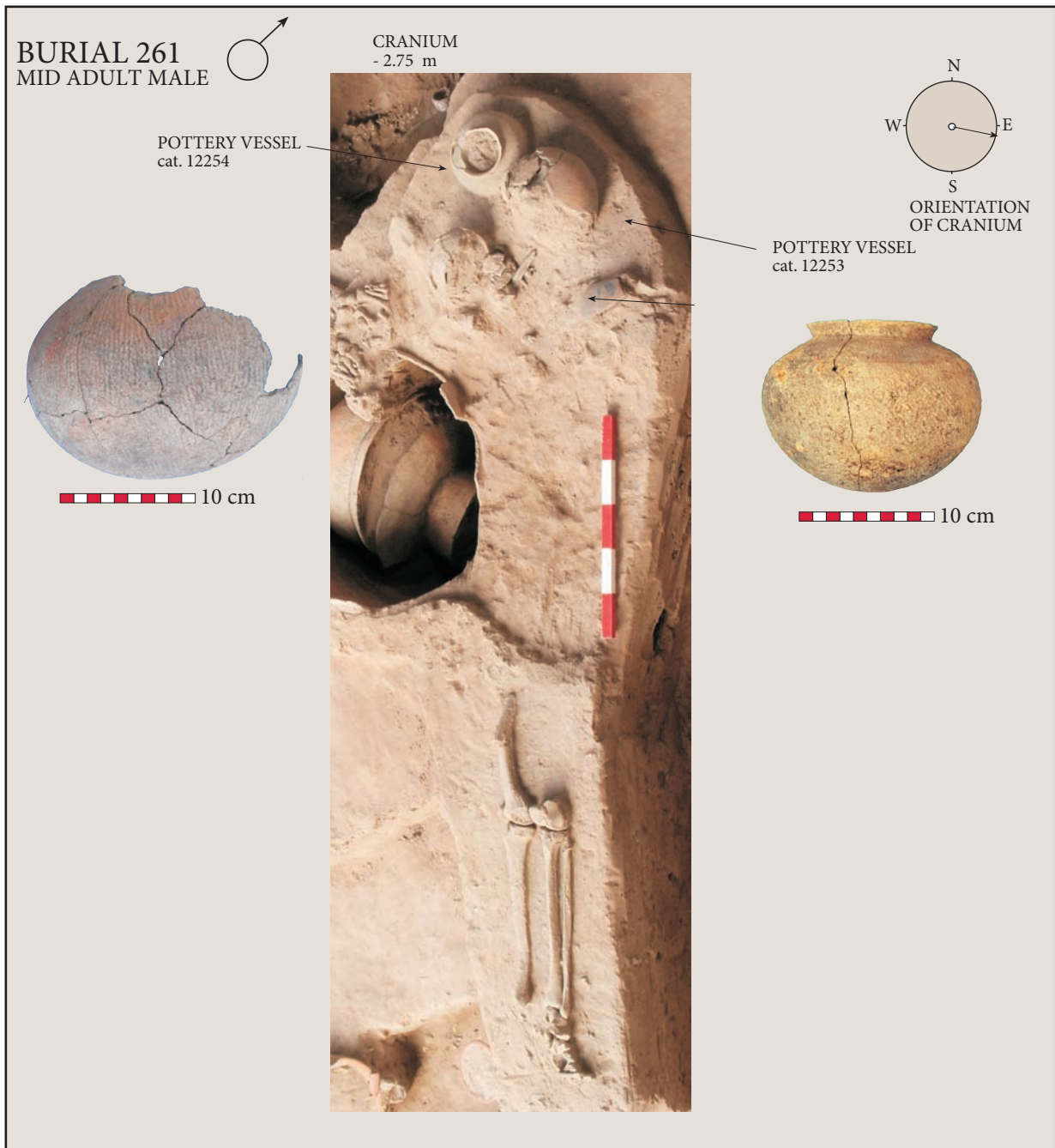


FIG. 4:21 Burial 261

Burial 261, a mid adult male, was cut across by Bronze Age burial 262, thereby removing the skeleton from the pelvis to most of the cranium. The area beyond the head was intact, and two cord-marked globular ceramic vessels were found there. One of these had two bands of carefully

impressed vertical cord marks on the shoulder area. The second was covered in cord marks impressed vertically. This burial was found at a depth of 2.75 m below datum in square D7. The skeleton had been interred in a supine position.

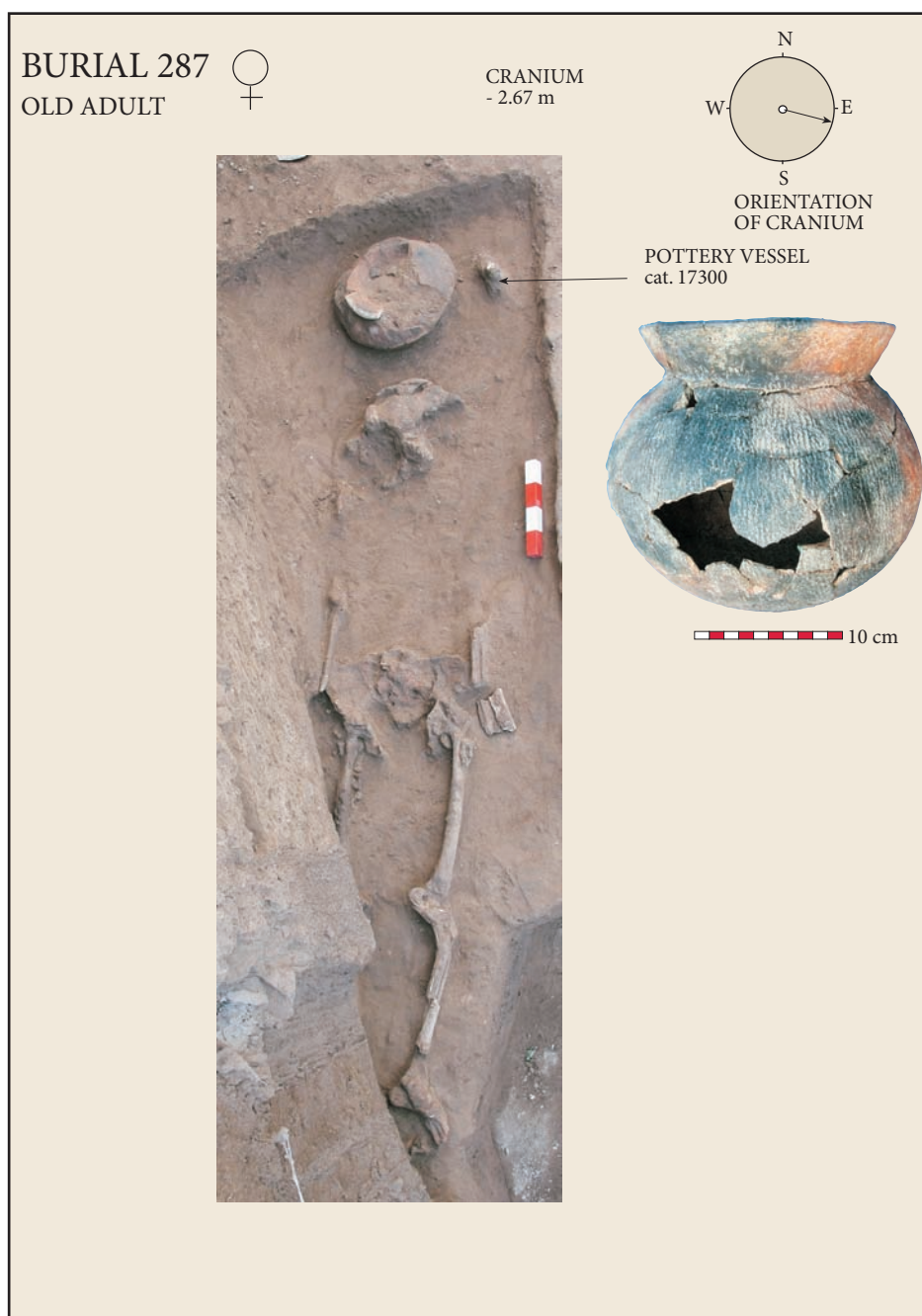


FIG. 4:22 Burial 287

Burial 287 contained the nearly complete skeleton of an old woman. She was interred with one cord-marked vessel

beyond her head, and was orientated east to west with the head pointing to the east

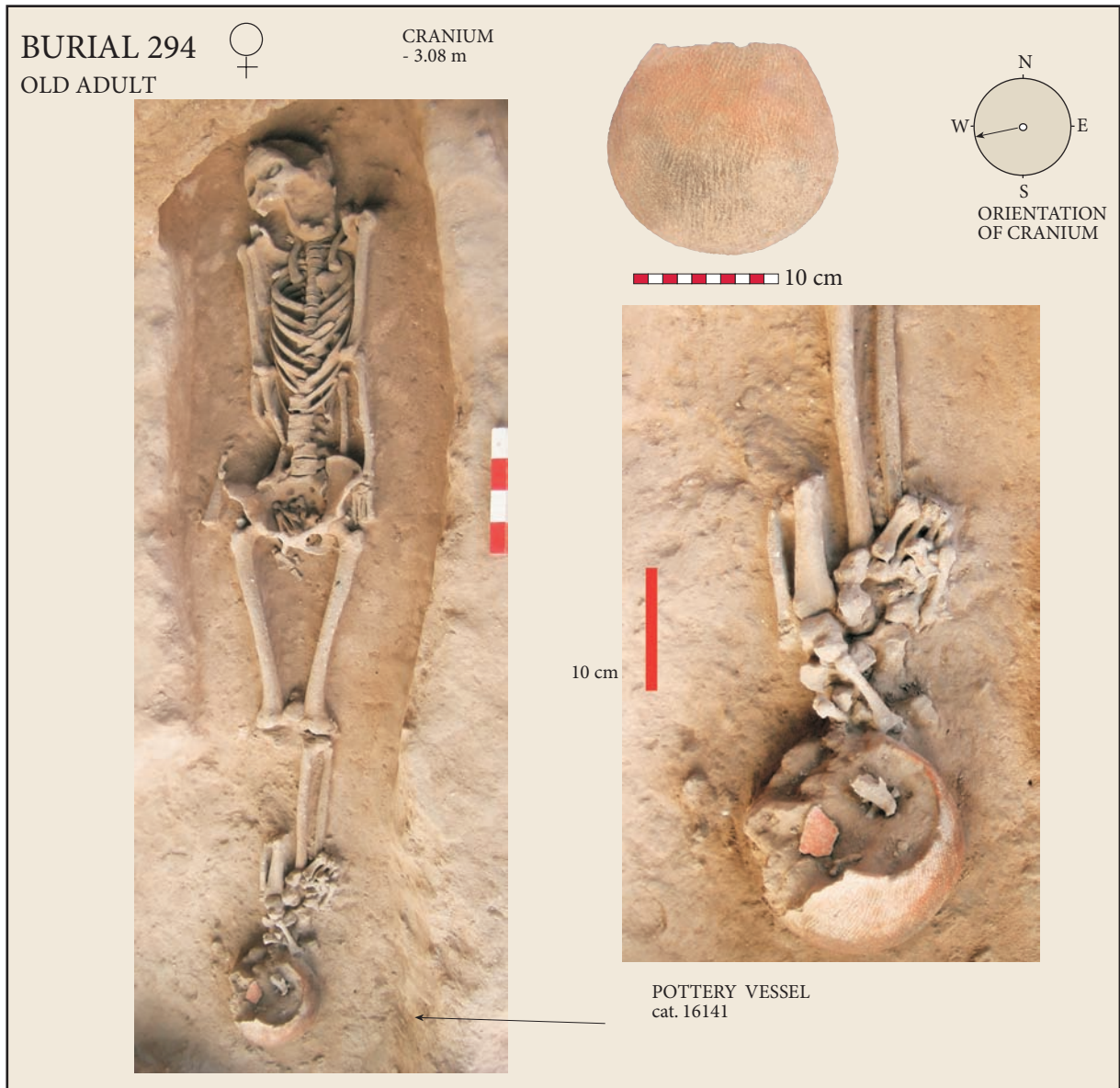


FIG. 4:23 Burial 294

Burial 294, an old adult male, was found orientated with the head pointing in a westerly, in square AA3. The skull lay 3.08 m below datum. This burial provides stratigraphic evidence for the sequence from Neolithic 1 to 2 burials, since it disturbed and cut into burial 289. The corpse was

laid out supine, with the hands beside the body and the mouth open. A single cord-marked pottery vessel was placed beyond the ankles. It lacked the rim, which seems to have been detached in antiquity.

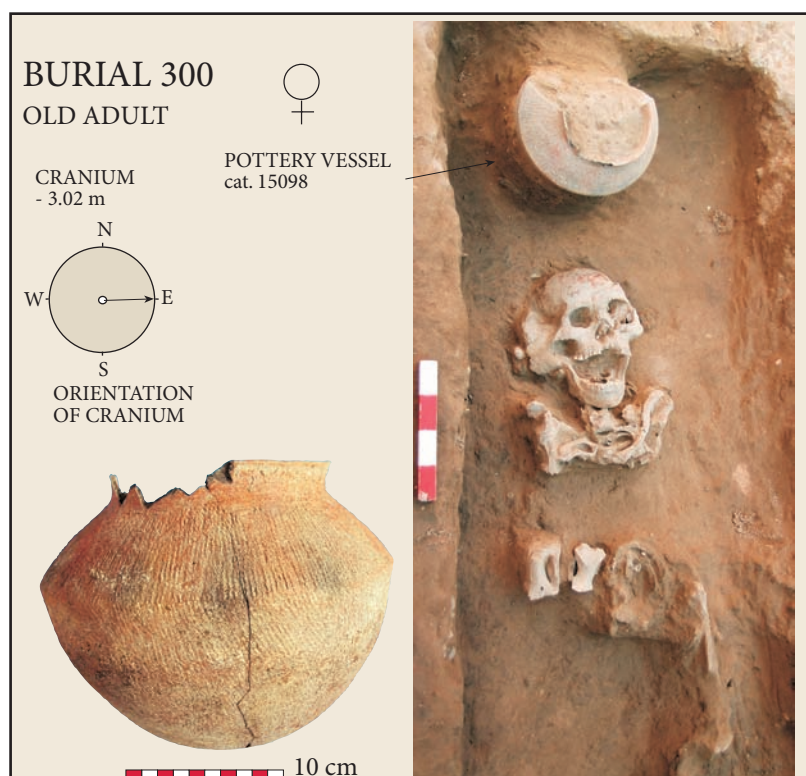


FIG. 4:24 Burial 300

Burial 300 was orientated with the head pointing to the east, at a depth of 3.02 m below datum. The lower half of the skeleton of an old adult female was disturbed in antiquity. The jaw had fallen open. It had been interred in

a supine position, with a cord-marked ceramic vessel beyond the skull. The cord marking on this vessel was at an angle below a slight carination, and vertically impressed above it.

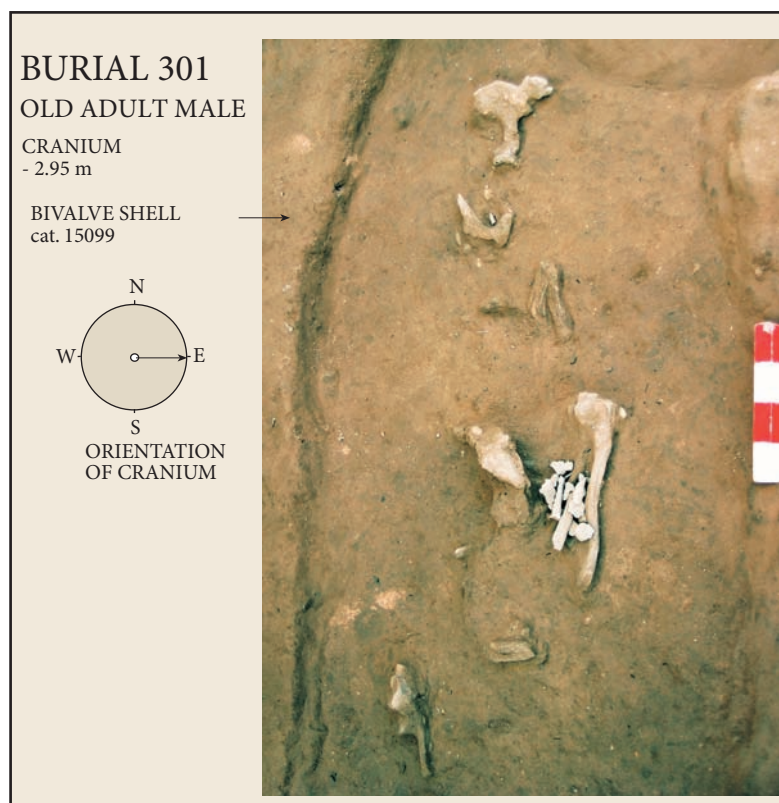


FIG. 4:25 Burial 301

Burial 300 was orientated with the head pointing to the east, at a depth of 3.02 m below datum. The lower half of the skeleton of an old adult female was disturbed in antiquity. The jaw had fallen open. It had been interred in a supine position, with a cord-marked ceramic vessel beyond the skull. The cord marking on this vessel was at an angle below a slight carination, and vertically impressed above it.

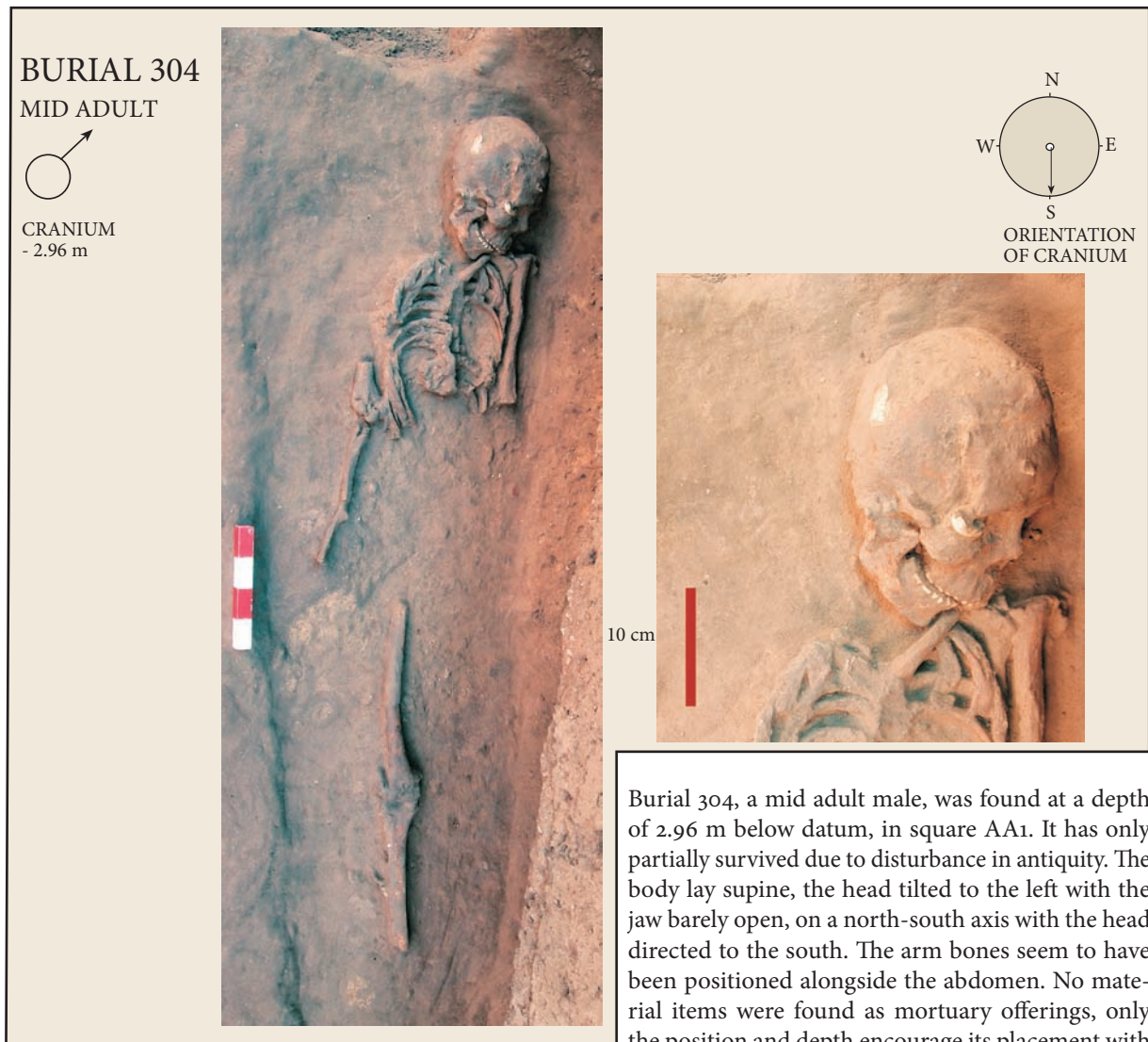


FIG. 4:26 Burial 304



FIG. 4:27 Burial 307

Only the femora and a tibia of burial 307 survive. The child bones were orientated with the head to the south at

a depth of 3.04 m below datum

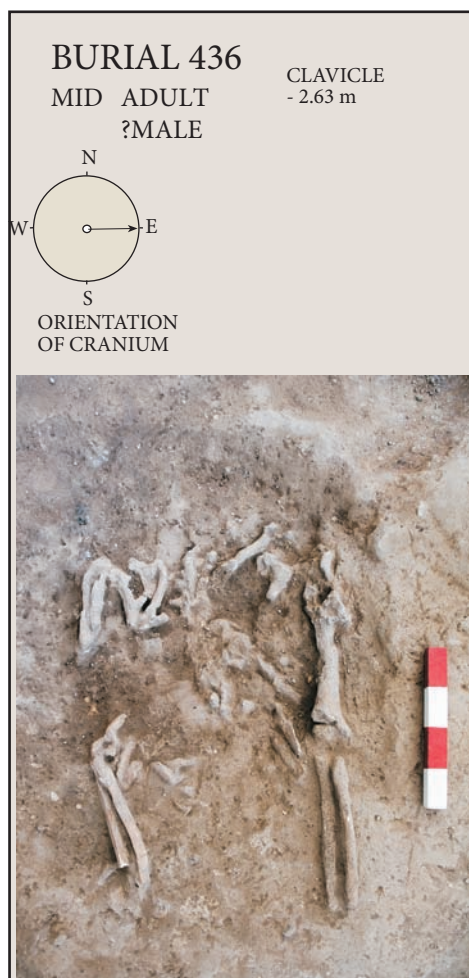


FIG. 4:28 Burial 436

Burial 436 contained the fragmentary remains of a mid-adult man, the body being orientated with the head to the east.

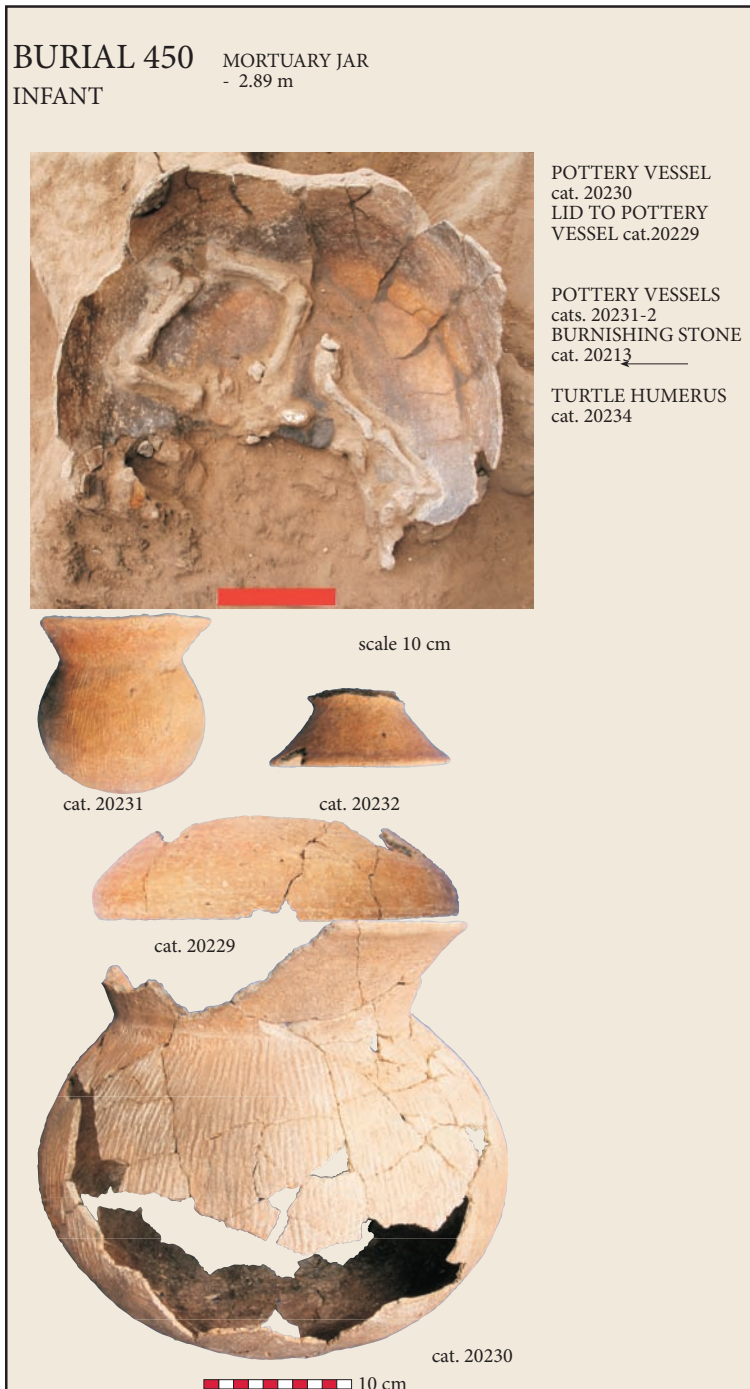


FIG. 4:29 Burial 450

This new-born infant burial involved a mortuary jar the exterior surface of which was decorated with vertical cord marking. There was also a lid, the base of a vessel and a

small, cord-marked globular pot. A burnishing stone lying next to the pot might also be associated, and the humerus of a turtle was found in the mortuary jar.

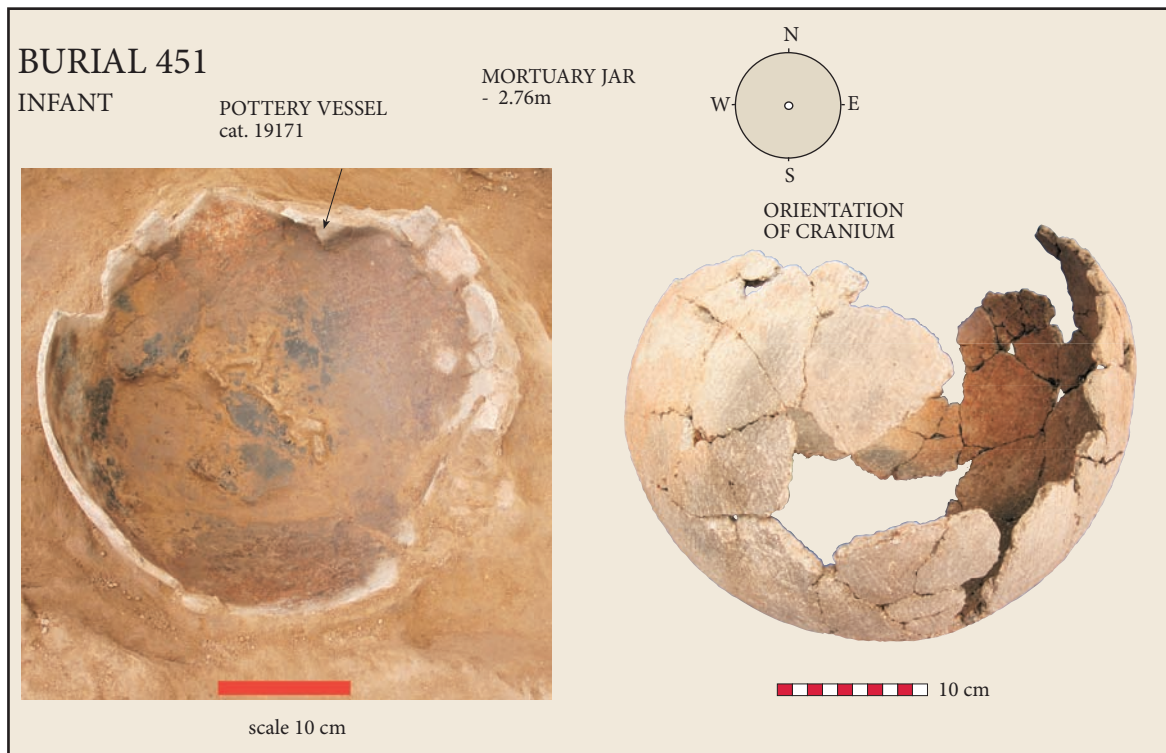


FIG. 4:30 Burial 451

Burial 451 comprises an infant jar burial in a vessel that lacks the rim, and was decorated on the exterior with vertically orientated cord marking

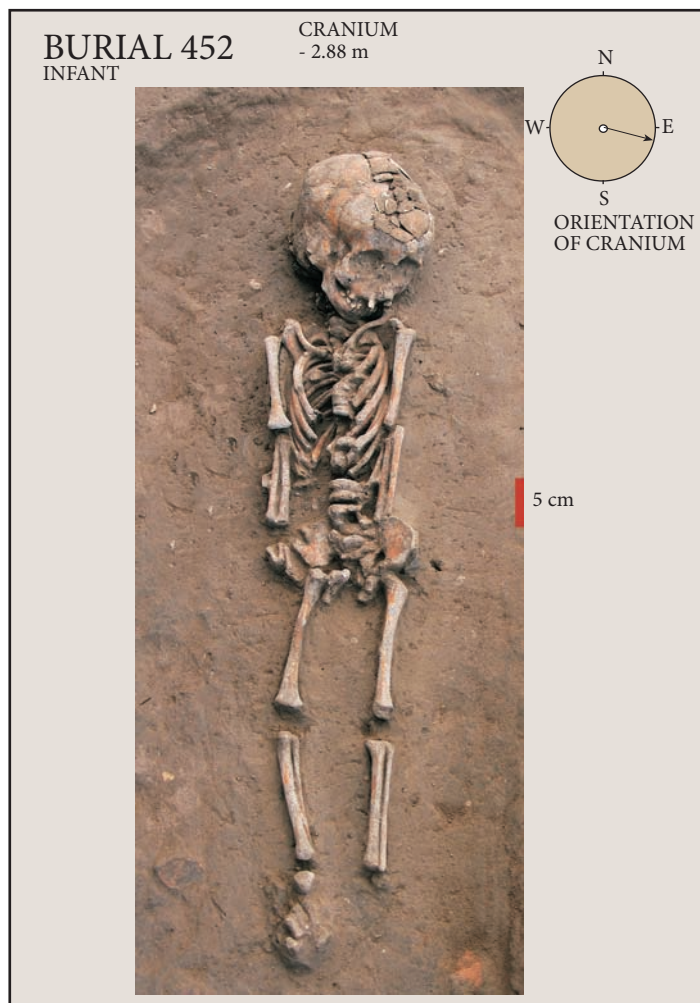


FIG. 4:31 Burial 452

Only the depth and orientation of this infant burial suggest that it might belong to Neolithic 2. No grave goods were encountered. The infant was laid out supine, with the arms beside the body, at a depth of 2.77 m below datum in square E5. The jaws were closed.



FIG. 4:32 Burial 547

The ribs alone survive for this burial.

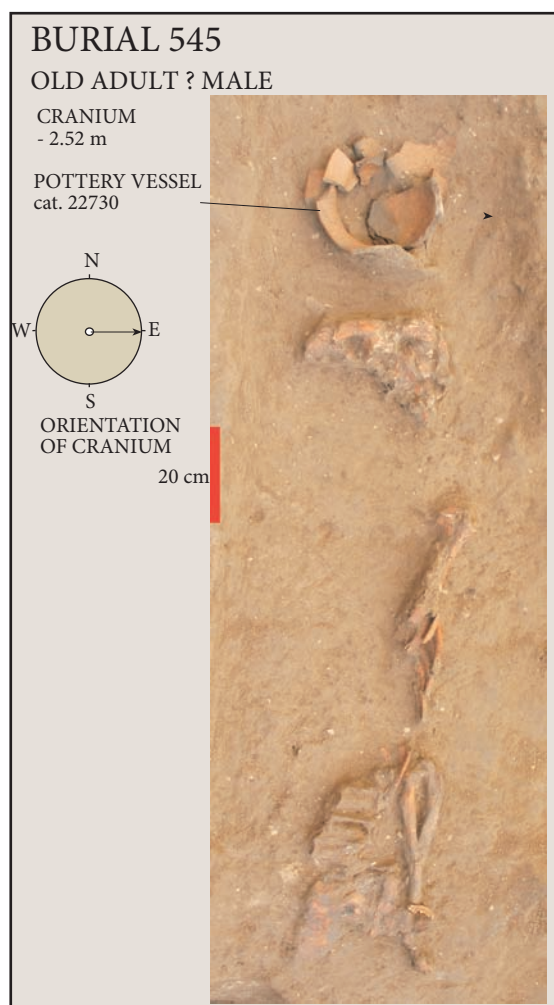


FIG. 4:34 Burial 556

Burial 556, a young-mid adult female, was found in square E2 at a depth of 2.67 metres. It was one of three such burials found in a row. This grave had been disturbed in antiquity when the grave for Bronze Age burial 571 was created. No grave goods were found.

FIG. 4:33 Burial 545

This burial of an old adult male was interred with the head orientated to the east. A single ceramic vessel was found beyond the head.

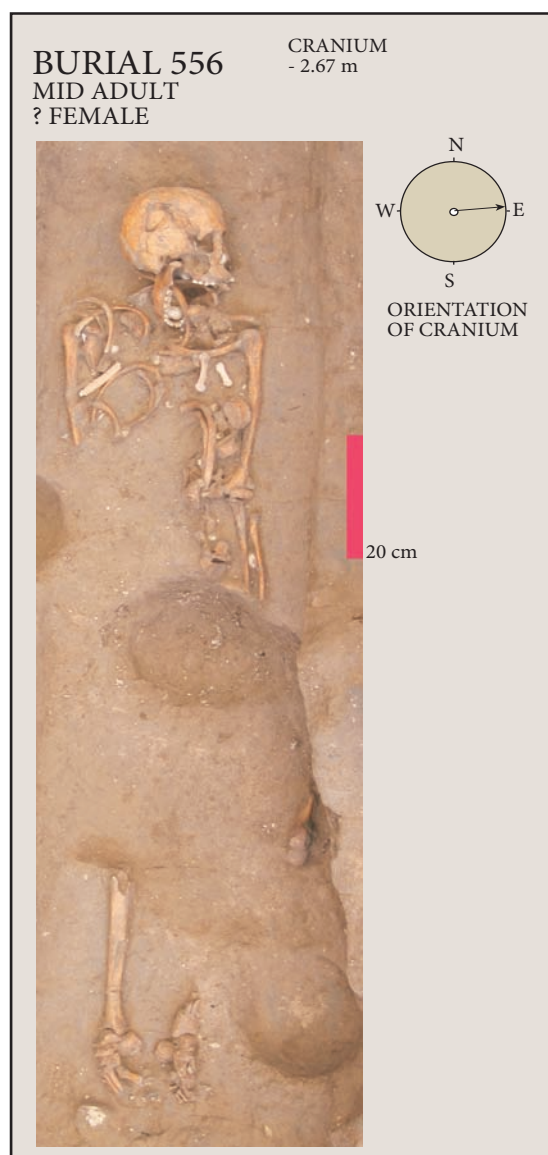




FIG. 4:35 Burial 558

Burial 558, an old adult female, was found in a row of three graves on the same orientation, in square E2. It was relatively complete, and the corpse was accompanied by a ceramic vessel placed beyond the head. The cranium lay at a depth of 2.63 m.

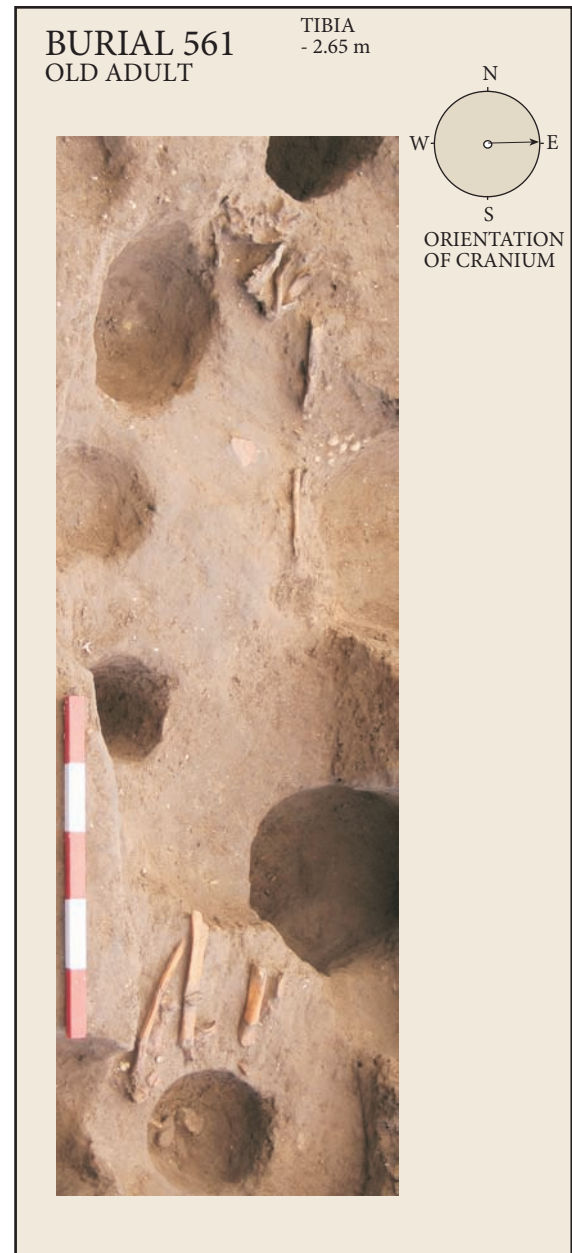


FIG. 4:36 Burial 561

Burial 561, an old adult female, had been seriously disturbed in antiquity. It was found in square E2 at a depth of 2.65 m below datum. The head was orientated to the east.



FIG. 4:37 Burial 562

Burial 562, mid-old adult male, was found in square E4 at a depth of 2.56 m below datum. Relatively complete, two pottery vessels were found beyond the head. A piece of polished stone, possible part of an adzehead, was found near the cranium. A child, burial 563, lay beside this grave and to the north. Pot cat. 26532 contained the bones of the fish *Clarias* sp. 1R pectoral fin spine and *Channa striata* 1R dentary; 1L palatine (very small fish).



FIG. 4:38 Burial 563

Burial 563 lay north of the grave of burial 562. The child lay with the head orientated to the east, at a depth of 2.51 m below datum. No grave goods were found with this individual.

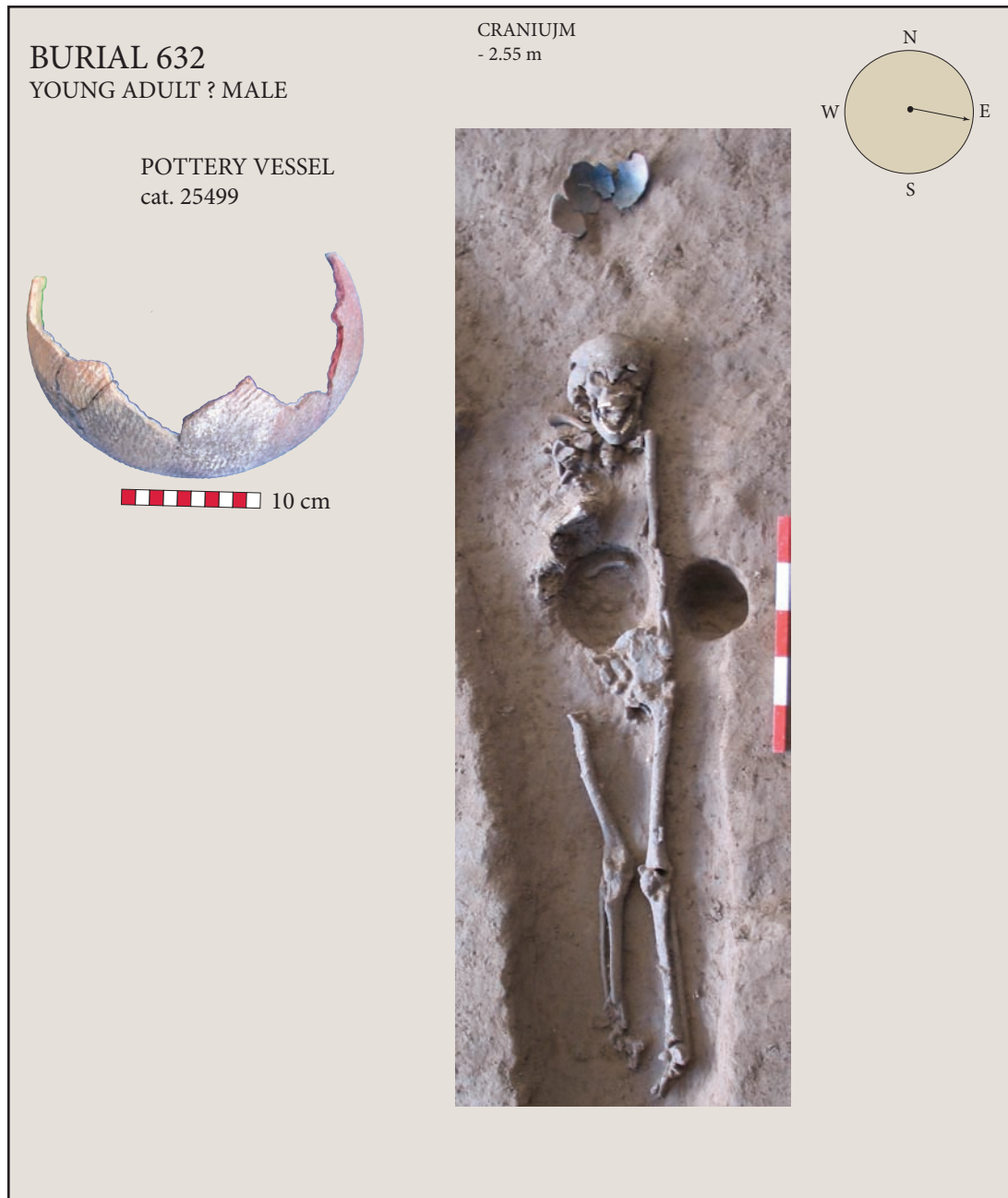


FIG. 4:39 Burial 632

Burial 632 contains the skeleton of a young adult probable male, interred with the head orientated to the east. One

ceramic vessel was found beyond the head.

SUMMARY

The burials of the later Neolithic phase are quite distinct from their predecessors. They were interred in the main, on a different orientation, and were associated with a markedly poorer set of mortuary offerings. Ceramic vessels are virtually the only items placed with the dead and in their form and decoration, they contrast markedly with the richly-decorated pots found with the Neolithic 1 burials. In terms of the distribution, we find that there were possible groupings of graves. Men and women were found in equal numbers. Some infants were interred in ceramic

vessels, others were laid out on the back. Just over a quarter of the 38 individuals were infants or young children, a marked decline on the figure for Neolithic 1.

The closest parallel to the burials found in this phase comes from a small group of late Neolithic burials, also dated to the late 2nd millennium BC, recovered from the nearby site of Ban Lum Khao (Higham and Thosarat 2005). These ten graves were rather richer in terms of offerings: one individual wore 786 shell beads, and two were associated with pig bones. Burial 64 there was accompanied by ten pots, far more than were found with any of the Neolithic 2 burials at Ban Non Wat.

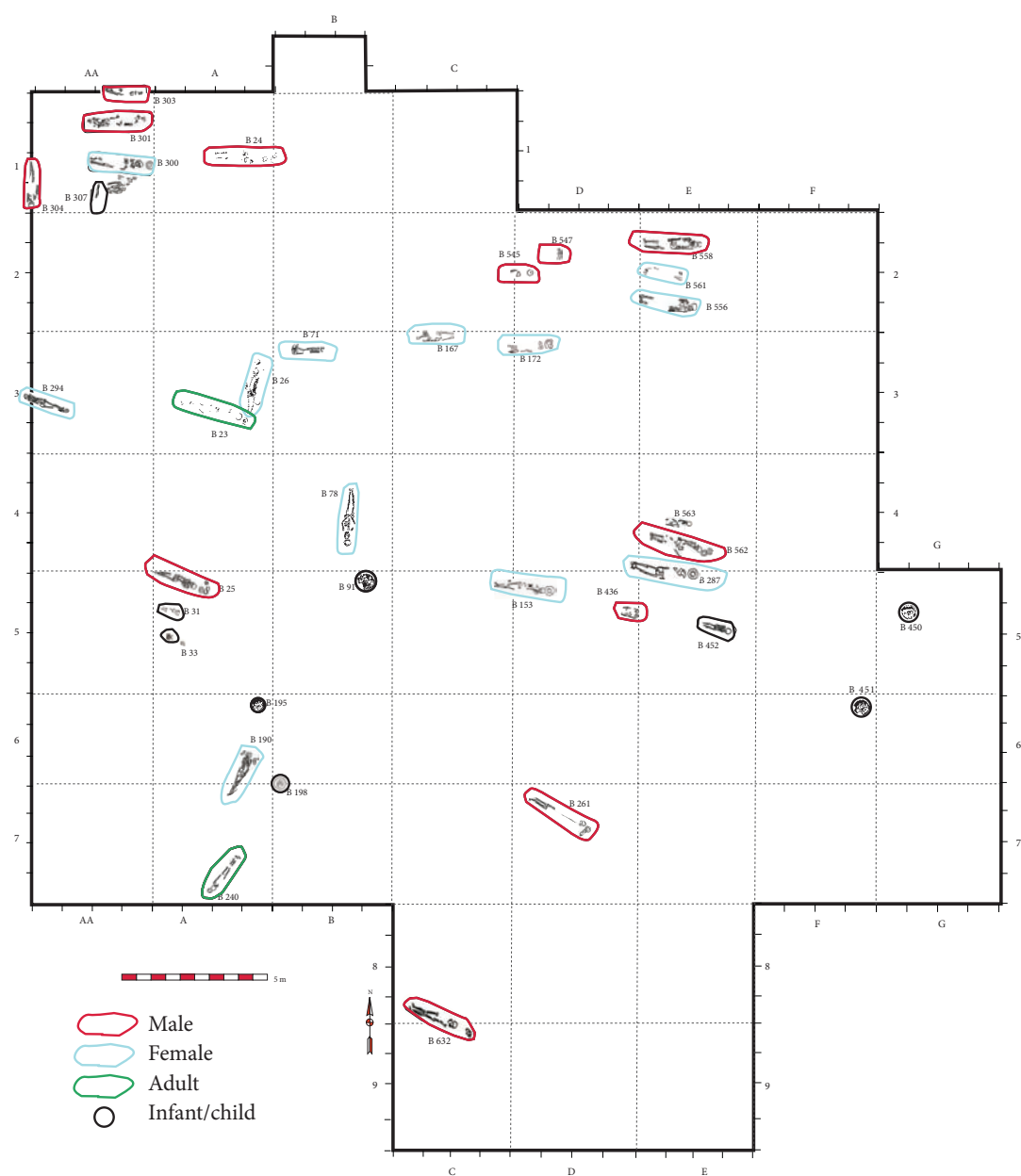


FIG. 4:40 The Neolithic 2 burials according to sex and age

V NEOLITHIC 1 CERAMIC MOTIFS

C.F.W. HIGHAM AND W. WIRIYAROMP

The Neolithic occupation of Ban Non Wat is complex. In the basal cultural layers at this site, there are areas of dense but relatively thin shell midden. These might well have been more extensive, but the Bronze Age inhabitants placed their wealthier graves deeply into the substrate, thus cutting through and redistributing the Neolithic occupation deposits. The basal layers also contain Neolithic inhumation burials, some intact, many disturbed, which may be divided into two groups on the basis of how the dead were interred and their associated mortuary offerings.

The Bayesian analysis of the radiocarbon determinations suggests that initial Neolithic occupation was later than the 18th century BC and ended early in the 15th century BC. Since the basal middens contain ceramic sherds that are identical in terms of form and decoration with Neolithic 1 mortuary vessels, it is concluded that the middens were laid down by the Neolithic 1 community.

THE CERAMIC VESSELS FROM BURIALS AND OCCUPATION CONTEXTS

The first issue is to examine the relationship between the ceramic vessels used as mortuary offerings, and the sherds recovered from the occupation middens. This is necessary in order to link one of the Neolithic groups with the dated occupation contexts, and to see if the same decorative motifs were in general domestic use. Therefore, sherds from the occupation midden in square D2 are illustrated in figures 5:1-4. As may be seen, they were decorated with the same incised, impressed and painted designs as found on Neolithic 1 mortuary vessels. The same situation applies to the incised and impressed technique of decoration. It was however, most surprising to find the quantity of painted designs on occupation potsherds. These form sets of parallel lines that were evidently components of quite complex patterns. There are also incised and punctate designs with red and black, red on buff and red on black painted patterns. Some of the sherds also reveal incised lines identical with those on mortuary vessels.

THE MORTUARY VESSELS

Form 1 vessels

Form 1 vessels have a pedestal base and a large, flaring rim (Fig. 5:5). The protocols for decorating these most impressive artefacts begin with a band of incised and impressed decoration at the rim. The rest of the upper body is usually left smoothed and plain. It is the pedestalled base which is reserved for the most intensive decoration, in the form

of incised and painted designs (Figs. 5:15, A-C). When viewed from above, these designs are seen to form a very precise and integrated whole (Figs. 5:7-8). The interior of the pedestal was also decorated, but in a quite distinct manner, with a series of painted designs.

The motifs to be found on the rims of these form 1 vessels are as follows:

- 1C-R1 An incised wave design
- 1C-R2 A series of large cross-hatches
- 1C-R3 Incised overlapping zig-zag design
- 1C-R4 A plain rim
- 1C-R5 A series of small cross hatches
- 1C-R6 A complex design field, involving the human figure motif into two bands and in opposition to each other, combined with a running animal motif again in two bands and in opposition to each other.

The exterior of the pedestal in the form 1 group of vessels was regularly decorated with horizontal bands infilled with impressed motifs (Fig. 5:10).

- 1. Variants of the human figure motif
- 2. The whale motif
- 3. The human motif

There is a degree of variation in the expression of these motifs, and they can be divided into at least 27 sub groups, classified in figures 5:11-13 as M.1-M27.

The whale motif can be assigned eight variants (Fig. 5:13). That with two legs appears on the base of the form 1 vessels.

The human motif at Ban Non Wat can be divided into at least 12 forms (Fig. 5:11). Forms M.1-3 and M.6-7 are found incised and impressed on the exterior pedestals of ceramic form 1 vessels. Form M.4-5 was placed on the rim of form 1 vessels. These motifs seem to resemble the head and upper part of the human body. In contrast, motifs M.26 and 27 seem to depict the lower part of the body of a male and a female.

Form 2 Vessels

The form 2 vessel is an open bowl with a round bottom and straight rim. Most were found as the lid of a burial jar. The most common decoration at the exterior of these vessels is cord marking over almost all the body, while in on occasion there are curvilinear designs painted in broad red bands over a cord-marked surface. In some cases, this design may represent the opposed human motifs (Fig. 5:14) and in others, a similar pattern as the human motif in an upside-down position similar to the pattern on burial jar cat. 1039 (Fig. 5:15E).

The interior surface of at least five form 2 vessels bears the multi striped parallel red painted lines forming unique

tri-human motifs in the circle (Fig. 5:16A, B, D). These tri-human motifs have the same direction, heading to the right. The forming lines of these motifs contain between four to eight bands. Two vessels in this category have the extra parallel circular motifs at the middle of the tri-human motifs (Fig. 5:16A)

One of these forms bears a different pattern of multi-striped parallel red-painted lines comprising three semi curves covering the entire interior area of the bowl (Fig. 5:16C). Otherwise the exterior of the other example was painted with red bands in a pattern of three semi curves with a central dot resembling a human face with eyes. So far, we really don't know the exact meaning of this unique pattern but it looked like the human motif and is seen inside the lid of the bigger burial jar which also has the incised and painted pattern at the shoulder.

Form 3 vessels

Form 3 vessels are large globular pots with a round base and plain everted rim. Most are burial jars for infants and an adult. The surface decoration of this form comprises 1) the parallel incised lines below the neck 2) the main incised and painted of the motif at the shoulder 3) a raised cordon at the lower end of the shoulder and 4) fine vertical strokes of cord marking over almost the entire surface of the body below the raised cordon.

The decorative patterns at the shoulders of these vessels can be divided into at least seven combinations (Figs. 5:18D-F). The main motifs of this pattern are the whale, sickle and human. All of these motifs were outlined with

fine incised lines then painted with two colours, either black or red on the red or black burnished surface.

In making this elaborate pattern, the potters used a thin sharp tool to make the incised line for outlining the space between neck and shoulder of the vessels and also outlining the main motif before applying the red or black colour.

A remarkable vessel example of this category is vessel cat. 1039. It is a huge mortuary vessel to contain an adult male corpse in a crouched position. It bears a series of incised sickle motifs and is painted with black pigment on a red burnished surface (Fig. 5:15E). The body of this vessel was decorated with small vertical cord marks and then embellished with red paint depicting a series of the huge human motifs in an inverted position. Only two vessels at Ban Non Wat bear a symbol of the black sickles on the red background. All of these sickles turn to the right. One vessel in this form has a series of whale patterns without a leg in a red painted on black burnished panel (Fig. 5:17A). The other one has a series of incised whale pattern with two legs but without colour (5:18F).

Form 4 Vessels

Form 4 pots are globular vessels with a round bottom and everted rim. They are smaller than the form 3 vessel and have less decoration at the shoulder area. Mostly the pots of this form were decorated with cord marking on the exterior surface of the body but on the neck and rim they were mostly plain.

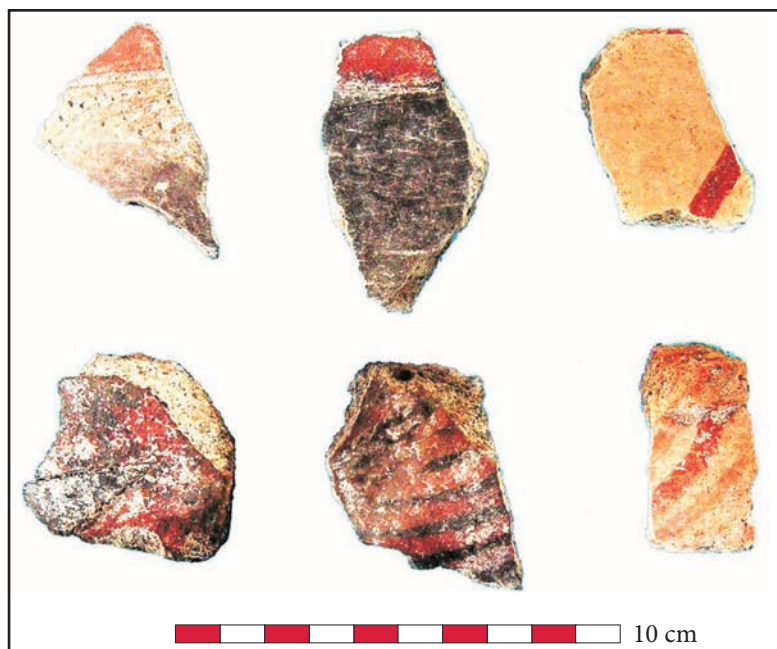


FIG. 5:1 Ceramic sherds from D2 layer 5, showing incised and punctate designs with red and black, red on buff and red on black painted patterns

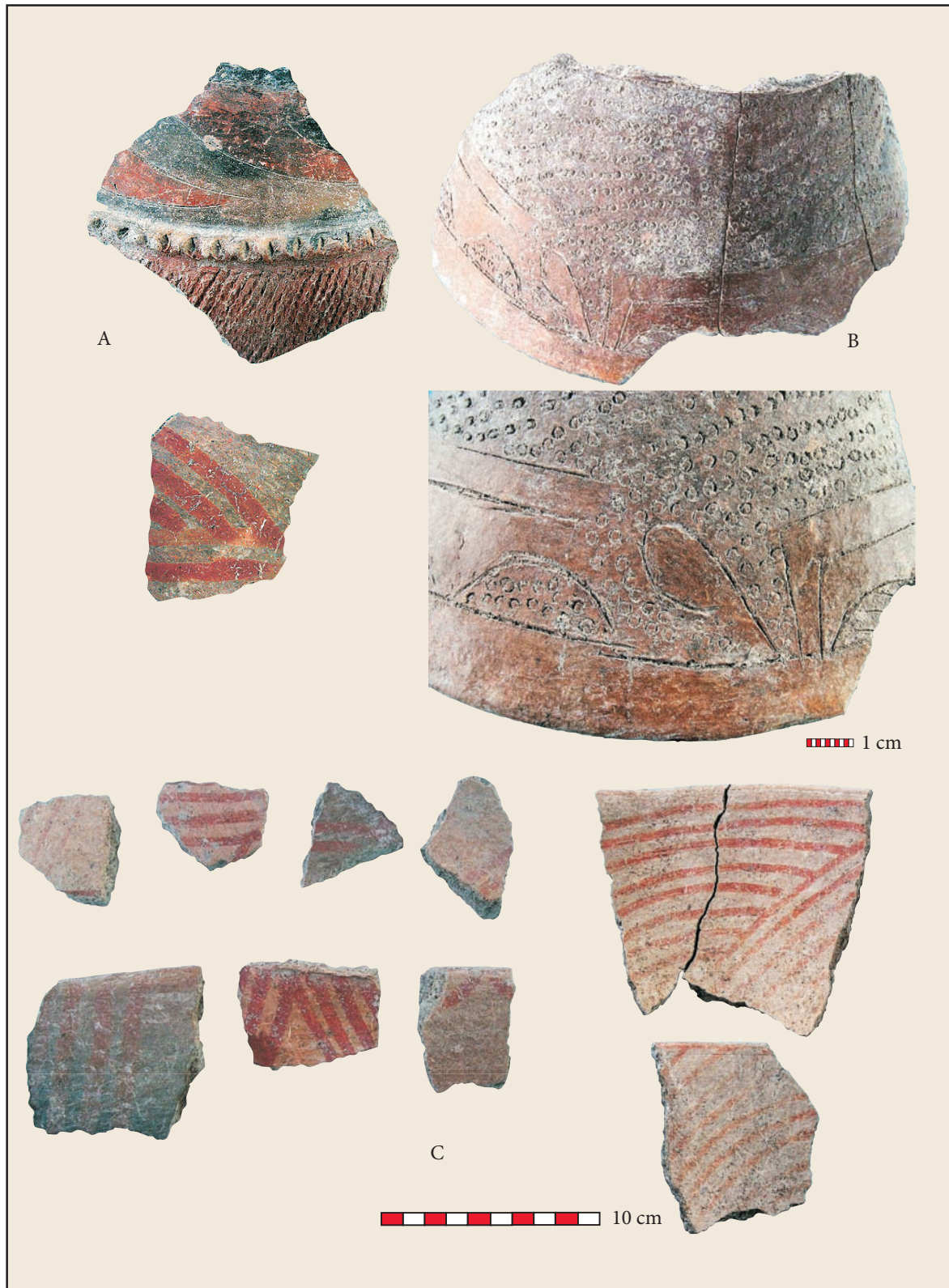


FIG. 5:2 Neolithic potsherds from D2 layer 5, an occupation deposit. A. incised and red-painted pattern with a cordon and cord marking on a potsherd. B. Incised and impressed pattern on a potsherd with enlargement below. C. Red painted parallel lined pattern on Neolithic potsherds. D. Red painted motif on the interior surface of rim sherd

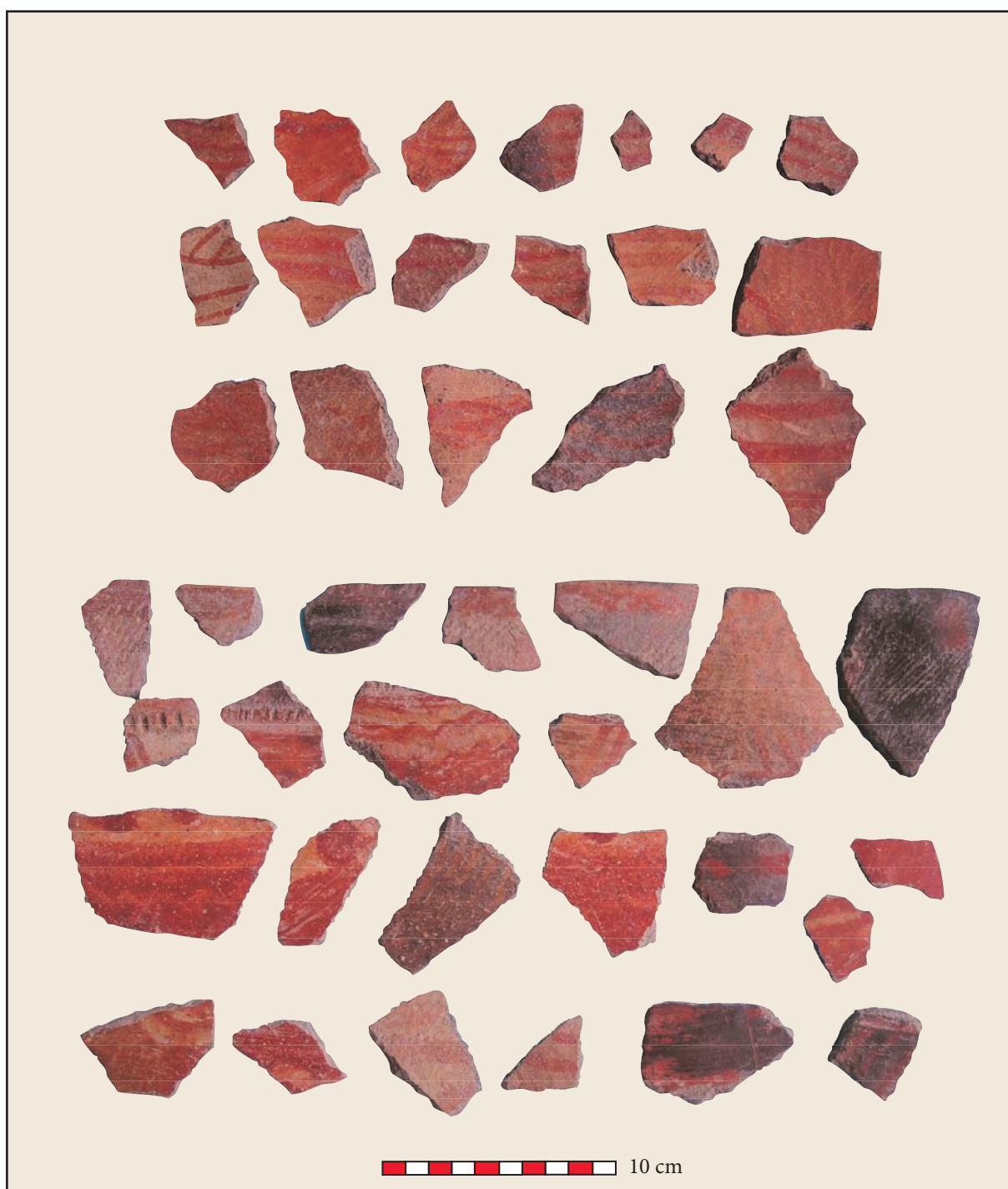


FIG. 5:3 Ceramic sherds from D2 layer 5, showing the painted decoration on the exterior surface



FIG. 5:4 Ceramic sherds from D2 layer 5, showing the incised decoration on the exterior surface

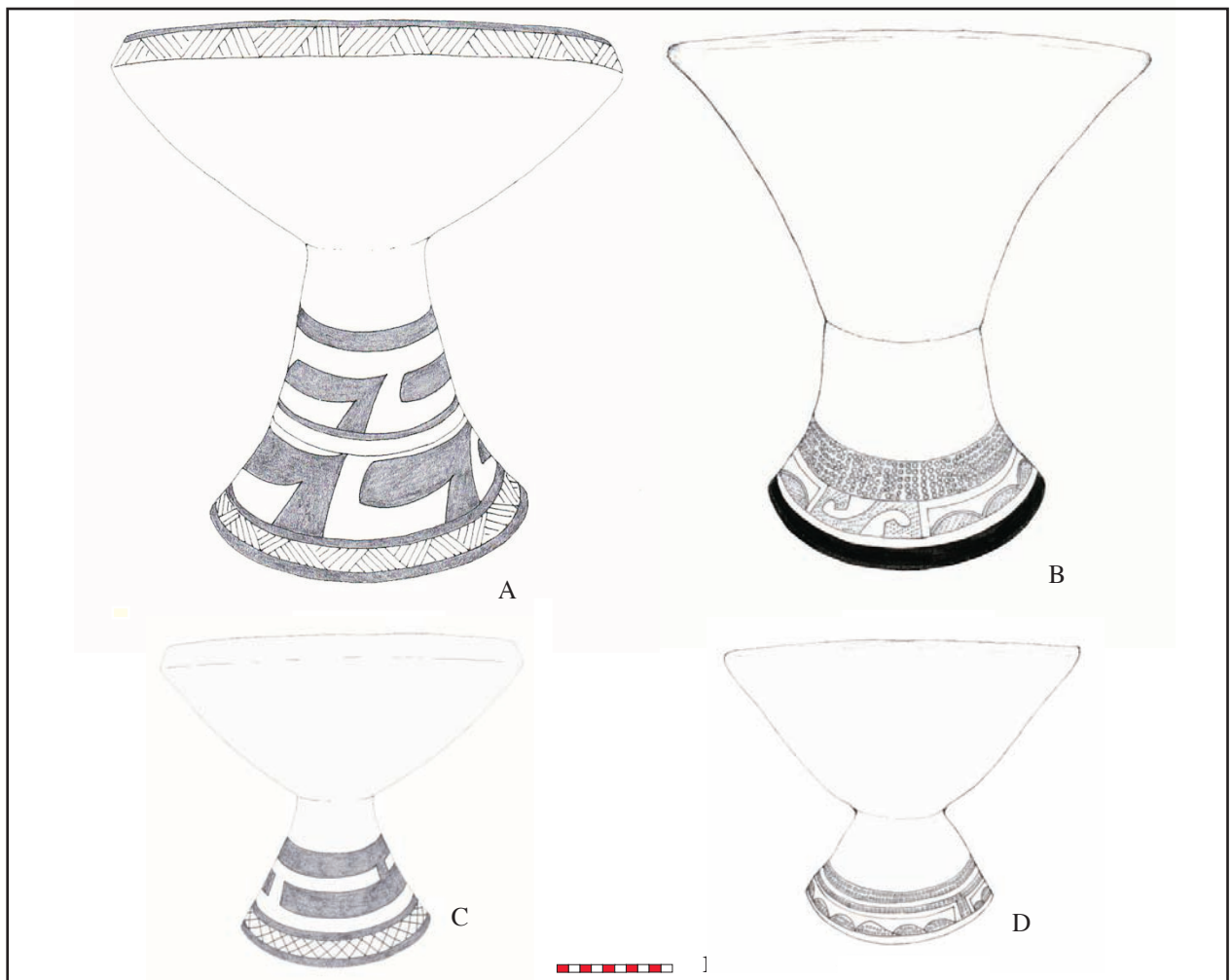


FIG. 5:5 Reconstructed drawing of Neolithic mortuary vessels of form 1 showing the decorative patterns of the bases. A. cat. 10301 layer 4:10 feature 4, burial 250. B. cat. 10302, burial 250. C. cat. 9139, burial 193. D. cat. 5785, burial 181

Some vessels of this form have a red burnished surface over the body and were decorated at the shoulder with two rows of red circles. One of them has a cord-marked body below a raised cordon. The shoulder area above the cordon is decorated with an incised and painted "S"-shaped pattern. The incised "S" shape pattern was accentuated on a background of red paint. The outer surface of the rim was decorated with an incised zig-zag pattern forming a

unique combination mortuary symbol (Fig. 5:18D).

Form 5 Vessels

There is only one vessel of this form which is a special type of the mortuary jar containing an adult burial in a crouched position. This vessel is an elongate shape with a round bottom. Its body is very big and deep if compared with its width (Fig. 3:57). The shoulder slopes into a small cylindrical neck and the entire body below the neck was



FIG. 5:6 Reconstructed drawings of form 1 mortuary vessels. A: cat. 6292 burial 179, B: cat. 2231 burial 86, C: cat. 2230 burial 86, D: cat. 19904, burial 459

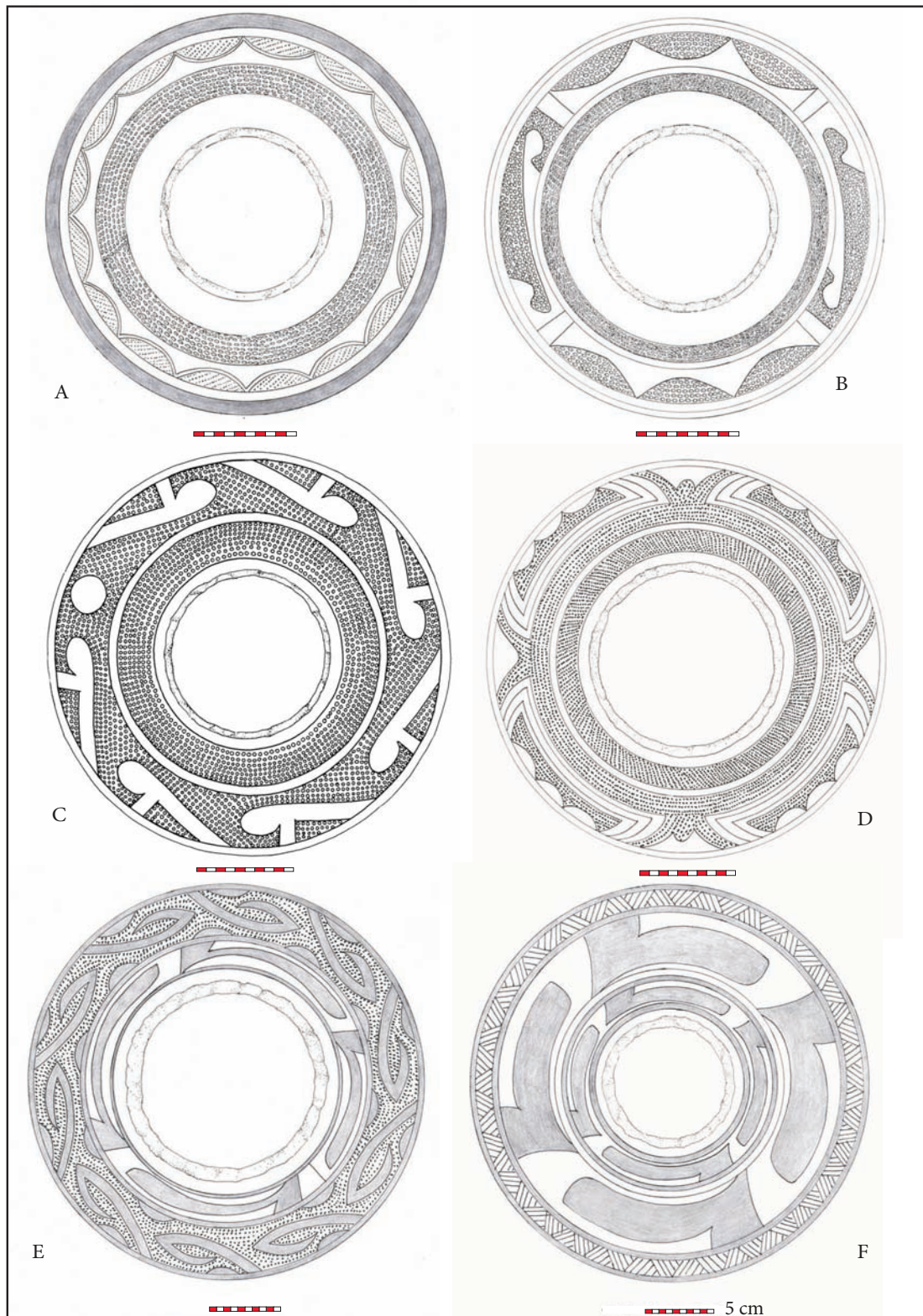


FIG. 5: 7 Reconstructed patterns on the base of Neolithic form 1 vessels from Ban Non Wat. A: cat. 2230 burial 86, B: cat. 19904 burial 459, C: cat. 6292.2 burial 179, D: cat. 764 burial 16, E: cat. 3196 burial 73, F: cat. 10301 burial 250

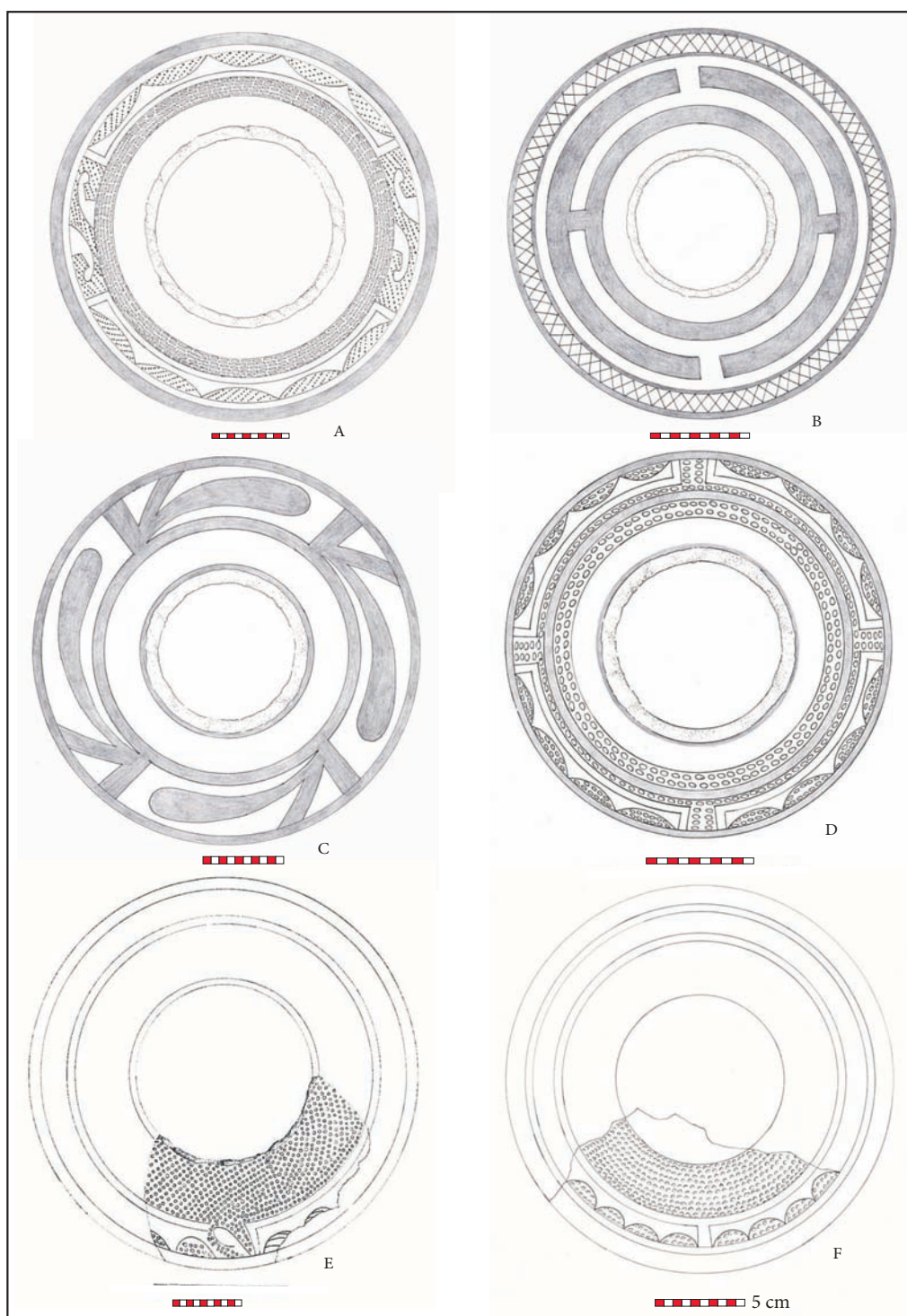


FIG. 5:8 Reconstructed patterns of Neolithic 1B form 1 vessels from Ban Non Wat. A: cat. 9139 burial 193 showing the top view of the full circle, B: cat. 10302 burial 250, showing the top view of the full circle pattern, C: cat. 2231 burial 86 showing the base full circle pattern, D: cat. 5785 burial 181, showing the top view of the full circle pattern, E. A vessel found in the Neolithic occupation floor showing the incised and impressed pattern at the base of the pedestal, F. cat. 763 burial 15, showing the base view of the circle pattern

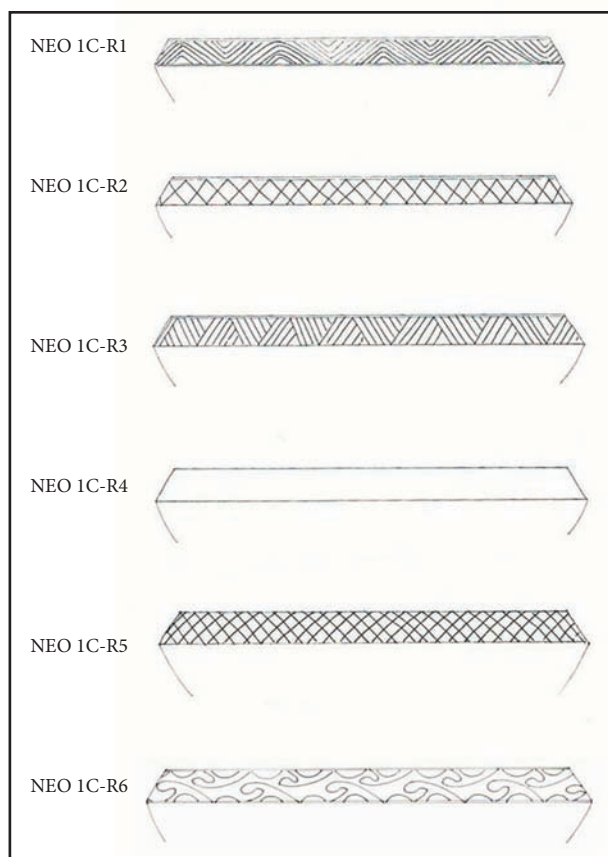


FIG. 5:9 Decorative patterns on the rims of Neolithic 1 vessels of form 1

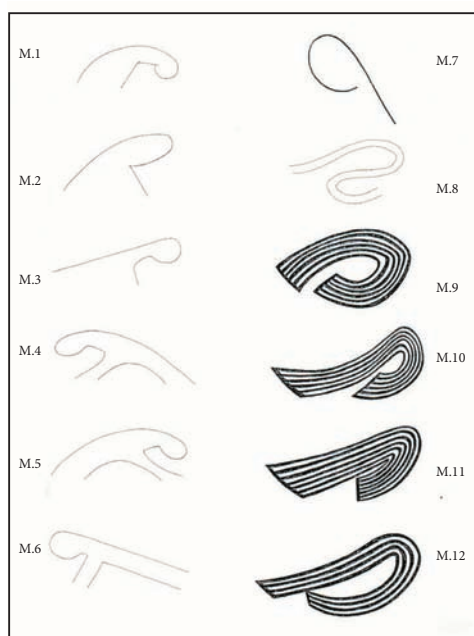


FIG. 5:11 Variants of the human motif from Ban Non Wat

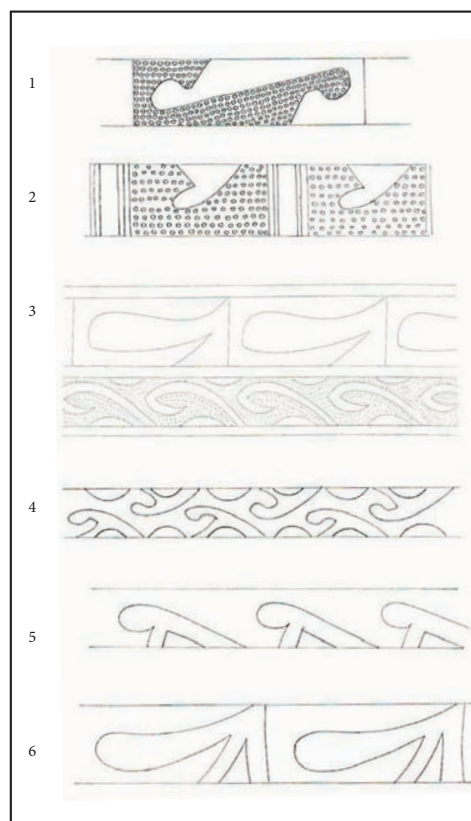


FIG. 5:10 Incised motifs on the exterior surface of the pedestals of form 1 vessels

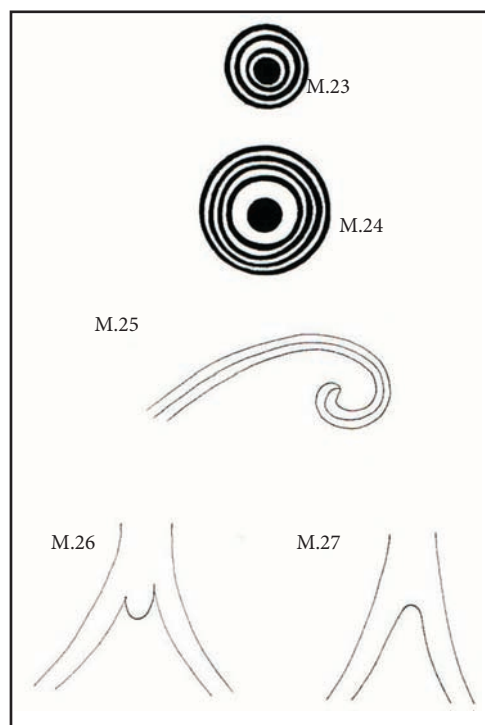


FIG. 5:12 Variants of the human motif from Ban Non Wat (M25-27)

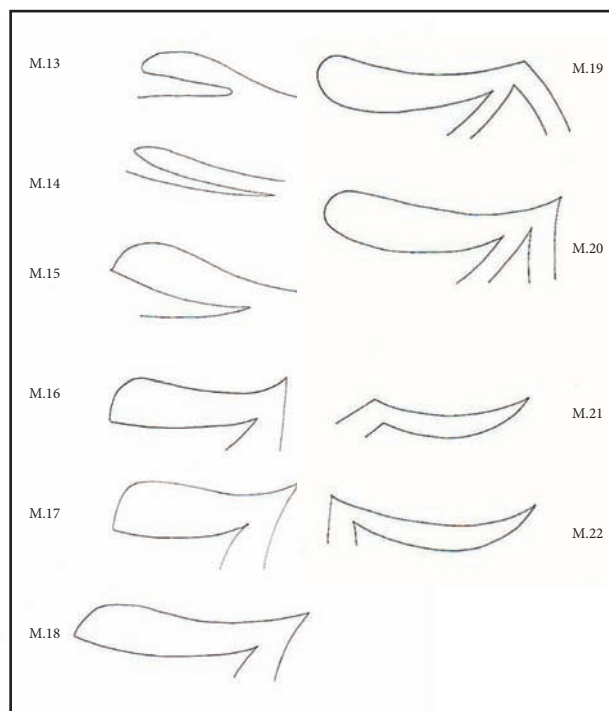


FIG. 5:13 Variants of the whale motif (M.13-20) and the sickle motif (M.21-22)

decorated with fine vertical-stroke cord marking.

Form 6 Vessel

There is also one pot in this form. It is a large cone-shaped lid with a plain burnished exterior surface (Fig. 3:17A). This vessel was found as the lid of the adult mortuary vessel cat. 1039 of burial 28.

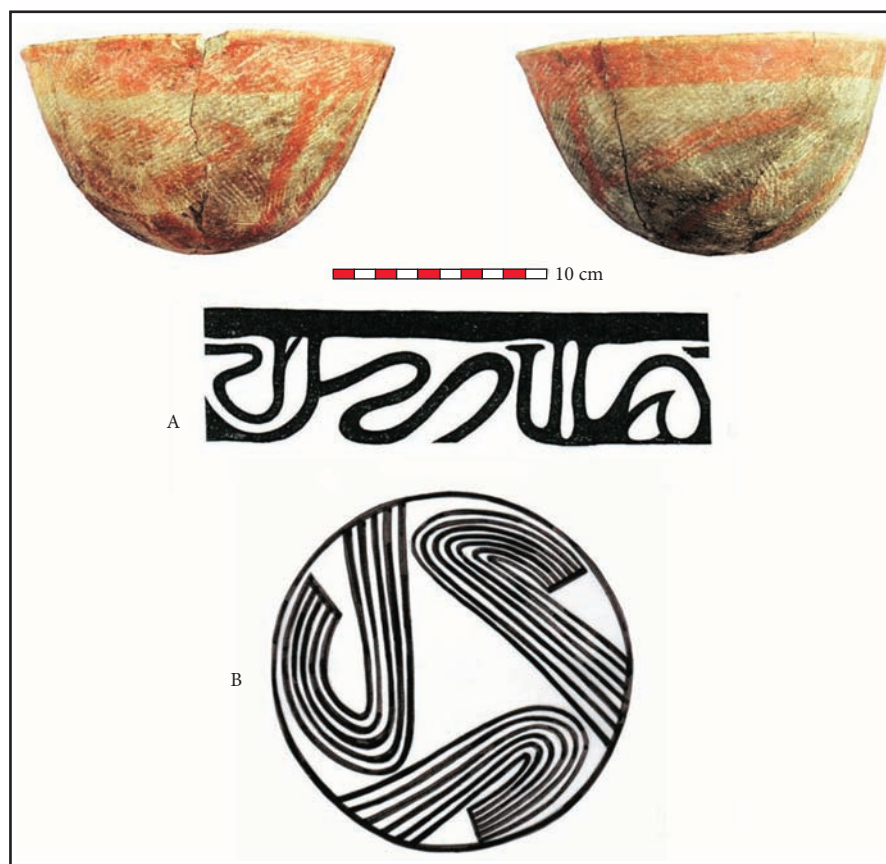


FIG. 5:14 Ban Non Wat cat. 2233, burial 86, with its reconstructed painted pattern on the exterior surface (a) and interior surface (B). A is not to scale

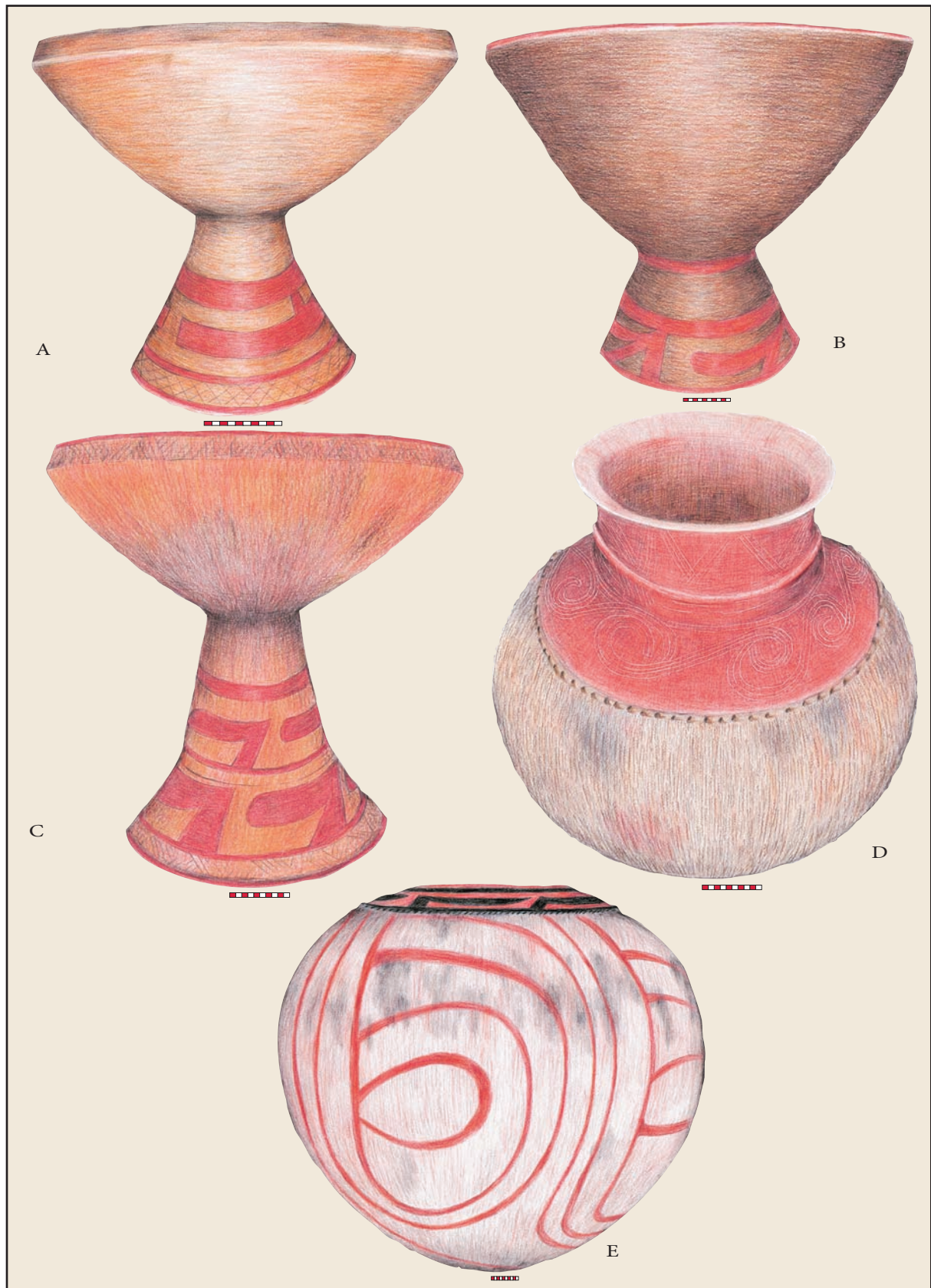


FIG. 5:15 Reconstructed pottery vessels from Neolithic 1 at Ban Non Wat. A: cat. 10302 burial 250, B: cat. 2231 burial 86, C: cat. 10301 burial 250, D: cat. 1376 burial 32, E: cat. 1039 burial 28. Scale 5 cm

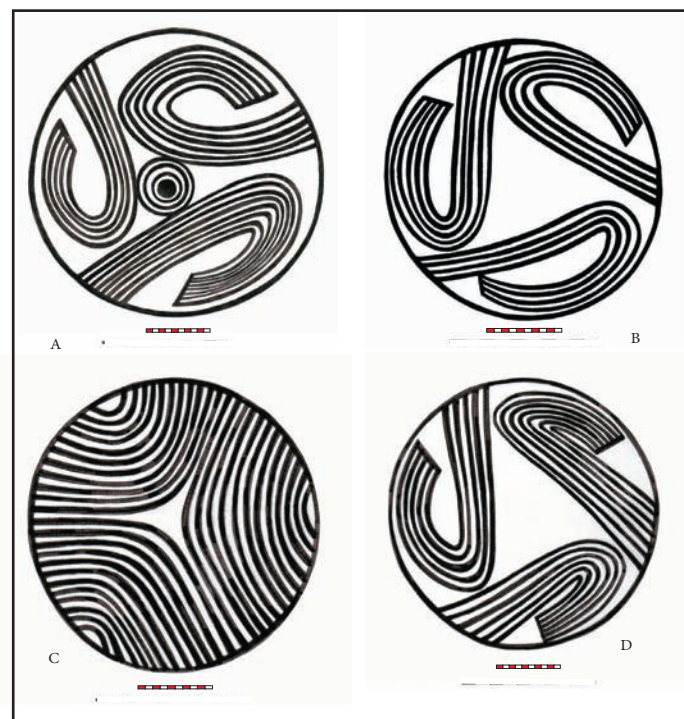


FIG. 5:16 Reconstructed red-painted designs on Neolithic 1 vessels from Ban Non Wat. A: cat. 723 burial 179, B: cat. 1414 burial 32, C: cat. 3193 burial 73, D: cat. 2233 burial 86

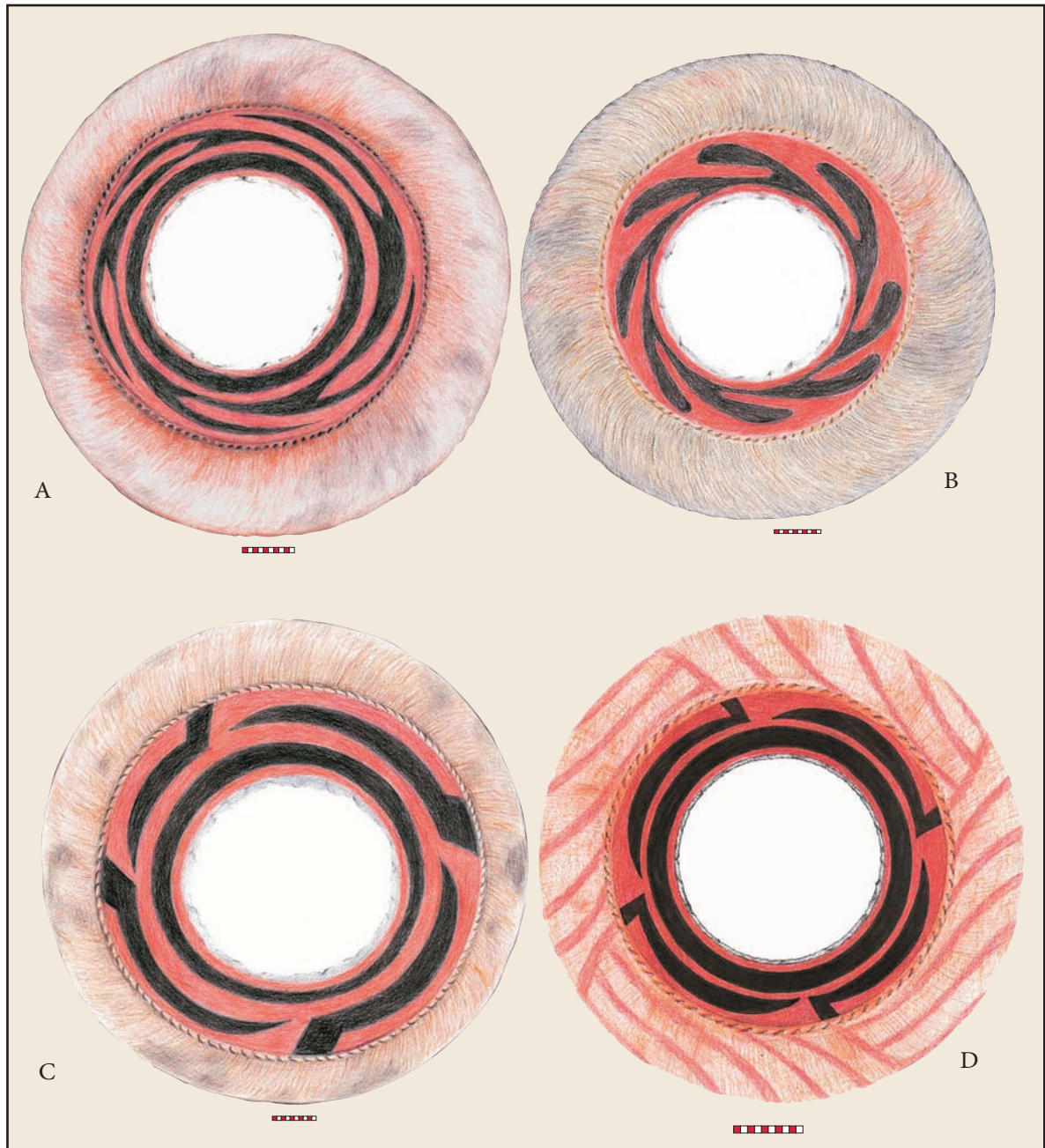


FIG. 5:17 Reconstruction of the red and black painted designs on the shoulders of vessels from Neolithic 1 at Ban Non Wat. A: cat. 6290 burial 179, B: cat. 9134 burial 192, C: cat. 2209 burial 103, D: cat. 1039 burial 28. Scale 5 cm

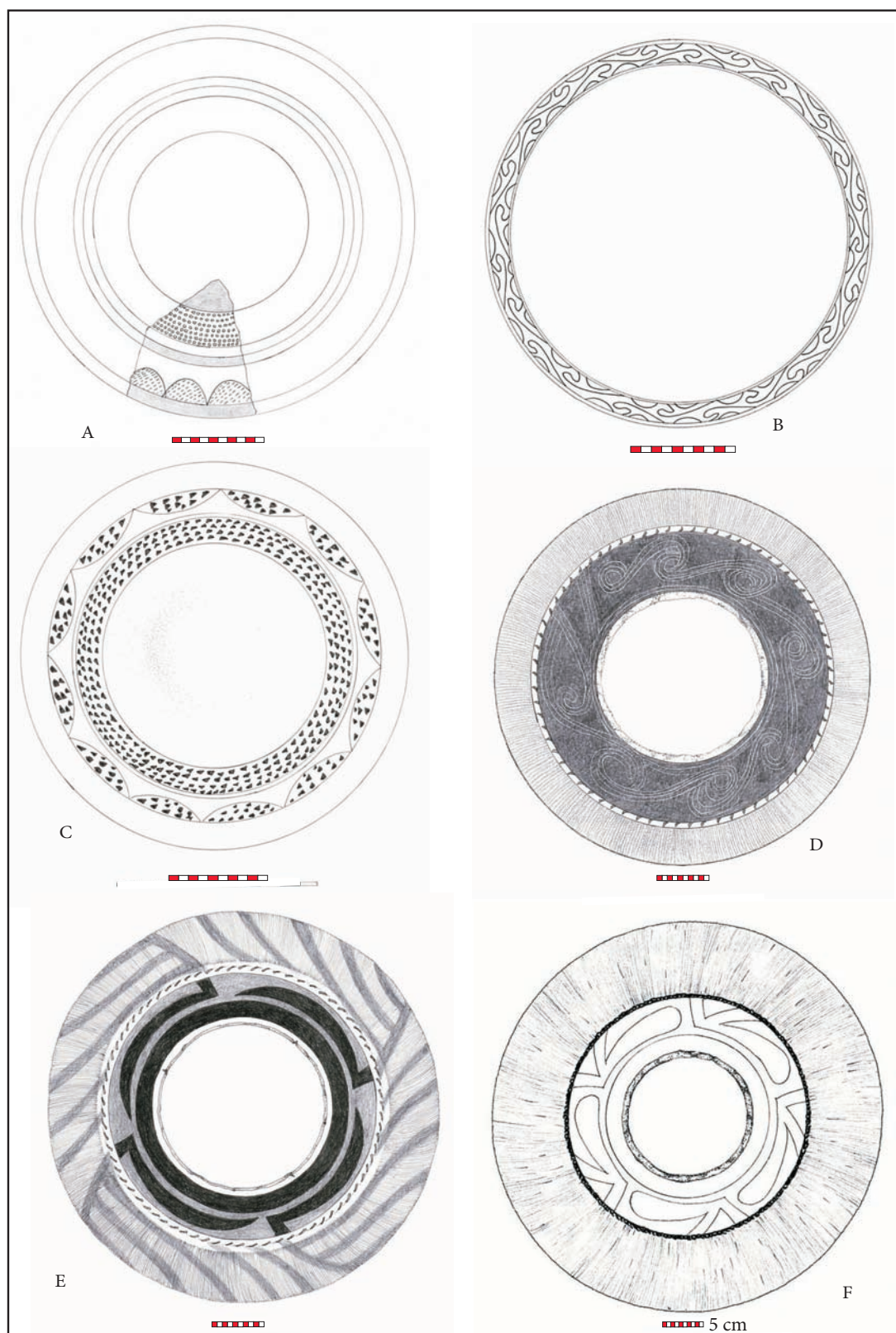


FIG. 5:18 Reconstructed patterns on the rim, base and shoulder of Neolithic 1 vessels from Ban Non Wat. A: cat. 18724, B: cat. 762 burial 16, C: cat. 5783 burial 180, D: cat. 1376 burial 32, E: cat. 1039 burial 28, F: cat. 9141 burial 193

VI THE WIDER RELATIONSHIPS OF THE NEOLITHIC 1 CERAMICS

W. WIRIYAROMP

The analysis of the Neolithic vessels of Ban Non Wat was undertaken by the author by the visual inspection of each individual vessel, and a review of digital images. The reconstruction of motifs where they were incised and therefore durable, is straightforward. However, the painted designs on many of the Neolithic vessels from Ban Non Wat were often very faint and had to be traced minutely through visual inspection. The analysis of vessels from Thai sites followed the same procedure, but those from further afield, such as Vietnam and China were studied from publications or from digital images made available by Dr. Nguyen Kim Dung.

The Neolithic artisans at Ban Non Wat favoured the incised and impressed technique to decorate their pottery vessels. Mortuary vessels were not only produced with outstanding skill, but were also the object of much detailed, fine decoration. This decoration involved at least six techniques as follows:

- 1) leaving open, plain areas in contrast to decorated panels
- 2) cord marking



FIG. 6:1 The human figure motif reconstructed from the design on a Neolithic vessel from Wat Yang Rak. It is very similar to a motif seen at Ban Non Wat

- 3) incised-impressed decoration
- 4) incised-painted decoration
- 5) incised-impressed and painted decoration
- 6) painted decoration

The cord marking was mostly applied to the body of vessel forms 2, 3 and 4 but rarely with form 1. The bodies of the vessels were invariably impressed by cord marking, probably applied with a cord-wrapped stick (rouletting) or paddle (impressing), but the rim is never so impressed. The rim surfaces and mostly the upper part of the shoulder

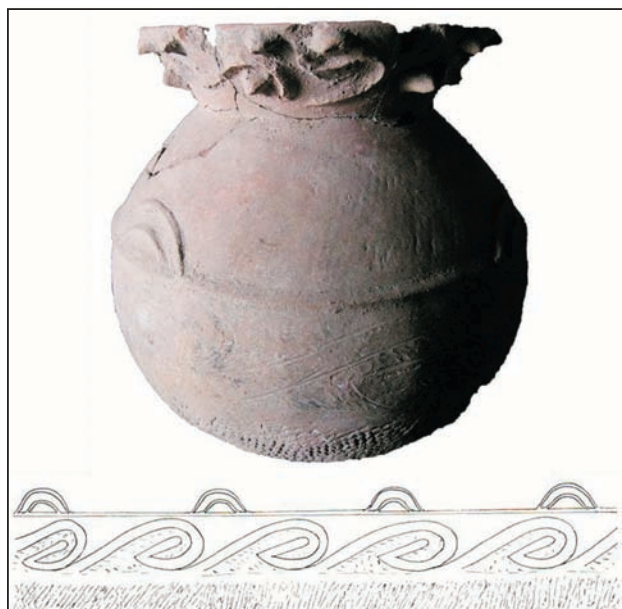


FIG. 6:2 A Neolithic vessel from the Lopburi site survey, showing the incised and impressed pattern, together with a reconstruction of the whole pattern. Not to scale

were decorated with incised or painted patterns composed of wavy lines, parallel strokes and variety of motifs.

In making these elaborate vessels, the potters commonly used an incised horizontal line to outline the space between the body and neck and marking the bottom line of the whole pattern. The potters arranged these motifs repeatedly in a full circle around the shoulder area, sometimes with a parallel row of opposed motifs.

In this ceramic tradition, we never found incised patterns on the inside of the body or the base, while the painted pattern, especially with red colour, was found in both areas. The component of the pattern in some cases seems to be very complex and looks like the labyrinth or mean-



FIG. 6:3 A Neolithic vessel from Wat Yang Rak, Lopburi Province, showing the incised and impressed pattern on the upper register. Scale 10 cm

der pattern, but in many cases, careful observation reveals that these complex labyrinthine patterns are actually well-organized pattern motifs or opposed motifs (Figs. 5:10 (4), 5:14, 6:1-3). However the decorative patterns at Ban Non Wat are generally less complex than those from the central region of Thailand and Vietnam.

The Neolithic pottery tradition at Ban Non Wat also favoured the painting technique on the exterior and interior of the vessel. Red was widely used to create a variety of motifs, such as humans and a cross, or alternatively to fill in the incised motif or between the lines for enriching the patterns. The black colour was also found but rarely, for enhancing the incised sickle or human motif or as a background for the red whale motif (Fig. 5:17). In Thailand, the Neolithic pottery vessels found at Ban Chiang, Ban Phak Top and Non Kao Noi have a distinctive black burnished

surface decorated with the incised pattern. Only few painted parallel red lines were reported from Ban Chiang and Non Kao Noi (Fig. 6:21, Higham and Kijngam 1984) and a vessel with an elaborate incised and painted pattern was found from a Neolithic mound near Sab Champa (Fig. 6:23C) (Higham 2004).

Generally the decorative patterns found in the Neolithic pottery tradition at Ban Non Wat can be separated into two categories 1) the main pattern, comprising a series of pictures in transfiguration form appearing as a stylized motif which may look like a human, whale or phallus, a sickle or hand and the 'S' shape. Sometimes, the main pattern appears as an opposing pair in the same direction (Fig. 5:10 (1)) or in a different direction (Fig. 5:10 (4)). In creating these elaborate patterns, the potters arranged each motif repeatedly into the full circle or row around the shoulder or on the pedestal of the vessel. In most cases, only one form of the motif has been placed on each vessel but in the rare cases, two forms of the motif appeared together as a combination pattern (Fig. 5:10 (3)).

The subordinate patterns are a combination of the small geometric forms such as parallel lines, the infilled semi-lunate motif, a band of cross-hatched incised lines and small circular impressions. All were formed by the incised and impressed technique. The subordinate pattern enhanced and expanded the main pattern to be bigger and enriching the plain vessel to be more prominent.

The main patterns which had been found in mortuary vessels at Ban Non Wat comprise four major motifs: 1) the human motif 2) the whale motif 3) the sickle motif 4) the 'S' shaped motif.

1) The human motif

There are 14 forms of the human motif at Ban Non Wat. Forms M.1-M.12 (Fig. 5:11) seem to resemble the head and

upper part of the human body. Forms M.26 and M.27 seem to represent the lower part of the body of the male and female. (Fig. 5:12)

In Thailand at least 17 forms of human motif have been found in the Neolithic sites from the North, Central and Northeastern part of the country (Fig. 6:4). There are another six forms of probably the human motif in a modified form (Figs. 6:5, 6:20).

The human motifs at Ban Non Wat showed some close similarity with the other Neolithic sites in Thailand such as Khok Charoen, Sab Champa, Khok Phanom Di and Ban Chiang (Figs. 5:11, 6:20,

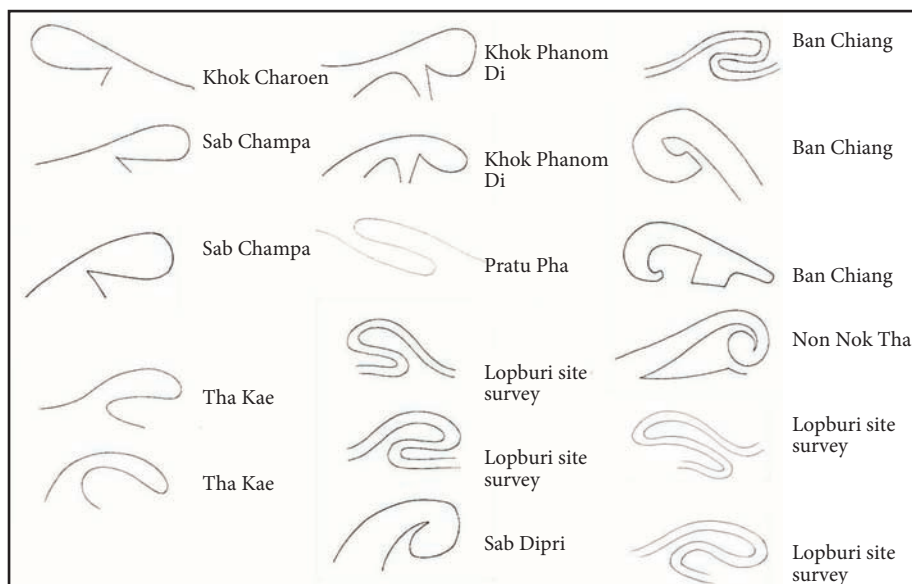


FIG. 6:4 The human motif found on ceramics from prehistoric sites in Thailand

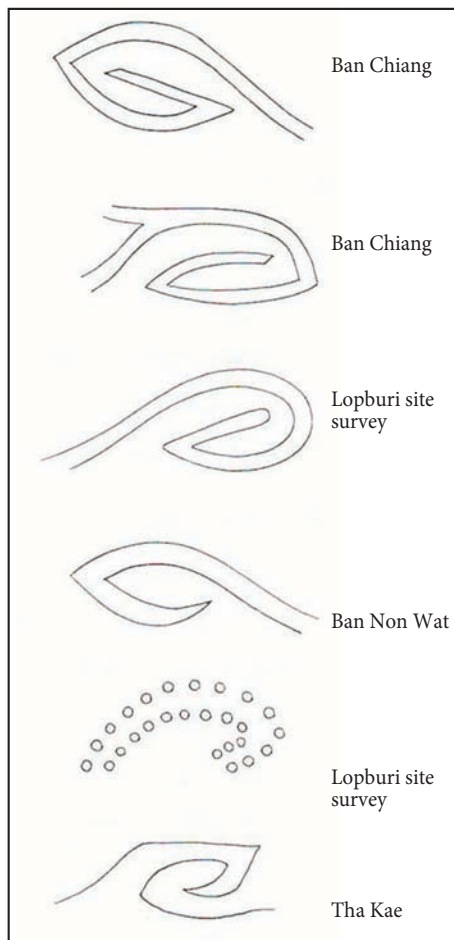


FIG. 6:5 Motifs found on ceramics from Neolithic sites in Thailand

6:23). Especially the human motif forms M.4 and M.5 of Ban Non Wat are very similar with that from Khok Phanom Di (Higham 2004). The human motifs that appeared on the shoulder and pedestal of the Neolithic vessels from Ban Chiang (Fig. 6:6) show a close resemblance with the human motif form M.8 of Ban Non Wat (Fig. 5:11 (M.8)), Khok Charoen, Sab Champa and Lopburi site survey ceramics (Fig. 6:4). Furthermore, the stylized human motif form M.6 of Ban Non Wat designated pattern type Neolithic 1 C-R5 (Fig. 5:10(4)), which was found at the rim of the mortuary vessel cat. 762 of burial 16, a young-mid adult female, showed the striking similarity with the human pattern found at Pusu Lumut Cave, Tapadon, the late Neolithic burial site, in Sabah, Malaysia (Fig. 6:7; Harrison and Harrison 1971).

2) The whale motif

There are eight forms of the whale motif at Ban Non Wat. (Fig. 5:13) Three of them (M.13-M.15) have no leg, another three (M.16-M.18) have one leg and the last two forms (M. 19-M. 20) have two legs. All have the head orientation facing to the left. The whale pattern at Ban Non Wat showed some close resemblance with that found on the pedestal of a Neolithic vessel from Lopburi (Fig. 6:8)



FIG. 6:6 A Neolithic vessel from Ban Chiang, showing the incised and painted motif similar to that seen at Ban Non Wat and the Lopburi Province survey

and also on a Ban Kao vessel (Fig. 6:9). Perhaps there was a specific convention in using this pattern in the Neolithic period of Thailand because all whale patterns found at Ban Non Wat, Lopburi site and Ban Kao appeared in the same character, on the same area on the vessel and with the same head orientation to the left side of the vessels (Fig. 5:13). This restriction was not found with the other patterns such as the human motif or the 'S' shape which were found in both direction.

3) The sickle motif

There are two forms of the sickle motif at Ban Non Wat. This motif was found on the huge mortuary jar cat. 1039 and on cat. 2209. The former contained an adult and the latter, an infant. These vessels were decorated with a series of four incised and black painted versions of the sickle motif on the red burnished surface. The two forms of this motif point in the same direction with the head orientated to the right, but the motif in cat. 2209 (Fig. 5:13 (M.21)) has its leg slightly sloping to the left side compared with that



FIG. 6:7 The incised pattern of a possible human motif from Pusu Lumut cave, Tapadone, Sabah. This is very similar to pattern Neo 1C-R5 at Ban Non Wat. After Harrison and Harrison 1971

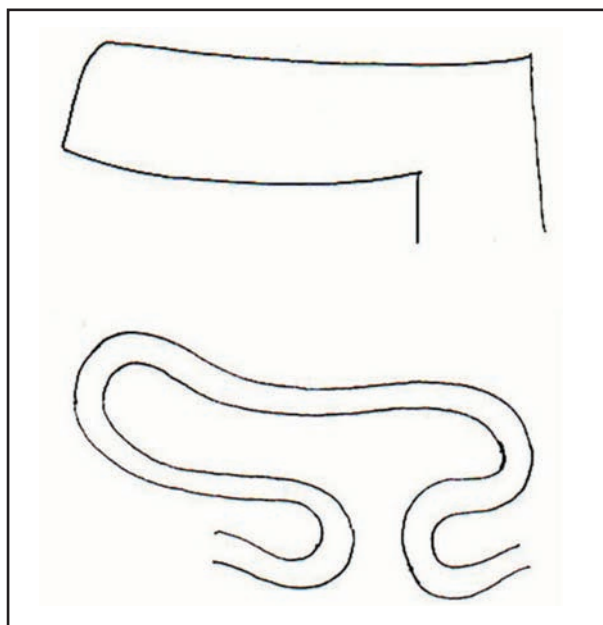


FIG. 6:8 Incised whale motif on a Neolithic vessel from Lopburi

in cat. 1039 (Fig. 5:13 (M.22)). Until now this sickle motif is unique and has only been found at Ban Non Wat.

4) The 'S' shape motif

There is only one 'S' shape pattern on a Neolithic vessel at Ban Non Wat. This motif appeared on the shoulder of the mortuary vessel cat. 1376 (Fig. 5:18D) in association with the incised zig-zag pattern at the exterior surface of the rim. The composition of this special pattern, zig-zag on the neck and 'S' shape on the shoulder, is however, widespread in Southeast Asia, being seen at Ban Non Wat, Non Nok Tha, Ban Chiang, Samrong Sen, Phung Nguyen and Gua Cha (Fig. 6:11).

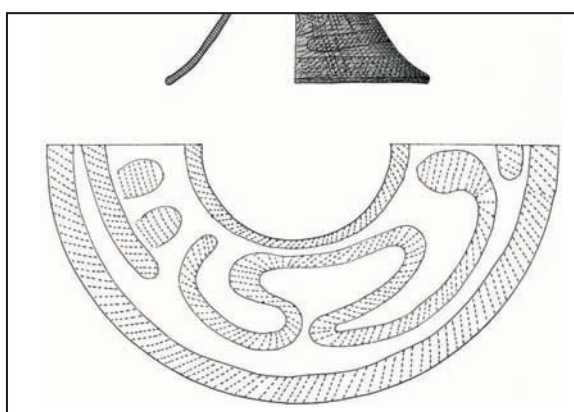


FIG. 6:9 An incised and impressed "snake" and whale pattern found on a Neolithic mortuary vessel from Ban Kao (after Sørensen and Hatting 1967), a pattern with parallels in the Lopburi area

PHUNG NGUYEN AND XOM REN

Higham (1996) has mentioned that the earliest cultural phase of the Phung Nguyen culture in Northern Vietnam has pottery decorated with incised parallel bands infilled with rows of impressions which may have been applied with a pointed stylus. The 'S' shaped motif was favoured in this period and in the second sub-phase there is a range of designs based on "geometric asymmetry". This decoration of the pottery has close parallels with the Neolithic sites in Yunnan like Baiyangcun and Dadunzi.

The Neolithic pottery patterns from Xom Ren, Northern Vietnam evidence some close similarities to the syntax of those identified at Ban Non Wat and other Neolithic sites in Thailand. The patterns reveal a rich and detailed series of incised human, 'S' shaped and 'C' motifs as the main theme, surrounded by impressed or incised subordinate patterns (Fig. 6:12 B-D, 6:16 (2)). The 'S' and 'C' pattern from Xom Ren are similar to the patterns found at many Neolithic sites in Thailand such as the 'C' shape pattern at Tha Kae (Siripanish 1985), while the 'S' shape appeared in almost every Neolithic site, such as Ban Chiang, Sab Champa, Tha Kae, Pratu Pha and Ban Non Wat. Actually the 'S' and 'C' shape patterns can be considered as variants of the human motif. The 'S' shape is probably being a stylised opposed human motif and the 'C' shape, the double human motif.

The drawing of the decorative patterns at the base of vessels from Xom Ren (Fig. 6:16(1)) shows five pairs of the human motif (with an arm) in combination with five single human motifs. This pattern looks very similar to the pattern of pottery found in the lowest layer of Non Nok Tha (Fig. 6:19B) and a pattern type of Ban Non Wat (Fig. 5:17D). Furthermore, the slender version of human motifs with an arm from Xom Ren has the same structured posture like the human motif type M.4, M.5 and M.6 of Ban Non Wat (Fig. 5:11) and Khok Phanom Di (Fig. 6:4).

The complex 'S' shape pattern from Xom Ren (Figs. 6:13B, 6:15 (1)) combines the human motifs. Some of

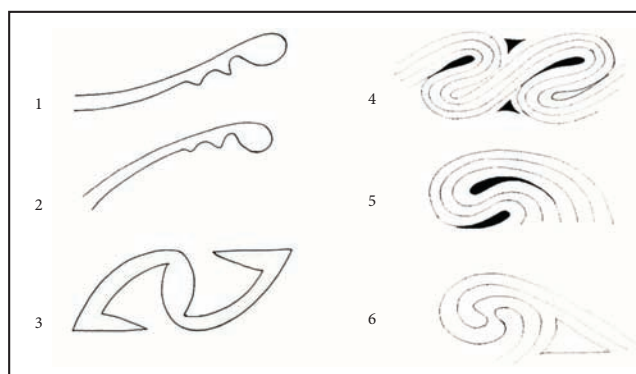


FIG. 6:10 The human motif pattern (1-2, 4-6) and 'S' pattern (3) from Phung Nguyen, after Ha Van Tan 1985

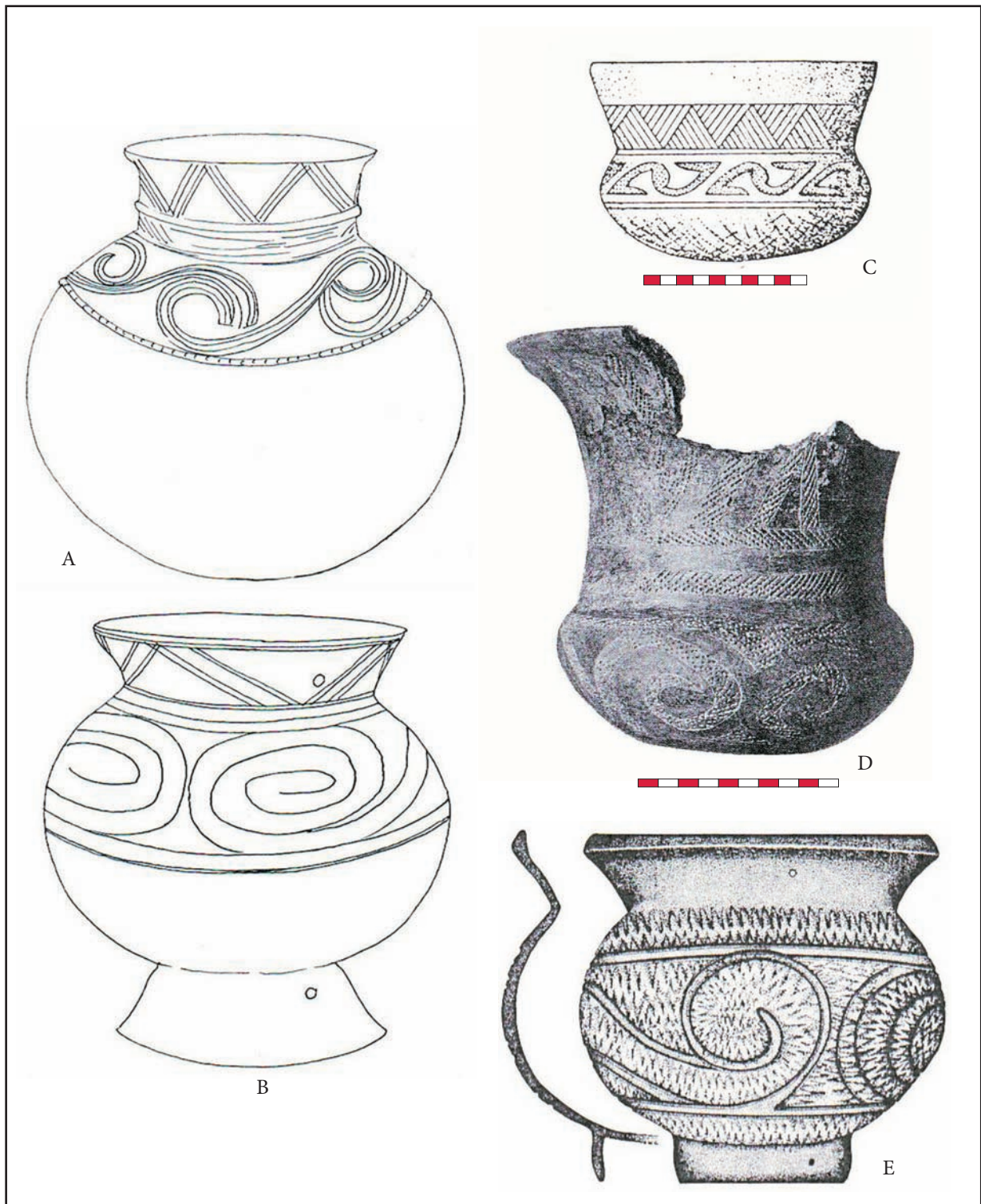


FIG. 6:11 Vessels showing the zig-zag and 'S' or spiral motifs. A: Ban Non Wat, B: Non Nok Tha, C: Phung Nguyen, D: Gua Cha (after Sieveking 1955), E: Ban Chiang (after White 1982)



FIG. 6:12 The decorative patterns on pottery from Xom Ren, Northern Vietnam, showing A: the opposed human figure motif in well arranged geometric forms, surrounded by multi-parallel lines, B-D: the 'S' and 'C' shaped patterns. Images by courtesy of Dr Nguyen Kim Dung



FIG. 6:13 The incised patterns on pottery from Xom Ren, Northern Vietnam. A. Incised strokes alternating between an angle of about 45° to the vertical. B. The complex 'S' motif. C. A vessel displaying the opposed human motif surrounded by multiple parallel lines. Images by courtesy of Dr Nguyen Kim Dung



FIG. 6:14 The decorative patterns on pottery vessels from Xom Ren, Northern Vietnam. A. The opposed human motif. B. The opposed slim human motif with notable breasts, C and D. The opposed human motifs in well arranged geometric forms. E. Five pairs of opposed human motifs in combination with five single human motifs maybe representing adult and child. Images by courtesy of Dr Nguyen Kim Dung

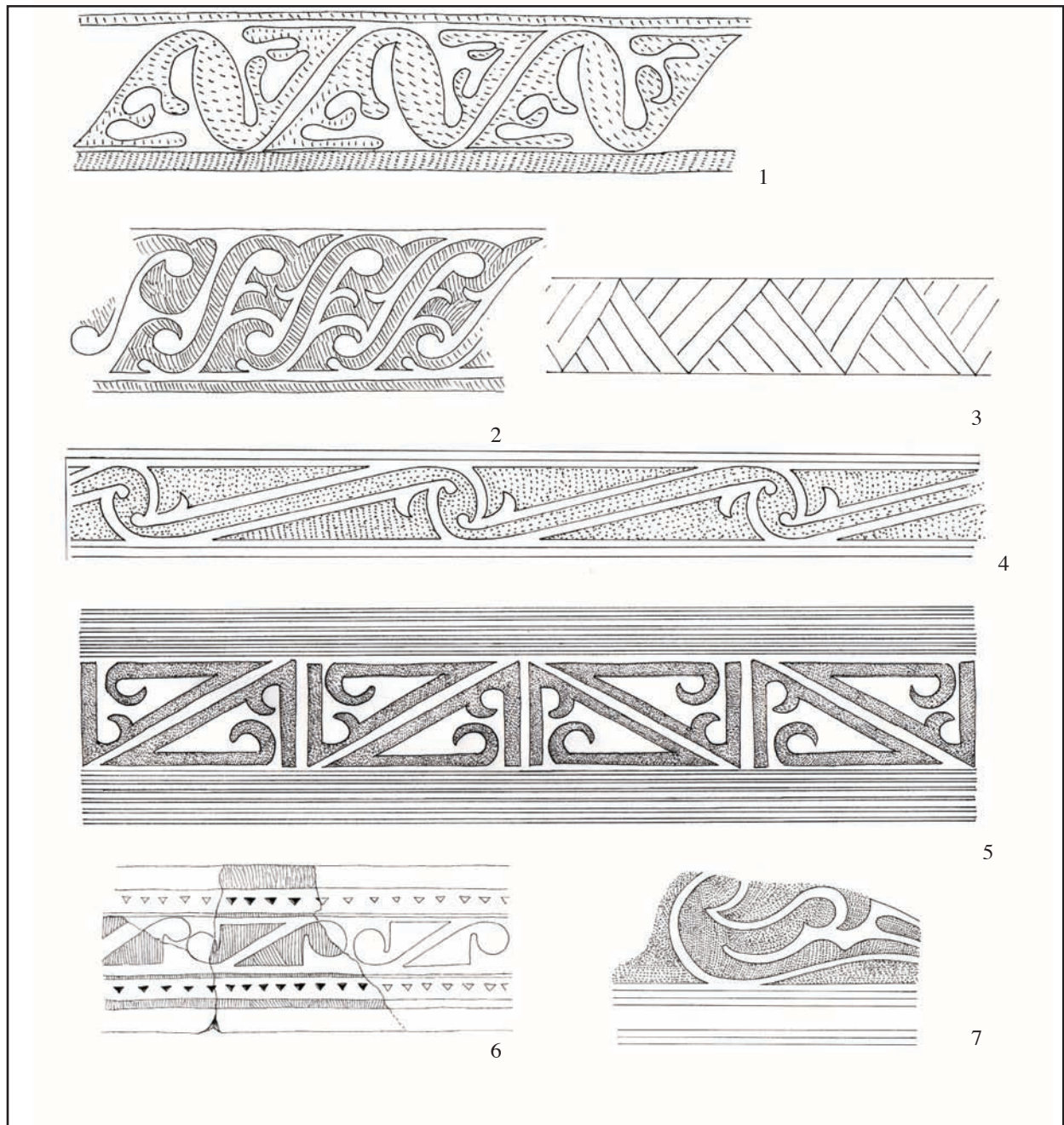


FIG. 6:15 Drawing of the decorative patterns of pottery from Xom Ren, Northern Vietnam, showing 1) the complex 'S' shape pattern 2) the opposed human motifs 3) the incised strokes alternating between an angle of about 45° to the vertical 4) the opposed human motifs, possibly female 5) the opposed human motifs in well arranged geometrical forms 6) the opposed human motifs quite similar to the human motif from M.1, M.2 and M.3 of Ban Non Wat (Fig. 5:11), Khok Charoen, Sab Champa and Sab Dipri (Fig. 6:4) 7) another type of human motif (by courtesy of Dr. Nguyen Kim Dung)



FIG. 6:16 Ceramic motifs from Xom Ren, Northern Vietnam. 1. five pairs of opposed human motifs in combination with five single human motifs. The pattern resembles those from Non Nok Tha (Fig. 6:19B). The human motifs with arm look very similar to the human motif type M.4, M.5 and M.6 of Ban Non Wat (Fig. 5:11) 2. showing the 'S' and 'C' patterns. These 'S' and 'C' shape motifs matching those at the Neolithic sites in Thailand. 3. the human motifs resembling human motifs from Ban Non Wat (Fig. 5:11) and Lopburi site (Fig. 6:4) (by courtesy of Dr. Nguyen Kim Dung)



FIG. 6:17 A Neolithic vessel from Wat Yang Rak, Lopburi Province, showing a slightly tubular shape with a short, ring base, three lugs and incised complex "S" design infilled with impressions



FIG. 6:18 A Neolithic vessel from Wat Yang Rak, Lopburi Province, showing the incised and impressed design of a snake, and two rows of the human motif below the cordon. Scale 10 cm

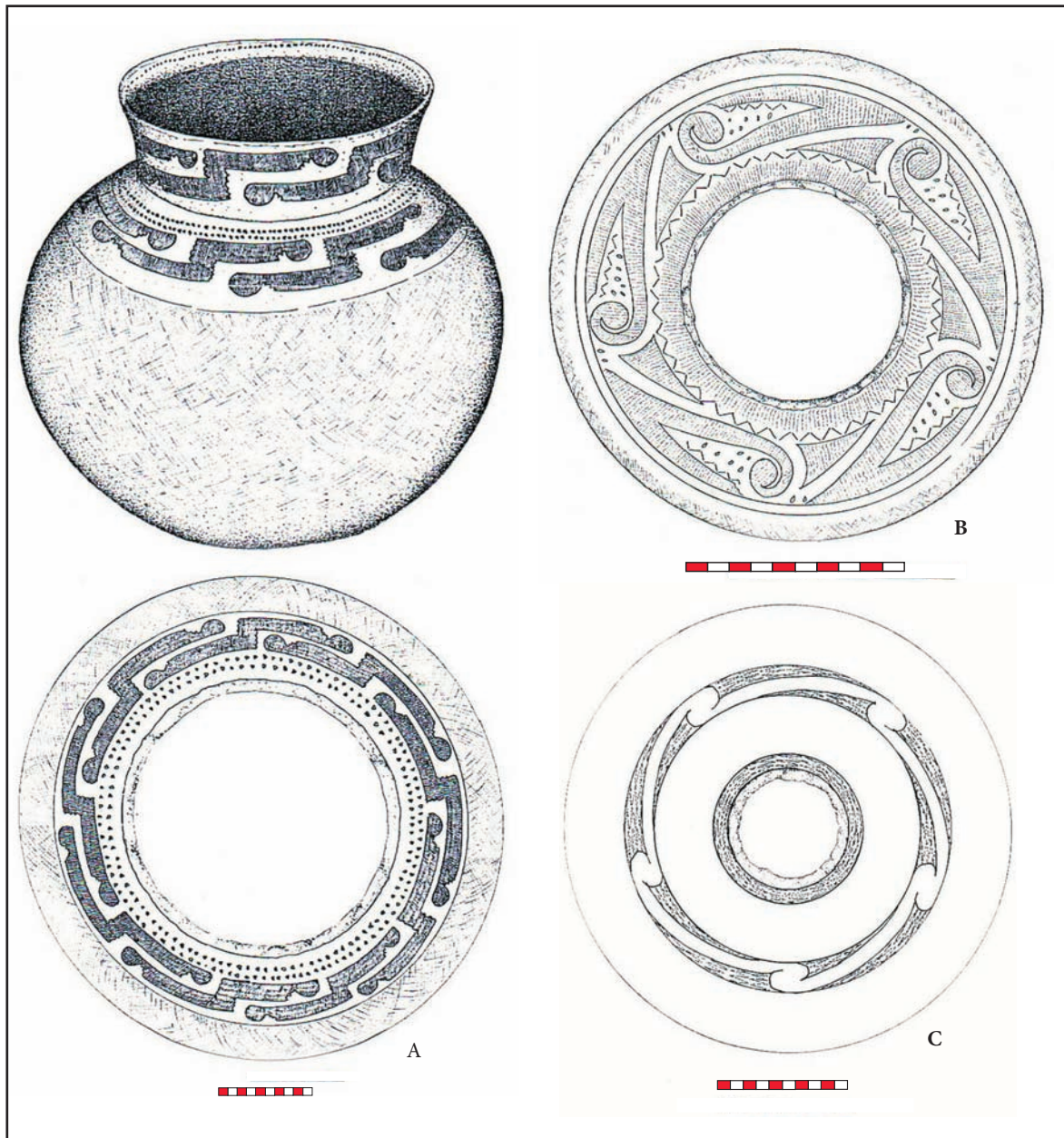


FIG. 6:19 A and B: views of reconstructed ceramic vessels from Non Nok Tha showing the incised and impressed pattern on the shoulder (redrawing from Solheim 1970), C: Drawing of an incised and impressed pattern on a Neolithic vessel from the Lopburi site survey area, showing the impressed zig-zag motif similar to patterns seen at Khok Phanom Di.
Scale in cm

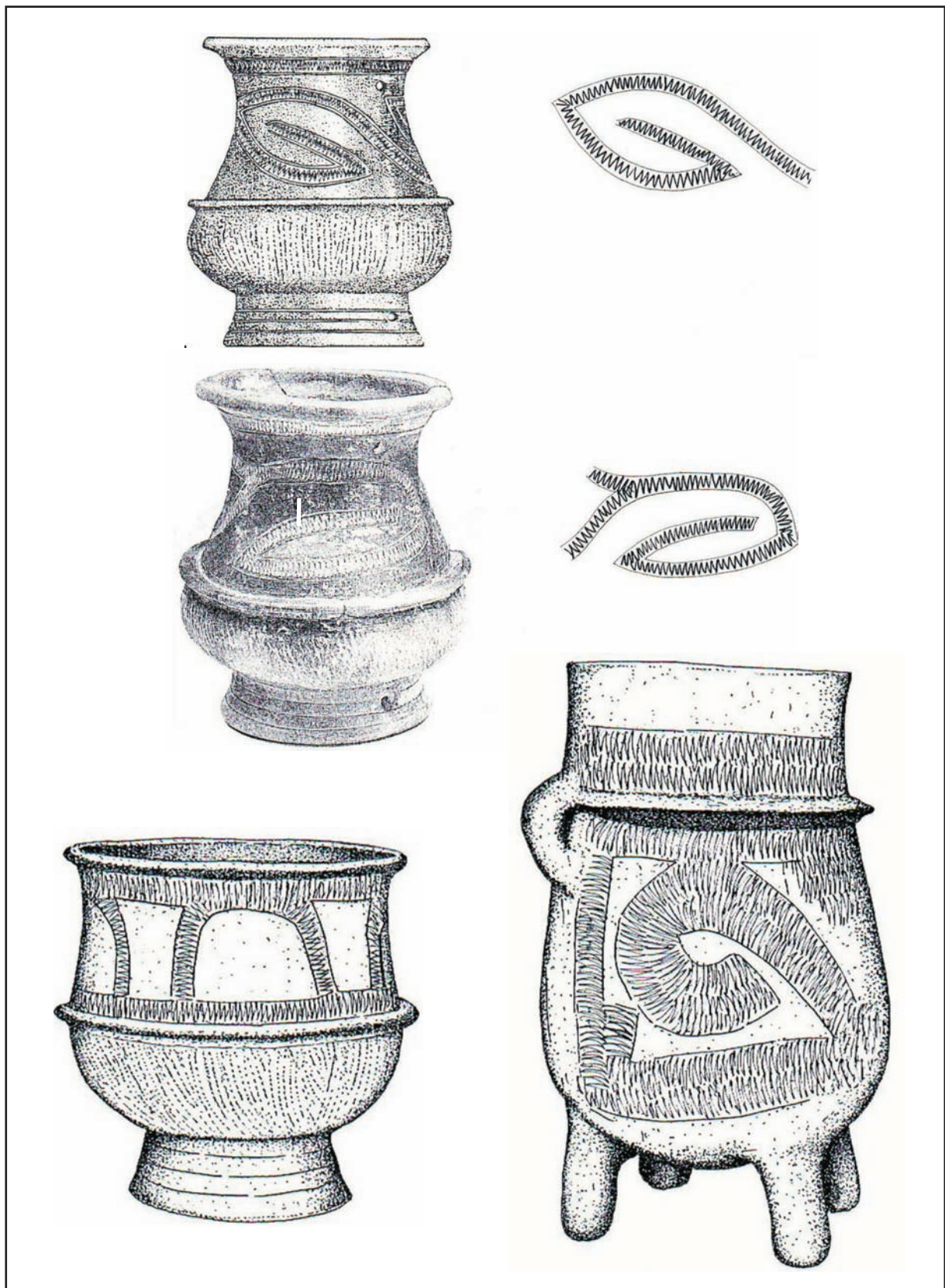


FIG. 6:20 The incised and zig-zag pattern on the area above the central cordon, on vessels from Early Period Ban Chiang. After White 1982, White *et al.* 1990 and Smith 1995. No scale

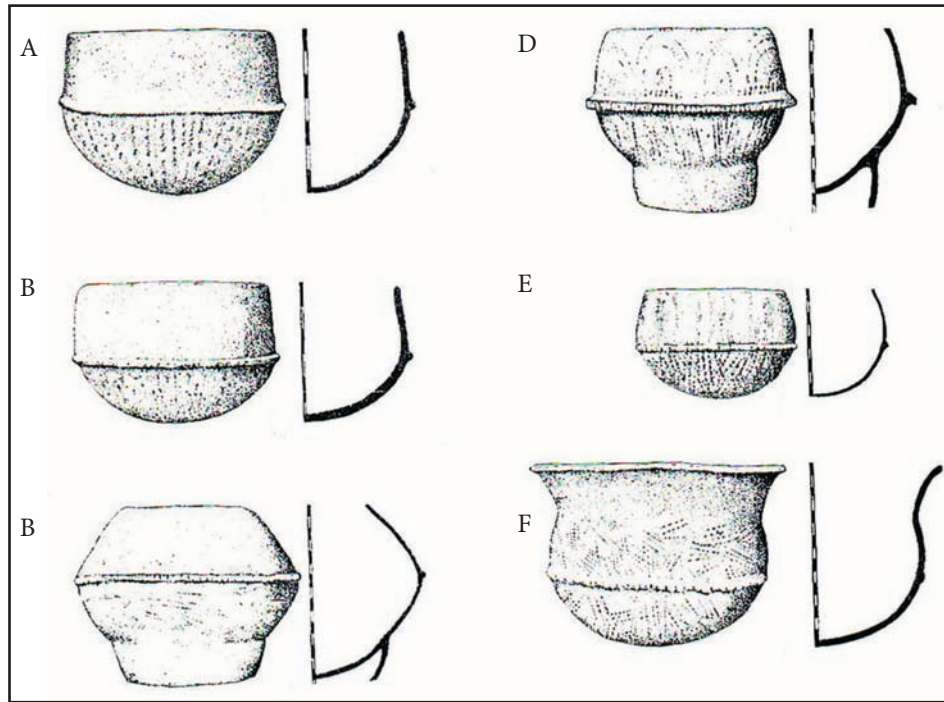


FIG. 6:21 The complete pots from Non Kao Noi burials. A-C, burial 1, D-F, burial 4. After Higham and Kijngam 1984



FIG. 6:22 The decoration on potsherds from the Xiantouling dune site, showing the human motif, after Chen Xingcan 1996

these are similar to those from Ban Non Wat (M.2 and M.7) (Fig. 5:11) and Lopburi site survey (Fig. 6:4). One of the patterns of Xom Ren, the incised strokes alternating between an angle of about 45° to the vertical also shows similarity with the rim pattern type Neo.1C-R3 of Ban Non Wat. There are at least five types of opposed human pattern from Xom Ren (Figs. 6:15 (2, 4-6), 6:16 (1)) most appearing as a slim figure. One of these (Fig. 6:15(2)) shows contact between persons, the other (Fig. 6:15 (4)) shows the opposed human with a long body and notable breast, suggesting a female. The opposed human motif type 5 of Xom Ren appears in a well-arranged geometrical form but it still shares the same character of the human pattern found at Ban Non Wat (type M.7, M.9-M.12) (Fig. 5:11) and at the Lopburi site (Fig. 6:4). The opposed human motif type 6 of Xom Ren is also very similar to the human motif form M.1, M.2 and M.3 of Ban Non Wat (Fig. 5:11, Khok Charoen, Sab Champa and Sab Dipri (Fig. 6:4).

Overall, the Neolithic pottery from Xom Ren exhibits more elaborate detail and appears in a slim shape and well-arranged position when compared with that found at Ban Non Wat and other sites in Thailand. Some of the complex detail in the opposed human motif from Xom Ren is hitherto absent in Thailand but some main motifs found at Ban Non Wat such as the whale and sickle do not so far recur in Vietnam. However, all the major patterns from Xom Ren appear in the transfiguration forms, so the original picture and meaning of these patterns may originate elsewhere, as suggested by Rispoli (2008) when she suggested that the pottery tradition with incised and impressed vessels suddenly appeared in the main river plains of mainland Southeast Asia from 2,000 BC.

PARALLELS BETWEEN SOUTHEAST ASIA AND CHINA

Rispoli (2008) has recently summarised the data available to consider parallels that might exist between the Neolithic expression in Thailand and that in China. Her article has clarified the continuity and the southern diffusion of the Neolithic package, especially the hallmark of the incised and impressed decoration of the Neolithic pottery widespread in this region from the early period.

The incised and impressed patterns from China, which appear in her article, seems to be very simple and undeveloped when compared with the Neolithic mortuary patterns found in Thailand. They comprised cord marking, incised lines and a variety of impressions, and the repertoire fails to reveal any striking resemblances with the main motifs found at Ban Non Wat and widespread in many Neolithic sites in Thailand. But on the basis of the foundation structure of these decorations, it appears to be in the same manner with its range of cord marking, incised parallel lines, and zig-zag impressions.

However, the Chinese archaeologist (Chen Xingcan 1996) has identified the incised opposed human mo-

tif on potsherds found at the site of Xiantouling near Hong Kong. (Fig. 6:22) This motif is quite similar to that found at Ban Non Wat (Fig. 5:11 (M.8)), in the central region of Thailand (Fig. 6:4) and in Vietnam (Fig. 6:10). Furthermore, the pottery types and the cardinal incised and impressed decoration of the pottery vessel from Daxi (Rispoli 2008) shows some similarities with the pattern found at Ban Non Wat and in the Lopburi area. The zig-zag decoration from the Neolithic site of Baiyangcun in Yunnan province also resembles the zig-zag impressed on the Neolithic black pottery of Ban Chiang and Ban Phak Top.

The decorative motifs on the mortuary vessels at Ban Non Wat appear in a well ordered pattern of the transfiguration symbols surrounded by the subordinate pattern. Its original picture and the real meaning of these symbols may well have a long historical development and certainly originated elsewhere due to its appearance at the earliest layer of Ban Non Wat in its transfigured forms.

This phenomenon is also found in many Neolithic sites in Thailand such as Ban Kao, Non Nok Tha, Ban Chiang, Khok Charoen, Tha Kae and Pratu Pha. The symbolic patterns found in the Neolithic vessels at these sites shared the common motifs such as the human motif, the 'S' shape motif or the whale motif in stylized or transfigured forms. These vessels have been found at the lowest layer of each site, indicating the coming of a distinctive pottery tradition which shared the common foundation of incised-impressed decoration.

However, in each area of Thailand there are regional differences in some pottery forms and the special features such as the tripod vessel of the western region, the trilugged, vessel of the central region, (Fig. 6:17-18) the black burnished vessels of the Sakon Nakhon region or the well ordered style of pattern at Ban Non Wat. This may imply that the different origin of each pottery tradition or in some cases displayed local variations based on a common ancestry.

The Neolithic pottery vessels in Thailand have a variety of forms and special features, but still share the same primary function as the offering vessel or the mortuary jar. It also shared the common ancient symbol which its meaning clearly related to the mortuary rite in the mortuary vessel found in many sites of Thailand. At this stage, we can separate the Neolithic pottery tradition in Thailand into at least two major groups. The first dominated in the western and southern region of the country. This tradition bears the different pottery form from the central and the northeast region. The type site at Ban Kao also has the peculiar tripod pottery with parallels in China. The surface decoration of this tradition preferred the plain burnished surface rather than the incised and impressed of the combination pattern. Some special pedestal vessels of Ban Kao has the whale and snake motif similar to those found in the Lopburi region and at Ban Non Wat.

The second major group was found widespread in the

central and northeastern region of the country. This group favoured the elaboration of the incised and impressed combination pattern. The theme motif appeared in the

transfiguration forms like human, whale, 'S' shape surrounded by the subordinate combination were found in the similar manner at many sites.

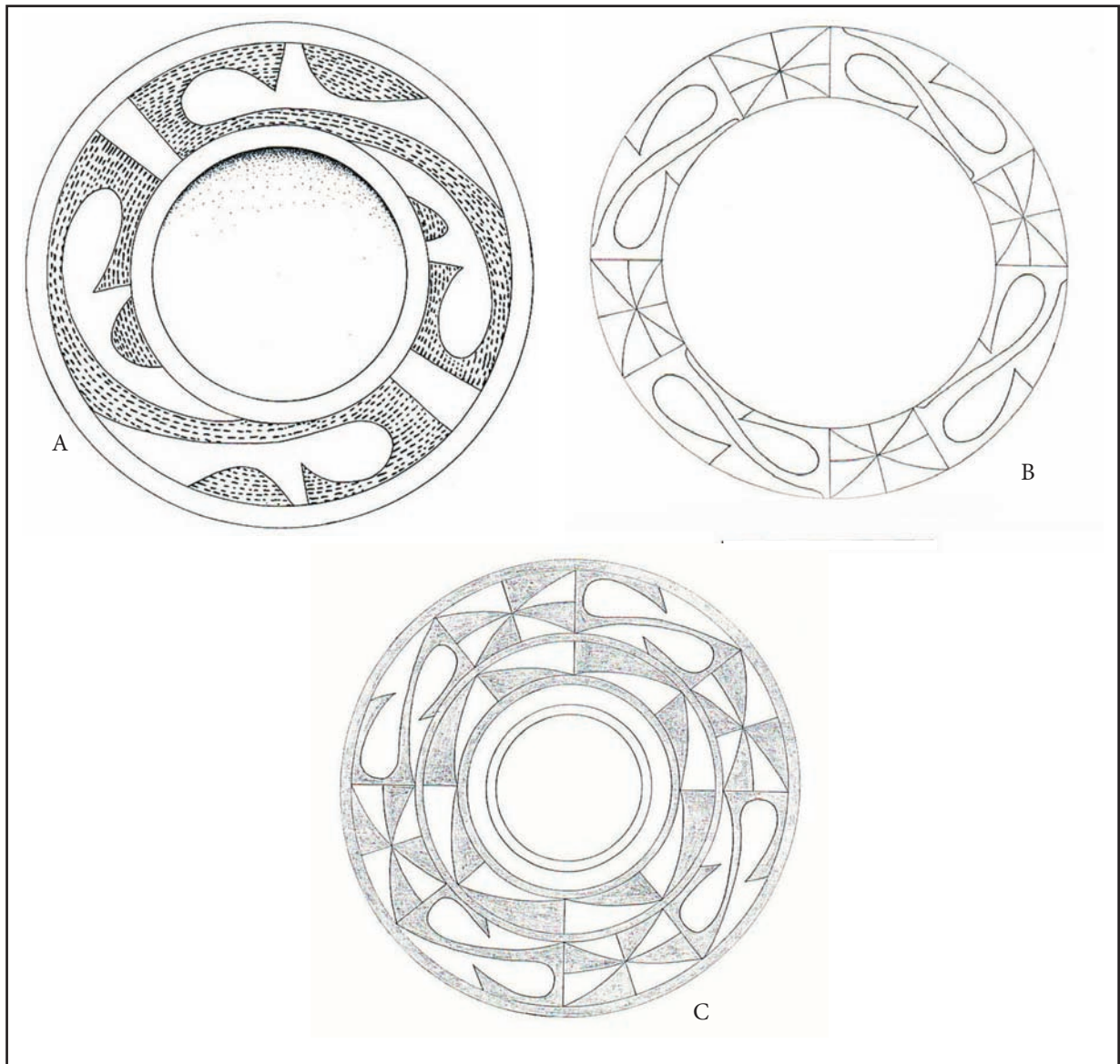


FIG. 6:23 The incised pattern of a stylised human figure seen on ceramic vessels from A: Khok Phanom Di, B: Khok Charoen and C: Sab Champa. Not to scale

VII MATERIAL CULTURE

C.F.W. HIGHAM

The issue of contamination of context through prehistoric disturbance of the Neolithic deposits means that only rarely can one be certain of an ascription to this period. Indeed only when an item is found with a burial, or in an undisturbed occupation deposit, can certainly prevail. Layer 5 and the lowest two contexts in layer 4 are ascribed to the Neolithic occupation and it is held likely that an item found therein is more likely to be Neolithic rather than later.

The presence of fine ceramic vessels with Neolithic burials of both phases indicates that there were skilled potters present, and the recovery of clay anvils supports this (Fig. 7:1). The pots were fashioned in the same way as

during later prehistoric periods and right through to the present. Two burnishing stones were also found in probable Neolithic contexts.

Cameron (2002) has studied the evidence for weaving in prehistoric East and Southeast Asia, and has found that the spindle whorl is the most widespread artefact that was associated with this craft. Originating in the Chinese Neolithic, the spindle whorls were, she has suggested, introduced into Southeast Asia through the expansion southward of rice farmers. No spindle whorls have been found in the two coastal sites ascribed to the indigenous coastal hunter-gatherers at Khok Phanom Di and Nong Nor. At Ban Non Wat, however, a sample of spindle

whorls comes from Neolithic layers (Fig. 7:2). While not as abundant as in the Bronze and Iron Ages at this site, nor found with Neolithic burials, these artefacts still represent an important association between putative intrusive rice farmers and the production of yarn, and probably of textiles. It is important to note that the form of the whorls from Ban Non Wat are virtually identical with some of those recovered from Phung Nguyen in the Red River valley



FIG. 7:1 Neolithic ceramic anvils. Cat. 22248 D2 5:2 feature 1, cat. 26547 E4 5:2 feature 1, cat. 15126 AA1 5:4. Scale 50%

TABLE 7:1 *Functional attributes of ceramic spindle whorls from Neolithic layers of Ban Non Wat*

Cat. number	Context	Munsell colour	Shape	Diameter (cm)	Central perforation	Height	Weight
11664	B7 4:8	5YR 6/3	conical	4.1	0.3	1.5	15.5
3689	B4 4a: 2/3 feature 5	5YR 6/1	conical	3.1	0.4	2.1	29.6
1214	A5 4:15	2.5YR 7/1	conical	3.4	0.4	2.1	29.5
25463	E8 5:4 feature 2	2.5YR 6/1	conical	3.4	0.4	1.5	16.5
21216	B368 E5 4:1 feature 7	5YR 6/1	conical	2.7	0.2	0.9	6.1
15571	B368 E5 4:1 feature 7	2.5YR 7/1	conical	4.3	0.5	1.9	37.7
22915	E2 5:1 feature 3	2.5YR 7/3	conical	4.0	0.5	1.6	22.7
8254	C4 L4:12	5YR 5/1	conical	1.6	0.1	0.4	5.4
5716	C1 4:10	2.5YR 7/3	conical	4.0	0.4	1.9	28.3
3698	B4 4a:5	5YR 5/1	conical	4.0	0.4	1.4	15.1
26313	F4 4:9	5YR 6/3	conical	4.4	0.4	1.5	32.6
15075	AA1 4:10		biconical				

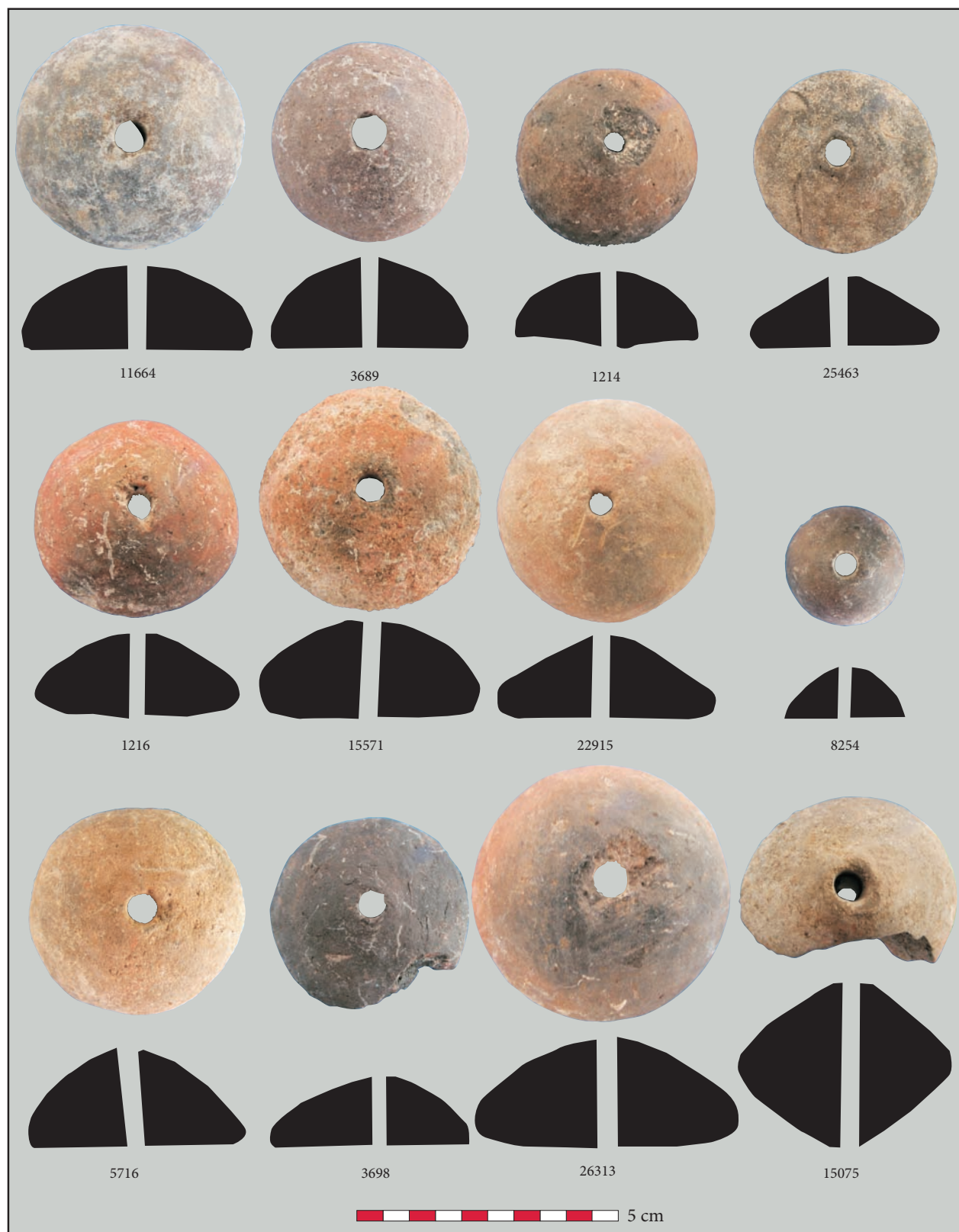


FIG. 7:2 Spindle whorls from layers ascribed to the Neolithic occupation. Cat. 11664 B7 4:8, cat. B4 4A:2 feature 5, cat. 1214 A5 4:5, cat. 25463 E8 5:1 feature 2, cat. 1216 A5 4:15, cat. 15571 AA2 5:1, cat. 22915 E7 5:1 feature 3, cat. 8254 C4 4:12, cat. 5716 C1 4:10, cat. 3698 B4 4A:5, cat. 26313 F4 4:9, cat. 15075 AA1 4:10

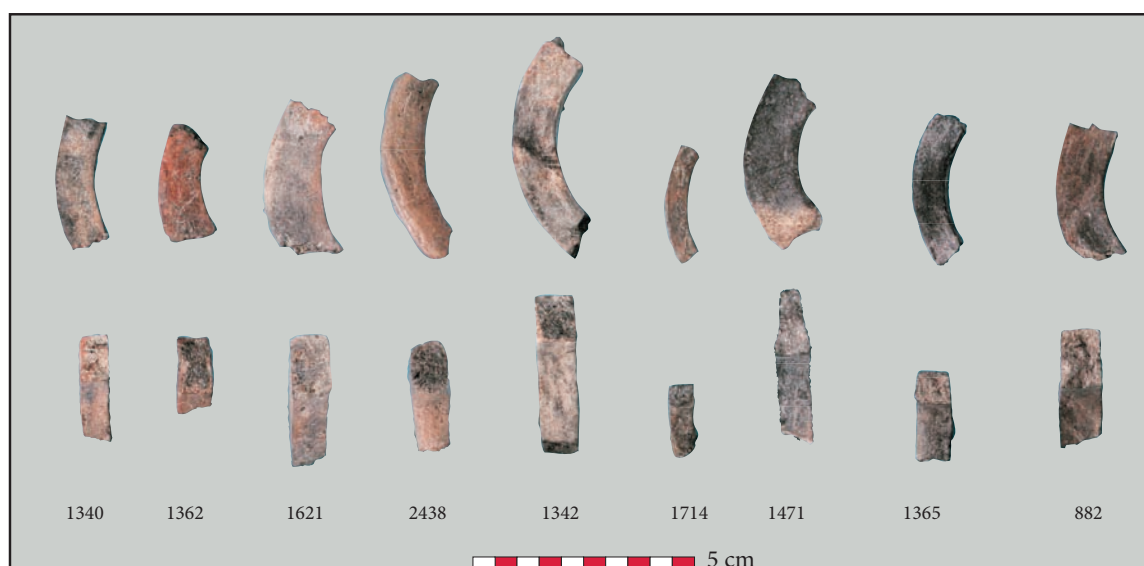


FIG. 7:3 Clay bangles from Neolithic contexts. Cat. 1340 A5 4:20, cat. 1362 A5 4:15, cat. 1621 A5 4:16, cat. 2438 B1 4A:8, cat. 1342 A5 4:10, cat. 1714 A3 4:15, cat. 1471 A4 4:19, cat. 1365 A5 4:19 cat. 882 A1 4:16

of Northern Vietnam (Hoang Xuan Chinh and Nguyen Ngoc Bich 1978: 101). However, there is also a much greater variety of forms at the Vietnamese site, and clearly several specimens were also decorated.

THE SPINDLE WHORLS

J. Cameron

The forms of the spindle whorls are highly standardized with 11 of the 12 items conical in shape. Only one whorl, cat. 15075 is biconical. The biconical whorl is significant in relation to the origins of spinning and weaving as Cameron's previous research has suggested that biconical whorls are atypical and can therefore be used to trace the movement of the technology from Tanshishan sites in Southeast China into mainland and island Southeast Asia. The whorls from the basal layers of Ban Non Wat are also similar in size, most ranging from 2.7-4.4 cm in diameter and 2.1 cm in height. Only cat. 8254 was appreciably smaller in size, measuring 1.6 cm in diameter and 0.4 in height. The central perforation of this whorl was also smaller in size than others in the layer measuring 0.1 cm in diameter rather than the more standard 0.3-0.5 cm which suggests that more than one spindle (presumably wooden) was used with whorls in these layers. None of the whorls in this layer is decorated.

CLAY BANGLES

C.F.W. Higham

Many clay artefacts were identified during the excavation of Ban Non Wat that take the form of a bangle (Fig.

7:3). These were clearly carefully formed and fired. None, however, has been found in a mortuary context. Their distribution in the site peaked during the Neolithic occupation, and remained high but on a declining trend during the Bronze Age. Very few were recovered from Iron Age layers.

PELLET BOW PELLETS

Pellet bow pellets are among the most abundant and enduring artefacts in prehistoric Thai sites. Used to hunt birds and small game, they persist in use to the present. At Ban Non Wat, there were two peaks in their frequency. The first took place during the Neolithic occupancy, and the second during the later Bronze Age. Thereafter, there was a sharp fall in the numbers found. Identical artefacts have been recovered from the eponymous Phung Nguyen site.

WHETSTONES

Given the number of stone adzes in Neolithic layers at Ban Non Wat, it is not surprising to find that whetstones for sharpening their blades are also relatively abundant. These artefacts were made of sandstone, and their worn surfaces reflects consistent use over some period of time (Fig. 7:4). The same situation was found at Phung Nguyen (Hoang Xuan Chinh and Nguyen Ngoc Bich 1978:63).



FIG. 7:4 Whetstones from Neolithic contexts. Cat. 6268 C2 4:11, cat. 2626 B2 4A:9, cat. 3475 C1 4:11, cat. 5868 C1 4:15 feature 1, cat. 17338 E5 4:10, cat. 26572 E4 5:3, cat. 25840 F3 5:2, cat. 25336 F2 5:2. Scale 45%

CERAMIC TEMPERS

K. McClintock

Ceramic studies are seen as important because the “composition of material and nature of techniques combine to make pottery one of the most complex artifacts that early man has left” with a range of clays used whose chemistry is complex (Shepard 1985:2). Because pottery, like stone, is durable and lasts in the archaeological record, it has also been important in classification studies, though unlike stone, clay can be made into almost infinite forms (Vincent 1988:8). Chemical characterization has been used in studies looking at production, consumption and exchange (Summerhayes 1997:108), as seen in studies regarding clay procurement, preparation and decorative techniques, especially petrographic studies which examine evidence for local and non local production (Voelker 2002:18). Modern local clays may be sourced to see if ancient pottery was manufactured locally. It has been suggested that “the way in which the paste was mixed would be dictated by tradition...(and therefore) a rather more drastic influence may be needed to change basic technological processes such as clay preparation or firing” with potters considered overall as being conservative in their selection of raw materials and technologies (Summerhayes 2000:31). This is relevant as any change in fabric can be interpreted as a major change in society. This is reflected in the view that pottery production can be regarded as being significant in socio-economic systems (Voelker 2002:1). It has also been believed that the organization of labour can be seen in the standardization and diversity of items produced as well as in production (Voelker 2002:18).

Characterization studies on pottery, however, can be complex because mineral inclusions may be naturally present or manually added to the clay in order to stop shrinkage when the pot dries. This addition affects the ‘chemical profile’ of the pot and can lead to bias in models of production, consumption and exchange. It is important to identify whether or not a mineral inclusion is natural or not, and the electron microprobe can be helpful as it looks at the matrix of the clay separately from the minerals unlike other methods of chemical pottery analysis such as Neutron Activation Analysis, X-ray Fluorescence Spectrometry, or PIXE-PIGME. “These techniques analyze sherd samples that are crushed, resulting in a chemical profile consisting of both the mineral and clay matrix components...the use of the electron microprobe is a viable alternative to these other techniques” (Summerhayes 1997:108). The electron microprobe is also useful as the minerals in clay often break down in the firing process, and the microprobe allows one to look at fine-grained material of the clay that remains, which gives some idea of the firing process used and the original fabric (Freestone 1982:100). By the 1980s the electron microprobe had become established as relevant in mineralogical and petrological

research, and its relevance for archaeological studies of ceramics was also being developed. In using the electron microprobe a beam of electrons is aimed at a sample held flat under a vacuum, and the x-rays produced are analyzed by energy-dispersive or wavelength-dispersive ways focused on high quality chemical analysis (Freestone 1982:99). A backscatter electron detector is also used, with the grey level of the image depending on the atomic number, with black equaling a low atomic number and white high (Tite 1992:113).

This study has been designed to characterise the ceramic tempers of Neolithic 1 and 2, and compare them with those of the Bronze and Iron ages in order to identify continuity or change over these phases of site occupancy. Sampling in the field consisted of extracting a small sherd from every ceramic vessel from securely identified burial contexts and features. This resulted in a sample for analysis of 117 sherds. In the case of the Neolithic material, which was mostly recovered from a floor surface in square D2, in the field samples were collected from any identifiable vessel or feature.

The following were selected for analysis: seven sherds from Neolithic 1 occupation contexts, five sherds from Neolithic 2 burials, one from a Bronze Age 1 burial, one from a Bronze Age 2 burial and five from Bronze Age 4 burials and one from an Iron Age 1 burial (Table 7.2).

TABLE 7.2 *Provenance information for samples selected for testing*

Sample	Period	Context
G	Neolithic 1	D2 5:1 feature 3
H	Neolithic 1	D2 5:1 feature 3
I	Neolithic 1	D3 4:9 feature 3b
J	Neolithic 1	D2 5:1 feature 2
K	Neolithic 1	D2 5:1 feature 7
L	Neolithic 1	D2 5:1 feature 5
M	Neolithic 1	D2 5:1 feature 3
A	Neolithic 2	Burial 562 cat. 26531
B	Neolithic 2	Burial 558 cat. 23821
D	Neolithic 2	Burial 562 cat. 26532
E	Neolithic 2	Burial 172 cat. 22272
F	Neolithic 2	Burial 545 cat. 22730
C	Bronze Age 1	Burial 560 cat. 24237
R	Bronze Age 2	Burial 550 cat. 23789
N	Bronze Age 4	Burial 542 cat. 25293
P	Bronze Age 4	Burial 548 cat. 26294
Q	Bronze Age 4	Burial 548 cat. 26295
S	Bronze Age 4	Burial 522 cat. 25687
T	Bronze Age 4	Burial 557 cat. 23257
O	Iron Age 1	Burial 541 cat. 24919

MATERIAL AND METHODS

Before the sherds could be chemically examined, they were washed with distilled water and cut into small pieces of less than two cm in length using a 14" diamond edge saw. The shape of the pieces was arbitrary as long as a straight edge was formed. The sherds were then left overnight, or for approximately 24 hours in a 38° oven to dry. A brass ring, approximately 4 cm in diameter, was then temporarily attached to a glass slide with wax. Three to four samples were then set into the ring using epoxy resin or araldite (Summerhayes 2000:38) which was used to fill the brass mould. The moulds were then put aside to dry. Once the resin had dried, the brass mould was removed from the glass slide and the resin-encased sherds were removed.

The surface of the briquette formed through this process was then ground down to expose the flat surface of the samples. Using four grades of diamond sanding paper and paste of progressively finer quality, the briquette was smoothed, and was highly polished, as any irregularities can affect the matrix corrections. An example of this is that rough surfaces can affect the detection and absorption rates of x-rays (Summerhayes 2000:38).

Finally samples were polished twice with ethanol and alcohol and carbon-coated in a vacuum. The carbon acts as a conductor, and with its low atomic number it does not significantly absorb the x-rays (Summerhayes 2000:38). Before placing the samples in the electron microprobe the briquettes were mounted with carbon paint acting as a conductor between the briquette and the metal mount.

Chemical analysis is a necessary step in the study of ceramic production with the electron microprobe analyzing both the matrix and the mineral inclusions in the pottery. Once the specimen holder had been placed into the probe, the samples could be viewed through a video camera or through a cathode ray tube. A specific area of the sample could also be identified as the samples could be manoeuvred using an X and Y axis control mechanism with the samples placed on a moveable stage.

An accelerating voltage of 15 KeV was used in this analysis. Initially wavelengths or images were taken of the specimens at 40, 80, 160 and 400x magnification. Images were taken using backscatter with the range current set to 10^8 . Images were saved using the semaphore computer program.

An energy dispersive spectrometer (EDS) was also used in this analysis. EDS is important in being able to determine if the spectrum obtained shows if the spot being analyzed is a mineral inclusion or a part of the matrix of the ceramic (Summerhayes 2000:38). The range current for this analysis is set at 10^9 , making sure the beam is stabilized once the current is at the correct level. A probe diameter of twenty to thirty was used for the beam when looking at the matrix, with a smaller diameter used for

very small inclusions (a diameter of 0 is needed for the images). The spectra obtained through this analysis were recorded using the Moran Scientific computer program with an acquisition time of one hundred, and a magnification of one hundred was used when locating points of interest on the sample. Five examples identified visually at different points of the sample as being matrix were obtained with the results averaged so any variability of the matrix can be determined and mineral inclusions can be discounted (Summerhayes 2000:38). The elements analyzed in the matrix were, Na, Mg, Al, Si, P, K, Ca, Ti, and Fe, all as oxides.

In this study, and in others looking at the "quantitative elemental characterization of pottery" (Summerhayes 2000:38), the idea of different groupings is important in analyzing the results with reference to the sample's archaeological context. In this study both principal component analysis (PCA) and hierarchical clustering analysis were used to statistically group the samples. These techniques are used to form CPCRU – Chemical Paste Compositional Reference Units, a term which refers to the groups or clusters of data formed when one manipulates elemental information (Summerhayes 2000:39).

PCA involves the alteration of the original variables into a set of unrelated variables, or principal components. "The major aim of PCA is to reduce the number of attributes to a few dimensions so that firstly, the data can be plotted and clusters can be identified individually, and secondly, an element's contribution to the hierarchical clustering methods outlined below can be assessed" (Summerhayes 2000:39). In this method the first element should account for the most variation in the data, and so on with the elements decreasing in order 2,3,2.

The basis involved in the use of hierarchical clustering is that the samples from objects with similar origins will form clusters. From these clusters a multidimensional probability distribution can be calculated. This allows a quantification of the similarity in composition between the samples, which is necessary in making the groups objective. In this study the aim is to define groups or clusters of sherd samples based on elemental similarities, and hierarchical clustering will help identify discrete groups within larger clusters, if they exist. It is important to note that clustering can be subjective, and it has been argued that if one has knowledge of the data before clustering, interpretation can be biased. Hierarchical clustering techniques can also fail to separate two groups if they are close. The shape of the clusters produced is influenced by the two dimensional plots produced by PCA. In this study the information gained by PCA is used in the hierarchical clustering analysis. Groupings are defined subjectively and kept simplistic with groups from PCA compared with the dendrogram produced by the group averaging hierarchical clustering technique (Summerhayes 2000:41).

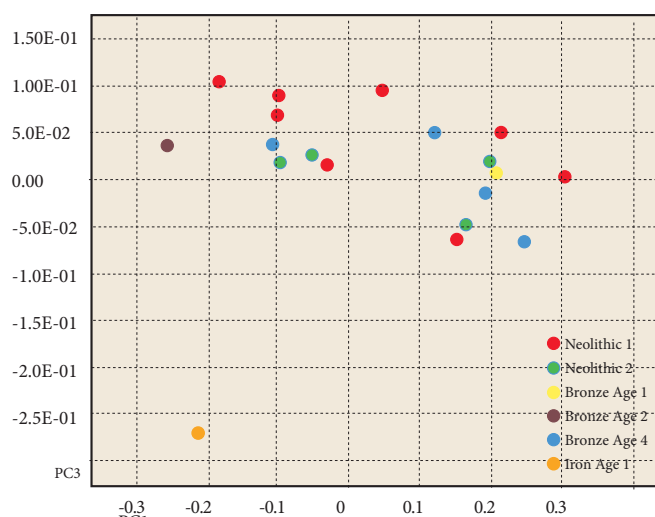


FIG. 7:5 PCA plot comparison of ceramic matrix: first and third components

RESULTS: FABRIC ANALYSIS

The results obtained for the Neolithic 1 and 2, Bronze Age 1, 2 and 4 and Iron Age 1 fails to reveal any major change in the fabric of the clay. The overall matrix consists of approximately 60-70% silica and 20% aluminium with small amounts of potassium, titanium and iron. The matrix in each sherd shows this consistency with quartz as the major inclusion present throughout the period. The dominance of this mineral has been observed in other areas of Thailand, as seen in Vincent's study of Khok Phanom Di (Vincent 2004:738). The only differentiation in fabric detected is in sample O from the Iron Age 1 burial 541, when the first and third components of the PCA analysis are plotted against each other. This specimen has a higher percentage of aluminium in the fabric when compared to other samples and perhaps this is why it is isolated from

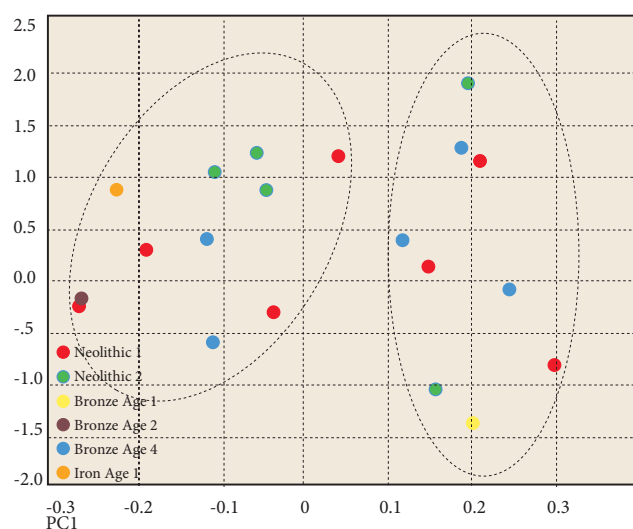


FIG. 7:6 PCA plot comparison of ceramic matrix: first and second components. Fabric group 1 on the left, and fabric group 2 on the right

the other samples in the plot (Fig. 7:5). This difference can also be seen visually when one looks at an image of the sherd compared to others analysed since it clearly contains rice chaff (Figs. 7:8-13)

While the fabrics do show much similarity throughout the Neolithic and Bronze Age (Figs. 7:9-17), two groups can be observed when comparing the first and second components in the statistical analysis of the matrix. This distinction is not temporal however, as seen in figure 7:5. Both fabric groups have a similar number of Neolithic, Late Neolithic and Bronze Age materials, which means pottery was being produced throughout these periods in both fabrics. The presence of the two groups of fabrics seen in the PCA analysis is confirmed with hierarchical cluster analysis, with the same samples being grouped together in two distinct clusters (Fig. 7:7).

MINERAL INCLUSION ANALYSIS

TABLE 7:3 Presence/absence analysis of minerals associated with fabric groups

mineral	Fabric 1	Fabric 2
quartz		
plagioclase feldspar	x	
alkali feldspar	x	
haematite	x	x
aluminium		x
titanium	x	x
calcium		x
chlorapatite		x
unidentified rock or clay	x	x
unidentified 1	x	x
unidentified 2		x
unidentified 3		x

While statistical analysis of information about the matrix taken from the electron microprobe shows two distinct fabrics, comparison of the chemical compositions of the matrix of each sherd shows no major variation (other than sample O as stated earlier). The answer to the question of how the two fabrics can be distinguished from one another can be approached by examining the mineral inclusions in the pottery. Quartz dominates the fabric of each sample. Other minerals present include both plagioclase and alkali feldspars, as well as haematite, titanium, and several unidentified minerals (Table 7:3). Again these inclusions are found throughout the chronology, but differences can be seen when a presence/absence analysis is undertaken looking at the presence of diverse inclusions in the two fabric groups (Table 7:3). This demonstrates that fabric group 1 is characterized by the presence of feldspars, while fabric 2 shows no evidence of these inclusions. Fabric 2 can perhaps be characterized by the unidentified miner-

TABLE 7:4 Comparison of mineral inclusions found in sherds A-F

sample	quartz	plagioclase feldspar	alkali feldspar	haematite	aluminium	titanium	calcium	chlorapatite	unidentified rock or clay	unidentified 1	unidentified 2	unidentified 3
Neolithic 1	X											
Neolithic 1	X			X				X				
Neolithic 1	X	X		X						X		
Neolithic 1	X				X			X			X	X
Neolithic 1	X		X			X		X		X		
Neolithic 1	X							X		X		
Neolithic 1	X							X				
Neolithic 2	X	X				X		X				
Neolithic 2	X	X		X								
Neolithic 2	X		X					X		X		
Neolithic 2	X						X					
Neolithic 2	X							X			X	X
Bronze Age 1	X							X				
Bronze Age 2	X	X						X				
Bronze Age 4	X					X		X				
Bronze Age 4	X							X				
Bronze Age 4	X							X		X		
Bronze Age 4	X			X				X				
Bronze Age 4	X			X								
Bronze Age 4	X							X				

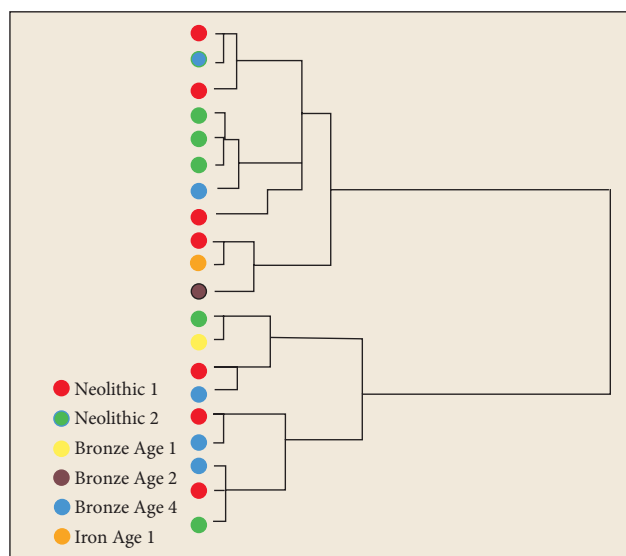


FIG. 7:7 Hierarchical cluster analysis: dendrogram using average linkage between groups

als referred to earlier including unidentified mineral 2 which has equal amounts of silica and phosphate, and unidentified mineral 3, which contains relatively equal amounts of silica, sulphur and titanium. However caution is advised when separating these two fabrics, as the pottery is primarily dominated by quartz and the sample size is too small to confirm these results and interpretations.

Surprisingly no distinctly different mineral inclusions were identified in the Iron Age sample O. Its different appearance is attributed to the inclusion of rice chaff. There is also the possibility that grog was used to temper the pots due to the appearance of some of the samples (Fig. 7:13), which isolated areas where the fabric appears to be distinctive from the rest, though a chemical analysis shows that it is made up of the same elements. This occurs in sample J, Neolithic 1 and only a small number of other samples and it can be difficult to recognize its presence due to the weathered appearance of many of the Bronze Age specimens.

DISCUSSION

On the whole these results fit the pattern of an early prehistoric society in Thailand with a focus on mineral temper, most likely quartz base sand, and can be compared with the early temper of Khok Phanom Di which consisted mainly of grog or sand temper (Vincent 2004:716). In examining the possibility of temporal change at the site of Ban Non Wat, these results demonstrate that technological modification did not occur in the manufacturing of pottery directly after the introduction of copper-base artifacts. This information shows that while there was no temporal change, variation within the assemblages could still be seen, with two fabric groups identified, both dominated by quartz but with temper variances. The consistency of these two fabrics over time suggests that the different fabrics cannot be explained as resulting from exchange or the influx of new people with new technologies, as the two fabrics are still too similar, and therefore probably came from two local sources. This conservatism in technology is interesting when looking at the change in decoration of the pottery, as the Neolithic examples showed evidence of incision, impression and red-slipped painting, with the Late Neolithic and Bronze Age examples decorated with cord impressed marks at the very most. This association is significant as it shows that the same people were probably making pottery throughout the Neolithic and Bronze Age. In looking at the archaeological question being asked by this study, where the Late Neolithic burials fit into the transition from the Neolithic to the Bronze Age, these re-

sults seem inconclusive. It would be, perhaps, more significant to consider the idea that the introduction of copper-base technologies and the change in pottery decoration cannot be seen alone as signifiers of major societal change. Changes such as these are seen as indicating exchange. However contact and interaction with other societies and cultures is not a straight forward concept. Rarely do societies passively submit to new cultural ideas. The results of this study show that while changes can occur in a society it does not necessarily indicate the influence of outside people to any great extent. It is possible that the people of Ban Non Wat had contact with other early settlements in Central and Northeast Thailand, with exchange of ideas and material goods, but the pottery of the area was probably manufactured using local clays and mineral sources, with the two different fabrics perhaps resulting from the exploitation of two sources to produce similar wares, with the potters preferences taken into consideration. Sample O perhaps indicates the use of different sources or tempers, and could indicate the development of the use of rice in ceramics at Ban Non Wat in the Iron Age.

Because of the rarity of Neolithic sites in Northeast Thailand, fabric studies in the past have examined the development of the Iron Age and the transition from the Bronze Age to the Iron Age, both of which show an increased use of rice as a temper (Vincent 1988, Voelker 2002). Ban Non Wat gives us an opportunity to explore the transition from the late Neolithic into the Bronze Age. Microprobe analysis of these pottery sherds reveals a picture contradictory to the change in pottery decoration seen. While two fabrics were identified, they were not temporally distinguishable. Rather it is concluded that two

different but related local sources were used to produce the vessels throughout the Neolithic and into the Bronze Age.

Further research is needed before making any clear statements about the pottery and its implications for society in this period. A study based on a larger number of samples would be desirable to determine if the fabric identification is correct. While the sample size in this study is not large enough to make grand declarations, it does provide a solid starting point for further study. More statistics are needed to confirm the pattern shown by the dendrogram included, and again confirm the separation of the Neolithic and Bronze Age samples into two fabric groups. A more solid identification of minerals and fabric is also needed, with comparative studies of contemporary local clay sources to see which sources were exploited. An interesting aspect for further study would be examining the samples to see if the difference in fabric is related to form, with samples taken from pots with an identifiable shape. However this can be a problem with ceramic vessels that are complete or could be reconstructed. This approach was not undertaken in this study as none of the samples taken from the Neolithic 1 floors can be associated with particular vessel forms as they were found in scattered fragments alongside shell and bone. These studies would further the research into the Neolithic occupation of Ban Non Wat and the implications that its ceramics have on the development of the settlement and its place in Thai archaeology.

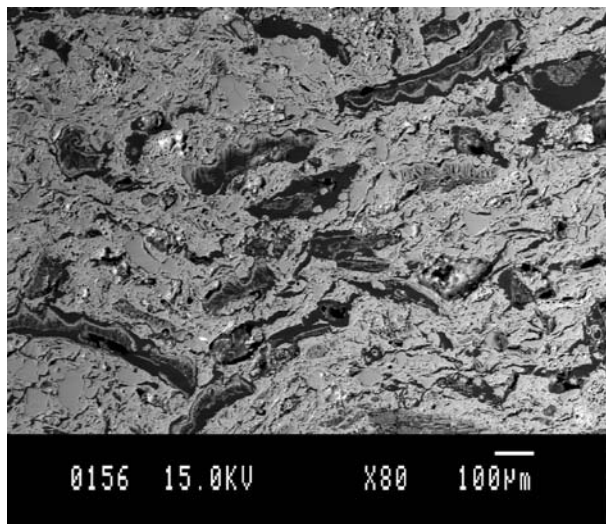


FIG. 7:8 Sample O from Iron Age 1 burial 541

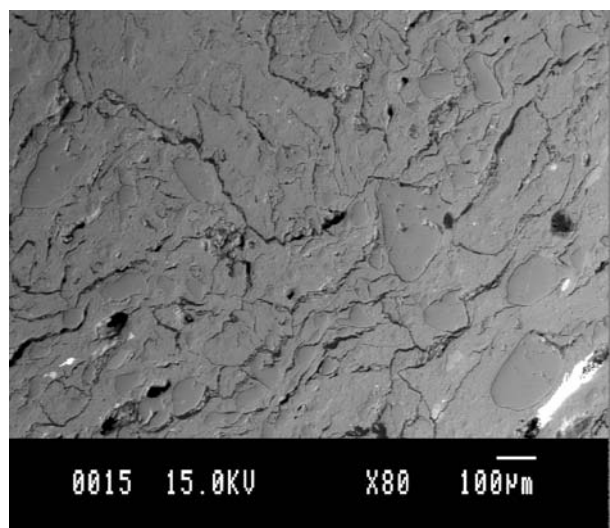


FIG. 7:9 Sample D from Neolithic 2 burial 562.

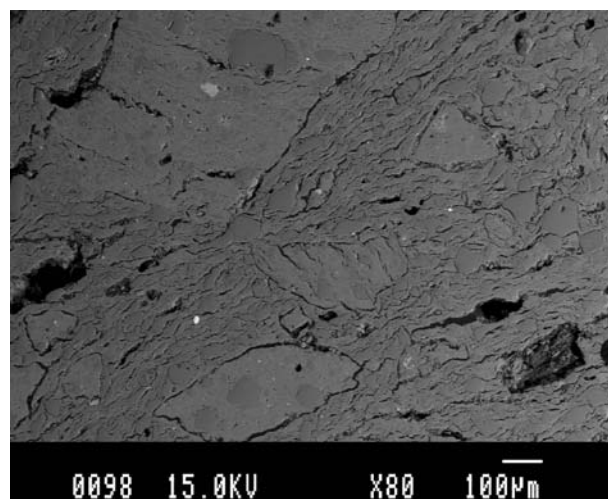


FIG. 7:11 Sample J, Neolithic 1 D2 5:1 feature 2

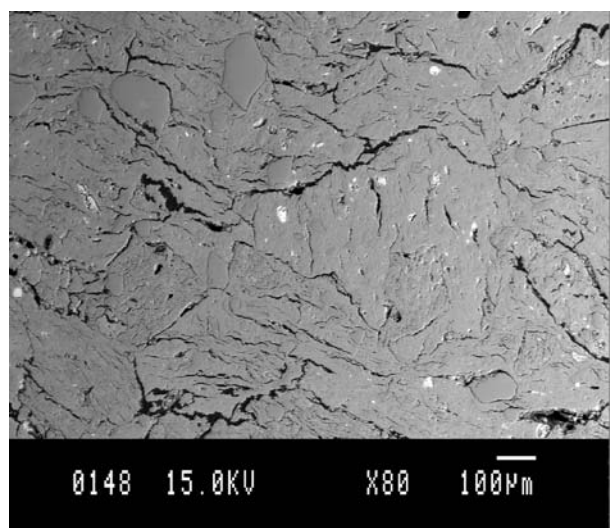


FIG. 7:10 Sample M from Neolithic 1 living surface D2 5:1 feature 3

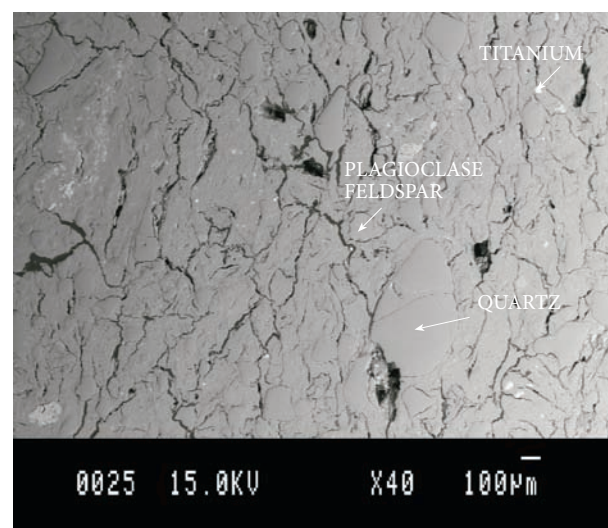


FIG. 7:12 Sample A Neolithic 2 burial 562 cat 26531

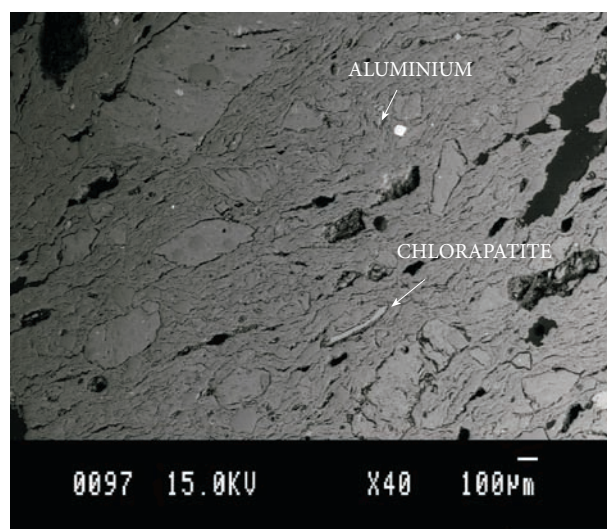


FIG. 7:13 Sample J Neolithic 1 D2 5:1 feature 2 cat 22295

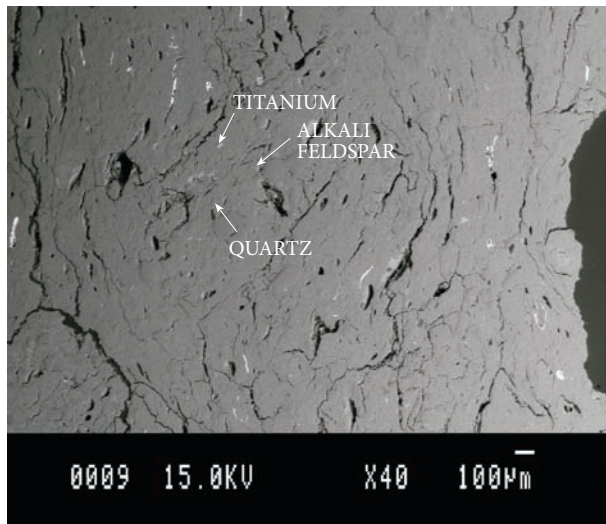


FIG. 7:14 Sample K Neolithic 1 D2 5:1 feature 7

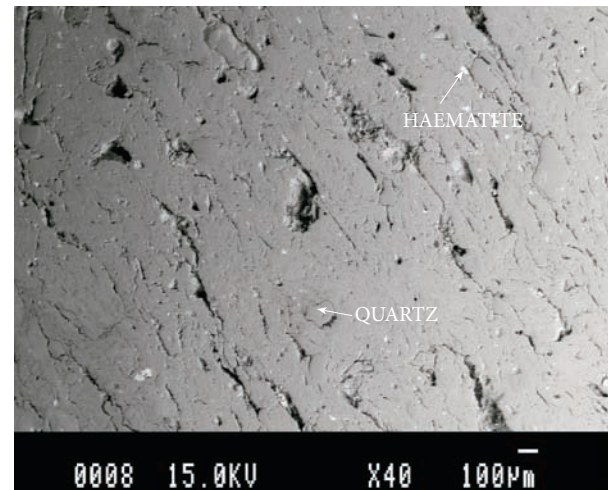


FIG. 7:16 Sample S Bronze Age 4 burial 522 cat 25687

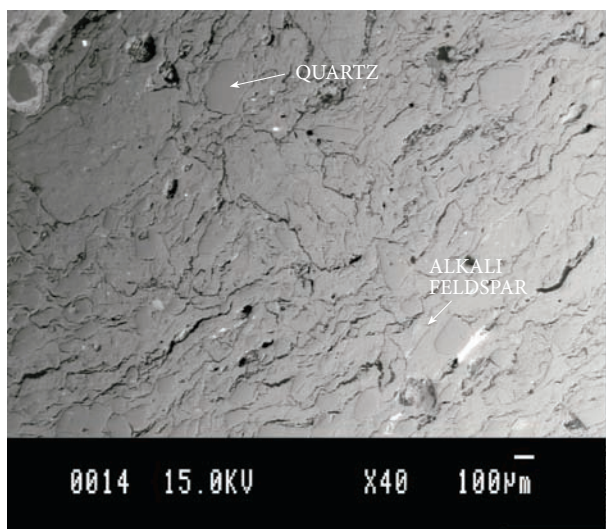


FIG. 7:15 Sample D Neolithic 2 burial 562 cat 26532

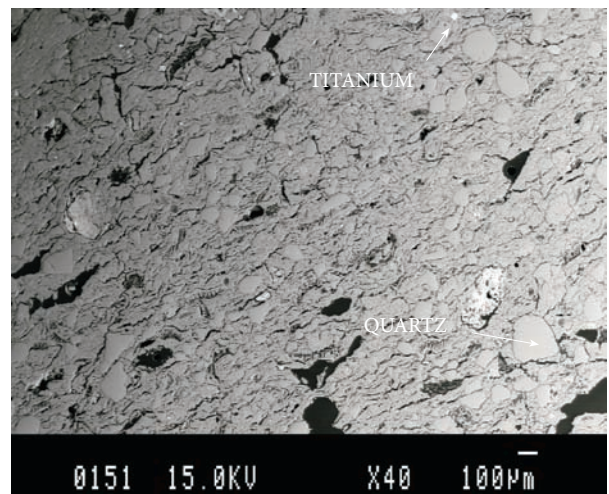


FIG. 7:17 Sample N Bronze Age 4 burial 542 cat 25293

THE ADZE ASSEMBLAGE

Tessa Boer-Mah

The ground stone adze assemblage from Ban Non Wat on the Khorat Plateau in northeast Thailand offers a rare opportunity to examine the prehistoric non-mortuary aspects of daily life in the Neolithic period. Few adzes have been recovered in association with human interments, rather, most derive from contexts associated with the occupation of the site. As such, the assemblage provides evidence for domestic adze consumption. More broadly, in this chapter, the assemblage has been used to examine adze procurement – in particular, whether adze materials were acquired locally or from more distant sources – thus providing insight into the workings of the Neolithic economy at Ban Non Wat.

A systemic procurement model has been developed to provide a theoretical framework for investigating the nature of adze procurement at Ban Non Wat. This model expands upon fundamental components outlined in Torrence's (1986:4-7) general systemic model for exchange. The components of the systemic procurement model relied upon in this study, consumption and acquisition, require an understanding of the archaeological and geological context of Ban Non Wat. The archaeological context of the site was considered in formulating testable predictions for adze consumption at the site. Predictions formulated regarding the acquisition of adze raw materials, and/or finished adzes, drew upon the local and regional geological context, as well as the petrographic examination of artefacts from Ban Non Wat.

The first section of this chapter outlines some fundamental definitions, the systemic procurement model which is used as the theoretical basis for this study, as well as the archaeological and geological context of the site. Results from the analysis of adze consumption are presented in the second section of this chapter, followed by the results of adze acquisition. The final section of this chapter builds on the data analysis by providing a discussion of the results, and develops interpretations which overturn previously held paradigms regarding adze procurement on the Khorat Plateau.

Definitions

An adze is a hafted percussive cutting implement which is usually applied to woodworking activities. It comprises a stone blade, a handle and associated bindings. The terms 'adze', 'axe', 'adze head', 'axe head', 'adze blade', 'axe blade' or simply 'blade', have been applied to the stone component of these tools. Thus 'adze' and 'axe' can refer to the unhafted stone component or to the entire set-up of stone head, handle and bindings. In most archaeological sites, however, only the stone component is recovered. At Ban Non Wat only the stone component of the adzes were identified, no bindings or handles were recovered from

the site.

An adze head is hafted with its cutting edge running transversely to the axis of the handle, whereas an axe head is hafted with the cutting edge parallel to the handle (Blackwood 1950) (Fig. 7:18). Adze heads are usually hafted at an acute angle to the handle, whereas an axe is hafted at right-angles to the handle (Semenov 1964), although some ground stone percussive implements have their blades set at intermediate angles (Crosby 1973). These differences in stone head orientation affect the development of usewear along the cutting edge. For adze heads, parallel striations usually develop at 90° to the cutting edge and are generally more prominent on the back face of the adze (due to frequent contact with the wood materials worked) (Semenov 1964). By contrast, striations on axe heads usually occur on both faces and run diagonally from the cutting edge (Semenov 1964). Generally, adzes have asymmetrical profiles (uneven bevels), whereas axes have symmetrical profiles (Semenov 1964). Using these criteria, all stone heads recovered at Ban Non Wat were identified as adzes.

Adzes in their original finished condition, that is, where the manufacturing process has been completed (including grinding and/or polishing) and the adze has undergone little or no use, have been referred to as 'primary' adzes (Turner 2000, Turner 2005). In contrast, non-primary adzes have been used, resharpened (by grinding), reworked (by flaking), or have evidence for prior breakage. Due to loss of raw material by grinding, flaking or breakage, a non-primary adze will be smaller than its original/primary form.

SYSTEMIC PROCUREMENT MODEL

Numerous theoretical models have been constructed for the prehistoric procurement of raw materials and goods through exchange (Polanyi 1957, Renfrew 1972, Renfrew 1975, Sahllins 1972, Torrence 1986) and some for direct access (Amick 1996, Bamforth 2006, Binford 1979). On review it became clear that exchange models, such as distance decay (Renfrew 1972, Renfrew 1975), relied upon artefact frequencies from numerous archaeological sites in a region, data which simply were not available for northeast Thailand (Boer-Mah 2008a). Thus a theoretical approach which could be applied to single site analysis was required.

Torrence's (1986) general systemic model for exchange was identified to be a suitable base for building an appropriate theoretical framework. The general systemic model separates exchange into four components: acquisition, production, distribution and use. The acquisition component of the model outlines the processes involved in acquiring suitable raw materials for the production of goods. Following acquisition, the raw materials may be exchanged and/or used, but in other cases undergo manufacturing (production) processes and/or are distributed.

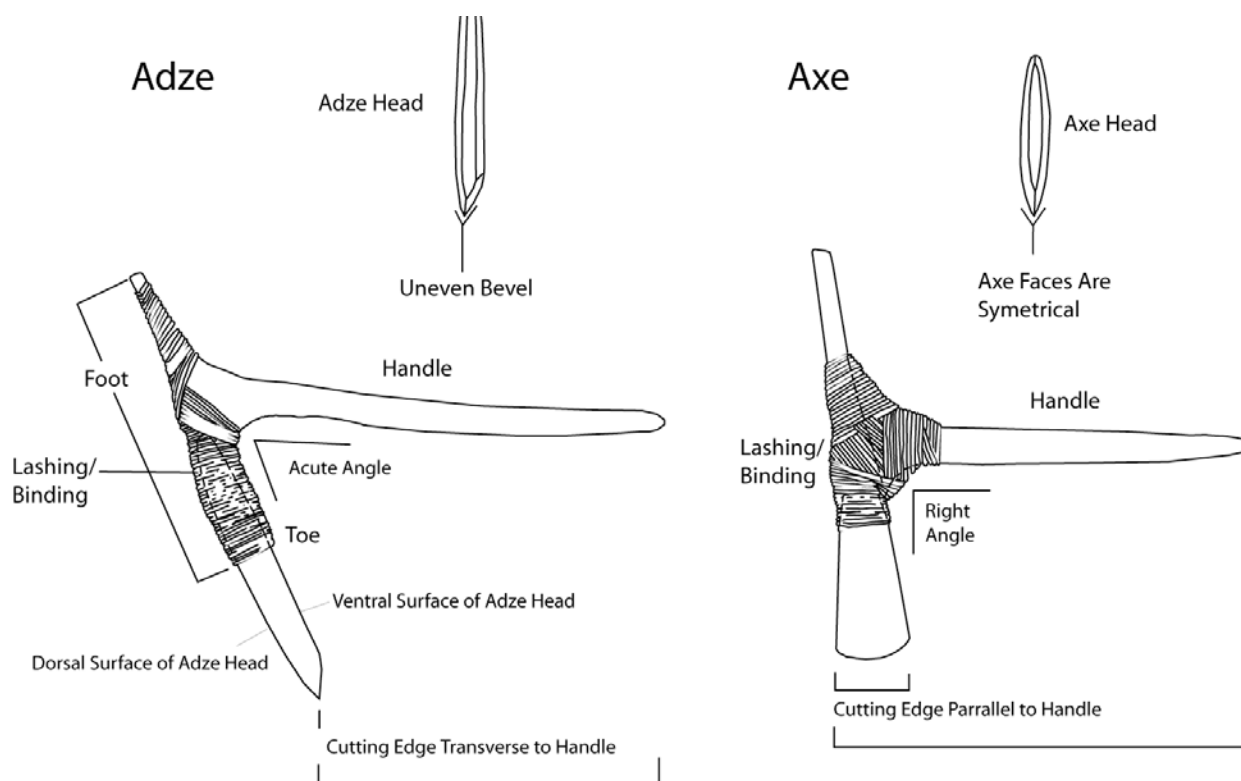


FIG. 7:18 Difference between adzes and axes, after Crosby (1973:16)

In the general systemic model each arrow indicates a possible exchange transaction, thus allowing the modelling of complex or simple exchange systems within the one framework (Fig. 7:19). Torrence (1986) argued that an exchange system influenced how objects were produced and used, and thus was detectable through the analysis of artefacts recovered from archaeological sites. In Torrence's (1986) study the production component of the model was examined using attributes such as standardisation and specialisation to identify exchange.

The elegance of the general systemic model is that it clearly identifies the components of an exchange system, however, by taking out the distribution component this model can also be used to describe direct access (Fig. 7:20). Thus the systemic procurement model can be used

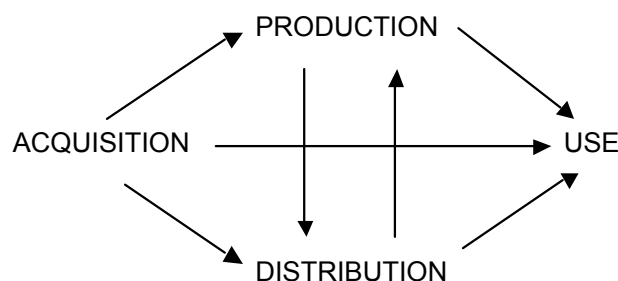


FIG. 7:19 Torrence's (1986) original general systemic model for exchange

to model both exchange and direct access. The systemic procurement model substitutes 'consumption' for the word 'use' in Torrence's (1986) original model to demonstrate clearly that the processes of reduction, repair (reworking) and use of adzes is being considered in this investigation, rather than the more narrowly defined 'function use' of adzes which has often been adopted by previous studies (Turner 2000, Turner 2005). For this investigation, 'consumption' encompasses use of the adze for various adzing tasks as well as related tool maintenance, such as resharpening by regrinding, or reworking by flaking. Due to the nature of the Ban Non Wat assemblage, consumption of adzes is a particularly important component of this study and will be elaborated on in the following section.

ARCHAEOLOGICAL CONTEXT OF BAN NON WAT AND CONSUMPTION

The Ban Non Wat assemblage is particularly suited to the study of consumption, as evidence for production and distribution was not recovered at the site. The majority of the 203 adzes (intact, reworked and broken) were recovered from occupation contexts at Ban Non Wat and are thus related, for the most part, to domestic use (and consumption of this tool). Only four adzes were recovered from Neolithic graves. At Ban Kao in western Thailand (Fig. 7:21), adzes were commonly placed beneath the skull

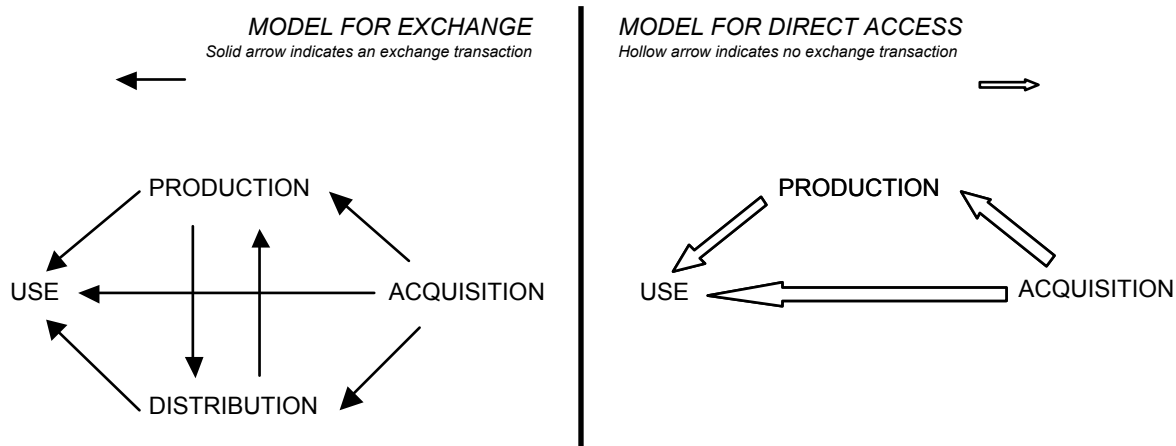


FIG. 7:20 General systemic model for exchange and direct access after Torrence (1986)

and were in clear association with the burial (Sørensen 1967). At Ban Non Wat, adzes were generally placed near the lower leg or feet of the skeleton (Fig. 7:22), however, the frequency of adzes being placed with burials is so low it is not possible to interpret this as a distinct mortuary tradition. Adzes identified with Neolithic graves at Ban Non Wat were not primary (pristine): they displayed signs of prior breakage and/or reworking. It appears that adzes were not a common grave good during the Neolithic at Ban Non Wat relative to other items, such as pottery.

The cultural layers at Ban Non Wat excavated in 10 cm spits, with all features such as pits, postholes, graves furnaces being accorded an unique recording context. Evidence for occupation at Ban Non Wat included features such as postholes, pits, broken pottery, middens of freshwater shell and the occasional occupation floor. Occupation layers in parts of the site had substantial evidence of bioturbation from insect activities. In addition, the digging of pits, postholes and graves for interments caused the mixing of deposits and may have resulted in some post-depositional vertical and/or horizontal movement of adzes. While acknowledging such taphonomic factors, the majority of adzes appear to have been associated with general occupational contexts at Ban Non Wat. Most were recovered from general spits and were not associated with pits, occupation floors, and other features. At Khok Phanom Di, there was evidence for the deliberate caching of adzes and burnishing stones within a pit (Pisnupong 1988). There was no evidence for such caching practices at Ban Non Wat. Adzes were not recovered in concentrations, rather, their (areal) spatial distribution appears random. The majority of adzes were recovered from Neolithic layers (71%), although a notable proportion of adzes were also recovered from Bronze Age (23%) occupation contexts and a few from later prehistoric contexts (6%). This chapter will report on the metamorphic/volcanic adzes recovered from Neolithic contexts (Table 7:19).

There was no clear evidence for adze production at the site: adzes were finished (ground and polished) and lacked cortex. Several dozen flakes of similar stone material to the adzes were recovered from Ban Non Wat. These flakes generally had polish on their platform or dorsal surface, indicating that they had been removed from already-finished adzes. None of the flakes made from metamorphic materials had cortex present. Some flakes had bending initiations, indicating that they had been detached through pressure, perhaps during use of the adze, while others had been struck off by percussion, possibly during reworking of the adze. Flakes were recovered in low quantities, relative to the adzes, their low frequency, presence of polish and size suggest strongly that these flakes were associated with use and/or reworking, rather than the primary production of adzes.

Unworked broken cobbles were also recovered and appear to have been transported to Ban Non Wat, and thus have been identified as manuports. These unworked cobbles do not appear to have been used in adze production, which is intriguing given that stone materials are macroscopically very similar to the adzes.

Relative to other prehistoric sites in Thailand, the adze assemblage from Ban Non Wat is one of the largest samples of ground stone adzes recovered (Table 7:5). The high frequency of adzes recovered from the site is probably related to the large area excavated. Assemblages with comparable frequencies of adzes have tended to have been recovered from manufacturing sites, rather than occupation sites. For example, 172 andesitic tuff adze blanks were recovered at Non Sila quarry in northeast Thailand near the Mekong River (Rutnin 1988, Leyavaniya 1992). The differences in area excavated and numbers of adzes identified, as well as taphonomic and chronological complications for sites in northeast Thailand, inhibited the analysis of adze procurement using previous theoretical frameworks such as distance decay (Renfrew 1972, Renfrew 1975).

That the majority of Ban Non Wat adzes had been re-

TABLE 7:5 *Count of ground stone adzes at sites in Thailand*

Region	Count of complete ground adzes*	Site Name	Reference
Northeast	154 36	Ban Non Wat Ban Lum Khao	This study (94 adzes from Neolithic layers) Higham and Thosarat 2005
	9-14	Non Nok Tha	Bayard 1971 (from burial register, n=9), Ueki n.d. as cited in Rutnin 1988, (n=14)
	9	Noen U-Loke	Higham <i>et al.</i> 2007
	3 4	Ban Tamyae Non Phrik	Welch and McNeill 1990 Rutnin/Leyavaniya 1988, 1992
	2	Tham Pha Phim	Rutnin 1988
Central	89	Ban Tha Kae	Hanwong 1985
	18 71	Khok Charoen Khok Phanom Di	Ho 1984 Pisnupong 1988, 1993
Coastal, Gulf of Thailand	~80	Khok Phanom Di	Fine Arts Department 1982
	6	Nong Nor	O'Reilly 1998
Western	26 10	Ban Kao Sai Yok	Sørensen and Hatting 1967 Sørensen and Hatting 1967
Peninsular	1	Lang Rongrien	Anderson 1990

* Differentiation between complete adzes and adze fragments is not always clearly defined in the available publications, so the absolute numbers cannot be deciphered

covered from occupation contexts (reflecting domestic use, rather than use as mortuary offerings) suggested the assemblage would be ideal for investigating the consumption component of the systemic procurement model, but not for examining either production or distribution.

GEOLOGICAL CONTEXT AND ADZE ACQUISITION

Understanding the geological context of the site, or 'lithic landscape' (Blanton 1985), is important for formulating predictions regarding adze acquisition within the systemic procurement model. In particular, it is important to identify whether potential sources are available in abundance or are scarce, as this will affect predictions formulated. Sources can be primary (quarry) or secondary (non-quarry). A primary source comprises an outcrop of stone in its original geological context, that is, one which has not been transported by erosion or other such mechanisms

(Doelman *et al.* 2008). Rock that is not in its original geological context, that is, has undergone some form of transportation through geomorphological or hydrological mechanisms, is identified as a secondary (non-quarry) source (Doelman *et al.* 2008). Gravels deposited through high water flow in a river are an example of a secondary source. The use of a primary source has different implications for exploitation than a secondary source. A rock outcrop from a primary source may have an abundance of suitable raw material, whereas the quantity of material available in a secondary source may be limited, depending on the geomorphological or hydrological conditions under which it was deposited. Another consideration for secondary sources is that the size of stone material available will depend on how far it has been deposited from its primary outcrop. For example, a study from far east Russia identified that cobble size decreased with increased distance from the primary outcrop, thus, cobbles close to the outcrop were 15–20 cm in diameter, compared with

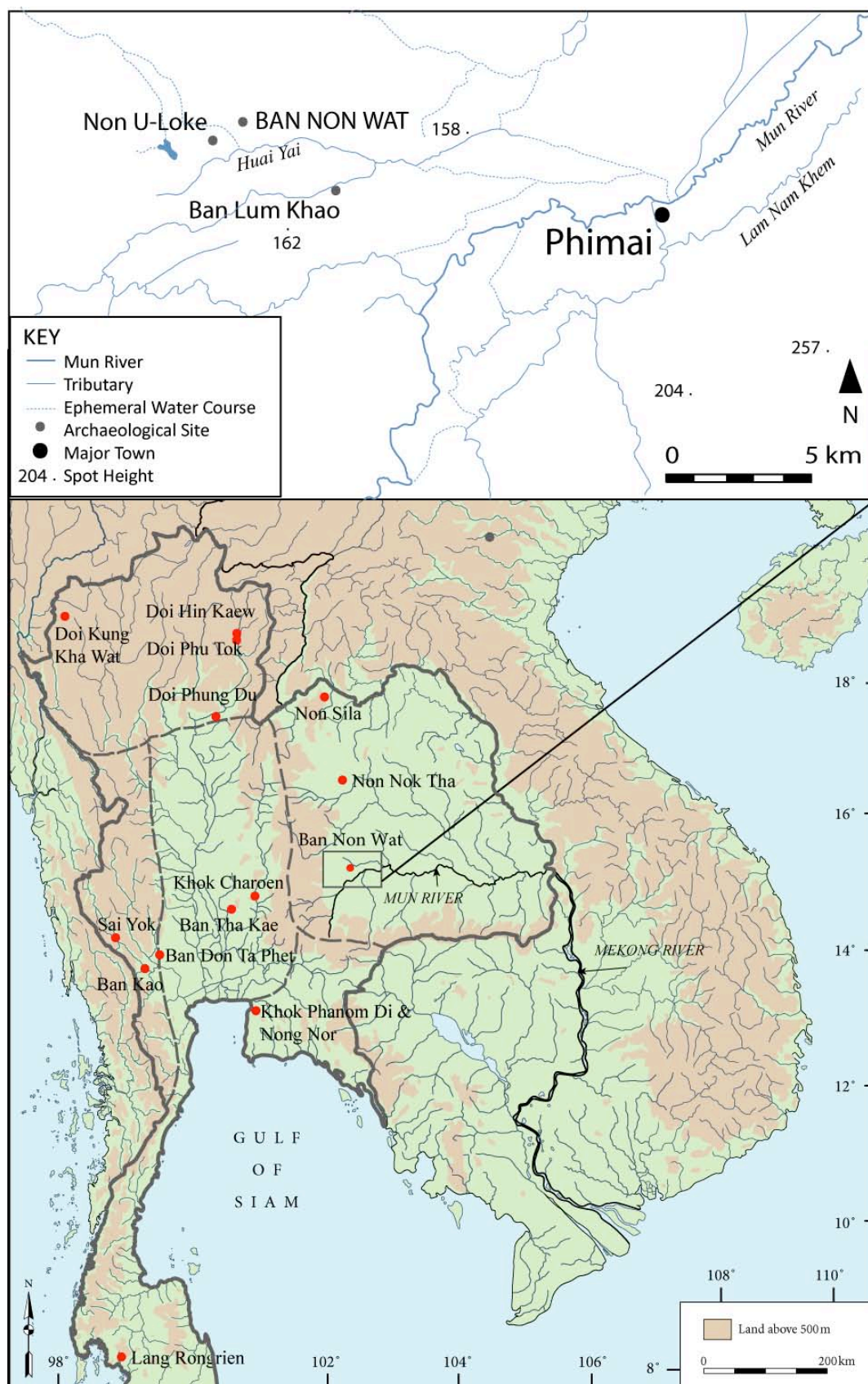


FIG. 7:21 Map of archaeological sites in Thailand



FIG. 7:22 The adzes were found in Neolithic occupation contexts such as D2 5:5 feature 1, left, and rarely with burials such as burial 438, above. Scale 5 cm left and 10 cm above

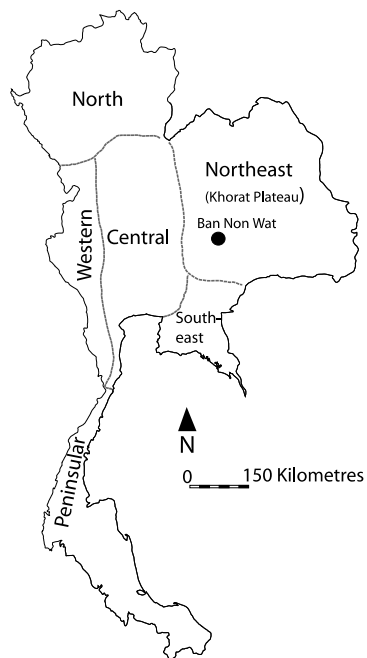


FIG. 7:23 Regions of Thailand

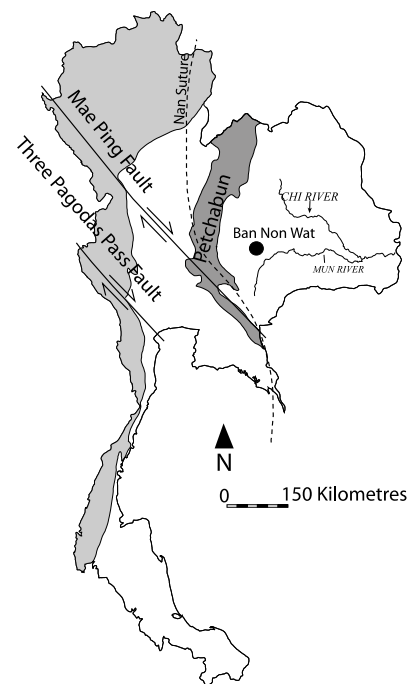


FIG. 7:24 Geology of Thailand, shaded areas show zones of metamorphic and igneous rocks in Thailand, after Racey *et al.* (1996:7)

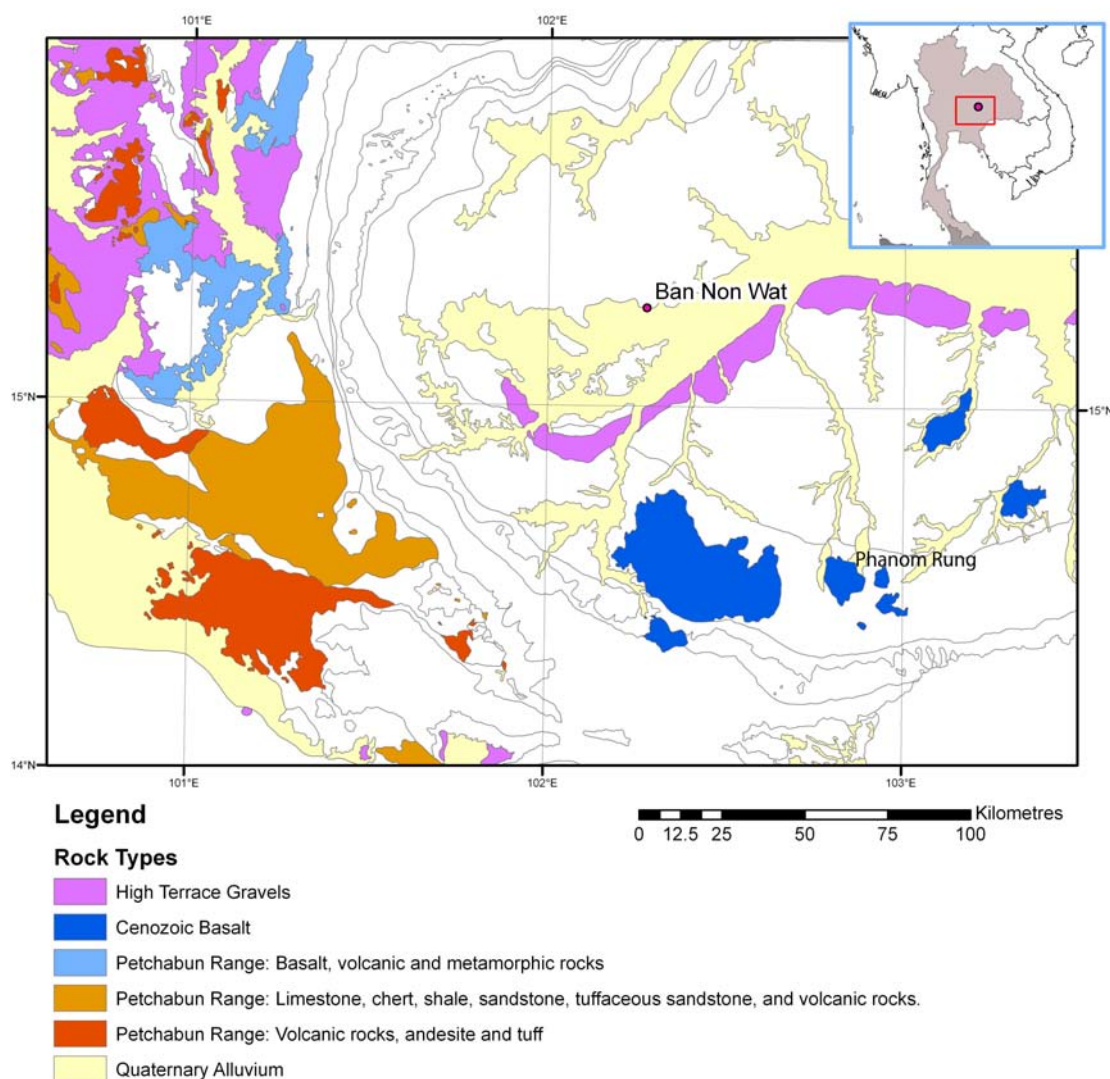


FIG. 7:25 Geological context of Northeast Thailand

5–8 cm 20 km from the source, while cobbles 35 km downstream were 2–4 cm in diameter (Doelman *et al.* 2008). In the far east Russian example, the obsidian had been transported along a river course, however, with increasing distance from the primary outcrop, the size of cobbles will depend on a number of factors, including the hardness of the stone material, the transport mechanisms (rivers, uplift events, and similar), as well as the duration of the transport event/s, among other factors. The implication of this evidence is that while cobble material may be considered as a potential source, further investigation into the size of nodules and quality of raw material should be assessed before it is considered as a raw material source.

The Khorat Plateau on which Ban Non Wat is situated is an area of low relief in northeast Thailand extending 450 km east-west (Fig. 7:23). It encompasses more than 170,000 square km (Parry 1996) and has been described as ‘saucer shaped’ (Moore 1988). It is approximately 200 m above sea level in its westernmost portion, in the east

its elevation is approximately 50 m above sea level. The Petchabun Ranges run along the western border of the plateau, approximately 130 km west of Ban Non Wat. These ranges reach a maximum height of 1500 m above sea level and are part of the Nan Suture (Orberger *et al.* 1995) which separates the central and northeastern regions of Thailand (Fig. 7:23). The Petchabun Ranges include a suite of metamorphic and volcanic rocks which likely contains materials suitable for the production of adzes, this area has often been identified as a potential source of stone for adzes recovered from archaeological sites on the Khorat Plateau (McNeill *et al.* 1991, Welch 1989, Welch *et al.* 1990).

A second potential raw material source comprises basalt outcrops located 60 km south and 100 km west of Ban Non Wat (Fig. 7:24). These basalts were formed from lava flows during the Cenozoic, and are not metamorphosed.

A third potential raw material source for adze production is the high terrace gravels, which until recently had not been included on the 1:250,000 geological maps for

the area, although had been reported by Parry (1996). The current gradient of the Khorat Plateau is too shallow to allow the transportation of cobble material by monsoonal floodwaters from the Petchabun Range along the Mun River catchment. However, it has been argued that approximately 2 million years ago the uplift of the Qinghai-Tibetan Plateau caused the Khorat Plateau to dramatically tilt, causing the extinction of forest cover and exposure of weathered regoliths at increasing slope angles (Parry 1996). This event, combined with high intensity rainfall, erosive surface and subsurface run-off, produced debris floods (*sjels*) which transported weathered rock material from the Petchabun Ranges down on to the Khorat Plateau. It is suggested that these debris floods were channelled through gaps in the *cuestas* bounding the Khorat Plateau and deposited gravels along the proto-Mun River channel, which lies approximately 25 km south of the current course of the Mun River (Parry 1996). Rock types as-

sociated with these high terrace gravels include: volcanic rocks, such as andesites, rhyolites, breccias, metamorphic rocks, as well as banded chert, flint and quartz of various colours (Parry 1996). The deposition of these gravels can be estimated to 0.68 and 0.73 million years ago on the basis of tektites (Parry 1996:165). Subsequent weathering of the surrounding soil during arid periods, as well as strong wind conditions, resulted in a distinctive polish on the high terrace gravels. Parry (1996) identified these wind-faceted pebbles and cobbles with their distinctive polish as *dreikanter*.

The main concentrations of these gravels, as indicated on 1:250,000 maps, are between 25 and 50 km from Ban Non Wat (Fig. 7:25). However, the size of individual cobbles within this secondary source was not reported by Parry (1996), so it was unclear whether adzes could have been made from such gravels. A survey of the high terrace gravels in the Mun River catchment was conducted

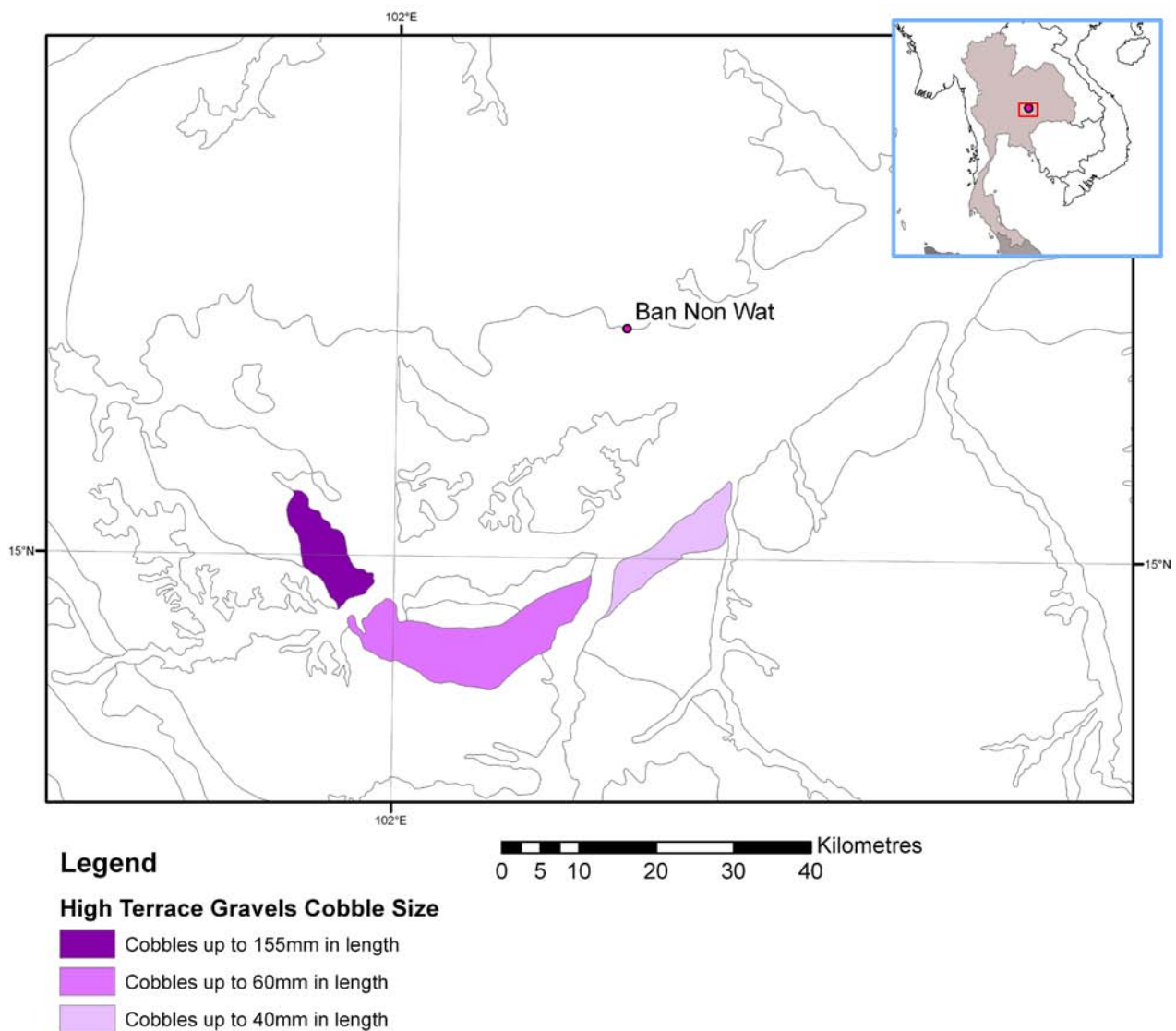


FIG. 7:26 Map of high terrace gravels



FIG. 7:27 Exposure of high terrace gravels in a creek bed. Scale 50 cm



FIG. 7:28 In some areas, gravels were approximately a metre below the current ground surface, note metamorphic cobble (20 cm right of bottom of scale), as well as, distinctive laterite capping above scale (scale is in 10 cm intervals)

in 2009 so that the size of cobbles within this potential source could be gauged.

The survey identified that the high terrace gravels contained metamorphic and volcanic cobbles that were suitable for adze production. Cobbles identified in high terrace deposits in the west were larger than cobbles observed further east, which likely reflects the slowing of the debris flow as it moved further away from the Petchabun Range. Gravels closest to Ban Non Wat (25–30 km south) were up to 40 mm in length, within 40 km of the site, cobbles were up to 60 mm in length, and in areas 50 km away the cobbles were up to 155 mm in length (Fig. 7:26).

The gravels were exposed in areas eroded by stream channels, and were observed to be between 1 and 2.5 metres below ground surface (Fig. 7:27). The gravel layers often comprised quartz pebbles as well as metamorphic cobbles and were often capped by laterite (Fig. 7:28), similar to Parry's (1995) description of the deposits. In some areas, gravels were exposed through surface wash (Fig. 7:29), but were also identified in disturbed contexts, for example ponds associated with Wats, road cuttings and similar (Fig. 7:30).

Cobble materials were of variable raw material quality. Many had a dark polished cortex typical of dreikanter as described by Parry (1996), and when broken the internal colour of rock was also mafic (Fig. 7:31), other cobbles had a rough weathered cortex which was light grey or brown/orange, while the internal rock was grey to dark grey.

While suitable materials for adze production were present within the high terrace gravels, they were not available in abundance, thus it would be considered a scarce source. By contrast, rock available in primary out-



FIG. 7:29 High terrace gravels outcropping as a result of sheet wash



FIG. 7:30 Gravels exposed in disturbed contexts (50 cm scale)



FIG. 7:31 Dreikanter from high terrace gravels, note the mafic interior and wind polished exterior

crops in the Petchabun Range and Cenozoic basalt were likely to have represented abundant sources of raw material. Differences in the quantity of material available in primary and secondary have implications for predictions formulated with regards to procurement, and are discussed in the following section.

Predictions for Consumption and Acquisition arising from the Systemic Procurement Model

The geological overview outlined three potential sources of raw material for adze production: the Petchabun Ranges, the Cenozoic basalt outcrops and the high terrace gravels, each of which are located at varying distances from Ban Non Wat (130 km, 60–100 km and 25–50 km, respectively). As the high terrace gravels were transported from the Petchabun Range through a debris flow, the rock materials within the gravels are potentially identical to materials outcropping in the Petchabun, and hence it was not possible to separate these potential sources on the basis of petrographical characteristics alone. Thus an appropriate theoretical framework and predictions were required.

The nature of adze consumption at Ban Non Wat could be analysed because the adze assemblage had been recovered primarily from occupation contexts. There was no clear evidence for adze production at Ban Non Wat: the site lacked performs and roughouts, and the flakes recovered had polished surfaces indicating that they had been detached from finished adzes. Thus the production component of the model could not be examined. Similarly, there was no evidence for caching at Ban Non Wat, which suggests that it was not a centre for the distribution of adzes in an exchange system, and therefore distribution could not be examined.

Acquisition can be directly observed at a quarry site, or where there is evidence of production at a secondary source. At consumption sites acquisition cannot be observed directly, but may be inferred by using thin-section petrography to identify adze raw materials, which provides essential information that can be used in conjunction with geological maps. Using petrographic methods for the Ban Non Wat assemblage was advantageous because quarry sites had not been identified in the local area and thus acquisition (and production) at thinly-distributed cobble sources would be difficult to detect. Analysing

TABLE 7:6 *Characteristics of potential raw material sources, proposed procurement system and associated predictions for Ban Non Wat*

Source	Source characteristics	Proximity to Ban Non Wat	Assumed quantity at acquisition source	Quantity at consumption site, Ban Non Wat	Procurement system	Consumption predictions for Ban Non Wat	Acquisition predictions for Ban Non Wat
Petchabun Range	Outcrop	130 km	Abundant	Scarce	Exchange	Small adzes Non-primary adzes Highly reduced	Metamorphic/ Igneous adzes High quality raw materials
Cenozoic	Outcrop	60–100 km	Abundant	Abundant	Direct Access	Primary adzes Large adzes Little reduction	Cenozoic basalt adzes High quality raw materials

adze consumption (and reduction) therefore had the potential to provide information useful for examining adze procurement.

The three potential sources for the adze raw material — the Petchabun Ranges, Cenozoic basalt and terrace gravels — each have their own characteristics, as well as being located at varying distances from Ban Non Wat (Table 7:6). Based on their distance from the site, as well as quantity of material at the source, a series of predictions were formulated for each potential source (Table 7:6).

Petchabun Range Outcrops (primary source)

It is proposed that if materials at Ban Non Wat were obtained from the Petchabun Ranges (the most distant source), they would have been likely procured by exchange. As exchange involves a high cost in procurement, it would be expected that stone raw material was economised. New Zealand studies have shown that higher quality adze raw materials were distributed by prehistoric exchange over greater distances than adzes made from lower quality materials (Turner 2000, 2005). Thus in analysing adze consumption it is anticipated that the Ban Non Wat assemblage would have small adzes, non-primary adzes (adzes which have been reworked and used), and high levels of reduction. It would be expected that the adze materials acquired would be metamorphic or volcanic materials which outcrop in the Petchabun Ranges and that high quality raw materials would be exploited. Adzes made from higher quality materials are more resistant to breakage, which increases their value in an exchange system, and their exploitation would be expected as part of the economisation strategies associated with exchange (Torrence 1986).

Cenozoic Basalt Outcrops (primary source)

If adzes or raw materials were procured from the Cenozoic basalt outcrops (which are closer to Ban Non Wat than the Petchabun Ranges), they would likely have been procured by direct access. Procurement from a primary source/quarry would mean there was an abundance of raw material, thus it could be expected that primary adzes would be present, the adzes would be large and they would not have undergone extensive reduction. In terms of acquisition, it would be expected that if the primary outcrops of Cenozoic basalt were exploited (an abundant source), then the higher quality materials at this source would be targeted.

High Terrace Gravels (secondary source)

The survey indicated that metamorphic and volcanic cobbles were thinly distributed among other materials within the high terrace gravels. Thus the availability of suitable raw material was low within the gravels and therefore would be classed as a non-abundant or scarce source. This potential source therefore requires a greater investment of time and labour in its exploitation than a gravel deposit

with abundant quantities of cobbles. Predictions for the high terrace gravels have been formulated with consideration to quantity of raw material available.

For exploitation of the high terrace gravels, raw materials would have to have been collected over a larger area, adding to the cost of procurement. In terms of adze consumption, it would therefore be expected that adzes would be small, non-primary and highly reduced. For acquisition, it would be expected that adzes were made from metamorphic or volcanic materials.

It is expected that the exploitation of the high terrace gravels may have resulted in poorer quality materials being utilised. The exploitation of poorer quality materials has been attributed to direct access of nearby cobble sources for Neolithic celts recovered from Frankthi Cave in Greece (Stroulia 2003). Cobble sources, particularly those deposited in debris flows, are likely to be variable in terms of raw material quality. It has been argued that cobbles transported by water are likely to contain high quality materials, since lower quality material with internal flaws is likely to have broken during river transport (Dickson 1981). However, cobbles transported in debris flows are likely to have been cushioned by surrounding sediment and mud in transport, resulting in both high and low quality materials being deposited in high terrace gravels. While raw material is usually tested by prehistoric knappers before manufacture, certain types of internal flaws may not have always been detected. It is therefore predicted that the exploitation of the high terrace gravels may have involved the exploitation of both high and low quality raw material.

ADZE CONSUMPTION AT BAN NON WAT

Predictions regarding size, primary/non primary adzes and reduction were developed for analysing adze consumption at Ban Non Wat. Three potential sources were identified and adze consumption predictions formulated according to whether the materials were procured from a nearby secondary source (high terrace gravels) or primary sources (Cenozoic basalt outcrops or the Petchabun Range).

Adze Size

In order to contextualise the size of adzes at Ban Non Wat, adze length data from other sites in Thailand were used for comparison (Table 7:7). The Ban Non Wat adzes were similar in length to adzes from Ban Lum Khao (located 15 km to the southeast). On average they were slightly larger than the Khok Phanom Di adzes, but smaller than those from Ban Kao. Pisnupong (1988) identified that the Khok Phanom Di adzes had been highly reduced, reworked and many had been broken, suggesting that the prehistoric inhabitants were attempting to maximise the utility of the tool. He suggested that adzes were likely procured by exchange, although a cobble source was also considered.

TABLE 7:7 *Comparison of adze length*

Site	Min of Length (mm)	Max of Length (mm)	Mean of Length (mm)	Std Dev of Length (mm) ²	Count of Length (mm)
Ban Non Wat	30.1	75.0	53.1	10.4	95
Ban Lum Khao	34.5	75.8	51.8	10.7	36
Khok Phanom Di	19.0	88.2	45.4	12.8	74
Ban Kao	38.0	220.0	83.4	43.8	38
Total					243

The results from Khok Phanom Di suggest that adzes procured by exchange resulted in a lack of abundance of raw material supply and thus the adzes were highly reduced and reworked.

By contrast, Ban Kao, with the largest adzes, is located within 20 km of the Three Pagodas Fault, which contains large outcrops of metamorphic rock. Ban Kao is the only site of those tabulated which is in close proximity to an abundant source or raw material. That it also has the largest adzes suggests that the conservation of raw material was not as important at this site as it was for sites further away from raw material sources. The inclusion of adzes as burial goods at Ban Kao also suggests an abundance in the supply of raw material, which allowed such valuable implements to be extracted from domestic use and expended in mortuary ritual, a luxury which was not paralleled at other sites such as Ban Non Wat, Khok Phanom Di and Ban Lum Khao where raw material supply appears less abundant. The comparison of adze length between sites suggests that there is a correlation between adze size and raw material availability, thus shedding some light on adze procurement.

Intactness: Primary/Non-Primary

It has been proposed that the presence of primary adzes as a consumption site would indicate that raw material was in abundant supply and therefore may have been acquired locally. Conversely, high frequencies on non-primary adzes would indicate that raw material was scarce and therefore may have been procured through exchange, or from a non-abundant local source.

Intactness, along with size, was used to gauge whether adzes were primary or not. Four levels of intactness were identified and defined: IRI, intact or relatively intact, EBR, evidence for breakage and/or reworking, SER, substantial evidence for reworking, and BN, broken (Table 7:8). The intactness of the adze is also important in understanding adze form, whereby low levels of intactness may lead to variation in adze form as breakage and reworking alter the original adze morphology.

The majority of Neolithic adzes at Ban Non Wat had evidence for prior breakage or reworking (63 %) (Table 7:9). While the remaining appeared intact or relatively intact (37%), they were of similar size to the reworked and adzes which had evidence for prior breakage (Table 7:9). This suggests the adzes which appeared intact or relatively intact had been substantially reduced. If these intact adzes were primary, it would be expected that on average they would be larger than adzes which had been reworked. The results suggest that the adzes at Ban Non Wat were not primary and had undergone varying degrees of resharpening and reworking (Figs. 7:32-7).

A consequence of the high levels of prior breakage

TABLE 7:8 *Levels of intactness*

Acronym	Description	Definition
IRI	Intact or relatively intact	These adzes are considered complete and have a cutting edge, shaft and poll, although there may be some damage along the blade in some cases, this does not affect the overall form of the adze.
EBR	Evidence of breakage or reworking	Adzes with some evidence of breakage or reworking, but appear not to affect the overall adze shape. For example, some adzes appear to have lost a small amount of material from the tip of the poll. Others had reworked cutting edges (where flakes had been removed from the edge). EBR adzes are likely to provide a reasonable impression of complete adze form.
SER	Substantial evidence of reworking	These adzes been reworked extensively with multiple removals of flakes, which has likely affected the adze form. It is very difficult to ascertain, the nature of the adze's original shape.
BN	Broken	This category was used to describe broken adzes (adze fragments). Such fragments could include recognisable portions of the adze, such as, cutting edge, shaft or poll. Miscellaneous adze fragments included fragments which had a polished surface, but the portion of the adze represented in the fragment could not be identified.

TABLE 7:9 *Intactness of Neolithic adzes at Ban Non Wat*

Intactness	Count	Percent	Length (mm)		Mean	Std. Dev.
			Minimum	Maximum		
Intact or Relatively Intact (IRI)	35	37.11%	30.10	73.59	54.18	10.09
Non-primary adzes (with evidence of breakage and/ or reworking (EBR, n=38, SER, n=21)	59	62.89%	33.41	75.00	52.21	10.53
Total	94					

and/or reworking was that the form of the adzes was highly variable, with twenty different adze non-shouldered forms, six shouldered forms and two adzes for which only the cross-section could be discerned (Table 7:10). By contrast, the relatively intact adzes had twelve non-shouldered adze forms and two shouldered forms (Table 7:11). The results suggest that much of the variation in adze form at Ban Non Wat is influenced by the life-history of the adze. The life-history, or use-life, comprises the cycle of events which an artefact may have undergone during its life within the systemic context. Such events include procurement, manufacture, use, maintenance and discard (Schiffer 1972). In this case, breakage of adzes at Ban Non Wat altered the overall shape of the adze. In some cases this could be overcome by re-grinding the broken edge, in other situations flaking of the lateral margins, poll or blade was required to reshape the adze so that it could be re-sharpened and re-hafted (Fig. 7:38). Another method of rejuvenation of broken adzes observed at Ban Non Wat was to add flaked modification shoulders, these shoulders were created by flaking finished (polished) adze fragments (Fig. 7:37). These three strategies for repairing broken adzes likely contributed to the wide variation in adze form at Ban Non Wat (Fig. 7:38).

The analysis of adze intactness and form indicate that adzes at Ban Non Wat were non-primary: many showed signs of previous breakage and/or reworking. Analysis of adze size demonstrated that adzes which appeared intact, or relatively intact, were of similar size to reworked adzes, which suggests that they had undergone substantial reduction and therefore were non-primary adzes. The wide variation in adze form can be attributed to changes in adze morphology due to breakage and/or subsequent repair by re-grinding or flaking. These results are significant because they suggest that the inhabitants of Ban Non Wat were maximising the utility of the adze raw material. This may have been a response to a scarcity in supply of adze raw materials, and will be further elaborated in the following section.

Adze Reduction

Reduction is the process by which stone is removed in the production, maintenance and use of stone artefacts,

stone mass can only be reduced, not added (Shott 2005). As such, reduction can provide information on adze consumption and whether raw material was available in abundance for the prehistoric inhabitants of Ban Non Wat. It is proposed that an abundant supply of adze raw materials would result in less reduction of the adzes, whereas a scarcity in availability of stone would result in high levels of adze reduction, thus providing testable predictions for analysing adze procurement.

Often, reduction of flaked implements can be gauged by examining features such as increased concavity (for notched tools), as well as edge steepness and overlapping scars (Blades 2003, Clarkson 2002, Clarkson *et al.* 2005, Dibble 1984, 1987, Grimes *et al.* 1985, Kuhn 1990). For ground stone implements a combination of tool size (length) and tool morphology have been adopted as indicators of reduction. Lekberg (2000), for instance, identified that smaller shaft hole axes had a small polished groove in the butt end (heart-shaped butt), which indicated the axe had once been larger, and used this morphological attribute along with axe length to detect reduction in assemblages.

At Ban Non Wat a morphological transition between shouldered and non-shouldered forms provides evidence for reduction in the assemblage (Boer-Mah 2008b). As shouldered adzes are re-sharpened, stone material is removed from the blade, which shortens the adze shaft (Fig. 7:39). As the adze continues to be sharpened the shaft becomes shorter than the tang length (cat 21889, Fig. 7:36) until only a remnant lip of the shoulder is apparent (cats. 3172 and 15055, Fig. 7:35). Once the remnant lip of the shoulder is ground away, the adze will take on the form of a non-shouldered adze (cat. 16067, Fig. 7:32).

The majority of shouldered adzes at Ban Non Wat had ovoid tang sections (Table 7:12), thus, once the shoulders were ground away through resharpener it became a non-shouldered adze with an ovoid tang section. Approximately ten percent of non-shouldered Neolithic adzes at Ban Non Wat had ovoid shaft cross-sections (Table 7:13), which suggests that these adzes were previously shouldered. These non-shouldered adzes with ovoid cross-sections and transitional stage adzes (with remnant lip) suggest that adzes at Ban Non Wat were highly reduced.



FIG. 7:32 Non-shouldered adzes



FIG. 7:33 Non-shouldered adzes



FIG. 7:34 Non-shouldered adzes showing substantial evidence for reworking



FIG. 7:35 Intact or relatively intact shouldered adzes



FIG. 7:36 Shouldered adzes with evidence for breakage or reworking

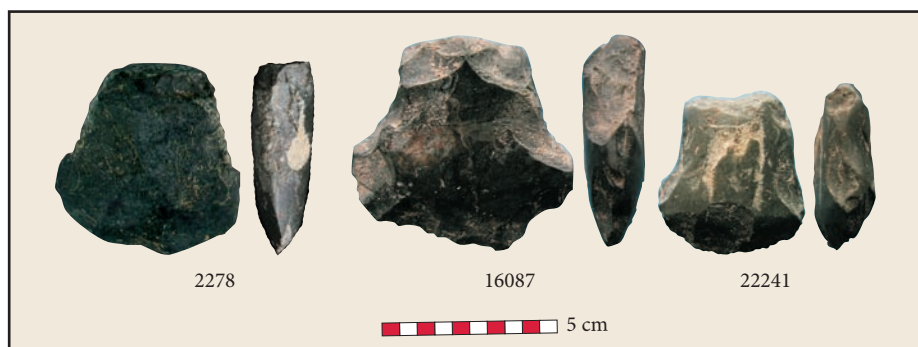


FIG. 7:37 Shouldered adzes with substantial evidence for reworking

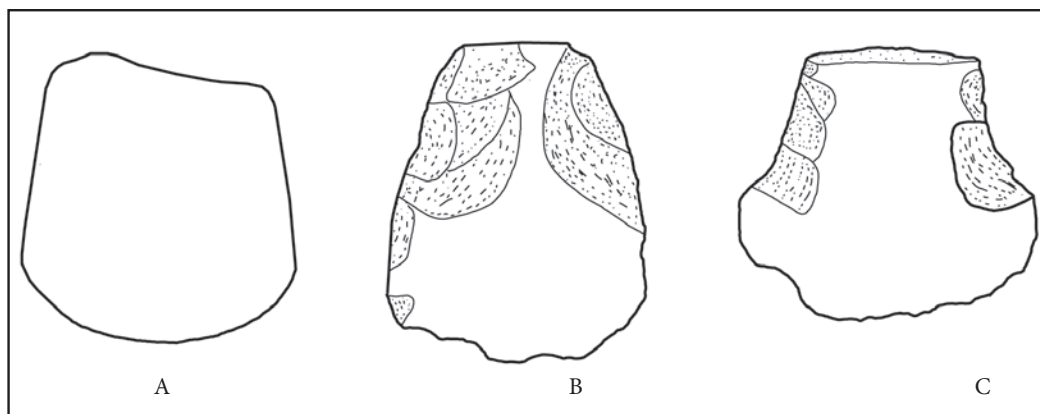


FIG. 7:38 Strategies for repairing broken adzes at Ban Non Wat: a) re-sharpen/ regrind break, b) reshape break by flaking thus modifying lateral margins, poll, or blade, c) flake lateral margins to create a shoulder

TABLE 7:10 *Forms of adzes with evidence of prior breakage and/or reworking*

	Form	Count	Percent
Non-shouldered adze forms (n=20)	NS[CT-L/]	7	11.86%
	NS[CZ-L/]	7	11.86%
	NS[CO-L/]	4	6.78%
	NS[CE-L/]	4	6.78%
	NS[CZ-S/]	3	5.08%
	NS[PO-O/]	3	5.08%
	NS[PO-L/]	2	3.39%
	NS[/-L/]	1	1.69%
	NS[/-S/]	1	1.69%
	NS[C/-L/]	1	1.69%
	NS[CR-L/]	1	1.69%
	NS[CT-O/]	1	1.69%
	NS[CT-P/]	1	1.69%
	NS[CZ-O/]	1	1.69%
	NS[P/-L/]	1	1.69%
	NS[PO-S/]	1	1.69%
	NS[PR-L/]	1	1.69%
	NS[PS-L/]	1	1.69%
	NS[PS-S/]	1	1.69%
	NS[PZ-L/]	1	1.69%
Shouldered Adze Forms (n=6)	SH[SG-LO]	5	8.47%
	SH[SS-LO]	3	5.08%
	SH[SF-LO]	3	5.08%
	SH[SF-OL]	1	1.69%
	SH[SG-OO]	1	1.69%
Very Damaged Adzes (only cross-section could be discerned)	SH[SS-PP]	1	1.69%
	/[/-L/]	2	3.39%
Total		59	

Synthesis of Adze Consumption at Ban Non Wat

These adze consumption practices resulted in a wide variation in adze shape and form at Ban Non Wat. In particular, breakage and damage of the adzes drastically altered the shape of the adze, leading to a number of reworking strategies being employed to rejuvenate and repair the tool (Fig. 7:38). The continued resharpening of shouldered adzes eventually exhausted the shoulder, resulting in a non-

TABLE 7:11 *Forms of adzes, intact or relatively intact*

	Form	Count	Percent
Non-shouldered adze forms (n=12)	NS[CT-L/]	7	20.00%
	NS[CO-L/]	7	20.00%
	NS[PO-L/]	4	11.43%
	NS[CZ-L/]	2	5.71%
	NS[CE-L/]	2	5.71%
	NS[CZ-S/]	1	2.86%
	NS[PO-O/]	1	2.86%
	NS[CO-O/]	1	2.86%
	NS[CO-S/]	1	2.86%
	NS[CT-LO]	1	2.86%
	NS[CT-S/]	1	2.86%
	NS[PR-S/]	1	2.86%
Shouldered adze forms (n=2)	SH[SS-LO]	5	14.29%
	SH[SG-LS]	1	2.86%
Grand Total		35	100.00%

shouldered adze. These processes of repair and resharpening caused changes to adze form during the use-life of the tool. Such changes in adze form provide evidence for reduction in the assemblage and thus form a reduction continuum, whereby tool morphology changes as the tool is reduced through maintenance or use (Hiscock *et al.* 2002, 2005). Two reduction continua related to breakage and the shouldered to non-shouldered transition have been detected at Ban Non Wat, and are illustrated in figure 7:39.

TABLE 7:12 *Tang cross-sections of shouldered adzes*

Tang Cross-section	Count	Percent
Ovoid	17	85.00%
Lenticular	1	5.00%
Plano	1	5.00%
Sub-Rectangular	1	5.00%

TABLE 7:13 *Shaft cross-sections of non-shouldered adzes*

Shaft Cross-Section	Count	Percent
Ovoid	7	9.72%
Lenticular	54	75.00%
Sub-rectangular	10	13.89%
Plano	1	1.39%
Total	72	100.00%

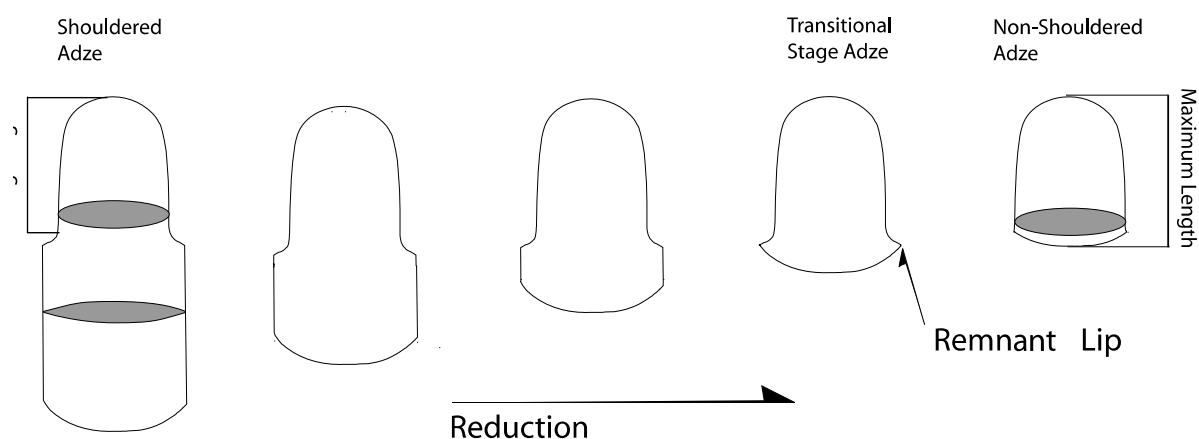


FIG. 7:39 Reduction sequence from shouldered to non-shouldered adze forms

However, reduction does not always result in changes in form throughout the use-life of the adze (Fig 7:40) and thus adze length is also a useful attribute for detecting adze reduction.

The reduction continua for adzes at Ban Non Wat demonstrate that the adze forms (and adze types) may be influenced by resharpener and repair, and this is particularly important for the analysis of consumption adze assemblages. The results suggest that the use of traditional Southeast Asian adze typologies (eg. Duff 1970) may not be a productive interpretive framework for analysing assemblages recovered from consumption contexts.

On the basis of adze length, primary/non primary adzes and reduction, the results suggest that raw material was being economised by the prehistoric inhabitants of Ban Non Wat. Adzes were re-sharpened by grinding and used extensively, thus resulting in small adzes. Examination of intactness (primary/non-primary adzes) and reduction (shouldered to non-shouldered transition) also indicates that adzes were reworked and re-ground to maximise the utility of the stone raw material. These results are important because they suggest that stone raw material was not available in abundance at Ban Non Wat. A scarcity of supply in stone raw material implies that adzes were either being procured by exchange from the Petchabun Ranges or were being procured locally from the high terrace gravels, which is a non-abundant secondary source. These implications will be further explored in the following section.

ADZE ACQUISITION AT BAN NON WAT

Using the systemic procurement model, predictions for raw material type and raw material quality were formulated to examine adze acquisition. Raw material type was examined using thin-section petrography and raw material quality was investigated through an analysis of fracture characteristics.

Thin-Section Petrography

Thin-section samples were taken from broken adzes and examined under unpolarised and cross-polarised light.

The results revealed that the majority of adze fragments sampled were metamorphic in origin ($n=46/48$, 96%). Photomicrographs of these adze fragments were presented in the previous volume in this series (Boer-Mah 2009). The results suggested that the majority of adzes were procured from a metamorphic source, that is, from the Petchabun Ranges or from high terrace gravels. The origin of the adze was basalt, however, this could either be from the nearby Cenozoic basalt outcrops or the Petchabun Range. In order to clarify this, the Cenozoic basalt outcrops to the south of Ban Non Wat were surveyed and

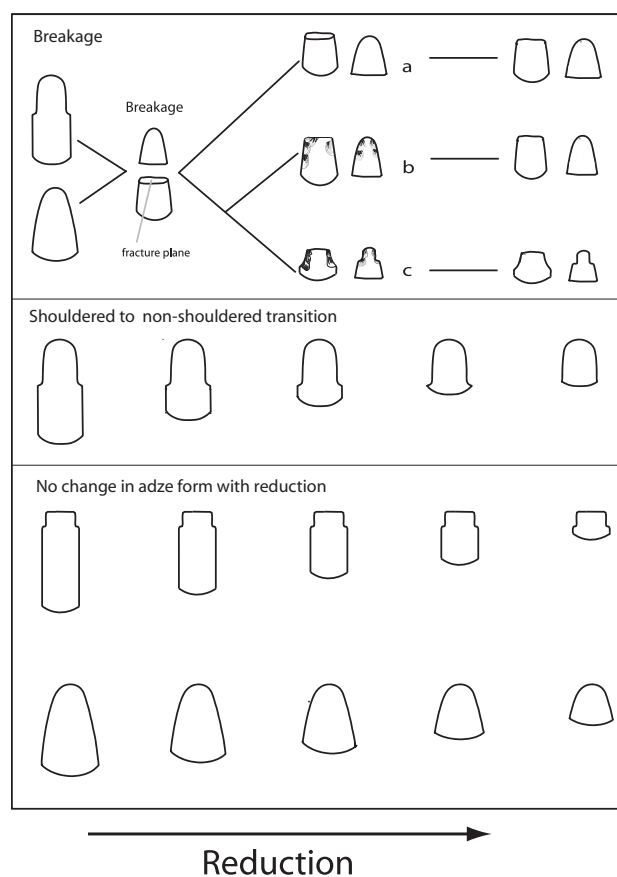


FIG. 7:40 Adze reduction continua identified at Ban Non Wat



FIG. 7:41 Basalt boulders from outcrops to the south of Ban Non Wat

samples collected for thin-sectioning.

The survey identified continuous exposures of outcropping basalt at Phanom Rung, however, the rock at this location was generally pitted from numerous air vesicles and thus unsuitable for adze manufacture (Fig. 7:25). More suitable basalt was observed as boulders in areas to the west of Phanom Rung (Fig. 7:25). The cortical surfaces of the boulders tended to be grey or red and external weathering generally penetrated 1–2 cm into the interior of the rock, which was generally medium to coarse grained (Fig. 7:41).

The thin-section petrography of the basalt outcrop

samples (n=22) showed much internal weathering of the rock had taken place: often olivine grains had rim alteration (goethite), as well as chlorite replacement. Corroded phenocrysts provided evidence for internal weathering (Fig. 7:42). By contrast, olivine grains from the basalt adze fragment were unaltered and internal weathering of rock was not observed (Fig. 7:43). The results indicate that the adze raw material was not derived from Cenozoic basalt outcrops to the south of Ban Non Wat, but is likely to have been derived from the Petchabun range — either from *in-situ* outcrops in the range or cobbles transported and deposited as high terrace gravels.

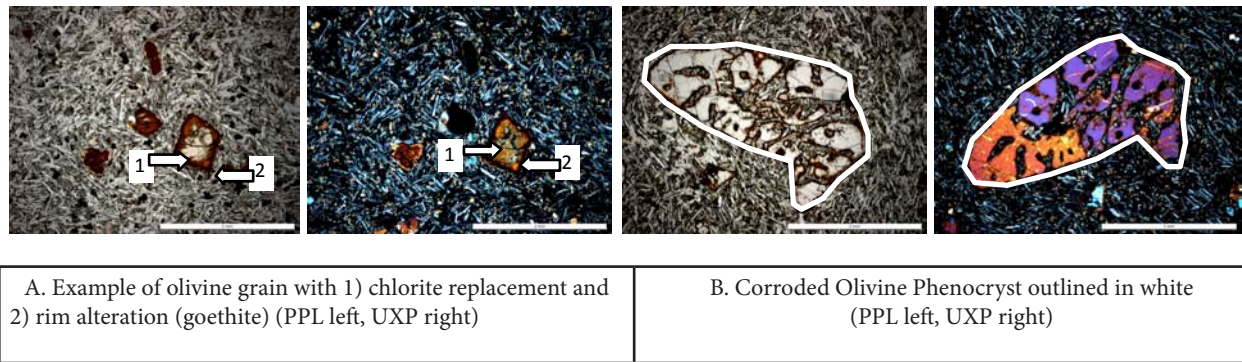


FIG. 7:42 Photomicrograph of a sample from a Cenozoic basalt outcrop

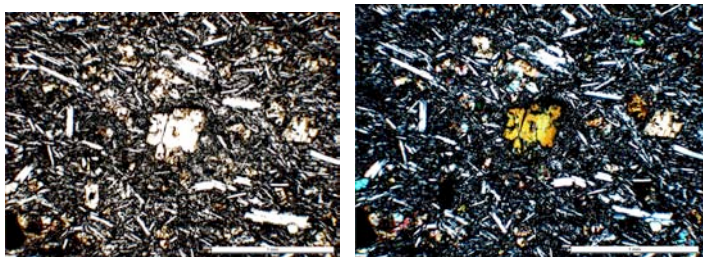


FIG. 7:43 Photomicrograph of a basalt adze fragment. Overall texture (PPL left, UXP right)

TABLE 7:14 *Fracture characteristics*

Reason for Fracture	Fracture Characteristic	Description
Poor quality raw material	Non-Uniform	Fracture surface is uneven and jagged, and is likely to be associated with flaws in the stone resulting in a raw material failure.
	Diagonal Non-Blade Initiated (Diagonal-NBI)	A diagonal fracture plane which has not been initiated from the blade, and is likely to be associated with flaws in the stone resulting in a raw material failure.
	Multiple	More than one fracture plane is present on the adze fragment and is likely to be associated with the use of poor quality raw material.
User Error	Transverse	The adze is broken transversely in the haft or at the junction between the hafted portion of the adze head and adze shaft.
	Blade Initiated Diagonal	Created when the adze has missed its target, a mis-strike or was used on inappropriate materials. Force travels diagonally through the adze head.

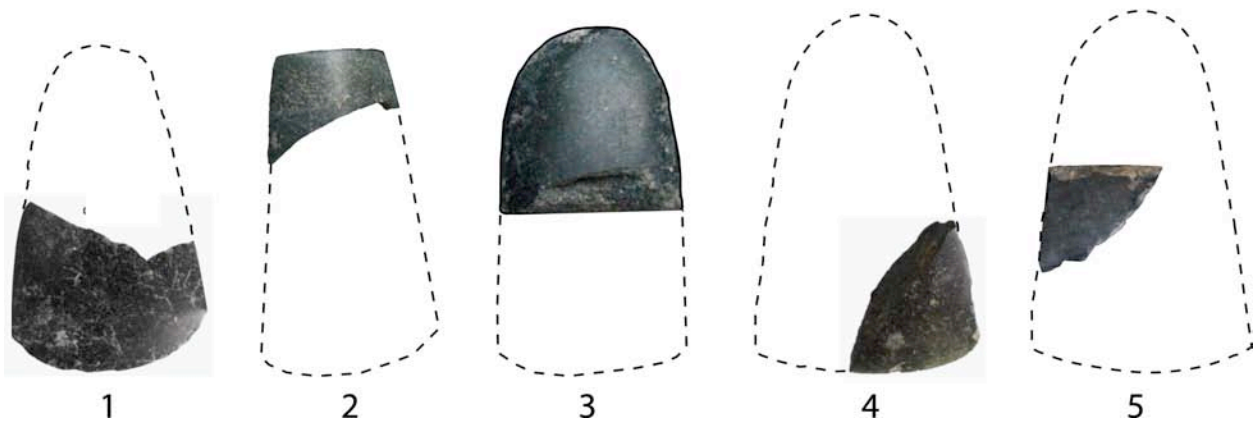


FIG. 7:44 Illustration of different kinds of adze fractures 1) non-uniform, 2) diagonal-not blade initiated, 3) transverse, 4) blade initiated diagonal and 5) multiple

TABLE 7:15 *Shoulder shapes and shaft cross-sections IRI*

Reasons for Fracture	Characteristics	Count	Percent
Poor Quality Raw Material	Non-uniform	24	
Multiple		22	
Diagonal (non blade initiated)		4	
Sub-total		50	45.87%
User error (low or high quality raw material)	Transverse	51	46.79%
Blade initiated diagonal		8	7.34%
Sub-total		59	54.13%

Raw Material Quality

This section will examine whether the Ban Non Wat adzes were made from high quality raw material, or variable quality raw material. As the Petchabun Range is over 130 km from Ban Non Wat, has large outcrops of raw material and is an abundant source, it was predicted that high quality raw materials from this area would be exploited to offset the cost of procurement. By contrast, the high terrace gravels, located between 25 and 50 km of Ban Non Wat, was predicted to be a non-abundant source with both high and low (variable) quality raw materials present. It was predicted that adzes made from low quality (variable) raw material would be present if the high terrace gravels were exploited.

Adze fracture characteristics were examined in order to assess raw material quality. Fracture of the adze head occurs when the tensile strength of the raw material is exceeded by the forces applied to the tool, in materials science this is referred to as mechanical failure, or fatigue wear (Buckley 1981). Fractures of the adze head can be propagated in a number of different ways, and it is proposed that certain kinds of fractures are associated with the exploitation of low quality raw materials (Table 7:14 and Fig.7:44).

It has been argued that high terrace gravels may contain cobble material with insipid internal flaws, and that such weakness may not have always been apparent during the initial testing and flaking of the cobble. If poor quality raw material was used for adze heads, mechanical failure of the raw material would be expected, and such failure would be associated with non-uniform, diagonal (non-blade initiated) and multiple fracture characteristics. Other types of fractures (transverse and blade-initiated diagonal) may occur as a result of user error and occur in both low and high quality raw materials.

Adze fragments were commonly recovered (n=109) from Neolithic contexts at Ban Non Wat and had a variety of fracture characteristics (Figs. 7:45-6). Analysis of the Ban Non Wat adze fragments revealed that approximately 46 % of fracture characteristics could be attributed to the

use of poor quality raw materials in manufacture (Table 7:15). The remaining fragments had transverse or blade-initiated diagonal fracture characteristics, which can be attributed to user-error and may occur on low and high quality materials. The results indicate that poor quality raw materials were exploited, which suggests procurement from the high terrace gravels.

A plot of maximum length and weight of cobbles observed in high terrace gravel 50 km from Ban Non Wat shows that they were of suitable size for the production of adzes (Fig. 7:47). However, gravels closer to Ban Non Wat (25–45 km) were generally too small for adze production. This suggests that while the prehistoric inhabitants of Ban Non Wat had access to local raw materials, the acquisition of cobbles over 50 km away would have involved substantial costs in procurement. To mitigate such costs the utility of the adze raw material was maximised through repair and reworking of broken adzes, leading to high levels of reduction in the assemblage.

High Terrace Gravels: Petrified Wood and Manuports

The procurement of adze materials from high terrace gravels 50 km from the site may have involved exchange and/or direct access. However, the presence of petrified wood and manuports suggests that at least some of the stone material was procured by direct access.

Petrified wood is associated with the deposition of the high terrace gravels (Parry 1996) and was observed during the survey of the cobble deposits. Similar sized petrified wood has also been recovered from Neolithic contexts at Ban Non Wat (Fig. 7:47), suggesting that the prehistoric inhabitants had access to the high terrace gravels. The petrified wood recovered from the site is not in association with burials or other features, and there is no other evidence that it was valuable enough to have been exchanged. It is therefore more likely to have been procured during direct access trips to the high terrace gravels.

The presence of metamorphic manuports at Ban Non Wat is intriguing since there is no clear evidence for adze production at the site. The manuports comprise dark grey/green unworked broken cobbles and rock fragments. Many of the cobbles were rounded to angular in shape with a highly polished cortex, similar to dreikanter, and thus are likely derived from the high terrace gravels (Fig. 7:49).

Manuports were recovered from all occupation contexts in the main excavation area at Ban Non Wat. Layer 4 at Ban Non Wat, predominantly Neolithic, contained the highest count of manuports, as well as the highest count of whole adzes and adze fragments, suggesting there is a relationship between the two (Table 7:16).

The thin-section petrography identified that the manuports comprised metamorphosed rocks: meta-basalt, meta-andesite and meta-dolerite (Table 7:17, Figs. 7:50-51), and therefore were suitable for adze production. The size and weight of the manuports also suggests they could



FIG. 7:45 Broken adzes



FIG. 7:46 Broken adzes

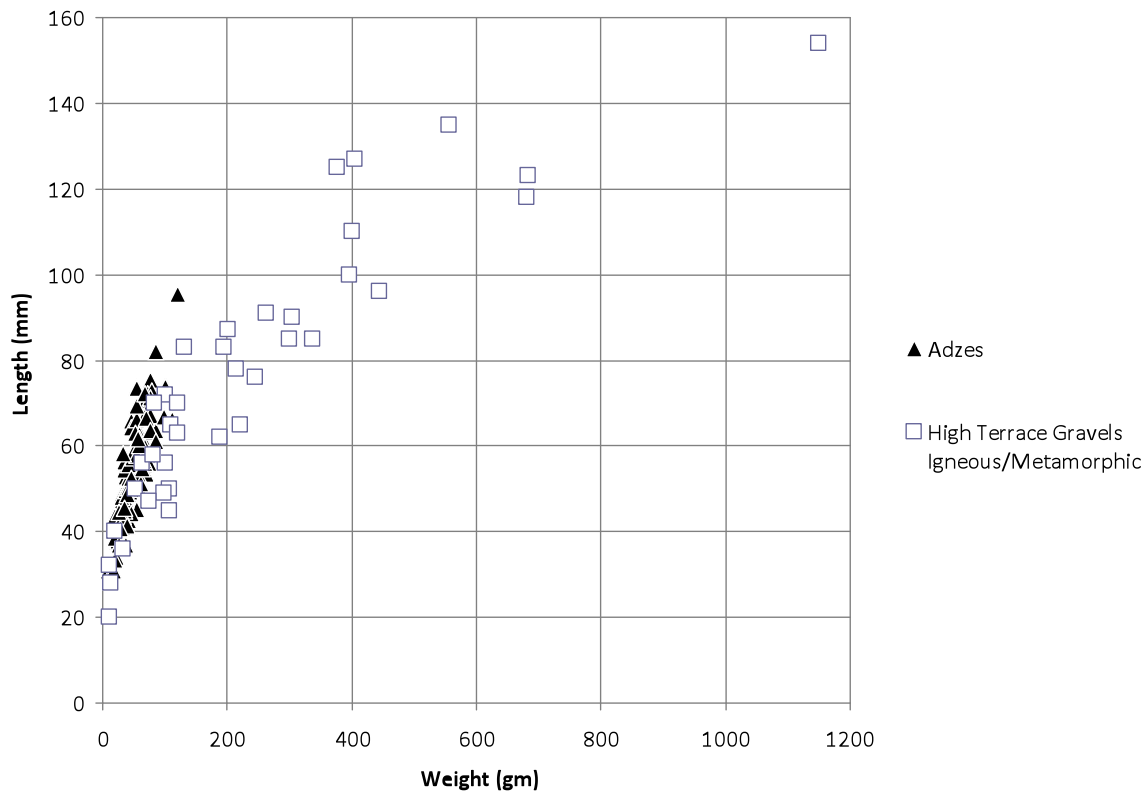


FIG. 7:47 Comparison of adzes and high terrace gravels on the basis of maximum length (millimetres) and weight (grams)



FIG. 7:48 Petrified wood collected from high terrace gravels (left) and a sample of similar petrified wood recovered from Layer 3:4 at Ban Non Wat.

have been used for adze production (Table 7:18 and Fig. 7:47). Despite these associations there is no clear evidence for adze production in the areas excavated at Ban Non Wat. One possibility is that adze production at Ban Non Wat was undertaken in a fairly contained area which was not subject to excavation. Another possibility is that the primary flaking and production of adzes was being undertaken at the secondary source and that adzes arrived at the site as roughouts or preforms which were then ground and finished, and that other metamorphic material (manuports) were being collected for an industrial or domestic



FIG. 7:49 Comparison of cobbles collected during survey (left) and material recovered from Ban Non Wat, manuport, Cat. 16632 (middle) and adze, Cat. 7658 (right)

purpose which was not related to adze production.

Synthesis of Adze Acquisition at Ban Non Wat

The thin-section petrography indicated that the Cenozoic basalt outcrops were an unlikely raw material source for the Ban Non Wat adzes, corroborating the adze consumption results. While the thin-section petrography was useful in identifying that the adzes were made primarily from metamorphic materials, further analysis was required to test whether the raw material was procured from the distant Petchabun Ranges or from nearby high terrace gravels.

TABLE 7:16 *Vertical distribution of manuports and adze material at Ban Non Wat*

Manuports			Adzes and Adze Fragments	
Layer	Count	Percent	Count	Percent
1	3	2.2	5	1.9
2	11	13.1	8	3.0
3	15	24.4	14	5.2
4	40	52.4	212	78.8
5	3	8.0	30	11.2
Total	72	100.0	269	100.0

TABLE 7:17 *Thin-section identification of manuports*

Manuports	Count	Percent
Meta-Basalt	6	54.5
Meta-Andesitic Tuff	4	36.4
Meta-Dolerite	1	9.1
Total	11	100

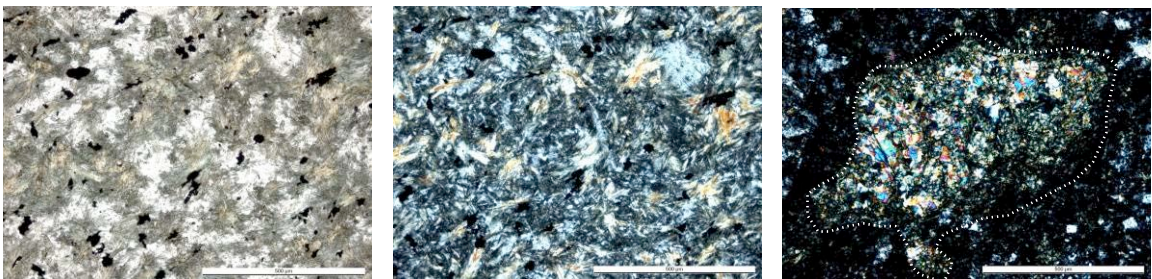
The analysis of fracture characteristics on adze fragments indicated that poor quality raw materials had been used, suggesting the high terrace gravels were utilised. The high and low quality materials from the high terrace gravels were likely exploited by the inhabitants of Ban Non Wat. While it is still possible that some higher quality raw materials were procured by exchange from sources in the Petchabun Range, this does not appear to be the dominant trend at Ban Non Wat. The presence of petrified wood at the site, as well as the petrographic analysis of manuports, suggests that for the most part, adze raw materials were acquired from the high terrace gravel deposits and that materials were probably procured through direct access.

DISCUSSION AND CONCLUSIONS

The analysis of the adze assemblage provides key information regarding the domestic use of adzes at Ban Non Wat, as well as providing insight into adze procurement. The results suggest that the systemic procurement model offers a productive theoretical framework which is suited to the analysis of consumption contexts. It also does not require information from multiple sites and therefore can be applied to an assemblage from a single site. The systemic procurement model therefore has a number of advantages over previous models used for analysing exchange and direct access (eg. Amick 1996, Bamforth 2006, Binford 1979, Polanyi 1957, Renfrew 1972, Renfrew 1975, Sahlins 1972, Torrence 1986).

The study also demonstrates that raw material availability has an effect on how adzes are consumed, thus providing important information into the workings of Neolithic economies in Thai prehistory. Of particular interest is the close proximity of Ban Kao to large outcrops of metamorphic rock and prevalence of adzes in the mortuary tradition. By contrast, burials at sites in northeast Thailand located further away from metamorphic outcrops rarely have adzes as part of the mortuary tradition. A similar pattern applies for the size of adzes, whereby Ban Kao has larger adzes than sites located further away from abundant metamorphic outcrops. The results suggest that in the Neolithic period shortages in the supply of adze raw materials at some sites precluded these tools from being regularly incorporated into the mortuary tradition.

The application of the systemic procurement model for this study has also demonstrated that the exploitation of a non-abundant local source and/or the procurement of adzes though exchange may result in a scarcity of raw material supply at a consumption site. As a consequence of shortages in raw material supply adzes may be reworked and highly reduced, and these consumption signatures



A. Overall texture of metabasalt manuport, Cat. 20568 (PPL left, UXP right)

A. Metabasalt vesicle (white dotted line) infilled with epidote, Cat. 1198 (UXP).

The meta-basalt samples typically included albite, actinolite, chlorite and epidote mineral, which are typically formed in during greenschist facies metamorphism, that is, at relatively low temperatures (<300 °C) (Blatt *et al.* 1996). The meta-basalts were nematoblastic to granoblastic in texture. Some samples also had small proportions of quartz. Modal percentages were 30–80% albite, 30–40% actinolite, 30–40% epidote and usually less than 3% quartz, if present.

Fig. 7:50 Photomicrographs of meta-basalt manuports

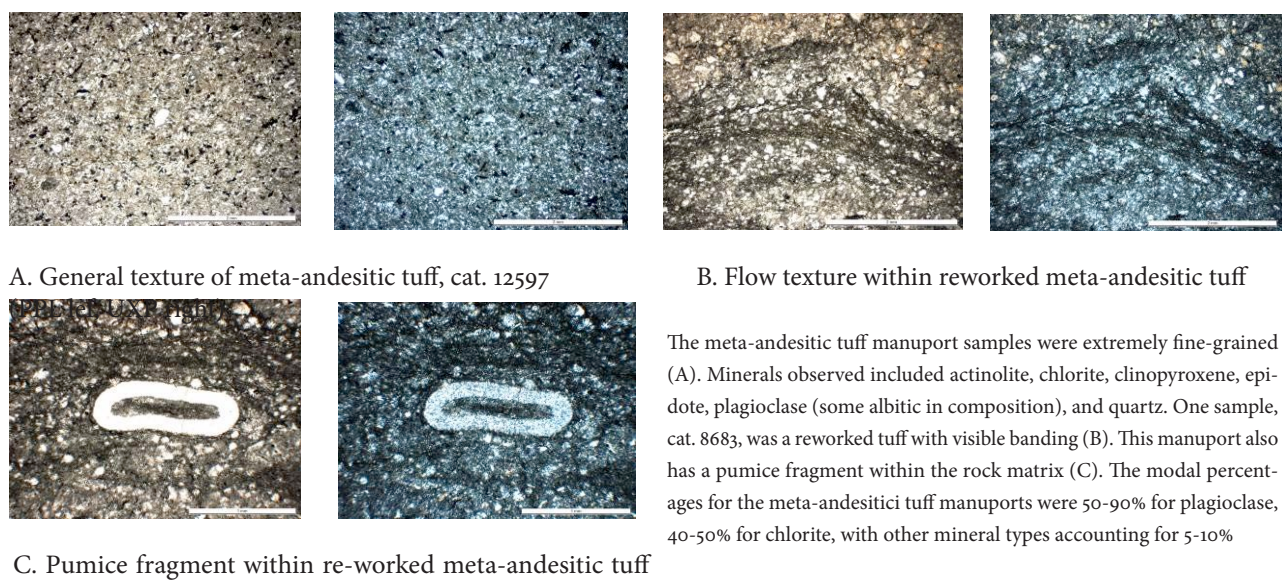


FIG. 7:51 Photomicrographs of manuports identified as meta-andesitic tuff

TABLE 7:18: *Weight and dimensions of manuports*

	Minimum	Maximum	Mean	Standard Deviation
Weight (grams)	3.1	400.0	79.7	76.1
Length (mm)	20.1	116.9	52.9	19.3
Width (mm)	15.9	80.4	39.0	13.2
Thickness (mm)	5.1	56.1	25.1	9.8

may be the same for local procurement, as well as long distance exchange. Thus raw material quality becomes an important attribute to consider when investigating adze procurement at a consumption site.

The notion that Neolithic adze materials were procured by exchange from the Petchabun Range has been a long standing paradigm (McNeill *et al.* 1991, Welch 1989, Welch *et al.* 1990). The results of this study are significant in demonstrating that adze materials could be procured

from other sources on the Khorat Plateau, thus providing a fresh perspective on adze procurement and Neolithic economies in the region.

Overall the results of this study suggest that adze materials were generally procured from high terrace gravels approximately 50 km from Ban Non Wat and were likely exploited by direct access, although limited local exchange may have also occurred. The importance of these results is that they suggest the prehistoric inhabitants of Ban Non Wat were, for the most part, participating in a predominantly localised economy with regards to utilitarian objects such as adzes. This evidence overturns previous assumptions that adze material was procured solely by exchange from the Petchbun Range (McNeill *et al.* 1991, Welch 1989, Welch *et al.* 1990). That a predominantly localised economic strategy was being utilised in the Neolithic suggests that long distance exchange networks became far more important during the Bronze Age occupation of Ban Non Wat.

TABLE 7:19 *Neolithic adze catalogue*

Cat.	Length (mm)	Width (mm)	Thick- ness (mm)	Weight (grams)	Tang Width (mm)	Tang Length (mm)	Intact- ness	Form	Raw Material
438	59.5	39.55	19.63	63.24	32.68	31.86	IRI	SH[SG-LS]	Metamorphic/Basaltic
471	43.27	36.82	12.48	30.48			EBR	NS[CZ-O/]	Metamorphic/Basaltic
498	37.79	37.4	19.28	43.62			F	/[// -O/]	Metamorphic/Basaltic
518	49.76	43.4	15.61	54.11	40.34	26.86	SER	NS[PS-S/]	Metamorphic/Basaltic
556	48.62	44.61	14.57	40.76	34.5	27	EBR	SH[SF-LO]	Metamorphic/Basaltic
589	32.19	51.45	18.48	56.97			F	/[// -L/]	Metamorphic/Basaltic
605	60.06	37.39	17.4	49.86	32.24	36.7	IRI	NS[PO-L/]	Metamorphic/Basaltic
660	42.87	38.09	13.27	30.24			F	/[// -P/]	Metamorphic/Basaltic
698	78.4	31.8	19.4	62.33	24.7	22.91	F	SHVS[SS-SS]	Metamorphic/Basaltic
768	12.94	29.05	6.93	2.6			F	/[// -//]	Metamorphic/Basaltic
778	45.73	32.73	16.66	36.39			SER	NS[PO-S/]	Metamorphic/Basaltic
789	60.08	29.82	16.03	39.33			F	/[// -//]	Metamorphic/Basaltic
818	29.83	55.68	15.67	31.81			F	/[// -//]	Metamorphic/Basaltic
994	22.99	24.98	28.37	8.48			F	/[// -//]	Metamorphic/Basaltic
1008	54.05	51.12	13.65	56.32			EBR	NS[CZ-L/]	Metamorphic/Basaltic
1032	58.19	27.91	13.79	33.18			SER	NS[// -S/]	Metamorphic/Basaltic
1059	41.05	33.47	14.73	21.36			F	/[// -L/]	Metamorphic/Basaltic
1061	70.14	43.32	18.68	68.23			IRI	NS[CE-L/]	Metamorphic/Basaltic
1105	54.68	40.94	14.16	47.17			SER	NS[PO-L/]	Metamorphic/Basaltic
1204	63.26	38.88	18.68	59.02			SER	NS[CE-L/]	Metamorphic/Basaltic
1205	41	28.77	11.55	19.71	26.45	19	EBR	SH[SS-LO]	Metamorphic/Basaltic
1209	33.41	30.05	12.56	19.75			EBR	NS[CZ-S/]	Metamorphic/Basaltic
1364	34.56	38.87	16.15	29.98			F	/[// -O/]	Metamorphic/Basaltic
1469	30.27	48.75	15.58	40.13			F	/[// -//]	Metamorphic/Basaltic
1649	42.87	19.23	12.65	11.54			F	/[// -//]	Metamorphic/Basaltic
1688	45.38	42.34	12.03	34.67	32.56	20.71	EBR	SH[SG-LO]	Metamorphic/Basaltic
2143	34.89	36.76	11.23	13.22			F	/[// -//]	Metamorphic/Basaltic
2144	43.2	55.5	14.4	52.8			F	/[// -L/]	Metamorphic/Basaltic
2150	37.5	36.95	11.71	20.82			IRI	NS[CZ-L/]	Metamorphic/Basaltic
2165	59.28	53.45	15.56	65.39			IRI	NS[CO-L/]	Metamorphic/Basaltic
2168	37.55	22.03	14.82	10.54			F	/[// -//]	Metamorphic/Basaltic
2179	60.05	48.43	13.68	54.81			IRI	NS[PO-L/]	Metamorphic/Basaltic
2193	51.47	34.21	13.17	38.77	31.78	23.86	EBR	SH[SG-LO]	Metamorphic/Basaltic
2196	74.19	54.49	15.47	101.77			SER	NS[// -L/]	Metamorphic/Basaltic
2211	26.39	51.82	11.75	14.04			F	/[// -//]	Metamorphic/Basaltic
2278	51.58	50.37	17.78	62.13	42.81	25.11	SER	SH[SF-LO]	Metamorphic/Basaltic
2291	54.69	52.56	13.99	58.37			EBR	NS[PZ-L/]	Metamorphic/Basaltic
2390	50.91	34	17.18	31.61			F	NS[CE-P/]	Metamorphic/Basaltic
2616	37.14	28.47	11.07	12.68			IRI	NS[CZ-L/]	Calcite
2623	54.12	57.77	14.94	70.51			F	/[// -//]	Metamorphic/Basaltic
3168	55.62	45.78	15.44	55.3			F	/[// -L/]	Metamorphic/Basaltic

TABLE 7:19 *Neolithic adze catalogue (cont.)*

Cat.	Length (mm)	Width (mm)	Thick- ness (mm)	Weight (grams)	Tang Width (mm)	Tang Length (mm)	Intact- ness	Form	Raw Material
3172	45.36	30.69	14	24.03	27.7	34.8	IRI	SH[SS-LO]	Metamorphic/Basaltic
3183	51.59	42.57	23.64	44.67			F	/[/-/-]	Metamorphic/Basaltic
4089	22.65	21.9	16.12	9.33			F	[-]	Metamorphic/Basaltic
4175	54.87	49.9	15.38	63.77			IRI	NS[CT-LO]	Metamorphic/Basaltic
4178	41.31	49.5	13.19	39.38			F	/[/-L/]	Metamorphic/Basaltic
4206	17.86	15.89	11.16	2.66			F	/[/-/-]	Metamorphic/Basaltic
4328	42.68	11.71	13.22	5.46			F	/[/-/-]	Metamorphic/Basaltic
5751	37	36	29	42.09			F	/[/-/-]	Metamorphic/Basaltic
5754	12.52	28.7	7.46	2.51			F	/[/-/-]	Metamorphic/Basaltic
5755	49.09	38.18	15.04	34.25			IRI	NS[CT-L/]	Metamorphic/Basaltic
5776	52.52	39.8	16.99	45.15			IRI	NS[CT-L/]	Metamorphic/Basaltic
5787	57.85	50.67	17	72.72			EBR	NS[CZ-L/]	Metamorphic/Basaltic
5845	51.09	54.08	15.5	51.82			IRI	NS[CO-L/]	Metamorphic/Basaltic
5864	62.55	44.37	16.91	58.92			SER	NS[CT-P/]	Metamorphic/Basaltic
5866	46.32	43.92	12.49	32.24			F	/[/-L/]	Metamorphic/Basaltic
6282	53.05	37.87	15.96	38.88			F	/[/-L/]	Metamorphic/Basaltic
6283	49.83	44.07	14.93	42.88			F	/[/-L/]	Metamorphic/Basaltic
6285	44.94	46.77	13.61	43.4			F	/[/-L/]	Metamorphic/Basaltic
6286	60.27	68.53	13.82	86.33			F	/[/-L/]	Metamorphic/Basaltic
6760	49.13	37.69	14.41	34.26	34.5	32.49	IRI	NS[CO-O/]	Metamorphic/Basaltic
6761	17.16	6.8	7.76	1			F	/[/-/-]	Metamorphic/Basaltic
6766	45.35	53.71	14.27	52.23			F	/[/-L/]	Metamorphic/Basaltic
6770	36.46	23.09	8.14	7.69			F	/[/-/-]	Metamorphic/Basaltic
6776	84.18	44.66	9.26	50.41			F	/[/-/-]	Metamorphic/Basaltic
6777	30.65	55.16	12.25	28.77			F	/[/-/-]	Metamorphic/Basaltic
6782	20.59	39.11	6.88	6.3			F	/[/-/-]	Metamorphic/Basaltic
6790	53.37	52.99	17.05	69.98			EBR	NS[CZ-L/]	Metamorphic/Basaltic
6791	43.72	19.8	17.01	10.02			F	/[/-/-]	Metamorphic/Basaltic
7220	66.97	50.38	14.06	75.76			SER	NS[CT-L/]	Metamorphic/Basaltic
7264	45.2	49.96	18.24	55.53			EBR	NS[CT-L/]	Metamorphic/Basaltic
7266	55.45	49.22	17.85	59.09			IRI	NS[CT-L/]	Metamorphic/Basaltic
7721	72.16	46.22	19.08	72.49	32.96	36.66	IRI	SH[SS-LO]	Metamorphic/Basaltic
7732	70.67	45.05	16.42	77.65			EBR	NS[CT-L/]	Metamorphic/Basaltic
7748	31.47	52.98	15.9	35.47			F	/[/-L/]	Metamorphic/Basaltic
8378	49.41	53.32	14.39	34.03			F	/[/-/-]	Metamorphic/Basaltic
8413	23.87	28.41	11.69	10.01			F	/[/-O/]	Metamorphic/Basaltic
8750	28.27	29.83	8.83	8.17			IRI	NS[CO-S/]	Calcite
8756	34.08	30.33	15.65	22.16	25.12	15.35	EBR	SH[SG-LO]	Metamorphic/Basaltic
8762	36.6	34.07	11.95	14.8			IRI	NS[CT-O/]	Calcite
8781	31.14	36.4	11.23	14.68			F	/[/-O/]	Metamorphic/Basaltic
8792	47.45	37.38	14.79	37.93			SER	NS[CT-L/]	Metamorphic/Basaltic
8856	60.67	52.73	14.78	67.01			EBR	NS[PO-L/]	Metamorphic/Basaltic

TABLE 7:19 *Neolithic adze catalogue (cont.)*

Cat.	Length (mm)	Width (mm)	Thick- ness (mm)	Weight (grams)	Tang Width (mm)	Tang Length (mm)	Intact- ness	Form	Raw Material
9106	32.07	38.87	15.62	27.14			F	/[// -O/]	Metamorphic/Basaltic
9114	50.96	50.24	16.9	57.69			EBR	NS[CO-L/]	Metamorphic/Basaltic
9117	30.1	33.2	12.04	13.97			IRI	NS[CO-S/]	Metamorphic/Basaltic
9584	44.77	14.72	7.76	4.78			F	/[// -//]	Metamorphic/Basaltic
9919	39.28	29.53	13.6	18.05			F	NS[CZ-L/]	Metamorphic/Basaltic
10061	32.28	31.86	13.31	15.23			F	/[// -L/]	Metamorphic/Basaltic
10062	38.01	10.68	5.28	2.66			F	/[// -//]	Metamorphic/Basaltic
10259	33	40.73	18.48	33.72	36.72	9.35	F	/[// -//]	Metamorphic/Basaltic
10506	37.8	31.43	14.28	25.06			SER	NS[PO-O/]	Metamorphic/Basaltic
10523	57.75	37.43	16.51	52.98			EBR	NS[PS-L/]	Metamorphic/Basaltic
11066	26.22	49.04	16.1	31.42			F	/[// -L/]	Metamorphic/Basaltic
11071	51.61	47.8	17.52	69.52			F	/[// -P/]	Metamorphic/Basaltic
11668	33.9	28.55	14.8	20.64			F	/[// -O/]	Metamorphic/Basaltic
11686	57.12	49.58	15.94	59.93			IRI	NS[CO-L/]	Metamorphic/Basaltic
11710	37.02	35.82	17.58	30.59			F	/[// -L/]	Metamorphic/Basaltic
12142	36.91	41.31	13.71	37.78			SER	NS[CZ-S/]	Metamorphic/Basaltic
12145	36.77	35.08	14.79	30.6			F	/[// -L/]	Metamorphic/Basaltic
12208	61.13	60.55	12.35	84.76	50.15	34.38	EBR	SH[SG-LO]	Metamorphic/Basaltic
12602	54.9	37.95	14.72	25.06			F	/[// -L/]	Metamorphic/Basaltic
12607	27.48	13.93	9.82	3.87			F	/[// -//]	Metamorphic/Basaltic
12618	35.28	42.15	12.62	29.39			SER	NS[CZ-L/]	Calcite
12643	37.01	29.16	16.83	26.22	23.25	15.59	IRI	SH[SS-SS]	Calcite
13106	56.84	46.76	17.43	61.49			IRI	NS[CT-L/]	Metamorphic/Basaltic
13117	37.31	40.4	11.85	26.54			F	/[// -L/]	Metamorphic/Basaltic
13118	55.75	48.25	11.26	49.53			EBR	NS[CO-L/]	Metamorphic/Basaltic
13713	19.07	32.05	7.11	5.34			F	/[// -//]	Metamorphic/Basaltic
13726	17.01	26.24	5.89	3.57			F	/[// -//]	Metamorphic/Basaltic
13750	52.46	51.6	13.92	49.66			F	/[// -L/]	Metamorphic/Basaltic
13755	27.95	26.16	11.1	7.74			F	/[// -//]	Metamorphic/Basaltic
13763	35.33	32.65	12.97	22.58			EBR	NS[PR-L/]	Metamorphic/Basaltic
14659	40.03	30.46	12.43	19.07			F	/[// -L/]	Metamorphic/Basaltic
15055	48.06	31.1	15.33	30.31	27.68	36.44	IRI	SH[SS-LO]	Metamorphic/Basaltic
15061	42.33	54.05	17.06	53.19			F	/[// -//]	Metamorphic/Basaltic
15071	20.89	19.51	16	7.68			F	/[// -//]	Metamorphic/Basaltic
15097	44.61	33.33	14.82	27.16			EBR	NS[CE-L/]	Metamorphic/Basaltic
15100	41.18	31.93	12.81	21.32			EBR	NS[CO-L/]	Metamorphic/Basaltic
15103	38.75	45.51	19.39	58.6			F	/[// -L/]	Metamorphic/Basaltic
15108	53.49	39.87	17.36	55.9			EBR	NS[CR-L/]	Metamorphic/Basaltic
15381	44.32	38.87	17.31	46.14			IRI	NS[CZ-S/]	Metamorphic/Basaltic
15542	41.6	40.51	14.6	32.57			F	/[// -L/]	Metamorphic/Basaltic
15562	39.14	52.62	22.05	58.66			F	/[// -L/]	Metamorphic/Basaltic
15572	36.52	43.67	18.75	39.47			F	/[// -//]	Metamorphic/Basaltic

TABLE 7:19 *Neolithic adze catalogue (cont.)*

Cat.	Length (mm)	Width (mm)	Thick- ness (mm)	Weight (grams)	Tang Width (mm)	Tang Length (mm)	Intact- ness	Form	Raw Material
15573	20.04	29.79	14.2	12.48			F	/[/-/-]	Metamorphic/Basaltic
15576	46.42	41.66	15.54	40.76			F	/[/-/-]	Metamorphic/Basaltic
16067	44.85	33.1	17.03	34.76			IRI	NS[PO-O/]	Metamorphic/Basaltic
16073	41.86	33.42	14.61	23.41			F	/[/-L/]	Metamorphic/Basaltic
16074	43.47	29.4	10.84	19.28			IRI	NS[PO-L/]	Metamorphic/Basaltic
16076	72.08	47.82	15.3	68.91			IRI	NS[CO-L/]	Metamorphic/Basaltic
16077	50.09	40.21	15.93	45.13	26.15	18.91	IRI	SH[SS-LO]	Metamorphic/Basaltic
16087	56.06	60.06	16.74	75.24	42.82	19.28	SER	SH[SF-LO]	Metamorphic/Basaltic
16629	62.67	39.49	14.65	46.02			F	/[/-P/]	Metamorphic/Basaltic
16641	34.53	35.76	18.16	26.98			F	/[/-/-]	Metamorphic/Basaltic
17259	30.46	26.03	12.71	10.46			F	/[/-/-]	Metamorphic/Basaltic
17274	45.46	31.73	13.72	21.04			F	/[/-/-]	Metamorphic/Basaltic
17298	45.21	8.11	8.9	3.63			F	/[/-/-]	Metamorphic/Basaltic
17303	56.12	49.68	12.27	46.23			IRI	NS[CO-L/]	Metamorphic/Basaltic
17304	73.64	38.36	16.72	55.34			EBR	NS[CE-L/]	Metamorphic/Basaltic
17306	56.3	52.43	14.01	60.63			EBR	NS[CZ-L/]	Metamorphic/Basaltic
17312	47.54	40.66	15.13	44.28			F	/[/-L/]	Metamorphic/Basaltic
17313	55.96	54.25	16.81	67.79			EBR	NS[CZ-L/]	Metamorphic/Basaltic
17316	28.37	41.78	14.27	12.15			F	/[/-/-]	Metamorphic/Basaltic
17317	13.87	31.98	9.49	4.28			F	/[/-/-]	Metamorphic/Basaltic
17318	24.38	17.35	12.93	6.4			F	/[/-/-]	Metamorphic/Basaltic
17319	27.07	18.62	12.58	6.78			F	/[/-/-]	Metamorphic/Basaltic
17320	60.2	41.9	16.07	59.01			EBR	NS[C/-L/]	Metamorphic/Basaltic
17322	49.67	39.1	14.74	38.13			EBR	NS[CT-L/]	Metamorphic/Basaltic
17323	66.4	48.1	14.1	56.32			F	/[/-L/]	Metamorphic/Basaltic
17324	56.82	36.63	13.42	34.49			F	/[/-L/]	Metamorphic/Basaltic
17325	50.27	37.66	16.82	42.29	30.96	28.64	IRI	SH[SS-LO]	Metamorphic/Basaltic
17477	66.72	57.7	17.46	97.47			IRI	NS[CZ-L/]	Metamorphic/Basaltic
17782	38.08	36.52	11.92	26.04			F	/[/-O/]	Metamorphic/Basaltic
17783	56.35	39.26	14.04	40.51			EBR	NS[CO-L/]	Metamorphic/Basaltic
17790	27.65	28.75	14.81	9.81			F	/[/-/-]	Metamorphic/Basaltic
17819	53.14	42	13.49	39.06			F	/[/-L/]	Metamorphic/Basaltic
17825	47.37	24.99	14.44	29.71			F	/[/-/-]	Metamorphic/Basaltic
17827	73.07	47.95	13.12	53.09			EBR	NS[CE-L/]	Metamorphic/Basaltic
18251	56.7	58.14	12.35	65.25			EBR	NS[CZ-L/]	Metamorphic/Basaltic
18281	27.67	32.17	11.65	11.85			IRI	NS[PS-S/]	Calcite
18282	15.8	23.92	8.8	3.67			F	/[/-/-]	Metamorphic/Basaltic
18283	66.01	47.3	16.25	64.7			F	/[/-L/]	Metamorphic/Basaltic
18637	24.49	51.82	11.78	20.21			F	/[/-/-]	Metamorphic/Basaltic
18692	28.95	43.37	16.21	28.33			F	/[/-P/]	Metamorphic/Basaltic
18822	22.51	47.36	13.42	27.31			F	/[/-L/]	Metamorphic/Basaltic
19963	73.59	38.15	16.69	55.35			IRI	NS[CE-L/]	Metamorphic/Basaltic

TABLE 7:19 *Neolithic adze catalogue (cont.)*

Cat.	Length (mm)	Width (mm)	Thick- ness (mm)	Weight (grams)	Tang Width (mm)	Tang Length (mm)	Intact- ness	Form	Raw Material
20157	54.3	40.59	13.36	34.9			IRI	NS[CO-L/]	Metamorphic/Basaltic
20210	61.11	46.91	19.67	72.59			F	/[/-L/]	Metamorphic/Basaltic
20212	72.96	19.01	16.26	34.57			IRI	VS[SS-ZS]	Calcite
20315	45.36	36.39	13.41	30.4			SER	/[/-L/]	Metamorphic/Basaltic
21710	25.74	48.59	10.5	16.93			F	/[/-L/]	Metamorphic/Basaltic
21889	37.79	34.45	14.07	24.66	28.04	23.84	EBR	SH[SS-LO]	Metamorphic/Basaltic
21890	56.27	38.87	13.72	35.49			IRI	NS[CT-L/]	Metamorphic/Basaltic
10700	52	50	14	64.6			SER	NS[CT-L/]	Metamorphic/Basaltic
22127	67	51	14	73.8			IRI	NS[PO-L/]	Metamorphic/Basaltic
22189	55	45	17	52.5			F	/[/-L/]	Metamorphic/Basaltic
22241	45	39	11	33.6			SER	SH[SS-LO]	Metamorphic/Basaltic
22591	61	51	18	68.7			F	NS[CO-O/]	Metamorphic/Basaltic
22677	40	27	13	18			F	/[/-L/]	Metamorphic/Basaltic
22680	50	27	17	16.7			F	/[/-L/]	Metamorphic/Basaltic
22706	60	55	17	89.9			F	/[/-L/]	Metamorphic/Basaltic
22708	41	28	12	19.1			F	/[/-L/]	Metamorphic/Basaltic
22726	36	27	12	22.1			EBR	NS[P/-L/]	Metamorphic/Basaltic
23220	17	16	4	1.4			F	/[/-L/]	Metamorphic/Basaltic
23793	35	24	14	12.6			F	/[/-L/]	Metamorphic/Basaltic
23797	48	34	12	24.4			IRI	NS[CT-L/]	Metamorphic/Basaltic
24201	40	38	18	31.1			SER	NS[CT-O/]	Metamorphic/Basaltic
24889	42	35	9	24.9			SER	/[/-L/]	Metamorphic/Basaltic
24894	49	41	10	22.1			F	/[/-L/]	Metamorphic/Basaltic
25221	75	59	15	115.9			EBR	SH[SS-PP]	Metamorphic/Basaltic
25279	62	47	14	61.3			F	NS[CO-L]	Metamorphic/Basaltic
25284	69	31	16	36.9			F	NS[/-L/]	Metamorphic/Basaltic
25295	43	37	19	28.6			IRI	NS[CT-L/]	Calcite
25371	44	42	16	35.1			F	/[/-L/]	Metamorphic/Basaltic
25637	41	30	13	25.7			IRI	NS[PR-S/]	Metamorphic/Basaltic
25700	59	45	18	51.3			SER	NS[CT-L/]	Metamorphic/Basaltic
25702	41	39	11	31.3			EBR	SH[SG-OO]	Metamorphic/Basaltic
25716	65	30	23	48.2			F	/[/-L/]	Metamorphic/Basaltic
25736	46	38	16	35.7			IRI	NS[CT-S/]	Metamorphic/Basaltic
25751	66	41	19	54.6			EBR	SH[SG-LO]	Metamorphic/Basaltic
25752	71	51	20	96			F	/[/-L/]	Metamorphic/Basaltic
25756	46	27	15	20.8			EBR	NS[CZ-S/]	Metamorphic/Basaltic
25763	61	59	16	73.6			SER	SH[SF-OL]	Metamorphic/Basaltic
25772	54	42	9	42.6			SER	NS[PO-O/]	Metamorphic/Basaltic
25779	45	32	11				F	/[/-L/]	Metamorphic/Basaltic
25787	46	33	14	25.4			F	/[/-L/]	Metamorphic/Basaltic
25792	62	47	14	61.3			IRI	NS[CT-L/]	Metamorphic/Basaltic
26221	52	40	13	35.1			IRI	NS[CO-L/]	Metamorphic/Basaltic
26261	47	31	12	31			EBR	NS[PO-O/]	Metamorphic/Basaltic
26275	52	40	13	27.4			EBR	NS[CZ-L/]	Metamorphic/Basaltic

VIII THE FAUNAL REMAINS

FISH AND SHELLFISH

R. THOSARAT

Faunal remains were abundant at Ban Non Wat. The Neolithic contexts comprise *in situ* middens, containing much shell and bone, and the general layers 5 and basal 4. Samples taken from both middens and general layers were subjected to wet sieving in order to recover a representative sample covering the smallest as well as the large and more easily recognizable bones. This procedure resulted in the collection of a very large sample of small fish bones, as well as the remains of shellfish and mammals. Had wet sieving not been undertaken, fish would have hardly been represented in the faunal spectrum. The following were identified.

Notopteridae: *Notopterus notopterus* (Pallas, 1769). These widely-consumed fish may reach a length of 35 cm. They enter swamps to spawn, then return to rivers. Many are smoked and marketed. Despite their name *pla chalat*, or clever fish, they are taken in nets and traps in considerable numbers.

Bagridae: *Hemibagrus nemurus* (Valenciennes, 1840). The Asian red-tailed catfish has the synonym *Mystus nemurus*. It is found in slow moving rivers with a muddy bottom, but it also inhabits large lakes, such as the Tonle Sap. The fish is widespread in Thailand, including the tributaries of the Mun River. It grows to a length in excess of 35 cm. The Thai name is *pla kot leung*.

Siluridae: *Wallago* sp. A voracious and determined feeder, this catfish, known as *pla khao*, can reach nearly a metre in length. They live in larger streams or rivers.

Ompok bimaculatus (Bloch, 1797). The sheatfish, or *pla nua on*, is widespread in Thailand, and reaches a maximum size of 40 cm but is usually much smaller. It is present in large numbers and is often found in markets.

Clariidae: *Clarias macrocephalus* (Gunter, 1864). These catfish breathe air and without access to it, they perish. Members of this family are widespread and important in Thailand for food. *Clarias macrocephalus*, the broad-headed catfish, lives in shallow open water, freshwater riv-

ers and canals, and extends into flooded fields during the wet season. It has the capacity to sink into mud to survive the dry season immobile.

Synbranchidae: *Monopterus albus* (Zieuew, 1793). The swamp eel is prolific and widely consumed. It lives in a wide range of fresh-water habitats, and is commonly found in wet rice fields during the rainy season. During the dry season, the eels survive in damp hollows with no surface water. They can be caught by hook in the wet season and by digging during the dry, and can survive for a long period out of water if kept moist. Large specimens can attain a length of 70 cm. They are known as *pla lai*.

Mastacembelidae: *Mastacembelus* sp. This widespread species is adapted to a wide range of freshwater habitats including lakes, rivers and swamps. It can reach a length of 70 cm, and is consumed, but not in great numbers. It is known as *pla kathing*.

Pristolepididae (Nandidae): *Pristolepis fasciatus* (Bleeker 1851).

This is not a large fish, a weight of 1 kg being most unusual. Its flat appearance and habit of sinking into the mud in stagnant swamps give it the name *pla chang yieb*, or flattened by an elephant.

Anabantidae: *Anabas testudineus* (Bloch, 1792). Members of this genus can breathe air, and are best known for their ability to traverse dry land and climb steep slopes or even trees. However, it is also one of the main food fishes of Thailand, adapted to fresh water rivers, streams, canals and marshes. A mature specimen will measure 10-15 cm and unusually large adults may attain a length of over 20 cm. It is known in Thai as *pla mor* (doctor fish).

Channidae: *Channa lucius* (Cuvier, 1831). The blotched snake-headed fish or *pla kasong* is found in streams and lakes in Northeast Thailand. It reaches a length of 35-40 cm but is normally half that size.

Channa micropeltes (Cuvier, 1831). The giant snake-headed fish or *pla chado*, is the largest species of *Channa*, reaching a maximum weight of 20 kg and a length of nearly a metre. It is a voracious feeder, and widely consumed. In Surin Province, Khmer speaking villagers regard this fish with reverence. It is commonly to be seen in Cambodian fish markets, and many are taken in the Tonle Sap.

Channa striata (Bloch, 1797). Known as *pla chon*, this

TABLE 8:1 The number of individual fish species from the Neolithic occupation layers

Species	number	Species	number	Species	number	Species	number	Species	number
<i>Hemibagrus</i>	30	<i>Hemibagrus/</i> <i>Mystus</i>	334	<i>Channa</i> <i>lucius</i>	4	<i>Channa</i> <i>micropeltes</i>	5	<i>Channa</i> <i>striata</i>	185
<i>Channa</i> sp.	50	<i>Clarias</i> sp.	219	<i>Clarias</i> <i>macrocephalus</i>	2	<i>Anabas</i> <i>testudineus</i>	179	<i>Ompok</i> <i>bimaculatus</i>	9
<i>Wallago</i>	3	<i>Ompok/</i> <i>Wallago</i>	107	<i>Monopterus</i> <i>albus</i>	47	Notopteridae	2	Cyprinidae	2

is probably the most popular and widely consumed fish in Thailand. It has been known to reach a length in the vicinity of a metre. It can be secured by trap or line, and survives for long periods without access to water. During the dry season, it can be cut out of the mud in which it takes refuge in dry lake beds. It is often dried and marketed.

FREQUENCY OF SPECIES

The *in situ* and undisturbed Neolithic middens are the most reliable source of information on the relative importance of each species of fish. The bagrid catfish *Hemibagrus* and *Mystus* are the most abundant, with 142 individual fish being represented. The snakehead, *Channa striata*, is also abundantly represented. There are 55 indi-

viduals of *Clarias* sp. while *Ompok* and *Wallago* account for 72. The fish identified in the Neolithic middens of Ban Non Wat confirm the presence of an aquatic environment that could contribute significantly to sustaining a relatively large sedentary community. The frequency of fish from Neolithic layers, rather than midden deposits, is set out in table 8:1. We find a similar pattern to the midden deposits. Bagrid catfish are the most abundant, followed by the snakehead, *Channa*, and then the walking catfish, *Clarias* and *Anabas testudineus*. The Siluridae, sheatfish, are also abundant, *Monopterus albus* appearing frequently. There are only two individuals from the Notopteridae and Cyprinidae. The latter have not been found in middens. The more abundant species remain popular to this day.

TABLE 8:2 the number of individual fish species from the Neolithic middens

Species	number	Species	number	Species	number	Species	number	Species	number
<i>Hemibagrus</i>	38	<i>Hemibagrus/Mystus</i>	101	<i>Mystus</i>	3	<i>Channa lucius</i>	1	<i>Channa micropeltes</i>	4
<i>Channa striata</i>	54	<i>Channa</i> sp.	6	<i>Clarias</i> sp.	53	<i>Clarias macrocephalus</i>	2	<i>Anabas testudineus</i>	47
<i>Monopterus albus</i>	13	<i>Notopterus notopterus</i>	3	<i>Mastacembelus</i> sp.	1	<i>Pristolepis fasciatus</i>	1	<i>Ompok</i>	10
<i>Wallago</i>	1	<i>Ompok/Wallago</i>	61						

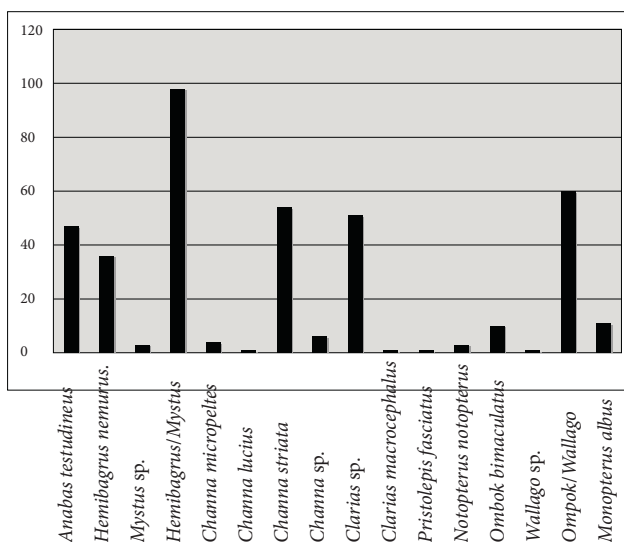


FIG. 8:1 The frequency of fish from Neolithic middens by individuals identified,

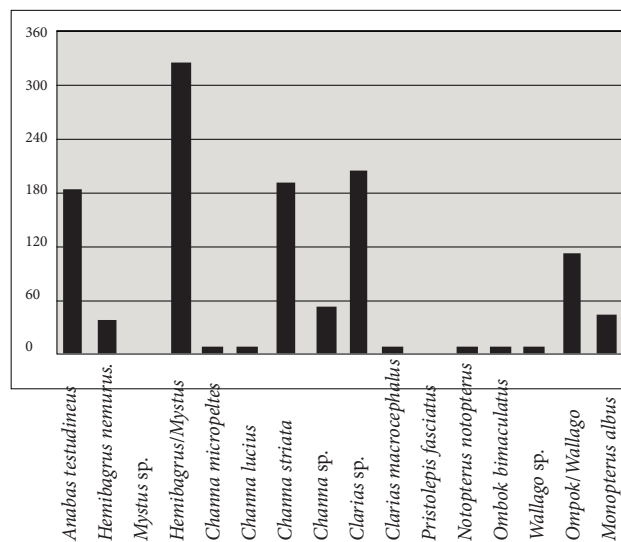


FIG. 8:2 The frequency of fish from Neolithic layers by individuals identified,

TABLE 8:3 *The fish species identified in the Neolithic occupation contexts based on the minimum number of individuals*

	Osteo-glossiformes	Siluriformes							
Context	Notopteridae	Bagridae			Siluridae			Clariidae	
Shell middens	<i>Notopterus notopterus</i>	<i>Hemibagrus nemurus</i>	<i>Mystus</i> sp.	<i>Hemibagrus/Mystus</i>	<i>Ompok bimaculatus</i>	<i>Wallago</i> sp.	<i>Ompok/Wallago</i>	<i>Clarias</i> sp.	<i>C. macrocephalus</i>
A2 4:12 F. 1	-	1	-	-	-	-	-	-	-
C1 4:15 F. 1	-	1	-	-	-	-	-	-	-
D5 5:1 F. 2	-	1	-	-	-	-	1	-	-
E2 5 sf. 4 F. 1	-	2	-	3	-	-	1	1	-
E2 5 sf. 2 F. 1	2	21	-	47	4	-	39	21	1
E2 5 sf. 1 F. 1	-	3	-	22	2	-	7	7	1
E2 5 sf. 1 F. 2	1	5	-	11	1	-	9	9	-
E2 5 sf. 1 F. 3	-	-	-	1	1	-	-	1	-
E3 5 sf. 1 F. 2	-	3	3	14	2	1	3	11	-
F4 5 sf. 1 F. 10	-	1	-	-	-	-	-	-	-
E2 4 sf. 9 F. 26	-	-	-	3	-	-	1	3	-
Total	3	38	3	101	10	1	61	53	2
		142			72			55	

	Synbranchiformes		Perciformes					
Context	Synbranchidae	Mastacembelidae	Pristolepididae	Anabantidae	Channidae			
Shell middens	<i>Monopterus albus</i>	<i>Mastacembelus</i> sp.	<i>Pristolepis fasciatus</i>	<i>Anabas testudineus</i>	<i>Channa lucius</i>	<i>C. micropeltes</i>	<i>C. striata</i>	<i>Channa</i> sp.
A2 4:12 F. 21	-	-	-	1	-	-	3	-
D5 5:1 F. 2	-	-	-	1	-	2	1	3
E2 5 sf. 4 F. 1	1	1	-	3	-	-	3	-
E2 5 sf. 2 F. 1	5	-	-	22	-	1	23	-
E2 5 sf. 1 F. 1	1	-	-	7	1	1	10	3
E2 5 sf. 1 F. 2	2	-	1	5	-	-	6	-
E2 5 sf. 1 F. 3	-	-	-	1	-	-	2	-
E3 5 sf. 1 F. 2	2	-	-	6	-	-	5	-
D2 4:8 F. 1	1	-	-	-	-	-	-	-
E2 4:9 F. 26	1	-	-	1	-	-	1	-
Total	13	1	1	47	1	4	54	6
					64			

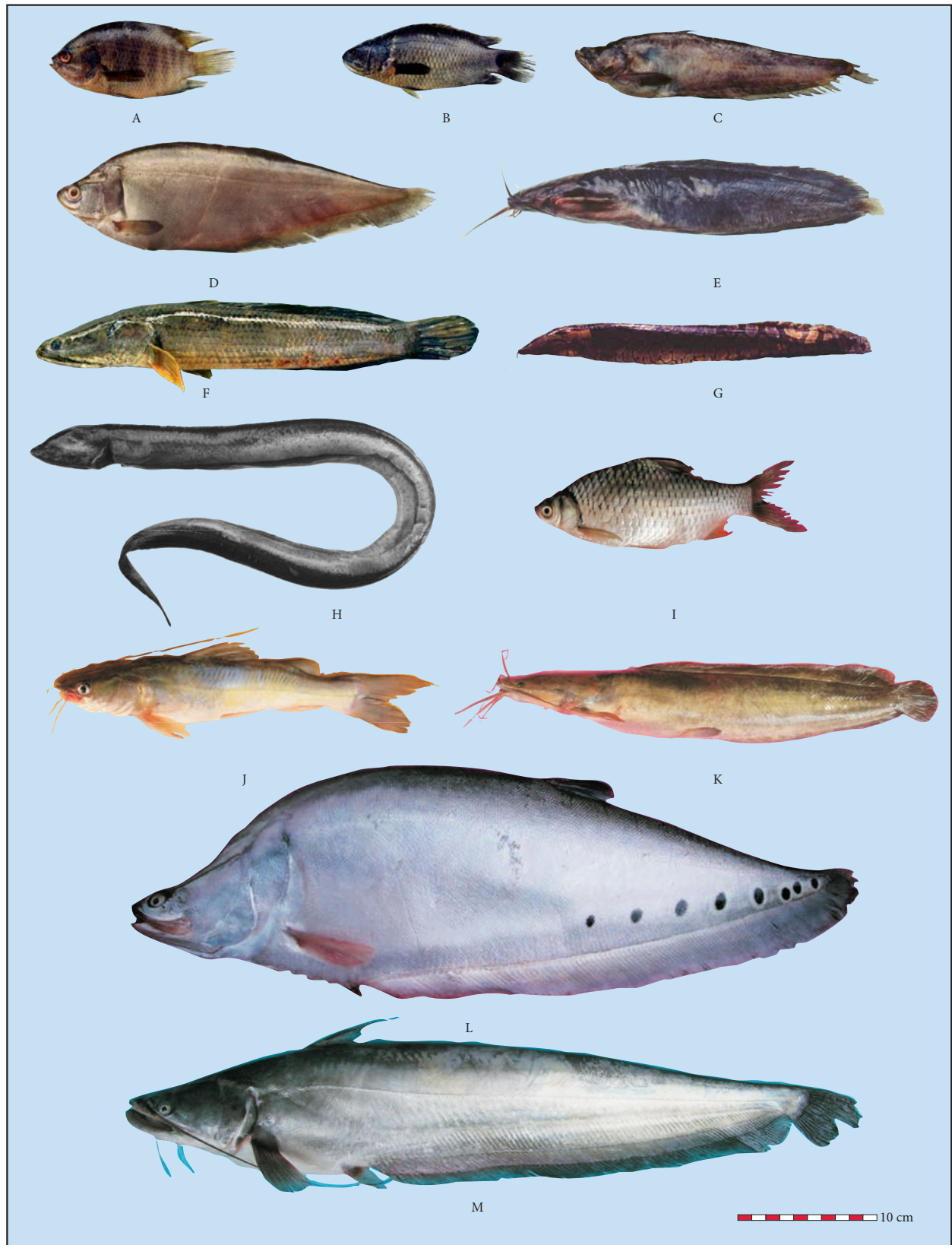


FIG. 8:3 The fish represented at Ban Non Wat. A. *Pristolepis fasciatus*, B. *Anabas testudineus*, C. *Ompok bimaculatus*, D. *Notopterus notopterus*, E. *Clarias macrocephalus*, F. *Channa striata*, G. *Mastacembelus favus*, H. *Monopterus albus*, I. *Barbodes*, J. *Hemibagrus nemurus*, K. *Clarias batrachus*, L. *Chitala ornata*, M. *Wallago attu*

APPENDIX: THE ANATOMICAL BONES OF FISH IDENTIFIED

AA1 5:5

- *Anabas testudineus* lacrimal 1L
- Bagridae dorsal fin spine 1, pectoral fin spine 1R
- *Channa striata* lower pharyngeal 1L, maxilla 1R

AA1 5:3

- *Anabas testudineus* lacrimal 1L, lower pharyngeal 1R
- Bagridae dorsal fin spines 3, pectoral fin spines 2L 1R
- *Clarias* sp. dentary 1R, pectoral fin spine 1L 1R
- Siluridae pectoral fin spine 1R

AA1 5:2

- *Anabas testudineus* supracleithrum 1L
- Bagridae pectoral fin spines 2L 5R
- *Hemibagrus nemurus* dentary 1R
- *Channa striata* lower pharyngeal 1L, maxilla 1R
- *Clarias* sp. cleithrum 1L, supraoccipital 1, urohyal 1

AA1 5:1

- Bagridae pectoral fin spine 1L
- *Channa* sp. supraoccipital 1
- *Clarias* sp. pectoral fin spine 1L, supraoccipital 1
- *Monopterus albus* articular 1R

AA1 4:10

- Bagridae pectoral fin spines 2R

AA2 5:1

- Siluridae pectoral fin spine 1R

AA2 4:10

- *Anabas testudineus* lacrimal 1R
- Bagridae dorsal fin spine 1, pectoral fin spine 1R
- *Clarias* sp. pectoral fin spines 3L 2R
- Siluridae pectoral fin spines 2L

AA3 5:2

- *Anabas testudineus* lower pharyngeal 1L
- *Channa* sp. ceratohyal 1L

AA3 4:9/5:1

- Bagridae pectoral fin spine 1R
- *Channa striata* maxilla 1R

AA3 4:7/8

- *Anabas testudineus* lacrimal 1R
- Bagridae pectoral fin spine 1R

AA3 4:5

- *Anabas testudineus* lacrimal 1R, supracleithrum 1L
- Bagridae dorsal fin spine 1, pectoral fin spines 2R
- *Clarias* sp. pectoral fin spine 1L 1R
- Siluridae pectoral fin spine 1R

AA4 4:8/9

- Bagridae dorsal fin spine 1
- *Clarias* sp. pectoral fin spine 1L

AA4 4:7/8

- *Hemibagrus nemurus* pectoral fin spine 1R

AA5 5:2

- *Channa* sp. fragment of articular from a large fish 1R

AA5 4:11

- *Hemibagrus nemurus* pectoral fin spine 1L
- *Channa striata* ceratohyal 1L
- *Clarias* sp. cleithrum 1L

AA5 4:10

- Bagridae pectoral fin spines 2L

AA5 4:7

- Bagridae pectoral fin spine 1R

AA6 5:1

- *Anabas testudineus* supracleithrum 1R
- *Channa striata* maxilla 1L
- *Clarias* sp. pectoral fin spine 1R
- Siluridae pectoral fin spine 1L

AA6 4:11

- *Anabas testudineus* supracleithrum 2L
- *Channa striata* palatine 1L

AA6 4:10

- Bagridae dorsal fin spine 1, pectoral fin spine 1R
- *Channa striata* upper pharyngeal 2R
- Siluridae pectoral fin spine 1R

AA6 4:9

- Bagridae cleithrum 1L

AA6 4:7

- *Anabas testudineus* lacrimal 1R
- Bagridae dorsal fin spine 1, pectoral fin spine 1R

AA7 4:11

- *Anabas testudineus* lacrimal 1L 1R
- Bagridae pectoral fin spines 2L
- *Channa striata* basioccipital 1
- *Clarias* sp. cleithrum 1R, dermethmoid 1

AA7 4:10

- Bagridae dorsal fin spine 1, pectoral fin spine 1R
- *Clarias* sp. pectoral fin spine 1R

AA7 4:9

- Bagridae pectoral fin spine 1R
- *Channa striata* maxilla 1L
- Siluridae pectoral fin spine 1L

AA7 4A:7

- Bagridae cleithrum 1R, pectoral fin spine 1L 1R
- *Clarias* sp. pectoral fin spine 1R

A's 4:19

- *Wallago* sp. pectoral fin spine 1R

A's 4:18

- *Channa striata* ceratohyal 1L

A's 4:12

- *Channa striata* dentary 1L
- *Wallago* sp. pectoral fin spine 1R

A1 5:2

- Bagridae pectoral fin spines 4L
- *Channa striata* cleithrum (ventral) 1R, maxilla 1L

A1 5:1

- *Anabas testudineus* suborbital4 1R

A1 4:19

- Bagridae pectoral fin spine 1L

A1 4:17

- *Anabas testudineus* frontal 1R, lacrimal 1R
- Bagridae pectoral fin spine 1L
- *Hemibagrus nemurus* pectoral fin spine 1R
- *Clarias* sp. cleithrum 1L, supraoccipital 1

A1 4:16

- *Anabas testudineus* lower pharyngeal 1L 1R
- Bagridae pectoral fin spines 3L
- *Channa striata* dentary 1L
- *Clarias* sp. pectoral fin spine 1L

A1 4:15

- Bagridae cleithrum 1L 3R, pectoral fin spines 5L 1R
- *Channa striata* basioccipital 1, ceratohyal 1L 2R, maxilla 1R, nasal 1R, palatine 1R, supracleithrum 1L
- *Monopterus albus* articular 1L

A1 4:14

- Bagridae dorsal fin spine 1, pectoral fin spine 1L
- *Channa striata* cleithrum (ventral) 1R
- *Clarias* sp. opercular 1R, pectoral fin spines 1L 2R
- Siluridae pectoral fin spine 1R
- *Monopterus albus* ectopterygoid 1L

A1 4:13

- *Anabas testudineus* lacrimal 1L, interopercular 1L, suborbital3 1L, supracleithrum 1L 2R
- Bagridae cleithrum 1R, dorsal fin spine 1, pectoral fin spines 7L 1R
- *Channa striata* dentary 1L 1R, maxilla 1L 1R, post-temporal 1R, premaxilla 2R

- *Clarias* sp. articular 1R, dentary 1R, opercular 1L, pectoral fin spines 2L 1R, supraorbital 1R

- Siluridae dentary 1R, pectoral fin spines 1L 2R

A1 4:12

- Bagridae dorsal fin spine 1, pectoral fin spines 2L

- *Clarias* sp. articular 1R
- A1 4:11
- *Anabas testudineus* supracleithrum 1L
- Bagridae pectoral fin spines 2L 1R
- *Channa* sp. quadrate 1R
- *Channa striata* dentary 1L 1R, lower pharyngeal 1R
- *Clarias* sp. neurocranium (part) 1, urohyal 1
- Siluridae pectoral fin spine 1R
- *Monopterus albus* ectopterygoid 1R
- A2 5:2
- *Anabas testudineus* supracleithrum 1L
- A2 4:20
- Bagridae pectoral fin spine 1R
- *Channa striata* basioccipital 1, premaxilla 1R
- A2 4:18
- *Anabas testudineus* supracleithrum 1R
- *Channa striata* articular 1R, supraoccipital 1
- *Clarias* sp. pectoral fin spine 1L, supraoccipital 1
- Siluridae pectoral fin spines 2L
- A2 4:17
- *Anabas testudineus* supracleithrum 1R
- Bagridae pectoral fin spine 1R
- *Channa* sp. cleithrum (ventral) 1L
- A2 4:16
- Bagridae cleithrum 1L, pectoral fin spine 1L 1R
- *Channa striata* basioccipital 1, cleithrum (ventral process) 1R, dentary 1L, palatine 1R, premaxilla 1L
- *Clarias* sp. pectoral fin spine 1L
- *Monopterus albus* articular 1R, cleithrum 1L, quadrate 1R
- A2 4:15
- Bagridae cleithrum 2R, pectoral fin spines 2R
- A2 4:14
- Bagridae pectoral fin spines 3L
- Siluridae pectoral fin spine 1L
- A2 4:13
- *Anabas testudineus* supracleithrum 1L, supraoccipital 1
- Siluridae pectoral fin spine 1R
- *Monopterus albus* cleithrum 1R
- A2 4:12
- Bagridae pectoral fin spine 1L
- *Channa striata* lower pharyngeal 1L 1R
- *Clarias* sp. pectoral fin spine 1R
- A2 4:12 feature 21 shell midden
- *Anabas testudineus* fragments of neurocranium 1
- Bagridae pectoral fin spine 1L
- *Channa striata* ceratohyal 1L 1R, post-temporal 1R, supracleithrum 1R
- *Clarias* sp. pectoral fin spine 1L 1R
- A2 4:11
- Bagridae pectoral fin spine 1L 1R
- *Clarias* sp. pectoral fin spine 1R
- A3 4:21
- Bagridae pectoral fin spine 1R
- *Channa* sp. articular 1L, epiphyal 1L
- *Channa striata* premaxilla 1L
- A3 4:20
- *Monopterus albus* ectopterygoid 1R
- A3 4:19
- Bagridae pectoral fin spine 1R
- *Channa striata* epiphyal 1R
- *Clarias* sp. pectoral fin spine 1L
- A3 4:18
- *Channa striata* cleithrum (ventral) 1L
- A3 4:17
- *Anabas testudineus* frontal 1R, lower pharyngeal 1L
- *Hemibagrus nemurus* articular 1R, dentary 1R, dorsal fin spine 1
- *Channa* sp. articular 1L 1R
- *Channa striata* palatine 1L, dentary 1R
- *Clarias* sp. cleithrum 1L 1R, pectoral fin spine 1R
- A3 4:15
- *Anabas testudineus* supraoccipital 1
- Bagridae dorsal fin spine 1
- *Channa striata* cleithrum (ventral process) 1L, palatine 1R
- *Clarias* sp. pectoral fin spine 1L
- *Monopterus albus* dentary 1R
- A3 4:12
- Bagridae pectoral fin spine 1R
- *Channa* sp. epiphyal 1R
- *Channa striata* nasal 1L
- *Clarias* sp. pectoral fin spine 1L
- A3 4:11
- *Channa striata* palatine 1L
- *Clarias* sp. supraoccipital 1
- A4 5:3
- *Anabas testudineus* lacrimal 1R
- Siluridae pectoral fin spine 1R
- A4 5:1
- Bagridae dorsal fin spine 1
- A4 4:20
- *Monopterus albus* articular 1R
- A4 4:17
- Bagridae pectoral fin spine 1R
- A4 4:16
- Bagridae pectoral fin spine 1R
- *Channa striata* maxilla 1L, premaxilla 1L
- *Clarias* sp. pectoral fin spine 1L
- *Monopterus albus* dentary 1R
- A4 4:15
- *Clarias* sp. jugal 1L, pectoral fin spines 2L
- A4 4:14
- *Anabas testudineus* supracleithrum 1L
- Bagridae pectoral fin spine 1L
- *Channa striata* dentary 1L, lower pharyngeal 1L, maxilla 1R
- *Clarias* sp. pectoral fin spine 1L
- Siluridae pectoral fin spines 2R
- *Monopterus albus* articular 1L, dentary 1L
- A4 4:12
- *Anabas testudineus* cleithrum 1L, lacrimal 1L
- Bagridae cleithrum 1R, pectoral fin spines 3R
- *Channa striata* basioccipital 1, ceratohyal 1L 1R, frontal 1R, maxilla 1L
- A4 4:10
- *Channa striata* lower pharyngeal 1L 1R, maxilla 1L
- A5 4:14
- Bagridae cleithrum 2L, pectoral fin spine 1L
- *Channa striata* cleithrum 1L, lower pharyngeal 1R
- *Monopterus albus* dentary 1L
- A5 4:13
- *Monopterus albus* dentary 1R
- A5 4:12
- *Channa striata* lower pharyngeal 1L
- A6 4:10
- *Anabas testudineus* lacrimal 1R, supracleithrum 1L
- Siluridae cleithrum 1R
- A6 4:9
- *Anabas testudineus* lacrimal 1R, supracleithrum 1L
- *Clarias* sp. fragment of supraoccipital 1
- Siluridae pectoral fin spine 1L
- A6 4:8
- *Anabas testudineus* fragment of an opercular 1, maxilla 1L
- *Channa* sp. opercular 1L
- *Channa striata* basioccipital 1, ceratohyal 1L, maxilla (distal end) 1L
- *Clarias* sp. urohyal 1
- A6 4:7
- *Anabas testudineus* cleithrum 1R, supracleithrum 1L
- Bagridae pectoral fin spine 1L 1R
- *Clarias* sp. pectoral fin spine 1L
- A6 4:6
- *Anabas testudineus* lacrimal 2L, supracleithrum 1L 2R
- Bagridae pectoral fin spine 1R
- *Channa* sp. ceratohyal 1L, cleithrum (ventral process) 1L
- *Channa striata* lower pharyngeal 2R

- *Clarias* sp. supraorbital 1R
- A7 5:2
- Bagridae pectoral fin spine 1R
- A7 5:1
- *Anabas testudineus* articular 1R
- Bagridae pectoral fin spine 1L
- *Channa* sp. ceratohyal 1L
- A7 4:12
- *Channa striata* ceratohyal 1R
- A7 4:11
- *Anabas testudineus* supracleithrum 1L
- *Channa striata* basioccipital 1, ceratohyal 1R
- A7 4:10
- *Clarias* sp. pectoral fin spine 1L
- B1 5:1
- *Anabas testudineus* supracleithrum 1R
- Cyprinidae lower pharyngeal 1R
- Siluridae pectoral fin spine 1L 1R
- B1 4A:10
- *Anabas testudineus* fragment of cleithrum 1R
- *Hemibagrus nemurus* pectoral fin spine 1R
- *Channa striata* fragment of lower pharyngeal 1R
- *Wallago* sp. pectoral fin spines 2R
- B1 4A:9
- Bagridae cleithrum 1L
- B1 4A:7
- Bagridae pectoral fin spine 1R
- *Channa striata* dentary 1L 1R
- *Clarias* sp. pectoral fin spine 1L
- Siluridae pectoral fin spines 2L
- B1 4A:6
- *Anabas testudineus* supracleithrum 1L
- Bagridae pectoral fin spine 2R
- *Channa striata* basioccipital 1, lower pharyngeal 1R, palatine 2R, pre-maxilla 1L 1R
- *Clarias* sp. pectoral fin spine 1R, supraoccipital 1, supraorbital 1L
- Siluridae pectoral fin spine 1R
- *Monopterus albus* dentary 1R
- B1 4A:5
- *Hemibagrus nemurus* pectoral fin spine 1L
- B2 4A:8
- *Channa* sp. ceratohyal 1R
- B3 5:2
- *Anabas testudineus* maxilla 1L
- *Channa striata* epihyal 1R, palatine 1L 1R
- B3 5:1
- *Clarias* sp. pectoral fin spine 1L 1R
- Siluridae pectoral fin spines 2R
- B3 4A:11
- *Anabas testudineus* lacrimal 2L, post-temporal 1R
- Bagridae pectoral fin spines 2 R
- Siluridae pectoral fin spine 1R
- B3 4A:9
- *Anabas testudineus* suborbital 4 1L
- Bagridae pectoral fin spine 1L
- B3 4A:7
- *Anabas testudineus* preopercular 1L
- Bagridae cleithrum 1L , pectoral fin spines 2L 1R
- *Channa striata* dentary 1R, lower pharyngeal 1L
- *Clarias* sp. dermethmoid 1, pectoral fin spine 1L
- *Ompok bimaculatus* articular 1L
- B3 4A:6
- *Anabas testudineus* supracleithrum 1L
- Bagridae pectoral fin spines 2L 1R
- *Channa striata* cleithrum (ventral)1L
- *Clarias* sp. post-temporal 1R
- Siluridae pectoral fin spine 1L
- B4 4A:8
- *Anabas testudineus* supracleithrum 1R
- Bagridae pectoral fin spine 1L
- *Clarias* sp. pectoral fin spine 1R
- Siluridae pectoral fin spines 2R
- *Channa striata* maxilla 1L, supracleithrum 1R
- *Clarias* sp. pectoral fin spine 1L 1R
- B6 5:2
- Bagridae pectoral fin spine 1L
- B6 4:12
- Bagridae pectoral fin spine 1R
- *Channa striata* cleithrum (ventral process)1L
- *Monopterus albus* ectopterygoid 1L
- B6 4:11
- *Anabas testudineus* lacrimal 1L
- Bagridae dorsal fin spines 2
- B6 4:10
- Bagridae articular 1L, cleithrum 1L, pectoral fin spines 2L
- *Channa* sp. articular 1R
- *Clarias* sp. pectoral fin spines 2R
- *Ompok bimaculatus* articular 1R
- B6 4:9
- *Anabas testudineus* articular 1R, lower pharyngeal 1L, opercular 1R
- Bagridae pectoral fin spines 2L 2R
- *Channa striata* articular 1L
- *Clarias* sp. pectoral fin spines 3L
- B6 4:8
- *Anabas testudineus* lacrimal 1R, opercular 1R
- *Channa striata* dentary 2R
- *Clarias* sp. pectoral fin spine 1L
- Siluridae pectoral fin spine 1L
- B6 4:6
- *Channa striata* articular 1L
- B7 4:11
- *Anabas testudineus* subopercular 1R
- B7 4:8
- Bagridae dorsal fin spine 1
- Siluridae pectoral fin spine 1R
- B7 4:7
- Siluridae pectoral fin spine 1R
- B7 4:6
- Bagridae pectoral fin spine 1L
- C1 5:2
- *Anabas testudineus* supracleithrum 1R
- Bagridae dorsal fin spine1
- C1 5:1
- *Anabas testudineus* articular 1L, lacrimal 1L, opercular 2R, supracleithrum 1L
- Bagridae cleithrum 1L 1R, pectoral fin spines 1L 3R
- *Channa* sp. articular 1L, ceratohyal 1L 1R, dentary 3R, frontal 1L, quadrate 1L
- *Clarias* sp. pectoral fin spines 1L 5R, supraorbital 1L
- *Monopterus albus* articular 1R, cleithrum 1L
- C1 4:16
- *Anabas testudineus* lacrimal 1L
- Bagridae pectoral fin spine 1L
- Siluridae pectoral fin spines 2L
- C1 4:15 feature 1 midden
- *Hemibagrus nemurus* pectoral fin spine 1L
- C1 4:14
- *Anabas testudineus* supracleithrum 1L
- Bagridae pectoral fin spine 1R
- *Channa striata* palatine 1L, scale bone 1R
- *Clarias* sp. pectoral fin spine 1L 1R

C1 4:13

- *Anabas testudineus* lacrimal 1L, suborbital5 1R
- Bagridae pectoral fin spines 3L 3R
- *Channa striata* palatine 1L
- *Clarias* sp. pectoral fin spine 1R

C1 4:12

- Bagridae cleithrum 2L, pectoral fin spines 4R
- *Channa micropeltes* maxilla 1L
- *Channa striata* maxilla 1L, post-temporal 1L
- *Clarias* sp. articular 1L, cleithrum dorsal process 1L 1R, ventral process 1L, pectoral fin spines 2R, supraoccipital 1
- Siluridae pectoral fin spines 2L

C1 4:11

- *Anabas testudineus* lower pharyngeal 1L
- Bagridae pectoral fin spine 1L
- *Channa striata* lower pharyngeal 1L
- *Clarias* sp. frontal 1R, supraorbital 1L

C2 5:6

- *Anabas testudineus* lacrimal 1L, suborbital5 1R

C2 5:5

- *Clarias* sp. urohyal 1

C2 5:4

- Bagridae pectoral fin spine 1L 1R
- Siluridae pectoral fin spine 1R

C2 5:3

- *Anabas testudineus* lacrimal 1L, suborbital5 1L
- Bagridae dorsal fin spine 1, pectoral fin spine 1R
- *Channa* sp. cleithrum (ventral) 1L, quadrate 1L 1R
- *Clarias* sp. pectoral fin spines 2L
- Siluridae pectoral fin spine 1L

C2 5:2

- *Anabas testudineus* post-temporal 1L, supracleithrum 2L
- Bagridae pectoral fin spine 1L
- *Channa* sp. articular 1R, cleithrum (ventral) 1L, supracleithrum 1L
- *Channa striata* maxilla 1L, premaxilla 1R, scale bone 1L
- *Clarias* sp. cleithrum 1R, dentary 1R
- Siluridae pectoral fin spine 1L

C2 4:13

- *Anabas testudineus* supracleithrum 1L 1R
- Bagridae dorsal fin spine 1, pectoral fin spines 2L 2R
- *Channa striata* maxilla 1R, premaxilla 1L
- *Clarias* sp. cleithrum 1R
- Siluridae pectoral fin spine 1R
- *Monopterus albus* cleithrum 1L

C2 4:12

- *Anabas testudineus* lacrimal 1, supracleithrum 1L 1R
- Bagridae dorsal fin spines 2, pectoral fin spine 1L 1R
- *Channa striata* maxilla 1R, palatine 1R, premaxilla 1R, scale bone 1L
- *Clarias* sp. pectoral fin spine 1L

C2 4:11

- *Anabas testudineus* lacrimal 1R, supracleithrum 2L 1R
- Bagridae dorsal fin spine 1, pectoral fin spines 1L 3R
- *Channa* sp. quadrate 1L
- *Channa striata* maxilla 1R
- *Clarias* sp. fragment of frontal 1R

C2 4:10

- *Anabas testudineus* dentary 1L, lower pharyngeal 1R, premaxilla 1L
- Bagridae dorsal fin spine 1, pectoral fin spines 1L 3R
- *Channa* sp. articular 1R, epihyal 1L 1R
- *Clarias* sp. pectoral fin spine 1R
- Siluridae pectoral fin spine 1L
- *Monopterus albus* articular 1R

C2 4:9

- Bagridae pectoral fin spine 1L
- *Channa lucius* articular 1L
- *Channa striata* cleithrum (ventral) 1L, lower pharyngeal 1R, supracleithrum 1R, supraoccipital 1
- *Clarias* sp. cleithrum 1R, dermethmoid 1, frontal 1R, pectoral fin spines 2R, supraorbital 1R

- *Monopterus albus* articular 1R

C2 4:8

- Bagridae cleithrum 1R, dorsal fin spine 1, pectoral fin spine 1L
- *Channa* sp. quadrate 1R
- Cyprinidae lower pharyngeal 1R
- *Clarias* sp. articular 1R

C3 5:3

- *Anabas testudineus* articular 1L, interopercular 1R, suborbital5 1L
- Siluridae pectoral fin spine 1R

C3 5:1

- *Anabas testudineus* lacrimal 1L
- *Channa striata* cleithrum (ventral) 1R, dentary 1R
- *Clarias* sp. 3 pieces of neurocranium = 1
- Siluridae dentary 1R
- *Monopterus albus* ectopterygoid 1R

C3 4:12

- Bagridae cleithrum 1L, pectoral fin spine 1L 1R
- *Clarias* sp. pectoral fin spine 1L, supraorbital 1R
- Siluridae dentary 1R

C3 4:11

- *Anabas testudineus* dentary 1R, lacrimal 2L, supracleithrum 1L
- Bagridae dorsal fin spine 1
- *Channa striata* lower pharyngeal 1L, scale bone 1L
- *Clarias* sp. articular 1L, cleithrum 1R, pectoral fin spine 1R, supraoccipital 1, urohyal 1
- Siluridae pectoral fin spines 3R
- *Ompok bimaculatus* articular 1L
- *Monopterus albus* ectopterygoid 1R

C3 4:10

- *Anabas testudineus* cleithrum 1L, supraoccipital 1
- Bagridae dorsal fin spine 1, pectoral fin spines 1L 2R
- *Channa* sp. ceratohyal 1L 1R, supracleithrum 1L
- *Channa striata* maxilla 1R, post-temporal 1R
- *Clarias* sp. pectoral fin spine 1L
- Siluridae dentary 1R

C3 4:9

- *Anabas testudineus* post-temporal 1R, suborbital 1L
- Bagridae cleithrum 1L, pectoral fin spines 1L 2R
- *Channa micropeltes* premaxilla 1R
- *Channa striata* ceratohyal 1R, cleithrum (ventral) 1R, dentary 1R, maxilla 1L 1R, palatine 2R, premaxilla 1R, pterotic 1L
- *Clarias* sp. cleithrum 1L
- Siluridae pectoral fin spine 1L

C4 5:6

- Bagridae pectoral fin spine 1L

C4 5:5

- *Anabas testudineus* cleithrum 1R

C4 5:4

- *Anabas testudineus* lacrimal 1R

C4 5:3

- *Anabas testudineus* suborbital5 1R

C4 5:2

- *Anabas testudineus* lower pharyngeal 1L
- Bagridae articular 1L, cleithrum 1L, pectoral fin spines 1L 2R
- *Clarias* sp. articular 1R

C4 5:1

- *Anabas testudineus* lacrimal 1R
- Bagridae pectoral fin spines 4R
- *Channa striata* dentary 1L, supraoccipital 1
- *Clarias* sp. pectoral fin spine 1R

C4 4:12

- *Anabas testudineus* lacrimal 2L
- Bagridae cleithrum 1L, dorsal fin spine 1, pectoral fin spines 2L
- *Channa striata* premaxilla 1L, post-temporal 1L
- *Clarias* sp. dermethmoid 1
- Siluridae pectoral fin spine 1L
- *Monopterus albus* dentary 1R

C4 4:11

- *Anabas testudineus* cleithrum 1L 1R, lacrimal 3L 1R, maxilla 3L, oper-

- culum 1R, supracleithrum 1R
- Bagridae dorsal fin spine 1, pectoral fin spine 1L
 - *Channa lucius* premaxilla 1L
 - *Channa striata* basioccipital 1, ceratohyal 1R, dentary 2R, palatine 1R, post-temporal 1R, premaxilla 1R, pterotic 2L, scale bone 1R
 - *Clarias* sp. cleithrum 1L, pectoral fin spines 4L 1R
 - *F. Notopterus* maxilla 1R
- C4 4:10
- *Anabas testudineus* lacrimal 2R
 - Bagridae cleithrum 1L, pectoral fin spine 1
 - *Channa striata* ceratohyal 2R, dentary 1L, maxilla 1L 1R, post-temporal 1L
 - *Clarias* sp. articular 1R, pectoral fin spines 2L 2R, supraoccipital 1
 - *Notopterus notopterus* dentary 1R
 - Siluridae pectoral fin spine 1L
- C4 4:9
- *Anabas testudineus* opercular 1L, supracleithrum 1R
 - Bagridae dorsal fin spine 1, pectoral fin spines 2L
 - *Channa striata* ceratohyal 2R, cleithrum (ventral) 1R, dentary 1R, lower pharyngeal 1L, maxilla 3L, premaxilla 1L
 - *Clarias* sp. cleithrum 1R, pectoral fin spines 7L 3R, supraoccipital 1R
- C5 5:5
- *Anabas testudineus* suborbital4 1L
- C5 5:3
- Siluridae pectoral fin spine 1R
- C5 5:2
- *Anabas testudineus* lacrimal 1L 2L, opercular 1R, suborbital5 1L, supracleithrum 1R
 - *Channa striata* maxilla 1R, post-temporal 1R, supracleithrum 1L
 - *Clarias* sp. fragment of neurocranium 1
 - *Monopterus albus* articular 1R
- C5 4:12
- *Anabas testudineus* lacrimal 1L 2R
 - Bagridae pectoral fin spines 2L 1R
 - *Channa striata* maxilla 1R
 - *Monopterus albus* articular 1R
- C5 4:11
- Bagridae pectoral fin spine 1R
 - *Monopterus albus* articular 1R
- C5 4:9
- Bagridae cleithrum 1L, dentary 1L, pectoral fin spine 1L 1R
 - *Channa lucius* maxilla 1L
 - *Channa striata* lower pharyngeal 1L
 - *Clarias* sp. pectoral fin spine 1L
 - Siluridae pectoral fin spine 1R
- C5 4:8
- *Anabas testudineus* lacrimal 2L, supracleithrum 1R
 - Bagridae pectoral fin spine 1L 1R
 - *Channa striata* basioccipital 1, maxilla 1L, premaxilla 1L 1R
 - *Clarias* sp. cleithrum 1R, pectoral fin spines 2L
 - Siluridae pectoral fin spine 1L
 - *Monopterus albus* articular 1L
- C6 5:2
- *Anabas testudineus* supracleithrum 1R
- C6 5:1
- *Channa striata* scale bone 1L
- C6 4:12
- Bagridae pectoral fin spine 1R
 - *Clarias* sp. pectoral fin spine 1L
- C6 4:11
- *Anabas testudineus* lacrimal 2R
 - Bagridae pectoral fin spines 2L
 - *Clarias* sp. cleithrum 1R
 - Siluridae pectoral fin spines 3L
- C6 4:10
- *Anabas testudineus* lacrimal 1L, lower pharyngeal 1L, supracleithrum 1R
 - Bagridae cleithrum 1L 1R, dorsal fin spine 1
 - *Channa striata* lower pharyngeal 1L
 - *Clarias* sp. pectoral fin spine 1L
- C6 4:9
- *Anabas testudineus* lacrimal 1R, suborbital4 1L, suborbital5 1R, supracleithrum 1R
 - Bagridae pectoral fin spine 1L
 - Siluridae pectoral fin spines 2R
 - *Channa striata* ceratohyal 3R, maxilla 1R, palatine 1R, post-temporal 1R, premaxilla 1L
 - *Clarias* sp. frontal 1R, pectoral fin spines 1L 2R, supraorbital 1R
 - Siluridae pectoral fin spine 1R
- C6 4:7
- Bagridae cleithrum 1L, pectoral fin spine 1L
 - *Clarias* sp. dermethmoid 1, pectoral fin spine 2R
- C7 5:4
- *Anabas testudineus* lacrimal 1L
- C7 5:3/4
- Bagridae pectoral fin spines 2R
- C7 5:1
- *Channa striata* premaxilla 1L
- C7 4:13
- *Channa* sp. ceratohyal 1R
 - *Channa striata* dentary 1R
 - *Monopterus albus* cleithrum 1R
- C7 4:12
- Bagridae cleithrum 1L, pectoral fin spine 1L
- C7 4:11
- Bagridae dorsal fin spine 1
 - *Channa striata* premaxilla 1R
 - Siluridae dentary 1L
- C7 4:10
- Bagridae dorsal fin spines 2, pectoral fin spine 1L
 - *Clarias* sp. cleithrum 1L
- C7 4:9
- *Channa striata* articular 1R, lower pharyngeal 1L
- C7 4:8
- *Clarias* sp. cleithrum 1L
- C7 4:7
- *Anabas testudineus* frontal 1L, lacrimal 1L
 - Bagridae cleithrum 1L, pectoral fin spines 2L
 - *Channa striata* sphenotic 1L
 - *Clarias* sp. fragment of cleithrum 1, fragment of supraoccipital 1
- C7 4:6
- Bagridae pectoral fin spine 1L
 - *Channa striata* lower pharyngeal 1R
 - *Clarias* sp. pectoral fin spine 1R
 - Siluridae pectoral fin spine 1L
- C7 4:5
- Bagridae pectoral fin spine 1R
 - *Clarias* sp. articular 1L, frontal 1L, pectoral fin spine 1L
 - *Monopterus albus* ceratohyal 1R
- C8 5:1
- *Clarias* sp. pectoral fin spine 1L
- C8 4:8
- *Channa striata* basioccipital 1
 - *Clarias* sp. pectoral fin spine 1L, supraoccipital 1
 - *Wallago* sp. fragment of dentary 1R
- C9 5:2
- *Anabas testudineus* supracleithrum 1L
 - Bagridae pectoral fin spine 1L
 - *Channa* sp. cleithrum 1L 1R, quadrate 2R
 - Siluridae pectoral fin spine 1L 1R
 - *Monopterus albus* supracleithrum 1R
- D2 5:4
- *Anabas testudineus* fragment of skull 1
 - *Channa* sp. fragment of skull 1
 - *Clarias* sp. fragment of cleithrum 1
- D2 5:3
- *Anabas testudineus* lacrimal 1L, suborbital 1R

- Bagridae cleithrum 1L, pectoral fin spine 1L
- *Channa striata* basioccipital 1, quadrate 1L
- *Clarias* sp. articular 1R, fragment of skull 2, pectoral fin spine 1R
- Siluridae pectoral fin spine 1R
- D2 5:2
- *Clarias* sp. distal end of pectoral fin spine 1
- D2 5:1
- Bagridae pectoral fin spine 1R
- *Hemibagrus nemurus* dorsal fin spine 1
- D2 4:9
- Bagridae pectoral fin spine 1L 1R
- *Clarias* sp. pectoral fin spine 1L 1R
- D2 4:8 feature 1 midden
- *Monopterus albus* dentary 1R
- D3 5:3
- Bagridae pectoral fin spine 1R
- *Clarias* sp. distal end of pectoral fin spine 1, fragment of skull 1
- D3 5:1
- *Anabas testudineus* dentary 1L, fragment of skull 3 pieces, supracleithrum 2L
- *Hemibagrus nemurus* pectoral fin spine 1R
- *Channa striata* articular 1R, ceratohyal 1L, quadrate 1L
- *Clarias* sp. cleithrum 1L, pectoral fin spines 2L 1R, supraorbital 1L
- D3 4:9
- *Anabas testudineus* opercular 2R
- Bagridae pectoral fin spines 3L
- *Channa* sp. articular 1L 1R, ceratohyal 1L
- *Channa striata* ceratohyal 1R, palatine 1R, pterotic 1R
- *Clarias* sp. pectoral fin spine 1L
- Siluridae pectoral fin spine 1L 1R
- *Monopterus albus* articular 1L
- D4 5:4
- *Channa striata* articular 1R
- *Clarias* sp. pectoral fin spine 1R, supraoccipital 1
- Siluridae pectoral fin spine 1R
- D4 5:3
- *Anabas testudineus* lacrimal 1R, post-temporal 1L
- Bagridae pectoral fin spines 3L
- *Channa striata* articular 1L
- *Clarias* sp. fragment of skull 3 small pieces = 1
- *Ompok bimaculatus* pectoral fin spine 1L 1R
- D4 4:10
- *Anabas testudineus* suborbital 5 1R
- Bagridae cleithrum 1R, pectoral fin spines 2L
- *Channa striata* articular 1R, palatine 1R, premaxilla 1R
- *Monopterus albus* supracleithrum 1R
- D4 4:9
- Bagridae pectoral fin spines 2L 3R
- Siluridae pectoral fin spines 2L
- D5 4:11/5:1 feature 2 midden
- *Anabas testudineus* interopercular 1R, lacrimal 1L, frontal 1L, opercular 1L
- Bagridae cleithrum 1L, pectoral fin spine 1L 1R
- *Hemibagrus nemurus* articular 1L, pectoral fin spine 1R
- *Channa lucius* maxilla 1R
- *Channa striata* ceratohyal 1L, cleithrum (ventral process) 2L, dentary 2R, lower pharyngeal 2L, palatine 2L, supraoccipital 1
- *Clarias* sp. articular 1R, cleithrum dorsal process 1L, ventral process 1L, dentary 1R, pectoral fin spine 1R
- *Monopterus albus* articular 1R
- D5 4:10
- *Channa striata* basioccipital 1
- Siluridae pectoral fin spines 2L 2R
- D5 4:9
- Bagridae pectoral fin spines 1L 2R
- *Clarias* sp. pectoral fin spine 1L 1R
- D5 4:8
- *Clarias* sp. pectoral fin spine 1R
- D5 4:6
- Bagridae dorsal fin spine 1
- *Clarias* sp. cleithrum 1R
- D6 4:11
- Bagridae cleithrum 1R, pectoral fin spines 2L 2R
- *Channa striata* maxilla 1L 1R, post-temporal 1R,
- *Clarias* sp. articular 1R, pectoral fin spine 1L
- D6 4:10
- *Channa striata* lower pharyngeal 1L
- *Clarias* sp. pectoral fin spine 1L 1R
- *Monopterus albus* cleithrum 1L
- D6 4:8
- *Channa striata* ceratohyal 1R
- Siluridae pectoral fin spine 1R
- D6 4:6
- Bagridae pectoral fin spine 1R
- D7 4:8
- Bagridae pectoral fin spines 2R
- D7 4:7
- *Anabas testudineus* supracleithrum 1R
- *Clarias* sp. pectoral fin spine 1L
- D7 4:6
- *Anabas testudineus* lacrimal 1L
- Bagridae dorsal fin spine 1
- *Hemibagrus nemurus* dentary 1L
- *Channa striata* lower pharyngeal 2L, maxilla 1L
- D7 4:5
- Bagridae pectoral fin spine 1L
- *Channa striata* ceratohyal 1L
- *Clarias* sp. pectoral fin spine 1L 1R
- Siluridae pectoral fin spine 1L
- D8 5:4
- *Anabas testudineus* lacrimal 1L
- Bagridae pectoral fin spine 1L
- *Channa striata* premaxilla 1R, supraoccipital 1
- *Clarias* sp. pectoral fin spine 1L 1R
- D8 5:1
- *Clarias* sp. fragment of neurocranium 1
- D9 5:2
- Bagridae pectoral fin spine 1R
- *Clarias* sp. pectoral fin spine 1R, supraoccipital 1
- D9 5:1
- *Anabas testudineus* cleithrum 1L
- Bagridae cleithrum 1R, pectoral fin spine 1L 1R
- *Channa striata* palatine 1R
- Siluridae pectoral fin spine 1R
- D9 4:8
- Bagridae pectoral fin spine 1R
- D9 4:7
- Bagridae cleithrum 1L 1R
- *Hemibagrus nemurus* dorsal fin spine 1, pectoral fin spine 1R
- *Channa* sp. epiphyal 1L
- *Clarias* sp. pectoral fin spine 1R
- Siluridae pectoral fin spine 1L
- *Monopterus albus* ectopterygoid 1L
- E2 5:4
- Bagridae pectoral fin spine 1R
- *Hemibagrus nemurus* dorsal fin spine 1
- *Channa striata* articular 1R, maxilla 1R
- *Clarias* sp. fragment of skull 1
- *Monopterus albus* cleithrum 1
- E2 5:4 feature 1
- *Anabas testudineus* articular 3L 1R, hyomandibular 1R, lacrimal 2L 1R, post temporal 1R suborbital 1R, supracleithrum 1L
- Bagridae, dorsal fin spine 3, pectoral fin spine 1L
- *Hemibagrus nemurus* pectoral fin spines 1L 2R
- *Channa striata* cleithrum 1L, epiphyal 1R, maxilla 2L, palatine 1L 1R, post temporal 1R, scale bone 1L, supracleithrum 1R, supraoccipital 1
- *Clarias* sp. fragment of post-temporal 1R, (pectoral) pelvic fin spine 1L 1R
- *Mastacembelus* sp. preopercular 1L
- Siluridae pectoral fin spine 1R

- *Monopterus albus* articular 1L

E2 5:2

- *Anabas testudineus* frontal 1L, lacrimal 1L 5R, post-temporal 1L

- Bagridae dorsal fin spine 1, pectoral fin spine 3R

- *Channa striata* dentary 1L, epihyal 2L, maxilla 3L, palatine 2L 1R, premaxilla 1R, scale bone 1R

- *Clarias* sp. articular 1L, derm-ethmoid 1, pectoral fin spines 4R

- Siluridae pectoral fin spines 2L

- *Monopterus albus* ectopterygoid 1L

E2 5:2 feature 1

- *Anabas testudineus* articular 3L 3R, basioccipital 5, ceratohyal 1L 4R, cleithrum 4L 6R, frontal 2L, lacrimal 18L 22R, lower pharyngeal 7L 7R, maxilla 1L 2R, opercular 1L 4R, post-temporal 2L 2R, premaxilla 1L 1R, preopercular 1L 3R, supracleithrum 14L 7R, supraoccipital 1

- Catfishes cleithrum fragments 9L 7R

- Bagridae pectoral fin spines 25L 47R, supraoccipital 4

- *Hemibagrus nemurus* articular 2L, coracoid 2L, dentary 1R, dorsal fin spines 12, pectoral fin spines 16L 19R, supraoccipital 2

- *Mystus* sp. dorsal fin spines 5

- *Channa micropeltes* premaxilla 1L

- *Channa striata* articular 5L 9R, basioccipital 13, ceratohyal 13L 14R, cleithrum 12L 12R dentary 7L 12R, epihyal 7L 10R, fragment opercular 1L, frontal 1R, interopercular 1L, lacrimal 2L 2R, lower pharyngeal 6L 5R, maxilla 21L 16R, nasal 1L 1R, quadrate 12L 8R, palatine 15L 8R, post-temporal 5L 3R, premaxilla 6L 7R, scale bone 3L, sphenotic 4L 3R, supracleithrum 7L 2R, supraoccipital 6, upper pharyngeal 2L 4R, Vomer 1

- Cyprinidae lower pharyngeal 1

- *Clarias* sp. Articular 2L, cleithrum fragment 2R, dentary 1R, derm-ethmoid 2, frontal 1R, Jugal 1L 3R, pectoral fin spine 16L 21R, post-temporal 1R, supraoccipital 3, supraorbital 2L 1R, urohyal 3

- *Clarias macrocephalus* supraoccipital 1

- *Notopterus notopterus* dentary 1R, maxilla 2L 1R, parasphenoid fragment. 1, premaxilla 1L

- Siluridae cleithrum 7L 4R, pectoral fin spines 16L 39R

- *Ompok bimaculatus* articular 1L 3R

E2 5:1

- *Hemibagrus* sp. pectoral fin spine 1

E2 5:1 feature 1

- *Anabas testudineus* cleithrum 2R, lacrimal 7L 5R, lower pharyngeal 1L 3R, maxilla 3L 1R, opercular 1R, quadrate 1L, post-temporal 2L 1R, suborbital 1L 1R, supracleithrum 4L 1R, Supraoccipital 1

- Bagridae cleithrum 3L 3R, dorsal fin spine 2, pectoral fin spines 19L 14R

- *Hemibagrus nemurus* cleithrum 3L, pectoral fin spines 2L

- *Channa* sp. articular 3L 3R, quadrate 1R

- *Channa lucius* maxilla 1

- *Channa micropeltes* epihyal 1R

- *Channa striata* basioccipital 8, ceratohyal 10L 3R, dentary 6L 4R, epihyal 1L, lacrimal 1L, lower pharyngeal 5L 4R, maxilla 2L 7R, palatine 1L 1R, post-temporal 1L, pterotic 1R, premaxilla 2L 1R, scale bone 2L, sphenotic 2R, supraoccipital 1

- *Clarias* sp. articular 1R, dentary 1L 1R, opercular 1L, pectoral fin spines 5L 6R, supraoccipital 1L, urohyal 2

- *Clarias macrocephalus* supraoccipital 1

- Siluridae pectoral fin spines 5L 7R

- *Ompok bimaculatus* articular 1R, dentary 1L 1R

- *Monopterus albus* articular 1R, cleithrum 1R, dentary 1L

E2 5:1 feature 2

- *Anabas testudineus* articular 1L, cleithrum 1L 3R, dentary 1R, lacrimal 3L 2R, lower pharyngeal 1R, maxilla 4R, post-temporal 2L 1R, suborbital 1L, supracleithrum 5L

- Bagridae cleithrum 2R, dentary 1L, dorsal fin spines 4, pectoral fin spines 9L 11R

- *Hemibagrus nemurus* articular 2L 2R, cleithrum 1L 1R, coracoid 2L 1R, dentary 1L, dorsal fin spines 2, pectoral fin spines 4L 3R

- *Channa striata* articular 2L 1R, basioccipital 2, cleithrum 3L 1R, dentary 2L, lower pharyngeal 2R, maxilla 2L 4R, opercular 1R, palatine 2L 2R, post-temporal 1L 1R, premaxilla 5L 1R, quadrate 1R, scale bone 1R, sphenotic 2L

- *Clarias* sp. articular 2R, cleithrum 2L, pectoral fin spines 3L 9R, supraoccipital 1, supraorbital 2R, urohyal 1

- *Pristolepis fasciatus* lower pharyngeal 1

- *Notopterus* dentary fragment 1R

- Siluridae pectoral fin spines 8L 7R

- *Ompok bimaculatus* articular 1R, cleithrum 1R

- *Monopterus albus* articular 1R, dentary 1L 1R, ectopterygoid 1L, basi-hyal 2

E2 5:1 feature 3

- *Anabas testudineus* post-temporal 1R

- Bagridae pectoral fin spine 1R

- *Channa striata* articular 1R, cleithrum 1L 1R, maxilla 1R, premaxilla 1R

- *Clarias* sp. small fragment of cleithrum 2, small fragment of skull 1

- *Ompok bimaculatus* articular 1R, cleithrum 1L, dentary 1L

E2 4:9

- *Anabas testudineus* articular 1L, lacrimal 1L 1R, supracleithrum 1R

- Bagridae dorsal fin spines 3, pectoral fin spines 6L 1R

- *Channa striata* ceratohyal 1L 1R, dentary 1L, maxilla 1L 1R, premaxilla 1R

- *Clarias* sp. articular 1R, pectoral fin spine 1R

- *Monopterus albus* dentary 1R, ectopterygoid 1R

E2 4:9 feature 26 shell midden

- *Anabas testudineus* lacrimal 1R

- Bagridae pectoral fin spines 1L 3R

- *Channa striata* ceratohyal 1L, epihyal 1L 1R, lower pharyngeal 1L, scale bone 1L, supracleithrum 1L 1R

- *Clarias* sp. articular 1R, cleithrum 1L 1R, pectoral fin spines 1L 3R

- Siluridae pectoral fin spine 1L

- *Monopterus albus* ectopterygoid 1R, quadrate 1R

E2 4:8

- *Anabas testudineus* supracleithrum 2L

- Bagridae pectoral fin spines 2L

- *Hemibagrus nemurus* pectoral fin spine 1R

- *Channa* sp. articular 1L, dentary 1L 1R

- *Channa lucius* articular 1L

- *Channa striata* ceratohyal 3L 4R, maxilla 2L, opercular 1L, palatine 1L, quadrate 1R, supraoccipital 1

- *Clarias* sp. pectoral fin spine 1L, supraoccipital 1

- Siluridae pectoral fin spine 1R

E3 5:4 feature 1

- *Anabas testudineus* lacrimal 1R

- *Channa striata* quadrate 1L

- *Clarias* sp. pectoral fin spine 1L

E3 5:3

- *Anabas testudineus* post-temporal 1L

- Bagridae pectoral fin spines 2L

- *Hemibagrus nemurus* dorsal fin spine 1

- *Channa striata* basioccipital 1

- *Clarias* sp. fragment of coracoid 1, fragment of skull 1, pectoral fin spine 1R

E3 5:2

- *Anabas testudineus* lacrimal 1L

- Bagridae pectoral fin spine 1L

- *Channa striata* fragment of skull 1, premaxilla 1L,

- Siluridae pectoral fin spine 1R

E3 5:1 feature 2

- *Anabas testudineus* lacrimal 4L 6R, lower pharyngeal 1L 1R, maxilla 1R, opercular 1R, post-temporal 1R, premaxilla 1R, suborbital 1L, supracleithrum 1L 2R

- Bagridae cleithrum 1L 3R, pectoral fin spines 13L 14R

- *Hemibagrus nemurus* dermethmoid 1, dorsal fin spine 1, pectoral fin spine 1L 1R

- *Mystus* sp. dorsal fin spines 3

- *Channa striata* articular 2L, basioccipital 1, ceratohyal 2L 3R, cleithrum 1L 1R, dentary 1L 1R, maxilla 3L, palatine 1L 1R, post-temporal 1L, premaxilla 1L 1R, quadrate 2L 1R, scale bone 1L, supracleithrum 1R

- *Clarias* sp. articular 3L 1R, cleithrum 2R, pectoral fin spines 5L 10R, supraorbital 1L, supraoccipital 2

- Siluridae pectoral fin spines 2L 2R

- *Ompok bimaculatus* articular 1L, cleithrum 1R, dentary 2L
- *Wallago* sp. pectoral fin spine 1R
- *Monopterus albus* articular 1R, cleithrum 1R, basihyal 1

E3 5:1 feature 2

- Siluridae pectoral fin spine 1R

E3 4:9

- *Anabas testudineus* lacrimal 1L
- Bagridae pectoral fin spines 2L 1R
- *Channa striata* palatine 1L
- Siluridae pectoral fin spines 2L 2R

E3 4 surface 9 feature 1,
shell midden.

1. Cypriniformes

Family Cyprinidae, *Barbodes* sp. 1L dentary = 1.

2. *Hemibagrus nemurus* 1L pectoral fin spine, 1 dorsal spine = 2

3. *Hemibagrus/Mystus* 2L, 2R pectoral fin spine = 4

4. *Ompok/Wallago* 1L pectoral fin spine = 1

5. *Clarias* sp 1L, 2R pectoral fin spine, 1 fragment of neurocranium = 2

6. *Monopterus albus* 1R ectopterygoid, 1 urohyal = 1

7. *Anabas testudineus* 1L maxilla, 1R lacrimal, 1R supracleithrum, 1 supraoccipital = 1

8. *Channa striata* 1L lower pharyngeal, 2L maxilla, 1R nasal, 2R palatine, 1L premaxilla, 1 supraoccipital = 2

E3 4:8

- Bagridae dorsal fin spine 1, pectoral fin spine 1L 1R
- *Channa striata* basioccipital 1
- *Clarias* sp. pectoral fin spines 2L

E4 5:2

- Bagridae dorsal fin spine 1
- *Clarias* sp. pectoral fin spine 1R
- *Ompok bimaculatus* pectoral fin spine 1L

E4 4:10

- *Anabas testudineus* lacrimal 1R, post-temporal 1L, supracleithrum 1L
- Bagridae pectoral fin spine 1R
- *Hemibagrus nemurus* cleithrum 1R, pectoral fin spine 1R
- *Clarias* sp. supraoccipital 1

E5 4:9

- *Anabas testudineus* lacrimal 1L
- bagridae pectoral fin spine 1L 1R
- *Clarias* sp. pectoral fin spine 1L

E5 4:8

- *Channa striata* ceratohyal 1R, palatine 1L
- *Clarias* sp. pectoral fin spine 1R

E5 4:7

- Bagridae pectoral fin spine 1R
- *Channa striata* supracleithrum 1R

E6 5:1

- Bagridae pectoral fin spines 2R
- *Channa striata* premaxilla 1L

E6 4:10

- *Anabas testudineus* dentary 1L, lacrimal 2L
- Bagridae dorsal fin spine 1, pectoral fin spine 1L
- *Channa striata* maxilla 1L

E6 4:9

- *Anabas testudineus* dentary 1R, lacrimal 1L
- Bagridae pectoral fin spine 1R
- *Channa striata* maxilla 1R

E6 4:8

- *Anabas testudineus* articular 1L, lacrimal 1R, supracleithrum 1L
- Bagridae pectoral fin spines 2L 2R
- *Hemibagrus nemurus* pectoral fin spine 1L
- *Channa striata* fragment lower pharyngeal 1L, premaxilla 1L
- *Clarias* sp. pectoral fin spine 1L

E6 4:7

- Bagridae pectoral fin spine 1L 1R
- *Clarias* sp. pectoral fin spine 1L

E7 5:1

- Bagridae pectoral fin spines 2L
- *Hemibagrus nemurus* articular 1R

E7 4:10

- Bagridae pectoral fin spines 1L 2R
- Siluridae pectoral fin spine 1R

E7 4:9

- *Anabas testudineus* lacrimal 2L
- Bagridae pectoral fin spine 1L
- *Hemibagrus nemurus* dorsal fin spine 1
- *Channa striata* maxilla 1R

E7 4:8

- *Hemibagrus nemurus* dorsal fin spine 1
- *Clarias* sp. pectoral fin spine 1R

E7 4:7

- Bagridae dorsal fin spine 1, pectoral fin spines 1L 2R

E7 4:6

- Bagridae pectoral fin spines 1L 2R
- *Clarias* sp. pectoral fin spines 2L

E9 5:2

- *Anabas testudineus* opercular 2L, supracleithrum 1R
- *Channa* sp. ceratohyal 1L
- *Channa striata* palatine 1L
- *Clarias* sp. pectoral fin spine 1L
- Siluridae pectoral fin spine 1L

E9 5:1

- *Hemibagrus nemurus* pectoral fin spine 1R
- *Channa striata* maxilla 1R
- Siluridae pectoral fin spine 1R

E9 4:8

- Bagridae pectoral fin spine 2L 3R

E9 4:7

- *Anabas testudineus* cleithrum 1L
- Bagridae pectoral fin spine 1L 1R
- *Channa striata* basioccipital 1, supraoccipital 1
- *Clarias* sp. 2pieces of neurocranium=1 1
- Siluridae pectoral fin spine 1R

F2 5:1

- *Anabas testudineus* preopercular 1L, supracleithrum 2R, supraoccipital 2

- Bagridae dorsal fin spines 3, pectoral fin spines 3L 3R

- *Channa* sp. cleithrum 1L 1R, supracleithrum 1L

- *Channa striata* ceratohyal 1L 2R, dentary 1R, epihyal 1R, maxilla 1R, pterotic 1L, sphenotic 1R

- Cyprinidae lower pharyngeal 1L

- *Clarias* sp. articular 1L, dentary 1R, pectoral fin spine 1L 1R

F2 4:10

- Bagridae pectoral fin spine 1L
- *Channa* sp. articular 1L, supraoccipital 1L
- *Clarias* sp. cleithrum 1L, jugal 1L
- *Monopterus albus* cleithrum 1L

F2 4:9

- *Hemibagrus nemurus* pectoral fin spine 1R

F2 4:8

- *Anabas testudineus* supracleithrum 1R
- Bagridae dorsal fin spine 1, pectoral fin spine 1L 1R
- *Channa striata* articular 1R, basioccipital 1, maxilla 1R
- *Clarias* sp. pectoral fin spines 2L 1R
- Siluridae pectoral fin spine 1L
- *Monopterus albus* dentary 1L, ectopterygoid 1R

F2 4:7

- Bagridae dorsal fin spine 1, pectoral fin spine 1L
- *Channa striata* basioccipital 2, dentary 1R, lower pharyngeal 1L 1R
- *Clarias* sp. cleithrum 1L, pectoral fin spines 2R, supraorbital 1L
- *Monopterus albus* articular 1R

F3 5:2

- *Channa striata* premaxilla 1R
- *Clarias* sp. pectoral fin spine 1R

F3 5:1

- Bagridae pectoral fin spines 1L 2R
- *Hemibagrus nemurus* pectoral fin spine 1R
- *Channa striata* ceratohyal 1R
- *Clarias* sp. pectoral fin spine 1R

- Siluridae pectoral fin spine 1L 1R
- F3 4:10
- *Anabas testudineus* lacrimal 1L
- *Hemibagrus nemurus* pectoral fin spines 2L 1R
- *Channa striata* maxilla 2R, scale bone 1L
- *Clarias* sp. cleithrum 1L, pectoral fin spine 1L
- Siluridae pectoral fin spine 1L
- F3 4:8
- Bagridae pectoral fin spine 1R
- *Clarias* sp. cleithrum 1R, pectoral fin spines 3R
- Siluridae pectoral fin spine 1R
- F4 5:1
- *Channa striata* lower pharyngeal 1R
- *Clarias* sp. pectoral fin spine 1R
- Siluridae pectoral fin spine 1L
- F4 5:1 feature 10
- *Hemibagrus nemurus* pectoral fin spine 1L
- F4 4:9
- *Anabas testudineus* lacrimal 1L, lower pharyngeal 1L
- Bagridae cleithrum 1R, pectoral fin spine 1L 1R
- *Channa* sp. epihyal 1L 1R
- *Channa striata* maxilla 1L
- *Clarias* sp. frontal 1R
- Siluridae pectoral fin spine 1L
- F4 4:8
- *Hemibagrus nemurus* cleithrum 1R
- F5 4:9
- Bagridae pectoral fin spines 2L 1R
- *Clarias* sp. articular 1L, dentary 1R
- Siluridae pectoral fin spine 1L 1R
- F5 4:8
- *Anabas testudineus* operculum 2L
- Bagridae pectoral fin spines 2L
- *Channa* sp. ceratohyal 1L
- *Clarias* sp. pectoral fin spine 1R
- *Monopterus albus* ectopterygoid 1R
- F5 4:7
- *Anabas testudineus* supracleithrum 1R
- Bagridae dentary 1R, pectoral fin spine 1R
- *Channa striata* maxilla 1R
- F6 4:8
- *Anabas testudineus* opercular 1L
- Bagridae pectoral fin spine 1L 1R
- *Channa striata* basioccipital 1
- F6 4:7
- *Anabas testudineus* lacrimal 1L
- Bagridae pectoral fin spine 1R
- Siluridae pectoral fin spine 1R
- F7 5:1
- Siluridae pectoral fin spine 1R
- F7 4:10
- Bagridae cleithrum 1L
- *Channa striata* basioccipital 1
- *Clarias* sp. pectoral fin spine 1R
- F7 4:9
- *Anabas testudineus* lacrimal 1R
- Bagridae pectoral fin spine 1L
- *Clarias* sp. pectoral fin spines 2L 1R
- F7 4:8
- *Anabas testudineus* lacrimal 1L, opercular 1R
- Bagridae pectoral fin spines 1L 2R
- *Channa striata* lower pharyngeal 1R, quadrate 1L
- *Clarias* sp. pectoral fin spines 1L 2R
- F7 4:7
- *Anabas testudineus* supracleithrum 1R
- Bagridae pectoral fin spine 1R
- G5 5:1
- *Channa striata* ceratohyal 1L
- G5 4:8
- Bagridae pectoral fin spines 1L 2R
- *Clarias* sp. pectoral fin spine 1L
- G5 4:6
- *Hemibagrus nemurus* articular 1L
- *Clarias* sp. pectoral fin spines 2R
- G6 5:1
- *Anabas testudineus* supracleithrum 1R
- *Clarias* sp. cleithrum 1L
- G6 4:9
- *Anabas testudineus* lacrimal 1R
- Bagridae dorsal fin spine 1, pectoral fin spines 2L 1R
- *Channa striata* ceratohyal 1L, cleithrum (ventral process) 1L 1R, lower pharyngeal 2L
- *Clarias* sp. cleithrum 1R, pectoral fin spine 1L
- Siluridae pectoral fin spine 1R
- *Monopterus albus* articular 1L
- G6 4:8
- *Anabas testudineus* lacrimal 1L
- Bagridae pectoral fin spines 2R
- *Channa striata* ceratohyal 1R, fragment of lower pharyngeal 1R, maxilla 1L
- *Clarias* sp. cleithrum 1R, dentary 1R, pectoral fin spine 1R
- *Monopterus albus* articular 1L
- G6 4:7
- *Anabas testudineus* lacrimal 1L 1R, lower pharyngeal 1R, supracleithrum 2L
- Bagridae cleithrum 1R, dorsal fin spines 2, pectoral fin spines 2L 3R
- *Hemibagrus nemurus* dentary 1L
- *Channa striata* dentary 1L, lower pharyngeal 2R, maxilla 2L 1R, palatine 1R
- *Clarias* sp. articular 1L, cleithrum 2R, pectoral fin spines 1L 3R, supraoccipital 1
- Siluridae pectoral fin spine 1R
- *Monopterus albus* ectopterygoid 1L
- G6 4:6
- *Anabas testudineus* cleithrum 1L, supracleithrum 1R
- *Channa striata* ceratohyal 1L, maxilla 1L 1R, palatine 1L
- *Clarias* sp. dentary 1R, frontal 1R, pectoral fin spines 1L 3R
- Siluridae cleithrum 1R, pectoral fin spine 1L
- *Monopterus albus* ectopterygoid 1L
- G7 5:1
- *Anabas testudineus* supracleithrum 1R
- *Channa striata* dentary 1R
- G7 4:9
- Bagridae pectoral fin spine 1L 1R
- *Channa striata* ceratohyal 1L
- *Clarias* sp. pectoral fin spine 1L
- Siluridae pectoral fin spine 1R
- G7 4:8
- Bagridae dorsal fin spines 2, pectoral fin spines 2L
- *Channa striata* frontal 1R, nasal 1R
- Siluridae pectoral fin spine 1L
- G7 4:7
- *Anabas testudineus* dentary 1L, lacrimal 3L 1R, supracleithrum 1R
- Bagridae pectoral fin spines 2L
- *Channa striata* basioccipital 1, dentary 1R, epihyal 1R, scale bone 1L
- *Clarias* sp. pectoral fin spine 1R
- Siluridae pectoral fin spine 1L
- *Monopterus albus* articular 1L
- G7 4:6
- *Anabas testudineus* cleithrum 1R
- Bagridae pectoral fin spine 1L 1R
- *Channa* sp. articular 2R
- *Clarias* sp. pectoral fin spines 2L, supraorbital 1R
- Siluridae pectoral fin spine 1R
- G7 4:5
- *Anabas testudineus* cleithrum 1R
- *Channa* sp. ceratohyal 1R
- *Clarias* sp. coracoid 1R, dermethmoid 1

THE SHELLFISH

The dominant genera found in the Neolithic shell middens are *Filopaludina* and *Pila*. Both gastropods are known to inhabit freshwater ponds and lake, and in the case of the former, streams. They are widely consumed today in Northeast Thailand, particularly during the wet season, for the *Pila ampullacea* aestivate if water dries out and are not

easy to find in quantities since they are often buried to a depth of up to a metre. Pilids are widely consumed today. It is essential to boil them to remove the risk of infection. They can be preserved by drying in the sun.

Bivalve shellfish were a significant part of the Neolithic diet at Ban Non Wat. *Ensisidens ingalsianus* was the most abundant, followed by *Scabies* sp. These come from river and lake beds, and are still collected and put on sale in the

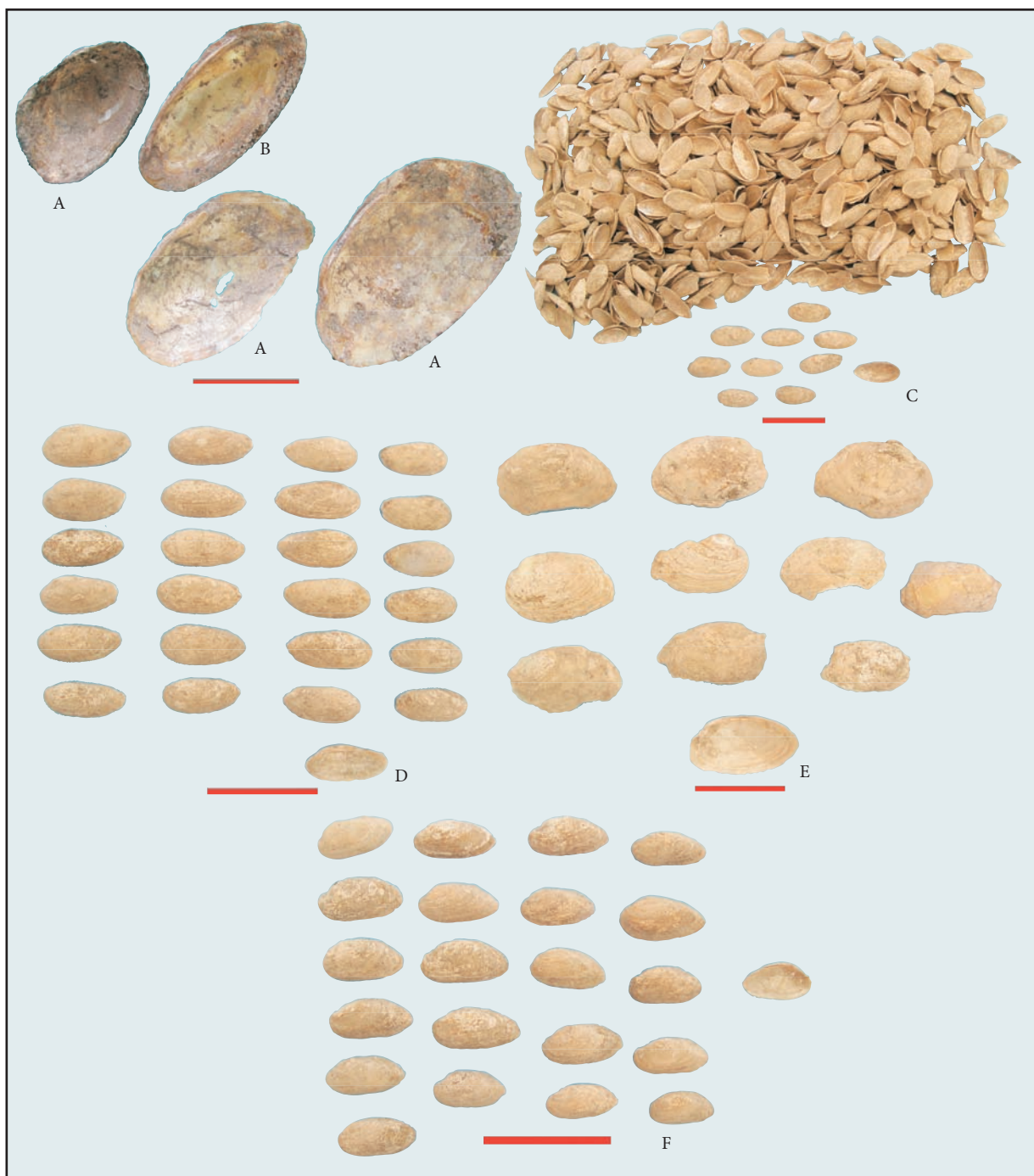


FIG. 8:4 Bivalve shellfish from Neolithic contexts. A. *Pseudodon* sp. B. *Hyriopsis* sp. C-D. *Ensisidens ingalsianus*, E. *Pseudodon* sp. F. *Scabies* sp. scale 5 cm

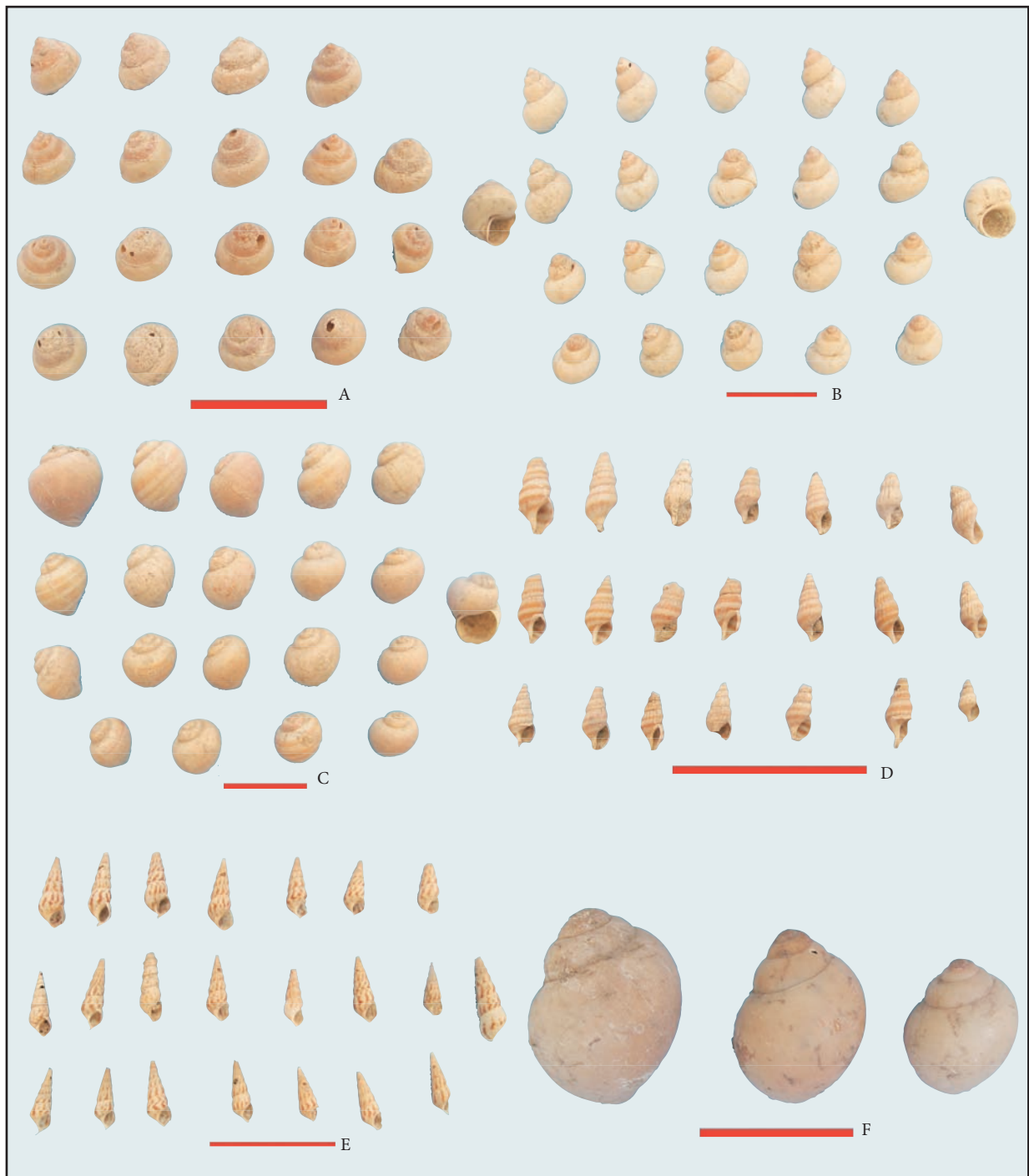


FIG. 8:5 Gastropod shellfish from Neolithic contexts. A. *Trochotaia trochoides*, B. *Filopaludina* sp. C. *Pila* sp. (*ampullacea/pesmei*), D. *Clea helena* E. *Adamietta housei*, F. *Pila polita*. Scale 5 cm

regional market places of Northeast Thailand. *Hyriopsis* sp. is mainly found as a mortuary offering, and probably had high symbolic value. The same applies to *Pseudodon*

sp. which was found in graves as well as occupation contexts.

TABLE 8:4 *The shell species from Neolithic firm contexts*

Context	<i>Adamietta</i>	<i>Bythinia</i>	<i>Clea</i>	<i>Cyclophorus</i>	<i>Filopaludina</i>	<i>Idiopoma</i>	<i>Pila</i> sp.	<i>Pila</i> sp. <i>Operculum</i>	<i>Trochotaia</i>	<i>Ensidens</i>	<i>Hyriopsis</i>	<i>Pilsbryconcha</i>	<i>Pseudodon</i> sp.	<i>P. inoscularis</i>	<i>P. inoscularis cumingi</i>	<i>Scabies nucleus</i>	<i>Scabies</i> sp.	<i>Uniandra</i>
D2 5 sf.5 f.1 pottery scatter	30	-	-	-	16	16	2	-	-	-	-	-	-	-	-	-	-	-
E2 5 sf.4 f.1 shell midden	3	-	-	-	92	9	33	21	2	347	1	-	55	-	-	11	417	-
D2 5 sf.3 f.1 pit	-	-	-	-	6	2	2	-	1	4	-	-	-	-	-	-	-	-
F2 5 sf.3 f.1 shell midden	-	-	-	-	76	7	37	-	2	2	-	-	-	-	-	-	-	-
D2 5 sf.2 f.1 pit	-	-	-	-	1	1	6	-	-	-	-	-	-	-	-	-	1	-
D2 5 sf.2 f. 2 pit	3	-	-	-	12	2	-	-	-	-	-	-	-	-	-	-	-	-
F2 5 sf.2 f.1 shell midden	2	-	-	-	8	2	3	1	-	68	-	-	2	-	-	-	48	3
F3 5 sf.2 f.2 shell midden	2	-	1	-	50	1	3	-	-	25	-	-	1	-	-	-	18	-
E2 5 sf.2 f.1 shell midden	475	-	47	-	1441	882	2537	2412	69	1088	3	1	46	-	-	44	792	-
D2 5 sf.1 f.3 Neolithic scatter	30	-	3	-	36	17	63	9	1	24	-	-	3	-	-	-	31	-
D2 5 sf.1 f.5 Neolithic scatter	1	-	-	-	40	8	245	4	3	5	-	-	-	-	-	-	1	-
D2 5 sf.1 f.6 Neolithic scatter	2	-	-	-	26	7	203	2	3	4	-	-	1	-	-	-	5	-
D2 5 sf.1 f.7 Neolithic scatter	-	-	-	-	6	-	2	1	-	-	-	-	-	-	-	-	-	-
E2 5 sf1 f.1	145	9	18	-	72	58	40	311	3	141	-	-	13	-	-	43	520	-
E2 5 sf1 f.2	228	-	16	-	848	343	1159	308	38	2264	2	-	159	7	-	32	2088	10
E2 5 sf.1 f.3 shell midden	13	-	1	-	78	29	182	119	2	6	-	-	11	-	1	-	12	1
E3 5 sf.1 f.2 shell midden	182	-	15	-	307	160	102	155	14	141	1	-	15	-	-	10	310	1
E3 5 sf.1 f.3 shell midden	1	-	-	-	11	2	11	-	-	8	-	1	-	-	-	-	4	-
F2 5 sf.1 f.1 shell midden	4	-	-	1	148	46	220	6	11	92	1	-	11	-	-	-	123	1
F4 5 sf.1 f.10 shell midden	5	-	-	-	39	12	34	4	1	466	-	-	8	5	-	14	555	-
C1 4:15 f.1	3	-	-	-	1571	53	231	20	1	-	4	-	-	-	12	-	-	-
D2 4 sf.8/sf.9 f.3b Neolithic floor	4	-	-	-	13	2	5	-	1	50	-	-	1	-	-	1	34	-

TABLE 8:4 *The shell species from Neolithic firm contexts (cont.)*

Context	<i>Adamietta</i>	<i>Bythinia</i>	<i>Clea</i>	<i>Cyclophorus</i>	<i>Filopaludina</i>	<i>Idiopoma</i>	<i>Pila</i> sp.	<i>Pila</i> sp. Operculum	<i>Trochotaia</i>	<i>Ensidens</i>	<i>Hyriopsis</i>	<i>Pilsbryoconcha</i>	<i>Pseudodon</i> sp.	<i>P. inoscularis</i>	<i>P. inoscularis cumingi</i>	<i>Scabies nucleus</i>	<i>Scabies</i> sp.	<i>Uniandra</i>
D2 4 sf.8/sf.9 f.3 Neolithic floor	29	-	-	-	139	50	121	19	6	58	-	-	3	-	-	-	23	1
D2 4 sf.8/sf.9 f.3c Neolithic floor	13	-	-	-	34	19	38	7	-	23	-	-	-	-	-	1	28	-
D2 4 sf.8/sf.9 f.3d Neolithic floor	14	-	1	-	106	44	169	10	-	41	-	1	5	-	-	-	53	-
D3 4 sf.9 f.3 Neolithic floor	38	-	1	-	42	30	26	19	3	20	-	-	-	-	-	-	41	-
D3 4 sf.9 f.3a Neolithic floor	22	-	-	-	101	51	140	-	1	19	2	-	2	-	-	-	26	-
D3 4 sf.9 f.3b Neolithic floor	23	-	1	-	168	52	201	17	9	37	1	-	3	-	-	3	74	-
D3 4 sf.9 f.3c Neolithic floor	6	-	-	-	13	1	26	-	1	6	-	-	-	-	-	-	4	-
E2 4 sf.9 f.23 shell midden	4	-	-	-	29	19	19	-	1	3	-	-	-	-	-	-	17	-
E2 4 sf.9 f.24 shell midden	13	-	-	-	298	117	228	10	12	33	-	-	-	-	-	-	14	-
E2 4 sf.9 f.26 shell midden	223	-	22	-	86	49	42	26	7	5	-	-	-	-	-	-	13	-
E3 4 sf.9 f.1 shell midden	70	-	9	-	20	30	14	28	3	32	-	-	1	-	-	-	49	1
Total	1585	9	135	1	5914	2116	6136	3551	197	5028	12	3	344	12	1	159	5312	18
<i>Adamietta housei</i> (Lea,1856); <i>Bithynia siamensis</i> Lea, 1856, <i>Clea helena</i> (Philippi,1847); <i>Trochotaia trochoides</i> (Martens,1860) <i>Ensidens ingallsianus ingallsianus</i> (Lea, 1852); <i>Hyriopsis bialatus</i> Simpson, 1900																		

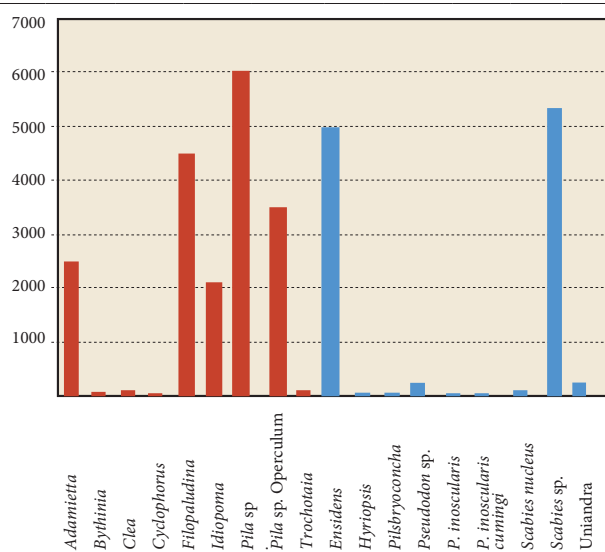


FIG. 8:6 The relative frequency of different species of shellfish in Neolithic contexts

TABLE 8:5 *The shell species from Neolithic contexts in square D5*

Shell	<i>Adamietta</i>	<i>Idiopoma</i>	<i>Filopaludina</i>	<i>Pila</i> sp.	<i>Trochotaia</i>	<i>Ensidens</i>	<i>Hy. bialatus</i>	<i>Scabies</i> sp.	<i>Unindra</i>
D5 4:11	-	1	55	12	-	-	-	-	-
D5 4:10	-	5	19	4	1	-	-	-	-
D5 4:9	2	21	390	65	2	1	-	1	-
D5 4:8	-	11	195	34	5	-	-	-	-
D5 4:7	-	24	292	49	7	1	1R	1	1R
D5 4:6	2	14	115	12	1	-	-	-	-
D5 5sf.1 f.1	-	1	5	1	-	46L	-	24L	-
	-	-	-	-		37R	-	24R	-

TABLE 8:8 *The shell species from Neolithic contexts in square A5*

Shell	<i>Adamietta</i>	<i>Idiopoma</i>	<i>Filopaludina</i>	<i>Trochotaia</i>	<i>Ensidens</i>	<i>Scabies</i> sp.
A5 4:18	-	-	-	-	1	1
A5 4:17	-	2	-	1	-	-
A5 4:16	-	5	2		4	1
A5 4:14	-	3	4	1	-	-
A5 4:13	2	1	1	1	-	-
A5 4:12		3	2	-	-	-
A5 4:11	-	-	2	-	-	-

TABLE 8:6 *The shell species from Neolithic contexts in square A6*

Shell	<i>Adamietta</i>	<i>Idiopoma</i>	<i>Filopaludina</i>	<i>Pila</i> sp.	<i>Trochotaia</i>	<i>Ensidens</i>	<i>Hyriopsis</i>	<i>Hy. bialatus</i>	<i>Pseudodon</i> sp.	<i>Scabies</i> sp.
A6 4:12	1	-	5	4	-	1	-	-	-	-
A6 4:11	1	2	13	4	2	2	-	-	1L	-
A6 4:9	7	10	58	16	1	2	-	-	-	2
A6 4:8	4	8	74	33	-	1	-	1R	-	-
A6 4:7	11	33	106	61	4	7	1R	-	-	2
A6 4:6	17	15	162	21	1	-	-	-	-	1
A6 4:5	47	54	83	20	4	-	-	-	1	4
A6 4:4	10	15	41	14	-	-	-	-	-	-

TABLE 8:9 *The shell species from Neolithic contexts in square A3*

Shell	<i>Adamietta</i>	<i>Idiopoma</i>	<i>Filopaludina</i>	<i>Pila</i> sp.	<i>Trochotaia</i>	<i>Ensidens</i>	<i>Hyriopsis</i>	<i>Scabies</i> sp.
A3 4:19	2	-	4	-	-	1	-	-
A3 4:18	-	-	3	-	-	1	-	-
A3 4:16	4	2	2	-	-	3	-	2
A3 4:15	4	1	3	-	-	-	-	-
A3 4:14	1	3	4	1	-	-	1	1
A3 4:13	-	3	4	2	-	-		2
A3 4:12	9	3	7	-	1	-	-	1
A3 4:11	1	-	1	-	-	-	-	-

TABLE 8:7 *The shell species from Neolithic contexts in square A7*

Shell	<i>Adamietta</i>	<i>Idiopoma</i>	<i>Filopaludina</i>	<i>Pila</i> sp.	<i>Trochotaia</i>	<i>Ensidens</i>	<i>Hyriopsis</i>	<i>Pseudodon</i> sp.
A7 5:1	-	2	14	6	-	-	-	-
A7 4:12	-	-	15	4	-	1	1L	-
	-	-	-	-	-	-	1R	-
A7 4:11	1	4	35	12	-	-	-	-
A7 4:10	1	20	101	26	3	1	1L	-
A7 4:9	2	5	106	43	1	1	2L	1L
	-	-	-	-	-	-	1R	-
A7 4:8	2	6	152	19	2	-	-	1L
A7 4:7	4	13	40	10	-	-	-	-

TABLE 8:10 *The shell species from Neolithic contexts in square D7*

Shell	<i>Adamietta</i>	<i>Idiopoma</i>	<i>Filopaludina</i>	<i>Pila</i> sp.	<i>Pila polita</i>	<i>Trochotaia</i>	<i>Ensidens</i>	<i>Pseudodon</i> sp.	<i>Scabies</i> sp.
D7 5:1	2	44	273	27	-	6	1	-	1
D7 4:10	-	10	68	10	-	-	-	-	-
D7 4:9	3	84	393	114	1	4	-	-	-
D7 4:8	2	6	63	21	1	-	-	-	-
D7 4:7	10	21	141	42	1	4	1	2R	2

TABLE 8:11 *The shell species from Neolithic contexts in square E3*

Shell	<i>Adamielta</i>	<i>Clea</i>	<i>Idiopoma</i>	<i>Filopaludina</i>	<i>Pila</i> sp.	<i>Pila polita</i>	<i>Trochotaia</i>	<i>Ensidens</i>	<i>Hyriopsis</i>	<i>Pseudodon</i> sp.	<i>Scabes</i> sp.	<i>Unidra</i>
E3 5:1								39L				
								34R				
E3 4:9	47	2	101	321	110	2	8	35 L		1R	40 L	1 R
								38 R			40 R	
E3 4:8	108	7	220	686	151	1	15	25 L	1R	1 L	21 L	
								26 R			18 R	
E3 4sf.9 f.1												1L

TABLE 8:12 *The shell species from Neolithic contexts in square E5*

Shell	<i>Adamielta</i>	<i>Bitynia</i>	<i>Clea</i>	<i>Idiopoma</i>	<i>Filopaludina</i>	<i>Pila</i> sp.	<i>Pila polita</i>	<i>Trochotaia</i>	<i>Ensidens</i>	<i>Hyriopsis</i>	<i>Pseudodon</i> sp.	<i>Pseudodon mouhoiti</i>	<i>Scabes</i> sp.
E5 5:1					10	11							
E5 4:10	56		1	119	405	449		19	102	2	1	3	104
E5 4:9	18			45	371	230		9	4				2
E5 4:8	52		2	92	349	81	1	8	1	1			1
E5 4:7	103	1	1	56	252	57	1	6	4				3
E5 4:6	85			105	275	117	2	7	1				
E5 4sf.10 f.6	2			132	539	526	1	10	28	1	2		12

TABLE 8:13 *The shell species from Neolithic contexts in square E2*

Shell	<i>Adamielta</i>	<i>Clea</i>	<i>Idiopoma</i>	<i>Filopaludina</i>	<i>Pila</i> sp.	<i>Trochotaia</i>	<i>Ensidens</i>	<i>Pseudodon</i> sp.	<i>Scabes</i> sp.
E2 4:9	60	4	131	278	171	12	38 L	2 L	67 L
	-	-	-	-	-	-	47 R	2 R	63 R
E2 4:8	245	6	-	461	139	-	28 L	-	25 L
	-	-	-	-	-	-	25 R	-	25 R
E2 4sf.9 f.2	80	8	21	18	14	1	3 L	-	5 L
	-	-	-	-	-	-	4 R	-	4 R
E2 4sf.:8 f.19	11	-	44	99	35	-	1 L	-	5 L
	-	-	-	-	-	-	-	-	2 R

TABLE 8:14 *The shell species from Neolithic contexts in square E4*

Shell	<i>Adamielta</i>	<i>Idiopoma</i>	<i>Filopaludina</i>	<i>Pila</i> sp.	<i>Trochotaia</i>	<i>Ensidens</i>	<i>Hyriopsis</i>	<i>Scabes</i> sp.	<i>Unidra</i>
E4 4:10	18	41	282	53	45	10R	1 R	12L	2 R
						10R		7R	
E4 4:9	11	55	308	87	7	6L		19L	
						3R		12R	

TABLE 8:15 *The shell species from Neolithic layer contexts*

Context	<i>Adamietta</i>	<i>Bythinia</i>	<i>Clea</i>	<i>Cyclophorus</i>	<i>Filopaludina</i>	<i>Idiopoma</i>	<i>Pila</i> sp.	<i>Pila</i> sp. Operculum	<i>Trochotaia</i>	<i>Ensis</i>	<i>Hyriopsis</i>	<i>Pilsbryconcha</i>	<i>Pseudodon</i> sp.	<i>P. inoscularis</i>	<i>P. inoscularis cumingi</i>	<i>Scabies nucleus</i>	<i>Scabies</i> sp.	<i>Unidra</i>
5:4 D3	8	-	1	-	2	1	-	-	-	1	-	-	-	-	-	-	1	-
D4	10	-	-	-	79	14	34	6	1	21	-	-	1	-	-	-	11	-
E2	3	-	-	-	27	5	23	1	1	27	1	1	7	-	-	-	15	-
5:3 D2	107	-	1	-	452	128	141	3	10	51	-	-	2	-	1	-	43	1
D3	1	-	1	-	1	-	-	-	-	-	-	-	-	-	-	-	1	-
D4	9	-	1	-	213	45	53	4	7	98	-	2	2	-	-	1	33	-
E2	1	-	-	-	182	19	109	3	7	57	-	-	4	-	-	1	30	-
E3	1	3	3	-	1	1	1	4	-	2	-	-	-	-	-	-	3	-
E4	2	-	-	-	11	3	5	-	-	2	-	-	-	-	-	-	2	-
5:2 D2	5	-	-	-	79	24	34	7	-	12	-	-	-	-	-	-	6	-
D3	11	-	2	-	6	2	1	1	-	1	-	-	-	-	-	-	2	-
D4	1	-	-	-	21	11	37	-	2	7	-	-	-	-	-	-	3	-
E2	-	-	-	-	105	34	50	3	2	13	-	-	2	-	-	-	6	-
E3	6	-	-	-	167	45	65	3	11	73	1	1	6	-	-	-	41	-
E4	3	-	-	-	192	26	44	4	1	52	-	-	4	-	-	-	42	-
F2	2	-	-	-	275	33	134	3	5	102	-	-	3	-	-	1	51	1
F3	2	-	-	-	147	8	42	-	1	30	-	-	-	-	-	-	20	-
F4	14	-	-	-	102	48	27	-	1	55	-	-	1	-	-	-	47	-
5:1 D2	7	-	-	-	80	12	16	7	-	13	-	-	-	-	-	-	14	-
D3	33	-	-	-	325	121	154	-	13	46	-	-	1	-	-	-	43	1
D4	16	-	-	-	509	179	490	37	21	113	1	-	9	-	-	1	112	-
E2	9	-	1	-	262	94	267	21	6	69	-	1	5	-	-	-	47	-
E3	2	-	-	-	106	20	70	1	2	39	-	-	3	-	-	-	24	-
E4	11	-	1	-	205	25	61	8	2	27	-	-	6	-	-	1	30	-
F2	20	-	3	-	544	60	309	21	19	84	-	-	2	-	-	1	41	-
F3	9	1	1	-	299	24	107	4	2	142	-	1	7	-	-	5	72	-
F4	21	-	-	-	241	20	53	-	5	54	-	-	2	-	-	-	27	-

THE MAMMALIAN FAUNA

AMPHAN KIUNGAM

The faunal remains from Ban Non Wat were obtained both from the excavation square itself and from the screening of all cultural material. Many of the smaller bones were also obtained through the wet sieving of a sample of cultural material from each context. The relative frequencies with which the species are represented are set out in table 8:16 and figure 8:7. Layer 5 is the earliest identified, followed by lower layer 4, which contains *in situ* Neolithic middens.

Distinguishing between the bones of *Bos* and *Bubalus* (water buffalo) is possible only on the basis of certain anatomical bones. Hence, those which are not distinct are combined under Bovidae. The majority of these, how-

ever, are most likely to come from cattle rather than water buffalo since where identification is possible, the ratio of cattle to water buffalo is approximately 4-6:1. There are at least three indigenous wild cattle: *Bos gaurus*, *Bibos javanicus* and *Novibos sauveli*.

Novibos sauveli, the kouprey, is now critically endangered, and there might only be 200 left alive due to habitat destruction and illegal hunting. It lives in herds of up to 20 animals (Fig. 8:10). An adult animal weighs between 600-800 kg. Its distribution centres on the plains of northern Cambodia, and there might still be relict populations in southern Laos and the Dang Raek range. Since its preferred habitat incorporates open terrain with monsoon forest, it is highly likely that its former distribution was more widespread and it could well have been numerous during the Neolithic period at Ban Non Wat (Corbet and Hill 1992). Identifying the kouprey in a prehistoric sample

TABLE 8:16 The number of bones for individual species

Layer	Bovidae	<i>Bubalus bubalis</i>	<i>Bibos</i> sp	<i>Sus scrofa</i>	<i>Canis familiaris</i>	<i>Cervus unicolor</i>	<i>Cervus schomburgki</i> / <i>Cervus eldi</i>	<i>Axis porcinus</i> / <i>Muntiacus muntjak</i>	<i>Muntiacus muntjak</i>	<i>Rattus</i> sp	<i>Gallus</i> sp	Small mammal	<i>Lepus peguensis</i>	<i>Testudo elongata</i> / <i>Malayemys subtrijuga</i>	<i>Rhinoceros sondaicus</i>	<i>Amyda cartilaginea</i>	Bird	<i>Hoplobatrachus tigerinus</i>	<i>Panthera tigris</i>	<i>Varanus nebulosus</i>
Lower 4	167	22	146	299	85	58	360	27	90	27	22	32	2	1,131	2	11	8	3	8	1
Lower 5	32	5	19	54	17	17	89	6	18	6	2	12	-	157	-	8	-	2	1	-

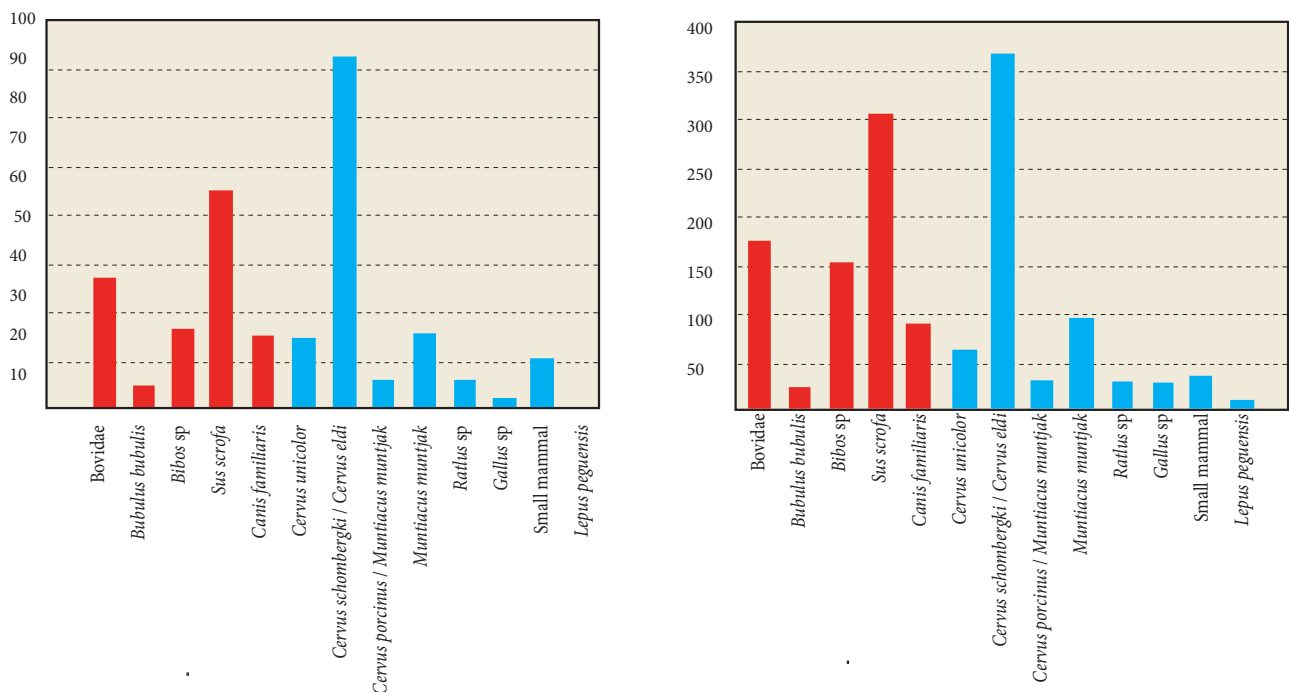


FIG. 8:7 The number of identified bones per species from Neolithic contexts at Ban Non Wat. Left, layer 5 and right, lower layer 4. Columns in red indicate animals that could have been domesticated, the blue columns represent animals that were probably wild



FIG. 8:8 The bovid first phalanges

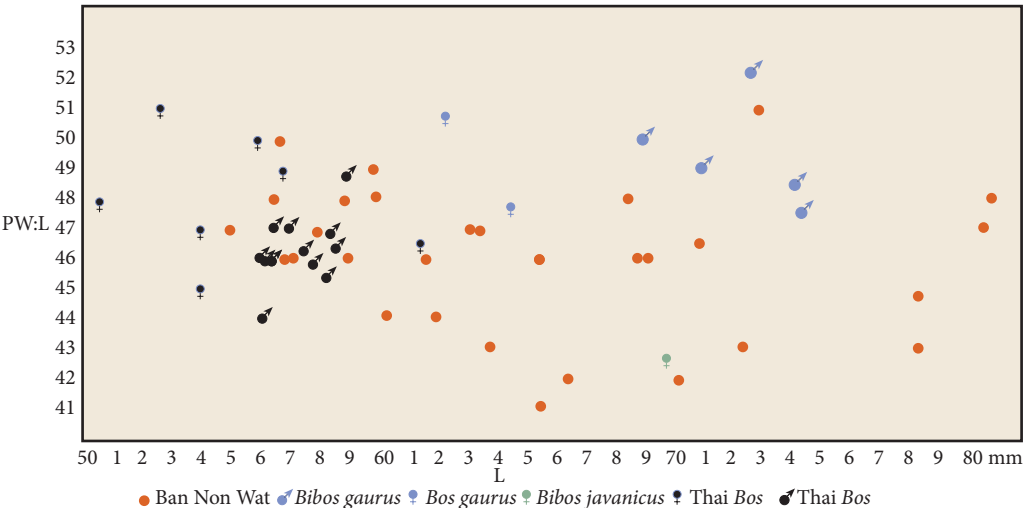


FIG. 8:9 The dimensions of bovid first fore phalanges from Ban Non Wat and wild species

may only be possible through the sequencing of DNA.

The gaur, *Bos gaurus*, is the largest of wild bovids, a large bull weighing up to 900 kg. It prefers a forested habitat and is more of a browser than a grazer. However, it is also attracted to grass regrowth after forest fires (Lekagul and McNeely 1977). Gaur were formerly widespread in distribution, from India through mainland Southeast Asia. One of the particular attractions of the Ban Non Wat area for the gaur is the presence of surface salt, for it is a daily visitor to salt licks when available. The bones of the gaur

are much larger than in modern domestic cattle.

The banteng, *Bos javanicus*, is bovid adapted to open terrain, but which also retreats into forested areas for safety or for feeding on bamboo during the rainy season. It lives in herds of up to 50 animals, in which there is a solitary dominant bull (Nowak 1999). A fully grown animal can weigh up to 800 kg. Banteng can interbreed with domestic cattle and produce fertile offspring. Hunting and habitat destruction has severely reduced numbers of an animal that could well have been a major player in the

Neolithic environment of Ban Non Wat.

Bovids were clearly a major food resource during



FIG. 8:10 A herd of kouprey, *Novibos sauveli*

the Neolithic occupation of Ban Non Wat. The issue of whether they were hunted, or a proportion were raised as domestic stock is at present, resolved on the basis of the size of the bones. Figure 8:9 shows that the size of some of the first fore phalanges together with a sample of modern Thai domestic animals collected in 1969 in the Bangkok municipal abattoir. Just under half the first fore phalanges correspond in size to the modern domestic animal. There are also bones that fall within the range of the male and female gaur or banteng. Four exceed the size of the modern male gaur specimens available for comparative purposes. In the absence of any DNA sequences, it is concluded that



FIG. 8:11 The gaur, *Bos gaurus*

the Neolithic occupants of Ban Non Wat maintained a herd of domestic cattle, but also took advantage of the locally available wild population.

The water buffalo, *Bubalus bubalis*, is now very rare in the wild. Lekagul and McNeely (1977) report a small herd in Utthai Thani Province. A large bull can stand nearly two metres in height and weigh 1200 kg. They prefer a diet of grass and close proximity to water, from swamps to rivers and streams, where they are wont to wallow nearly submerged. Under natural circumstances, herds can be as

large as 100 or so animals and the bulls in particular can be very dangerous when confronted.

The distribution of water buffalo first phalanges, when compared with that of a sample of modern Thai domestic animals collected from the Bangkok abattoir in 1969, reveals that three of the four specimens are almost certainly from wild animals on the basis of their size, while one might possibly be a small wild or a large domestic example. They certainly seem to have been rarer than cattle, and might have been hunted opportunistically.

The pig, *Sus scrofa*, was had a significant presence in layers 5 and 4. Appreciating the status of pigs in East and Southeast Asia has advanced considerably with the development of the detailed analysis of tooth patterns, and specimens from Ban Non Wat are currently under analysis (Dobney *et al.* 2008). The importance of pig DNA in tracking the origins and the spread of the domestic pig has hitherto been applied more to island than to mainland



FIG. 8:12 The banteng, *Bos javanicus*

Southeast Asia, where the mainland pig has been identified as the ancestor of the animals taken with Austronesian expansion, into the Pacific. (Larson *et al.* 2007). Again, the potential for tracing the origin of mainland Neolithic pig is work in progress.

The dog, *Canis familiaris*, is an important domesticate in Thailand, because of its exotic origin. An examination of the crania of domestic Thai dogs, wolves, golden jackals and cuons has concluded that the form of the prehistoric dogs match that of the wolf and the domestic dog (Higham *et al.* 1980). Since there are no native wolves in Thailand, the dog must have been introduced. Dog bones were not found at Nong Nor, a hunter-gatherer site dating to the late 3rd millennium BC, nor at Khok Phanom Di until there was evidence there for contact with rice farmers. Its presence can thus be seen as an indicator of settlement by early Neolithic rice farmers.

The sambar deer, *Cervus unicolor*, is well represented in the Neolithic faunal spectrum. This is the largest deer found in Thailand. Large males can attain a height of 2 m

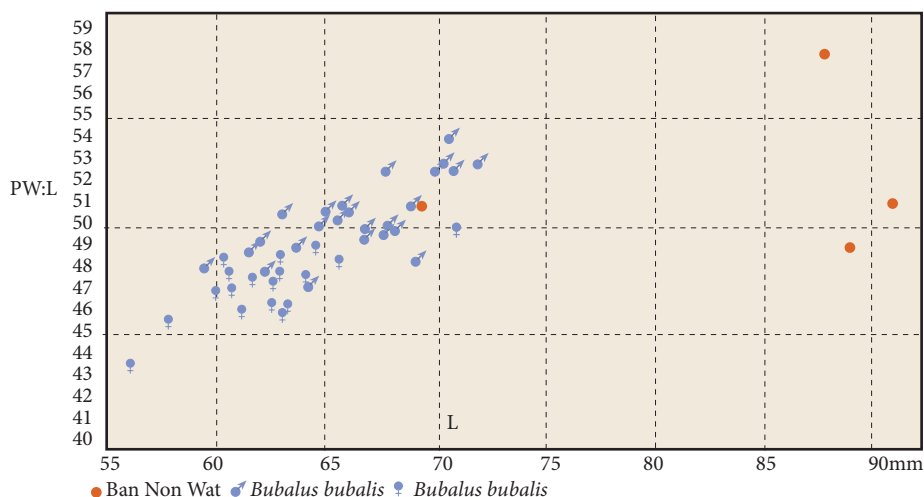


FIG. 8.13 The dimensions of the first phalanges of water buffalo from Ban Non Wat and modern domestic animals



FIG. 8.14 The wild water buffalo, *Bubalus bubalis*

and weight of 200 kg. Under ideal conditions having been introduced into Australia, some stags have been known to weigh 350 kg. Under severe hunting pressure, the sambar now retreats into forest cover by day and feeds by night, preferring grassy clearings. It is also a browser in the forests ranging from dry deciduous to evergreen. The sambar is a regular visitor to its favoured watering places, and is also attracted to salt licks. It must have been frequently sighted during the Neolithic period at Ban Non Wat.

Due to the difficulty of distinguishing between the bones of *Cervus eldi*, the brow-antlered deer, and *Cervus schomburgki*, Schomburg's deer, they are combined. The former, however, is by far the most widespread in distribution, and most if not all the deer bones in question probably come from this species. Schomburg's deer, now extinct, was adapted to the swampy riverine plains of the Chao Phraya River, but the expansion of rice farming led to its elimination. It might once have populated the similar environment of the Mun River valley. Its broad spread of antlers make it maladapted to forest refugia (Lekagul and McNeely 1977:692). The brow-antlered deer can weigh up



FIG. 8.15 The sambar, *Cervus unicolor*

to 150 kg and with a height of 1.30 m at the shoulder. They can congregate in herds of up to 50 animals, and prefer relatively open, swampy conditions. McShea *et al.* (1999) report that their preferred habitat in Myanmar centres on dry dipterocarp forest. This deer is the most commonly represented in the Neolithic faunal spectrum. It is clear that hunting was a major activity then. This may well be linked to the need to protect vulnerable rice fields from predatory animals. Ringing fields with a fence incorporating traps was formerly a widespread practice.

The medium-sized deer bones could come from either *Cervus porcinus*, the pig deer, or *Muntiacus muntjak*. The former can reach .72 m in height, the latter .56 m. Maximum weights vary between 110 and 28 kg. Clearly the pig deer is usually much larger but there can be an overlap. Thus some bones are assigned to either one or the other species. The pig deer, so called because of its characteris-



FIG. 8:16 The bones of the water buffalo, *Bubalus bubalis*



FIG. 8:17 The bones of the dog, *Canis familiaris*. Left to right, ulna, radius, humerus and mandible

FIG. 8:18 The brow-antlered deer, *Cervus eldi*

tic way of running, lives by preference close to rivers or lakes, and feeds on grasses rather than by browsing. The muntjac, a small deer, has distinctive antlers allowing for a confident identification where the cranium is recovered. These relatively solitary animals prefer living along forest fringes.

Two bones were identified as coming from *Rhinoceros sondaicus*, the Javan rhinoceros. This animal, once widespread from India to Sumatra, is now close to extinction. This rhinoceros, a solitary herbivore prefers a swampy, lowland habitat where it has access to salt as well as a wide range of vegetation.

In an environment populated by so many deer and wild bovids, it is not surprising to find that the Neolithic occupants of Ban Non Wat encountered tigers, *Panthera*

FIG. 8:19 The pig deer, *Cervus porcinus*FIG. 8:20 Schomburgk's deer, *Cervus schomburgki*FIG. 8:21 The muntjac, *Muntiacus muntjak*

FIG. 8:22 Hunting the Javan rhinoceros during the 1860s



FIG. 8:23 Mandibles identified as muntjac, *Muntiacus muntjak*



FIG. 8:24 The bones of the Javan rhinoceros, *Rhinoceros sondaicus*. Left, metacarpal, right, molar

tigris. On several occasions, prehistoric men in Thailand were interred with tiger canine pendants worn at the neck. Tigers are adapted to a wide range of habitats, the key being sufficient prey and availability of water.

The hare, *Lepus peguensis*, was relatively rarely encountered in Neolithic contexts at Ban Non Wat. An interesting point about the habitat of the hare is its preference for ar-



FIG. 8:25 The bones of the tiger, *Panthera tigris*

eas that have been disturbed by human activity. Opening an area of forest for example, results in grass growth and thus a supply of the hare's preferred food.

A single bone was identified from the clouded monitor lizard, *Varanus nebulosus*, in layer 4. The animal prefers thick forest with access to rivers.

Testudo elongata, the elongated tortoise, and *Malayemys subtrijuga*, the Malayan snail-eating turtle, are treated together because on the basis of fragmentary pieces of carapace or plastron, it is not easy to distinguish between them. They were clearly collected in considerable numbers



FIG. 8:26 The Siamese hare, *Lepus peguensis*

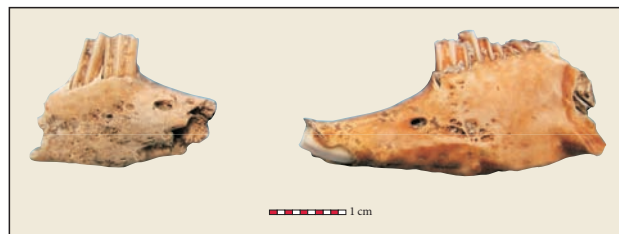


FIG. 8:27 Mandibles of the Siamese hare, *Lepus peguensis*

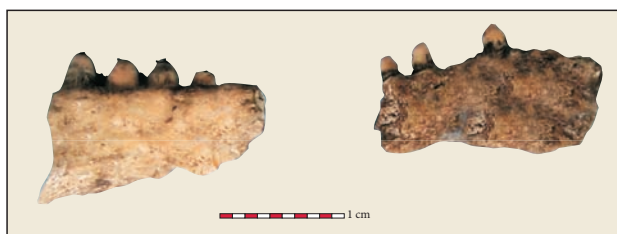


FIG. 8:28 Mandibles of the clouded monitor lizard, *Varanus nebulosus*

during the Neolithic occupancy of Ban Non Wat, since over 1000 fragments were identified.

The Asiatic soft-shell turtle, *Amyda cartilaginea*, is the most intensively collected turtle in Southeast Asia, being highly valued for food. Represented by relatively few bones in Neolithic Ban Non Wat, this turtle lives in ponds, streams and rivers, where it feeds on fish, insects, crabs and fruits. There are also a few specimens of the Indian bullfrog, *Hoplobatrachus tigerinus*.

There are a few bones identified as chicken, *Gallus*, and other birds. It is possible that the former were domestic. In addition, there are small mammalian bones for which identification can only be undertaken with reference to a well documented comparative collection.



FIG. 8:29 The Asiatic soft-shell turtle, *Amyda cartilaginea*



FIG. 8:30 Bones of the Asiatic soft-shell turtle, *Amyda*

SUMMARY

The faunal spectrum for Neolithic Ban Non Wat presents two aspects. In the first place, we find the introduction into the upper Mun Valley of domesticated cattle, pigs and dogs. There might also have been domestic chickens. The few bones of the water buffalo, given their size, are more likely to have been hunted. Wild deer were clearly abundant, and hunting or trapping was clearly a major preoccupation. Other animals in vicinity of the site included rhinoceros and tiger, hares and rats. The environment of Ban Non Wat during the Neolithic must have incorporated wetlands that attracted the rhinoceros, the frogs, deer and water buffalo. Woodland and forest fringes with access to water and salt would also have been an important part of the ecosystem that supported such a range of species as has been identified.

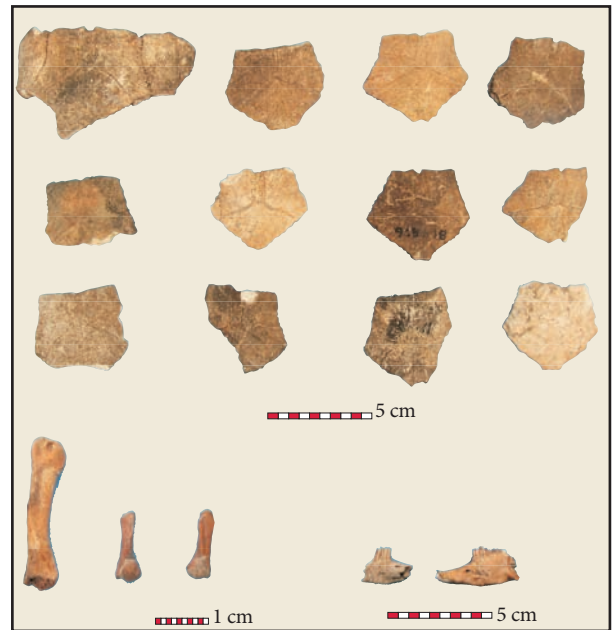


FIG. 8:31 Bones of the tortoise (above) the frog (bottom left) and the hare, *Lepus peguensis*

IX SUMMARY AND CONCLUSIONS

C.F.W. HIGHAM

INTRODUCTION

This volume confronts four major issues on the basis of new information from Ban Non Wat. The first is the nature of the Neolithic society represented there. It is then necessary to discuss the chronology of the Neolithic period, and its origins before turning to relationships between the farmers and the indigenous hunter-gatherers.

NEOLITHIC BAN NON WAT

There are three distinct hunter-gatherer groups in mainland Southeast Asia. The best documented is found in upland rock shelters, and is known generally as the Hoabinhian after the Vietnamese province where it was first identified. The second was coastal. When the sea rose above its present level about five thousand years ago, the shore was occupied by marine hunter gatherers. Khok Phanom Di is one site that was located on the margins of the estuary of the Bang Pakong River, and Nong Nor is a second site that commanded a large marine inlet. Finally, there are hunter gatherer sites on the inland plains, although these are best documented in Guangxi Province. (Xie *et al.* 2003, Xie and Peng 2006, Higham *et al.* 2010).

The Hoabinhian rock shelters were occupied it seems, periodically by groups of mobile broad-spectrum hunters and gatherers. By contrast, the rich coastal environment encouraged a degree of sedentism. At Nong Nor and Khok Phanom Di between c. 2300-1800 BC, the inhabitants made fine ceramic vessels, used polished stone adzes and prospered through deep sea fishing and the exploitation of inshore food resources. In the Guangxi open sites, riverine resources were enjoyed and there is much evidence for stone tool manufacture. Relatively rare potsherds indicate familiarity with ceramics. If there is a common thread that links all three groups, it is the interment of the dead in a flexed posture with minimal mortuary offerings.

Viewed against this background, the initial Neolithic settlement of Ban Non Wat presents a sharp contrast. In terms of subsistence, we find that domestic pigs and cattle were raised, and unlike the hunter-gatherer sites, there is evidence for the domestic dog. We also find evidence for the cultivation of rice. Nevertheless, hunting, fishing and the collection of shellfish contributed significantly to the diet. The dead were now interred in an extended supine position with on occasion impressive mortuary offerings, but two individuals were found seated within large lidded pottery vessels. It is indeed the ceramic industry that impresses. Large and expertly fashioned vessels were embellished with ornate incised, impressed and painted motifs.

These were placed with the dead. Some contained fragments of fish bone, suggesting that feasting might have been part of the rituals of death. Pig bones also accompanied the dead, and some individuals lay under a carpet of shellfish. Infants were interred in large, lidded and impressively decorated mortuary vessels. Two individuals were accompanied by cowrie shells that indicate contact with distant maritime communities. The occupation contexts of this initial Neolithic community contain many polished stone adzes, whetstones and spindle whorls. The whorls assume considerable significance because of their widespread presence in other Neolithic settlements in China and Southeast Asia (Cameron 2002). Enigmatically, this Neolithic occupation seems to have been contemporary with a series of flexed burials associated with a radically different assemblage of mortuary offerings.

The first phase of Neolithic settlement at Ban Non Wat was followed by a second, represented only by the cemetery. Here, we find that the graves were differently orientated, and contained ceramic vessels of simple form and no decoration other than cord marking and very rare red painted lines. This in turn was succeeded by the initial phase of the Bronze Age. The burials now contained a similar range of pots, but in much greater numbers.

The chronological framework has been determined on the basis of radiocarbon determinations, some from charcoal found in *in situ* contexts, and the remainder from the bivalve shellfish placed with the dead (Higham and Higham 2009). These indicate that the initial settlement of Ban Non Wat by rice farmers took place in the mid 17th century BC. This phase lasted for about four centuries, until the inception of Neolithic 2 in the mid 13th century BC. The first phase of the Bronze Age is dated to c. 1000 BC.

THE NEOLITHIC IN MAINLAND SOUTHEAST ASIA

Defining the timing of the establishment of Neolithic communities in Southeast Asia is by no means as rigorously established as in other regions, such as Europe, with a much longer history of enquiry. In Thailand, there are very few excavated and fully published Neolithic sites. The earliest and still best published settlement is Ban Kao (Sørensen and Hatting 1967). It lies in Kanchanaburi Province, near two tributaries that flow into the Khwae Noi River. The site covers about 8000 m², of which 400 m² were excavated in 1961-2. A total of 42 inhumation graves were opened. Sørensen divided them into early and late groups on the basis of their depth below the surface, and the form of the pottery vessels found as mortuary offer-

ings. However, one grave is intermediate between the two, and suggests a continuous use of the cemetery. The radiocarbon determinations suggest that occupation falls within the period 2300–1500 BC. There is some evidence for patterning in the burials. Where it is possible to determine the sex of a skeleton, it seems that men and women were interred in pairs, women being found orientated with the head to the northwest, and men in the opposite direction. Only one infant interment was found, which surely means that either young and fragile bones did not survive, or that they were buried elsewhere. Early phase bodies were buried with pottery vessels and stone adzes, while the later burials incorporated richer sets of grave goods, including more pottery vessels, adzes, shell disc beads, the bones of young pigs, freshwater bivalve shells and stone beads.

The importance of this site goes well beyond the number of the graves, and the quality of complete mortuary assemblages. Sørensen brought meticulous excavation procedures to the excavation and the occupation remains allow insight into the daily activities of the inhabitants (Sørensen 1972). Stone bangles were manufactured there, and the bone fishhooks and clay net weights reflect the role of fish in the diet. There are shell knives and stone sickles, probably used to harvest rice. Spindle whorls evidence a textile industry and the whetstones were probably used to sharpen stone adzes. Ban Kao produced a wide range of pottery forms, the most distinctive being a carinated bowl raised on tripod feet. Similar forms have been found over a very wide area from Kanchanaburi south to peninsular Malaysia. Sørensen has noted their presence at Sai Yok, and at the site of Nong Chae Sao, where two burials were found under what may well be the remains of a domestic building. Shoocondej (1996) has described this pottery assemblage at Han Songchram and Rai Arnon, while far to the south, parallels have been found at upper layers of the Lang Rongrien rock shelter (Anderson 1990) and at Jenderam Hilir on the western coastal plain of Malaysia. Leong (1991) has suggested that the latter site, dated from the later third millennium, represents the intrusion of agriculturalists.

Khok Charoen is located at the junction of two small streams, on an ecotone between the Petchabun Range and the Pa Sak flood plain. Trial soundings in 1966 revealed five inhumation burials accompanied by pottery vessels and polished stone adzes, so the following year, William Watson and Helmut Loofs-Wissowa commenced a major excavation programme. Ultimately, almost 400 m² were excavated and 44 burials uncovered. Natural soil was encountered at a depth of just over a metre. The burials follow a widespread pattern of being extended inhumations with an array of grave goods. Ho (1984) has concluded that there is a considerable differential in wealth between graves, the richest being accompanied by 19 pottery vessels, stone beads, 10 shell and nine stone bracelets and many small shell disc beads. Other burials were less well endowed, though shell disc beads were found in the pel-

vic areas of some skeletons and small, trapezoid polished stone adzes were common. Pottery vessels include examples with incised and impressed decoration recalling those from Tha Kae, Ban Chiang and Non Pa Wai. Others were cord marked and red slipped. Much of the shell used to make ornaments has a marine origin, trochus being used for bracelets, ear ornaments and possibly finger rings, and conus for small rings which Ho feels could have been worn on the fingers. No radiocarbon dates are available.

At Non Pa Wai, Pigott *et al.* (1997) have uncovered a 75 cm-deep occupation layer rich in the remains of pottery sherds, stone adzes and marine shell jewellery. The pottery was decorated with the incised and impressed designs, but there was also a new and localised style in which the pots were formed within baskets which leave an unmistakable surface texture christened “elephant hide” ware. Sixteen Neolithic burials were also found, grave goods including pottery vessels, stone adzes and marine shell jewellery. To judge from the faunal remains recovered in this early context, the site lay within a low-lying and swampy habitat. However, a recent analysis of the plant remains has revealed that *Setaria italica*, millet, was the principal food crop being cultivated in the Khao Wong Prachan valley sites during the Neolithic period (Weber *et al.* 2010). One millet grain from Non Pa Wai has been AMS radiocarbon dated to 2470–2200 cal. BC, and charcoal from the same site had yielded a determination of 2140–1940 BC. Both suggest that Neolithic occupation began towards the end of the third millennium BC, although it is stressed that the precise contexts of the samples is not defined and that more determinations are desirable (Weber *et al.* 2010:85). Rice, it seems, superseded millet as the preferred crop during the first millennium BC in this region.

In his study of these human remains, Agelarakis (1997) has identified the remains of five women, three men, four children aged between three and seven years, and a newly-born infant. Only one individual, a man, survived into his 30s and there was relatively high mortality among those still in their teens. Health was not good. Eight out of ten displaying appropriate evidence suffered childhood stress. However, the dental wear revealed a diet of well-prepared food compatible with an agricultural community.

Tha Kae is located a few kilometres north of Lopburi, and to judge from air photographs, must once have been a large, late prehistoric moated settlement of great regional significance. The initial occupation matches in many respects, that of early Non Pa Wai. There are burials with red slipped and black incised and impressed pottery styles, along with shell beads, bivalve shells, bangles and earrings. Siripanish (1985) has described the motifs and forms of several pottery vessels recovered from earlier excavations at this site, and these include incised and impressed decoration in the form of snakes and possibly stylised humans, the latter being paralleled in late graves at Khok Phanom Di. The local manufacture of marine shell bangles also provides evidence for exchange contact with

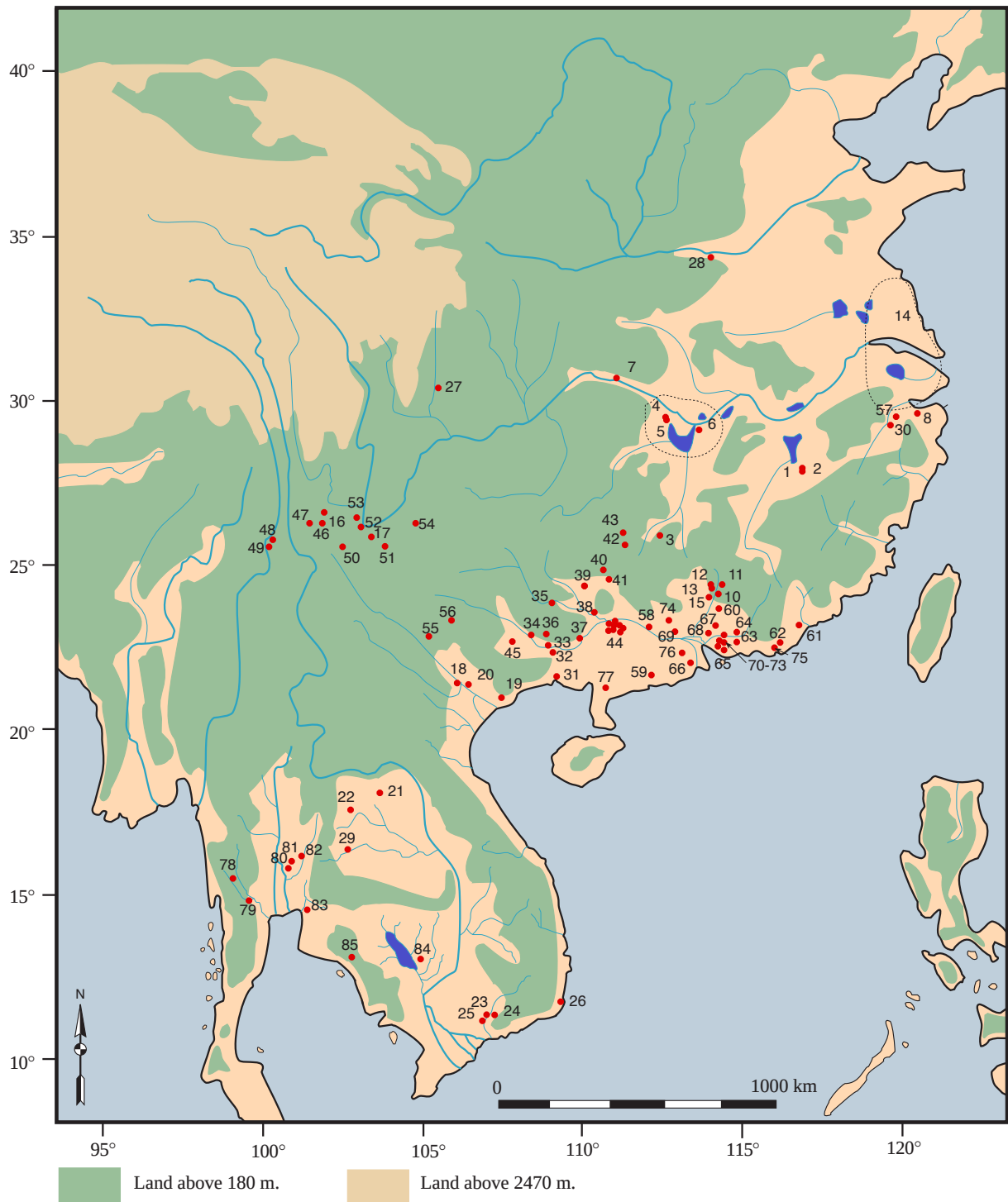


FIG. 9:1 The location of the major sites discussed 1. Diaotonghuan, 2. Xianrendong, 3. Yuchanyan, 4. Bashidang, 5. Pengtoushan, 6. Fenshanbao, 7. Chenbeixi, 8. Hemudu, 9. Area of the Tangjiagan culture, 10. Shixia, 11. Xincun, 12. Chuangbanling, 13. Niling, 14. Area of the Liangzhu culture, 15. Nianyzhuang, 16. Baiyangcun, 17. Dadunzi, 18. Phung Nguyen, 19. Trang Kenh, 20. Lung Hoa, 21. Ban Chiang, 22. Non Nok Tha, 23. Cu Lao Rua, 24. Cau Sat, 25. Ben Do, 26. Xom Con, 27. Sanxingdui, 28. Erlitou, 29. Ban Non Wat, 30. Shangshan, 31. Duliao, 32. Dingshishan, 33. Baozitao, 34. Gantouyan, 35. Gexinqiao, 36. Dalongtan, 37. Jiankou, 38. Nanshanwan, 39. Liyuzuji, 40. Zengpiyan, 41. Dayan, 42. Wumashan, 43. Xiaojin, 44. Sites in the Xunjian river valley, 45. Shijiaoshan, 46. Tuanshanwo, 47. Xinjuang, 48. Chuankouba, 49. Dahuashi, 50. Sunjiaotun, 51. Yingpanshan, 52. Mopandi, 53. Caiyuanzi, 54. Jianjiaodong, 55. Xiahedong, 56. Tongmulu, 57. Kuahuqiao, 58. Huangyandong, 59. Dushizai, 60. Shixing, Renhua, Yingde, Qujian, Lianhan, Luoding, Huaiji, the Qingtan Cave sites, 61. Chao'an type sites, 62. Shangkeng, 63. Xiaomeisha, 64. Dameisha, 65. Qi-ao Island sand bar sites, 66. Pucashantang, 67. Jinlansi, 68. Wanfu'an, 69. Xiqiaoshan, 70. Dahuangsha, 71. Xiantouling, 72. Dongwanzi, 73. Wujiayuan, 74. Xiankezhou, 75. Haifeng/Son, 76. Loshanzui, 77. Liyudi, 78. Sai Yok, 79. Ban Kao, 80. Tha Kae, 81. Non Pa Wai, 82. Khok Charoen, 83. Khok Phanom Di, 84. Samrong Sen, 85. Laang Spean

coastal groups (Ciarla 1992).

Rispoli (1997) has undertaken a regional study of the decoration to be found on pottery vessels from these early Neolithic sites and has identified four main categories. The first is now familiar, the black burnished ware with incised and impressed designs. The potters also applied a thick red slip to the rims and necks of some vessels, or applied red painted designs. Elephant hide ware was also recognized, but it has a very limited distribution. The recovery of such ceramics during site surveys suggests a dense distribution of sites in the eastern margins of the Bangkok Plain north of Lopburi, particularly where springs emerge from the surrounding foothills. Thus Neolithic burials, associated with impressive mortuary vessels and stone and shell jewellery, have been revealed at the site of Non Mak La. Excavations there in 1994 by Vincent Pigott and Andrew Weiss encountered an unusual pottery vessel in the form of a cow, and two burials in a cruciform pattern. Infants were often interred in ceramic vessels.

Definition of the main styles of Neolithic pottery in this area on the basis of these excavations have made it possible for Mudar (1995) to ascribe broad-band dates to a series of sites identified during her survey of the Lam Maleng Valley. This valley drains into the Lopburi River, and is located just to the north of Non Pa Wai. There are two major soil types, a lower grumosol which today yields a single crop of rice per annum, and an upper or high terrace soil not suited to rice, but sufficiently fertile for maize and beans. Mudar identified 20 sites with Neolithic pottery styles, all but three of which were located on the high terrace. The lower tract in the valley bottom attracted only three sites. Mudar has suggested that the earliest agriculturalist in the valley avoided the lower terrace, with its good soils for inundation rice cultivation in favour of dry land crops such as non-inundation rice, millet or root crops. This hypothesis needs to be tested through excavation.

THE KHORAT PLATEAU

A handful of sites provide some insight into the chronology of early Neolithic settlement in this important region. Ban Chiang has been the subject of much controversy over claims for very early settlement, and the inception of bronze and iron working (Gorman and Charoenwongsa 1976). This site has been excavated on several occasions, the 1974-5 seasons being best known because they provided the data for the present chronology. Initial attempts to obtain an internally consistent dating framework foundered due to contradictions and problems over the provenance of the charcoal being dated. Very few Neolithic burials were found during the 1974 season, and the associated pottery vessels were decorated with distinctive incised and impressed designs. The chronology remains uncertain. Charcoal-based conventional radiocarbon determinations do not present a coherent pattern. White

(2008) has turned to the dating of rice chaff temper derived from mortuary vessels. This is a most unreliable technique, not least due to the likelihood of contamination from carbon in the clay, and absorption of carbon from the firing material (de Atley 1980, Hedges *et al.* 1992, Bonsall *et al.* 2002, Berstan *et al.* 2008:702, Higham *et al.* 2010). These conspire to provide determinations often demonstrably earlier than reality. In the case of Ban Chiang, the results from three Neolithic burials are 2032-1526 BC, 2198-1891 BC and 2289-1978 BC (White 2008). These are best seen as *termini post quem*, meaning that the Neolithic settlement probably took place in the first half of the second millennium BC.

Non Nok Tha is if anything, even more difficult to interpret. Excavated by Bayard in 1966 and 1968, it was found to be a cemetery with a cultural stratigraphy barely a metre deep. Bayard himself has stressed the internal inconsistencies and different chronological frameworks which could be compatible with the initial radiocarbon determinations (Bayard 1971, 1972, 1972a). The earliest phase is known as Early Period 1, and there are two determinations, again based on rice chaff ceramic temper. One is 2307-1858 BC, the other is 1770-1310 BC. Again, the first half of the second millennium BC is suggested.

Ban Phak Top is located about 25 km southwest of Ban Chiang. Had the site not been completely destroyed by looting, it would have ranked as one of the most important of this period in Southeast Asia. The pottery vessels for sale there in 1974 were spectacular examples of the black incised style so characteristic of the Neolithic period. Schauffler (1976) excavated a small square and submitted a large radiocarbon sample interpreted as pre-dating the first occupation there. The resulting date is about 2500 BC. The lowest cultural level has a date of 2000 BC, and level 8 has three dates of between 1000-1500 BC. Excavations at Ban Lum Khao in 1995-6 encountered a Bronze Age cemetery, stratified over an initial occupation phase that yielded the familiar black incised and impressed pottery style. This site lies in the upper Mun Valley, and the five determinations for this first occupation phase suggest initial settlement by about 1500 BC. A few miles upstream, a small mound known as Ban Sanuan was found in 1999 to contain burials and pottery vessels of undoubted Neolithic affinities. Sadly, it was removed by a bulldozer before proper investigations could proceed.

There appears to be a consistent pattern to these radiocarbon determinations. On present evidence, the Neolithic period on the Khorat Plateau lasted from about 2000 until 1000 BC. This might well change with the course of future research, for it is stressed that earlier sites might now lie entombed under later, redeposited sediments.

Unfortunately, we know very little of the Neolithic settlement of the Khorat Plateau beyond its probable date, and the fact that early settlers introduced the inhumation burial rite, in which the dead were interred with mortuary offerings: pottery vessels, animal bones and personal orna-

ments. At Non Kao Noi for example, excavations in 1980 revealed a group of inhumation burials, one of which was accompanied by three incised pottery vessels, while another wore beads of an exotic green stone. No radiocarbon dates are available due to lack of datable material (Higham and Kijngam 1984). White has considered the location of Ban Chiang relative to local informants' perceptions of the soil, flooding regimes and vegetation, and has identified a preference for well-drained alluvial sediments adjacent to intermediate reaches of streams. Kijngam's analysis of the faunal remains from the basal layer in the 1975 excavation, which dates to the Bronze Age but remains relevant to the earlier settlement, points to an environment in which fish played an important part in the diet, while domestic cattle, pigs and dogs were present (Kijngam 1979). The inhabitants also hunted or trapped a wide range of wild mammals, including large and small deer, squirrels, wild cats and civets. The rice used to temper potting clay also points to some local cultivation, which was probably undertaken in the adjacent gently-flooded river flats.

The 1974 excavation at Ban Chiang uncovered 20 burials within part of a Neolithic cemetery, all but one coming from the second mortuary phase. Pietrusewsky and Douglas (2002) have identified eight as adult females, four adult males and a further adult of unknown sex. Seven infants or children were also found, of which three died when aged less than three years and the balance, between the ages of three and ten years. Four women had an average height of 1.55 m, while two men stood, on average, 1.65 m tall.

Further insight into subsistence and the environment is provided by the excavation of Ban Lum Khao. The earliest layer has been dated to 1300-1050 BC (Higham T.F.G. 2005). It comprises a thin occupation layer and several pits. The contents of each pit were subjected to flotation to recover all the organic remains, and a very large sample of bones was recovered. The mammalian remains include bones from the water buffalo so large as to fall well within the range for wild rather than domestic animals. One pit contained the bones from 11 Eld's deer, as well as an adult sambar deer and a muntjak. There were also bones from the pig and domestic dog. A second pit also included the bones of three water buffalo and deer, but also over 100 carapace fragments from turtles (Higham 2005). Fish were remarkably abundant (Thosarat 2005). One pit contained 348 individuals, another 283 and a third, 130. *Anabas testudineus*, the doctor fish, was the most abundant. It occupies rivers, streams and marshes and remains a favoured food fish in this area today. *Ophicephalus striatus* is also abundant. This fish survives the dry season by sinking into soft mud in dried out streams or lake beds, and can grow up to a metre in length. Indeed, the size of the fish from basal Ban Lum Khao far exceeds those seen in the area today.

PHUNG NGUYEN

The earliest agricultural settlements in Northern Vietnam take their name from Phung Nguyen, a site which has been extensively investigated. There are relatively few radiocarbon dates for this sequence. The Phung Nguyen phase probably belongs from the late third to the mid second millennium BC. The recent research at Co Loa has revealed initial settlement during this phase, from about 2000 BC (Lai Van Toi 1999). Most settlements are found above the confluence of the Red and Black rivers. They cover between 1-3 ha, and are found on slightly elevated terrain near small stream confluences. The principal excavated site is at Phung Nguyen itself (Hoang Xuan Chinh and Nguyen Ngoc Bich 1978). It covers 3 ha, of which 3960 m² have been excavated. The stratigraphy, as in most Phung Nguyen sites, is shallow, barely exceeding 1 metre in depth. Excavations commenced in 1959, and were followed by two further campaigns.

All this activity provided a large sample of most interesting material culture. No trace of bronze was recovered, but there was a substantial sample of ceramic, bone and stone artefacts. Spindle whorls attest to a weaving industry, and bone harpoons suggest some form of hunting. The stone adzes take a variety of forms. Only four of the shouldered variety were found, compared with 777 examples of a quadrangular form, some of which were sharpened so consistently that they are broader than they are long. When one adds stone adze fragments for which the shape is indeterminate, 1138 adzes or adze fragments were recovered. There are also 59 small stone chisels, some with cutting edges only 10 mm wide. Almost 200 whetstones were found. They bore grooves that result from sharpening the stone adzes and chisels. Stone projectile points were rarer. Three reach the dimensions of a spear point, the remainder are more likely to be tanged arrowheads.

The inhabitants of Phung Nguyen also fashioned stone rings mostly in nephrite. The total sample of 540 specimens has been sub-divided into eight types based on the shape of the cross-section. Most are rectangular, but some are much more complex, having a range of ribs and flanges. While some are large enough to rank as adult bracelets, others have small diameters and were either designed for children or perhaps for display as earrings. Stone beads were also made, most being tubular and measuring up to 1.3 cm in length.

There was also a vigorous tradition of working clay. There are pellet-bow pellets and clay net weights, but most attention was accorded the manufacture of clay vessels. It is on the basis of changing decorative styles, that the Vietnamese archaeologists have designated phases to this culture. The earliest, called after the site of Go Bong, is characterised by incised parallel bands infilled with rows

of impressions imparted with a pointed implement. The favoured motif is in the shape of an "S" meander. The second sub-phase incorporates a range of designs based according to Ha Van Tan (1980, 1985) on "geometric asymmetry". Incised bands infilled with dentate impressions alternate with bands left blank, to form a series of most attractive design fields. This form of decoration has clear parallels with the Yunnan Neolithic sites of Baiyangcun and Dadunzi.

The late Phung Nguyen style of pottery is found at the site of Trang Kenh, near Haiphong. Nguyen Kim Dung's excavations there have revealed a sophisticated workshop for the manufacture of nephrite bracelets and beads, involving working chisels, drills points, saws and grinding stones (Nguyen Kim Dung 1990, 1998). The radiocarbon dates suggest that the workshop dates to about 1650-1500 BC, but the introduction of craft skills in working nephrite and jadeite ornaments represents a key link with the Chinese Neolithic. The bangles from Phung Nguyen are the product of highly-skilled lapidaries. The value attached to stone jewellery and weaponry is also in evidence at Lung Hoa, a second late Phung Nguyen site characterised by deep graves, some cut over 5 metres into the ground and equipped, as in the Lingnan Fubin culture, with ledges (Hoang Xuan Chinh 1968). Two graves include stone bracelets, beads and earrings as well as ceramic vessels as mortuary offerings. One *ge* halberd is particularly interesting, because it matches those found in southern China and north into the early urban states at Sanxingdui and Erlitou. The *yazhang* jade blade is also a central feature of the latter two assemblages, and specimens have been recovered from Phung Nguyen and Xom Ren (Hán Văn Khấn 2007). Excavations in 2002 at the latter, located on the left bank of Lo River in Phu Tho Province, Northern Vietnam, have uncovered four burials containing jade beads. Jade rings, slit rings, *bi* (disks), and beads were also found in the occupation layers. Foremost among these jades was a broken piece from a *yazhang* blade recalling those from Sanxingdui, a major walled city of the Shu civilization in Sichuan. The pottery vessels also found in the burials are heavily ornamented with incised and impressed designs. Even at this late stage in the expansion and establishment of Neolithic communities in Southeast Asia, contact was maintained with the increasingly complex societies of the Yangtze and Huanghe rivers (Ha Van Tan 1993).

Archaeological fieldwork in the uplands north of the Red River has resulted in an appreciation that Neolithic sites were not confined to the relatively open terrain above Viet Tri. The Lo River, for example, attracted intrusive settlements characterised by a range of stone adze forms, stone bangles and a ceramic industry. These sites, known collectively as the Ha Giang culture, might well have been sources for the high quality stone found in such profusion at the many Phung Nguyen settlements (Bui Vinh 1995). Further south, recent excavations at the coastal

late Neolithic site of Con Nen have yielded tubular stone beads, stone bangles and adze heads, decorated potsherds and tubular ceramic feet for pottery vessels. The settlement of Central Vietnam during the late Neolithic period is a major area of future research.

Beginning in 1998, several seasons of excavations at the site of Man Bac in Ninh Binh province have uncovered 48 human burials and a wealth of material culture that includes ceramics and anvils for shaping pots, stone adzes and chisels, grinding stones and semi-precious stone jewellery (Matsumura *et al.* 2008). The date and relationships of the site suggest occupation during the late Neolithic, perhaps 1800-1500 BC, with parallels to be found in the Phung Nguyen culture. In their analysis of the complete human crania, Matsumura *et al.* (2008) have found that five of the six individuals closely resemble Neolithic samples from China, while the sixth has a skull similar in form to the local hunter-gatherers. This finding introduces again, the need to consider the nature and timing of the establishment of rice farming communities in Southeast Asia. Further south, the Neolithic site of An Son was occupied from the early second millennium BC (Masanari and Dung 2002).

THE NEOLITHIC IN CAMBODIA

Although Cambodia was opened to archaeological research earlier than in adjacent countries, little is known of the Neolithic period there (Stark 2004). The first information about this period came from the excavation at Samrong Sen by Henry Mansuy in the early 20th century, followed by the work of French archaeologists, Roland and Cecile Mourer in 1966-1968 at Laang Spean in Battambang province.

Samrong Sen is an archaeological site located on the right bank of Stung Chinit, a tributary of the Tonle-Sap in Kompong Chhnang province. It was discovered in 1876 by M. Roques, leading to series of collecting expeditions and excavations in the late nineteenth century. Only one radiocarbon determination of 1749-1253 BC has been obtained.

Dani (1960) has summarized the characteristic of pottery found at Samrong Sen, which can be divided into two series as follows:

- 1) Fine pottery decorated with incised patterns. Some vessels were decorated with red burnishing. These pottery vessels can be classified as small size bowls or cups with rounded or straight sided bodies, with or without feet and almost rimless, though a few simple rims are present.
- 2) The decorated pottery vessels mostly can be classified as footed bowls, storage jars and globular vessels. One type is identical with the Duc Thi earthenware jar.

Dani also noted that the decoration on these pots is entirely different from those appearing on the sherds of the Bacsonian and Hoabinhian cultures, and indicate a source in South East China.



FIG. 9:2 Three ceramic vessels from Samrong Sen, showing incised and impressed decoration

Loofs-Wissowa (1967) has pointed out a remarkable likeness between two complete vessels from Samrong Sen and the earliest style recovered at Ban Chiang (Fig. 9:4). Higham and Thosarat (2004) also mentioned that some of the pottery from this site belong to the South East Asian tradition of incised and impressed decoration and also reveal some close similarities with material from Khok Phanom Di.

There is thus a growing consensus that the Neolithic settlement of mainland Southeast Asia was widespread, and took place during the early centuries of the second millennium BC. As mentioned by Higham (2002) this was a critical in Southeast Asia prehistory. There are two principal alternatives, which this study is designed to address. The first is that these Neolithic communities originated through local stimulus within the hunter-gatherer groups of Southeast Asia. The second, is that the Neolithic settlements represent the intrusion of people with a fully developed agricultural economy from southern China.

THE ORIGINS OF THE SOUTHEAST ASIAN NEOLITHIC

Resolving this issue is becoming increasingly clear as research proceeds in the vital area of southern China. Following his excavations at Ban Kao, Sørensen suggested that the Neolithic occupation of Central Thailand involved expansion from China (Sørensen and Hatting 1967, Sørensen 1972). However, even when Blust (1996) suggested that the expansion of rice farmers into Southeast Asia could be traced through the distribution of Austro-Asiatic languages, archaeological data were still rare. Two publications have summarised the emerging new material, and they present an important consensus. Zhang and Hung (2010) have outlined the expansion of rice farmers south from the Yangtze Valley into Guangxi and Guangdong on the basis of radiocarbon determinations and the presence

of rice remains. Rispoli (2008) has concentrated on similarities in Neolithic material culture that link Southeast Asia and southern China. To this must be added the important new finding that millet was the dominant plant crop in the Lopburi region of Central Thailand by the later third millennium BC. As Weber *et al.* (2010) note, millet was originally domesticated in the Yellow River region of China by at least 5500 BC and its presence in Thailand points clearly to a northern stimulus.

Zhang and Hung (2010) begin by stressing the results of research by Fuller *et al.*'s (2009) examination of the actual rice remains from the early sites of the Shangshan tradition in the lower Yangtze region. These indicate that, far from presenting a sudden and fully developed establishment of rice farming societies in the seminal region, the evidence rather indicates a slow uptake within the period 8500-5000 BC among communities that continued, with some pre-domesticated rice, to maintain a broad spectrum subsistence economy involving the collection of a wide range of wild plants and much hunting and gathering. From 5000-3500 BC, rice cultivation became increasingly prominent and as seen at the site of Caoxieshan, it was now grown in permanent and enclosed fields. Sites of the Daxi culture in the middle Yangtze lakelands and Majiabang in the lower reaches of the valley proliferated. The real take off of rice farming and animal herding came from 3000 BC with the establishment of the Liangzhu culture with its aristocratic burials, ceremonial jades and plough cultivation in banded field systems.

It was from this base that the expansion of rice farmers south into Lingnan and ultimately Southeast Asia can be traced archaeologically. Fuller *et al.* (2010) describe the expansion of rice farming into Southeast Asia as their fifth thrust from the seminal Yangtze area. Their preferred route was through the lowlands of Guangdong and Guangxi provinces rather than into Yunnan and thence southwards using the Mekong River conduit. Zhang and Hung (2010)

suggest that there were two major routes. The first linked the Liangzhu culture with the sites of Tanshishan and Shixia which saw rice cultivation established in Fujian and Guangzhou in the mid third millennium BC. The second originated in the Middle Yangtze Qujialing culture and involved movement into Guangxi. After three phases of hunter-gatherer occupation at Dingsishan in Guangxi, the fourth occupation phase yielded the remains of rice phytoliths, dated between 2500-2000 BC. The same evidence for rice cultivation recurred during the second period of occupation at Xiaojin during the same period of time. Further west in Yunnan, rice cultivation has been attested at Shizhaishan during the Neolithic between 3100-2500 BC while two radiocarbon determinations from Baiyangcun again fall within the second half of the third millennium BC. It was from this base that rice farmers expanded further south into Southeast Asia, where the Phung Nguyen sites of the Red River region show parallels in material culture with southern China, and exchange contact that brought a *yazhang* jade blade and an axe halberd to Lung Hoa (Hoang Xuan Chinh 1968).

If the consensus of dates for southern China is sustained by further research, then the ingress of rice farmers from the north took place in the 25th-20th centuries BC, thus providing a *terminus post quem* for the further expansion into the hot and inviting broad riverine plains of Southeast Asia. There, they would have encountered communities of hunter gatherers adapted to the area over a period in excess of 40,000 years.

Rispoli (2008) has considered the origins of the Neolithic by beginning in Southeast Asia and looking north. She began by identifying and defining a particular technique for decorating ceramic vessels, which she describes as "incised and impressed". This involved incising mainly curvilinear designs on the surface of the pot, and infilling them with impressions. Not only is this technique widespread in Southeast Asia, but the sites in question have other factors in common. These include the inhuming of the dead in an extended, usually supine position, the presence of domestic dogs, pigs and cattle, rice cultivation, the wearing of stone or shell bangles and necklaces fashioned from shell beads. These people also used spindle whorls to create the threads needed to weave fabric. The motifs formed by the incised and impressed tradition present quite similar forms over wide distances, as seen above in the comparisons undertaken by Wiriyaromp.

Rispoli has undertaken an exhaustive consideration of the prehistoric sites from Southeast Asia and the Yangtze valley in order to trace the origins of this design tradition in particular, and the Neolithic package in general. She thereby has suggested three zones, which in general match those suggested by Zhang and Hung. The first is the seminal area of the Yangtze River valley from Lake Dongting east to the delta. The second is a spread zone to the south comprising the river valleys of southern China from Yunnan to Guangzhou, and the third is the main riv-

er valleys of Southeast Asia. The key to this enquiry is the spread zone in southern China where there is compelling evidence for the presence of long-adapted hunter gatherer communities living in an environment rich in natural resources. These people, who interred their dead in a flexed posture, were familiar with pottery although it was not a prominent part of their material culture, and forms were simple and limited. In the case of the periods 2-3 of the Dingsishan culture of Guangxi, which flourished between 6000-4000 BC, we find polished stone adzes, shell reaping knives and bone tools. However, there is no evidence for agriculture or the raising of domestic stock.

During the 3rd millennium in Guangxi, however, there was a major change: new ceramic forms are encountered at Shijiaoshan and related sites. Pots were decorated with incised curvilinear patterns, and the burial rite increasingly involved extended inhumation. To the east in Guangdong, similar trends involving links with the Liangzhu culture of the lower Yangtze are seen at Shixia, while in Yunnan to the west, incised and impressed motifs have been recovered at Baiyangcun, Dadunzi, Mopandi and Xinguang, dating to the period 2000-1400 BC.

It is becoming increasingly clear that there was not a single clearly identifiable expansion of rice farmers south from the Yangtze to southern China and Southeast Asia. Rather, there were different currents of interaction between expansive rice farming groups and the indigenous hunter-gatherers. The impetus for the expansion of the former accelerated in the later third millennium BC, providing for further infiltration into Southeast Asia and another episode of interaction with hunter gatherers. It is possible, in the repertoire of decorative techniques employed by the early farmers of southern China, to recognise in the incised and impressed motifs, possible prototypes for those identified in Southeast Asia. This makes it possible to review the place of the Neolithic occupation of Ban Non Wat in a wide regional perspective.

DISCUSSION AND CONCLUSIONS

It is now necessary to review the situation. In doing so, it will be necessary to weigh the evidence for two principal models for Neolithic origins. On the one hand, is there convincing evidence for strong cultural links between the people of Ban Non Wat and proposed contemporaries and predecessors in other parts of Southeast Asia and Southern China. Alternatively, is it possible to derive them from long-established indigenous hunter-gatherer communities without recourse to a model of demic diffusion recently proposed by Bellwood (2005, 2006), Higham (2002), Rispoli (2008) and Zhang and Hung (2010)?

Many Neolithic sites in Thailand and neighbouring countries exhibit some or all of these features in their Neolithic cultural context. The Neolithic pottery in South China southward to Vietnam, Thailand and Cambodia reveals some intriguing similarities in ceramic decoration.

This must be considered against the background of the long and extensive research on the origins of agriculture in Thailand and most parts of the mainland Southeast Asia which has failed otherwise to account for the sudden appearance of Neolithic sites. Rispoli (2008) has suggested that Southeast Asia between 10,000-4,000 BP was occupied by hunter-gatherers who shared a common substratum of cultural traits from at least the beginning of the Holocene.

The archaeological evidence for the hunter-gatherer communities and the Neolithic found in Thailand and also neighbouring countries shows clearly distinct cultural forms during the period that witnessed the transition to agriculture. No evidence of a close relationship in stone technology between the hunting-gathering society and agricultural society has yet been found in this area. Hoabinhian tools are characteristically made on flat, oval or elongated river pebble, flaked around their peripheries and over or both surfaces. Bifacial workmanship dominates in parts of the Malay Peninsula and unifaces, generally called “Sumatraliths” are common in Thailand and Vietnam.

By contrast, sites like Pengtoushan, situated near Lake Dongting in the middle Yangtze valley, shows in its stone industry, based on flaked pebbles, close relations with the late glacial hunter-gatherer sites of this region. The burial tradition between the Hoabinhian and Neolithic people also shows marked contrasts. During the Neolithic, corpses were in the main, interred supine, and pot were placed at the head and feet, and sometimes over the lower limbs. The placement of grave goods is rare in the Hoabinhian. Bellwood (1992) early proposed that in most of Southeast Asia (excluding southern China and possibly coastal northern Vietnam), there is no evidence to suggest a primary development of agriculture, and it seems basically to have been introduced by people already acquainted with the cultivation of rice, millet and other subtropical crops like yam, taro and sugarcane. They also kept domesticated pigs, chickens, dogs and perhaps cattle.

It must, however, be stressed that the Hoabinhian occupation of rock shelters in the inland forests of Southeast Asia and southern China provides a distorted image of the hunter-gatherers of this region. This is due to the fact that the sea level rose dramatically during the middle Holocene period, and in doing so, probably drowned many coastal settlement sites. As Higham (2002) has said, it was only with the establishment of a higher sea level than at present, that this coastal settlement can be examined. At the site of Nong Nor, Higham and Thosarat (1998) excavated a settlement of marine hunter-gatherers dated to the second half of the third millennium BC. There was no evidence for domestic animals or plants, but the occupants made ceramic vessels, and some of these were decorated with incised and impressed decoration (Fig. 9:5). Could such coastal hunter-gatherers have been the source of the widespread and rapidly developing inter-

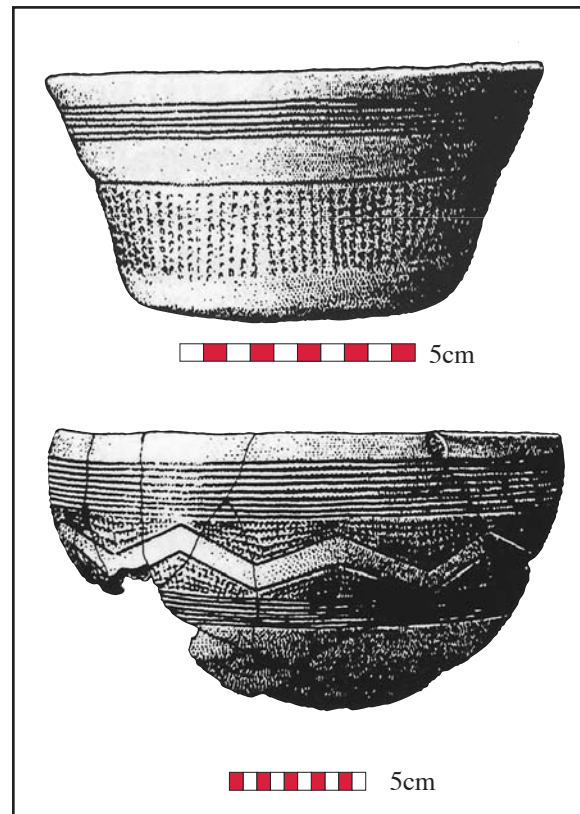


FIG. 9:3 Two vessels from the first occupation phase of Nong Nor, late third millennium BC, showing incised and impressed decoration

est in this form for decoration? The early phases at the nearby site of Khok Phanom Di have also failed to provide evidence for domestic crops or animals. Dating from the 20th century BC, the inhabitants lived beside an estuary, in a habitat dominated by mangroves. The pottery they interred with the dead during mortuary phases 2 and 3A included vessels decorated with incised and impressed motifs (Fig. 9:6). None of the forms, however, is matched in any known inland Neolithic site. Only from phase 3B at Khok Phanom Di is there evidence for local rice harvesting in the form of shell reaping knives, and the remains of cultivated rice. During mortuary phases 5-7, there is undoubted evidence of contact with and influence from Neolithic groups, seen in the new range of incised and impressed motifs on ceramic mortuary vessels linked with a new series of forms. Higham and Thosarat have suggested that social relations, even the arrival of individuals into the community from some distance, might have occurred, and that this site provides evidence for contact between hunter-gatherers and intrusive farmers.

At Ban Non Wat, evidence from the lowest layer showed that the Neolithic 1 people were involved in rice cultivation and stock raising. They made polished stone tools, reveal expertise in pottery making, practiced a weaving technology, a complex mortuary cult and long distance trading between the 17th and 14th centuries BC.

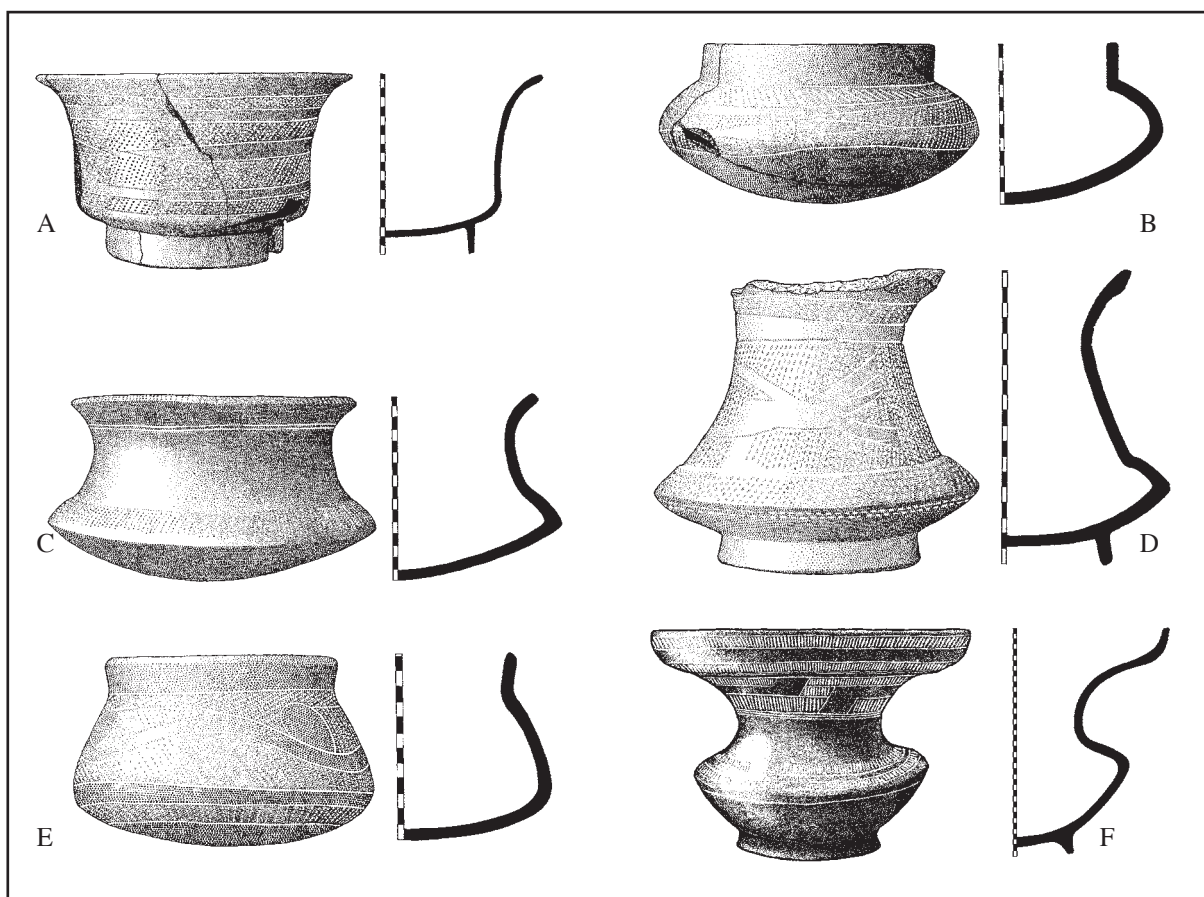


FIG. 9:4 Mortuary vessels from Khok Phanom Di showing incised and impressed decoration, A. Burial 72 Mortuary Phase 3A, B. Burial 99 MP 2, C. Burial 120 MP 2, D. Burial 99 MP 2, E. Burial 86 MP 3A, F. Burial 15 MP 5

The Neolithic package was adaptive for the support of life in the new settlements formed in the Mun River valley. It is most likely to have been introduced by people who already practiced this mode of life for a long time.

The basic issue to be resolved, is whether or not the evidence founded in the ceramic motifs is sufficient to support the model of demic diffusion originating in the northern Starburst zone. From Ban Non Wat to the west and south, the use of the human and whale motifs, it is argued, provide strong evidence of a shared repertoire and a common origin. To the north, there are sufficient parallels with Non Nok Tha and Ban Chiang to draw a similar conclusion. There is also a relationship with the pottery vessels known from Samrong Sen in Cambodia. Further to the west, however, at Ban Kao and related sites, parallels are not so obvious. Forms differ, particularly in the use of the tripod base, and the vessels were hardly decorated at all. However, crossing the Truong Son range to the Red River valley in Vietnam, the decorative techniques and motifs on Phung Nguyen ceramics provide some notable parallels with those in the Northeast and Central Thailand. The parallels between the motifs from Ban Non Wat and Xom Ren supports some form of cultural link between peoples in these two widely-separated areas.

The parallels as one proceeds north into Rispoli's proposed spread zone are not so obvious. Judging from the illustrations of Lingnan Neolithic ceramics in her recent paper, there was a widespread use of the incised and impressed technique, but there are no convincing antecedents to the human, whale or other motifs seen in the Southeast Asian assemblages. However, at Shixia and related sites, there is convincing evidence for the establishment of agricultural societies at an appropriate time span in the early third millennium BC, societies with cultural ties in the Yangtze Valley.

The most logical means of this expansion was by demic diffusion that took advantage of coastal and river routes. The centre of this diffusion still under investigation and more research is needed before being conclusive. At present it is argued that stimuli originated in southern China, but much innovation occurred with southward movement. The early evidence for rice consumption documented at Diaotonghuan and Xianrendong in Jiangxi province, which is thought to date between 10,000-8,000 B.P. helps to identify the ultimate source of this expansion. Younger sites with evidences of cultivated rice in the Yangtze Valley are known at Pengtoushan, Bashidang and Fenshanbao within the period 8,000-7,500 BP. Fuller *et*

al.'s (2007) scepticism on the presence of early domesticated rice in the lower Yangtze summarised above, however, raises an important point. If he is correct in asserting that full rice cultivation was established there as late as 4000 BC, then the proposed demic diffusion south from the Starburst zone would have been a much faster process than under a chronological framework which had rice cultivation fully established millennia earlier.

Geographically, Neolithic people from Yangtze Valley had access to the Lingnan area by the Ganjiang and Xiangjiang river valleys, the former flowing north into lake Poyang, the latter into lake Dongting. In the prehistoric period, dense forest would have dominated the lowlands of Southeast Asia and the rivers systems would have facilitated movement. Higham (2002) has proposed that Yunnan is a key area for tracing any expansionary movement south, following the Mekong, Red, Salween and Chao Phraya rivers.

Baiyangcun dates between 2,462–2,014 B.C. and Shifodong between 1,684–1,262 BC. They indicate a similarity in pottery decoration with the incised and impressed decoration found widespread in Thailand at nearly the same date. The new agricultural community also first appeared in the Phung Nguyen sites of Vietnam and showed some close parallel in the mortuary practice with the Fubin culture of Lingnan.

Rispoli (2008) has further stressed the similarity between the incised and impressed pottery decoration from southern Fujian to the Hong Kong region, at sites such as Xiankezhou, Xiantouling, Baojingwan, Haifeng (Guangdong) and at Fuguodun and Keqiutou (Fujian) dated to c. 4,000–3,000 BC. and Neolithic pottery from sites in the mainland Southeast Asia.

In judging between exotic and indigenous models for the origins of the Thai Neolithic, it is necessary to incorporate linguistic and archaeogenetic evidence. Bellwood (1996) has suggested that there is strong evidence of languages spreading on the scale of the family or phylum during a major process of population expansion. He also stated that agriculture has caused a massive restructuring of the world's language map. According to Bellwood the linguistic picture suggests that populations of Austro-Asiatic (AA) cultivators spread down from South China into Northern Southeast Asia and perhaps even across into India (in case of Munda subgroup) by 3,000 – 2,500 BC. Explaining the present distribution of AA languages in this way has the support of Blust (1996) who in an important paper, developed Reid's (1993) contention that AA and AN languages might have a common ancestor. Higham (2002) has added details to this model, through listing cognate words between Munda and Southeast Asian AA languages for rice, fish, the dog and numerals. This seems to be a very satisfactory and supportive situation for the demic diffusion explanation of Neolithic origins, except that Fuller (2006) has controversially proposed that AA languages originated in India and with rice

cultivation, spread east into Southeast Asia.

Archaeogenetics is too young a discipline to contribute significantly. However, a pointer to the future is found in the recent sequencing of mt DNA from the Iron Age inhabitants of Noen U-Loke, situated only three km west of Ban Non Wat. It was found that the closest modern group to the prehistoric people are the Mon speaking inhabitants of the Petchabun Range to the west. Since Mon is an AA language, and the Iron Age people were probably descended from Neolithic and Bronze Age inhabitants of the area, a link between the evidence of language and genes is hinted at (Lertrit *et al.* 2008).

Cumulatively, the evidence presented above is held to support the model, that the Neolithic settlement of Thailand took place when groups of people conversant with rice farming and the maintenance of domestic animals expanded their area of settlement from southern China to the south into Southeast Asia. The new information from Ban Non Wat allows the integration of several strands of evidence. In addition to the distinctive forms of ceramic decoration, there is the cumulative evidence of mortuary practices, the subsistence base, weaving technology, linguistics, and the overall chronological framework. Fuller's proposal that full sedentary cultivation of rice in the Yangtze was established as late as 4000 BC if confirmed, would be compatible with a relatively rapid spread from the Starburst zone south during the following two millennia.

However, there remain important issues that might add to and even modify this model. The first is the obvious distinction between the Neolithic of the western zone in Thailand, centred on Ban Kao, and the Central and Northeastern Thai sites, on the basis of ceramic form and decoration. It will be necessary to explore the possibility of multiple routes of expansion by different groups of people into Southeast Asia. Secondly, there remains the still little-known status of the coastal marine hunter gatherers seen at Nong Nor and in early contexts at Khok Phanom Di. A feature of the latter site, seen in both material culture, subsistence and the origin of individuals through isotope analyses, is the whole question of the relations between long-established hunter gatherers in Southeast Asia, and the intrusive farming communities. Models are for testing, and as this study has hopefully shown, such testing is best done on the basis of data obtained through extensive excavation, the rigorous establishment of chronological frameworks, and intensive analysis.

INTERACTION WITH HUNTER GATHERERS

The expansion into Southeast Asia of rice farmers did not lead to the extinction of the long-established hunter-gatherers. Indeed, some of the latter continue to thrive, albeit in relatively remote and inaccessible places. It also leads to recent findings from the analysis of modern human DNA sequences. A particularly clear testing of this situa-

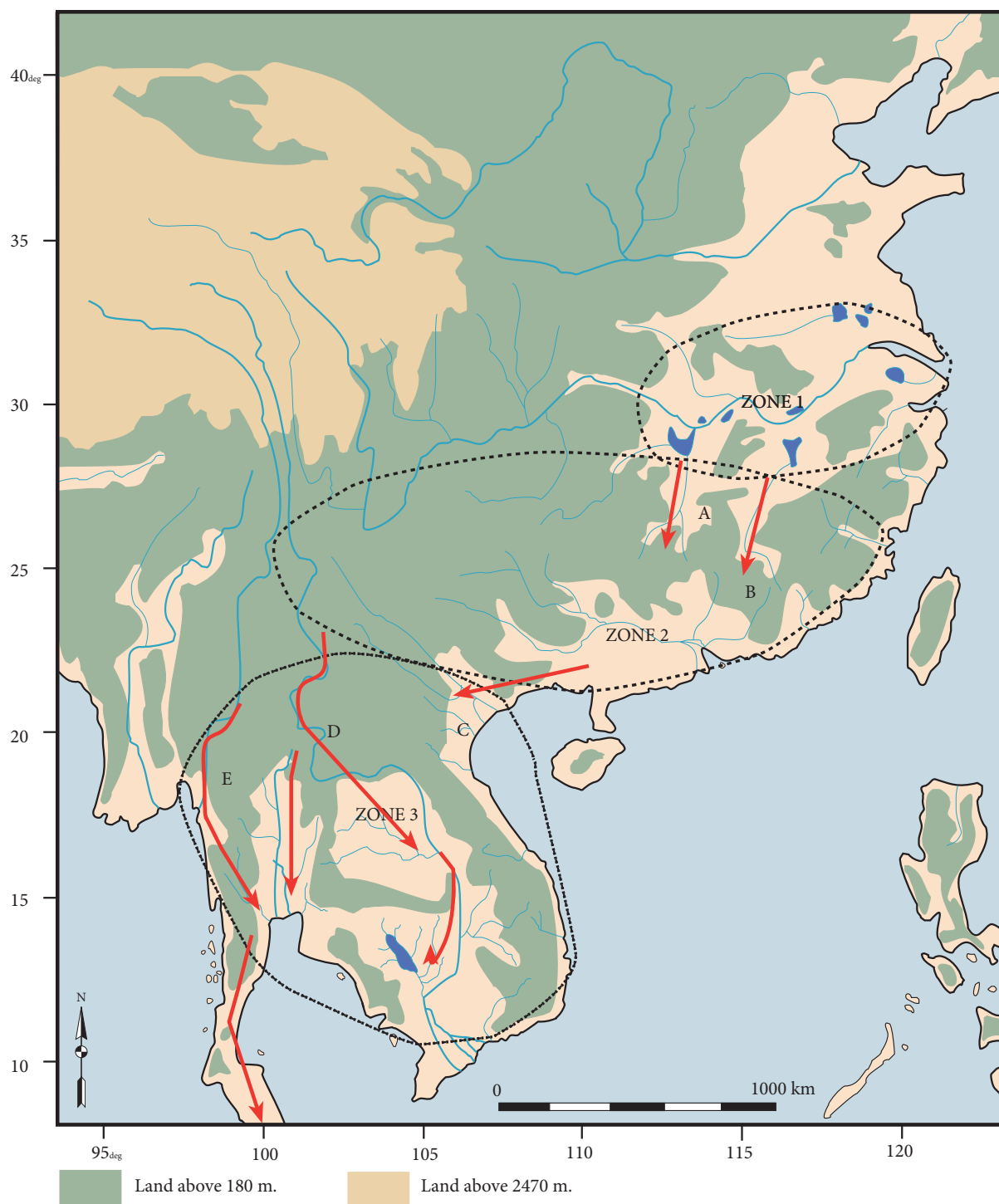


FIG. 9:5 Map showing a proposed zone 1, the starburst zone, 2: the area of a spread zone and 3, a friction zone. A and B are possible routes of contact from Lakes Poyang and Dongting south. C. a possible movement form Guangxi to the Red River delta. D, a possible route from Yunnan to Northeast Thailand, Central Thailand and Cambodia and E, Sørensen's proposed route to Ban Kao via the Salween River

tion comes from the different ethnic groups that occupy the Malay Peninsula (Hill *et al.* 2006, Soares *et al.* 2008). On the basis of mt DNA sequences, the Semang, who are adapted to rainforest foraging and have a distinct Negrito appearance, reveal in haplogroups M21 and R21, a deep ancestry in the region that stretched back at least 60,000 years to the original Anatomically Modern Human expansion into Southeast Asia. Long term continuity is further indicated by the recovery of ancient DNA from prehistoric hunter-gatherer skeletons in Moh Khiew cave in Krabi Province, dating to about 25,000 years ago, which suggests that they were ancestral to the modern Semang hunters of the same region (Oota *et al.* 2001). The Senoi differ from the Semang in being slash and burn agriculturalists. Their mtDNA is consistent with an indigenous component, as with the Semang. However, they also carry a strong admixture of Haplogroup F1a1a, which Hill *et al.* (2007) ascribe to an origin on the Southeast Asian mainland within the past 7,000 years. This, they suggest, could originate in the expansion into the area of Neolithic farming groups who intermarried with the indigenous inhabitants.

On a broader canvass, the genetic evidence is now identifying major demographic events coinciding with the sea level rises that drowned Sundaland between 14,000 and 5000 years ago. Environmentally, this would have greatly expanded the extent of the coastline as a great archipelago was created, and reduced the extent of dry land. For coastal groups long adapted to ocean voyaging, this would have provided an opportunity for an increase in population and expansion of settlement. This is precisely what has been identified on the basis of the modern genetic evidence. At least for island Southeast Asia, there is a growing body of genetic evidence for a demographic expansion out of Sundaland, and less emphasis on the later dominance of Austronesian speaking agriculturalists. As archaeological research gathers momentum on the mainland, one of the key issues to arise will be documenting the interaction between the indigenous hunter-gatherers and the Neolithic wave of advance from the north. It is predicted that the significance and contribution of the former will be considerable.

The evidence from Ban Non Wat is tenuous and tantalising. Deep into the substrate of this site, we encountered a lens of freshwater bivalve shellfish one of which furnished a radiocarbon date of 15045 ± 55 BP. However, it lay at the southern edge of the excavated area, and no artefacts were found in association. At the same depth, there was an almost complete deer skeleton and the remains of an infant the bones of which were heavily concreted. These finds hint that the site had been occupied by hunter-gatherers at a period when virtually all our evidence elsewhere comes from the sheltered environment of caves. There is then, the assemblage of flexed burials dating within the second millennium BC. It is the flexed position of these individuals that poses the possibility that they were indigenous hunter-gatherers. This might be supported in due course

when the results of the analysis of the bones themselves is complete. The few associated mortuary offerings are quite distinct from those found with the Neolithic people. The shell beads with burial 454, for example are of a different form and are much larger than any found in a Neolithic context. The woman in burial 461 wore beads roughly finished shell disc beads. The solitary ceramic vessel found with burial 1 fails to match any from the Neolithic assemblage. It is also notable that some of the complete flexed burials had no mortuary offerings at all. The radiocarbon determinations for three of these graves indicate contemporaneity with Neolithic 1 and 2. Could it be that the cemetery was used by hunter gatherers during the occupation of the site by Neolithic farmers? What was the relationship between the two groups? These are questions for which there is, at present, no answer.

A related situation is found at the site of Khok Phanom Di (Higham and Thosarat 2004). During mortuary phases 1 to 3A there, the occupants appear to have been coastal hunter-gatherers. With phase 3B, there were a series of major changes. These included the local cultivation of rice, the presence of a domestic dog, introduction of shell reaping knives and granite hoes, and slight changes in the form and decoration on ceramic vessels. In due course, some of the incised and impressed designs on the mortuary vessels present close parallels with those from Neolithic 1 Ban Non Wat. Once again, the possibility is posed that this became a mixed community with some immigrants from an inland Neolithic group or group, a possibility given substance by the results of isotope analyses that identify individuals with an exotic origin (Bentley *et al.* 2007).

The cultural relationships between the intrusive Neolithic people and indigenous hunter-gatherers is one of several topics that the excavation of Ban Non Wat has generated and which require further research.

THE COMING OF THE BRONZE AGE

There was a seamless transition at Ban Non Wat from the late Neolithic into the initial Bronze Age. This took place in about 1000 BC. As has been stressed by Linduff and Mei (2009) and Roberts *et al.* (2009), the adoption of copper-base technology requires an element of social complexity that would fuel a social demand for metal objects, the pyrotechnical expertise necessary to undertake the necessary smelting and casting, and the ability to deploy the labour necessary to fulfil the manifold tasks that metallurgy entails. The sophistication of the Neolithic ceramics is self evident when examining the material culture of Ban Non Wat. Moreover, particularly during the initial Neolithic phase, there was clearly exchange with coastal communities who had access to cowrie shells. It is therefore concluded that these basic elements of preadaptation to copper-base metallurgy were in place, making it possible to continue tracing the life of this community of Ban Non Wat into the Bronze Age and beyond.

BIBLIOGRAPHY

- Agelerakis, A. 1997. Some reconstructions of human bio-cultural conditions during the 3rd and 2nd millennia B.C. in South-East Asia. In Ciarla, R. and Rispoli, F. editors, *South-East Asian Archaeology 1992*, pages 99-117. Rome: Istituto Italiano per L'Africa e l'Oriente.
- Amick, D. S. 1996. Regional Patterns of Folsom Mobility and Land Use in the American Southwest. *World Archaeology* 27(3):411-26.
- Anderson, D.D. 1990. *Lang Rongrien Rockshelter: a Pleistocene-Early Holocene Archaeological Site from Krabi, Southwestern Thailand*. Philadelphia: University Museum Monograph No. 71.
- Bamforth, D.B. 1986. Technological efficiency and tool curation. *American Antiquity* 51(1):38-50.
- Bamforth, D.B. 2006. The Windy Ridge quartzite quarry: hunter-gatherer mining and hunter-gatherer land use on the North American Continental Divide. *World Archaeology* 38(3):511-27.
- Bayard, D.T. 1971. *Non Nok Tha. The 1968 Excavation: Procedure, Stratigraphy and a Summary of the Evidence*. Otago University Studies in Prehistoric Anthropology No. 4.
- Bayard, D.T. 1972. Excavations at Non Nok Tha, Northeastern Thailand 1968: an interim report. *Asian Perspectives* 13:109-43.
- Bayard, D.T. 1972a. Early Thai bronze: analysis and new dates. *Science* 176:1411-2.
- Bellwood, P., 1992. Southeast Asia before history. In Tarling, N., editor, *The Cambridge History of Southeast Asia*. Vol. I. *From Early Times to c. 1800*. Cambridge: Cambridge University Press
- Bellwood, P. 2005. *First Farmers. The Origins of Agricultural Societies*. Cornwall: Blackwell
- Bellwood, P. 2006. Asian Farming Diasporas ? Agriculture, Languages and Genes in China and Southeast Asia. In Stark, M.T., editor, *Archaeology of Asia*, pages 96-118. Oxford: Oxford University Press.
- Bellwood, P. and Oxenham, M. 2008. The expansions of farming societies and the role of the Neolithic demographic transition. In Bocquet-Appel, J.-P. & Bar-Yosef, O. editors, *The Neolithic Demographic Transition and its Consequences*, pages 13-34. Springer Science.
- Bentley, A., Tayles, N.G., Higham, C.F.W., Macpherson, C. & Atkinson, T.C. 2007. Shifting gender relations at Khok Phanom Di, Thailand: Isotopic evidence from the skeletons. *Current Anthropology* 48(2): 301-14.
- Berstan, R., Stott, A.W., Minnit, S., Bronk Ramsey C., Hedges, R.E.M. & Evershed, R.P. 2008. Direct dating of pottery from its organic residues: new precision using compound-specific carbon isotopes. *Antiquity* 82:702-13.
- Binford, L. R. 1979. Organisation and formation processes looking at curated technologies. *Anthropological Research* 353:255-72.
- Blackwood, B. 1950. The technology of modern Stone Age people in New Guinea. *Occasional Papers on Technology* 3:1-57.
- Blades, B. S. 2003. End scraper reduction and hunter-gatherer mobility. *American Antiquity* 68:141-56.
- Blanton, D. 1985. Lithic raw material procurement and use during the Morrow Mountain phase in South Carolina. In S. C. Vehik, editor, *Lithic Raw Material Procurement: Proceedings from the Second Conference on the Prehistoric Chert Exploration* pages 115-134. Carbondale: Center for Archaeological Investigation, Southern Illinois University.
- Blust, R. 1996. Beyond the Austronesian homeland: the Austric hypothesis and its implications for archaeology. In Goodenough, W.H. editor, *Prehistoric Settlement of the Pacific*, pages 117-40. *Transactions of the American Philosophical Society* 86, Philadelphia.
- Boer-Mah, T. 2008a. *An Adze to Grind: Lithic Resource Procurement and Reduction of Ground Stone Adzes from Ban Non Wat, Northeast Thailand*. M.Phil. thesis, Archaeology Department, University of Sydney.
- Boer-Mah, T. 2008b. Reduction and adze form: ground stone adzes from Ban Non Wat, Northeast Thailand. *Bulletin of the Indo-Pacific Prehistory Association* 28:44-51.
- Boer-Mah, T. 2009. The material culture: stone adzes. In C. F. W. Higham and A. Kijngam, editors, *The Origins of the Civilization of Angkor, Volume 3, The Excavation of Ban Non Wat: Introduction*, pages 187-96. Bangkok: The Thai Fine Arts Department.
- Bonsall, C., Cook, G., Manson, J. & Sanderson, D. 2002. Direct dating of Neolithic pottery: progress and prospects. *Documenta Praehistorica* 29:47-59.
- Buckley, D.H. 1981. *Surface Effects of Adhesion, Friction, Wear and Lubrication*. Amsterdam: Elsevier.
- Bùi Vinh 1995. Initial steps on determining areas of distributions and characteristics of stone artefacts of the Ha Giang culture (in Vietnamese). *Khảo Cổ Học* 1995(3):33-45.
- Cameron, J. 2002. *Textile Technology in the Prehistory of Southeast Asia*. PhD dissertation, Australian National University.
- Chen Xingcan, 1996. Xiantouling dune site: its significance in understanding the coastal area of south China in prehistory. *Bulletin of the Indo-Pacific Prehistory Association* 15:207-10.
- Ciarla, R. 1992. The Thai-Italian Lopburi regional archaeological project, a preliminary report. In Glover, I.C. editor, *Southeast Asian Archaeology, 1990*, pages 111-28. Centre for South-East Asian Studies, University of Hull.
- Clarkson, C. 2002. An index of invasiveness for the measurement of unifacial and bifacial retouch: a theoretical, experimental and archaeological verification. *Journal of Archaeological Science* 29(1):65-75.
- Clarkson, C. & Lamb, L. editors 2005. *Lithics 'Down Under': Recent Australian Approaches to Lithic Reduction, Use and Classification*. British Archaeological Reports International Series 1408. Oxford: Archaeopress.
- Corbet, G. B., & Hill, J. E. 1992. *The Mammals of the Indo-Malayan Region: A Systematic Review*. Oxford: Oxford University Press.
- Crosby, E. 1973. *A Comparative Study of Melanesian Hafted Edge-Tools and other Percussive Cutting Implements*. Canberra: Australian National University.
- Dani, A.H. , 1960. *Prehistory and Protohistory of Eastern India with a detailed account of the Neolithic Cultures in Mainland Southeast Asia*. Firma K.L. Mukhopadhyay
- De Atley, S.P. 1980. Radiocarbon dating of ceramic materials: progress and prospects. *Radiocarbon* 22(3):987-93.
- Dibble, H. L. 1984. Interpreting typological variation of Middle Paleolithic scrapers: function, style, or sequence of reduction? *Journal of Field*

- Archaeology* 11:431-6.
- Dibble, H. L. 1987. The interpretation of Middle Paleolithic scraper morphology. *American Antiquity* 52:109-17.
- Dickson, F. P. 1981. *Australian Stone Hatchets: a study in design and dynamics*. Sydney: Academic Press.
- Dobney, K., Ervynck, A., Albarella, U. & Rowley-Conwy, P. 2008. The transition from wild boar to domestic pig in Eurasia, illustrated by a tooth developmental defect and biometrical data. In *Pigs and Humans: 10,000 Years of Interaction*. Oxford: Oxford University Press.
- Dockall, J.E. 1997. Wear traces and projectile impact: a review of the experimental and archaeological evidence. *Journal of Field Archaeology* 24:321-31.
- Doelman, T., R., Torrence, R., Popov, V., Ionescu, M., Kluyev, N., Sleptstov, I., Panatyukhina I., White, P. & Clements, M. 2008. Source selectivity: an assessment of volcanic glass sources in the Southern Primorye Region, Far East Russia. *Geoarchaeology* 23:243-73.
- Duff, R. 1970. *Stone Adzes of Southeast Asia: An Illustrated Typology*. Christchurch: Canterbury Museum.
- Fine Arts Department 1982. *The Excavation of Khok Phanom Di, Chonburi Province* (in Thai). Bangkok: Fine Arts Department.
- Freestone, I.C. 1982. Applications and potential of electron probe micro-analysis in technological and provenance investigations of ancient ceramics. *Archaeometry* 24:99-116.
- Fuller, D.Q., Harvey, E. & Ling Qin 2007. Presumed domestication? Evidence for wild rice cultivation and domestication in the fifth millennium BC of the Lower Yangtze region. *Antiquity* 81:316-31
- Fuller, D.Q., Ling Qin, Yunfei Zheng, Zhijun Zhao, Xugao Chen, Leaoi Hosoya & Guo-Ping Sun 2009. The domestication process and domestication rate in rice: spikelet bases from the Lower Yangtze. *Science* 323(5921):1607-10.
- Fuller, D.Q. Sato, Y-I., Castillo, C., Qin, L., Weisskopf, A.R., Kingwell-Banham, E.J., Song, J., Ahn, S.-M. & van Ettem, J. 2010. Consilience of genetics and archaeobotany in the entangled history of rice. *Archaeological and Anthropological Science* 2:115-31.
- Gorman, C.F. and Charoenwongsa, P. 1976. Ban Chiang: a mosaic of impressions from the first two years. *Expedition* 8(4):14-26.
- Grimes, J. R. & Grimes, B. G. 1985. Flakeshavers: morphometric, functional and life-cycle analyses of a Paleoindian unifacial tool class. *Archaeology of Eastern North America* 13:35-57.
- Hán Văn Khấn 2007. Xóm Rèn, một di tích khảo cổ đặc biệt quan trọng trong văn hoá Phùng Nguyên. *Khảo Cổ Học* 2007(3):12-31.
- Ha Van Tan 1980. Nouvelles recherches préhistoriques et protohistoriques au Viet Nam. *Bulletin de l'École Française d'Extrême Orient* 68:113-54.
- Ha Van Tan 1985. Prehistoric pottery in Vietnam and its relationships with Southeast Asia. *Asian Perspectives* XXVI (1):135-46
- Ha Van Tan 1993. *Yazhang* plaques in the Phung Nguyen culture sites (in Vietnamese). *Khảo Cổ Học* 86:16-27.
- Hanwong, T. 1985. *Artefact Analysis from the Excavation at Ban Thakae Amphor Muang Changwat Lopburi* (in Thai). MA Dissertation, Silpakorn University.
- Harrison, T. and Harrison, B., 1971. *The Prehistory of Sabah*. Monograph IV. Sabah: Sabah Society Journal.
- Hedges, R.E.M., Tiemei, C. & Housley, R.A. 1992. Results and methods in the radiocarbon dating of pottery. *Radiocarbon* 34(3):906-15.
- Higham, C.F.W. 1996. *The Bronze Age of Southeast Asia*. Cambridge: Cambridge University Press.
- Higham, C.F.W., 2002. Languages and Farming Dispersals: Austroasiatic Language and Rice Cultivation. In Bellwood, P. & Renfrew, C., editors, *Examining the Farming / Language Dispersal Hypothesis*, pages 223-32. Cambridge: McDonald Institute for Archaeological Research
- Higham, C.F.W. 2004. The opposed human figure at Khok Phanom Di. *Journal of the Siam Society* 92:15-36.
- Higham, C.F.W. 2005. The faunal remains. In Higham C.F.W. and Thosarat, R. editors, *The Origins of the Civilization of Angkor*. Volume 1: *The Excavation of Ban Lum Khao*, pages 159-70. Bangkok: the Fine Arts Department of Thailand.
- Higham, C.F.W. & Higham, T.F.G. 2009. A new chronological framework for prehistoric Southeast Asia, based on a Bayesian model from Ban Non Wat. *Antiquity* 82:1-20.
- Higham, C.F.W. and Kijngam, A., editors, 1984. *Prehistoric Investigations in Northeast Thailand*. Oxford: British Archaeological Reports (International Series) 231(1-3).
- Higham, C.F.W., Kuzmin, Y.V. & Burr, G.S. 2010. The AMS 14C dating of Iron Age rice chaff ceramic temper from Ban Non Wat, Thailand: First results and its interpretation. *Nuclear Instruments and Methods in Physics Research Section B: Beam Interactions with Materials and Atoms Research B* 268:1022-25.
- Higham, C.F.W., Kijngam, A. and Manly, B. 1980. An analysis of prehistoric canid remains from Thailand, *Journal of Archaeological Science* 7(2):149-66.
- Higham, C.F.W., Kijngam A. and Talbot S. editors, 2007. *The Origins of the Civilization of Angkor*. Volume 2. *The Excavation of Noen U-Loke and Non Muang Kao*. Bangkok: Fine Arts Department.
- Higham, C.F.W. and Thosarat, R. 2004. *The Excavation of Khok Phanom Di: Volume VII. Summary and Conclusions*. London: The Society of Antiquaries of London.
- Higham, C.F.W. and Thosarat, R., editors, 2005. *The Origins of the Civilization of Angkor*. Volume 1. *The Excavation of Ban Lum Khao*. Bangkok, The Fine Arts Department of Thailand.
- Higham, C.F.W. and Thosarat, R. editors, 1998. *The Excavation of Nong Nor, a Prehistoric Site in Central Thailand*. Dunedin: Otago University Studies in Prehistoric Anthropology 18.
- Higham, C.F.W., Xie Guangmao & Lin Qiang 2010. The prehistory of a friction zone: first farmers and hunters-gatherers in Southeast Asia. *Antiquity* in press.
- Higham, T.F.G. 2005. Dating the occupation of Ban Lum Khao. In Higham C.F.W. and Thosarat, R., editors, *The Origins of the Civilization of Angkor*. Volume 1: *The Excavation of Ban Lum Khao*. pages 5-8. Bangkok: the Fine Arts Department of Thailand.
- Hill, C., Soares, P. Mormina, M., Macauley, V., Meehan, W., Blackburn, J., Clarke, D., Maripa Raja, J., Ismail, P., Bulbeck, D., Oppenheimer, S. & Richards, M. 2006. Phylogeography and Ethnogenesis of Aboriginal Southeast Asians. *Molecular Biology and Evolution* 23:2480-91.
- Hill, C., Soares, P. Mormina, M., Macauley, V., Clarke, P.B., Blumbach, D., Vizuete-Forster, M., Forster, P., Bulbeck, D., Oppenheimer, S. & Richards, M. 2007. A mitochondrial stratigraphy for Island Southeast Asia. *American Journal of Human Genetics* 80(1):29-43.
- Hiscock, P. and Attenbrow, V. 2002. Morphological and reduction continuums in Eastern Australia: measurement and implications

- at Capertee 3. S. Ulm, editor, *Barriers, Borders and Boundaries: Proceedings of the 2001 Australian Archaeological Association Annual Conference* pages 167-74. Brisbane: University of Queensland.
- Hiscock, P. and Attenbrow V. 2005. Reduction continuums and tool use. In C. Clarkson & L. Lamb, editors, *Lithics 'Down Under': Australian Perspectives on Lithic Reduction, Use and Classification* pages 43-5. Oxford: Archaeopress.
- Ho, C.M. 1984. *The Pottery of Kok Charoen and its Farther Context*. Ph.D. dissertation, University of London.
- Hoang Xuan Chinh, 1968. *Bao Cao Khai Quat Dot Di Chi Lung Hoa*. Nha Xuat Ban Khoa Hoc Xa Hoi, Ha Noi.
- Hoang Xuan Chinh and Nguyen Ngoc Bich, 1978. *The Excavation of the Archaeological Site of Phung Nguyen* (in Vietnamese). Ha Noi: Nha Xuat Ban Khoa Hoc Xa Hoi.
- Hoffman, C. M. 1985. Projectile point maintenance and typology: assessment with factor analysis and canonical correlation. In C. Carr, editor, *For Concordance in Archaeological Analysis: Bridging Data Structure, Quantitative Technique and Theory* pages 566-612. Kansas City: Westport Press.
- Kijngam, A. 1979. *The Faunal Remains from Ban Chiang and their Implications for Thai Culture History*. M.A. thesis, University of Otago, Dunedin.
- Kuhn, S.L. 1990. A geometric index of reduction for unifacial stone tools. *Journal of Archaeological Science* 17(5):583-93.
- Lai Van Toi, 1999. The initial inhabitants of Co Loa (in Vietnamese). *Khảo Cổ Học* 1998(3):39-54.
- Larson, G., Cucchi, C., Fujita, M., Matisoo-Smith, E., Robins, J., Anderson, A., Rolett, B., Spriggs, M., Dolman, G., Kim, T.H., Thuy, N.T., Randi, E., Doherty, M., Awe Due, R., Boltt, R., Djubiantono, T., Griffin, B., Intoh, M., Keane, E., Kirch, P., Li, K.-T., Morwood, M., Pedriña, L.M., Piper, P., Rabett, R., Shooter, P., Van den Bergh, G., West, E., Wickler, S., Yuan, J., Cooper, A. & Dobney, K. 2007. Phylogeny and ancient DNA of *Sus* provides insights into Neolithic expansion in Island South East Asia and Oceania. *Proceedings of the National Academy of Sciences* 104(12):4834-9.
- Lekagul, B. & McNeely, J. 1977. *Mammals of Thailand*. Bangkok: Sahakarnbhat.
- Lekberg, P. 2000. The lives and lengths of shaft-hole axes. In D. Olausson and H. Vandkilde, editors, *Material Culture Studies in Scandinavian Archaeology* pages 155-61. Lund: Institute of Archaeology.
- Leong Sau Heng, 1991. Jenderam Hilir and the mid-Holocene prehistory of the west coast plain of Peninsular Malaysia. *Bulletin of the Indo-Pacific Prehistory Association* 10:150-60.
- Lertrit, P., Poolsuwan, S., Thosarat R., Sanpachudayan, T., Boonyarit H., Chinpaisal, C. and Suktitipat, B. 2007. Genetic history of prehistoric Asian populations as revealed by ancient and modern mitochondrial DNA analysis. *American Journal of Physical Anthropology* 137(4): 425-40.
- Leyavanija, S. 1992. The Non Sila lithic analysis. *Bulletin of the Indo-Pacific Prehistory Association* 12:32-43.
- Linduff, K. M. & Jianjun Mei. 2009. Metallurgy in ancient Eastern Asia: retrospect and prospects. *Journal of World Prehistory* 22:265-81.
- Loofs-Wissowa, H.H.E. 1997. "Hill of Prosperity": state of the art of the publication of Khok Charoen site, Lopburi Province, Thailand. *Bulletin of the Indo-Pacific Prehistory Association*, 16:199-211
- Masanari, N. & Dung, N.K. 2002. Excavation of An Son: a Neolithic mound site in the middle reaches of the Vam Co Dong River, southern Vietnam. *Bulletin of the Indo-Pacific Prehistory Association* 22:101-9
- Matsumura H, Oxenham M.F, Nguyen L.C., Nguyen K.T., Nguyen K.D., Huffer D., Dodo Y., Domett K., & Yamagata, M. 2008. Morphometric affinity of the late Neolithic human remains from Man Bac, Ninh Binh Province, Vietnam: key skeletons with which to debate the 'Two Layer' hypothesis. *Anthropological Science* 116(2):135-48.
- McNeill, J. R. & Welch, D. J. 1991. Regional and inter-regional interaction on the Khorat Plateau. *Bulletin of the Indo-Pacific Prehistory Association* 10:327-40.
- McShea, W.J., Leimgruber, P., Myint Aung, Monfort S.L. & Wemmer, C. 1999. Range collapse of a tropical cervid (*Cervus eldi*) and the extent of remaining habitat in central Myanmar. *Animal Conservation* 2:173-83.
- Moore, E. H. 1988. *Moated Sites in Early North East Thailand*. Oxford: British Archaeological Reports (International Series) 400.
- Mudar, K.M. 1995. Evidence for prehistoric dryland farming in Mainland Southeast Asia: results of regional survey in Lopburi Province, Thailand. *Asian Perspectives* 34:157-94.
- Nguyen Kim Dung 1990. The lithic workshop at Trang Kenh. *Khảo Cổ Học* 1990:3 64-82.
- Nguyen Kim Dung 1998. Nephrite and jadeite manufacturing tradition in prehistoric Vietnam (in Vietnamese). *Khảo Cổ Học* 1998(4):15-22.
- Nowak, R. 1999. *Walker's Mammals of the World*. 6th ed. Baltimore, Maryland: The John Hopkins University Press.
- Oota, H., Kurosaki K., Pookajorn S., Ishida, T. and Ueda S. 2001. Genetic Study of the Paleolithic and Neolithic Southeast Asians. *Human Biology* 73: 225-31.
- Orberger, B., Lorand, J. P. Girardeau, J., Mercier, J. C. C. & Pitragool, S. 1995. Petrogenesis of ultramafic rocks and associated chromitites in the Nan Uttaradit ophiolite, Northern Thailand. *Lithos* 35:153-82.
- O'Reilly, D.J.W. 1998. The lithic artefacts. In Higham, C.F.W. and Thosarat R., editors, *The Excavation of Nong Nor, a Prehistoric Site in Central Thailand*, pages 129-34. Dunedin: Otago University Studies in Prehistoric Anthropology.
- Parry, J. T. 1996. The high terrace gravels, northeast Thailand - a re-evaluation and an integrated theory of their origin. *Zeitschrift für Geomorphologie* 40(2):145-75.
- Pietrusewsky, M. 1988. Multivariate comparisons of recently excavated Neolithic human crania from the Socialist Republic of Vietnam. *International Journal of Anthropology* 3:267-83.
- Pietrusewsky, M. & Douglas, M.T. 2002. *Ban Chiang, A Prehistoric Village Site in Northeast Thailand I. The Human Remains*. Philadelphia, the Museum of Archaeology and Anthropology.
- Pigott, V.C., Weiss, A.D. & Natapintu. S. 1997. The archaeology of copper production: excavations in the Khao Wong Prachan Valley, Central Thailand. Ciarla, R. and Rispoli, F. editors, *South-East Asian Archaeology* 1992, pages 119-57. Rome: Istituto Italiano per l'Africa e l'Oriente.
- Pisnupong, P. 1988. *Aspects of Stone Working at Khok Phanom Di*. M.A. thesis, Department of Anthropology, University of Otago.
- Pisnupong, P. 1993. The industrial stone technology. In Higham, C.F.W. and Thosarat, R., editors, *The Excavation of Khok Phanom Di*. Volume 3 (part 1): *The Material Culture*, pages 45-104. London: Society of Antiquaries of London, Research Report no. L.

- Polanyi, K. 1957. The economy as an instituted process. In K. Polanyi, C. M. Arensberg & H. W. Pearson, editors, *Trade and Market in the Early Empires*, pages 243-70. New York: Academic Press.
- Pookajorn, S. 1992. Recent evidence of a Late Pleistocene to a Middle Holocene archaeological site at Moh Khiew Cave, Krabi Province, Thailand. *Silpakorn Journal* 35(3):93-119.
- Pookajorn, S. 1994. Final report of excavations at Moh Khiew Cave, Krabi province; Sakai Cave, Trang Province and ethnoarchaeological research of hunter-gatherer group, so-called Mani or Sakai or Orang Asli at Trang Province (The Hoabinhian Research Project in Thailand). Bangkok: Silpakorn University.
- Racey, A., Love, M.A., Canham, A.C., Goodall, J.G.S., Plachan, S. & Jones, P.D. 1996. Stratigraphy and reservoir potential of the Mesozoic Khorat group, NE Thailand: Part 1: stratigraphy and sedimentary evolution *Journal of Petroleum Geology* 19:5-39.
- Renfrew, A.C. 1972. *The Emergence of Civilisation: the Cyclades and the Aegean in the third millennium B.C.* London: Methuen and Co.
- Renfrew, A.C. 1975. Trade as action at a distance: questions of integration and communication. In J. A. Sabloff & C. C. Lamberg-Karlovsky, editors, *Ancient Civilisation and Trade*. Albuquerque: University of New Mexico Press.
- Rispoli, F. 1997. Late-third/early second millennium BC pottery traditions in Central Thailand: some preliminary observations in a wider perspective. In R. Ciarla & F. Rispoli, editors, *Proceeding of the 4th International Conference of EurASEAA*, pages 59-97. Rome: Serie Orientale Roma.
- Rispoli, F. 2008. The incised and impressed pottery style of mainland Southeast Asia: following the paths of Neolithization. *East & West* 57(1-4):235-304.
- Rispoli, F., Ciarla, R. & Pigott, V.C. 2009. Towards a working chronology for the greater Lopburi region. Paper read at the 19th congress of the Indo-Pacific Prehistory Association, Hanoi.
- Roberts, B.W., Thornton, C.P. & Pigott, V.C. 2009. Development of metallurgy in Eurasia. *Antiquity* 83:1012-22.
- Rutnin, D. 1988. *The Prehistory of Western Udon Thani and Loei Provinces, Northeast Thailand*. PhD dissertation, Australian National University, Canberra.
- Sahlins, M.D. 1972. *Stone Age Economics*. Chicago: Aldine.
- Schauffler, W. 1976. Archaeological survey and excavation of Ban Chiang culture sites in Northeast Thailand. *Expedition* 18:27-37.
- Schiffer, M.B. 1972. Archaeological context and systemic context. *American Antiquity* 37(2): 156-65.
- Semenov, S. A. 1964. *Prehistoric Technology*. London: Cory, Adams & Mackay.
- Shepard, A.O. 1985. *Ceramics for the Archaeologist*. Washington: Carnegie Institute of Washington Publication 609.
- Shott, M. J. 2005. The reduction thesis and its discontents: overview of the volume. lithics 'down under'. In C. Clarkson & L. Lamb, editors, *Australian Perspectives on Lithic Reduction, Use and Classification* pages 109-25. Oxford: Archeopress.
- Shoocondej, R. 1996. Working towards an anthropological perspective on Thai prehistory. *Bulletin of the Indo-Pacific Prehistory Association* 14:119-32.
- Shoocondej, R. 2004. *Archaeological Heritage Management at Ban Rai and Tham Lod Rockshelters Project* (in Thai). Bangkok: Silpakorn University.
- Shoocondej, R. 2008. *Highland Archaeology in Pang Mapha District, Hae Hongson Province* (in Thai). Bangkok: Silpakorn University.
- Shott, M. J. 2005. The reduction thesis and its discontents: overview of the volume. In C. Clarkson & Lamb, L. editors, *Lithics 'Down Under': Australian Perspectives on Lithic Reduction, Use and Classification*. pages 109-25. Oxford: Archeopress.
- Sieveling, G. de G. 1955. Recent archaeological discoveries in Malaya (1954). *Journal of the Malayan Branch of the Royal Asiatic Society* 28:196-217.
- Smith, B.D. 1995. *The Emergence of Agriculture*. New York: Scientific American Library.
- Siripanish, S. 1985. *An Analytical Study on Pottery from the Excavation of Ban Tha Kae, Muang District, Lopburi Province* (in Thai). Master's thesis, Silpakorn University.
- Soares, P., Trejaut, J.-A., Loo, J., Hill, C., Mormina, M., Lee, C.-L., Chen, Y.-M., Hudjashov, G., Forster, P., Macaulay, V., Bulbeck, D., Oppenheimer, S., Lin, M. & Richards, M.B. 2008. Climate Change and Postglacial Human Dispersals in Southeast Asia. *Molecular Biology and Evolution* 25(6):1209-18.
- Solheim, W.G. II, 1970. Northern Thailand, Southeast Asia and world prehistory. *Asian Perspectives* XIII:145-62.
- Sørensen, P. & Hatting, T., 1967. *Archaeological Investigations in Thailand*. Vol. II, *Ban Kao, Part 1: The Archaeological Materials from the Burials*. Munksgard: Copenhagen.
- Sørensen, P. 1972. The Neolithic cultures of Thailand (and North Malaysia) and their Lungshanoid relationship. Barnard, N. editor, *Early Chinese art and its possible influence in the Pacific Basin* pages 459-506. New York: Intercultural Arts Press.
- Stark, M., 2004. Pre-Angkorian and Angkorian Cambodia. In Bellwood, P. and Glover, I., editors, *Southeast Asia : From Prehistory to History*, pages 89-119. London: Routledge Curzon.
- Stroulia, A. 2003. Ground stone celts from Franchthi Cave: a close look. *Hesperia* 72(1):1-30.
- Summerhayes, G.R. 1997. Losing your temper: the effect of mineral inclusions on pottery analyses. *Archaeology in Oceania* 32:108-17.
- Summerhayes, G.R. 2000. *Lapita Interaction*. Canberra: Department of Archaeology and Natural History and Centre for Archaeological Research, the Australian National University. *Terra Australis* 15.
- Thosarat, R. 2005. The fish remains. In Higham C.F.W. and Thosarat, R. editors, *The Origins of the Civilization of Angkor*. Volume 1: *The Excavation of Ban Lum Khao* pages 171-90. Bangkok: The Fine Arts Department of Thailand.
- Tite, M.S. 1992. The impact of electron microscopy on ceramic studies. In Pollard, A.M. editor, *New Developments in Archaeological Science*. *Proceedings of the British Academy* 77:111-31.
- Torrence, R. 1986. *Production and Exchange of Stone Tools: Prehistoric Obsidian in the Aegean*. Cambridge: Cambridge University Press.
- Treerayapeewat, C. 2005. Patterns of habitation and burial activity in the Ban Rai rockshelter, Northwestern Thailand. *Asian Perspectives* 44:231-45.
- Turner, M. 2000. *The Function, Design and Distribution of New Zealand Adzes*. Department of Anthropology: University of Auckland.
- Turner, M. 2005. Functional and technological explanations for the variation among early New Zealand adzes. *New Zealand Journal of Archaeology* 26:57-101.
- Vincent, B.A. 1988. Prehistoric Ceramics of Northeastern Thailand,

- with special reference to Ban Na Di. *British Archaeological Reports, International Series* 461.
- Vincent, B.A. 2004. *The Excavation of Khok Phanom Di: A Prehistoric Site in Central Thailand* Volume VI, *The Pottery. The Material Culture*, (Part II). London: Society of Antiquaries of London.
- Voelker, J. 2002. *Ceramic Production in Northeast Thailand 1500 B.C. – 500 A.D.* Ph.D. dissertation, the State University of New York at Buffalo.
- Weber, S., Lehman, H., Barela, T., Hawks, S. & Harriman, D. 2010. Rice or millets: early farming strategies in prehistoric Central Thailand. *Archaeological and Anthropological Science* 2:79-88.
- Welch, D. J. 1989. Late prehistoric and early historic exchange patterns in the Phimai Region, Thailand. *Journal of Southeast Asian Studies* 20(1):11-26.
- Welch, D. J. & McNeill, J. R. 1990. Excavations at Ban Tamyae and Non Ban Kham, Phimai Region, Northeast Thailand. *Asian Perspectives* 28(2):99-123.
- White, J.C. 2008. Dating early bronze at Ban Chiang, Thailand. In J-P. Pautreau, A-S. Coupey, V. Zeitoun & E. Rambault. editors *From Homo erectus To the Living Traditions* pages 91-110. Bougon: European Association of Southeast Asian Archaeologists.
- White, J.C. 1997. A brief note on new dates for the Ban Chiang cultural tradition. *Bulletin of the Indo-Pacific Prehistory Association* 16:103-6.
- White, J.C., Vernon, W., Fleming, S., Glanzman, W., Hancock, R., & Pelein, A., 1990. Preliminary cultural implications from initial studies of the ceramic technology of Ban Chiang. *Bulletin of Indo-Pacific Prehistory Association* 2:188-203.
- Xie G., Lin, Q. & Peng, C. 2003. Gexinqiao Neolithic site in Baise City, Guangxi. *Archaeology* 12:3-6 (in Chinese with English abstract).
- Xie G. & Peng, C. 2006. An important discovery from the excavation of Baida site in Baise, Guangxi (in Chinese) *China Cultural Relics News* 1409.
- YPM (Yunnan Provincial Museum) 1977. The Neolithic site of Ta-Tun-Tzu in Yuan-Mo County, Yunnan Province (in Chinese). *Kaogu Xuebao* 1977:43-72.
- YPM (Yunnan Provincial Museum), 1981. The Baiyangcun site at Binchuan County, Yunnan Province (in Chinese). *Kaogu Xuebao* 1981:349-68.
- Zhang, C. & Hung, H.-C. 2010. The emergence of agriculture in southern China. *Antiquity* 84: 11-25.

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