The Excavation of Nong Nor

a Prehistoric Site in Central Thailand

Edited by

C.F.W. Higham and R. Thosarat

Authors

W.E. Boyd, N.J. Chang, J. Debreceny, K. Domett,
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V. Hunt, B.F.J. Manly, G.M. Mason, D.J.W. O'Reilly,
C. Pailles, A. Reay, N.G. Tayles and R. Thosarat

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PREFACE

Nong Nor has two periods of occupation. The first, dated to about 2450 B.C., saw a community of hunter-gatherer-fishers occupy a coastal, mangrove habitat for a period lasting no more than a few months. The second involved a Bronze Age cemetery dating to between 1100-700 BC. We worked there over three seasons in 1991-2-3.

This report has many authors, and we are indebted to them all for contributing to an understanding of the site in all its aspects. In the field, William Boyd, Graeme Mason, Nancy Tayles, Joss Debreceny and Nigel Chang worked with us for all three seasons, where we were joined by Anat Bamrungwongse, Anand Poomjam and Amphan Kijngam. Several specialists joined forces in the analysis of the material and we are grateful to Kate Domett, Tony Reay, Dougald O'Reilly, Ewan Fordyce, Tom Higham, Alan Hogg, Veronica Hunt, Bryan Manly and Christine Pailles. The authors of the section on human remains wish to thank George Dias for assistance with the differential diagnosis of the mandibular pathology and Hallie Buckley for proof reading.

The excavation was made possible by research grants from the University of Otago, the National Geographic Society, Earthwatch and its Research Corps and Southern Cross University. We thank these institutions for their support. Associate Professor Boyd acknowledges grants from the Australian Institute for Nuclear Science and Engineering for the provision of AMS radiocarbon dates at the Australian Nuclear Science and Technology Organisation.

Once again, we have relied upon Martin Fisher and Leslie O'Neill for their skill and professionalism in preparing the illustrations. It will be noted that we experimented with new means of illustrating the complete pottery vessels. Some never left Thailand, and were drawn there before being scanned and digitised in New Zealand. Others were scanned from photographs and the remainder were drawn by Leslie O'Neill, who also drew all the burials. Leslie O'Neill also undertook the Herculean task of formatting the book using the Aldus Pagemaker program. Bill Boyd also acknowledges the assistance of Maria Cotter in translating pencil sketches of the sediment sections into computer graphics. It is with a sense of relief that in producing this report, we have fulfilled our obligation to this research programme, and hope that this volume will be useful to those who, like ourselves, are attracted to the prehistory of Southeast Asia.

During the course of the excavation, we were joined by members of the Research Corps of Earthwatch. Without their dedicated support, we could not have completed the excavation of Nong Nor. We thank Robert Acker, Dorothy Albee, Joan Anderson, Bonnie Baskin, Marianna Battey, Kai Binford, Louis Connick, Virginia Blair, Barbara Claxton, Karen Evans, Helena Holmes, Jennifer Huggins, Jonathon Huggins, Veronica Hunt, Jeffrey Huyck, Geralyn Lambson, Herchel Lamp, Virginia McNear, Sherry McVitie, William Mead, Lillian Morton, Elizabeth Plott, Maureen Reed, Robert Schilling, Beverly Schmidt, Donald Schmidt, June Schneider, Herm Seibert, Allen Thompson, David Unkefer, Anne Wilder, Helen Wolcott, Oliver Wolcott, Tiffany Yelton and Stephen Zabarauskas.

SECTION ONE

I. INTRODUCTION: RESEARCH OBJECTIVES

C.F.W. Higham and R. Thosarat

THIS report is a contribution to a research project concerned with the Bang Pakong Valley in prehistory. The initial impetus was provided by the large and enigmatic site of Khok Phanom Di, which dominates the surrounding flood plain of the Bang Pakong River (Fig. 1). In 1984, it was decided to undertake a site survey in an area chosen because it incorporated the principal landforms and soil types present in the valley as a whole. These included the lower terrace and marine and brackish water clays, as well as Recent fluviatile alluvia (Fig. 2). The lower Bang Pakong Valley lies within an area subjected to sea level changes over the past 7,000 years, and since the tropical estuarine habitat represents one of the richest ecosystems known, in terms of self-replenishing food resources, reconstructing the pattern of human settlement as it developed through both environmental changes and innovations in subsistence and technology is a magnetic theme.

While the distribution of marine and brackish water clays is a general indication of the maximum extent of the expanded Gulf of Siam under the influence of marine transgressions, identifying the shoreline during regressive conditions is not always straightforward. This is demonstrated in the research undertaken at Khok Phanom Di. Virtually all biological indicators are unanimous in showing that this site was initially located near the estuary of a major river, which was in all likelihood the ancestral Bang Pakong itself (Maloney 1991, Mason 1991, McKenzie 1991, West 1991). Perhaps two centuries after its initial occupation at *c*. 2000 B.C., there was a major change in the course of the adjacent river which, allied with progradation of the shore, distanced the occupants from easy access to marine resources.

The excavation of Khok Phanom Di in 1985 has revealed how a community adapted to this rich habitat over a period of about 20 generations (Higham and Bannanurag 1990, 1991, Higham and Thosarat 1993, 1994). This site covers *c*. 5 ha, and rises to a maximum of 12 m above the surrounding plain. During the five centuries of its prehistoric occupation, the inhabitants buried the dead in clusters which, as the associated deposits accumulated, saw individuals interred over the ancestors. The mortuary ritual involved the preparation of a grave, and interment of the corpse within a fabric shroud, associated with a range of grave goods. A detailed analysis of the associated offerings has stressed that, within a context of marked temporal change, the inhabitants manufactured ceramic vessels of outstanding quality. Other grave goods included jewellery fashioned from marine shell and fish bone, the rare stone adze, ornate turtle carapace ornaments, clay anvils for shaping clay into pots, and burnishing stones. If the quantity and associations of grave offer-

ings reflect personal attributes, then it seems that women fashioned the pots, and that with time, they achieved social prominence. It is particularly noted that no metal was found in any context at Khok Phanom Di, and Higham (1996a) has suggested from this and much other evidence that the Bronze Age of Southeast Asia began after about 1500 B.C.

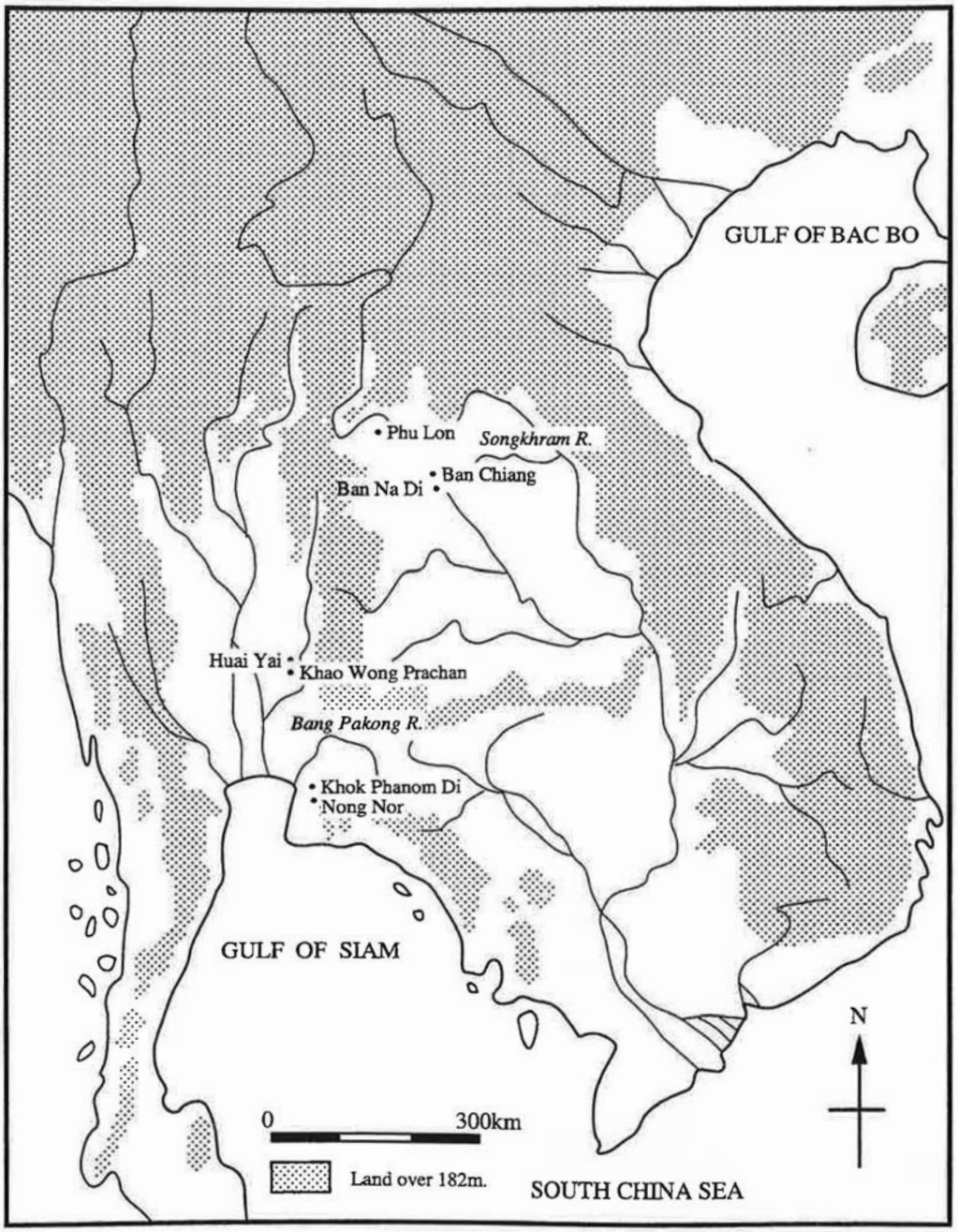


FIG. 1. Southeast Asia, showing the location of Khok Phanom Di and Nong Nor

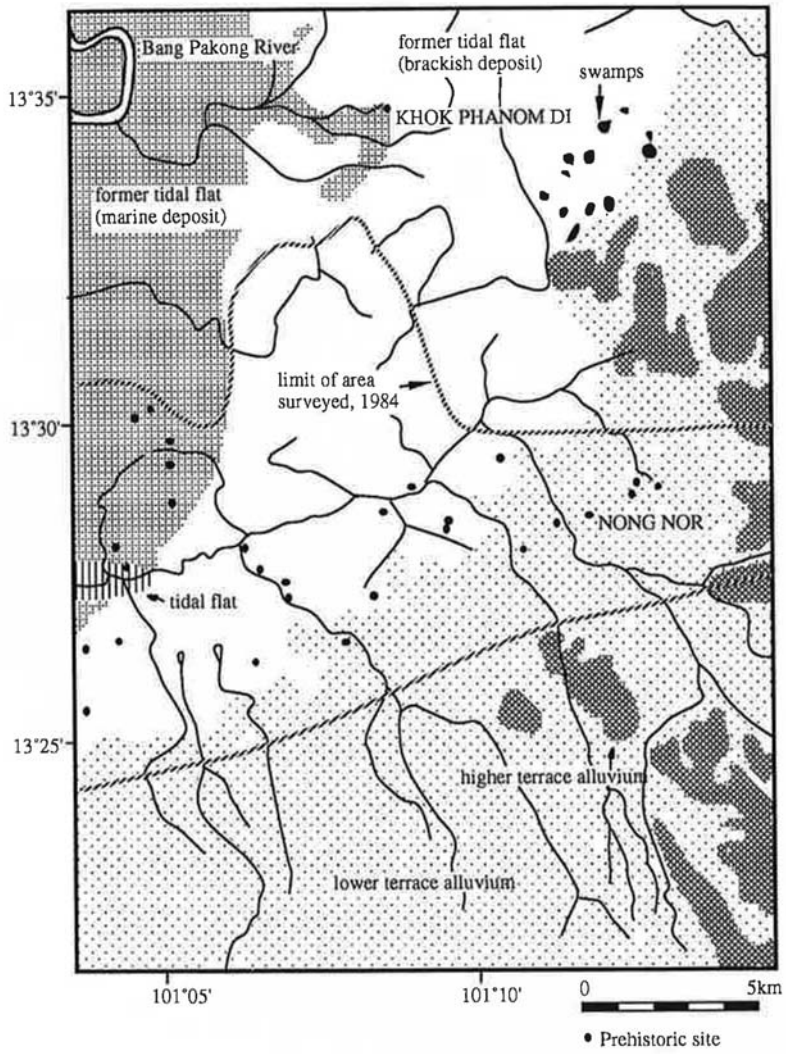


FIG. 2. The Bang Pakong Valley survey area

The biological remains from Khok Phanom Di indicate that fishing and shell fish collecting, in conjunction with the cultivation of rice, dominated the diet, a finding reinforced by the analysis of partially digested food remains and faeces (Kijngam 1991, Mason 1991, Thompson 1996). The people were well nourished and physically robust, but also suffered health problems, identified by Tayles (1992) as being the result of haemoglobinopathies which in part provide resistance to malaria. While most women bore several children, infant mortality was very high, particularly during the first 8-10 generations.

Already by the third of the seven mortuary phases at Khok Phanom Di, there are hints that men and women were being distinguished in death by their grave offerings. From this juncture, men were usually buried with ornate turtle carapace ornaments, while clay anvils were restricted to some women and infants. It is particularly intriguing that during mortuary phase 5, a woman was

interred with unparalleled finery, including over 120,000 shell beads. Her body was covered with clay cylinders thought to represent clay stored against future potting needs, and by her left ankle, there was a clay anvil and two burnishing stones contained within a large shell valve. A very rich infant's grave lay adjacent, likewise including clay cylinders and on this occasion, a tiny anvil. This, and much other evidence, has been used to reconstruct a situation in which women played a prominent social role, and young females were valued for their potential as future potters. But this does not rule out the role of men in this community, for at least one was interred with a rich array of exotic shell jewellery. By mortuary phase 6, we encounter a raised mortuary structure over a female, with a further woman and a child as secondary burials.

FIG. 3. View of Nong Nor during the 1991 excavation season. The excavation is under the thatched roof.

When the analysis of the Khok Phanom Di material had reached the point when further fieldwork could be contemplated, we narrowed our options to two. The first would have involved a return to Khok Phanom Di to extend the excavation and expose more of the cemetery. While attractive in many respects, we preferred the alternative. Having re-examined the results of our 1984 site survey (Fig. 2), we decided to seek a site which might have been contemporary with Khok Phanom Di, but located in a less wealthy natural habitat. In doing so, we were guided by the degree of wealth accumulated by some of the later interments at Khok Phanom Di, and the wish to explore this site in its regional context. Were, for example, large estuarine communities

so advantaged by their nodal location and control over exchange, that two levels of settlement hierarchy were developing already during the early second millennium B.C.? Could it have been that the elite at Khok Phanom Di exercised a wider social dominance? To approach this issue, we sought to examine a contemporary but smaller settlement.

This was not easy. The site surveys had confronted a major problem: regular flooding by the Bang Pakong River and its tributaries had deposited sediments, blanketing or partially covering former settlements and changing the present landscape. Discovering prehistoric sites which did not attain the height of Khok Phanom Di was to a considerable degree, fortuitous. For example, we regularly asked villagers if they knew the location of marine shell and pottery sherds. On occasion, we would be taken out into the rice fields, and shown a hole dug into the ground, at the bottom of which there would be a prehistoric site. One such site was Nong Nor, although in at least one respect, this was a special case (Fig. 3). The low mound is divided between two owners. One retained their part as a rice threshing floor, the other had levelled the mound with a tractor blade to encourage rice production. The planed area, on our revisiting the site in early 1990, was dotted with pits where the owners of the intact segment had indulged in sporadic looting. The

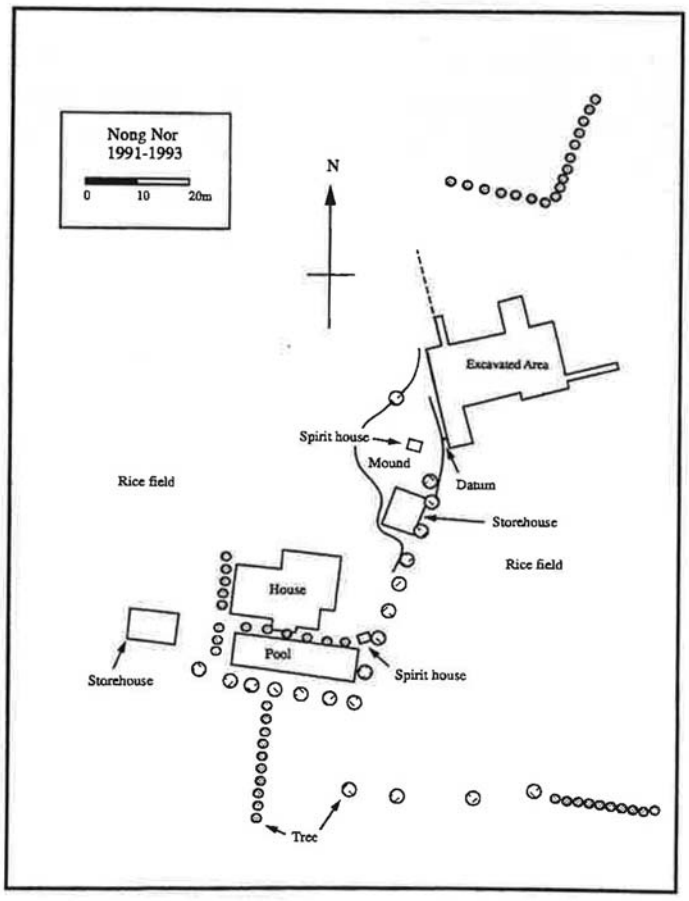


FIG. 4. The layout of the excavated area

looted area bore witness to what lay below: human remains, broken pottery vessels and shell beads. Some of the pottery resembled that from Khok Phanom Di.

Our proposal was to excavate the intact part of the mound, and test all round the site to identify its extent. In our most extravagant mood, we planned to excavate the entire site over several seasons, if it proved small enough. This would provide us with some of the information we needed to compare a non-estuarine small settlement with its presumed contemporary, on its estuary 14 km to the north. Our research would necessarily involve a team of specialists, and we were most fortunate that many of our colleagues who had worked on aspects of the Khok Phanom Di material were able to continue at Nong Nor. Nancy Tayles agreed to study the human remains, which conferred the added advantage of her participation in the excavation as well as the laboratory. Graeme Mason, likewise, was able to study the shellfish and fish remains. William Boyd joined our team to work on the geomorphology and Christine Pailles agreed to analyse the diatoms. Two graduate students, Nigel Chang and Joss Debreceny, were also introduced to fieldwork in Thailand, and continued their interest with research degrees. Dougald O'Reilly joined the group at a late stage to undertake his research programme. Again, as at Khok Phanom Di we were particularly fortunate that Amphan Kijngam and Anat Bamrungwongse were able to play critical roles in the excavation.

Our initial intention to excavate the intact part of the mound, however, was not to be. The owners steadfastly refused permission, despite intercessions on our behalf from the local police, the Nai Amphoe and the Abbot of their wat. Not only were we refused access to the mound, but we were also unable to test pit in the surrounding rice fields to track the extent of the prehistoric site. We never understood their motives. On the other hand, Khun Chup, owner of the levelled and partially looted section, willingly agreed to our research. The area ultimately excavated over three seasons is seen in figures 4-5. This might, at first, seem an odd format, but is easily understood as our research proceeded. During the 1991 season, we resolved to excavate an area of 10 by 5 m (A1 in figure 5). William Boyd also wished to excavate out from this square, two narrow trenches, to proceed for as long as necessary to define the edges of the site and relate the cultural sequence to the surrounding natural deposits (B1 and A2 in figure 5). The cultural material in A1 was not only shallow, but had been badly disturbed by looting. As we proceeded with the excavation of A2 and B1, however, we encountered less looting and intact burials protruded into the excavated areas. Consequently, we decided to open a further 5 by 5 m area, square AX1. Had we not done so, and encountered a concentration of interments and intact shell midden, we would probably not have returned to Nong Nor for a further two seasons of research.

The following season, 1992, we decided to link the area lying between the partially exposed intact burials recovered during the previous year in square A2 and square AX1. Although the southern edge had been disturbed, most was intact. It contained many burials, and the shell midden layer became progressively thicker as we proceeded to the north. At this juncture, we grew to appreciate how burials were laid out in apparent rows, while the relatively shallow nature of the cultural deposits encouraged the opening of what is, for Thailand, a relatively large area. In our 1993 season, therefore, we decided to extend further to the north and east into squares A4-7. By now, our local work force was highly skilled and motivated, and we had developed a technique for on-site analysis which again proceeded fluently. Consequently, we were able, as the season proceeded, to open more than had been envisaged. Squares A9 and 10 contained relatively shal-

low deposits and few burials, and likewise incorporated the effective edge of the shell midden deposits. In square A6, we encountered a human cranium ringed by large bovid horns and pottery vessels at the northern edge, and we therefore extended the area to include square A8 (Fig. 5). This allowed us to recover all of burial 145, but as we proceeded to the north, we encountered another cranium, and so the process was repeated to include squares A11 and A14. This was fortunate: we again tracked the edge of the midden deposits and reached, we feel, the outer northern margin of the cemetery as well. Under the direction of Nigel Chang, squares A12-13 were opened with the same result, the western edge of the burial area and a marked thinning of midden deposits.

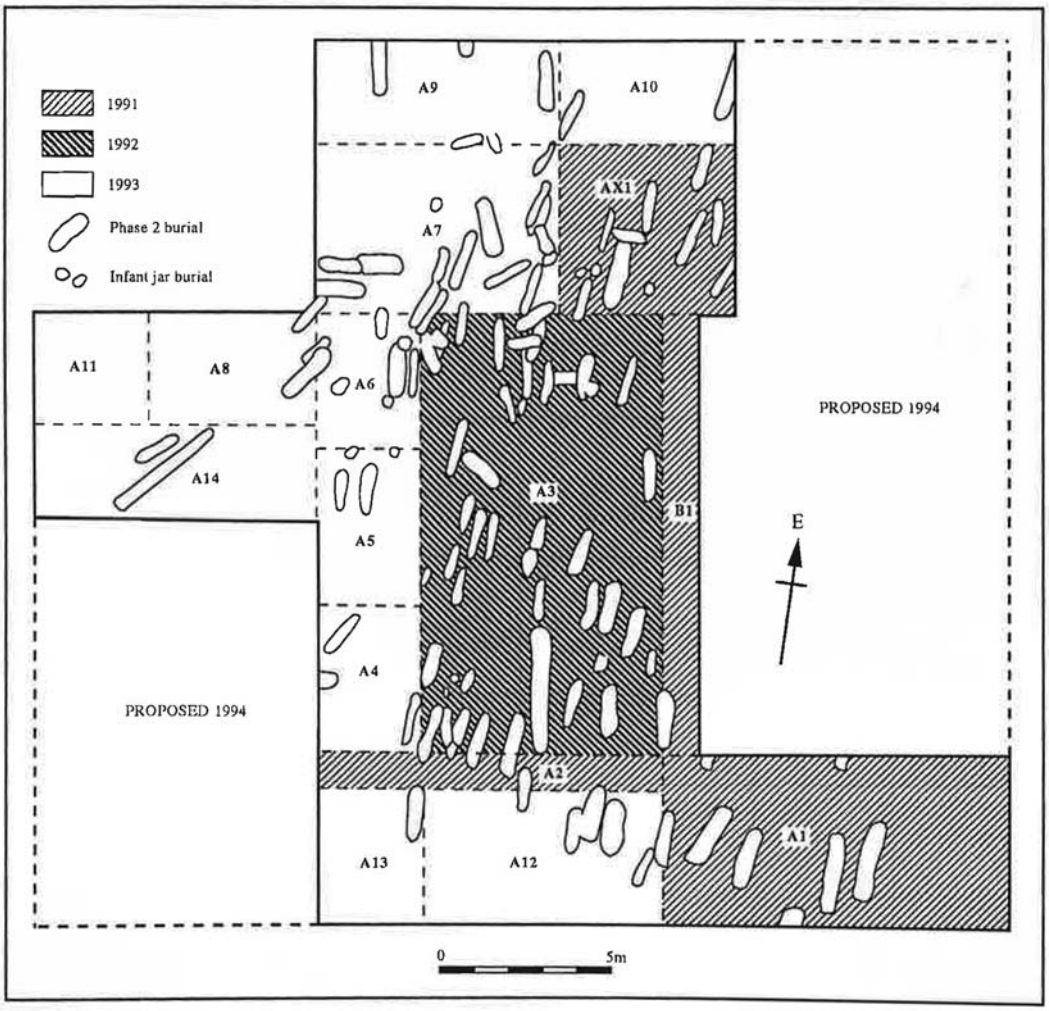


FIG. 5. The excavated area over three seasons, showing the square designations

We had planned to open two further areas in 1994 (Fig. 5). This would have produced a satisfying, almost square configuration to the excavated area, but this was not to be. Shortly after the end of the 1993 season, one of us (R.T.) was moved by the Fine Arts Department from the Bangkok to the Phimai office, effectively ruling out further involvement at Nong Nor. Since it has

always been our policy to co-direct our fieldwork, we terminated further excavation. However, we had already placed small test pits (1x1 m) over the southern area earmarked for examination, and found that the midden deposits were very shallow and then terminated, and that some looting had taken place. Although a dangerous presumption, we also felt that the northwestern segment would contain few cultural remains.

As the excavations proceeded, and we grew more familiar with the stratigraphic sequence, so we modified our research objectives. Our first season involved the recovery of inhumation burials set within a tightly compacted shell midden which comprised, almost exclusively, the remains of the bivalve *Meretrix lusoria*. In some areas of deeper deposit, the shell midden contained lenses of dark red material rich in charcoal (Fig. 6). Some burials incorporated bronze bangles. We had not then detected convincing evidence that the burials had been cut into the shell midden, and indeed in many cases, we had to remove the compacted midden with hammer and chisel, and recovered burials in the process. Our working hypothesis then was that we had encountered a coastal site, in which burials were set within the occupation deposits. Shortly after returning from the field, we obtained the first set of radiocarbon dates from basal midden contexts, and the pooled mean indicated occupation at about 2450 B.C. At that juncture, the basal cemetery at Non Pa Wai to the

FIG. 6. View of the section from Q/R 1-26

north, which also contained evidence for copper metallurgy, had been ascribed a date in the last few centuries of the third millennium B.C. (Pigott and Natapintu 1988). Much to our surprise, for Khok Phanom Di half a millennium later contained no metal, we were confronted with a bronze age site preceding the Neolithic.

One of our objectives the following year was to understand the stratigraphic relationship between these burials and the shell midden. Fortunately, the distal end of the grave for burial 47 was available for inspection by re-opening and freshly exposing the western section of AX1. This burial had been recovered during the last hours of the 1991 season, when unseasonable rain had made conditions difficult. Burial 47 underlay burials virtually cemented in place by the dense and hard shell midden. Our re-examination of the section enabled us to appreciate that the angle of individual valves and their relatively loose distribution in the burial area described a grave cut which became clearer by the minute. In this case, an early grave post-dated the shell midden. We reserved judgement on the balance of the burials, and had great difficulty with the interpretation of burial 109, one of two which intruded into the northern section. The oblique angle of the grave as seen in section made interpretation difficult and much on site debate ensued. Graeme Mason was proved correct in 1993, when we ascertained again that it was cut through the midden. This division into an early occupation and a later mortuary phase was amply confirmed once we found burials stratified in floodplain clay over the midden surface.

The 1992 season saw us seek dating contexts for these burials. Aware of the pitfalls confronting the dating of cemeteries from charcoal found near the human remains or in grave fill, we rejected all dubious samples. Within a lidded burial jar, however, we encountered charcoal remains, which were sent to the University of Waikato for dating. The result indicated a context in the early first millennium B.C. For confirmation we sent samples of human bone and rice chaff from mortuary vessels to Oxford University for AMS dating. The former proved undatable, the latter confirmed an early to mid first millennium B.C. context, perhaps extending back to 1100 B.C. Finally, we submitted a sample of shellfish to Waikato, and although not as early as the charcoal dates from the midden context, the result comfortably predated the results from the burials.

These developments fundamentally changed our objectives. Instead of a site contemporary with Khok Phanom Di, we had a site with two separate contexts, one earlier, the other later. Both merit detailed analysis and description on their own terms. To our knowledge, Nong Nor phase 1 is the only excavated third millennium B.C. site located on a former shore of the Gulf of Siam. Phase 2 is one of a small number of extensively-excavated Bronze Age cemeteries in Thailand. Both contribute to our understanding of human settlement in the lower Bang Pakong Valley. There is also, however, a much broader framework to which our research at Nong Nor contributes.

When we pondered our objectives in excavating Khok Phanom Di, we had good reason, in the form of radiocarbon dates from an earlier excavation there, to expect that that the basal layers dated from at least 4000 B.C. We also knew that rice had been recovered. In consequence, we formulated a model for the origins of rice cultivation in the coastal tropics which saw the exploitation of the wetlands behind the coastal fringe (Higham and Bannanurag 1991). This was superseded once we established that the site in fact dates from about 2000 B.C., and that cultivated rice was present from initial occupation. Subsequent archaeological research, and a re-evaluation of earlier sites, has shown that the establishment of Neolithic communities in tropical Southeast Asia south of Lingnan cannot on present evidence be taken beyond about 2300 B.C. Moreover,

the sites in question - Phung Nguyen, Non Pa Wai, Ban Kao, Samrong Sen, Ban Chiang, Non Nok Tha and Tha Kae, have in common a burnished pottery incised with elaborate curvilinear or geometric patterns infilled with dentate stamping. Kealhofer (1992) has also suggested, on the basis of her preliminary findings from phytolith cores taken from the Central Thai plain, that there was serious modification to the environment in the region of 2000 B.C., modification compatible with rice cultivation. This, it is emphasised, does not rule out earlier human induced changes to the habitat, or indeed earlier rice cultivation. But no undoubted evidence for the latter has yet been identified.

It will already be evident that hypotheses applied to Thai prehistoric sites have a short life. But based on current evidence, there is enough information to suggest that rice cultivation was undertaken in a proliferating number of lowland, riverine or coastal settlements from about 2300-2000 B.C. Khok Phanom Di is one such site and indeed the first to provide undoubted evidence that the rice was cultivated (Thompson 1996). This archaeological evidence cannot be employed without taking account of other information, particularly that provided by linguistics.

It has long been held that the present distribution of Austronesian (AN) languages can best be explained by an expansionary process which, to judge from the cognates noted by Blust (1985), would have originated at least on the island of Taiwan if not the Chinese mainland. Bellwood (1985, 1989) has suggested that this expansion originated in the context of early rice cultivation. Austronesian may, if we follow Benedict (1942, 1975), be related to the Austro-Tai languages, now spoken in parts of southern China and Southeast Asia. We have already suggested that the distribution of Austro-Tai (AT) languages might reflect an expansion of rice cultivators from the Yangzi Valley to the south (Higham and Thosarat 1994). Few would disagree that the oldest surviving languages spoken in mainland Southeast Asia belong to the Austroasiatic (AA) super family. The present distribution stretches from eastern India to Vietnam, and from southern China to the Nicobar Islands. Schmidt (1906) was the first to suggest that AA is related to AN within the Austric phylum. This proposal has long lain in a suspense account since, and few convincing cognates have been advanced to link the two (Diffloth 1994).

A new interest in languages and prehistory, with particular reference to the origins of agriculture, has been generated by Renfrew's (1987) proposal that Indo-European languages assumed their present widespread distribution in Eurasia through the gradual expansion of Neolithic agriculturalists whose original point of departure was Anatolia. On the assumption that AT and AA languages are distinct, we have suggested that there might have been more than one transition to rice cultivation, one in the Yangzi Valley over 8000 years ago which spawned the AT and AN languages, the other in coastal tropical Southeast Asia much later, which saw the expansion of those speaking early AA languages. Certainly, there are cognates for rice and aspects of rice processing which are shared between the western, or Munda subgroup in India, and the Khmer and Viet languages to the east (Zide and Zide 1976). Such a model would have Khok Phanom Di and Nong Nor close to the origins of tropical rice cultivation.

In late 1993, however, after our excavation programme ceased, Reid (1994a and b) and Blust (1996) revisited the Austric hypothesis. The former isolated shared morphemes between AN and AA, which supported Schmidt's earlier supposition. The latter explored the archaeological implications, and suggested that AA languages were introduced into Southeast Asia through the expansion of rice cultivators from the upper Yangzi region. This would have seen an early split

between Munda and Mon-Khmer sub groups, speakers of the former proceeding westward, perhaps by the Brahmaputra Valley, while the latter could have followed the course of the Mekong and Chao Phraya rivers. We were not familiar with the deep seated and early division between Munda and Mon-Khmer languages, one which does not conform with our suggestion that there was a late expansion up rivers from the coastal source of rice cultivation, and are much more comfortable with Blust's framework.

Under this hypothesis, Khok Phanom Di would no longer be seen as a possible location of a transition to rice cultivation. On the contrary, it would become a southern terminus of an expansionary process which originated in the Yangzi Valley about 8,000 years ago. This situation also puts phase 1 at Nong Nor in a new light. How does this settlement relate to Khok Phanom Di? Was it another example of an intrusive movement of agriculturalists or was it occupied by a community with local antecedents, one involved in fishing and collecting but not rice cultivation? The latter possibility recalls the many coastal midden sites on raised, fossil shorelines from Central Vietnam to Guangdong known as "coastal Neolithic" but not, to our knowledge, yielding any evidence for agriculture. O'Reilly's analysis of the Nong Nor material culture involves a comparison with that of basal Khok Phanom Di. Are the assemblages so different that cultural relationships are unlikely? Several hypotheses can be proposed.

1. Khok Phanom Di represents an intrusive group of agriculturalists. They brought an early AA language, the dog and domestic rice, and intruded into territory long occupied by communities which were sedentary over periods of at least months, possibly years. The latter subsisted on the rich coastal resources available. This hypothesis would be supported if the material culture of phase 1 Nong Nor and Khok Phanom Di are radically different. Further support would be provided if human remains revealed different phenotypes and DNA sequences. Again, the marked change in subsistence involving cultivation and the arrival of an exotic domesticate, the dog, would support a basic distinction.

2. Conversely, the initial occupation of Khok Phanom Di could have involved a community with its origins in the phase 1 context at Nong Nor and related but as yet unexcavated sites. This would be supported if the material culture, particularly nuances of ceramic form and decoration, were shown to be similar, and if the people displayed a similar phenotype and DNA sequence. In this situation, the presence in the later site of cultivated rice could reflect either a local transition to agriculture, or its adoption following contact with intrusive Neolithic groups. This last medium of exchange could also account for the presence of the exotic dog.

3. Under the third hypothesis, the initial settlement of Khok Phanom Di might represent a direct continuity in terms of both material culture and subsistence with phase 1 Nong Nor. With the passage of time, rice cultivation and access to domestic dogs might have been incorporated into the range of activities undertaken at Khok Phanom Di. This hypothesis would be sustained if the material culture of the two sites were similar, and would require a minute examination of the stratigraphic contexts within Khok Phanom Di of all evidence for the presence of demonstrably domestic rice, associated agricultural implements and the first presence of the dog.

4. Nong Nor might represent a dry season temporary occupation, in which a group exploited a marine habitat before returning to an agricultural base for the wet season agricultural round. This hypothesis would be sustained by demonstrating the presence of such agricultural bases by the middle of the third millennium B.C. in the orbit of Nong Nor, and through an examination of

the biological remains from Nong Nor, identifying only dry season indicators.

Our appreciation of the nature of the Bronze Age in Southeast Asia remains blurred, although there is now a consistent thread of evidence that copper smelting began by the middle of the second millennium B.C. Fourteen kilometres north of Nong Nor, we have exposed a large pre Bronze Age mortuary assemblage at Khok Phanom Di. The material from Nong Nor can, therefore, be viewed not only as a source of information on the social organisation of a Bronze Age community, but also as means of assessing the role and impact of bronze working compared with the preceding occupants in this valley. Do we encounter the same, or similar, mortuary tradition? Was there a marked increase in mortuary wealth with the Bronze Age? Were there any enclaves of particularly rich burials in the extensive area uncovered and are there any obvious criteria for the interment of bronzes? Again, what was copper or tin converted into during this period?

LOCATION AND STRATIGRAPHY

Nong Nor (Nor Swamp) is located in Tambon Rai Lak Thong, Amphoe Phanat Nikhom, Changwat Chonburi. On the Thai Survey Department map series L7017, it is found on edition 1-RTSD sheet 5235-IV at grid reference 377908. It lies about 500 m east of the present course of the Khlong Luang stream in a broad band of rice fields. Several other low mounds were found in this stream valley during the 1984 site survey (Fig. 2). Boyd has undertaken a detailed analysis of the site's setting and the palaeoenvironment.

Excavations over three seasons uncovered 404 m^2 Of this area, 397 m^2 comprised a contiguous part of the site, and seven test squares were excavated in order to identify the eastern edge of the settled area. In addition, many squares were excavated in the general environs, in order to assess the environment of the area when the site was occupied. The excavated area has been divided by a grid into metre squares. The north-south section will be considered initially along the axis A5-Z5 (Figs. 7 and 8). From the south, this section begins with floodplain clay the top of which has recently been cultivated for rice (layer 1). This covers a layer of compacted shell midden 20 cm thick (layer 2), and then the natural substrate (layer 3), which is described by Boyd (see below). The surface of this substrate is impregnated with much charcoal, although no visible charcoal was evident once the natural substrate was itself excavated. It is considered likely that this charcoal results from the burnoff of natural vegetation cover when the site was initially occupied. The midden, which proved to be highly compacted, contained pottery sherds, and bones from fish and marine mammals. The shell midden between A to R/S 5-6 was regularly cut into by inhumation graves, and more recently by a number of looters' pits. Until J/K 5-6 the midden remains relatively thin, but from there to the north, it grew to a depth of up to 40 cm. Between K/L 5-6 and W/X 5-6, the midden also incorporated red (Munsell 10R4/4) lenses which included much charcoal, ash and pottery. Two hearths were found at R/S 5-6, located just above the natural substrate. At this point, the natural layer dipped markedly to the north. The midden petered out at U/V 5-6, beyond which there was a thin spread of potsherds which in turn terminated at X/Y 5-6. Beyond, the floodplain clay directly overlay the natural substrate.

The east-west section runs from Q/R 1-26 (Fig. 9). The western edge of this section at Q/R 1 begins with a thin red lens which underlies the shell midden. Proceeding to the east, the section at Q/R 7 shows that the red lens lies within the shell midden, layer 2. Up to Q/R 16, the shell midden grew in thickness as at least two red lenses lie within it. At Q/R 14-15, there is a marked dip

in the layer 3, and the hollow was filled with midden and accumulated red material. This section saw very little disturbance by burials, only burial 109 offering a significant element of disturbance at Q/R 17-18. This grave was clearly cut through a red lens, and the grave fill largely comprises a loose deposit of relocated shellfish. Between Q/R 2-15, the alluvial deposit (layer 1) incorporates a distinctly dark grey, rather gritty lens in which several burials were found overlying the shell midden. The interface between basal layer 2 shell midden and the natural substrate is characterised by a lens of potsherds and fragments of both wood and charcoal. From Q/R 19, the shell midden thins markedly, and the red lens peters out.

The hollow referred to above incorporates the deepest and most complex stratigraphy encountered. Two further sections illustrate this. One covers between J/K 13-14 to Q/R 13-14, and shows the natural substrate dipping from 60 cm to 1.6 m below datum over a distance of 4 m (Fig. 10). The second section is taken between M/N 14-15 to Q/R 14-15, and shows the same dipping, together with three superimposed red coloured lenses within the shell midden (Fig. 10). There was a notable concentration of potsherds over the surface of layer 3. The angle of the lenses suggests that this hollow might have filled through use as a dump.

Alternatively, material which accumulated on the flat, southern part of the site might have been washed in by monsoon rains. The sections taken at H/I 23-24 to T/U 23-24 show how the shell deposition to the east of the excavated area was thin, rarely exceeding 20 cm, and no remains of the red lensing are apparent (Fig. 11). At the extreme eastern edge (H/I 26-27 to T/U 26-27), we find that the shell midden is hardly present other than in isolated patches. The edge of the occupied area on the northern margin incorporated another deep hollow at T/U12-13 to BB12-13, the midden deposit ending abruptly at Z/AA 12-13 (Fig. 11). The base of the hollow has a band of shell midden and of potsherds, and is filled with a series of alluvial deposits.

The extent of the shell midden, representing the first occupation phase of Nong Nor, is seen in figure 12. It is evident that the excavation reached the margins of the site in the northern, eastern and the northwestern edges. Test pits excavated to the south of the main square were designed to ascertain the southern margins of the site. The thin spread of midden material was encountered in test squares 1, 5 and 6, but not in the two southern squares, 4 and 7. It is unfortunate that we cannot trace the edge of the site to the west, but permission was not given by the owners. However, it is clear that the midden was already thinning along the entire western edge of the excavated area, and it is considered most unlikely that much remains beyond it. If this is the case, then the midden would have covered an area of about 700-1000 m^2, or 0.07-0.1 ha. This compares with areas of 0.16 ha and 0.2 ha for the coastal Vietnamese midden sites of Da But and Con Co Ngua (Bui Vinh 1991). The site might have been slightly elevated, enough to attract a later Bronze Age community for use certainly as a cemetery, and possibly as a settlement. The removal of the upper part of the mound to enable rice to be grown could have removed any settlement evidence and it is unfortunately the case that only the cemetery remains to document this second period of use. Again, the excavation in the intact portion of the mound would resolve this issue. The burials follow the general organisational principles of Neolithic and Bronze Age mortuary customs in this area. The dead were inhumed, usually on the back and with a range of associated grave goods. At Nong Nor, a series of rows can be identified, while some burials were also interred over earlier graves.

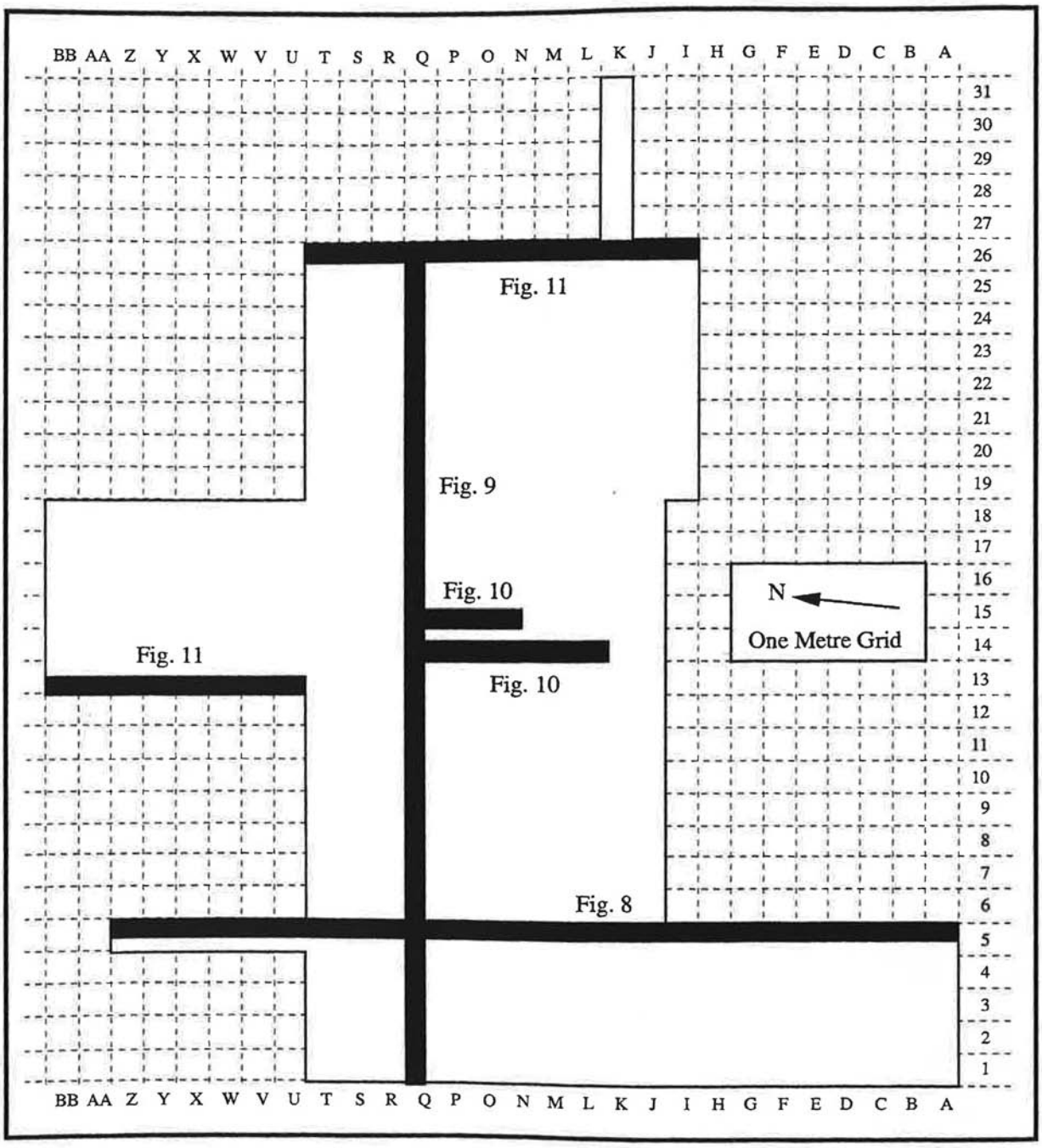


FIG. 7. The excavated area, showing the location of illustrated sections

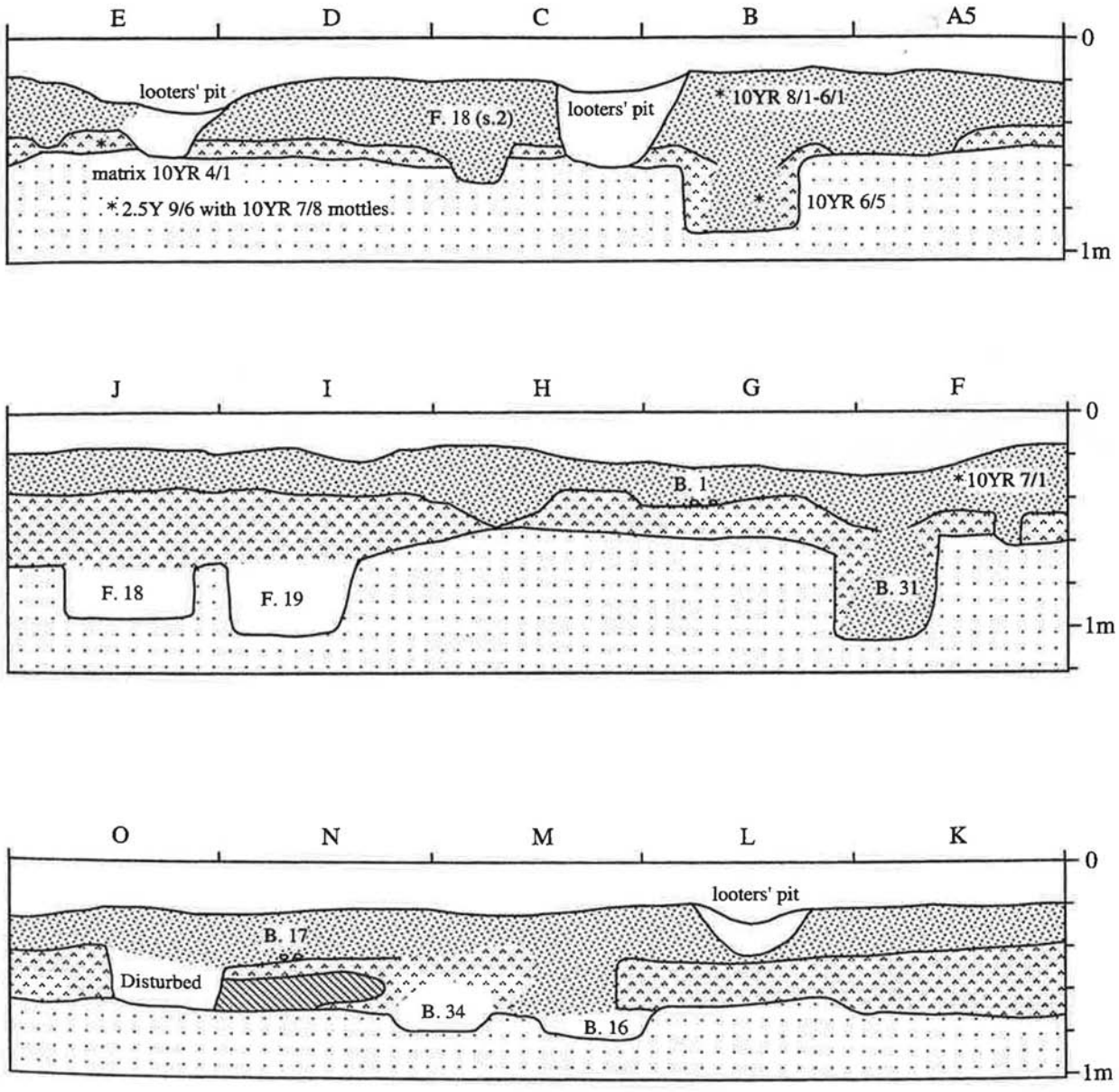


FIG. 8. The section from A5-Z5

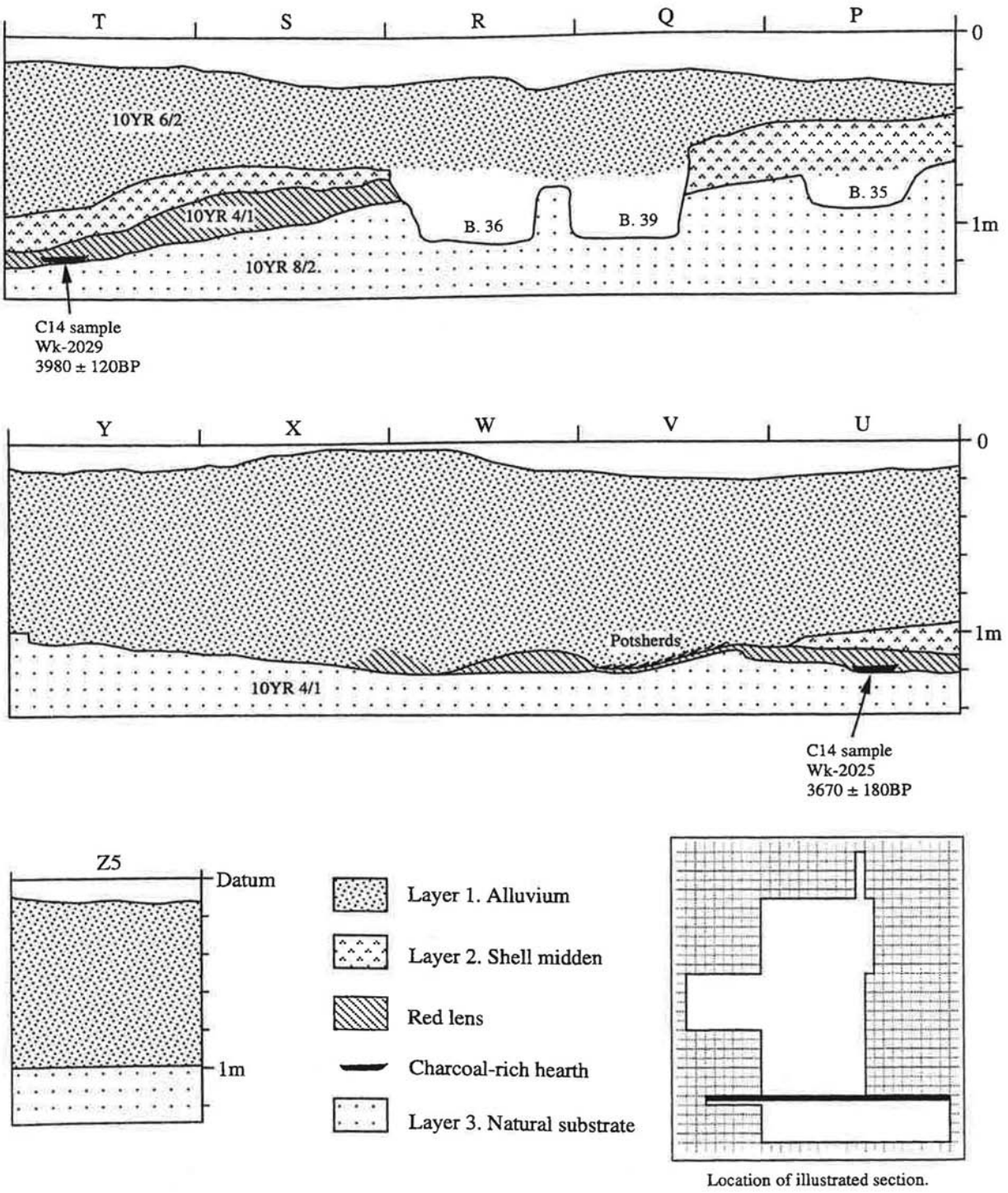


FIG. 8 (cont.). The section from A5-Z5

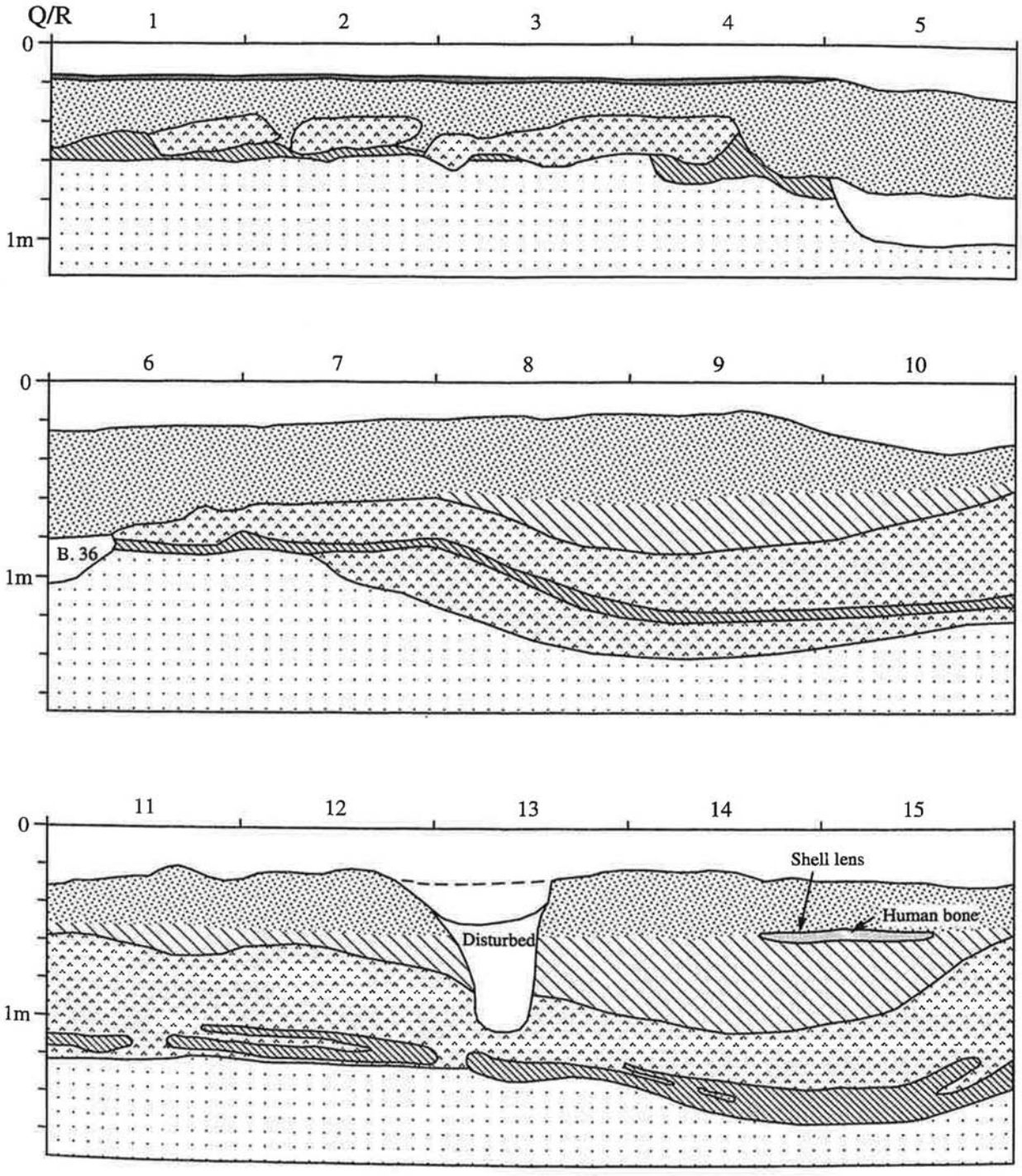


FIG. 9. The section from Q/R 1-26

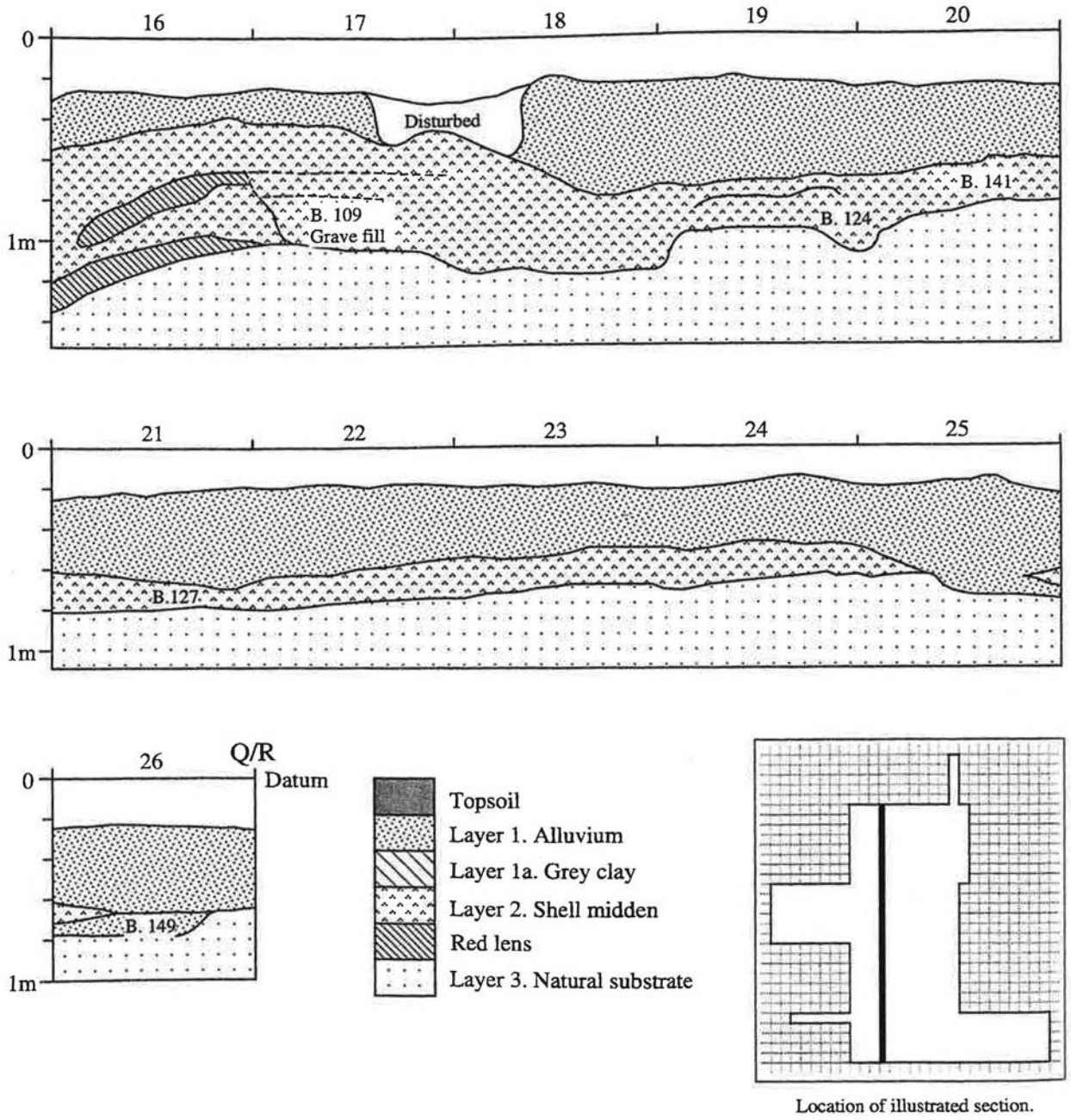


FIG. 9 (cont). The section from Q/R 1-26

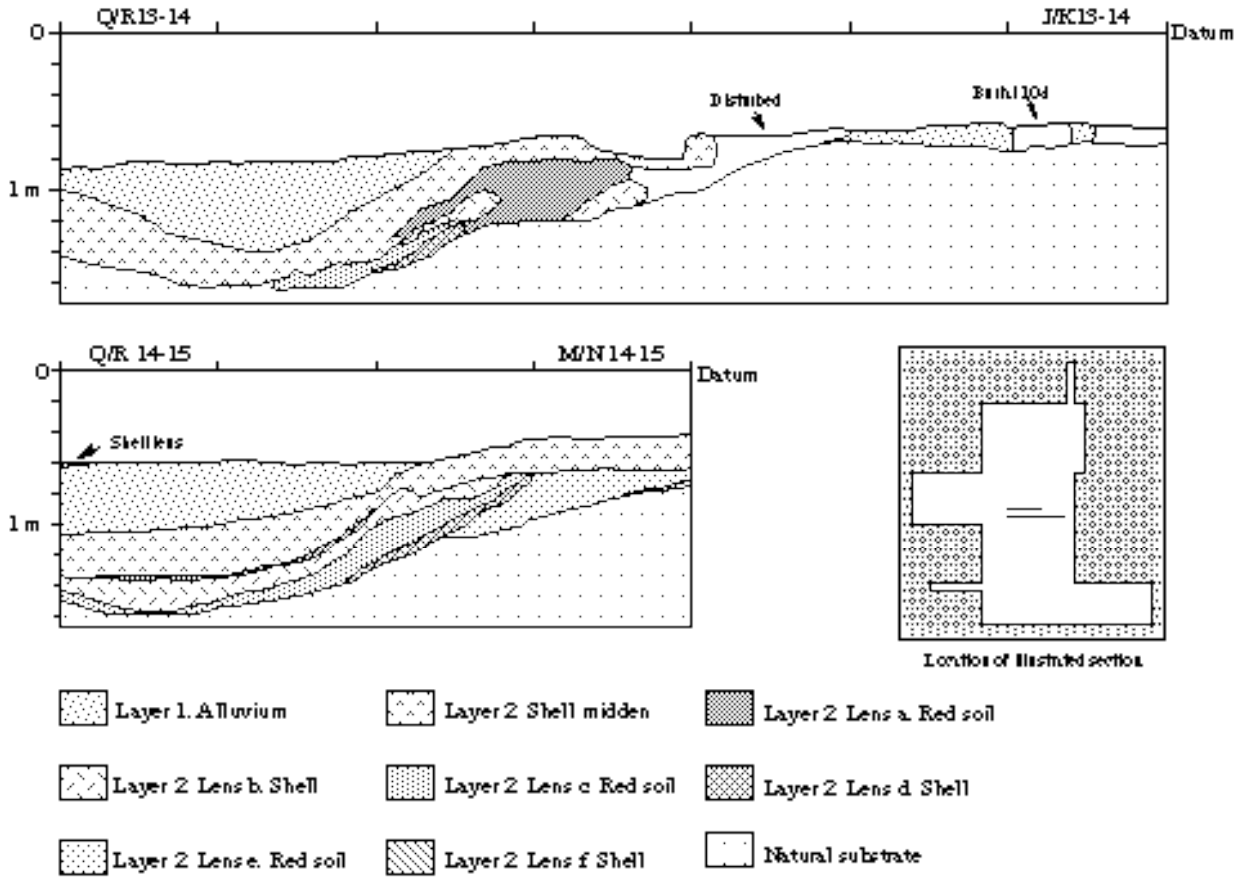


FIG. 10. The sections from J/K 13-14 to Q/R 13-14 and from M/N 13-14 to Q/R 13-14

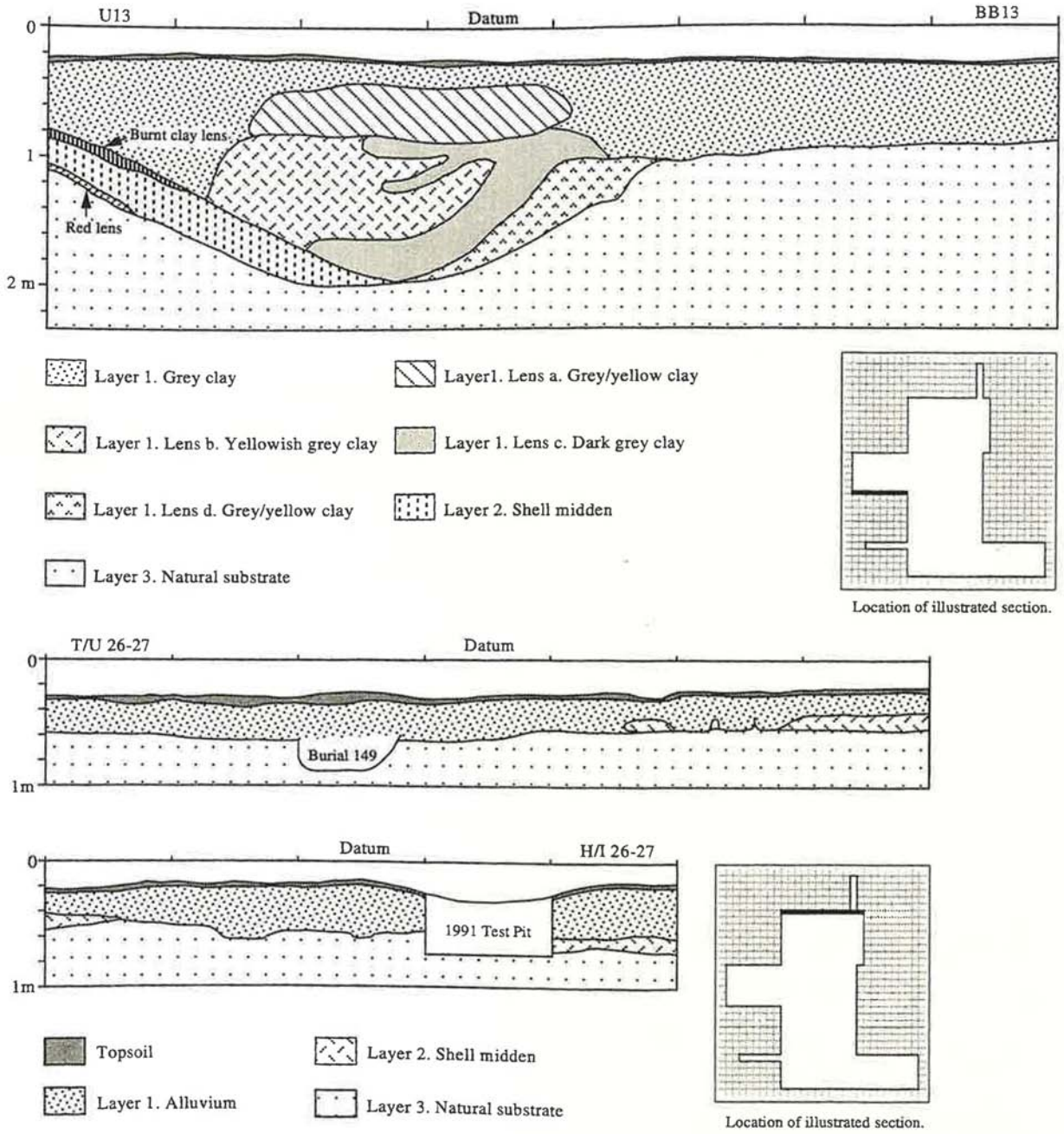


FIG. 11. The sections from T/U 12-13 to BB 12-13 and from H/I 26-7 to T/U 26-7

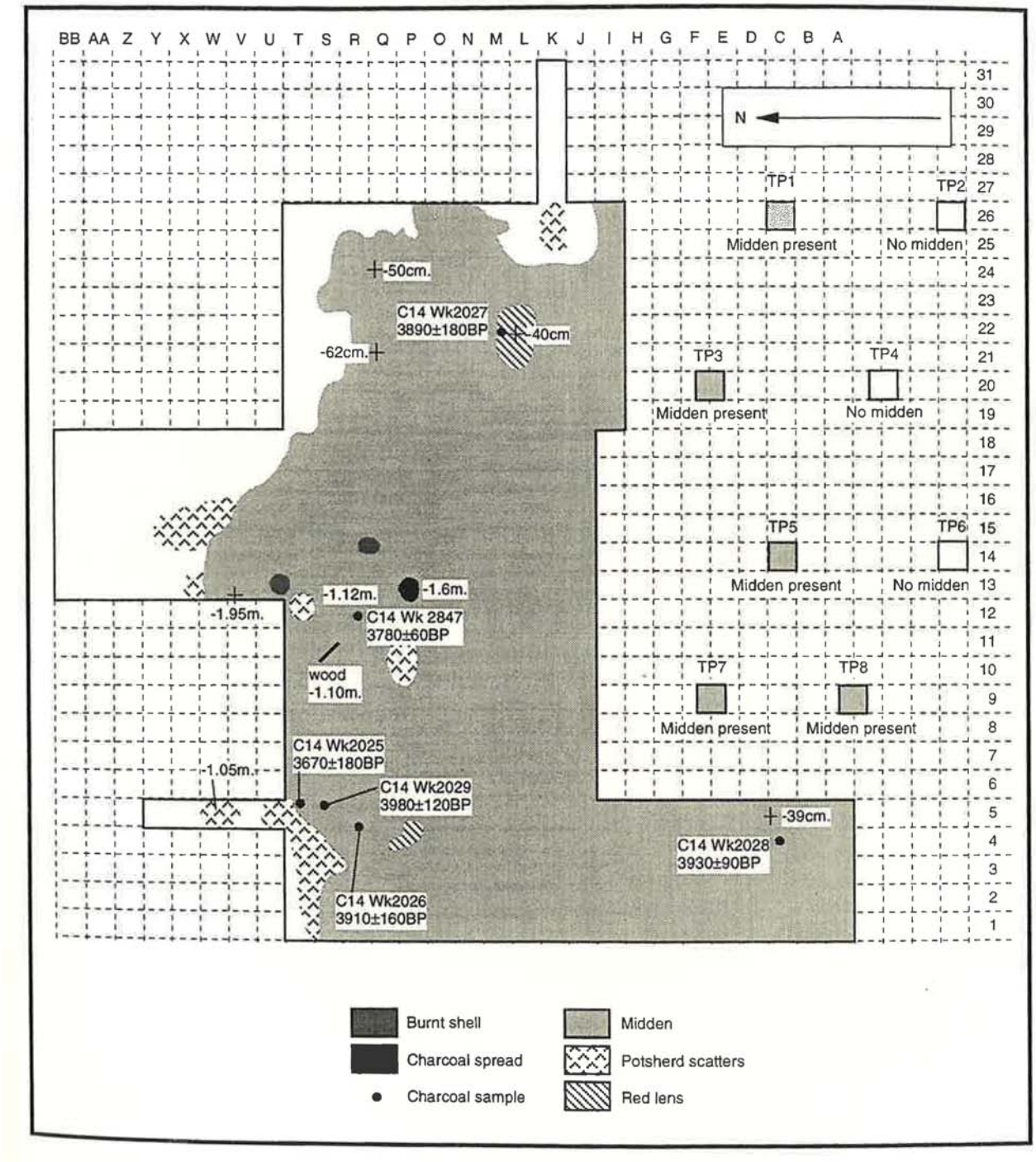


FIG. 12. The layout of metre squares, showing the extent of the shell midden and the location of radiocarbon dates from phase 1

II. THE RADIOCARBON CHRONOLOGY

T.F.G. Higham and A. Hogg

Twelve radiocarbon dates have been obtained, seven from the University of Waikato and the balance from the AMS facility of the University of Oxford. The first phase of occupation has been dated on the basis of six determinations. Three come from hearths located in the red soil underlying the shell midden (WK-2025, 2026 and 2029). Two were collected from charcoal impregnated in the surface of natural immediately underlying the shell midden (Wk-2028) and X1 (Wk-2027), interpreted by the excavators as the result of the burnoff at initial occupation. The sixth sample was derived from shell collected from the midden itself (Wk-2847). T.F.G. Higham and A.G. Hogg, who undertook the dating of this series, report as follows:

THESE samples were dated by the University of Waikato Radiocarbon Dating Laboratory (Wk) with the radiocarbon (^{14}C) signal determined by Liquid Scintillation Counting (LSC) of benzene. All determinations were performed in a Pharmacia-Wallac 1220 "Quantulus"™, which has extremely low background levels and high electronic stability, making it an ideal LSC spectrometer for radiocarbon dating. The Waikato laboratory follows the internationally accepted practice for reporting ^{14}C ages (Stuiver and Polach 1977). Thus the results are reported as the conventional radiocarbon age B.P., with respect to 95% of the ^{14}C activity of NBS Oxalic Acid 1, with sample and standard normalised for $^{13}C/^{12}C$ stable isotope fractionation (δ13C) and utilizing the Libby half life of 5568 years. The errors represent the statistical uncertainty (1σ) of standard, sample and background measurements and a laboratory error multiplier of 1.22. Calibrated ages were obtained utilising the computer program based upon the high precision dendrochronology calibrations by Pearson and Stuiver (1993) and Stuiver and Pearson (1993).

To assist in the validation and interpretation of the ^{14}C interpretations, we have (1) pretreated the samples to ensure that as far as is possible the ages are derived from the organic matter originally deposited; (2) determined stable isotope ratios ($^{13}C/^{12}C$ ie δ13C) on all samples by mass spectrometer; and (3) checked the accuracy of our measurements through involvement in the recent international cross-check coordinated by the IAEA in Vienna (Rozanski *et al*. 1992) and the TIRI programme coordinated by the University of Glasgow (Gulliksen and Scott 1994).

The radiocarbon dating programme of Nong Nor incorporated physical and chemical pretreatment designed to remove contaminants and isolate the original carbon fraction. The immediate

geological environs of the site are composed of acid sulphate soils used predominantly for rice farming. Agricultural landuse and monsoonal flooding are often associated with mobile humic and fulvic acid contamination which originate from decayed organic products. Humic acids may leach down soil profiles and become adsorbed by other materials. This affects radiocarbon age determinations because the humic component will often be non-contemporaneous. There was also evidence at Nong Nor of abundant root material within the strata of the site and the precipitation of calcium carbonate and calcium sulphate, probably derived from the overlying shell midden.

TABLE 1. *The Radiocarbon Dates from Nong Nor*

Laboratory Reference No.	Radiocarbon Age B.P.	Calibrated Age (1σ)	δ13C (‰)	Context in site
Wk-2025	3670±180	2289-1858 1847-1772	-26.7	A2 hearth
Wk-2026	3910±150	2577-2178 2166-2142	-26.7	A2 hearth
Wk-2027	3890±180	2582-2127 2080-2045	-26.2	X1 surface of natural
Wk-2028	3930±90	2558-2530 2497-2284	-25.8	A1 layer 2
Wk-2029	3980±90	2582-2396 2380-2347	-27.1	A2 layer 2
Wk-2847	3780±60	1851-1672	-5.3	A6 L. 2:1
Wk-2461	2650±100	898-777	-23.8	burial 73
OxA-3846	3040±75	1399-1191 1189-1161 1143-1136	-25.8	burial 89
OxA-3847	2785±70	1002-834	-23.4	burial 39
OxA-3848	3040±80	1401-1158 1145-1134	-24.7	burial 105
OxA-3849	2860±75	1123-913	-24.2	burial 109
OxA-3850	2680±75	900-798	-27.6	burial 75

All Waikato radiocarbon samples obtained at the site were physically pretreated. They were initially washed in distilled water and calcitic accretions and root hairs found adhering to the charcoal were removed with tweezers. Some samples were tightly bonded with calcites and were difficult to pretreat in this manner. The samples were then placed in plastic vials and air-dried at 35°C.

Acid-base-acid extractions were used to remove humic and fulvic contaminants from the collected samples. After acid washing for one hour using 10% conc. HCl, the samples were rinsed and slowly boiled for another hour in dilute (5%) conc. NaOH. They were then rinsed with distilled water, re-acidified with 10% conc. HCl and rinsed again. Finally, they were oven dried at

70°C prior to combustion.

Conventional ages, calibrated ages and stable isotope measurements are shown in table 1. The $\delta^{13}C$ measurements for terrestrial samples range from -23.8 to -27.1‰ which is entirely consistent with the -25.2‰ value for woody plants photosynthesising using atmospheric carbon. The $\delta^{13}C$ value of -5.1‰ for the shell date Wk-2847 is depleted in comparison to marine shell values (ranging from *c*. +4 to -2‰) and is closer to the range shown by riverine molluscs (Keith *et al*. 1964). There is no ΔR value for the Southeast Asian coast, so this shell date was calibrated and reservoir corrected using the marine curve (Stuiver and Braziunas 1993) with ΔR set at 0 radiocarbon years.

The terrestrial calibration data were compiled using Pearson and Stuiver's (1993) bidecadal dataset (method A) and they show that the pooled mean (A'p) of the five basal dates is 3908±58 (T'=2.18), compared with C^2:0.05=9.49 (Case II Method, Ward and Wilson, 1978:19-31). The calibrated age ranges for the mean are 2465 - 2288 (1σ) and 2561 - 2527 and 2499 - 2197 (2σ).

Dating the second, cemetery phase was not straightforward due to a lack of well-provenanced charcoal. One conventional sample came from within a mortuary vessel from burial 73, and the remaining dates come from rice chaff found as a tempering agent in pots associated with five other burials. There is a reassuring degree of consistency within these five results, given the recent development of the rice chaff dating technique, and taken in conjunction with the associated material culture, it is concluded that the cemetery falls within the period 1100-700 B.C.

SECTION TWO

THE PALAEOENVIRONMENT OF NONG NOR

INTRODUCTION

C.F.W. Higham and R. Thosarat

TO the untutored eye, Nong Nor is surrounded on all sides by a flat plain now intensively cultivated for rice. During our site survey of 1984, we concluded from the available soil maps that this area had been inundated by the sea during the Holocene climatic optimum, and that marine clays gave way to the lower terrace soils to the east and south of the site. The soil maps, however, are generalised and of little value when considering an area where there was much environmental change during prehistory as a result of the many fluctuations in sea level. Before embarking on the excavation of Nong Nor, we decided that it was essential to involve a geomorphologist with the necessary skills and an interest in reconstructing a prehistoric landscape. We were most fortunate when Associate Professor William Boyd, of the Southern Cross University, agreed to join our team in the field.

His initial concern lay in the site and its immediate environs, and we employed a small team of professional well diggers to excavate squares into the substrate. Boyd would then evaluate and sample the sedimentary sequences. We found that this was a better method than taking cores, because it was possible to descend into the squares, draw sections and take much better samples for laboratory analysis than was possible with corings.

Thereafter, Boyd expanded his areal coverage, taking advantage of any recent cuttings to consider the sedimentary sequence and take further samples. These involved fish ponds, road cuttings, canal drainage operations and where necessary, further directed excavation from our well diggers. This work was undertaken in tandem with an analysis of the air photographs. We also visited previously excavated sites, such as Khok Phutsaa and Khok Phanom Di.

By degrees, we began to appreciate how the environment evolved. It came as a revelation to us that Nong Nor during its initial occupation had been located on a prominence overlooking a broad marine embayment. A particularly telling moment came when we superimposed the sites we had found in 1984 over Boyd's reconstruction of the coast during the occupation of Nong Nor phase 1, and found that a group was located on the opposite shore of the embayment. In the field, we were directed to the slight rise in elevation, a former shoreline, and the embayment in front of us, now infilled with riverine alluvium.

In the following section, Dr Boyd takes us through each of his sequences, and then presents palaeogeographical models for the environment of the Nong Nor region. He demonstrates that anyone undertaking prehistoric research such as ours without a geomorphologist does so at their peril.

III. THE PALAEOENVIRONMENT OF THE ARCHAEOLOGICAL SITE AT NONG NOR

W. E. Boyd

THIS report presents descriptions of the natural sediments of the region which surrounds the archaeological site at Nong Nor, on the southeastern margin of the Bangkok Plain. The resulting stratigraphic sequence, containing 6 major units, provides the basis for a palaeogeographical model for the region which extends from late Pleistocene times to the late Holocene. The palaeogeographical model comprises three major phases of landscape development reflecting the evolution of landscape in this region. This development progresses from an inland undulating plain completely unlike the present floodplain, through a phase of marine inundation and coastal conditions, to the present freshwater floodplain environment. This sequence provides a geographical framework for the phase 1 occupation of Nong Nor. In particular, it is possible to describe the landscape in which the prehistoric occupants of the site lived, and the distribution of environmental resources available to them. The palaeogeographical model also places time constraints on the prehistoric occupation during phase 1 by reference to the timing of changes in past environmental processes and conditions throughout the Holocene. Finally, the palaeogeographical model provides a basis for predicting the location and ages of prehistoric sites throughout the region's landscape; in this respect, a geo-archaeological model is constructed to partition the landscape according to the potential for the presence and preservation of archaeological sites of various types and ages.

INTRODUCTION

The archaeological site at Nong Nor comprises the material remains of two phases of prehistoric occupation. The matrix of the site is a coastal midden, dating from the mid third millennium BC, which contains a series of burials which are of a later age than the period of formation of the midden. The initial expectation of the excavation of Nong Nor was that it would provide archaeological evidence for a smal settlement associated, both temporarily and socio-culturally, with the occupation of the large, very rich estuarine settlement of Khok Phanom Di, some 14 km to the north (Higham and Bannanurag 1990, 1991, Higham and Thosarat 1993). The results of the excavations at Nong Nor, however, indicate that the phase 1 occupation of this site significantly pre-dates that of Khok Phanom Di, while phase 2 is later.

This raises questions concerning the relationships between these two sites. In order to understand Nong Nor in its regional setting, a palaeoenvironmental investigation includes consideration of the relationships between the archaeological remains and the natural sediments in the region. This illuminates the physical environment into which the occupants of Nong Nor entered, within which they lived, and ultimately from which they abandoned their site. It also yields indications of the physical site processes that operated before, during and after site occupation. Essentially a site-specific palaeoenvironmental study, it also provides a broader regional palaeogeographical perspective in the form of a geographical model of the region surrounding Nong Nor. This model is detailed for the surrounding 35 km^2, but extends, in less detail, considerably further. It now allows us to place Nong Nor into a firm palaeogeographical setting, to predict the locations of further archaeological sites, and to place other known archaeological sites into a firmer geographical and temporal context.

THE SITE OF NONG NOR

Nong Nor is located on the present flood plain on the southeast margin of the Bangkok Plain, approximately 4.5 km north-northeast of the town of Phanat Nikhom, Chonburi Province, some 27 km east of the present coast of the Gulf of Siam (Figs. 1-2, grid reference $^{7}388\ ^{14}911$; 1,000 metre UTM grid, zone 47; map sheet Thailand 1:50,000, edition 2-RTSD, series L 7017, sheet 5235 IV). The area is now under wet rice cultivation, and is seasonally flooded. The site comprises the remains of a shell midden, approximately 700-1000 m^2 in area, and originally standing some decimetres above the field level, of which between 20 and 70 cm of midden thickness has survived. This lies over a natural substrate the upper surface of which appears to have been burnt, at least in places.

Regional geology

Initial field work indicated that the phase 1 cultural deposits are interleaved and related to the surrounding natural sediments. Indeed the economic analysis indicates that this was a coastal resource site, thus linking human use with the geological development of the coast during the mid-Holocene marine transgression and regression. Since phase 1 Nong Nor is integrally linked with the recent geological evolution of the landscape, it is relevant to consider its geological setting. Nong Nor lies within the upper horizons of the sediments which comprise the Bangkok Plain. The plain itself is a large embayment (*c*. 150 km across, east to west, and extending at least 250 km northwards from its present southern edge on the coast of the Gulf of Siam. This embayment represents the long-term (Pliocene-Pleistocene) sedimentary infilling of a horst and graben block faulted structural depression, within which alluvial sands and gravels, interbedded with floodplain silts and clays grading seaward into deltaic clastics and marine clays have been accumulating to thicknesses of, in places, at least 1,800 m (Nutalaya and Rau 1981:4).

The uppermost sediments of this sequence have been investigated in most detail, and are of greatest interest in this study. In the Bangkok area, for example, these comprise muddy sub-tidal shelf sediments overlying deltaic plain and front sediments, representing the marine transgression

from late Pleistocene times of relatively low sea level (the delta phase) through to mid Holocene high sea level (the shelf phase) (Jitapunkul 1982, Nutalaya *et al*. 1984). Subsequent marine regression is reflected in the thin veneer of fluvial sediments. Reviews by Somboon (1988) and Somboon and Thiramongkol (1990, 1992) of palaeoenvironmental data associated with the sediments in the central area of the Bangkok Plain contain additional detail regarding this latest phase of marine transgression and regression during mid-Holocene times, a phase during which the sea appears to have risen to approximately 2 to 4 m above the present level (the sea level changes are discussed below). Somboon (1988, Fig. 7) illustrates the sectional stratigraphical relationships between the marine clays, brackish water (coastal) and fluvial deposits across the Plain. Radiocarbon dating of sediments indicates that the area now exposed as the lower Bangkok Plain was probably inundated by the sea from before 7,800 years B.P. to after 4,600 years B.P. (Takaya 1972:319, Chonglakmani *et al*. 1983:346-347, Thiramongkol, 1987:42, Somboon 1988:205-210, Somboon and Thiramongkol, 1992:56-57).

The area under investigation in this study represents a marginal situation within the broader picture of the Bangkok Plain, lying at its southeasternmost corner, less affected by the major Chao Phraya River system, and more by the Bang Pakong or, more probably, minor rivers flowing northwestwards from the uplands to the east and south. The Bangkok Clay, the uppermost part of the embayment sediments, thins notably to this southeastern edge (Nutalaya and Rau 1981:4), where it abuts onto the rising basement of outcropping Palaeozoic metasediments and other crystalline rocks (Rau and Nutalaya 1981:145, Anon. 1982, Khantaprab and Sarapirome 1982, Chonglakmani *et al*. 1983:344, Anon. 1984). The bedrock here forms a strongly undulating peneplain of *c*. 30 m relief, lying between 10-100 m above sea level, with a surface mantle of laterites, saprolite or regolith and footslope deposits (Thiramongkol 1984). Takaya (1972:308-310, 317-319) describes the sediments along this edge of the plain, indicating that the margin is characterised by sediments of a fan complex, probably dating to the penultimate interglacial period, although there may be some younger fan sediments. The upper surface of this fan complex dips towards the northwest, and is overlain by Holocene sediments referred to as recent delta sediments, and comprising marine and fluvial sequences (i.e. equivalent to the suite of sediments described above by Chonglakmani *et al*. 1983, and Somboon 1988).

While such general statements are of some use, they provide little local detail of relevance to the specific study undertaken here. The local soil survey maps (Anon. 1972) provide further information of a slightly more local nature. In general there are two groups of soils on the plain. These appear to be equivalent either to the marine and fluvial sediments, comprising, for example, clay-rich, poorly-drained sulfic tropaquepts such as the soil no. 23, the Maha Phot type, or to the fan or similar deposits, comprising sand loam or clay gley soil oxic plinthaquults (terminology used in the soil survey follows Dudal and Moorman 1964, and Anon. 1970). The distribution of these groups of soils indicates that the spatial patterning of the sediments of various origins is moderately complex within this margin zone, despite the virtual absence of any geomorphological expression of these differing sedimentary conditions. The soils to the east and south of the study area reflect the rising land surface and exposed pre-Quaternary bedrock and its laterised surface. Such a compartmentalisation of landscape is reflected in other small-scale mapping (e.g. Okhura *et al*. 1989) where it clearly reflects the limitations of scale and provides detail which is insufficient for the purposes of a study such as the one being reported in this paper. However, in the previous absence of more detailed data, Higham has used these soil distributions to compartmentalise the

landscape in this region into areas of (i) higher terrace alluvium, (ii) lower terrace alluvium, (iii) former tidal flat (brackish deposit), and (iv) former tidal flat (marine deposit), (Higham and Bannanurag 1990).

It appears, following this classification, that Nong Nor occurs within the area of lower terrace alluvium. The use of the term "terrace" is widespread in the literature concerning the Quaternary geology of Thailand, where it is used in a variety of ways (e.g. Eiumnoh and Osathanontha 1982, Takaya and Thiramongkol 1982, Dheeradilok *et al*. 1983, Boonsener and Tassanasorn 1983, Thiramongkol 1983, Boonsener 1987). This concept appears to derive from Moorman *et al*.'s (1964) interpretation of soils and landscapes in northeastern Thailand, in which stages in the fluvial erosion of the landscape are recognised. The "terraces" include both morphological features (i.e. elevated more or less horizontal platforms) and, for some authors, sedimentary stratigraphy which characterise the different terraces. In general, there are three terraces recognised: an upper terrace of presumed Pliocene-early Pleistocene age, a middle terrace of middle to late Pleistocene age and a lower terrace of late Pleistocene to Holocene age. Subsequent studies, however, emphasise alternative, non-fluvial, processes and alternative chronological implications (Michael 1982, Boonsener and Tassanasorn 1983, Boonsener 1987, Nutalaya *et al*. 1989:96), with, in

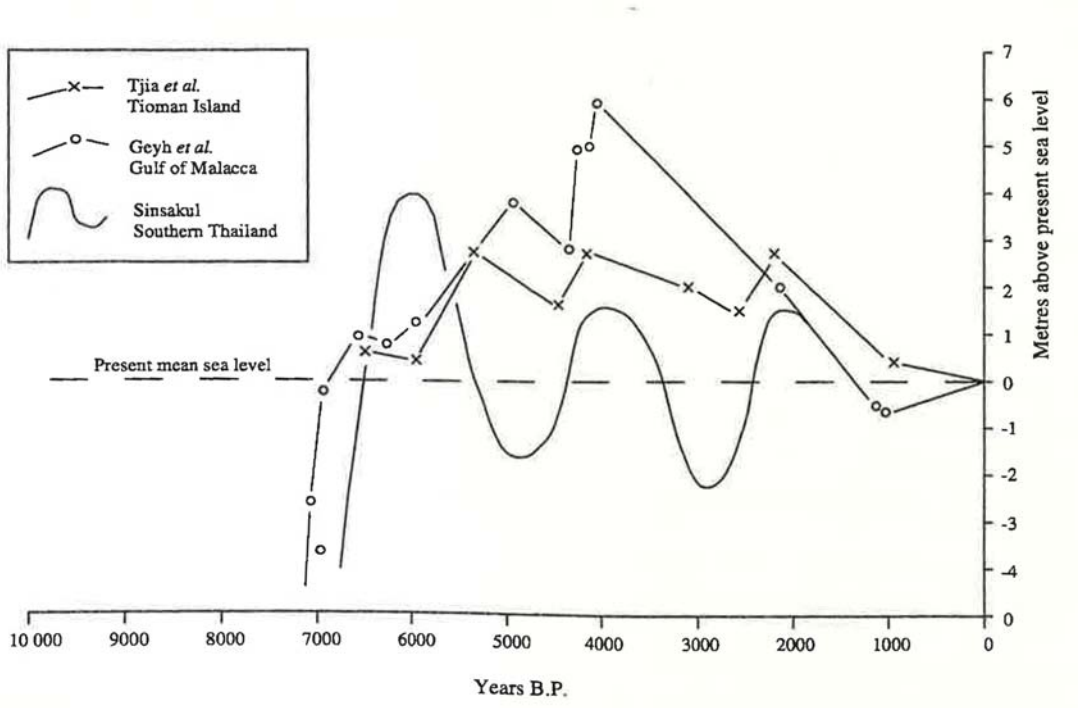


FIG. 13. Eustatic sea-level curves for the mainland Southeast Asian region. The elevation-age points plotted are after data presented by Geyh *et al*. (1979) and Tjia *et al*. (1977, 1983), whereas the lines connecting them are interpolated by the author. The line representing Sinsakul's interpretation is derived from Sinsakul (1992a)

particular, Michael's (1982) concepts of mass movement, surface wash and small stream activity rather than major river erosion providing a most satisfactory model for landscape development. A further consequence of this refocussing of interest is reflected, for example, in Nutalaya *et al*.'s (1984:147, 1989:33) reservations about the use of terraces in developing a chronostratigraphic framework, and subsequent proposal (Nutalaya *et al*. 1989) for major changes in the chronology, at least for the Northeast Plateau region of Thailand, and in Udomchoke's (1989) more recent review and replacement of the former stratigraphic model based on the terraces as a sequence of chronologically-stacked fluvial landscape elements. Although, on the basis of some of this work, the upper terrace referred to by Higham above is probably better described as being equivalent to the middle terrace (cf. Takaya and Thiramongkol 1982), it may, in fact, be best at present to avoid the use of this model of landscape compartmentalisation, since its appears that although there are some general concepts of the longer-term evolution of the landscape common throughout central and eastern Thailand, the detailed chronostratigraphies and their underlying dominant geomorphological processes are sub-regionally specific.

An integral part of this issue of sediment distribution is some understanding of the former sea level changes which occurred during the geologically-recent past (i.e. from the late Pleistocene through into the Holocene), which are, in part, responsible for the sediment deposition patterns evident in this region. While there is a general agreement that sea level rose from its last-glacial relative low level to a relatively high mid-Holocene level, probably a little above the present sea level, the details of the change are poorly understood. Somboon's (1988; Somboon and Thiramongkol 1992) sedimentological and palaeontological study of sediments around and to the north of Bangkok provide the most useful indication of the shoreline changes. Somboon (1988:209) identifies an early Holocene period of marine transgression from prior to 7,800 years B.P. (sea level has been demonstrated to have lain at *c*. 70 m below present sea level at around 11,000 years ago; Biswas 1973, Fig. 13), culminating in the shore reaching a maximum inland position between 7,500 and 4,600 years B.P., from where the sea regressed from some time before 4,600 years B.P., eventually reaching the present shoreline position (dating based on radiocarbon dates).

Although these changes, especially the regression, may have been influenced by changes other than in sea level, such as sediment infilling of the marine embayment possibly related to back barrier sedimentation - Takaya and Thiramongkol (1982:15, 93) and Thiramongkol (1984:22) provide evidence for the probable, presumed middle to late Holocene formation of sand barriers between the mid-Holocene and modern shorelines - this pattern of change suggests the details of the sea level changes. The exact heights of former sea levels are difficult to establish, especially given the tectonically-unstable nature of this region (*cf*. Baker 1993, Pirazzoli 1993). This region has been tectonically active throughout the Cenozoic (Bunopas and Vella 1983), as have neighbouring areas of coastline (e.g. Pramojanee and Hastings 1983). There is evidence for both faults themselves (Rau and Nutalaya 1980) and their continued activity throughout the Holocene as shown by the presence of unusually high-elevation recent brackish-water and tidal clays and peculiar rectilinear topographic arrangements within the plain (Takaya 1972:319, Thiramongkol 1987). These latter features indicate that recent and continuing tectonic disturbance is particularly important in the peripheral parts of the plain, i.e. in regions such as that being investigated in this study. The pattern of uplift of mid-Holocene coastal (marine) clays to heights as great as 32 m above sea level (Thiramongkol 1987:39), clearly shows that tectonic effects are highly variable laterally, and thus tectonic effects on the Holocene sediments cannot be easily predicted from

elsewhere. Lastly, surface instability is compounded by the recent sediment subsidence related to the high rate of ground water pumping, especially in the metropolitan areas (Nutalaya and Rau 1981:7-8, Chonglakmani *et al*. 1983:346-347, Somboon 1990a, 1993). Exact former sea levels in this region may, therefore, be difficult to establish with certainty. In a review of the probable sea level changes affecting this region, Maloney (1991) concluded that the most useful evidence of the sea-level changes that occurred during Holocene times is to be found in studies from beyond this immediate region, primarily from elsewhere on the Sunda Shelf and in the South China Sea. For the purposes of this study (i.e. regarding sea-level change during the Holocene) the most relevant eustatic sea-level change data are those discussed by Geyh *et al*. (1979) and Streif (1979) for the Strait of Malacca, Tjia (1980) for peninsular Malaysia, Tjia *et al*. (1977, 1983) for Tioman Island, off the east coast of peninsular Malaysia, and Sinsakul (1992a) for southern Thailand

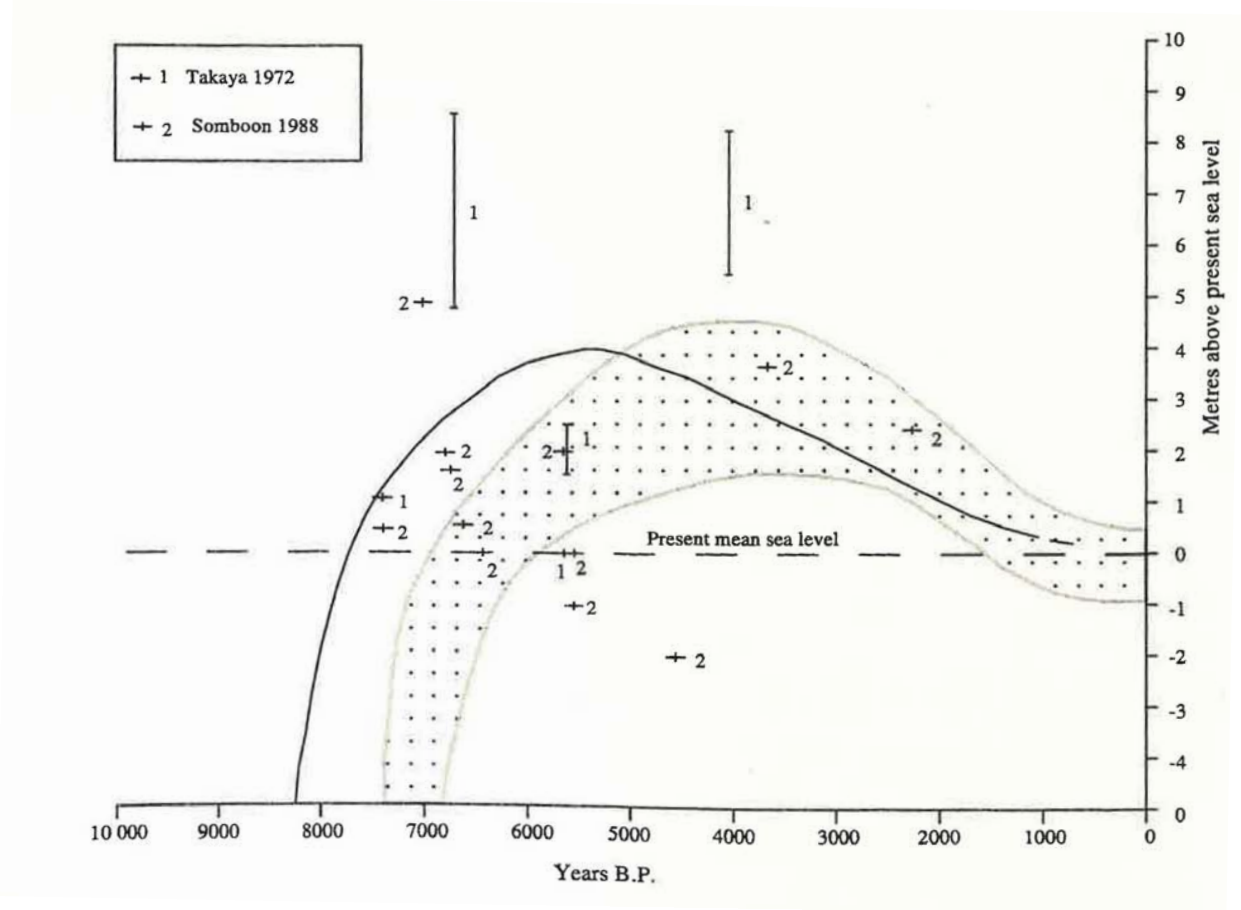


FIG. 14. Sea-level elevation-age indicators in the Bangkok Plain region. The points are plotted from data presented by Takaya (1972) and Somboon (1988). The shaded envelope includes values from Geyh *et al*. (1979) and Tjia *et al*. (1977, 1983), using Geyh *et al*.'s (1979, Fig. 13) curve smoothing, whereas the full line represents maximum values from Sinsakul's (1992a) data

(Fig. 13; see also Tjia 1987:9-11). This plot of eustatic sea level indicators suggests, as expected, a mid-Holocene sea level which is slightly higher than present, although the exact level of the sea surface is still difficult to establish. Although Geyh *et al*.'s (1979) curve implies a maximum sea level at over 5 m above present, the highest altitude dates represent terrestrial peats overlying brackish deposits. Indeed Geyh *et al*. (1979, Fig. 13) use these points to provide a smoothed sea-level curve, reaching a maximum elevation of just under 5 m above sea level. Although the form of the curve is similar to that generated by Tjia *et al*. (1977, 1983), the maximum values on the latter lie at less than 3 m above present sea level. Sinsakul's (1992a) maximum elevation lies between these estimates. Tjia (1987) argues for maximum elevations of, variously, 3 to 5 m above present. Observations from the tectonically-stable coasts of India (Brückner 1989) indicate that a lower rather than higher maximum eustatic sea level may be expected. Whatever the details, if the dated sea-level indicators presented by Takaya (1972:307-310, 315, 319) are plotted against the data from Tjia *et al*. (1977,1983) and Geyh *et al*. (1979) and Sinsakul (1992a,b), (Fig. 13), it is apparent that some form of late Holocene tectonic influence is apparent on the Bangkok Plain. While some of the marine sediment dates from radiocarbon dating of wood fragments and shells presented by Somboon (1988: table 1) and Somboon and Thiramongkol (1992: table 2) support the sea-level curve from elsewhere, others suggest that uplift of sediments has occurred since their deposition in the Bangkok Plain area (Thiramongkol 1987; Fig. 14). Radiocarbon dating of sea level change indicators is notoriously difficult (e.g. Chappell 1987:298-304), and it appears that many of the dated indicators in these studies are only indicators of marine or terrestrial conditions rather than of an exact position of sea level at any particular time.

The sediments and landforms associated with the Holocene marine transgression and regression represent only the latter stages of the evolution of landscape of this region which extends back into the Tertiary period. There are several key elements to this evolution which are relevant in the context of this study, in particular the results of various periods of weathering, soil development and erosion. The region is characterised by lateritic weathering typical of this tropical region as a whole: laterite is the chemically deposited iron pan of hydrated iron oxides which form under the ground surface close to the dry season water table level within the soil or regolith, and expresses itself in various forms of both hard concretions, in some cases forming continuous and impermeable iron pan, and loose iron-enriched soil. Various descriptions of the characteristic products of lateritic weathering in this region draw the distinction between weathering dating to the Pliocene or early Pleistocene (or possibly older), the middle to late Pleistocene, and the late Pleistocene to Holocene (e.g. Thiramongkol 1983, 1984, 1987). Thiramongkol (1987), for example, describes the peneplain developed on the hill slopes surrounding the east and southeast of the Nong Nor area as being typical of the Plio-Pleistocene lateritic weathering, and comprising deep residual deposits and thick honey-comb structured laterite. Elsewhere, notably throughout the Northeast Plateau, differences are described between types of laterite in reference to location on slopes (e.g. Pramojanee *et al*. 1984) or to the presumed age of landforms and land surfaces (e.g. Boonsener and Tassanasorn 1983; Dheeradilok *et al*. 1983); other studies are less inclined to make correlations between laterite type and landscape chronology (e.g. Boonsener 1987), and as Nutalaya *et al*.'s (1989) interpretation indicates, surface morphology and underlying stratigraphy may not be closely linked chronologically. Again, as for the "terrace" geomorphological model, it may be best to avoid the use of prior chronologies of laterite development; although some general concepts of the long-term development of laterites are common throughout central and eastern Thailand,

the details are sub-regionally specific, and must be determined in relation to the local geological history.

METHODS

The field methods adopted during two site visits (January/February 1991; February 1992) primarily comprised (i) field mapping and aerial photograph interpretation to determine the distribution of soil and sediment units in the region, (ii) excavation of sediment exposures on and around the archaeological site, (iii) examination of sediment exposures available in river banks and other cuttings, and (iv) collection of sediment samples for subsequent laboratory analysis. Laboratory analysis of sediment samples comprised sediment size analysis of selected samples, using grain separation in a nested sieve set (Lewis and McConchie 1994), and identification of the fossil pollen and diatom content following standard Quaternary palynological techniques (Berglund 1986). Identification of pollen is based on keys and pollen floras by Huang (1972, 1981), Knox (1950), Maloney (1991), Thanikaimoni (1987) and Tissot (1980), and on an unpublished key by Boyd partly based on Maloney's pollen type listing.

IV. THE PALAEOENVIRONMENT

W.E. Boyd

THE results are based first on a series of sediment sequences taken from locations at or near the archaeological site. These data are supplemented in places by the results of sediment size, grain characteristic, and fossil pollen and diatom analyses. These results have been supplemented by maps derived from the examination of aerial photographs of the region within which the archaeological site lies. The interpretative aspect of deriving maps from the aerial photographs is, in part, influenced by the results of the field survey of exposed sediment sequences.

SITE DESCRIPTIONS AND INTERPRETATIONS OF SEDIMENT SEQUENCES AND GEOMORPHIC SITES

A number of sediment sections were exposed in the area around the archaeological site (Fig. 15). Some were dug under the guidance of the author, expressly for the purpose of examining the underlying sediments, whereas others are exposures in, for example, river banks, dams and other holes being dug by local people. These sections and other sites can be grouped into several types. The main type comprises exposures of the natural sediment sequences within an area of *c*. 20 x 6 km, centred on the archaeological site, but largely within a smaller area of *c*. 6 x 3 km. The second type comprises exposures of interfingering archaeological and natural deposits at the edge of the archaeological site, while the third consists of other archaeological sites.

The locations given below are described using three descriptors. The first is a locality code, used as a locality label for each site during field work, and represents the informal codes used in the field notes. The second is a geographical descriptor which is also informal, and refers to geographical features such as place names, roads and rivers identified by local people or derived from maps. The third descriptor is the formal location statement being a grid reference based on the 1,000 m UTM Zone 47 grid (horizontal datum: Indian datum), and derived as best approximation from the 1:50,000 topographic map sheet 5235 IV (Amphoe Phanat Nikhom; edition 2-RTSD, series L7017; map information as of 1982).

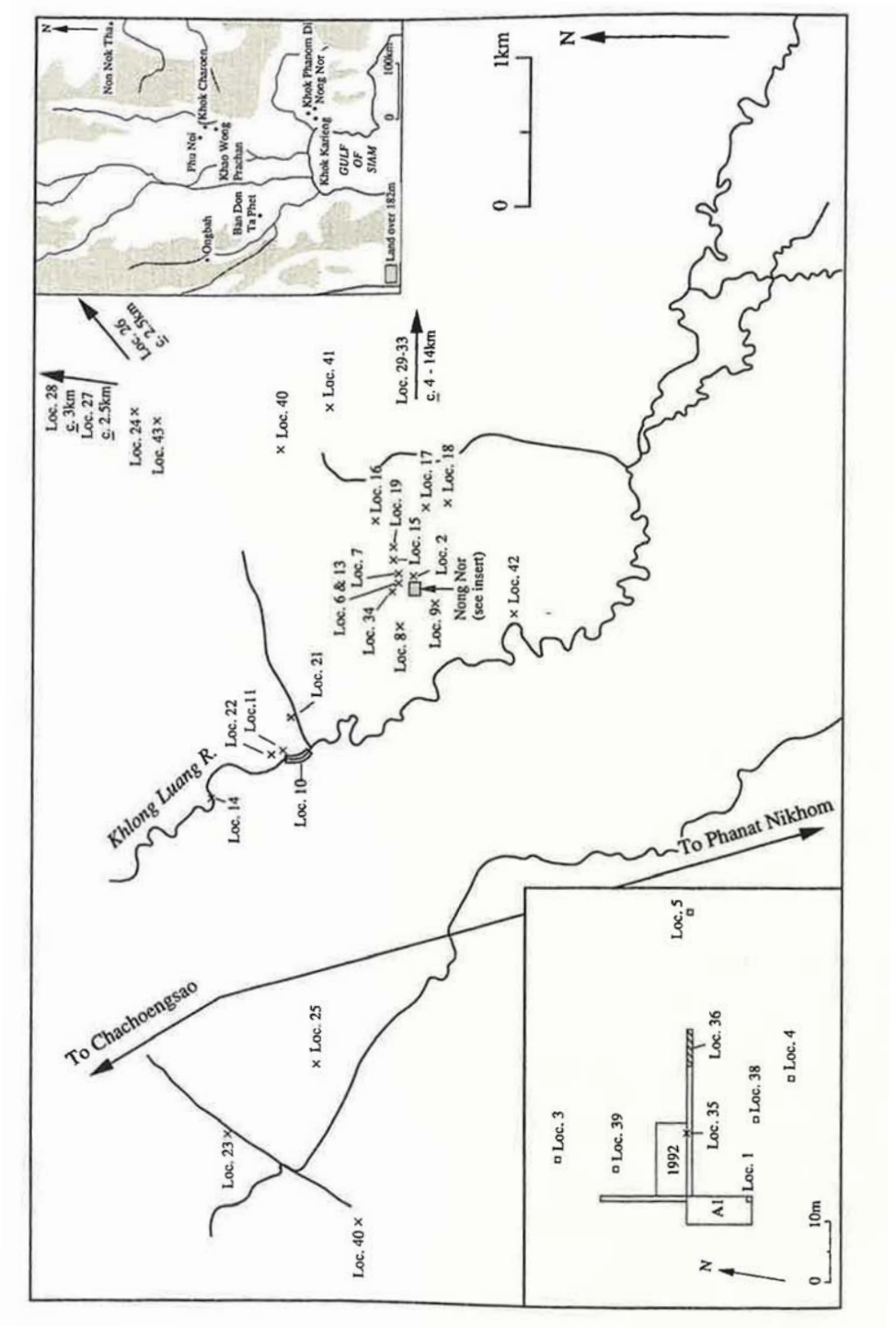


FIG. 15. Location map of the sites surveyed for the environmental investigation of Nong Nor. Location numbers refer to the inventory of sites detailed in the text

1. Exposures of natural sediments

Location 1.

Type: Excavated pit at the archaeological site.

Location: Nong Nor Pit #1, southeast corner (southeast quadrant) of excavation area A1(1991); map grid reference $^{7}378\ ^{14}911$.

Description: A 1 x 1 m pit was dug to a depth of 2.16 m, through site deposits and into the underlying substrate (Fig. 16). The sediment size and character analysis suggests that the sub-midden unit displays a coarsening-upwards sequence, with a suggestion of three discrete units, a basal unit (below *c*. 170 cm) of fine sediment, to an upper unit (above *c*. 48 cm) of mostly coarse sediment (Fig. 17). Grain sphericity and degree of roundness were also recorded; trends in these characteristics are unclear, with grains generally being isodiametric to tabular, and being angular in the lowermost two samples, rounded/subrounded in the middle section and becoming increasingly angular/subangular towards the top.

Interpretation: This sediment sequence indicates that the midden is lying on a sediment substrate upon which a lateritic type soil has developed. The degree of soil development suggests that exposure of the sediments has occurred over a long period, and it is unlikely that these sediments are Holocene in age. The results of the sediment size and grain characteristics analysis, combined with analyses from Locations 35 and 36, suggest that this substrate sediment was deposited under low energy, prograding shoreline conditions with variable amounts of reworking.

Location 2.

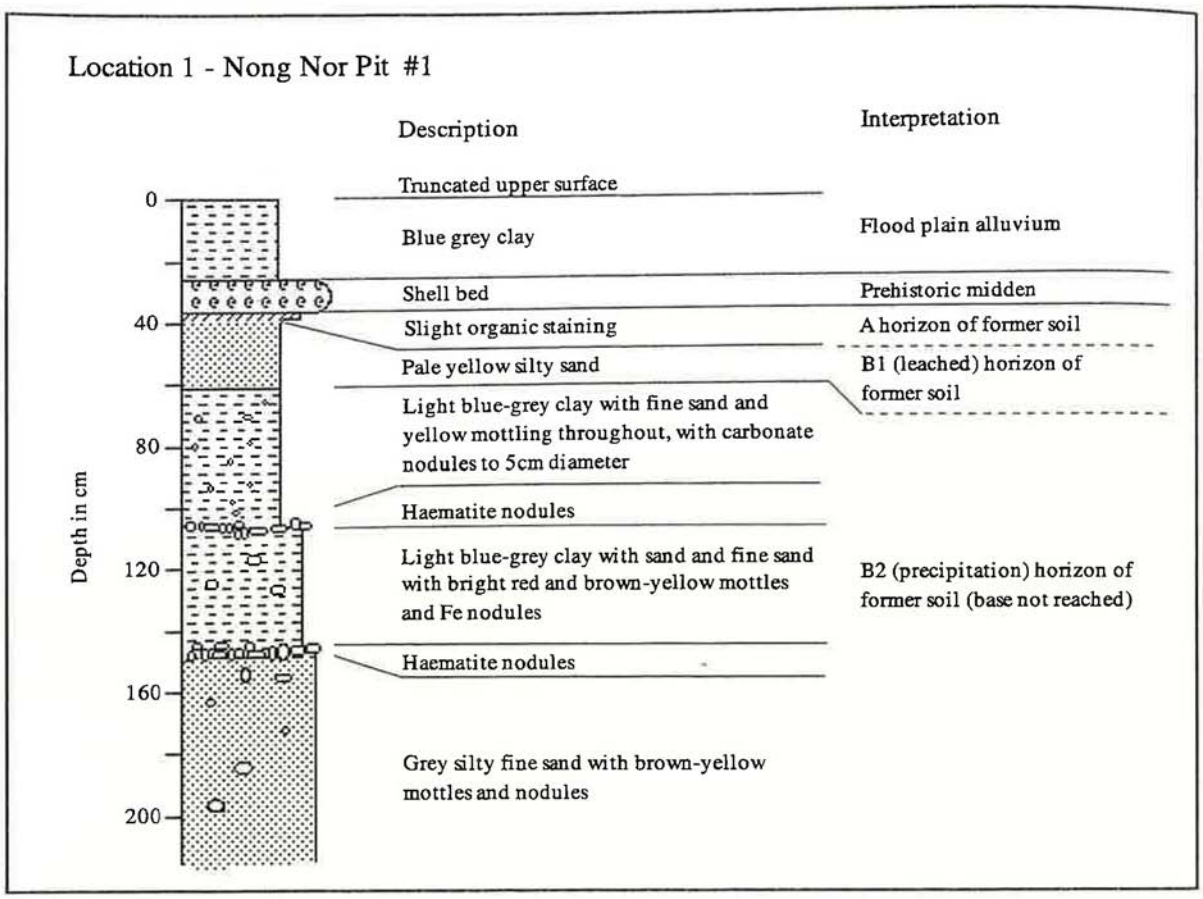
Type: Excavated pit near the archaeological site.

Location: Nong Nor Pit #2, *c*. 60 m east of end of trench B1 (Location 30); map grid reference $^{7}379\ ^{14}911$.

Description: This is a pit 1 x 1 m in plan, excavated to a depth of 3.50 m, and probed to a depth of 4.13 m below the surface, through sediments lying to the east of the archaeological site (Fig. 18). The results of pollen and diatom analysis of selected portions of the sequence are presented in table 2 and chapter VI.

Interpretation: The sediment sequence indicates that the types of sediment exposed at Location 1 under the midden are absent, and that a sequence is present of river sand, overlain by estuarine clay and, uppermost, freshwater clay. The pollen analysis is limited due to the extremely poor preservation conditions represented in these sediments, and the diatom analysis is also limited, although to a lesser extent, due to poor preservation (Pailles, this volume). Nevertheless both lines of evidence indicate that the basal dark grey clays at *c*. 300 - 240 cm depth were deposited under estuarine or coastal water conditions. The pollen data indicate the close proximity of mangrove forest to the site, with nearby dryland vegetation being dominated at this time by dry woodland and open coastal communities. Although the pollen data are sparse, comparison with Somboon's (1990b) account of the palynological representation of modern Thai mangrove vegetation in the Gulf of Siam indicates that the lowest sample (292-3 cm) may represent immediately off-shore conditions, and that the uppermost sample probably represents upper and supra-tidal transitional swamp. The middle two samples best represent open mangrove woodland at the lower tidal limits.

Such a sequence accords well with the rest of the sedimentological interpretation and the suggestion of shallowing upwards is supported by the diatom evidence.



Six AMS radiocarbon dates have been obtained from the Australian Nuclear Science and Technology Organisation AMS facility, based on slight quantities of fine charcoal recovered from the alluvial and estuarine sediments. The dates are reported with δC13 values of -25.00‰ assumed and all are calibrated at 1σ. The lowest sample, from a depth of 2.97 m, dates the pre-mid-Holocene sand and gravel alluvium: OZA722 4870±440 B.P., cal. 4092-3075 B.C. Four samples date the mid-Holocene estuary: 2.73 m, OZA723 3790±120 B.P., cal. 2405-2031 B.C.; 2.57-2.60 m, OZA721 3860±80 B.P., cal. 2459-2148 B.C.; 2.54-2.55 m, OZA720 4050±70 B.P., cal. 2622-2468 B.C. and 248-250 m, OZA719 4010±80 B.P., cal. 2611-2457 B.C. The sixth sample dates the basal Holocene floodplain formation at a depth of 2.46-2.5 m, OZA718 3869±60 B.P., cal. 2457-2203 B.C.

In discussing these dates, it is noted that the lower boundary of the estuarine sediment at location 7 (pit 8) has been dated (Wk-2462) at 3770±70 B.P. (radiocarbon years; δC13 = -28.2‰). This is a statistically overlapping date to the lower two dates at Location 2. The dates of the upper

TABLE 2. *Results of pollen analysis of sediments from Location 2*

Pollen and spore type	Sample depth (cm)			
	292-293	287-288	283-284	223-224
Trees, shrubs & climbers (excl. mangroves)				
cf. *Acalypha*	-	-	5	-
cf. *Alyxia* comp.	-	4	1	-
Ardisia comp.	-	5	-	-
Betulaceae	-	1	4	-
Celtis	-	3	5	-
Heritiera	-	-	1	-
Rutaceae cf. *Euodia*	-	3	-	-
Moraceae type	-	13	18	3
Myrtaceae cf. *Eugenia*	1	-	-	-
Pandanus	-	-	1	-
cf. *Polyalthia* comp.	-	1	-	-
Vaccinium	-	4	10	-
Sum: Trees, shrubs & climbers	1	34	45	3
Mangrove trees				
Avicennia cf. *A. alba*	-	3	5	-
cf. *Brownlowia*	-	1	3	-
Bruguiera cf. *B. cylindrica*	-	1	8	-
Ceriops	-	3	4	5
Lumnitzera	-	2	-	-
Phoenix paludosa	-	4	1	-
Rhizophora; cf. *R. mucronata*	-	31	31	-
Sonneratia alba	-	5	4	-
Xylocarpus	-	26	16	-
Sum: Mangrove trees	0	76	72	5
Herbs				
Chenopodiaceae	-	10	1	-
Compositae (Liguliflorae type)	-	-	1	-
Crinum type	-	1	-	-
Cyperaceae	-	-	1	1
Gramineae	3	12	2	-
Liliaceae (3 types)	-	1	7	-
Ranunculaceae cf. *Clematis*	-	2	-	-
Rosaceae cf. *Agrimonia*	-	2	-	-
Solanum	-	1	1	-
Sum: Herbs	3	29	13	1

Table 2 *(cont.)*

Pollen and Spore type	Depth (cm)			
	292-293	287-288	283-284	223-224
Ferns & fern allies				
Lycopodium clavatum group	-	-	7	-
Monolete fern spore types	1	8	12	-
Trilete fern spores types	-	4	2	-
Sum: Ferns & fern allies	1	12	21	0
Unidentified				
Identity not established	-	2	-	-
Damaged beyond recognition	7	36	27	8
Sum: Unidentified	7	38	27	8
Total identified pollen	5	151	161	9
Total pollen counted	12	189	188	17
Proportions of main pollen groups as % of total pollen counted				
Trees, shrubs & climbers (excl. mangrove trees)	8%	18%	24%	18%
Mangrove trees	0%	40%	38%	29%
Herbs	25%	15%	12%	6%
Ferns and fern allies	8%	6%	11%	0%
Unidentified	58%	20%	14%	47%
Total pollen undamaged	8%	36%	0%	24%

The condition of pollen preservation is generally very poor, this being reflected in the low counts, few samples analysed and the tentative identification of some pollen types (labelled "cf."). The use of the term "comp." follows Maloney's (1991) usage. The proportional values given in the final rows of the table are only indicative, especially given the low counts of identified pollen in the samples

two estuarine sediment samples at Location 2 are statistically identical and slightly older than the lower two, suggesting some reworking of carbon within the estuary. All five dates overlap at 2σ. Also, the uppermost reported date is from a sample at the very base of the overlying floodplain alluvium, and is statistically identical to the lower estuarine dates, suggesting a very short period of estuarine conditions at this locality. Both the dates and the short duration of estuarine conditions are supported by the radiocarbon dating of the midden phase at the site, where the dates provide a pooled mean of 3908 ± 58 B.P. (Higham and Hogg page 25). This compares with a pooled mean of 3957±43 B.P. for the four AMS dates derived from estuarine clay at location 2.

It is clear that the initial occupation phase of Nong Nor took place during the period when estuarine clays were being deposited adjacent to the site.

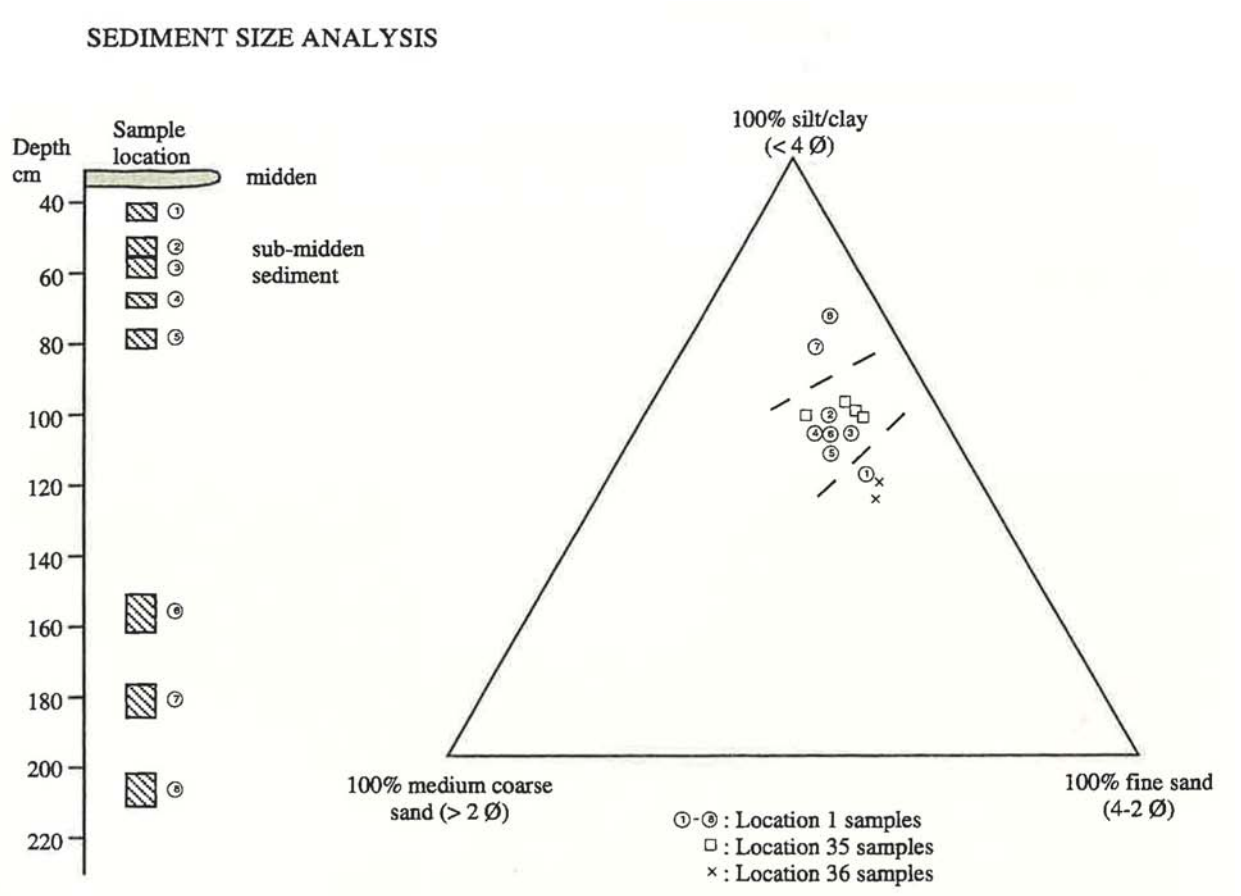


FIG. 17. Size analysis of sediments at Location 1

Location 3.

Type: Excavated pit at the archaeological site.

Location: Nong Nor Pit #3, 18 m north of northerly limit of 1992 excavation; map grid reference $^{7}378\ ^{14}911$.

Description: This is a 1 x 1 m pit, excavated to a depth of 2.20 m below the surface, and dug close to the archaeological site to assist in determining the location of its northern edge (Fig. 19).

Interpretation: The sediment sequence represents flood plain alluvium, as recorded in the uppermost 2.5 m of the sequence at Location 2, overlying site-substrate sediments such as those recorded below the midden at Location 1.

Location 4.

Type: Excavated pit at the archaeological site.

Location: Nong Nor Pit #5, *c*. 20 m south of southerly limit of 1992 excavation; map grid reference $^{7}378\ ^{14}911$.

Description: This is a 1 x 1 m pit, excavated to a depth of 2.60 m, and cored to a depth of 4.20 m below the surface, dug close to the archaeological site to assist in determining the location of its southeastern edge (Fig. 20).

Interpretation: The sediment sequence represents lower river sediments comprising angular siliceous grains, overlying sediment equivalent to that underlying the midden at Location 1, which have probably been truncated. The river sediments are overlain by freshwater flood plain fine-

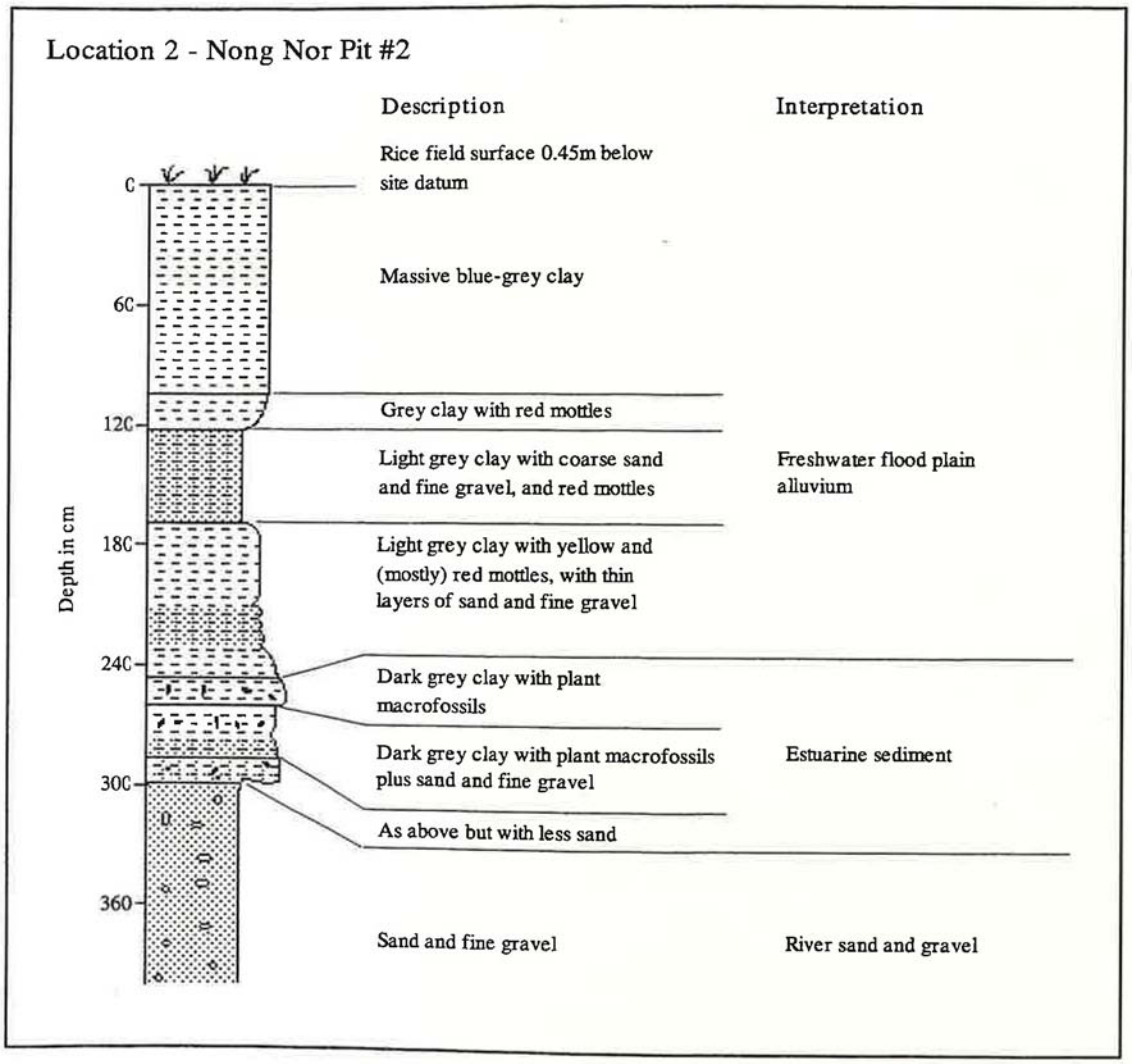


FIG. 18: Lithology of the sedimentary sequence at Location 2

grained alluvium.

Location 5.

Type: Excavated pit at the archaeological site.

Location: Nong Nor Pit #6, 38 m east of easterly limit of 1992 excavation; map grid reference $^{7}378\ ^{14}911$.

Description: This is a 1 x 1 m pit, excavated to a depth of 2.70 m, and augered to a depth of 3.88 m below the surface. The pit was dug close to the archaeological site to assist in determining the location of its eastern edge (Fig. 21).

Interpretation: The sediment sequence represents a basal unit of river sand and gravel with some overbank deposits of clay-rich sediment, and an upper unit of freshwater flood plain clay. The boundary between these is unconformable, with hollows in the upper surface of the sand unit being infilled with a dark clay and organic material similar to that interpreted at Location 2 as being estuarine sediment.

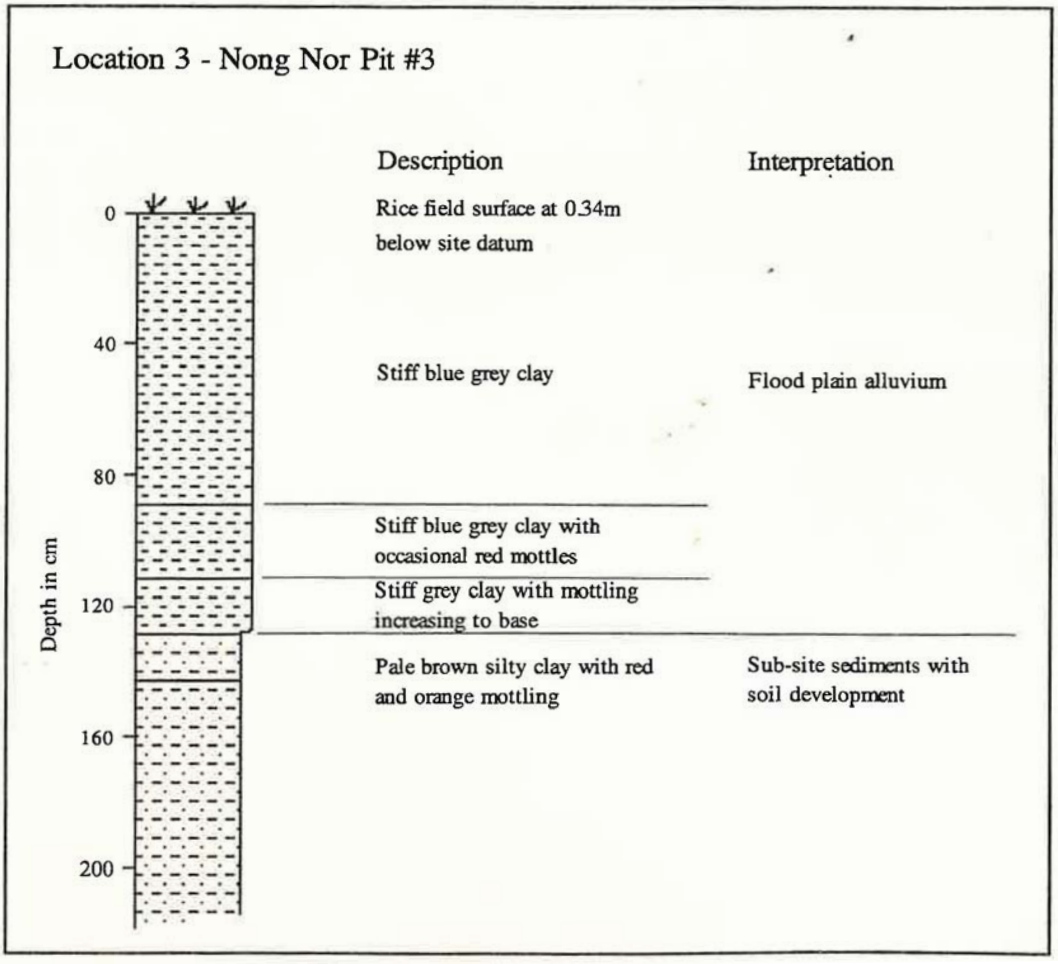


FIG. 19. Lithology of the sedimentary sequence at Location 3

Location 6.

Type: Excavated pit at the archaeological site.

Location: Nong Nor Pit #7, next to water hole to north of site (Location 13); map grid reference $^{7}379\ ^{14}912$.

Description: This is a 1 x 1 m pit, excavated to a depth of 3.59 m (Fig. 22).

Interpretation: The sediment sequence represents a basal unit of river sand and gravel, overlain, probably unconformably, by probable estuarine clays with organic inclusions, which is further overlain by freshwater flood plain clays. A provisional AMS radiocarbon age of *c*. 3800 B.P. is available for a sample of the estuarine sediments.

Location 7.

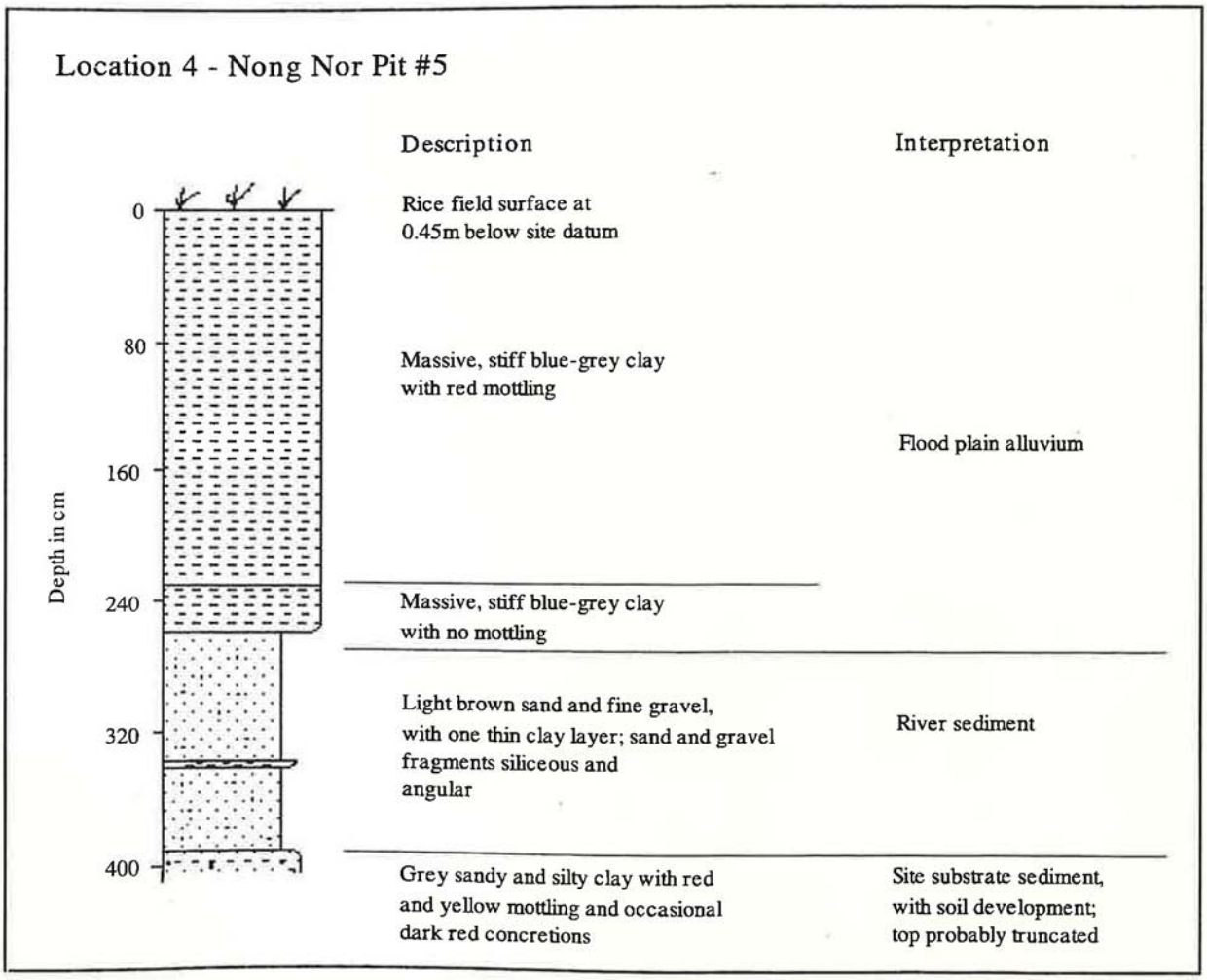


FIG. 20. Lithology of the sedimentary sequence at Location 4

Type: Excavated pit at the archaeological site.

Location: Nong Nor Pit #8, at eastern boundary of field containing the site; map grid reference $^{7}380\ ^{14}912$.

Description: This is a 1 x 1 m pit, excavated to a depth of 3.11 m (Fig. 23). One sample of fossil wood from the discontinuous woody organic layer at the base of the presumed estuarine sediment yields a radiocarbon age of 3770 ± 70 B.P. (Wk-2462).

Interpretation: The sediment sequence is very similar to the sequence at Location 6, and represents a basel unit of of river sand and gravel, overlain by estuarine clays with organic inclusions, which is further overlain by freshwater flood plain clays. As at Location 6, the boundary between the river sand and gravel unit and the estuarine unit is probably uncomformable. The lower boundary is dated 3770 ± 70 B.P., indicating a calibrated date at 2 sigma of 2451-1976 B.C. for the onset of coastal conditions at this location.

Location 8.

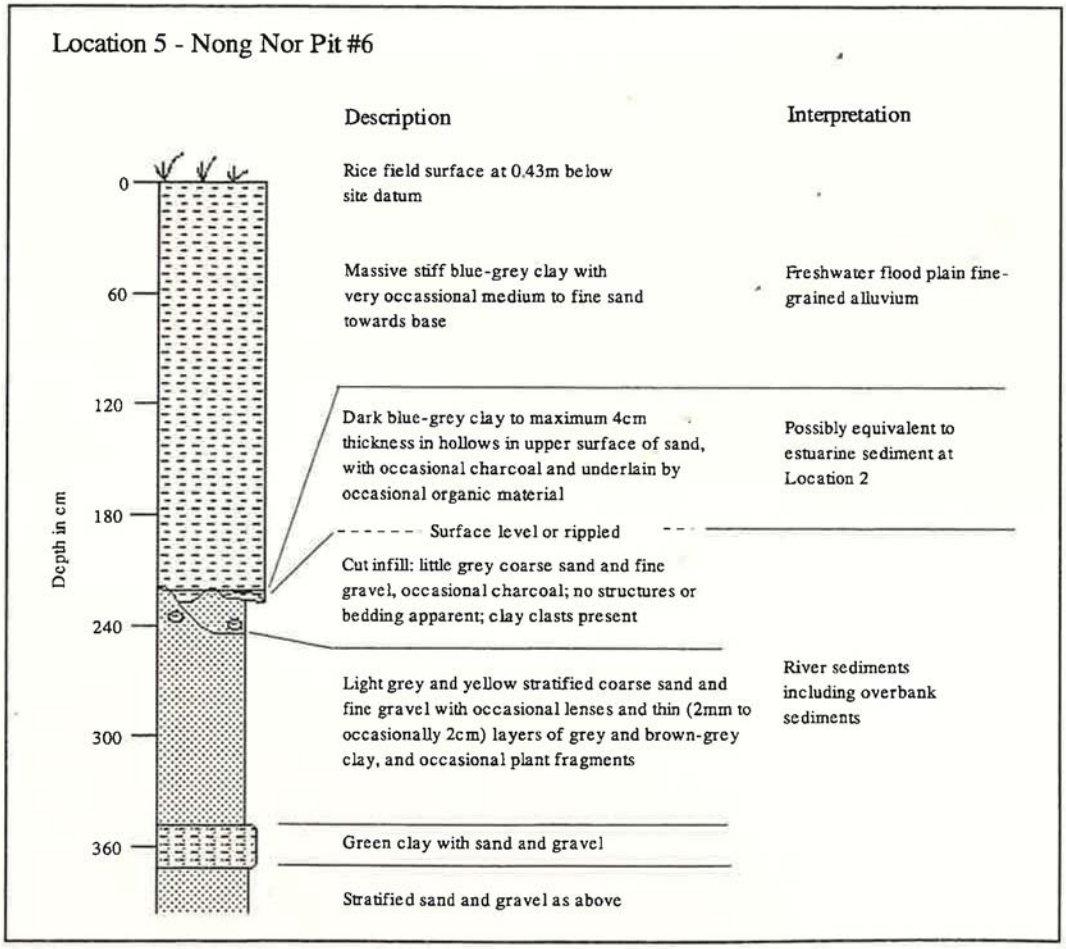


FIG. 21. Lithology of the sedimentary sequence at Location 5

Type: Water hole, *c*. 20 x 5 m in plan, *c*. 4 m deep.

Location: *c*. 250 m northwest of Nong Nor archaeological site; map grid reference $^{7}376\ ^{14}912$.

Description: A newly-excavated water hole, *c*. 20 x 5 m in plan, and 4 m deep, sides with a gradient of around 70°. Sediments were freshly exposed on three of the four sides, and on the fourth (the south face) were obscured by slumping (Fig. 24). Observation of these was from the edge of the hole, due to the steepness of the exposures, and thus the vertical measurements given are estimates.

Interpretation: These exposures represent the sediment which underlies the archaeological site, with its development of soil profile, overlain, unconformably, by freshwater flood plain clay deposits. The upper surface of the lower unit is notably non-horizontal, and appears to dip towards the SW or WSW. This surface may represent a pre-flooding land surface, although there is no obvious evidence for an organic A horizon; a B1 horizon and probably the upper parts of a B2 horizon are evident in this lower unit.

Location 9.

Type: Water hole, *c*. 20 x 5 m in plan, 4 - 4.5 m minimum depth.

Location: *c*. 150 m southwest of Nong Nor; map grid reference $^{7}377\ ^{14}910$.

Description: This is a newly-excavated water hole, *c*. 20 m (north-south direction) by 5 m in plan, and 4-4.5 m deep, with the sides having a steep gradient of similar value to that observed at Location 8. Observation of the sediments exposed in this water hole was, as for Location 8, from the edge of the hole, due to the steepness of the exposures, and thus the vertical measurements given are estimates. The sediment sequence comprised predominantly silty clay with mottles, with a similar appearance to the basal unit at Locations 1 and 8, overlain by a thin (10 - 20 cm) layer of blue clay such as occurs at the top of the sequence at Location 8.

Interpretation: This sequence represents similar conditions to those indicated for the Location 8 sequence, i.e. freshwater flood plain clay overlying a probable land surface, or remains of one, on older sediments of undetermined origin upon which soil development has occurred.

Location 10.

Type: Canal (*khlong*) banks during re-excavation to clean it out.

Location: Khlong Luang at Wat Luang; map grid reference $^{7}365\ ^{14}919$ to $^{7}365\ ^{14}921$.

Description: This is a long (*c*. 250 m) section, exposed in both banks, during the dredging and clearing of the canal channel. Access to the sediments was largely impossible due to the treacherously muddy conditions around these excavations, although access was gained at one locality at the south end of the section. 50 m north of the south end of the exposure, *c*. 1 m of moderately well-sorted, and in some places moderately coarse-grained, more-or-less horizontally-stratified yellow quartz sand underlies *c*. 2 m of fill. This sand unit becomes increasingly clay-rich towards the top. The exposure, while in most places being parallel to the line of the canal, at the southern end of the cleared section lies across the canal, being *c*. 15 m long. Where this occurs, at the centre of the exposure the sand unit exhibits at least 3 fining-upwards cycles, with *c*. 10 cm of sand overlain by *c*. 5-10+ cm of light grey clay in each cycle; in some places more cycles are evident. This sand unit extends some 140 m downstream (i.e. northwards), being up to 1.5 m thick, but

thinning out and being replaced by the clay beds which occur within the fining-upwards cycles further upstream. This, now clay-rich, unit is exposed for a further *c*. 60 m downstream, and ap-

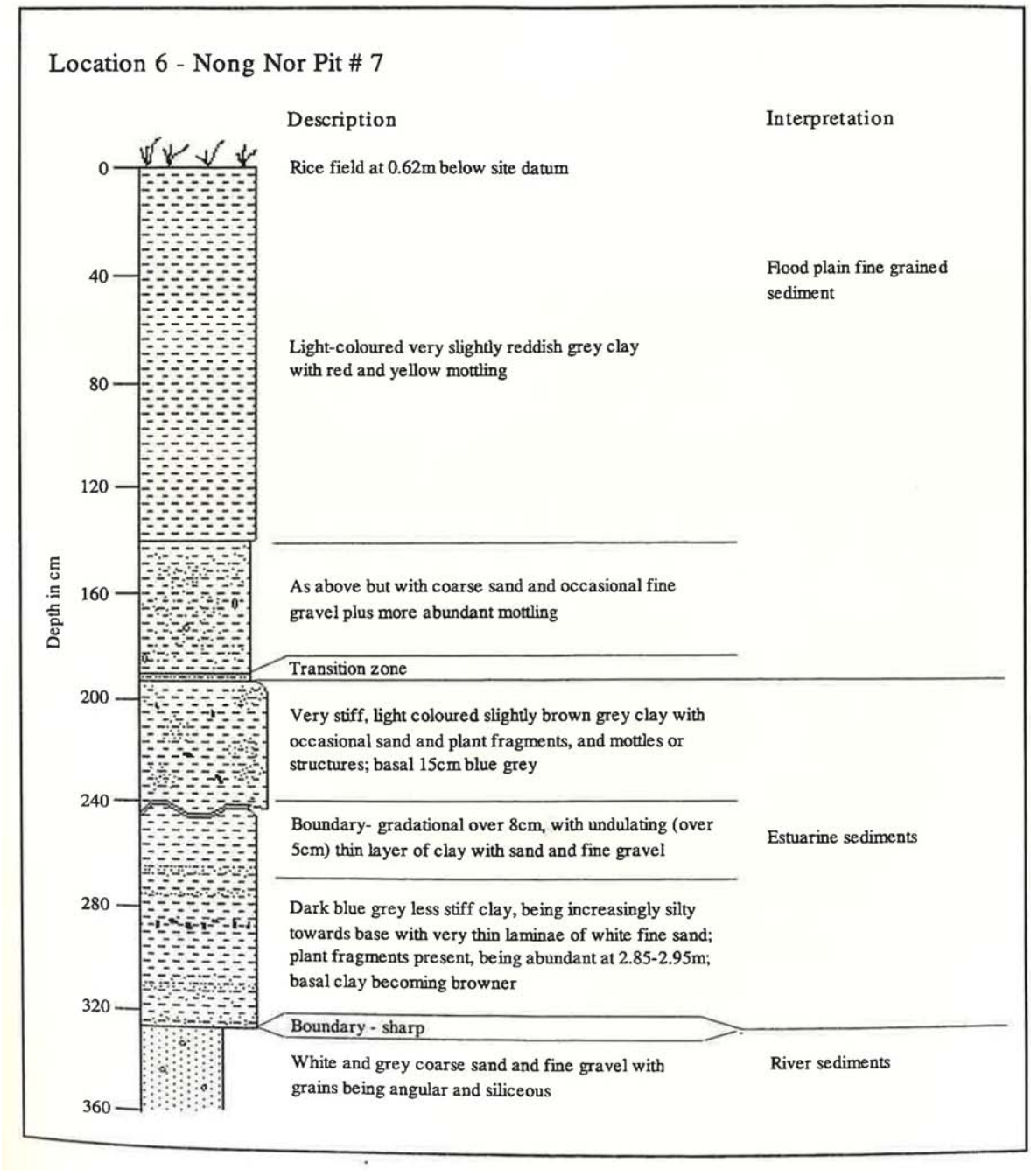


FIG. 22. Lithology of the sedimentary sequence at Location 6

pears to overlie light yellow-grey sand. Beyond *c*. 200 m, the unit is largely obscured by slumping and regraded sediment, but it appears to become sandier again, with apparently similar, variably white and/or yellow coarse-grained and more-or-less horizontally-stratified sand being present.

Interpretation: This unit is interpreted as being river alluvium, very probably having been deposited by the Khlong Luang, and represents the levée and over-bank deposition of this river.

Location 11

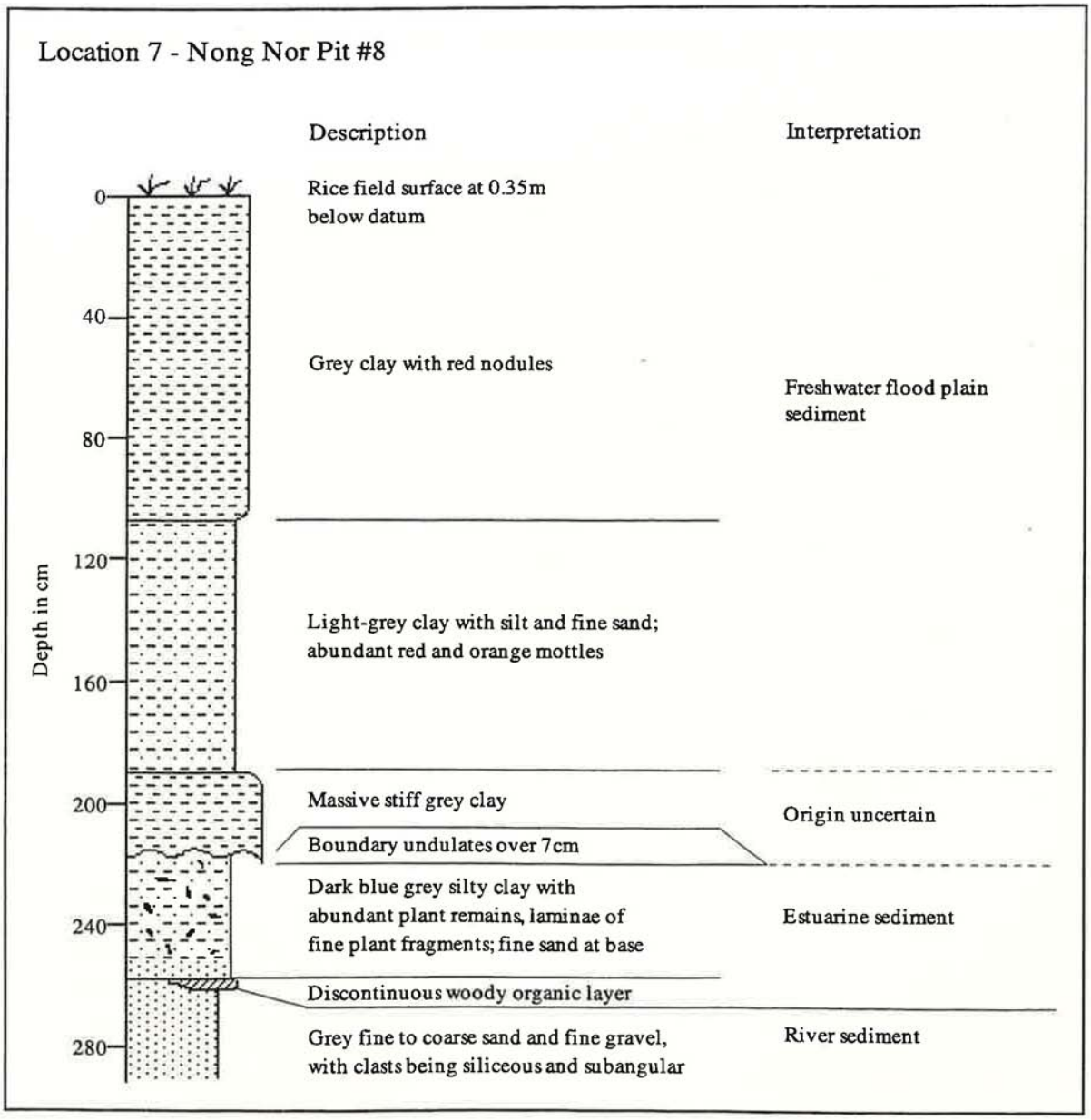


FIG. 23. Lithology of the sedimentary sequence at Location 7

Type: New water hole being dug, *c*. 4 m minimum depth.

Location: Just east of Khlong Luang and north of Wat Luang; map grid reference $^{7}365\ ^{14}921$.

Description: This is a deep (*c*. 4 m), hole, being excavated as a new water hole, within *c*. 40 m east of the canal and the downstream (northern) end of the sediment exposure at Location 10. As for Location 10, conditions were treacherous, and observation could only be made of the *in situ* sediments from a distance, or where they had been placed on the working spoil pile. This exposure appears to comprise *c*. 3 m of massive, unstratified, mottled yellow and red sand overlying at least 1 m of white-grey sand. Samples in the spoil pile strongly resemble the sediment being excavated from under Nong Nor, although their exact provenance is doubtful.

Interpretation: There appears to be no flood plain (blue-grey) clay in this sediment section, nor an equivalent of the stratified sand unit described for close by at Location 10. It is, therefore, assumed that this exposure represents the archaeological site substrate sediment unit.

Location 12.

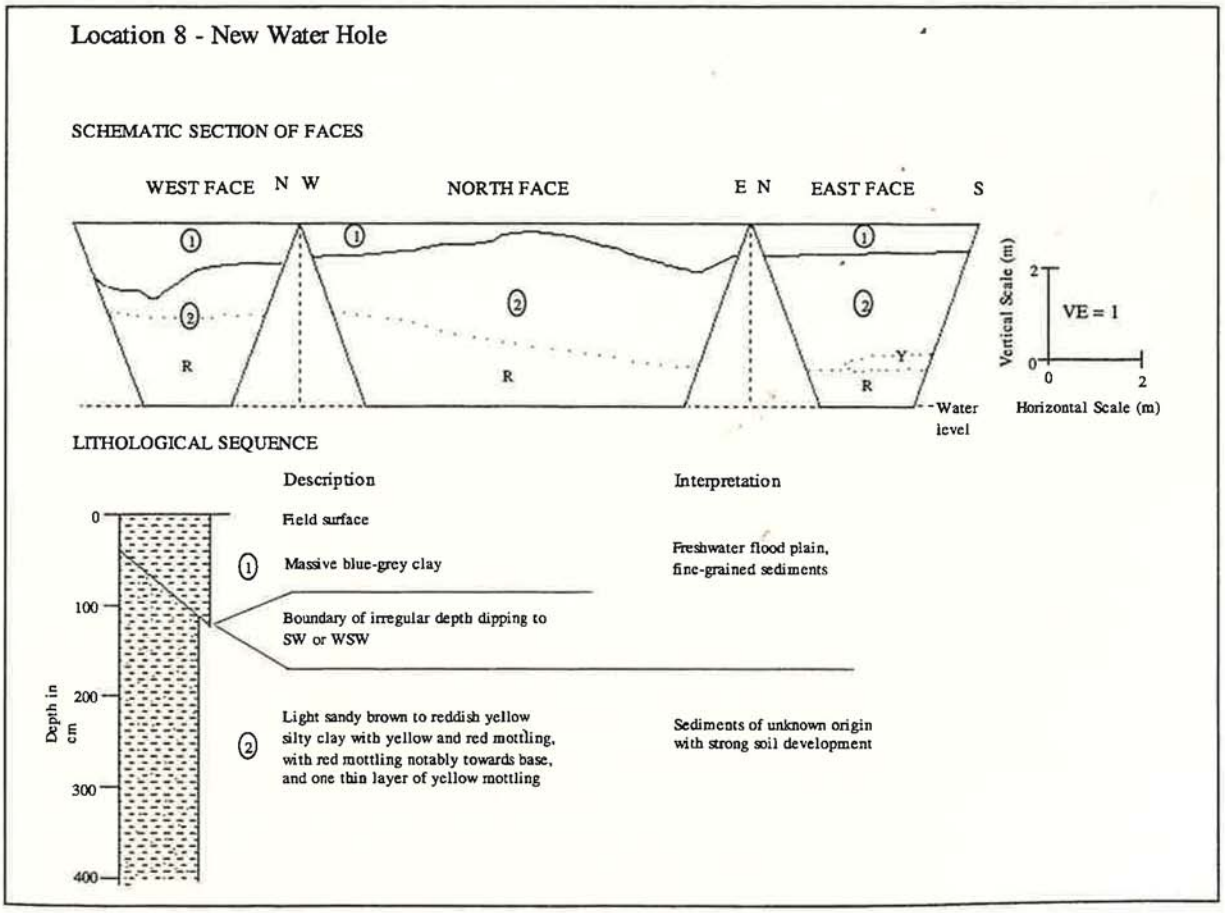


FIG. 24. Lithology of the sedimentary sequence at Location 8. In the schematic section of faces, the figures 1 and 2 refer to the lithological units described in the lithological sequence below. R and Y refer to the dominant colour of mottling in the lower part of unit 2: R = red, Y = yellow

Type: Sediment exposures in the banks of a fish pond.

Location: Southeast of Wat Luang, south of road; map grid reference $^{7}367\ ^{14}918$.

Description: The sides of this fish pond are not fresh and are slightly weathered, although they appear to have been cut into non-stratified, non-flood plain sediments.

Interpretation: This pond has probably been cut into the sediment type which underlies the archaeological site.

Location 13.

Type: Water hole.

Location: *c*. 100-150 m north of Nong Nor, beside Location 6; map grid reference $^{7}379\ ^{14}912$.

Description: The sediment spoil from this water hole contains grey clay similar to that near the surface of the surrounding fields, overlain by (and, therefore, presumably from a greater depth) yellow and white, sub-angular coarse quartz sand with fine gravel. The local workmen who recently cleared this water hole reported that the gravel was encountered at about 2 m depth, and is underlain by sand.

Interpretation: This sequence supports that exposed at Location 6, and probably represents the succession of river sand and gravel being overlain by clays, some of which are of flood plain origin

Location 14.

Type: Canal bank, both west and east sides of canal.

Location: Khlong Luang; map grid reference $^{7}362\ ^{14}926$.

Description: Sediments are exposed in the banks of the canal at this locality over a short length of bank; in general the banks are overgrown. Two types of sediment are exposed. In the west bank, the sediment is exclusively blue grey clay (minimum depth *c*. 1 m) similar to the clay commonly found in the fields of this area and presumed to be of recent flood plain origin. In the east bank, however, up to *c*. 2 m of more-or-less horizontally-stratified sand and clay is exposed. These sediments exhibit fining-upwards cycles, and contain occasional leaf and wood fragments in the finer-grained units.

Interpretation: This combination of sediment sequences is interpreted to represent alluvial sandy sediments, on the east of the canal, with the canal cutting into flood plain clays to the west. The canal is currently a meandering river; this locality is a straight stretch between a left turn (upstream) and a right turn (downstream). The stratified sandy sediments on the east bank, therefore, are probably point bar deposits usually deposited in the upper part of the inside of a river meander.

Location 15.

Type: Dry water hole.

Location: Locality A, *c*. 250 m northeast of Nong Nor; map grid reference $^{7}380\ ^{14}912$.

Description: This dry water hole has been cut into mottled (red and yellow) light grey silty clay which is overlain by 60 cm of blue grey clay.

Interpretation: This appears to represent the sequence of flood plain clay overlying the archaeological site substrate deposit.

Location 16.

Type: Dry water hole.

Location: Locality B, *c*. 300 m northeast of Location 15; map grid reference [7]383 [14]913.

Description: This is a large, dry water hole, with a hole dug in the floor, exposing a similar sequence to that at Location 15, with the mottled silty clay being overlain by *c*. 70 cm of blue grey clay.

Interpretation: This sequence is interpreted as at Location 15.

Location 17.

Type: Ditch at house and rice processing site.

Location: Locality C, south of Location 16; map grid reference [7]384 [14]910.

Description: This is a rice processing area with an open working surface established on light-coloured silty clay. Nearby drainage ditches cut into this sediment, exposing an overlying (*c*. 40 cm layer of blue grey clay).

Interpretation: This site is interpreted as for Locations 15 and 16, with the exception that in places the laterised substrate appears to be exposed at the surface, although this may represent utilisation of this sediment to provide a stable working surface. Nevertheless, if the latter is the case, this sediment is present only a short depth below ground surface.

Location 18.

Type: Two water holes.

Location: Locality D, south of Location 17; map grid reference [7]384 [14]908.

Description: Sediments are partially exposed in the banks of a newly-dug water hole and an older water hole. These sediments appear to be similar in types and sequence to those already described at Locations 15 to 17, with the overlying blue grey clay being thicker to the west (to *c*. 1-1.2 m) than to the east (*c*. 20 cm).

Interpretation: These sediments are interpreted as for sequences at Locations 15 to 17.

Location 19.

Type: Dry water hole.

Location: Locality E, east of Location 15; map grid reference [7]381 [14]912.

Description: This is a dry water hole in which the mottled light grey silty clay is found at about 60 cm below the general field surface level.

Interpretation: The sediments in this hole are largely obscured, but it appears that the presumed laterised site substrate is present in the floor of this water hole.

Location 20.

Type: Ditch banks.

Location: Locality F, on road between Wat Luang and Ban Nong Po, *c*. 1.1 km north of Nong Nor; map grid reference [7]376 [14]922.

Description: The drainage ditches at this locality appear to be dug into the mottled, presumed

laterised silty clays of the site substrate. This sediment can be traced along much of the drainage ditch between this locality and Location 21, although in many places it is obscured by slumping, spoil and overgrowth.

Interpretation: This location indicates extension of the distribution of sediments presumed to be equivalent to those underlying the archaeological site.

Location 21.

Type: Water hole.

Location: Locality G, on north side of road between Nong Nor and Wat Luang, just east of Wat Luang; map grid reference $^{7}368\ ^{14}920$.

Description: This water hole appears to be cut into sediments with a similar sequence as those recorded at Locations 15 to 18, i.e. with the mottled silty clay being overlain by *c*. 60 cm of blue grey clay.

Interpretation: The interpretation of this sequence is as for Locations 15 to 18.

Location 22.

Type: New water hole.

Location: Locality H, north of Wat Luang at road corner; map grid reference $^{7}366\ ^{14}922$.

Description: This newly-dug water hole has been cut into sediments exhibiting similar characteristics as described above for Locations 15 to 18 and 21, with at least 1.5 m of mottled silty clay being overlain by *c*. 60 cm of blue grey clay.

Interpretation: The interpretation of this sequence is as for Locations 15 to 18 and 21.

Location 23.

Type: Water hole

Location: At Ban Khlong Khwang on the west side of the canal *c*. 100 m upstream from Wat Uthok; map grid reference $^{7}337\ ^{14}926$.

Description: This is a large hole (*c*. 20 x 20 m) connected to the canal which has recently been cleaned out (the pre-1982 aerial photographs show it being present then), and probably used as a sediment quarry. The upper part of the hole is cut into light grey clay with dark grey towards the top and red and yellow mottling in places. There is also some silt in this sediment. This bed is at least 2 m thick. The sediment underlying this is not exposed, although the sediment spoil piles from the recent re-excavation of this hole largely consist of clean quartz and fine gravel.

Interpretation: This site appears to represent the deposition of flood plain clay-rich sediment over river alluvium. This lower alluvium may represent a levée sediment associated with the Khlong Khwang or, alternatively, associated with the channel alluvium described at Location 25.

Location 24.

Type: Geomorphological site of former sand dunes.

Location: Noen Nong Ka, *c*. 2.25 km northeast of Nong Nor; map grid references $^{7}390\ ^{14}930$ and $^{7}391\ ^{14}932$ (the former being equivalent to Location 43).

Description: This locality consists of geomorphological features, which according to the farmer who lives here, are not present elsewhere in the area. The features are two mounds, the southern one (map grid reference $^{7}390\ ^{14}930$) being approximately circular in plan and *c*. 50 m in diameter, and the northern one (map grid reference $^{7}391\ ^{14}932$) being larger in plan (*c*. 100 x 50 m) and aligned approximately N-S. The upper surfaces of these mounds lie an estimated 2 m and 2.5 - 3 m, respectively, above the surrounding flood plain surface. The surface of the former mound may be more disturbed, and currently has a farm located on it, whereas the latter mound has been and is still being used as a Chinese cemetery. These mounds are composed of fine sandy sediments, overlain by both modern fill in places and, on the southern mound, prehistoric midden to a depth, where dug, of *c*. 30 - 50 cm (see Location 43 for description of the archaeological aspect of this locality).

Interpretation: Both of these mounds resemble sand dunes, which were presumably formed in antiquity. They are both stable and there is no evidence for current geomorphological sand dune activity. These are probably fossil sand dunes dating to a period during which this locality was close to the coast.

Location 25.

Type: Sand quarry.

Location: Near Wat Uthok, west of main road between Chachoengsao and Phanat Nikhom (location name not obtained), map grid reference $^{7}343\ ^{14}918$.

Description: This is a local business sand quarry which apparently supplies a significant amount of sand locally (in 1992 operating under a 100,000 baht/year contract). The site comprises two ponds at a farm, with one currently being dredged for sand. The locality appears to be limited in extent, with sand outcropping at the surface at this site; within 50 m east of the site the surface sediments comprise blue-grey clay, and at *c*. 50 m west of the quarry pond (see below) sand is overlain by up to 50 cm of clay. In one pond, which may have been a former sand quarry, but is now used as a water hole, a *c*. 75 cm deep surface layer of angular quartz sand and fine gravel overlies clay. To the west of this pond, the quarry pond (*c*. 70 m x 30 m in plan), is excavated in a thicker unit of sand, which is currently exposed at the surface, and has been dug to at least 4 m depth; quarrying is continuing, so this is a minimum depth. The sand comprises poorly sorted, angular quartz and some feldspar sand and fine gravel; some is oxidised and some is fresh. This sediment contains *c*. 1 per cent wood fragments, which while only being evident in the spoil piles, nevertheless appear to be a component of the sediment.

Interpretation: This sediment unit is interpreted as being a relatively fresh course-grained alluvium, apparently spatially-restricted in its distribution, and clearly representing river depositional conditions different to those prevailing at present on this plain.

Location 26.

Type: Excavated hole of undetermined use.

Location: Northeast of Ban Ko Loi; approximate grid reference $^{7}405\ ^{14}953$.

Description: This is an exposure of the subsurface geology of the slightly elevated land surface bordering the present flood plain upon which the archaeological site at Nong Nor and Locations 1 to

25 are located. This hole exposes 1-1.5 m depth of a coarse-grained sedimentary deposit containing vein quartz pebbles and, being strongly laterised, forming a resistant cemented conglomerate.

Interpretation: This site exposes a former slope wash gravel which has been cemented during the course of laterisation. The upper surface of this bed has been eroded, and its lateritic soil truncated. This sediment is presumably of some antiquity, exhibiting a considerably greater degree of laterite development than evident in any of the presumed laterised sediments close to the surface of the present flood plain at lower elevations than this site.

Location 27.

Type: Ditch section at edge of flood plain.

Location: South of Ban Ko Loi; approximate map grid reference $^{7}392\ ^{14}938$.

Description: This site lies at the edge of the flood plain (with the flood plain to the west), where the land surface very gently rises eastwards. The ditch exposes a sequence of *c*. 50 cm of grey clay overlying a minimum of 50 cm of mottled light grey silty clay. The latter sediment strongly resembles the substrate found under the archaeological site at Nong Nor (Location 1).

Interpretation: This sequence is interpreted as at several other sites nearer the archaeological site at Nong Nor, as being recent flood plain sediments overlying an older sediment, probably equivalent to the site substrate sediment, which exhibits some former soil development. This represents the easternmost or most landward location of such a sequence, lying at the eastern margin of the flood plain.

Location 28.

Type: Surface exposure and well section.

Location: Ban Pa Gaew, half way between Ban Ko Loi and Wat Khiri Rom; approximate grid reference $^{7}387\ ^{14}967$.

Description: This is an area, aligned more or less N-S and *c*. 200 m wide, which fringes the edge of the flood plain, lying on a surface of *c*. 0.5 - 1 m elevation above the flood plain surface. The surface sediment comprises a light sandy-brown fine-grained sandy silt, deposited as a massive sediment with no apparent sedimentary structures or bedding. The sediment unit is at least 40 cm thick in places, and in a well exposure 70 cm of this sediment lies directly and unconformably on solid laterised conglomerate similar to that described for Location 26.

Interpretation: The origin of this upper sediment unit is unclear, and given its grain size characteristics, massive sedimentary nature and lack of bedding structures, appears to be an aeolian deposit, possibly a loess-type deposit. It, nevertheless, represents a considerably younger period of deposition than the underlying conglomerate, whose upper surface must have eroded in antiquity.

Locations 29 to 33.

Type: Surface exposures and quarries.

Location: In the uplands to the east of the flood plain, along the road east from Ban Nong Ta Nak (map grid reference $^{7}413\ ^{14}911$) for *c*. 13.5 km through Ban Nong Kha (at 9 km). Five localities are described (distances given are road distances from Ban Nong Ta Nak)

Location 29, quarry at 3.3 km (map grid reference $^{7}435\ ^{14}912$);

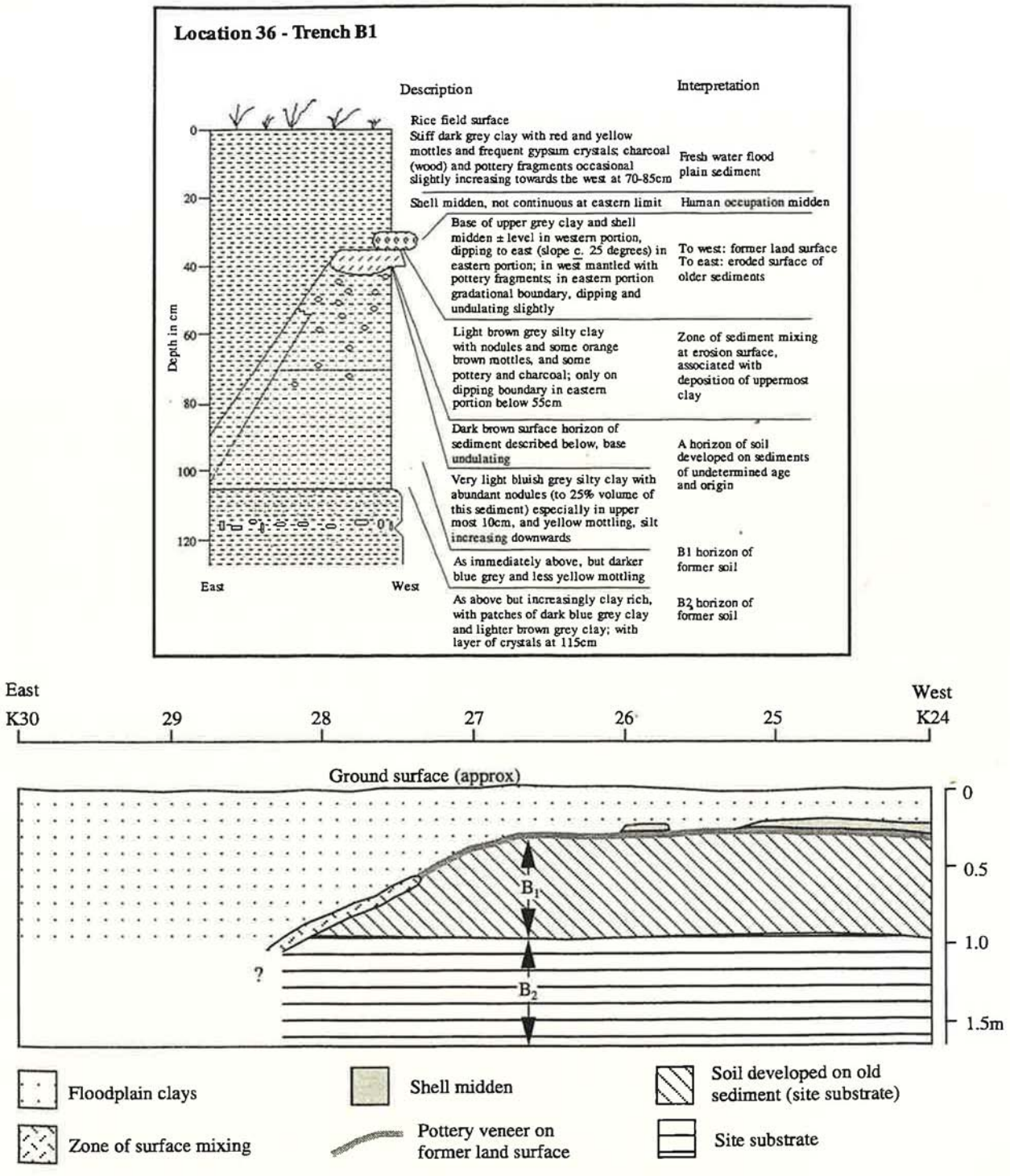


FIG. 25. Lithology of the sedimentary sequence at Location 36, looking south

Location 30, quarry at 10.7 km (approximate map grid reference $^{7}519\ ^{14}894$;

Location 31, ditch and surface exposure at 11.9 km (map grid reference $^{7}519\ ^{14}894$);

Location 32, at 12.3 km (map grid reference $^{7}526\ ^{14}894$);

Location 33, ditch and surface exposure at 13.5 km (map grid reference $^{7}535\ ^{14}895$).

Description: This locality comprises a number of exposures along a road line in an elevated area east of the flood plain. In general these all provide evidence for at least 4 m thickness of strongly laterised regolith. The regolith comprises, variably, angular gravel, with remnants of weathered quartz veins and, close to the surface, erosional channel infills with more-or-less rounded and angular gravel. The gravel comprises crystalline rock types (often exclusively at a particular locality), conglomerate, sandstone and schist cobbles; where the latter occur, they are all present at a locality (Location 29). Where the regolith is exposed to the present land surface (e.g. Location 30), it appears to be finer-grained towards the surface (fine to coarse sand and fine gravel). In some places (Locations 32 and 33) an overlying bed of light grey or light brown sandy and/or clay-rich sediment to 50 cm depth, generally lies unconformably on the irregular upper surface of the laterised regolith. At the most elevated (over 60 m above datum) more-or-less level places in the landscape (Location 31), the laterised regolith is overlain by *c*. 50 cm of hard, but friable, red brown sandy soil with fine quartz gravel inclusions. This bed thins downslope, being replaced by surface exposure of the laterised regolith.

Interpretation: These series of exposures represent the remnants of an old land surface developed on a substrate of crystalline bedrock and alluvial deposits. The degree of laterisation suggests the considerable antiquity of this land surface, which may date to Tertiary times. The moderately wide-spread surface unit of sand and clay represents recent and modern weathering of the laterised regolith, whereas the red brown sandy soil found only on the uppermost level surfaces of the landscape represent the remnants of former soils developed on the regolith. The importance of these exposures lies in their provision of a probable sediment source for the basal sand and gravel unit exposed at Locations 2, 4 to 7 and 13 and interpreted at these localities as river alluvium.

Location 34.

Type: Water hole.

Location: *c*. 200 m north of Nong Nor; map grid reference $^{7}378\ ^{14}912$.

Description: This is a *c*. 5 x 10 m (in plan) water hole in a field with dark grey stiff clay on its surface. The spoil piles from this water hole, however, contain a mixture of dark- and light-coloured clay and, of, note, clay with sand and fine gravel. The latter sediment is light brown grey in colour.

Interpretation: Although the stratigraphic context of this sandy sediment is unclear, it is clearly from below the surface dark grey clay, and is probably equivalent to the presumed alluvial sand and gravel recorded at depth in nearby localities (Locations 2, 4 to 7, 13).

Location 35.

Type: Subsurface samples from the archaeological exposure.

Location: Nong Nor archaeological excavation area X1; map grid reference $^{7}378\ ^{14}911$.

Description: Two samples of the sediment underlying the archaeological strata were collected for sediment size and grain character analysis (Fig. 17). Sample 1 is a well-sorted fine to medium-

grained brown and light brown grey sand with yellow and brown yellow mottles and black flecks, whereas sample 2 is finer-grained. These samples are very similar in grain size characteristics to the uppermost samples from Location 1.

Interpretation: The results of these analysis, combined with analyses from Locations 1 and 36, are discussed for Location 1. Of note is the strong similarity in grain size characteristics between these samples and the uppermost sample at Location 1, suggesting that similar sediment horizons are present at these two locations.

2. Site margin

Location 36.

Type: Trench at archaeological site.

Location: Nong Nor archaeological excavation area B1, running east from the northeast corner of excavation area A1; map grid reference $^{7}378\ ^{14}911$

Description: In order to examine the stratigraphic relationships between the archaeological and the natural sediment sequences at the eastern margin of the archaeological site at Nong Nor, a 1 m wide trench was excavated from the NE corner of the archaeological excavation area A1, running directly east for 30 m. The last 6 m (i.e. 24 - 30 m) were examined from the point of view of

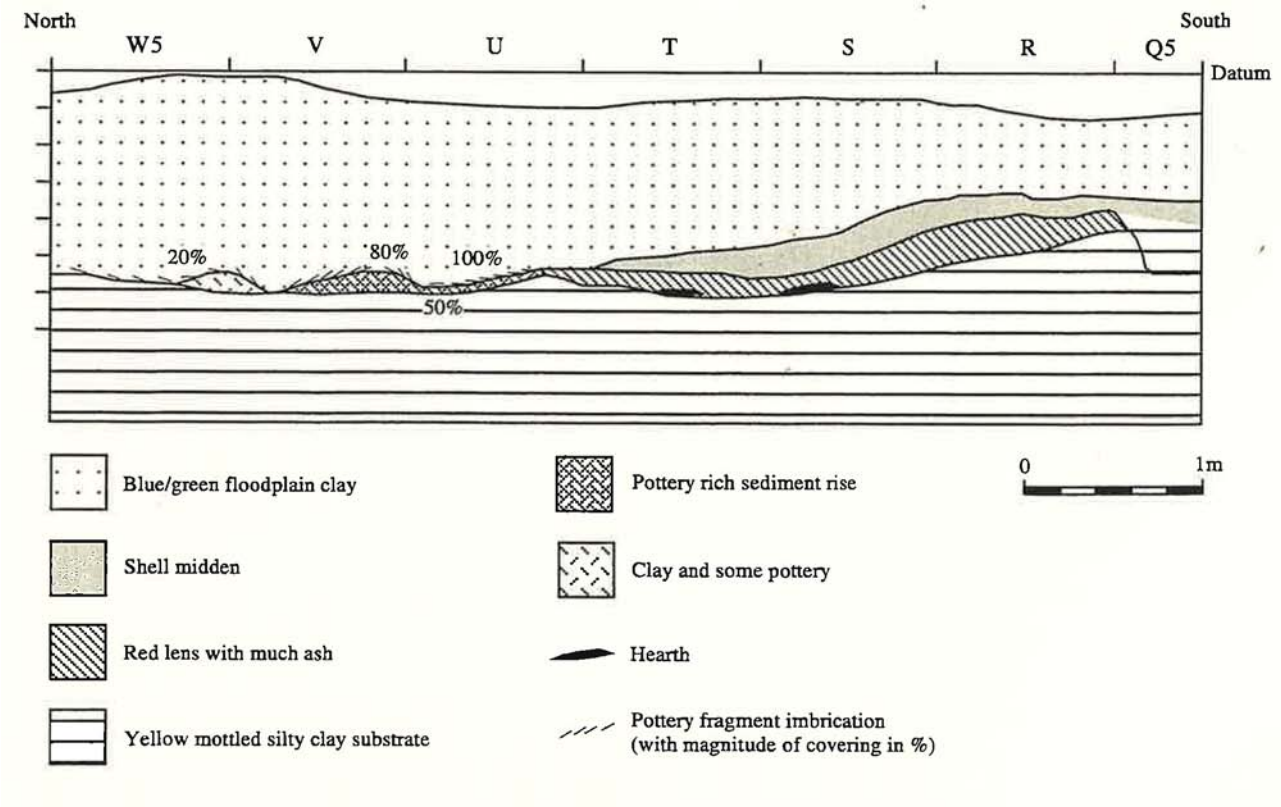


FIG. 26. Cultural and sedimentary sequence at Location 37

the sedimentary rather than explicitly archaeological evidence. The sediment sequence (Fig. 25) represents this eastern edge of the archaeological site. Samples were analysed for sediment grain size and characteristics from 0 - 4 cm, 10 - 14 cm, 20 - 24 cm and 30 - 34 cm below the base of the midden at 25 m from A1. The sediment size analyses (Fig. 17), and the grain characteristic analyses which indicate decreasing roundness up profile, supplies evidence that the sediments sampled at this location are very similar to those in the middle part of the sub-site sediment exposure at Location 1.

Interpretation: This sequence represents a basal sediment which is equivalent to the site substrate encountered elsewhere (Locations 1 and 35), with evidence for a former soil development, overlain variously by midden sediments and freshwater flood-plain clay-rich sediments found throughout

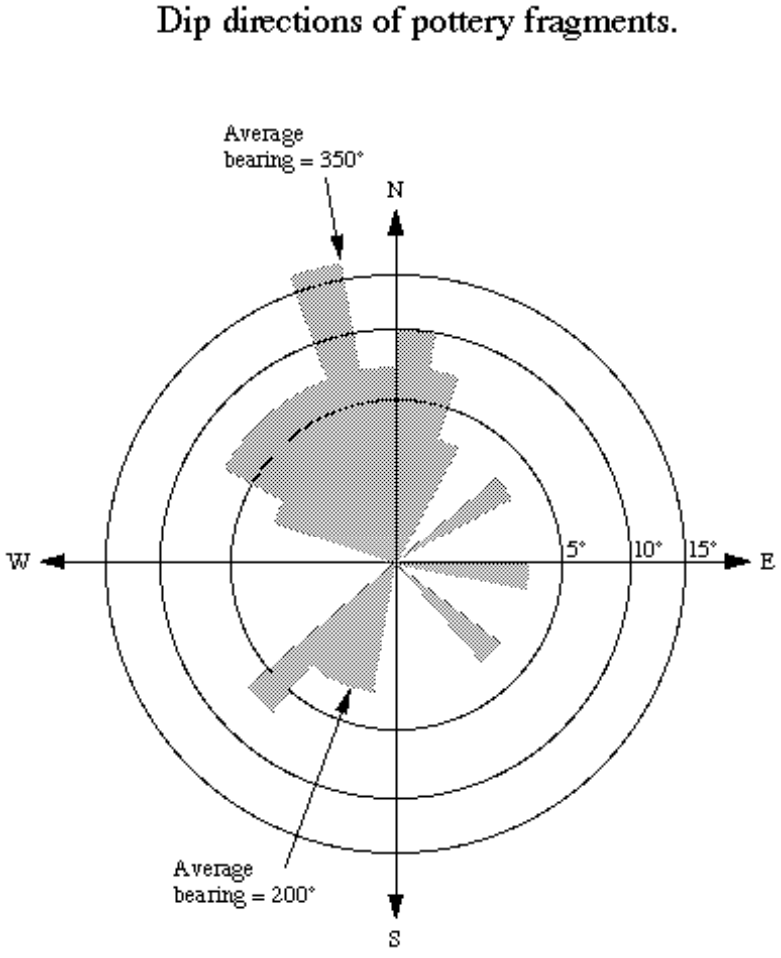


FIG. 27. Location 37. The rose diagram shows the frequencies (in %) of dip directions for pottery fragments lying on the buried substrate surface. All values north of the east-west line are from the north-facing slope (A) and all other values are from the south-facing slope (B). The average bearings are from these north- and south-facing slopes respectively

this area. The upper surface of this basal unit takes two characters. To the west, the upper surface appears to be an original land surface, albeit slightly eroded compared with the surface at Locations 1 and 35, with a mantle of pottery fragments overlying it and underlying the midden sediments which are deposited discontinuously in this surface. To the east, however, the surface dips eastward and appears to be an erosional surface, cutting across the soil features developed within this sediment. This erosion surface has been further altered by mixing of the underlying sediment with material (notably pottery and charcoal fragments) derived, presumably, from the archaeological site. The upper limit of this zone of mixing is unclear, but probably lies at approximately 20 - 25 cm below the land surface upon which the pottery mantle and midden are deposited; this level, therefore, may represent a wash line or contemporary water surface level during or shortly after the occupation of the archaeological site.

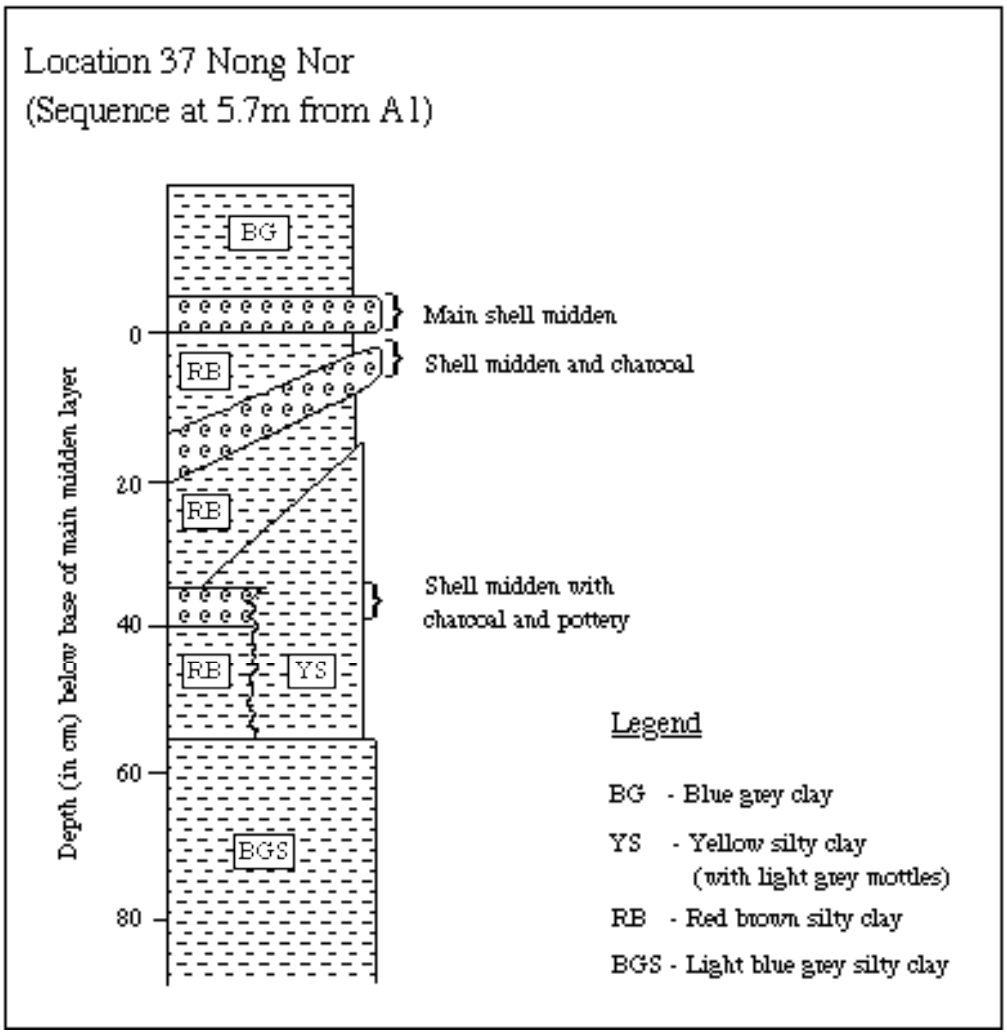


FIG. 28. Lithology of the sedimentary sequence at Location 37

Location 37.

Type: Trench at archaeological site.

Location: Nong Nor archaeological excavation area A2, running north from the northeast corner of excavation area A1; map grid reference $^{7}378\ ^{14}911$.

Description: In order to examine the stratigraphic relationships between the archaeological and the natural sediments at the northern margin of the archaeological site at Nong Nor, a 1 m wide trench was excavated from the NE corner of archaeological excavation area A1, running directly north for 13 m. The sedimentary sequence in this trench (Figs. 26-8) was examined from the point of view of the sedimentary rather than archaeological evidence. The trench exposes an edge of the archaeological site where the midden material becomes increasingly complex in its stratigraphy. Underlying blue grey flood plain clay there are interbedded layers and lenses of shell, pottery fragments, red brown and possibly burnt soil, and red brown and yellow mottled silty clay sediment, all containing charcoal fragments. This complex drops down a slope towards the north from about 0.5 m below the site datum at 8 m north of the NE corner of area A1, to *c*. 1.1 m maximum below the site datum as 11-12 m NE of area A1. On the slope between 0.7- 0.9 m below datum, the shell midden deposit cuts out, and the major archaeological deposit from 0.75 m below datum (*c*. 10 m from A1) is a layer of pottery of a 2 - 3 cm thickness lying between the blue grey clay, above, and the mottled silty clay below. The pottery layer continues northwards, and at the lowest points (*c*. 1 - 1.1 m below site datum) appears to form morphological units resembling at least one ripple and possible parts of a second ripple. On removal of the pottery, it is apparent that these features

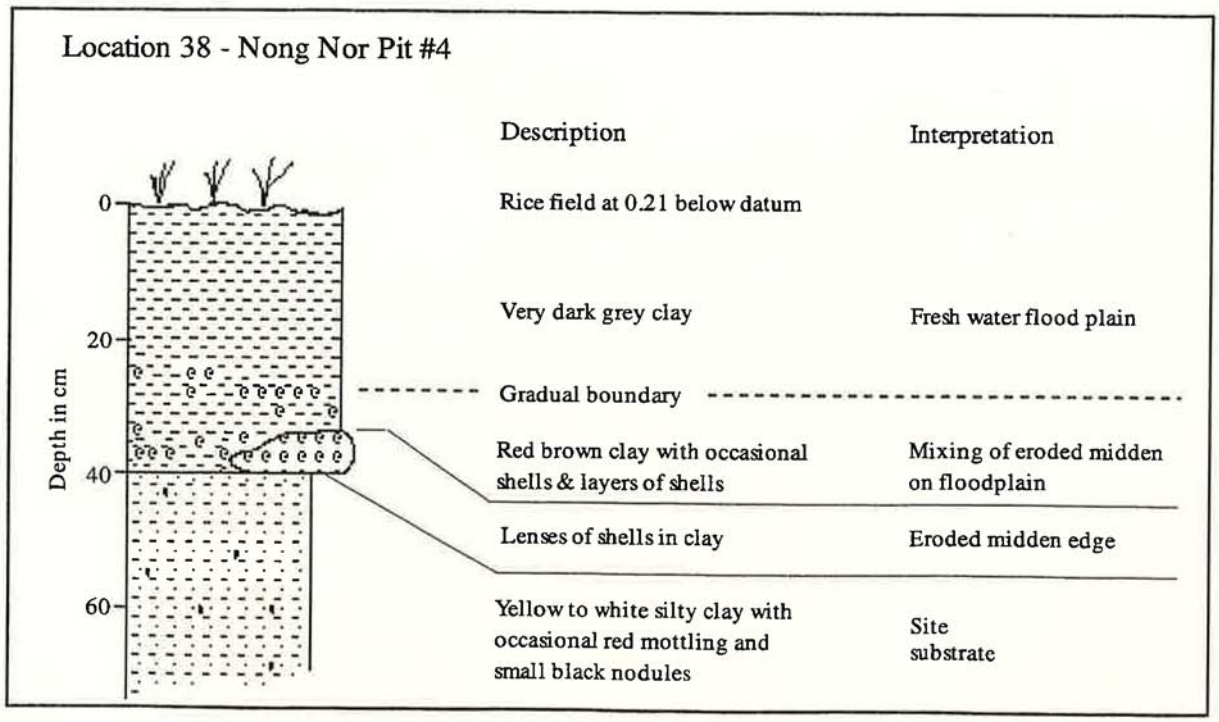


FIG. 29. Lithology of the sedimentary sequence at Location 38

predominantly comprise pottery fragments which form a ripple-like feature on an otherwise approximately level substrate surface. This layer of pottery is discontinuous, comprising variable concentrations of pottery (from 100 per cent on the main slope, to <20 per cent scatter on the lowermost surfaces either side of the ripple-like feature) on the site substrate surface. The pottery fragments appear, in places, to be aligned preferentially, showing signs of being imbricated on the main north-facing slope and the south-facing slope of the ripple-like feature (Fig. 26). Figure 27 details measures of the direction of slope of the imbricated pottery fragments. This entire complex of sediments mantles a substrate surface which is dipping approximately north (bearing of surface dip is variable, between *c*. 344° and 20°) from beneath the main part of the site, and levelling out at ≥1.1 m below the site datum.

Interpretation: This entire sequence represents a margin of the archaeological site where midden material has been deposited down a slope, causing mixing of the various sediments deposited there. The imbricated pottery and the ripple-like feature suggests that this site margin may have been water-washed by waves. The edge of the shell midden at about 0.7 - 0.9 m below site datum may represent a wash line. Below this level, pottery fragments have been deposited, moved about and sorted, in places being deposited in a resting position controlled by the effect of onshore and offshore (reflected) waves. The evidence of the pottery fragment imbrication data suggests an average on-shore wave direction from the NNW (350°) and a reflected offshore wave direction from the SSE (220°); these imply a shoreline aligned approximately E-W (bearing 275°). Erosion on this shoreline appears to have been minimal, reflecting one or more of the following influences: the relatively low energy of onshore waves; the relative stability of the substrate; the mantling effect of the pottery layers; the presence of an offshore shoal protecting the site; and the low impact of direct wave direction. In respect to the latter influence, it is of note that erosion along the eastern margin of the site (Location 36) has been more severe; if the predominant wave direction is determined correctly, then the margin would have been under the influence of waves shearing along the shoreline at this eastern edge of the site (the shoreline strike is estimated, from site morphology, to be approximately NW-SE), thus enhancing the erosion potential.

Location 38.

Type: Dug hole at Nong Nor site.

Location: Nong Nor Pit #4, *c*. 10 m south of southerly limit of 1992 excavation; map grid reference $^{7}378\ ^{14}911$.

Description: This is a 1 x 1 m pit, excavated to a depth of 0.65 m below the land surface, and dug close to the archaeological site to assist in determining the location of the southeastern edge of the site (Fig. 29).

Interpretation: This sequence represents the edge of the midden site approximately on a surface of equivalent elevation to that underlying the central part of the midden. Here the midden appears to have been partly reworked, with the remains of the midden either remaining *in situ* on the substrate surface, or being reworked within the overlying flood plain sediment.

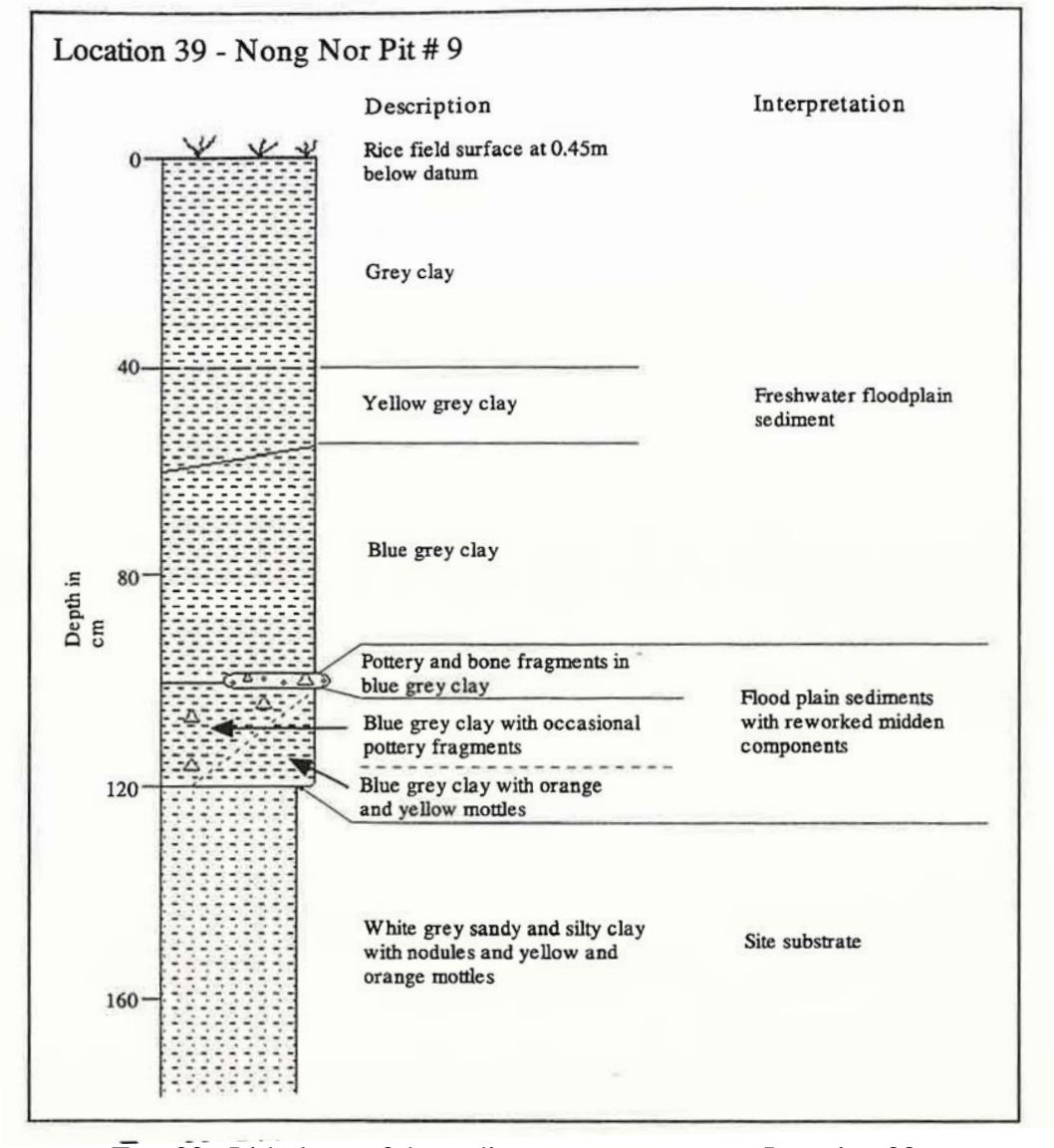


FIG. 30. Lithology of the sedimentary sequence at Location 39

Location 39.

Type: Dug hole at Nong Nor site.

Location: Nong Nor Pit #9, 9 m north of northerly limit of excavation; map grid reference $^{7}378$ $^{14}911$.

Description: This is a 1 x 1 m pit, excavated to a depth of 1.9 m below the land surface, and dug close to the archaeological site to assist in determining the location of the northern edge of the site (Fig. 30).

Interpretation: This location represents a sequence from the site substrate sediment to the freshwater flood plain sediments, with, in the lowermost part of the latter, reworked material from the

midden and its substrate.

3. Other archaeological sites

Location 40.

Type: Surface scatter and field edge exposure.

Location: Ban Noen Tan, northeast of Nong Nor; map grid reference $^{7}389$ $^{14}921$.

Description: This site is a farm on a slight topographic rise (*c*. 1 m above the surrounding fields), and consists of an outcrop of sediments yielding shells and pottery fragments; the people living in this farm have collected shell beads similar to those found at Nong Nor.

Interpretation: The present farm is located on a prehistoric midden site.

Location 41.

Type: Surface scatter and field edge exposure on mound.

Location: Noen Ta Chan, northeast of Nong Nor; approximate map grid reference $^{7}390$ $^{14}917$.

Description: This is a slightly elevated topographic feature, comprising an irregular mound of some 200 m x 100 m in plan, with an upper surface *c*. 1.5 - 2 m above the surrounding land surface. The upper surface has a capping of grey flood plain clay, with occasional fragments of pottery and shells at the surface. At least one of these is probably prehistoric (*Anadara granosa*, G. Mason, pers. comm.).

Interpretation: Although this site is very overgrown it appears that this may be a slightly elevated archaeological site.

Location 42.

Type: Surface scatter and field edge exposures of a former mound.

Location: Ta Tang Guian, south of Nong Nor; map grid reference $^{7}375$ $^{14}904$.

Description: This is the site of a former mound, reported to have been *c*. 50 x 50 m in plan, with its upper surface being about 1.5 m above the surrounding land surface. It lies close to the Khlong Luang, but sits on grey clay flood plain sediments, and was removed several years ago to create another rice field. During removal, three human burials are reported to have been found, each exhibiting an approximately E-W orientation. One bone fragment found during a visit by the author is not human (N. Tayles, pers. comm.). Other finds consist of pottery fragments in the field edges and within the clay soil to at least 20 cm below the present rice field surface, pig teeth, and metal (bronze) objects, including a Buddhist amulet. Of note is the apparent absence of shells.

Interpretation: This appears to be an archaeological site of a notably non-coastal economy character. The antiquity of this site, however, is unclear, and the site certainly includes a relatively recent element.

Location 43.

Type: Surface scatter and buried material on former sand dune.

Location: Noen Nong Ka, *c*. 2.25 km northeast of Nong Nor; map grid references $^{7}390$ $^{14}930$

(equivalent to one of the Location 24 sites).

Description: This locality consists of a farm site on the top of a mound, a mound interpreted as being one of two former coastline sand dunes (see discussion above for Location 24). This mound is approximately circular in plan and *c*. 50 m in diameter, and its upper surface lies *c*. 2 m above the surrounding flood plain surface. The mound is composed of fine sandy sediment, overlain by a prehistoric midden to a minimum depth of 30 - 50 cm. The midden material comprises some very rich layers of shells and pottery; in places these consist almost exclusively of pottery fragments. No metal objects or bone fragments are reported from this site. Although some of the shells are not ancient, four species are recorded as being fossils (*Anadara granosa*, *Telescopium telescopium*, *Meretrix lusoria* and *Nerita articulata* G. Mason, pers. comm.).

Interpretation: This mound is a sand dune, probably formed in antiquity as a coastal feature, which has been occupied also in antiquity, during a period in which the shoreline lay close to this now-inland location.

Location 44.

Type: Archaeological site and ditch edges.

Location: Khok Put Sa, west of Khlong Luang and the main road between Chachoengsao and

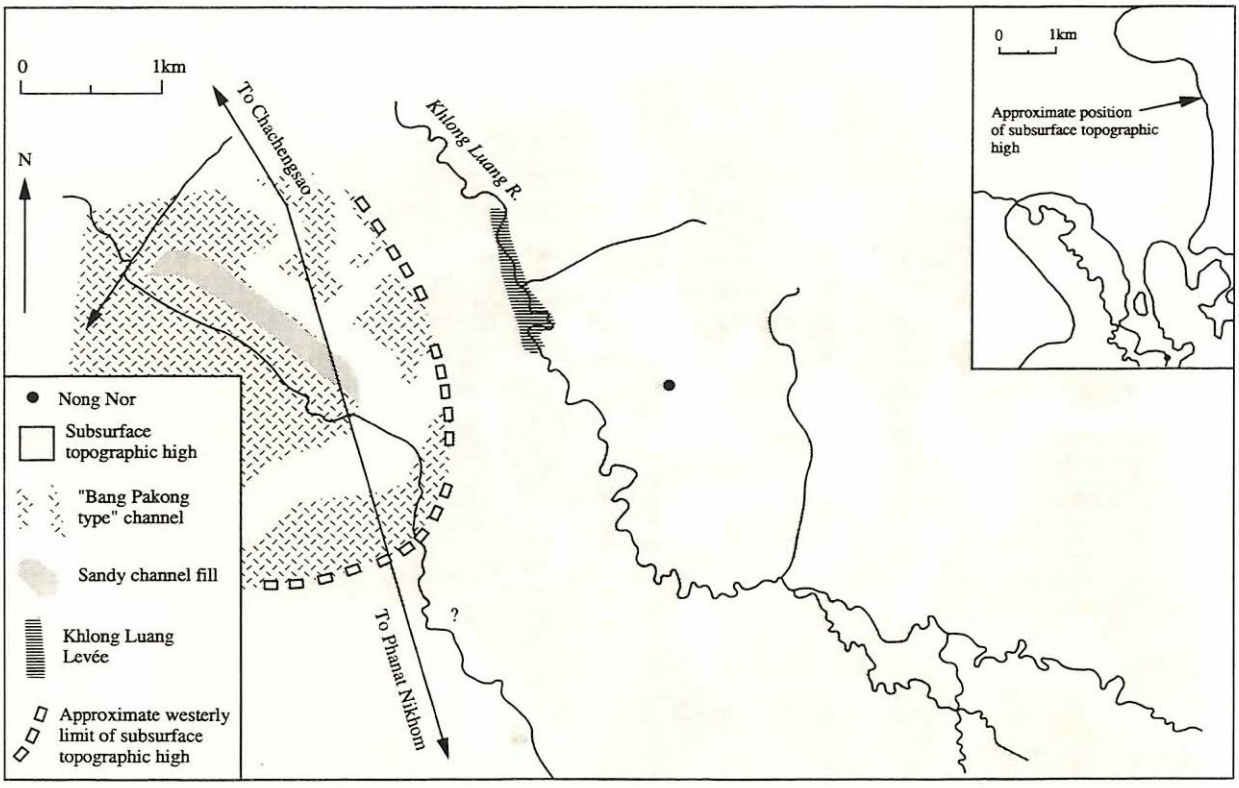


FIG. 31. Aerial Photograph interpretation of the Nong Nor area

Phanat Nikhom; map grid reference $^{7}316\ ^{14}919$.

Description: This is an archaeological site in the grounds of a monastery, which has been excavated a few years ago (Pisnupong 1982). It is situated on a slight mound whose upper surface lies approximately 2 m above the surrounding land surface; the surrounding countryside is extremely flat, being notably more level than the land surface around Nong Nor. The archaeological site is reported to have had 1 m removed by bulldozer, and thus previously comprised at least 2 m thickness of midden and burials, similar to those recorded at Khok Phanom Di, and associated with bronze artefacts. The drainage ditch to the south of the site is cut, to a depth of *c*. 2 m below the general surrounding land surface, into the slightly blue grey clay of the flood plain.

Interpretation: This is an archaeological site representing the human occupation of a coastal locality prior to the onset of the flood plain conditions prevailing at present.

SPATIAL DISTRIBUTION OF SEDIMENTS

Aerial photograph coverage of the area under investigation is moderately good. The available photographs yield images upon which the spatial distributions of some of the sedimentary differences recorded in the sections described above, are visible to a greater or lesser extent. Analysis of this aerial photograph coverage relies on the recognition and interpretation of the patterns and distributions of soils types, soil-water relationships, land use, vegetation and crop types. Eight sets of aerial photographs are used (Table 3), these representing a variety of times, scales and ground conditions. Of these, the dry-season photographs (1952, 1953, 1974 and 1984) are generally more useful, since during the wet season the widespread presence of water tends to obscure the finer details of soil, vegetation and crop patterns.

The spatial distribution of a major soil condition boundary is evident on the photographs. This varies according to conditions at the time of photography, but generally is represented by a separation between darker- and lighter-coloured soils. On the basis of the sections described above, this appears to predominantly reflect two conditions, at least in the immediate vicinity of the archaeological site. Where, on the one hand, the site subsurface sediments (the mottled silty clay) outcrops or is covered only by a thin veneer of flood plain clay (e.g. at Locations 8 and 9), the soil appears light-coloured on the aerial photographs, largely due to their relatively low water retention ability. On the other hand, where there is a greater thickness of flood plain clay (e.g. at Locations 2 and 4), the soils are darker on the aerial photographs. The boundary between areas exhibiting these two conditions is moderately sharp, and its location is possibly identifiable within a few metres. The exact position of the boundary, however, is in places obscured by field patterns, although it appears that the field patterns and locations of field boundaries themselves are soil-controlled, either due to differing suitabilities of the soils, their water-holding or drainage capacities. By consideration of the sediment sequences outlined above, this boundary probably represents the situation where the upper surface of the sub-site sediment comes within *c*. 1 m of the present land surface. In passing, it is notable that farm buildings and other modern occupation sites are largely located on the better drained areas underlain by only a thin veneer of flood plain clay overlying the sub-site sediment. These locations may also represent very slight topographic highs, which would be advantageous as occupation sites during the wet season. It may be that the present locations of farms and other buildings represent historical patterns from periods when the topographic differentiation may have been more pronounced.

TABLE 3: *Details of aerial photograph coverage used in the mapping of the spatial distribution of sediments in the Nong Nor region.*

Date	Scale	Set	Prints
24.12.1952	1:35,000 (approx.)	VV WWS M1 AMS24 119	60 & 61
2.1.1953	1:35,000 (approx.)	VV WWS M11 AMS2 119	1353 & 1354
12.12.1974	1:15,000	N.S.3, M11	34 - 38
13.12.1974	1:15,000	N.S.3, M16	40 - 42, 100 - 108
26.1.1984	1:10,000	Bang Pakong Project, R.8	780
12.3.1990	1:15,000	Eastern Seaboard, 476-533 Run 47A	510 - 512
19.3.1990	1:15,000	Eastern Seaboard, 407-458 Run 48B	426 - 432
19.3.1990	1:15,000	Eastern Seaboard, 459-542 Run 49	504, 506, 508

The map drawn from the aerial photograph analysis (Fig. 31), therefore, is a form line map representing the plan of a subsurface topography, in which topographic highs, comprising the mottled silty clay sediment and blanketed with flood plain clay, are separated from intervening topographic lows in which greater thicknesses of flood plain clay are deposited as infill deposits. The form lines represent an approximately horizontal plane at *c*. 1 m below the present land surface, a plane which may be broadly equivalent to the washline plane indicated at the margins of the Nong Nor archaeological site (Locations 36 and 37). In the area immediately surrounding this site, these topographic lows have, in plan, a strong resemblance to a river channel system. In other words, this map largely represents a former landscape, in which the land surface is an undulating one characterised by differentiation between interfluvial and fluvial conditions, and dating from prior to the onset of flood plain sedimentation.

There are, however, five problematical points about the aerial photographic interpretation. First, the apparent submerged drainage system depicted in figure 31 is, in the area around Nong Nor, entirely discordant with the present drainage pattern in this landscape. This increases confidence in the interpretation of the soil differences as depicted on the photographs, since the influence of present drainage channels on the soil distribution at large can be discounted. However, in some places and in particular to the southeast, it is difficult to be certain that the soil condition boundaries being mapped are not at least in part controlled by the location and distribution of the present drainage system. Nevertheless, the apparent continuity between the area round Nong Nor and further southeast suggests that the mapped distributions in the southeast of the area are real. In this area, where the flood plain enters laterally-restricted valleys and merges into the gently rising land surface of the hills to the east, the present and former drainage patterns may be expected to show greater conformity than in the open landscape of the flood plain round Nong Nor.

A second problematic point is that to the west of the area round Nong Nor, landscape conditions change considerably. Field patterns show much greater uniformity than to the east, and suggest a more widespread uniformity in soil and soil-water conditions. Throughout this area there is evidence on the photographic images of clearly defined infilled meandering channels whose exact boundaries, however, are unclear at a large scale (Fig. 31). These lie on the coastal plain both north and west of the Nong Nor area, between the Khlong Luang, the present Bang Pakong, and the present coast, and they resemble in plan the large modern rivers such as the Bang Pakong, which presently drain the flood plain. Although the landscapes around Nong Nor and to the west of the Khlong Luang are markedly different, both visually in the field and on the photographs, it is difficult to define an exact boundary location between these two landscapes. An estimate, however, based on both field and soil patterns, is placed at approximately 0.5 to 1 km west of the Khlong Luang (Fig. 31). The difficulty in locating this boundary exactly suggests that it is gradational with the upper surface of the subsurface sediments which form the submerged topographic highs in the Nong Nor area, dipping on a low gradient towards the west and north. In the west, such a gently dipping surface may represent a gradational margin, possibly along a shoreline, to the submerged topographic high mapped to the east of the Khlong Luang. To the north, this gradational boundary represents the natural talweg of the now infilled fluvial system inferred on figure 31. The pattern of channels implies an approximately northwards direction of river flow, and it may be expected that the elevations of such river channels will become increasing lower towards the north. Such a surface lowering is expected to be of low gradient, and thus an exact boundary is unclear.

The area further to the north is also unclear, partly due to the availability of only small scale (1952, 1963) aerial photographs. On these, the channels of the presumed submerged landscape merge northwards into a large area showing considerably less land surface differentiation and soil characteristics which are typical of those areas with a substantial thickness of flood plain sediment. This area is bounded to the east by a topographic rise, with the boundary between the plain area and the rising upland surface to the east resembling in plan a shoreline; this is the area containing Locations 26, 27 and 28, and bordering the area of Locations 29 to 33 to the east. The entire area to the west of this shoreline-like boundary resembles a large embayment, within which several infilled channel-like features are also apparent. These infilled channels resemble the Bang Pakong- type channels described for the area to the west of the Khlong Luang.

The fourth difficulty in interpretation concerns the levée of the present Khlong Luang. Although the sedimentary evidence is quite clear that there are levée sediments associated with and probably derived from the Khlong Luang (Locations 10 and 14), their location on the aerial photographs is unclear. This partly stems from the fact that the levée provides a slight topographic high in the present landscape, and therefore is a focus for present human occupation; the photographic images of this occupation (field patterns, tree-dominated vegetation, cleared areas, and villages) dominate the image and obscure more subtle characteristics which represent the soil characteristics of the levée. Furthermore, much of the levée sediment is buried and presently obscured by flood plain sediments. Nevertheless, in some areas, an approximate extent of the levée can be indicated. It probably occurs elsewhere (Okhura *et al*. 1989, map it as lying along the full length of the *khlong* throughout the area studied here), cutting across soils and sediment patterns and boundaries such as those discussed above which are typical of former environmental conditions. Its absence on figure 31 along the present line of the Khlong Luang, therefore, cannot be

taken as evidence for the absence of levée deposits.

The final point concerns the synchronicity of the various landscape features identified on the aerial photographs. In the absence of good evidence for cross-cutting of channel features, at least in the area to the east of the Khlong Luang, it is assumed that the identified features belong to a single period of the evolution of this landscape. The fresher-looking nature of the Bang Pakong-type channels to the west and north suggest that they are more recent, although this interpretation is partly founded on the inferred landscape chronology outlined in the discussion which follows. The only evidence for cross-cutting of the channels occurs to the west, where a sandy channel (Location 25 and possibly 23) is clearly cut by a more recent Bang Pakong-type channel.

V. STRATIGRAPHY AND PALAEOGEOGRAPHY OF THE NONG NOR AREA

THE foregoing data provide evidence for a palaeogeographical model of the area around Nong Nor. A summary of the sediments and their vertical and lateral relationships in section (Fig. 32) provides the basic stratigraphic framework within which to place a landscape evolution model (Figs. 33-5). Six geological stratigraphic units are identified (Fig. 32).

Stratigraphic Unit 1: Unit 1 is the bedrock, comprising highly laterised *in situ* and in places highly iron-cemented weathered Palaeozoic metasediments and crystalline rocks. These form the hills to the east of the Nong Nor area, and are generally overlain by thin stony skeletal soils. The exception to this is on the uppermost surfaces where residual, partially cemented brown soils remain. This unit represents a geologically-long period of weathering, most recently concluded with the stripping of most of the soil and regolith products of that weathering, leaving only thin stony soils on the slopes and residual patches of brown soil on the upper more-or-less protected level surfaces of the hill tops. This weathering probably represents millions of years, and may extend back at least into the middle to early Pleistocene if not the Tertiary period. The upper residual soils are relics from that period. The importance of this land surface and its geological nature is that it provides a source of sediment for Stratigraphic Unit 3. Furthermore, given this relationship between Units 1 and 3, it indicates that the hills to the east of Nong Nor supported skeletal soils, and thus probably an impoverished biological environment by the time people were occupying the coast at Nong Nor.

Stratigraphic Unit 2: Unit 2 is the laterised silty clay sediment which underlies the superficial sediments in the low-lying area around Nong Nor. This unit appears to have an undulating upper surface, most of which is now submerged and covered by the sediments which comprise the flood plain (Stratigraphic Unit 5). Although it is unclear, this Unit probably extends above the present flood plain upper surface elevation, and may be present as the fine-grained sediments overlying Stratigraphic Unit 1 and occurring at Location 28. The degree of soil development exhibited in this Unit suggests that the sediments are moderately old, probably being greater than Holocene in age, certainly being older than the soils developed on the sediments of Stratigraphic Units 3, 4, 5 and 6, and clearly being much younger than the soil development of Stratigraphic Unit 1. The sediment size and characteristics analysis is equivocal, but appears to indicate a prograding shoreline origin at least for the upper surface of these sediments. If this is valid, the sedimentary sequences

at Location 4, with the alluvial sand and gravel of Stratigraphic Unit 3 overlying sediments of this Unit, and at Locations 2, 6 and 7 where Stratigraphic Unit 3 sediments underlie the Holocene estuarine sediments of Stratigraphic Unit 4, indicate at least two periods of high sea level. While it may be possible that there has been a double cycle of sea-level rise and fall during the Holocene, with an intervening period in which sea level dropped at least 4 m prior to rising again, evidence from elsewhere in the region does not support such a model. The prograding shoreline conditions which may have given rise to the Stratigraphic Unit 2 sediments, therefore must be viewed as being pre-Holocene in age. If this is the case, it is most suggestive that these sediments are at least Last Interglacial in origin. The importance of Stratigraphic Unit 2 and especially its undulating upper surface, is that it provides a land surface upon which the remaining sediments were deposited, and upon which the human occupants of Nong Nor lived. On the available evidence from this area, this land surface displayed elevational relief of at least 5 m, contrasting it considerably with the present landscape whose elevational relief is generally in the order of 0.5 m.

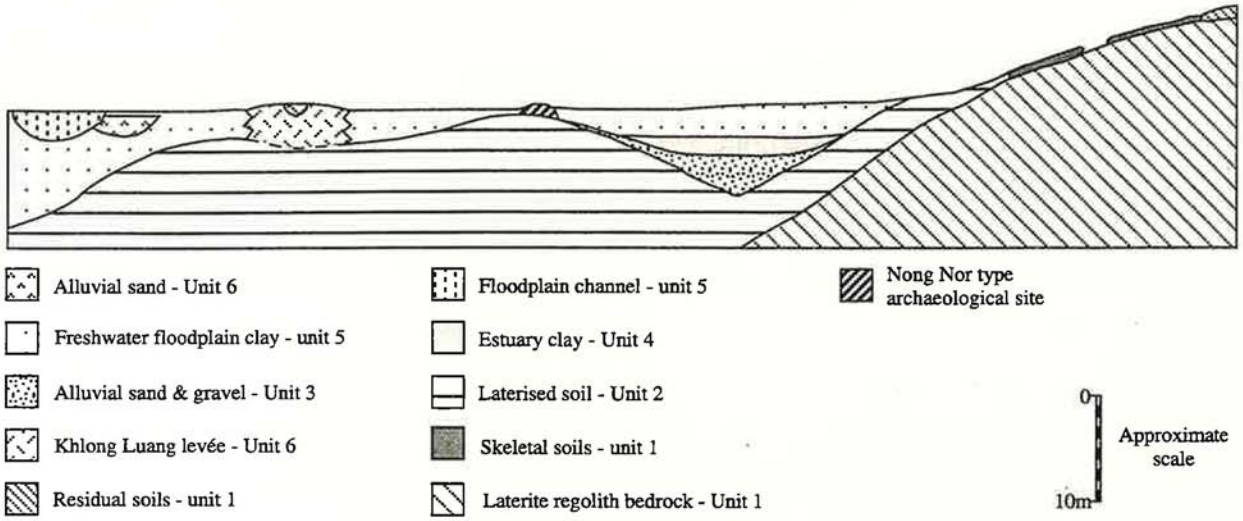


FIG. 32. Summary sketch of the natural sediment sequence stratigraphical relationships in the Nong Nor area

There is, however, a difficulty with this chronological interpretation, since the relationship between the apparently-coastal sediments comprising most of this Stratigraphic Unit and the fine-grained sediments lying above the level of the present flood plain which overlie Stratigraphic Unit 1 at Location 28, is unclear. The latter sediments are probably a dune-like wind-blown deposit, which by an analogy with the sequence of Quaternary events elsewhere in eastern Thailand, probably represents the deflation, during a period of heightened aridity (such as during a glacial period) of alluvium derived from the erosion of bedrock regolith. If this is so, then there are two options regarding the relationship between the two sediments contained in this Stratigraphic Unit. The first is that all the sediments being discussed here belong to the same deposit, and that deposit is early in its formation, and has been reworked in the sub-tidal zone during an interglacial high sea-level period. The resultant distribution of sediments comprise, on the one hand, limited remnants of the

original dune sediment above the elevation of maximum sea-level and, on the other hand, slightly reworked deposits, now forming the substrate of the flood plain, below that elevation. An alternative is that the dune-like sediment is reworked coastal sediments derived from the laterised silty clay sediment underlying the superficial sediments of the plain, and thus represents glacial period modification and partial relocation of prior interglacial sediments. In the absence of evidence for the ages of these two bodies of sediment, this issue must remain open.

Stratigraphic Unit 3: This Unit comprises at least 1.6 m depth of sand and gravel alluvium, interpreted as a river sediment. It occurs within topographic lows in the upper surface of Stratigraphic Unit 2, and the sediments of this Unit are derived from the crystalline and ancient sedimentary bedrock currently outcropping in the hills to the east of this area. The full depth of this unit is unknown, but appears to be an alluvial fill of at least 2 m thickness within the lower points of the undulating landscape of the Stratigraphic Unit 2 upper surface. The relatively coarse-grained nature of the sediments, especially in comparison with the sedimentation on the present canal levées, implies sedimentation of Unit 3 sediments during a period of greater soil and regolith erosion than is occurring at present, and under conditions of higher energy river flow than at present. These characteristics imply that the supply of sediment to the rivers depositing this Unit represents a period of low base level (i.e. a lower sea level than is indicated by Stratigraphic Units 2 and 4 and probably lower than at present) and relative climatic wetness, during which enhanced erosion is evident in the hilly landscape to the east and southeast. This Unit may, therefore, have been deposited during the late Pleistocene interstadial period or during the early Holocene (cf. Pramojanee and Hastings's (1983) wet and warm periods of around 30,000 years before present and from the beginning of the Holocene in this region).

Other than this Unit overlying Stratigraphic Unit 2, it is unclear what the exact relationship between the two Units is. The deposition of this fluvial sand and gravel must have been preceded by an erosional phase in which the channels now containing the alluvium were formed. There is no evidence at present to indicate whether this represents erosion associated with early activity of the coarse-load-bearing rivers associated with the alluvium, or landscape development associated with an earlier period of lower-energy fluvial conditions. Whatever the case, given the general agreement that previous Interglacial sea levels were as high if not higher than the present Interglacial maximum sea-level elevation, this downcutting must have occurred during a Glacial or early Interglacial phase of lowered sea level.

Stratigraphic Unit 4: The sediments of this Unit are fine-grained clay-dominated sediments deposited under estuarine conditions. Sedimentary conditions within the areas underlain by sediments of Unit 3 (river alluvium) changed, possibly after a period of no deposition or greatly reduced deposition, and became dominated by conditions of variable but generally low energy sedimentation, close to land, in an estuary. The sediments of this Unit have not been weathered strongly, reflecting their mid-Holocene age. These sediments are clearly related to the mid-Holocene high sea level.

As discussed above, the local elevation of the mid-Holocene high sea level is difficult to gauge in this region, due to lack of clear eustatic elevation data and the probability that isostatic (tectonic and/or sediment settling) elevational change has occurred in this region. Although it has not been possible to measure the exact elevation of the site above regional datum, the site

lies close to (but elevationally below) the 5 m land surface contour on the 1:50,000 map. While the planar location of such contours, especially on a very low gradient surface is of notably low accuracy, this may be taken as a general guide to site elevation. Assuming a surface elevation of *c*. 5 m above datum at this locality, and a former tidal range similar to that at present (microtidal, range is less than 2 m, around 1.5 m, Sinsakul 1992a: Fig. 14), an estimated high sea level of *c*. 3 m above datum may be inferred for Stratigraphic Unit 4. This Unit is important, since it represents environmental conditions equivalent to those implicated by the archaeological evidence at Nong Nor, and thus may represent natural conditions contemporaneous with the occupation of that site.

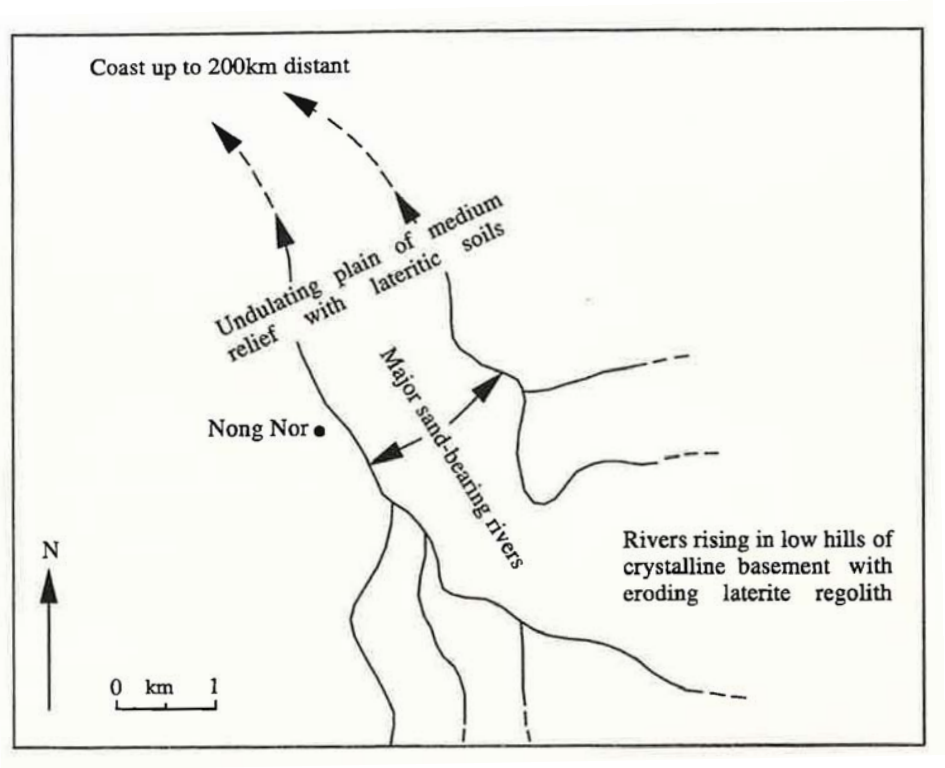


FIG. 33. The palaeogeography of the Nong Nor area: Palaeogeographical Phase 1, Late Pleistocene. Nong Nor was not occupied during this phase

Stratigraphic Unit 5: This unit represents sediments deposited under freshwater flood plain conditions similar to those prevailing at present throughout most of the Bangkok Plain, and includes the thick blanket of blue-grey clays which cover the previous Units and form the upper horizons of most of the soils in the present flood plain area. This Unit includes channel deposits which, while not having been examined in section, are clearly evident from the aerial photographs and have been labelled as the Bang Pakong-type channels, following their planar resemblance to the present Bang Pakong River channel. There is no evidence locally to indicate the reason for a change from estuarine to freshwater conditions, although one or more of several processes may have operated to cause this change: a lowering of sea level; regression of the shoreline due to sedimentation in-

fill of estuaries and coastal embayments; hydrological changes due to the development of coastal barrier(s) seaward of this area. The conditions under which this Unit was deposited include water levels being higher, at least temporarily, then previously, since the clays deposited during this phase infill archaeological sediments presumed to have lain at a higher elevation than the estuary, and eventually blanket the entire landscape. In the process of the formation of this Unit, probably a process of seasonal flooding equivalent to present conditions, landscape relief was considerably reduced, ultimately reaching a low value of 0.5 m local relief. During this period, the landscape included major river channels such as those found now to the north and northwest (i.e. the Bang Pakong River), which have subsequently been infilled and are now extinct. The onset of these conditions brought a habitat unsuited for at least the early phases of human occupation at Nong Nor as a coastal resource site; unless the site had been abandoned earlier for some other reason, it would have undoubtedly been abandoned at the time of this sedimentation change.

Stratigraphic Unit 6: This Unit includes the sandy and clay-rich levée sediments of the Khlong Luang and, possibly, the sandy channel sediments described from the west of the Khlong Luang.

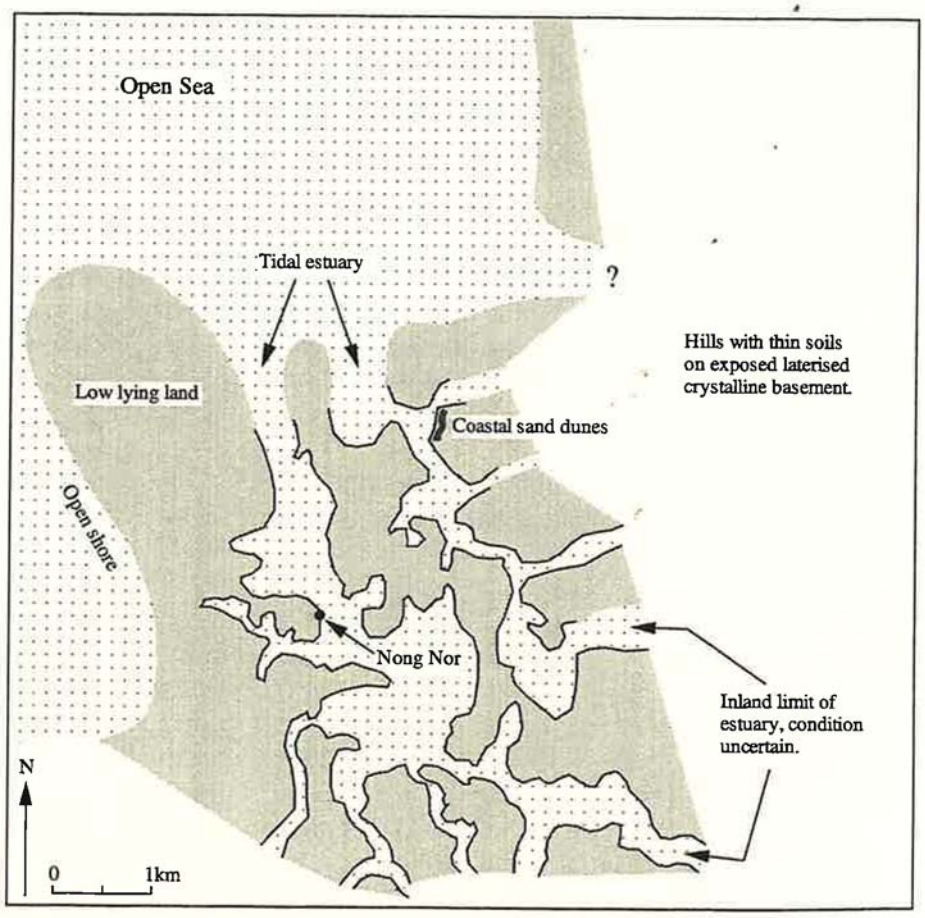


FIG. 34. The palaeogeography of the Nong Nor area: Palaeogeographical Phase 2, mid-Holocene. Nong Nor was occupied during this phase

The exact relationships between these two sandy sediment bodies is unclear, as also is the lower stratigraphic boundary of this Unit. These sediments appear to be contemporaneous with at least part of the Stratigraphic Unit 5 flood plain sediments. The sandy channel to the west is cut by one of the Stratigraphic Unit 5 channels, and must therefore be older than that channel. The Khlong Luang levée, on the other hand, continues to be deposited at present. It may, therefore, be that the western sandy channel represents a former channel of the Khlong Luang, abandoned in favour of the present channel. This, with evidence of the Bang Pakong-type channels, provides evidence for the dynamic nature of the late Holocene drainage of the flood plain, and indicates that while some of the processes of landscape change had largely ceased (in particular the reduction of local relief and microenvironmental variation), the new landscape was still a dynamic one capable of substantial geographical change.

PALAEOGEOGRAPHY OF THE NONG NOR AREA

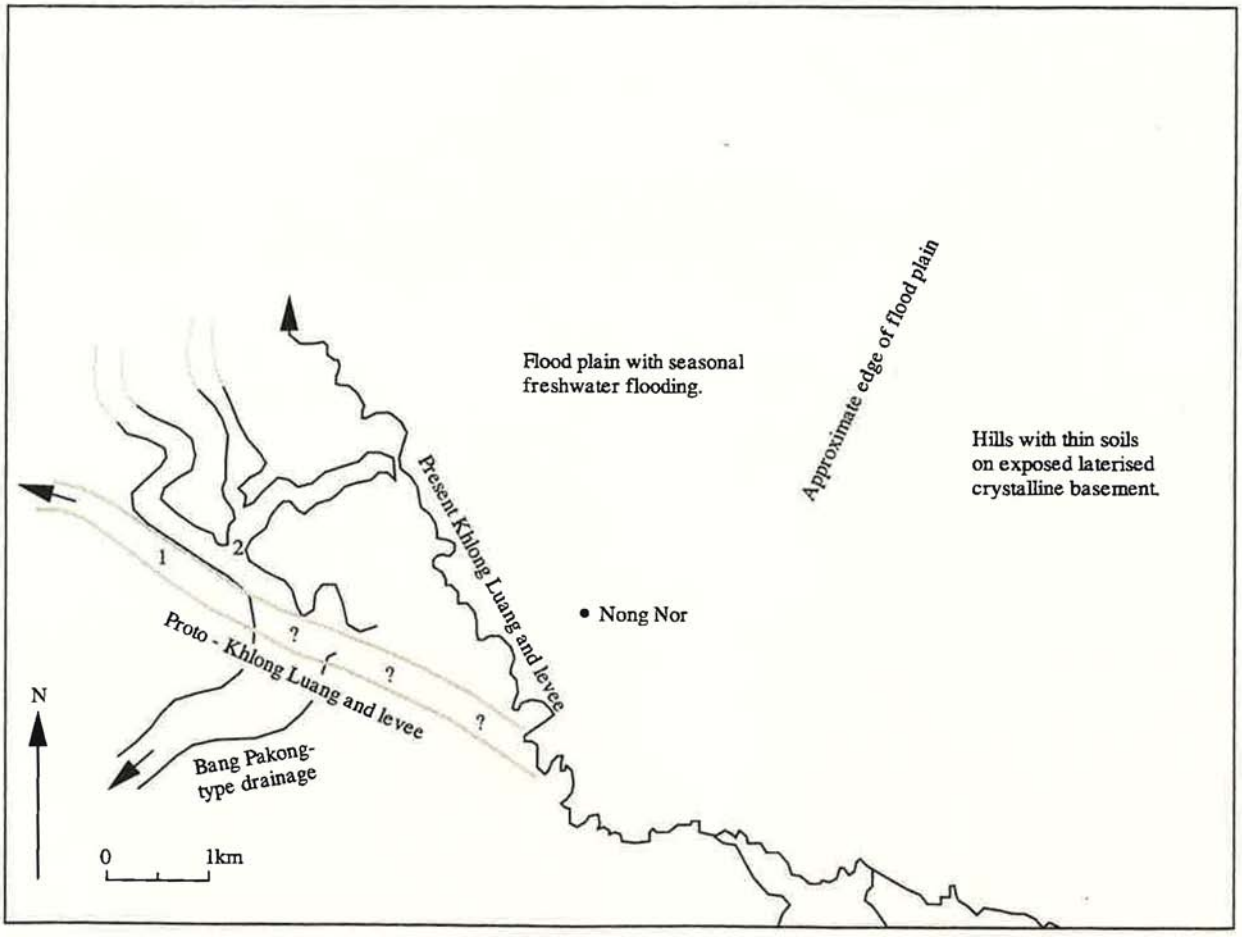


FIG. 35. The palaeogeography of the Nong Nor area: Palaeogeographical Phase 3, mid to late Holocene. Nong Nor was occupied only intermittently during this phase

This stratigraphic assemblage of geological units can also be usefully interpreted in terms of the palaeogeography of the area around Nong Nor. In figures 33-5, which summarise the palaeogeographical evolution of this area, Nong Nor is shown for locational purposes. Its presence does not necessarily imply the prehistoric occupation during the period represented. This palaeogeographical model may be summarised as a series of phases.

Palaeogeographical Phase 1: Probably middle to late Pleistocene. This phase is represented by Stratigraphic Units 1, 2 and 3. Nong Nor lies on an undulating plain some distance (possibly more than 100 km) from the coast. This plain is underlain by a lateritic soil developed on probable Glacial-period deposits reworked in the upper tidal zone during a period of Interglacial high sea level, and probably subsequently eroded during a Glacial or early Interglacial phase of low sea level to form an undulating land surface. The hydrology of the area is, during this period, dominated by large sand and gravel bearing rivers flowing from the hilly country to the east and south. These hills have a crystalline and metasediment bedrock, now deeply weathered and highly laterised, with the regolith from this weathering continuing to be eroded to provide the fluvial bedload being deposited in the channels on this undulating plain. This period of erosion represents the late stage of erosion which has been ongoing since earlier Glacial phases and is probably represented by the low-lying deposits (Stratigraphic Unit 2) which may have been derived from earlier periods of alluvial deposition of the eroded regolith. The soils, now showing signs of laterisation, on this plain probably represent equivalent soils, albeit younger, to those originally found on the hill slopes or at least on low-gradient areas of the landscape. In the hills only small areas of original soil are present on the uppermost protected level surfaces, and generally the hills would have been characterised possibly since the middle Pleistocene and into the late Pleistocene and Holocene by increasingly impoverished edaphic and thus probably vegetational conditions. Human occupation is unknown for this period.

Palaeogeographical Phase 2: Mid Holocene. This phase is represented by Stratigraphic Unit 4, possibly some of the superficial soils and sediments on Stratigraphic Unit 1, and by the archaeological deposits at Nong Nor. It represents the culmination of the sea level rise and shoreline progradation around 3800 years ago (uncalibrated radiocarbon years). To the east of Nong Nor, this resulted in former river valleys being flooded by the sea to form estuaries at the fringe of this former undulating plain. Sedimentation in the area changed in response to this major adjustment in drainage base level (cf. Somboon and Thiramongkol 1992), and became restricted to fine-grained sediment deposition in the centres of the former river channels. To the west and north of Nong Nor, open shore became present, lining the eastern edges of an open marine embayment. Nong Nor now lies on the eastern edge of a narrow (*c*. 1 km wide) spit of land, bounded to the east by an estuary and to the west by open shore. Furthermore, open shore also lies only several kilometres to the north. The estuary shoreline immediately in the vicinity of Nong Nor was variable in nature, with both fine-grained (silty clay) soils of the former undulating plain and the coarser-grained (sand and gravel) of the former sandy river channels exposed at the land surface nearby. In addition to these, fine-grained sediments were being deposited within the tidal area of the estuary itself. The exact location of the upstream freshwater limit of this estuary is not known, but probably lies at least within some 10 km of the site of Nong Nor, and possibly much closer. At the mouth of the estuary, some 4 km distant from Nong Nor, coastal sand dunes were formed, although these

were probably uncommon. This phase represents the period of greatest environmental diversity in the region, and clearly provided a wide range of environmental resources for the prehistoric occupants of Nong Nor.

Palaeogeographical Phase 3: Mid to Late Holocene. This Phase is represented by Stratigraphic Units 5 and 6. It represents the final major phase of landscape development in this region, although by no means represents a phase of invariable environmental conditions on the plain. The dominant environmental process in evidence during the Phase is that of freshwater seasonal flooding, resulting in the deposition of fine-grained clay-rich sediments throughout the low-lying area, infilling topographic depressions and blanketing much of the landscape. This ultimately resulted in the reduction of local relief to the present conditions of a more-or-less horizontal land surface with a local relief of *c*. 0.5 m. Drainage of this flood plain has changed during this period, with there being evidence for at least three probably related phases of drainage in the vicinity of Nong Nor. The present drainage along the Khlong Luang has been altered somewhat by a large amount of recent artificial drainage. Nevertheless, there appears to have been an earlier stage of a similar type of drainage (the proto-Khlong Luang on Fig. 35) which resulted in the formation of a levée similar to that forming at present along the Khlong Luang. This drainage may have fed into a Bang Pakong-type channel, and appears in this area to have been replaced by such a channel as it migrated across the flood plain. Following infilling of this channel, the present Khlong Luang became the main natural drainage channel of this area. There is little evidence indicating the location of a shoreline during this Phase, and either it was migrating towards its present position, or it was replaced rapidly due to some event such as the establishment of coastal barriers. The shift from Palaeogeographical Phase 2 conditions of coastal/estuarine sedimentation to freshwater flood plain conditions may have been moderately rapid. Whatever the case, it resulted in environmental conditions which were unsuitable for the human occupation of Nong Nor as a prehistoric coastal resource site.

ARCHAEOLOGICAL IMPLICATIONS OF THE PALAEOGEOGRAPHICAL MODEL

The implications of this palaeogeographical model fall into three categories: (i) implications derived from the variability of past landscapes in the area; (ii) implications regarding the prehistoric occupation of the Nong Nor archaeological site; and (iii) implications regarding the distribution and location of other archaeological sites.

(i) Variability of past landscapes. It is clear that the landscape of Nong Nor has changed considerably during the Holocene. Of particular interest is the change in the ranges of microenvironments, expressed most cogently in the changes on local relief upon what is now a relatively flat and geomorphologically-featureless flood plain. The early period of known human occupation of this area, i.e. the period of midden construction at Nong Nor, was one in which a wide range of microenvironments was available within a small distance from the site. In addition to the range of estuarine conditions, both in terms of substrate and vegetation, open shore conditions were present within 4 - 5 km by water and closer by land. Freshwater conditions at the upper limit of the estuary were within a few kilometres from the site, and a range of dryland conditions were either within immediate access to the site, within a short distance across the estuary, or a little

further from the site on the hills rising to the east of this area.

A further implication regarding this variability within the landscape is that prior to the onset of coastal conditions around Nong Nor, this region also exhibited a range of dryland environmental conditions supported by extensive freshwater fluvial resources. Of particular note is the greater degree of local relief and the presence of substantial rivers. It may be assumed that the usual range of river valley and interfluvial landscape elements were present during this period. These, combined with the range of local environmental conditions associated with the hills to the east, despite their probable relative impoverishment, would have again provided a locality for human occupation with some considerable environmental potential in terms of resource range and availability.

(ii) Prehistoric occupation of Nong Nor: Implications regarding the occupation of Nong Nor have been introduced in (i) above, especially in relation to the potential range of, and availability and access to environmental resources from this site. Of particular note is the relatively small size of a rich resource catchment required by the occupants of this site, at least during the phase of occupation represented by the construction of the midden. This rich catchment was probably in contrast to the inland areas on the hills bordering this site to the east and south, where soil degradation and probable vegetational impoverishment had been occurring for some considerable time prior to the occupation of Nong Nor. A further implication of this resource richness is that the area around Nong Nor may be expected to have been occupied by quite a large population, and thus other contemporaneous or approximately contemporaneous archaeological sites may be concentrated in this marginal zone of the Bangkok Plain. The second implication concerns the dates during which natural conditions at Nong Nor were suited to an estuarine-based occupation. At present, only one radiocarbon date is available (Wk-2462: 3,770±70 BP (uncalibrated); Location 7), although further dates are presently being processed. The one available date provides a calibrated range of 2451-1976 B.C. for the onset of estuarine conditions in the area, and thus a lower age limit to the occupation of Nong Nor.

(iii) Distribution and location of other archaeological sites. The palaeogeographical model provides an opportunity to assess the distribution of other archaeological sites on the flood plain in this region. This can be done from both the points of view of the spatial and the chronological distribution of archaeological sites in this area, and has a predictive capacity, both in terms of probable site location and establishment of relative site ages. Assessment of figure 34 provides an opportunity, for example, to identify probable locations of sites which are broadly contemporaneous with Nong Nor. In this case, several localities were identified in the field as occurring on or very close to the presumed shoreline during Palaeogeographic Phase 2 (Fig. 36). There are Locations 40, 41 and 43, each of which proves to be a prehistoric site with typical evidence for a former coastal economy. A fourth site close to Nong Nor - Location 42 - neither accords with the palaeogeographical model as a shoreline site nor with the archaeological evidence as a coastal economy site. While there is no evidence regarding the age of this site, the lack of coastal archaeological elements at this site accords well with its geomorphological setting.

The palaeogeographical model provides a possible chronological framework for site location in the region around Nong Nor (Fig. 36). In general terms, this framework contains five main

Geo-archaeological Periods.

Geo-archaeological Period pre-1. This period is equivalent to the pre-Palaeogeographic Phase 2 period, within which there may have been prehistoric human occupation of this then-inland region. Site location is difficult to predict, and depends upon the preferred model of adaptation to the landscape and pattern of resource access and utility. Around Nong Nor it is probable that sites would, had they occurred, been on the topographic rises (interfluves) lying between the sandy rivers which ran through the landscape at this time. Given (i) the apparent lack of sedimentary accumulation (or possible subsequent removal of any sediment accumulated) in the landscape during this period other than in river channels, (ii) the apparent dominance of environmental processes such as weathering and non-accumulation of sediments under the open terrain conditions of the interfluves on the undulating plain, erosion and stripping of loose lateritic soil and exposure of the duricrust at the land surface on the hill slopes, and (iii) marginal erosion associated with the later marine transgression, it is unlikely that archaeological sites would have survived on these now submerged topographic highs on the undulating plain and the surrounding hill slopes.

Geo-archaeological Period 1. It must be assumed that the process of marine flooding of the Palaeogeographic Phase 1 landscape during the transgression associated with the mid-Holocene sea-level rise was a progressional one over a land surface which rose gradually from west or north west to east towards the region around Nong Nor. The upper land surface of the present flood plain between Nong Nor and the coast is a more-or-less horizontal surface, so it must be assumed that the pre-mid-Holocene land surface is progressively buried under increasingly greater depths of recent sediment to the west and north west. Early Palaeogeographic Phase 2 sites may, therefore, be still preserved at depth under this modern surface, although it should be note that submergence of land during a period of rapid sea-level rise is likely to be accompanied by erosion and redistribution of sediments, and that transgressive shorelines are frequently associated with sediment discontinuities, thus tending to mitigate against site preservation. If they have survived, however, such sites would represent the prehistoric coastal occupation of this transgressing shoreline, during the period prior to the occupation of Nong Nor. Such sites are very likely to have been short lived as the early Holocene sea-level rise created a rapidly-transgressing shoreline. As an order of magnitude indication of the speed of shoreline transgression, it is pertinent to note the rate of marine regression during late Holocene times. The present coast is prograding at 4 - 5 m/year (Somboon, 1988: 210), a rate which corresponds well with the rate at which the coastline must have transferred from Nong Nor to the present nearest point on the shore of the Siam Gulf. Assuming a seaward shoreline move of 27 km (the present distance from Nong Nor to the closest point on the coast) since around 5,000 to 4,000 years ago, a rate of >5.4 m/year may be assumed. The rate of early Holocene sea-level rise is generally considered to be much greater than the rate of the late Holocene sea-level fall (*cf.* Fig. 14); from this one may assume that the rate of marine transgression was probably faster in early Holocene times than the rate of the late-Holocene marine regression. Should this be the case, then any early Holocene coastal site would lie more than 270 m seaward of its former coastal location within 50 years. Finally note that the process of marine transgression is not a simple one of the sea flooding over unaltered land. As studies of both the potential transgression of the Bangkok Plain associated present sea-level rise (Somboon, 1990a, 1993) and the realised effects of the mid-Holocene transgression in the central Bangkok Plain (Somboon

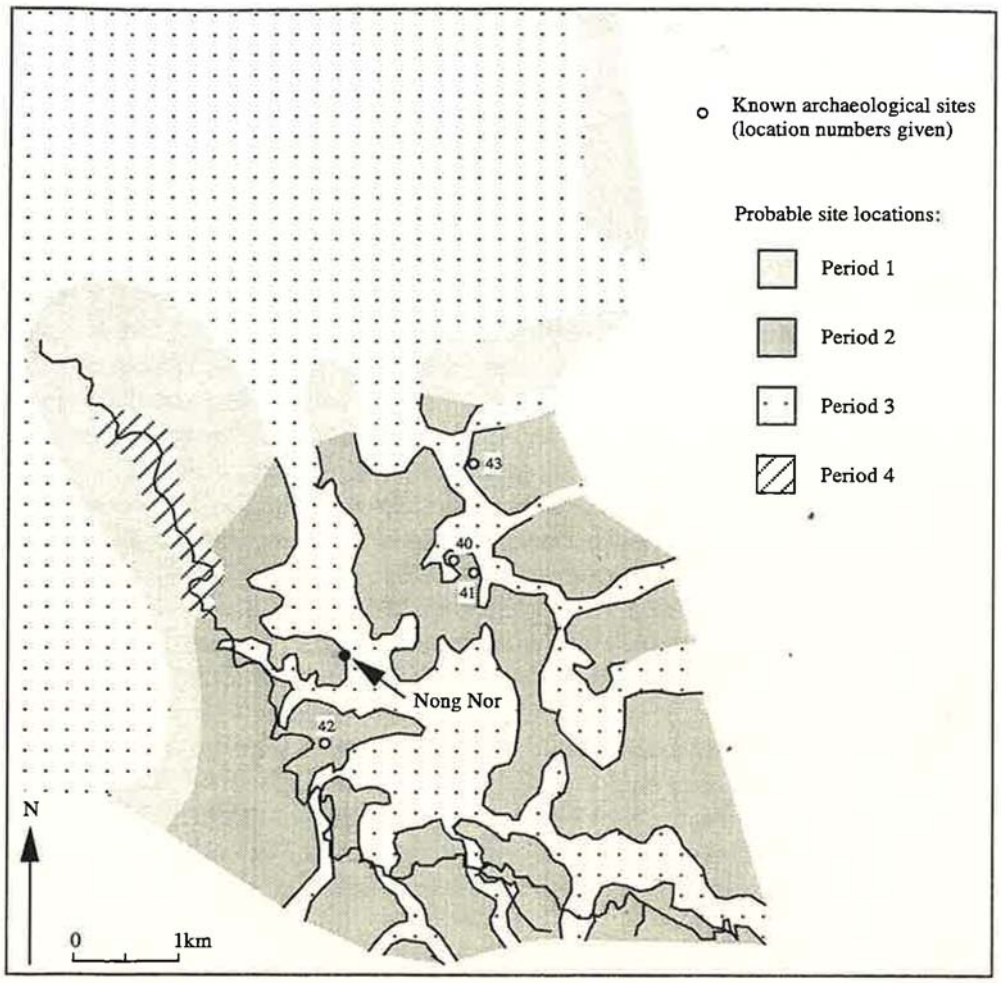


FIG. 36. Geo-archaeological model of the chronological framework for the spatial distribution of archaeological sites around Nong Nor; the distribution of potential Geo-archaeological Period pre-1 sites is not indicated on this map. However, such sites may be expected at depth to the north and west and on the land surface to the east and south. Site 40: Ban Noen Tan, 41: Noen Ta Chan, 42: Ta Tang Guian, 43: Noen Nong Ka

and Thiramongkol 1992) show, the changes which take place represent the complex interaction of sea-level rise, erosion, redistribution of sediments, and changes in water table hydrology and tidal range. The values presented here, therefore, need to be used with caution. Whatever the details, however, the events of this period represent the dynamic processes of coastal occupation which culminated in the occupation of Nong Nor. Locally, if such sites are present, they may be found at shallow depth along and generally to the west and north of the margins of the submerged topographic high depicted as a possible shoreline position on figure 34. Such sites would date from shortly before, if not be virtually contemporaneous with, the occupation of Nong Nor.

Geo-archaeological Period 2. This is the period of the occupation of Nong Nor as a coastal midden site, and represents the culmination of the shoreline transgression at its inland limit. The location of Nong Nor is distinctive. It is clearly a shoreline site, having even been partly eroded by coastal processes operating on that shore. It may be noted also, that the midden lies on the west bank of an arm of the presumed mid-Holocene estuary; to the west is a spit of slightly raised land lying between the site of Nong Nor and the open sea shoreline. Given the dominance of south westerly cyclonic winds at present and the likelihood that such winds were also present during mid-Holocene times, the location of Nong Nor would provide some protection from adverse weather. This geographical advantage would have, of course, complemented the resource access advantage derived from being situated on the estuary margin. The recognition of the probable position of this shoreline allows local prediction of other archaeological sites. The presence of archaeological sites exhibiting coastal components at Locations 40 (Ban Noen Tan), 41 (Noen Ta Chan) and 43 (Nun Nong Ka) appears to confirm this possibility. Indeed Ban Noen Tan and Noen Ta Chan are located in a very similar fashion to Nong Nor on the west bank of another arm of the estuary, suggesting that deliberate prehistoric selection of site locality is in evidence in this area. Furthermore, the placing a little inland from the shoreline, and possibly regardless of the shoreline, of the non-coastal archaeological site at Location 42 (Ta Tang Guian) also supports this model. It is probable that coastal archaeological sites of the antiquity of this period do not occur locally more than several kilometres from Nong Nor: the open shore lies within 2 km to the west, the mouth of the estuary lies within 4 km to the north, the base of the hills rising to the east lies within 5 km to the east and the freshwater upstream limit of the estuary may lie only 5 km southeast of Nong Nor.

Geo-archaeological Period 3. During and following the cessation of estuarine conditions around Nong Nor, the location of the prehistoric coastal-economy sites would have migrated westwards (predominantly) and possibly northwestwards, as the shoreline relocated seaward. Sites of a coastal nature would no longer be expected around Nong Nor, and coastal sites such as that at Location 44 (Khok Phut Saa), lying in the area beyond the western limit of Palaeogeographic Phase 2 dry land are expected to be younger than Nong Nor. In this respect, it is pertinent to note that the major archaeological site at Khok Phanom Di may, on these geomorphological and palaeogeographical grounds, either represent an island site contemporaneous with the occupation of Nong Nor, or be younger than the Palaeogeographic Phase 2 occupation of Nong Nor. Depending on the process of shoreline regression during Palaeogeographic Phase 3, sites may be expected to become progressively younger towards the present shore. Furthermore, assuming the simplest case of a more-or-less constant rate marine regression between the area of Nong Nor and the present coast, the rate of coastline displacement lies in the order of >5.4 m/year (see above); this implies that occupation sites with a strong coastal emphasis would have been relatively short lived. An alternative process which may influence the spatio-temporal distribution of sites in this region is the creation and infilling of channels such as the Bank Pakong-type channel identified to the west of Nong Nor (Stratigraphic Unit 6 and drainage phase 2 of Palaeogeographic Phase 3), which could potentially result in the presence of sites younger than those on the land surface surrounding these former drainage channels. A further complication is evident. There is evidence in various parts of the Bangkok Plain for extensive sandy sediments resembling sandy barriers or sand shores (Nutalaya *et al*. 1984:155, Takaya and Thiramongkol 1982:15, 93). The presence of

these provides both a potentially uneven rate of regression and a variety of landforms and surface elevations in the regression zone. Both features may influence the spread and distribution of the prehistoric occupation of the then-newly-emerging coastal land.

Geo-archaeological Period 4. This period is in many respects a sub-period of Geo-archaeological Period 3, and represents the location of sites on the present levée of the Khlong Luang. This would represent one of the more recent periods of human occupation of the landscape during the later part of Palaeogeographic Phase 3.

OVERVIEW OF STRATIGRAPHIC, PALAEOGEOGRAPHIC AND GEO-ARCHAEOLOGICAL MODELS OF THE NONG NOR AREA

Examination of the sediment and weathering stratigraphy of the region around Nong Nor allows it to be placed within its palaeogeographical context. The stratigraphy of the region can, for this purpose, be summarised into six Stratigraphic Units (Fig. 32). The derived stratigraphic assemblage bears some resemblance to the model of four clastic formations derived by Takaya (1972) to classify the Quaternary outcrops of the southern part of the central plain of Thailand.

Stratigraphic Units 1 to 3 represent pre-Holocene conditions and provide a basement upon which Holocene sediments were deposited. Stratigraphic Unit 1, representing Pleistocene or earlier conditions, comprises the bedrock of highly laterised and, in places, iron-cemented weathered crystalline and metasedimentary rocks, which form the hills to the east of Nong Nor and presumably underlies the superficial sediments in its immediate area. This Unit provides a source of sediment for Stratigraphic Unit 3. Stratigraphic Unit 1 is equivalent to Takaya's Laterite Formation, a 1 - 5 m thick highly weathered (laterised) surficial horizon of the bedrock on this southeastern margin of the plain. Takaya indicates that its distribution is discordant with the present drainage system, and tentatively ascribes an early Pleistocene or late Pliocene age to it; Alekseev and Takaya (1967) and Thiramongkol (1987) correlate this old laterised land surface with similar ones of Plio-Pleistocene age elsewhere. Stratigraphic Unit 2 comprises laterised silty clay sediment, possibly of a penultimate Glacial and Last Interglacial age, which forms the basal superficial sediment in the Nong Nor area. Its upper, undulating and now submerged surface represents a former land surface, formed during the Last Glacial or Early Postglacial period, displaying relative relief of at least 5 m, and was probably subaerially exposed until early to mid-Holocene times. This Unit probably corresponds to Takaya's Formation II or Thiramongkol's (1984) middle terrace, an assemblage of coastal deposits now generally occurring up to several 100 km from the present coast, and characterised by fluvial and marine facies of deltaic origin, with surficial weathering represented by pisolithic iron concretions in the upper 1 - 2 m. The exact mode of formation of Stratigraphic Unit 2 in this case, however, appears to be slightly different, with aeolian processes in evidence. Takaya provisionally dates this Formation as last Interglacial. Comparison with laterite development in sediment sequences elsewhere and consideration of the possible coastal reworking evident in this Unit supports such an age although a previous Glacial age is also implicated here. Stratigraphic Unit 3 comprises sand and gravel alluvium, and represents sediment deposition under sandy river alluvial conditions, possibly during the Late Pleistocene or Early Holocene. This Unit does not have an equivalent Formation in Takaya's scheme.

Stratigraphic Units 4 to 6 represent Holocene conditions, and have the greatest bearing

upon the archaeology of this area. Stratigraphic Unit 4 represents deposition under estuarine conditions during the mid-Holocene high sea level phase, whereas Stratigraphic Units 5 and 6 represent sediments deposited under subsequent freshwater flood plain conditions similar to those prevailing at present throughout most of the Bangkok Plain. These latter Units include the thick blanket of blue grey clay which covers earlier sediments and forms the upper horizons of most of the soils in the flood plain, and the laterally-restricted sandy and clay-rich levée sediments of the present drainage channels and their predecessors. These Units represent overbank and levée sediments typical of those being deposited under the present sedimentary regime, and dating from mid-Holocene times to present. They are equivalent to Takaya's Formation I, marine and brackish water sediments interfingering with fluvial sediments being deposited variously as levée, back swamp or alluvial fan deposits, dated to the Holocene.

This stratigraphic sequence provides the basis for a palaeogeographical model of the region, which can be conveniently summarised into three Palaeogeographical Phases (Figs. 33-5). Palaeogeographic Phase 1, probably dating from the Late Pleistocene, represents Nong Nor as lying on an undulating plain some distance (possibly more than 100 km) from the coast, through which several large sandy rivers flow from hilly country to the south and east, draining a Plio-Pleistocene peneplain whose lateritic soils are being largely removed to expose an extensive area of duricrust. Evidence for human occupation of both the undulating plain and the peneplain surface of the neighbouring hills is not available. Palaeogeographic Phase 2 is the mid-Holocene phase in which sea-level rise and marine transgression resulted in the former undulating plain and, at the upper elevational limits of the sea-level rise, river valleys being flooded by the sea. At the inland limits of this marine transgression, river valleys converted to estuaries, and slopes converted to open shorelines; in the Nong Nor area, this coastal geography expresses itself as estuarine channels close to Nong Nor, flowing into a open sea embayment flanked, to the north and west of Nong Nor by open shorelines. This Phase is most relevant to the archaeology of Nong Nor in that, first, it represents the palaeogeographical conditions under which the original occupants of Nong Nor lived. Secondly, it represents the period of greatest environmental diversity in this region, providing a potentially very wide range of environmental resources within a moderately small site catchment. Palaeogeographical Phase 3 represents mid to late Holocene conditions of freshwater seasonal flooding following the cessation of estuarine and other coastal conditions in this area. This shift in landscape process resulted in the formation of a flood plain of very low relative relief with a surficial drainage system exhibiting a strong sense of variability both in nature and through time. Such conditions would have been unsuitable for the human occupation of Nong Nor as a coastal resource site.

The production of the palaeogeographical model allows archaeological sites in this region to be placed into a locational-chronological framework, summarised in a model of five Geo-archaeological Periods (Fig. 36). This geo-archaeological model serves to assess site locations and ages within the context of the palaeogeography of the region, and may also be used to predict site locations or at least provide geographical limits to the potential locations of sites. Geo-archaeological Period pre-1 is a speculative period pre-dating the Palaeogeographic Phase 2 conditions, within which there may have been prehistoric human occupation of this then-inland undulating plain and the peneplain surface of the neighbouring hills to the east and southeast, but for which the potential for archaeological site preservation is considered to be poor. Geo-archaeological Period 1 represents early Palaeogeographical Phase 2 sites which, if they exist, would be preserved at

depth upon the undulating plain land surface of Palaeogeographical Phase 1. Such sites would represent prehistoric use of the then-transgressing mid-Holocene shoreline, with each site probably representing very short periods of use and occupation. Geo-archaeological Period 2 is the period of occupation of Nong Nor as a coastal midden site. This Period represents the culmination of shoreline transgression at its inland limit in this area, and thus probably is the most stable period of site occupation associated with the prehistoric use of coastal resources in the region. Geo-archaeological Period 3 occurs during and following the cessation of estuarine and other coastal conditions around Nong Nor. In this Period the location of prehistoric coastal-economy sites would have followed the prograding shoreline westwards. Sites of a coastal nature are no longer expected around Nong Nor, and archaeological sites with a coastal signature beyond the western limit of the Palaeogeographical Phase 2 land may be expected to be younger than Nong Nor. Lastly, Geo-archaeological Period 4, a sub-period of Period 3, represents the more recent location of archaeological sites on the levée of the present Khlong Luang, during the later part of Palaeogeographical Phase 3. These types of site, together with potential sites associated with older levée deposits, represent the non-coastal human occupation of a seasonally-flooded plain.

CONCLUSIONS

Consideration of some of the archaeological sites around Nong Nor appears to conform to this locational-chronological framework for the archaeology of the region, and further examination of the sites recorded during the 1984 Bang Pakong Valley Survey may enhance the conclusions reached here. For the moment, these models provide geographical components to the archaeological examination of the prehistoric remains of occupation at Nong Nor and its environs, including identification of potential resource catchment limits, preferred locations for occupation, and the nature and temporal limits for change within the surrounding environment. Furthermore, Nong Nor and other known archaeological sites may now be placed into a relative chronological framework, a framework which, in particular, provides independent support for the notable difference in the dates of occupation of Non Nor and Khok Phanom Di.

VI. THE DIATOM ANALYSIS OF SEDIMENTS FROM LOCATION 2

Christine Pailles

Sixteen samples from the clay-rich deposits recorded at Location 2 were examined for fossil diatoms, these being 1 cm thick samples at the following depths below land surface: 292, 287, 283, 259, 255, 251, 247, 243, 239, 200, 180, 160, 149, 129, 80 and 60 cm (Figs. 37-38). They contain a poor diatom flora, mostly badly preserved due to dissolution. However, sponge spicules are relatively abundant in all samples. Based on diatom assemblages, three units are recognised.

Unit I (292-239 cm). Diatoms are relatively abundant and distributed among 10 to 20 species. The dominant species are *Cyclotella striata (Kütz.) Grun.* and *Paralia sulcata* (Ehr.) Cleve, representing 30-40 per cent and 20-35 per cent of the total flora respectively (Fig. 38). Sub-dominant species are *Nitzschia granulata* Grun., *N. cocconeiformis* Grun. and *Campylodiscus daemelianus* Grun. Based on the accessory species, this unit is divided into two sections. In the lower section (292-283 cm), *Coscinodiscus* spp (*C. argus* Ehr., *C. devius* A. Schmidt, *C. oculus-iridis* Ehr.) are generally fragmented, while in the upper section (259-239 cm) they are largely intact. The upper section also contains the highest frequencies of *Diploneis bombus* (Ehr.) Cleve, *D. smithii* (Breb.) Cleve, *Navicula punctulata* W. Smith and *Trachyneis aspera* (Ehr.) Cleve.

The diatom flora in Unit 1 indicates estuarine or coastal water conditions. *P. sulcata* is an important species in terms of palaeoenvironmental reconstructions as it is common in modern shallow marine coastal waters (Crosby and Wood 1958, Servant-Vildary and Suguio 1988). All species in this unit are reported from locations in the Swan River estuary, Western Australia (John 1983), and a similar assemblage is reported by Tempere and Peragallo (1897-1908) from Kobe Bay, Japan. The presence of neretic and planktonic species such as *Coscinodiscus* spp. indicates the proximity of open sea. Better preservation in the upper section, however, suggests a quieter depositional environment, while the presence of epiphytic species such as *Diploneis* and *Trachyneis*, suggests the proximity of aquatic plants (confirmed by plant macrofossils). The shift in accessory species seems to reflect an environmental change, with conditions becoming quieter and/or shallower.

Unit II (200-120 cm). This unit is characterised by the virtual disappearance of diatoms, and those that could be identified are commonly fragmented and showed signs of dissolution (Fig. 37). Nevertheless, the main species are *P. sulcata*, *C. striata* and *Coscinodiscus* spp. In the upper part of this unit some *Eunotia* fragments are present. The decrease in diatom diversity and abundance in this unit suggests harsh conditions in which diatoms struggled to survive. This could be

explained by an increase in sedimentation rate and/or a water level change.

Unit III (80-60 cm). In this unit diatoms are very rare, although better preserved and more diverse than in unit II. Five *Eunotia* species are present (*E. serpentina* Ehr., *E. dydima* fo. *genuina* Hust., *E. camelus* Ehr., *E. pectinalis* (O.F. Muller) Rabh., *E. praerupta* Ehr.) along with *Navicula mutica* Kütz. and fragments of *Stauroneis*, *Gomphonema* and *Pinnularia*. Both *E. dydima* and *E. camelus* have been reported from Asia (Foged 1978), and with *E. serpentina* are regarded as being indifferent to salinity. Only *E. pectinalis* and *E. praerupta* are freshwater, halophobous species. However, as *Eunotia* species are generally bottom-dwelling species frequently found in peat bogs, their presence probably indicate shallow water conditions.

The diatom flora present here is indicative of estuarine coastal waters in the lower part of the sequence (Fig. 37). The disappearance of diatoms and their poor preservation in the middle part, however, suggests a dramatic change in the depositional environment, with conditions becoming possibly shallower and quieter. The presence of different *Eunotia* species in the top part of the section further reflects the establishment of floodplain or peat bog environment, with little evidence for true freshwater conditions.

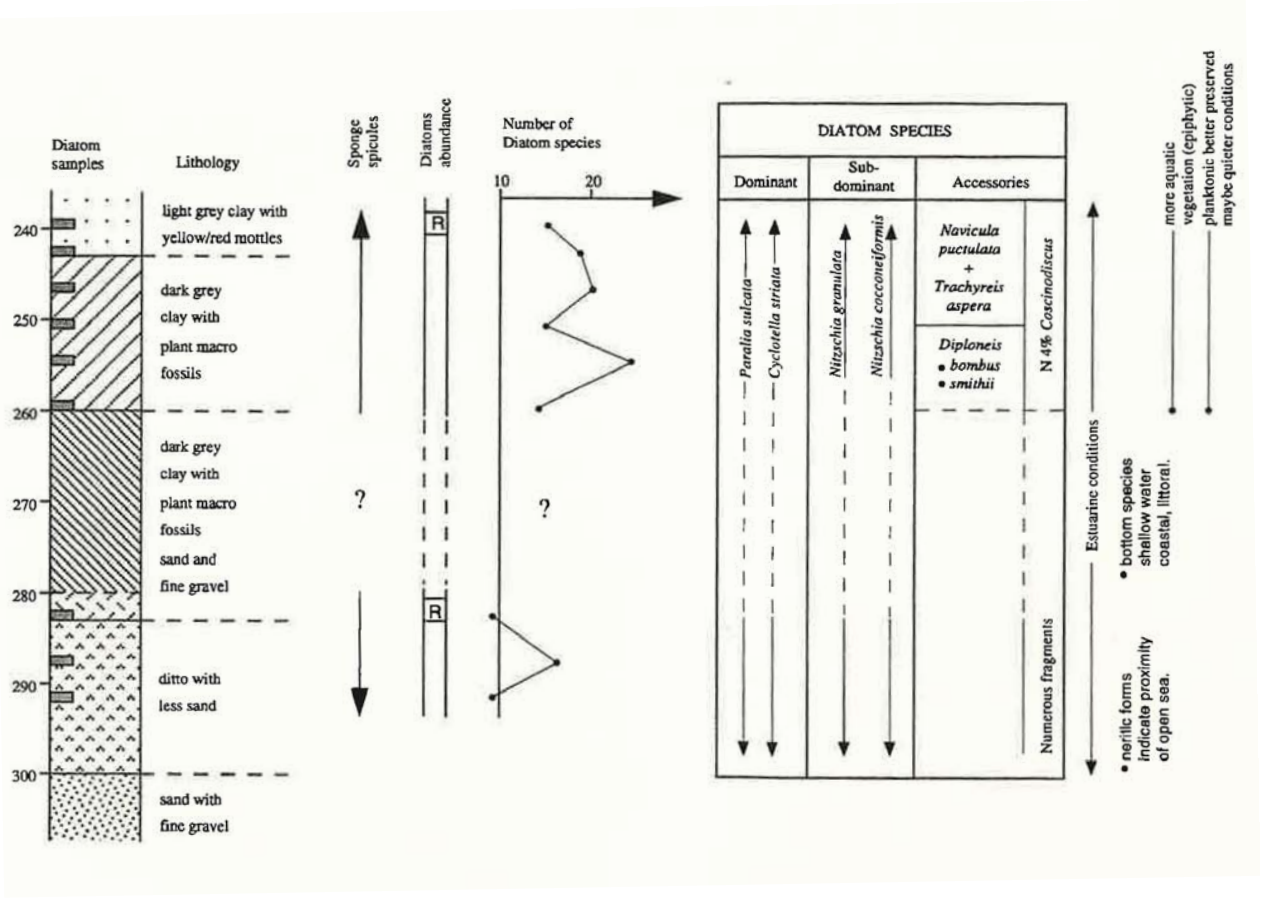


FIG. 37. Summary of the diatom analysis at Location 2

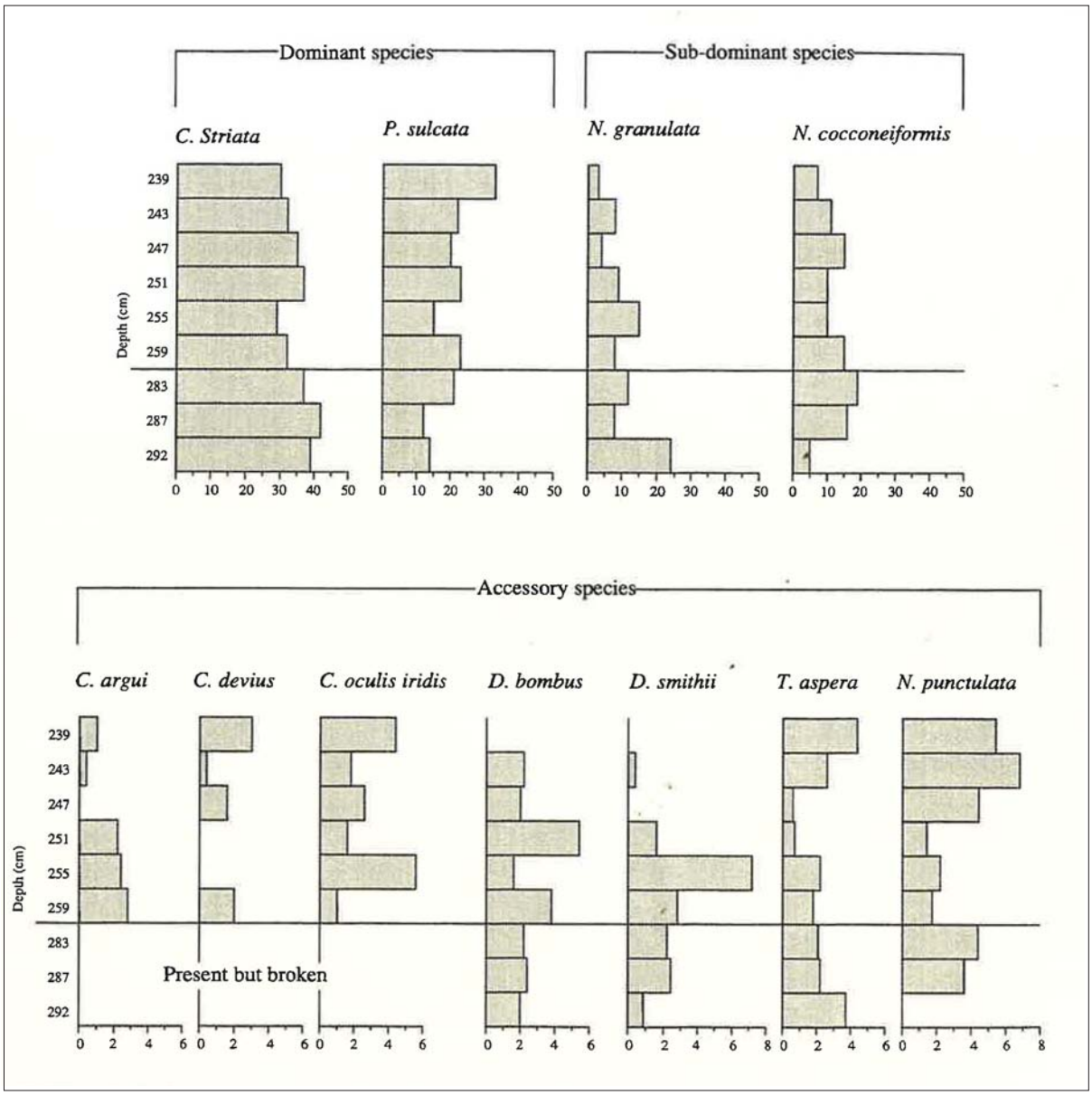


FIG. 38. Details of the diatom analysis at Location 2

SECTION THREE

THE FIRST OCCUPATION PHASE

INTRODUCTION

C.F.W. Higham and R. Thosarat

Nong Nor comprises two distinct phases of occupation. The first has been dated to the mid-third millennium BC. The layers in question comprise solid concentrations of shellfish, among which the bivalve *Meretrix lusoria* predominates, interspersed with lenses of ash and burnt material. There are also spreads of potsherds, which concentrate towards the edges of the midden, and often lie on the natural substrate. Samples from all contexts of the midden were subjected to very fine screening. This involved first drying the material, and then wet sieving. This resulted in the recovery of small fish remains, and micro-gastropods. There were also larger faunal remains, including the remains of dolphins and sharks.

It is clear, from the presence of clay anvils and burnishing stones, that the inhabitants of Nong Nor made pottery on the site. Bone was also converted into fishhooks, awls and possibly weaving shuttles. Sandstone was used to sharpen and grind adzes. One possible burial belonging to this early phase involved interment in a seated crouched position, the corpse being covered with upturned pottery vessels.

This assemblage is, to our knowledge, a unique record of maritime adaptation on the shore of the Gulf of Siam as early as the third millennium BC, and its analysis involves several areas of local and wider significance. In 1985, Bernard Maloney took several cores from the vicinity of Khok Phanom Di, 14 km to the north, and identified periods when there was local burning and the proliferation of grasses and other open indicators (Maloney 1991). These, dated from the third and fifth millennia BC, could result from some form of rice cultivation, from fires generated by hunter-foragers for one reason or another, or from natural conflagrations. Archaeological documentation of the behaviour of the coastal groups in question is provided by Nong Nor phase 1. Did the people, for example, cultivate rice? Characterisation of this coastal culture follows. Were the people sedentary gatherers, whose ancestors had for millennia benefitted from the wealth of their coastal habitat? Our analysis of the material of Khok Phanom Di has revealed a large and permanently occupied estuarine site, dating from 2000-1500 BC. Domestic rice remains there were abundant. Do the inhabitants of this later site represent intrusive agriculturalists, or does their material culture link them with the people of Nong Nor? Indeed, could there have been a local transition to agriculture?

The following section of this report addresses all these issues. Graeme Mason, who was present during all three seasons of excavation, considers the shellfish and fish remains. He sug-

gests that the site was not occupied for long and that it was located on dry ground within range of a mangrove-fringed sandy shore. During the course of the laboratory analysis of the material from Nong Nor, Dougald O'Reilly consulted us over a possible topic for a master's dissertation. We unhesitatingly encouraged him to consider the phase 1 occupation of Nong Nor and most of the rest of the following section of the report contains a modified version of his findings.

Much is concerned with an empirical description of the material culture: the ceramic industry, the preferred decorative motifs on the pots, the lithic industry and the bone working tradition. He then proceeds to consider the spatial distribution of the various artefacts, and finds that there were signficant clusters which probably reflect activity areas. One was for making pots, another for fashioning bone tools. Since these recur throughout the midden deposition, from the top to the bottom of the sequence, he concludes, as does Mason, that the site was not occupied for long. One of the most intriguing of his results is that the material culture of Nong Nor presents many very close parallels with that of basal Khok Phanom Di. Some of the pottery vessels, the adzes and the bone fishhooks are virtually identical between the two sites. He suggests that there was a strong element of cultural continuity from 2500-1500 BC, during which span, rice cultivation was incorporated into the subsistence base and the exotic dog made its appearance.

VII. INTRODUCTION: THE ISSUES AND PROBLEMS

D.J.W. O'Reilly

THE excavation of Nong Nor has provided an opportunity to examine the archaeological remains of a third millennium B.C. coastal occupation located on a marine embayment. This is the only such site excavated on the raised shores of the Gulf of Thailand. Yet Nong Nor falls into a broad grouping of coastal settlements which are found on raised beaches from Northern Australia through East and Southeast Asia to Japan.

Although 'shell middens' are well known in Southeast Asia and have been investigated since the early twentieth century, we have little, if any, knowledge of a range of basic and important cultural variables including the duration of occupation, and whether it was seasonal/intermittent or permanent. We know little of the use of internal space or the range of subsistence activities. These sites may have been agricultural or may represent a transition to agriculture, including rice. Pottery and polished stone adzes have often been found, giving rise to the use of the term "Neolithic".

In approaching these issues, the occupation deposits at Nong Nor may provide evidence for the duration of the occupation. Were the stratigraphic profile to include one or more sterile layers, for example, it might indicate episodic abandonment. The length of the occupation phase may be related to the amount and changes in the material culture, especially the form and decoration of pottery. The recurring utilisation of activity areas would suggest continuity of occupation, whereas widely distributed areas of activity used only once may represent episodic occupation.

The excavation procedure involved recording the horizontal and vertical location of each artefact. This permitted the consideration of groupings of artefacts, both stratigraphically and horizontally, which may indicate specific activity areas. The analysis of these data allows the interpretation of intrasite spatial dynamics, in which various production areas, such as pottery and bone tool manufacture, may be identified.

The possibility of the cultivation or collection of rice will be explored. Evidence for the use of rice in archaeological contexts postdating *c*. 2000 B.C. is abundant in Southeast Asia. Phytoliths, grains and husks have been found in soil samples, coprolites, and preserved stomach contents at Khok Phanom Di, and were used as a temper in prehistoric pottery at many sites including, Ban Kao (Sørensen and Hatting1967), Ban Na Di (Higham and Kijngam 1984:73) and Ban Tha Kae (Rispoli 1992:130).

Through the analysis of the material culture a picture of the settlement at Nong Nor *c*. 2400 B.C. will be presented. There is, however, a second level of abstraction to be considered, which places Nong Nor in a regional perspective. Boyd (above) has shown that the site was located on

the edge of an extensive marine embayment, while Mason's findings also suggest dry land. The consensus is that the inhabitants were able to exploit a wide range of marine and mangal resources. When Boyd's reconstruction is considered in conjunction with the results of the Bang Pakong site survey undertaken in 1984 (Higham and Thosarat 1994), an interesting pattern may be perceived. Sites identified during the survey are found on similar promontories around the same embayment. This location would have facilitated access to the various resources available. Khok Phanom Di itself is located 14 km to the north and commanded the estuary of a major river, an environment which, during the initial stages of occupation was similar to that of Nong Nor (Higham and Thosarat 1994).

From the initial occupation, the inhabitants of Khok Phanom Di exploited local clay in pottery production. Net weights, fishhooks and harpoons were found in the early contexts and stone adzes indicate participation in a regional trade network, as the raw material was unattainable locally (Pisnupong 1988). Fish, shellfish, crab and turtles dominated, although terrestrial species were also represented including, pig, dog, deer and macaque. In the uppermost strata the marine species ceased to occur and mammalian remains associated with a swamp/woodland environment became predominant. Of particular interest, is the amount of cultivated rice recovered (Thompson 1996). It was found in the occupation layers as well as in mortuary contexts and the chaff was used as a temper in pottery manufacture, indicating local availability.

How does Nong Nor relate to Khok Phanom Di, situated only 14 km away? The possibility that the former is ancestral to Khok Phanom Di needs to be explored. Was the material culture of the latter rooted in a local tradition, represented at Nong Nor? This relationship can be evaluated on the basis of the ceramics and the form and function of all aspects of the material culture from both sites.

The evaluation of Nong Nor need not be restricted to the immediate region, but could include a much broader perspective. Wider issues include the origins and spread of rice cultivation. The inhabitants of Nong Nor were, on available evidence, unfamiliar with rice, which contrasts with its abundance at Khok Phanom Di. It is necessary to consider the possibility that rice cultivation was established around the Gulf of Thailand between 2400-2000 B.C.

The extent of the midden as revealed through excavation is displayed in figure 12. It is apparent that the edges of the site have been uncovered at the northern, eastern and northwestern margins. Test pits two, four and six revealed thin concentrations of shell, while the other two did not. The western extent of the midden is not known, as permission to excavate was declined by the landowner. We may only speculate that the trend of thinning found in Q1 continues and that the site does not extend much further. A fair estimate of the site size based upon these assumptions would be 700-1000 m^2 or 0.07-0.1 ha (Higham, above).

The environment around Nong Nor was characterised by great diversity, marine, estuarine and terrestrial zones all being represented. During the initial occupation phase the site was located on the eastern margin of a spit of land about one kilometre in width, the western side probably comprising a sandy beach, washed by the open sea. The eastern margin of the spit was bounded by an estuary (Fig. 34). The mouth of the estuary is estimated to have been located about four km to the north of the site and brackish water would have extended less than 10 km upstream. This rich catchment of variable micro environments contrasts with the inland areas, especially the hills located to the southeast, where soil degradation and vegetational impoverishment was probably

occurring.

Not only does the palaeogeographic reconstruction provide an understanding of the local environment, it allows for the prediction of other site locations, based upon suitable environmental conditions. Ethnographic research among the Gidjingarli of coastal Arnhem Land, Australia, revealed that a supply of fresh water was the primary determinant in site location, followed closely by the absence of mosquitoes (Meehan 1982:26). These insects breed well in mangrove swamps and mudflats, but are less prolific during the dry season in these environments. Among the Gidjingarli, site locations are chosen to take advantage of breezes which disperse the insects (*ibid*. 1982:26). Proximity of other less essential resources seems to play a limited role among the Gidjingarli, for it is not uncommon for the residents of a coastal camp to range 20 km during a foraging day and return to the base camp by nightfall (*ibid*. 1982:40).

Further ethnographic investigation among the Chaw Lay of Southern Thailand, has revealed that the exploitation of coastal environmental niches is hierarchical (Rogers and Engelhardt 1997). These maritime hunter-gatherers primarily prefer beach landfalls, behind which either the land rises sharply or is low and flat. The vegetation complex in these environments is defined as strand forest, incorporating plants which tolerate salt spray and poor soil. The most common of these is the coconut palm. The second type of coastal niche exploited by the Chaw Lay are mud flats and mangrove swamps, composed mainly of *Rhizophora* and *Avicennia*. These people rely heavily on the sea from which they take fish and various other marine species. Although fish play a large part, shellfish are the most important aspect of the Chaw Lay diet (*ibid*. 1997:7). There are also two main types of settlement among these peoples, temporary camps and base camps. The former are utilised by few people, one to three boatloads, for short periods of time. Base settlements are larger and capable of supporting year-round occupation. These sites will usually be located on a raised beach adjacent to a mangrove lagoon (*ibid*. 1997:11).

The archaeological remains at Nong Nor reflect closely the habitats preferred by modern hunter-gatherers in coastal Thailand. The presence of other, possibly contemporaneous sites, near Nong Nor corresponds to the model of shifting hunter-gatherers. Archaeological sites, which are of a marine adaptation, are located at Ban Noen Tan, Noen Ta Chan and Noen Nong Ka (Fig. 36). According to Boyd's palaeogeographic model, all were ideally situated for the exploitation of the open sea-estuarine habitat.

VIII. THE CERAMIC ANALYSIS

D.J.W. O'Reilly

IN order to address the issues raised above, a detailed analysis of the material culture excavated at Nong Nor has been undertaken. Of all artefacts, pottery is the most indicative of duration and continuity at the site due to its variability. The ceramic assemblage was also valuable in the comparative analysis with Khok Phanom Di, the results of which are presented in a later chapter.

METHODS OF POTTERY ANALYSIS

The methods and procedures used in the analysis and classification of the ceramic assemblage will follow four steps:

1. A definitive statement of the guidelines which determine the study.
2. A statement of the objectives which are to be achieved through the analysis.
3. A delineation of the sample to be studied and an explanation for its selection.
4. A definition of the attributes to be used in the pursuit of the objectives stated in the second step (Sokal and Sneath 1963:1, Egloff 1979:41).

Guidelines:

Perhaps the most important guideline to be adhered to is that the scheme employed should be as free as possible from investigator bias. A second consideration is the need for clearly-defined units and objectives "with a broad enough base to exploit fully the information content of the data" (Egloff 1979:41). A clear statement must be made, that the problem to be addressed is the classification and analysis of a specific body of material in as concise a manner as possible. The procedure is never to be regarded as an exercise in taxonomy in which the archaeological facts become submerged and lost. Other aspects which should be considered are the ability to repeat the classification and obtain the same results. There should also be as little room as possible for ambiguity in the forms which result from the classification procedure. With this general framework in mind we may turn to the second step

OBJECTIVES

The analysis of the ceramic remains from the midden at Nong Nor was carried out to address a number of questions. These include the duration of occupation and the periods of use; was occupation seasonal or continuous over a certain period of time? Did the same group inhabit

Nong Nor continuously or was it used successively by different people? Another line of inquiry is the relationship between Nong Nor and Khok Phanom Di, a site in close proximity but separated by half a millennium. Major differences in the pottery forms between the two sites may indicate a different cultural affiliation, a situation which has far reaching implications. The site will also be placed in perspective on a wider regional scale. Other sites in Vietnam, Cambodia, Malaysia and Thailand of similar antiquity will be examined. The possibility of assigning Nong Nor to one of the prehistoric regional culture groups needs to be explored. The ceramic assemblage clearly plays a significant role in the interpretation of intra- and inter-site relationships.

In addressing these problems, it was necessary to isolate the basic attributes of the ceramic sample. Once established, the attributes which singly or in combination provided the most relevant information, were identified. Forms and motifs were defined using the attributes elucidated later. These forms and motifs will be used to identify chronological change or areal differences within the ceramic sample. Changes stratigraphically may indicate a longer period of habitation by one group or successive habitations by varied groups. It shall be determined whether the ceramic evidence suggests a seasonally utilised site or one which was occupied continuously for a short period. Areal differentiation may indicate specific use/habitation areas within the midden and possibly suggest social differentiation.

The areal distribution of the rim forms and decorated sherds is examined in chapter XII. This aspect is of interest, as it may indicate specific use areas which could be complemented by the presence of other artefacts. The continued use of specific areas through the stratigraphic sequence would tend to indicate a shorter duration of occupation than would widely spread distribution, as people tend to use the same areas for various activities during continuous occupation of a site (Meehan 1982:116).

THE CERAMIC SAMPLE

A large sample of pottery was returned from Nong Nor after three seasons of excavation. Since much of the site was disturbed by Bronze Age burials, it was deemed important that only pottery representing the initial occupation phase be examined, to avoid the possible inclusion of intrusive artefacts. A judgement sample was therefore utilised. The site plan was consulted and it was decided that Areas 4, 5, 6, 8, and 14 of the1993 season offered the best opportunity to examine undisturbed cultural material.

ATTRIBUTES

Having selected the material to be examined, initial sorting was undertaken. This involved examining all the sherds and separating the various categories: rims, bases, decorated, cord marked, diagnostic, scraped/cord marked and plain sherds. Thereafter the rims and decorated sherds were subjected to a typological analysis. The sherds in all categories were both counted and weighed during the sorting procedure to provide an accurate accounting of the amount of material present. Each area of excavation was examined individually, being broken down into units and stratigraphic layers. The sherds were laid out on tables in this manner to facilitate the recognition of patterns (Fig. 39).

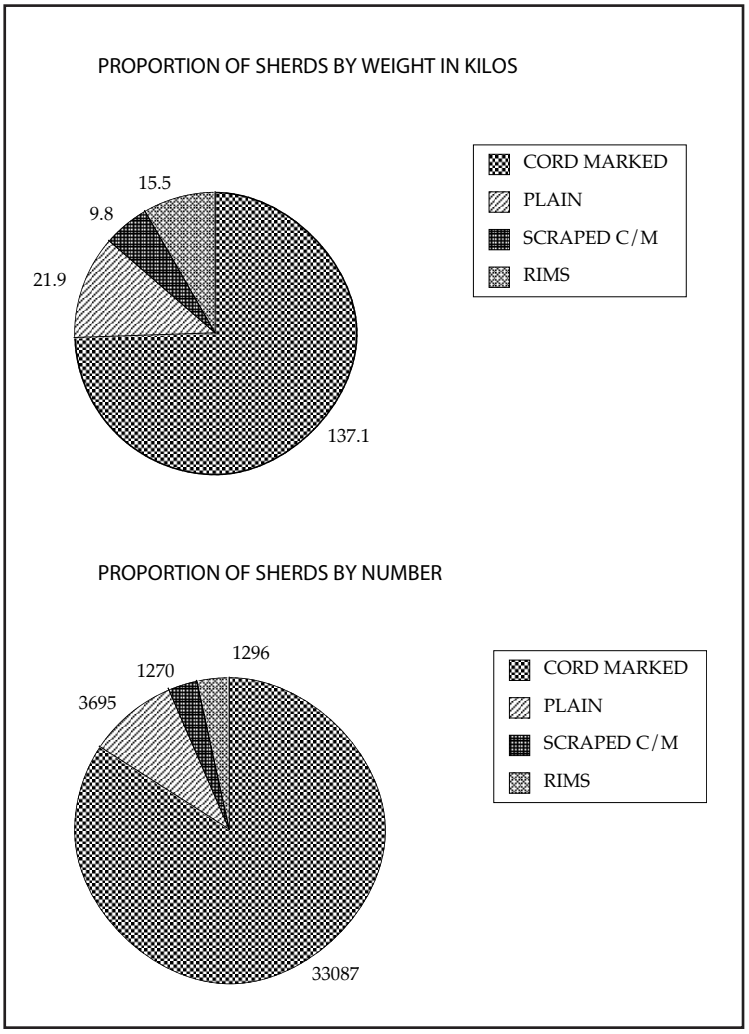


FIG. 39. The count and weight of various sherd types

Rims

Each category of sherd was dealt with individually, necessitating the creation of some form of typological classification for the various components. Rim sherds were considered following Irwin's (1985:103) typology of Mailu ceramics. Only 'complete' rim sherds were used, in that the lip portion had to be present with no exfoliation on either the interior or the exterior. The first attribute was rim direction: everted, inverted or direct. The second was rim profile which was divided into six possibilities: a simple parallel profile, a gradual thickening to the lip or a gradual reduction to the lip, abrupt thickening or abrupt reduction to the lip and, lastly, a single fold at the lip or a rolled fold. The third attribute was lip shape in which there were seven variations, rim contour unchanged at the lip, either flattened or rounded rim contour changed at the lip, either flattened and

flaring out or flattened and flaring in. Other variations of lip shape included rim contour changed at the lip, being rounded and flaring out or rounded and flaring in. The last variation was a changed contour at the lip, flaring both out and in (Fig. 40). The spatial and stratigraphic distribution of the rim forms are seen in figures 46-7.

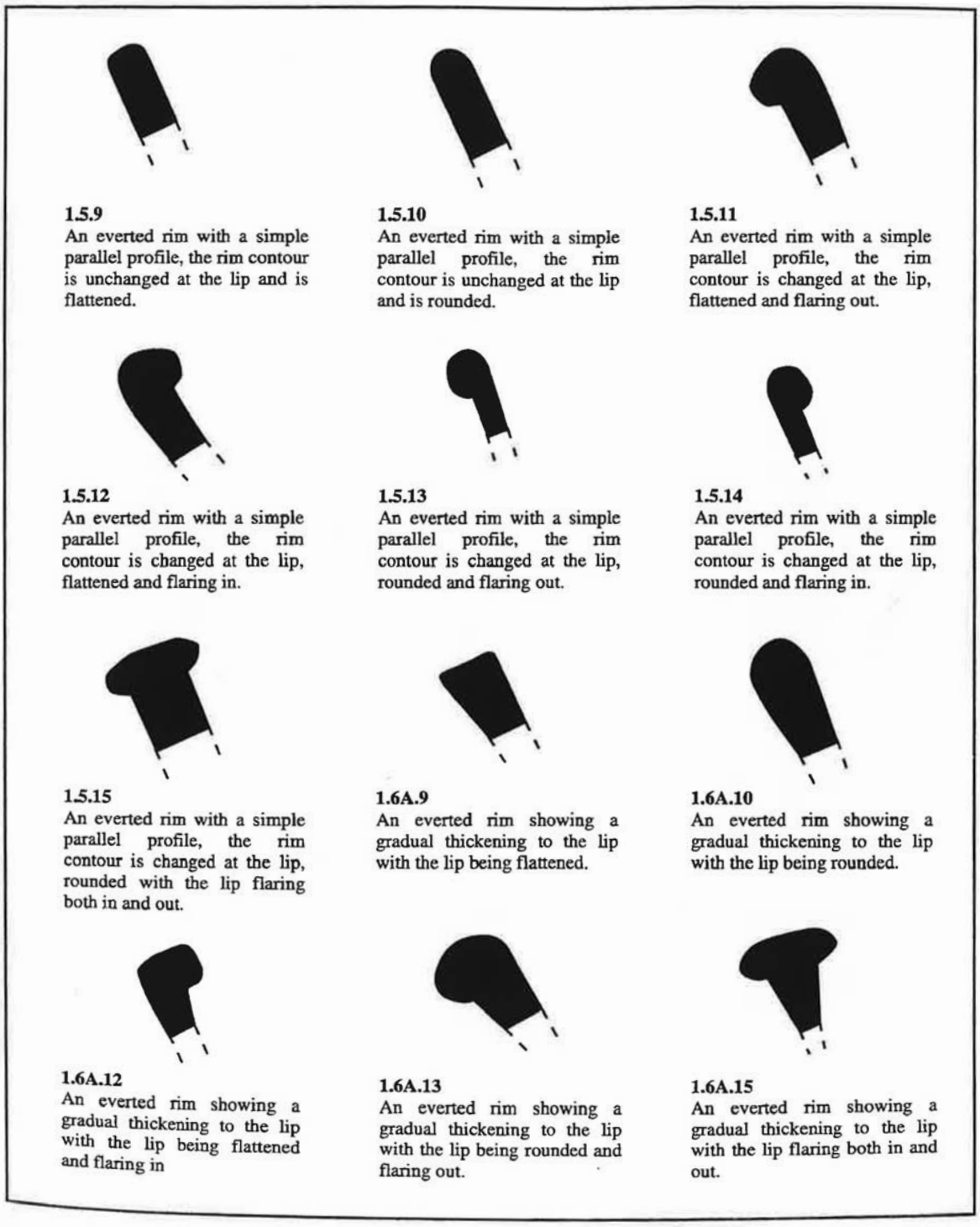
Each rim sherd was examined on the basis of this typology in order to determine the number of forms present. It is stressed that the term "form" is employed when describing the classified rims, as only shape in profile was considered and not the fabric of the rim sherds. The number of different rim forms and the number of rims in each stratigraphic layer for each unit and area excavated during 1993 were entered into a database. A total of 1,296 rims were examined and assigned one of 36 possible forms which, along with the corresponding numbers of rims of each form are displayed in table 4.

TABLE 4: *The number of rims of each form*

Rim Form	Number of Rims	Rim Form	Number of Rims
1.5.9	57	2.6A.10	40
1.5.10	79	2.6B.10	3
1.5.11	37	3.5.9	35
1.5.12	14	3.5.10	31
1.5.13	54	3.5.11	20
1.5.14	9	3.5.12	6
1.5.15	9	3.5.13	12
1.6A.9	10	3.5.14	3
1.6A.10	46	3.5.15	4
1.6A.12	25	3.6A.9	1
1.6A.13	6	3.6A.10	10
1.6A.15	2	3.6A.11	2
1.6B.9	9	3.6A.12	27
1.6B.10	70	3.6B.9	5
1.6B.11	15	3.6B.10	8
1.6B.13	29	3.7B.13	1
1.8A.10	592	1.8A.14	3
2.5.10	7	1.8B.10	15

The decorated sherds, having been separated from the rest of the sample, were subjected to a similar typological classification as the rim sherds. The decorative techniques found on archaeological pottery are expressive representations of the community that produced them, representations which may have been internally generated or influenced by external factors. They may also be regarded as cultural markers, susceptible to chronological and spatial definition.

Each sherd was examined and classified on the basis of the decorative technique and the type of



1.5.9
An everted rim with a simple parallel profile, the rim contour is unchanged at the lip and is flattened.

1.5.10
An everted rim with a simple parallel profile, the rim contour is unchanged at the lip and is rounded.

1.5.11
An everted rim with a simple parallel profile, the rim contour is changed at the lip, flattened and flaring out.

1.5.12
An everted rim with a simple parallel profile, the rim contour is changed at the lip, flattened and flaring in.

1.5.13
An everted rim with a simple parallel profile, the rim contour is changed at the lip, rounded and flaring out.

1.5.14
An everted rim with a simple parallel profile, the rim contour is changed at the lip, rounded and flaring in.

1.5.15
An everted rim with a simple parallel profile, the rim contour is changed at the lip, rounded with the lip flaring both in and out.

1.6A.9
An everted rim showing a gradual thickening to the lip with the lip being flattened.

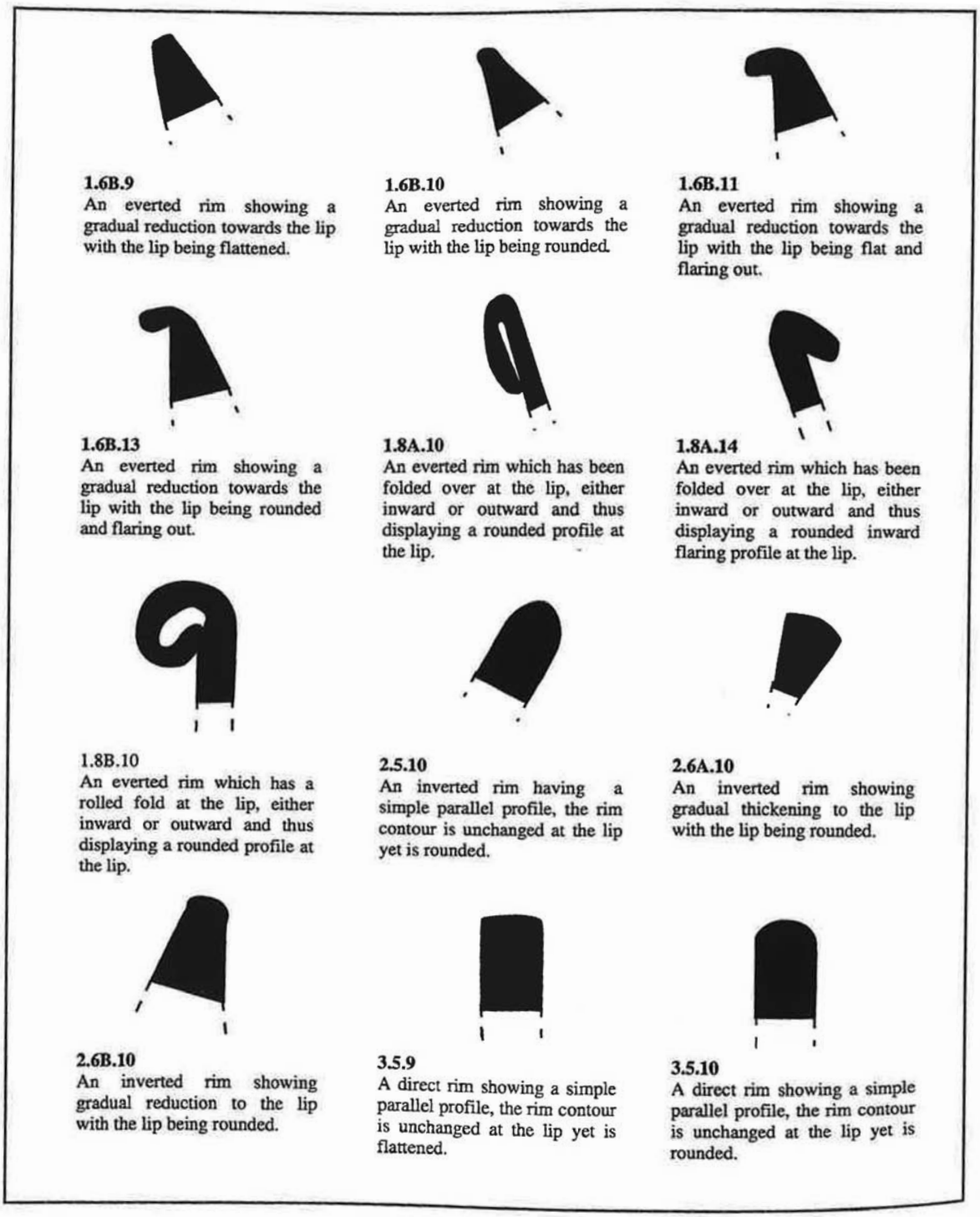
1.6A.10
An everted rim showing a gradual thickening to the lip with the lip being rounded.

1.6A.12
An everted rim showing a gradual thickening to the lip with the lip being flattened and flaring in

1.6A.13
An everted rim showing a gradual thickening to the lip with the lip being rounded and flaring out.

1.6A.15
An everted rim showing a gradual thickening to the lip with the lip flaring both in and out.

FIG. 40. The rim forms from Nong Nor



1.6B.9
An everted rim showing a gradual reduction towards the lip with the lip being flattened.

1.6B.10
An everted rim showing a gradual reduction towards the lip with the lip being rounded.

1.6B.11
An everted rim showing a gradual reduction towards the lip with the lip being flat and flaring out.

1.6B.13
An everted rim showing a gradual reduction towards the lip with the lip being rounded and flaring out.

1.8A.10
An everted rim which has been folded over at the lip, either inward or outward and thus displaying a rounded profile at the lip.

1.8A.14
An everted rim which has been folded over at the lip, either inward or outward and thus displaying a rounded inward flaring profile at the lip.

1.8B.10
An everted rim which has a rolled fold at the lip, either inward or outward and thus displaying a rounded profile at the lip.

2.5.10
An inverted rim having a simple parallel profile, the rim contour is unchanged at the lip yet is rounded.

2.6A.10
An inverted rim showing gradual thickening to the lip with the lip being rounded.

2.6B.10
An inverted rim showing gradual reduction to the lip with the lip being rounded.

3.5.9
A direct rim showing a simple parallel profile, the rim contour is unchanged at the lip yet is flattened.

3.5.10
A direct rim showing a simple parallel profile, the rim contour is unchanged at the lip yet is rounded.

FIG. 40. The rim forms from Nong Nor (cont.)

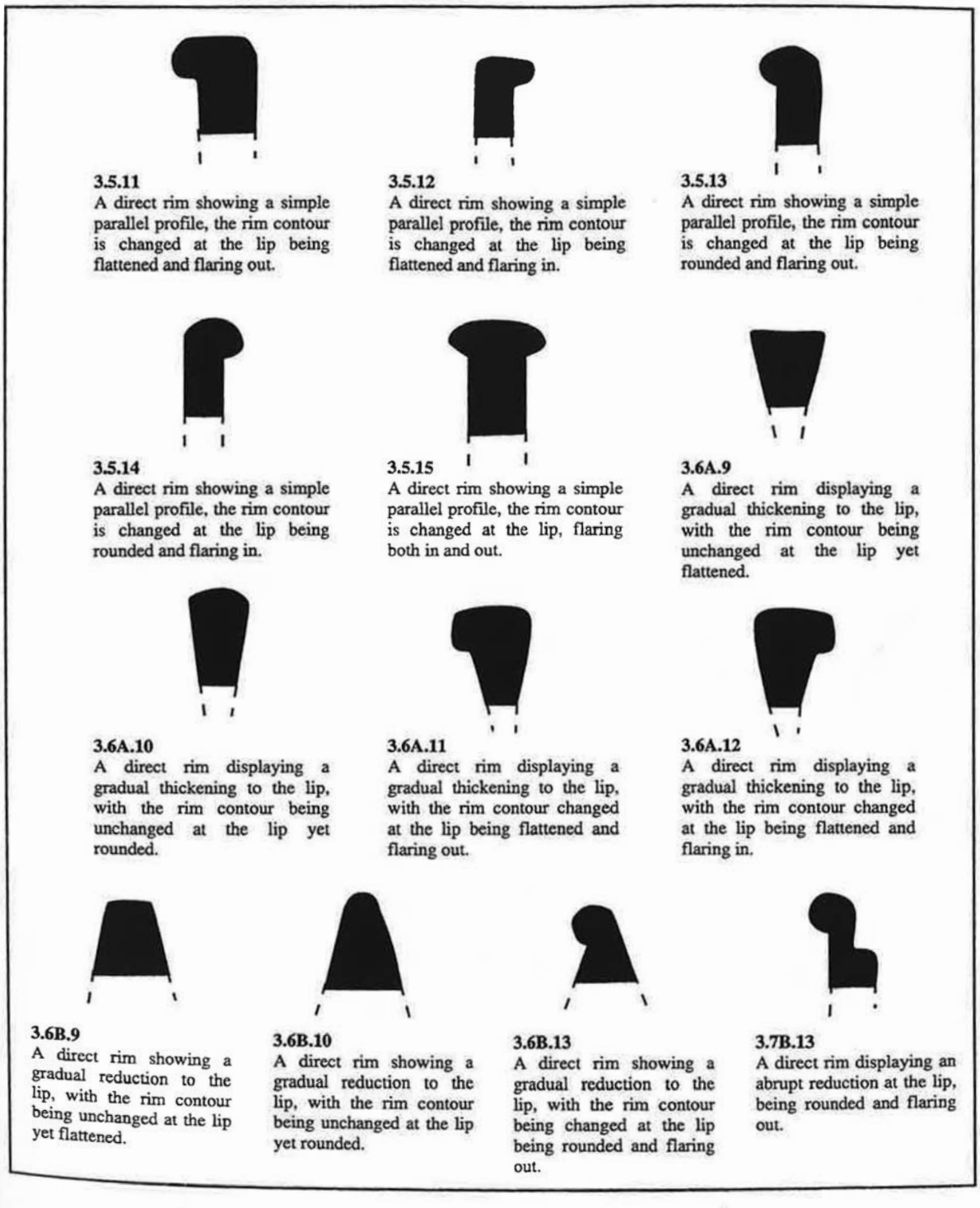


FIG. 40. The rim forms from Nong Nor (cont.)

sherd. These sherds were then drawn individually and all of the pertinent information including provenance was entered onto a description form to maintain a record of design in graphic form (Shepard 1956:256). Nine decorative techniques were defined, which could be found either alone or in combination. Due to the quantity of cord-marked sherds, these were omitted from the categorisation of the decorated sherds. A detailed analysis of the width of twine marks and other quantitative data present on cord-marked sherds was beyond the scope of this research. The decorative techniques excluding cord-marking are:

1. One or more incised lines, created by using what appears to be a sharpened object such as a stick or stalk of grass.

2. Combed concentric rings, created by using an implement which consisted of a variable number of comb teeth and dragging it around the vessel when it was in a leather hard state resulting in evenly-spaced incised lines.

3. Incised, cross hatching, zig-zags, waved lines and short single incisions.

4. Punctate/dentate decoration, in which depressions were punched into wet clay with a sharp instrument (Rice 1987:145).

5. Painted sherds refer to those to which a pigment was applied either before or after firing.

6. Slipped sherds are those which have had a fluid suspension of clay and/or other materials in water applied before firing (Rice 1987:149) and were identified by the thickness and texture on the sherd.

7. Stamped sherds have impressions made on them through the use of rollers or stampers to create repeated patterns.

8. The creation of a smooth matte finish has been considered here as a decorative element as long as it was present on the outer surface of the sherd. The added effort of creating a finish on a pot by polishing the leather hard surface with a smooth implement such as a stone legitimises the inclusion of this technique as a form of decoration. Sherds were not highly burnished, but demonstrated a higher degree of surface treatment than plain sherds. Those which demonstrated a plain matte finish on the inside were excluded as this may have been done for functional reasons, such as reducing permeability (Hall 1993:264).

9. Paddle impressed pottery is that which has negative impressions of a carved design resulting from the use of a carved or wrapped ‘paddle’. The cord-marked sherds could thus be classified as paddle impressed because they were created through the use of a stick or paddle which was wrapped in twine. This was the only type of paddle impressed design found on the ceramic assemblage studied, as there was a complete absence of carved paddle designs. Only those cord-marked sherds which had other decorative elements were included. Each of these decorated sherds was numbered and bagged separately for future reference.

TABLE 5. *Decorative techniques on Nong Nor pottery*

Type	Description
1a	Single incised line
1b	Combed multiple concentric rings
1c	Incised multiple rings
1d	Other incised decoration
1ad	Single incised line with other incised decoration
1a2	Single incised line with dentate stamping
1a4	Single incised line, painted
1a7	Single incised line with burnishing
1a9	Single incised line with shell impressions
1bd	Combed multiple concentric rings with other incised decoration
1bd4	Combed concentric rings with other incised decoration, painted
1b2	Combed multiple concentric rings with dentate
1b4	Combed multiple concentric rings with paint
1b7	Combed multiple concentric rings with burnishing
1b9	Combed multiple concentric rings with shell impression
1cd	Incised multiple rings with other incised decoration
1c8	Incised multiple rings with cord marking
1c9	Incised multiple rings with shell impressions
1d4	Other incised decoration with paint
1d7	Other incised decoration with burnishing
1d9	Other incised decoration with shell impressions
1ad9	Single incised line with other incised decoration and shell impressions
1bd2	Combed multiple concentric rings with other incised decoration and dentate
1bd9	Combed multiple concentric rings with other incised decoration and shell impressions
1d49	Other incised decoration with paint and shell impressions
2	Dentate
4	Painted
5	Slipped
7	Burnished
8	Paddle impressed
9	Shell impressed

The various decorative techniques were represented by numerical and alphabetic characters to facilitate the processing of this information (Table 5). Each assignation represents an element or the "simplest regular parts" of decoration which would combine to form a decoration motif on a whole pot. The concept of the element has been especially useful in the study of sherds because a small part of the design shows in the fragment when the motifs and structures do not (Shepard 1956:266-7). The combination of these numerical and alphabetic assignations would then form

a motif. There are, however, some problems to be considered when dealing with fragmentary pottery remains, as analysts often disagree on what constitutes an element (Rice 1987:257). An element in the present study may be defined as a single aspect such as stamping or punctate with a plain matte finish which contribute to making up a motif. A single punctation may be seen as an element, whereas more than one may be interpreted as a motif, provided the entire field of design is observable.

One of the primary aims of categorising the rim sherds was to understand temporal and spatial variation. Therefore, the frequency of the different types of rim form and decoration type was established for each stratigraphic layer (Figs. 45-6). The presence of particular rim forms or decorations throughout the sequence may indicate continuity of occupation by one group. Evidence for the gradual increase of the number of particular forms or patterns may indicate a longer span of time, as these cultural traits gradually come into wider use (Brainerd 1951:301-13). Similarly, the introduction of new design techniques in conjunction with the continued use of other forms would also tend to support the case for a longer occupation.

The problem of the classification of 'other incised decoration' remains, because these represent parts of motifs, separate design elements which have been combined. A review of these partial motifs is most interesting in that there is a broad range of patterns. Forty nine sherds with 'other incised decoration' were found in the 1993 excavation. A similar combination of decorative elements is present on only a few of these sherds. Overall there were 18 vessels which were decorated with more complicated 'other incised decoration' represented in the 1993 excavated area, assuming that the partial motifs identified all come from different pots. These incised decorations are described below and are illustrated in figure 41.

1. Curvilinear designs were the most popular and appeared on 16 sherds. These designs are found on plain backgrounds (n=5) and in conjunction with impressions (n=11).

2. Another more popular combination of elements was two parallel lines between which is an undulating incised line which rises and sinks to touch both the upper and lower incised lines alternately.

3. A series of three or more parallel lines running horizontally, juxtaposed by evenly spaced vertical lines was a design found on three sherds. A similar pattern with slight variations was found on two others.

The other partial motifs were represented by fewer than four sherds and were therefore deemed to be of limited use in determining the constancy of decoration style, areally or stratigraphically. A description of these designs may, however, be useful in comparing the Nong Nor assemblage with other sites in Southeast Asia.

4. The first design may be described as two parallel lines joined by a series of evenly-spaced diagonal lines. The parallel lines are very close together (4mm, n=3).

5. Another partial motif comprised two sets of parallel lines in between which there was a row of small z-shaped stamps on a slight angle (n=1).

6. Two parallel lines, between which parallel diagonal lines were mirrored although not adjoin-

ing, (n=3).

7. One impressed sherd was retrieved which had a wave-like design running across the impressions.
8. Two zig-zag lines which match one another (n=1).
9. Four parallel lines, in between which three undulating wavy lines are incised (n=1).
10. Incised zig-zag through which a straight incised line ran (n=1).
11. Parallel wavy lines 3 mm apart. Just below the lip of the rim there is a line of small impressed markings (n=1).
12. Two parallel lines between which crosshatching is incised. Below this is a single angular line and a single straight line. In between these two, diagonal lines are incised, connecting the two. There is another straight line below these elements (n=1).
13. Two parallel lines enclose a wavy undulating line which does not touch the parallel lines (n=4).
14. Four straight parallel lines, the bottom two of which are connected by evenly-spaced vertical lines (n=1).
15. Some of the incised decoration was executed with little evident care, one sherd was simply scratched, resulting in short horizontal lines. Another sherd is decorated with two horizontally running lines over the top of which are scratched diagonal lines.

Plain Sherds

Plain sherds were not included with the decorated sherds, but were counted and weighed. These are thought to have been formed in one of two ways. A plain smooth paddle may have been used in beating the clay in conjunction with an anvil which resulted in the formation of a smooth, plain surface. Alternatively, a cord-wrapped paddle may have been used to join the coils of the pot and a further process of smoothing the exterior was carried out, perhaps using a burnishing stone. The presence of many partially smoothed cord-marked sherds attests to the use of the latter technique. The variation in the amount of plain pottery stratigraphically was tested, as was the variation in distribution horizontally, by examining the frequency of occurrence by layer and area.

The plain sherds may derive from pots which were partially cord marked and therefore represent a decorative technique. Alternatively, they may come from pots with some form of decoration or from pottery which was exclusively plain. The absence of any complete cord-marked pottery vessels negates the possibility of assigning the plain sherds to one of these categories. The proportional relationship between cord-marked and plain sherds in each layer, however, suggests some connection. There is a ratio of about five cord-marked sherds to one plain, consistently through the sequence. The presence of cord marking on the folded rim form leads to the conclusion that there was a zone of plain decoration upon the vessels. Yet when one considers the number of rims exhibiting plain, smoothed surfaces the significance of this relationship is diminished.

Cord-Marked Sherds

The majority of the ceramic material recovered from Nong Nor comprised cord-marked body sherds. Their distribution stratigraphically is therefore important in the interpretation of the site. Cord-marking is a result of the potter beating the exterior of a vessel with a wooden paddle which is wrapped in an organic material, such as twine. The result of this action is a negative impression of the twine on the vessel surface. The purpose of cord marking may be both decorative and utilitarian. The twine better serves to join coils during manufacture and the resulting texture makes for easier handling.

Analysis of the cord-marked body sherds was limited to counting and weighing in order to determine the quantity of pottery present. It would have been possible to examine the width and depth of cordage marks but the lack of any comparative data from other sites in the region would limit the value of any results. Variation in the amount of cord-marked pottery was tested against the stratigraphy, as was variation in distribution horizontally, by examining the frequency of occurrence by layer and area.

Scraped/Cord-Marked Sherds

Scraped cord-marked sherds are those which demonstrate both cord-marked and plain smoothed surfaces. It is apparent that the pots from which they come were first beaten with a cord wrapped paddle and later scraped with a hard implement, such as a burnishing stone, to produce a smooth or partially smooth surface on part of the sherd.

Diagnostic Sherds

The sherds categorised under this heading comprise those which have significant angulation present. The zone of interest included the collar, the throat and a portion of the body (Rice 1987:213). Only those sherds which had a significant section of the body and collar remaining were selected for measurement. A protractor was used to measure the angle from the outside surface of the collar to the body. As each sherd was measured, the provenance and surface decoration was recorded. From each excavation unit, only sherds which were determined to be from different vessels, based upon the decoration, colour and temper were selected. Although not a foolproof method, a significant degree of overlap was eliminated.

In attempting to recreate vessel morphology, orifice diameter was examined where possible. Rim sherds measuring over 5 cm in length were deemed to be large enough to estimate rim diameter. Each sherd was placed on a board which had several concentric rings representing orifice diameter. The diameter was recorded along with the presence and form of decoration, the provenance and rim type. The information compiled was then categorised by rim form, so that all the rim diameters for one rim form could be examined. These values were then converted into the circumference for each sherd measured. The median was also calculated for the circumference. The sample of 5 cm rims from each rim form was then subjected to the Shapiro-Wilks test to ensure the sample was normally distributed.

A sample of each rim form was then selected at random from the population of like rims. This sample was 15 per cent of the total. The length of these rims was then recorded and the median calculated. The mean circumference of pots from each rim form was then divided by the average length in the sample to estimate the number of rim sherds that would be present in a pot. The total number of rims for each type was then divided by this figure to arrive at an estimate of how many pots with a certain rim form were present in the area excavated at Nong Nor in 1993. The results

provide a rough estimate of the number of whole pots that are represented by the fragmentary rim sherds. It is impossible, however, to account for pots that were removed from the site through various activities in prehistory.

Bases

This ceramic category consists of the robust rings which attach to the lower portion of a vessel, although there is an alternative base represented at Nong Nor which will be examined below. Very few bases were recovered during the 1993 excavation. Considering the durable construction of

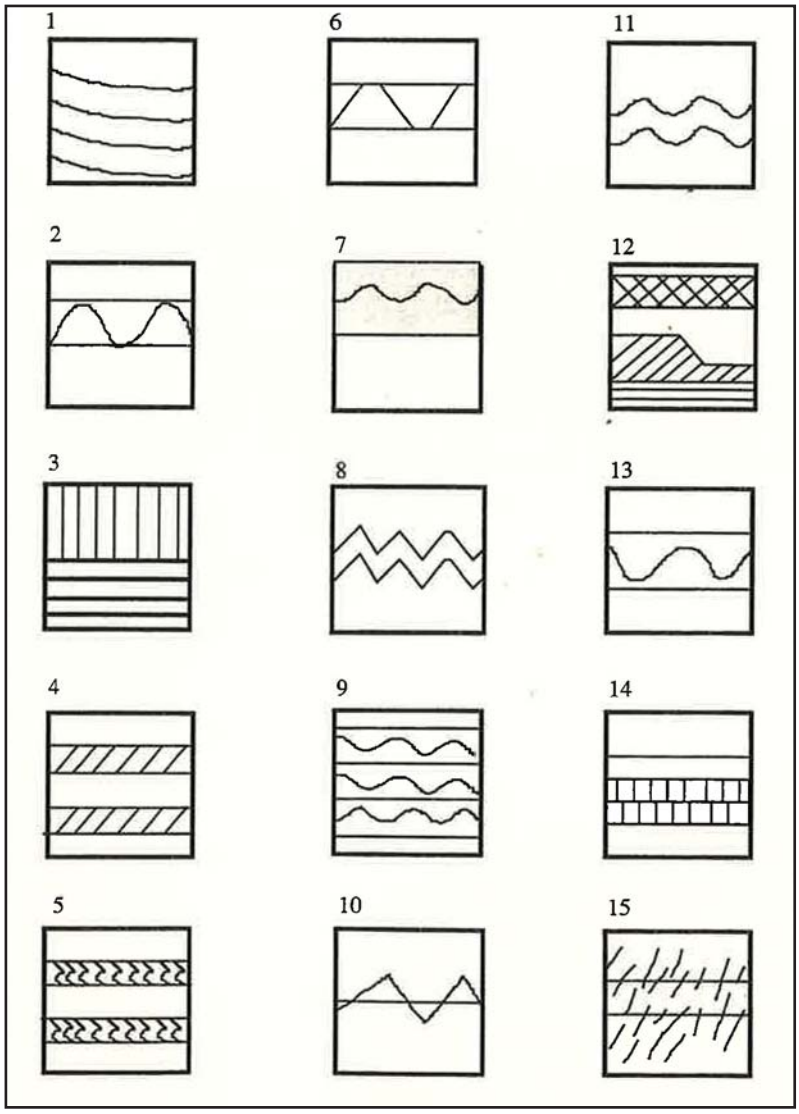


FIG. 41. Decorative patterns at Nong Nor

this portion of a pot, this would suggest that relatively few vessels were equipped with a base. The lack of sherds exhibiting 90˚ angles and the absence of completely flat sherds inevitably leads to the conclusion that the majority of pots had a rounded bottom.

RECONSTRUCTED VESSELS

There were several partially reconstructable vessels retrieved from the occupation deposit. Although many come from areas other than those excavated in 1993, it was felt that, due to the scarcity of information on vessel form and the secure provenance of the vessels in a phase one context, they should be included.

A beautifully decorated vessel (cat. 110) comes from Area 1, unit A, Layer 2:2, which was excavated in 1991. It is a bowl-shaped container of quartz-sand temper, with a 22 cm diameter, decorated half way down its exterior surface. The rim form is 2.6A.12, inverted with a gradual thickening to the lip which flattens and flares inward. The interior of the vessel has been smoothed to a considerable degree. The decorative motif consists of nine combed rings, below which there is a stamped pattern. Through the stamped pattern runs an incised zig zag the interior of which is plain. Below the stamping is another set of seven incised rings. The rest of the vessel exterior has been smoothed and no evidence of cord marking is present (Fig. 42E).

The undecorated lower portion of a vessel was retrieved from Area 12 on the surface of the midden (cat. 941). The exterior and interior have both been smoothed. The slope of the walls is dramatic, suggesting it was a bowl. There is also evidence for a base ring (Fig. 42B).

A very fine, thin-walled vessel was recovered from Area 1, unit A, level 2:1 (cat. 31). All that remains of the pot is a carinated portion. There is evidence of decoration in the form of an incised line above which is a zone of dentate stamping (Fig. 42D).

The remnants of a large ceramic vessel came from Area 7 (cat. 294), on the surface of the midden. Unfortunately it is difficult to assess the shape of the vessel from the remaining portion, although it seems to have a bulging shoulder, above which are 14 combed incisions. The areas above and below these incisions are smoothed plain. Another ceramic fragment recovered from Area XI Layer 2:1 is identical in form and decoration to this vessel. It is possible that they are from the same pot as these areas of excavation are adjacent (Fig. 42C).

A miniature cord marked vessel was recovered from Area 4 in Layer 2:2 (cat. 1279). The pot is round bottomed to all appearances and cord-marked over most of the surface. The area leading up to the rim is plain. Unfortunately the rim is missing. (Fig. 42A)

A complete cup-like vessel was found in Area 7, Layer 2:1 (cat. 836). It is 4.7 cm high. The rim form is 1.5.10, everted, parallel and rounded at the lip. The outer surface is decorated. The rim has been smoothed and then a band of six incised rings has been applied with a comb. The rim projects slightly over the body, which is stamped. There is a strong possibility that this vessel was fitted with a base of some kind as there is an exfoliated circular zone on the bottom (Fig. 42F).

ANVILS

A number of clay anvils, used in the manufacture of pottery, were recovered during excavation

over three seasons (Fig. 43A-F). Anvils are the implements which are applied to the interior of a vessel during construction to counter the paddle used on the exterior. At Nong Nor the paddle was very often cord wrapped. This process serves not only to join the coiled clay but also rids the clay of any remaining air pockets, which may cause explosions during firing. These artefacts were examined by Spiers (n.d.) and the results below are a result of his research.

The majority of the anvils were fragmentary, consisting of 15-50 per cent of a complete anvil. The minimum number of individual (MNI) anvils was calculated using diagnostic similarities, temper and colour resulting from firing temperatures, as discriminatory elements. The total number of anvils recovered, based on the findings of the MNI, was 42. Due to the fragmentary nature of the artefacts it was only possible to identify the shape of some of the specimens. Twelve were circular, nine were ellipsoid and two were circular with handles. The spatial distribution of the various anvil shapes is discussed in chapter XII.

All anvils contained silica as the major tempering element. There was some differentiation apparent in the size of the quartz fragments in the artefacts when they were examined microscopically. The significance of this differentiation is indeterminate, possibly indicating different sources of sand used in the tempering process.

The presence of anvils in the midden, along with pot sherds demonstrating evidence for the coil building of pottery and cord marked sherds confirms beyond doubt, that these vessels were hand built.

OTHER CERAMIC ARTEFACTS

A number of ceramic artefacts were recovered for which a purpose can not be confidently assigned. Two conical clay objects, (cats. 1023, 1018, Fig. 43I-J) were found in Area 8/14 and Area 14 respectively, both in undisturbed contexts. These measure 2.9 cm in height and have a diameter of 4.5 cm. One of them is slightly sloped on one side. Another conical artefact was recovered from Area 8 on the surface of the natural substrate. It is much smaller than the other two, (height 1.6 cm, diameter 1.9 cm) but demonstrates a similar sloping found in cat. 1018. All lack surface decoration. Possible uses include, pot stands or gaming pieces. A similar conical artefact, made of stone is described from a cave at Chande, Thailand, which measures 4.0 cm in height and a diameter of 5.5 cm (Sørensen and Hatting 1967:65, 75).

A clay pellet (cat. 333) was found in Area 3 unit 55, Layer 2:1. These are a common find at archaeological sites in Thailand. It measures 1.6 cm across and was probably used in conjunction with a sling to hunt small game such as birds. Similar weapons are still in use in some parts of rural Thailand (Fig. 43G-H).

A total of 67 ‘wasters’ were recovered during the 1993 excavation. These are pieces of fired pottery which do not appear to have any function. The shape of the wasters varies widely, most seem to be lumps of clay that have been squeezed and then fired, the depressions caused by fingers, still evident in some. There is no concentration of these, they occur in all strata and are spread across most excavation units.

The results of the ceramic assessment are presented in chapter XI and the comparative analysis of the ceramic assemblages of Nong Nor and Khok Phanom Di are examined in chapter XIII.

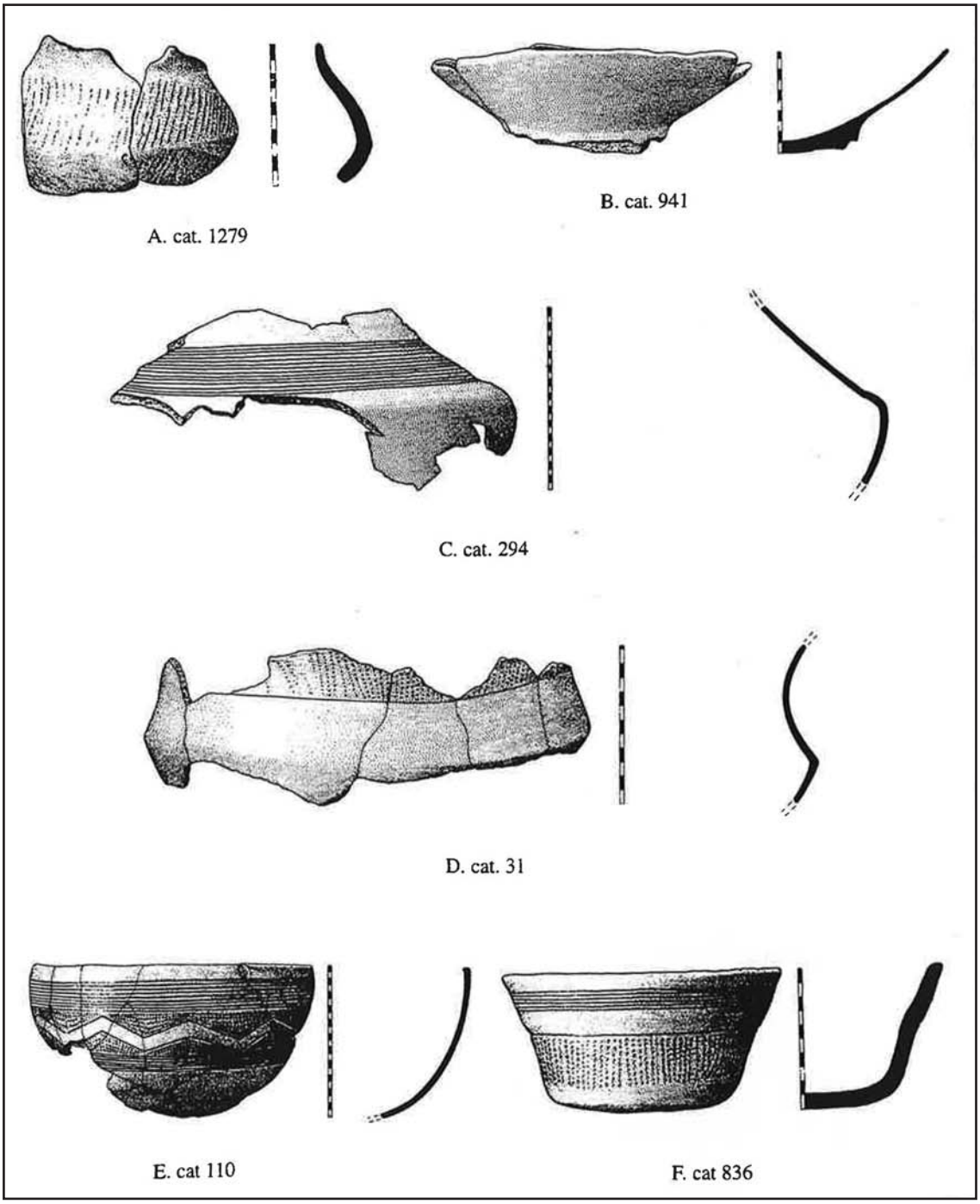


FIG. 42. Complete phase1 ceramic vessels. Each scale segment = 0.5 cm

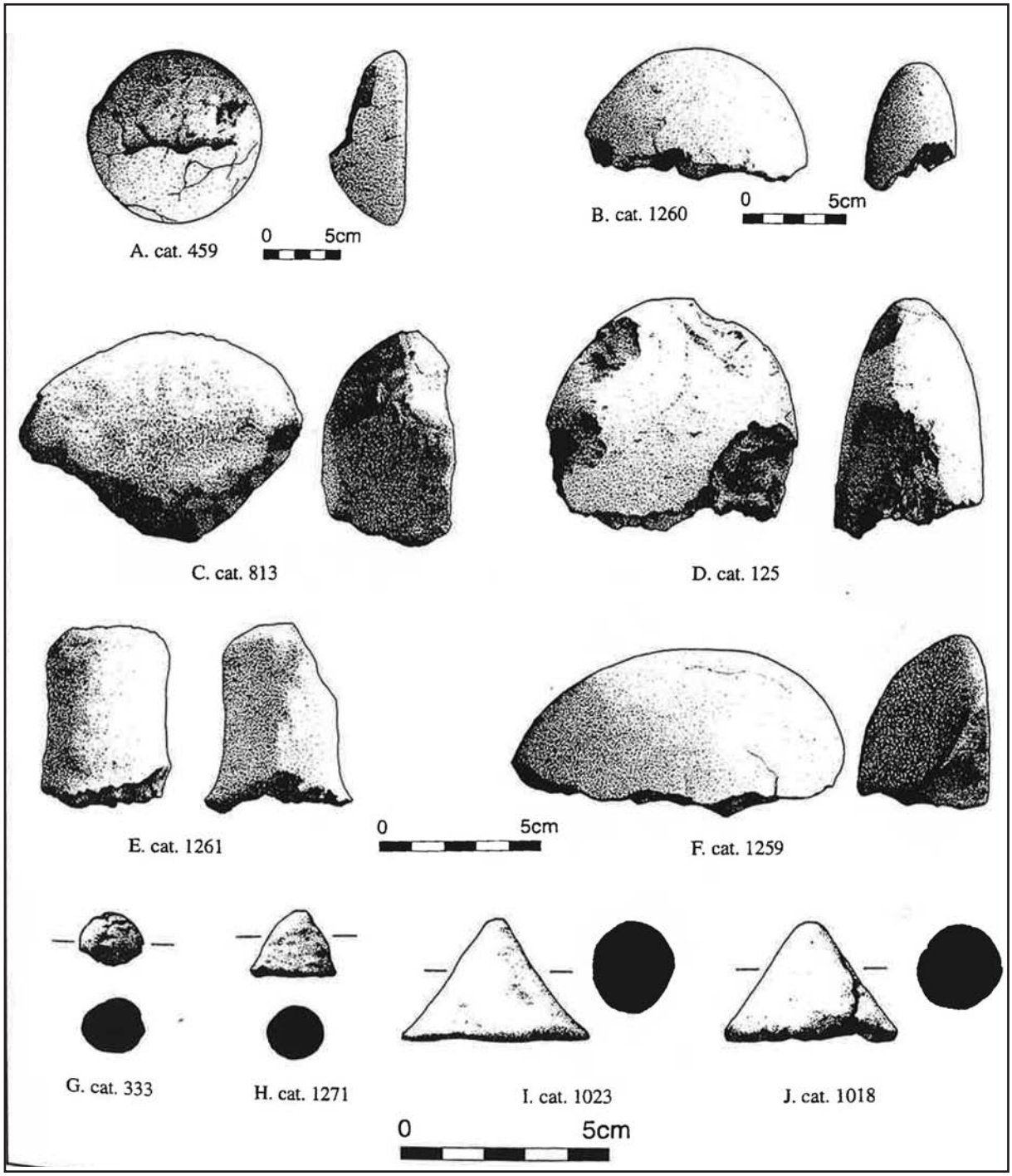


FIG. 43. Clay anvils and miscellaneous clay artifacts

APPENDIX: THE DISTRIBUTION OF DECORATED SHERDS AND RIM FORMS

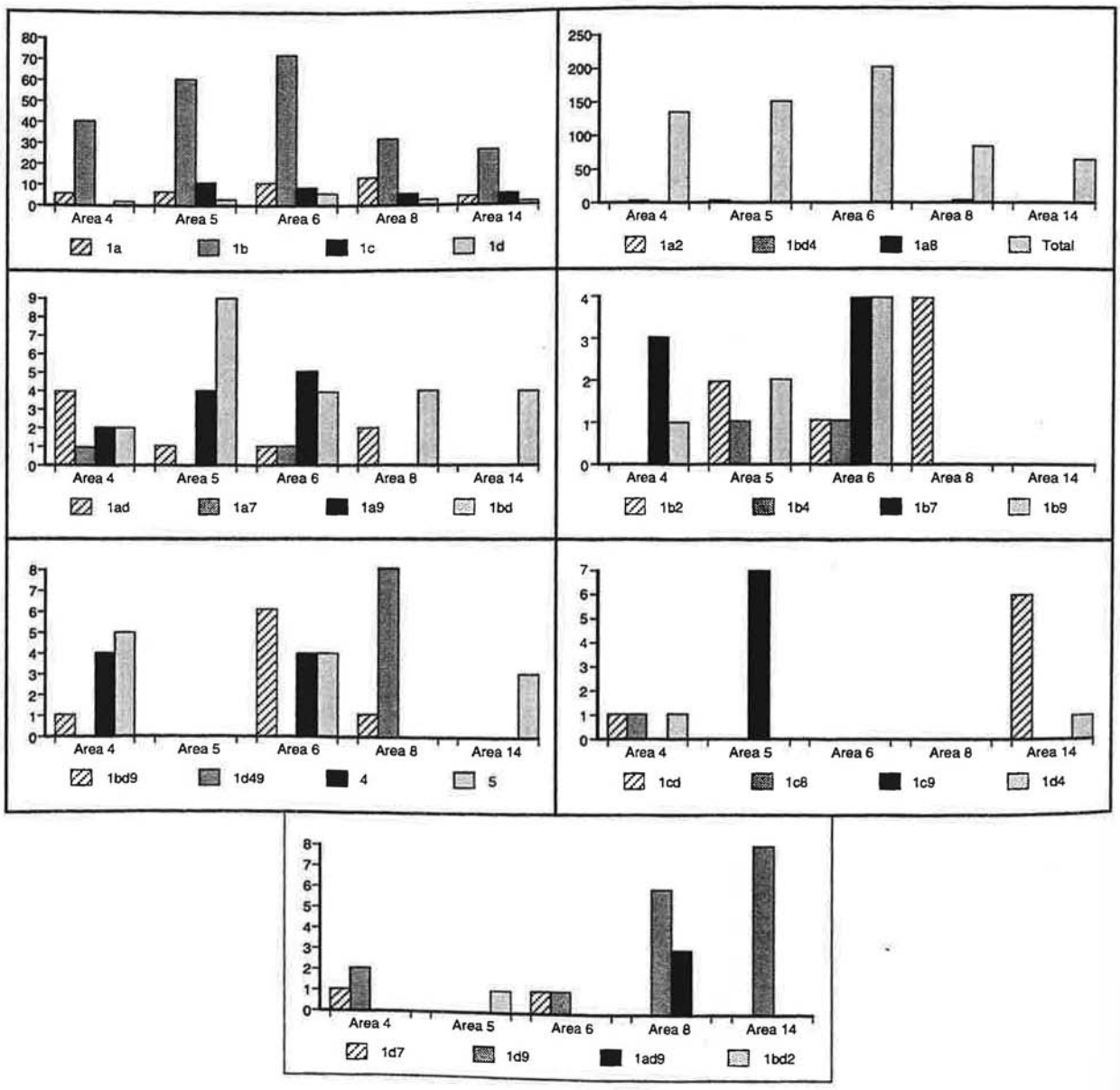


FIG. 44. The areal distribution of phase 1 decorated sherds

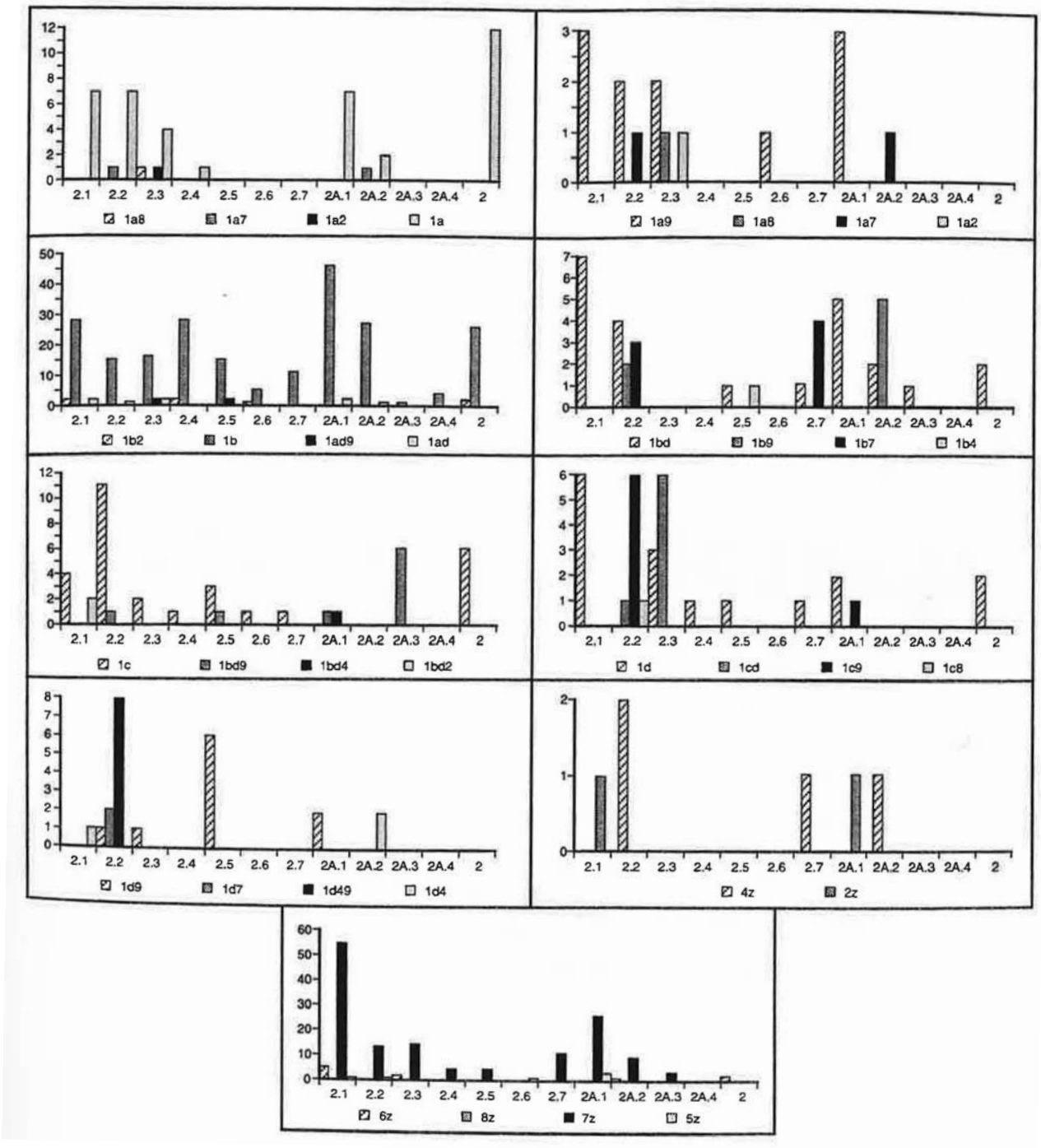


FIG. 45. The stratigraphic distribution of phase 1 decorated sherds

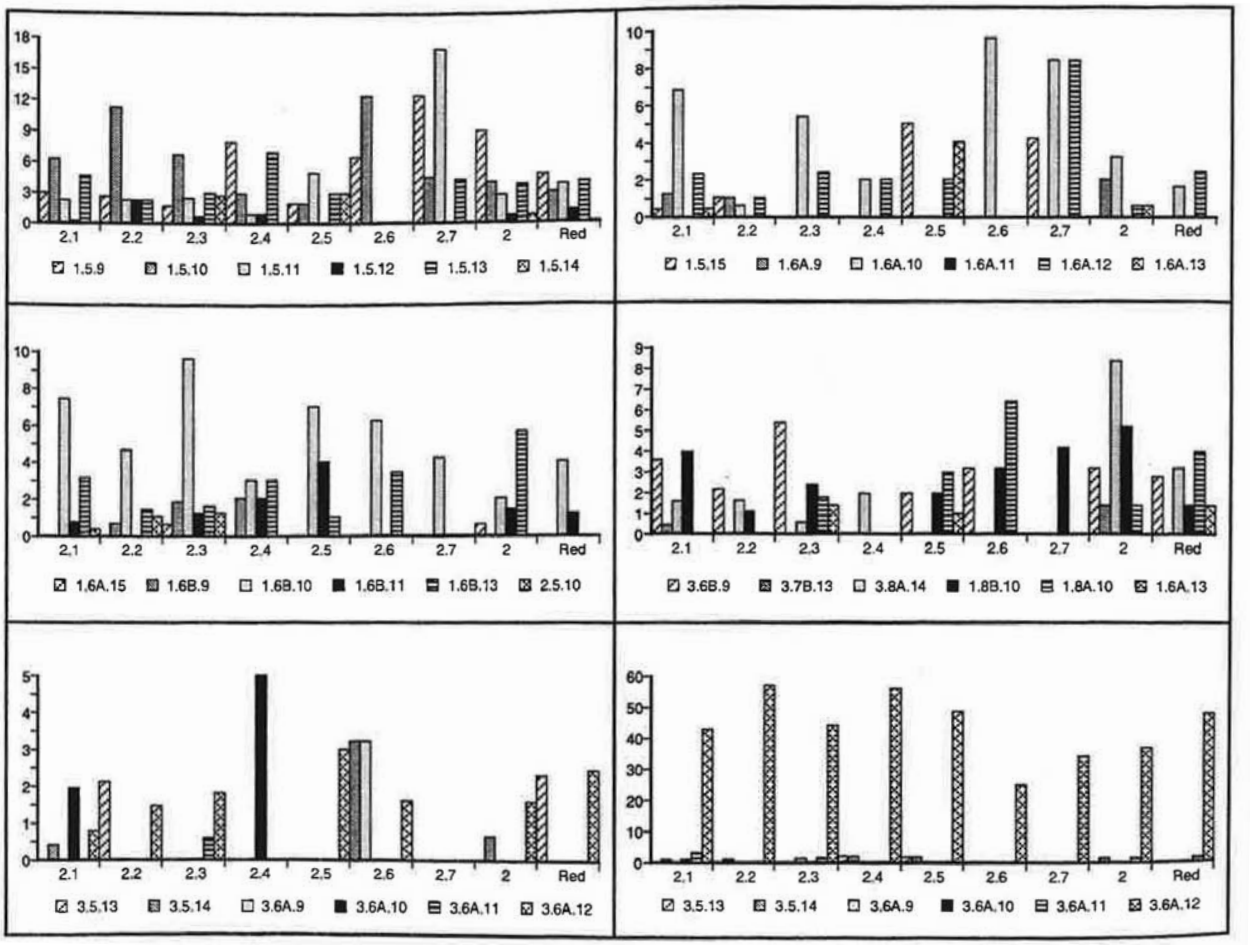


FIG. 46. The stratigraphic distribution of phase 1 rims

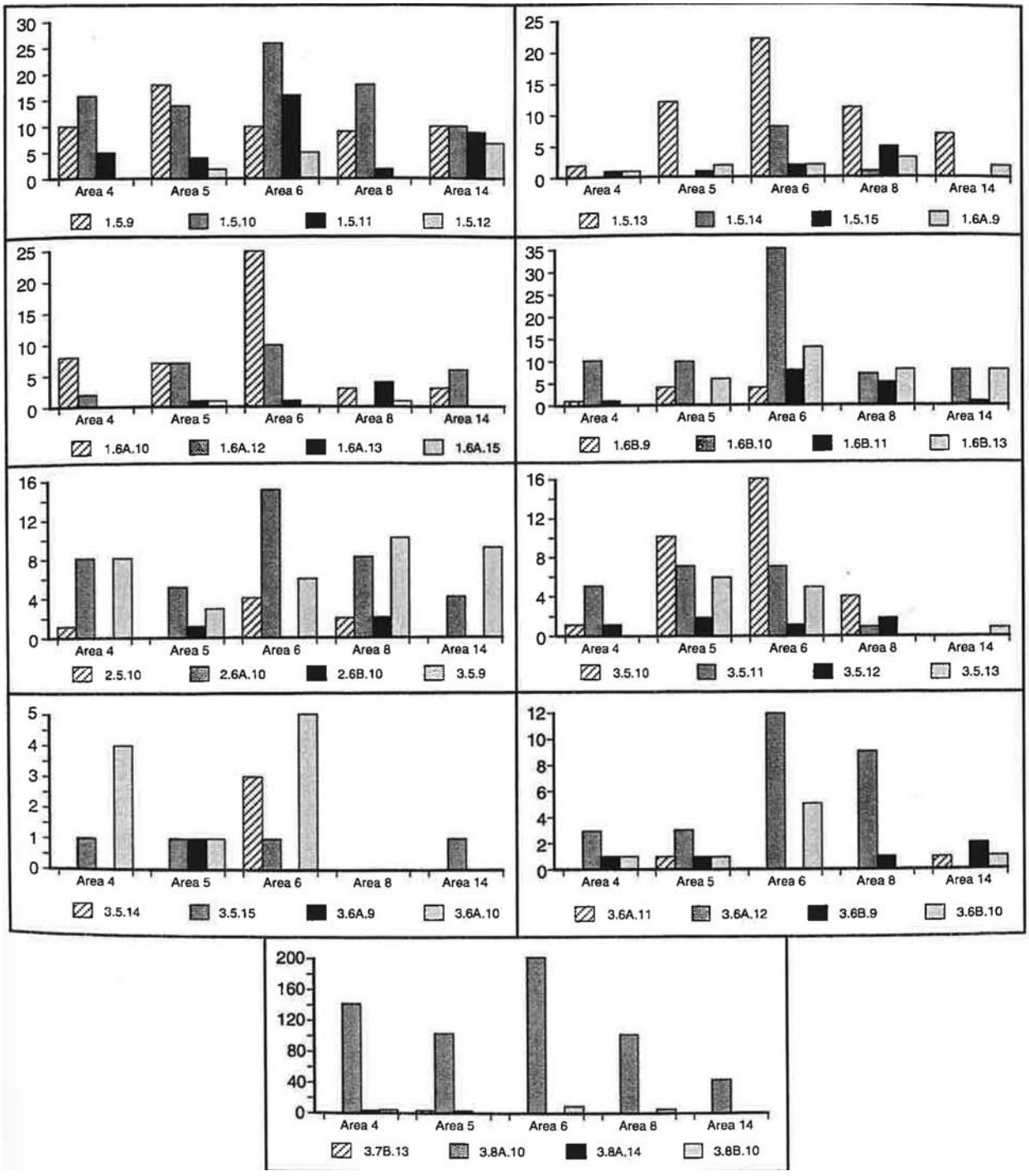


FIG. 47. The areal distribution of phase 1 rims

IX. THE FAUNAL REMAINS AND WORKED BONE

C.F.W. Higham, R.E. Fordyce and D.J.W. O'Reilly

INTRODUCTION

FAUNAL remains were recovered from phase 1 contexts and as grave goods during the second or mortuary phase. Where graves were cut into the midden, there was an unknown degree of admixture between material which could have come from either phase. In the following review, the mammalian and turtle fauna from undisturbed contexts within the phase 1 layers will be described, and all measurements are in millimetres.

LARGE DEER

Two species of large cervid could be in question. *Cervus unicolor* was formerly widespread in lowland Southeast Asia, preferring to browse within a wooded habitat (Lekagul and McNeely 1977). Schomburgk's deer (*Cervus schomburgki*) is rather smaller, and was adapted to the floodplains of the Chao Phraya Basin before extinction. It is not possible to distinguish between the two species on the basis of bone fragments, but as will be seen below, where comparison is possible, the larger cervid bones correspond in size to *Cervus unicolor*.

1. T-R 10-11, lens 2a. Femur. Width of *caput femoris*, 39.0.
2. T-R 14, layer 2:3. Cuboid navicular. L, 42.0. The length for *Cervus unicolor* from Northeast Thailand is 41.0.
3. T-N 24, layer 2, surface of layer 3. Cranium fragment with pedicel in place. The dimensions of the pedicel are 33.0 by 31.0.
4. T-N 24, layer 2, surface of layer 3. Distal end of an adult metapodial.
5. V-U 16-17, surface of layer 3. Two fragments from the distal end of a femur and a fragment from the distal end of the humerus.
6. T-R 6, layer 2:2. A fragment of cranium.
7. T-R 8, lens 2A:2. Proximal end of radius, charred specimen. Bp, 59.5[1]. The largest of three measurable specimens from Ban Chiang is 56.0 (Kijngam 1979).
8. T-R 7, layer 2:1. Phalanx 2, complete. Bp, 19.0. The same dimension was obtained from a modern *Cervus unicolor* from northern Thailand (Mae Hongson Province).
9. T-R 8, lens 2A:1. Phalanx 1. L, 56.0, Bp, 20.5. Virtually identical dimensions were taken from the modern specimen of *Cervus unicolor* from northern Thailand.
10. V-U 17-18, occupation on top of layer 3, natural. Maxilla fragment, LM^3, 27.5.

[1] Bp: proximal width, Bd: distal width. Bracketed dimensions are estimated

11. T-R 14-15, layer 2:3. Phalanx 2. L, 41.0, Bp, 19.0. The same measurements were taken from the modern comparative specimen of *Cervus unicolor.*
12. Q 16, red lens over layer 3, natural. The fragment of a diaphysis from a tibia.
13. O 15, layer 2:2. Two fragments from the proximal end of a tibia.
14. O 14, layer 2a, red lens, cat. 1178. The distal end of a tibia, Bd, 53.0. This is the same size as a specimen from Ban Chiang ascribed to *Cervus unicolor.;*
15. T-R 10-11, lens 2A:1, cat. 1177. The proximal end of a femur, width of *caput femoris*, 38.5.
16. M 17, found in the grave fill of burial 83, cat. 521. Tibia. Bd, 57.5.
17. T-R 12, layer 2:3, cat. 1145. The distal end of the radius of an adult deer. Bd, 49.0, the same size as specimens from Ban Chiang.
18. T-R 9, layer 2a, red lens, cat. 895. Distal end of a humerus. Bd, 58.0.
19. T-R 11, layer 2:2, cat. 1125. Radius. Bp, 60.5.
20. J 6, layer 2:1, cat. 1136. Tibia. proximal end unfused, subadult specimen.
21. T-R 13-14, lens 2A:1, cat. 1134. Proximal end of femur.
22. T-R 14, layer 2, cat. 1056. Distal end of tibia. Bd, 55.5.
23. T-R 9, lens 2A:1, cat. 1120. Radius, distal end. Bd, 50.5.
24. T-R 11, layer 2:1, cat. 803. Tibia. Bd, 50.2.
25. P 16, layer 2C, red lens, cat. 1153. Metacarpal. Bd, 46.0.
26. T-R 14-15, layer 2A, cat. 1181. Metatarsal. Bp, 42.5.
27. T-R 18, layer 2, surface of natural, cat. 1138. Tibia. Bp, 45.0.
28. T-R 14-15, layer 2:2, cat. 1144. The proximal end of a tibia.
29. T-R 13-14, lens 2A:1, cat. 1151. Distal end of femur.
30. K 15, layer 2:2, cat, 1156. Distal end of tibia.
31. Q-P 1-5, layer 2:2, cat. 1155. Distal end of tibia. Bd, (48.0).

MEDIUM-SIZED DEER

The most likely species to correspond to the medium sized deer is *Cervus eldi* which, according to Lekagul and McNeely (1977), formerly inhabited low-lying, swampy terrain.

1. T-R 14-15, lens 2A:1. Phalanx 1, L, 48.2, Bp, 13.6. These dimensions correspond to those cited by Kijngam (1979) as being from *Cervus eldi*.
2. P-O 20-21, layer 2:2. Scapula. Minimum width of the neck, 22.3; length of glenoid cavity, 29.1.
3. T-R 13-14, lens 2A:1, cat. 1149. Distal end of femur. Bd, (50.0).

SMALL DEER

1. T-R 7, layer 2:1. Mandible with $M_{1\text{-}2}$ in place. L premolar row, 29.0. The corresponding dimension in a specimen of modern Thai *Muntiacus muntjak* is 30.5.
2. T-R 18, layer 2:2. Diaphysis fragment from a metatarsal of the same size as a modern *Mun-*

tiacus muntjak.

BIBOS SP., *NOVIBOS SAUVELI* OR *BUBALUS BUBALIS*

Bovid bones could come from any of at least four species, the gaur, banteng, kouprey or water buffalo. It is not possible to distinguish between them on the basis of most fragmentary bones.

1. T-R 15, layer 2:3. The distal end fragment of a humerus.
2. P 10, feature 1, a concentration of potsherds on the surface of layer 3. Astragalus. L, 74.0, breadth, 55.0.
3. T-R 8-9, surface of 2A. The distal end of a metapodial, almost certainly from a large water buffalo.
4. L 12, layer 2:3. PM2, from an adult animal.
5. Q 14, layer 2c, red lens, cat. 693. This is the proximal end of a metacarpal from *Bubalus bubalis*, the Bp. being 84.0. The corresponding dimension from a wild animal in the collection of the American Museum of Natural History (AMNH 54766) is 76.8, while a modern domestic male from Thailand was 67.0. It seems highly likely, therefore, that this large bone comes from a wild water buffalo.
6. V-U 13-14, layer 2:1, cat. 1058. Proximal end of a metacarpal from *Bubalus bubalis*. Proximal anterior-posterior width, 45.0. This is the same size as the wild specimen from the AMNH.
7. L 15, layer 2:2, cat. 1123. Distal end of a metacarpal from *Bubalus bubalis*. Bd, 88.8. This bone is slightly larger than AMNH 54766.
8. T-R 9-10, layer 2:2, cat. 1146. Radius. Bp, 88.5. This width compares with dimensions of 86.5 for a wild female gaur (AMNH 1847 12.15.2), and 87.7 for a wild female banteng (AMNH 1846 12.15.7).
9. T-R 13-14, lens 2A:1, cat. 1135. Metatarsal. Bd, 57.2.

TURTLE OR TORTOISE

1. V-U 14-15 layer 2:2. Four fragments of carapace or plastron.
2. T-R 9. lens 2A. One charred fragment of carapace or plastron.
3. T-R 14-15 layer 2:1. Two fragments of carapace or plastron.
4. T-R 14-15 layer 2:2. Four fragments of carapace or plastron.

DISCUSSION

The sample of mammalian bones is dominated by large ungulates. Large deer are most numerous, the species in question probably being *Cervus unicolor*. Of the bovid bones which can be assigned a species, the water buffalo (*Bubalus bubalis)* is present more often than other bovids. The majority of the identified specimens are limb bones, and over half the large cervid and the bovid bones were worked by grooving and removing blanks. There is every likelihood that other bones had also been worked in antiquity. Vertebrae, ribs, scapulae and pelves, bones which would not have lent themselves to such working, are not found. It is considered likely that the early inhabitants of Nong Nor sought out particular bones from deer and bovids as a raw material for the manufacture

of artefacts, rather than engaging in regular hunting for food. None of the bones can with confidence be ascribed, on the basis of size, to a domesticate. It is also noted that no dog bones were found in the early occupation phase of the site.

CETACEAN REMAINS

R.E. Fordyce

A generalised mid-sized dolphin, perhaps *Steno* sp.

1. A8 surface of layer 3. Eight vertebrae.
2. A3 47 2:2. One vertebra.
3. A6 14 2:2. One vertebra.
4. A3 52 2:1. One vertebra.
5. A4 22 lens 2A:1. Three vertebrae

A finless porpoise *Neophocaena phocaenoides*.

1. A3 surface of 2 Burial 35. one vertebra.
2. A4 24 2:1 one vertebra.
3. A6 Unit 14 2:7. one vertebra.
4. A8 Surface of layer 3.
5. A8 Unit 38-9 2:2 One vertebra.
6. A8 Unit 38-9 2:3 One vertebra.
7. A8 Unit 38-9 2:4 One vertebra and one rib fragment.

A pelagic dolphin, probably *Dolphinus* or *Stenella*.

1. Looted fill in the vicinity of burial 164. Vertebra of a young animal.

Small delphinoid, possibly *Neophocaena* (Phocoenidae) or smaller Delphinidae.

1. A8 Unit 36-7, occupation over natural. Right tympanic bulla.

CROCODILIAN REMAINS

1. A3 57 2:1. One tooth, probably *Crocodylus porosus*.

THE WORKED BONE

D.J.W. O'Reilly

Bone is sparsely represented at Nong Nor and it was probably a valuable commodity. The sample of worked bone includes many specimens modified by sawing, cutting and abrading. Sixty bones were found to have modifications of various sorts. These could not be classified as tools, yet in many cases represent the debitage from tool manufacture. Some are the ends and heads from long bones, from which the useful diaphysial bone has been detached. Eighteen of these can be identified as the long bones from terrestrial mammals.

The majority of the identifiable worked bones are from limbs, which indicates a preference

among the prehistoric inhabitants for the strong, thick bones in the creation of tools. Thinner bones with more cortical material, such as pelves, scapulae and ribs are not represented. It is unlikely that the faunal remains from Nong Nor represent a regular hunting tradition. Rather, it seems more probable, that certain bones were sought for their physical properties and brought to the site for secondary use. If whole animals were brought to the site, a greater variety would be expected.

Much of the sample has evidence for cutting or sawing. These cuts extend all the way round the outer surface of the bone. The worker was using some sort of hard implement, for which we have no evidence, to separate the long bones from the proximal and distal heads. The bone was probably rotated while the sharp-edged implement was dragged repeatedly across the surface. In some cases it appears that the bone was cut all round and then snapped, evidenced by jagged processes on one side of a shaft, the other side being characterised by a smooth cut.

The formation of the faunal assemblage is explicable in a number of ways. It is conceivable that the inhabitants brought bone from other coastal or inland sites at the initial occupation of Nong Nor. The raw materials for bone tool manufacture may have been carried at all times so that implements could be fashioned depending upon the environment the tool maker encountered. The most probable explanation is that the people of Nong Nor were supplementing their diet of fish and shellfish with mammalian fauna. The low number of animal bones at the site may suggest that the animals were butchered at the kill site and the disarticulated limbs were returned to Nong Nor for consumption and secondary use. Whatever the case, mammals did not play a large role in the diet of the inhabitants of Nong Nor, if the archaeological remains are any indication. This is consistent with modern hunter-gatherers in Arnhem Land, where mammals made up just 12.4 per cent of the dietary intake during the late dry season when the consumption of terrestrial mammals was at its peak (Meehan 1977: 502).

Many of the excavated bones were covered with concretions which were removed by placing the bones in a Sonicor ultrasonic cleaner for five minutes. Each artefact was examined both macroscopically and microscopically at 10x magnification using a Zeiss GSZ microscope. Evidence of cut and saw marks, as well as abrasion were noted when encountered. Bones which retained natural landmarks and evidence for the removal of segments for further use were speciated and measured using Mitutoyo metric callipers.

FISHHOOKS

Thirteen fishhooks and partial fishhooks were identified, many of which appear to have been broken during manufacture. It is likely that the hooks were prepared using a hard material to drill holes and cut out a tab, a technique used among the Maori in prehistoric New Zealand, who would "fix a sharks tooth in the end of a small piece of wood...to bore holes (in bone)" (Anderson 1776). The Maori also used silcrete drills (Smith *et al*. 1996), while in the Pacific islands, shell drills were often employed (Emory *et al*. 1959).

The fishhooks are all jabbing hooks, identifiable by the fact that the points are parallel to the shanks. Most have a U-shaped shank, where most have broken, the bend being the weakest section of hooks of this type.

Cat. 1261 A3 62 2:2. A shank from a bone fishhook. The tip is worked into a knob to hold a line. The artefact is 20 mm in length (Fig. 48H).

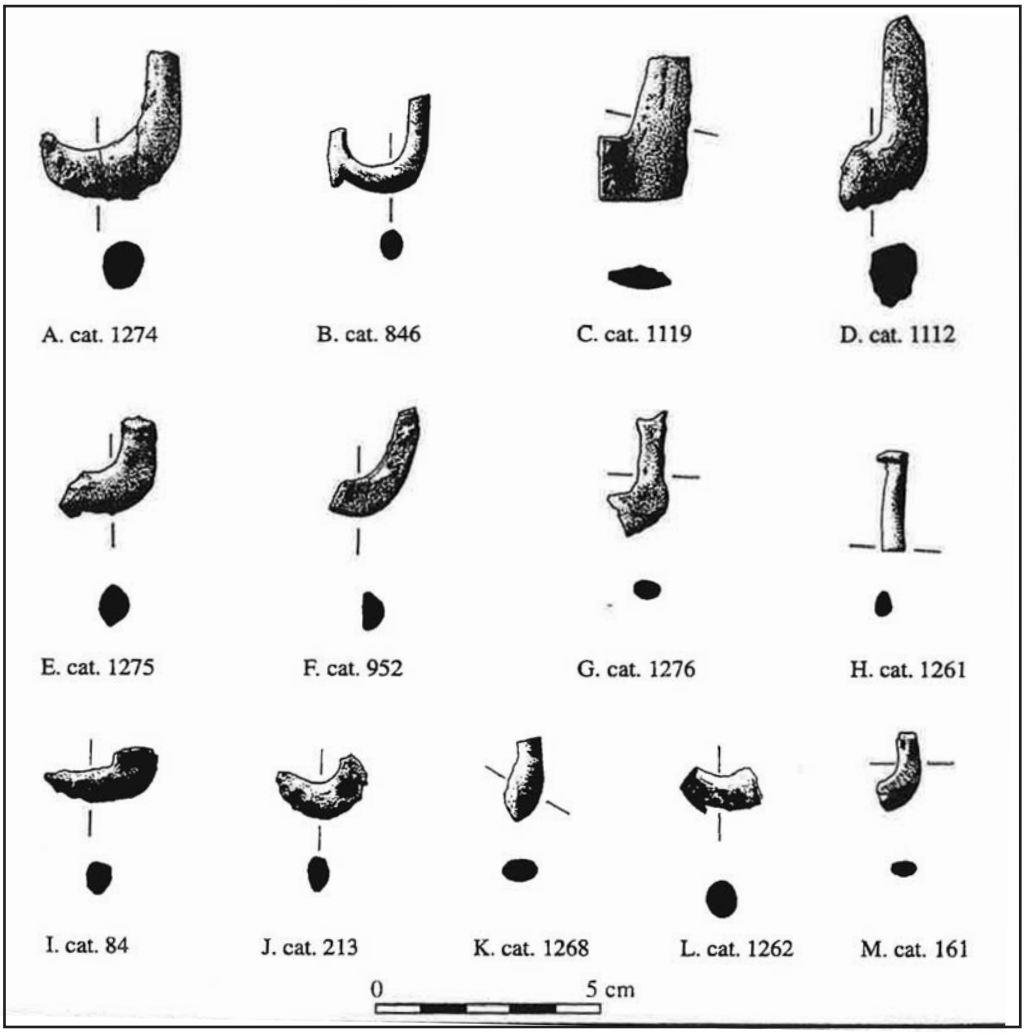


FIG. 48. Bone fishhooks from Nong Nor

Cat. 1262 A3 48 2:2. A fishhook fragment with the shank and tip missing. There is a barb present at the bend. The artefact is 15 mm in length and 7 mm wide at the thick end (Fig. 48L).

Cat. 846 A5 21 2:2. A fishhook with a barb on the outside of the point. The shaft is broken and the tip is missing. The width of the hook is 22 mm (Fig. 48B).

Cat. 1274 XI 2:1. Fishhook with no barbs. The shank is broken and the head and tip are missing. The hook is largely rounded and the hook is quite bulky. The width is 31 mm (Fig. 48A).

Cat. 213 A3 84 2:1. A fishhook fragment. Most of the shank is missing as is the point, leaving just the bend. There is no evidence for barbs (Fig. 48J).

Cat. 84 XI 2. A fishhook fragment. Most of the tip and shank are missing. There is slight rounding

on the bend (Fig. 48I).

Cat. 952 A 7/9 2/3. A shank fragment remains minus the head and tip. The artefact is badly exfoliated (Fig. 48F)

Cat. 161 XI 2:2. A fishhook fragment missing the point and the head, leaving the shank and part of the bend (Fig. 48M).

Cat. 1275 A 3 70 2:1. A fishhook of which only the bend remains, on which there is some evidence for a barb (Fig. 48E).

Cat. 1122 A 6 16-17 2:3. A robust fishhook, which was probably broken during manufacture. There is a barb at the bottom of the shank. It has been abraded. The head had not been crafted at the time of discard (Fig. 48D).

Cat. 1119 A 3 44 2:3. A fishhook which was probably broken during manufacture. The heads and point are missing. There is no evidence of a barb. This hook has a thick L-shape (Fig. 48C).

Cat. 1276 A3 79 2:2. A small fishhook the point of which is missing but the bend, shank and head remain. There is no evidence for a barb. There is a significant amount of concretion adhering to the artefact (Fig. 48G).

Cat.1268 A6 15 2:6. This bone fishhook is broken and all that remains is the bend. The shaft and tip as well as the point are missing (Fig. 48K).

AWLS

Twelve artefacts may be classified as awls. These are often characterised by a groove which runs down the side of the implement. The awls terminate in a point on which there was frequently a gloss extending back along the tool to about a quarter of it's length. The posterior ends were often cut. There is also a degree of curvature to many of the awls. It has been suggested that the tools were used to puncture “a somewhat resilient medium such as fabric or leather....the groove would facilitate the threading of a yarn through the hole just created...” (Higham and Thosarat 1993:8). These artefacts are individually described below. Unidentified bone refers to the lack of information on the anatomical portion and genus.

Cat. 1129 A3 64 2c. Three pieces of unidentified worked bone. There is a groove along one side, the other side is shaped into an angled edge.

Cat. 626 A3 22 2c. Unidentifiable bone shaped into a point with a slight groove on one side.

Cat. 1124 A3 27 2:2. An unidentified bone artefact with patination on the surface. The bone has a longitudinal groove down one side, crosscut by a diagonal groove with a noticeable polish.

Cat. 1247 A3 66 2d. A broad point fashioned from unidentifiable bone. It is sawn at the opposite end. There is evidence of abrasion on the surface.

Cat. 1163 A5 19 2:2. Unidentified bone. The artefact has three longitudinal grooves, one side with two and the other with one. The artefact is pointed and resembles an awl, but has been sawn off. Careful craftsmanship is notable (Fig. 49A).

Cat. 1161 A5 17 2:2. Unidentified bone. This artefact is pointed, the two sides forming a point

are grooved through abrasion and the top surface is abraded as well. The other side consists of cortical bone (Fig. 49C).

Cat. 1263 A3 49 2:6. This is a rather small fragment of awl made of unidentified bone. The artefact is pointed with slight evidence of a groove down one side.

Cat. 1264 A3 51 2:3. Awl fragment of unidentified bone. The artefact is pointed yet is badly preserved, obliterating abrasion and use wear. One edge is flattened while the other is sharper (Fig. 49B).

Cat 1267 A5 21 2:3. A bone awl of unidentified bone. The tip is blunt. Two deep grooves are evident along two opposite sides (Fig. 49I).

Cat.1269 A6 16-17 2A:2. Small fragment of awl made of unidentified bone. Characteristically grooved on two sides (Fig. 49H).

Cat. 1148 A3 19 2:3. Concreted bone awl with a single groove up one side. Use wear is unobservable (Fig. 49F).

Cat 704 A3 66 2c. Large awl, abraded. No groove runs down the side as with other awls suggesting it may be incomplete or for a different purpose. No polish is present (Fig. 49D).

THE SHUTTLE

One artefact was found (cat. 1180) which compares closely to what Higham (1993:4) called bobbins (Fig. 49E). This artefact is 49 mm in length and is curved. On one side there is a deep groove which makes it appear nearly spoon-like. There is a gloss on either end, one being pointed and sharpened, the other squared. There is no groove down one side, however, as is the case with examples from Khok Phanom Di. It seems plausible that the implement was used in the weaving process, perhaps used to pass the thread of the weft through the warp, which would explain the high gloss on either end. Modern Thai shuttles are made of wood and have the same curvature as this specimen.

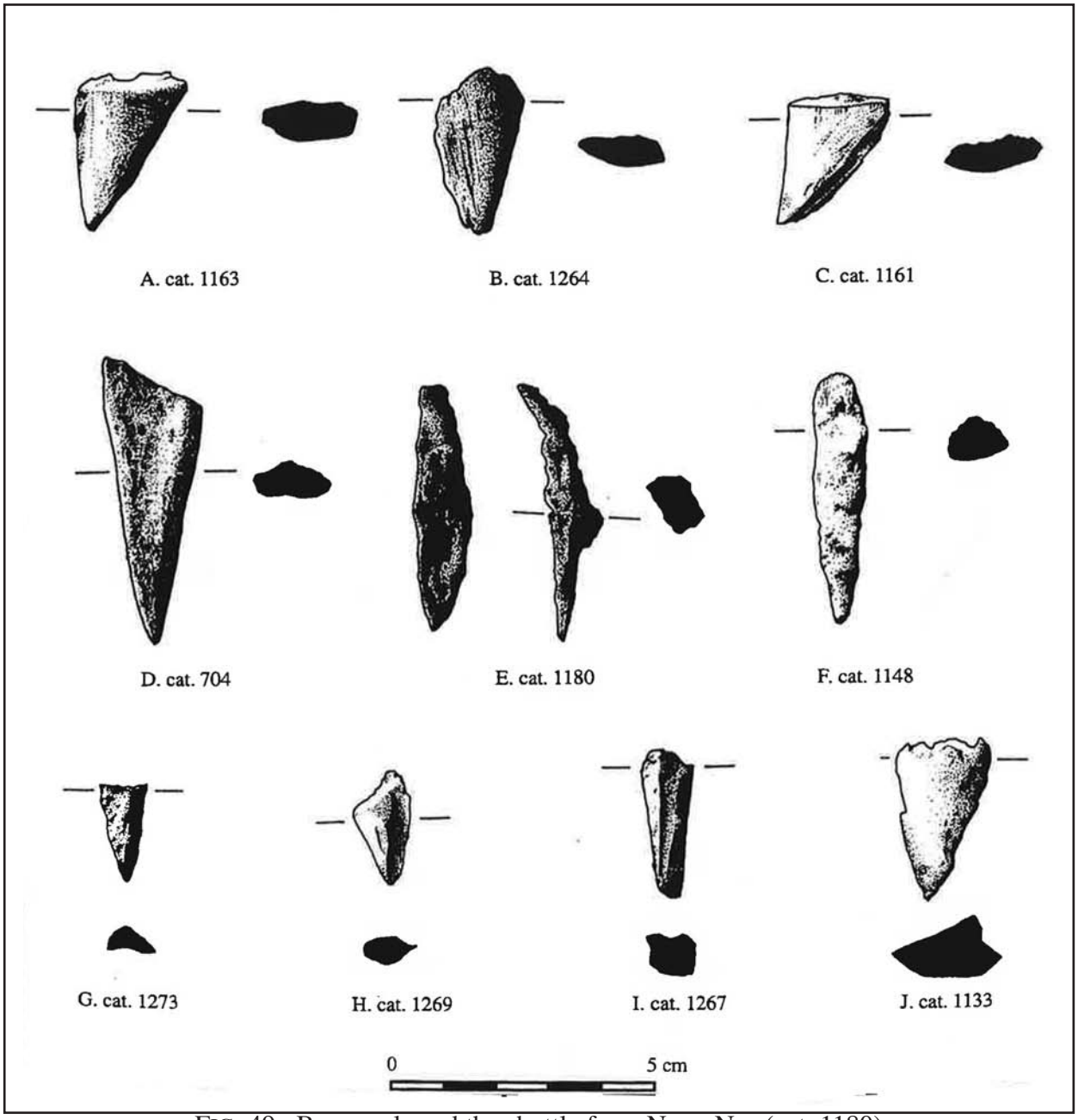


FIG. 49. Bone awls and the shuttle from Nong Nor (cat. 1180).

X. THE LITHIC ARTEFACTS

D.J.W. O'Reilly

THIS chapter catalogues the lithic artefacts excavated from Nong Nor during the three seasons of excavation.

GRINDSTONES AND WHETSTONES

Fifty eight sandstone artefacts which may be classified as grindstones or whetstones were recovered from Nong Nor. These artefacts are characterised by smooth ground surfaces, which are either flat, concave or V-shaped. Due to their fragmentary nature, it was difficult to assess the precise function of some, but it is clear that they were used as abraders. Grindstones are artefacts of which the specific use is unclear. Those found at Nong Nor are characterised by U-shaped depressions which are very smooth. There may be more than one depression on a face and more than one face may have been utilised. Pisnupong (1988) has suggested that those artefacts at Khok Phanom Di with a U-shaped groove were used as anvils or querns and those which have a V-shape groove were used to resharpen other implements and may be termed whetstones. At Nong Nor, the latter are characterised by steep grooves, differentiating them from the grindstones. They may be classified into two types (Pisnupong 1988), the first have a shallow stepped, U-shaped groove formed around the end of a tool. The grooves are rectangular and usually curved at the end. This type of whetstone is occasionally worked on both sides. The curved and stepped edge on both margins of the grooves show that it was used in polishing the cutting edge of bone points and perhaps, shell artefacts. The second type has long and narrow V-shaped grooves at the middle of either one or both faces, which was possibly formed by rubbing the cutting edge of an adze back and forth.

Each artefact was examined individually for traces of use wear under a Zeiss GSZ microscope at 10x magnification and measured with a Mitutoyo metric calliper. The length was recorded as being the largest distance between two points on the artefact. The width was recorded as the largest distance which was perpendicular to the length measurement. The depth was recorded as well, representing the thickness of the artefact. The specimens were then assigned a colour category using the Revised Standard soil colour chart (Oyama and Takehara 1967). Those which could be classified as grindstones and whetstones are illustrated in figure 50.

HAMMERSTONES AND POUNDERS

Three artefacts can be classified as pounders or hammerstones. The first, from Area 3, Unit 57, Layer 2:2 (cat. 431) is made of sandstone. It measures 5.6 x 4.5 x 3.4 cm and there is strong evidence of a ground surface on one side with a degree of polish evident. The artefact fits comfort-

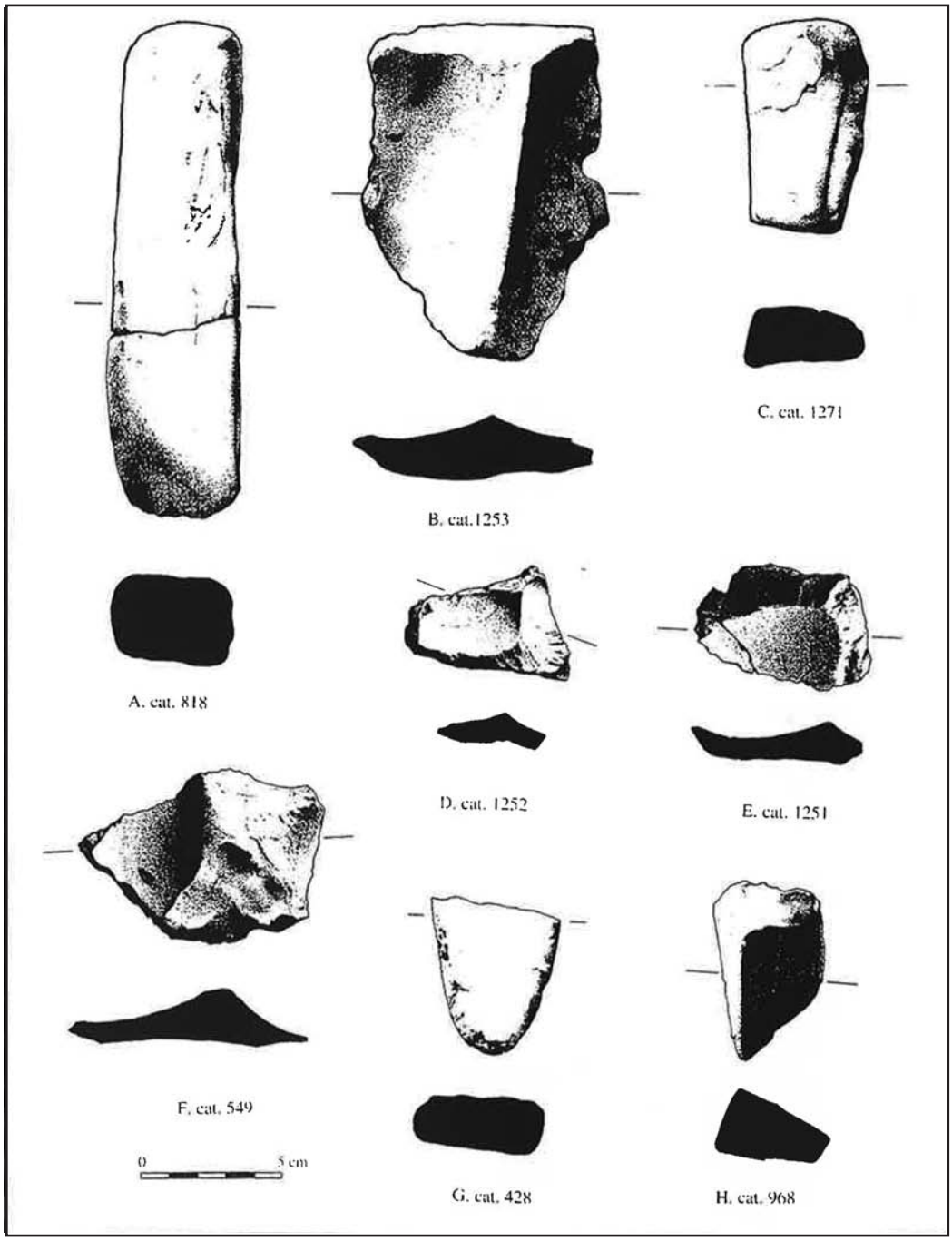


FIG. 50. Grindstones and whetstones

ably in the hand, with the worn surface facing down. The pattern of wear appears to be in a lateral direction, indicating a side to side motion in the original use of this artefact (Fig. 51A). The other artefact is made of quartzite with evidence of use on three sides. It comes from Area 3, Unit 86, Layer 2:5 (cat. 694). The artefact measures 9.8 x 8 .4 x 6.5 cm. Part of the cortex has been removed on one end, indicating the aggressive use of the stone. The worn surfaces are both smooth and chipped. The artefact was utilised in two ways, with a grinding action as well as hammering. It is rather difficult to assess the original use of this object but its smoothed surfaces suggest that it was used primarily as a grinder (Fig. 51D). The last artefact comes from Area 7 (cat. 953), on the surface of the substrate. It is a sandstone object, measuring 8.3 x 8.1 x 5.0 cm. It is worked on only one surface, as indicated by the presence of chip marks in the centre of the stone as well as some smoothing. This would suggest that it was used to hammer another object as well as being employed as a grinder (Fig. 51B).

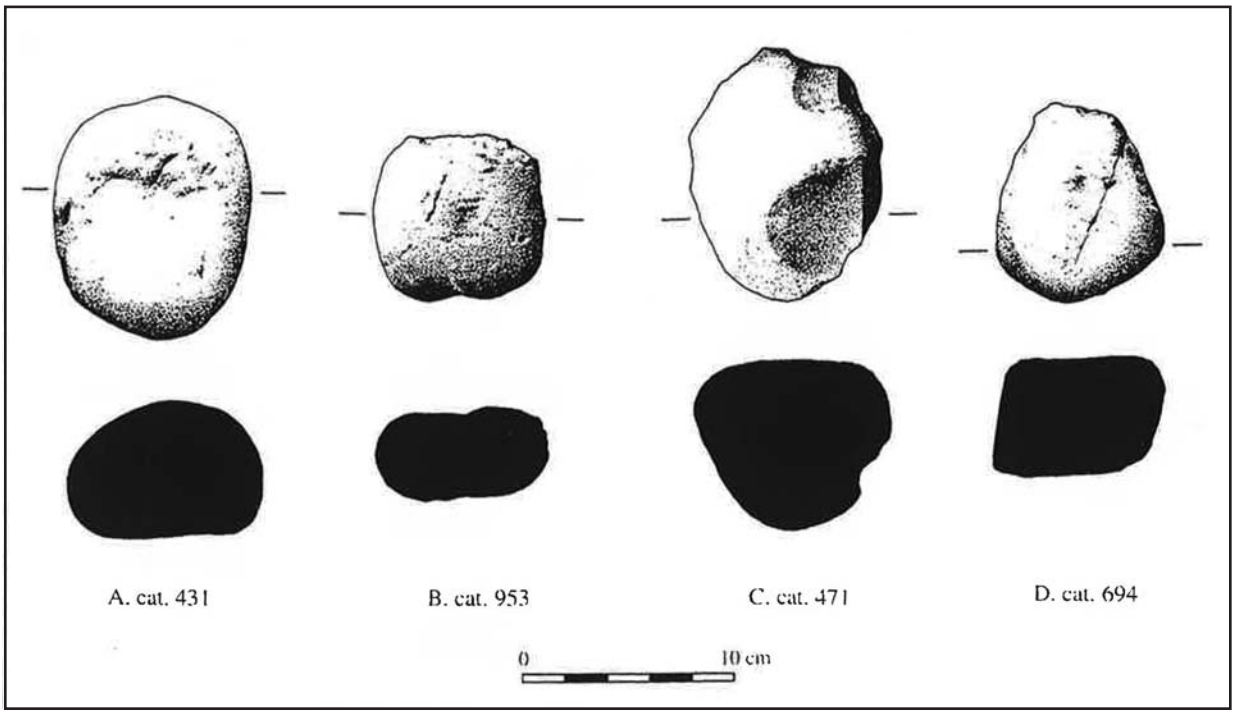


FIG. 51. Hammerstones, pounders and a miscellaneous artefact (cat. 471)

MISCELLANEOUS STONE ARTEFACTS

There were 43 lithic artefacts which were too fragmentary for classification. They are probably the remnants of larger artefacts, as the materials, quartz, silcrete and sandstone, are quite similar

to a number of implements already described. Some appear to be pounder fragments with some of the cortex still in evidence. Others may be fragmentary remains of grindstones or whetstones. There are 16 fragments of stone which still retain the cortex. These have all been smashed and there is some possibility that they are the result of initial tool preparation. The predominant material, however, is of rather poor quality for the production of tools, being mostly quartz, quartzite and quartz cemented sandstone.

There are four artefacts which have definitely been used in artefact production. There are two large pieces of quartz cemented sandstone, from which flakes have been struck. The artefacts demonstrate a variety of angles of percussion. They come from Area 3 Unit 19 Layer 2:1 (cat. 471, Fig. 51C) and Area 7 at the surface of natural (cat. 969). There are also two pieces of chert which demonstrate modification. The first core comes from Area 9. It has four different angles of percussion, from which flakes were removed. The other chert core is from Area 4 at the surface of natural (cat. 956). It has five faces where flakes have been removed, as well as some surviving cortex.

STONE FLAKES

There were 13 lithic flakes recovered. Seven are volcanogenic metasedimentary rocks of which two show evidence of secondary use. The rarity of this type of stone around Nong Nor (Pisnupong 1988:92) may be reflected in the scarcity of flakes. This scarcity may suggest that they were gathered up after retouching primary tools, for use elsewhere. The flakes recovered may well result from retouch activities and provide no evidence for secondary use. The absence of large quantities of lithic debitage suggest that the manufacture of stone tools, especially adzes was executed elsewhere. It is possible that the adzes were imported to Nong Nor in a finished state or that they were fashioned elsewhere from imported raw stone by the inhabitants.

ADZES

Four adzes were recovered. Their condition is poor, one being fragmentary and the others worn or flaked to very small sizes. These adzes may be classified using the Duff (1970) adze typology in which the cross section and butt modification are the major determinants. All are type 2G. These have an elliptical to oval section, or sub-triangular section, sides tapering to a rounded or flattened poll and unilateral bevel somewhat weakened by the downward descent of the front. The adzes were measured using the Mitutoyo callipers. The measurements correspond to an adze which has the cutting edge pointing downward, the length being taken from the poll to the cutting edge. The width was measured from the left to right side at the widest portion and the depth was measured from the front butt to the back at the thickest point.

1. Cat. 917, A11/8 baulk L 2. Length: 5.9 cm. Width: 4.3 cm. Depth: 2.3 cm.

A sandstone adze which is elliptical in cross-section, the poll is flattened and the corners have been rounded. The artefact is incomplete and no comment can be made regarding a bevel at the cutting edge. There are flake scars present down the sides and on the poll (Fig. 52C).

2. Cat. 1024, A8/14 baulk L 2. Length: 5.7 cm. Width: 3.9 cm. Depth: 1.7 cm.

This polished adze is made from volcanogenic metasedimentary stone. It is elliptical in cross-section, the rear face being more rounded than the front. The poll is flattened and rounded. The cutting edge is absent and there is a significant amount of flaking present on the left side (Fig.

52D).

3. Cat. 899, A9 L 2. Length: 5.6 cm. Width: 3.1 cm. Depth: 1.7 cm.

This adze was reconstructed from three fragments. It is made from volcanogenic metasedimentary material and has a polished surface. It is elliptical in cross-section and the poll has been flattened and the corners, rounded. There is some remaining evidence of the bevels which appear to be unilateral (Fig. 52B).

4. Cat. 879, A9 L2. Length: 8.3 cm. Width: 4.9 cm. Depth: 1.9 cm.

This adze made from gneiss, was polished, but has weathered significantly leaving it with a rough texture. It is elliptical in cross-section, the rear face being more rounded than the front. The poll is flattened and the corners rounded. The bevels are non existent but the adze does taper unilaterally toward the cutting edge (Fig. 52A).

One fragment from the side of an adze is possibly made of metamorphosed volcanic tuff. It was found in Area 3, Unit 40 on the surface of natural (cat. 722). This artefact has polished surfaces on two sides and it appears to have an elliptical cross section. It is rather difficult to classify it based upon what remains.

The adzes recovered from the midden phase are all damaged, with a great deal of chipping present on their surfaces. It is possible that once their usefulness as adzes was exhausted, they were used as a source of lithic flakes before being discarded. The condition of these artefacts confirms that

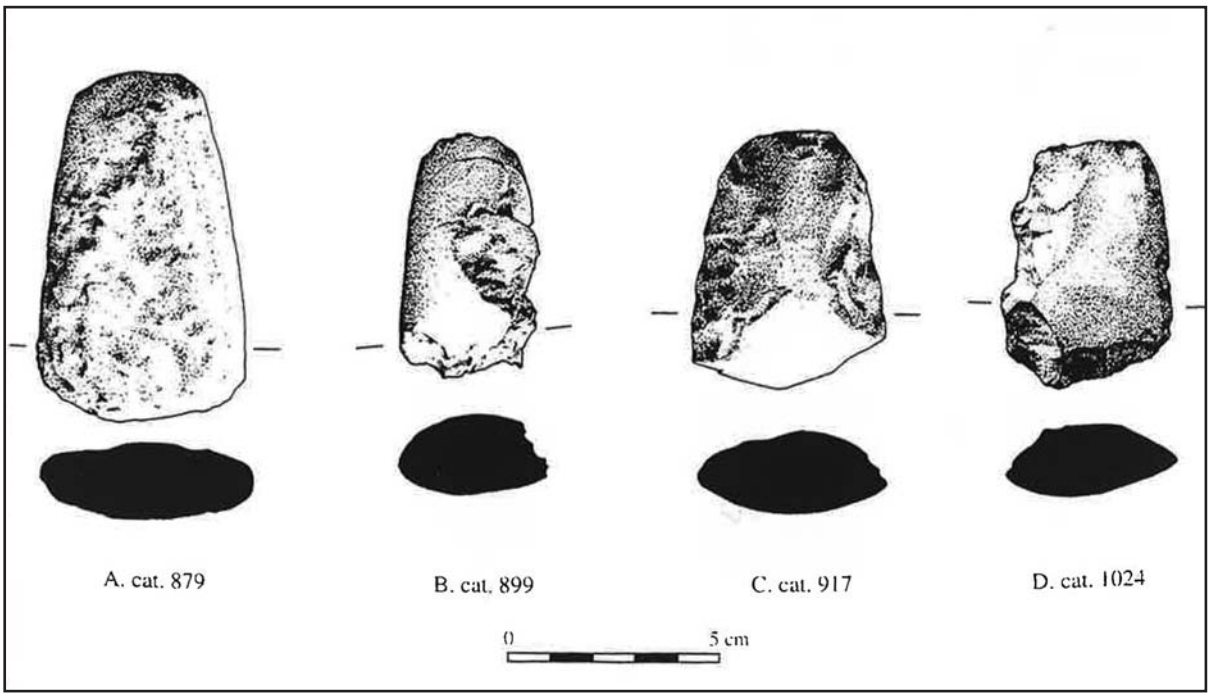


FIG. 52. Stone adzes

lithic material was a valuable commodity at Nong Nor and implements made from it were used to their full potential. The stone from which some of the adzes were made seems quite unsatisfactory for the purpose to which they were put. The sandstone adze would have been of limited use due to the friable nature of the stone. The volcanic tuff must have been difficult to shape and the gneiss would tend to dull quickly. We may conclude from this that suitable stone was not locally available.

BURNISHING STONES

Nineteen burnishing stones were recovered from midden contexts (Fig. 53). These small water worn stones which are still used to impart a lustre to vessels through vigorous rubbing when the clay is in the leather hard state. The sheen is maintained even after firing. Burnishing, aside from being a decorative technique, also improves water retention. These artefacts were examined by Spiers (n.d), and the summary below is based on his conclusions. The study of 392 burnishing stones from Khok Phanom Di (Moore 1987) was used as a guide. Each stone was washed and measured and the stone material was identified as probably having come from the metamorphic deposits in the foothills about 10 km from Nong Nor, or from closer local deposits about 2 km distant (G. M. Mason, pers. comm.). The stones were then examined using a low powered (15x) Olympus stereo microscope. Many, revealed use wear, visible as striations, worn surfaces or edges and highly polished areas. Further examination of the artefacts using an Olympus SZ4045TR zoom stereo microscope revealed micro wear which was not apparent under low magnification. Parallel striations were interpreted as being indicative of the artefacts use as a burnishing stone. In Thailand burnishing stones are still used to smooth vessel surfaces and similar striations are found on modern comparative specimens. The action used is unidirectional, which serves to align the clay particles, and provides the desired lustre.

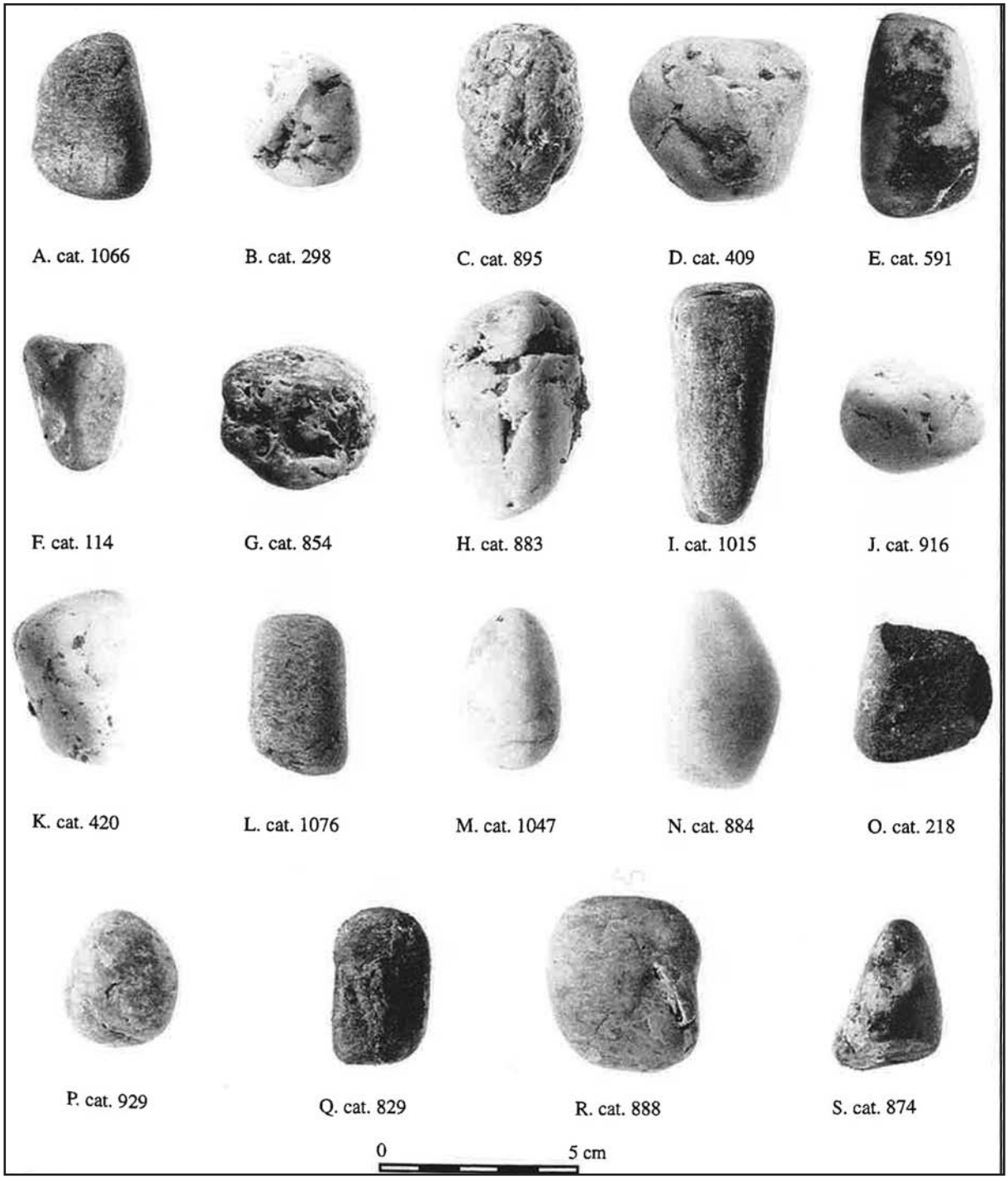


FIG. 53. Burnishing stones

XI. ANALYTICAL RESULTS

D.J.W. O'Reilly

IN this chapter, the results of the empirical analysis of all aspects of the material culture from Nong Nor during the phase 1 occupation are presented.

RESULTS OF THE CERAMIC ANALYSIS

The variable nature of the ceramic assemblage was particularly valuable in the archaeological assessment. It will be remembered that the analysis of the ceramic remains from Nong Nor was carried out to address a number of questions. These include the duration of occupation at Nong Nor and the periods of use; was it seasonally occupied or was occupation continuous over a certain period of time? Did the same group inhabit Nong Nor continuously or was it used successively by different people. It was hoped also that some estimate of the size of the population at Nong Nor could be proposed using the ceramic data in conjunction with other information.

The ceramic sample has been utilised to address these issues by defining forms or motifs using a number of attributes set out in chapter VIII. These forms and motifs have been used to test the presence of chronological change or areal differences within the ceramic sample.

Plain Sherds

The number of plain sherds decreases steadily from the top layer of the midden (2:1) from 487 sherds to 23 in the bottom layer (2:7). This pattern is seen in the weighed sample as well. The basal layer (2/3) shows an increase in the number and weight of plain sherds. This may be misleading, however, in that Layers 2:5 to 2:7 are only present in the deeper units. Therefore, in order to interpret the graphic representation accurately, those layers may be omitted. The chart (Fig. 54) then, reveals a consistent occurrence of plain sherds throughout the sequence.

A feature within the midden (2A), was noted by the excavators as being a red burnt lens indicating some form of pyrotechnic activity. It is interesting to note the increased amount of pottery on the surface and in the first 10 cm of the feature (Fig. 54). The evidence is consistent with the use of the area for open-air firing and pottery production,the increased number of sherds representing pots damaged or broken during firing.

Cord-Marked Sherds

The number and weight of this sherd type show little change throughout the sequence. This steady

accumulation may indicate a continuous occupation of Nong Nor. Once again, there is a significant amount of pottery in the upper levels of the red feature (2A). The amount of pottery decreasing with depth is consistent with the interpretation of the feature as a firing surface. It must also be remembered that this feature did not stretch across the entire site, a fact which increases the possibility that the interpretation has some validity.

Scraped Cord-Marked Sherds

The same pattern of consistency exists in the distribution through the stratigraphy of the scraped cord-marked sherds (Fig. 54). The presence of cord-marked sherds which have been scraped indicates that there were some vessels in use which incorporated both plain and textured decoration on their surfaces. Sherds exhibiting both design patterns would be expected to yield a lower number and weight than either plain or cord-marked sherds alone. There are nearly twice as many plain sherds and over ten times as many cord-marked sherds as scraped cord marked. The scraped sherds tend to demonstrate a gentle curvature rather than any definite diagnostic shape which would suggest that the plain pattern on cord-marked pots was either on the rounded bottom or mid body of the vessels.

Diagnostic Sherds

The type of decoration found on the diagnostic sherds was restricted to cord marked, scraped and plain. There was some grouping in the values attained from the measurement of the angle at the throat. The 25 cord-marked sherds measured had angles ranging from 120˚ to 160˚ with a large number of shoulders demonstrating a 130˚ angle (Fig. 55).

Angles on scraped cord-marked sherds range from 95˚ to 130˚, the majority of collars being at a 110˚ angle from the body (n=22, Fig. 55).

Plain shoulder sherds have a wider range of angles, from 90˚ to 140˚. A large proportion did, however fall into the 120˚ range. There were notably fewer examples of plain shoulder sherds, (n=12; Fig. 55).

Rim sherds which retained a significant portion of the body were then examined to determine the angle of rim to body in association with a specific rim form. Sherds with the rolled rim and cord marking (1.8A.10) provided the most examples which retained enough of the body to permit measurement of the angle. Ten were examined, having a range of 120˚ to 160˚. Half of the rim sherds had a 130˚ angle, three had a 160˚ angle and just two had a 120˚ angle. This demonstrates with some confidence that the rolled rim form was part of a wide mouthed, round bottomed vessel which was cord marked at least from the shoulder up. The limited numbers of other rim forms retaining both collar and body did not merit a comparison to the diagnostic sherds.

Rim Diameter and Vessel Numbers

The most abundant rim form at Nong Nor (1. 8A. 10) has an everted folded rim with a rounded lip, which was always cord marked. To create an estimate of how many pots with this type of rim were actually present at Nong Nor the procedure laid out above was followed. The average length of rim sherds was 2.9 cm (n=93). The average circumference of the pots was found to be 87.9 cm. The number of rims in one pot was arrived at by dividing the latter by the former, equal-

ling 30.33. The number of rims of this type (592) was then divided by this figure resulting in an estimate of 19 to 20 pots.

The second most abundant rim form (1.5.10) has an everted, parallel profile with a round lip. By following the same procedure it was found that three to four pots with this rim form are represented.

Rim form 1.6B.10, an everted rim which gradually reduced in thickness to the lip and had a rounded lip was represented by 70 rims in the 1993 excavation. The average length was calculated from a sample of eight rims, resulting in a figure of 3.43 cm. The average circumference of the pots was found to be 74.61 cm. The number of rims in one pot equalled 21.75. The total number of rims of this type (70), divided by 21.75 rendered the approximate number of pots present in the area excavated in 1993 of this rim form, 3.21, or four whole pots.

The last rim form examined was 1.5.9, an everted rim with a parallel profile and a squared lip shape (n=57). The average length of rim sherds was calculated from a sample of eight rims, which was 2.82 cm. The average circumference of the pots was found to be 59.7 cm. The number of rims in one pot equalled 21.16, representing three vessels.

Bases

Only 13 recognisable base rings, either whole or partial, were recovered during the 1993 excavation. These artefacts were seen to be present in restricted areas as well. Four come from Area 8 at the basal level and six bases were found in Layer 2A:1, the red burnt layer, in Areas 4 and 6. One was found in Layer 2:7 of Area 6 and two in Area 14, Layer 2:1. Area 6 also contained three rather unusual pot bases in the same layer. These are conical in exterior shape yet have a concave interior surface. Whether these come from the same vessel or from three similar pots is unknown. All are basket impressed and have the same quartzitic temper. Their location in the supposed firing area (2A), makes the assertion that they come from the same vessel rather dubious as they may easily be wasters destroyed during a batch firing. The remaining base rings demonstrate homogeneity of form. Those which had more than 5 cm remaining were measured. Of the nine base rings which were measurable, four were 8 cm and three measured 9 cm in diameter. Two other rings were 6 and 7 cm in diameter. The height of the rings, from the bottom to the area where the body of the vessel was originally attached ranged from a delicate 1 cm to 2.4 cm (1.0, 1.5, 1.7, 1.8, 2.0, 2.2, 2.2, 2.3 and 2.4 cm, base heights). The base rings are fairly consistent in their surface appearance as well, all being plain except for one stamped base (Fig. 56).

THE DURATION OF THE OCCUPATION

The duration of the occupation of Nong Nor is difficult to assess solely through the examination of the ceramic assemblage. Several factors impede the assessment. Some of the site remains unexcavated and only the material excavated during 1993 has been examined. Taphonomic factors must be considered, as well as the possibility that some of the pottery was removed from the site through exchange. Considering the reasons listed, any statement concerning the duration of the occupation of Nong Nor, based solely on the ceramic assemblage is highly tentative. Nevertheless, an informed estimate may be offered, based upon the number of rim forms delineated, as well as continuity in these forms and in decorative style on body and rim sherds.

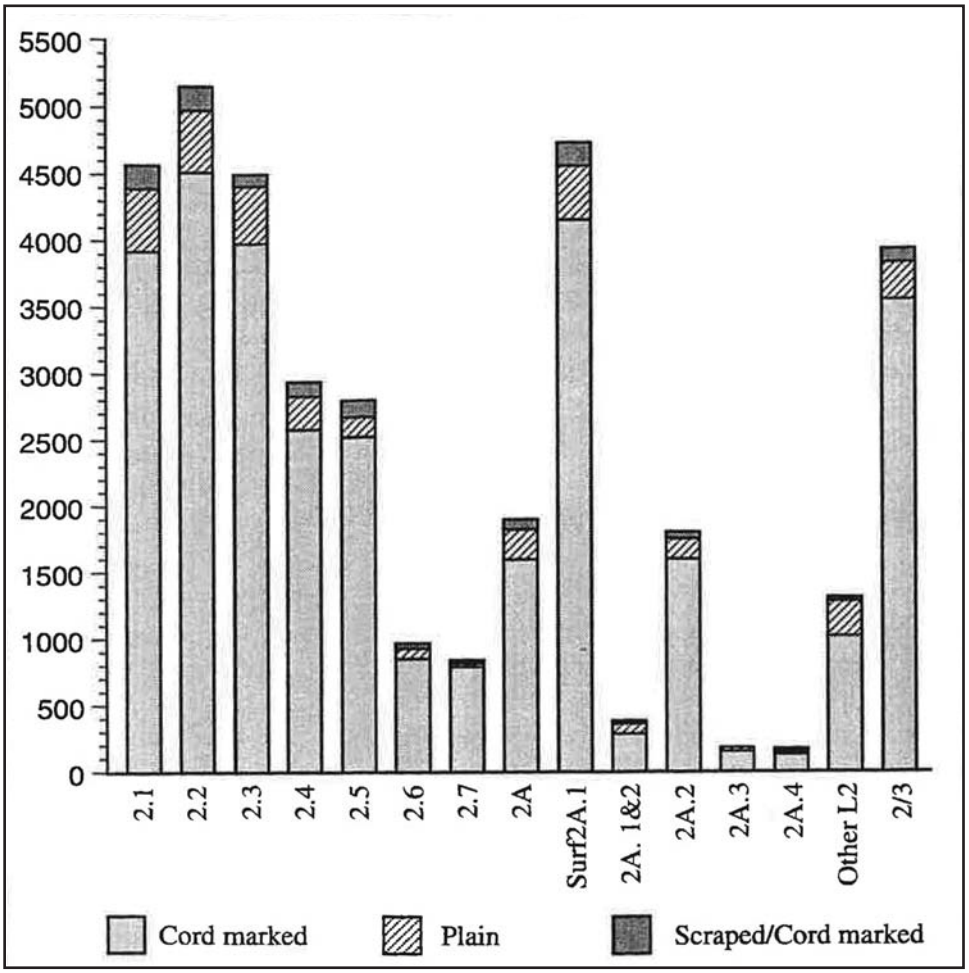


FIG. 54. The quantities of sherds by stratigraphic level

Based upon ethnographic evidence of pottery production, it is possible for one person to create three or four ceramic vessels per day, assuming that quarrying for clay takes about 60 minutes, preparation, coil building, scraping and shaping, decorating, drying and firing all take about 4.5 hours (Irwin 1977:230). The area revealed 30 whole pots, based upon the calculations above which are derived from four different rim forms. There are 36 different rim forms present in the excavated sample and after subtracting the four rim forms already calculated, there is a minimum of 32 different pots represented by the remainder. The minimum number of vessels present in the Areas 4, 5, 6, 8 and 14 is 62. Based on Irwin's (1977:230) research it would take one person from 15 to 20 days to produce this number of vessels. Bearing in mind the fact that the occupation area excavated in 1993 was particularly deep, calculations were devised to determine the total number of vessels. If the total number of pots is multiplied five times, which roughly corresponds to the ratio of analysed midden (70 m^2) to the total area excavated over three years (350 m^2), the amount of time it would take one individual to produce the resulting three hundred and ten ves-

sels is rather short, just 77 to 105 days. It further seems unlikely that there was just one person responsible for the creation of the entire ceramic assemblage. Based upon these calculations and heeding the conditions mentioned above, it would seem that the duration of occupation was quite short, certainly less than six months.

There is no absolute evidence present in the ceramic assemblage which indicates the time of year Nong Nor was occupied. It is apparent from the number of vessels present in the midden, that the occupation was not lengthy. This being the case, the discovery of what appears to be an open hearth used in the firing of pottery takes on considerable significance. The presence of this feature indicates that the site may have been occupied exclusively during the dry season (October-May). In present day rural Thailand the production of pottery is a dry season activity. This is because ambient humidity and the frequency of rain during the wet season prevents the clay from drying properly prior to firing. Although there are rare cases of peoples living in tropical environments firing their wares during the rainy season (Rice 1987:156), the evidence of firing strongly suggests a dry season occupation.

RESULTS OF THE LITHIC ANALYSIS

Grindstones and Whetstones

Based upon the examination of the lithic artefacts, the occupants of Nong Nor were using sandstone in two capacities. Grindstones may have been utilised as querns to pulverise various substances such as grains, vegetable matter or minerals. The other use of sandstone was in the production of whetstones which appear to have been used to hone other lithic, bone or wooden implements. The diagnostic grooving on the surface of these artefacts suggests that a different action than that used with grindstones may have been employed. None of the sandstone artefacts is very large, and many are worn on several faces, indicating that the implements were used to their maximum potential. This is not surprising when it is considered that the closest deposit of sandstone is 100 km north of Nong Nor (Pisnupong 1988). Procuring raw materials, then, would have entailed substantial effort. It is possible that this stone was obtained through an exchange network although it is difficult to substantiate such an assertion based on the evidence available.

Hammerstones and Pounders

Three hammerstones and pounders were recovered from the occupation deposit. It is apparent from the scarring evident, that these artefacts may have been used in the production of stone tools but the lack of large quantities of stone flakes seems to contradict this possibility. It is more likely that the hammerstones were used in percussion flaking to repair damaged tools, an activity represented by 13 lithic flakes. It is also possible that the hammerstones were used to smash bone or shell but there is no direct evidence of this type of activity.

Adzes

Just four adzes were found, all being Duff (1970) type 2G, with an elliptical cross-section and a rounded poll. All were badly damaged, making it impossible to determine whether the bevel was bi- or unilateral. The state of these adzes is testament to their value, for like the grindstones and whetstones they have been used to their maximum potential before being discarded.

Burnishing stones

The 19 water worn pebbles recovered in the excavation have been confirmed as burnishing stones, used to impart lustre to the surface of ceramic vessels. The striations apparent on the surface of these artefacts are consistent with those found on modern examples. All the stones are of a similar size and fit comfortably in the hand. These are in all derived from river gravels washed down from the interior.

RESULTS OF THE ANALYSIS OF BONE ARTEFACTS

Based upon the limited amount of bone retrieved, the absence of intact diaphysial bones and the economy demonstrated in the removal of the ends of long bones, it is apparent that it was a valuable commodity. Boyd has suggested that the inland environment adjacent to Nong Nor was probably impoverished, an assertion reflected in the scarcity of the remains of terrestrial mammals at the site. The predominantly mangrove/marine environment is not the preferred habitat of the mammals of which there are remains at Nong Nor.

Bone was valued for the preparation of fishhooks, awls and other utilitarian devices which were manufactured at the site, as is evidenced by the presence of blanks and tabs. It is difficult to assess the manner in which the faunal assemblage accumulated. The best interpretation seems to be that the animals were butchered at the kill site and select limbs brought to Nong Nor, or that long bones from previous hunting expeditions were imported at the initial occupation. Whatever the case, it is clear that entire animals were not being butchered at the site. The hunting may have been opportunistic, the fish and shellfish providing an abundant amount of food, along with archaeologically invisible vegetable supplements, rendering the hunting of terrestrial species for nutritional purposes, largely unnecessary.

SYNTHESIS AND CONCLUSIONS

The analysis of the ceramic assemblage excavated from Nong Nor during 1993 has resulted in a number of conclusions. It may be surmised that the site was occupied for a short period of time during the dry season. Based upon the continuity seen in the technique of pottery manufacture and decorative style, we may speculate that one social group occupied the site. The occupants were producing a variety of different vessels, the most common of which were large, round-bottomed pots with everted rims. The bulk of the pottery at Nong Nor was cord marked, suggesting that the favoured technique of vessel construction was coil building followed by the use of a cord-wrapped paddle and a ceramic anvil (Solheim 1952). The use of the anvil is testified by the presence of indentations on the vessel interiors and the coiling technique is affirmed by the presence of overlapping folds on the interior of some sherds.

Other vessels were decorated by smoothing the surface, to varying degrees. Some exterior surfaces were treated with a burnishing stone, the grooved impressions being visible. Some smoothed surfaces were further decorated with incised bands or other incised designs. The application of stamps to the unfired vessels created attractive textures on the exterior surfaces.

The fact that the pottery was elaborately decorated, making it aesthetically pleasing and not strictly utilitarian, suggests deeper cultural significance than may be understood solely through an archaeological analysis. The symbolic significance of decorative elements be it religious, societal

or economic, will never be fully understood.

The variation in rim form at Nong Nor suggests an extensive range of vessel shapes and uses, assuming that vessel form and function are related (Ericson *et al*. 1972:84-95, Hally 1986:267-95, Rice 1987:224-8). This variation in vessel form further hints at a diversity in the life ways of the people that created the midden at Nong Nor, that their lives were not dedicated exclusively to survival but that they had a rich social fabric and were concerned with artistic expression.

The lithic material suggests that the inhabitants either ranged widely to acquire raw materials, or engaged in some sort of exchange network. The latter seems more probable based upon the lack of evidence for the production of stone tools at Nong Nor. The scarcity of suitable stone is attested by the advanced state of wear on all of the lithic artefacts. Stone was not the only scarce commodity, bone appears to have been highly prized as well. Artefacts suitable for use in the environment surrounding Nong Nor were fashioned from the long bones of several terrestrial mammals. The presence of awls and a shuttle indicate that the inhabitants were working fabric or hides.

In summary, we have been able to recreate the environment surrounding Nong Nor, based upon the material culture. It has been determined that the occupation was a single event probably dur-

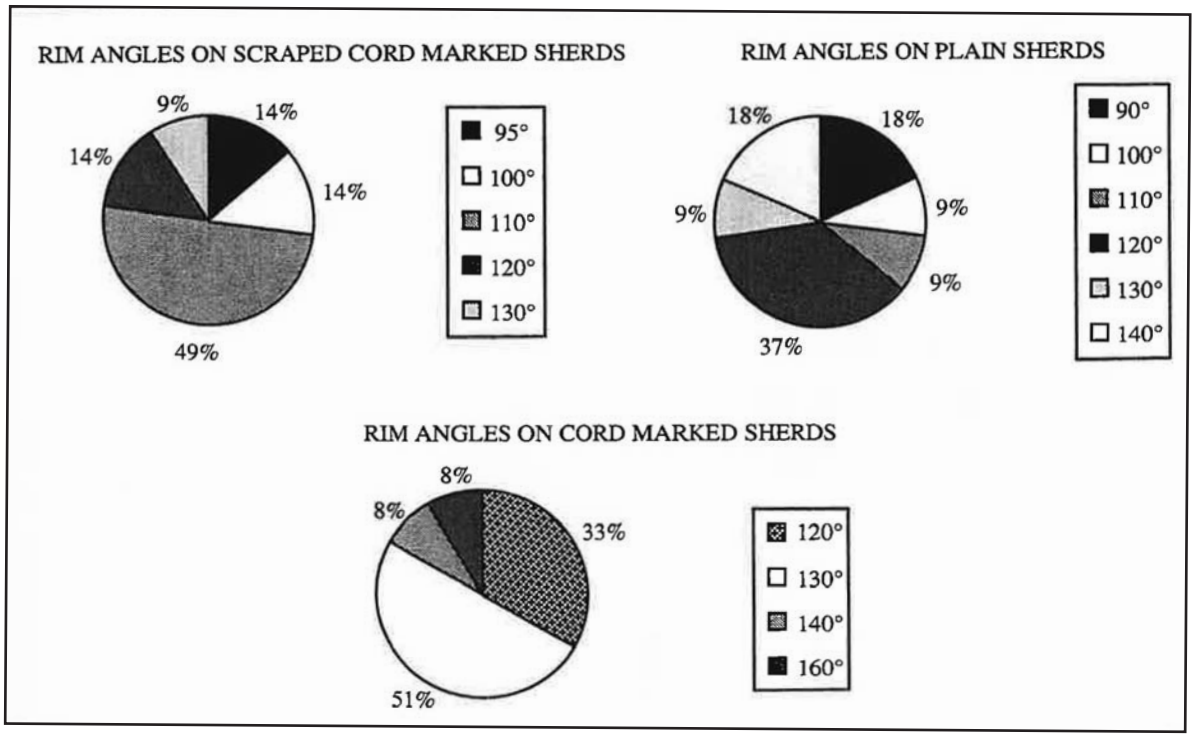


FIG. 55. The relationship between rim angles and decorative technique

ing the dry season. The environment was one of abundance, although material such as stone was scarce. Shellfish beds were exploited and the inhabitants engaged in fishing. Animals were hunted opportunistically and their bones were used in the production of tools.

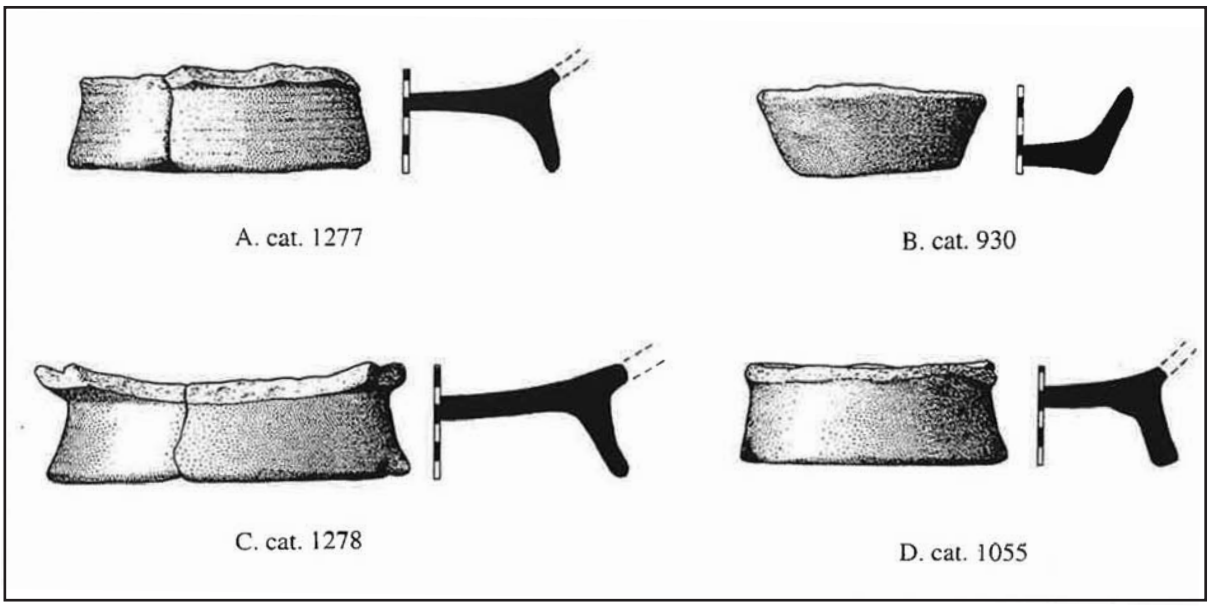


FIG. 56. Pot bases from Nong Nor phase 1. Scale segments are 0.5 cm

XII. THE SPATIAL ANALYSIS

D.J.W. O'Reilly

THIS chapter will consider the distribution of artefacts within the phase 1 occupation area. If spatially restricted, such distributions may be referred to as activity areas, where particular human events occur (Kent 1984:1). The analysis of activity areas is an important field of study rarely applied to Southeast Asian contexts. Further afield, however, it has received a great deal of attention from many authors (Binford 1978, Kintigh and Ammerman 1982, Kent 1984, Heitala 1984, Kroll and Price 1991). Two avenues of research have been explored in the attempt to understand the use of space among different cultures. The first is ethnographic investigation, which involves the scientific examination and observation of living ethnic populations. The second avenue has focused on the definition of spatial patterning in the archaeological context. The most fruitful efforts have been those which have combined both methods and approached the problem from an ethnoarchaeological perspective. With this approach archaeological patterns are matched in living communities in order that the investigator may understand the processes underlying the archaeologically observed phenomena.

A limited range of activities contribute to the creation of the archaeological record in a sedentary hunter-gatherer society. It is the task of the archaeologist to determine the causative factors which created the features and distribution of artefacts. Brooks and Yellen (1987) outline four categories of debris generating behaviour, "a) procurement or the gathering, hunting, harvesting or collecting of natural materials for immediate or later consumption or manufacturing; b) processing or the transformation of procured food into ready to eat states by such activities as butchering, peeling, cracking of shells, and roasting (processing may also include the separation of edible parts from non-edible parts destined for later use in manufacturing, and may involve the use of firewood or other fuel); c) consumption or the eating of food items by consumers, with or without further cooking, and in the context of social rules such as sharing or the segregation of single sex consumption areas; and d) manufacturing, or the processing of non food items into artefacts or other culturally significant items or modified surfaces." The debris left by these activities may be concentrated in certain areas, which will be later identified as an activity area or the locus of a specific event.

It is necessary to exercise caution when attempting to interpret activity areas in archaeological contexts. Kent (1984) has demonstrated that activity areas cannot be observed at a site based solely on the content and patterning of artefact and faunal assemblages. She also demonstrated that the activities performed at such areas are not necessarily sex specific and mono functional. Corollaries of these hypotheses are, that the artefacts and faunal remains were deposited in the location

where they were used and that inferences may be made regarding an area's function based on the refuse deposited there. Furthermore, the investigator must understand that the uses of specified activity areas are not valid cross culturally and may not be applied to all groups through time and space. The interpretation of activity area use is fraught with pitfalls, but is still a valid and important avenue of research provided one proceeds with caution. If the subsistence systems and lifeways of ethnographically observed cultures demonstrate a significant degree of similarity to archaeologically observed peoples and a modicum of discretion is employed, the archaeologist may gain an understanding of inter and intra-site variability on several levels, including space and time. The interrelationship demonstrated by the modern group may be extrapolated by the archaeologist to help in the understanding of prehistoric societies in which the material remains closely match those of the ethnographic group. "By ascertaining the frequencies of a prehistoric group's sex specific and mono functional artefacts and activity areas, and comparing them with that of other archaeological and/or ethnographic groups frequencies, it is possible to postulate the relative emphasis placed on the differences between the sexes and differentiation of their division of labour, amount of specialisation present and so on" (Kent 1984:2).

Some important considerations have been illustrated by Garrett and Hayden (1991:11). Primarily, it is necessary to ponder the structure of a site (the distribution on the landscape of habitations, activity areas, refuse areas and other features) as a whole. In this way it is possible to make inferences about past social interaction, thus enabling archaeology to make a significant contribution to the study of cultural adaptations and dynamics. The authors suggest that, in order to interpret community patterns successfully, we first need to recognise discrete residential units at a site. These include hearths and roasting pits, which are usually closely associated with residential units. Even in the absence of evidence for a structure, hearths represent an opportunity to monitor inter-household spacing. They can be expected to be relatively close to the sleeping/eating area, and thus they should render relatively accurate observations on household spacing. Refuse concentrations should help to delineate individual subsistence units. These are more difficult to discern, however, in long occupations or where there is a great deal of accumulated refuse, as is the case with shell middens. Artefact clusters, observable workshop areas (perhaps identified by lithic debitage or micro-debitage) may be repeated across a site and be used to distinguish residential units. Other indicators include structural remains and the patterns resulting from refitting debitage to cores. There are, then, two levels of concern, the first with the identification of specific activity areas and the second with group/subgroup structure within and between the defined areas of activity (Ferring 1984:116).

The interpretation of the spatial patterns at Nong Nor was undertaken in conjunction with a group of contemporary coastal dwellers. The Chaw Lay, mentioned earlier, are an autochthonous group of hunter-gatherers, known as "sea nomads" or "gypsies". They inhabit the coastal regions from Burma to the Philippines (Rogers and Engelhardt 1997). The similarities between the modern Chaw Lay occupations and that represented archaeologically at Nong Nor are relevant to the present study.

Several Chaw Lay sites have revealed a consistent pattern in the spatial distribution of activity areas, structures and refuse deposits. A typical site will be characterised by a band of shell midden along the front of the site, which acts as a wave break. Another band of shell and mixed refuse is usually located behind the habitation area. Smaller deposits of shell are located

around trees and between dwellings (Rogers and Engelhardt 1997). The similarities between the Gidjingarli base camps and the Chaw Lay are striking. The Aborigine camps are also surrounded by shell deposits and the area inside is spotted with smaller piles of shellfish remains (Meehan 1982:116).

The Chaw Lay live in semi-permanent pile dwellings which are clustered in irregular ovals. The spaces between residential units are used in communal economic and social activities and the periphery of the site is used for activities which create large amounts of waste. When a site becomes overpopulated the spatial integrity begins to dissolve. The density of residential structures increases as does the amount of waste produced, infringing upon the communal areas. The waste producing activities which would usually be executed in the peripheral areas begin to occur within the inhabited area, causing uniformity in the midden across the site. After the inevitable abandonment of a site in such condition, what remains is a mixed shell midden, which contains discrete activity areas and household deposits. The seaward and landward middens merge with the smaller mounds in the habitation areas and the distinctions between primary and secondary deposits become blurred (Rogers and Engelhardt 1997).

There appear to be discrete clusters of artefacts such as worked bone, fishhooks, adzes and lithic flakes present at Nong Nor, as well as possible ceramic firing areas and refuse deposits. The clusters are readily apparent, in that similar objects are grouped together and may be discerned from other artefact types. These artefacts came to rest where they did by the processes outlined by Brooks and Yellen (1987). The site therefore meets many of the archaeological requirements set out above and is suitable for the analysis of activity areas.

It is not sufficient to note groupings of artefacts on a map and assume that they are correlated clusters, these assumptions must be mathematically confirmed for each artefact class and the significance of activity areas determined statistically. Due to the aspatial nature of conventional statistics, however, their use in determining areally distributed elements may lead to erroneous results (Kvamme 1993:102). It was, therefore, necessary to employ statistical methods which have been formulated to calculate and evaluate the significance of the distribution of artefacts at a site. One such statistical method is the k-means cluster analysis (Kintigh and Ammerman 1982), which seeks an underlying structure in a cluster of artefacts other than that which can be intuitively discerned. This statistical method partitions sets of artefacts/objects into clusters. Artefacts are assigned to a group whose centre (defined as the mean of the artefacts in the cluster) is closest in Euclidean distance to the artefact. The k-means analysis begins with all of the artefacts in one cluster and then splits it in two until an optimal number of clusters is attained, in this manner the latent structure of the data is elucidated. An archaeological computer programme (Wright 1992) was utilised in the application of the k-means analysis of the data from Nong Nor. In the implementation of this method and in the interpretation of the results it is important to remember that the excavated area at Nong Nor is merely a partial representation of the shell midden as a whole. It must also be stressed that the excavated area is not a random sample of the midden, as decisions were made during the excavation based upon the results of test pitting and other considerations. Yet it is the obligation of the archaeologist to try and derive the utmost information from an excavated site and short of complete excavation, which is an impractical if not an impossible expectation, all available information must be utilised.

There are several post-depositional factors to be considered when examining the distribu-

tion of artefacts, especially with bone. These include human traffic, the actions of scavengers and natural events such as flooding. Bone movement has been recorded ethnographically among the Kua in Botswana, where bones discarded in communal or nuclear areas were kicked away, trampled or buried as later activities were conducted in the same place. The cleaning of hearths caused concentrations of various materials as well (Bartram *et al*. 1991:104). Scavengers are a significant agent in the non human movement of bone which need to be considered. The existence of dogs at Nong Nor however, is rather doubtful because none of the bone examined had any evidence for gnawing, nor were any canine remains recovered. Another consideration is the patterning in the distribution of the bones themselves. Kent (1984) discovered that the existence of specific patterns in bone distribution could be attributed to human deposit rather than animal. The absence of gnawing also obviates the presence of smaller scavengers such as rats. It is safe to surmise that the bones from Nong Nor were not subject to post-depositional disturbance by animals.

Flooding is a factor which must be given serious consideration at this site, being located on the sea shore at the mouth of a large estuary (Boyd, this volume). It is unlikely that artefacts would remain separated in discrete clusters if the site had been subjected to heavy flooding during its occupation. It is contended that the artefacts have been uncovered *in situ* and were sealed by the rapid accumulation of shells shortly after deposition. The riverine silt deposits which would indicate a flood are absent during the first phase of occupation, and the horizontal distribution of the artefacts confirm this. Barring major disturbance, it has been shown that "the original spatial organisation of a human site may be maintained in large part, though probably with some generalisation or loss of resolution, through the relatively extensive attrition and physical disturbance that may occur during the process of its transformation into an archaeological location" (Gregg *et al*. 1991).

The organisation of space at Nong Nor may be determined through an examination of the distribution of the artefacts. There are several factors, some of which may not be represented archaeologically, which contribute to intra-site organisation. These include the intensity of use of a place, site population, activity type, anticipated length of stay as well as the characteristics of the space itself (Hitchcock in Bartram *et al*. 1991:140). To this list may be added other variables which contribute to the spatial organisation of a site, such as the subsistence strategies employed and the institutionalisation of food sharing. The threat of predators, seasonal and climatic differences which create intra group spatial variation (Kent 1991:33) as well as the post-depositional disturbances mentioned are other contributors. There are, then, a wide range of variables which contribute to the spatial organisation of a site including cognitive strategies and environmental factors. It is the task of the archaeologist to determine which variables were responsible for the artefact distributions represented at a particular site.

THE AREAL AND STRATIGRAPHIC DISTRIBUTION OF THE RIM FORMS

The abundance of ceramic material gathered from Nong Nor makes the analysis of clustering rather difficult. The distribution of the various rim forms and decoration types were organised in a manner in which the data were more manageable. This involved the production of histograms in which the areal and stratigraphic provenance of these artefacts are represented. It is thereby possible to determine which rim forms are present in individual layers as well as their location by excavated area. The analysis of the rim forms allows a determination of continuity and change

within the stratigraphic and spatial assemblage and thereby renders valuable information regarding the duration of occupation and the utilisation of particular areas for specific purposes.

The results of the areal and stratigraphic distribution of the various rim forms are graphically represented in figures 44-7. The results of the distribution of rim forms found in significant numbers (n>5) are examined below.

1. 1.5.9. This rim form is evenly distributed across all the areas excavated. There is, however, a notable increase in the number of rims in Area 5 where nearly double the number were located. The highest concentrations are in the lower levels, yet the distribution is fairly constant through the layers.
2. 1.5.10. Again a fairly even distribution with the exception of Area 6, which shows nearly double the number in the other areas. It is found most abundantly in the upper layers of Nong Nor but they are still present in all the other layers.
3. 1.5.11. Area 6 is again the area with the most sherds of this rim form. This form makes up a sizeable percentage of Layer 2:7 with just four sherds, but is most abundant in the red layer, with nine sherds. Overall the distribution of this rim form is constant through the sequence.
4. 1.5.12. This rim form was rather uncommon, only 14 sherds being found. Half were located in Area 14, although they were also found in Areas 5 and 6 in less abundance. Rims of this form were present in all layers but 2:5 and 2:7, the lower levels of Area 6.
5. 1.5.13. Rims with this profile were widely distributed across Area 6 which contained the largest number of these sherds. Individually 1.5.13 is found most prominently in the upper layer of the midden. It is however present in significant numbers in the basal layer and is absent only in Layer 2:6.
6. 1.5.14. Only nine sherds of this form were excavated, eight coming from Area 6. This uncommon form of rim, appeared only in three layers, 2:3, 2:5 and basal midden. There is some possibility of a phasing out in the upper layers. The limited numbers however do not permit a definite conclusion.
7. 1.5.15. This rim form probably represents a single vessel discarded in Area 8 where five of the seven sherds were located. Examples are absent in the last 20 cm of the lowest level of the midden and is fairly sparsely represented elsewhere. The highest occurrence is in Layer 2:5 with five sherds, supporting the single vessel hypothesis.
8. 1.6A.9. This form is spread evenly in low numbers across the excavated area. 1.6A.9 rims are present in the upper two layers as well as the basal layer and the red lens. The absence of this form in the intermediate layers could possibly indicate separate occupations.
9. 1.6A.10. Area 6 included 25 sherds of this type, which indicates strongly that it was discarded there. Area 4 and 5 had nearly equal numbers while the edge of the midden in Areas 8 and 14 revealed only six sherds. Most abundant in the first layer of the midden this rim form was also found throughout the sequence excepting Layer 2:5.
10. 1.6A.13. With only six sherds recovered it is rather difficult to assess the areal distribution of this form, although Area 6 contained four of them. Of the six rims recovered there was a

representation in both the basal and top layers of the stratigraphy, indicating a continuity in the use of this rim form.

11. 1.6B.9. Of the nine sherds found, eight were located in Areas 5 and 6. 1.6B.9 was found in 2:3, 2:4, the basal layer as well as the red layer. It is possible that its absence in the upper 20 cm of the stratigraphy represents the abandonment of this form.

12. 1.6B.10. A majority of the rims of this form were found in Area 6, there was an even distribution of the remaining rims over the other areas. This rim form demonstrates a definite decrease deeper in the stratigraphy. The rim apparently increasing in popularity later in the sequence. Only three rims were present in the basal level but 18 were found in Layer 2:1.

13. 1.6B.11. Area 6 contained the most of these rims followed by Area 8. This rim is found in consistent numbers through the strata but was absent in levels 2:2, 2:6 and 2:7.

14. 1.6B.13. Yet again Area 6 held the greatest number of rims in this form. 1.6B.13 is most strongly represented in the basal layer with nine sherds being found. The next most abundant deposit comes from Layer 2:1. This form is also found in all the intervening layers.

15. 1.8A.10. The distribution of the most dominant rim form follows the developing trend of abundance in Area 6. Area 14 had noticeably few sherds of this type. Otherwise they are spread fairly evenly over the excavated area. This rim is found in the greatest proportions in the red layer where it made up 48 per cent of all rims found. There seems to be an increase in the incidence of this particular form over time, as only 58 rims or 37 per cent of the total, are found at the basal level. A steady increase may be noted, up to 200 in the top 20 cm of the midden, nearly 50 per cent of all the rims in those two layers.

16. 1.8B.10. Area 6 held the greatest number of sherds in this category, nine out of 14. The surface of the midden held the most rims of this description. It was present in the red feature (three sherds) as well as the basal level and Layer 2:3 (two sherds each).

17. 2.5.10. With only seven sherds recovered it is difficult to assess the distribution in a meaningful manner. Found only in the upper three levels of the midden, this rim could represent the introduction of a new form to the assemblage. It may also be found in the upper portion of the red feature.

18. 2.6A.10. This rim was spread widely across the excavated area with most being located in Area 6. The numbers of sherds decrease further away from Area 6. This rim was present in every layer, most abundantly in the top three layers, although significant numbers exist in the red feature and the basal level.

19. 2.6A.12. Most of these rims were located in Areas 5 and 6. It was absent only from Area 8. This rim form is present throughout the stratigraphy, most abundantly in the top layer and the red feature but is sparsely represented in the other layers.

20. 3.5.9- This rim form is most prevalent at the edge of the midden in Areas 8 and 14. The next largest concentration was quite far removed in Area 4. This rim form represents over eight per cent of the rims in the basal layer and is found all through the stratigraphy save the very deepest levels, 2:5- 2:7.

21. 3.5.10- This rim was confined largely to Areas 5 and 6, the majority being located in Area 6.

Absent only in Layer 2:7, most of these rim sherds came from the lowest level which indicates a continuous use of these vessels.

22. 3.5.11- Areas 8 and 14 had the least sherds of this type and they were fairly evenly distributed over the other areas. The most sherds of this type were found in the red feature, ten in all, representing four per cent. Others are present in Layers 2:3, 2:5, 2:6 and on the surface of natural. The form is not seen in the upper 20 cm. of midden.
23. 3.5.12- There were very few of these sherds recovered but they were distributed uniformly over the excavated areas. Of the six sherds found, two came from level 2:3, one from level 2:5 and three from the red layer.
24. 3.5.13- These sherds were confined only to Areas 5 and 6 with one being found in Area 14. Of the ten sherds, half were located in the red feature, while four came from level 2:2 and the last from 2:6.
25. 3.5.15- This rim was absent only in Area 8, all other areas surrendering one sherd. This rim form seemed to be confined to the upper levels, being found in 2:1, 2:3, 2:4 and 2A:3.
26. 3.6A.10- These were absent in the edges of the midden being present in Areas 4, 5 and 6 in limited numbers. Half the ten rims of this form come from level 2:1 the other from level 2:4.
27. 3.6A.12- Area 6 rendered the most of these rims followed by Area 8, suggesting the vessel was discarded in the eastern end of the midden. There appears to be an even distribution of this rim in all the layers, although it is slightly more common in the lower layers and in the red feature.
28. 3.6B.9- This rim had an even distribution over the midden, although not in great numbers. It was also absent in Area 6. Present in levels 2:4, 2:5 and the red feature it is difficult to assess the distribution with such limited numbers.
29. 3.6B.10- Found mostly in Area 6, single sherds were present also in Areas 4, 5 and 14. These rims are sparsely represented in all layers but 2:3, 2:6 and 2:7.

After reviewing the areal distribution of the various rim forms, it seems that a definite pattern may be discerned, in that Area 6 consistently held the most sherds of nearly every form. The basal layer in Area 6 dipped to 80 cm below datum, which may have led the inhabitants to fill this natural hollow with debris. The build up of the rest of the midden is rather enigmatic, however, because after this hollow in Area 6 was filled, the midden continued to accumulate. It is difficult to establish whether or not the original inhabitants were dwelling on top of their own refuse. The lack of any clear pattern of post holes hampers the delineation of residential units, but the hearths identified may represent the only surviving evidence of dwellings. The presence of activity areas leads to the conclusion that the occupants of Nong Nor lived on the accumulating midden. These activity areas are evidenced by the burned surfaces which contains large amounts of pottery. The distribution of other artefacts also suggest that the midden surface was being utilised on a daily basis for artefact production (see below). The formation of a shell mound involves complicated processes which have been ethnographically recorded. Among the Gidjingarli “various parts of the base camps are continually being moved...debris continues to be deposited on the periphery of each hearth complex and the remains are usually left there for some time. At regular intervals,

every week or two the entire camp area is cleared with rakes, sticks or feet. The rubbish is dumped in various places around the periphery of the hearth complex, usually in areas which are unimportant for use or access. Eventually, quite large banks of debris form, and these are occasionally burnt..." (Meehan 1982:114).

The consistent appearance of rim forms suggests that the site was occupied by one group. While the data available regarding the rate of change among pottery assemblages is variable, the consensus seems to support a conservative tendency in tribal society. Rice (1987:464) believes that potters are not wont to alter ceramic styles citing "forces of *costumbre*, adherence to familiar motor habits, traditional diets and use of customary clay resources (as establishing) a cultural context of continuity that fosters a corresponding continuity of styles in the utilitarian vessels produced." With these principles in mind, it is clear that ceramic change through time does not occur at Nong Nor during phase one. Rim forms from the basal layer are identical to those excavated from the top layers. Examining the stratigraphic distribution of the rim forms, it seems that there were no dramatic shifts in vessel morphology. Only two forms are absent in the upper levels. Every other rim form was found throughout the sequence, consistent with a short occupation. Three different rim forms (3.5.14, 1.6A.13 and 1.6A.9) appear in basal layers and upper midden layers exclusively, possibly indicating abandonment and reoccupation, there is, however, no supporting evidence for this.

THE AREAL AND STRATIGRAPHIC DISTRIBUTION OF DECORATED SHERDS

The decorated sherds were subjected to the same analysis as the rim forms, with similar goals in mind. The results are displayed in figures 44-5 and the distribution of the sherds found in significant numbers (n>5) is discussed below.

1. 1a. Sherds with a single incised line were classified under this designation. Forty were found, most coming from the basal layer (n=12). Seven sherds each were found in Layers 2:1 and 2:2. This decorative form was absent in 2:5, 2:6 and 2:7. The areal distribution showed Area 8 containing the highest number (n=13), then Area 6 (n=11). Areas 4 and 5 had six and seven sherds respectively and Area 14 only three.
2. 1b. These sherds demonstrate combed concentric rings, they were also the most numerous decorative element. They were recovered in all stratigraphic layers. In Layer 2:4 they made up 75 per cent of all sherds. This type represented 45 five per cent of all sherds in the basal layers and 48 per cent in the red feature. It was a dominant decorative feature throughout the occupation. The areal distribution was not even, in that Area 6 had the greatest number of sherds (n=72) followed by Area 5 and 4 with 60 and 41 sherds respectively. Area 8 had only 32 sherds and Area 14 had the least number, with 18.
3. 1c. This is a pattern consisting of incised multiple rings which occurs in all levels, most heavily in Layer 2:2, where 11 of the 29 sherds appeared. This decorative technique was absent only in Area 4 but was most common in the adjacent Area 5.
4. 1d. Sherds which had other, more complicated forms of decoration were classified under this heading and although it seems an all encompassing designation only seventeen sherds with this kind of decoration appear. The most were found in Layer 2:1 (n=6). They were present in all layers except 2:2 and 2:6. All of the areas excavated in 1993 had a nearly even spread

of sherds of this type.

5. 1ad. These sherds have both a single incised line and other incised decoration. Eight were recovered. They seem to be confined to the top three layers of the midden and the red feature. Areally they are found in all but Area 14. Most came from Area 4.
6. 1a9. These sherds have a single incised line with impressions. They appear in the upper levels, 2:1(n=3), 2:2(n=2) and 2:3(n=2) as well as in the red feature (n=2). One sherd came from Layer 2:6 however. Areas 8 and 14 did not have any of these sherds. Area 6 contained five, Area 5, four sherds and Area 4 just two.
7. 1bd. Twenty three sherds which had combed rings, and other incised decoration were found. These came from Layers 2:1, 2:2, 2:5, 2:7 and the basal layer, but were most prevalent in the top layer of the midden. Seven sherds came from the red feature. Area 5 contained the most of these sherds (n=9) and the rest of the areas shared a fairly even distribution.
8. 1b2. Sherds of this type had combed multiple concentric rings as well as dentate stamps. Only seven of these were found, they were present in Layers 2:1, 2:4, 2:6 and the basal layer in complimentary numbers. Areas 4 and 14 contained no sherds of this type. Area 8 had the greatest number (n=4).
9. 1b7. Combed concentric rings with a plain matte finish were found on seven sherds, located in Layers 2:2 and 2:7, in Area 4 and 6 respectively.
10. 1b9. Impressions accompanied by combed concentric rings existed on seven sherds, five from 2A:2 and two from 2:2. The sherds in the red feature came from Area 4 and the others from Area 6.
11. 1cd. This decorative technique consists of incised concentric rings and other incised decoration of which only seven sherds were found, all from Area 14 in level 2:2(n=1) and 2:3 (n=6).
12. 1c9. Sherds with incised rings and impressions were uncommon, a total of seven being recovered. Six of these came from Layer 2:2 in Area 5 and one from the red feature.
13. 1d49. These sherds showed other incised decoration with paint and impressions. Eight were recovered, all from Area 8 in Layer 2:2.
14. 5z. Slipped sherds were found in Layers 2:1, 2:2 and 2:6 as well as the top of the red feature. The areal distribution was limited to Areas 6 and 14.
15. 6z. Impressed sherds existed in Layer 2:1 (n=5), 2:3 (n=2) and the basal layer, with two sherds as well as one in Layer 2A:2. The areal distribution was fairly even across all the excavated areas.
16. 7z. Plain matte finish sherds (n=138), were found in all the stratigraphic layers but 2:6 and the basal layers. The top layer had the heaviest concentration (n=55), the next greatest number came from the top of the red feature (n=26). It appears that there is an increase in these as one moves upwards in the stratigraphy. The areal distribution is interesting as well. Area 6 had the most sherds with 64, Area 5 had 40 sherds and Area 4, 30. There were very few in Areas 8 (n=3) and 14 (n=1).

Sherds with curvilinear designs are found in all the excavated areas except Area 5. Area 8 contained the most, five sherds which came from the basal layer, and Layers 2:2 and 2:3. Area 6 surrendered three sherds, two from 2A:3 in the red feature and one from 2:5. The top of the red feature contained two more sherds of this decorative combination in Area 4. The curvilinear incisions in conjunction with stamping appears to have been current throughout the occupation and use of the midden, being found as it is, in both the basal layers and on the surface. The design on a plain background seems to be more prevalent in the upper layers, except for one sherd found in Layer 2:5.

Seven sherds with two parallel lines between which is an undulating incised line which rises and sinks to touch both the upper and lower incised lines alternately, were recovered from all areas except Area 4. Three were located in the red feature and the remaining four came from the basal layers. It seems that this type of decoration is restricted to two zones, the bottom of the midden and the red burnt feature, suggesting a short use period for this particular design.

Sherds with three or more parallel lines running horizontally, juxtaposed by evenly spaced vertical lines were found both at the top of the midden and in the basal layers. The red feature (2A:1) contained one such sherd. It is not surprising that this simple pattern is found throughout the sequence, even if the site did have a long period of occupation. The areal distribution is wide, only Area 14 did not contain a sherd decorated in this fashion.

The distribution of decorated sherds at Nong Nor, seems to match that of the rim forms, in that most of the combinations of elements are found throughout the sequence. Elemental combinations not found throughout the stratigraphy were often apparent in the basal layers and the upper layers. Of all the combinations of elements, just two 'motifs' appear isolated stratigraphically. These are 1ad and 1a9 which appear only in the upper layers. The elements that make up motifs are, however, present in all layers. Based on the findings of the decorative analysis the conclusions are the same as those reached for the rim analysis.

THE DISTRIBUTION OF THE WORKED AND UNWORKED BONE

The spatial configuration of the worked and unworked bones at Nong Nor is extremely interesting (Fig. 57). It is apparent that discrete activity areas were being used by the inhabitants, judging from the patterns of discard observable in the faunal remains. There is one large activity area represented by the worked bone along the northern margin of the excavated area, coinciding with the location of three hearths (Fig. 57B). This concentration is observable throughout the stratigraphy from Layer 2:5 up to the surface of the midden. The unworked bone may be seen rather clearly in a complementary pattern along the southern margin of the excavated area (Fig. 57C). Visually, the relationship between the two is strong. We may surmise that the bone was being worked in one area and discarded in another (the southern side of the excavated area). The fact that the worked bone is found in all levels in the same horizontal location supports the hypothesis of a short duration of occupation at Nong Nor.

The k-means analysis was applied to the worked and unworked bone together in order to test the viability of the intuitively distinguished north and south groups. The optimal number of clusters was four. This divided the objects on the northern half into two in an east-west direction and the objects on the southern side were similarly divided. The statistical significance of dividing the whole group in two was assessed through the application of the k-means analysis. The results, displayed in figure 57D, clearly validate the intuitive assessment. There is a consistent clustering,

through all of the layers, of worked bone objects on the northern side of the excavated area and of unworked bone on the southern side.

THE DISTRIBUTION OF BONE AWLS AND FISHHOOKS

The awls are also spatially isolated to a significant degree. They appear in the same areas as the worked bone, along the northern margin. Although there are just five artefacts appearing here, it may still be interpreted as a significant concentration. The fishhooks do not demonstrate the same evidence of concentration as the awls or the worked bone, yet they do seem to be confined to a linear pattern along the southern boundary of the excavated area. Three were located close together in Area XI and could represent a discrete area of artefact manufacture or specified area of discard. Due to the unfinished nature of the recovered hooks, it is possible that they were broken in manufacture and discarded with the other unwanted bone.

The application of the k-means analysis rendered five distinct clusters of fishhooks and awls (Fig. 57A). The first contains four awls, two from the same stratigraphic location, and a fishhook. The second group consists of ten awls and fishhooks, five of the artefacts are from Layer 2:2. One awl and one fishhook are from Layer 2:3 and another awl comes from Layer 2:6. The third statistically defined cluster contains four fishhooks, three from Layer 2:1 and the last from 2:2, which may indicate a locus for fishhook production for a limited duration of time. The fourth group contains two fishhooks and an awl. The last cluster is represented by a sole artefact on the surface of natural substrate.

THE DISTRIBUTION OF THE BURNISHING STONES AND ANVILS

Examining the distribution of the clay anvils in the excavated area, there are five intuitively apparent clusters which are statistically viable. The statistical optimum, however, is two groups. These clusters are illustrated in figure 58C. There is a separate cluster in the most southerly portion of the excavated area, where five anvils are found. The second cluster is less nucleated, containing seven widely dispersed artefacts. Group three holds 11 anvils, eight of which are tightly clustered. This is the strongest representation of an activity area present. The fourth group is more scattered, containing ten artefacts and the fifth cluster is located in the north east section of the excavated area. The eight anvils there are fairly evenly spaced and are distinctly recognisable as an independent entity.

The anvils are diagnostically differentiated and some pattern is apparent in their distribution on this plane. Ellipsoid anvils cluster separately from the circular anvils, the former appearing more frequently near the eastern and southern edges of the excavated area (Fig. 58C). This may indicate specialisation in the process of pottery production.

The distribution of the burnishing stones, when submitted to the statistical analysis, revealed an optimal grouping of two. These clusters are readily apparent, being widely separated (Fig. 58D). The first cluster is located centrally, in the northern section of the excavated area. There are nine stones included, but one appears to be an outlier. The second cluster contains 10 stones which are evenly spaced, in the south eastern section of the excavated area.

When the two artefact types are overlayed, there is some loose correlation between them.

Cluster three and four among the clay anvils are matched respectively by cluster one and two of the burnishing stones. Two stones are also located within the fifth anvil grouping. This strongly suggests that the potters were paddle beating their vessels and burnishing them in the same place. Both the anvils and the burnishing stones are represented consistently through the stratigraphy.

THE DISTRIBUTION OF LITHIC ARTEFACTS

There seems to be a clustering of grindstones and whetstones in Areas 5 and 6 which persisted throughout the sequence. This suggests that specific areas were utilised consistently and is another indication of the short duration of occupation. Another concentration of these artefacts is evident in Area 8 at level 2/3 representing a locus of activity concurrent with the initial settlement of Nong Nor.

The sandstone artefacts are divided into an optimal seven clusters when subjected to the k-means analysis (Fig. 58B). Six of the clusters demonstrate consistent use through the stratigraphy which would indicate a repeated utilisation of the statistically defined activity areas. The seventh cluster is composed of nine artefacts, six of which are located in the basal layers, indicating an activity area which was utilised at the initial occupation of the site and then only sporadically afterward.

When viewed together, it is interesting to note that the sandstone artefacts have a similar distribution to that of the worked bone, described above. This may suggest that the crafts people were sharpening their implements as they sawed the bone. Exhausted grinders and whetstones would have been discarded *in situ* along with the useless pieces of cortical bone.

The other lithic artefacts were difficult to interpret due to their scarcity. There were five adzes recovered, three of which were located in Area 8. The other two come from Area 9 in the northern part of the excavated area. There were three lithic flakes located in Area 4 and two in Area 1. The last four were located in fairly close proximity in the northwest corner of the excavated area.

Four groups were defined among the flakes and adzes when the data were subjected to the k-means analysis (Fig. 58A). The first is represented by two flakes from the top of the midden. Group two contains seven objects, three flakes from the basal layer, three adzes and a flake from 2:4, as well as a flake from 2A:1. The third cluster contains three closely grouped flakes from 2:1, 2:2 and the basal layer. This cluster also takes in an adze which lies some distance from these flakes on the surface of natural. The final cluster contained two adzes from Layer 2 and a flake from the basal layer. The groups of adzes demonstrated certainly implies that they were either being used or maintained in specific areas. There seems to be some correlation between the distribution of the abraders, adzes and flakes.

CONCLUSIONS

Reviewing the different artefact categories, it is clear that activity areas are represented, indicating the repeated use of specific spaces. The significance of these activity areas is weighted when one considers, that they are consistent with the location of the three hearths uncovered at Nong Nor. The clustering of artefacts suggests that the inhabitants habitually returned to familiar areas to perform the same tasks. The repeated use of these areas further suggests that the occupation of

FIG. 57. The spatial distribution of fishhooks, awls, worked and unworked bone

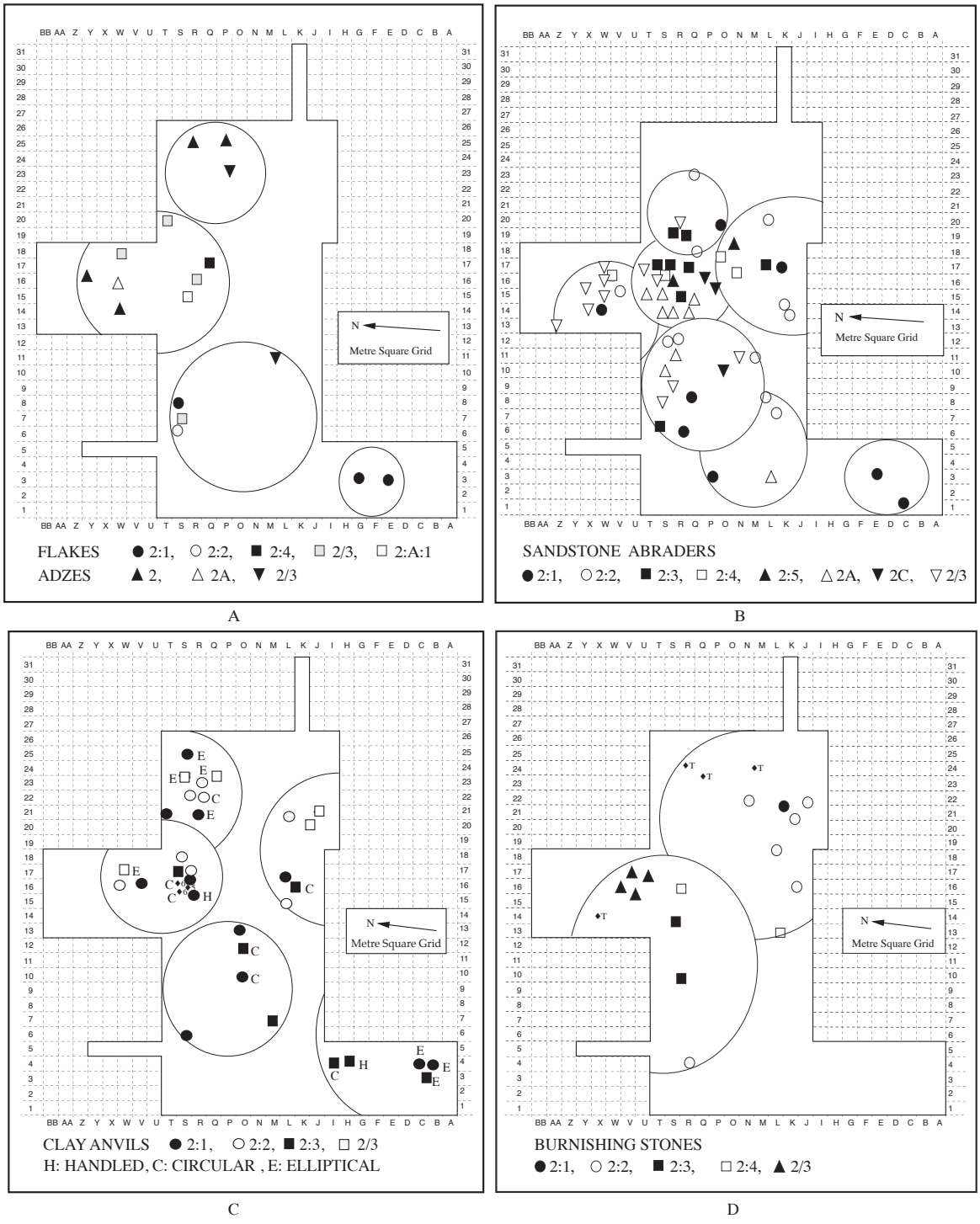


FIG. 58 . The spatial distribution of stone artefacts and clay anvils

Nong Nor was relatively short and the site was probably only utilised once.

There is no apparent correlation between the worked/unworked bone on the one hand and the anvils/burnishing stones on the other. This may be indicative of some form of division of labour, certain tasks being executed in prescribed areas. There appears to be a very vague overlap among the anvils/burnishing stones and the fishhooks/awls in two areas. The strongest association of artefact clusters is found among the sandstone abraders and the anvils/burnishing stones. The former fit neatly into six of the seven statistically significant artefact clusters defined for the abraders. These results suggest that certain activities were performed in association with one another, assuming the artefacts were abandoned where they were used. In the recent past it was common in Thailand for pottery manufacture to be executed by women, a task represented at Nong Nor by the anvils/burnishing stones. The results of the spatial distribution of artefacts, however, do not permit an assessment of the sexual differentiation of the labour. We may conclude that there were areas used for specific tasks which are defined archaeologically by the clustering of specific artefact types horizontally and vertically at the site.

XIII. COMPARATIVE ANALYSIS BETWEEN NONG NOR PHASE 1 AND KHOK PHANOM DI

D.J.W. O'Reilly

INTRODUCTION

THE importance of a comparative analysis of the material culture from Nong Nor to that of Khok Phanom Di has been stressed in earlier chapters. The ramifications of a demonstrated similarity between the sites are profound, yet just as important are the demonstrable differences in material culture. The results of this analysis will play a role in the debate over the dispersal of languages across Southeast Asia, as well as the debate over the origins of rice agriculture along the coast of the Gulf of Thailand.

The 1985 excavation of Khok Phanom Di reached a depth of 6.8 m and three major stratigraphic zones were identified (A, B and C), consisting of 11 layers. The earliest zone (A) contained two layers, designated 10 and 11, comprised discrete shell middens, ash lenses filled with pottery and biological remains, small hearths and 104 inhumation burials. The second stratigraphic zone (B) comprised layers nine to four, in which changes in the environment and the artefact assemblage are apparent. The final zone (C), layers three to one, was restricted to the uppermost metre of deposit and although rich in ceramic material and faunal remains, it contained no burials (Higham 1989:71).

It must be noted that the burial strategy in zone B (layers nine to four) was different from the mortuary practice of zone A (Higham 1989:71). The ceramic assemblage also registered changes between the two zones (Vincent pers. comm.), as did a number of other artefact categories. Based upon possible similarities between the zone A pottery of Khok Phanom Di and the Nong Nor, phase one pottery, the current comparative analysis was undertaken.

A relationship in the ceramic assemblage of two sites may be assumed provided that there is a close similarity in shape and design. Differences in the raw materials and traditions may produce differences in the physical properties of the vessels between the two assemblages but "vessel shape and pattern of decoration are free from the restrictions that composition of materials places on such features as colour of body, slip and paint, quality of surface finish, thinness of vessel wall etc." (Shepard 1957:351). Although referring to foreign influences on pottery style, the quotation above could also apply to assemblages displaced by time and location as at Khok Phanom Di and Nong Nor.

A COMPARISON BETWEEN RIMS FROM EARLY KHOK PHANOM DI AND NONG NOR

Layer 11, the lowest in the sequence at Khok Phanom Di, represented the initial occupation episode *c*. 2130 -1700 B.C. The results of the comparison of the rim forms from that layer to those rims described earlier from Nong Nor are presented below and rims are illustrated in figure 59.

The rim form 1.5.9 was represented at Khok Phanom Di, Layer 11. The profiles are very similar except that the rim is thicker and has a more rounded lip. It also demonstrated a greater degree of curvature.

Rim form 1.6A.10 was found in Layer 11 although it thickens toward the lip a great deal more than the Nong Nor equivalent. The latter also demonstrates more of an outward flare which is absent in the Khok Phanom Di rim. Another example from Khok Phanom Di which may be classified as a 1.6A.10 is very close in profile to the Nong Nor rim except for the less pronounced everted flare.

Form 2.6A.10 from Layer 11 is less similar to its Nong Nor counterpart although the inversion of the rim is very slight.

It is not surprising to find the simple form, 1.5.10, the everted rim with a parallel profile and rounded lip, represented at both Nong Nor and Khok Phanom Di. The Nong Nor rim is however slightly more everted.

The form 2.6B.10 is represented at Khok Phanom Di in Layer 11. This rim most strongly connects the two ceramic assemblages in form as well as decorative technique.

Rim form 3.5.10 has a parallel profile and a rounded lip and examples are identical at both sites.

Form 3.6A.10 is represented at Khok Phanom Di, yet the similarities between it and the rims recovered from Nong Nor are very slight, the curvature of the vessel is much more pronounced in rims from the former.

Form 2.6A.12 was found at Khok Phanom Di but was seen to be extremely robust at the lip, a feature not found in the Nong Nor rims. These rims have inward facing lips with very slight flaring on the inner edge, a feature which was more pronounced at Nong Nor.

The folded cord marked rim, 1.8A.10 was also present in Layer 11 and was indistinguishable from those rims at Nong Nor except in their fabric. This rim seems to be found exclusively in coastal sites in Thailand. It is unknown in the central plains, the closest approximation being a “false folded rim” which is a strongly inverted rim, internally folded, resulting in a circular groove around the internal join of rim and wall. These are found on hole mouth jars and date to around the first half of the first millennium B.C. (Rispoli pers. comm.).

Nong Nor and Khok Phanom Di-Layer 10

The results of the comparison between Layer 10 at Khok Phanom Di, and the Nong Nor assemblage are presented below.

Rim form 1.5.9 was found in Khok Phanom Di Layer 10 in two slightly differing forms. The lip

of the Nong Nor rim slants at a greater angle toward the interior of the vessel than does one of the Khok Phanom Di rims. It is also less robust, being just 0.5 cm thick where the Khok Phanom Di rim is .7 cm and more crudely formed. The other Khok Phanom Di rim however is nearly identical to those rims found at Nong Nor.

The rim form 1.5.10 from Nong Nor closely resembles a rim from Khok Phanom Di. Both have an outward flaring rounded lip the only variance being that the Khok Phanom Di specimen is a little more pronounced in this aspect.

Two rims which could be described as being closely related are Nong Nor form 2.6B.10 and its counterpart at Khok Phanom Di. They are both inverted, with similar profiles. The Nong Nor rim does, however, have a longer rim to body length measured from the point of carination on the exterior of the vessel the difference being just 0.3 cm. The Khok Phanom Di rim is also more robust than its older counterpart but there is no questioning their similarity.

Rims of the 1.8A.10 form are found at Khok Phanom Di and are nearly identical apart from the colour and fabric of the sherds. They are simply cord-marked sherds with an everted rim and the lip has an inward fold.

The rim form 2.5.10 from Khok Phanom Di is almost identical in profile to those found at Nong Nor. There is a good deal of variation in the rims from Khok Phanom Di within this type, but the robust form most closely matches those from Nong Nor, although the curvature on the latter is more pronounced. The less robust examples of this rim form demonstrate the same exaggerated curvature.

The similarities between 3.6A.10 at Nong Nor and some rims from Khok Phanom Di is rather slight. While both are direct rims widening toward the lip, where they round off, they are dissimilar in other ways. The Khok Phanom Di rim is much more delicate. The walls of the body are extremely fine, rendering the widening to the lip much more dramatic. The curvature in the body portion is more notable also.

Rim form 1.5.13 from Khok Phanom Di appears to be from rather hastily manufactured vessels. The closest parallel from Nong Nor is so similar that it could come from the same vessel. The formation of the rim is identical down to the impressions of the outer surface.

Other rims which are very similar between the sites are the 1.6A.10 form, even in the colour and surface texture of the sherds. The Nong Nor rim tends to flare out to a greater degree at the lip however. There is another rim in the category which does not correspond closely to any rims from Nong Nor, although it is a 1.6A.10 form it is everted at a 90˚ angle, a feature not found at Nong Nor.

Some rims at Khok Phanom Di could not be matched at Nong Nor. There was a cord-marked rim which instead of folding inward as do the 1.8A.10 rims at Nong Nor, folded outward. Other forms were cord marked with rims which tapered, gradually reducing their width to the lip and were then folded inward. Some rims were cord marked and could be classified as a 3.6B.10, but this form of rim was never cord marked at Nong Nor.

This comparative exercise has demonstrated that from both Layers 10 and 11 at Khok Phanom Di, there are eight rims which can be matched with confidence to those from Nong Nor. A further

four are not identical but may possibly be related to those from the earlier site.

COMPARISON OF DECORATIVE TECHNIQUES

The analysis of the Khok Phanom Di ceramic assemblage involved an analysis of the decorative techniques employed (Hall 1989a,b). A direct comparison between the assemblage retrieved from Nong Nor and that of Khok Phanom Di is difficult because Hall's analysis was based upon entire motifs. Due to the fragmented nature of the archaeological ceramics recovered from Nong Nor it was often impossible to match entire motifs. Combinations of various decorative elements were matched where possible and similarities do exist where elements alone are observed, indicating some connection between the sites.

'Other incised decoration', described in chapter VIII, included curvilinear incisions with stamped impressions. This combination of elements is best represented at Khok Phanom Di on a burial pot (cat. 853, MP 5). This vessel is decorated with a "unique curvilinear motif of burnished bands and a plano-convex lens...the exterior surface of the body is covered with small impressions, giving the pot a textured appearance" (Hall 1989a:26). The bands in these motifs were burnished in both instances.

Cross hatching bounded by incised lines was found on one sherd at Nong Nor and was listed at Khok Phanom Di as motif 1:6 (Hall 1989a:21). Hall's motif 1:3 was present on the same sherd below the cross hatching where diagonal lines are bounded by double horizontal lines.

Of the remaining items which were categorised above, under 'other incised decoration' none was represented in the assemblage from Khok Phanom Di. It should be mentioned that they were also rare at Nong Nor.

The main design elements found at Nong Nor as well as Khok Phanom Di include 1a, sherds with a single incised line and 1b, sherds with multiple combed concentric rings. Hall has classified these as motif 1:1. Design 1c should also be included in this group, as there is no differentiation between combed and hand drawn incised lines in the Khok Phanom Di assemblage.

The partial motif 1a9, a single incised line bounded by stamped impressions relates to Khok Phanom Di motif 3:1, in which bands of stamped impressions are bounded by incised lines (Hall 1989a:24).

1b2, sherds with combed rings and stamping, were found at both Khok Phanom Di and Nong Nor. The congruity between these two designs is strengthened by the placement of the pattern. This design is located just below the carination on rim sherd form 2.6B.10 from Nong Nor. It is also found on the corresponding rim form from Khok Phanom Di in the same place (Fig. 59). The stamping present on these sherds from the different sites is nearly identical, almost as if the same tool were used to execute the pattern.

Very few sherds from Khok Phanom Di show any signs of applied pigment (Hall 1989a:18). The sherds that do have painted surfaces are not described or quantified, making comparison between the sites difficult.

Highly burnished sherds did not occur at Nong Nor, although they are present at Khok Phanom Di. Some sherds from Nong Nor were smoothed to a greater degree than those which were classified

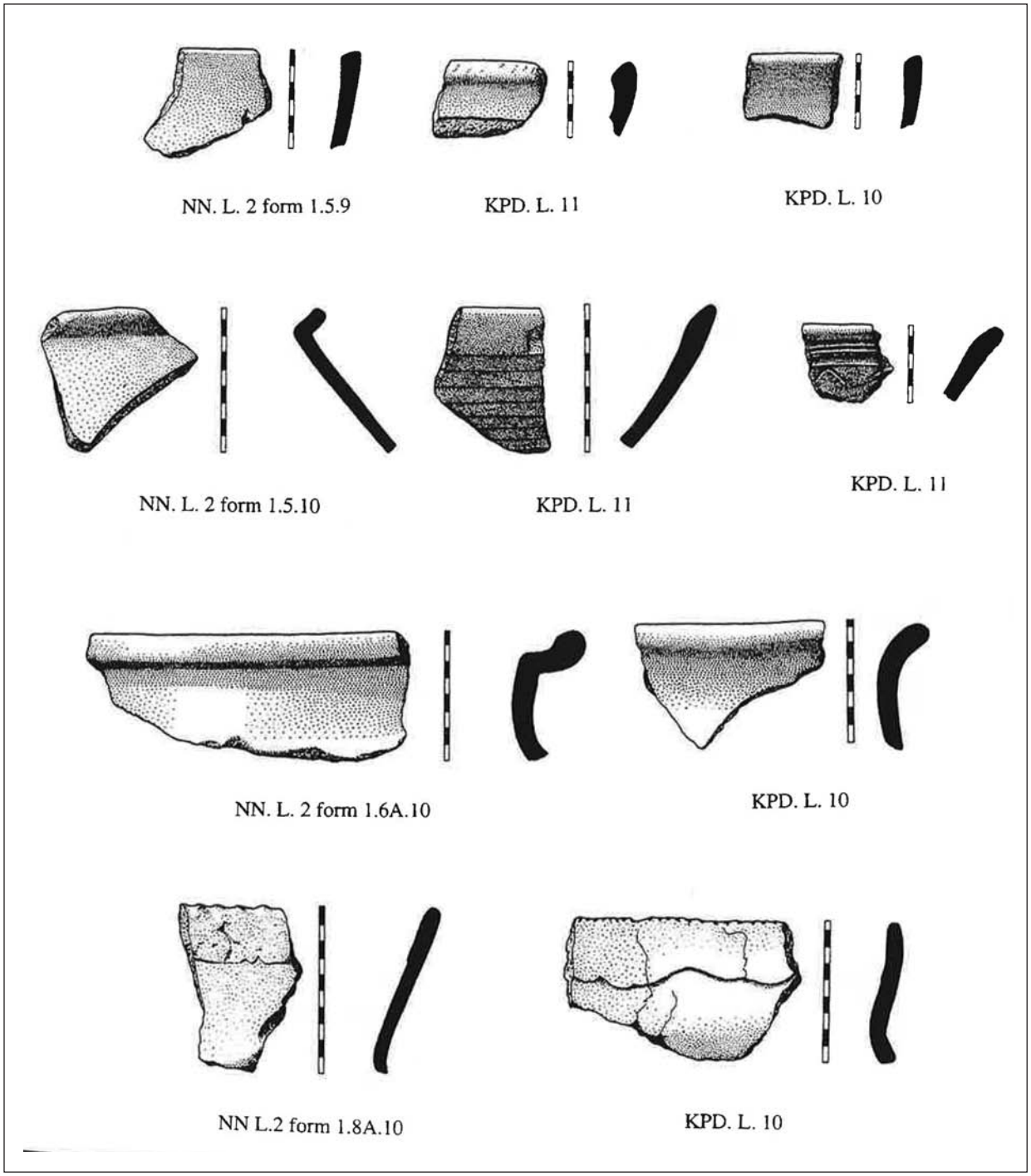


FIG. 59. Rim forms from Khok Phanom Di and Nong Nor

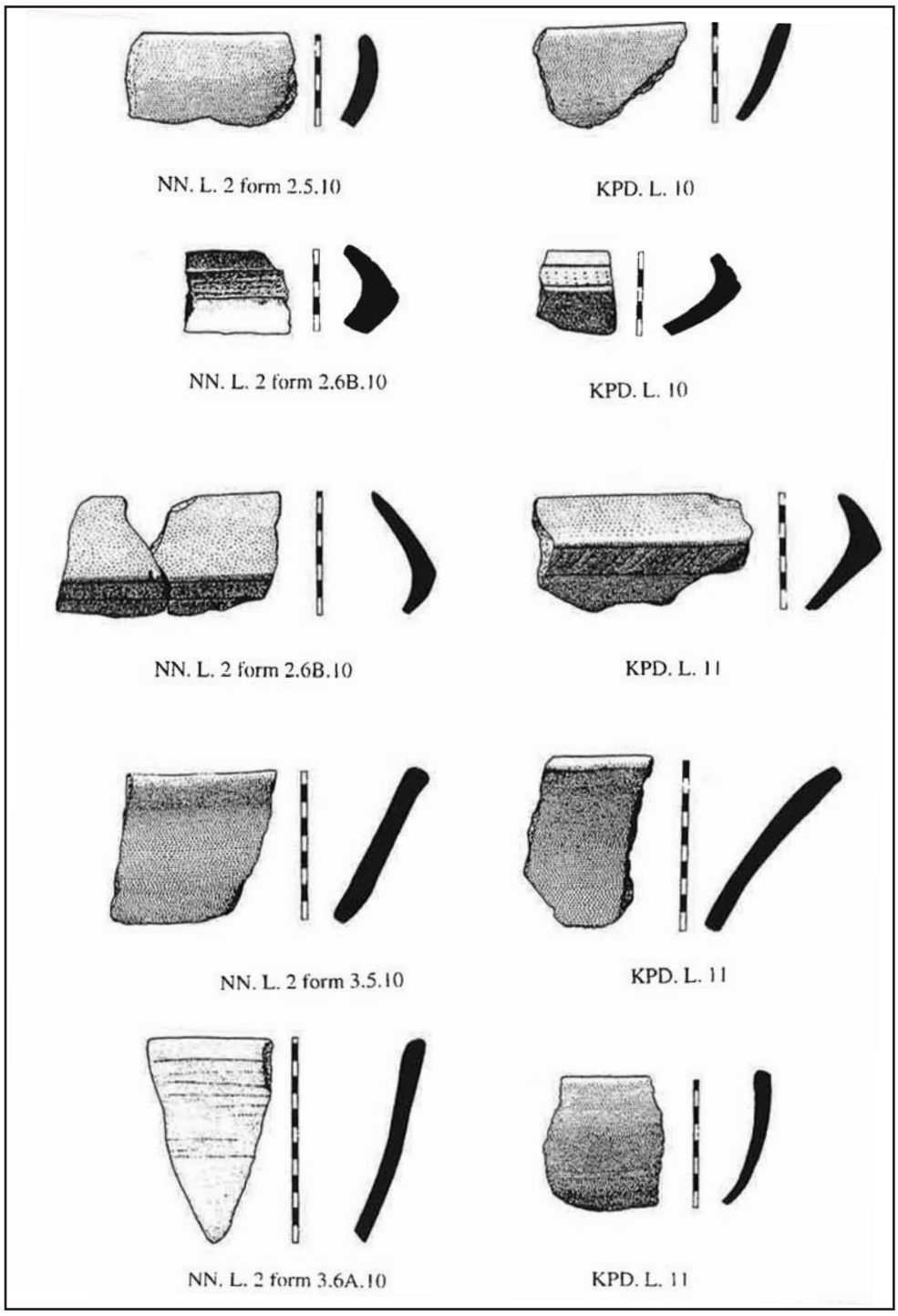


FIG. 59 *(cont.)*. Rim forms from Khok Phanom Di and Nong Nor

as being plain but they lacked a high gloss.

Another decorative pattern paralleled closely at Nong Nor on a reconstructed vessel (cat. 110) described above is Hall's motif 3:30, which is "a plain burnished zig zag band enclosed in a panel of stamped impressions" (Hall 1989a:36).

The absence of some design techniques at either site is hardly surprising, considering the time which separates the two. Changes in the material culture of a site over time is to be expected so the blurring of parallels between Nong Nor and Khok Phanom Di is not surprising.

There are three design motifs which unquestionably link Nong Nor and Khok Phanom Di. These are the combed concentric rings, the curvilinear incisions with stamping and the dentate pattern bounded by the two incised lines. Based upon these associations and the relationships illustrated between the rim forms from both sites, there is an indication of continuity in style and in all probability, some cultural connection between Nong Nor and Khok Phanom Di.

COMPARISON OF LITHIC ARTEFACTS

Miscellaneous Sandstone Fragments

Nine sandstone fragments were recovered (see appendix to section III). There were 245 similar lithic artefacts discovered during the 1985 excavation at Khok Phanom Di. These are probably fragments of sandstone grinders. Layer 10 at Khok Phanom Di held the most of any layer. There were also a significant number of pounders present in this layer, 63.64 percent of the total. These were probably used in conjunction with the grindstones, being round with evidence of use on the edges (Pisnupong 1988). There is a definite correlation in the morphology of the grinders and whetstones found at Khok Phanom Di and Nong Nor (Fig. 60).

Grindstones and Whetstones

Grindstones were abundant at Khok Phanom Di. Layer 11 contained 2.86 per cent of the total recovered and Layer 10 held the largest amount of any layer, 30.20 per cent of the total sample. The correlation in the morphology of the grinders and whetstones found at Khok Phanom Di and Nong Nor is obvious (Fig. 60). It appears, based on the parallels, that the implements were used in similar capacities at either site. This may indicate that the tools being sharpened with the whetstones were similar and that the grindstones were employed in the same unascertainable function.

Pounders

Over 60 per cent of the pounders recovered at Khok Phanom Di came from zone A. Pisnupong (1988) has concluded that these artefacts were probably used in conjunction with the grindstones to crush vegetal or mineral matter, being rounded with evidence of use on the edges. The pounders found at Nong Nor share a similar morphology to those described for Khok Phanom Di and were, in all likelihood, used in the same capacity.

Adzes

Layer 10 at Khok Phanom Di contained 17 type 2G adzes, the most common adze found and the only type found at Nong Nor. Nearly half of these came from Layer 11 but their numbers drop

significantly in Layer 9 and they did not regain popularity until Layer 3 (Pisnupong 1988). The presence of this adze type at Nong Nor and its abundance in the lowest levels at Khok Phanom Di suggests continuity in the adze technology of the region. It should be noted that there were other adze forms present in Layers 10 and 11 at Khok Phanom Di which were not found at Nong Nor including:

Type 2B. Rounded rectangular section; back and front mutually concave longitudinally which reduces the quality of bevels; butt unmodified; poll of deep rectangular section.

Type 2E. The cross-section varies between sub elliptical with flattened sides, or sub-rectangular; unilateral bevel; strongly curved cutting edge with everted corners.

Type 2F. Shallow elliptical section with unilateral bevel.

Type 8D. A right angled or open curved shouldered adze which may have types 2D and 2G as its prototype.

Type 8E. A right angled shouldered tool with symmetrical bilateral bevels which may be regarded as a shoulder.

Type 8H. Shouldered adze with elliptical section, tanged with a robust poll.

The presence of stepped adzes (type 8) at Khok Phanom Di and their absence at Nong Nor may represent some connection with the inception of rice agriculture at the former site. Stepped adzes are commonly found in many Southeast Asian sites and are often associated with the Neolithic by the Vietnamese. Adzes of this type are proposed by Duff (1970) to belong to what he calls adze focus two, as do the type 2 adzes. "On the grounds of distribution the Red River basin of North Vietnam may be regarded as the foyer of this invention. As no example of the type is known north of the Bay of Tonkin (Bac Bo) , the direction of diffusion was south along the Mekong, west to the Gulf of Thailand, thence via the Chao Phraya River and its upper tributaries to Burma and further India. There was also a southern extension into Malaya." There may be a chronological differentiation of these implements, as type 8 adzes seem to occur in later contexts throughout the region.

COMPARISON OF THE BONE ARTEFACTS

Fishhooks and Awls

The fishhooks are similar to the 24 found at Khok Phanom Di in Layers 10-11. The hooks are all of the same form, one piece bait hooks, and as with the Nong Nor hooks, the point of breakage was in the bend (Fig. 61). The surfaces of the hooks from Khok Phanom Di were similarly treated with an abrasive surface, probably sandstone (Higham and Thosarat 1993:1). Based upon this evidence it appears that the subsistence strategy had changed very little from 2500-2000 BC. Bone awls were rather common in Layers 10 and 11 at Khok Phanom Di after which they appear less frequently. The awls found at Nong Nor are nearly identical to those from the later site, exhibiting similar wear patterns and polish (Fig. 61).

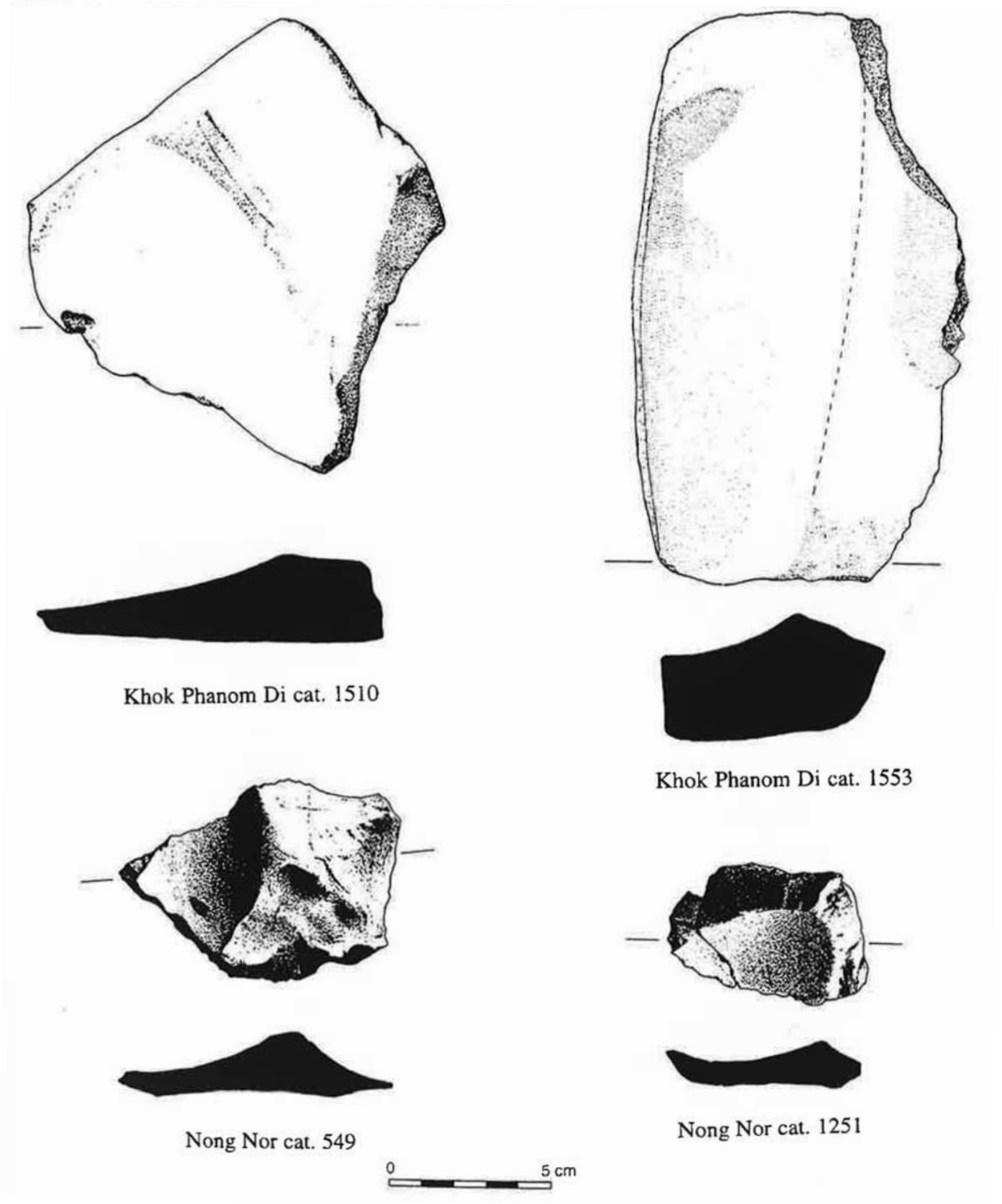


FIG. 60. Abraders from Khok Phanom Di and Nong Nor

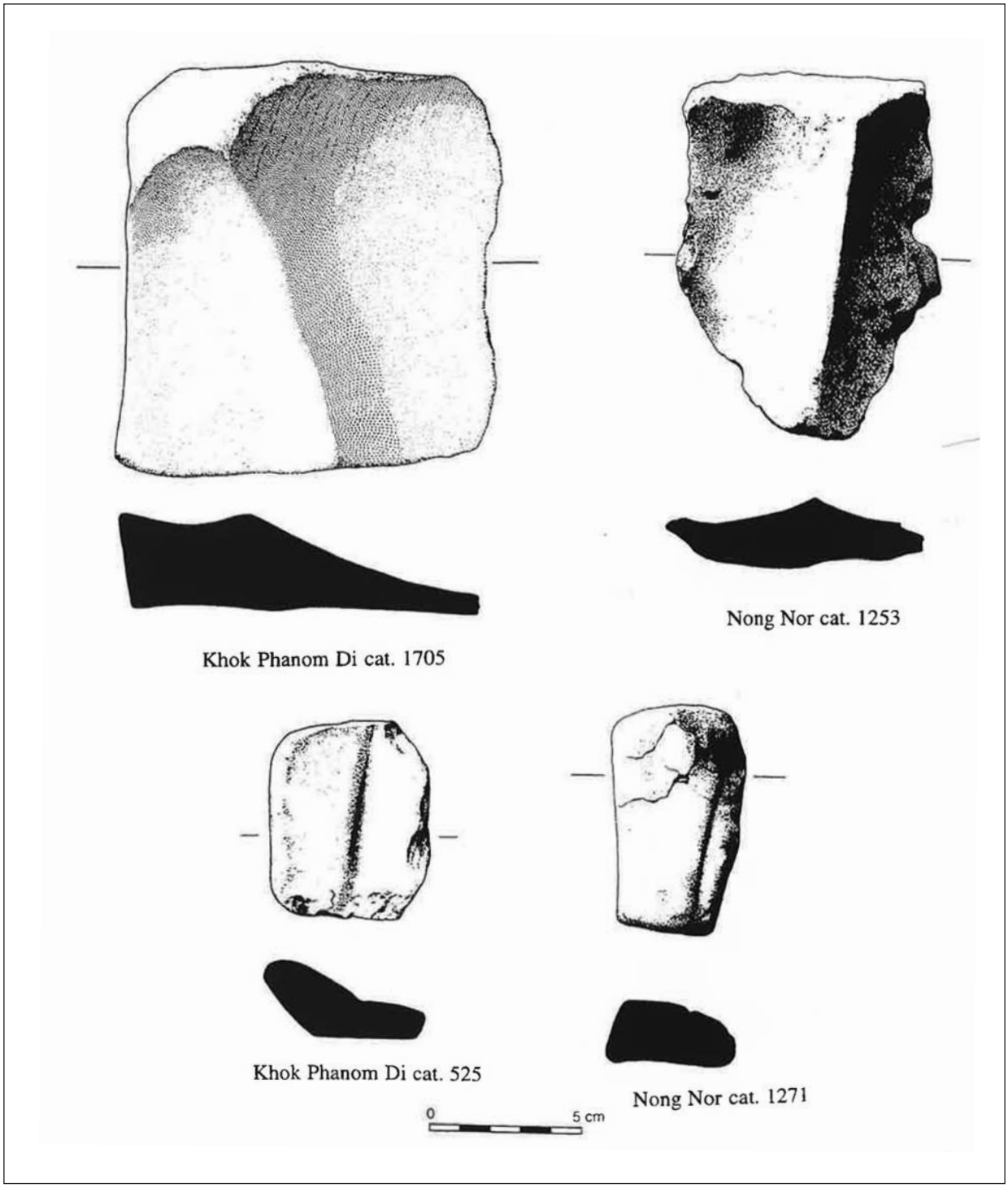


FIG. 60 *(cont.)*. Abraders from Khok Phanom Di and Nong Nor

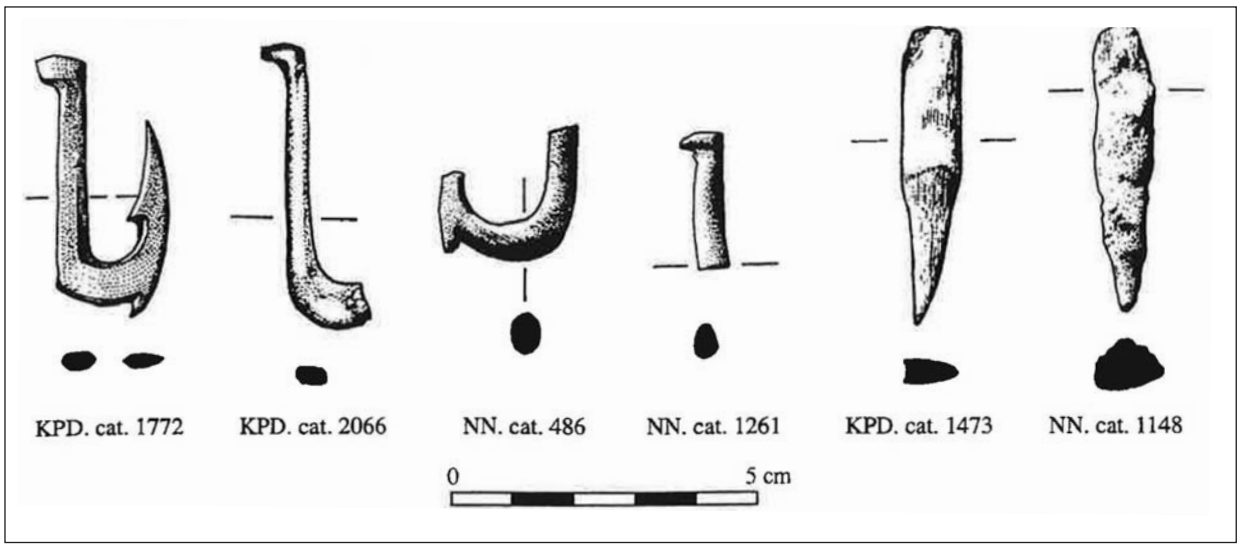


FIG. 61. A comparison between fishhooks and awls from Nong Nor and Khok Phanom Di

MISCELLANEOUS ARTEFACTS

Shell knives

A number of the shells (*Pseudodon inoscularis*) recovered from Khok Phanom Di, beginning in Layer 10, demonstrated unique striations and a concave edge, which indicated to the investigators that they may have had a secondary use. Empirical testing of similar shellfish determined that the wear patterns were comparable to those resulting from harvesting grass (Higham T.F.G., 1993). It is suggested that these shell knives were being used to harvest rice at Khok Phanom Di and were in use at least from the time that Layer 10 was created. These artefacts are not represented at Nong Nor.

Net weights and harpoons

Many rounded, pierced clay objects, interpreted as net weights, were found at Khok Phanom Di which were not present at Nong Nor. These objects were found from Layer 7 down, being abundant in Layer 10. The absence of these artefacts at Nong Nor is difficult to explain, unless the technology of net fishing was not employed due to environmental conditions or unfamiliarity with the technique. This may also explain the absence of another artefact at Nong Nor, the bone harpoon, which was found in small numbers at Khok Phanom Di.

Stone hoes

Pisnupong (1988) described a number of stone implements from Khok Phanom Di which were unlikely to have been used as adzes due to their weight and rounded edges. These ground and polished implements were made of leucogranite which is available about 40 km from the site (Higham and Thosarat 1994:83). These tools do not appear until Layer 9, and are not found at all in the assemblage from Nong Nor.

CONCLUSIONS

It is apparent from this evaluation of the material culture from both Nong Nor and Khok Phanom Di that the two sites have much in common. There are demonstrated similarities in the types of fishhooks and awls found, as well as in the adzes, grindstones, whetstones and burnishing stones. The most striking parallel, however, is found among the ceramic assemblage, which links the cultural traditions of Nong Nor and Khok Phanom Di beyond doubt, demonstrating that the latter may have evolved from the former. Of note is the abrupt change in the material culture at Khok Phanom Di at the juncture of Layers 9 and 10, a change which marks the end of many of the similarities illustrated. With these points noted it is now possible to place Nong Nor in a wider arena and consider the implications of the results discussed above.

XIV. THE SHELLFISH, FISH AND CRAB REMAINS

G.M. Mason

THE MOLLUSC REMAINS: INTRODUCTION

IN this chapter, the mollusc, fish and crab remains are reviewed for their palaeoenvironmental information content, but not to any extent for other purposes such as seasonal dating, food economy, or palaeo-temperature determination. The shells were too poorly preserved for these later studies. Two classes only of mollusc were recognized in the site: gastropods and bivalves, with 34 and 18 taxa respectively. With a few possible exceptions, these were contained in a midden which ranged in thickness from a thin scatter of individual shells to a dense mass over 80 cm thick, as shown in Fig. 12. The total area of excavated midden is 407 m^2.

As the site is underlain at depth by oxidized, sulphide-rich marine/estuarine clays, the shells were, without exception, heavily chalkified and generally badly pitted from the solution of the primary shell carbonate or secondary calcium sulphate which has precipitated as gypsum crystals in and under the midden. Many shells were too poorly preserved to identify beyond class level, and, in the case of *Meretrix lusoria* on sectioning, the apparently fresh shell fabric was found to be too degraded to yield information on either growth rates or season of harvest. Where the midden was close to the present-day ricefield surface, crushing of the shells was much in evidence, thus making it likely that minimum numbers will be artificially low in the shallow parts of the site.

Recovery methods

Methods of recovering the remains varied as increasingly diverse experience of the site sediments was gained. For the first season (1991), shells with a minimum of matrix were bagged directly from the ground and placed in 50 kg sacks, as were those recovered from the 1 cm mesh screens, and transported to a nearby village where water was available to wash the material and thus expedite both the identification of specimens and the recovery of small shells with a 4 mm mesh sieve. When dry, the samples were sorted to species, the minimum numbers recorded, measurements of shell sizes made on selected species and samples, and specimens put aside for laboratory study. The most abundant species, *Meretrix lusoria* (Röding, 1798), was counted on the basis of intact hinge-lines, no effort being made to distinguish right and left valves owing to the large size of the samples. Other bivalves were counted by right and left valve: gastropods were counted by either intact shells (rare), spires or thickened calcified outer lips as in the larger ellobiid snails.

Modern mollusc specimens from marine, estuarine, freshwater and terrestrial habitats were

collected to form a small comparative collection. This facilitated the identification of excavated material and extended the author's knowledge of the ecology and habitat range of species met archaeologically. Live-collected material was generally relaxed with menthol, fixed in 4 per cent formaldehyde solution, then preserved in 70 per cent ethanol, or 70 per cent isopropanol.

In 1992, this regime was modified to obtain *Meretrix* counts by taking a 2 l sample per 100 l of midden with all other non-matrix components removed. The hinges were counted and scaled up for the total volume. Field experiment showed that the estimates compared to actual counts for the 100 l lots were within 3-4 per cent of true values. This was deemed satisfactory in view of the constraints of time and labour force available. In addition, samples of 7.5l per 100 l of sediment were air-dried (to aid disaggregation) and then wet sieved through 1 mm sieves.

INVENTORY OF SPECIES

Where not otherwise acknowledged, the habitat and ecological observations are from the writer's unpublished field notes made over a number of years mainly in the vicinity of the Gulf of Siam, but also including other tropical and, particularly, mangal coasts.

TROCHIDAE

Umbonium vestiarium (L., 1758)

Range: Tropical Indo-West Pacific province, as far south as northern Australia.

Habitat and ecology: this species is found on gently sloping sandy beaches that may include some finer sediment grades. Fretter (1975) has given an account of the unusual filter-feeding habit of this gastropod and Berry and Othman (1983) outline the reproduction and growth cycle of the species. They suggest that there is an annual reproductive cycle with most of the adults dying in their second year. It is predated by four species of naticid, the most important being *Natica tigrina* (recorded as *N. maculosa*) and a starfish (*Astropecten vappa*) according to Berry (1984).

Provenance within site: A7, 1.

NERITIDAE

This ancient family contains marine, brackish, fresh water and partly terrestrialized snails mainly confined to the tropical and subtropical areas of the world. The marine forms range from about 1m below low tide up to the supratidal splash zone and may enter streams, rivers and mangal. Fresh water species may be diadromous at some stage in their life cycle. Herbivores, they graze algae from hard substrates. There appears to be no recent review of the family, but Russell (1941), in a review of the western Atlantic species, covers much of the earlier literature.

Nerita articulata (Gould, 1847)

Synonyms: *Nerita lineata* Gmelin, 1791; *Nerita balteata* Reeve, 1855; *Nerita birmanica* Troschel, 1877.

Range: Bengal east to Indonesia, New Guinea and north and eastern Australia. Common on all Thai mangrove coasts.

Habitat and ecology: coastal mangal and nipa palm swamps. Berry and Chew (1973:189) note that *Nerita articulata* (as *N. birmanica*) is the commonest of several neritaceans in the mangrove of West Malaysia, where "It is found on mud and, more frequently, on trees over wide areas of the mangrove forest near the sea, river, or streams. It does not extend close to the landward limit of the mangrove where prosobranchs tend to become replaced by ellobiid [auriculid] snails and ochidiid slugs." They also record (*ibid*.:199-200) that the young of the species occur at all times of the year and that the calcified egg capsules occur on trees, snails shells and patches of firm soil. The animals generally keep above water level by remaining on waterlogged soil or by climbing high in trees. Thus, they would be continuously available as a food source.

Provenance within site: A1, 631; A2, 38; B1, 111; X1, 271; A3, 401; A4, 6; A5, 35; A6, 16; A7, 11; A12, 3; A14, 1.

Neritina violacea (Gmelin, 1791)

Synonyms: *N. crepidularia*, Lamarck, 1822, *Dostia* Gray, 1842.

Range: Southeast Asia and Southwest Pacific.

Habitat and ecology: commonly on gravel in areas of reduced salinity, in intertidal areas and often near mangrove.

Provenance within site: A1, 2; X1, 1.

LITTORINIDAE

A cosmopolitan group, well represented in the tropics, which is usually found in colonies in supratidal situations. They are grazers, scraping microalgae and other plants from hard substrates, such as rocks and tree trunks. They are tied to the sea by their reproductive cycle. There are, however, a few fresh water species. Important references are: Rosewater 1970, 1972; Reid 1986, 1989.

Littoraria melanostoma (Gray, 1839)

Range: Southeast India (and Sri Lanka) to Burma, Malaysia, Indonesia, Gulf of Thailand and then north to Hong Kong and Taiwan.

Habitat and ecology: Reid (1986) says that this species is found 'on trunks and sometimes leaves in *Avicennia* fringe, 0.3-1.8 m above ground, only on the outermost trees in very sheltered situations; most common at back of *Avicennia* zone and in outer parts of *Rhizophora* forest; roots and occasional leaves in *Rhizophora* forest 0.2-0.6 m above ground; scarce in *Bruguiera*. Juveniles occur mainly on leaves. Berry and Chew (1973) report juveniles amongst marsh grass [*Fimbristylis* sp.].' They (1973:333) note also that this species breeds all year round, releasing pelagic egg capsules during spring tides. The species feeds on algae and other micro-organisms.

Provenance within site: A3, 2.

BITHYNIIDAE

Bithynia wykoffi Brandt, 1968

Range: endemic to Thailand where it occurs sporadically from the north (Chiang Mai) as far south as Phetburi and Chonburi (Brandt 1974).

Habitat and ecology: Brandt (*l.c.*) mentions that the type specimen was found in a swampy rice-

field. No other habitat information appears to be available. Berry (1974) states that bithyniids are known to carry the parasites *Clonorchis, Opisthorchis* and *Echinochasmus* with other trematodes, some being human pathogens, but Brandt (*ibid*.) says that this species is without parasitological importance.

Provenance within site: X1, 1; A3, 4.

IRAVADIIDAE

This family of brackish water and marine snails, found mainly in South and Southeast Asia, Indonesia, northern Australia and Japan, contains about 13 genus-group taxa of which only two, *Iravadia* and its subgenus *Fairbankia* are recorded from Thailand. Members of this family have subulate (tall, slender) shells less than 15 mm long. The Thai species inhabit mangal and nipa intertidal and subtidal mudflats of marine and estuarine aspect. They are microphagous detritivors. This interesting group is treated by Brandt (1974) and Ponder (1984, 1988).

Iravadia reticulata Brandt, 1968

Range: presently known from the more southern and southeastern provinces of Thailand and may also be present in Burma and Malaysia.

Habitat and ecology: this species is found in the drainage channels of brackish water mudflats associated with nipa and mangal swamps, where they live partly submerged in mud, eating organic detritus.

Provenance within site: X1, 1.

TRUNCATELLOIDEA

Rissoid sp

This single small shell has a rissoid facies, but it is impossible to identify it further.
Provenance within site: X1.

ASSIMINEIDAE

This family of about 40 genus-group taxa falls into two subfamilies, the Assimineinae, found in marine, brackish and fresh waters and the Omphalotropinae, a terrestrial group tending to live in damp places. The shells are usually less than 10 mm tall, the whorls convex, well-rounded and somewhat smooth.

Assiminea nitida (Pease, 1865)

Synonymy: *Hydrocena nitida* Pease, 1865; *Syncera nitida* of Abbott 1949. Many subspecies and races have been named.

Range: common on the Andaman Sea coast of Thailand and also in the Gulf of Siam. Elsewhere it is widely found in the eastern India Ocean and the Western Pacific area where it extends north to Hong Kong and south to the Philippines.

Habitat and ecology: these animals may be found on the underside of stones, logs and branches where they feed on decaying vegetation and microbial slimes. Mangal and nipa palm swamps of coastal aspect are their usual environment.

Provenance within site: A3, 3.

Assiminea philippinica O. Böttger, 1887

Synonymy: *Assiminea philippinica lirocincta* O. Böttger, 1893.

Range: southern Thailand, Philippines, and Java.

Habitat and ecology: lives on mudflats and in muddy brackish-water creeks where it feeds on decaying organic material.

Provenance within site: A3, 1.

THIARIDAE

A family of essentially fresh water snails with a few brackish-water representatives. They are distributed through southern Europe, Africa, South and Southeast Asia, South America and some Pacific islands. It is noteworthy that reproduction is almost entirely parthenogenic, functional males being found in very few species. The widespread nature of many species, their ability to occupy a great range of habitats and their reproductive mode has led to a large number of superfluous species names.

Melanoides tuberculata (O.F. Müller, 1774)

Synonyms: Brandt (1974:164-5) lists about 35 synonyms for this taxon, generally associated with the genus *Melania* despite the availability of *Melanoides* Olivier, 1804 based on the species *Melanoides fasciolata*. The interested reader is referred to his list. The extremely variable morphology largely accounts for this rather long synonymy.

Range: from southern Europe through Africa, Asia, to the West Pacific Islands and Australia. Common in all provinces of Thailand.

Habitat and ecology: "Lakes, ponds, trenches, rivers, brooks and mountain streams. The species mainly found in slightly brackish water and is [locally] abundant ... in tidal areas.." (Brandt 1974:166). Dudgeon (1989:41) notes that this snail is primarily a deposit feeder, unselectively ingesting particles as it crawls and burrows through fine sediments. He has reported (1986) that the species is viviparous and parthenogenic and breeds throughout the year but releases the young from the brood pouch only when conditions are favourable. The adults attain a length of 20-40 mm and are thought in general to live for about a year but not infrequently for 18-24 months. This animal can colonize new areas with a suitable habitat with remarkable speed due to its parthenogenic habit. In modern Thailand the author has commonly seen this species as a bye-catch in freshwater crab traps and fine-mesh set nets placed to catch fish in ponds and other standing water.

Provenance within site: A1, 2.

POTAMIDIDAE

Members of this family are generally restricted to brackish water and are to some extent amphibious, being abundant in mangrove mud and at the mouth of rivers and estuaries. There are about 78 genus-rank taxa placed in eight subfamilies. Predominantly circum-tropical in distribution, a few temperate forms are known. It is thought that they are deposit feeders (Houbrick 1984, Wells 1985).

Cerithidea cingulata (Gmelin, 1791)

Synonym: *C. fluviatile* (Potiez and Michaud, 1838).

Range: the species ranges into the Indian Ocean from the western Pacific.

Habitat and ecology: Vohra (1970:187) says "*Cerithidea cingulata* ... is one of the most common species on the estuarine shores and mangrove regions of Singapore and West Malaysia". It is also found in muddy inland creeks and on river banks with over-head mangrove. It tends to avoid clean and well-drained sand but occurs in big aggregations in wet areas especially along furrows, runlets, drainage canals, ditches and channels on the beach. Jutting (1956) reported the occurrence in intertidal regions, brackish water estuaries, mangrove swamps and fish ponds, in India, Ceylon, southern China, Japan, Philippines, Malay archipelago and New Guinea. In Java, it lives and feeds on the upper bottom layer of liquid mud in brackish and hypersaline fish ponds with a salinity range of 14-45 parts per thousand. Vohra (*ibid*) reports that the study of the annual cycle of this snail indicated that after spawning, the majority of the larger adult population dies. "Towards the winter months (December-January) the bimodal distribution of size classes tend to become unimodal as the rapid growth of the young individuals hatched in the summer (June-July) began to close the gap with surviving parent snails. The reproductive activity, however, was spread over a longer period with a possible peak in June-July as indicated by the greater number of juveniles."

Provenance within site: A1, 5; A2, 1; X1, 1; A3.

Cerithidea obtusa (Lamarck, 1822)

Synonyms: *C. kieneri* Hombron & Jaquinot, 1854, *C. anticipata* Iredale, 1929.

Range: western Pacific and Indian oceans.

Habitat and ecology: this species inhabits muddy bays, river estuaries and mangrove swamps, generally in brackish water. Coleman (1981:35) indicates that it is commonly found on mangrove tree roots and trunks. Most of the adults are decollate.

Note: called in Malay '*siput mata meral*' and also '*belitong'* or *beliton'*. The species is collected for eating in large quantities from among the buttress roots on the seaward margin of mangal (Purchon and Purchon, 1981:309).

Provenance within site: A1, 249; A2, 12; B1, 21; X1, 50; A3, 176, A4, 9; A5, 58; A6, 12; A7, 6; A12, 3; A14, 9.

Cerithioid sp

These few specimens are consistent with being *Cerithidea obtusa* but are too weathered to be totally certain.

Telescopium telescopium (Linnaeus, 1758)

Synonyms: *T. indicator* Mountford 1810, *T. fuscum* Schumacher, 1817.

Range: from Queensland, westward in the Indian and Pacific Oceans.

Habitat and ecology: this gregarious species is found, often in large numbers, in most aspects of mangal but particularly in runnels and shallow pools at low tide. It also occurs on intertidal mudflats where there is sufficient shelter from the sun.

Note: Malay '*sipot borongan*'. This species is collected from the landward side of mangroves and marketed as a popular food (Purchon and Purchon 1981:309).

Provenance within site: A1, 24; A2, 6; B1, 3; X1, 22; A3, 283; A4, 20; A5, 146; A6, 55; A7, 14; A8, 2; A12, 6; A14, 12.

Terebralia palustris (Linnaeus, 1767)

Synonyms: *T. agnatus* Gmelin, 1791; *T. carinatum* Perry, 1811; *T. crassum* Lamarck, 1822.

Range: tropical Pacific.

Habitat and ecology: mangrove swamps, and low-energy intertidal mudflats.

Provenance within site: B1, 1; A3,1.

STROMBIDAE

A sand-dwelling shallow-water marine family of about 6 genera and fewer than 100 species. They are generally subtidal to 100 m but a few deeper water forms are known. They are herbivorous, grazing small gracile algae and micro-algae from sand grains, and may be a locally important dietary item (Abbott 1960).

Strombus canarium (Linnaeus, 1758)

Synonym: *S. isabella* Lamarck, 1822.

Range: it ranges through the southwestern Pacific in shallow water in clean sand (Abbott and Dance 1982:80). Kira (1965:35 pl.16 figs. 11-12) treats *S. canarium* and *S. turturella* as separate species in the genus *Laevistrombus* of Kira, 1955 (type species of this genus is *S. canarium*). He puts the pale form in *L. canarium* and gives its distribution as Taiwan and southwards in water of 9-20 m.

Habitat and ecology: it is found on mudflats, usually camouflaged by algal growth (Coleman 1981:38).

Note: Malay "*siputgungong*". Taken from patches of fine algae on sand for consumption (Purchon and Purchon 1981:310).

Provenance within site: A1, 2; A7, 3; A14, 1.

Strombus luhuanus Linnaeus, 1758

Synonym: sometimes placed in *Conomurex* as a full genus, e.g. Kira (1965).

Range: Southeast Japan to Indonesia and eastern Australia and then east to Palmyra and Fiji (Abbott 1960:135, Oliver 1975:82).

Habitat and ecology: these epifaunal grazers spend most of their time in aggregations on the surface of coralline sand and clean sandy sediments, but will burrow under the surface to escape predators. When they do so, they leave a shallow depression some 8 cm in diameter with a raised rim which, once recognized, makes these animals easy to collect (Savazzi 1988). The sexes are separate, the shell of the female being larger than that of the male. They form large colonies to mate and spawn in inshore waters in the zone transitional between reef outcrop and sandy shore in the summer months. Then, they migrate to deeper water (Kuwamura *et al*.. 1983:433). Abbott

(*ibid*: 135) records them from shallow, subtidal water to a depth of 10 m usually on coral sand, coral rubble and algal patches, avoiding muddy conditions. Coleman (1981:232) observes that they are to be found in intertidal coral rubble and to a similar depth on sand.

Note: this species is regarded as a desirable culinary item in Japan and elsewhere.

Provenance within site: X1, 1; A7, 3; A14, 1.

Strombus spp

Five specimens were recovered that were too eroded or fragmentary to be attributed firmly to either of the above species.

Provenance within site: A1, 2; X1, 2; A3, 1.

NATICIDAE

A marine family of about 150 species of predatory gastropods that live in sand and sandy mud. Their stout, glossy shells are covered by extensions of the foot. When prey is located, generally infaunal bivalves, a hole is drilled through the shell with the aid of acid secretions and the animal is removed by the highly protrusible proboscis. The family is cosmopolitan in shallow to deep water with some species to be found in the lower littoral (Oyama 1969, Kilburn 1976, Marincovich 1977, Shileyko 1977, Golikov and Sirenko 1988, and Kabat 1990).

Natica tigrina (Röding, 1798)

Synonyms: *N. maculosa* Lamarck, 1822, *N. pellistigrina* Küster, 1850.

Habitat and ecology: found commonly in beds of *Anadara granosa* which it feeds upon.

Range: eastern Asia, at 10-30 m depth (Abbott and Dance 1982:109).

Provenance within site: A1, 16; B1, 2; A3, 9.

Polinices tumidus (Swainson, 1840)

Synonyms: *P. pyriformis* Reclus,1844; *albula* Reclus, 1851; *ponderosa* and *cygnea* Philippi, 1852.

Habitat and ecology: the author has recorded this species living in slightly silty sand flats at spring low tide in mangrove areas. Its main food appears to be polychaete worms and possibly an unidentified tellinid bivalve.

Provenance within site: A1, 2.

Polinices sp

The two specimens recovered could not be confidently identified as *P. tumidus* due to poor preservation.

Naticid spp

Further naticid shell remains that could not be identified to genus are included here.
Provenance within site: A1, 19; X1, 15; A3, 17; A4, 3; A5, 9; A6, 7; A7, 2; A14, 2.

MURICIDAE

A large and highly diverse group of carnivorous gastropods split into about 130 genus-rank taxa contained in 8 subfamilies. They are cosmopolitan, living mainly in shallow tropical and subtropical waters. There are a few species, however, habitually found in brackish water of estuaries and mangrove swamps. Like the naticids, they bore into the shells of other invertebrates (gastropods, bivalves, barnacles and sedentary polychaetes) and then eat the animals with their long, flexible probosces. There is little consensus in the literature as to how the family should be divided and as to what should or should not be included. Small, localized populations, large variations of shell sculpture, and small numbers of eggs, from which the young hatch directly, all combine to give a large amount of splitting of species in this family.

The literature for this family is extensive, but the following are useful: E.H. Vokes 1964, 1971, Ponder 1972, 1973, Emerson and Cernohorsky 1973, Fair 1976, Radwin and D'Attilio 1976, and Houart, 1992.

Chicoreus capucina (Lamarck, 1822)

Synonyms: Formerly placed in the genus *Naquetia*. *Murex bituberculatus* Baker, 1891; *Murex permaesta* Hedley, 1915.

Range: this species is found today throughout Thailand (including mangrove areas of the Andaman coast), the Philippines, Singapore, Western Australia to Queensland.

Habitat and ecology: *Chicoreus capucina* is confined entirely to an intertidal habitat in mangrove swamps under a permanently closed canopy. It eats various species of boring molluscs, worms from dead logs, stumps and branches and also mudworms. It grows up to 85 mm, and is very rarely found to 120 mm.

Provenance in site: A1, 51; A2, 1; B1, 16; X1, 24; A3, 64; A4,1; A5, 13; A6, 6; A7, 3; A12, 2; A14, 4.

THAIDIDAE

Cymia lacera (Born, 1778)

Synonyms: Mienis (1985:631-2) has discussed the synonymy of this species in some detail and concludes that the entity so well entrenched in the literature as *Thais carinifera* (Lamarck, 1822) is validly named as above. *Thais mutabilis* (Link, 1807) is also synonymous. This taxon has been placed in the following genera: *Cuma* Swainson, 1840 (*non* Milne-Edwards, 1828) and *Cymia* Mörch, 1860.

Habitat and ecology: Indian Ocean to Southeast Asia. A littoral species (Abbott and Dance 1982:145).

Notes: 1. this species is highly variable in shell form and ornamentation. Sexual dimorphism is suspected as well as an influence from the habitat.

2. Malay: '*halaiti*'. Abundant on rather bare muddy rocks near Penang and is collected in quantity for eating (Purchon and Purchon 1981:309).

3. It is possible that, as at present, these shells were favoured for ritual purposes or fertility charms.

Provenance within site: A1, 9; A2, 1; X1, 1; A3, 1; A6, 11; A7, 1.

Cymia tissoti (Petit de la Saussaye, 1852)

Distribution and range: Indian Ocean, Andaman Sea, Malaysia and China Sea.

Habitat and ecology: intertidal mudflats and seaward edge of mangal where it drills and consumes mainly barnacles and polychaetes.

Provenance within site: see next taxon.

Thaidid spp

This group of remains includes *Cymia lacera* and *C. tissoti* that could not with full confidence be attributed to either species individually.

Provenance within site: A1, 1; A3, 9; A5, 29; A12, 1; A14, 2.

NASSARIIDAE

This predominantly marine family of snails inhabits mainly soft mud and sand sediments in intertidal and shallow tropical and subtropical waters especially. Some species have colonized brackish and even fresh water. Most species feed as carnivores or carrion scavengers but the rare herbivore is known (Allmon 1990, Cernohorsky 1984).

Nassarius pullus (Linnaeus, 1758)

Synonyms: *N. thersites* Bruguiere, 1789.

Range: from Mauritius to India, Japan and New Caledonia.

Habitat and ecology: intertidal in muddy sand and among mangroves; appears to tolerate some reduction of salinity on organic-rich sand flats at stream debouchures.

Provenance within site: A3, 1.

VOLUTIDAE

A widely-distributed marine family of some 200 species divided among about 70 genus-rank taxa placed in nine, sometimes 10, subfamilies. They are predominantly predators of other molluscs, occasionally scavenging in shallow to intertidal waters over sandy bottom. A few live in deep water. As in the Muricidae, there is much variation in shell shape in some species, and populations can be small and geographically scattered with direct development of the young from a small number of large eggs. This has resulted in many names being applied to some species (Weaver and duPont 1970).

Volutid sp.

The few shell fragments of volutid that have survived are quite massive and may well be *Cymbiola nobilis* (Lightfoot, 1786) which can be found on mud or muddy sand flats off mangrove coasts at low tide down to about 70 m. The species is edible.

Provenance within site: A1, 1; A3, 2.

CANCELLARIIDAE

This family of about 150 species has about 52 available genus-rank names split into four subfamilies. Most species live in temperate to tropical seas but a few prefer cold, boreal waters. They range from sandy intertidal shores to depths of over 2000 m. Petit and Harasewych (1986) suggest that the highly-specialized radula found in this group is used to cut holes in the body sac of small invertebrates to reach internal fluids which are then sucked out (Verhecken 1986a, 1986b, Jung and Petit 1990, Petit 1970, 1974, 1975, 1980, 1984 and 1986, Harasewych and Petit 1984, Petit and Harasewych 1987 and Garrard 1975).

Scalptia cf. *crossei* (Sowerby, 1833)

Synonyms: *Cancellaria crenifera* Sowerby, 1833; *Trigonaphera* Iredale, 1936, is identical to *Scalptia*.

Range: Indo-West Pacific oceans ranging south to Australia and north to Honshu.

Habitat and ecology: fine sandy bottom at 5-50 m depth.

Provenance within site: A single specimen comparing to *S. crossei* was found in area X1.

CONIDAE

This predominantly tropical marine group typically inhabits coral reefs and shallow waters. There are about 300 species which are usually less than 100 mm tall but a few species may exceed 200 mm. About 45 genus names are available, but many workers prefer to use only *Conus* until the taxonomy is better understood. They are active carnivores, with a radula modified into protusible, poisoned harpoon-like darts with which they catch small fish, worms, molluscs and other invertebrates. The venom is not infrequently fatal to humans (Dautzenberg 1937, Kilburn 1971, Ponder 1973, and Walls 1978).

Conus spp

The 12 fragments of cone recovered from the site may not belong to a single species, but cannot be identified below the family level.

Provenance within site: A1, 1; B1, 3; X1, 7; A3, 1.

AURICULIDAE

(=Melampidae Stimpson, 1851; =Ellobiidae, H. & A. Adams 1855)

This group of about 30 genus-rank taxa occupies a wide range of terrestrial, intertidal, supratidal and estuarine niches. Of world-wide distribution, these primitive pulmonates appear to be mainly vegetarian, grazing microalgae and consuming fine, organic detritus (Morton 1955a, 1955b).

Cassidula aurisfelis (Bruguiere, 1789)

Synonyms: *Auricula felis* Lamarck, 1819, *A. fusca* Hombron and Jacquinot, 1841.

Range: coasts of India, Burma, Thailand, Malaysia, Indonesia to the Philippines and southern Vietnam.

Habitat and ecology: this animal lives on the mud in mangal and nipa swamps within a few tens of centimetres of the high spring tides so that it probably spends most of its time out of the water. They feed on the organic detritus found on the mud surface and breed all through the year (Berry

1958). They are not known to be eaten in present day Thailand and are thought to be a site autochthon at the time of midden deposition.

Provenance within site: A1, 93; A2, 3; X1, 14; A3, 33; A4, 2, A5, 7.

Ellobium aurisjudae (Linnaeus, 1758)

Synonyms: *E. labrosum* and *E. subtile* Röding, 1798. *E. judae* Lamarck, 1822.

Range: westward from the Western Pacific.

Habitat and ecology: mangrove swamps where the ground is damp and well vegetated and apparently not subjected to tidal inundation.

Provenance within site: A1, 223; A2, 21; B1, 31; X1, 124; A3, 338; A4, 8; A5, 101; A6, 27; A7, 7; A12, 5; A14, 13.

Ellobium aurismidae (Linnaeus, 1758)

Synonyms: *E. midae* and *E. ceramense*, both of Röding, 1798

Range: ranges westward from the West Pacific.

Habitat and ecology: mangrove swamps, in settings similar to *E. aurisjudae*.

Provenance within site: A1, 276; A2, 16; B1, 52; X1, 130; A3, 464; A4, 21; A5, 97; A6, 21; A7, 10; A8, 2; A12, 9; A14, 6.

Cylindrotis quadrasi Möllendorff, 1895

Range: known from the Philippines and Thailand only.

Habitat and ecology: feeding on decaying organic matter, these animals are to be found on coastal mudflats and in nipa palm swamps.

Provenance within site: A1, 6.

Melampus siamensis von Martens, 1865

Range: in Thailand known only from Petchburi Province; elsewhere widespread through the tropical Indo-West Pacific province.

Habitat and ecology: on mudflats under brackish coastal mangal.

Provenance within site: A5, 1; A6, 1.

Melampus nucleolus von Martens, 1865

Range: Trang Province in Thailand, elsewhere in the Philippines and New Guinea.

Habitat and ecology: coastal, in and about organic-rich brackish ponds in mangal above high tide level.

Provenance within site: X1, 2; A3, 1.

Auriculastra subula (Quoy et Gaimard, 1832)

Synonymy: Brandt (1974:222) suggests that *Auriculastra dunkeri* and *saccata,* both of Pfeiffer, and perhaps *Auriculastra semiplicata* A. Adams may be synonyms.

Range: in Thailand, the southern and southeastern provinces; extralimitally in the tropical Indo-West Pacific province.

Habitat and ecology: found living in mangal swamps, nipa palm stands and vegetated mudflats.

Provenance within site: A3, 7.

Laemodonta punctatostriata (H. & A. Adams, 1853)

Synonymy: formerly placed by many authors in the genus *Plecotrema*.

Range: in Thailand known from the mangal coasts of both the Gulf of Siam and the Andaman Sea strands. Peninsular Malaysia and the Philippines are host to this species.

Habitat and ecology: coastal mangal swamps, mudflats and nipa stands.

Provenance within site: A4, 1.

BULIMINIDAE (Enidae)

This family of land snails, widely distributed in Asia, Europe and Africa, contains about 80 genera of dextral (sometimes sinistral) species generally less than 10 mm in height. The shell aperture usually bears columellar plaits and apertural barriers. In outline, the shells are broadly conical to subcylindrical.

Buliminid sp

Range: unknown.

Habitat and ecology: modern examples of this sinistral shell have been collected by the writer from archaeological mounds on the east Bangkok Plain. These mounds, rising a few metres above the surrounding ricefields, are well-drained and are in part covered with closed canopy deciduous trees with an understory of drought-tolerant shrubs, herbs and some bamboos.

Provenance within site: A3, 1; A4, 1; A5, 2.

ARIOPHANTIDAE

These terrestrial pulmonates embrace a number of genera (*Euplecta, Hemiplecta*, for example) that have species large enough to eat.

Macrochlamys sp

Habitat and ecology: modern populations are to be found on the low, well-drained scrub-covered archaeological mounds on the east Bangkok Plain, as well as in elevated, well-drained domestic gardens in Phanat Nikhom. In all cases terrestrial, it was found living in hollows under damp vegetation. These species are thought to be active predators of other invertebrate animals. Burrowing in hot, dry weather is known and may be for both feeding and protection.

Range: in excess of 100 species have been described from tropical South, East and Southeast Asia, the Philippines and Indonesia.

Provenance within site: A5, 2.

Ariophantid sp

A single fragment of what may be *Hemiplecta* sp was recovered from A1.

SUCCINEIDAE

Known by some as amber snails on account of the shell colour, this worldwide family of terrestrial pulmonates of ancient lineage is characterized by either a greatly reduced shell or one with a reduced spire and greatly inflated body whorl. The shells are thin and fragile and not especially helpful for identification at the species level. The animals occupy a range of habitats, but are frequently found in vegetation in damp places or near streams and ponds, or under damp leaf litter. Important references are Solem (1959) and Patterson (1971).

Oxyloma sp

Range: according to Patterson (1971), *Oxyloma* is found in the Americas, Europe, Asia and East Asia (including Japan, Korea and India), and the whole African continent. It is nearly as widespread as *Succinea* itself.

Habitat and ecology: probably in grasses and herbs in damp situations near ponds and streams.

Provenance within site: A5/6, 1.

ARCIDAE

This predominantly marine family of about 25 genus-rank taxa contains two subfamilies. There may be about 200 species, but the family is in urgent need of revision. Most members are either infaunal in the lower littoral or sublittoral or byssally attached to hard surfaces in shallow water with a few descending to abyssal depths. A few fresh water nominal species are known from India, Burma and Thailand. They appear to be both deposit and plankton feeders (Lamy 1907, Sheldon 1917, Reinhart 1935).

Anadara granosa (Linnaeus, 1758)

Synonyms: *Arca corbicula* Gmelin, 1790; *Arca cuneata* Reeve, 1844.

Range: Southwest Pacific, Southeast Asia, Australia northwards to Honshu.

Ecology and habitat: this 'cockle' (and the closely-related *Anadara nodosa*, von Martens) has been of economic importance since prehistoric times, and is at present widely cultivated commercially in Thailand (since about 1900), Malaysia and elsewhere in the Indo-Pacific region. This species spawns in July to August and by the age of six months usually reaches a size of *c* 18 mm in diameter (*c* 5 gm), when it can be transplanted for commercial farming. The spat can be collected either in the wild or from seedbeds at a smaller size (0.5 gm) and transplanted, but with poorer results. The animals are harvested after 18-24 months, when they have reached about full size of 5-6 cm in diameter. The smallest size taken is about 26 mm. They are harvested with hand dredges, generally used from small boats.

This species prefers a substrate of fine silt and silty muds which are relatively free of sand. They inhabit areas about mangal coast, especially near river, estuarine and other fresh water outlets where wave action and rapid siltation are at a minimum. The animals are quite active and can recover from modest burial (a few cm of sediment) and can move laterally by means of a muscular foot. They are suspension filter feeders, recovering algae and other phyto- and zooplankton from

near the water/sediment interface. Some detritus is also found in the gut. Despite living near fresh water sources (which provide nutrients for plankton proliferation), salinities of less than 25 parts per thousand are fatal. Normal marine salinity is about 35 parts per thousand of dissolved solids. The preferred growing area under natural circumstances is 200-500 m offshore, situated from mid-tide down to mid low water spring tide, the slope being less than 15° from horizontal. Tidal exposure is not usually more than 2-3 hours per cycle. Non-human predators are birds, starfish and, among the molluscs, *Natica tigrina* and *Cymia lacera*, both of which are represented in the site.

Provenance within site: A1, 3083; A2, 296; B1, 408; X1, 675; A3, 4218; A4, 270; A5, 1419; A6, 1124; A7, 114; A8, 103; A12, 169; A13, 3; A14, 164.

Anadara nodifera (von Martens, 1860)

Synonyms: *Arca oblonga* Philippi, 1849.

Range: Taiwan, Japan, Philippines, Malaysia and Burma.

Habitat and ecology: a sublittoral dweller down to about 10 m in fine sand or sandy mud, often locally very abundant.

Provenance within site: A1, 1; A2, 2; A3, 2.

Barbatia sp

This genus is represented by species byssally attached to generally clean substrates of rock or sand at low tide to subtidal levels. They are filter feeders and one species, *Barbatia velata* (Sowerby, 1843) has been recorded by the writer in large numbers in a modern shell midden adjoining a clean, sandy beach.

Provenance within site: A1, 1.

OSTREIDAE

The true oysters. Many authors have divided this family into two groups: those that incubate their young in the mantle cavity and live in relatively non-turbid water of normal salinity and those non-incubatory oysters that live in low salinity turbid conditions such as in estuaries. An example of the former is *Ostrea*, and of the latter, *Saccostrea* and *Striostrea* (Thompson 1954, Ranson 1967, Harry 1985).

Saccostrea cucullata (Born, 1778)

Synonyms: *S. glomerata* Quoy and Gaimard, 1835, *S. denticulata*, *S. echinata* Quoy and Gaimard, 1835, *S. mordax* (Gould, 1850), *Saxostrea commercialis* (Iredale and Roughley, 1933), *Ostrea cornucopiaeformis* (Saville-Kent, 1893).

Range: this is one of the most widespread of all the oysters, ranging from East Africa and throughout the Indo-West Pacific province.

Habitat and ecology: occurs in mangal, attached to roots, branches or anything else which provides a hard surface for attachment. This species is found in a wide range of environments from wave-washed cliffs to the most quiet of backwaters. The low energy environments are marked by rudistiform ecophenotypes.

Provenance within site: A1, 180; A2, 9; B1, 11; X1, 34; A3, 147; A4, 6, A5, 61; A7, 20; A12, 8; A14, 2.

Saccostrea gigas (Thunberg, 1793)

Synonyms: there is no general agreement on the genetic make up of this species, or which "geographic races" should be included.

Range: the natural (as opposed to anthropogenic) range appears to be from Japan southwards to mainland Southeast Asia to Peninsular India in the west.

Habitat and ecology: predominantly sheltered marine conditions with some measure of reduced salinity, from the lower intertidal to a few metres depth.

Provenance within site: A1, 49; A2, 1; B1, 21; X1, 15; A3, 87; A5, 2; A6, 1; A12, 3.

PINNIDAE

Pinna bicolor Thunberg, 1793

Synonyms: Rosewater (1961:196-97) lists, with some discussion, about thirty synonyms, not one of which seems to be commonly in use in the literature.

Range: East Africa to Melanesia (and Hawaii) and Japan in the north and tropical Australia in the south.

Habitat and ecology: sand and silty sand at low tide down to about 4 m on reef flats.

Notes: as well as the two species listed for Thailand by Rosewater (*l.c*) (*Pinna bicolor* and *P. murcata* Linnaeus, 1758) may be added *P. incurva* Gmelin, 1791 and *P. atropurpurea* Sowerby, 1825 found sympatrically with *P. bicolor* in shallow, inshore water on Ko Pha Ngan by the author. The fact that over 100 specimens of *P. bicolor* and *P. atropurpurea* failed to show any intermediate forms forces the conclusion that these are good species and not just forms of a variable *P. bicolor* as held by Rosewater.

Provenance within site: The single fragment of the anterior end of both valves was recovered from B1.

ANOMIIDAE

The saddle oysters. This group contains 8 genus-rank taxa and very few species. The lower (right) valve generally has a hole or a notch to allow passage of the byssus by which the animal is firmly fastened to the substrate. They are widespread in the world's seas (Morton 1976, Yonge 1977).

Enigmonia aenigmatica (Holten, 1802)

Range: Southeast Asia, Philippines.

Habitat and ecology: this bivalve is unique in possessing the improbable habit of climbing trees which it does by means of a long, narrow foot extended through the byssal sinus of the lower (right) valve. The animal possesses pallial eyes that can detect light through the upper valve (Rosenberg 1993:140). It inhabits the trunks and leaves of trees in the upper tidal areas of mangal and nipa swamps.

Provenance within site: A1, 1.

PLACUNIDAE

Window-pane shells. This small family of two genera is very similar to the Anomiidae, but in the adult, the byssal notch or foramen is closed and the animals may be either byssally attached or free living. They are generally found in shallow, muddy marine waters (Yonge 1977).

Placuna placenta (Linnaeus, 1758)

Synonyms: *P. orbicularis* Retzius, 1788; *P. auriculata* Yoldi, 1790.

Range: a widely distributed Indo-West Pacific species ranging from Aden and the Persian Gulf in the west around India and Sri Lanka to Burma and Southeast Asia down to Australia and up to China and Japan.

Ecology and habitat: a lagoonal species also found on mud, clay and muddy gravel substrates intertidally to depths of *c* 40 m.

Provenance within site: B1, 1.

UNIONIDAE

This group of world-wide fresh water mussels of some few hundred species is placed in about 197 genus-rank taxa. Despite a lot of work, the taxonomy of the whole order (Unionoida) is very much in a state of flux but will stabilise as molecular techniques are increasingly applied (Haas 1969, Heard and Gluckert 1970). Many small fragments of shell attributable to freshwater mussel were seen in the site, but none could be confidently placed in a genus.

TRIDACNIDAE

Despite the fact that there are only seven living species in this family, their large size (*Tridacna gigas* is the largest known living bivalve) and their peculiar anatomy and nutritional mechanisms has occasioned an extensive literature. The best entry to this area is through Morton (1983a), Rosewater (1965, 1982), and Yonge (1980). These authors provide good reviews and bibliographies of the taxonomy, nomenclature, biology and ecology of these animals. The shell from members of this family has been widely used by many peoples, for the manufacture of hand tools and other items such as shell jewellery.

Tridacna sp

Provenance within site: A1, 1.

MESODESMATIDAE

A small group of about 40 species. They are marine or estuarine, actively burrowing in sediments in shallow water. Their siphons are used for filter feeding (Lamy 1914, Beu 1971).

Coecella horsfieldi Gray, 1853

According to Beu (1971), this genus has been spelled *Caecella* due to a misreading of Gray's (1853) original description.

Synonyms: *Caecella oblonga, C. transversalis* and *C. zelandica* all of Deshayes, 1854.

Range: Indo-West Pacific oceans, West Pacific, Southeast Asia.

Ecology and habitat: this animal lives in sublittoral sandflats and in sandbars near river mouths where there may be both scouring and, occasionally, reduced salinity.

Provenance within site: A3, 1.

Donacilla nitida (Deshayes, 1854)

Range: Australia and Southeast Asia.

Habitat and ecology: this species lives on low energy sandy beaches, where it is buried at shallow depths above and below low tide mark.

Provenance within site: B1, 1.

PSAMMOBIIDAE

This group of shallow-water marine infaunal deposit feeders contains about 100 species ranged in about 30 genus-rank taxa. Their bright, radial colour banding in red, orange and purple gives rise to the popular name of sunset shells. A small group (the Novaculininae) in South and Southeast Asia is found in fresh and brackish water (Ghosh 1920, Coan 1973).

Asaphis violascens (Forskäl, 1775)

Synonym: *A. dichotoma* (Anton, 1839).

Range: tropical Indo-West Pacific oceans.

Habitat and ecology: in muddy or gravelly substrates at low tide, and especially sandy beaches at the same level.

Provenance within site: A1, 3; B1, 2; A3, 5; A5, 4; A6, 3.

CORBICULIDAE

This family of fresh to brackish water bivalves is found mainly in tropical and subtropical areas. Many of the larger species (such as those of *Batissa, Polymesoda* and the larger *Corbicula* spp) are taken for food (Prashad 1924, 1928-30).

Polymesoda (*Geloina*) *erosa* (Solander, 1786)

Most modern authors would agree that there are only three species of *Polymesoda* (*Geloina*). These are: *P.* (*G.*) *erosa, P.* (*G.*) *expansa* (Mousson, 1849) and *P.* (*G.*) *bengalensis* (Lamarck, 1818). These appear to be the earliest valid names for these taxa. Specimens from this site are all attributed to *P.* (*G.*) *erosa* but it is probable that there are some *P.* (*G.*) *expansa* which could not be distinguished. Brandt (1974) also lists three species with a dubious fourth species. They are: *P.* (*G.*) *coaxans* (Gmelin, 1791), (= *P.* (*G.*) *erosa*), *P.(G.) proxima* (Prime, 1864) (=*P. (G.) expansa*, and *P. (G.) bengalensis* (Lamark, 1818) and *P.* (*G.*) *galatheae* (Morch, 1850). Brandt considers that this last species is probably a slightly elongate form of *P.* (*G.*) *expansa*. For further information on the synonymy of these three species, see Brandt (1974:309 ff) and Morton (1983b).

Habitat and ecology: both *P. (G.) erosa* and *P. (G.) expansa* are largely sympatric with a widely overlapping geographical distribution in the Indo-Pacific. Typically, these species occur together in pools or runnels on the landward side of coastal mangal where the soil acidity may be less than pH 5.4 and where the shells are rarely covered by the tides and considerable periods of emersion are the rule. This is one of the few molluscan genera which appears to be confined to mangal both

in the New and Old Worlds.

Provenance within site: A1, 145; A2, 10; B1, 10; X1, 27; A3, 340; A4, 9; A5,30; A6, 36; A7, 6; A8, 1; A12, 4; A14, 5.

VENERIDAE

This large, diverse and possibly polyphyletic family is currently split into twelve subfamilies with about 150 genus-rank taxa. There are probably in excess of 500 species all of which are marine in shallow to deep water worldwide. Most are infaunal, shallow-burrowing suspension filter feeders (Palmer 1927, Frizzell 1936, Nielsen 1964, Fischer-Piette and Delmas 1967, Fischer-Piette and Métivier 1971, Fischer-Piette and Vukadinovic 1977).

Meretrix lusoria (Röding, 1798)

Synonyms: *M. cytherea* Lamarck, 1805 (*non* Fabricus, 1794); *M. nympha* Mörch, 1853 (*non* Fitzinger, 1826). Frequently confused with *Meretrix meretrix* (Linnaeus, 1758), which is mainly confined to parts of the Philippine Islands.

Range: Southeast and East Asia up to and including Japan, Korea and China.

Habitat and ecology: found in vast numbers in sandy ground from just below low tide down to about 20 m.

Note: this species is of commercial importance as a food source in most of the areas in which it occurs.

Provenance within site: A1, 272 843; A2, 16 567; B1, 27 950; X1, 283,286; A3, 2 675, 841; A4, 323,576; A5, 38,500; A6, 497,784; A7, 253,500; A8, 38,500; A12, 333,075; A13, 55,125; A14, 38,666.

SOURCES OF THE REMAINS

Looked at in terms of how the shells arrived in the site (and ignoring *Meretrix lusoria* for the moment), the species list reveals that 97.92 per cent are easily refered to the categories of foodstuff, and tool material/ornaments, being 97.85 per cent and 0.07 per cent respectively. Two further groups, autochthonous and miscellaneous make the respective contributions of 0.88 and 1.2 per cent to make the balance. The food group is dominated by *Meretrix lusoria* making up 99.7 per cent of the total number of individuals in the site. Ignoring this species again, the percentage frequency of the thirteen most abundant taxa identified to the species level are shown in table 6.

TABLE 6. *The percentage frequencies of shellfish species*

Species,	N individuals,	Percentage
Anadara granosa	12046	64.3
Nerita articulata	1524	8.1
Ellobium aurismidae	1104	5.9
Ellobium aurisjudae	898	4.8
Polymesoda erosa	623	3.3
Cerithidea obtusa	605	3.2

Telescopium telescopium	593	3.2
Saccostrea cucullata	484	2.6
Naquetia capucina	185	1.0

TABLE 6 *(cont.). The percentage frequencies of shellfish species*

Species	N individuals	Percentage
Saccostrea gigas	179	1.0
Cassidula aurisfelis	152	0.8
Natica tigrina	27	0.1
Asaphis violascens	17	<0.1
Balance of species	290	1.5

This shows that *Anadara granosa* (64.3 per cent), *Nerita articulata* (8.1 per cent), *Ellobium aurismidae* (5.9 per cent), and *E. aurisjudae* (4.8 per cent) dominate the food group with over 80 per cent of the numbers between them. Other comestible species include (in order of diminishing frequency): *Cerithidea obtusa, Telescopium telescopium, Saccostrea cucullata, Naquetia capucina, Saccostrea gigas,* ?*Natica tigrina,* and *Asaphis violacea*. The case of *Natica tigrina* is uncertain: no modern record of this species being eaten is known to the author, but the numbers present in this, and other, archaeological sites is, at least, suggestive of their having been eaten in prehistoric times. Amongst the minor edible species may be ranged the two *Strombus* spp (*S. canarium*, *S. luhuanus*), the *Cymia* spp (*C. lacera* and *tissoti*), *Terebralia palustris*, the volutid, *Anadara nodifera*, *Barbatia* sp, *Pinna* sp, *Donacilla nitida* and, lastly *Coecella horsfieldi*. For *Cassidula aurisfelis*, occuring regularly across the site, there is no record or sign that it has ever been eaten. It is therefore placed in the autochthonous group along with *Macrochlamys*, the buliminids, *Littoraria melanostoma* and, doubtfully, the large ariophantid. This latter may well have been living on the site as it was recovered in the surface of the natural substrate, but this has to be balanced against the fact that these animals are very commonly eaten (Panha 1986).

The industrial materials/ornament/ritual category contains two taxa: *Tridacna* sp and *Conus* sp. The former, represented by one lump (very weathered) a few centimetres in length, is regarded as raw material and the gastropod may have been authentically part of the grave offerings or connected with the funebrial ritual, having in all cases been recovered from the grave cuts rather than the general midden.

The miscellaneous category (taxa that cannot be placed in any of the above groups) comprises mainly species of small size such as *Neritina violacea, Melanoides* sp, and *Cerithidea cingulata*, which are just large enough to occur as a bye-catch in fishermens' nets. The author has seen small piles of such shells by modern fresh and brackish waterways and ponds from such a source. The smaller forms such as *Bithynia, Iravadia, Assiminea, Cylindrotis, Auriculastra* and *Laemodonta* may have been brought into the site in fish guts. For the few remaining items, *Polinices tumidus, Oxyloma* sp and *Enigmonia aenigmatica*, one can only speculate. The *Oxyloma* may have of course, with its somewhat palustral life style, been brought onto the site on edible water plants such as *Trapa bicornis, Ipomoea aquatica* and *Nymphaea lotus*.

TABLE 7. *The minimum numbers of molluscan taxa*

Species	A1	A2	B1	X1	A3	A4	A5	A6	A7	A8	A12	A13	A14	TOTALS
Umbonium vestiarium	-	-	-	-	-	-	-	-	1	-	-	-	-	1
Nerita articulata	631	38	111	271	401	6	35	16	11	-	3	-	1	1524
Neritina violacea	2	-	-	1	-	-	-	-	-	-	-	-	-	3
Littoraria melanostoma	-	-	-	-	2	-	-	-	-	-	-	-	-	2
Bithynia wykoffi	-	-	-	1	4	-	-	-	-	-	-	-	-	5
Iravadia reticulata	-	-	-	1	-	-	-	-	-	-	-	-	-	1
Rissoid sp	-	-	-	1	-	-	-	-	-	-	-	-	-	1
Assiminea nitida	-	-	-	-	3	-	-	-	-	-	-	-	-	3
Assiminea philippinica	-	-	-	-	1	-	-	-	-	-	-	-	-	1
Melanoides sp	2	-	-	-	-	-	-	-	-	-	-	-	-	2
Cerithidea cingulata	5	1	-	1	1	-	-	-	-	-	-	-	-	8
Cerithidea obtusa	249	12	21	50	176	9	58	12	6	-	3	-	9	605
Cerithioid sp	5	-	-	1	-	-	-	-	-	-	-	-	-	6
Telescopium telescopium	24	6	3	22	283	20	146	55	14	2	6	-	12	593
Terebralia palustris	-	-	1	-	1	-	-	-	-	-	-	-	-	2
Strombus canarium	2	-	-	-	-	-	-	-	-	-	-	-	-	2
Strombus luhuanus	-	-	-	1	-	-	-	-	3	-	-	-	1	5
Strombus sp	2	-	-	2	1	-	-	-	-	-	-	-	-	5
Natica tigrina	16	-	2	-	9	-	-	-	-	-	-	-	-	27
Polinices tumidus	2	-	-	-	-	-	-	-	-	-	-	-	-	2
Polinices sp	1	-	-	1	-	-	-	-	-	-	-	-	-	2
Naticid spp	19	-	-	15	17	3	9	7	2	-	-	-	2	74
Chicoreus capucina	51	1	16	24	64	1	13	6	3	-	2	-	4	185
Cymia spp	9	1	-	1	1	-	-	11	1	-	-	-	-	24
Thaidid sp	1	-	-	-	9	3	29	21	-	-	1	-	2	66
Nassarius pullus	-	-	-	-	1	-	-	-	-	-	-	-	-	1
Volutid sp	1	-	-	-	2	-	-	-	-	-	-	-	-	3
Scalptia sp	-	-	-	1	-	-	-	-	-	-	-	-	-	1
Macrochlamys sp	-	-	-	-	-	-	2	-	-	-	-	-	-	2
Conus sp	1	-	3	7	1	-	-	-	-	-	-	-	-	12
Cassidula aurisfelis	93	3	-	14	33	2	7	-	-	-	-	-	-	152
Ellobium aurisjudae	223	21	31	124	338	8	101	27	7	-	5	-	13	898
Ellobium aurismidae	276	16	52	130	464	21	97	21	10	2	9	-	6	1104
Cylindrotis quadrasi	6	-	-	-	-	-	-	-	-	-	-	-	-	6
Melampus siamensis	-	-	-	-	-	-	1	1	-	-	-	-	-	2
Melampus nucleolus	-	-	-	2	1	-	-	-	-	-	-	-	-	3
Auriculastra subula	-	-	-	-	7	-	-	-	-	-	-	-	-	7
Laemodonta punctatostriata	-	-	-	-	-	1	-	-	-	-	-	-	-	1
Buliminid sp	-	-	-	-	1	1	2	-	-	-	-	-	-	4
Ariophantid	1	-	-	-	-	-	-	-	-	-	-	-	-	1
Oxyloma sp	-	-	-	-	-	-	1	-	-	-	-	-	-	1
Anadara granosa	3083	296	408	675	4218	270	1419	1124	114	103	169	3	164	12046
Anadara nodifera	2	1	-	-	2	-	-	-	-	-	-	-	-	5
Barbatia sp	1	-	-	-	-	-	-	-	-	-	-	-	-	1

TABLE 7 *(cont.). The minimum numbers of molluscan taxa*

Species	A1	A2	B1	X1	A3	A4	A5	A6	A7	A8	A12	A13	A 1 4	
Enigmonia aenigmatica	1	-	-	-	-	-	-	-	-	-	-	-	-	1
Saccostrea cucullata	180	9	11	34	147	6	61	6	20	-	8	-	2	484
Saccostrea gigas	49	1	21	15	87	-	2	1	-	-	3	-	-	179
Ostrea sp	13	-	-	-	7	-	-	-	-	-	-	-	-	20
Pinna sp	-	-	1	-	-	-	-	-	-	-	-	-	-	1
Placuna placenta	-	-	1	-	-	-	-	-	-	-	-	-	-	1
Tridacna sp	1	-	-	-	-	-	-	-	-	-	-	-	-	1
Donacilla nitida	-	-	1	-	-	-	-	-	-	-	-	-	-	1
Asaphis violascens	3	-	2	-	5	-	4	3	-	-	-	-	-	17
Polymesoda erosa	145	10	10	27	340	9	30	36	6	1	4	-	5	623
*Meretrix lusoria**	273	17	28	283	2676	323	39	498	254	39	333	55	39	5,557,090
Coecella horsfieldi	-	-	-	-	1	-	-	-	-	-	-	-	-	1

* x 1000, except total

Without knowing a great deal more about methods of transport available and used by the earliest known inhabitants of Nong Nor and their food preferences, speculation as to where they may have collected their provand and what distances were involved, may be deemed idle. It may not be unfair to assume that the closest, most popular foods were eaten in greatest abundance. This has some support in that the nearby site, Khok Phanom Di, has middens dominated by *Anadara granosa*, a species requiring muddy conditions, apparently in good supply close to the site, whilst at Nong Nor, there is a preponderance, whole orders of magnitude greater than all the other species combined, of *Meretrix lusoria* which requires a sandy substrate, thought on geological grounds to have been widespread here. Without the use of a water-going craft, it seems unlikely that *Crassostrea gigas,* if indeed they were eaten, with pairs of valves weighing between 0.5 and 0.9 kg each were found more than a few hundred metres from the site.

PARASITOLOGY

The only taxon than may be of parasitological interest is *Oxyloma* sp, being a member of a family known to be a vector of helminthic diseases.

THE PREHISTORIC BIOTOPES

Table 7 shows the fifty or so taxa found in the site arranged by habitat on the basis of a meagre literature and on the writer's observations. Five broad settings are recognized: marine, mangal, estuarine, freshwater and terrestrial. Each of these is divided into a number of more circumscribed habitats as indicated in the table legend.

TABLE 8. *The habitats of Nong Nor as represented by molluscan taxa*

	Marine						Mangal				Estuary					F.Water		Land		
Species	m	ms	s	fa	c	h	mf	se	c	le	g	m	s	h	ch	le	lo	g	n	b
Umbonium vestiarium	-	+	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Nerita articulata	-	-	-	-	-	-	-	+	+	-	-	-	-	-	-	-	-	-	-	-
Neritina violacea	-	-	-	-	-	-	-	-	+	+	-	-	-	+	-	-	+	-	-	-
Littoraria melanostoma	-	-	-	-	-	-	-	+	+	+	-	-	-	-	-	-	-	-	-	-
Bithynia wykoffi	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-
Iravadia reticulata	-	-	-	-	-	-	+	+	+	-	-	-	-	-	-	-	-	-	-	-
Assiminea nitida	-	-	-	-	-	-	+	+	-	-	+	-	-	-	-	-	-	-	-	-
Assiminea philippinica	-	-	-	-	-	-	+	+	+	-	-	-	-	-	-	-	-	-	-	-
Melanoides sp	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	+	+	-	-	-
Cerithidea cingulata	+	-	-	-	-	-	+	+	-	-	+	-	-	-	-	-	-	-	-	-
Cerithidea obtusa	+	-	-	-	-	-	+	+	-	-	+	-	-	-	-	-	-	-	-	-
Telescopium telescopium	+	-	-	-	-	-	+	+	-	-	-	-	-	-	-	-	-	-	-	-
Terebralia palustris	-	-	-	-	-	-	+	+	-	-	-	-	-	-	-	-	-	-	-	-
Strombus canarium	-	-	+	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Strombus luhuanus	-	-	+	+	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Natica tigrina	+	+	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Polinices tumidus	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Chicoreus capucina	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-
Cymia lacera	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cymia tissoti	-	-	-	-	-	-	-	+	-	-	-	-	-	+	-	-	-	-	-	-
Nassarius pullus	+	+	+	-	-	-	+	+	-	-	-	-	-	-	-	-	-	-	-	-
Volutid sp	+	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Scalptia cf *crossei*	-	-	-	-	+	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cassidula aurisfelis	-	-	-	-	-	-	-	+	+	+	-	-	-	-	-	-	-	-	+	-
Ellobium aurisjudae	-	-	-	-	-	-	-	-	+	+	-	-	-	-	-	-	-	-	-	-
Ellobium aurismidae	-	-	-	-	-	-	-	-	+	+	-	-	-	-	-	-	-	-	-	-
Cylindrotis quadrasi	-	-	-	-	-	-	+	+	-	+	-	+	+	-	-	-	-	-	-	-
Melampus siamensis	-	-	-	-	-	-	+	+	-	-	-	-	-	-	-	-	-	-	-	-
Melampus nucleolus	-	-	-	-	-	-	+	+	+	-	-	-	-	-	-	-	-	-	-	-
Auriculastra subula	-	-	-	-	-	-	-	+	+	-	-	-	-	-	-	-	-	-	-	-
Laemodonta punctatostriata	-	-	-	-	-	-	+	+	+	-	-	-	-	-	-	-	-	-	-	-
Buliminid sp	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-
Macrochlamys sp	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-
Ariophantid	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-
Oxyloma sp	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	?	?	-	-
Anadara granosa	+	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-
Anadara nodifera	+	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Barbatia sp	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Saccostrea cucullata	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-
Saccostrea gigas	-	-	-	-	-	?	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pinna sp	-	+	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Enigmonia aenigmatica	-	-	-	-	-	-	-	+	+	-	-	-	-	-	-	-	-	-	-	-
Placuna placenta	+	-	-	-	-	-	+	+	-	-	-	+	-	-	-	-	-	-	-	-

TABLE 8 *(cont.). The habitats of Nong Nor as represented by molluscan taxa*

	Marine						Mangal				Estuary					F.Water		Land		
Species	m	ms	s	fa	c	h	mf	se	c	le	g	m	s	h	ch	le	lo	g	n	b
Unionids	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+	-	-	-
Tridacna sp	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Coecella horsfieldi	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-
Donacilla nitida	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Asaphis violascens	-	+	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Polymesoda erosa	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-
Meretrix lusoria	-	+	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Key to Symbols.— Marine: m, mud; ms, muddy sand, sandy mud; s, sand; fa, fine algae on sand; c, clean coral sand/reef flat; h, hard ground of gravel, cobbles or rock; Mangal: mf, mudflat; se, seaward edge; central region; landward edge; Estuary: g, general setting; m, mud; s, sand; h, hard ground/logs and branches; ch, channels; Fresh water: le, lentic (standing); lo, lotic (running); Land: g, general; n, nipa, damp land; b, Barringtonia association, dry land.

Marine mudflats: Broom (1982) describes an *Anadara granosa*-dominated mudflat community from near the mouth of the Sungai Bulah River (Peninsular Malaysia). Of the ten mudflat species recorded at Nong Nor, only *Cymia tissoti* seems to require a normal marine mudflat environment. Six of the mudflat species may also be found in the same setting in mangal, with reduced salinity. *Cerithidea obtusa, Natica tigrina*, and *Nassarius pullus* occur in the site and as part of Broom's mudflat community, making it reasonably certain that this biotope was accessible for exploitation from Nong Nor.

Marine muddy sand: of the eight species found in this, perhaps ecotonal habitat, two (*Anadara nodifera* and the volutid) range into marine mudflats and five range into clean marine sand substrates. It can be seen that the signal for muddy sand is weak.

Clean marine sand: this is the most strongly represented marine environment with 11 species, only six of which may to a lesser extent be found also in slightly siltier conditions. The other five species are purely clean water, some of them also being found in a clean reef-flat context. It seems that this biotope was well represented close to the site.

Sand and algae: evidence for this habitat and the related seagrass (*Enhalus*-dominated) low tide flats, is scanty. Only *Strombus canarium* may have been found here, but could equally well have been found in a clean sand setting. While the writer thinks it likely that this substrate was present at the low tide, seaward edge of extensive sand flats bearing substantial *Meretrix* beds, hard evidence is lacking.

Clean coral sand/reef-flat: indicators for this habitat are few: *Tridacna* sp, the two strombids and *Scalptia*. Of these only the tridacnid and perhaps *Scalptia* are not found elsewhere. The absence of large, edible *Anadara* species (*A. uropigimelana, A. secticosta*) which would have preserved well in the site may be, taken together, significant indicators that if present, this biotope has left little trace.

Marine hard ground: the only convincing evidence for a clean, hard substrate is *Crassostrea gigas* many of whose lower valves were found affixed to cobbles of laterite. As this species is known

to favour waters of slightly reduced salinity, it is tempting to speculate that on a coastline of predominantly fine, but not muddy sediment, unidirectional storm exposure and no pronounced longshore currents, that a tidally scoured channel in a bar-protected inlet receiving seasonally variable amounts of fresh water may afford a suitable habitat.

Mangal mudflats: of the 14 species that may have been collected from this setting, six are also found on normal marine mudflats and 13 at the seaward edge of mangal. This biotope is probably best regarded as ecotonal in the sense that it is an area where the lower shore molluscs overlap with those more typical of the mangal plant formation. In the former group may be placed the bivalves *Anadara granosa* and *Placuna placenta* and the scavenging gastropod *Nassarius pullus*. Species more typical of mangal include *Cerithidea cingulata, C. obtusa, Telescopium telescopium*, and *Terebralia palustris*.

Seaward mangal: this three-dimensional habitat may be divided into mud substrate, tree-trunks and logs submerged by the tides and mangal trunks and canopy above tidal influence. Each has its own distinctive group of inhabitants. Infaunal mud-dwelling bivalves may include the uncommon *Anadara granosa* and sometimes abundant *Placuna placenta*. Oyster clumps (*Saccostrea cucullata*) may also occur set in the mud along with their chief predator, *Cymia lacera*. *Cerithidea cingulata, C. obtusa, Telescopium telescopium* and *Terebralia palustris* form a group of gastropods grazing bacteria and microalgae from hard and soft surfaces, and may often be found in large numbers in rills and channels in the mangal and on adjacent mudflats. In many ways, the intertidal trunks act like a sheltered rocky shore, bearing large numbers of sessile organisms that need a hard substrate such as barnacles and *Saccostrea cucullata*. Browsing gastropods, climbing over this dense epifauna include *Nerita articulata, Cerithidea cingulata*, *C. obtusa* and *Terebralia palustris*. The predators include *Naquetia capucina* (hunting polychaete worms) and *Cymia tissoti* which drills and eats barnacles.

The subaerial faunule includes the pulmonates *Cassidula aurisfelis* (and *C. mustelina,* which is suspected to be in the site, but could not be reliably separated from *C. aurisfelis*) and the wide-ranging *Littoraria melanostoma*, rasping epiphytes from the surface of tree leaves. *Nerita articulata* is nearly as widespread, grazing upon microalgae from hard surfaces and even the surface of firm mud.

Central mangal: with the decline of marine influence, the brackish and freshwater regime tightens its grip along with increasing areas of supratidal ground with the fern, *Acrostichum aureum* where may be found the primitive pulmonate snails, *Auriculastra subula, Cassidula aurisfelis* (and probably *C. mustelina*), *Ellobium aurismidae, E. aurisjudae* and *Laemodonta punctatostriata*. Co-dominant in the subaerial realm is *Nerita articulata*. In the aquatic aspect of this biotope the gastropods *Neritina violacea, Iravadia reticulata* and *Assiminea philippinica* rise to dominance. *Littoraria melanostoma* persists as a canopy species.

Landward, the mangal may pass into saltmeadows or the dry-footed *Barringtonia* forest association. While the nature of the site substrate suggests that the area was well enough drained at the time of first settlement to allow of an *Ipomoea pescaprae-Barringtonia* association, the pollen record needs to be invoked to confirm this. The existence of saltmeadows is strongly suggested by the presence of *Cylindrotis quadrasi*, but on its own it is not conclusive. *Polymesoda erosa*, a member of the essentially fresh water family Corbiculidae is one of the few molluscs dependant

on the mangal association for its existence. It is highly adapted to survive long periods of emersion and the wide range of salinities that occur at the landward edge of the mangal. Here again, the auriculids are the dominant gastropods, many of the smaller species (*Cylindrotis*) extending into the rushes and grasses of the saltmeadows where present. *Neritina violacea* extends into the fresh or brackish streams in this setting.

Estuary setting: animals found here are characterized by a tolerance of large and rapid fluctuations of salinity and include typically marine species that are euryhaline and fresh water species that tolerate some degree of salinity. At Nong Nor, there is no one species, or constellation of species, that indicates an estuary. The only species that is listed in the literature as peculiar to estuaries, *Coecella horsfieldi*, has now been found by the author on several ocassions in fresh water seepages on open sea sandy beaches. The other species such as *Neritina violacea, Assiminea nitida, Cerithidea cingulata, C. obtusa, Cymia tissoti, Cylindrotis quadrasi*, and *Placuna placenta* can all be accommodated elsewhere with greater probability.

Fresh water: the presence of freshwater mussel fragments, and *Bithynia wykoffi* are the only certain indicators for this environment.

Terrestrial environment: *Cassidula aurisfelis* occurs in damp nipa palm groves with a coastal aspect so qualifies to be included here, though its real stronghold is in coastal mangal. Characteristically dry-footed terrestrial species include the buliminid, ariophantid and the *Macrochlamys* sp: all typical higher pulmonate snails. If all these species were living on the site before, during and after its phase 1 occupation, as seems likely, one might suspect that there was a continuous link of high ground to areas landward of the mangal association.

THE PALAEOENVIRONMENT OF NONG NOR

Synthesizing the available evidence, there can be no reasonable doubt that Phase 1 of occupation at Nong Nor occured whilst the site was surrounded by mangal and within a few hundred metres of an open seacoast. Equally clear evidence places the site above the level of marine and freshwater seasonal flooding as attested by the land snails. The existence of saltflats and marshes to landward of the mangal, while deemed probable, cannot be demonstrated with certainty. If the pollen record were to show unusual amounts of chenopodacean microfossils for this period, this could be construed as support for this biotope. The nature the land snails suggests that both a *Barringtonia* and *Ipomoea pescaprae* plant association may have been present, giving way to a less maritime mixed dipterocarp deciduous shrubland/savannah association with fresh water streams as indicated by the unionid mussel remains. Evidence is good for streams with brackish reaches within the mangal.

The marine setting, in strong contrast to the nearby, but later site of Khok Phanom Di appears to have been sandy rather than muddy (Mason 1991). The number of species and individuals, particularly *Meretrix*, from sandy substrates heavily outnumbers those from other marine sediment types. The picture that emerges is one of predominantly low angle, low energy sandy, to muddy sand beaches extending to, or beyond, low tide with a mud bed beyond this. The presence of quantities of *Anadara granosa* more than hints at sheltered shore mudflats in reach of the site.

The existence of some amount of hard ground is indicated by the *Crassostrea gigas,* but when this hard ground existed is open to question. It is possible that these animals were brought

onto the site to be eaten or the shells used as raw material for artifacts. However, close examination of all the valves shows no sign of breakage or working that might suggest intended industrial use, but many of them show signs of abrasion along the valve edges consistent with rolling in a coarse sediment environment. This raises the strong likelihood that they are part of the natural substrate rather than part of the cultural record. Oyster reefs of Holocene age are well known from China (Wang and Strydonck 1997), Korea (Lee *et al*. 1994) and Thailand (ZZZ, 19cc) in the Bangkok Clay. The author's field observations suggest that the site may be a chenier ridge, quite typical in being a few tens of metres wide, a few hundred long and about one to two metres high from the surface on which it accumulated and moved. A lowering of sea level to expose and erode the surface of the marine Bangkok Clay would make available a lag of oyster valves to be incorporated in any chenier that should form during a sea level standstill, and then be moved over the exposed surface, along with coarse sediments should sea level rise. A rise in sea level after the formation of the chenier ridge may have had the effect of causing swamps (and the observed swamp/flood plain deposits) about the site and make it unfavourable for occupation after its first abandonment.

If the giant oysters are indeed part of the natural substrate, as seems likely, particularly in view of the fact that almost none of the valves match, left to right, then evidence disappears for a bar-protected tidally scoured inlet, and its associated hard ground.

As the midden appears to have no appreciable time depth, environmental changes, other than as speculated upon above, can be hardly considered. In the midden, which locally achieved a thickness of about 90 cm, but more usually 15-20 cm, there was no evidence of any lapse of time such as soil development horizons, weathering surfaces, or strong disjuncts in the biological remains or their physical and chemical state of preservation. The overwhelming impression in the field was of a very short occupation: perhaps not more than one or two seasons. Some support could be sought from the number of molluscs apparently eaten on the site. Of the about five and a half million *Meretrix* recovered (the writer has no reason to believe that any substantial number were not excavated), large numbers appear not to have been eaten: the valves being tightly adpressed. In the few instances that were counted, 24 to 39 per cent of *Meretrix* individuals were apparently intact. and the impression was gained that as many as 20 per cent across the whole site may not have been eaten.

As the size/frequency graph (Fig. VV) was being compiled, the over-all shape was examined after the addition of each 250 individuals (five samples of average 50 individuals each) and it was noticed that the three peaks at 24, 35 and 40 mm classes were quite persistent, as was the low point at 27 mm. This suggests that within A3, from which all the samples were taken, the size frequency properties are remarkably consistent from top to bottom. Comparison of this graph with those of shell height against age class as shown by Koike (1980:32), it can be seen that the three peaks correspond well with the expected position of the third, fourth and fifth year classes. If the shells had been collected over more than one season, it would be expected that the year classes would have blurred out with this size of sample (n=3027) and the fact that the samples were drawn at random from the top to bottom of the sampled area. For these reasons, a single, probably short, period of occupation during Phase I is suspected, but not necessarily demonstrated.

Assuming that 4.4 million cockles were eaten in the space of six months (say, 200 days), at the rate of 220-440 cockles per day per person, this would need between100 to 50 persons respectively. In view of the known size of the site, this is not too improbable.

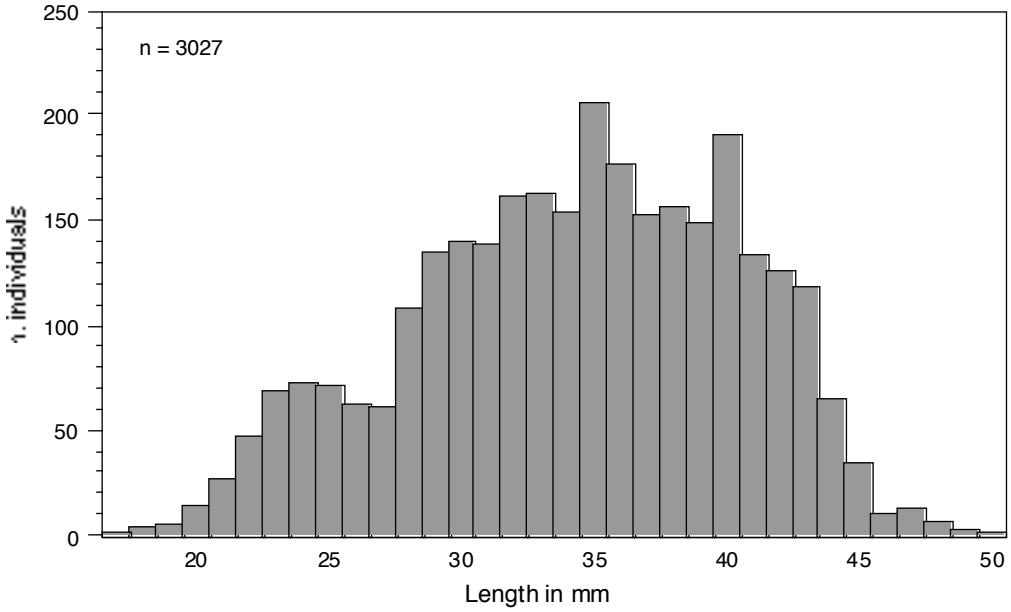


FIG. 62. The size and frequency distribution of *Meretrix lusoria* from all contexts of square A3

THE CRAB REMAINS

Of the 235 pieces of crab exoskeleton recovered from phase 1 contexts, 171 were identified as right or left dactyli of the claw. Most of the material, which could not be used to establish minimum numbers of individuals, were cheliped fragments together with three nondescript body or limb portions. No crab remains from phase 2 contexts were found. The crab remains were evenly dispersed when midden thickness and disturbance by grave cutting are allowed for. All three brachyuran species identified belong to the swimming crab family Portunidae and are, in order of abundance, *Scylla serrata* (Forskåll, 1775) (minimum of 61 individuals), *Portunus pelagicus* (Linnaeus, 1766) (minimum of two individuals) *Thelamita* sp. (possibly *Thelamita sima* H. Milne-Edwards, (at least one individual). The absence of well-calcified remains of the large, comestible grapsid crabs *Cardisoma* and *Sesarma* is interesting in that this may reflect prehistoric food preferences on the assumption that neither of these genera are likely to have been absent from the mangal (Macnae 1968:200). Freshwater crabs are present in modern ricefields in the vicinity of the site and are eaten, the main species being *Parathelphusa germaini* (Rathbun, 1902). Consumption of these crabs may not be without medical consequences, as they are known to be the intermediate host of *Paragonimus* (Naiyanetr 1987), a digenean parasite. It is possible that these crabs were available near the site during the second occupation phase, but not during the first.

Autecology of species

Scylla serrata

Synonyms: Serene (1952) notes that a complete synonymy for this species would include over eighty references. Stephenson and Campbell (1960:112) say that *Scylla* is monospecific, the important synonyms being *S. tranquebarica* (Fabricius, 1798) and *S. oceanica* (Dana, 1852).

Range: East Africa (Tanzania) to Tahiti, including Australia and northern New Zealand (Stephenson 1972:44).

Habitat: Macnae (1968:214) states that this is the only portunid crab found in the mangal. It lives in burrows which may be up to 5 m long and gently sloping down to the water table. They are commonly found on the banks of creeks and among roots on the seaward fringe. Stephenson (1972:44) observes that of all the Indo-West Pacific portunids, it penetrates farthest into the estuaries where it may be found intertidally and to depths of 7 m.

Distribution in site: sparsely at all places throughout the shell midden of phase 1.

Portunus pelagicus

Synonyms: there is considerable nomenclatural confusion attached to this animal. The name *Portunus* having been applied to two different genera. The important generic names applied to *pelagicus* are *Neptunus, Lupa* and *Callinectes*. Species-group names include *mauritianus* Ward 1942 and *alexandri* Rathbun, 1907.

Range: from East Africa to Tahiti, ranging north to Japan and south to northern New Zealand.

Habitat: intertidal, in mud and *Zostera* flats, shallow pools, estuaries. It is trawled to a depth of 65 m (Stephenson 1972). Unlike *Scylla serrata*, which is amphibious, *P. pelagicus* requires water to breathe.

Distribution in site: one individual, represented by a left manus, occurred in area A3, unit 53 layer 2D.

Thalamita sima

Synonyms: The only important synonym is *Portunus (Thalamita) arcuata* de Haan, 1850.

Range: Malagasy Republic, Mozambique and Red Sea to Hawaii, ranging north to Japan and south to New South Wales, Australia.

Habitat: intertidally on mudflats, also under intertidal stones and rocks. It has been trawled to depths of 36 m (Stephenson and Hudson 1957). The same authors record specimens with a carapace width of 85 mm, which is considerably less than the 200 mm width of *Scylla serrata* noted by Grant (1972). These latter specimens weighed about 2 kg each.

Distribution in site: one individual, represented by a left manus, from Area 3, unit 49, layer 2:7.

Harvesting techniques.

No clue is given by the artefactual remains from Nong Nor as to how the crabs may have been caught. However, one may suppose that the simple techniques of netting, spearing and trapping as recorded in present day Malaysia, were used in prehistory in the same general area. Tweedy and Harrison (1954) state that *Scylla serrata* is the most important edible crab in Southeast Asia, and "is caught in small baited nets suspended on a rod and line, which are allowed to rest on the bottom of the creek [in the mangal] for a time, and are then quickly pulled up, giving the crab no time to scramble out".

Malley and Chye (1978) speaking of West Sabah, say that only two crabs, *Scylla serrata* and *Portunus pelagicus*, are caught in large quantities. The fishermen move through the mangrove channels in dugout canoes, setting baited lift-net traps in water depths up to 1.5 m. These are

supplied to the market the year round, but are considered best from February to May. *Portunus pelagicus* is usually caught by trawling, which takes the largest specimens. Alternatively, crabs may be caught by torchlight in shallow water to 60 cm depth. They also remark that the meat of *S. serrata* is superior to that of *P. pelagicus,* which factor is reflected in the 25 per cent price premium.

In recording small-scale fishing in Johore, Malaysia, Goto (1996) notes that several types of baited bamboo traps are used by the local fishermen for catching mangrove crabs. It is to be noted that none of the above mentioned techniques would leave a discernible archaeological trace, except perhaps, under the most unusual circumstances.

THE FISH REMAINS

Nature of Material

Bony fish remains for the whole site totalled about 2.4 kg and elasmobranch remains about half that at 1.3kg. The material is all heavily mineralized with mainly iron and calcium compounds which also form extensive, intractable, incrustations. The fact that the bones have been quite plastic in the ground is frequently in evidence. Of the teleost material, little other than the otoliths (belonging to nine or ten species) and, perhaps, some of the dorsal and lateral fin spines are potentialy identifiable with appropriate reference material. Other than this, only some cranial dermal armature of *Ophicephalus* spp can be recognized with confidence along with dental plates of a parrot fish and some of the cranial bones of barramundi. Only in the case of the parrot fish (*Callyodon* sp) was a minimum number arrived at. It was not deemed possible to get useful minimum numbers of individuals based on skull fragments (in the case of the teleosts) or teeth or dermal denticles from the elasmobranchs. The shark remains counts refer to the number of teeth recovered. Where the counts are for denticles, this is noted.

The elasmobranch remains comprise teeth, dermal denticles and calcified (presumably *in vivo*) vertebrae. These latter range in size from a few millimetres to about 36 mm in diameter. With the exception of the two catfish and the barramundi, identifications of the fish remains were done from the literature without the aid of comparative material and should thus be treated with appropriate caution.

Literature consulted included a typescript checklist of elasmobranchs known from Thailand's waters (some 95 spp, but may not be exhaustive) compiled by the author from a wide range of sources. Other works used include Monkolprasit (1984), Compagno (1984, 1988), and Last & Stevens (1994) for the elasmobranchs and Smith (1945) for the freshwater taxa. Marine teleost general references include Randall, Allen and Steene (1990), Smith (1953), Suvatti (1981), Nelson (1994) and Schultz (1969) (for the scarids).

FAMILY HEMIGALIDAE (WEASEL SHARKS)

This small family of common coastal sharks, of tropical waters, may be found in continental and insular shelf water to a depth of 100 m. Of the seven species, which grow to about 1.4 m, only *Hemipristis elongatus* is appreciably larger, in obtaining 2.4 m. These fishes are frequently taken in artisanal and small inshore, and near offshore fisheries where they occur in the Indo-West Pacific.

Hemipristis elongatus (Klunzinger, 1871)

Synonym: *Carcharias ellioti* Day, 1878. Snaggletooth shark.

Range: Indo-West Pacific from southern Africa to southern China.

Habitat and ecology: may be found inshore and offshore on continental and insular shelves at depths of 1-30 m. This fish-eating animal may obtain a length of 2.4 m. While its teeth present a fearsome aspect, it is not known to attack humans.

Comments: at the present day, it is caught in artisanal fisheries in many parts of the Indo-West Pacific, including Thailand. It is taken in gill nets and on floating long lines. The flesh is deemed to be one of the best for human consumption when fresh.

Distribution in site: A5, 2.

FAMILY CARCHARHINIDAE (WHALER SHARKS)

With 49 species, this is probably the largest and most important family of sharks. A manuscript checklist compiled by the author, of elasmobranchs found in Thai waters shows no fewer than 26 species for this family. A range of sizes is represented: a few are less than 1 m long, most are 1-3 m and the largest, the tiger shark, (*Galeocerdo cuvier*) may grow to 7.4 m. They are found in all warm and temperate seas, and dominate tropical seas in variety and abundance. They usually frequent continental and offshore coastal waters, but a few, such as the blue shark, (*Prionace glauca*) are truly oceanic. Some (eg the bull shark, *Carcharhinus leucas*), known from Thailand) can spend extended periods in completely fresh water. Members of the family occur singly or in small to large schools and are active and strong swimmers. All are voracious predators on fish, other sharks, molluscs, and other verterbrate and invertebrate groups. Larger whaler sharks attack humans, the bull shark and tiger shark being among the most dangerous known. Members of this family comprise the most important tropical shark fisheries in recent times.

Carcharhinus longimanus (Poey, 1861)

Synonym: *Squalus maou* Lesson, 1830. Oceanic white-tipped shark.

Range: tropical seas, to about 30°N and S of the equator in the Indo-Pacific Ocean to West America and the Atlantic Ocean.

Habitat and ecology: a common oceanic, pelagic species that may be occasionally coastal, but usually open sea far offshore in tropical to temperate waters. This large, stocky species may reach 3 m or more, does not form schools, but may appear to group when food is available. It feeds predominantly on teleost fishes and cephalopods, feeding by day and night. It has large teeth and powerful jaws, and is known to attack both humans and boats alike.

Comments: at present, this species is frequently caught with long lines, hand lines and sometimes pelagic and bottom trawls. It is used fresh, smoked or dried and salted for human consumption. The hide is used for leather.

Distribution in site: A3, 13; A7, 1.

Carcharhinus sorrah (Vallenciennes, 1839)

Synonyms: *Squalus spallanzani* Peron & Lesueur in Lesueur, 1822; *Carcharias bleekeri* Dumeril, 1865. Spot-tail shark.

Range: Indo-West Pacific, generally within 20° of the equator, over shallow continental and insular shelves from intertidal to about 80 m, throughout the water column, but generally near the surface.

Habitat and ecology: this stocky shark may grow to about 1.6 m. They eat teleost fishes and octopus. Common in open areas over muddy bottoms, they may also appear round coral reefs. Comments: this inshore shark is frequently caught in modern Thai artisanal and small commercial fisheries by means of lines and gill nets. The flesh is eaten.

Distribution in site: A3, 20; A4, 4; A5-6, 3; A6, 3; A7, 1; A8, 3.

Carcharhinus spp

Four sets of more or less distinct lower teeth were separated from the material as *Carcharhinus*, but were not relatable to the above named *Carcharhinus* species. It is unclear how many species may be involved.

Distribution in site: species A, A3, 8; A5, 1. Species B, A3, 16; A6, 1. Species C, A3, 19; A4, 1; A5-6, 1; A6, 2. Species D. A14, 1.

Galeocerdo cuvier (Peron and Lesueur, 1822)

Synonyms: *Squalus arcticus* Faber, 1829; *Galeocerdo rayneri* McDonald and Barron, 1868. Tiger shark.

Range: circumglobal in warm temperate and tropical seas, from close inshore to well off the continental shelf, ranging from the surface to about 150 m.

Habitat and ecology: this nocturnal animal seems to prefer turbid areas, and is found frequently in estuaries and shallow areas by night, moving to deeper water during the day. They are usually solitary but may form feeding aggregations. Tiger sharks are opportunistic omnivores, there being no manner of live food or carrion they will not eat as well inanimate objects such as plastic bags and aluminium cans. It is one of the most dangerous sharks, with more confirmed attacks on humans and boats than any other shark except the great white (*Carcharodon carcharias*). They may be inquisitive and aggressive, and approach humans closely. Its reputation as the worst man-eating shark in the tropics, is well deserved. Most tiger sharks are smaller than 5 m, but large females are not uncommonly 5.5 m, Fourmanoir (1961) recording one such off Vietnam measured at 7.4 m and weighing 3 tonnes.

They are commonly caught in coastal and offshore fisheries with long lines, fixed bottom nets and other gear. The flesh is used fresh or salted and smoked for human consumption and the hides for leather.

Provenence in site: A3, 6; A4, 1; A5, 1; B87, 2.

FAMILY RHINOBATIDAE (SHOVELNOSED RAYS)

This family of rays, also known as guitar fishes, comprises small to medium sized animals with broad, flattened tails lacking a stinging spine. It is represented world wide by four genera and about 40 species, five of which are known to occur in Thailand, and achieves its greatest diversity in the Indo-West Pacific. They seem to live mainly over soft substrates feeding predominantly on shellfish and other bottom-dwelling and infaunal invertebrates.

Shark vertebrae

An attempt was made to identify the calcified vertebrae, but was abandoned due to a number of ambiguities and the fact that concretionary material and poor preservation in the majority of cases disguised the anatomical features required for confident identifications.

Distribution in site: A1, 34; X1, 3; A3, 406; A4, 139; A5, 248; A6, 63; A7, 17; A8, 21; A12, 11; A13, 11; A14, 17. Burial 20, 2; B27, 1; B39, 1; B61, 1; B82, 6; B86, 1; B97, 1; B96, 1; B106, 1; B109, 1; B114, 1; B140, 5; B142, 2; B148, 7; B165, 1.

FAMILY CLARIIDAE (AIR BREATHING CATFISHES)

This family of catfishes is found in fresh water in Africa, Syria and southern and western Asia (Philippines to Java). Some members of this family can move across land, most notably *Clarias batrachus* (widely distributed in Thailand). They are divided into about 15 genera with about 100 species, five or six of which occur in Thailand. Members of this family have an accessory air-breathing organ in the upper part of the branchial cavity, allowing these fish to breath atmospheric air, without which they die. Most of the Thai species belong to the genus *Clarias*, which contains the most important economically of the fresh water fishes of Thailand. Eaten throughout the land, their flesh is deemed wholesome.

The most common species is *Clarias batrachus* (L., 1758), frequenting rivers, canals, lakes and swamps in all parts of the kingdom. When caught (by netting) or in modern times by hand when parts of canals or waterways are blocked off, they may be kept alive for many days at a time in damp covered ceramic jars.

Many fragments of clariid skull (about 5-10 mm long) were recovered from the site thus: A3, 34; A4, 28; A5, 38; A5-6, 12; A6, 7; A7, 4; A8, 2; A14, 5; B112 1; B115, 1; B135, 1.

FAMILY SCARIDAE (PARROTFISH)

This family of purely marine, mainly tropical fishes is found in the Atlantic and Indo-Pacific oceans. Aptly named for its bright colours and fusion of its teeth to form beak-like sharp-edged plates, parrot fish also have an unusual pharyngeal crushing dentition with rows of molariform teeth. They are generally held to have evolved from the wrasses (family Labridae). From this latter group they are distinct in having fused jaw teeth, a unique pharyngeal dentition, a very long intestine, no true stomach and in being largely herbivorous. They feed mainly on algae scraped from mangrove trunks, logs, dead coral and limestone rock. The rock and plant material are titurated in the pharyngeal mill to comminute and make more digestible the plant food and thereby supply a major source of fine sediment in tropical and subtropical seas. Some large scarids are known to eat live coral.

Strikingly different adult colour patterns are prevalent in all species of this family. The juveniles of a given species will have their own immature colour pattern which changes to either the typical male or female pattern on reaching sexual maturity. The young female may become a male and keep a harem. There are, for some individual species, different styles of mating and other sexual behaviour, all of which have combined to produce much confusion in the taxonomy and nomenclature of this family. The large number of resulting nominal species has now been reduced to about 70, split into about 16 genus-group taxa. A curious habit found in this family is that many species at night hide in small caves and under ledges where they envelope themselves in a cocoon

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Ophicephalus striatus Bloch, 1797

Synonyms: *Ophicephalus vagus* Sauvage, 1881, *Channa striata* Fowler 1937. *Pla chon.*

Range: China to India, Sri Lanka and throughout Thailand, mainland and island Southeast Asia.

Habitat and ecology: it is found in fresh water in coastal plains and rivers, canals, lakes, ponds, swamps and marshes. It inhabits waters of downland and piedmont regions but in mountainous areas it is replaced by lesser species such as *Ophicephalus gachua* Hamilton, 1822 and *O. melasomus* Bleeker, 1851. It may grow to over a metre long, but fish this size are now rarely if ever seen due to heavy exploitation, the usual size in the market being usually 30-45 cm. They are carnivorous, devouring fish, frogs, snakes and insects. Readily taken by hook and line, they are also caught in bamboo traps. During the dry season when swamps and shallow waterways dry out, these fish bury themselves in the bottom mud at depths of up to a metre, where they survive if the skin and suprabranchial apparatus is kept damp for many months until the rains return. They live off their stored fat.

Huge numbers of *pla chon* are consumed each year by the Thai. Used in fresh condition, many more are decapitated, split and sun dried in flat shape to facilitate packing and transport. The firm, white and nearly boneless flesh has an agreeable flavour and has earned, deservedly, a high reputation. These fish are taken year round and may, during the dry season, be dug up from damp cavities in stiff mud.

Distribution in site: A3, 34; A4, 28; A5, 38; A5-6, 12; A6, 7; A7, 4; A8, 2; A14, 5; B112, 1; B115, 1; B135, 1.

CONCLUSIONS

The caution expressed above on the precision of identification of some taxa should be borne in mind at this juncture. Some of these fishes, if correctly identified, such as *Carcharhinus longimanus* are truly oceanic and almost unknown in a coastal setting, the tiger shark is likewise oceanic, but not uncommon inshore. They are both big fishes, growing to in excess of 3 m and 5 m respectively. Nearly all the elasmobranchs from the site potentially grow to over 2 m, thus raising the possibility that shark, ray and skate fishing may have been a group pursuit, rather than that of the solitary fisherman. Further, fishing equipment such as vessels carrying more than one person and nets requiring many hands to set and haul, may have been used communally. The hint of oceanic fishing is also present and if substantiated by further investigations, has interesting implications with respect to the abilities of the first known inhabitants of Nong Nor to navigate out of sight of land, and their use of multiperson craft with sails. Such tantalizing speculations need much more archaeological evidence before acceptance, although given the long adaptation of prehistoric communties to a coastal habitat, and the arrival of human communities in Australia by at least 50,000 years ago, we should not be surprised by long distance voyaging at a date of 2500 B.C.

Palaeoenvironmental information revealed by the fishes is in good agreement with that construed from the crabs and molluscs, but with a stronger accent on the presence of fresh water bodies at no great distance from the site. The ubiquity of the clariid and ophicephalid remains attest this conclusion. Little new information is added by *Lates*, which may have been taken at any time from the sea and seasonally in estuaries and fresh water. The *Callyodon* sp is interesting in that most members of its family tend to inhabit coral reef areas, but are otherwise known to crop algae from hard substrates. This is the only hint (apart from tridacnid fragments which may have

been traded in) that reef corals may have been found in the site catchment area. Without strong corroboration, the author prefers to think that this is a mangal species, moving in and out with the tide rather than a coral reef dweller.

The skates and rays may be signalling collectively the presence of a sheltered, shallow bay perhaps with slightly reduced salinity in the case of the dasyatid. All three are known to inhabit estuaries, but even so, there is still no clear cut evidence for an estuary proper as opposed to, say, a spit-protected, sheltered embayment.

How the various fish were caught, on the basis of their remains, would be no more than totally unsupported speculation. Fishhooks, however, are reported on by O'Reilly on page 123 of this volume.

APPENDIX: FIELD SKELETON PREPARATION

When it was realized that there was a substantial amount and variety of fish remains in the site, the writer, knowing well the difficulties and uncertainties inherent in making bone identifications from the literature, set out to create a comparative collection of fish species. This was done by buying fishes from both the local fishermen and the market at nearby Phanat Nikhom where a good range of commonly eaten marine and freshwater fishes was available. A total of nearly 40 species (sometimes with two or more specimens each) were prepared. Unfortunately elasmobranchs were not to be had. Each specimen was assigned a number, photographed in colour with its number and a scale, then weighed, measured and the details of provenance, date, finray count, scale counts (and any other data to aid identification such as skull proportions) was recorded, along with its local name, in a field log book. Habitat and seasonal availability was also recorded where ascertainable, along with mode of capture.

Several techniques were experimentally employed to prepare the skeletons for use in New Zealand. They all involved removing selected areas of skin with attached scales which were then placed in 4 per cent formaldehyde (to sterilize them to meet Border Protection requirements) for an hour or so, and then air-dried, away from scavengers (which included large cockroaches). When perfectly dry, they were placed in labeled, sealable plastic packets. The fish was then defleshed as far as practicable without damaging or removing fine bones then simmered for a few minutes to the point where the flesh was just soft enough to be easily removed by fingers, probe and firm-bristled brush, but before the flesh begins to harden again. This technique, being time intensive, was soon abandoned, particularly as it was not always very effective with oily fishes such as carrangids and serranids. Even repeated simmering with detergent in many cases failed to remove oil and grease which under tropical conditions invariably goes rancid making the bones objectionable to handle by reason of smell, greasyness and appearance. This can sometimes be remedied in the laboratory by a suitable choice of solvent treatment. Straight cyclohexane in a soxhlet extractor or methanol/chloroform will both give good degreasing results, but neither will work where oils have become polymerized to tarry material.

The second method tried involved defleshing then wrapping the specimen in coarse nylon mesh (to keep the bones together and prevent them from being carried away) and then placing them where they would be found by one or other of the six local ant species known to the author. The specimens were protected from larger scavengers (rats, cats and dogs) by placing them under weighted-down light-gauge sheet iron, or where placed in trees, inside punctured tins. This method

too, took weeks at a time and rarely gave a satisfactory preparation, possibly due to the lack of a suitable ant species. Straight burial of nylon mesh-wrapped, defleshed fish in damp, well-drained soil sometimes worked quite well to give good preparations, but was not reliable for reasons that were not immediately apparent. Time did not permit the isolation of the numerous potential variables, such as fungal, bacterial and protozoan floral and faunal microbiota, the organic and inorganic properties of the various soils tried, or the immediate past history of the soil. The only common feature shown by the successful preparations was a warm soil, well drained and aerated, and constantly moist, either by regular watering (with natural stream water) or by its location.

ANAEROBIC FERMENTATION

The final method which worked quickly and invariably well, was anaerobic aqueous fermentation. The only small drawback with this technique is the odour produced when the samples are opened – a particularly foul, somewhat sickening smell – which can be largely avoided as we shall see. In brief, the specimens are pretreated as limned above, then placed after defleshing in a 1-2 l stout plastic bag, depending on size, large fish may need more than one bag. To each bag is added cold, freshly boiled water (which should contain no dissolved oxygen) sufficient to well cover the specimen. To each bag is then added about a tablespoon of good field or garden soil, not soil from excessively dry, or burnt areas, nor from places where the biological activity of the loam may be suspected to have been injured or impaired. The numbered bags are then closed, every last bubble of air being driven out before they are firmly tied with heavy string or light cord. To protect from scavengers, a warm, sheltered building (such as a disused ricestore) should be chosen, away from human habitation, where the bags can be hung for 4-5 days from the walls and rafters, in semi-darkness. At the end of this time the flesh and connective tissue will be totally mascerated and the skeleton disarticulated. The top of the bag should now be submerged in a bucket of water before being untied. the diluted (and slightly less smelly) 'soup' in the bucket is then strained through a *c.* 250 μm screen to recover the bones which are then rinsed in the sieve several times with clean cold water, or if available, warm water with a little detergent to lift fats, oils and grease. The bones are then air-dried in a safe place, avoiding prolonged direct sunlight until after the bones are thoroughly dry. The sunlight helps with bleaching and deodorizing the specimens before packing. The beauty of this last technique is that it is quick, simple and requires virtually no reagents or equipment not routinely available in the field, yet gives quite acceptable specimens for laboratory or field use.

An especial effort should be made to make sure that both the large (sagittae) otoliths are recovered either from the sieve or the otic cavities on each side of the skull. They should be processed, labeled and bagged separately in the field. Never wait until one is back in the laboratory to discover that they are lost. It is rarely possible to recover the astericus and lapillus due to their small size. They are almost never recovered from archaeological sites, so little is lost. Where one is dealing with species with highly modified or otherwise unusual skull morphology (freshwater catfish may be mentioned), the author has found it useful to deflesh a second specimen of the species as far as possible, leaving all the bones in position of articulation. The frame is then steeped in 70 per cent alcohol (either isopropanol or ethanol) for a day or so, then air dried. The fully articulated skull, particularly, will be found to be invaluable then it comes to identifying individual cranial elements back in the laboratory. To be able to see the anatomical relationships of the bones greatly eases, or in some cases, only makes possible ascription to anatomical part.

Where possible, more than one specimen of a species was prepared, particularly where it was known that the mature form of the sexes were significantly different and also where the adults and juveniles differed substantially in their anatomical proportions. A further reason for preparing more than a single example of a species, is that Thailand is now known to have over 600 freshwater fish species: Smith (1945) listed some 560, many of them closely related, so that an adequate range of material is available to separate them.

APPENDIX TO SECTION III

D.J.W. O'Reilly

THIS appendix describes the artefacts recovered from the phase 1 occupation deposits at Nong Nor, and records graphically the distribution of various categories of the ceramic sample. Abbreviations used are La: layer, u: unit, L: Length, W: Width, D: Depth and Mu: Munsell designation. Bd. Distal breadth. All measurements are in centimetres.

Grindstones and Whetstones

1.Cat.1236, A6, u16-17, La. 2A:2. L: 4.2 W: 4.1 D: 3.9. This sandstone artefact had three deep grooves present on one facet. The other sides of the object showed no evidence for utilisation. Mu. 2.5 Y 8/3 Pale Yellow.

2. Cat. 1027, A8, u14, La. 2. L: 5.5 W: 3.7 D: 1.3. Sandstone fragment with one face smoothed flat, no evidence of grooving. Mu. 2.5 Y 8/3 Pale Yellow.

3. Cat. 1239, A1, u30, La. 2:1. L:3.7 W: 2.6 D:1.5. Sandstone fragment flattened on one facet. Mu. 7.5 YR 8/1 Light Grey.

4. Cat. 1237, A6, u16-17, La. 2A:2. L: 3.5 W: 3.4 D: 1.4. A sandstone fragment which has a concave smoothed face. Mu. 5 YR 8/2 Pale Orange.

5. Cat. 919, A7, u3, La. 2.1. L: 6.4 W: 6.0 D: 1.6. A ferruginous sandstone abrader probably a whetstone. Flattened only on one side. Mu. 5 YR 5/2

6. Cat. 1206, A8, u38-39, La. 2/3. L: 2.5 W: 2.2 D: 1.1. A small sandstone grindstone flattened on two sides. One side has five linear scars where a sharp implement has been dragged across it. The other side has less pronounced linear scarring. Mu. 5 YR 6/3 Dull Orange.

7. Cat. 1213, A8, u38-39, La. 2/3. L: 3.4 W: 2.4 D: 0.8. A laterite fragment which appears to have been used as an abrader. There is a sharp groove running along the length of the stone and a flattening in conjunction with this groove. Mu. 2.5 YR 6/3 Dull Orange.

8. Cat. 1207, A4, u23, La. 2:1. L: 3.5 - 2.9 W: 2.5 - 2.4 D:1.6. Two fragments of ferruginous sandstone. The smoothed sides of these are concave indicating that an object was dragged across the surface of the artefact at an angle repeatedly. Mu. 7.5 YR 4/3 Dull Reddish Brown.

9. Cat. 1222, A6, u15, La. 2:6. L: 5.3 W: 3.6 D: 1.8. This sandstone fragment has been abraded on one of its sides. There is also evidence of linear scarring. Mu. 2.5 YR 8/2 Light Grey.

10. Cat. 1227, A6, u14, La. 2:3. L: 5.0 W: 3.6 D:1.1. Sandstone fragments, one of which has a marked concave groove on one side and a flat surface on the other. The other fragment has one utilised surface which is flat. Mu. 2.5 YR 8/2 Light Grey.
11. Cat. 1208, A6, u16-17, La. 2A:4. L: 5.1 W: 2.9 D: 1.4. This sandstone fragment has a very narrow flattened area and there are no use wear markings other than this. Mu. 2.5 YR 8/2 Light Grey.
12. Cat. 896, A5, u17-18, La. 2A:1. L: 6.7 W: 4.2 D:1.1. Sandstone fragment flattened on one side due to abrading. Mu. N 6/0 Grey.
13. Cat. 221, A XI, u ?, La. 2. L:2.4 W: 2.0 D:1.1. This small piece of sandstone has been extensively utilised, having evidence of abrasion on four surfaces. One surface is grooved and the others are flat. Mu. 7.5 YR 8/3 Light Yellow Orange.
14. Cat. 1215, A6, u15, La. 2:5. L: 5.3, 4.1, 2.3 W: 3.9, 3.9, 1.5 D:1.3, 1.3, 0.7. Three sandstone fragments, two of which have definite evidence of abrasion and are clearly from the same artefact. Mu. 10 YR 8/1 Light Grey.
15. Cat. 934, A12, u31, La. 2:1. L:11.3 W: 6.4 D:4.9. This is a relatively large sandstone fragment flattened on four surfaces. There are no striations visible on these surfaces. Mu. 2.5 YR 8/1 Light Grey.
16. Cat. 1223, A 5, u19, La. 2:2. L4.7 W: 2.9 D: 2.1. A very slight concave surface was apparent on this sandstone fragment. Mu. 2.5 Y 8/2 Light Grey.
17. Cat. 1219, A6, u16-17, La. 2:3. L: 4.5 W: 2.8 D: 0.9. Ferruginous sandstone with one side flattened. Mu. 10 YR 5/3 Reddish Brown.
18. Cat. 1218, A8, u38-39, La. 2:4. L: 4.8 W: 3.1 D: 1.6. This sandstone fragment has been smoothed on one side and has a slightly concave shape indicating the abrader was used at an angle. Mu. 10 YR 6/2 Greyish Red.
19. Cat. 1225, A14, u40-41, La. 2/3. L: 6.3 W: 6.0 D: 2.5. This friable sandstone fragment is smoothed on one side and exhibits a broad groove. This may be classified as a whetstone, type A. Mu. 2.5 YR 8/4 Pale Yellow.
20. Cat. 1069, A8 u38-39, La. 2:2. L: 6.3 W: 3.9 D:1.5. Sandstone fragment, flattened on three sides. This artefact may be classified as a whetstone. Microscopic examination was obviated due to the presence of concretions on the worked surface. Mu. 2.5 Y 8/3 Pale Yellow.
21. Cat. 1224, A14, u40-41, La. 2:2. L: 5.0 W: 4.0 D: 1.6. Ferruginous sandstone with a small concave grooved surface. The rest of this irregularly shaped fragment demonstrates no evidence of use. Mu. 7.5 R 4/4 Dusky Red.
22. Cat. 1057, A14, u40-41, La. 2:1. L: 5.4 W: 4.3 D: 1.3. This whetstone is made of sandstone and is smoothed on four of its six sides. No grooves are evident and the surfaces are perfectly flat. Mu. 7.5 Y 8/2 Light Grey.
23. Cat. 1210, A6, u15, La. 2:4. L: 4.7 W: 3.3 D: 1.1. This sandstone fragment is related to cat. 1215. It has been smoothed flat on one side, the other surfaces are all irregular. Mu. 10 YR 8/1 Light Grey.

24. Cat. 1209, A5, u21, La. 2A:1. L: 4.1 W: 2.8 D: 0.8. Sandstone fragment, smoothed on one face, with a very slight concave shape. There are no marks visible on the flattened surface. Mu. 7.5 YR 8/1 Light Grey.

25. Cat. 1220, A4, u23, La. 2:1. L: 3.8 W: 2.7 D: 1.2. Sandstone fragment with some possible evidence for smoothing on one surface. Mu. 7.5 YR 8/1 Light Grey.

26. Cat. 1216, A3, u80, La. 2:4. L: 3.4, 4.5 W: 2.6, 2.5 D: 1.4, 1.8. Two sandstone fragments, only one of which shows definite signs of use on one face. Mu. 7.5 YR 8/1 Light Grey

27. Cat. 430, A3, u16, La. 2:2. L: 3.4 .W: 1.5. D: 1.4. Sandstone fragment with flattening on one facet. Mu. 7.5 YR 8/1 Light Grey

28. Cat. 646, A3, u33, La. 2:2. L: 9.1 W: 7.3 D: 4.9. This large fragment of sandstone is flattened on one face. No grooves are apparent. There is some Quartz present in the matrix. Mu. 5Y 8/1 Light Grey

29. Cat. 403, A3, u1, La. 2:3. L: 3.6 W: 2.7 D: 1.7. Sandstone abraded on three surfaces. One is concave, the others are flat. There is no evidence of use wear other than this smoothing. Mu. 10YR 7/2 Dull Yellow Orange.

30. Cat. 490, A3, u40, La. 2:2. L: 4.6 W: 2.5 D: 2.0. This whetstone fragment is made of sandstone. There is a slight degree of curvature on the two utilised facets which are on opposite sides of the artefact. Mu. 5YR 7/2 Light Grey.

31. Cat. 428, A3, u16, La. 2:2. L: 5.2 W: 4.5 D: 1.8. This whetstone fragment is rounded at one end, the other has been broken off. The utilised surface, of which there is only one, has a very slight curvature. The artefact is made of sandstone. Mu. 5YR 5/2 Greyish Brown.

32. Cat. 1062, A8, u36-39, La. 2. L: 7.1. 4.7 W: 4.4, 4.0. D: 3.7, 3.1. Two friable sandstone fragments. There are two smoothed faces on the larger fragment, with no evidence of curvature. The smaller fragment has four smoothed faces, being hexagonal in cross section. Mu. 7.5 YR 8/1 Light Grey.

33. Cat. 1039, A6, u13-16, La. 2/3. L: 5.5 W: 4.4 D: 3.9. A sandstone fragment utilised on two sides. One face demonstrates significant curvature. The other face is flat and has a linear groove on it. Mu. 7.5 YR 8/1 Light Grey.

34. Cat. 819, A7, u9, La. 2:3. L: 6.6 W: 4.6 D: 3.1. A hard sandstone fragment which is smooth on all sides. The one utilised side has been worn flat. This fragment joins another, Cat. 818. Mu. 7.5 YR 8/1 Light Grey.

35. Cat. 1013, A8, u36-37, La. 2/3. L: 3.7 W: 3.2 D: 2.1. This sandstone fragment has evidence on two sides of utilisation. One surface has a noticeable curvature, while its opposite face is worn flat. Mu. 10 YR 7/3 Dull Yellow Orange.

36. Cat. 811, A7, u4, La. 2:2. L: 4.7 W: 4.0 D: 2.4. This ferruginous sandstone fragment has a marked curvature on its utilised surface. There were no use wear marks evident. Mu. 10R 4/4 Reddish Brown.

37. Cat. 608, A3, u21, La. 2:2. L: 5.4 W: 4.7 D: 2.5. This sandstone artefact has been well used, five of the seven sides have been worn flat. There is no noticeable curvature on any of these

surfaces. Mu. 7.5 YR 8/1 Light Grey.

38. Cat. 1205, A8, u38-39, La. 2/3. L: 5.5 W: 3.8 D: 2.0. A sandstone fragment with a marked concave shape on the one worked surface indicating that it was a grindstone. Mu. 10YR 7/4 dull Yellow Orange.

39. Cat. 1228, A4, u25, La. 2:1. L: 7.5 W: 4.1 D: 2.4. This sandstone fragment is worked on three surfaces. One is concave and the others are smoothed flat. It appears to be part of a whetstone, type A. Mu. 7.5 YR 8/1 Light Grey.

40. Cat. 959, A4, u22-25, La. 2/3. L: 8.9 W: 6.8 D: 6.4. A large sandstone fragment which has a smoothed concave surface on one facet indicating its use as a grindstone. Mu. 7.5 YR 8/2 Light Grey.

41. Cat. 961, A4, u35, La. 2A/3. L: 4.8 W: 2.1 D: 1.7. This is a conical sandstone artefact which appears to have been shaped by abrasion. The fact that it is smoothed into a point indicates that it may have been used in smoothing hollowed objects. It has been broken at one end. Mu. 7.5 YR 8/1 Light Grey.

42. Cat. 1250, A3, u14, La. 2:3. L: 2 W: 2.5 D: 2.6. A sandstone fragment with a concave smoothed surface indicating its use as a grindstone. Mu. 7.5 YR 8/1 Light Grey.

43. Cat. 1204, A8, u36-39, La. 2/3. L: 5.8 W: 5.0 D: 1.9. This sandstone fragment has been utilised on one side, creating a broadly concave smoothed surface. This artefact may be classified as a grindstone. Mu. 2.5Y 8/3 Pale Yellow.

44. Cat. 1212, A5, u20-21, La. 2A:2. L: 3.2 .W: 3.1. D: 1.1. One facet of this sandstone fragment is flat but it is difficult to say whether this is due to utilisation. Based on the size and shape it may have been used as a whetstone. Mu. 2.5 Y 7/8 Yellow.

45. Cat. 1211, A6, u16-17, La. 2A:4. L: 3.2 W: 3.1 D: 1.1. There is one smoothed face on this sandstone fragment. A crest runs down the middle of the facet separating two utilised surfaces on the same side. These are concave hollows which indicate that it may have been used as a grindstone. Mu. 2.5 Y 8/2 Light Grey.

46. Cat. 1238, A6, u13, La. 2:2. L: 2.6 W: 2.4 D: 1.3. A sandstone fragment with evidence of smoothing on one facet. No definite grooves or other use wear marks are apparent. Mu. 2.5 YR 7/2 Light Reddish Grey.

47. Cat. 1198, A3, u81, La. 2:1. L: 7.7 W: 5.9 D: 2.2. A sandstone fragment worked on two sides, one with a concave groove. The other side is smoothed flat. The shape of this artefact would indicate that it was used as a grindstone. Mu. 7.5 YR 8/1 Light Grey.

48. Cat. 1229, A8, u36-39, La. 2. L: 4.4 W: 2.7 D: 1.7. This sandstone fragment is smoothed flat on one face and concave on the other suggesting its use as a grindstone. Mu. 2.5 Y 8/3 Pale Yellow.

49. Cat. 720, A3, u76, La. 2c. L: 7.4 W: 5.3 D: 3.4. This artefact is made of sandstone and has seven faces which have been utilised, all smoothed flat by abrading. Mu. 2.5 YR 7/2 Light Reddish Brown.

50. Cat. 820, A7, u9, La. 2:3. L: 5.0 W: 4.8 D: 4.1. Possibly acidic volcanic rock which has evidence of use wear on one surface. This area has ben smoothed flat. The cortex is preserved on three of the six faces. Mu. 7.5 YR 7/2 Light Brownish Grey.

51. Cat. 968, A7, u8, La. 2/3. L: 6.2 W: 3.4 D: 2.7. This is a very fine sandstone abrader with evidence of wear on two sides. It is difficult to determine what the original use of the artefact was however. Mu. 7.5 YR 8/1 Light Grey.

52. Cat. 549, A3, u69, La. 2:3. L: 8.7 W: 6.1 D: 1.7. A sandstone grinder with evidence of use on two faces. One side has three concave smoothed hollows. The other side is characterised by two concave hollows separated by a ridge. This artefact has a definite association with cat. 246. Mu. 7.5 YR 5/3 Dull Reddish Brown.

53. Cat. 1251, A6, u15, La. 2:1. L: 5.6 W: 4.5 D: 1.6. A sandstone grinder worked on one face. A deep concave bowl shape is apparent. Mu. 5Y 8/2 Light Grey.

54. Cat. 2, NWQS sf 2. L: 7.5 W: 4.1 D: 1.fl9. This whetstone has been worked on two faces. It is made of sandstone and is of type B. One face has a smooth surface and a step, the other has a deep linear V-shape groove. Mu. 2.5 Y 8/4 Pale Yellow.

55. Cat. 818, A7, u9, La. 2:3. L: 11.0 W: 4.1 D: 3.4. A sandstone artefact, smoothed on one side, probably a whetstone, although no grooving is apparent. The worked surface is flat. Mu. 7.5 Y8/1 Light Grey.

56. Cat. 1252, A3, u16, La. 2:1. L: 5.9 W: 3.7 D: 1.4. There is evidence of use on one face of this sandstone fragment. This area is smoothed into a concave shape suggesting that the stone was used as a grinder. Mu. 7.5 R 5/3 Dull Reddish Brown.

57. Cat. 1253, A5, u18, La. 2:1. L: 11.2 W: 8.4 D: 2.3. This artefact may be classified as a grindstone. It demonstrates smoothing on either side of a ridge on one face. The worked areas are deep and concave. The other facets are unfinished. There is an interesting notch on one side, which appears to have been used in the sharpening of a small rounded implement. Mu. 5Y 8/2 Light Grey.

Miscellaneous Sandstone Fragments

58. Cat.1036, A6, u15, La. 2:6. 59. Cat. 1235, A8/14, La. 2. 60. Cat. 1230, A8/14 L2.

61. Cat. 1231, A8/14, La. 2. 62. Cat. 1233, A8/14, La. 2. 63. Cat. 1234, A8/14, La. 2.

64. Cat. 1254, A5, u20, La. 2:3. 65. Cat. 1255, A14, u40-41, La. 2:4. 66. Cat. 1270, A4, u23, La. 2/3.

Flaked Stone

1. Cat. 962, A7 u11 surface of 3. This flake demonstrates a polished cortex on one facet. A smaller flake has been removed from it, indicating the initial blow from the hammer stone. There is some evidence of secondary use as well as some possible retouch.

2. Cat. 1075, A8 u36-37 La 2/3. There is evidence of a polished surface on this flake as well. It is of irregular shape with no clear bulb of percussion.

3. Cat. 914, A4 u25 La 2:2. This tiny flake has evidence of polishing on two facets. It may come from the corner of an adze or similar tool.

4. Cat. 676, A3 u79 La 2:4. Polished on one face this flake has a slight ridge running down its centre.

5. Cat. 1026, A4 u34 surface of natural. Polished flake with a pronounced bulb of percussion.

6. Cat. 1197, A1 u C La 2:1. This flake has two polished faces and may come from the cutting edge of a polished adze. There is some evidence of secondary use on this flake.

7. Cat. 1256 A1 u C L 2:1. Polished flake, very thin. There is no clear bulb of percussion.

8. Cat. 949, A7/9 baulk 2/3. A polished flake of volcanogenic metasediment. This artefact fits on the poll of an adze found in the baulk of A8/14 (cat.1024), which is described below.

9. Cat. 1257 A8 u? L 2A. This flake is clearly from the side of a polished adze. It is made from a volcanogenic metasediment. Unfortunately it does not fit any of the adzes recovered.

10. Cat. 1266 A6 u16-17 L 2A:1. There is one polished facet on this flake. No sign of secondary use.

The other flakes recovered from Nong Nor were made of quartz;

11. Cat. 927, A4 u24 L 2A:2. A very thin flake of red quartz with no evidence of a cortex.

12. Cat. 877, A4 u23 2:1. This is a flake of white quartz which was clearly struck from a core, one side has the remains of a cortex. There is no use wear.

13. Cat. 1038, A6 u15 L 2:6. Another piece of white quartz which has been struck from a core. There is no use wear.

Burnishing stones

1. Cat. 114, A X1, La 2:1. Quartz. L: 3.2 W: 2.1 B: 2.15. Two well worn surfaces with parallel and unidirectional striations are visible on both surfaces.

2. Cat. 218, A X1, La 2:2. Quartzite. A fragmentary stone, on which two wear surfaces are apparent. These form a sharp edge. There are unidirectional striations visible on the sides and the tip is well polished.

3. Cat. 298, A X1, La 2:2. Quartz. L: 3.6 W: 3.2 B: 1.6. One polished facet with very faint unidirectional striations.

4. Cat. 409, A 3, u 86, La 2:2. Quartz. L: 4.6 W: 4.5 B: 2.4. There are two worn surfaces present on which there are parallel and unidirectional striations.

5. Cat. 420, A 3, u 71, La. 2:2. Material: Quartz. L: 4.0 W: 2.95 B: 2.15. The tip of this pebble has been worn and is highly polished with parallel striations.

6. Cat. 591, A 3, u55, La. 2:4. Material: Quartz. L: 5.3. W: 3.05. B: 1.4.5. There are two flat surfaces on this stone, upper and lower, connected by four smaller rectangular surfaces. Parallel striations cover the stone entirely. The smallest surface demonstrates the most wear.

7. Cat. 829, A 7, u1, La. 2:2. Material: Quartzite. L: 3.65 W: 22 B 1.15. The surface of this ar-

tefact is damaged. The tip has similar wear patterns to that of the other pebbles but there are no firm striations.

8. Cat. 854, A 5, u21, La. 2:3. Material: Quartz. L: 4.2 W: 3.8 B: 1.8. There is one flattened facet on this pebble. The existence of striations is not clear.

9. Cat. 874, A 5, u17, La. 2:3. Material: Quartz. L: na W: na B: na. This is a fragmented stone with a worn surface. Numerous parallel striations cover most of the surface.

10. Cat. 883, A 8, La. 2/3. Material: Quartz. L: 5.9 W: 3.75 B: 2.95. There is a clearly worn surface on this stone, with other less obvious wear areas present. There are no clear striations.

11. Cat. 884, A 8, La. 2/3. Material: Quartz. L: 4.45 W 2.7 B: 1.6. Two worn surfaces are visible on this pebble, both are polish facets with parallel striation.

12. Cat. 885, A 8, La. 2/3. Material: Quartz. L: 4.7 W: 3.25 B: 3.0. There is one worn surface on this stone with faint unidirectional striations apparent.

13. Cat. 888, A 9, La. 2:1. Material: Quartz. L: 4.3 W: 3.8 B 1.5. There is one flattened surface due to use on this pebble.

14. Cat. 916, A8, La. 2/3. Material: Quartz. L: 3.7 W: 2.9 B: 2.0. Use wear has created a flat facet on this stone. There are parallel striations apparent.

15. Cat.929, A 9/7, La. 2. Material: Quartz. L: 3.2 W: 2.55 B: 1.5. One smoothed surface is apparent with faint striations.

16. Cat. 1015, A 9/10, La. 2. Material: Quartzose chloride schist. L: 6.3, W: 2.7, B: 1.8. One surface has been abraded and has flattened the tip of this artefact.

17. Cat. 1047, A14, La. 2. Material: Quartz. L: 3.65, W: 2, B:1.65. One worn face with parallel striations apparent.

18. Cat. 1066, A 6, u14, La. 2:4. Material: Quartzite. L: 4.2 W: 3.0 B: 1.8. This pebble is well worn. Several surfaces have been flattened through abrasion.

19. Cat. 1076 ,A13, u28, La. 2:2. Material: Quartz. L: 3.7 W: 2.5 B: 2.15. Five surfaces on this stone show extensive wear giving the stone a cubed shape. There are a few parallel striations on each surface.

Bone Artefacts

1. Cat. 1195, A1, La. 2:1. Two pieces of unidentified bone. Both are definitely sawn at one end and broken at the other. They may be fishhook tabs.

2. Cat. 589, A3, u35, La. 2:7. Unidentified bone sawn on both ends.

3. Cat. 1120, A4, u22, La. 2A:1. The distal end of a radius from a large cervid, Bd, 5.0. The long bone has been removed by sawing all around the outside of the bone. The distance from the styloid process to the cut is 4.5.

4. Cat. 1127, A3, u56, La. 2. Unidentified bone fragment which has been sawn on all sides. It is most likely a fishhook tab.

5. Cat. 403, A3, u, La 2:1. A deer antler, sawn at both ends and split in half. The artefact is 4.1 x 1.3.

6. Cat. 1123, A3, u69, La. 2:2. The distal end of a metacarpal of *Bubalus bubalis*, Bd, 8.88. The specimen is sawn on one surface.

7. Cat. 1136, A3, u La. 2:1. The proximal end of an unfused tibia. The bone is from a sub adult of a species of large deer. It has been sawn at the distal end.

8. Cat. 1153, A3, u76, La. 2c. The distal end of the metacarpal from *Cervus unicolor*. Bd, 4.6. The artefact has been sawn at one end.

9. Cat. 1178, A3, u 61, La. 2A:1. The distal end of a tibia from *Cervus unicolor* Bd, 5.3, sawn at the proximal end.

10. Cat. 693, A3, u63, La. 2c. The proximal end of the metacarpal from *Bubalus bubalis*. There are saw marks on the distal end.

11. Cat.1139, A3, u23, La. 2:8. Unidentified worked bone, sawn on one end. This artefact is very poorly preserved.

12. Cat. 1156, A3, u70, La. 2:2. Unidentified bone with no concrete signs of modification.

13. Cat. 1158, A3, u84, La. 2:2. Two pieces of unidentified bone. Both have been sawn at either end. There is also evidence of burning.

14. Cat. 1248, A3, u63, La. 2:1. Two pieces of unidentified bone, both of which are worked. One is sawn at the end. The other is a point with a groove down one side. Both artefacts appear to have been burned.

15. Cat. 1141, A3, u61, La. 2:2. Unidentified bone which has been sawn at one end. The other end is splintered.

16. Cat. 1137, A3, u76, La. 2:2. Unidentified worked bone, sawn at one end. The other end appears to have been snapped.

17. Cat. 1258, A3, u20, La. 2d. Unidentified bone artefact which has been sawn at one end. The other is broken.

18. Cat. 1124, A3, u27, La. 2:2. An unidentified bone artefact with patination on the surface. The bone has a longitudinal groove down one side, crosscut by a diagonal groove with a noticeable polish. It is possibly an awl fragment.

19. Cat. 895, A4, u22, La. 2A:1. The distal end of a humerus from a large cervid, Bd 5.8. The distance from the trochlea to the cut which goes around the entire exterior is just 5.0.

20. Cat. 1077, A4, u23, La. 2:2. Unidentified bone, which has been sawn at opposite ends and along one side, leaving a square artefact measuring 2.3 x 1.9. It may have been a fishhook tab.

21. Cat. 1179, A4, u23, La. 2A:2. An unidentified bone badly exfoliated, sawn at one end.

22. Cat. 1129, A4, u23, La. 2:2. An unidentified bone with an abraded groove along one side. There is no other evidence of manipulation.

23. Cat. 1120, A4, u22, La. 2A:1. An unidentified bone from which the cortical bone has been removed and the interior surface polished. The bone appears to be formed to a point, to which there is a curvature. It is of indeterminate use.

24. Cat. 1131, A4, u22, La. 2A:1. Unidentified bone, the cortical bone has been removed and the remaining surface polished, as above. There is an abraded groove down one side.

25. Cat. 1134, A5, u17-18, La. 2A:1. Proximal end of a cervid femur. This bone has been sawn, the distance between the head and the cut mark is 8.3. The saw marks are angled and extend around the entire exterior surface.

26. Cat. 1146, A5, u 21, La. 2:2. Two fragments from the proximal end of a bovid radius. The W equals the dimensions for a wild female gaur, 8.65 (American Museum of Natural History 1847 21.15.2) and 8.77 for a wild female banteng (AMNH 1846 12.15.17). There is evidence on both the specimens of having been sawn. One has horizontal cut marks where the head was removed from the long bone. The other bears evidence of vertical sawing.

27. Cat. 803, A5, u 20, La. 2:1. The distal end of a tibia from a large cervid Bd, 5.02. The long bone has been removed, leaving just the head where there is evidence of sawing.

28. Cat. 1151, A5, u17-18, La. 2A:1. The distal end of a femur, possibly *Cervus unicolor*. Due to the presence of concretions it is impossible to determine whether it has been sawn.

29. Cat. 1135, A5, u17-18, La. 2A:1. The distal end of the metatarsal from a bovid, Bd, 5.77. There is some evidence for sawing, but the majority of the surface where this occurs appears to have been snapped off.

30. Cat. 1171, A5, u20-21, La. 2A:1. The proximal end of the femur from a *Cervus unicolor*. The W of the caput femoris is 3.85.

31. Cat. 831, A5, u21, La. 2:1. Unidentified bone from which the cortical bone has been removed. There is evidence of sawing on one end and several parallel cut marks on the side of the bone.

32. Cat. 1165, A5, u21, La. 2:1. An unidentified bone, the artefact has been sawn at one end.

33. Cat. 832, A5, u 21, La. 2:1. Unidentified bone, cut along one end straight and cut in a curve at the other end. This may be the debitage from the manufacture of a fishhook.

34. Cat. 881, A5, u20, La. 2:3. Unidentified bone, this artefact has been abraded on three sides.

35. Cat. 1126, A5, u21, La. 2:1. Unidentified bone, worked extensively, it appears to have been drilled in two places and abraded on all of its surfaces. Possibly debitage from tool manufacture.

36. Cat. 1152, A5, u21, La. 2A:1. Unidentified bone fragment. There is evidence of sawing on one end as well as traces of abrasion on other surfaces.

37. Cat. 1145, A5, u21, La. 2A:3. The distal end of the radius from an adult deer, Bd, 4.9. There is evidence of sawing on the proximal aspect.

38. Cat. 1149, A5, u17-18, La. 2A:1. Distal end of a femur from a medium sized cervid, Bd, 5.0.

There is evidence of sawing on the proximal aspect all around the outside of the bone.

39. Cat. 1125, A5, u20, La. 2:2. The proximal end of a cervid radius, Bd, 6.05. There is evidence of sawing on the distal aspect all around the outside of the long bone.

40. Cat. 1150, A5, u17-18, La. 2A:1. Unidentified bone with evidence of sawing on each end. The cortical bone has been removed.

41. Cat. 1147, A5, u21, La. 2:2. Unidentified bone, with strong indications of having been sawn on one end, the striations still being visible to the naked eye.

42. Cat. 1181, A6, u16-17, La. 2A:1. The proximal end of a metatarsal from a large cervid, Bd, 4.25. The artefact has been removed from the long bone by sawing, and discarded as there is no other evidence of working.

43. Cat. 1123, A6, u15, La. 2:1. Two unidentified bone artefacts. One is covered with concretions and has been sawn at one end. It measures 5.5 x 2.0.The other artefact is smooth, sawn at one end and measures 2.4 x 2.0. They represent possible debitage from tool manufacture.

44. Cat. 1164, A6, u15, La 2:6. Unidentified bone, sawn at one end. There is also an abraded groove up one side. It measures 1.6 x 5.0.

45. Cat. 1144, A6, u16-17, La. 2:2. Unidentified bone, sawn at one end.

46. Cat. 1159, A6, u15, La. 2:2. Unidentified bone, sawn at one end.

47. Cat. 1143, A6, u16-17, La. 2:2. Unidentified bone, sawn at one end and snapped off at the other. There is an abraded notch on one side.

48. Cat. 1174, A6, u15, La. 2:5. Unidentified bone, sawn at both ends. There is a deep notch on one side near the end of the artefact, with abrading continuing up the side.

49. Cat. 1175, A6, u16-17, La. 2:3. Six fragments of bone and one bone artefact, found in association. The worked bone is sawn at one end.

50. Cat. 1080, A6, u16-17, La 2A:1. Unidentified bone. This artefact has a peculiar shape. It is curved and there is patination on either end. Unfortunately it is badly concreted. Its use is indeterminate.

51. Cat. 1110, A6, u16-17, La. 2A:1. Unidentified bone, sawn at one end with evidence of abrading in two other areas. It may have been broken during the manufacture of a fishhook.

52. Cat. 1138, A6, u13, La. 2/3. The distal end of a tibia from a *Cervus unicolor*, Bd, 4.5. The bone has been sawn all around. The distance from the medial malleolus to where it was sawn is 2.6.

53. Cat. 1155, A12, u29-30, La. 2:2.The distal end of a tibia from a *Cervus unicolor*, Bd, 4.8. The distance from the medial malleolus to where it was sawn is 5.5.

54. Cat. 1154, XI, La. 2:2. Unidentified bone which is heavily concreted but there are abrasion marks visible along two sides.

55. Cat. 1162, A12, La. 2. section cleaning. Unidentified bone with abrasions along one surface. It is sawn at both ends and may be a fishhook tab.

56. Cat. 1157, A3, u18, La. 2:1. An unidentified bone, abraded on one surface and sawn at one end. Probably a fishhook tab.

57. Cat. 1056, A14, u40-41, La. 2. The distal end of a tibia from a *Cervus unicolor*, Bd, 5.55. The long bone has been removed by sawing. The distance from the medial malleolus to the cut is 4.4.

58. Cat. 1058, A14, u40-41, La. 2:1. The proximal end of the metacarpal from a *Bubalus bubalis*. The proximal anterior-posterior W is 4.5. There is evidence of sawing where the specimen was removed from the longer bone.

59. Cat. 1052, A14, u40-41, La. 2:1. Unidentified bone. The cortical bone has been removed. There is evidence of abrasion on one exterior surface as well as sawing at one end.

60. Cat. 1176, A8/14, La. 2. Unidentified bone, with evidence of sawing on one end. The artefact is badly exfoliated obscuring evidence of other working.

61. Cat. 1029, A8/14, La. 2. Three pieces of unidentified bone. Only one has definite evidence of sawing on one end. These bones have been subjected to high temperatures.

SECTION FOUR

THE BRONZE AGE CEMETERY

INTRODUCTION

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THE excavation of Nong Nor resulted in the exposure of part of a bronze age cemetery. The burials were interred with a range of grave goods, and most were orientated so that the head pointed in an easterly direction. Pottery vessels predominated among the grave offerings, but as in other Bronze Age cemeteries, there was a range of other items, including bangles of shell, bronze, serpentine, marble and talc, beads including a handful fashioned from carnelian, animal remains, predominantly dog skulls, copper socketed implements and tin ornaments. The tin bangles and earrings are, as far as we know, unique in Thai contexts, although examples are known from late prehistoric cemeteries such as Wanjiaba in Yunnan (Wang Dadao 1985). This section will begin with a description of the pottery vessels found in mortuary contexts, by J. Debreceny. The vessel forms and manner of decoration are quite distinct from the wares recovered from Khok Phanom Di (Hall 1993). At the earlier site, most of the mortuary pottery was burnished and bore incised designs. The vessels from Nong Nor were more often red slipped, and were made of a clay richly tempered with rice chaff. The petrographic analysis of the sample has yet to be undertaken because it is beyond the skills of those contributing to this project.

In the following chapter, N. Chang will present the typology of the ornaments. This sample represents one of, possibly the largest provenanced assemblage of such ornaments from Thailand, and it has been possible to quantify the preferred styles, forms and materials employed. We will find that most were made of shell, probably from marine species, bronze and marble. More exotic stone, in the form of jade, serpentine, talc and carnelian were also used, and these items concentrated in the eastern part of the cemetery. There will follow a chapter describing the animal bones from mortuary contexts, among which the domestic dog predominated. Dogs were rare in all layers at Khok Phanom Di, but were abundant at phase 2 Nong Nor.

The human remains will then be described by N. Tayles, K. Domett and V. Hunt. In chapter *, each burial will be described, where appropriate illustrated, and the associated grave goods catalogued. This is a necessary prerequisite to a consideration of the statistical analyses which were applied to the complete burials. These suggest that there was no segregation between individuals or groups on the basis of mortuary wealth and, by inference, rank. Nevertheless, older males tended

to be endowed with more grave goods than any other group within the cemetery. This lack of a hierarchy is matched at other bronze age sites, with the possible exception of Ban Na Di. While exotic grave goods always recovered from the known mortuary assemblages, extremes of mortuary wealth as found in the Iron Age are missing.

XV. THE CERAMIC ASSEMBLAGE FROM PHASE 2

J. Debreceny

THIS chapter will describe the ceramic assemblage from phase 2, the Bronze Age cemetery, concentrating on vessel form and surface treatment. Debates on classification and typology are first considered to assist understanding the issues involved. The scheme used to classify the forms is then presented, and each form described. The methods of decoration are outlined, and their frequency in the assemblage summarised. The relationship between form and function is considered, and the occurrence of rice in vessel fabrics noted.

CLASSIFICATION AND TYPOLOGY

The classification and typology of ceramic vessels has attracted an extensive and continuing debate. This has occurred at both philosophical and practical levels. Under the former, consideration has been given to definitions of type, while the latter has considered which criteria should be used to assign vessels to types. The classification of the vessels from Nong Nor will be considered within the framework of these two aspects.

The formation of classifications and typologies is essential for the understanding, manipulation and analysis of ceramic assemblages. This requires an understanding of the theoretical and methodological groundings of the schemes we create. Debate on the question of typology has tended to revolve round what make up attributes, classes and types, and at what levels of analysis or description an artefact becomes a type. The basis of typologies often differs from site to site. These debates have been made more important by the tendency of archaeologists to use cultural - historical approaches, thus seeking similarities between types and relating these to cultural contact and movements of people.

In part, Vincent's work (1988, 1989) has been a reaction to this lack of theoretical clarity and the tendency to rely on style-orientated typologies. He has obviously been influenced by the theoretical bases of New Archaeology, and has sought clear definitions of typologies and the integration of technological information into such schemes. Undoubtably, clear classificatory and typological schemes are necessary. Vincent (1988) has suggested that ceramic types are best defined on the basis of the formula type equals style (form plus surface treatment) and fabric. He cites this practice as being widely used by European ceramicists. This approach gives fabric an important place in typological systems, and is particularly useful in the identification of production centres and technological variation. If we were to apply this formula to the Nong Nor assemblage, we would be unable to define 'types', as the fabric of the vessels is not taken into account, other than superficially.

There is, however, a danger in requiring that types be formulated on the basis of style and fabric in all circumstances and contexts. Typologies are formed by researchers to suit their questions, practical problems, and theoretical orientations. Fabric is important for us because it is the most secure way of determining the place of manufacture (or at least the place of origin of the clay). For others, it is less important. In the study of historic European ceramics for example, makers' marks serve the same purpose, and fabric is relatively unimportant, vessels being divided into stoneware, earthenware and porcelain for other reasons.

Typology is a process of categorisation, which involves several factors. A typology is only one reflection of reality. Categories used to describe forms will only reflect reality, rather than being a match with a perfect 'type' that exists apart from culture, context and research questions. What we, researching particular problems, recognise as important categories may not match what was important to the people who made the vessels. This is especially true as the process of categorisation is context based, and people may define the same artefact in different ways under different circumstances.

Equally, they may define clearly different forms of artefact as the same when used for the same function. A common assumption in ceramic analysis is that there is a relationship between vessel form and function (MacDonald 1980). The presumed correlation between form and function may be only partially valid. In an ethnographic study in India, for example, Miller (1985) found only an imprecise relationship.

The process of categorisation of ceramic forms is influenced by many factors, including vessel appendages, contents and cultural practice. To attempt to define categories that have a 'life' of their own outside the purposes they are defined for, and outside the researcher's own perceptions and interests, may be misguided, Rather than attempting to define perfect types, it is better that the research goals affecting the typology are clearly stated, and that any bias is brought into the open.

Turning to the use of descriptive terms in ceramic classification, it can be seen that one criticism of work in Southeast Asia is that descriptive concepts overlap or contradict each other, or fail to provide sufficient discrimination between forms. Pottery can be made into an infinite variety of shapes, and the words that we use to categorise assemblages can only imperfectly approach the many variations possible in ceramic form. It is necessary to attempt to resolve the tension between adequately categorising an assemblage and its internal variation, and at the same time be able to use the same descriptive system to compare assemblages between or within sites in a general way to isolate similarities.

If we are too fine in our categories and types, comparison between assemblages becomes difficult as variation within a site, phase, level or some other grouping obscures cultural links. If we are too general, the ability to define internal variation is lost, and comparison between sites may become unreal. We find red-slipped bowls at many sites, yet this does not necessarily indicate cultural links. It may be that it is not possible to resolve this tension, and it is likely that many descriptive systems will have to be employed.

A number of discussions about descriptive terms and attributes for form can be found (Shepard 1956, Rice, 1987, Rye 1988). Most typologies of Southeast Asian ceramics do not discuss what particular attributes make up a type or form, except in the actual process of describing each in detail. For example, Bayard's typology for the Non Nok Tha assemblage uses the categories

round-bottomed pots, footed globular vessels, cups, footed bowls, bowls and jars (Bayard 1977:67), yet does not define the terms. While these terms are internally consistent, without a discussion of their meaning it is difficult to compare forms from different assemblages. There is a lack of clear understanding about what constitutes types, styles or forms, and some schemes are internally inconsistent. This practice has been rightly criticised by Vincent (1988). It is clear that terms or concepts that are used in classification must be clearly defined.

Any system of classification must also consider practical problems in dealing with any particular assemblage. Irwin (1977) constructed his typology of rim forms from Mailu specifically to deal with level sherds rather than complete vessels. At Nong Nor, a number of practical problems affect any typology. These include the damaged state of the assemblage, the retention of some vessels in Thailand, and the lack of fabric analysis. The system used at Nong Nor has been developed around these problems, and excludes a number of attributes that may be included when complete assemblages are available for analysis. The typology has been developed with a concern to find variation and patterning in the burial ritual, with the hope of adding to our understanding of social factors. It also excludes an analysis of the fabric, due to lack of the necessary expertise, and is thus style based.

The classification of decoration has received less attention than that of form. The decoration of the Nong Nor mortuary wares provides little variation, and presents few problems for classification. It is worth mentioning some approaches to the study of decoration, especially as the decorative motifs from Khok Phanom Di are more complex. The analysis of Lapita decoration illustrates some of the problems of classifying decoration, in this case of repeated motifs. Debate has focused on what constitutes a motif, and on ways of recording them. Early approaches recorded motifs at a relatively high level of analysis, and numbered these consecutively. The numbering system, similar to that used by Hall at Khok Phanom Di (Hall 1989) and O'Reilly for the Nong Nor occupation phase 1 decoration (O'Reilly, this volume), broke down over time as different researchers working independently gave the same number for different motifs. Sharp (1988) has criticised the conceptual understanding of the motifs, and has focused her analysis on the individual stamps used to create them. Other approaches are equally possible, such as the use of symmetry to classify patterns (Washburn and Crowe 1988).

THE CLASSIFICATION OF THE VESSEL FORMS

Many schemes have been developed in an attempt to resolve problems posed by the plastic nature of clay and variety of possible forms. These include schemes based on volume, vessel proportions, contours, characteristic points and geometric shapes. Even if it should be desirable, none has proved capable of completely resolving these basic issues. The schemes offered here do not attempt finally to resolve questions, but attempt to clarify concepts and offer a basis for further refinement.

One way of overcoming some of the limitations inherent in various methods is to integrate two or more into one system. The analysis of the extensive Non Nok Tha assemblage has provided the basis for much work on ceramics in Thailand. The typology used by Bayard was centred on a classification of shape (more or less globular / closed versus more or less open) and base form (round, ring footed and flat). Non-metrical attributes such as surface decoration and rim form were then used to subdivide these groups. A similar approach is used here, with a consideration of vessel

TABLE 9. *Definitions of vessel shapes, adapted from Rice 1987: 216-7*

Name	Height/Maximum Width	Mouth	Neck	Other
Plate	0-0.20	open	no	
Dish	0.20-0.33	open	no	
Bowl	0.33-1	open/restricted	no	
Jar	1 plus	restricted	yes	
Vase	1 plus	open/restricted	no	
Flagon	Narrow neck relative to height and girth			
Beaker	A vessel whose height is greater than its rim diameter, and is suitable for drinking from			
Cup	0.5-1	open	no	relatively straight sides

shape and vessel base. Whether vessels were open or restricted at the mouth was also recorded.

Bayard's classification of shape is extended by including two further variables, vessel proportion and the geometric shape of vessel bodies. Including these variables gives greater weight to the divisions based on shape. Rice (1987) has presented the basis of the system for considering vessel proportion, which has been used mainly in Mesoamerica. Vessels are divided into commonly-used descriptive terms, on the basis of the presence or absence of a neck, and height divided by maximum diameter. This provides a guide for a clearer definition of terminology (Table 9). However, many common terms cannot be easily fitted into this scheme, as is shown by attempts to define jars, vases, flagons and beakers. Nor does it account for all the Nong Nor vessel forms, and the category of cup has been added to describe the form 7 vessels.

This scheme allows an understanding of what terms actually mean, in a physical sense. The wide range in proportion, however, of bowls in particular, means that many vessels will fall into the same category. This is reflected in the Nong Nor assemblage, where most forms are termed 'bowls' using vessel proportion. In order to describe vessel forms further, descriptions of geometric shape are included (Fig. 63). Using these descriptions, Form 2 is a more or less spherical bowl, while Form 3 is a more or less cylindrical bowl.

This does not clearly distinguish between all forms, but allows a greater degree of understanding of the differences between forms. Initially, rim morphology was taken into consideration, using the typology devised by Irwin for his work in Mailu. A variation of this typology has been used by O'Reilly in his examination of the Nong Nor phase one rim sherds. As Irwin's typology was devised to categorise rim sherds rather than rims from complete vessels (Irwin 1977), some difficulty was encountered in using the typology for the Nong Nor burial wares. As the rims did not appear to vary within forms, the rim categories were discarded from the classification of shape. The classification of forms is summarised in table 10.

Two forms, 4 and 10, are further subdivided by the angularity of the mid point of the vessel. Form 4.1 and 10.1 vessels have a rounded turning point, 4.2 and 10.2 have a sharply carinated turning point. Where the nature of this point could not be determined, vessels are recorded as form 4 or 10.

The majority of Nong Nor vessels were pedestalled, both in the number of forms (13 out of 20)

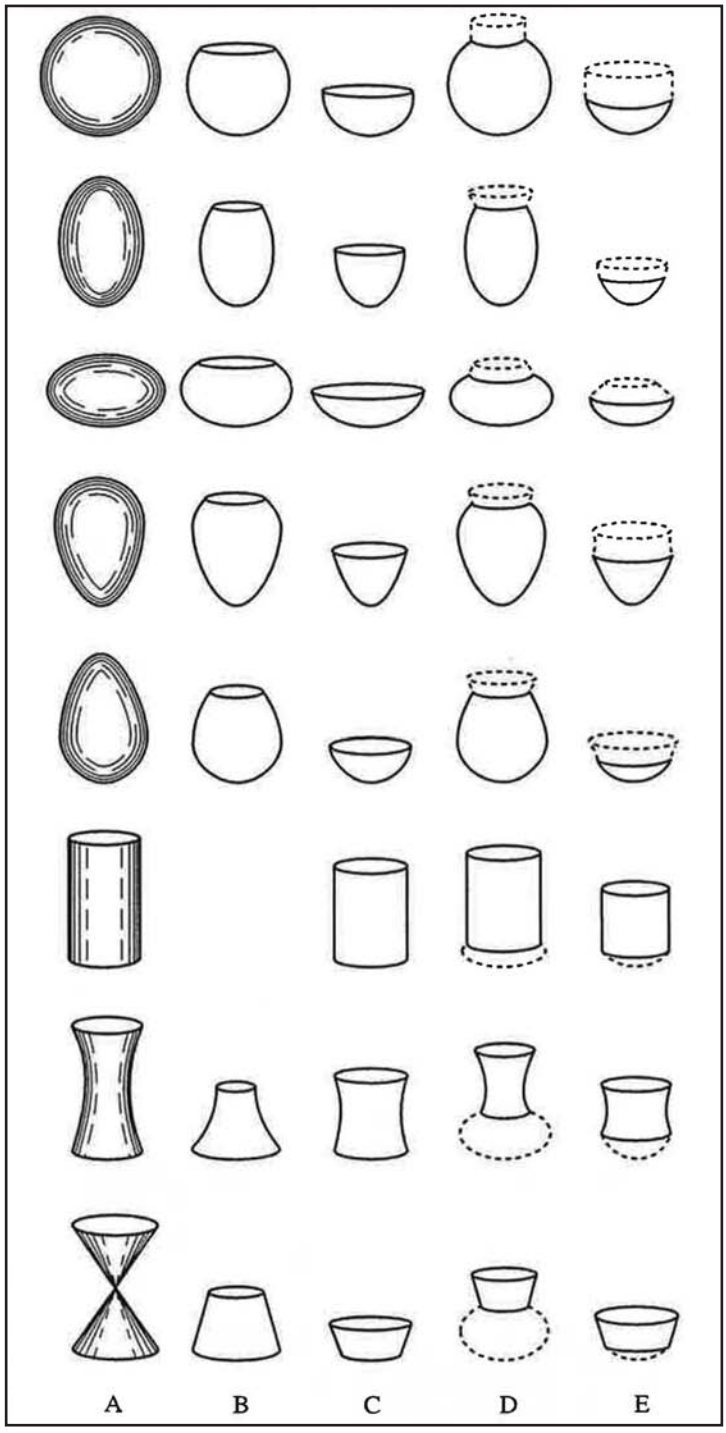


FIG. 63. Geometric Solids as reference norms for vessel description: sphere, ellipsoid, cylinder, hyperboloid, cone and ovaloid (from Shepard 1985:234)

and the total number of vessels (150 of the 176 vessels attributed a form). There is little variation in pedestal form. Twelve flat-based vessels comprised two of the 20 forms. Eleven round- based vessels were divided into three forms. Forms 8 and 19 could not be attributed a shape for the base. Plates and dishes were the most common shapes (forms 1, 11 and 20), with 88 being recorded. Bowls, covering a wide range in proportion, were also common, making up 15 of the forms and 76 of the vessels. Form seven vessels made up all the cups that were attributed forms.

TABLE 10. Summary of the Form Classification

Form	Base	Mouth	Shape (proportional)	Shape (geometric)
1	Pedestal	Open	Plate or Dish	Ellipsoid
2	Pedestal	Restricted	Bowl	Spherical
3	Pedestal	Open	Bowl	Cylindrical
4	Pedestal	Restricted	Bowl	Ellipsoid
5	Round	Restricted	Bowl	Spherical
6	Round	Open	Bowl	Spherical
7	Flat	Open	Cup	Ovaloid
8	Round?	Restricted	Bowl	Ellipsoid
9	Round	Restricted	Bowl	Spherical
10	Pedestal	Restricted	Bowl	Ellipsoid
11	Pedestal	Open	Dish	Conical
12	Pedestal	Restricted	Bowl	Spherical
13	Pedestal	Restricted	Bowl	Spherical
14	Pedestal	Restricted	Bowl	Ellipsoid
15	Pedestal	Restricted	Bowl	Spherical
16	Pedestal	Restricted	Bowl	Spherical
17	Pedestal	Open	Bowl	Cylindrical
18	Pedestal	Restricted	Bowl	Ellipsoid
19	Round?	Restricted	Bowl?	Spherical?
20	Flat	Open	Dish	Conical

DESCRIPTION OF THE VESSEL FORMS

- Form 1 (Figs. 66-67). This is the most common form. As such, form 1 vessels that were unable to be reconstructed were more easily recognised than other vessel forms, and the proportion of form 1 to other forms is probably overstated. The vessels are pedestalled with an open orifice, and a straight, direct rim. They are ellipsoid in geometric shape. Many could not be reconstructed, and thus height / width proportions could not be determined. There is no clear break between form 1 plates and dishes, thus they are grouped together rather than separately. Form 1 vessels vary in base width from 2 - 30 cm, rim width from 7 - 63 cm and from 3.5 - 20 cm in height. A few miniature form 1 vessels were found.
- Form 2 (Fig. 67). This form is a pedestalled, restricted spherical bowl with a distinctive ‘flared’ rim. They are generally smaller than the similar form 12 vessels, ranging in base diameter from

9.5 - 16 cm and mouth diameter from 13.5 - 22 cm.

- Form 3 (Fig. 68). Only one vessel of this form was found at Nong Nor, cat. 66. It is a pedestalled open bowl, cylindrical in shape. The rim is everted and 'folded' over. This is a tall vessel, 24.5 cm in height.
- Form 4 (Figs. 68-70). This form is a pedestalled, restricted, ellipsoid-shaped bowl, with an everted rim. Two variations are present, divided on the basis of the 'mid-point' of the bowl. With form 4.1 vessels, this turning point is rounded, with form 4.2 vessels, the turning point is a sharp carination. Appliqué decoration is sometimes present at the carination. Form 4.1 vessels range in rim width from 18 - 24 cm, in maximum width from 24 - 36 cm and base width from 10 - 15.2 cm. Form 4.2 vessels are generally larger, varying from 18.5 - 30 cm in rim width, 28 - 34 cm in maximum width and 14.2 - 22 cm in base width.
- Form 5 (Figs. 70-71). These are round-based, restricted spherical bowls, with an everted rim. This form includes all round-based restricted bowls, and matches the common description of "cooking pot". There are four examples of this form. They range in mouth diameter from 9.8 - 20.2 cm and in maximum diameter from 11.7 - 24 cm.
- Form 6. This form consists of round - based open ellipsoid bowls, with direct rims. Three examples are present, two being interred with burial 133.
- Form 7 (Figs. 71-72). This form is a flat-based, open ovaloid cup with a concave rim. These vessels are small, with an orifice diameter ranging from 8.3 - 10 cm, and height from 5.5 - 9.2 cm. A few miniature examples are present. Form 7 vessels were probably shaped by pinching rather than with a paddle and anvil.
- Form 8. Only one example of this form has been found (cat. 257). It is a probably round-based restricted bowl. Most of the rim is missing. The lower part of the vessel is cord marked, the shoulder and rim are plain.
- Form 9 (Fig. 72). This form is a round-based, restricted spherical bowl with an everted rim. The two examples (cats. 264 and 1070) could not be fully reconstructed, but are large vessels, cord-marked all over their bodies. These may be storage vessels.
- Form 10 (Figs. 72-74). This is a pedestalled, restricted ellipsoid bowl, with an everted rim. Two variations are present. Like form 4 vessels, they are divided on the basis of the turning point in the middle of the vessel. Form 10.1 vessels have a rounded turning point, 10.2 vessels a sharper carination. Form 10.1 vessels range from 13-18 cm in rim width, 10.2-13.8 cm in base width and 14-25 cm in maximum width. Form 10.1 vessels are larger, ranging from 16-28 cm in rim width, 9.5-18 cm in base width and 14-31 cm in maximum width.
- Form 11 (Fig. 74). This vessel form has a very high pedestal, and is an open conical dish with direct straight rims. Two examples were excavated at Nong Nor, cats. 479 and 631. They range in height from 12.2 - 18 cm and in maximum diameter from 12.5-20 cm.
- Form 12 (Figs. 74-76). A pedestalled, restricted spherical bowl with everted rim. These vessels were large, ranging in rim diameter from 22-31 cm, maximum diameter from 26-42 cm, and base diameter from 10-21 cm. For the three vessels that could be reconstructed, the height ranged from 23-28.8 cm. Many were used to inter infants. They were typically cord marked in

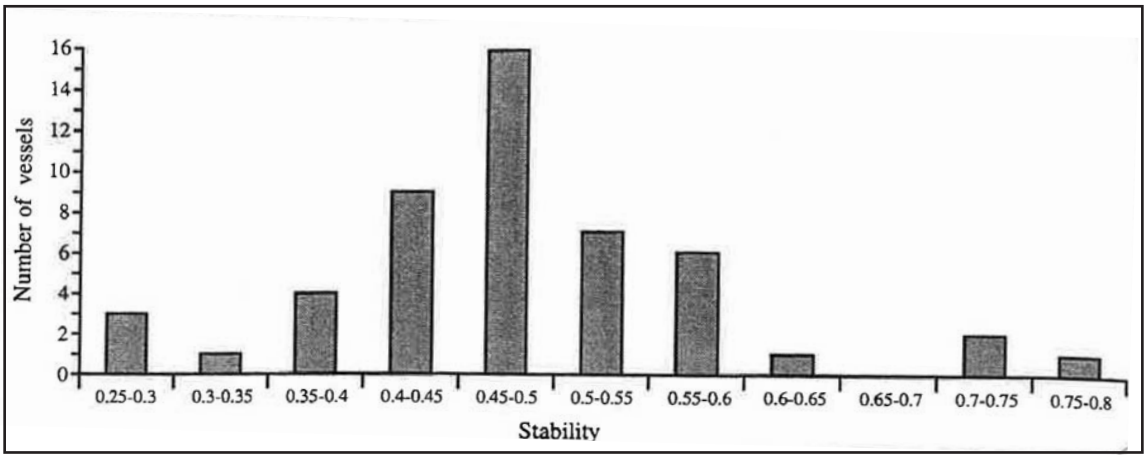


FIG. 64. Stability of form 1 vessels.

the lower portion, with red-slipped upper portions and rims.

- Form 13 (Fig. 76). This form was a pedestalled, restricted spherical bowl with everted rim. These were quite small, with cord-marked lower portions and plain shoulders and rims. Orifice diameter ranged from 10.8-17 cm, and base width from 6.5-8 cm.
- Form 14 (Fig. 76). Only one example of this form was excavated (cat. 611). It is a pedestalled, restricted carinated bowl with an everted rim. The vessel has an unusual incised pattern around the pedestal base, and is 'smoothed' elsewhere. A band separates the upper portion of the body and the vessel shoulder. This may be a variation of form 4 vessels.
- Form 15 (Fig. 77). This form is a pedestalled, restricted spherical bowl, with an everted rim that thickens at the lip. There is only one example (cat. 709). The base has a hole through it. A second hole is located near the rim. These may be present in order to suspend the vessel.
- Form 16 (Fig. 77).This is another pedestalled, restricted spherical bowl, but has a direct, straight rim. A band of fairly crude appliqué decoration is present around the middle of the vessel. Only one example is present, cat. 708.
- Form 17 (Fig. 77). This is pedestalled, open cylindrical bowl, with a rim similar to that of form 3, being everted and folded over. There is only one example of this form, cat. 698, interred with burial 109.
- Form 18 (Fig. 77). This form is a pedestalled, restricted ellipsoid dish with an everted rim. It is similar to form 10.1, but was kept separate as it is smaller (the height of the one example, cat. 617, is 8 cm) and is a dish rather than bowl.
- Form 19 (Fig. 77). There are two examples of this form. Both occur with burial 133, the possible phase 1 interment. It has not been possible to reconstruct either vessel fully. Both have carinations, are restricted, and are probably ellipsoid bowls.
- Form 20 (Fig. 77). This is a flat-based, open conical bowl, with a straight direct rim. Both exam-

ples, (cats. 598 and 600), may be made from the same distinctive fabric. Neither is decorated, and both were interred beyond the head of burial 39.

VESSEL FUNCTION

Determining vessel function has been a perennial concern of archaeologists for some time. If it is possible to determine or suggest functions for certain forms, these can be compared with the occurrence of forms in different graves. Access and stability have been used to indicate vessel function (MacDonald 1980). The method is based on the assumption that potters are aware of the physical variables affecting their wares, and thus will design vessels to fit the presumed requirements of certain tasks. Shanks and Tilley (1992) have explicitly rejected relationships between form and function, and Miller (1985) has provided a cautionary note on such presumptions through his ethnographic work. In Thai archaeology, both MacDonald (1980) and Bayard (1984a) use an ethnographic study by Calder (1972) to demonstrate a relationship between access and stability and function. Calder's study demonstrates clear clustering of several groups in a simple scatter plot of access and stability (MacDonald 1980:138). It is suggested here that relationships between form and function should be explored, without presumptions that such relationships automatically do or do not exist.

Bayard (1984a:94-95) plotted access and stability of Non Nok Tha vessel classes. His six classes (primarily based on morphology) clustered separately. When these are plotted with the access and stability of Calder's ethnographic examples they show an imperfect correlation. This is to be expected, due to various problems such as sampling and cultural differences. In some cases, there is only an imperfect match between vessel function and variables that we presume to be 'correct' for those functions (Miller 1985). This would seem to be especially so for mortuary vessels, as they were probably ceremonial, and thus do not necessarily relate to functional forms.

In any case, access and stability measurements are rather arbitrary. While the mouth diameter of a vessel may be its widest diameter, if the vessel is necked, real access will be rather less than, for example, a plate. Similarly, a round-based cooking vessel that has a very low 'stability' may be used in practice on coals or on some other support, and is stable in practice. As it is impossible to measure the base width for a round bottomed vessel, an arbitrary figure of 1 cm is given, following MacDonald (1980:131). A vessel with the widest point very low in its shape will be in reality more stable than one with the mouth being the widest point.

Given these concerns, a plot of access against stability may still indicate distinctions between vessels, and may suggest possible functions. Access is determined by dividing the diameter of the vessel mouth by the maximum diameter of the vessel, and stability is determined by dividing the maximum diameter of the base by the maximum diameter of the body. Form 1 vessels are plotted separately because they occur in larger numbers than other forms.

The stability of form 1 vessels fits easily within the range suggested by MacDonald for serving vessels (Fig. 65). The plot of access and stability of the other forms does not fit so easily into the suggested functions (Fig. 65). Macdonald's cluster A, cooking vessels, matches Nong Nor Form 5 vessels. However, most round - based restricted vessels will fall near this area. Forms 3 and 7 also lie within this range. Form 3, being tall, is unlikely to be a serving vessel. Including a volume variable in the plot would be useful, but is difficult to achieve at Nong Nor, due to the small number of complete vessels. Many vessels cluster in a range of access 0.75 - 0.85, stability

0.55-0.7. These include forms 4, 10 and 12, and suggest that these vessels had similar functions. While MacDonald's storage clusters (E and I in Fig. 65) lie outside this range, it is possible that

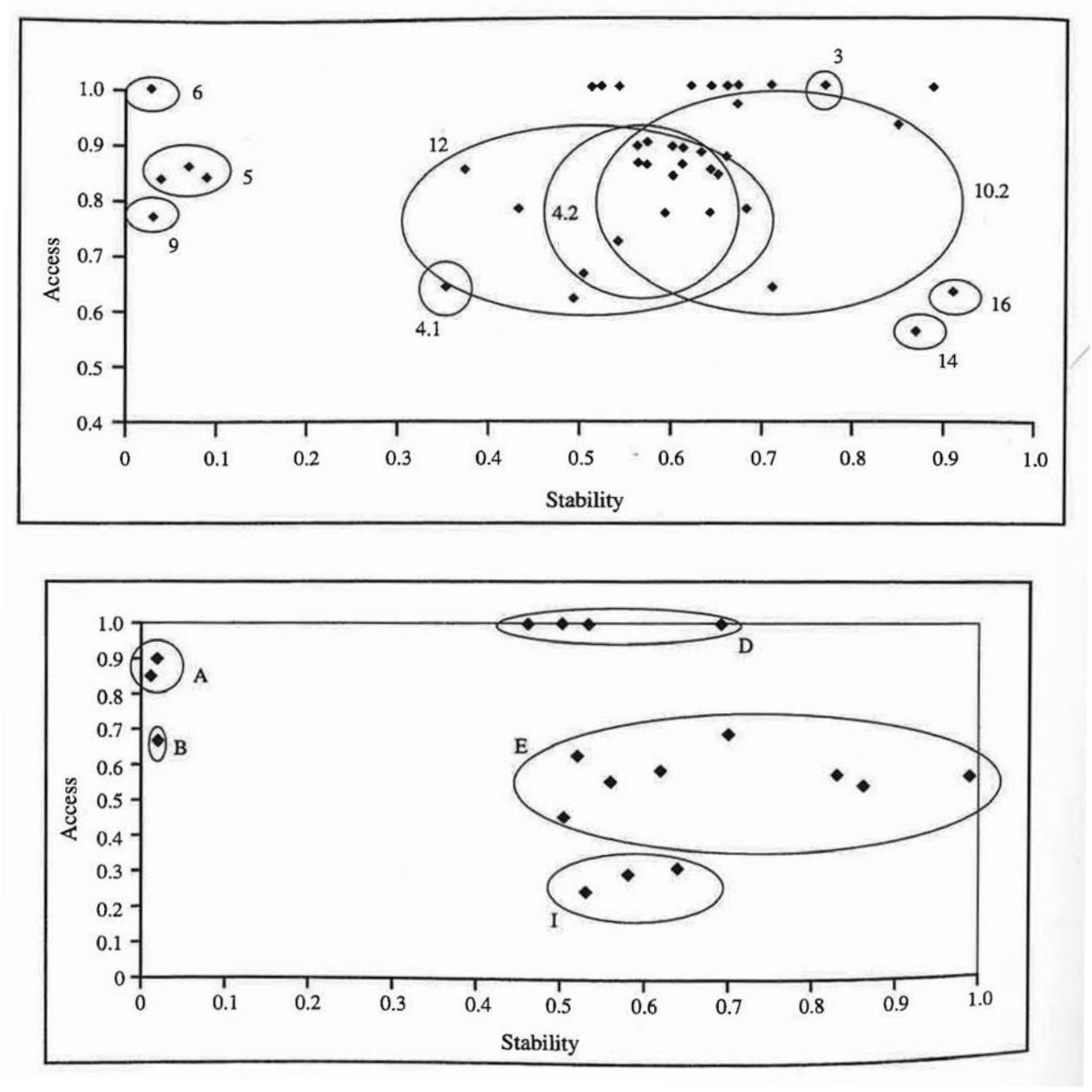


FIG. 65. Stability and access of *above*: other forms of pottery vessels from Nong Nor and *below*: for ethnographic examples (adapted from MacDonald 1980:135). A: cooking, B: boiling, D: serving, E and I: storage

this group consists of storage vessels. What was stored, if anything, is uncertain. It is possible, even likely, that a mortuary ceramic assemblage may exclude cooking and storage vessels as such. The exception to this uncertainty is with the form 12 vessels, many of which were obviously containers for infant burials.

In general terms only, then, can it be suggested that the majority of vessel forms were made as containers for storage. It is possible that rice was stored, given its importance economically and possibly ritually. The forms that may have served for storage include forms 2, 3, 4.1, 4.2, 10.1, 10.2, 12, and 14 to 17. Forms 1, 11, 18 and 20 may have been utilised for the serving of food. Form 7 was probably used as a cup for drinking, and forms 5, 6, and 13 may have been used for cooking.

SURFACE TREATMENT

The decoration of the Nong Nor mortuary vessels was based around red slipping, cord marking and plain or smoothed surfaces. This contrasts with the elaborate incised and burnished decoration of both the earlier phase one Nong Nor wares and the burial vessels from Khok Phanom Di. The exceptions to this, the two form 19 vessels with burial 133, are almost certainly from an earlier context, relating to the occupation phase. Incising, appliqué and punctuation occurred less frequently, and always in combination with the more common techniques. There do not appear to be any motifs present in the assemblage, with the exception the form 14 vessel, cat. 611. The occurrence of the various decorative techniques is summarised in table 11, and the techniques are then described.

DESCRIPTION OF DECORATIVE TECHNIQUES

- Plain/No decoration (n=60): a number of vessels have no decoration. Form 7 vessels in particular fall into this category, as they appear to have been formed by a pinching method, rather than with a cord-wrapped paddle. Such a paddle would have left cord marks, and the deliberate removal of these marks could be considered as 'decoration'. A large number of Form 1 vessels also appear to have had no decoration. Many of these may have been red slipped, and there is the possibility that the slip has not survived.
- Cord marking (n=25): it is thought that a cord-wrapped paddle was used to fashion many of the pots. It is debatable, then, whether the cord marked patterns left from shaping vessels should be considered 'decoration' as such. For the majority of functional wares, it is probable that such patterns are not decoration in the sense of it being a deliberate technique used to enhance the vessel after the main stages of forming. With the burial wares, this question becomes more complex. Some vessels have clearly been made with corded paddles, and then had the cord marks removed. Thus, it is presumed that retaining cord marking on a vessel was a deliberate decorative choice. This is especially so where cord marking is present with another decorative technique.
- Cord marking and smoothing (n=14): this technique occurred most often with form 4, 4.1 and 4.2 vessels. The lower portion of the pot was cord marked, while the pedestal base, top half and rim were smoothed. Smoothing removed presumed cord marking, but was not heavy enough to be considered burnishing.

- Cord marking, smoothing and appliqué (n=1): this occurred with one form 4.1 vessel, which was typically cord marked in the lower portion and smoothed elsewhere. In addition to this, it had an appliqué band running around the middle portion, where the two halves of the main body joined.
- Cord marking, smoothing, impression and punctuation (n=1): this combination of techniques also occurred with a form 4.1 vessel, and is again a variation on the basic cord marking and smoothing decoration. A series of impressions run round the mid point of the vessel, possibly achieved by using a stamp or roller of some kind.
- Cord marking, smoothing and punctuation (n=1): a form 10.2 vessel was decorated in this manner. Holes were present in the base, presumably for suspension of the vessel. Otherwise, it was typically decorated with cord marking in the lower portion and smoothing above.
- Red slip (n=87): the single most common form of decoration was a simple red slip. This usually covered the entire vessel, and in some cases was observed inside the vessels.
- Red slipping and cord marking (n=42): a number of forms combined red slipping with cord marking. Form 2 vessels were all decorated in this way, with cord marking being present in the lower portion and red slip on the base, upper portion and rim. This is similar in concept to the cord marking and smoothing decoration for form 4, 4.1 and 4.2 vessels.
- Red slipping, cord marking and incising (n=2): two form 10.2 vessels were decorated with cord marking in the lower portion, red slipping elsewhere, and a band of incised lines running round the vessel immediately below the rim. The incising formed a cross-hatched pattern.
- Red slipping, cord marking and punctuation (n=3): red slipping and cord marking occurred quite frequently with form 10.2 vessels. Two examples are cord marked below and red slipped elsewhere, with holes bored into the base for suspension.
- Red slipping and incising (n=2): two form 1 vessel were typically red slipped, but had a simple 'X' incised into parts of their bodies, one on the base, another repeated around the outside walls.
- Red slipping, incising and appliqué (n=1): a vessel of uncertain form was red slipped, with an appliqué band added around the carination. A series of the motif 'X' had been incised into this band.
- Red slipping and punctuation (n=1): one example of the form 1 vessel was red slipped, and had holes in the base, probably for suspension or for tying the vessel onto another as a lid.
- Red slipping and smoothing (n=1): one 4.1 vessel was red slipped as well as being smoothed in the top portion. Only this part of the vessel survived, so it may have been cord marked in the lower portion as well.
- Smoothing (n=5): no vessels are believed to have been truly burnished. Burnishing is effected by rubbing the clay before firing, when it is "leather hard", with a pebble or other suitable object. Burnishing pebbles occurred in phase one contexts, but only one stone is known from secure burial contexts. This example is not believed to have been used for burnishing (Spiers, personal comment). While burnishing does not occur with the burial phase pots, it is present in the phase one wares. In some cases, it is believed that vessels have been deliberately 'smoothed' as a

decorative technique.

From observing attachments of pedestal bases, it appears that a cord-wrapped paddle was used to form many vessels. This leaves a typical cord-marked pattern. In a number of vessels that do not have cord marking visible, when the bases have been broken off, the 'remains' of earlier cord marks can be seen. The cord marking has been deliberately removed from the rest of the vessel, and smoothing is thus considered to be a decorative technique.

This has taken place in a number of vessel forms. Most, however, have had some other form of decoration such as a red slip placed over the top. These are not considered to have been 'smoothed'. Only those which have no decorative techniques over the top of smoothing are included in this classification. Of those vessels that have been attributed forms, these are mostly forms 4, 4.1 and 4.2.

- Smoothing, appliqué and incising (n=1): this decoration occurred on a unique vessel, the only form 14 example. Most of the vessel was smoothed, and an appliqué band ran around the mid point. On the lowest portion of the pedestal base a pattern was incised around the vessel. This consisted of a double line in a 'X' repeated pattern. This creates a series of rectangular spaces, each with an '' incision inside.
- Smoothing, appliqué and impression (n=1): one form 4.1 vessel does not appear to be cord marked, otherwise being similar to the standard technique for this form. The vessel has had cord marking removed from the surface by light smoothing, and an appliqué band runs around the mid point. This band has possibly stamped impression along it.
- Incising and smoothing (n=2): a few vessels had motifs or lines incised into the clay. This was done before firing, while the clay was still wet (eg. the base of vessel cat. 567) or while leather hard (eg. cat. 611). Two vessels that had incised double zig-zag line motifs occurred with burial 133, which is probably a phase one burial.
- Incising and stamping (n=2): both the form 19 vessels had a motif consisting of a double incised zig-zag line, bordered by stamping. The stamping effect may have been achieved by a shell edge, but the preservation of both vessels is inadequate to determine this precisely. As stated elsewhere, these vessels occur with burial 133, which may relate to the phase 1 occupation. This decorative motif is similar to that found on phase one sherds, and does not relate to any other burial vessels.
- Punctuation: a few examples of punctuation occur. These are all holes, usually on bases or near rims. The function of these is probably either for the suspension of vessels, or for tying 'lids' onto larger vessels.

As can be seen from the descriptions of the decoration, there is in some cases a close relationship between certain forms and decoration. Of those that occur in any number, two forms in particular have regular decoration. No form 7 vessels are decorated, and form 2 vessel are always cord marked in their lower portion and red slipped elsewhere. Other forms tend to have a basic decoration, and any differences are variations on this. All form 13 vessels, for example, are cord marked, with three of the four being red slipped as well. All form 12 vessels are red slipped, with eight of these being cord marked as well (and one of these having holes in the base). Form 1, 4 and 10 vessels have more variation in decoration. With these as well, however, red slipping and cord marking

occur in most examples. The exceptions are that 27 of the form 1 vessels are undecorated, and that smoothing is the dominant technique with the form 4 vessels.

FABRIC

Ideally, a detailed consideration of fabric would be included in the typology of the Nong Nor ves-

TABLE 11. *Percentage of decorative techniques*

Technique	number	percentage
None	60	23.53
Cord Marking	25	9.80
Cord Marking; Smoothing	14	5.49
Cord Marking; Smoothing; Appliqué	1	0.39
Cord Marking; Smoothing; Impression; Punctuation	1	0.39
Cord Marking; Smoothing; Punctuation	1	0.39
Red Slip	87	34.12
Red Slip; Cord Marking	42	16.47
Red Slip; Cord Marking; Incising	2	0.78
Red Slip; Cord Marking; Punctuation	3	1.18
Red Slip; Incising	3	1.18
Red Slip; Incising; Appliqué	1	0.39
Red Slip; Punctuation	1	0.39
Red Slip; Smoothing	1	0.39
Smoothing	5	1.96
Smoothing; Appliqué; Incising	1	0.39
Smoothing; Appliqué; Pinching	1	0.39
Incising; Smoothing	2	0.78
Incising; Stamping	2	0.78
Punctuation	2	0.78
Total	255	100.00

sels. Vincent (1988) has rightly criticised the practice and assumptions of style-orientated studies. Unfortunately it has not been possible to undertake a study of fabric in this work for the Nong Nor pots. It is hoped that more information will be obtained on the fabrics in the future. Boyd has taken a limited sample of sherds to the Southern Cross University is order to examine clay minerals, while Dr. G.B. Thompson of Bradford University has a larger sample of rice tempered sherds, where she is examining the rice remains.

One important feature of the Nong Nor phase 2 fabrics is the common presence of rice chaff. This has enabled AMS dating of some vessels, and has obvious important cultural implications. If it is possible positively to identify the rice as being domesticated, this will advance our understanding of the subsistence strategies of the Nong Nor people considerably. Of the 211 ves-

sels with which it was possible to examine fabric, rice was identified in 174 (82.5 per cent). Rice was identified using a x10 hand lens, by examining fresh breaks. The large number of vessels with rice temper strongly suggests that rice was easily available to the people of Nong Nor, and was probably cultivated. Rice temper was used in most vessel forms, the exceptions being forms 4, 9 and 20.

SUMMARY

The basis of the classification was previewed with an examination of some theoretical issues. Classification is considered to be context based, rather than regarding types as fixed definitions. Particular concern is given to the problem of adequately describing vessel forms. The methodology for classifying was presented, with particular attention being paid to the definition of descriptive terms. The forms were described, and possible functions were suggested. The surface treatment was described, and some relationships between certain forms and methods of decoration were noted. The clay for many vessels was tempered with rice chaff.

TABLE 12. *Catalogue of the mortuary vessels (continued on page 257)*

Cat.	Burial	Form	Dec.	RW	BW	MW	BH	RH	Bo.H	TH	Stab.	Acc.
142	8	1	rs	19.8	9.5	19.8	1.5	-	4.0	5.5	0.48	1.00
165	8	1	rs	18.0	10.8	18.0	2.3	-	5.2	7.5	0.60	1.00
199	33	1	rs	24.0	-	24.0	-	-	-	-	-	1.00
206	33	1	rs	16.0	7.3	16.0	1.5	-	3.2	4.7	0.46	1.00
241	44	1	rs	-	12.5	-	2.0	-	-	-	-	1.00
265	47	1	rs	26.0	11.0	26.0	1.5	-	-	-	0.42	1.00
266	47	1	rs	14.0	7.3	14.0	1.5	-	3.5	5.0	0.52	1.00
267	47	1	rs	15.6	9.2	15.6	3.5	-	3.0	6.5	0.59	1.00
273	37	1	rs	35.0	15.5	35.0	4.0	-	-	-	0.44	1.00
296	30	1	none	20.0	12.5	20.0	2.5	-	-	-	0.63	1.00
302	30	1	none	-	6.5	-	1.5	-	-	-	-	1.00
352	52	1	rs	10.0	2.0	10.0	1.5	-	2.0	3.5	0.40	1.00
358	52	1	none	17.0	6.4	17.0	2.5	-	5.0	7.5	0.38	1.00
359	56	1	rs, p	26.0	13.0	26.0	2.5	-	-	-	0.50	1.00
423	74	1	rs	26.0	13.0	26.0	3.0	-	-	-	0.50	1.00
453	36	1	rs	22.0	-	22.0	-	-	-	-	-	1.00
462	60	1	rs	17.0	6.0	17.0	1.5	-	2.5	4.0	0.35	1.00
497	83	1	rs	28.0	-	28.0	-	-	-	-	-	1.00
544	75	1	rs	-	-	-	-	-	-	-	-	1.00

Dec: Decoration, RW: rim width, BW: base width, MW: maximum width, BH: base height, RH: rim height, Bo.H: body height, TH: total height, Stab: stability, Acc: access. *Decoration types:* rs: red slip, in: incised, cm: cord marked, p: punctuation, sm: smooth, ap: appliqué, im: impressed, st: stamp

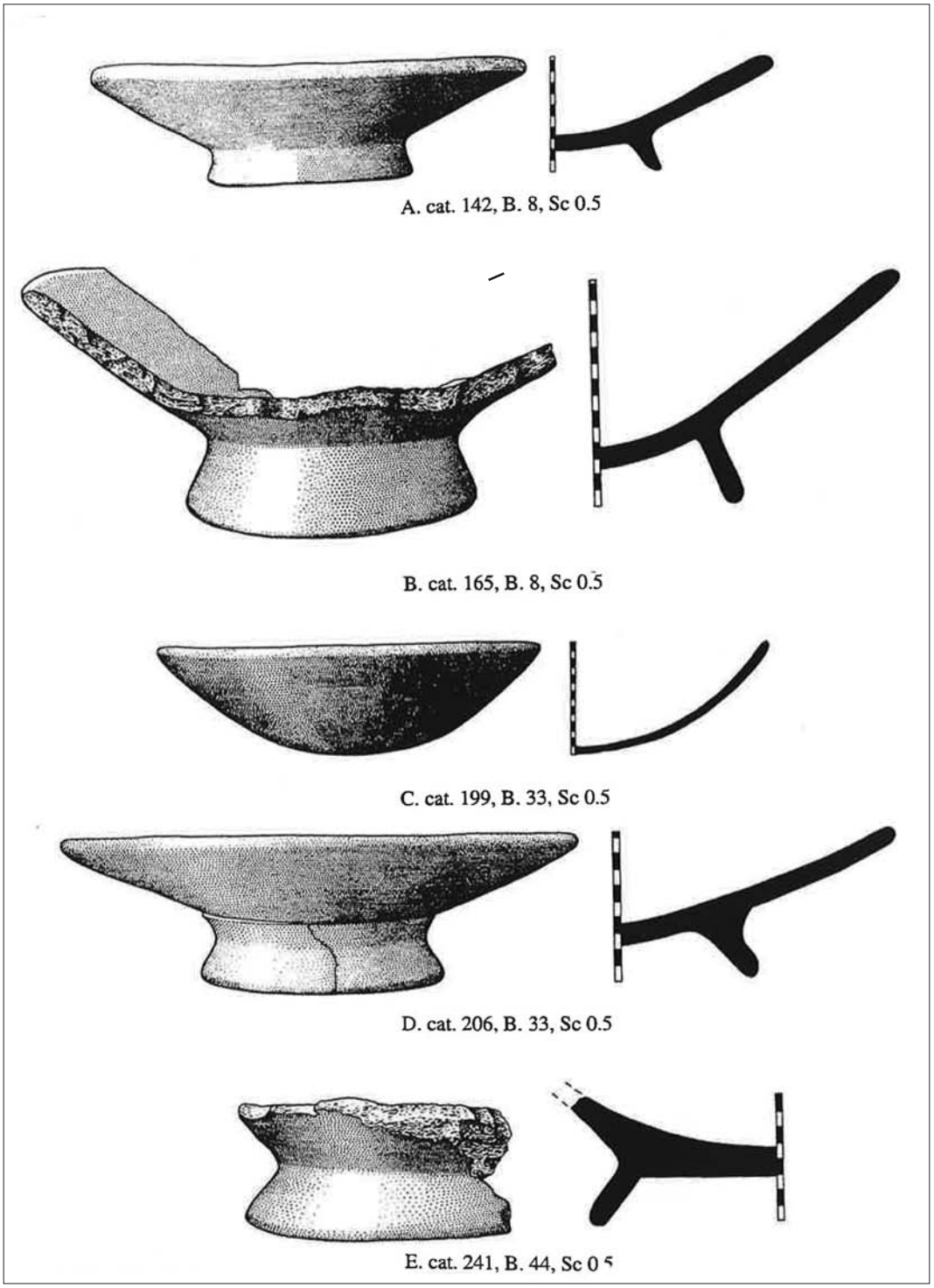


FIG. 66. Mortuary vessels of form 1. Sc: Scale increments (cm)

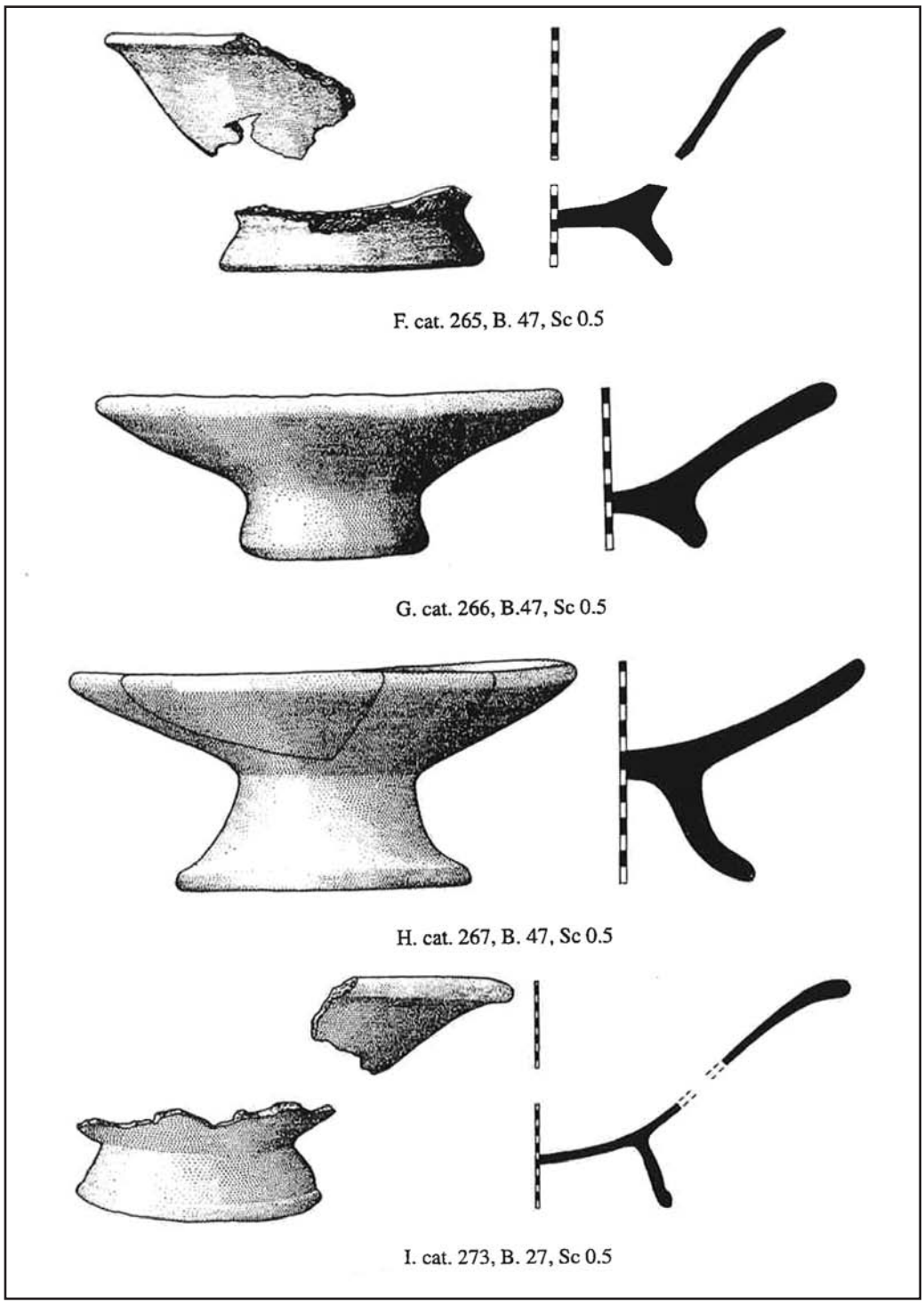


FIG. 66 *(cont.)*. Mortuary vessels of form 1. Sc: Scale increments (cm)

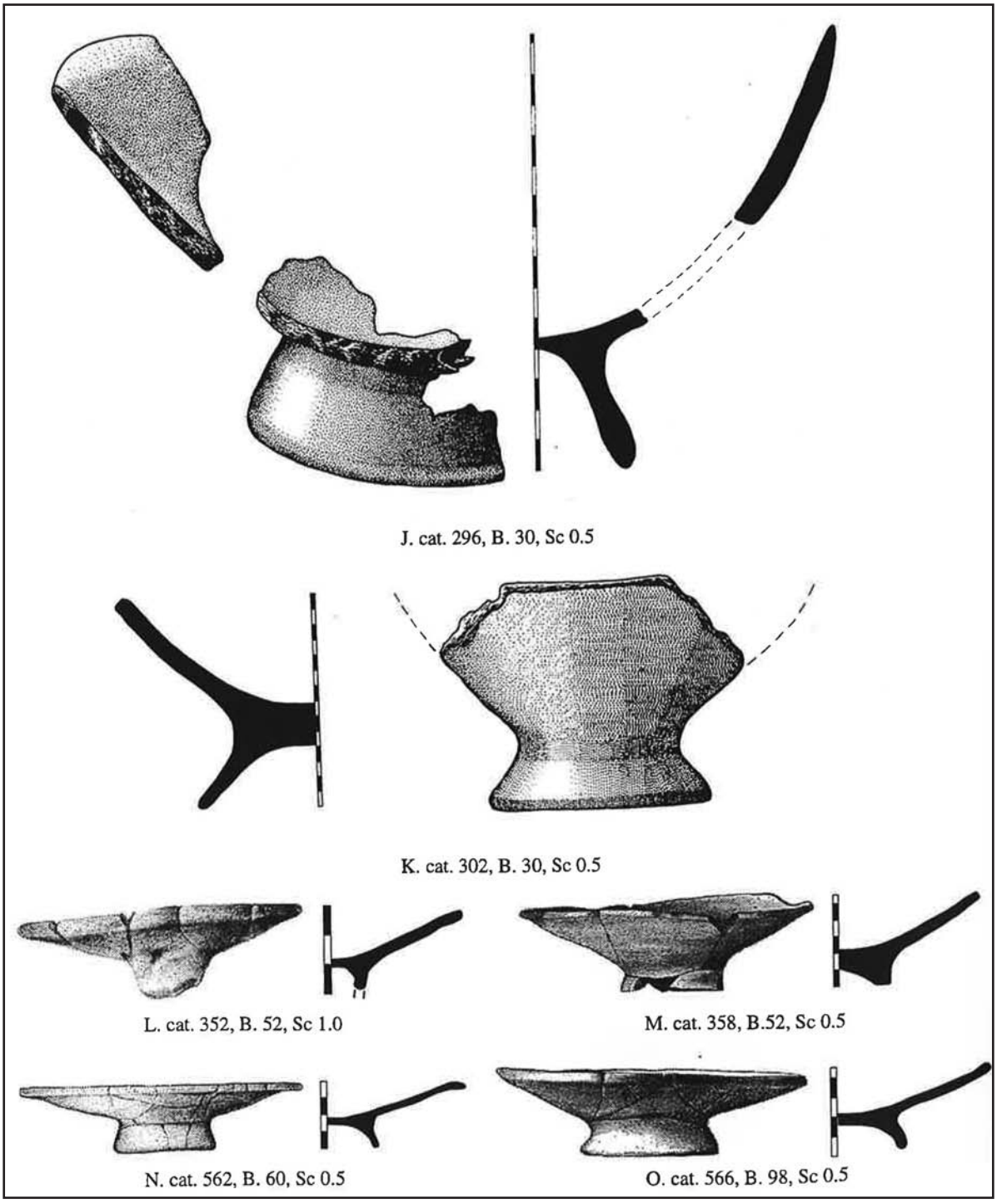


FIG. 66 *(cont.)*. Mortuary vessels of form 1. Sc: Scale increments (cm)

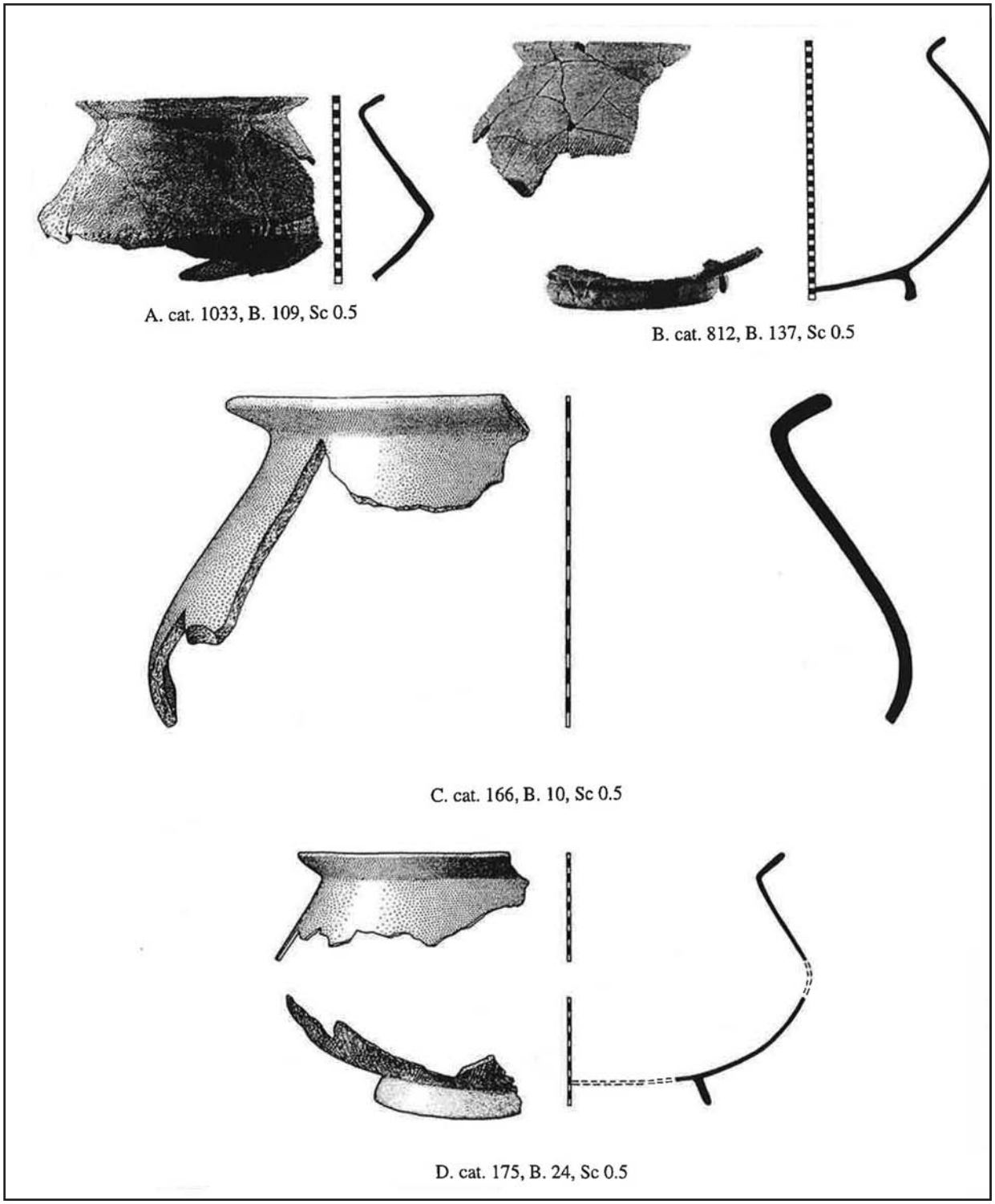


FIG. 66 *(cont.)*. Mortuary vessels of form 1. Sc: Scale increments (cm)

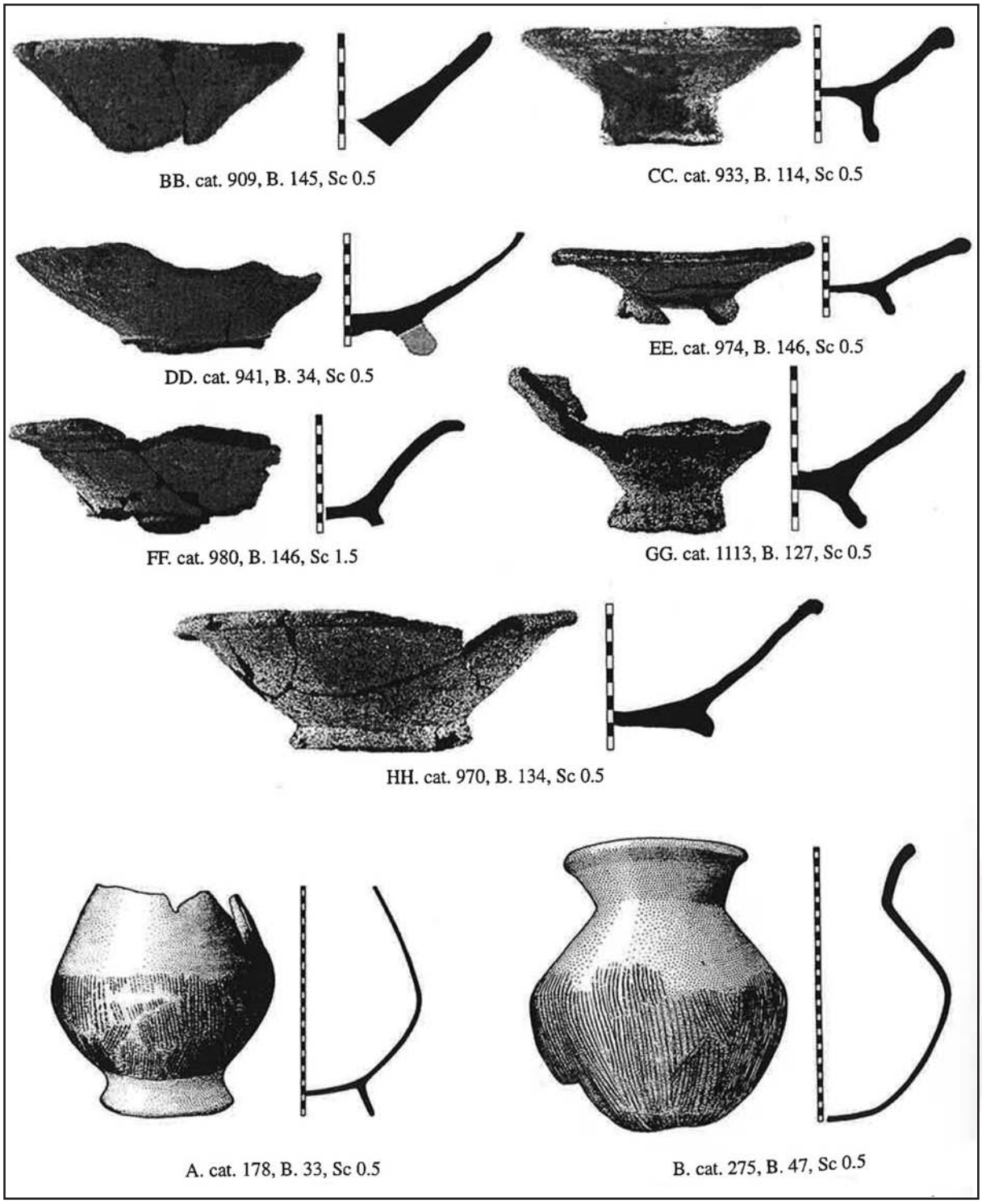


FIG. 67. Pottery vessels of form 1 *(cont.)* and form 2(A-B). Sc: Scale increments (cm)

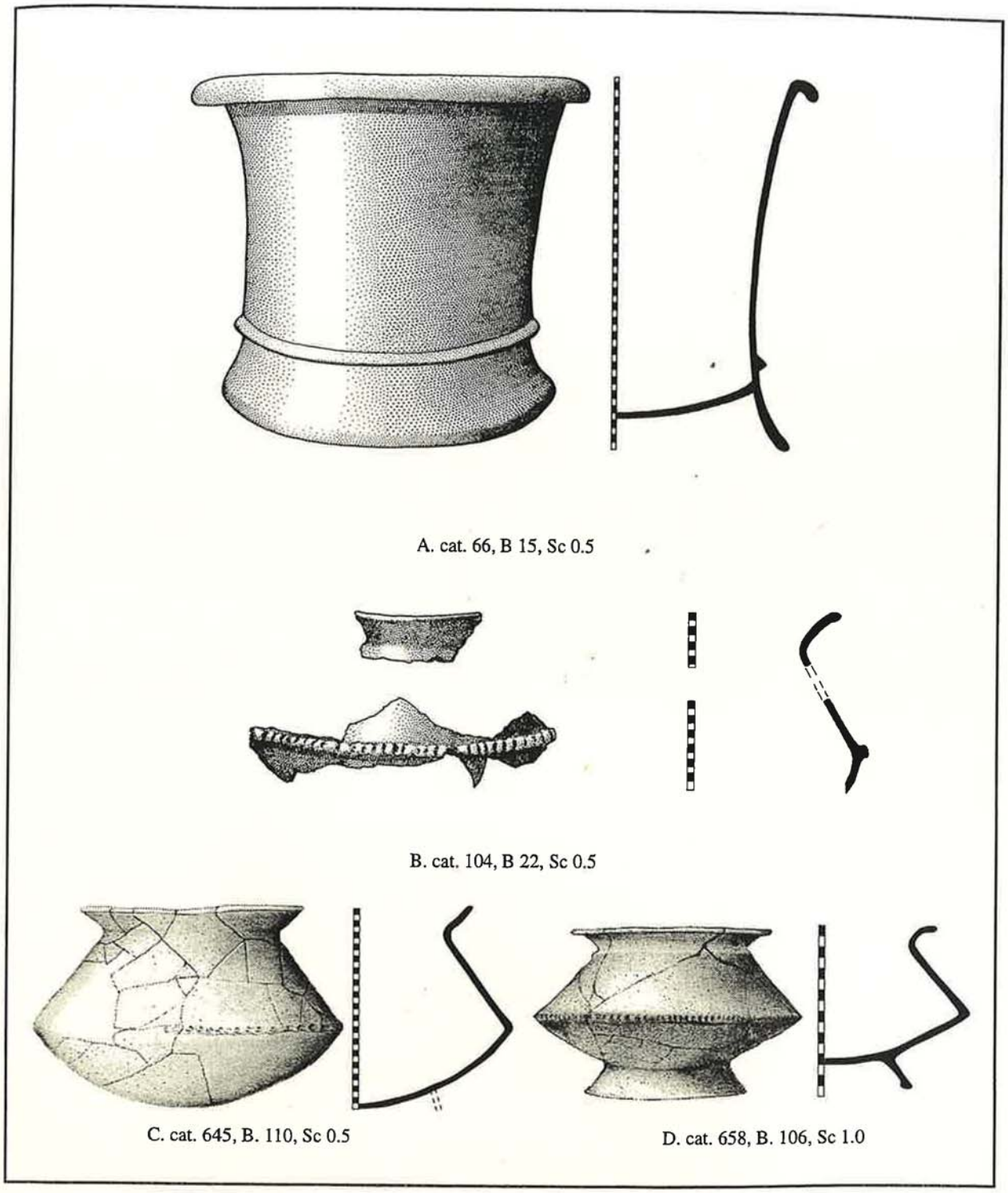


FIG. 68. Pottery vessels of forms 3(A) and 4.1(B-D). Sc: Scale increments (cm)

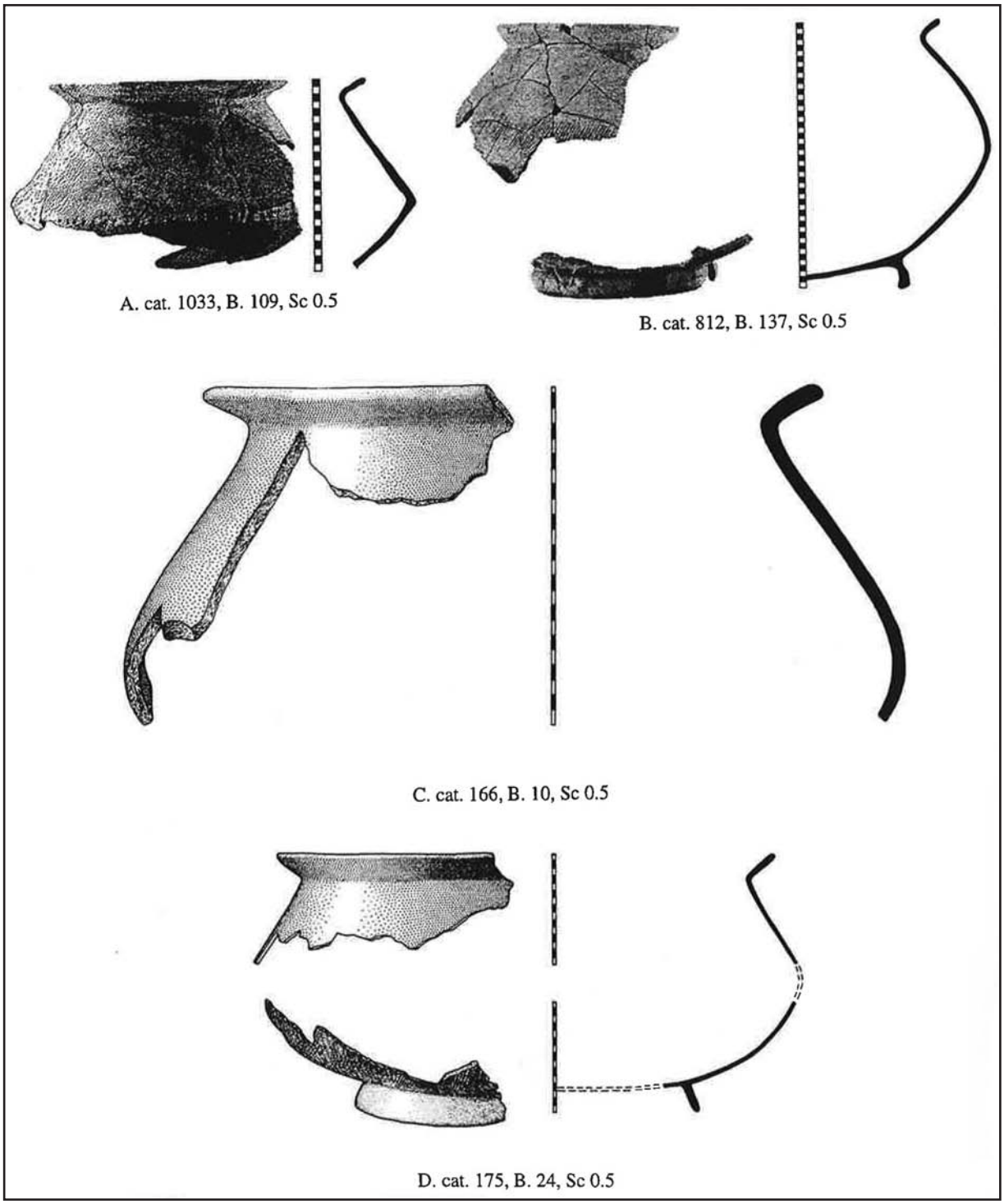


FIG. 69. Pottery vessels of form 4.1(A) and 4.2(B-D). Sc: Scale increments (cm)

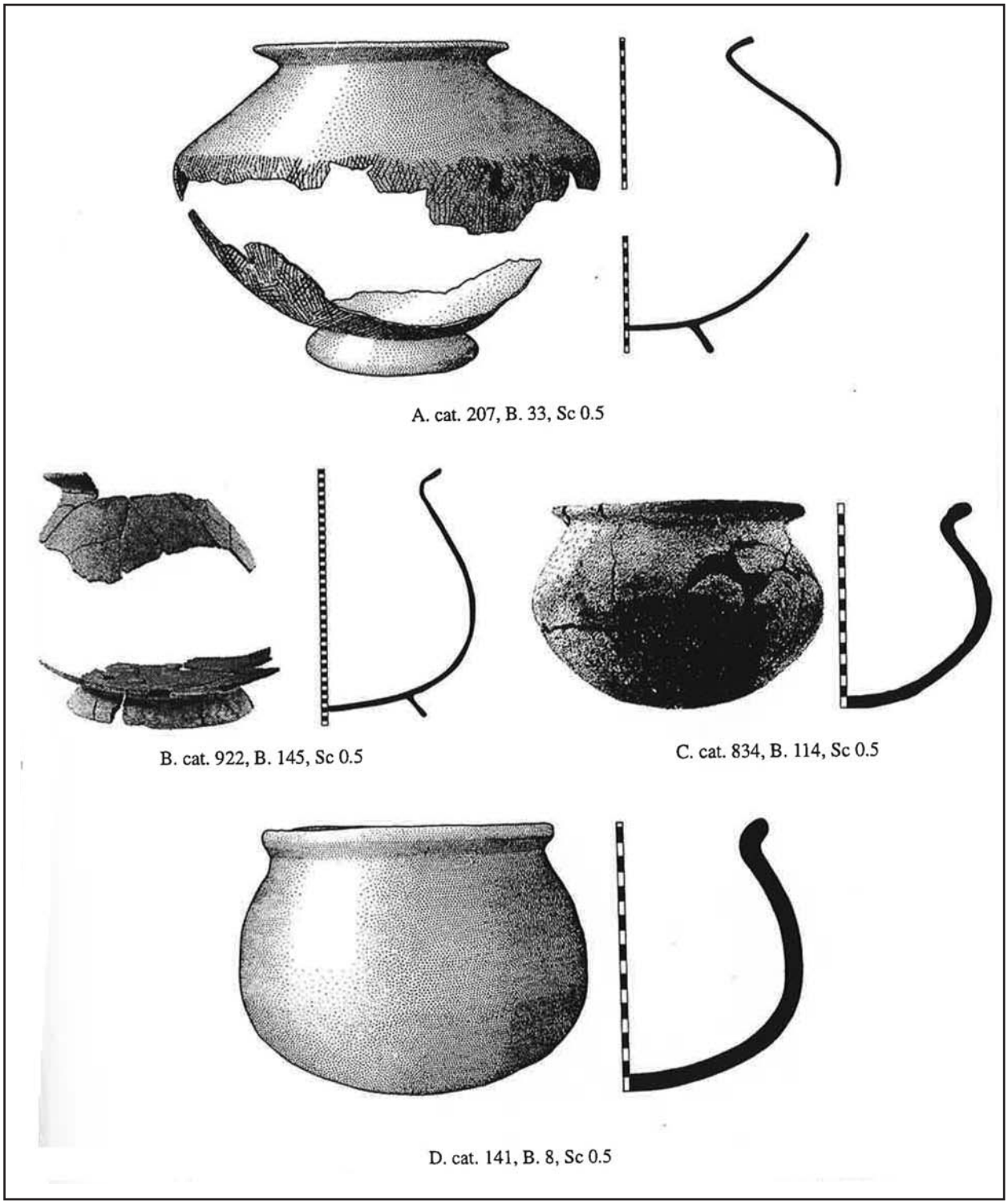


FIG. 70. Pottery vessels of form 4.2(A-B) and 5(C-D). Sc: Scale increments (cm)

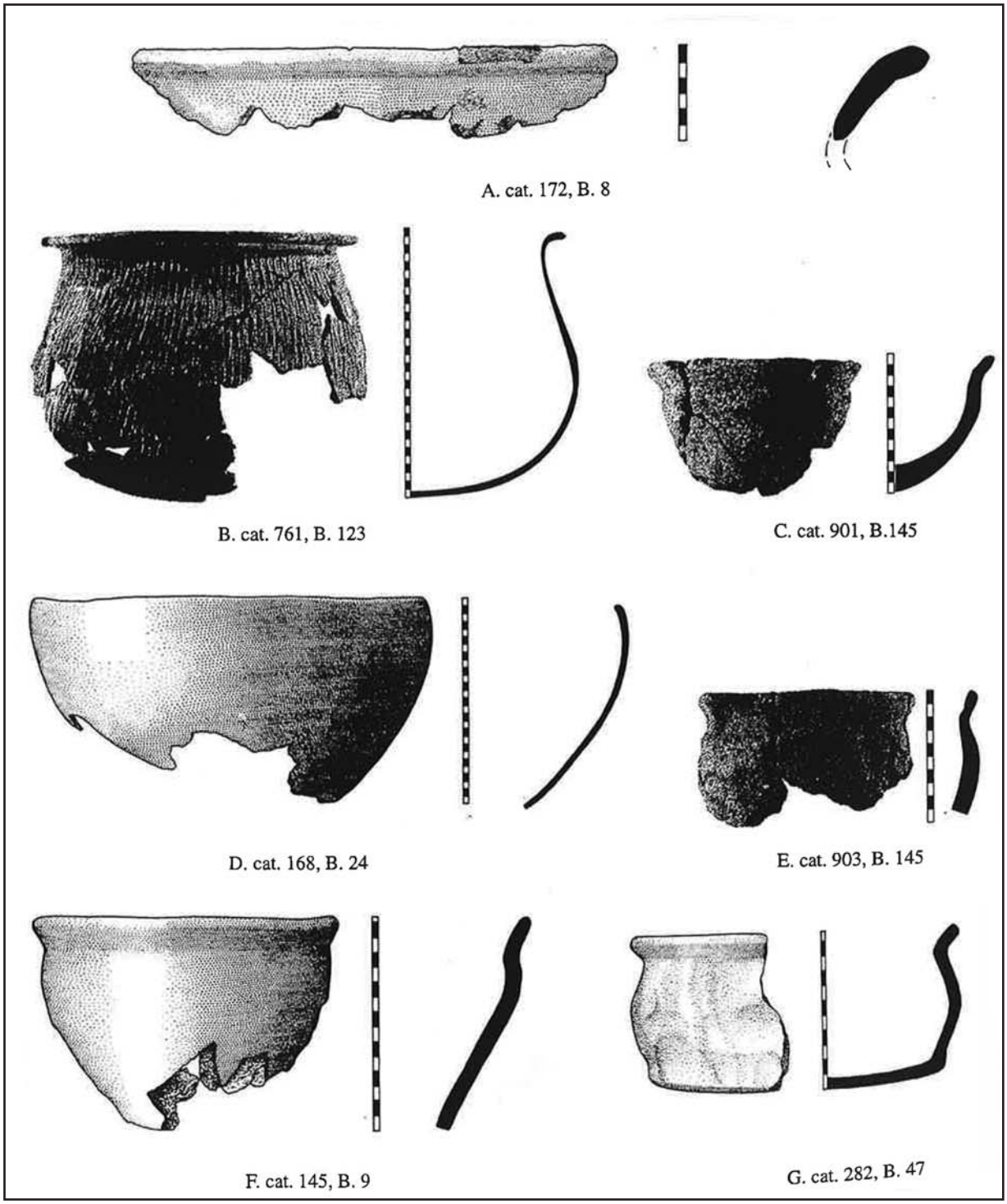


FIG. 71. Pottery vessels of forms 5(A-B) and 7(C-G). All scale increments O.5 cm

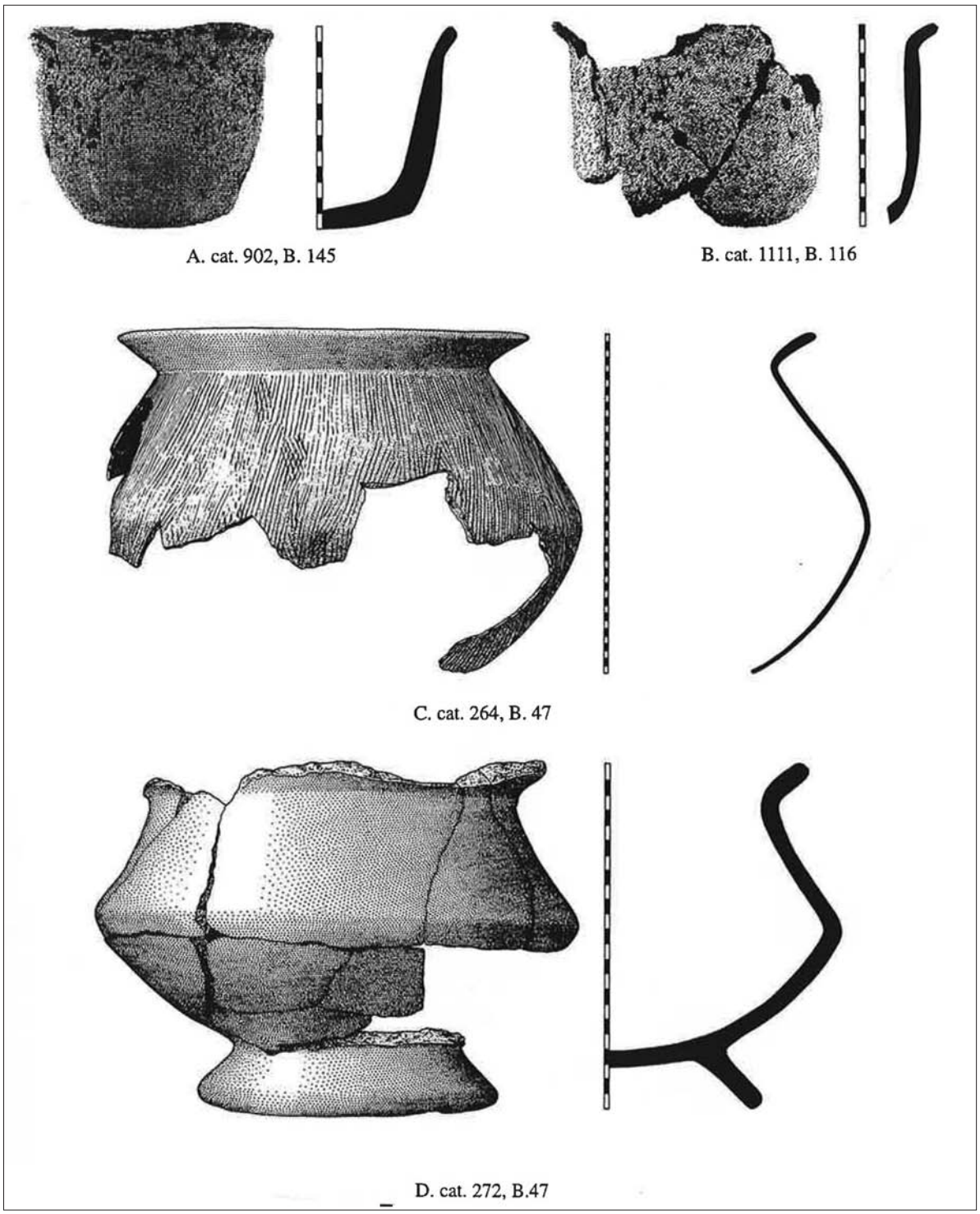


FIG. 72. Pottery vessels of forms 7(A-B), 9(C) and 10.1(D). All scale increments O.5 cm

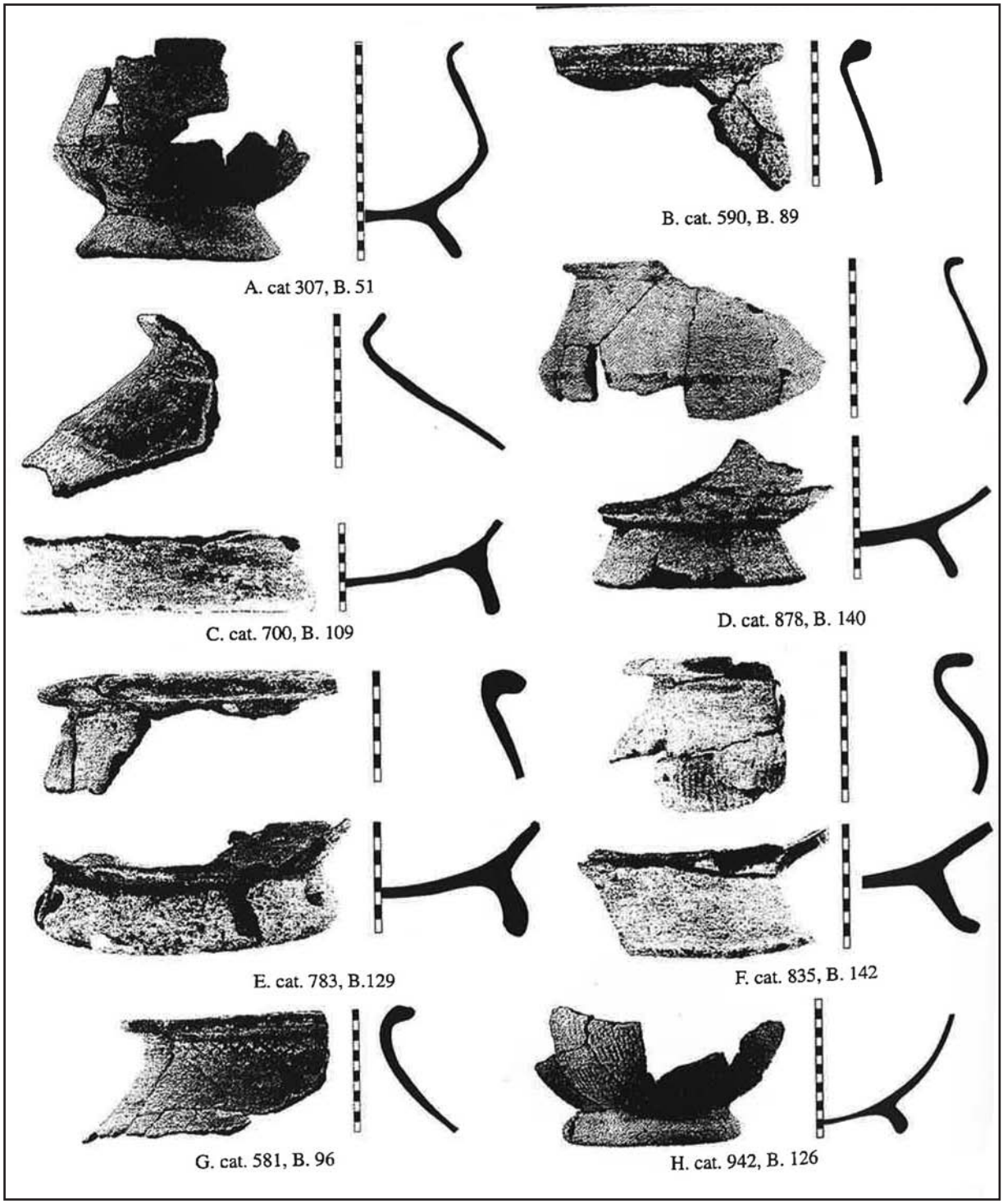


FIG. 73. Pottery vessels of forms 10.1(A-D) and 10.2(E-H). All scale increments O.5 cm

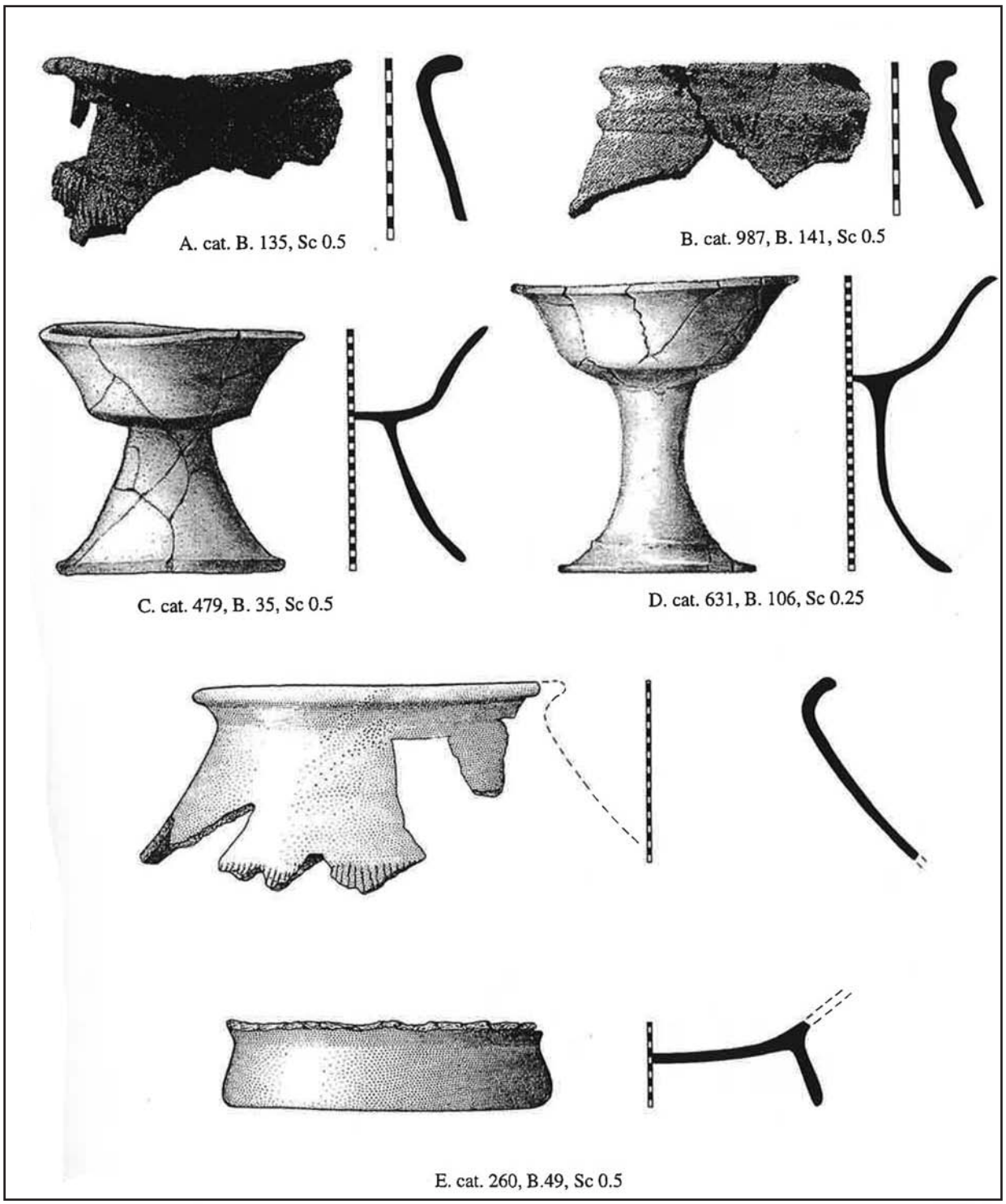


FIG. 74. Pottery vessels of forms 10.2(A-B,) 11(C-D) and 12(E). Sc: Scale increments (cm)

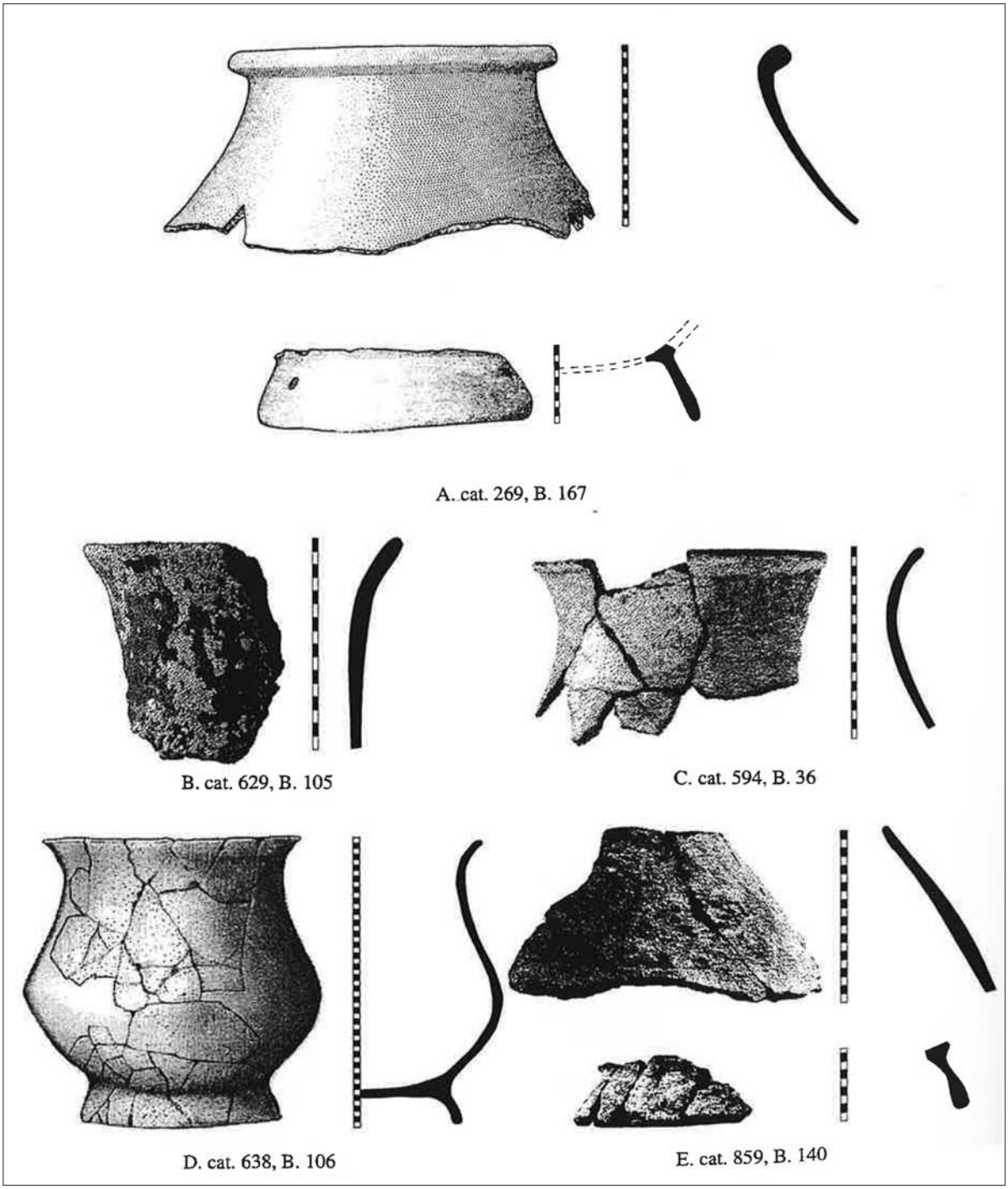


FIG. 75. Pottery vessels of form 12. All scale increments O.5 cm

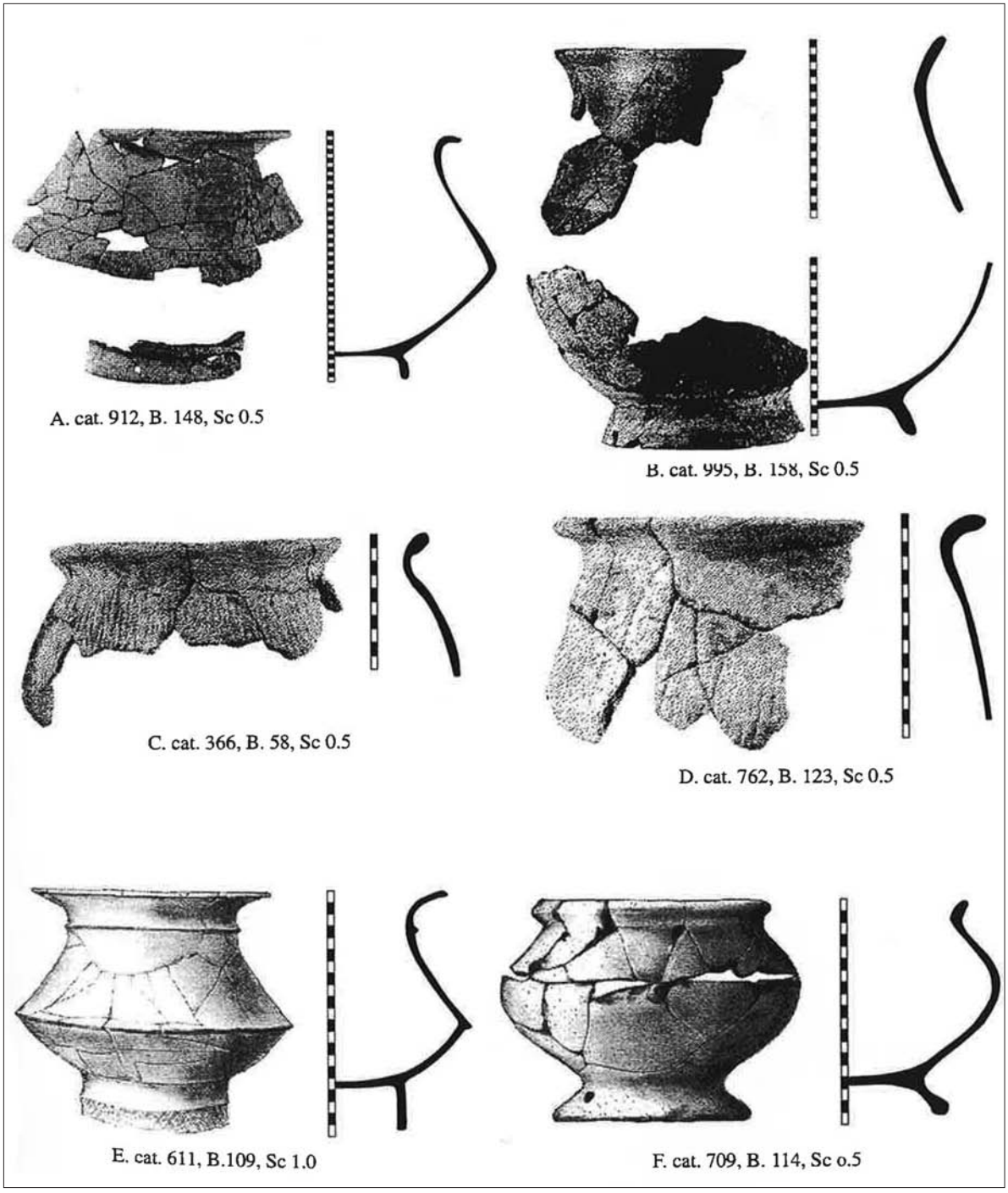


FIG. 76. Pottery vessels of form 12(A-B), 13(C-D), 14(E) and 15(F). Sc: Scale increments (cm)

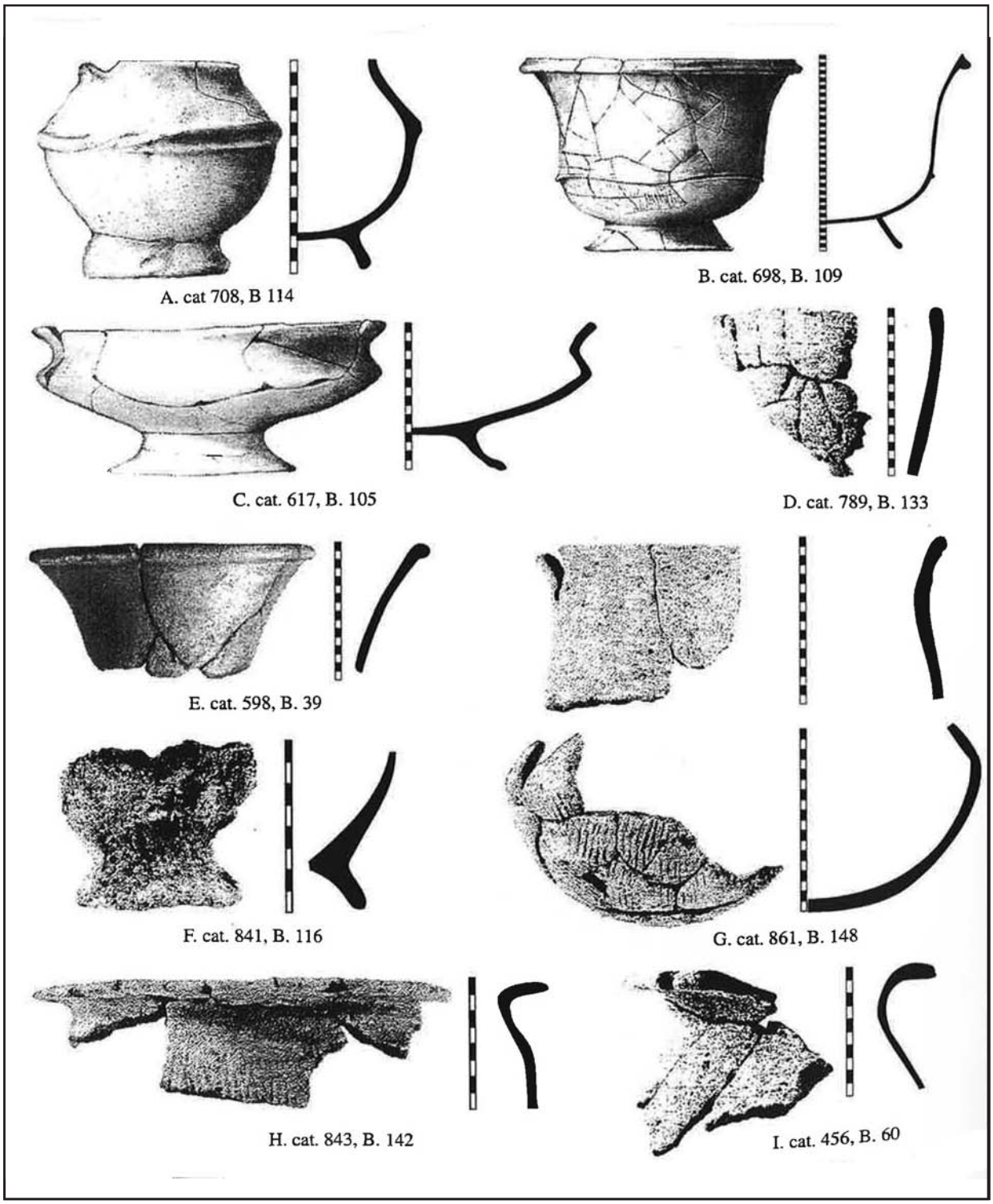


FIG. 77. Pottery vessels of form 16(A), 17(B), 18(C). 19(D) and 20(F). All scale increments O.5

TABLE 12 *(continued from page 241). Catalogue of the mortuary vessels*

Cat.	Burial	Form	Dec.	RW	BW	MW	BH	RH	Bo.H	TH	Stab.	Acc.
562	93	1	none	24.0	10.5	24.0	3.5	-	-	-	0.44	1.00
566	98	1	none	16.5	7.5	16.5	1.5	-	3.0	4.5	0.45	1.00
575	98	1	none	18.0	8.3	18.0	1.0	-	-	-	0.46	1.00
577	96	1	rs	-	-	-	-	-	-	-	-	1.00
578	96	1	rs	28.0	15.0	28.0	4.0	-	5.0	9.0	0.54	1.00
580	96	1	rs	18.0	-	18.0	-	-	-	-	-	1.00
583	85	1	none	9.0	4.0	9.0	0.5	-	3.0	3.5	0.44	1.00
601	39	1	rs	20.0	-	20.0	-	-	-	-	-	1.00
605	39	1	cm	16.0	-	16.0	-	-	-	-	-	1.00
613	109	1	rs, in	-	9.3	-	3.0	-	-	-	-	1.00
621	105	1	rs, cm	22.0	-	22.0	-	-	-	-	-	1.00
632	107	1	none	7.6	6.0	7.6	-	-	2.0	-	0.79	1.00
635	107	1	none	7.3	5.5	7.3	-	-	2.0	-	0.75	-
640	107	1	rs	17.2	9.0	17.2	-	-	-	-	0.52	1.00
643	107	1	none	30.0	14.2	30.0	3.0	-	87.0	11.0	0.47	1.00
650	107	1	none	20.6	-	20.6	-	-	-	-	-	1.00
651	106	1	rs	12.5	7.5	12.5	2.0	-	4.5	6.5	0.60	1.00
660	104	1	rs	24.0	12.0	24.0	3.5	-	-	-	0.50	1.00
665	106	1	rs	20.0	-	20.0	-	-	-	-	-	1.00
682	109	1	rs	24.0	7.0	24.0	2.0	-	-	-	0.29	1.00
683	109	1	rs	28.0	14.0	28.0	3.0	-	7.0	10.0	0.50	1.00
710	114	1	p	9.0	4.5	9.0	1.0	-	3.0	4.0	0.50	1.00
734	115	1	rs	36.0	-	36.0	-	-	-	-	-	1.00
758	129	1	rs, cm	-	-	-	-	-	-	-	-	1.00
759	127	1	rs	26.0	13.0	26.0	3.5	-	-	-	0.50	1.00
760	127	1	rs	-	-	-	-	-	-	-		1.00
763	123	1	rs	15.0	-	15.0	-	-	-	-	-	1.00
775	118	1	rs	17.0	-	17.0	-	-	-	-	-	1.00
776	118	1	rs	22.0	8.9	2.0	3.0	-	-	-	0.40	1.00
784	123	1	rs	20.0	-	20.0	-	-	-	-	-	1.00
785	123	1	none	11.2	4.3	11.2	1.5	-	2.3	3.8	0.38	1.00
786	123	1	none	26.0	13.0	26.0	3.0	-	-	-	0.50	1.00
814	143	1	rs	28.0	20.0	28.0	3.5	-	-	-	0.71	1.00
816	123	1	none	-	-	-	-	-	-	-	-	1.00
842	142	1	rs	27.0	14.8	27.0	3.0	-	7.0	10.0	0.55	1.00
845	133	1	rs	32.0	18.0	32.0	3.0	-	10.0	13.0	0.56	1.00
849	135	1	rs	24.0	13.0	24.0	2.5	-	-	-	0.54	1.00
853	140	1	rs	20.0	12.0	20.0	2.5	-	-	-	0.60	1.00

Dec: Decoration, RW: rim width, BW: base width, MW: maximum width, BH: base height, RH: rim height, Bo.H: body height, TH: total height, Stab: stability, Acc: access. *Decoration types:* rs: red slip, in: incised, cm: cord marked, p: punctuation, sm: smooth, ap: appliqué, im: impressed, st: stamp

TABLE 12 *(cont.). Catalogue of the mortuary vessels*

Cat.	Bur.	Form	Dec.	RW	BW	MW	BH	RH	Bo.H	TH	Stab.	Acc.
855	135	1	none	23.8	12.0	23.8	3.0	-	7.0	10.0	0.50	1.00
856	86	1	none	17.6	7.6	17.6	1.5	-	3.9	5.4	0.43	1.00
857	126	1	none	-	-	-	-	-	-	-	-	1.00
858	126	1	cm	-	12.0	-	3.0	-	-	-	-	1.00
866	126	1	rs	-	-	-	-	-	-	-	-	1.00
867	126	1	rs	-	-	-	-	-	-	-	-	1.00
904	145	1	none	9.0	5.0	9.0	1.0	-	3.0	4.0	0.56	1.00
908	145	1	none	-	-	-	-	-	-	-	-	1.00
909	145	1	none	11.0	-	11.0	-	-	3.5	-	-	1.00
911	145	1	none	26.0	-	26.0	-	-	-	-	-	1.00
928	147	1	rs	27.0	11.0	27.0	1.4	-	7.8	9.2	0.41	1.00
931	145	1	rs	-	-	-	-	-	-	-	-	1.00
932	14	1	rs, in	-	13.7	-	2.5	-	-	-	-	1.00
933	114	1	rs	13.3	6.3	13.3	2.0	-	3.6	5.6	0.47	1.00
941	34	1	none	-	-	-	-	-	-	-	-	1.00
970	134	1	none	16.5	7.6	16.5	1.3	-	3.5	5.4	0.46	1.00
974	146	1	rs	14.8	7.5	14.8	1.5	-	2.8	4.3	0.51	1.00
976	146	1	rs	10.5	5.5	10.5	1.0	-	3.5	4.5	0.51	1.00
978	146	1	none	58.0	22.0	58.0	2.0	-	16.0	18.0	0.38	1.00
980	146	1	rs	52.0	25.0	52.0	5.0	-	10.0	15.0	0.48	1.00
982	146	1	rs	24.0	10.0	24.0	3.0	-	11.0	14.0	0.42	1.00
986	146	1	none	63.0	30.0	63.0	4.0	-	16.0	20.0	0.48	1.00
994	141	1	none	14.5	4.0	14.5	3.6	-	3.4	7.0	0.28	1.00
1007	163	1	rs	36.0	21.0	36.0	3.5	-	10.5	14.0	0.58	1.00
1012	155	1	rs, cm	40.0	11.0	40.0	3.5	-	7.5	11.0	0.28	1.00
1032	109	1	rs	26.0	-	26.0	-	-	-	-	-	1.00
1110	116	1	none	7.0	-	7.0	-	-	2.0	-	-	1.00
1113	127	1	rs	10.0	4.3	10.0	1.5	-	4.5	6.0	0.45	1.00
178	33	2	rs, cm	-	9.5	16.0	2.0	4.0	-	-	0.59	-
275	47	2	rs, cm	13.5	-	17.5	-	4.0	-	-	-	0.77
412	66	2	rs, cm	-	-	-	-	-	-	-	-	-
454	60	2	rs, cm	-	16.0	-	-	-	-	-	-	-
603	39	2	rs, cm	-	-	-	-	-	-	-	-	-
618	105	2	rs, cm	14.0	12.5	18.0	3.0	1.0	-	-	0.69	0.78
619	105	2	rs, cm	22.0	-	-	-	-	-	-	-	-
66	15	3	sm	30.0	23.5	30.0	5.5	1.5	17.5	24.5	0.78	1.00
771	131	4	cm, sm	-	-	-	-	-	-	-	-	-
104	22	4.1	cm, sm, ap	19.0	-	29.0	-	2.5	-	-	-	0.66

Cat.	Bur.	Form	Dec.	RW	BW	MW	BH	RH	Bo.H	TH	Stab.	Acc.
510	81	4.1	none	24.0	-	36.0	-	1.5	-	-	-	0.67
567	98	4.1	sm, in	-	-	-	-	-	-	-	-	-
576	98	4.1	cm, sm	-	15.2	-	3.6	-	-	-	-	-
645	110	4.1	sm, ap, im	21.0	-	30.0	-	3.0	17.0	-	-	0.70
658	106	4.1	cm, sm, im, p	-	-	-	-	-	-	-	-	-
1004	141	4.1	rs, sm	20.0	-	24.0	-	-	-	-	-	0.83
1033	109	4.1	cm. sm	18.0	10.0	28.0	-	1.5	-	-	0.36	0.64
166	10	4.2	cm, sm	29.0	-	31.0	-	0.7	-	-	-	0.94
175	24	4.2	cm, sm	26.0	20.0	30.0	2.2	1.7	-	-	0.67	0.87
207	33	4.2	cm, sm	18.5	14.2	28.0	1.5	1.3	-	-	0.51	0.66
397	61	4.2	cm, sm	28.0	-	-	-	-	-	-	-	-
434	36	4.2	cm, sm	-	-	-	-	-	-	-	-	-
439	39	4.2	cm, sm	-	-	-	-	-	-	-	-	-
481	35	4.2	cm, sm	25.0	16.0	28.0	2.5	1.5	-	-	0.57	0.89
496	83	4.2	cm, sm	-	22.0	-	3.0	0.8	-	-	-	-
593	36	4.2	cm, sm	-	-	-	-	-	-	-	-	-
812	137	4.2	cm, sm	-	-	-	-	-	-	-	-	-
922	145	4.2	cm, sm	29.0	22.0	34.0	3.5	2.5	-	-	0.65	0.85
141	8	5	none	9.8	1.0	11.7	-	1.0	7.8	8.8	0.09	0.84
172	8	5	rs	18.0	1.0	-	-	-	-	-	-	-
761	123	5	cm	20.2	1.0	24.0	-	1.0	-	-	0.04	0.84
834	114	5	none	12.0	1.0	14.0	-	0.9	8.6	9.5	0.07	0.86
168	24	6	sm	29.0	1.0	29.0	-	-	-	-	0.03	1.00
838	133	6	cm, sm	29.0	1.0	29.0	-	-	13.0	13.0	0.03	1.00
892	133	2	cm, sm	29.0	1.0	29.0	-	-	13.0	13.0	0.03	1.00
145	9	7	none	10.0	5.5	10.0	1.0	1.3	4.9	7.2	0.55	1.00
282	47	7	none	9.0	6.5	9.0	0.6	0.8	4.1	5.5	0.72	1.00
570	98	7	none	10.0	-	10.0	-	1.0	-	-	-	1.00
787	123	7	none	-	-	-	-	-	-	-	-	1.00
901	145	7	none	10.0	-	10.0	-	-	6.5	6.5	-	1.00
902	145	7	none	8.5	5.5	8.5	-	1.0	6.0	7.0	0.65	1.00
903	145	7	none	8.3	-	-	-	0.3	-	-	-	1.00
905	145	7	none	-	-	-	-	-	-	-	-	1.00
906	145	7	none	9.6	6.0	9.6	-	1.0	8.2	9.2	0.63	1.00
1111	116	7	none	-	-	-	-	-	-	-	-	1.00
257	44	8	rs, cm	-	1.0	13.0	-	-	-	-	0.08	-
264	47	9	cm	27.0	-	35.0	-	1.5	-	-	0.03	0.77
1070	165	9	cm, sm	-	-	-	-	-	-	-	-	-
590	89	10	rs, cm	-	-	-	-	-	-	-	-	-

TABLE 12 *(cont.). Catalogue of the mortuary vessels*

Cat.	Bur.	Form	Dec.	RW	BW	MW	BH	RH	Bo.H	TH	Stab.	Acc.
762	123	10	rs, cm	14.0	10.3	16.0	2.3	1.0	-	-	0.88	0.64
272	47	10.1	rs	14.0	10.2	16.7	2.0	1.3	11.0	14.3	0.61	0.84
307	51	10.1	none	13.0	12.0	14.0	3.0	0.5	-	-	0.86	0.93
700	109	10.1	rs, cm	18.0	13.8	25.0	3.0	1.3	-	-	0.55	0.72
878	140	10.1	sm, in	16.0	11.2	18.0	2.7	0.6	-	-	0.62	0.89
581	96	10.2	rs, cm	-	-	-	-	-	-	-	-	-
783	129	10.2	rs, cm, in	16.0	11.0	-	2.5	1.0	-	-	-	-
835	142	10.2	rs, cm	19.0	12.6	19.0	3.2	0.7	7.6	11.5	0.66	1.00
865	126	10.2	rs	13.5	9.5	14.0	2.0	0.7	6.3	9.0	0.68	0.97
942	145	10.2	cm, sm, p	16.0	11.0	18.0	2.0	2.0	13.0	17.0	0.61	0.89
957	135	10.2	rs, cm	-	-	-	-	1.5	-	-	-	-
979	146	10.2	cm	24.0	16.0	24.0	3.0	2.0	19.0	24.0	0.67	1.00
981	146	10.2	rs	28.0	18.0	31.0	4.0	2.0	22.0	28.0	0.58	0.90
983	146	10.2	rs	16.0	18.0	25.0	3.0	2.0	19.0	24.0	0.72	0.64
987	141	10.2	rs, in	-	-	-	-	-	-	-	-	-
479	35	11	sm	20.0	18.0	20.0	11.0	-	7.0	18.0	0.90	1.00
631	106	11	sm	12.5	8.5	12.5	8.0	-	4.5	12.5	0.68	1.00
260	49	12	rs, cm	26.0	21.0	42.0	4.0	2.5	-	-	0.50	0.62
269	167	12	rs, cm, p	23.0	18.0	30.0	4.5	1.5	-	-	0.60	0.77
594	36	12	rs, cm	24.0	-	-	-	-	-	-	-	-
629	105	12	rs	-	-	-	-	-	-	-	-	-
638	106	12	rs	25.0	18.0	29.0	3.0	3.0	21.0	27.0	0.62	0.86
859	140	12	rs, cm	-	17.0	30.0	4.5	-	-	-	0.57	-
912	148	12	rs, cm	27.0	21.0	32.0	3.5	1.5	-	-	0.66	0.84
936	158	12	rs, cm	22.0	10.0	26.0	2.5	2.0	18.5	23.0	0.38	0.85
995	168	12	rs, cm	31.0	21.0	36.0	3.8	1.0	24.0	28.8	0.58	0.86
1116	169	12	rs, cm	-	-	-	-	-	-	-	-	-
366	58	13	cm	10.8	-	-	-	1.5	-	-	-	-
801	127	13	rs, cm	12.0	7.6	-	2.0	-	-	-	-	-
827	126	13	rs, cm	14.0	8.0	18.0	1.5	1.0	-	-	0.44	0.78
828	126	13	rs, cm	17.0	6.5	-	2.0	-	-	-	-	-
611	109	14	sm, in, ap	14.0	22.0	25.0	4.0	4.0	14.0	22.0	0.88	0.56
709	114	15	rs, p	10.0	8.5	13.0	1.5	1.0	7.0	9.5	0.65	0.77
708	114	16	rs	6.0	5.5	9.5	1.0	-	7.0	8.0	0.92	0.63
698	109	17	cm	38.0	20.0	38.0	4.0	2.0	20.0	26.0	0.53	1.00
617	105	18	rs	19.0	10.0	19.0	2.3	1.5	4.2	8.0	0.53	1.00
789	133	19	in, st	-	-	-	-	-	-	-	-	-
795	133	19	in, st	-	-	-	-	-	-	-	-	-

Cat.	Bur.	Form	Dec.	RW	BW	MW	BH	RH	Bo.H	TH	Stab.	Acc.
598	39	20	none	18.3	9.5	18.3	-	-	8.5	8.5	0.52	1.00
600	39	20	none	24.0	16.0	24.0	-	0.8	5.5	6.3	0.67	1.00
134	29	-	rs, cm	-	-	-	-	-	-	-	-	-
146	9	-	rs, cm	-	-	-	-	-	-	-	-	-
158	23	-	rs	-	-	-	-	-	-	-	-	-
164	28	-	rs	26.0	23.0	26.0	6.3	-	-	-	0.89	1.00
169	24	-	rs	-	-	-	-	-	-	-	-	-
182	35	-	cm	-	-	-	-	-	-	-	-	-
191	8	-	rs, cm	-	-	-	-	-	-	-	-	-
210	36	-	rs	-	-	-	-	-	-	-	-	-
211	36	-	cm	-	-	-	-	-	-	-	-	-
228	43	-	rs, cm, p	-	20.6	-	5.9	-	-	-	-	-
242	44	-	rs	-	-	-	-	-	-	-	-	-
243	44	-	cm	-	-	-	-	-	-	-	-	-
259	50	-	rs, cm	-	26.0	-	5.0	-	-	-	-	-
300	37	-	rs	15.0	-	-	-	-	-	-	-	-
330	54	-	none	-	-	-	-	-	-	-	-	-
351	52	-	rs, cm	-	-	-	-	-	-	-	-	-
355	56	-	rs	-	-	-	-	-	-	-	-	-
361	57	-	cm	-	-	-	-	-	-	-	-	-
365	58	-	rs, cm	-	-	-	-	-	-	-	-	-
437	36	-	rs	26.0	16.0	26.0	-	-	-	-	0.62	1.00
441	39	-	rs, cm	-	24.5	-	4.2	-	-	-	-	-
445	73	-	rs	-	25.0	-	6.0	-	-	-	-	-
446	68	-	none	24.0	-	-	-		-	-	-	-
455	60	-	none	19.0	-	19.0	-	-	-	-	-	1.00
456	60	-	rs	24.0	17.0	-	3.2	2.5	-	-	-	-
480	35	-	rs	-	-	-	-	-	-	-	-	-
483	35	-	rs	-	-	-	-	-	-	-	-	-
485	35	-	rs	-	-	-	-	-	-	-	-	-
494	91	-	rs	-	24.0	-	6.0	-	-	-	-	-
541	83	-	none	-	7.0	-	-	1.2	-	-	-	-
545	75	-	rs	17.0	13.0	-	2.2	2.5	-	-	-	-
561	93	-	rs, in, ap	-	18.0	27.0	4.0	-	-	-	0.67	-
564	93	-	rs, cm	-	-	-	-	-	-	-	-	-
574	98	-	cm	-	-	-	-	-	-	-	-	-
579	96	-	rs	-	-	-	-	-	-	-	-	-
584	85	-	none	-	-	-	-	-	-	-	-	-
585	85	-	rs	-	-	-	-	-	-	-	-	-

TABLE 12 *(cont.). Catalogue of the mortuary vessels*

Cat.	Bur.	Form	Dec.	RW	BW	MW	BH	RH	Bo.H	TH	Stab.	Acc.
587	99	-	none	-	-	-	-	-	-	-	-	-
597	39	-	rs	-	-	-	-	-	-	-	-	-
612	109	-	rs	-	10.4	-	2.0	-	-	-	-	-
633	107	-	none	-	7.0	-	-	-	-	-	-	-
634	107	-	none	-	-	-	-	-	-	-	-	-
636	107	-	none	-	-	-	-	-	-	-	-	-
648	77	-	rs	-	-	-	-	-	-	-	-	-
657	111	-	rs	-	-	-	-	-	-	-	-	-
770	131	-	cm	-	-	-	-	-	-	-	-	-
777	118	-	rs	-	21.0	-	5.0	-	-	-	-	-
778	119	-	rs, cm	-	24.0	-	6.0	-	-	-	-	-
779	122	-	none	-	-	-	-	-	-	-	-	-
782	128	-	rs	-	7.3	-	2.2	-	-	-	-	-
788	135	-	rs, cm	-	-	-	-	-	-	-	-	-
791	133	-	rs	-	15.0	-	3.8	-	-	-	-	-
797	139	-	cm	-	-	-	-	-	-	-	-	-
800	118	-	cm	-	-	-	-	-	-	-	-	-
807	132	-	cm	-	-	-	-	-	-	-	-	-
824	38	-	rs, cm	-	-	-	-	-	-	-	-	-
836	114	-	rs, cm	-	24.0	-	3.5	-	-	-	-	-
837	114	-	rs	-	-	-	-	-	-	-	-	-
840	144	-	cm	-	-	-	-	-	-	-	-	-
841	116	-	none	-	-	-	-	-	-	-	-	-
843	142	-	rs, cm	-	-	-	-	-	-	-	-	-
852	135	-	none	-	-	-	-	-	-	-	-	-
860	135	-	cm	-	-	-	-	-	-	-	-	-
861	148	-	rs, cm	13.0	-	-	-	-	-	-	-	-
863	136	-	cm	-	-	-	-	-	-	-	-	-
868	86	-	cm	-	-	-	-	-	-	-	-	-
870	146	-	rs	-	-	-	-	-	-	-	-	-
920	120	-	cm	-	-	-	-	-	-	-	-	-
924	138	-	cm	-	-	-	-	-	-	-	-	-
937	159	-	rs, cm	-	-	-	-	-	-	-	-	-
939	161	-	rs	-	26.0	-	5.0	-	-	-	-	-
977	146	-	none	-	-	-	-	-	-	-	-	-
992	158	-	rs	-	-	-	-	-	-	-	-	-
1003	122	-	none	-	-	-	-	-	-	-	-	-
1013	155	-	none	45.0	11.0	45.0	3.0	-	12.0	15.0	0.24	1.00

Cat.	Bur.	Form	Dec.	RW	BW	MW	BH	RH	Bo.H	TH	Stab.	Acc.
1030	14	-	rs	55.0	9.0	-	1.5	-	-	-	-	-
1040	138	-	none	-	-	-	-	-	-	-	-	-
1045	165	-	cm	-	-	-	-	-	-	-	-	-
1046	117	-	none	-	-	-	-	-	-	-	-	-
1240	170	-	rs, cm	-	-	-	-	-	-	-	-	-
1241	154	-	rs, cm	-	-	-	-	-	-	-	-	-

XVI. THE PERSONAL ORNAMENTS

N.J. Chang

INTRODUCTION

DURING the excavation of Nong Nor, a wide range of personal ornaments was recovered, both in terms of form and material used. This chapter will provide a descriptive typology, in order to facilitate an understanding of the relationships between graves on the basis of age, gender and location within the cemetery. It first divides the ornaments on the basis of class, and then form. Following Kenoyer (1991:82), the following classes were identified:

1. Bead - any object that is perforated along its major axis, generally worn on a cord or a wire, sewn onto clothing or used as an ornament.

2. Pendant - any object that is perforated or scored at one end, *or otherwise hung from one end*, and is hung or attached to a cord or a wire, sewn onto clothing or used as an ornament (italics mine).

3. Bangle - any circlet (closed or open) made of a continuous homogenous material that can be worn on the arm.

4. Bracelet - any circlet made of components such as beads, chain or cord, etc. that can be worn on the arm.

5. Anklet - any circlet made of components such as beads, chain or cord, etc that can be worn on the ankle.

6. Solid Anklet - any circlet (closed or open) made of a continuous homogeneous material that can be worn on the ankle.

7. Necklace - any circlet made of components such as beads, chain or cord, etc. that can be worn around the neck.

8. Earring - any object, either of a homogeneous material or of composite manufacture, that is attached to, or hung from, the ear.

9. Miscellaneous - any object for which the primary purpose is ornamental but which does not fit into the previously defined groups.

Artefacts within these classes have been further subdivided according to material and form, and will be described by incorporating the following variables:

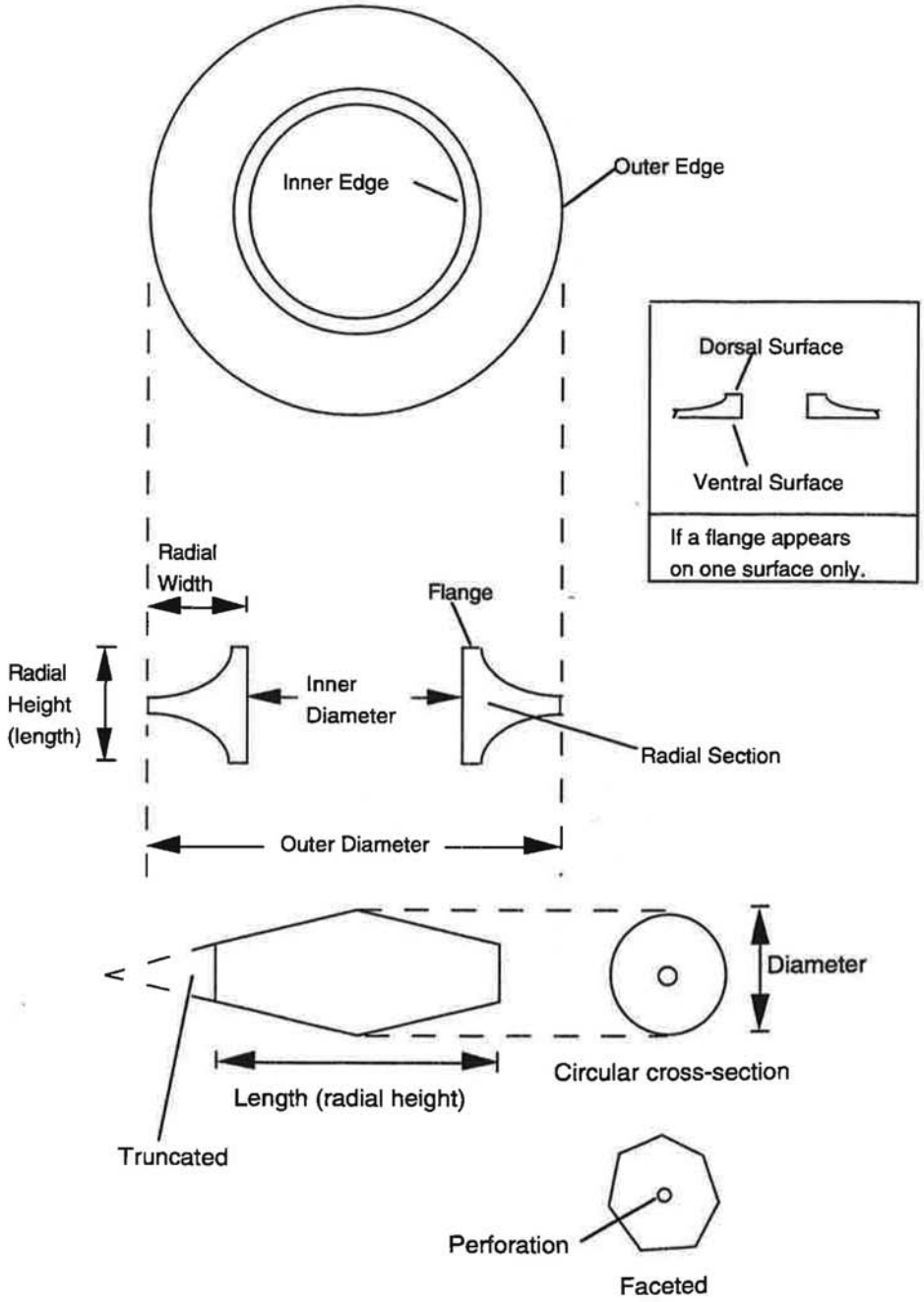


FIG. 78. Schematic illustration depicting descriptive terminology for bangles and beads. The bead shown in longitudinal section is biconical in shape

Catalogue number (cat.) - the identification number for each artefact.

Context within the site. Most involve a burial (B), but some were found in layers within the site (L).

Material was identified by eye and under hand-lens and stereoscope magnification. G. Mason has identified many of the materials, and Dr A. Reay has identified the tin and limestone-marble bangles.

Decoration - a simple description of any decoration on the surface of the artefact. This was very rare.

Dimensions recorded varied with the artefact type. Figure 78 illustrates those recorded for bangles and beads, as well as the relevant terminology. In cases of corroded or otherwise irregular artefacts, measurements were taken at the least corroded or most 'representative' points. For rigid artefacts, where the diameter varied, the largest measurement was taken. Second diameter measurements were always taken at right angles to the first. All measurements were recorded in millimetres.

BEADS

Various schemes have been proposed for the classification of prehistoric beads (Beck 1928, Bennyhoff and Hughes 1987, King 1990, Kenoyer 1991, Pilditch 1993). A relatively simple scheme has been used, based upon Pilditch's methodology at Ban Na Di and Khok Phanom Di (Pilditch 1986, 1993).

Shell

The vast majority of beads at Nong Nor are made of shell, and have been assigned four forms: disc, barrel, long barrel and spherical-carinated.

Disc Beads. These beads have a circular cross-section (transverse section) and a rectangular longitudinal section. In Kenoyer's (1991) terminology, they would ideally have a length measuring less than one third their diameter. However, length (or thickness) is more variable at Nong Nor, and for some is greater than one third the diameter. The designation of these as disc beads is based on their inclusion in strings where they fall at one end of a continuous scale of variation. One interesting example is cat. 378, identified as a belt, from B 58. This includes a large proportion of thick disc beads, all with relatively large perforations (one third or more of the total diameter). These were made from a thick-shelled bivalve, probably tridacna, suggesting that material significantly affects form.

The beads were passed through a graded series of sieves to establish the size distribution. In part, this was an attempt to replicate a technique employed by Pilditch (1993) at Khok Phanom Di. It was not possible to replicate her sieve series. Although her series ran in roughly 0.5 mm steps, investigations revealed that scientific sieves are produced in a variety of geometric, rather than arithmetic, series. This is reflected by the uneven steps in Pilditch's scheme. The Nong Nor sample is described using the international standard phi (ø) series of sieve sizes (Endecotts 1977). Table 13 outlines the relationship between the two size classification schemes.

Table 13. *The relationship between Nong Nor and Khok Phanom Di sieve series. The Phi (ø) series (NN) can be extended, and further subdivisions made, according to table 3.7 in Endecotts (1977)* Test Sieving Manual

(NN)	(mm)	(mm)	(KPD)	(mm)	(mm)
One	>0.71-1.0	0.29			
Two	>1.00-1.4	0.40	One	1.20-2.29	1.09
Three	>1.40-2.0	0.60			
Four	>2.00-2.8	0.80	Two	2.30-2.79	0.49
Five	>2.80-4.0	1.20	Three	2.80-3.39	0.59
			Four	3.40-3.89	0.49
Six	>4.00-5.6	1.60	Five	3.90-4.49	0.59
			Six	4.50-6.00	1.50
Seven	>5.60-8.0	2.40	Seven	≥6.00- ∞	∞
Eight	>8.00-11.2	3.20			
Nine	>11.20-16.0	4.80			

A total of 5474 disc beads have been analysed, of which 4766 are associated with burials, the remainder being found on the surface or loose within the midden. None fell through the 1.4 mm (-0.5 ø) sieve and the maximum diameter (measured directly) is about 12.8 mm. Over 40 per cent were retained in the 2.8 mm (-1.5 ø) sieve. That is, they have a maximum dimension between 2.8-4.0 mm (Fig. 79). Discounting those where size could not be determined, a normal distribution is indicated.

Barrel Beads. This term has been widely used, yet it is poorly defined in the archaeological literature. The level of variation that may be included, for example, has not been specified. At Nong Nor this term includes classic barrel-shaped beads with truncated elliptical longitudinal sections and circular transverse sections as well as cylinders and shorter, almost spherical, beads. Beads with curving longitudinal sections may or may not be truncated at the ends. Cross-sections vary from blunt triangular to circular and elliptical and in some cases are quite flat. Some are very regular in section and carefully finished, but others received little such treatment.

Long Barrel Beads. Almost all these beads come from a single artefact (a necklace in B 32, cat. 163). These are best considered a sub-type of the barrel beads where the ratio of length/width is ≥ 2.5. Figure 80 indicates why this ratio value is chosen to differentiate barrel and long barrel beads.

Spherical-Carinated Beads. There are thirteen beads of this distinctive form. They are nearly spherical with a carination running around the equator (where perforations occupy the poles). Length is usually slightly shorter than diameter, producing, in effect, a very short bicone.

Stone Beads

There are eight stone beads, seven from burials. They occur in carnelian and serpentine. The former are found in three forms, sub-spherical, barrel and faceted-barrel. Serpentines occur in

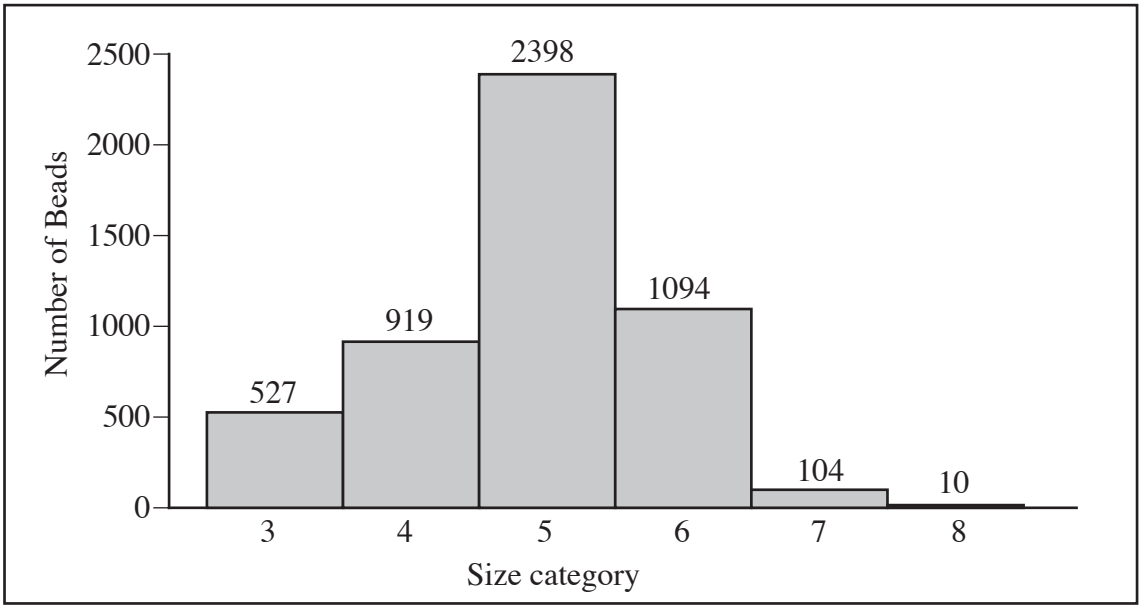


FIG. 79. The distribution of disc beads, sorted by size category. A normal distribution is indicated, centred on size 5 (also 422 beads were unable to be assigned to a size category)

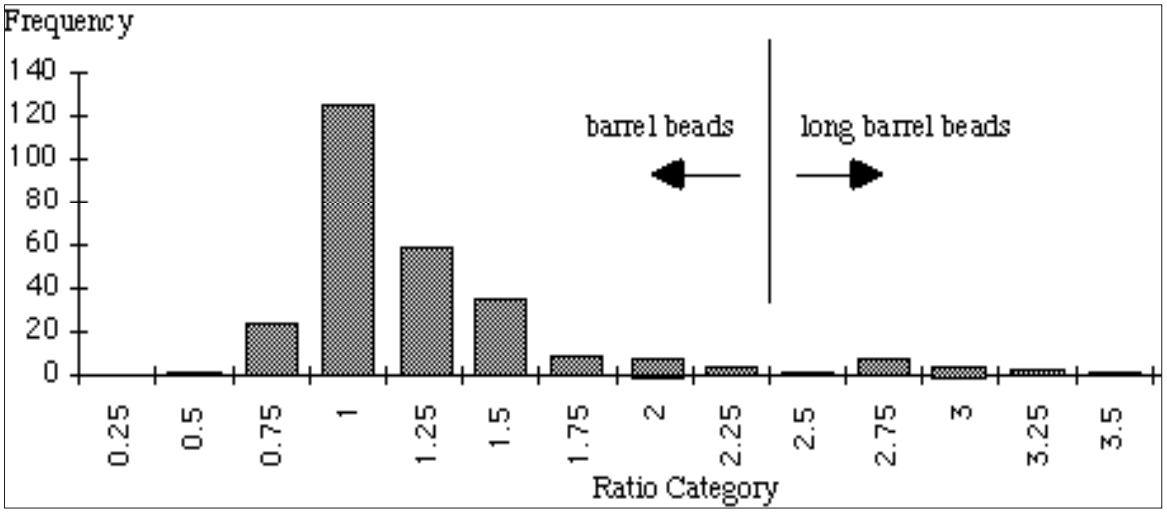


FIG 80. Histogram showing the distribution of the ratio length/width for barrel beads. A bimodal distribution is indicated with a probable demarcation at the ratio value of 2.5. Figures on the X-axis (Ratio Category) represent the lowest value in each category (rather than the mid-point)

spherical and faceted-barrel forms.

Serpentine Beads

Spherical. A single bead in black serpentine was associated with B 107. It was neatly finished.

Faceted-barrel. Two beads were found in the mouth of B 8. Neither is carefully finished, both exhibiting irregular polygonal transverse sections.

Carnelian Beads

Sub-spherical. Three beads were found with B 40, shaped as if a sphere were squashed by pressure from both ends. The perforations are relatively large and crudely formed.

Barrel. One bead was collected as a surface find. It was neatly finished with a symmetrical longitudinal section, circular transverse section and finely drilled perforation.

Faceted-Barrel. One bead, found with B 40, together with the three sub-spherical beads. It was neatly finished with a fine and well-formed perforation. The transverse section is square with rounded corners.

Stone belt ornament

This cylindrical serpentine ornament was found in the pelvis region of B 83. It is bead-like in shape, very long (99 mm), tapering slightly to one end and cut diagonally across the long axis at the ends. It is perforated longitudinally.

TABLE14. *Stone barrel beads of form 1-4*

Form	Cat. No.	Context	Material	L.	D.1	D.2	P.D.
1	4	Surface	Carnelian	9.10	5.65	5.65	1.30
2	231a	B 40	Carnelian	12.15	6.05	5.80	1.20
2	237a	B 8	Serpentine	13.50	7.00	7.25	2.65
2	237b	B 8	Serpentine	7.35	5.15	5.65	2.35
3	6	Surface	Carnelian	6.60	10.10	-	2.00
3	231b	B 40	Carnelian	6.20	9.80	9.60	1.85
3	231c	B 40	Carnelian	5.80	9.15	9.40	2.20
3	231d	B 40	Carnelian	5.15	8.40	8.50	2.00
3	674	B107	Serpentine	6.10	6.40	6.25	2.00
4	522	B 83	Serpentine	99.00	14.20	14.00	5.10

L.: Length, D.1: Diameter 1, D.2 : Diameter 2, P.D.: Perforation Diameter

Barrel/rod. Two very small glass beads were recovered, one blue-green and the other pale yellow. Both were found loose in the midden and cannot be considered to have been *in situ*. Both have circular transverse sections.

Disc. A single opaque, brick-orange coloured bead found during post-excavation cleaning of the

femur of B 56.

Clay beads

Spherical . A single sandy-brown coloured bead was included in B 107.

TABLE 15. *Glass and clay beads*

Form	Cat. No.	Context	Material	Colour	L.	D.1	D.2	P.D.
1	152	A1-A L2:3	Glass	Opaque powdery green	4.15	4.70	7.30	1.55
1	223	A1-1 L2:3	Glass	Opaque sandy yellow	4.50	4.20	4.25	1.20
1	950	A12 disturbed	Glass	Opaque blue/green	3.45	3.90	3.90	1.50
2	304	B 56	Glass	Opaque brick orange/brown	1.60	5.20	-	2.55
3	675	B 107	Clay	Yellow/brown	6.40	6.70	7.45	1.20

L: Length, D.1: Diameter 1, D.2: Diameter 2, P.D.: Perforation Diameter

Beads as composite artefacts

Beads are usually components of composite artefacts (Table 16). Identification of such ornaments was based predominantly on their location with respect to the body. These identifications may be insecure. For example, those identified as belts may actually have been attached to clothing. The general lack of ordered arrangement of the beads when excavated argues against this interpretation; Garanger (1972: figs. 47, 104, 162 and 181) has shown the expected patterning when embroidered disc beads are encountered during excavation. However, the level of disturbance at Nong Nor may preclude the survival of such arrangements. In any case, such clear patterning was not noted during excavation and a level of ambiguity persists.

Table 16 indicates that disc beads are by far the most numerous components of composite artefacts, less than half of those recovered have anything else and only four have no disc beads. Only three artefacts have significant numbers of non-disc shell beads and two of these also include very large numbers of disc beads. One spherical-carinated bead is represented *in situ*. Beads of materials other than shell are rare in these artefacts.

PENDANTS

This is a conspicuous class at Nong Nor. Initially it was difficult to decide whether these should be considered separately from the beads, because most are perforated along their length rather than at one end. However, these artefacts are found in the chest or neck area in a position that indicating that they hung vertically, rather than horizontally as a bead. As well as shell, pendants are made of bronze and perforated animal teeth.

Shell

This is the least modified of the ornaments at Nong Nor. Made from a large shell (perhaps tridacna), these are generally pendulum shaped, varying from 57-114 mm in length. Some are sinuous in outline giving the effect of a scimitar blade rather than a symmetrical pendulum. They recall

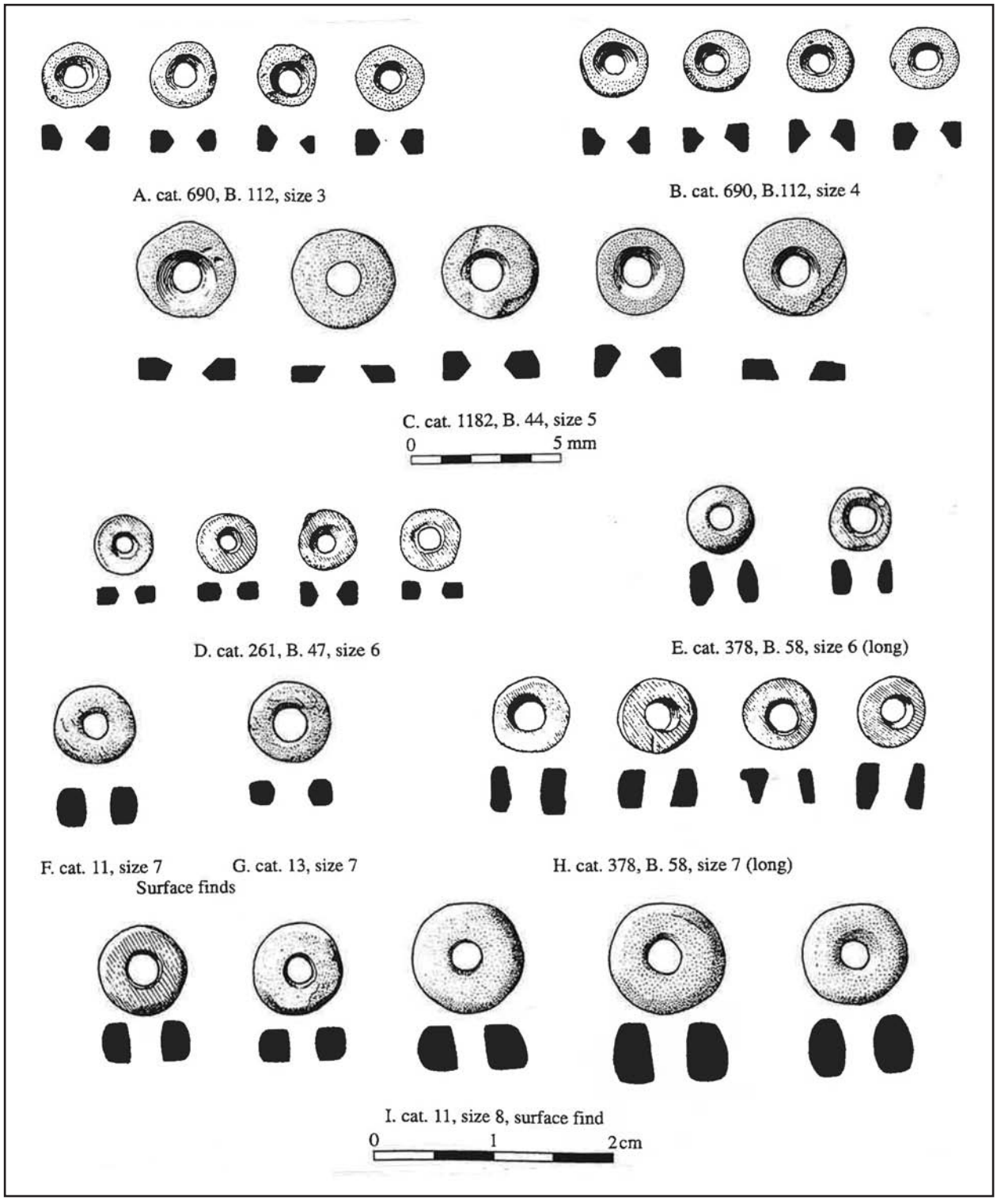


FIG. 81. Disc beads, sizes 3-8

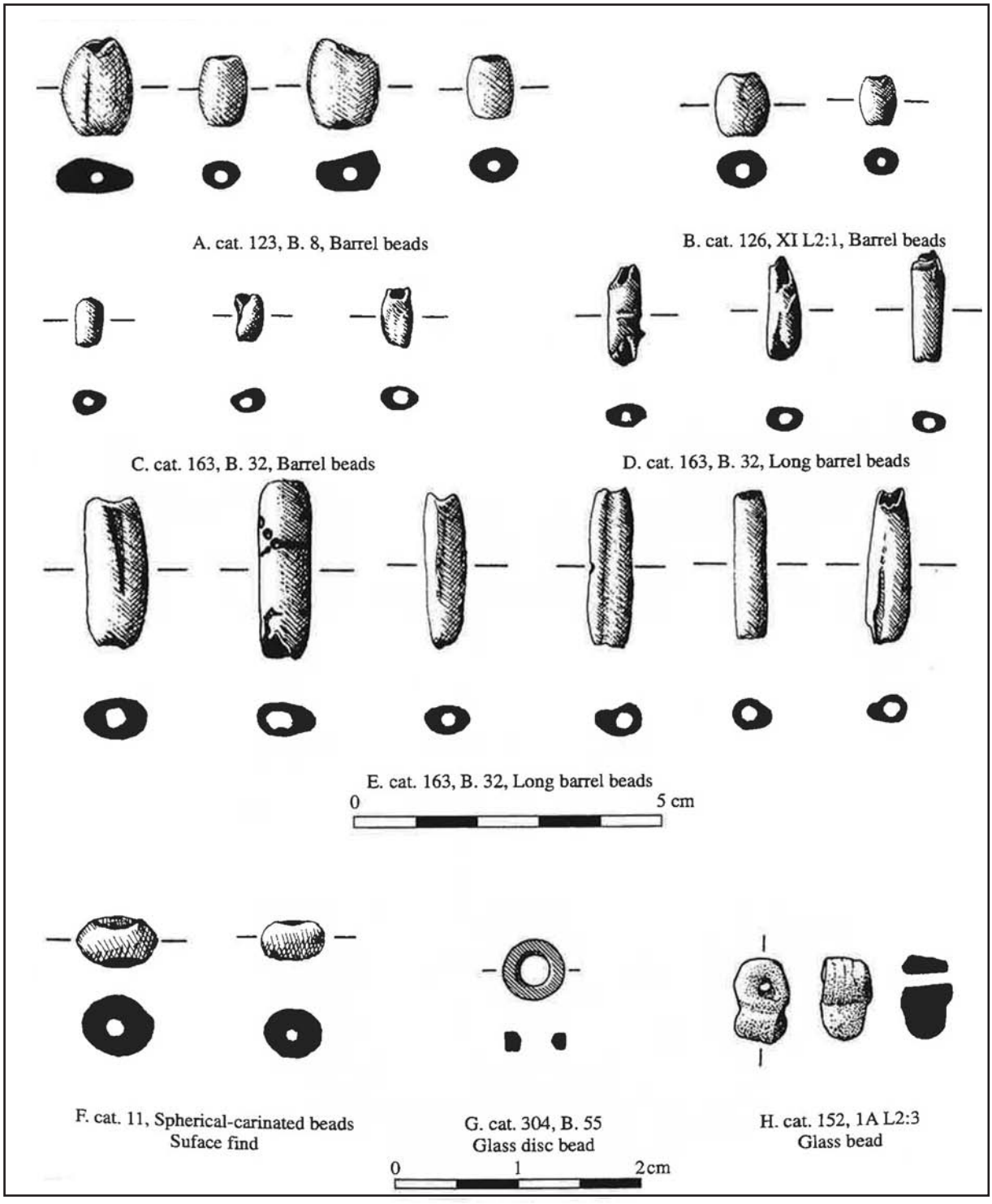


FIG. 82. Shell and glass beads

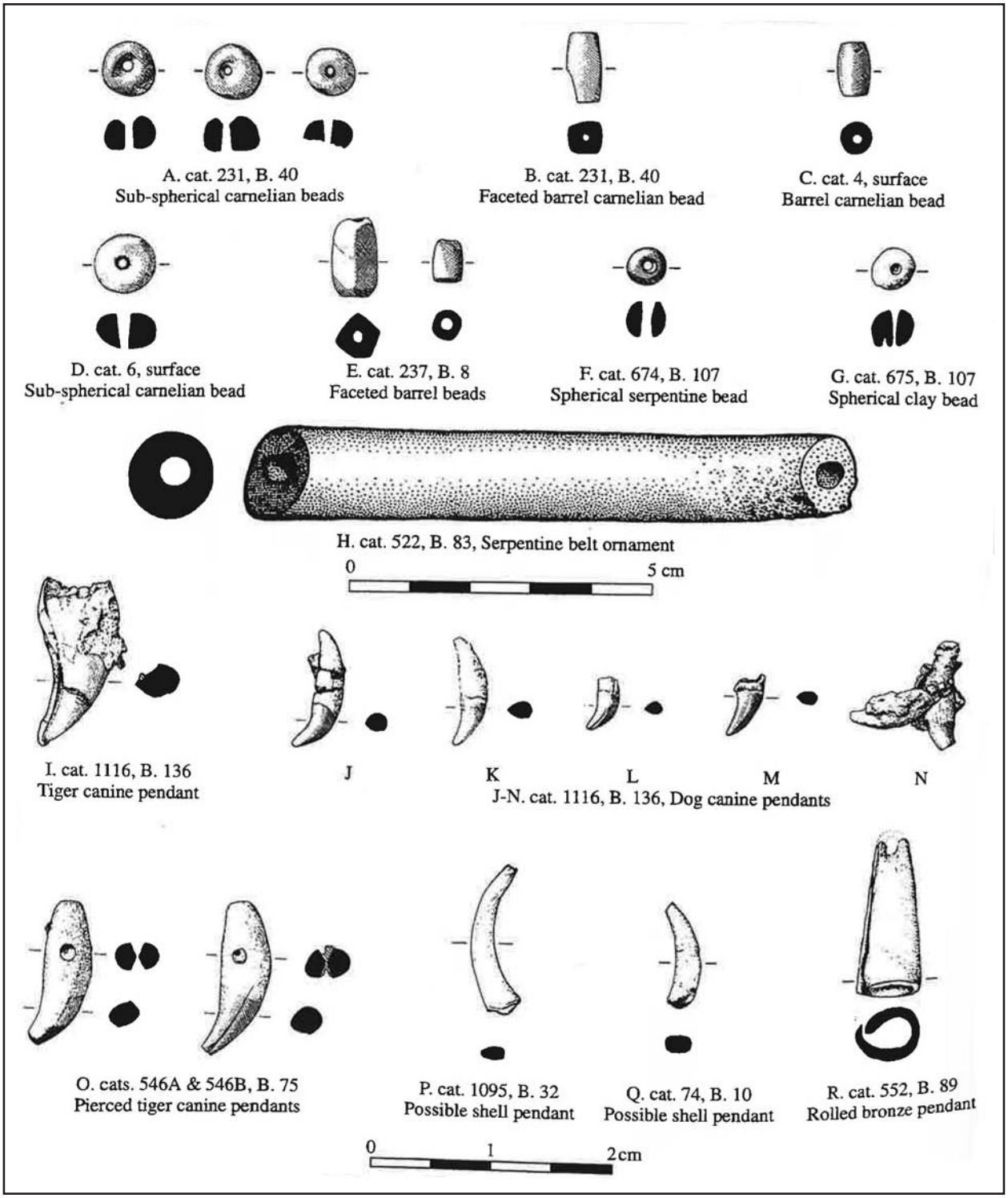


FIG. 83. Stone & clay beads (A-H), animal tooth, shell & bronze pendants (I-R)

Poulsen's (1987) 'Long Units (class 5D)' from Tonga, ascribed to tridacna on the basis of the surviving hinge of the shell (*ibid*, pers. comm.). This feature is repeated in the Nong Nor examples. Poulsen has noted parallels in Fiji and the Mariana Islands (*ibid,* 199-200) and Samrong Sen, Cambodia (Mansuy 1902). A similar artefact has recently been recovered from the Balobok Rock shelter site in the southern Philippines (Ronquillo *et al*. 1993: plate 13b).

Although the Nong Nor examples are all of the same basic form, they can be sub-divided on the basis of the nature of the perforation.

Form 1a, End drilled. these are perforated diagonally from the end to one side, with a perforation length of *c*. 5-10 mm. As they are only pierced at one end, they were intended to be worn as pendants. Poulsen's 'units', by contrast, were perforated at both ends.

Form 1b, Length drilled. these have been perforated longitudinally. X-ray analysis has shown that some perforations are remarkably straight and regular in width. Others have been drilled more than once, with the holes not meeting. Some of the holes are filled, or lined, with bronze and one pendant had been repaired with bronze 'wire'. This had involved three sets of paired holes being drilled, two on one face and one on the other.

TABLE 16. *Composite artefacts made up of beads*

Artefact Class	Burial No.	Cat. No.	Shell 1	Shell 2	Shell 3	Shell 5	Serpentine 6	Serpentine 4	Carnelian 7	Carnelian 2	Carnelian 4	Clay	Total
Necklace	32	163	-	47	11	-	-	-	-	-	-	-	58
	8	237	-	-	-	-	-	2	-	-	-	-	2
	44	254	424	-	-	-	-	-	-	-	-	-	424
	47	261	449	-	-	-	-	-	-	-	-	-	449
	77	410	40	2	-	-	-	-	-	-	-	-	42
	75	547	13	2	-	1	-	-	-	-	-	-	16
	39	626	2	2	-	-	-	-	-	-	-	-	4
	107	670, 674-5	458	60	-	-	1	-	-	-	-	1	520
	111	685	257	-	-	-	-	-	-	-	-	-	257
	112	689	8	11	-	-	-	-	-	-	-	-	19
	126	826	-	5	-	-	-	-	-	-	-	-	5
	165	1067	27	-	-	-	-	-	-	-	-	-	27
Bracelet	9	202	17	-	-	-	-	-	-	-	-	-	17
	44	253	149	-	-	-	-	-	-	-	-	-	149
	63	340-1	167	-	-	-	-	-	-	-	-	-	167
	63	346	33	-	-	-	-	-	-	-	-	-	33
	35	514	6	4	-	-	-	-	-	-	-	-	10
	107	559	326	16	-	-	-	-	-	-	-	-	342

TABLE 16 *(cont.)*

Artefact Class	Burial No.	Cat. No.	Shell				Serpentine		Carnelian			Clay	Total
			1	2	3	5	6	4	7	2	4		
	107	667	186	-	-	-	-	-	-	-	-	-	186
	111	684	106	-	-	-	-	-	-	-	-	-	106
	112	690	78	-	-	-	-	-	-	-	-	-	78
	165	1068	60	-	-	-	-	-	-	-	-	-	60
Belt	58	378	49	-	-	-	-	-	-	-	-	-	49
	36	438	550	64	-	-	-	-	-	-	-	-	614
	39	443	138	-	-	-	-	-	-	-	-	-	138
	107	668	186	-	-	-	-	-	-	-	-	-	186
	90	737-8	77	-	-	-	-	-	-	-	-	-	77
Anklet	37	213	4	-	-	-	-	-	-	-	-	-	4
	25	214	27	-	-	-	-	-	-	-	-	-	27
Head Ornament	40	231	-	-	-	-	-	-	3	-	1	-	4

Bead Forms - 1: disc, 2: barrel, 3: long-barrel, 4: faceted-barrel, 5: spherical-carinated; 6: spherical, 7: sub-spherical

Although drilled longitudinally, the placement of these artefacts in relation to the body confirms that they were worn as pendants.

Form 1c, Double drilled. A single pendant that has been perforated longitudinally as well as diagonally at the thinner end.

Form 2, Claw or canine form. This form is rectangular in cross-section, tapering from a roughly finished thick end to a more regular thin end. They do not appear to come to a point and there is no evidence of perforation. However, binding at the thicker end would be effective. It is also possible that these are bangle fragments. Tridacna shell is the most likely material.

TABLE 17. *Shell pendants*

Form	Cat. No.	Context	L.	W.	T.	P.D.
1b	196	B 33	71.9	23.4	9.1	3.6
1b	197	B 33	105.8	27.3	9.8	2.7
1c	203	B 23	90.7	23.3	11.4	2.8
1b	263	B 47	82.4	26.3	14.3	3.4
1b	345	Surface	-	16.6	9.0	2.9
1b	399	B 69	89.3	17.4	9.3	6.9
1b	518	B 35	-	18.8	10.5	4.4 & 2.4

TABLE 17 *(cont.)*

Form	Cat. No.	Context	L.	W.	T.	P.D.
1b	519	B 35	57.7	20.5	7.2	3.1
1b	615	B 98	114.5	23.4	11.8	3.1
1a	624	B 105	112.8	21.0	10.2 & 13.0	2.4
1a	742	B 109	109.0	24.8	15.8	2.3
1b	1008	B 163	108.0	27.0	13.8	2.4
2	74	B 10	35.0	9.0-5.3	8.2 -4.4	-
2	1095	B 32	52.8	11.8-5.4	7.2-3.1	-

L: length, W: width, T: thickness P.D.: perforation diameter

Bronze

Cat. 552, B 89. A single bronze pendant has been recovered. It consists of a rectangle of bronze rolled into a tapering tube. The bottom is open and the top, closed. An eyelet, or suspension loop, is found at the closed end. The original metal sheet was about 3-4 mm thick (length: 53.0 mm, width: 22.8 mm, perforation diameter 3.2 mm).

Animal tooth

Canines of dog (*Canis familiaris*) and tiger (*Panthera tigris*) are present. Some have been drilled for suspension through the root, near to the base of the enamel. On others the root has broken off and it is impossible to know if they had been similarly treated.

TABLE 18. *Animal canine tooth pendants*

Cat. No.	Context	Species	L.	P.D.
1116a	B 136	Tiger	58.00 (broken)	-
1116b	B 136	Dog	36.85	1.80
1116c	B 136	Dog	38.20	1.50
1116d	B 136	Dog	21.70 (broken)	-
1116e	B 136	Dog	28.75 (broken)	-
1116f	B 136	Dog	33.10 (broken)	-
1116g	B 136	Dog	28.25 (broken)	-
546a	B 75	Tiger	49.70	4.20-5.00
546b	B 75	Tiger	53.50	4.50

L: Length, P.D.: Perforation Diameter

Pendants as composite artefacts

Pendants, like beads, are often components in composite artefacts. It is notable that at Nong Nor, no artefacts combine pendants and beads. However, pendants are sometimes combined with other

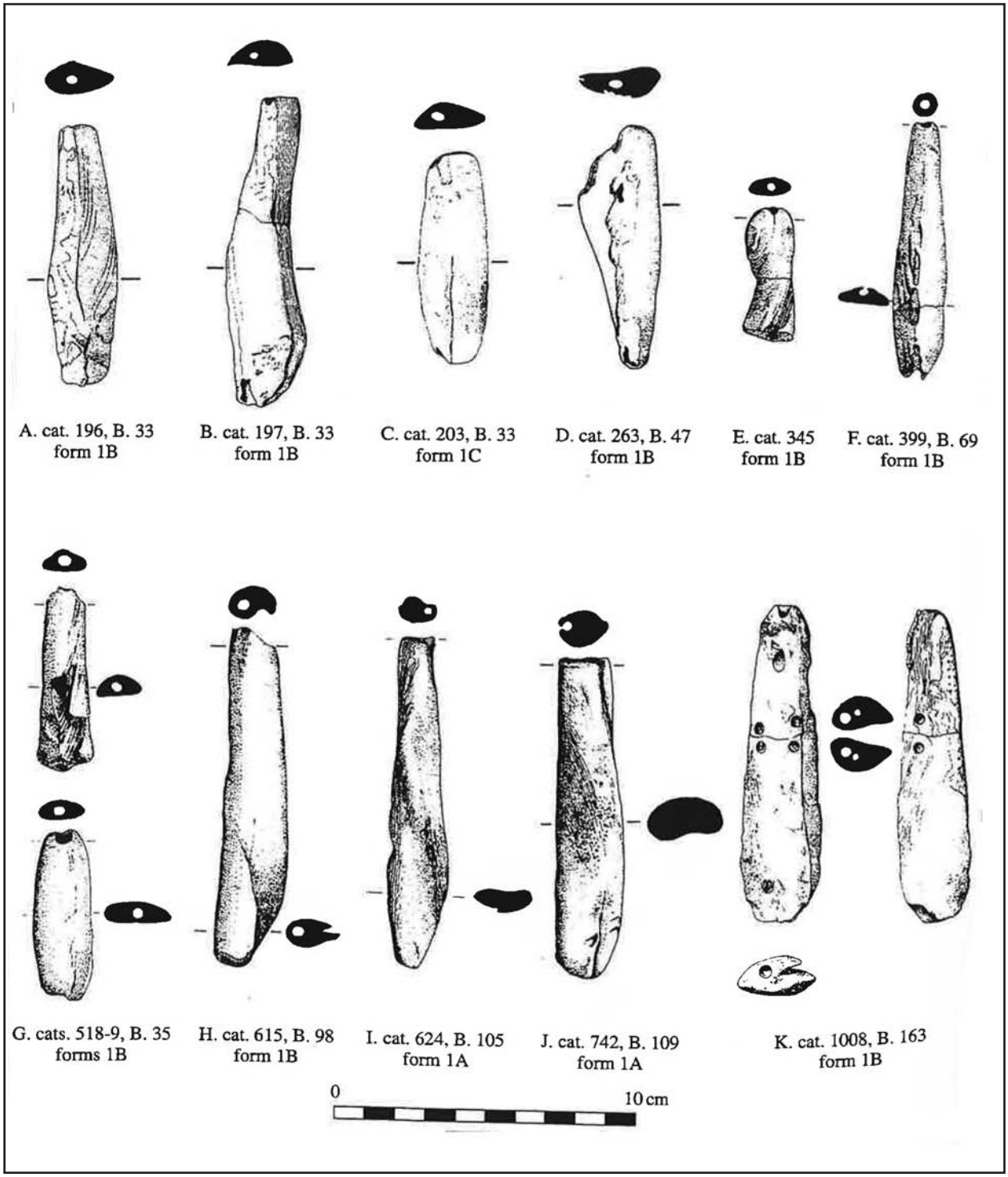


FIG. 84. Shell pendants

pendants. Cat. 1116 is a necklace made up of six dog and one tiger canine. Cat. 546 is a necklace combining two tiger canines. Cats. 196 and 197 are a pair of form 1 shell pendants, associated with a single burial, and are interpreted as components of a single necklace. The same is true for cats. 518-9.

BANGLES

In sorting the Khok Phanom Di artefacts Pilditch (1993) was prompted to begin a comprehensive classification scheme for 'Southeast Asian Disc/Bangle Forms'. In the interest of consistency the Nong Nor artefacts are similarly classified. However, due in part to the addition of bronze as a material at Nong Nor, additional classes are created. Most of Pilditch's 12 basic 'styles' are further subdivided (e.g. style 1, 1a, 1b etc.). These subdivisions are not employed here as their basis is debatable; the criteria may be site specific. Pilditch's scheme, including the styles created to include Nong Nor (styles 13-21), can be summarised as follows (for descriptive terminology see figure 78).

Style 1 discs with L-shaped radial sections formed by a single flange around the inner edge. Subdivisions include discs with perforations too small to be worn as bangles (less than 3.5 cm) and artefacts with no perforation at all, the 'flange' becoming a horn-like projection in the centre of the disc. These variations are absent at Nong Nor.

Style 2 discs with T-shaped radial sections formed by concentric flanges on either side of the inner edge.

Style 3 discs with triangular radial sections, the long sides of which are deeply concave (the short side formed by the inner edge).

Style 4 discs with triangular radial sections. The internal to external diameter ratio is 1:1.75–2. This results in a heavier bangle that projects further out from the arm when worn. In some specimens the triangular radial section has been truncated at the outer edge.

Style 5 discs with triangular radial sections. The internal to external diameter ratio is 1:<1.75, resulting in a lighter weight, less projecting, bangle. In some bangles the triangular radial section has been truncated at the outer edge.

Style 6 discs with rectangular radial sections, modified by single or double bevels at the outer edge. Internal to external diameter ratio is 1:≥1.5, and the radial width to depth ratio is 1:≥4, resulting in a heavy bangle that projects considerably from the arm when worn.

Style 7 discs with rectangular radial sections, modified by single or double bevels at the outer edge. The internal to external diameter ratio is 1:<1.5, resulting in a lighter, less projecting, bangle than style 6. Variations of radial width to depth ratios occur, but width is always greater than depth.

Style 8 discs with a rectangular radial section; unbevelled and approaching square. The radial width to depth ratio is 1:>1.25-≤2. Variations in absolute radial dimensions occur.

Style 9 discs with rectangular radial sections; unbevelled. The radial depth to width ratio is 1:>2. Variations in absolute radial dimensions occur.

Style 10 discs with square radial sections. Radial width to depth ratio is 1±0.25:1. Variations in absolute radial dimensions occur.

Style 11 bands with rectangular radial sections. Radial width to depth ratio is >1.25:1, resulting in a bangle orientated along the arm, not projecting, when worn. Variations in absolute radial dimensions occur.

Style 12 discs with concave arcs removed from the outer edge producing a star shape in plan view. Other features vary.

Style 13 discs with right-angled triangular radial sections, the long side of which curves convexly from the inner to the outer edge. Variations in absolute radial dimensions occur.

Style 14 discs with D-shaped radial sections in which the straight side is formed by the inner edge. The inner to outer diameter ratio is 1:≥1.5, resulting in a heavy bangle.

Style 15 discs with D-shaped radial sections in which the straight side is formed by the inner edge. The inner to outer diameter ratio is 1:<1.5. resulting in a relatively light bangle.

Style 16 discs with approximately square radial sections; though the exact form round the circumference and between artefacts varies, due to the natural form of the original gastropod (e.g. conus or trochus shells).

Style 17 bands with approximately rectangular radial sections in which the ratio of radial width to radial depth is 1:>2. The exact form varies with the natural form of the original shell (e.g. conus or trochus shells).

Style 18 discs with circular radial sections. The internal to external diameter ratio varies.

Style 19 band with a rectangular radial section in which the ratio of radial width to height is about 2:1. A very light form, 3 mm is a typical measurement for radial width, and the inner to outer diameter ratio is 1:<1.5.

Style 20 band with a very small rectangular or D-shaped radial section, 1.5 mm (width) by 3 mm (length) being typical dimensions, resembling a wire. Inner to outer diameter ratio is 1:<1.5.

Style 21 band with a rectangular radial section where the radial width to depth ratio is >1.25:1. There is a concave depression around the outside edge. Inner to outer diameter ratio is 1:<1.5.

Shell Bangles

The shell bangles occur in a variety of forms. They were manufactured from two basic materials, a large bivalve, probably tridacna, and one or more gastropod species, probably conus. Six styles are recognised (Tables 19-20, Figs. 85-87).

Style 1. Only two bangles are present, manufactured from tridacna shell. Both are large artefacts with perforations consistent with use as bangles. While the cross section sweeps sharply up from the outer edge to the top of the flange, the flange itself is not clearly demarcated. These would have been impressive as personal adornments.

Style 9. Cat. 877, B 138 is the only example. It is a fragment only and was probably relocated from the midden deposit during the interment of B 138.

Style 10. These seven bangles form a particularly homogenous set, despite the fact that two (cats. 466, 680) do not strictly conform to radial width:depth criteria. They are included because of an obvious 'intuitive' similarity with the rest of the group, due particularly to the presence of a carved 'notch' on the outer edge. This decoration imitates the natural effect on bangles made from gastropod shell. These bangles are manufactured from tridacna shell.

Style 13. These appear similar to style 1. They show basically the same radial section except that the curve of the upper surface is convex, from the inner down to the outer edge. At Nong Nor, these bangles are small and always associated with infant burials, whereas the style 1 examples are relatively very large.

Style 14. Manufactured from tridacna shell, these two D-sectioned bangles are massive artefacts, especially as both are associated with child burials (reflected in the internal diameters - less than 50 mm).

Style 15. Of the five bangles only cat. 741 is complete, it is also set apart by a carved notch on the outer edge identical to the style 10 bangles. All are manufactured from tridacna.

Style 16. Seven artefacts are present. Variable solidity of the bangles suggests that more than one species is being employed, though all are within the conus genus. Cat. 354 was associated with a young adult burial, the rest with infants and children.

Style	Cat. No.	Context	R.H.	R.W.	I.D.	O.D.
1	155	B 23	21.7	36.0	61.0	134.4
1	746	B 128	23.2	37.5	61.9	*c.*140.2
8	396	B 66	5.1	6.7	31.3	44.6
9	877	B 138	8.3	19.2	-	-
10	193	B 32	8.5	9.8	-	-
10	381	B 36	10.4	7.8	57.9	74.6
10	406	B 35	14.4	11.8	55.2	75.2
10	466	B 87	12.3	7.9	54.8	72.1
10	679	B 111	14.4	11.3	56.5	78.3
10	680	B 111	14.3	9.5	56.2	76.2
10	747	B 128	8.4	8.0	57.9	74.4
10	794	B 128	9.0	8.4	60.0	71.2
13	181	B 28	5.8	9.3	33.3	*c.*51.5
13	425	B 68	7.9	10.1	36.9	58.4
13	426	B 68	8.4	13.2	38.3	61.7
13	427	B 68	5.6	8.2	*c.*38.0	*c.*52.0
13	461	B 68	7.5	9.0	36.3	*c.*51.0
14	198	B 33	26.0	12.5	44.0	67.3
14	394	B 69	17.8	14.3	38.1	67.7
15	67	B 15	12.5	5.6	*c.*45.8	*c.*57.0
15	124	B 8	4.1	6.3	-	-

TABLE 19 *(cont.)*

Style	Cat. No.	Context	R.H.	R.W.	I.D.	O.D.
15	293	A1-B, L2:2	8.1	6.3	-	-
15	741	B 90	12.7	7.9	53.5	68.8
15	793	B 118	10.9	5.6	-	-
16	258	B 50	8.1	8.1	36.9	51.5
16	354	B 56	14.5	12.6	34.8	57.6
16	465	A3:42, L2:2	7.7	10.8	*c.*46.0	*c.*67.0
16	748	B 130	14.2	9.3	31.4	49.7
16	1088	X1, surface	13.2	9.4	35.8	52.7
16	1089	A1-A, L2:2	7.0	-	-	-
16	1092	B 50	8.1	8.3	-	-
17	280	B 49	32.1	13.5	41.5	67.8

R.H.: Radial Height, R.W.: Radial Width, I.D.: Inner Diameter, O.D.: Outer Diameter

Fragmentary. Cat. 193 is from a relatively lightweight bangle with a nearly square radial section. The complete bangle was probably a style 10 (above). Cats. 300 and 347 are from fairly thick bands, with the latter being irregularly formed. Cat. 339 is probably a fragment from a style 16 shell bangle, but appears to have had the original spiral architecture ground away. Cat. 474 is probably from a T-sectioned or simple disc form.

TABLE 20. *Shell bangles – fragmentary*

Cat. No.	Context	Material	R.H.	R.W.
300	A3 L1	Tridacna ?	14.4	9.0
339	B 63	Conus ?	11.7	3.9
347	A3:16 L2:1	Tridacna ?	19.3	10.1
474	B 73	Shell ?	-	-

R.H.: Radial Height, R.W.: Radial Width

Stone Bangles

There are two forms of stone bangle in a variety of raw materials, including serpentine, marble and talc (Tables 21-23, Figs. 88-91).

Style 4. This is the most common stone form. They are made from marble and both Reay and Mason (pers. comm.) consider that all 22 examples could derive from the same quarry. Many are significantly corroded. Their consistent form suggests standardised production.

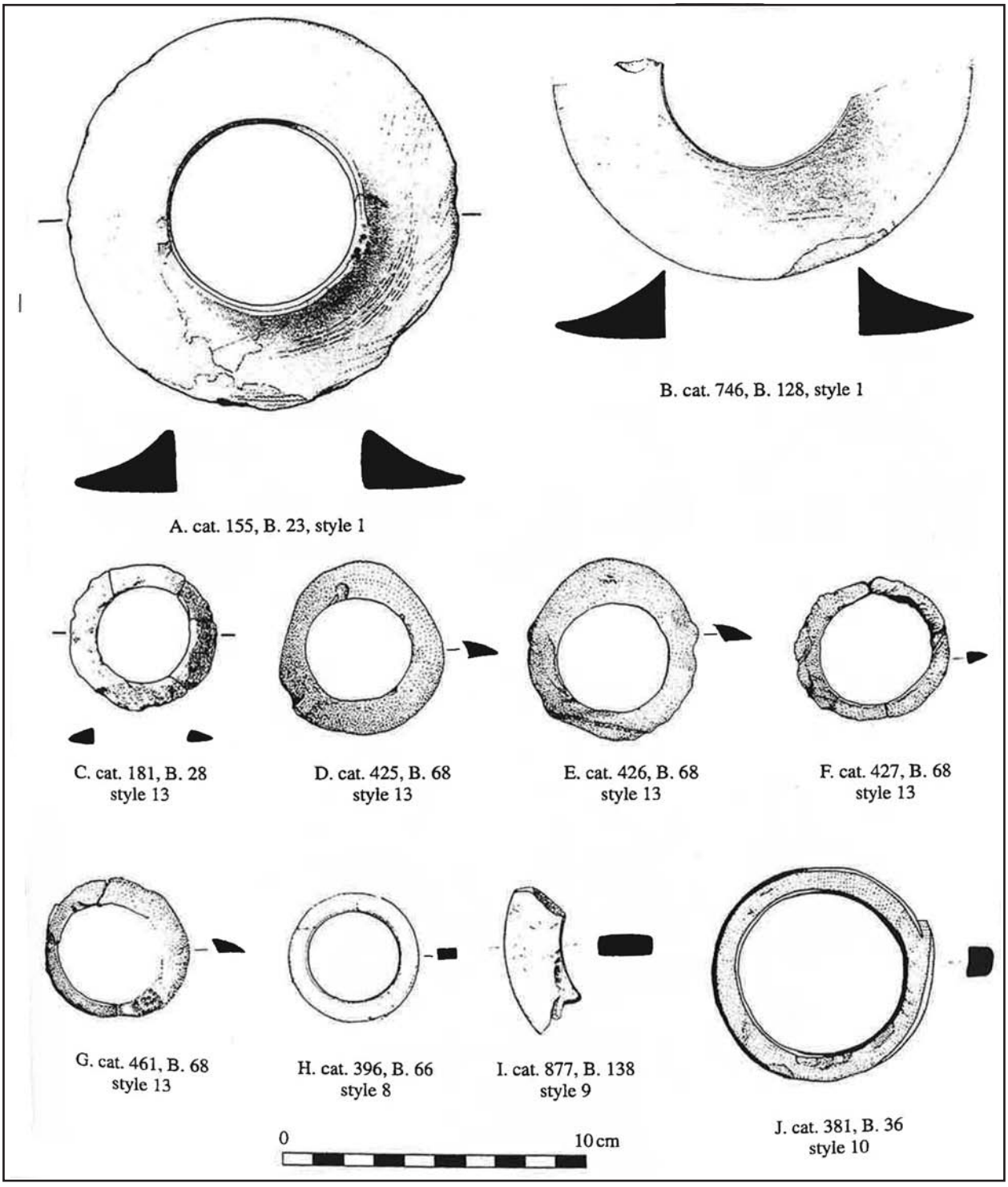


FIG. 85. Shell bangles; styles 1, 8, 9, 10 and 13

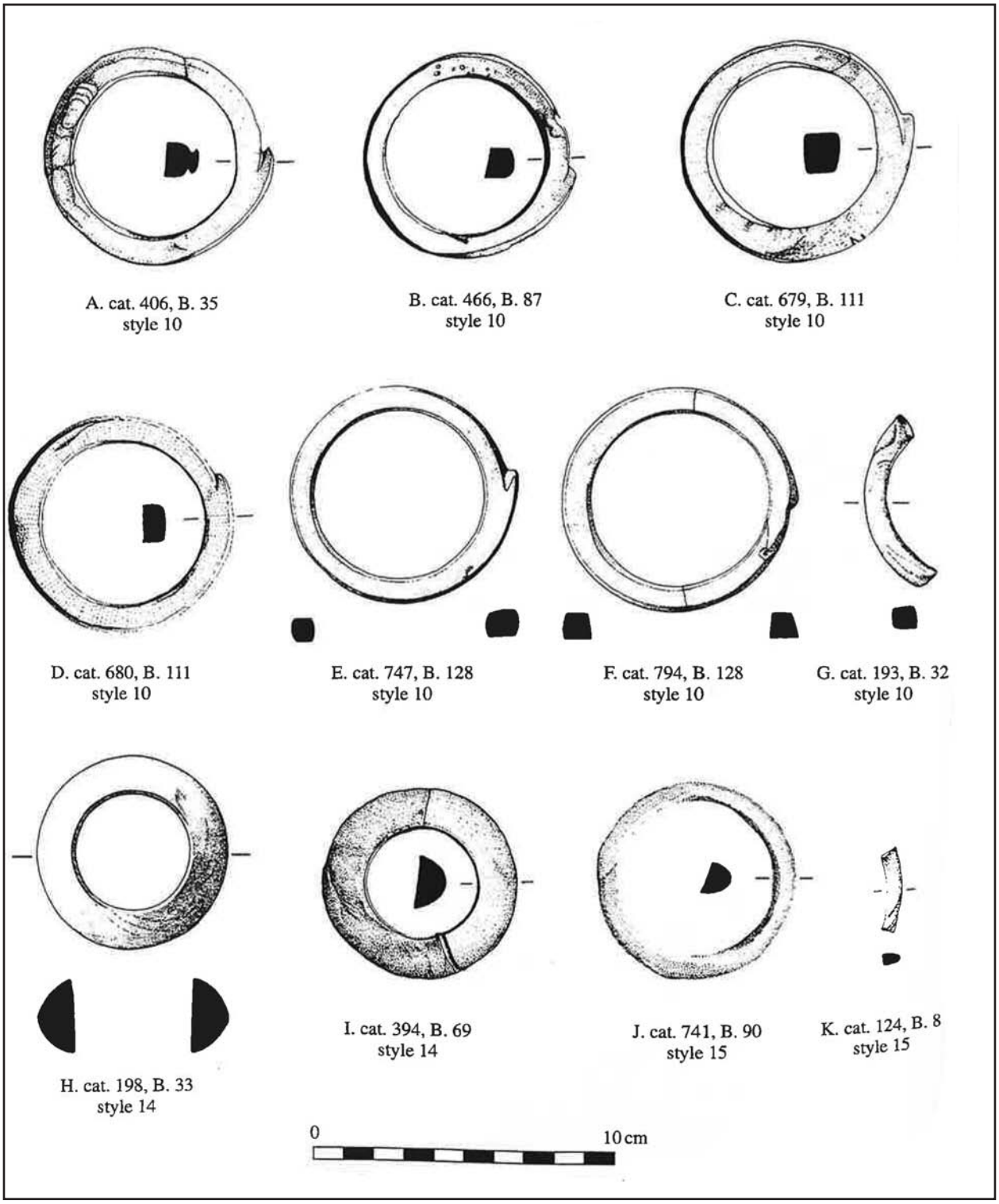


FIG. 86. Shell bangles; styles 10, 14 and 15

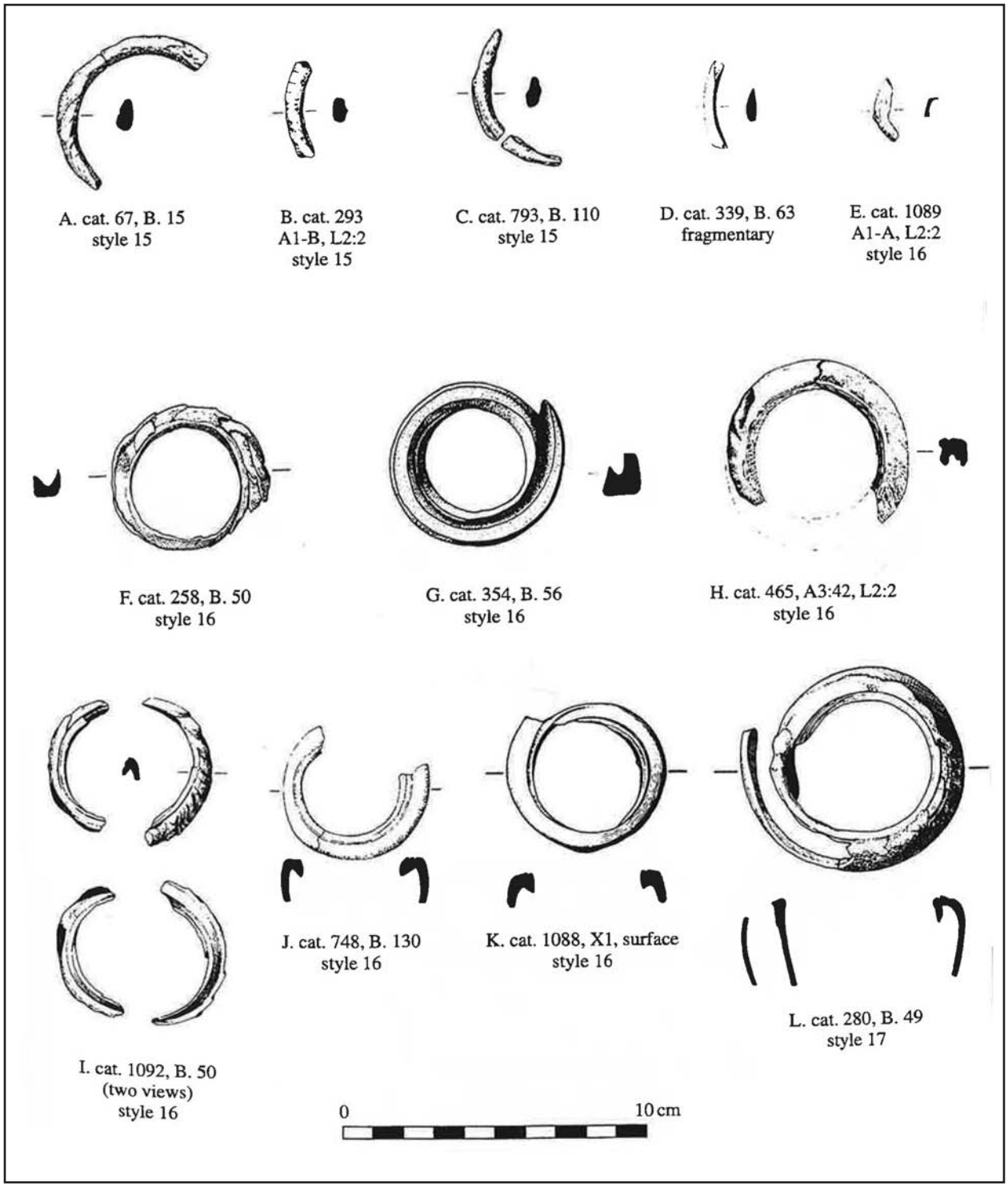


FIG. 87. Shell bangles; styles 15, 16 and 17

TABLE 21. *Marble bangles of style 4*

Cat. No.	Context	R.H.	R.W.	I.D.	O.D.
262	B 47	-	-	-	-
271	B 44	-	-	-	-
370	B 35	8.6	19.3	*c.*58.0	*c.*92.0
379	B 36	7.4	23.7	54.7	99.0
380	B 36	8.1	19.2	54.0	89.0
382	B 36	8.2	22.9	57.4	103.3
383	B 36	7.9	24.0	53.4	101.2
386	B 39	8.4	19.9	56.3	97.8
387	B 39	8.3	15.6	60.5	88.2
388	B 39	7.1	19.8	53.3	99.5
447	B 77	6.1	24.8	55.5	105.2
448	B 77	6.4	20.0	55.5	96.0
449	B 77	8.6	23.4	59.1	104.2
450	B 77	8.5	23.4	56.7	101.2
623	B 105	7.7	21.2	57.4	98.6
656	B 111	9.4	20.9	59.6	100.3
664	B 106	8.2	20.6	55.9	94.9
752	B 128	7.8	23.0	*c.*59.0	*c.*103.0
753	B 128	9.3	22.4	*c.*51.4	*c.*97.0
755	B 128	10.2	21.0	*c.*58.0	*c.*98.0
1025	B 165	9.9	21.2	55.0	97.3
1059	B 165	7.3	20.0	54.9	94.7

R.H.: Radial Height, R.W.: Radial Width, I.D.: Inner Diameter, O.D.: Outer Diameter

Style 2. At Nong Nor the degree of demarcation of the flanges from the main body in these T-sectioned bangles is variable. In some, both the flange and the main body of the radial section are thin and platelike, and the demarcation between them is clearly defined; i.e. very close to a true T-shape. On others the flange is very low (less than 5 mm), and merges with the main body in such a way that no point of demarcation can be identified.

TABLE 22. *Stone bangles – style 2, T-section*

Cat. No.	Context	Stone	R.H. 1	R.H. 2	R.W.	I.D.	O.D.
316	B 53	Marble	13.0	6.3	23.6	*c.*57.0	*c.*97.0
332	A3:55, L2:1	Serpentine	8.6	5.2	17.2	-	-
356	B 56	Marble	8.7	2.2	2.8	-	-

TABLE 22 *(cont.)*

Cat. No.	Context	Stone	R.H. 1	R.H. 2	R.W.	I.D.	O.D.
495	B 83	Serpentine	9.3	3.0	13.1	50.8	76.7
662	B 111	Serpentine	17.3	7.7	21.9	54.8	97.0
697	B 109	Serpentine	8.9	7.0	22.4	*c.*57.0	*c.*111.0
792	B 127	Marble	9.0	4.1	28.6	*c.*58.0	*c.*115.0
802	B 123	Marble	*c.*8.0	-	-	-	-
890	B 136	Marble	15.4	6.2	15.0	55.8	*c.*83.4
943	B 149	Talc	6.9	3.8	29.4	*c.*57.7	*c.*115.6
944	B 149	Serpentine	14.3	4.5	18.0	59.2	94.4
1087	B 83	Serpentine	13.6	4.2	18.3	*c.*51.7	*c.*88.0

R.H.1: Radial Height 1, R.H.2: Radial Height 2, R.W.: Radial Width, I.D.: Inner Diameter, O.D.: Outer Diameter

Fragmentary. Three fragmentary artefacts have been recovered. Although width and thickness measurements are given for cat. 1243, it is impossible from the fragments present, to know which radial dimension is represented by either figure.

TABLE 23. *Stone bangles – fragmentary*

Cat. No.	Context	Stone	R.H.	R.W.
292	X1, L2:2	Marble?	-	-
1090	B 56	Serpentine	-	-
1243	B 136	Marble?	1.9	10.9

R.H.: Radial Height, R.W.: Radial width

Bronze

Bronze is a third raw material employed in bangle manufacture. It is found in seven main styles (Figs. 91-94, Table 24).

Style 2, T-sectioned. One very large T-shaped bangle of this form was recovered (cat. 604, B 105). The flanges and body are clearly demarcated and well defined. This artefact clearly recalls style 2 bangles in stone.

Style 11, Simple Band. This is by far the most common form. The radial section is narrow and deep, with typical dimensions of *c.*9 mm (height) and *c.*3 mm (width). A possible join, where the circlet has been closed, is often visible as a diagonal lump of corrosion.

Style 18, O-sectioned. Only two bangles, from a single burial, were ascribed to this form (cats. 671-2, B 112). They have a circular radial section. Once again, there appears to be a join at one point on the circlet, however, the level of corrosion makes it difficult to be certain.

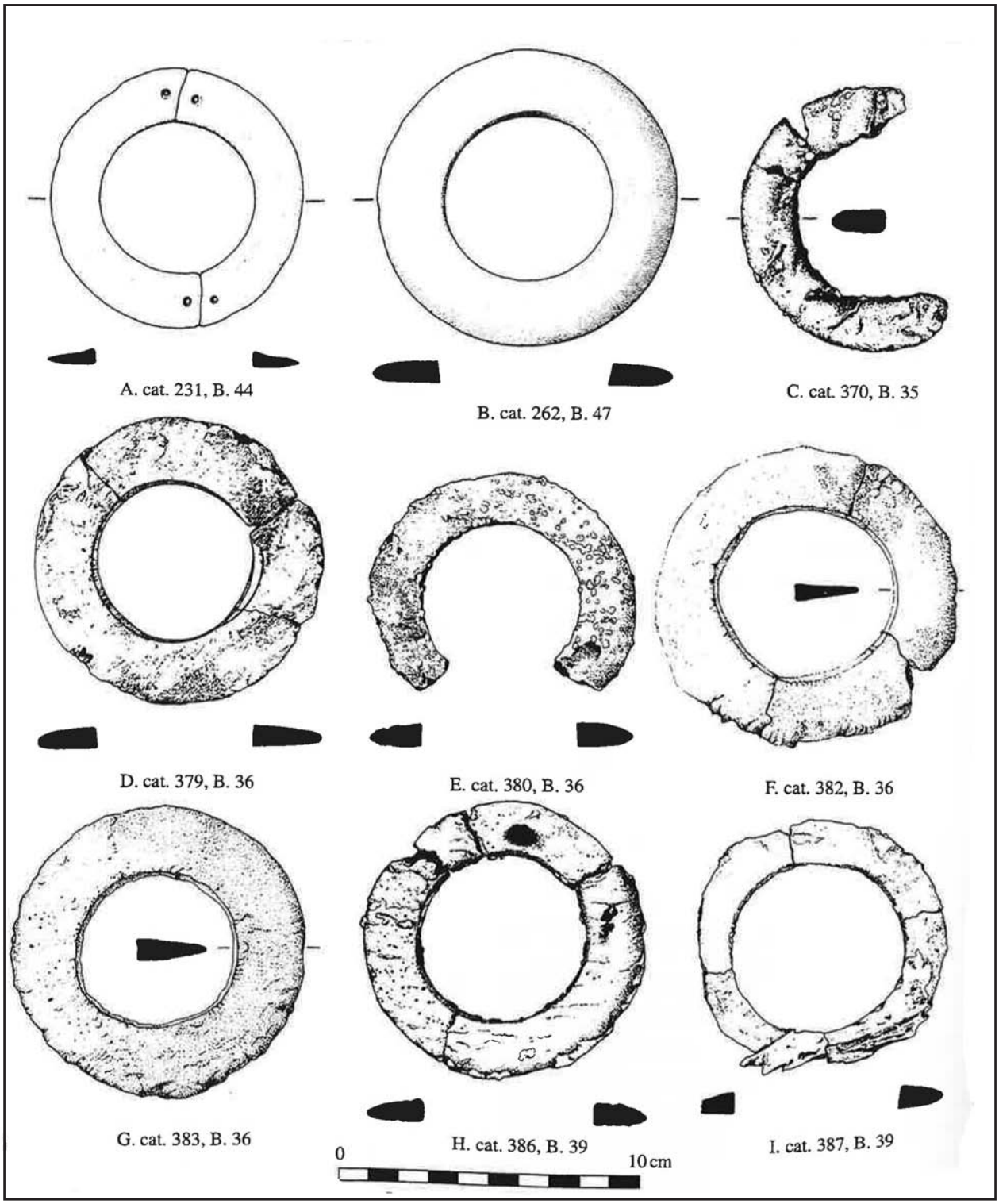


FIG. 88. Marble bangles of style 4

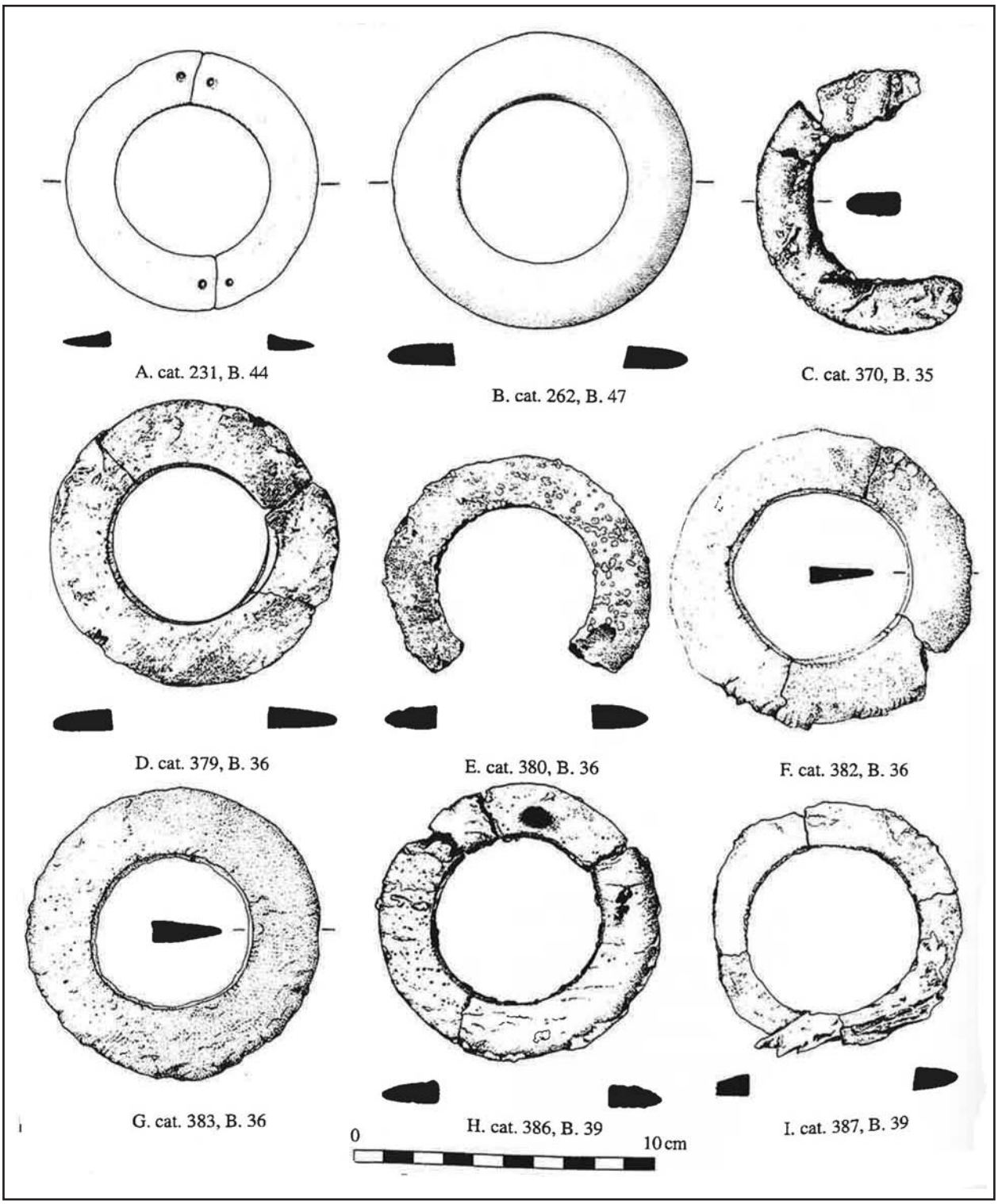


FIG. 89. Marble bangles of style 4 (cont.)

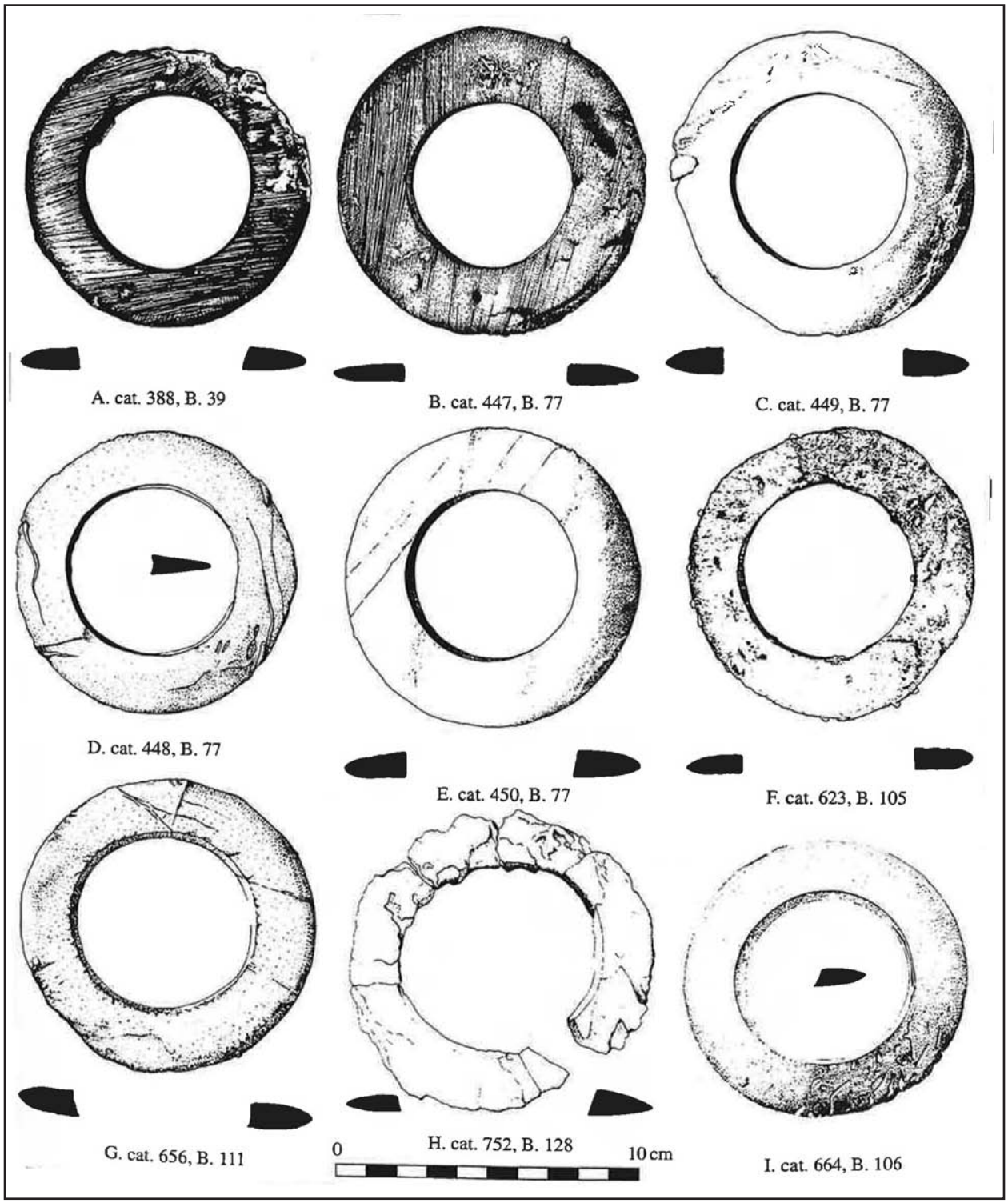


FIG. 90. Marble bangles of style 4 (cont.) also marble and other stone bangles of style 2

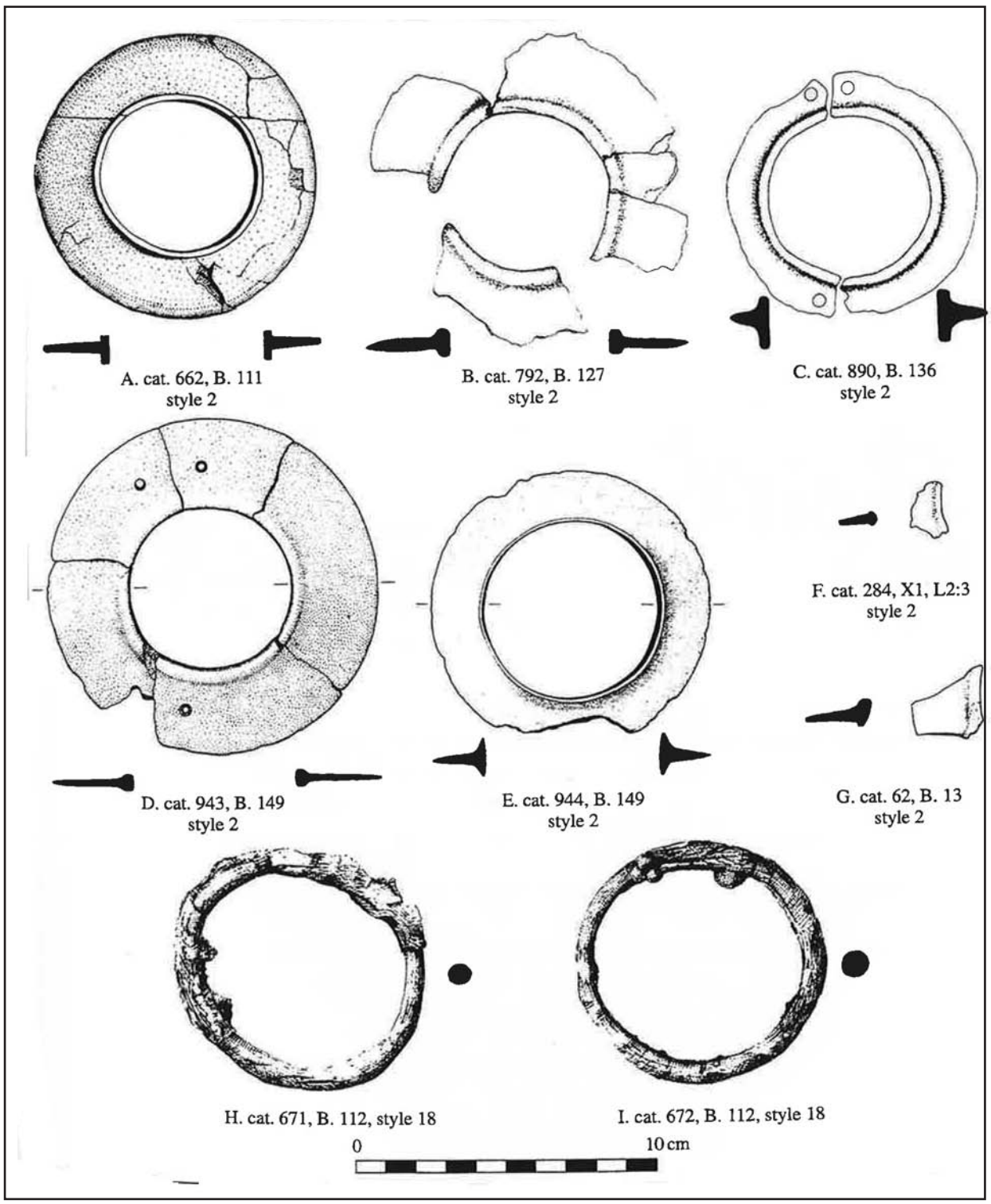


FIG. 91. Stone bangles of style 2 and bronze bangles of style 18

TABLE 24. *The bronze bangles*

Form	Cat. No.	Context	R.H.	R.W.	I.C.	Form	Cat. No.	Context	R.H.	R.W.	I.C.
11	8	surface	6.7	2.9	-	11	966	B 147	9.7	3.2	*173.0
11	29	B 7	9.0	2.6	-	11	967	B 147	6.8	3.0	192.0
11	38	B 7	9.4	2.9	-	11	999	B 147	8.7	2.3	-
11	59	B 12	5.0	2.0	-	11	1000	B 147	11.4	2.1	168.0
11	95	X1, surface	11.2	3.8	-	11	1001	B 147	11.4	1.9	170.0
11	97	X1, surface	9.1	2.2	-	11	1096	B 111	7.1	2.7	*183.0
11	102	A1, L2:2	6.5	2.2	-	11	1097	B 35	8.6	3.1	*179.0
11	117	X1, L2:1	11.8	4.2	-	11	1098	A3:28, L2:1	7.3	2.1	-
11	204	B 25	9.2	4.6	-	11	1100	A3:69, L2:1	4.6	2.2	-
11	227	B 43	8.1	2.3	129.0	11	1102	B 97?	7.0	2.2	-
11	301	A3, L1	10.8	2.8	-	11	1103	X1, L2:1	9.2	4.6	-
11	309	A3:28 L2:1	11.9	3.2	-	11	1104	B 25	10.5	4.1	-
11	335	A3:55 L2:1	7.0	2.7	-	11	1105	B 43	7.8	2.7	-
11	360	B 56	6.6	2.9	-	11	1107	A1-B L2:2	6.8	2.6	-
11	384	B 39	9.2	3.3	207.0	18	671	B 112	8.3	6.8	218.0
11	385	B 39	9.6	3.0	*176.0	18	672	B 112	8.7	7.3	213.0
11	389	B 35	8.8	3.5	184.0	2	604	B 105	20.6	36.4	195.0
11	390	B 35	8.0	3.0	185.0	20	205	A1-D L2:3	*c.*1.5	*c.*1.5	-
11	391	B 35	8.3	3.4	*177.0	20	283	B 48	2.3	1.8	-
11	392	B 35	7.4	3.3	*178.0	20	305	B 55?	2.4	1.7	-
11	393	B 35	7.2	2.9	202.0	20	326	A3:69 L2:1	2.6	1.5	-
11	419	B 80	9.7	3.9	-	20	350	A3:46 sfce.	3.3	1.6	-
11	457	B 84	10.6	4.0	-	20	433	A3:58 L2:2	3.4	1.8	-
11	467	A3:44 L2:2	12.0	4.2	-	20	460	A3:55 L1b:1	3.0	1.6	-
11	475	A3:15 L2:3	10.4	3.7	-	20	464	A3:59 L2:2	3.0	1.3	-
11	488	A3:41 L2:2	9.4	3.8	-	20	470	A3:59 L2:2	3.0	1.6	-
11	492	A3:41 L2:2	7.6	2.5	-	20	1101	surface	2.0	1.4	-
11	515	A3:28 L2:3	9.8	3.9	-	15	3	surface	5.7	3.1	-
11	517	B 35	8.8	3.5	-	15	32	A1-A L2:1	5.3	3.1	-
11	520	A3:30 L2:2	11.0	4.3	-	15	36	A1-A L2:1	5.8	4.4	-
11	525	B 96	10.6	3.3	-	15	47	A1-D L2:1	4.3	3.3	-
11	539	B 92	9.2	2.2	-	15	101	A1-A L2:1	5.5	3.7	-

TABLE 24 *(cont.)*

Form	Cat. No.	Context	R.H.	R.W.	I.C.	Form	Cat. No.	Context	R.H.	R.W.	I.C.
11	661	B 111	7.6	3.1	200.5	15	123	B 8	5.5	2.6	-
11	796	B 65	8.6	4.1	*257.0	15	281	B 48	5.9	3.3	-
11	830	B 116	7.2	2.5	-	15	337	A3:30 L2:1	5.4	3.5	-
11	873	B 138	11.1	1.8	-	15	486	A3:44 L2:3	5.1	2.8	-
11	882	B 147	11.1	2.3	-	19	48	A1-D L2:1	5.5	2.9	-
11	963	B 147	11.0	2.0	172.0	19	89	A1-C L2:1	6.4	3.2	-
11	964	B 147	7.6	2.7	-	21	1099	B 84	10.4	3.5	-
11	965	B 147	11.4	1.8	166.0						

R.H.: Radial height, R.W.: Radial width, I.C.: Inner circumference, * measurements taken from incomplete bangles

Style 15, D-sectioned. These have a D-shaped radial section with the flat side of the 'D' formed by the inner edge of the bangle. Indications are that they were lightweight bands with the inner diameter large relative to the radial dimensions. Some longer fragments show the longitudinal curvature expected in a bangle.

Style 19, Double Wire. The fragments recovered give the impression of two wires, each almost square in section, fused together along one side. A complete bangle would resemble two thin bands fused side by side. Once again, only fragments are present and it is possible that they are not bangles at all, or perhaps represent remnants of more complex forms, for example spiral bangles (see the spiral forms in tin, discussed below).

Style 20, Wire. Only one of these collections of fine wire-like bronze fragments was confidently associated with a burial. The radial sections generally resemble a flattened 'D' with typical dimensions being 1.5 mm (width) by 3 mm (length). As none is complete, it remains possible that they are not bangles but needles, wires (Maddin and Weng 1984) or some other utilitarian artefact.

Style 21, Concave Band. A single fragment with a radial section similar to the simple bands (form 1) described above, but with a concave depression around the outside edge.

Fragmentary. Cat. 1010 & Cat. 1048, B 117. The fragments are so small and broken that no likely form can be reconstructed.

None of the artefacts represented by styles 15, 19, 20 and 21 is complete and it remains possible they are not bangles at all. The most questionable are those assigned to style 20. Conversely, the curvature of style 15 specimens is consistent with their being bangles. Most of these bangles were not associated with burials, so interpretations cannot be confirmed by their location. Very few other types of bronze artefact have been identified, so that an interpretation as bangles remains the most likely.

Tin

Two tin spiraliform bangles are associated with B 86 (Fig. 94, Table 25). These are made by coiling a length of metal, the radial section of which is circular and has a diameter of about 1 cm. They

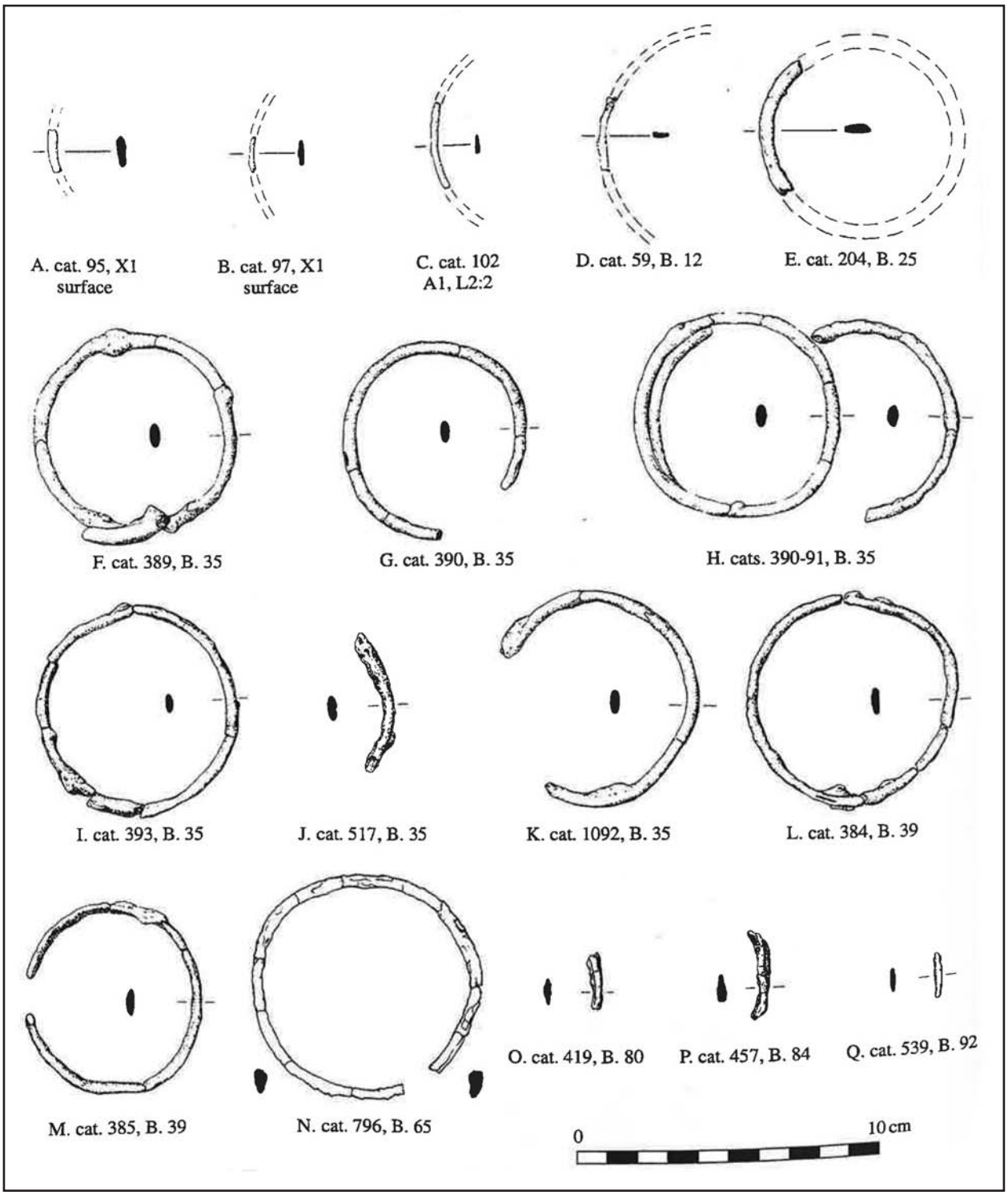


FIG. 92. Bronze bangles, style 11

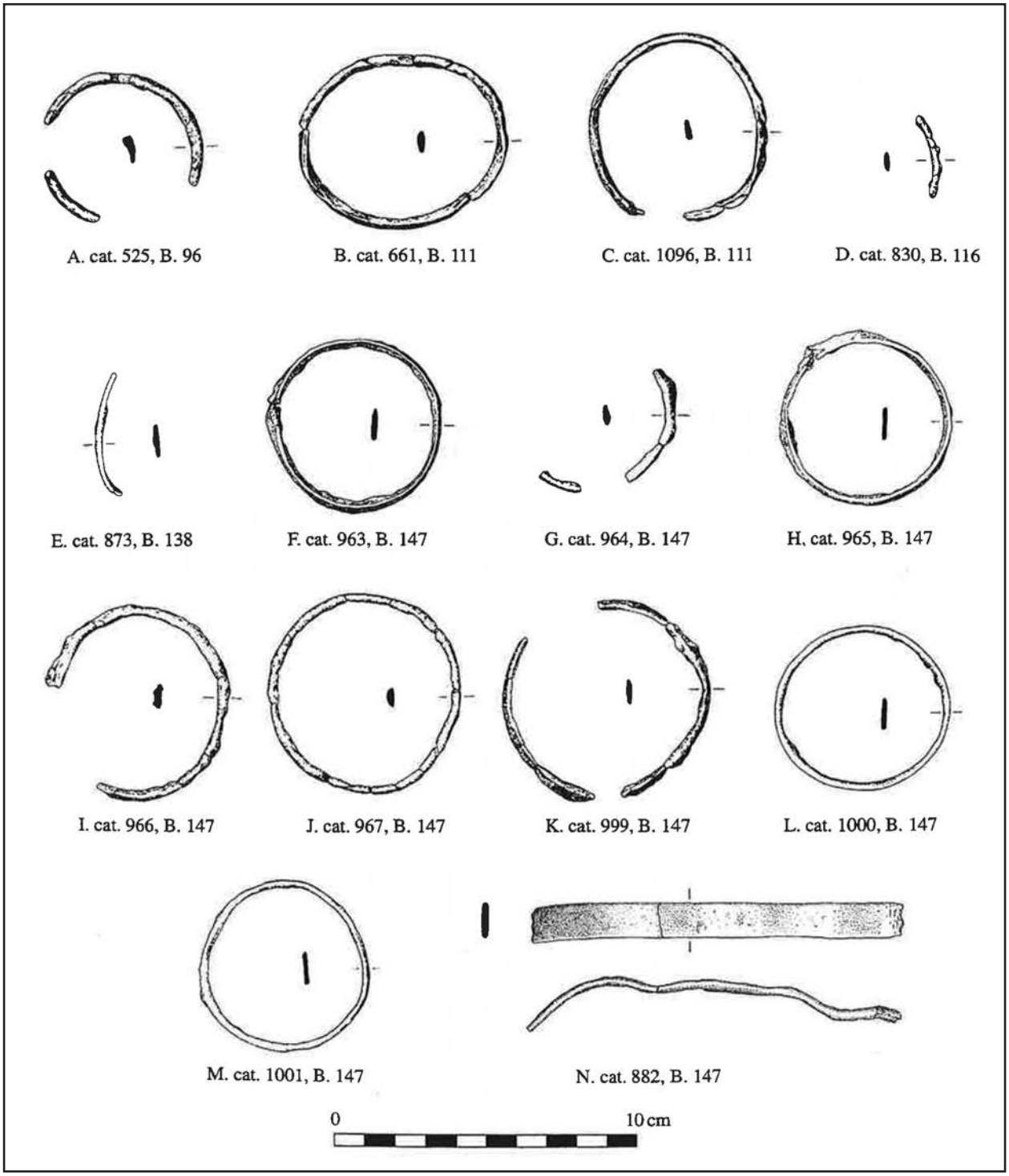


FIG. 93. Bronze bangles, style 11 (cont.)

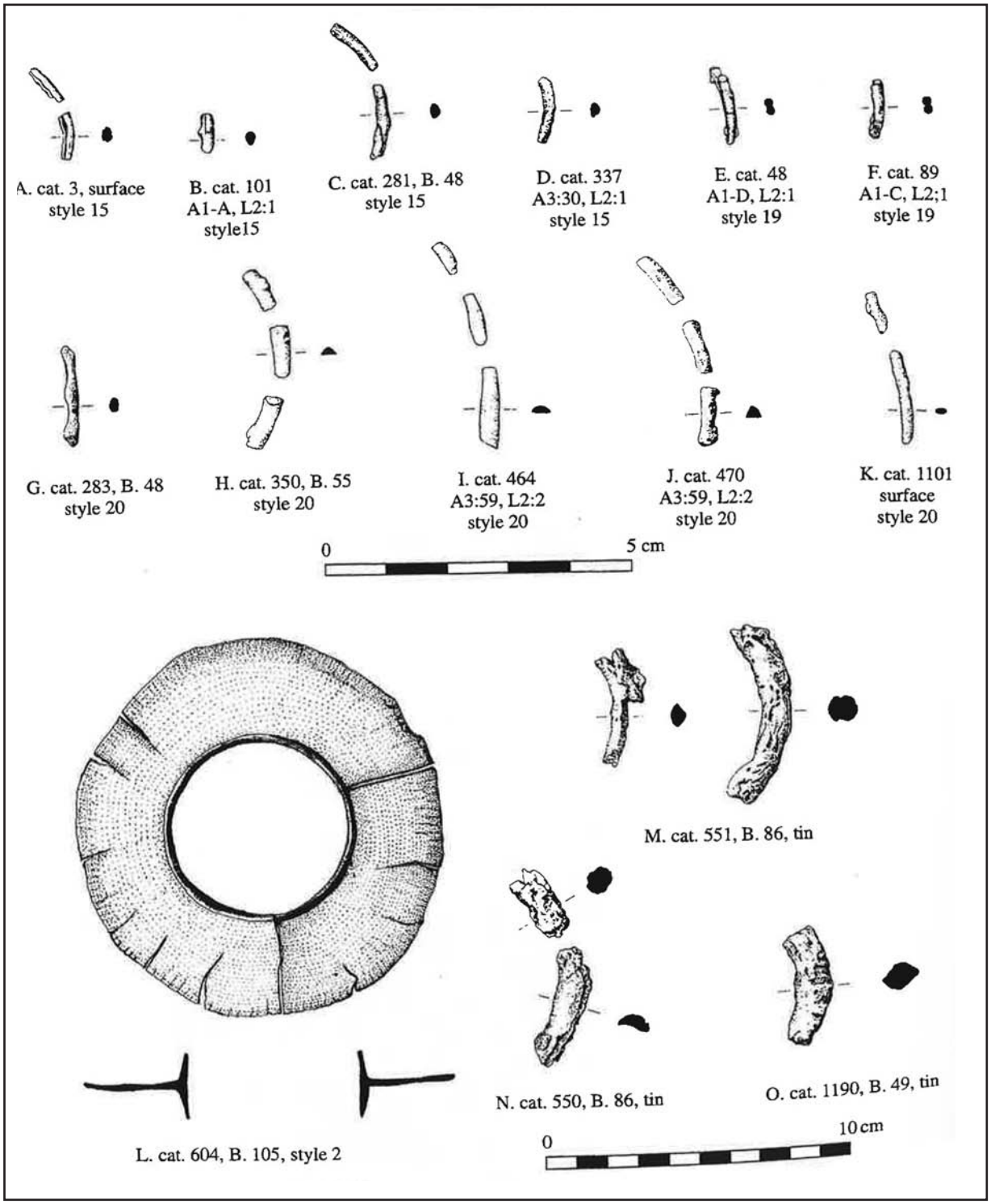


FIG. 94. Bronze bangles, styles 15, 19, 20 & 2 and three tin bangles

can be assigned to style 18 on the basis of radial section, but may be a special example due to the spiral form. A third possible bangle fragment was recovered from B 49. The radial dimensions appear similar, although only fragments remain. It is impossible to tell if the complete artefact was of spiral form. Two other fragments were recovered, near the wrists of B 154, and are interpreted as bangles. They are exceedingly fragmentary and no form can be reconstructed.

Table 25. *Tin bangles*

Cat. No.	Context	R.H.	R.W.	Cat. No.	Context	R.H.	R.W.
550	B 86	*c.*11.0	*c.*11.0	1190	B 49	10.2	12.1
551	B 86	10.2	10.3	925	B 154	-	-

R.H.: Radial Height, R.W.: Radial Width

Discussion

Two points can be made about the bangles as a whole. There are few matching forms in different materials, the T-shaped bronze and stone bangles being the only clear examples (style 2). This is interesting as more such parallels may have been expected. Second, we should note the standard character of some of these forms, in particular the style 10 shell bangles, the style 4 stone bangles (and to a lesser degree the style 2 stone bangles) and the style 11 bronze bangles. The first two of these forms appear to be unique to Nong Nor. The third (the T-sectioned bangles) represent a form that is widespread across Southeast Asia. The style 11 bronze bangles may also represent a widespread form

ANKLETS

A single flake of tin was found in the ankle area of B 154 (cat. 921). Its location has prompted the identification.

EARRINGS

Artefacts most likely to be earrings are present in most of the materials already noted at Nong Nor.

Shell Earrings

Two forms are present (Fig. 95, Table 26). None was found in a burial context, and their designation as earrings cannot be supported by contextual evidence.

Form 1, Simple ring. These possible earrings are flat circular discs perforated centrally, and with a slot cut at one point in the circumference so that the ring is discontinuous. The radial section is rectangular with the radial height generally less than the width. The ratio between the diameter of the central perforation and the outer diameter varies from less than a third (cat. 377, ratio = 0.29) to more than a half (cat. 745, ratio = 0.54, figures are calculated based on the maximum outer diameter). Therefore, while this last specimen can be described as ring-like in appearance, others are better described as perforated discs. Those identified as of bivalve origin have obvious growth lines creating a layered effect (except cat. 745, which appears homogeneous). These layers usually lie nearly parallel to the planar face of the ring. The single gastropod example has the

spiral structure of the original shell still visible, even though it has been considerably modified. This last artefact appears to have been burnt.

Serpentine and Nephrite Earrings

Two forms are present. (Fig. 95, Table 27).

Form 1, D-shaped keyholed. While the shell earrings were circular these are generally D-shaped. The straighter edge is thicker than the curved one. A hole is drilled centrally (usually from both sides) and a slot cut, joining the hole with the centre of the curved edge in such a way as to resemble a keyhole. The serpentine example is amber-yellow in colour and the serpentine/nephrite artefacts range from a pale mottled green through to a dark, evenly-hued black-green; no two appear the same colour. Two of these stand out. Cat. 805 has been made from part of a T-sectioned bangle, as has cat. 477. This specimen has a second hole at one end which has been filled with bronze, it

TABLE 26. *Shell earrings of form 1*

Cat. No.	Context	Shell	L.	W.	Th.	I.D.	S.W.
11	surface	Tridacna	29.1	29.1	3.7	11.5	2.8
81	X1 surface	Tridacna	32.4	32.3	8.4	14.9	2.5
376	A3:89 L2:1	Conus	25.2	25.0	5.6	8.5	3.0
377	A3:2 L2:2	Tridacna	17.9	17.78	5.7	5.2	3.2
745	A5 L1a	Tridacna	20.3	20.0	3.7	11.0	2.0
33	A1-D L2:1	Conus	36.2	-	6.1	9.4	-
132	A1-A L2:2	Conus	-	-	3.0	-	-

L.: Length, W.: Width, Th.: Thickness, I.D.: Inner Diameter, S.W.: Slot Width

TABLE 27. *Stone earrings of forms 1 and 2*

Form	Cat. No.	Context	Material	L.	W.	Th.1	Th.2	I.D.	S.W.
1	477	B 84	Serpentine	32.9	24.8	2.2	5.2	5.8	2.0
1	655	B 111	Serpentine	35.3	28.8	4.8	-	5.4	3.2
1	805	B 123	Nephrite	45.4	22.5	2.0	7.9	3.7	2.6
1	895	B 86	Serpentine	21.0	17.7	6.8	-	6.6	2.9
1	1078	B 44	Serpentine	23.9	17.4	5.0	-	4.0	2.3
2	245	B 44	Serpentine	14.7	14.1	9.1	-	6.1	2.0

L.: Length, W.: Width, Th.1: Thickness, Th.2: Thickness at flange, I.D.: Inner Diameter, S.W.: Slot Width

180B 123Nephrite45.422.52.07.95.72.6

Bronze

This item might be an earring (B 147, cat. 998). It comprises a strip of bronze of similar radial dimensions to the form 1 bronze bangles, and was found in close proximity to a number of the same. However it is not a closed circlet but has been bent into a U-shape and could have been worn as an earring. The other possibility is that it is a broken bangle, however, it seems too short. Also, there is little other evidence for the deformation or 'killing' of mortuary jewellery at Nong Nor.

Tin

Form 1, Simple Ring. A single earring, cat. 652, was recovered from B 105. Although poorly preserved, it appears to be a simple ring with a circular radial section of *c*.7 mm diameter. Cat. 1108 is a fragment of tin associated with B 45 (radial depth: 4.75 mm, radial width: 5.65 mm).

Fragmentary. Some possible flecks of tin were found near the skull of B 163 (cat. 1054).

RAW MATERIAL AND MANUFACTURING DEBRIS

A number of tridacna shell artefacts provide evidence for local manufacture (Figs. 95-96, Tables 28-29). Two forms are present.

Flaked Blanks. These are a variety of roughly-flaked circular discs. Some have relatively flat surfaces, being one of the planar faces or occurring along part of the outer edge and forming an 'end'. One was partially ground to a more regular, circular shape round part of the circumference. Diameters vary considerably and none is large, suggesting that these were blanks for children's bangles. All come from a single burial cache except cat. 516, which is an irregular block rather than an obvious preform.

Bangle cores/truncated cones. These are all cylinders with a slightly tapering longitudinal section. One is very short. The most interesting is cat. 531. A circular groove was deeply cut into the thinner end to form a ring and a small core. The artisan had then begun to saw round the outside to separate the ring from the main block. It is not known whether the other examples resulted from, or were destined to be subject to, the same treatment. Diameters are again small and it seems likely that these artefacts are re-used bangle cores (Ciarla 1992).

TABLE 28. *The shell bangle blanks*

Cat. No.	Context	M.D.	M.Th.	Cat. No.	Context	M.D.	M.Th.
498	B 87	35.4	15.4	504	B 87	55.6	19.0
499	B 87	33.0	16.7	505	B 87	55.4	21.0
500	B 87	34.2	12.4	506	B 87	52.9	15.1
501	B 87	33.5	9.9	507	B 87	53.4	18.0
502	B 87	30.6	11.0	508	B 87	52.0	19.5
503	B 87	47.9	15.3	516	A3:28 L2:3	32.0	19.0

M.D.: Maximum Diameter, M.Th.: Maximum Thickness

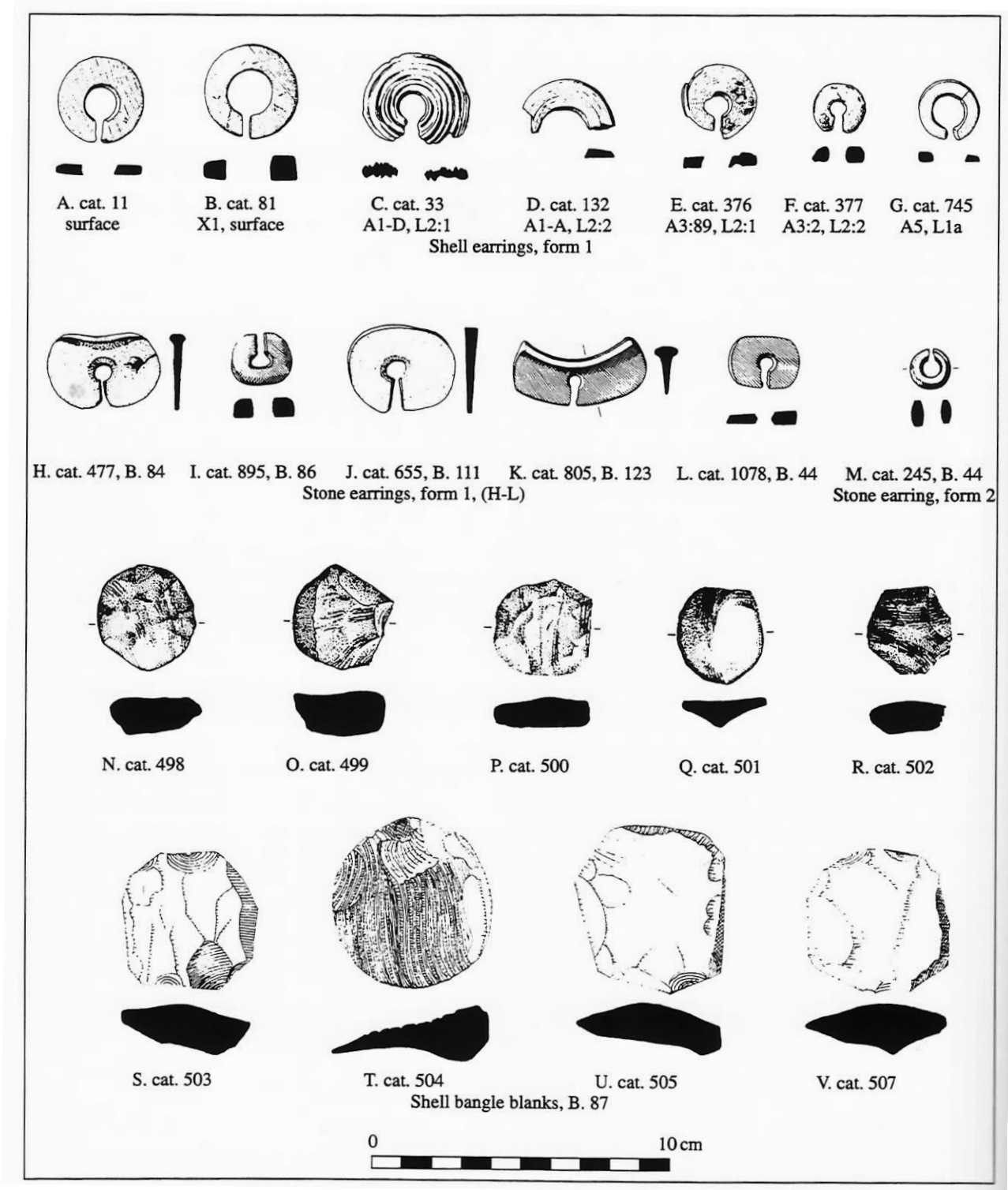


FIG. 95. Shell & stone earrings and shell bangle blanks

TABLE 29. *The shell bangle cores*

Cat. No.	Context	L.	Mx.D.	Mn.D.
239	B 44	38.0	38.6	35.6
318	A3:57 L2:1	20.5	26.0	22.2
531	B 89	44.1	42.8	36.0
627	A2:91 L2:2	11.7	30.3	27.5

L: Length, Mx.D.: Maximum Diameter, Mn.D.: Minimum Diameter

MISCELLANEOUS

As with all archaeological investigations, a number of artefacts, in particular bronze fragments, cannot be easily classified. It is likely that some are not ornaments at all, however, they are discussed here as some sort of ornamental function is the simplest explanation for their presence.

Shell

Modified operculum. Cat. 806, B 138. A piece of fossil or sub-fossil operculum from a gastropod shellfish. It is perforated at one end, probably by gouging rather than drilling. It is of relatively even width and thickness and is curved along its length. The main planar surfaces have not been ground or smoothed in any way (length: 138.0 mm, width: 13.7 mm, thickness 3.3 mm).

Earplug/spindle whorl. A single, probably tridacna, artefact (cat. 78). It has a concave outer edge and so could have been worn as an earplug. However, it is also perforated centrally and could have been used as a spindle whorl. The overall shape is similar to a thin pulley with one end smaller in diameter than the other.

Animal tooth

A single pig tusk is present, found under the right femur of B 83 (cat. 484). There is no evidence of working but part of the base of the tusk has broken away. It remains possible that it was perforated for suspension as with the dog and tiger teeth noted above. Alternatively, binding round the base would serve equally well for suspension. However, no notches, or distinctive wear, were noted.

Bone

Disc. Two artefacts made from fish vertebrae. The outer edges appear to have been smoothed and relatively large perforations made through the centre. The most likely use is as beads or pendants.

TABLE 30. *Fish vertebra discs*

Cat. No.	Context	R.H.	R.W.	I.D.	O.D.
230	X1 L2	5.7	8.8	10.2	26.2
236	A1-B L2:2	5.4	9.6	14.9	*c.*34.4

R.H.: Radial Height, R.W.: Radial Width, I.D.: Inner Diameter, O.D.: Outer Diameter

Clay

Disc. Cat. 751, A7 L2:1, Unit 5. A single fragment of a disc-shaped object with an original diameter of about 5 cm. The cross section is bowl like and it is perforated in the centre. The most likely uses would be as some sort of pendant or bead, or as a spindle whorl (diameter: *c.*50.0 mm, perforation diameter: 6.3 mm, thickness; 10.4 mm).

Earplug/spindle whorl. A single artefact (cat. 69) that resembles the shell artefact noted above (cat. 78) in that it is cylindrical and perforated longitudinally with the outer edge being concave around its circumference. One end has a greater diameter than the other. However, it may be too heavy, and the outer groove too shallow to have functioned as an earplug. Other interpretations include use as a spindle whorl or as a bead.

TABLE 31. *Earplug/spindle whorl*

Cat. No.	Context	Material	L.	D.1	D.2	W.D.	P.D.
69	B 15	Clay	22.1	40.6	35.2	35.1	6.4
78	X1, surface	Tridacna	12.9	28.2	23.9	20.7	5.3–9.0

L.: Length, D.1: Diameter end 1, D.2: Diameter end 2, W.D.: Waist Diameter, P.D.: Perforation Diameter

Bronze

Sphere. Cat. 1 is solid bronze sphere with a diameter of 11.9 mm. It may have been a bead.

Metal sheet. Cat. 523, B 93. A single object which may simply be part of a larger, original artefact. It is oblong in shape, slightly curved along its length and with a small triangular projection to the side, near one end. It may be a pendant but does not appear to be perforated for suspension. The area most likely to be perforated, in the case of a pendant however, has not survived (length: 36.1 mm, width: 21.1 mm. thickness: 1.7 mm).

Isolated Fragments. A number of small fragments of bronze were recovered in various contexts. None can be identified as belonging to particular artefacts but given the paucity of other types of complete bronze artefacts, it is likely that most are from bangles.

TABLE 32. *Bronze fragments*

Cat. No.	Context	M.D.	Cat. No.	Context	M.D.
10	A1 L1	10.2	177	A1.B L3 feature 29	10.2
35	A1.C 2:1	7.4	180	B 33	2.0
98	A1.D 2:1	3.8	1019	B 117	5.2
137	B 8	8.7	1191	X1 L2:2	6.9

M.D. : Maximum Dimension

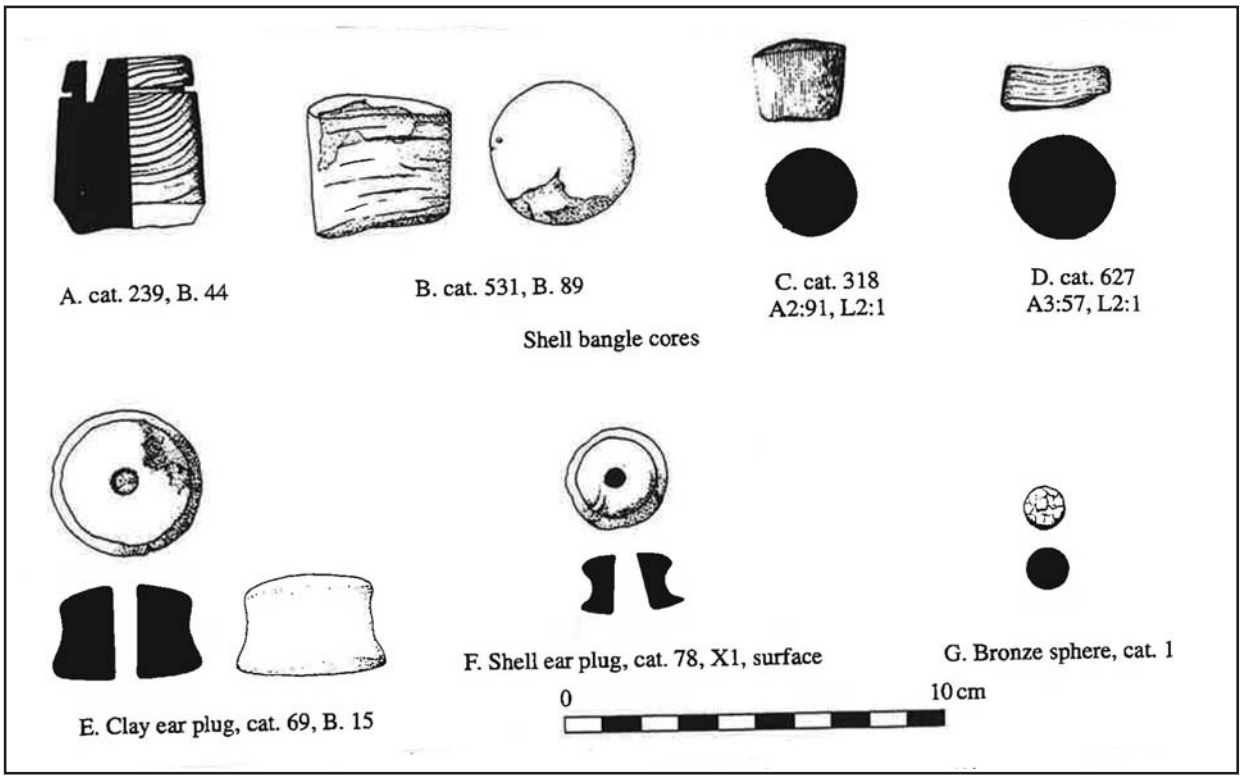


FIG. 96. Manufacturing debris and other miscellaneous artifacts

METALS AT NONG NOR

Metal artefacts in this report have been described as made of either bronze or unalloyed tin. Recent work has confirmed the status of the tin artefacts. For the bronzes however, while the majority are likely to be copper/tin alloys at least one artefact, cat. 882, may in fact be composed of copper only. Similarly, a cache of projectile points (cat. 556), or possibly chisels, found at the knee of B 102 also appear to comprise unalloyedcopper (Fig. 101). In this report then, 'bronze' is a convenient appellation and some variation is implied. A fuller discussion of the analysis of metals at Nong Nor is provided in Reay and Chang (this volume).

SUMMARY AND CONCLUSION

In this report a classification scheme for the personal ornaments from Nong Nor has been presented, the types have been described, and data concerning the individual artefacts have been tabulated. This work builds upon that of Pilditch (1986, 1993), who first introduced an holistic approach to the study of prehistoric personal ornaments in Southeast Asia. For such an approach to succeed, it is important that basic information is available for comparison between sites and regions; such information is rare (Williams 1984). This report is a first step in this process.

It is acknowledged that refinements to classification schemes and descriptive and analytical methods will be made. These will be important in elucidating manufacturing techniques, sources and

other information required for detailed social and economic analysis. At present, the classification scheme presented here is appropriate to the goal of describing and comparing the range of personal ornaments within, and between, sites.

XVII. THE METAL ARTEFACTS

A. Reay and N. J. Chang

Introduction

METAL at Nong Nor was found predominantly as jewellery. Field identifications indicated that bronze bangles were by far the most common items. Notable exceptions were two caches of socketed copper implements, possibly arrowheads or chisels, and several tin artefacts, including bangles and a single earring. Bronze was also used in the repair of broken stone bangles, as has been observed at Ban Na Di (Maddin and Weng 1984).

More detailed analysis of the metals was undertaken in order to address the following questions:

- How many different metals and/or alloys were being used at Nong Nor?
- Tin artefacts have not previously been identified in Thai Bronze Age contexts. Can we confirm the field identification?
- Socketed copper arrowheads/chisels of a similar form also occur at Non Pa Wai, to the north (Pigott and Natapintu 1988). Do the Nong Nor examples also contain only copper; do they contain arsenic as a hardening agent?
- Lead is often used in Iron Age bronzes to assist in the casting of complex forms. Was lead a component of the Nong Nor alloys?
- Because the chemistry of the artefacts has been significantly altered, due to prolonged contact with ground water, it is important to clarify the relationship between the corroded and original metals.

Despite an intensive search using all the available techniques, particularly reflected light microscopy, only six out of nineteen samples investigated yielded metal and/or alloy phases. A number of the heavily corroded samples without any metal phase were also analysed to identify the secondary phases present and hence attempt to determine the original metal or alloy composition.

Samples

A comprehensive study of all of the metal artefacts was not feasible. Samples were taken from as wide a variety of artefacts as possible.

Techniques

TABLE 33. *The analysed metal artefacts*

Cat. No.	Context	Description	Metal Phase Present	Analyses
38	B7	bronze bangle	no	XRF-TE
117	X1 L2:1	bronze bangle	no	XRF-TE
204 & 1104	B 25, area of	bronze bangle	no	XRF-TE
227	B 43	bronze pendant	no	XRF-p
528	B 97, area of	sheet bronze, pendant?	no	XRF-p
550	B 86	tin spiral bangle	no	XRF-up
551	B 86	tin spiral bangle	no	XRF-up, EMPA
552	B 89 pot,area of	bronze pendant, bell?	no	XRF-p
556a	B 102	copper arrowhead, socket	yes	XRF-TE, XRF-p, EMPA
556b	B 102	copper arrowhead, socket	no	XRF-TE
556c	B 102	copper arrowhead, blade	yes	XRF-p, EMPA, element map
604	B 105	bronze bangle	yes	XRF-p, EMPA, element map
671	B 112	bronze bangle	yes	XRF-up, EMPA
882	B 147 (pot), in fill of, B 138	bronze strip, at rim of pot	yes	XRF-p, EMPA, element map
964	B 147, adjacent	bronze bangle	no	XRF-p
967	B 147, adjacent	bronze bangle	no	XRF-p
1096	B 111	bronze bangle	no	XRF-p
1097	B 35	bronze bangle	yes	XRF-p, EMPA, element map
1190	B 49	tin bangle/ring	no	XRF-p, EMPA, element map

TE: Trace Element, p: polished artefact, up: unpolished artefact

For the artefacts containing remnants of the original metal, polished samples were examined with a reflected light microscope and chemically analysed with a Jeol JX 8600 electron microprobe (EMPA) following techniques developed by Nakamura and Coombs (1973). Mineral identification was by X-ray diffraction (XRD) using a Phillips PW1010 diffractometer with identification based on the search programme MacDiff. Bulk samples of the oxidised artefacts were scanned using X-ray fluorescence analysis (XRF, Phillips PW 2400) to determine the element content qualitatively.

Petrography of the metals

The metals copper, tin and a bronze alloy have been identified in a limited number of samples.

Reflected light microscopy revealS significant differences between the bronze samples and the unalloyed metals. The copper and tin have an equigranular texture typical of equilibrium crystallisation, with individual crystals being about 0.14-0.25 mm in diameter. In contrast, the bronze samples show the classic dendritic pattern of quickly cooled metals with individual dendrites being up to 0.4 mm long. In the case of bronze in cat. 1097, rectangular exsolution features at the 100 micron scale can also be observed .

Chemistry of the metals

Because the amount of metal present is small, all samples were analysed by EMPA. This technique analyses small volumes of a few cubic micrometres. The EMPA analysis is dependant on analysing a flat polished surface which was difficult to achieve because of the corroded nature of the samples. As a result many of the analytical totals show some minor variation around 100 per cent.

Anomalous readings also resulted from measuring areas where the original metal had corroded to an oxide, hydroxide or carbonate. For example, one reading on cat. 556c, a copper artefact, gave 56.33 per cent copper with no other metals present, indicating that in the area analysed copper metal had corroded to $CuCO_3$ $Cu(OH)_2$ (malachite) which has 56.97 per cent copper. Such readings were easily identified and discounted.

Copper

Remnants of copper metal have been found in three samples; cat. 882, cat. 556a and cat. 556c. Most of the metal has been oxidised to the copper oxide, cuprite. There are trace concentrations of tin in cat. 882, with a maximum concentration of 0.56 per cent, which is close to the minimum detection limit and probably means that no tin is present in this sample.

Bronze

In the bronzes, discounting readings on corroded metal, variation in the ratio of copper to tin at different points on the same sample was evident. This variation can be the result of several processes including; original inhomogeneities in the metal, re-equilibration following casting, mechanical displacement and/or oxidation during high temperature working, oxidation during corrosion or exsolution (Charles 1973). In table 2, copper/tin ratios are therefore given as a range rather than

TABLE 34. *Microprobe analysis of bronzes*

Context	Sample made up of:	Measured metal Cu:Sn	Cu/Sn ratio	Probable original composition Cu:Sn
cat. 604 B 105 bangle	bronze metal, oxides & carbonates of tin & copper	91.6:12.4	7.36	88:12
cat. 671 B 112 bangle	bronze metal, oxides & carbonates of tin & copper	88.0:12.6 88.1:9.7 93.4:6.3	14.95 9.02 7.01	87:13 90:10 94:6

TABLE 34 *(cont.). Microprobe analysis of bronzes*

Context	Sample made up of:	Measured metal Cu:Sn	Cu/Sn ratio	Probable original composition Cu:Sn
cat. 1097	bronze metal, oxides	85.4:14.3	5.6	86:14
B 35	& carbonates of tin	**94.3:6.8**	**13.9**	**93:7***
bangle	& copper	98.2:5.6	17.5	95:5

in absolute terms. An average composition of 7-10 per cent tin is indicated.

THE OXIDISED ARTEFACTS

Mineralogy of the oxidised artefacts

The majority of the artefacts are extensively corroded through reaction with oxygenated ground water which has converted the original copper alloys to a variety of minerals. Optical examination of samples suggests that cuprite (Cu_2O) and malachite ($CuCO_3$ $Cu(OH)_2$) are the major minerals present in the artefacts. This has been confirmed by XRD analysis and is illustrated in figure 97 where the only phases present are the copper oxide (cuprite) and the copper carbonate hydroxide (malachite). Other minerals include azurite and the tin oxide romarchite. From this mineral assemblage, it is possible to predict from geochemical calculation the conditions under which the artefacts were oxidised. Cuprite and malachite are only stable at a pH of greater than eight and an Eh of *c.* + 0.15, so alkaline oxidising conditions are indicated.

Only one of the oxidised bronze samples contains any tin-bearing phases; romarchite (SnO) has been identified as the major phase coexisting with quartz. The limited presence of tin-bearing mineral phases is unusual given that the samples appear to have been bronzes. In an attempt to identify such phases, a sample was investigated using element mapping techniques on the electron microprobe confirming the dominance of copper carbonates and copper oxides (Fig. 98). Two analyses of five micrometre areas of higher tin concentration on a sample from cat. 38 showed 31 per cent and 42 per cent tin respectively. These high tin concentrations are probably the result of copper being lost from the sampl. It should be noted that this high tin mineral phase has yet to be identified.

Petrography of the oxidised artefacts

Petrographically the oxidised bronze artefacts show textures reminiscent of dendritic growth (Fig. 99). The comparison with textures of modern bronze alloys is difficult to make since the major oxidation phase present is the deep red copper oxide cuprite whose depth of colour tends to obscure detail and makes petrographic examination difficult. In addition, the alteration and crystallisation of cuprite from the copper alloy together with the *in situ* crystallisation of other secondary minerals such as malachite, azurite and romarchite may have had a significant modifying effect on the textures in the sample. Hence the present textures may not be original.

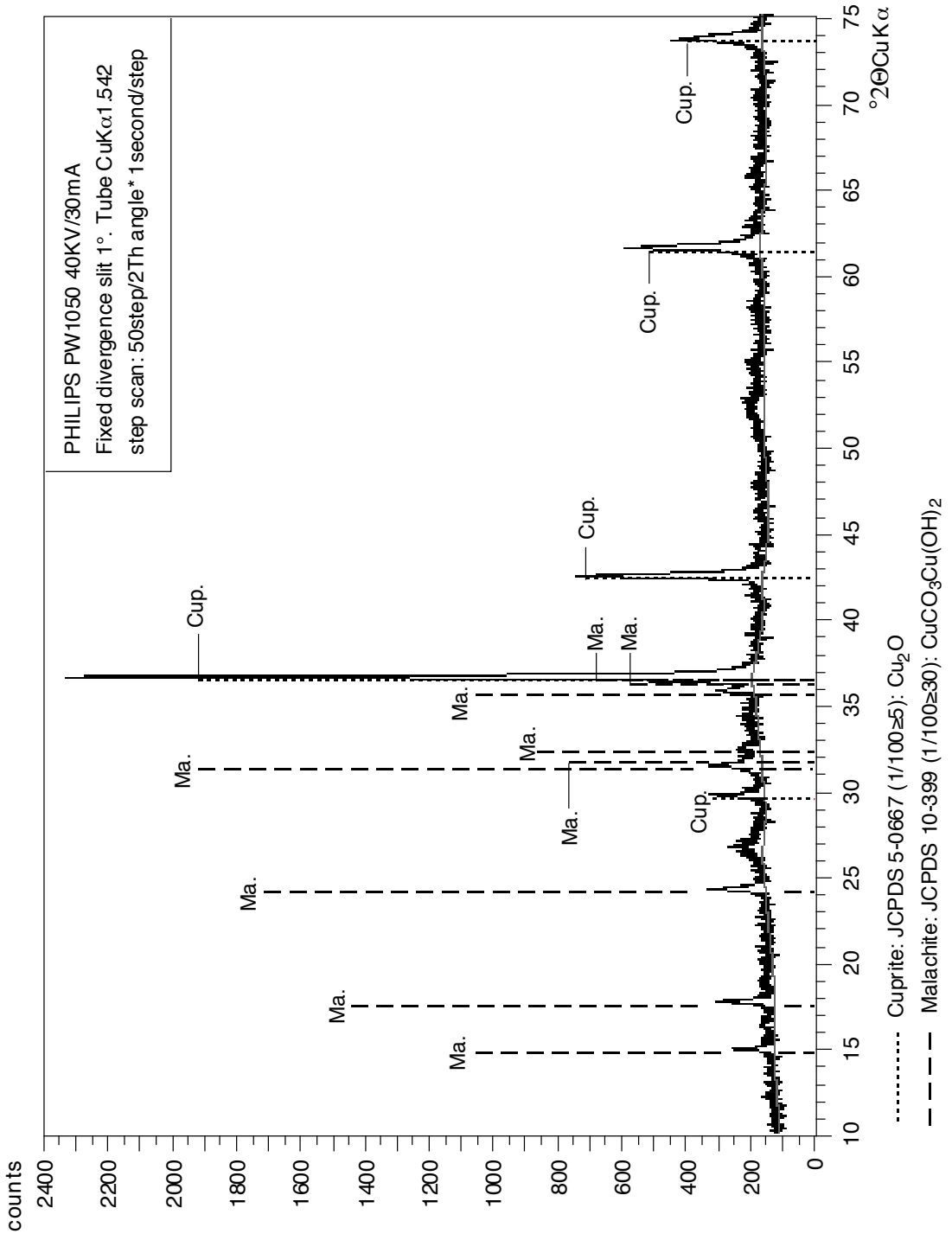


FIG. 97. XRD analysis of cat. 38 indicating that cuprite, Cu_2O, and malachite, $Cu(OH)_2$, are the only phases present.

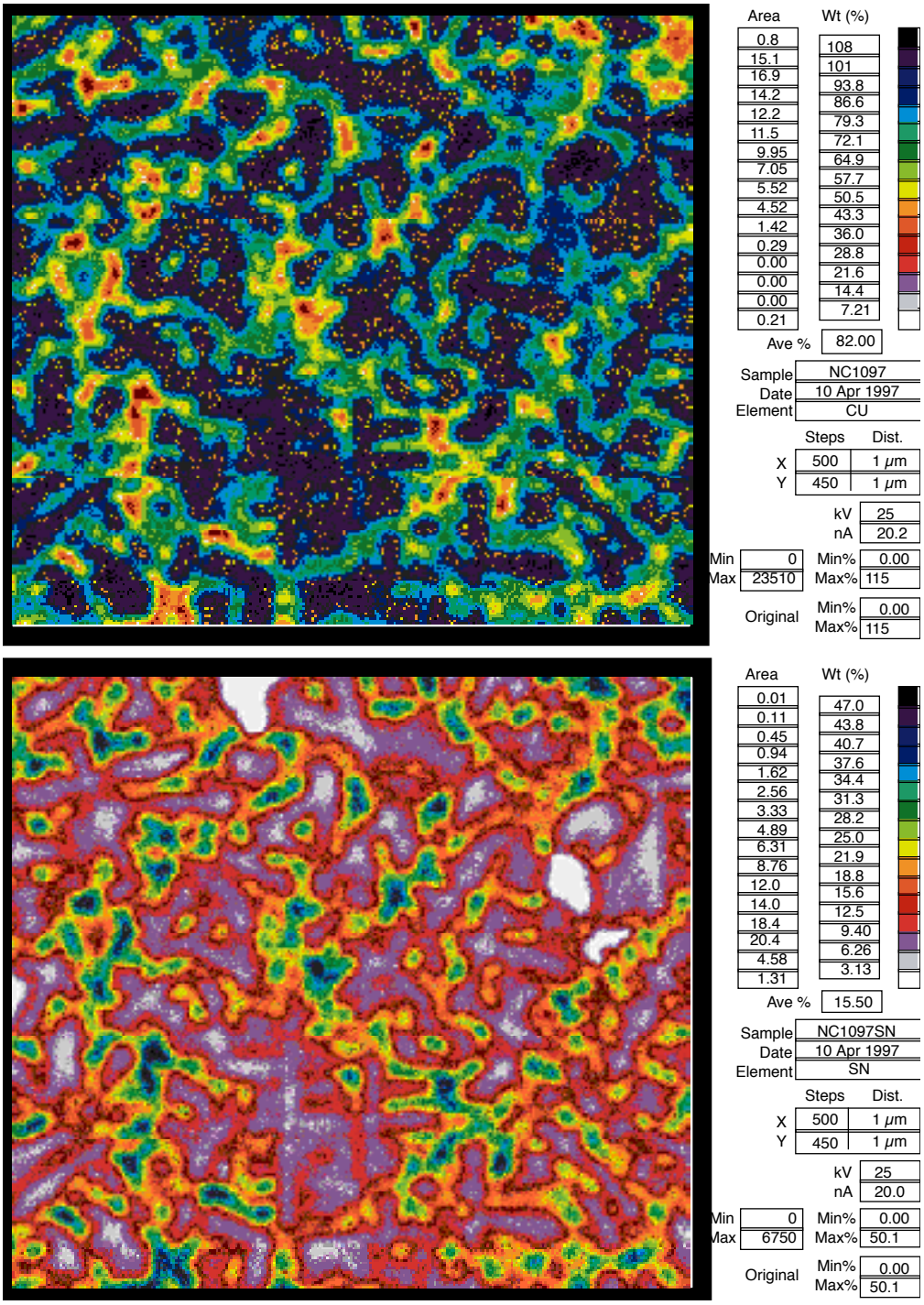


FIG. 98. Element maps for copper *(above)* and tin *(below)* over a 500 x 450 µm area of cat. 1097. Dentritic structure is indicated by the angular textures in the lower central portions of the maps.

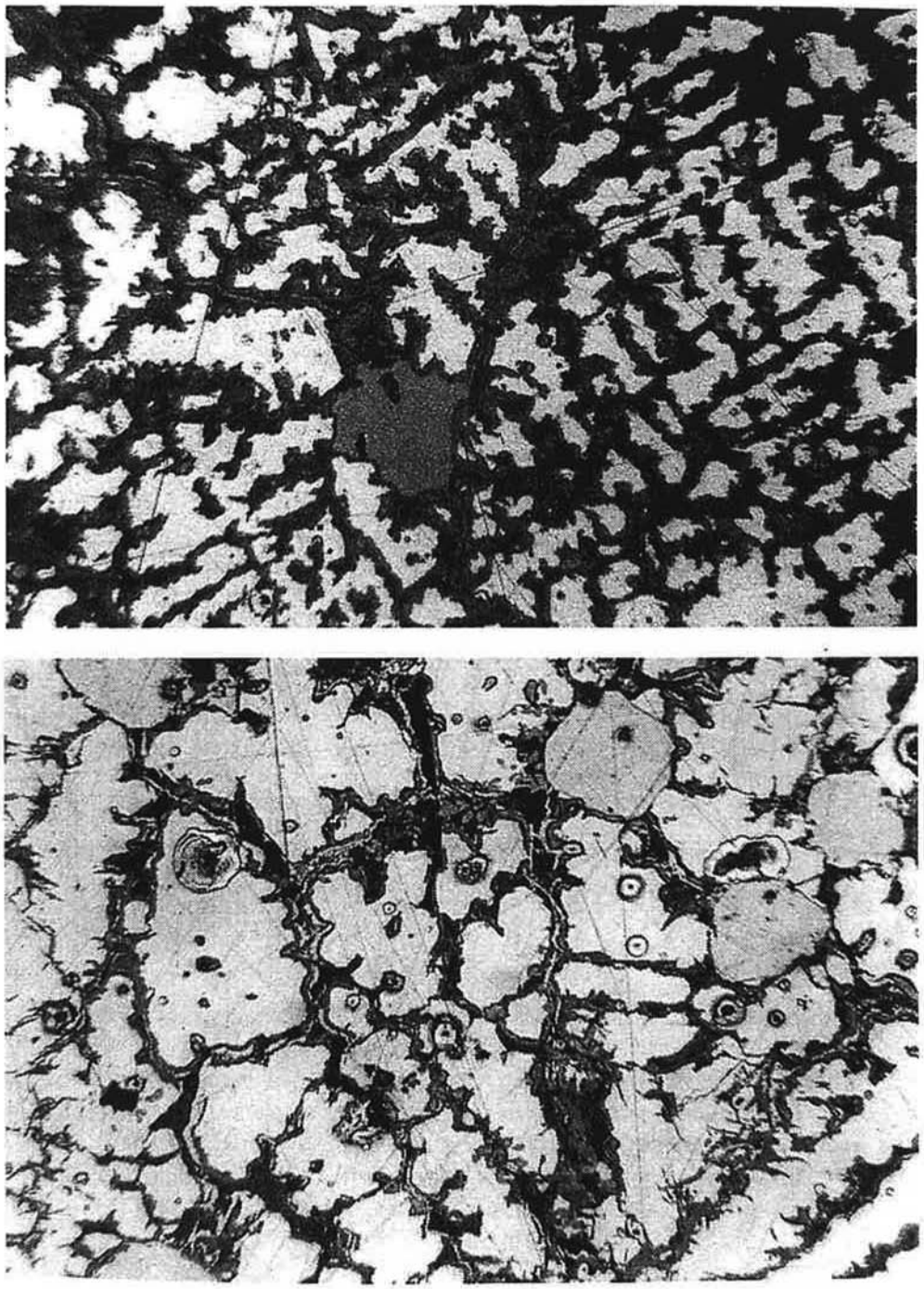


FIG. 99. Polished sections of cat. 1097 *(above)* and cat. 671 *(below)* showing dentritic structures. Slightly darker grey sub-circular feature in top right of cat. 671 micrograph is composed of copper (magnification = x 165)

Chemistry of the oxidised artefacts

The chemistry of all the oxidised samples is dominated by copper and/or tin. Analyses of three oxidised bronze samples are given in table 35 recalculated to oxides. The analyses fall short of 100 per cent and the difference will be due to carbon dioxide and water content arising from the oxide and carbonate phases present. Copper/tin ratios in the samples are also given in table 35. The three samples analysed sort into two groups based on copper/tin ratios; cat. 38 with a Cu/Sn value of *c*. 4.4, and cats. 117 and 204 with an average value of 2.7. These ratios would indicate bronzes with 18 and 27 per cent tin respectively. However, it is likely that these values have little relevance to the original composition of the metal since copper and tin have different chemistries and will behave differently in the oxidising ground water situation. Copper is more soluble than tin in the mildly oxidising situation and it is probable that the copper/tin ratio changed during oxidisation, in which case the ratio is likely to have decreased. The ratios observed in the bronze metals vary between 6.1 and 19 (Cu/Sn) indicating that copper has been lost from the oxidised samples. This is consistent with the oxidised and metallic archaeological samples originally being of similar composition.

Table 35. *Bulk major element analyses (weight per cent) of oxidised samples*

Cat. No.	38a	38b	117a	117b	117c	204
Cu	50.26	46.83	43.66	43.57	43.61	42.99
Sn	11.82	10.63	15.47	16.25	17.21	16.16
Fe	1.16	1.12	0.36	0.98	0.31	0.70
Cu/Sn	4.3	4.4	2.8	2.7	2.5	2.7

38a & b and 117a, b & c refer to multiple samples prepared from just two artefacts

Analyses of cats. 551 and 1190 do not show any copper content. The original artefact must have been composed of unalloyed tin but all the original metal has been converted to tin oxides and/or carbonates.

Trace element content of the oxidised artefacts

Trace elements can provide evidence for the origin of the ores smelted to produce the bronze, copper or tin artefacts. None of the metal samples was available in sufficient quantity for an XRF scan, so as an alternative, a number of the oxidised samples were scanned. A trace element scan of one sample is given in figure 100. The only trace elements detected were titanium, iron, lead, vanadium and manganese. Titanium, iron and manganese are likely to be present in the hundreds to thousands of parts per million (ppm) concentration range whilst the other two elements will be in the tens of ppm range. It is likely that the oxidation and hydration process responsible for the corrosion of the artefacts has also modified the trace element content so little can be read into the results. However, in the oxidising environment lead is unlikely to migrate so it is possible to say with some certainty that lead contents of the original artefacts must have been in the few parts per million range. Seeley and Rajpitak (1984) have reported varying concentrations of lead, arsenic, antimony, iron, silver, nickel, cobalt, bismuth and zinc in samples from Ban Na Di. If any of these elements is present in the oxidised samples, then their concentration is likely to be less than 50 parts per million

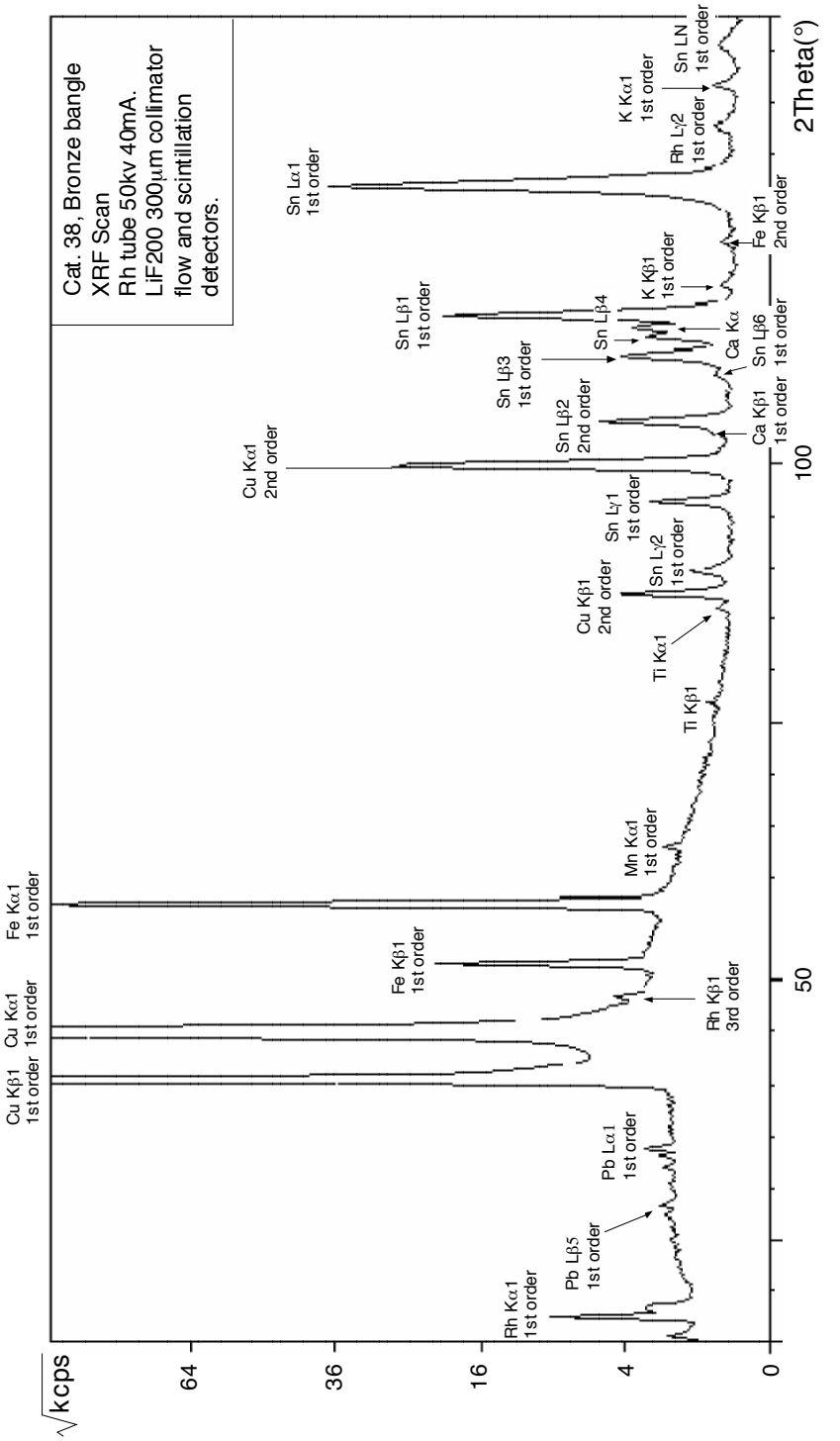


FIG. 100. XRF trace element scan of cat. 38. The x axis has been exaggerated by using √kcps, rather than kcps (thousand counts per second), to assist identification of trace elements.

SUMMARY AND CONCLUSIONS

Analyses were carried out on remnants of original metal where possible. However, as most of the artefacts have been chemically altered in an alkaline oxidising environment, chemical and mineralogical knowledge was required to assess original metal compositions.

Results indicate that the people of Nong Nor had access to artefacts made from at least three different metals; copper, tin and bronze. The copper artefacts showed no evidence of significant inclusions of arsenic, a common hardening agent, and indeed neither the tin nor copper artefacts had any impurities of note.

There is some variation in thecopper/tin ratio in the bronzes but the small sample analysed, and its corroded nature, make for tentative conclusions only. Where metal is present, an average composition of seven to ten per cent tin is indicated. This is close to the ten to twelve per cent range regarded as an ideal compromise between hardness and brittleness (Forbes 1964:146). The level of variation in copper/tin ratios suggests that the artisans were trying for a single standard composition, with variable success, rather than purposely manufacturing a range of metals. Due to a probable loss of soluble copper from the oxidised bronzes, their original copper/tin ratios cannot be accurately assessed. However, as the measured ratio values are less than in the metals, the original values could have been similar in all the artefacts sampled.

High-tin bronzes (*c*. 24 per cent tin; Seeley & Rajpitak 1984) are absent from Nong Nor, as are ternary alloys containing lead. These omissions, in concert with the variation in composition of the bronzes, may indicate an early stage in metal technology, or perhaps, that when metal artefacts were imported into Nong Nor the more sophisticated pieces were not made available. In any case, there is no evidence that any stage of the production of metal artefacts was carried out at Nong Nor.

Finally, the unexpected recovery of tin artefacts at Nong Nor is important. Tin is very difficult to identify in the field as it is of a similar colour and consistency to the alluvial deposits in which it has been found. With its presence confirmed at Nong Nor it may be that tin will be identified at more sites in the future.

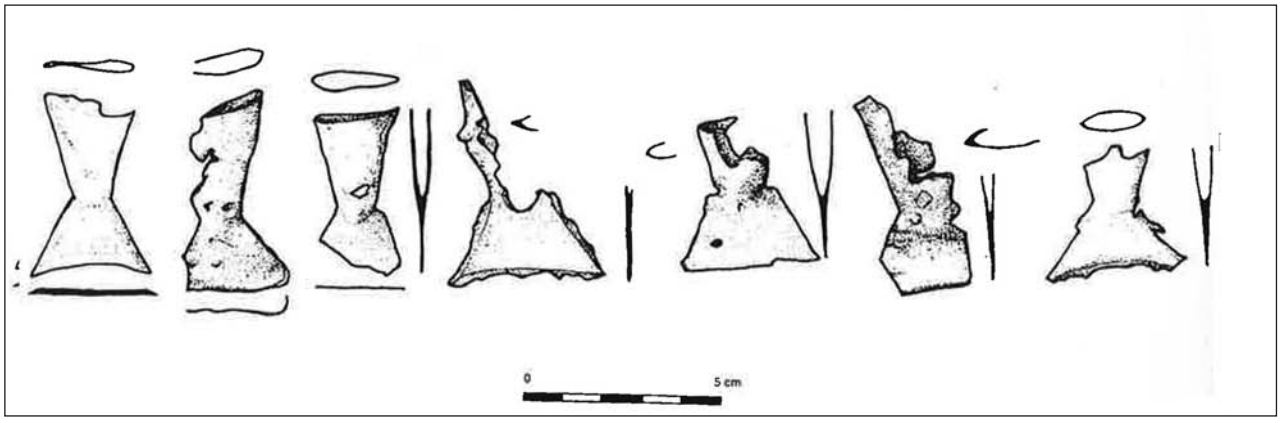


FIG. 101. Copper socketed artefacts, cat. 556, from burial 102

XVIII. THE FAUNAL REMAINS FROM MORTUARY CONTEXTS

C.F.W. Higham

INTRODUCTION

THE remains of animals were often incorporated into graves as mortuary offerings. In the following description, all measurements are in mm.

Bibos sp.

Burial 81. Cat. 555. The distal end of the metatarsal of *Bibos* sp. Bd, 57.0.

Sus scrofa

Burial 2. Cat. 1203. A lower first molar, unerupted, from a very young animal.

Burial 8. Cat. 1196. Second phalanx of an immature animal. L, 27.0, Bp, 17.2.

Burial 23. Cat. 156. Articulating foot bones, comprising all first, second and third phalanges from two feet. They were found beside the right hand, and come from a very young animal, for the epiphyses were unfused. A further third phalanx, cat. 157, was found beside the right shoulder.

Burial 33. Cat. 215. Articulating right and left second and third phalanges. Proximal end of the epiphysis just fused, a young animal. Bp, 2nd phalanx, 15.5.

Burial 39. Cat. 1117. Distal epiphysis of the metapodial and the first phalanx, found in articulation, from a very young animal.

Burial 56. Cat. 368. The first, second and third phalanges of a very young pig were present beside the right elbow. The epiphyses were unfused.

Burial 58. Cat. 364. The third phalanx of a very young pig was found by the left femur.

Burial 77. Cat. 1168. First phalanx II-V of a very young animal, found in the vicinity of the bones.

Burial 90. Cat. 1172. Two second phalanges were found when sorting the material in the laboratory. The come from a subadult animal, since the epiphyses had only recently closed. Dimensions:

L: Length, Bd: Distal width, Bp: Proximal width.

L, 23.5 mm, Bp, 16.8 mm, second specimen, L, 24.0, Bp, 15.8.

Burial 99. Cat 1170. Articulating first and second phalanges, found at the eastern end of the grave. Dimensions are: phalanx 1. L, 39.5, Bp, 19.1. Phalanx 1, second specimen, L, 39.0, Bp, 20.1, Phalanx 2, L, 24.0, Bp, 18.3, second specimen, L, 24.5, Bp, 18.1.

Burial 105. Cat. 653. Part of the proximal end of a pig's tibia was found by the human cranium.

Burial 106. Cat. 663. The first and second phalanges of an extremely young pig were found beside the upper body.

Burial 107. Cat. 688. An unfused 2nd phalanx from a very young animal, found under the cranium.

Burial 109. Cat. 705. The first phalanx of a very young pig.

Burial 111. Cat. 677. The articulating phalanges from a pig's foot were found beside the left femur. No epiphyses were closed, and the animal was very young.The first and second phalanges, probably from the same animal, were found at the right femur (cat. 678).

Burial 123. Cat. 817. The first phalanx of a very young pig.

Burial 129. Cat. 756. The second phalanx of an immature pig.

Burial 136. Cat. 907. The articulating second and third phalanges from one pig's foot were found beyond the human cranium. They come from a very young animal with just fused epiphysies. Bp, 2nd phalanx, 16.2.

Gallus

Burial 33. Cat. 1167. Distal end of the humerus, found within pottery vessel cat. 199. Bd,17.0.

Canis familiaris

Dogs' crania were often placed with the dead, the preferred location being beyond the human head. The following graves contained canid remains, dimensions being given in table 1.

Burial 15. Cat. 513. Fragments of an adult dog's maxilla.

Burial 23. Cat. 174. A complete but crushed and distorted cranium of an adult dog with slight tooth wear.

Burial 27. Cat. 171. A formerly complete skull, the dentition reveals a moderate degree of wear.

Burial 30. Cat. 167. A complete dog's cranium was interred, but it survived in a fragmentary condition. It comes from a young adult animal.

Burial 33. Cat. 195. The complete cranium and mandibles, slightly crushed and distorted. All the permanent teeth in place, but no sign of wear.

Burial 35. Cat. 338. A complete but severely crushed and distorted cranium, teeth just coming into wear. A second skull, cat. 513, comes from a young adult dog, but it has been badly crushed.

Burial 39. Cat. 609. Fragments from what was interred as a complete skull, with very slight tooth

wear.

Burial 44. Cat. 240. Very fragmentary mandible remains.

Burial 47. Cat. 278. The mandible fragments from a young dog, the lower first molar was unerupted.

Burial 55. Cat. 1202. A PM_4, unworn, from the vicinity of the human cranium.

Burial 59. Cat. 324. Fragments of an adult dog's jaw and cranium.

Burial 74. Cat. 1171. The cranium and mandible fragments of an adult dog.

Burial 83. Cat. 540. A complete skull, but crushed almost flat. It comes from a young adult dog, there being no sign of tooth wear.

Burial 85. Cat. 599. Two fragmentary jaws, probably from an adult animal.

Burial 92. Cat. 533. Upper canine of an adult dog.

Burial 93. Cat. 565. An immature dog, the complete skulll survives but it is badly crushed. There is no evidence for tooth wear.

Burial 99. Cat. 538. Fragmentary remains of what was interred as a complete cranium. A young adult, there are no signs of wear on the permanent dentition.

Burial 105. Cat. 681. The cranium and mandible of a very young dog, the decidous dentition being unworn.

Burial 114. Cat. 714. An astragalus and the metatarsals and first and second phalanges from both rear limbs, representing a juvenile dog. The epiphyses on the metapodials were unfused.

Burial 116. Cat. 848. Fragments of the maxilla including the canine and fourth premolar of an immature dog. The premolar had not erupted.

Burial 122. Cat. 1002. Parts of the cranium of an adult dog, with slight tooth wear.

Burial 123. Cat. 822. Both mandibles of a very young dog, with the first molar unerupted.

Burial 126. Cat. 847. Fragments of the cranium and mandible of an adult dog.

Burial 128. Cat. 754. Part of an adult dog's mandible.

Burial 129. Cat. 757. Parts of the cranium and mandible of an adult dog.

Burial 138. Cat. 1041. The remains of two dog's crania, interred together. One represents an adult animal, the other a very young specimen with unworn deciduous dentition.

Burial 141. Cat. 993. The skull and jaw fragments of a young dog, the lower first molar has just erupted.

Burial 146. Cat. 985. Fragments of an adult dog's mandible.

Burial 155. Cat. 1028. The very fragmentary remains of the cranium.

Burial 158. Cat. 991. The left mandible and part of the dentition of a young adult dog.

TABLE 36. *Dimensions of the dog crania and mandibles from Nong Nor burials*

Burial number	15	23	27	30	33	35	35	39	58	74
Catalogue number	65	174	171	167	195	338	513	609	991	1171
Total length	-	-	-	-	198.8	-	-	-	-	-
Condylobasal length	-	-	-	-	182.0	-	-	-	-	-
Mastoid breadth	-	-	-	62.5	71.0	-	-	-	-	-
Orbit breadth	-	-	-	-	35.0	-	-	-	-	-
Palate breadth	-	-	58.0	69.0	72.0	-	-	-	-	-
Prosthion-staphylion	-	-	-	-	97.0	-	-	-	-	-
Staphylion-basion	-	-	-	-	71.0	-	-	-	-	-
L. auditory bulla	-	-	-	21.0	-	-	-	-	-	-
Br. auditory bulla	-	-	-	14.8	-	-	-	-	-	-
Br. max. at canines	-	-	34.0	36.0	40.5	-	-	-	-	-
L. molar row	16.0	19.8	15.0	19.0	20.0	19.0	-	17.0	-	-
L. premolar row	-	48.0	43.6	48.2	49.5	44.0	-	-	-	-
L. upp. canine at base	-	-	8.1	10.1	10.1	10.0	-	10.0	-	-
L. M^1	11.5	12.1	10.0	12.1	12.3	12.1	11.3	11.0	11.8	-
Br. M^1	13.2	15.0	13.1	14.8	15.2	14.5	13.0	14.0	15.1	-
L. PM^4	-	-	16.0	17.0	18.1	17.2	18.0	17.5	17.2	-
Br. PM^4	-	-	7.8	8.5	10.0	9.0	10.0	10.0	9.1	-
L. pal. fiss.-staphylion	-	-	-	-	71.2	-	-	-	-	-
L. akromion-basion	-	-	-	-	50.0	-	-	-	-	-
L. mandible	-	139.0	122.0	139.0	154.0	139.0	130.0	-	142.0	-
Br. mandible @ M_1	-	11.1	9.8	11.1	11.2	11.1	10.0	11.0	12.0	12.0
Br. artic. condyle	-	22.2	21.9	-	28.0	-	-	-	-	-
Ht. mandible @ M_1	-	26.0	20.2	23.0	26.0	25.0	20.8	25.0	24.0	23.5
LM_1	-	20.5	18.0	19.8	20.1	20.5	20.0	20.5	21.0	21.1
Br. M_1	-	8.1	7.0	8.0	8.5	8.0	7.5	8.2	8.6	8.6
L. M_{1-3}	-	41.5	29.2	33.5	34.0	33.0		34.6	34.0	34.5
L. PM_{1-4}	-	39.0	35.8	40.7	39.2	39.0	36.5	38.0	37.0	38.2
Br. lower canine	-	7.0	5.8	6.5	7.1	6.0	6.0	6.5	6.0	7.1

Burial number	83	93	99	99	122	126	128	129	138	141
Catalogue number	540	565	538	1169	1002	847	754	757	1041	993
Total length	190.0	-	-	-	-	-	-	-	-	-
L. auditory bulla	21.2	24.0	-	-	-	-	-	-	-	-
Br. auditory bulla	14.5	14.5	-	-	-	-	-	-	-	-
Br. max. at canines	-	-	-	-	36.0	-	-	-	-	-
L. molar row	-	-	-	-	17.5	-	-	-	-	-
L. M^1	-	-	-	-	11.5	-	-	12.1	12.9	11.5
Br. M^1	-	-	-	-	14.5	-	-	14.2	15.0	13.6
L. PM^4	-	-	-	-	17.0	-	-	19.8	19.6	-
Br. PM^4	-	-	-	-	9.0	-	-	8.5	10.4	-
L. mandible	134.0	125.0	-	-	138.0	-	-	-	-	-
Br. mandible @ M_1	11.2	11.1	10.4	10.4	12.2	10.2	12.2	-	11.0	-
Br. artic. condyle	21.8	-	-	-	-	-	-	-	-	-
Ht. mandible @ M_1	24.0	-	23.0	23.0	23.0	24.0	28.5	-	23.2	-
LM_1	-	20.5	18.2	18.2	20.5	-	19.0	-	21.8	-
Br. M_1	-	8.0	7.6	7.6	8.0	-	7.1	-	8.0	-
L. M_{1-3}	-	-	30.1	30.1	36.8	-	-	-	-	-
L. PM_{1-4}	37.0	-	-	-	-	-	-	-	-	-
Br. lower canine	6.5	-	-	-	6.5	-	-	-	-	-

XIX. THE PEOPLE OF NONG NOR

N. Tayles, K. Domett and V. Hunt

THE human skeletal remains excavated at Nong Nor during the 1991-1993 field seasons form the basis for this chapter, which describes the skeletal collection and discusses the people who used the site as a cemetery during the period 1100-700 B.C. The material comprises 155 skeletons, with representation of the individuals ranging from a few articulated bones to complete skeletons.

The chapter provides a census of the sample, an initial assessment of their physical appearance, and dental and skeletal health. The Nong Nor burials were recovered from within the midden which predates the burials by *c*. 1500 years. There is no direct evidence of the environment and subsistence mode of the people. It also includes a preliminary comparison of some aspects of the people of Nong Nor with the occupants of Khok Phanom Di. In contrast to Nong Nor, the latter incorporates a well preserved and complete collection of human skeletal remains with a large amount of information on the environment of the site and the technology, subsistence mode and social structure of the people. The preservation of the skeletal remains from Nong Nor has restricted the quality and quantity of the data which could be used in a comparison.

The remains were catalogued in the field and preliminary age, sex and stature estimates were made where possible. This preliminary census was reconsidered in the laboratory and details of the final census are provided. Revised age and sex estimates have incorporated as much additional information as possible. The widespread disturbance of remains through the superpositioning of graves, recent agricultural activities and prehistoric and recent looting of grave goods resulted in commingling of remains. During the laboratory analysis there was some reclassification of 'burials' so the final total of individuals differs from that defined by the original burial numbers. The treatment of the material in the field and in the laboratory is described. The completeness of the 'burials' is given in detail in the profiles in appendix 1 and is summarised in the text. All metric information, apart from dental measurements, is provided in appendix 2. There are no craniometric data as there are no measurable skulls in the collection.

FIELD METHODS

The burials were photographed and drawn, the skeletal elements present recorded and preliminary estimates made of age and sex where possible. Complete or almost complete long bones were measured and any evidence of pathology or non-metric traits was recorded before the bones were lifted. There were very few complete long bones and no undamaged crania in the sample. The bones were then washed, dried and packed in plastic bags in the field, with individual bones or groups of

bones separately packed. Crania were lifted whole and cleaned without washing where appropriate. The material was shipped to the University of Otago packed in wooden crates. The reconstruction and recording was undertaken in the laboratories of the Anthropology Department.

COMPLETENESS OF SKELETONS AND PRESERVATION OF BONE

A total of 168 human burials were identified during the three excavation seasons, including five putative infant burial jars with no bone associated. During the analysis of the burial pottery a further four large pots, again without any bone associated, were classified as infant burial jars on the basis of similarity of form and position to the known burial jars. Three burials identified by bones projecting into one of the trenches in the first season were not lifted at the time and because they were not within the area of later excavations were not recovered. A total of 15 burials, including the nine infant burial jars mentioned above, did not contain any bone. The six adult burials included in this number were identified from grave cuts, some with pots and other grave goods. From the total of 172, the number of individuals represented by skeletal remains, after allowing for some amalgamation of incomplete and scattered skeletons and the addition and deletion of others, totals 155. The sample ultimately comprised 29 complete and 95 incomplete but articulating skeletons, and 31 instances of scattered bone.

Some skeletons are incomplete because they extended beyond the excavation area. A number of incomplete skeletons were represented by limb bones, mainly from the lower limbs. A recurring and enigmatic finding is the absence of feet on many skeletons, even those which are otherwise virtually complete. There is no obvious explanation for this phenomenon.

Many burials were damaged by human activity, including the removal of the upper layers of the mound during levelling of the paddy field, subsequent agricultural activities, and looting of graves. This had apparently occurred in prehistory along with disturbance through superpositioning of graves, as well as in very recent history. In addition to this human activity, there is evidence of disturbance of bones by natural processes such as the annual inundation of the field during the wet season. Many of the skeletons had long bones overturned and smaller bones disturbed, even in the deeper burials. This probably reflected the periodically high water content of the matrix. In some areas towards the edges of the mound, bones tended to drift down the slope. Bone tissue was particularly poorly preserved in burials at the northern edge of the mound, where the composition of the surrounding matrix resulted in chemical dissolution of the bone. The state of preservation of the bone tissue is generally better in skeletons buried in graves cut into the natural deposits than in those buried in the midden. Most bones had suffered some damage for one or more of the reasons noted above. Very few long bones were intact with complete articular surfaces and in most cases shafts only were recovered, although many had shadows of complete bones, enabling an estimate of length to be made in the field. No crania were complete, with very few facial bones surviving and most calvaria broken and/or crushed into many pieces. None could be fully reconstructed, largely because of the crushing of the broken edges of the bone fragments.

NON-BURIAL HUMAN REMAINS

A large quantity of human bone was recovered in the disturbed upper layer of the site and scattered amongst the midden. Among the bones from the disturbed upper layer is a segment (*c*. 10 cm in length) of tibial shaft which has *c* . 1 mm of bone added to the cortex at the subperiosteal

surface and 3-5 mm of cancellous bone with thickened trabeculae added at the endosteal surface (Fig. 102:A-B). The subperiosteal margins of the original cortex are defined by a difference in colour, with the additional bone stained a lighter colour. This suggests a difference in histological structure between the subperiosteal new bone and the cortex. The additional bone on the subperiosteal surface is striated, with increased porosity. The entire length of the fragment is affected, which, together with the involvement of the medullary cavity, indicates that the pathology is not the result of a discrete traumatic lesion. Differential diagnosis includes leprosy and one of the treponemal infections, such as yaws. Neither of these diseases has been identified in prehistoric Southeast Asia. As these are infectious diseases and there is no evidence of either on any skeleton in the Nong Nor sample, identification on the basis of a single bone fragment is not warranted. The absence of cloacae or sequestra suggests that the pathology is not osteomyelitis although there

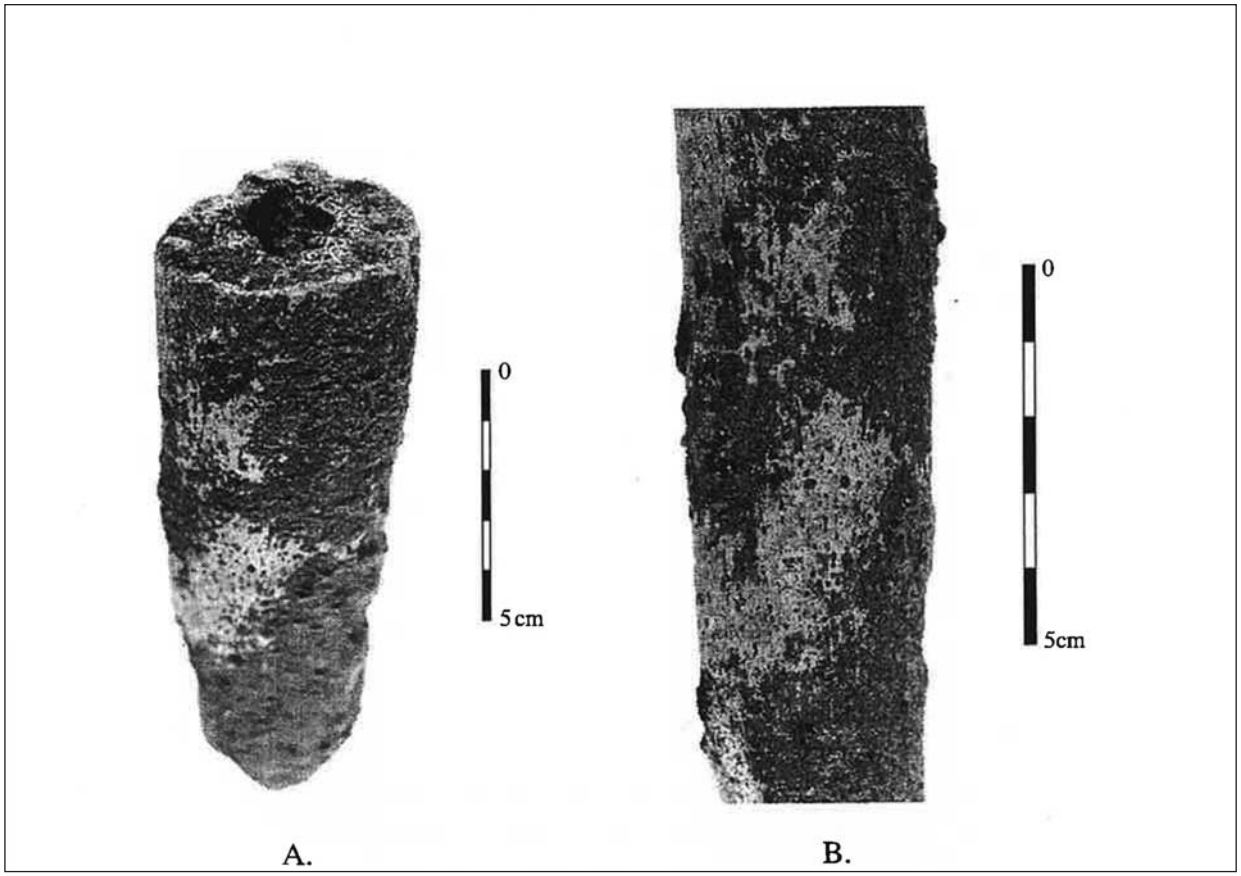


FIG. 102. A: Segment of tibial shaft (*c*. 10 cm in length) found in surface collection at the site. This bone has c 1mm cortical bone added to the cortex at the subperiosteal surface and 3-5 mm of cancellous bone with thickened trabeculae added at the endosteal surface. The subperiosteal margins of the original cortex are defined by a difference in colour, with the additional bone stained a lighter colour. This suggests a difference in histological structure between the subperiosteal new bone and the cortex. B: Lateral surface of the tibial shaft. In the area not covered by the calcareous deposit the increased porosity and striations of the additional bone are evident.

may have been a remote focus.

A further large collection of bones removed from the site following recent looting of the burial ground is now stored at Wat Nong Pho, in a nearby village. These bones were also examined, although their removal from an archaeological context and subsequent mixing reduces their value as a source of data. A minimum number of twenty people (based on the count of left mandibular bodies) were represented by the remains. There were no complete long bones in the collection, and no complete crania. As is discussed later in relation to the burial skeletons, considerable variation was evident in the size of bones, including the presence of both large and very small bones from adults. No gross pathology was evident other than the healed fracture of a clavicle.

BURIAL CENSUS

Sex Estimation

Standard morphological criteria of the pelvis and the cranium were used in the first instance for sex estimation. In many cases other sexing criteria were also used to support what little morphological assessment could be carried out. On the pelvis, the shape of the greater sciatic notch and the pubic arch angle were used where possible. The presence and pitting of the preauricular groove were also noted. Cranial and/or mandibular characteristics used were the morphology and relative size of the supraorbital ridge, nuchal lines on the occiput, the mastoid process and orbital rim in the cranium and the shape and size of the mandible. General gracility and robusticity (subjective assessment of size and development of muscle attachments) were also noted, relative to the rest of the population. Sex estimates were not attempted for children (<15 years).

Other methods were used in the estimation of sex of individuals without pelvic or cranial bones, and also to support the morphological sexing estimates. A discriminant function analysis of the dentition was attempted, using the bucco-lingual and mesio-distal measurements of those sexed on the pelvis and cranium. It was found, using t-tests, that the dentition was not statistically sexually dimorphic. Only seven measurements out of a total of 64 differed significantly. The sample sizes for all measurements were small (n=1-10) and those that did have statistically significant differences had sample sizes of 2-4.

Alternatives were tested using skeletal dimensions. The measurements of the anterior-posterior and medio-lateral tibial shaft diameters, taken at the level of the nutrient foramen, were used in a discriminant analysis based on data from the Khok Phanom Di population. While there is debate about the reliability of this landmark (Steele 1970, Andermann 1976) it was used in the absence of other possibilities. A discriminant function analysis requires a group of individuals of known sex and the discriminant function is calculated from this group (Giles 1970, Rösing 1983, van Vark and Schaafsma 1992). The individuals of unknown sex that could have the appropriate measurements taken are then applied to the discriminant function and an estimate of sex is calculated depending on whether the result is greater or less than the section point determined from the reference population. Obviously this is not the optimum situation. Results would be more reliable if the discriminant function was derived from a group of known sex individuals from the Nong Nor population. It was decided that the use of the Khok Phanom Di population was justified because the difference between the means of the tibial measurements from the two populations was not statistically significant. An accuracy score of 81 per cent was obtained for the discriminant analysis. The 19 per cent that would be incorrectly estimated could be attributed to the overlap in size of males and females that could be found in any population.

Section point analyses were used on other metric variables. This method is employed for single variable analyses where the mid-point between male and female averages for the trait are used as the sectioning point for sex assignment (DiBennardo and Taylor 1979). The section point was calculated from the Khok Phanom Di population. Before this analysis was carried out each measurement was statistically analysed to justify the use of the comparison between the two populations. T-tests were performed on the population means and those that were significantly different were excluded. Three measurements which were not significantly different between the two populations were used; the diameter of the femur head taken in the anterior-posterior plane, the maximum breadth of the mandibular condyle and the width of the elbow (i.e. between the lateral and medial epicondyles of the distal humerus).

If the measurement from an individual from the Nong Nor population was greater than the section point it was deemed male, if less then the individual was estimated to be female. Sexual dimorphism was also checked for in each measurement in the Khok Phanom Di population. If there was no sexual dimorphism there would be no point using that measurement to predict the sex of another population.

Sex Estimation - Results

Pelvic, cranial and mandibular morphology provided sex allocation for 49 individuals, less than half the adults. The pelvis was used in 21 cases. Seventeen of these were based on the greater sciatic notch which was often reconstructed or not complete. Forty-two adults were able to be included in the cranial and/or mandibular analysis.

A further 41 individuals were sexed using the metric analyses. The raw data used are given in appendix 2, tables 50-53. The section points are as follows: femur head, 43.4, mandibular condyle, 21.48, left elbow, 59.56 and right elbow, 59.65 mm. The elbow measurements from the Khok Phanom Di people are asymmetrical so left and right sides were treated separately. Where analyses estimated different sexes for an individual the tibial discriminant function analysis was given first priority[1]. Each case was assessed individually with greater weight given to measurements furthest from the section point.

The individual sex estimates and the basis of estimation are listed in appendix 2, table 49. The data are summarised in table 37. Because of the poor preservation of the material, two categories were created within each sex to reflect the difficulties in the estimation of sex within this population. A question mark indicates these individuals are 'possible' males or females. Otherwise the estimate indicates 'probable' male or female. With this caveat, in subsequent analyses, the two categories within each sex are combined.

There are a similar number of males and females, a ratio of 1:1.1. An equal ratio could be expected in the entire cemetery population and the results suggest that, despite the unsatisfactory nature of the basis of sex estimation in many cases, there is no systematic bias and the sample may be representative of the entire cemetery.

Almost a quarter of adults remain without sex estimates. Some studies have shown that recovery of nuclear DNA from bones is possible and a sex marker can be used to determine the presence or absence of the Y chromosome, thereby definitively identifying sex (Hummel and Herrmann 1991, Stone *et al*. 1996). The very poor condition of the bone tissue makes the success of this procedure improbable with the Nong Nor collection.

[1] Discriminant Function for sexing using tibial nutrient foramen measurements. Discriminant Score = (antero-posterior diameter x 0.4581572) + (medio-lateral diameter x 0.1629583) - 18.10747. Section Point = 0.10235. Male > section point, Female < section point

TABLE 37. *Composition of the adult (15 years or older) burials*

Adults	Total	% total adults	% of total population
females	17	14	11.0
?females	32	26	20.6
Subtotal	49	40	31.6
males	20	16	12.9
?males	24	20	15.5
Subtotal	44	36	28.4
unknown	29	24	18.7
Total adults	122	100	78.7

Age estimation

The state of preservation of the skeletons resulted in a number of different methods being used in the estimation of age. For subadults, the estimates were based on tooth eruption (Kamalanathan *et al*. 1960, Ubelaker 1978), the development of epiphyses (McKern 1970) and long bone lengths. Not all factors were able to be considered in each individual. The most reliable age indicator in infants and children is the development of the dentition. The chronology of tooth development is less variable than osseous development so the dentition was used where possible. The second choice was the state of the epiphyses. A combination of these methods was used where possible. Those subadults that had neither of these indicators were aged by comparison of long bone lengths with those subadults aged from the more reliable indicators or from the long bone lengths from the children and infants of the Khok Phanom Di population.

Adults were classified in relative age groups of young, middle and old age rather than any more precise chronological estimates being attempted because of the poor standard of preservation of the material. The primary criterion used for age estimation was molar wear. The Miles (1963) method of aging using molar wear was not used because of the lack of the ideal sample of at least 20 immature individuals with dentition to form the base line (Nowell 1978). However, seriation was used. Lovejoy (1985) states that if an entire skeletal population is reviewed systematically by seriation, dental wear can be a highly accurate indicator of relative age at death. Seriation has a number of advantages and also a number of assumptions. It assumes dental wear progressed at the same rate in each individual and in each molar, thereby assuming diet and access to food sources is the same (Nowell 1978). However, seriation can reduce intraobserver error and is unique in that relative age standards can be established from the population being analysed and therefore requires no external standards from other populations (Lovejoy *et al*. 1985). Each individual was seriated according to the average grade of wear, established using the Molnar (1971) scale, calculated from the number of first molars present. The next level of seriation uses the average wear of the second molars, then the average wear of the third molars. The average grades delimiting the age groups are listed in table 38.

When anomalies arose, such as a wide range of grades allocated for a single individual, teeth other than the molars were taken into consideration to determine the best age estimate for the

individual. Once all allocations were made, each individual was considered separately to determine if all other teeth fitted into the general pattern and that other, more subjective, age indicators such as antemortem tooth loss, joint degeneration and bone development (muscle markings for example) also correlated with the assigned age.

Table 38. *Average wear grade ranges used for age at death determination. Grades according to Molnar (1971)*

Age Category	First molars	Second molars	Third molars
Young adult	2 - 4.5	1 - 5	1 - 3
Middle aged adult	5 - 5.75	2.5 - 5.5	1 - 4
Old adult	6 - 8	2 - 8	1.5 - 7

Those adults without dentition were aged comparatively with those that had already been aged using dental wear on the basis of the development of muscle and ligament attachment sites (entheses) on the long bones. Six burials (two young, two middle aged and two old adults) were used as 'standards' for the basis of comparison. Other criteria for aging included joint condition, i.e. level of joint degeneration and bone size as an indicator of skeletal maturity. Because many of the age estimates are based on minimal evidence, more detailed analysis of this information has not been attempted.

Age estimation - Results

The individual age at death estimates, with the basis of estimation, are listed in appendix 2, table 49. The data are summarised in table 39. Estimates have been made for all infants and children and 70 per cent of adults.

Table 39. *Composition of the burials by age at death. The structure of the burial sample from Khok Phanom Di (KPD - Tayles 1997) is given as a comparison.*

	Female		Male		?	Total		% of total	% of adults	KPD % of total
Children/infants	n	%	n	%	n	n	%			
0					17	17	51.5	10.9		
1-4y					6	6	18.2	3.9		48.1
5-9y					4	4	12.1	2.6		4.6
10-14y					6	6	18.2	3.9		3.2
Total chn/infants					33	33	100.0	21.3		55.9
Adults										
15-19y	1	2.6	-	-	1	2	1.6	1.3		
young adult	12	31.6	12	31.6	2	26	21.3	16.8	45.5	20.1
mid age adult	20	52.6	18	47.4	5	43	35.2	27.7	37.0	16.2
old adult	5	13.2	8	21.0	1	14	11.5	9.0	17.5	7.8
Subtotal adults	38	100.0	38	100.0	9	85	69.7	54.8	100.0	
unknown adults	11		6		20	37	30.3	23.9		0.0
Total adults	49		44		29	122	100.0	78.7		44.1
Total	49		44		29	155		100.0		100.0

The proportion of infants and children, at 21 per cent of the total sample, represents a low level of child mortality for a prehistoric group. Excluding the nine infant burial jars in which no bone was found, 14 per cent are infants and 7 per cent children (5 to 14 years of age). If the extra burial jars were taken into the calculation the level of child mortality is still low at 25 per cent (18 per cent infants, 7 per cent children). Comparable data are 56 per cent (48 per cent infants; 8 per cent children) at Khok Phanom Di (Tayles 1997), and 42 per cent (33 per cent infants; 9 per cent children) at Ban Na Di (Houghton and Wiriyaromp 1984). A relatively high proportion of deaths in infancy compared with those later in childhood is to be expected in these populations, but the infant representation at Nong Nor is clearly very low. This suggests either that the sample is not representative of the cemetery population or, more likely, infant bones did not survive. The condition of the bones of infants recovered from the jar burials is so poor that it is very unlikely that such small bones not buried in jars would have been preserved in the midden. The level of child mortality, however, suggests that the sample is representative of this age group.

In the adults, more males than females survived to 'old' age but the individuals without sex estimates may have affected the results. For comparative purposes, the 'young adult' category is compared with Khok Phanom Di ages 15-29, 'mid adult' with 30-39 and 'old adult' with 40+. The data suggest that the Nong Nor adults lived longer than those at Khok Phanom Di, with more Nong Nor adults surviving to middle age. The difference is not statistically significant, however, and taken together with the relatively poor criteria on which Nong Nor age estimates are based and the proportion of adults of unknown age, these data are not presented as reliable.

PHYSICAL APPEARANCE

Morphology

As there were no complete, undistorted, skulls, it is impossible to describe the skull metrically and difficult to gain an impression of the shape of the vault and the face. Figure 103A shows the anterior view of the best preserved adult skull but even in this case the base and occiput were fragmented, and the facial bones were crushed and distorted. As with all skulls, the bone is held together by the soil matrix which fills the cranium. The only calvarium which could be partially reconstructed is illustrated in figure 103B. This shows a short, wide vault (brachycephalic) but no measurements were taken because of the distortion which is obvious at the coronal suture where the frontal and parietal bones do not meet. Figures 103C-D and 104A-C show views of other adult crania, in varying states of preservation). Figure 104D is a lateral view of a child skull. These photographs suggest that the facial morphology is similar to that at Khok Phanom Di, with wide faces (bimaxillary and bizygomatic widths), very wide nasal and interorbital breadths and prognathic maxillae.

Although it is not possible systematically to assess muscular development because of the condition of the material, there is considerable variation among individuals. Figure 105 shows considerable development of the medial third of the superior nuchal line and the external occipital protuberance which suggests the vigorous use of the shoulder and neck muscles. Other individuals have very little development of these muscle attachments. Mandibular morphology varies greatly in this group. Sexual dimorphism is illustrated by figure 106A-B, which shows a large, angular male mandible and a gracile female mandible.

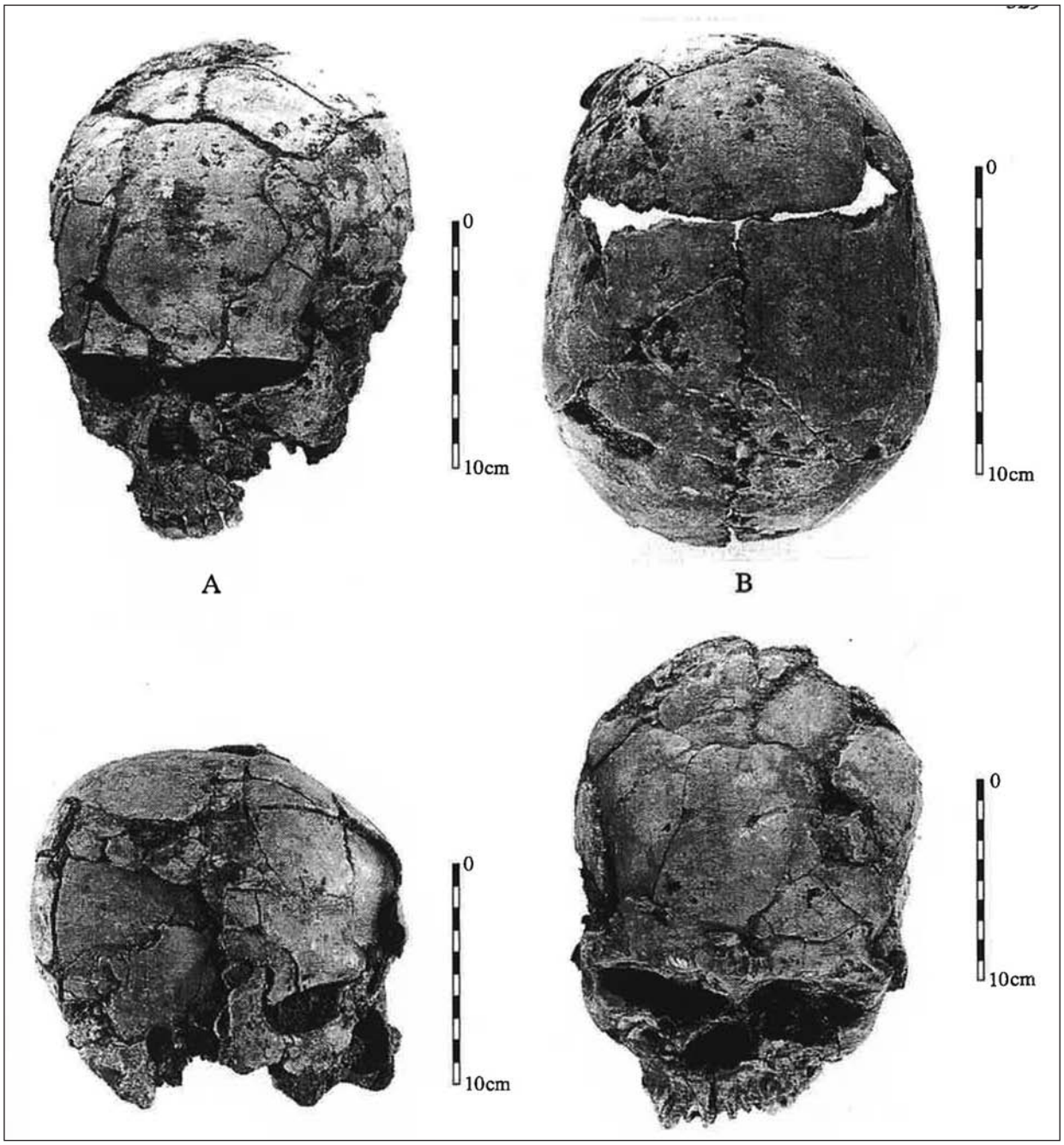


FIG. 103. A: Cranium, Burial 165, female. This is the best preserved adult skull but even in this case the base and occiput were fragmented, and the facial bones crushed and distorted. B: Calvarium, Burial 114, female. This is the only vault which could be recontructed. It is slightly distorted but is brachycephalic. C: Lateral aspect of cranium, Burial 106 (male) D: Superior aspect of cranium, Burial 47 (male)

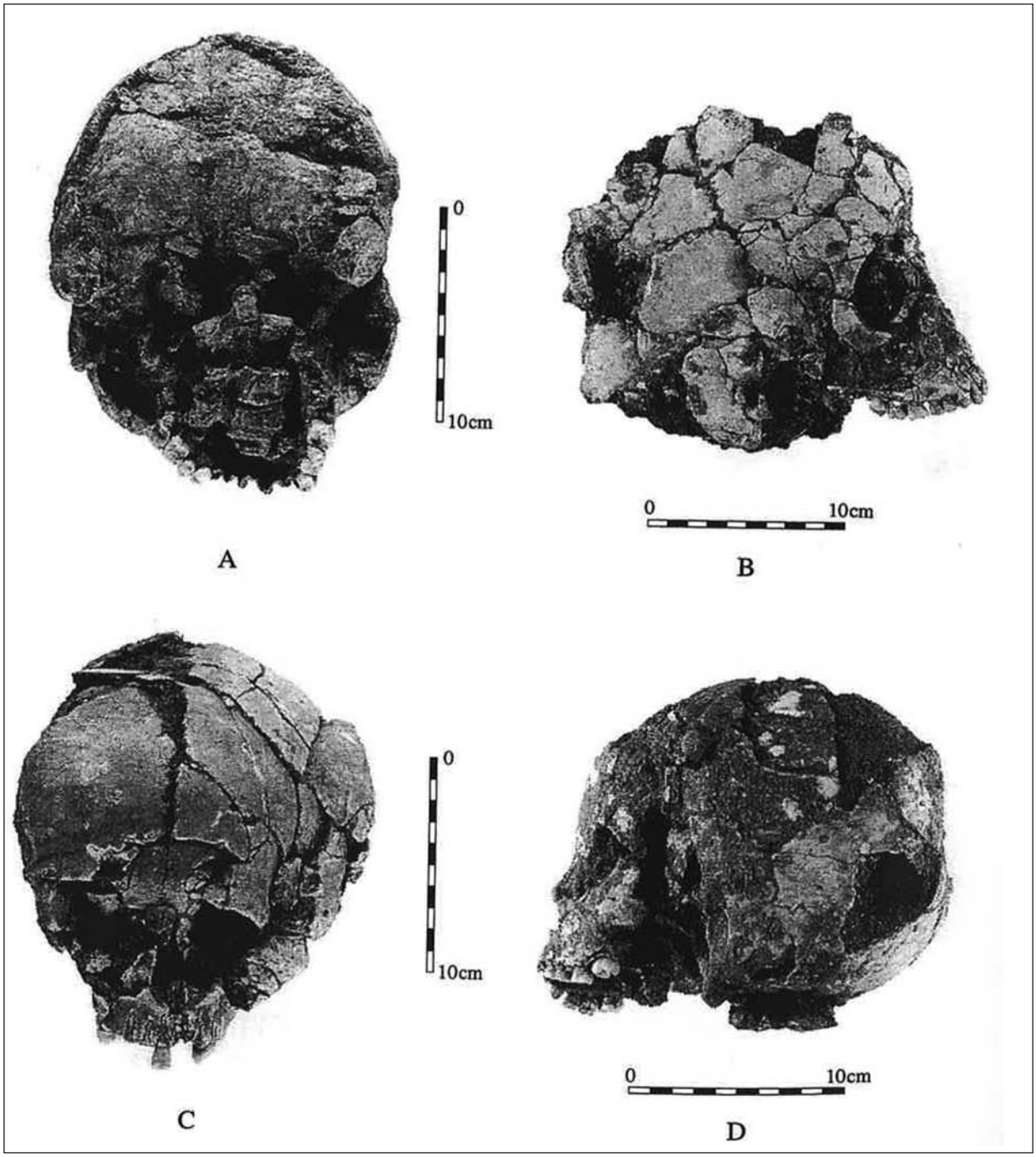


FIG. 104. A: Basal aspect of cranium, Burial 47 (male). Atlas and the 3rd and 4th cervical vertebrae are unable to be removed because of calcareous deposits. B: Lateral aspect of cranium, Burial 141 (female). C: Anterior skull, Burial 84 (female), with metopic suture. D: Lateral aspect of a child skull (Burial 33).

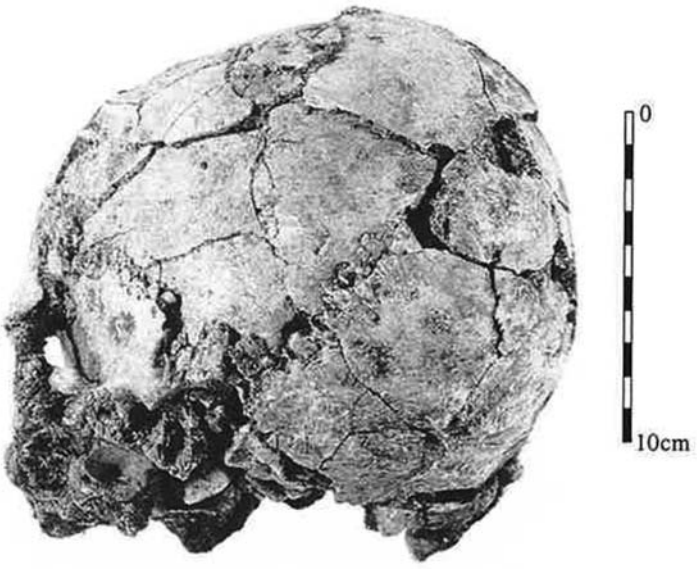


FIG. 105. Occipital aspect of cranium, Burial 106 (male) showing considerable development of the medial third of the superior nuchal line and the external occipital protuberance.

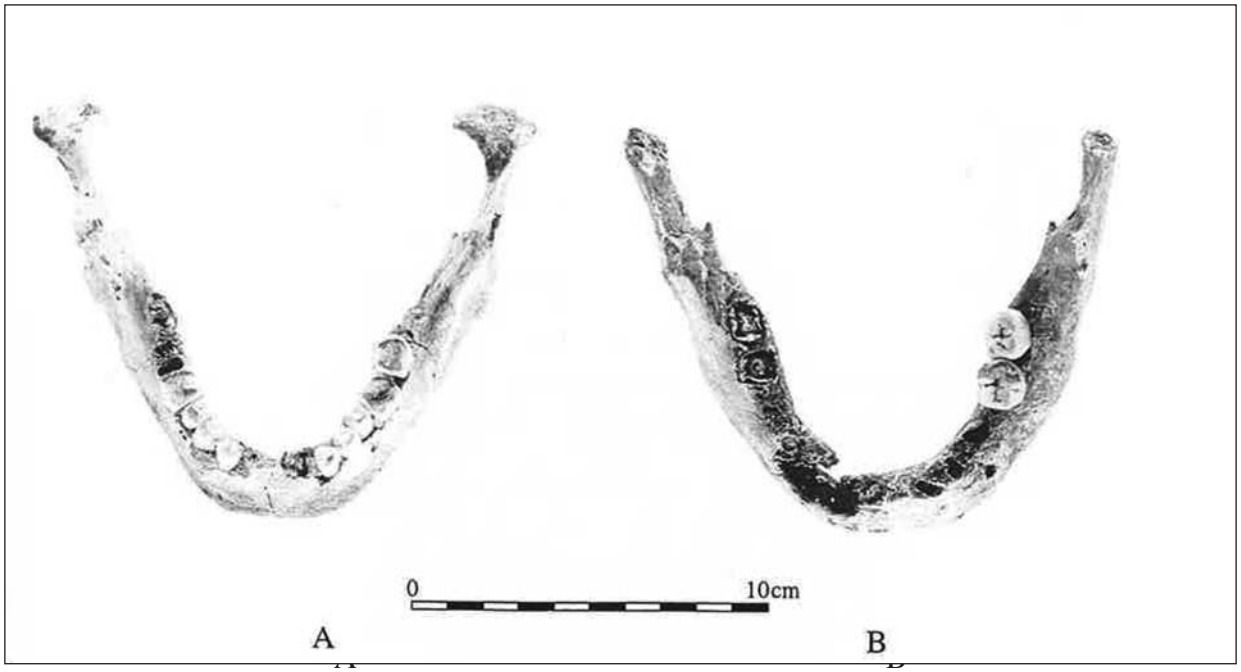


FIG. 106. A: Large, angular male mandible (Burial 47); B: Gracile female mandible (Burial 61)

Postcranial morphology is also variable. Figure 107A-C show the variation in size of upper limb bones. A well developed muscularity in the larger individuals is suggested by the size of the deltoid tuberosity on the humerus and the pronator ridge on the large radius. The shaft of the radius is also bowed, suggesting response to biomechanical stress from vigorous use. Figure 107D illustrates the variation in the degree of flattening, or platymeria, of the proximal femoral shaft within the group. Figure 108A-B shows the condition of two of the better preserved infant skeletons, one from a jar burial and one inhumation.

The 'non-metric' traits were not able to be systematically recorded because of the condition of the material. The skull of Burial 84 has a metopic suture (Fig. 104C). A large sutural bone at lambda is present on Burial 107 (Fig. 108C). Another burial, Burial 106, has an unusually shaped and positioned loose fragment of bone on the occiput in the vicinity of lambda (Fig. 106). Post-mortem fractures elsewhere on this occipital bone and damage to the edges of the fragment and the surrounding bone makes definitive interpretation of the structure difficult, but it does appear to be a type of extra ossification centre, possibly also a large sutural bone at lambda (Fig. 108D). Despite the uncertainty of the basis of development of extra sutural bones, these two individuals lay in adjacent graves which raises the possibility that they were related.

Stature

Stature has been estimated using equations derived from modern Thai (Sangvichien *et al*. 1985, Sangvichien *et al*. n.d.). The standard errors of each estimating equation provided a ranking system for determining the bone or combination of bones best used to estimate stature. The order of preference was slightly different between males and females so for consistency the male ranking was used. This is the same as was used in the Khok Phanom Di stature estimates. The order of preference is: 1. femur and tibia, 2. tibia, 3. femur, 4. humerus and radius, 5. humerus, 6. radius, 7. ulna.

The Thai equations tend to produce shorter statures than other equations available, such as those based on white Americans or 'Mongoloid' peoples (Native Americans) (Trotter and Gleser 1952, 1958) originally used in calculating statures for skeletons from some of the other prehistoric Thai sites. However, as the Thai equations produced the least variation in the stature estimates based on different long bones from individuals, they are favoured as most closely representing the body proportions and therefore the stature of the prehistoric people.

Stature - results

Long bone lengths measured in the field and in the laboratory, together with the stature estimates are given in appendix 2, tables 54-55. Stature was calculated for 33 adults (14 females, 19 males), using measurements taken on bones *in situ* (24 individuals) and in the laboratory (9 individuals). The *in situ* measurements were used in the majority of cases because most long bones were so badly fragmented that it was not possible to reconstruct them. Of the 10 field measurements which were able to be repeated in the laboratory, the mean difference between the two sets of measurements was 1.4 mm (paired t-test, n.s. range -8 to +7 mm). The laboratory measurements were used where they were available, although it should be noted that as no long bone was complete, all had to be reconstructed before measurements could be taken.

Summary statistics for Nong Nor and Khok Phanom Di are given in table 40. The mean

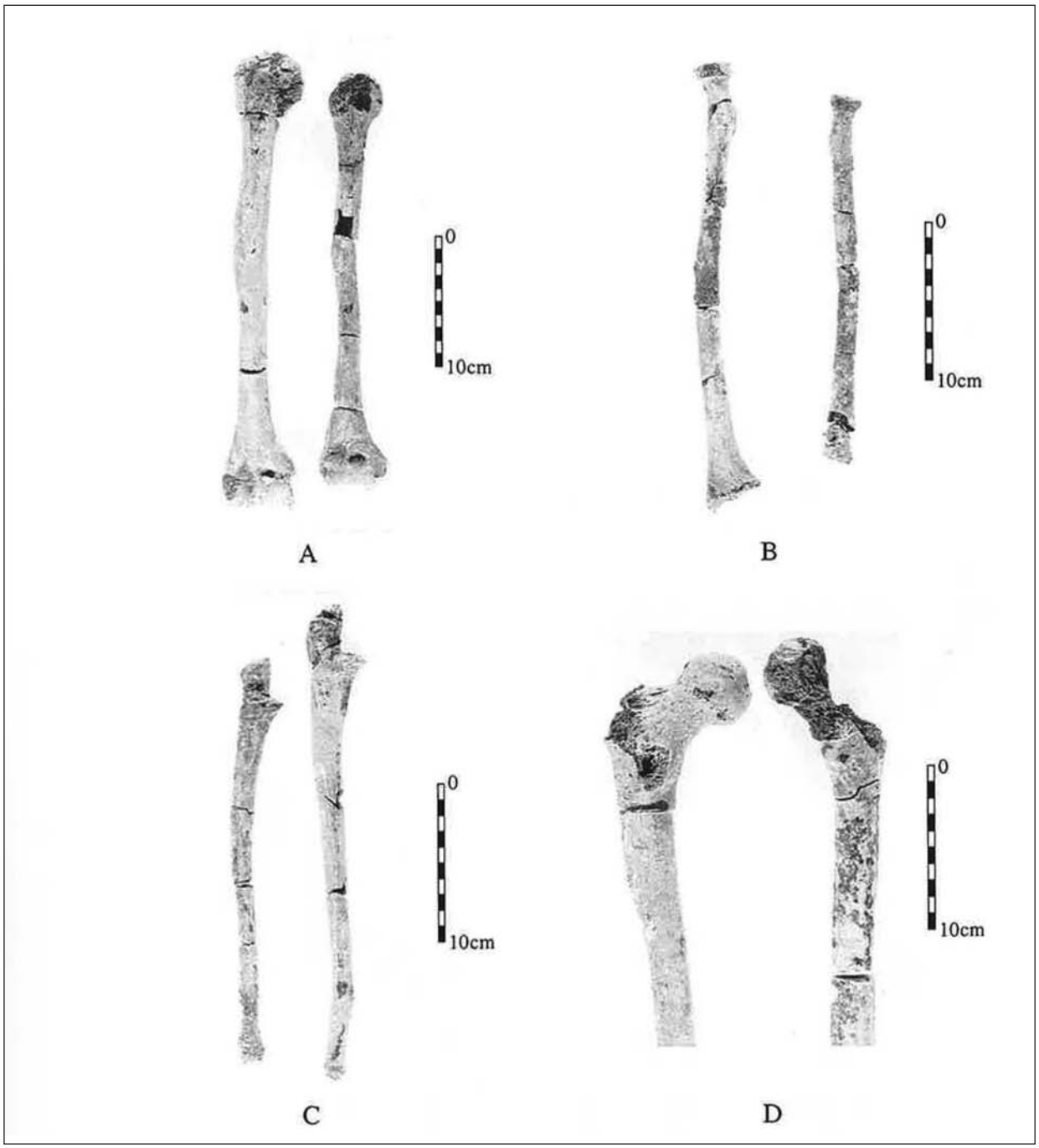


FIG. 107. Variation in upper limb bone sizes. A: Humeri: large - Burial 47 (male) small - Burial 40 (female). B: Radii: larger - Burial 81 (male) small - Burial 165 (female). C: Ulnae: large - Burial 165 (female) small - Burial 47 (male). D: Posterior view of proximal femora shafts, illustrating variation in the shape of the bone. Left - Burial 107 (male) with platymeric shaft. Right - Burial 105 (male) with rounded shaft.

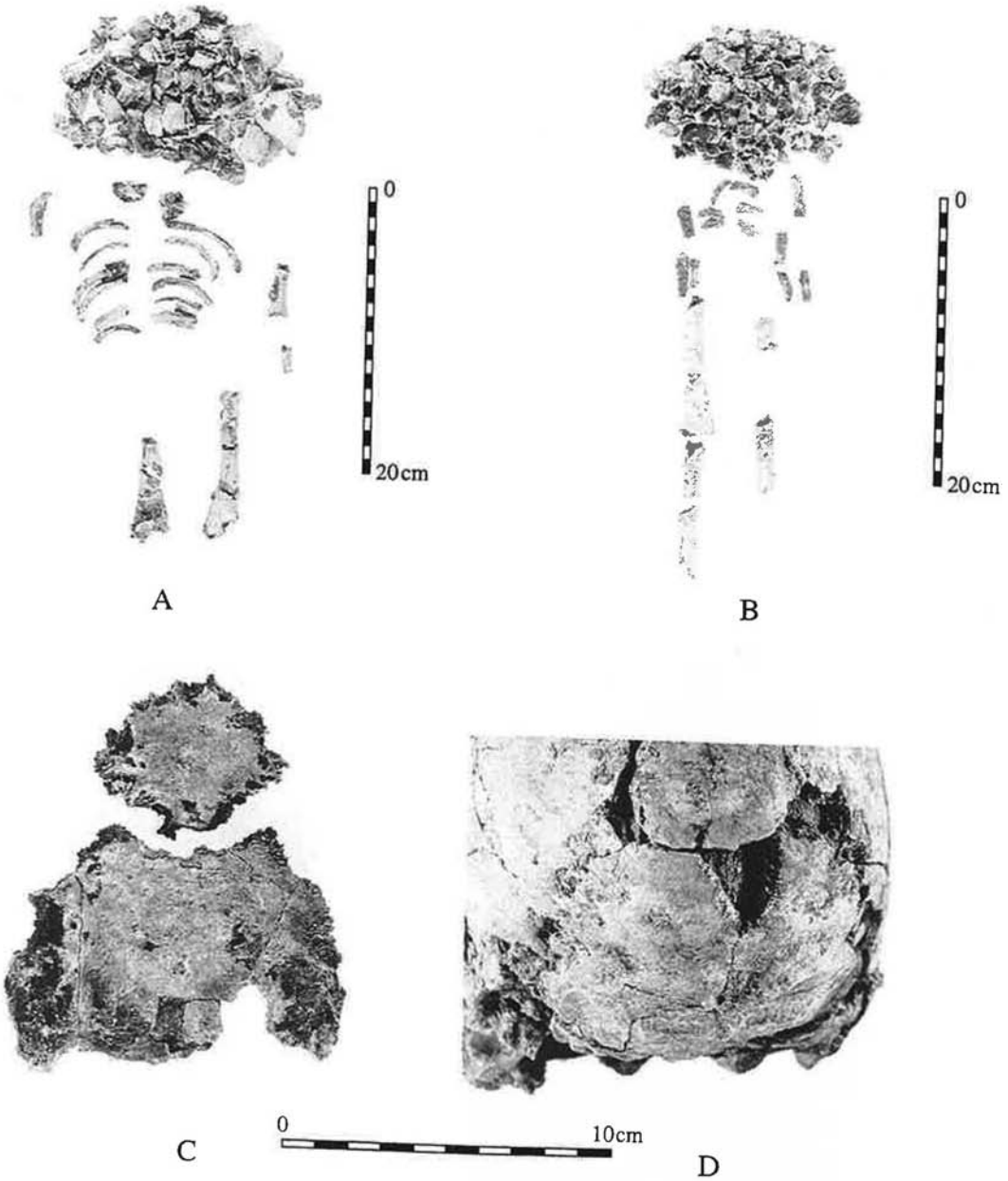


FIG. 108. A: Infant skeleton, jar burial (Burial 28; 6-9 months). B: Infant skeleton, inhumation burial (Burial 69; 2 years). C: Occipital bone, Burial 107 (male) with a large sutural bone at lambda. D: Occipital bone, Burial 106 (male). In this view the unusually shaped and positioned loose fragment of bone on the occiput in the vicinity of lambda has been removed. Damage to the edges of the fragment and the surrounding bone and postmortem fractures elsewhere on the bone make definitive identification of the structure difficult, but it does appear to be an extra ossification centre, possibly also a large sutural bone at lambda (also shown in figure 105)

stature of both sexes at Nong Nor is greater than at Khok Phanom Di, but the difference is not statistically significant in the females. Two Nong Nor males (Burials 47 and 112) were exceptionally tall at over 180 cm.

Table 40: *Summary statistics of stature estimates (cm). These have been calculated using the equations based on modern Thai (Sangvichien et al. 1985 Sangvichien* et al. *n.d.). A proportion of the estimates are based on measurements taken while the skeletons were* in situ *(see text).*

Females	n	Mean	s.d.	Range	cf KPD*
Nong Nor	14	156.1	3.6	150.7-162.1	
Khok Phanom Di	36	154.3	4.5	141.1-163.2	ns
Males					
Nong Nor	19	167.2	6.5	158.8-181.6	
Khok Phanom Di	30	162.2	5.1	153.8-170.7	p = 0.005

* Nong Nor > KPD (Khok Phanom Di - Tayles, 1997) t-test (ns= not significant)

Sexual dimorphism in stature

There was an overlap in stature estimates between females and males with three females being taller than the shortest male and five males shorter than the tallest female. Sexual dimorphism in the mean stature estimates is 11.1 cm, which is 6.6 per cent of male stature. This difference is significant (p = <0.0001), as is to be expected. The male stature estimates cover a range of 22.8 cm, twice that of the female stature range (11.4 cm). Sexual dimorphism in stature is greater than the difference at Khok Phanom Di, which is 7.9 cm or 4.9 per cent of mean male stature.

Body proportions

Summary statistics for long bone lengths at Nong Nor and Khok Phanom Di are given in table 41. The samples from Nong Nor are small but compared with Khok Phanom Di the bones are relatively long, as has been indicated by the stature estimates. The proximal bones in both limbs in the males and the tibiae in both sexes differ significantly at the two sites.

Table 41: *Mean maximum long bone lengths (mm). Measurements according to Bass (1987). A proportion of the estimates are based on measurements taken while the skeletons were* in situ *(see text).*

Bone	Sex	Mean	s.d.	n	Range	cf KPD*
Humerus	Male	320.92	18.69	13	294-350	p=<0.05
	Female	290.57	9.05	7	279-306	ns
Radius	Male	256.44	17.88	8	233-279	ns
	Female	224.00	9.90	2	217-231	-
Femur	Male	459.00	25.92	10	419-504	p=<0.01
	Female	421.25	14.38	4	407-436	ns
Tibia	Male	389.15	33.94	10	341-440	p=<0.05
	Female	360.38	11.41	4	347-372	p=0.05

* Nong Nor > KPD (Khok Phanom Di - Tayles, 1997) Mann-Whitney U-test (ns= not significant)

Proportions of the forearm to humerus (brachial index) and tibia to femur (crural index) were calculated and are listed in table 42.

Table 42. *Summary statistics of upper limb proportions (brachial index) and lower limb proportions (crural index). Brachial index: mean radius x 100/mean humerus. Crural index: mean tibia x 100/mean femur. (St. Hoyme and Iscan 1989)*

	n	Mean	s.d.	Range	cf KPD*
Brachial index: Females					
Nong Nor	1	78.0	-	-	-
Khok Phanom Di	18	79.5	2.4	75.4-84.8	
Brachial index:Males					
Nong Nor	5	78.5	2.7	76.0-81.6	p= <0.05
Khok Phanom Di	17	82.2	2.6	78.4-88.4	
Crural index: Females					
Nong Nor	1	85.0	-	-	-
Khok Phanom Di	10	84.3	2.0	80.4-87.3	
Crural index:Males					
Nong Nor	7	84.9	3.1	81.0-89.0	ns
Khok Phanom Di	11	84.7	2.8	80.0-89.2	

* Nong Nor < KPD (Khok Phanom Di - Tayles, 1997) Mann Whitney U-test (ns= not significant)

The single Nong Nor female has limb proportions almost identical to the limb proportions of the small sample of Nong Nor males and similar to the Khok Phanom Di females. Lower limb proportions are similar in the males in both groups, but the relatively longer humeri in the Nong Nor males are reflected in the significantly lower brachial index.

HEALTH

Methods

All bone surfaces were examined for pathology by Tayles and Domett. No radiographs were attempted because the medullary cavities and intertrabecular spaces were completely filled with dirt in every bone. Teeth and alveolar bone were examined by Hunt for caries, calculus, antemortem loss and evidence of periodontal infection in the form of cavities in the alveolar bone.

Skeletal health: degenerative joint disease

Changes were recorded on joints in 14 individuals. These involved joints in all regions of the vertebrae, the shoulder, knee, elbow, wrist, hands, ankle and feet. There were no cases in the hip joint. The evidence for degenerative joint disease is not quantified because there are so few intact joint surfaces that the data can not be assumed to present a reliable view of degenerative patterns.

Trauma and infection

Several adults had healed fractures - two ulnae (Burials 6 and 53, Fig. 109 B-C, a clavicle (Burial

47, Fig. 109D) and a proximal foot phalanx (Burial 27). There were no signs of damage to the radii adjacent to the ulnae that had been fractured. Burial 53, a middle aged adult with a left ulna fracture in the proximal shaft, also had minor lipping on the proximal articular surface of the left 4th metacarpal. The right hand also had nonspecific periostitis (see below). The middle aged male (Burial 47) with a broken right clavicle also had osteoarthritis in the right shoulder and right elbow, possibly as a result of slight malalignment of the shoulder joint subsequent to a fracture. Burial 32, a young adult male has an angular deformity in the body of the mandible in the region of the left molars (Fig. 109E). This appears to be a well healed fracture. He may have lost tooth 36, the mandibular left first molar, as a result of the fracture. The maxilla and the remainder of the mandible were not present for analysis of any occlusal problems as a result of the fracture.

Non-specific periostitis

Four individuals had non specific periostitis. Burial 100, an old adult male, had periostitis on the medial aspect of the distal left tibia. Burial 141, a young adult female, also had periostitis on the left tibia, on the medial aspect of the proximal end (Fig. 110A). The medial surface of this bone is directly subcutaneous, making it vulnerable to trauma. It is most likely that these cases reflect pathology in the overlying soft tissue such as ulcers and infections. Periostitis was also present on the lateral tibial shaft of burial 2, a middle aged male (Fig. 110B). Burial 53 had a lesion on the palmar aspect of a 4th or 5th metacarpal shaft (Fig. 110C). Again, infection from trauma to the overlying soft tissue is the most likely cause of this lesion.

Other pathology

Three adults had cribra orbitalia. Burial 95 is of unknown sex, Burial 105 a middle aged male and Burial 148 a middle aged female (Fig. 110D-F).

The mandible of burial 57, an old adult female, has an area of resorption where a cavity has been created. This appears on fragments of the right mandibular body and the internal surface is quite smooth with the loss of trabeculae. The bony changes stop abruptly at the midline, in the region of the mental eminence, so only the right side of the mandible was involved. The bone is not well preserved so it is not clear whether there may have been a thin wall of cortical bone covering the lesion (Fig. 111A-B).

Differential diagnosis includes cysts of odontogenic origin, arising from developmental anomalies or most commonly from infection of a tooth. Other possibilities are odontogenic tumours such as a myxocoma, which is a benign tumour of mesenchymal origin, or an ameloblastoma, a tumour of epithelial origin. Cysts and tumours of non-odontogenic origin include unicameral bone cysts, eosinophilic granulomata, or neoplasms such as giant cell tumours and hemangiomas. Most of these conditions result in a lytic region with smooth walls which is difficult to differentiate in dry bone. The most that can be said of the lesion is that it is likely to represent a slow-growing, primary tumour which was either benign or at worst locally malignant. It is unlikely that it reflects chronic osteomyelitis as the margins of the lesion are smooth, without ragged edges.

The left lower second incisor, canine, and first, second and third molars were all lost antemortem. The condition of the material makes it impossible to assess the state of the dentition on the right side of the mandible. The rest of the skeletal material recovered from this individual included only fragments of the cranial vault and the two humeral shafts. There are no lesions on

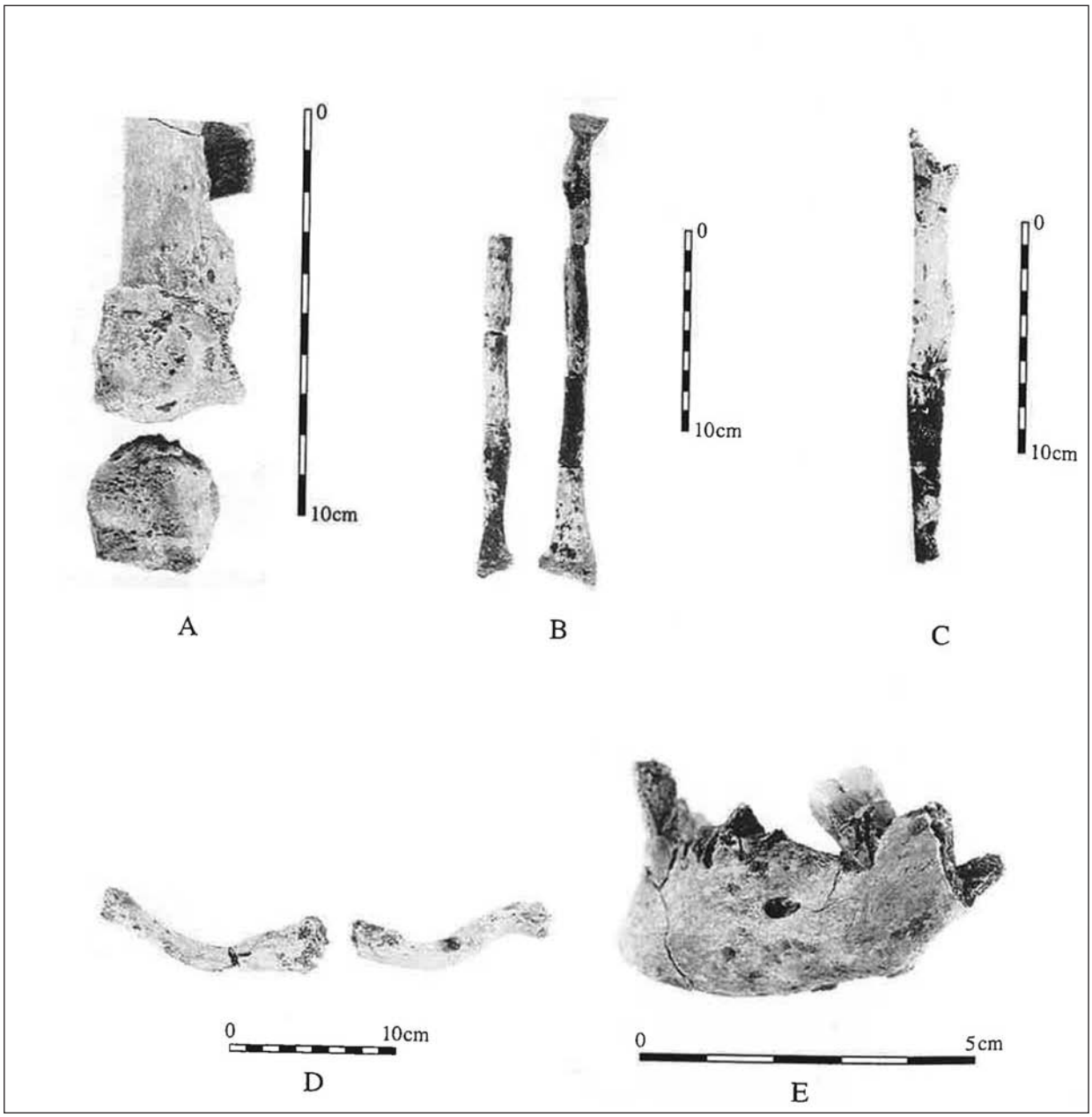


FIG. 109. A: illustrates a severe example of joint degeneration, in the left patello-femoral joint of Burial 104 (female). The articular surfaces of the right knee were damaged. B: Left radius and ulna of Burial 6. There is an expanded area on the distal shaft of the ulna which appears to be a well-healed fracture. C: Left ulna of Burial 53. The mid shaft is mis-shapen, indicating a well healed fracture. D: The clavicles of Burial 47. The right clavicle has a well healed lesion in the centre of the bone, probably a well healed fracture. E: Left aspect of mandible, Burial 32. There is an angular deformity in the body of the mandible inferior to the molar. This appears to be a well-healed fracture.

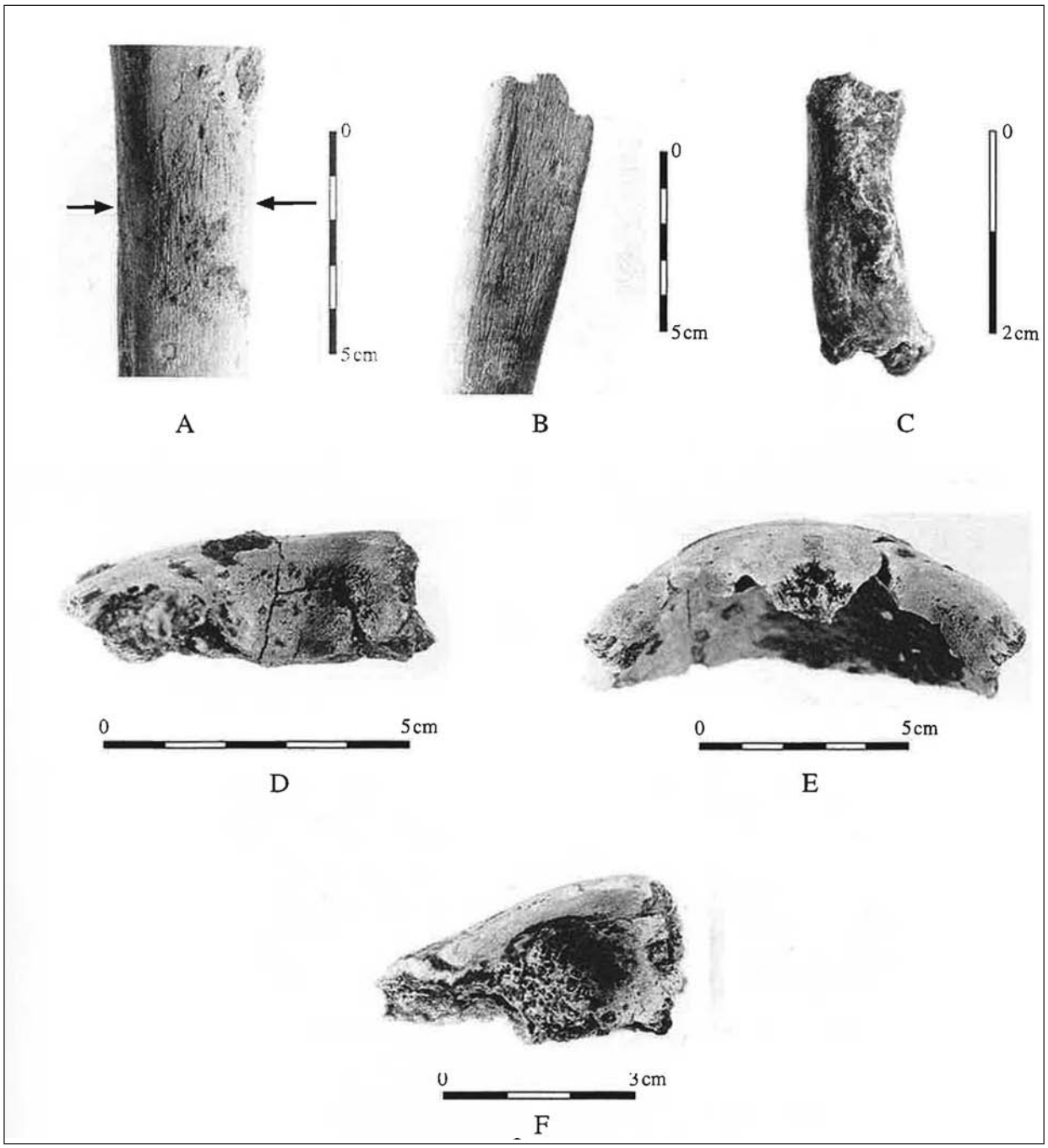


FIG. 110. A: Medial aspect of proximal shaft, left tibia, of Burial 141. There is a discrete area of periostitis on the bone. B: Lateral aspect of distal shaft of the right tibia of Burial 2 also with an area of periostitis. C: Lesion on the palmar aspect of a 4th or 5th metacarpal shaft of Burial 53. D: Left orbit, Burial 148 with light cribra orbitalia. E: Anterior aspect of frontal bone, Burial 105. There is light cribra orbitalia in the left orbit. F: Left orbit, Burial 95, with severe cribra orbitalia.

these bones.

The mandible of Burial 61 is asymmetric, with mild hyperplasia on one half. Infection is an unlikely explanation as there is no evidence of reactive bone. Trauma is also unlikely as the hyperplasia affects both the body and the ramus, with no obvious focus. An untreated fracture would have left a misalignment at the fracture site. The most probable explanation is a developmental disturbance of unclear aetiology, a mild condylar hyperplasia or facial hemihypertrophy. The maxilla was not sufficiently well preserved to be assessed for involvement.

Dental health

The dental data were recorded by Hunt. This preliminary assessment of dental health is based on caries and tooth loss during life, which provide data which are comparable with other populations. The relatively complex and less easily defined evidence of periodontal disease will not be discussed here.

The dental health of this population is based on a sample which represents just over half (76/132) of the burials from individuals aged over 5 years. These had one or more permanent teeth, with a mean of less than half of the total dentition (15 teeth per individual) and a range of 1 - 32 teeth. Only one individual had all 32 teeth. A further mean of 4.5 tooth positions (alveolar bone intact but tooth unerupted or lost during life) per individual were able to be recorded. None of the 37 adults without age estimates had teeth.

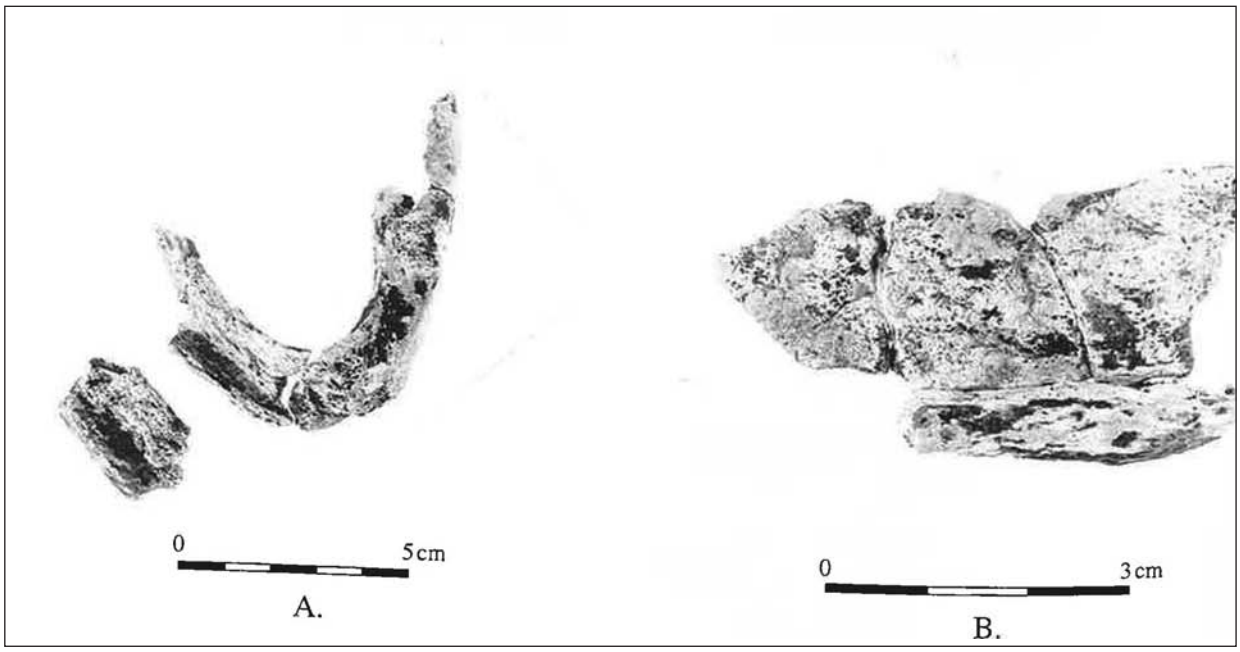


FIG. 111. A: Mandible, Burial 57. The loose fragment is part of the anterior cortex of the right mandible. There is an area of resorption of the trabecular bone which has created a cavity in the right body of the mandible. B: The interior surface of the anterior cortex of the right mandible body of Burial 57. This shows reactive bone covering the cortical bone with no remaining trabeculae.

Of the 1483 tooth positions that could be recorded from the 76 individuals, 78 per cent were whole teeth, 4 per cent had been lost antemortem and 17 per cent were damaged or lost postmortem. As could be expected, given the relative ease with which single-rooted teeth can be displaced postmortem, the data include a relatively high proportion of posterior teeth.

Table 43. *Summary of permanent teeth present by age group*

	<15 years	Young	Mid	Old	? adults	Total
n individuals	10	28	43	14	37	132
n with teeth	5	27	32	11	0	75
% with teeth	50	96	74	79	0	57
n teeth	65	460	444	179	0	1148
mean n teeth*	13.0	17.0	13.9	16.3	-	15.3

*per individual with teeth

Table 44. *Summary of permanent teeth present in adults by sex*

	Females	Males	? adults	Total
n individuals	49	44	29	70
n with teeth	33	29	8	122
% with teeth	67	66	28	57
n teeth	472	545	66	1083
mean n teeth*	14.3	18.9	8.3	15.5

*per individual with teeth

The number of teeth present per adult differs significantly among age groups, with the mid age adults having less teeth than the other two groups (χ^2 p=<0.0001) and between sexes with females having less teeth than males (χ^2 p=<0.0001). These differences reflect post mortem damage rather than the relative dental health of the groups.

Ten children aged between 1.5 and 7.0 years had a total of 86 fully erupted deciduous teeth (range = 1-19). The average number of recorded deciduous teeth was 8.6. Two of these children had mixed dentitions and the permanent teeth are included in the above data.

Caries

Caries were identified by careful observation of all visible surfaces of all teeth, supplemented by microscopic observation where there was doubt.

Of the 76 individuals with permanent teeth, 49 per cent had one or more teeth that were carious. Six per cent of all permanent teeth were carious. The data are summarised in table 45. The prevalence includes lesions of all sizes on any tooth surface. The data show that the prevalence of caries does not increase with age, once adulthood is reached.

Table 45. *The number and proportion of individuals with at least one carious lesion, the mean number and proportion of carious teeth per individual, and the overall number and proportion of teeth with caries*

	<15 years	Young	Mid	Old	Total
n individuals	5	27	32	11	75
n with caries	1	13	18	5	37
% with caries	20.0	48.1	56.3	45.5	49.3
mean n teeth #	25.0	20.2	14.7	16.2	15.3
mean n carious teeth#	1.0	2.3	1.5	2.2	1.9
mean % carious teeth #	4.0	11.4	10.2	13.6	10.9
n teeth	65	460	444	179	1148
n carious teeth	1	30	27	11	69
% carious teeth	1.5	6.5	6.1	6.2	6.0

per individual with caries.

A higher proportion of females than males had caries (Table 46). Although the difference is not statistically significant, it will have been affected by the significantly fewer extant teeth in females (p=0.03). Had the females retained the same proportion of teeth per individual as the males, the difference in the proportion of caries may have been significant. The females with caries had a significantly higher proportion of carious teeth per individual than the males with caries (chi2 p=0.001).

Table 46. *The number and proportion of adults of each sex with one or more carious lesions, the mean number and proportion of carious lesions per individual and the overall number and proportion of teeth with caries*.

	Females	Males	? adults	Total
n individuals	33	29	8	70
n with caries	20	14	2	36
% with caries	60.6	48.3	25.0	51.0
Nong Nor < KPD	ns	ns	-	ns
mean n teeth #	14.4	19.7	22.5	16.9
mean n carious teeth#	2.2	1.6	1.5	1.9
mean % carious teeth #	14.9	8.0	6.7	11.7
n teeth	472	545	74	1083
n carious teeth	43	22	5	68
% carious teeth	9.1	4.0	6.8	6.3
Nong Nor < KPD	0.005	<0.05	-	0.0001

per individual with caries, Comparison, Nong Nor with Khok Phanom Di: chi2 (ns= not significant)

Ten children aged 2-7 years have deciduous teeth fully erupted (n=1-19, mean 8.6). There are no caries in these teeth.

The proportion of individuals with caries was similar in both sexes at Nong Nor and Khok

Phanom Di but the proportion of teeth with caries in both sexes was significantly lower at Nong Nor. This suggests that, although a similar proportion of the population had caries, individuals with caries at Nong Nor had a lower proportion of carious teeth than the individuals with caries at Khok Phanom Di.

A higher proportion of females than males had caries at both sites, and the proportion of carious teeth per individual was higher in females than in males at both sites.

Antemortem loss

Teeth were recorded as lost during life when the alveolar bone was intact and there was either no evidence of a socket or the socket was in the process of being remodelled. The rates of tooth loss were assessed using the number of tooth positions, which includes almost all intact alveolar bone regardless of whether the tooth was lost or damaged ante or postmortem. The sample size is therefore larger than that used in the assessment of caries rates. As there is a possibility of agenesis of the third molars, these tooth positions were excluded.

Of the adults (15 years +) with permanent teeth, almost one third had lost one or more teeth antemortem. As the loss of teeth was used, where necessary, as a variable in the estimation of age at death, both the number of individuals and the proportion of teeth lost during life increases with age.

Table 47. *The number and proportion of adults with one or more tooth lost antemortem and the mean and total numbers and proportions of teeth lost antemortem.*

	Young	Mid	Old	Total
n individuals	27	32	11	70
n with antemortem loss	3	10	6	19
% with antemortem loss	11.1	31.3	54.5	27.1
mean n tooth positions#	24.3	22.5	22.3	22.8
mean n teeth lost antemortem#	3.3	2.9	2.7	2.9
mean % teeth lost antemortem#	13.7	12.9	11.9	2.7
n tooth positions	532	626	247	1405
n teeth lost antemortem	10	32	16	58
% teeth lost antemortem	1.9	5.1	6.5	4.1

per individual with antemortem loss

A higher proportion of females than males had lost teeth antemortem but the difference is not statistically significant. Of those who had lost teeth, females had a significantly higher proportion of teeth lost than the males (χ^2 p=<0.0015) and a higher proportion of teeth lost per individual.

The adults from Khok Phanom Di have higher rates of lost teeth both in the number of individuals involved and in the number of teeth compared with Nong Nor. Comparing the sexes separately, both males and females at Khok Phanom Di have lost significantly more teeth than the Nong Nor adults and a higher proportion of females is affected at Khok Phanom Di than at Nong Nor, but no difference in the proportion of males between the populations. Both sites had the pattern of higher rates in females than in males.

Table 48. *The number and proportion of adults of each sex with one or more tooth lost antemortem, the mean number and proportion of teeth lost antemortem and the overall number and proportion of teeth lost antemortem.*

	Females	Males	? adults	Total
n individuals	33	29	8	70
n with antemortem loss	13	7	0	20
% with antemortem loss	39.4	24.1	-	28.6
Nong Nor < KPD	<0.05	ns	-	<0.01
mean n tooth positions#	20.0	28.0	-	22.8
mean n teeth lost antemortem#	3.1	2.6	-	2.9
mean % teeth lost antemortem#	15.4	9.2	-	12.8
n tooth positions	630	693	82	1405
n teeth lost antemortem	40	18	0	58
% teeth lost antemortem	6.3	2.6	-	4.1
Nong Nor < KPD p=	<0.001	<0.05	-	<0.0001

per individual with antemortem loss. Comparison, Nong Nor with Khok Phanom Di (KPD) : chi2 (ns= not significant)

Summary of Dental Health

Although the dental sample represents only about half the teeth of half the skeletons in the sample, there are some consistent patterns. The use of antemortem loss in the age estimations precludes its use in the assessment of dental health in relation to age, but caries did not increase with age which is unexpected. There are consistent sex differences in dental health, with more caries and tooth loss during life in females, which suggests that they were more vulnerable than males. Although the proportion of individuals affected by caries and antemortem loss did not differ significantly between males and females, in females with these dental problems a greater proportion of the teeth was involved.

Compared with the people at Khok Phanom Di, the people at Nong Nor had better dental health. Overall, a similar proportion of individuals had caries at both sites, but the individuals with caries had a higher proportion of carious teeth at Khok Phanom Di. More individuals lost teeth during life at Khok Phanom Di and the proportion lost per individual was higher. Dental health was poorer in females compared with males at both sites.

SUMMARY AND CONCLUSIONS

The skeletal sample from Nong Nor represents the remains of ~155 people, although only 29 are more-or-less complete skeletons. The remainder were either partial skeletons, articulated but disturbed (95 individuals) or discrete bone scatters. Sex was estimated using standard morphological indicators on the skull and pelvis, supplemented by discriminant function and section point analyses on selected measurements. Estimates were made for 75 per cent of the adults. Males and females are almost equally represented in the sample. Age was estimated for infants and children using dental development, supplemented by skeletal size and ossification where necessary. Adult age was estimated on tooth wear, using broad categories of young, middle and old. Infant and

child mortality was low at 21 per cent, over half being neonates. The low mortality rate possibly reflects poor bone preservation and hence low recovery rates for small infant skeletons. Age was estimated for 70 per cent of adults. The results suggest that males lived longer than females, although these results may have been affected by the poor quality of the evidence for age. Compared with the people from Khok Phanom Di, the Nong Nor adults may have lived longer, although the unsatisfactory condition of the evidence for age may again be a confounding factor.

Stature estimates were made using equations developed on modern Thai. Compared with Khok Phanom Di, Nong Nor females were a similar stature but males were taller. Small samples preclude comparison of the body proportions in females at the two sites but the males at Nong Nor have longer proximal limb bones and therefore different body proportions from the males at Khok Phanom Di. On the basis of the limited observations possible, the Nong Nor crania appear brachycephalic and the faces broad with prognathic maxillae, similar to the Khok Phanom Di skull morphology.

It is difficult to assess the general health of the population with such poor quality material. Evidence of healed fractures and periostitis indicates that the individuals were healthy enough to survive trauma and mild infections. There is no evidence of widespread infectious disease. Half the adults had carious teeth and over one quarter had lost teeth during life. The caries rates are high compared with modern Southeast Asian populations but similar to prehistoric populations (Tayles 1997).

Despite the poor preservation of the material which has compromised the quality of the results, a pattern has emerged which suggests that the people at Nong Nor were healthier than the occupants of the nearby site of Khok Phanom Di. These preliminary results show that males in particular were taller, may have lived longer and had better dental health. There is relatively little variation in the females from the two sites.

There are several alternative explanations for this possible difference in health between the Nong Nor and Khok Phanom Di populations. The ~1000 years between the burials at Khok Phanom Di and those at Nong Nor appear to have been a period of significant change in the local environment. This occurred through natural agencies such as the alteration in ocean levels and associated changes in drainage patterns, vegetation, and other resources. Human activities such as destruction of vegetation through the demands of agriculture both locally and in the hinterland could have also played a role in the local environment and resource accessibility. These changes offer the possibility that any difference in health between the Khok Phanom Di and Nong Nor people was environmental, although this would require that the change was to the advantage of the inhabitants since life appears to havebeen better at Nong Nor than at Khok Phanom Di, especially for the males. Alternatively, an improvement in the efficiency of rice cultivation may have resulted in a more reliable food source by the time of occupation of Nong Nor. Yet another explanation is a change in the gene pool through immigration of taller, healthier people to the area in the period between the time of occupation of Khok Phanom Di and the use of the cemetery at Nong Nor. This could be expected to affect both sexes equally, although the social organization of the group with a less egalitarian society at Nong Nor than at Khok Phanom Di, with differential access to resources, could be acting as a counterbalance. The reality of the postulated differences between the Nong Nor and Khok Phanom Di groups and the most likely explanations for them remain unresolved and will be addressed in more detail in future (Domett, in prep.).

APPENDIX ONE

BURIAL CATALOGUE.

Burial 1. No bone.

Burial 2. The remains of a middle aged adult male, with a stature of 163.7 cm. The skeleton is complete from the mid thoracic vertebrae to the feet, but the remainder has been disturbed with all the left side in a line from the right shoulder to the left hip missing. The cranium and the right forearm are also missing. The bone is poorly preserved, with multiple breaks in the long bones. The right hand was lying over the pelvis. The right tibia and fibula have an area of periostitis.

Burial 3. A disturbed burial, no bone.

Burial 4. Consists of fragments of the skeleton of a child. Present is the right ilium, with the proximal end of the femur articulating with the acetabulum. The distal radius was lying beside the ilium in a position which suggests that the arm had been lying by the side. The unfused epiphysis on the head of the femur indicates that the child was between 10-15 years of age at death.

Burial 5. Fragments of the tibiae of an adult, lying in anatomical position, over the feet of Burial 6. The orientation is the same as Burial 6, but further to the west so that the feet, if still extant, project beyond the western baulk.

Burial 6. The remains of a middle aged, female adult with the lower legs and feet intact. Part of the shaft of the right femur, fragments of the pelvis, the left forearm and the ribs were *in situ*, but the remainder of the body was missing. The bones are very gracile, suggesting that the individual was a female, and arthritic lipping on the hands and feet indicate maturity. The arms were by the sides. The left ulna has a healed distal fracture.

Burial 7. A few scattered fragments found to belong with Burial 10.

Burial 8. The virtually complete but poorly preserved skeleton of a young person, aged 15-18 years from dental development.

Burial 9. The skeleton of a child aged between 13-15 years according to tooth eruption. The left forearm, the left lower leg and the face are missing, and although most of the rest of the skeleton is present, it is poorly preserved. The feet projected into the west baulk. This burial probably disturbed Burial 10.

Burial 10. Part of the left arm and ribs of an adult. The robustness of the bones suggest that the individual was possibly a male. This burial was probably disturbed by Burials 8 and 9.

Burial 11. A few adult bones projecting from the north baulk of Trench B1. These were not removed.

Burial 12. A few adult bones projecting from the north baulk of Trench B1. These were not removed.

Burial 13. A few adult bones projecting from the north baulk of Trench B1. These were not removed.

Burial 14. Distal tibiae and fibulae only projected into Trench B1. The bones were poorly preserved and the feet were missing. The remainder of the upper body was recovered in 1993 in the southern end of square A10, which extended across the eastern end of B1. The grave was within scattered midden. The skeleton was largely complete, although the skull was crushed

and most long bones represented by the shafts only. The individual was a young adult male, with age based on molar wear, and sex based on the robusticity of the fibula and other bones.

Burial 15. Fragmented ribs and part of the shaft of the left humerus only. The bones were *in situ*, and their gracility identified at excavation suggests that the burial was of an adult female.

Burial 16. The very poorly preserved remains of the skull and upper body of an adult, with the lower body projecting into the west baulk of Trench A2. The bones are very gracile, suggesting that the individual was a female. Molar wear indicates a middle aged adult.

Burial 17. The tibiae and fibulae of an adult projected into the trench from the east baulk of Trench A2. The feet were missing, and the bones were lying upside down and crossed. Either the individual had been lying prone or postmortem disturbance had overturned both legs. The gracility of the bones suggests this individual was possibly a female.

Burial 18. Fragments of an adult skull and left arm *in situ*.

Burial 19. The shaft of the right femur, both lower legs and feet of an adult. The burial was close to the east baulk, and any remains of the cranium would have been beyond the baulk. Gracility and tibial measurements indicate a female.

Burial 20. An almost complete skeleton, but with brittle and fragmentary bones. The skeleton is of a young adult male as determined from molar wear, cranial morphology and the tibial metric analysis.

Burial 21. This burial consists of poorly preserved fragments of the skull, ribs and left clavicle of an adult. Cranial morphology and general gracility suggests this was a female.

Burial 21.1. The remains of an infant found during laboratory analysis of bone within the vicinity of Burial 21. Fragments include cranial vault, mandible, ribs, arches and bodies of vertebrae, shafts of forearms, pelvis, femur shaft and tibia and three mandibular teeth. Aged between 3-9 months from dental development.

Burial 22. The remains of an adult, with fragments of ribs, distal ends of both humeri, fragments of hands, pelvis and lower limbs. The bone is in relatively good condition and is assessed as male, based on the pelvis. The hands were lying in the lap. From the development of entheses and joint degeneration this individual is thought to be middle aged.

Burial 23. Grave cut into natural. This is the burial of an adult, virtually complete apart from the legs from the mid femur down. The grave projected into the west baulk and the feet may have been present beyond the baulk. The bones are in relatively good condition, although there are numerous breaks. The skeleton is estimated to be that of a middle aged male based on molar wear, pelvic and cranial morphology and the distal humerus measurement. Stature is estimated at 161.6 cm based on the radius.

Burial 24. Grave cut into natural. This burial is represented by the legs from the mid-femur down and the feet. It is the skeleton of an adult, assessed as being probably a female, on the basis of bone gracility and metric analysis of the tibia, with a stature of 155.6 cm (based on the right tibia). Age at death is estimated to be middle aged as determined from development of entheses and joint degeneration. The bone is in relatively good condition, and the right femur and both tibiae have almost overturned while the fibulae remained *in situ*.

Burial 25. This adult burial consists of the distal right humerus and proximal radius and ulna of an adult. The bones were in anatomical position but very poorly preserved. The foot bones found

under the legs of Burial 37 may belong to this burial.

Burial 26. Grave cut into natural. This skeleton is represented by the legs, from the mid-femur down, and the feet. This person is judged to be a middle aged, male adult. The bones are in good condition. The tibiae, the right fibula and right foot have been overturned, but the left fibula and foot are *in situ*.

Burial 27. Grave cut into natural. The skeleton is represented by the feet and distal left tibia of an adult, *in situ*. One of the proximal foot phalanges had fractured during life but had healed.

Burial 28. This is the burial of an infant in a large jar. The body was placed in the jar facing north, in a crouched position with the arms across the chest and the head resting on the arms. The bone was poorly preserved, and the skeleton is represented by fragments of the skull, ribs, vertebrae and long bones. On the basis of tooth calcification, the infant was aged between six to nine months at death.

Burial 29. This burial is represented by a part of the shaft of the right ulna of an adult and is designated as a burial on the basis of its proximity to a large pot.

Burial 30. Grave cut into natural. There were no human bones in this grave, although the cut projected into the west baulk and there may have been lower limb bones beyond the baulk.

Burial 31. Grave cut into natural. There were no human bones in this grave, apart from a fragment of fibula shaft sitting vertically in the grave fill. The grave cut projected from the east baulk, and bones of the upper body may have existed beyond the baulk.

Burial 32. This burial consists of the mandible, left shoulder, left femoral shaft and both tibiae and fibulae *in situ*, with other bones scattered. The skeleton is that of a young adult male as based on the degree of molar wear and the morphology of the mandible. The preservation of the bones is variable. There was evidence of a healed fracture of the left body of the mandible.

Burial 33. Grave cut into natural. This is the burial of a child, with the skeleton virtually complete although the bone is very fragile. On the basis of tooth eruption and bone size, age at death is assessed at between six to eight years.

Burial 33.1. This burial was found within the fill of the grave of Burial 33. It consists of the right distal femur, both lower legs and bones of the feet of a child aged about 9-12 years at death. The epiphyses were also present, although the bones were not in anatomical position. The bone is well preserved, but heavily encrusted.

Burial 34. Grave cut into natural. This burial consists of a skull with mandible, fragments of vertebrae and a femoral head and acetabulum. The latter was projecting from the west baulk of Trench A2. The skull was crushed but appeared to be *in situ*, with cervical vertebrae. This individual was aged as a young adult on the basis of tooth wear. Cranial morphology was suggestive of a female. The other bones were either not from the same individual or the body was disturbed soon after burial while there was still sufficient soft tissue to hold the bones together.

Burial 35. Grave cut into natural. The pelvis and lower limbs of an adult female extended into Trench A2 from the eastern baulk. The bone is in good condition. Stature is estimated at 154.3 cm based on the femur. The pelvis and lower limbs of this adult projected into the 1991 trench and the upper body was recovered in the 1992 excavation. The surviving bones consisted of the long bones of both arms, rib fragments, and the cranium. The individual has been estimated as female on the basis of skull morphology, pelvic morphology and metric analysis of the tibia.

Age is estimated as middle age on the basis of tooth wear.

Burial 36. Trench A2, grave cut into natural. The very badly preserved distal tibiae, fibulae and foot bones of an adult projected into the trench from the eastern baulk. Both tibiae and fibulae were overturned. The poorly preserved and incomplete remains of the proximal lower limbs, the pelvis, the upper limbs and parts of the skull were recovered in the 1992 square. Age is estimated as old adult on the basis of molar wear. The gracility of the bones suggests a female.

Burial 37. The burial of an adult female, with complete lower limbs and bones of the forearms, ribs and pelvis present but disturbed. The condition of the bone is good, although there are many breaks. The left arm was lying by the side of the body. Stature is estimated at 162.1 cm from the length of the tibia. Sex was estimated from tibial metric analysis and gracility. This woman was the tallest of the adult females. From development of entheses and joint degeneration this person was assessed as middle aged.

Burial 38. Infant. Burial jar with no bone

Burial 39. Cut into natural. The very badly preserved feet of an adult projecting into Trench A2 from the east baulk. The remainder of the body was recovered in the 1992 square. The skeleton was virtually complete, apart from the right forearm, and the bone in reasonably good condition. The mandibular metric analysis indicates a possible female as does the general gracility of the bones. On the basis of the unfused spheno-occipital synchondrosis and sternal clavicular epiphysis, together with tooth wear, age is estimated as young adult 18-20 years. Stature is estimated at 161.0 cm based on the lengths of the tibia and femur.

Burial 40. The virtually complete skeleton of an adult male. The head projected partially into the south baulk of the square. The proximal right femur and right pelvis were missing. The left hand was lying in the lap, and the right arm lying by the side. Sex was estimated from tibial measurements. Age at death is assessed as middle aged on the basis of tooth wear and tooth loss during life. Stature is estimated at 165.8 cm on the basis of humerus length.

Burial 41. These adult bones were lying directly under Burial 37, and consist of a right femoral shaft and calcaneum in approximate anatomical position, with a radius and patella in the vicinity. They are thought to represent an old aged adult as determined by development of entheses and joint degeneration.

Burial 42. The right distal humerus and proximal radius and ulna of a small adult, possibly a female (based on gracility). The bone is very poorly preserved. The burial is close to the western baulk, and further bones may be present beyond the baulk. On the basis of tooth wear this woman was assessed as middle aged.

Burial 43. This is the burial of an infant in a jar. The bones are very poorly preserved and encrusted. They consist of fragments of the skull, humeri, ribs and tibiae, together with teeth. Age at death is assessed at about 9 months, on the basis of dental development.

Burial 44. This burial is the only one excavated with the head oriented to the west. It is of an adult, with the upper limbs, including the scapulae and clavicles, *in situ*. Parts of the calvarium with mandible fragments were lying slightly out of position. The ribs and vertebral fragments were slightly disturbed. Overlying the torso were an articulated left femur and tibia, also oriented to the west, and a disarticulated right femur and fibulae. These may belong to the same individual and have been disturbed shortly after interment, or may belong to a second person. Sex is as-

sessed as female, on the basis of gracility and mandibular metric analysis, and aged at death as old aged, on the basis of tooth wear. Stature is estimated at 153.8 cm, based on the humerus. The lower half of the body could have been disturbed by Burials 49 and 50.

Burial 45. The skeleton is the poorly preserved remains of an adult male, based on robusticity and mandibular morphology. Age at death is estimated as old on the basis of the degree of molar wear. The skull is largely intact, and the left limbs and pelvis intact and *in situ*. The ribs, vertebrae, right forearm and femur are disturbed and the right pelvis is missing. Projecting into the 1992 square were the distal tibiae and fibulae and some foot bones, all poorly preserved.

Burial 46. The bones of the adult in this burial consist of a disarticulated femoral shaft and tibial shaft.

Burial 47. Grave cut into natural. This is a complete skeleton of a very robust adult male. Sex estimation was also based on pelvic and cranial morphology, tibia, mandibular and distal humerus measurements. All the bones are present, although some of the vertebrae had been moved out of alignment. Preservation is exceptionally good, compared with other skeletons at this site. Stature is estimated to have been 180.7 cm based on the right tibia. This is the second tallest person in the sample. The right clavicle had a healed fracture.

Burial 48. This burial consists of the calvarium of an adult and fragments of other bones lying over and around the burial jar of Burial 49.

Burial 49. This is an infant jar burial. Only fragments of bones were recovered. Bone size indicates an age of between 0-3 months.

Burial 50. This is an infant jar burial, identified as a burial on the basis of the presence of a bronze bangle. No bones were recovered.

Burial 51. Shafts of the long bones of both upper and lower limbs of an adult, together with fragile, fragmented remains of the skull and clavicles. Sex is estimated as male on the basis of mandibular morphology and distal humerus width, and age as young adult on the basis of tooth wear. Stature is estimated at 163.3 cm based on the humerus.

Burial 52. The incomplete skeleton of an adult, with the long bones of the right arm, parts of the left, fragments of the cranium, ribs, thoracic vertebrae and right pelvis and femur. Age is estimated as middle aged adult, on the basis of tooth wear. Cranial morphology and the distal humerus measurement are indicative of a female. Stature is estimated at 150.7 cm based on the humerus and radius. This woman was the shortest person of this population.

Burial 53. The very fragmented and incomplete skeleton of an adult, with the distal legs and feet projecting into the north baulk. The skeleton is represented by fragments of the cranium, mandible, upper limbs, pelvis, and lower limbs. There is a well-healed fracture on the left ulna. Age is estimated as middle aged on the basis of tooth wear.

Burial 54. The very degraded and incomplete remains of an adult, represented by fragments of the skull, upper limb, and left femur. On the basis of tooth wear, age is estimated as middle age.

Burial 55. Incomplete fragments of an adult skeleton, in anatomical position. The proximal femora, fragments of the pelvis, and the left forearm and hand were present. On the basis of femur head size, sex is estimated as female.

Burial 56. Poorly preserved fragments of the skull, upper and lower limbs of an adult. Age is estimated as middle aged, on the basis of tooth wear. Sex is estimated to be male from the

morphology of the mandible.

Burial 56.1. Fragments found next to the skull of Burial 56. Remains include rib fragments and fragments of long bones and a single tooth. This is a child aged about 3 years from tooth and bone size.

Burial 57. The poorly preserved skull and humeri of an adult, lying beside and parallel with Burial 58. Age is estimated as old adult, on the basis of tooth wear and tooth loss during life. Sex is female, based on mandibular morphology. The right mandibular body has a large lytic lesion, probably created by a tumour.

Burial 58. The remains of an adult, with most bones present down to mid-femur, although the bone is poorly preserved. Sex is estimated as female on the basis of skull morphology and age as young adult on the basis of tooth wear. Stature is estimated to be 158.2 cm based on the humerus.

Burial 59. Fragments of upper limbs of an adult in anatomical position, together with scattered skull and lower limb fragments. Sex is estimated as male on the basis of a pubic bone (identified at excavation) within the scattered fragments.

Burial 60. The comparatively complete but poorly preserved remains of an adult skeleton, lying parallel and between the burials from 1991 at the west end of the square. This individual was identified as a female on the basis of skull morphology, mandibular metric analysis and general gracility. Stature is estimated to be 155.3 cm based on the length of the femur.

Burial 61. The upper body of an adult, estimated as female on the basis of skull morphology and gracility. The remainder of the body, from the chest down, was disturbed by a pit. Age is estimated as young adult on the basis of tooth wear and the unfused sternal clavicular epiphysis but she had poor dental health, with caries and tooth loss during life. Stature, based on the humerus, is estimated to be 151.9 cm, the second shortest person.

Burial 62. The femoral shafts and right tibia fragment of an adult, in anatomical position but very poor condition.

Burial 63. Beside Burial 64. Fragments of the shafts of the lower limb bones and right arm of an adult, in very poor condition.

Burial 63.1. Adult remains consisting of fragments of one tibia and fibula and several metatarsal shafts.

Burial 64. The tibiae shafts and fragment of the left femur of an adult, in very poor condition.

Burial 65. Fragments of the shafts of the lower limb bones of an adult were found in 1992. This skeleton is lying across the north-east corner of the square, with the upper body projecting into the east baulk and the feet into the north. The bones are in poor condition. The upper body was recovered from the 1993 square A7, but the feet were missing. The bone is in poor condition, and the pelvis and hands missing. Age is estimated as old adult on the basis of tooth wear, and sex as female, on the basis of gracility of the bones.

Burial 66. Infant jar burial. The crushed fragments of the skeleton of a very small infant aged 3-9 months, crouched in a jar. Only ribs and some long bone fragments were present.

Burial 67. The distal lower limbs of an adult, projecting into the west baulk. The remainder of the body was removed by the grave of Burial 36. From the metric analysis of the tibia this adult is

a male and from development of entheses and joint degeneration age at death is estimated to be middle aged. Stature was estimated to be 161.1 cm from the length of the tibia.

Burial 68. Infant jar burial. Fragments of limb bones and teeth of an infant. Age at death is estimated at 18 months from dental development .

Burial 69. Fragments of the skull and long bones of a child. Age is estimated at two years on the basis of dental development.

Burial 70. Shafts of the long bones of the lower limbs of an adult in anatomical position. These were under Burial 72, and above Burial 77. The upper body was removed by a looters pit. This person is thought to be a female because of the gracility of her bones.

Burial 71. The shafts of the right tibia and fibula and some hand bones of an adult. The bones are well-developed and robust and therefore thought to belong to a male.

Burial 72. The left femoral shaft, tibial shafts and some metatarsals of an adult in poor condition.

Burial 73. Infant jar burial. Bones of an infant in poor condition. Although fragmented, the skeleton is possibly largely complete. Age is estimated at 18-30 months on the basis of dental development.

Burial 74. Infant jar burial. The crushed bones of an infant, compressed by the collapse of the burial jar. On the basis of tooth development, the infant was between 1-3 months.

Burial 75. The skeleton of an adult, virtually complete apart from the feet. The bone is in reasonable condition. On the basis of pelvic and cranial morphology and tooth wear, the individual was a male of middle adult age.

Burial 76. The humeri, mandible, and cranial fragments of an adult. These bones are very gracile and are suggestive of a female. Age is young adult on the basis of tooth wear.

Burial 77. The lower limbs, ribs and left forearm of an adult in comparatively good condition. The metric analysis of the tibia suggests this was a male. Age was estimated as young adult on the basis of tooth wear. The length of the femur estimated stature to be 160.6 cm.

Burial 78. The ribs, humeri shafts, and mandible fragments of an adult. The bone is in very poor condition. These are very small and suggest this person was a female.

Burial 79. The lower limbs, from the knees down, of an adult.

Burial 80. The ribs of an adult, in anatomical position within a looters pit. Scattered upper limb bones, including a radius, found one metre to the east may belong to this individual.

Burial 81. The almost complete skeleton of an adult, with the bone in comparatively good condition. This individual appears to have been a middle aged male, with the age estimate based on tooth wear and sex on the morphology of the pelvis and metric analysis of the tibia and femur head. Stature is estimated at 174.9 cm on the basis of the length of the humerus and radius.

Burial 82. The calvarium of an adult, possibly a male, together with the scattered left radius and ulna, part of the left pelvis, and both patellae.

Burial 83. The virtually complete but partly disarticulated skeleton of an old adult male. Sex is based on pelvic and cranial morphology and measurements of the tibiae, femur head and mandible. Age is estimated from tooth wear and joint condition. Stature is estimated at 165.5 cm on the basis of tibia length. He had well developed muscular attachments and arthritis in the

neck, suggesting he had led a physically active life.

Burial 84. The almost complete skeleton of an adult. The pelvic area had been removed by a pit and the feet were missing. The bone is in relatively good condition. Sex is estimated as female on the basis of skull morphology, gracility and femur head diameter, and age as young adult on the basis of tooth wear. Stature is estimated at 161.8 cm (based on femur), making this person the second tallest female.

Burial 85. Secondary burial. The very degraded bones of an adult. The skull is largely complete and fragments of most bones present apart from the femora. The postcranial bones were arranged around the skull. The left tibia were in anatomically correct position. The individual is estimated to have been an old male (sex based on skull morphology and mandibular metrics, age on molar wear).

Burial 85.1. Infant dentition associated with Burial 85.

Burial 86. The skeleton of an adult, complete from the waist down, projected from the east baulk of the 1992 square, adjacent and to the south of Burial 65. The remainder of the body was recovered in 1993 in square A3. Based on tooth wear and the fact that the sternal clavicular epiphysis is unfused, the individual appears to have been a young adult who died before the age of 25. On the basis of pelvic and skull morphology and femur head diameter, sex is estimated as male. He was not large, but muscular. Stature is estimated at 167.3 cm, on the basis of femur and tibia length.

Burial 87. The skeleton of an adult, complete from the chest down. Sex is estimated as male on the basis of pelvic morphology and tibial measurements. The development of entheses and joint degeneration is indicative of a middle aged adult. Stature is estimated as 168.9 cm on the basis of femur length.

Burial 88. The feet of an adult, in very good condition. The bones are very robust with slight lipping and therefore intimates an old aged male.

Burial 89. Infant jar burial. No bone.

Burial 90. The skeleton of an adult, with the upper right thorax, the right humerus and the cranium missing. The mandible was present but disturbed. Sex was estimated as female on the basis of mandibular morphology and gracility and age as young adult on the basis of molar wear. The bones are heavily encrusted.

Burial 91. Infant jar burial. Fragments of the skeleton of an infant.

Burial 92. The femora, hands and part of left pelvis of an adult, possibly male because of robusticity.

Burial 93. Cut from surface of layer 2. The calvarium and lower limbs, from above the knees down, of an adult. The bone is in good condition. Both the calvarium and the femora appear to have been cut. Development of entheses and joint degeneration indicate a middle aged adult. The metric analysis of the tibia and general robustness are indicative of a male. Stature is estimated at 162.5 cm based on the length of the tibia.

Burial 94. Scattered fragments of an adult female skull, humerus and ribs. Sex estimation is based on cranial morphology and bone gracility.

Burial 95. Scattered fragments of an adult skull, ulna and other long bones. The bones belonging with Burial 67 may be part of this individual. This individual has cribra orbitalia.

Burial 96. Grave cut with pots. No bone.

Burial 97. The complete cranium, minus the mandible, of a young adult, possibly a male. Age is based on molar wear and sex on cranial morphology.

Burial 98. Disturbed fragments of the cranial vault of an adult, found to belong with Burial 95.

Burial 99. Distal tibiae, fibulae and feet of an adult *in situ* in a large grave cut. A complete right femur and fragments of other bones were lying disturbed in the grave. The bone is in good condition. This adult was identified as a young female on the basis of development of entheses, joint degeneration and gracility.

Burial 100. Within the same grave and over Burial 104. The legs from mid-femur down of an adult. From development of entheses and joint degeneration and metric analysis of the tibiae this individual is estimated to be an old aged adult male. There was nonspecific periostitis along the shaft of the left tibia.

Burial 101. Fragments of the right tibia, fibula, and foot of a middle aged adult male. Age and sex estimates are based on development of entheses and joint degeneration, robustness and metric analysis of the tibia.

Burial 102. The fragmented lower limbs of an adult from the mid femur down. The metric analysis of the tibia suggests this is a female.

Burial 103. The tibial shafts of an adult in anatomical position. The bone is in poor condition.

Burial 104. The legs from the mid femur down, some rib and vertebral fragments and fragments of the humeri of an adult, beneath Burial 100, in the same grave. The bone is in poor condition. This individual is identified as a female, based on the gracility of the bones and a middle aged adult due to joint condition.

Burial 105. Very large, deep grave, cut through midden (layer 2) into natural and containing the complete skeleton of an adult. This appears to have been a middle aged male (molar wear and pelvic and cranial morphology). Stature is estimated at 165.5 cm, on the basis of the right humerus. There is cribra orbitalia in this individual.

Burial 106. The largely complete skeleton of an adult, in poor condition. The upper left arm was disturbed. Based on the degree of molar wear and pelvic and cranial morphology and tibial measurements, this individual is a middle aged male.

Burial 107. The skeleton of an adult, with the upper right arm and legs from the knees down missing. Only the occiput of the skull is present. This was a young male. The iliac crest and sternal clavicle were recently fused and sex is based on femoral head diameter. Stature is estimate to be 165.3 cm based on the length of the radius.

Burial 108. The fragmented and disturbed tibiae and fibulae of an adult.

Burial 109. The complete skeleton of an adult in a very deep grave within layer 2. This was a young adult male (tooth wear, pelvic and cranial morphology and distal humerus width). Stature is estimated at 174.1 cm, on the basis of femur.

Burial 110. Infant jar burial, within the grave (over the pelvis and legs) of Burial 109. The bones are very degraded fragments of calvarium and ribs. The vault sutures appear to be fused, suggesting the infant was older than 12 months.

Burial 111. The incomplete skeleton of an adult male (based on cranial morphology). Fragments

of the ribs, upper limbs and femora were *in situ*. Molar wear suggests this was an old person.

Burial 112. The largely complete but degraded skeleton of an adult. The face, anterior calvarium and right foot are missing and the upper limbs were disturbed. Tooth wear and pelvic and mandibular morphology and femoral head diameter and tibial metric analysis suggest that this is a young adult male. Stature is estimated at 181.6 cm, based on the femur and tibia and makes this person the tallest in the population.

Burial 113. This burial consists of a disarticulated 'scatter' of bones in and around the grave of Burial 114. Calvarial fragments, the right maxilla, and fragments of the pelvis and distal ulna were recovered the eastern end of the 1992 square. In 1993 further cranial fragments and fragments of long bone shafts, probably from both upper and lower limbs were recovered adjacent to the skeleton of Burial 114, as if within the grave cut. This individual is estimated to be a middle aged adult based on molar wear.

Burial 114. The lower limbs from mid femur were recovered at the eastern end of the 1992 square. The upper body was recovered in 1993 from the south western corner of square A7. The bone is in reasonably good condition and most of the skeleton was present. The skeleton is lying in correct anatomical position for a prone burial. Age was estimated as young adult on the basis of tooth wear and sex as female on the basis of cranial morphology and femur head diameter.

Burial 115. Identified as a burial on the basis of a grave cut in the southern baulk, adjacent to Burial 90 (western end of the square). No bone was found in this grave.

Burial 116. The almost complete but poorly preserved skeleton of an adult. The left arm and lower leg bones were disturbed. Age is estimated as middle aged on the basis of tooth wear; sex is estimated as female from cranial morphology and gracility.

Burial 117. The head of this burial was in the north baulk of A7 and the distal lower limbs in the east baulk of A8. The excavation was extended to recover the skeleton. The bone was very degraded, and although the skeleton had not been disturbed only the skull and long bone shafts had survived. Age is estimated as middle aged, on the basis of tooth wear, but the sex of the person is not evident.

Burial 118. This was a complete, undisturbed adult skeleton, but bone preservation is poor. Sex is estimated as female on the basis of skull morphology and gracility. Age at death, from molar wear, is middle age.

Burial 119. Jar beyond the feet of Burial 118. This was classified as a putative infant burial on the basis of its location in relation to an adult, although no bone was recovered from the jar.

Burial 120. This is a fragmentary and poorly preserved skeleton of a child. The skull was present but crushed into small fragments and the only infracranial bones surviving were the shafts of the left clavicle and humerus and both femora and tibiae. Age is estimated at 12-15 years on the basis of tooth development.

Burial 121. This was a secondary burial, placed over the head end of the grave of Burial 145. The outline of most bones was identifiable but the bone so poorly preserved and crushed that little could be recovered. Age is estimated as young adult on the basis of tooth wear and sex as female on the basis of gracility.

Burial 122. This was comprised of the shafts of the leg bones of an adult, together with disturbed

fragments of an adult calvarium. The bone was in reasonable condition.

Burial 123. The very poorly preserved skeleton of an adult, with fragments of most major bones present except the lower right leg. Age is estimated as middle aged adult on the basis of tooth wear and sex as female on the basis of cranial morphology and gracility.

Burial 124. The poorly preserved remains of an adult, complete to the distal tibia, which appear to have been cut by the grave of Burial 122. Age is estimated as old aged adult, on the basis of tooth wear. Cranial morphology suggests that this was a male. Stature is estimated to be 158.8 cm based on the humerus and makes this individual the shortest male of the population.

Burial 125. This was represented by adult tibia and fibula shafts *in situ*, adjacent and to the east of Burial 123. Disarticulated bones beneath Burial 123 are assumed to also belong to this individual. These are cranial fragments, humerus, femoral and clavicular shafts and pelvic fragments. Sex is estimated as female on the basis of cranial morphology and gracility; age as middle aged on the basis of molar wear.

Burial 126. This was an almost complete but poorly preserved skeleton of an adult. Skull, rib and pelvic fragments and the shafts of long bones have survived. Age is estimated as middle aged adult on the basis of tooth wear, and sex as male on the basis of cranial morphology.

Burial 127. This was the skeleton of an adult, complete to the mid-thoracic region. The remainder of the body was disturbed and removed by the grave of either Burial 123 or Burial 125. Tooth wear is indicative of a middle aged adult; gracility is suggestive of a female.

Burial 128. This was the scattered skeleton of an adult, together with several shell bangles, a dog jaw and various pots and stone artefacts. The bones present are skull, humeri, radius and ulna fragments. An age of young adult was determined from tooth wear but no sex estimation could be made.

Burial 129. The tibial shafts were *in situ*, with fragments of other long bones, vertebrae and the skull in the vicinity. Age is estimated as young adult on the basis of tooth wear, and sex as male on the basis of mandible morphology, and femur head and distal humerus sizes.

Burial 130. Scattered infant bones in the vicinity of Burials 128 and 129. A small shell bangle was also associated.

Burial 131. This was the fragmentary skeleton of an older child. The skull, thorax, right upper and lower limbs and left femoral shaft are present. Age is estimated as 11-12 years on the basis of tooth eruption.

Burial 132. This skeleton was undisturbed but very degraded, with bones *in situ* but crushed to fragments of maximum one centimetre size. The legs from mid tibia projected into the western baulk, into the 1991 trench A1. Age is estimated as middle aged adult on the basis of tooth wear and sex as female on the basis of gracility.

Burial 133. This was a crouched burial, with several large pots placed over the body. Fragments of the cranium, mandible, shafts of major long bones of the right arm and both legs, some cervical vertebrae and hand and foot bones were present. The bone was in reasonable condition. Age is estimated as old adult, on the basis of tooth wear and antemortem tooth loss and sex as female on the basis of cranial morphology and tibial metric analysis.

Burial 134. This was a skull and articulated mandible of an adult, in an otherwise empty grave cut which extends from the west baulk of A7 into A9. Preservation is poor. Age is estimated as

young adult on the basis of tooth wear, and sex as female on the basis of gracility.

Burial 135. This was the moderately well preserved skeleton of a child, complete except for the feet. Age is estimated as 4-6 years on the basis of tooth eruption and wear.

Burial 136. The complete (except feet) and reasonably well preserved skeleton of an adult. Sex is estimated as male on the basis of skull morphology and distal humerus and femur head sizes. Age is estimated as old adult on the basis of molar wear.

Burial 137. This burial was well below the modern surface but nevertheless above the midden, i.e. down slope from most of the cemetery. A complete pot over the head crushed the skull, but the remainder of the skeleton down to the lower thoracic vertebrae, was in reasonable condition. The lower skeleton lies beyond the baulk. Age is estimated as middle aged on the basis of molar wear and sex as female on the basis of gracility and mandibular metrics.

Burial 138. The head and left shoulder had been disturbed by the grave cut for Burial 163, with the mandible lying over the right forearm. A disarticulated calvarium found in the vicinity may belong to this individual. The postcranial skeleton was present to the distal femora. The tibiae are missing but the fibulae were lying, disarticulated, over the upper skeleton. The person was an adult, probably a female on the basis of pelvic morphology, gracility and femur head diameter. Age at death is estimated as middle aged according to molar wear. Stature is estimated to be 154.3 cm based on the radius.

Burial 139. A jar burial beyond the head of Burial 118. This burial was identified when the jar was emptied. Infant teeth and bone fragments were recovered by wet sieving of the jar contents. An age estimate of 4-6 months was made based on dental development.

Burial 140. The complete skeleton of an adult with the bone in reasonable condition. Age is estimated as middle age on the basis of tooth wear and sex as male on the basis of mandibular morphology, distal humerus width and femur head diameter.

Burial 141. Above and in the same grave as Burial 165. This was the almost complete skeleton of an adult, in reasonable condition. The thorax and right arm had been disturbed, although some of the vertebrae found around the head of Burial 165 may belong. Age is estimated as young adult on the basis of tooth wear. Sex is female, on the basis of femur head diameter. Stature is estimated at 156.7 cm based on the humerus and radius lengths. Non-specific periostitis was evident on the left tibial shaft.

Burial 142. Infant jar burial in the centre of the square. The bone is fragmented and in poor condition. Apart from the cranium and femoral shafts, most fragments are unidentifiable. Age is estimated at about six months, on the basis of tooth development.

Burial 143. Infant jar burial by the head of Burial 116. The bone is fragmented and in poor condition. The mandible and long bone shafts are identifiable. This burial is estimated to be a neonate.

Burial 144. Infant burial beside the head of Burial 116, between Burials 116 and 143. This was not obviously a jar burial, although there was a fragmented pot in the area. The bone was fragmentary, disarticulated, and in poor condition.

Burial 145. Apart from the left foot, this was the complete burial of an adult, in reasonable condition. Age is estimated as young adult on the basis of tooth wear and sex as male on the basis of cranial morphology and femoral head diameter. Stature is estimated to be 170.8 cm based on

the lengths of the femur and tibia.

Burial 146. This burial was the largely complete but very poorly preserved skeleton of an adult, age estimated as middle aged adult on the basis of tooth wear and sex as male on the basis of distal humerus width.

Burial 147. Infant jar burial over the feet of Burial 148. The bones were in poor condition, disarticulated and fragmentary. The skull and long bone fragments were identifiable. Age is estimated at about four months on the basis of tooth development.

Burial 148. The reasonably well preserved skeleton of a small adult, complete to the distal femora. Age is estimated as middle aged, on the basis of tooth wear, and sex as female on the basis of pelvic morphology, gracility, and the sizes of the distal humerus, mandible metrics and femur head. Stature was calculated at 153.3 cm based on the humerus length. There is evidence of cribra orbitalia in this individual.

Burial 149. The skull, left arm and clavicle, leg bone shafts except left tibia and pelvic fragments were identifiable but the bone was so degraded nothing was recoverable apart from a few fragments of leg bones. The individual was an adult, possibly a male based on an estimate of femur length *in situ*.

Burial 150. This was the crushed and degraded fragments of the tibia and femur shafts of an adult. The excavation was extended beyond the baulk but no further remains were found.

Burial 151. The skeleton of an adult, complete apart from the thorax, with the bone fragmented but in reasonable condition. Age is estimated as middle age, on the basis of tooth wear and tooth loss. Mandibular metrics identified this individual as a female.

Burial 152. This was a totally crushed and degraded skull, together with two teeth. On the basis that one tooth, which may be a third molar, is hardly worn, age is estimated as young adult.

Burial 153. This burial consisted of an articulated adult skeleton, complete from the lower thoracic region to distal tibia, plus an articulated left scapula and humerus fragment and cervical vertebrae in correct anatomical relationship to the lower skeleton. Associated were disarticulated bones including cranium and mandible which may have belonged and long bone shafts including femora and tibiae which could not have belonged. The bone was in good condition. Sex is estimated as female on the basis of gracility of the articulated bones and pelvic morphology. Tooth wear indicates a middle aged adult.

Burial 154. This was the poorly preserved skeleton of an adult, from the pelvis to the feet. Sex is estimated as female on the basis of gracility. The size and parts of the skeleton present suggest that this may have been the remainder of Burial 16, identified in 1991, although the plans show that they are a metre apart.

Burial 155. This was the crushed and very degraded fragments of a child skeleton. Although the position of the skeleton could be seen, no bones were recoverable other than occipital fragments and tooth crowns. The remainder of the teeth appear to have dissolved. Age is estimated as an older child about 13-14 years, on the basis of minimal tooth wear and tooth development.

Burial 156. Crushed fragments of an adult skeleton, including the right humerus, left forearm, and femoral and tibial shafts.

Burial 157. The remains of an adult. The bone is in good condition. The left femoral shaft and tibial shafts were *in situ*. Disarticulated bones associated include distal humerus, hand bones

and some teeth. Age is estimated as middle aged, on the basis of tooth wear.

Burial 158. This was the totally crushed fragments of the skull of an infant, with a dog skull and two pots by the head. An age estimate of 15 months has been made using dental development.

Burial 159. Infant jar burial, with humerus shaft, ilium, distal femur and one tooth present. The bone is in good condition. The tooth implies the skeleton is that of a neonate.

Burial 160. The articulated left forearm, hand and pelvis fragments of an adult. The condition of the bone is variable. Sex is estimated as female on the basis of gracility identified at excavation.

Burial 161. Infant jar burial, no bone.

Burial 162. Infant burial. This was the articulated but poorly preserved skull, long bone and rib fragments of an infant aged 3-4 years on the basis of tooth development.

Burial 163. The partly disarticulated partial skeleton of a child, in a clear grave cut. The skull, right arm, and left femur are in anatomical position, with the right femur and both tibiae disarticulated but within the grave cut. The bone is in good condition. Age is estimated between 6-8 years on the basis of tooth development.

Burial 164. One distal femur and both tibiae from a child *in situ*, in a clear grave cut. There was an associated scatter of disarticulated bones, including adult dentition. An age estimate of 6-8 years is given on the basis of comparative long bone length.

Burial 165. This was the relatively well preserved but partly disarticulated skeleton of an adult. The skull, upper thorax, left humerus, left pelvis and legs are *in situ*, with the right humerus beyond the head, the right pelvis over the chest and the forearm bones over the pelvic area. The disturbance was probably the result of the grave cut of Burial 141. Age has been estimated as young adult on the basis of the unfused sternal epiphysis of the clavicle and molar wear. Sex was estimated as female on the basis of pelvic and cranial morphology and distal humerus width. Stature was calculated to be 156.4 cm based on the ulna.

Burial 166. Infant long bone shafts and ribs associated with Burial 165.

Burial 167. Infant jar burial, no bone.

Burial 168. Infant jar burial, no bone.

Burial 169. Infant jar burial, no bone.

Burial 170. Infant jar burial, no bone.

APPENDIX TWO

TABLE 49. *Age and sex estimates, with the bases of estimation*

No.	Age	Aged from	Sex	Sexed from
1	no bone (adult)			
2	middle aged	entheses/joints	male	pelvis and tibial metrics
3	no bone (adult)			
4	10-15 yrs	epiphyses		
5	adult	bone size	?	
6	middle aged	entheses/joints	?female	gracility
7	material amalgamated with burial 10			
8	15-18 yrs young	dental development	?	
9	13-15 yrs	dental development		
10	adult	bone size	?male	robusticity
11	not lifted (adult)			
12	not lifted (adult)			
13	not lifted (adult)			
14	young adult	molar wear	?male	robusticity of fibula
15	adult	bone maturity	?female	gracility identified at excavation
16	middle aged	molar wear	?female	gracility
17	adult	bone size	?female	gracility
18	adult	bone size	?	
19	adult	bone size and maturity	female	gracility and tibial metrics
20	young adult	molar wear	male	cranium, mandibular metrics and tibial metrics
21	adult	bone size	female	cranium and gracility
	21.1	3-9 months	dental development	
22	middle aged	entheses/joints	?male	pelvis
23	middle aged	molar wear	male	pelvis, skull, distal humerus width
24	middle aged	entheses/joints	female	gracility and tibial metrics
25	adult	bone size	?	
26	middle aged	entheses/joints	?male	tibial metrics
27	adult	bone size	?	
28	6-9 month	dental development		
29	adult	bone size	?	
30	no bone			
31	no bone (adult)	size of grave cut		
32	young adult	molar wear	?male	mandible
33	6-8 yrs	dental development, bone size		
33.1	9-12yrs	bone size		

No.	Age	Aged from	Sex	Sexed from
34	young adult?	molar wear	?female	cranium
35	middle aged	molar wear, joint maturity	female	skull, pelvis and tibial metrics
36	old adult	molar wear	?female	gracility
37	middle aged	entheses/joints	female	gracility and tibial metrics
38	no bone (infant)	burial jar		
39	18-20 young	molar wear, epiphyses	?female	gracility and mandibular metrics
40	middle aged	molar wear	?male	tibial metrics
41	old adult	entheses/joints	?	
42	middle aged	dental wear	?female	gracility identified at excavation
43	9 months	dental development		
44	old adult	molar wear	?female	gracility and mandibular metrics
45	old adult	molar wear	?male	mandible and robusticity
46	adult	bone size	?	
47	middle aged	molar wear, pubis metrics, tibial metrics and distal humerus width	male	pelvis, skull, mandibular
48	adult	bone size	?	
49	0-3 months	bone size		
50	no bone (infant)	burial jar		
51	young adult	molar wear	male	mandible and distal humerus width
52	middle aged	molar wear	?female	cranium and distal humerus width
53	middle aged	molar wear	?	
54	middle aged	molar wear	?	
55	adult	bone size	?female	femur head diameter
56	middle aged?	molar wear	?male	mandible
56.1	3 yrs +	dental development, bone size		
57	old adult	dental wear	?female	mandible
58	young adult	molar wear	?female	skull
59	adult	bone size	?male	pubis shape identified at excavation
60	middle aged	molar wear	female	gracility, skull and mandibular metrics
61	young adult?	molar wear, epiphysis	female	skull and gracility
62	adult	bone size	?	
63	adult	bone size	?	
63.1	adult	bone size	?	
64	adult	bone size	?	
65	old adult	molar wear	?female	gracility
66	3-9 months	dental development		
67	middle aged	entheses/joints	?male	tibial metrics

TABLE 49 *(cont.). Age and sex estimates, with the bases of estimation*

No.	Age	Aged from	Sex	Sexed from
68	18 months	dental development		
69	2 yrs	dental development		
70	adult	bone size	?female	gracility
71	adult	bone size	?male	robusticity
72	adult	bone size	?	
73	18-30 months	dental development		
74	0-3 months	dental development		
75	middle aged	molar wear	male	pelvis and skull
76	young adult	molar wear	?female	gracility
77	young adult	tooth wear, bone maturity	?male	tibial metrics
78	adult	bone size and maturity	?female	gracility
79	adult	bone size	?	
80	adult	bone size and maturity	?	
81	middle aged	molar wear	male	pelvis, tibial metrics, femur head diameter, robusticity
82	adult	bone size	?male	robusticity
83	old adult	molar wear, joint maturity	male	pelvis, cranium, tibiae, femur head diameter, mandibular metrics
84	young adult	molar wear	female	skull, femur head diameter, gracility
85	old adult	molar wear	male	skull and mandibular metrics
85.1	infant	dental development		
86	23-30 yrs	molar wear, epiphysis	?male	pelvis, skull and femur head diameter
87	middle aged	entheses/joints	male	pelvis, tibial metrics
88	old adult	entheses/joints	?male	robusticity
89	no bone (infant)	burial jar		
90	young adult	molar wear	female	mandible and gracility
91	infant	dental development		
92	adult	bone size	?male	robusticity
93	middle aged?	bone maturity	male	tibial metrics and robusticity
94	adult?	bone size	female	cranium and gracility
95	adult	bone size	?	
96	no bone			
97	young adult	molar wear	?male	cranium
98	not allocated			
99	young adult	entheses/joints	?female	gracility
100	old adult	entheses/joints	?male	tibial metrics
101	middle aged?	enthesis/joints	male	robusticity and tibial metrics
102	adult	bone size	?female	tibial metrics

No.	Age	Aged from	Sex	Sexed from
103	adult	bone size	?	
104	middle aged	joint maturity	?female	gracility
105	middle aged	molar wear	?male	pelvis and cranium
106	middle aged	molar wear	male	pelvis, cranium and tibial metrics
107	young adult	epiphyses	?male	femur head diameter
108	adult	bone size	?	
109	young adult	molar wear	male	pelvis, skull, mandibular metrics, femur head diameter, distal humerus width
110	infant	bone size		
111	old adult	molar wear	?male	cranium
112	young adult	molar wear	male	pelvis, mandible, tibial metrics and femur head diameter
113	middle aged	molar wear	?	
114	young adult	molar wear	female	cranium, femur head diameter,gracility
115	no bone (adult)			
116	middle aged	molar wear	female	cranium and gracility
117	middle aged	molar wear	?	
118	middle aged	molar wear	female	skull and gracility
119	no bone (infant)	burial jar		
120	12-15 yrs	dental development		
121	young adult	dental wear	?female	gracility
122	adult	bone size	?	
123	middle aged	molar wear	?female	cranium and gracility
124	old adult?	molar wear	male	skull
125	middle aged?	molar wear	female	cranium and gracility
126	middle aged?	molar wear	?male	cranium
127	middle aged	tooth wear	?female	gracility
128	young adult	tooth wear	?	
129	young adult	molar wear	male	robusticity, mandible, femur head diameter, distal humerus width
130	infant	bone size		
131	11-12 yrs	dental development		
132	middle aged?	molar wear	?female	gracility
133	old adult	molar wear	?female	cranium and tibial metrics
134	young adult	molar wear	?female	gracility
135	4-6 yrs	dental development		
136	old adult	molar wear	male	skull, femur head diameter, distal humerus width

137	middle aged	molar wear	?female	gracility
138	middle aged	molar wear	?female	pelvis, femur head diameter, gracility
139	4-6 months	dentition		
140	middle aged	molar wear	male	mandible, femur head diameter, distal humerus width, robusticity
141	young adult	molar wear	?female	femur head diameter
142	6 months	dentition		
143	neonate	dental development		
144	infant	dental development		
145	young adult	molar wear	male	cranium and femur head diameter
146	middle aged	molar wear	?male	distal humerus width
147	4 months	dental development		
148	middle aged	molar wear	female	pelvis, femur head diameter, mandibular metrics, distal humerus width, gracility
149	adult	bone size	?male	in situ bone length measurement
150	adult	bone size	?	
151	middle aged	molar wear	?female	mandibular metrics
152	young adult	molar wear	?	
153	middle aged	tooth wear	female	pelvis and gracility
154	adult	bone size	?female	gracility
155	13-14 yrs	dental development		
156	adult	bone size	?	
157	middle aged	molar wear	?	
158	15 months	dental development		
159	neonate	dental development		
160	adult	bone size	?female excavation	gracility identified at
161	no bone (infant)	burial jar		
162	3-4 yrs	dental development		
163	6-8 yrs	dental development		
164	6-8 yrs	comparative partial long bone length		
165	young adult	molar wear,epiphyses	female	pelvis, cranium, femur head diameter, distal humerus width
166	infant	bone size		
167	no bone (infant)	burial jar		
168	no bone (infant)	burial jar		
169	no bone (infant)	burial jar		
170	no bone (infant)	burial jar		

Table 50: *Width of distal humerus (mm)*

Burial	Right	Left	Burial	Right	Left
23		64.9	47	69.6	65.3
51	62.4	63.4	52	53.7	
109		62.6	129	65.1	
136	64.0		138	60.2	
140	61.0	63.0	146	62.4	
148		56.6	165		52.1

Table 51. *Femur head antero-posterior diameter (mm)*

Burial	Left	Right	Burial	Left	Right
55	43.0	42.5	77		39.6
81	44.0		83	45.3	44.7
84		42.3	86	46.8	
87	43.3		105		42.2
107	45.2	45.5	109	45.5	46.7
112		47.2	114	40.7	41.4
129		47.9	136	46.1	46.4
138		41.7	140		46.0
141		43.4	145		44.6
148	39.6	41.4	151		42.6
165	40.2	41.2			

Table 52. *Mandible measurements (mm)*

Burial	Maximum condylar breadth		Minimum ramal breadth		Body height	
	Left	Right	Left	Right	Left	Right
20	22.79				31.05	30.93
23			35.40			32.25
34				33.71		
35				31.42	29.66	28.54
39	13.83				30.13	30.56
40		21.80				
44		19.97				
45						30.19
47	22.74		30.58	29.96	29.93	32.47
51					32.30	
56			37.61			
58					26.46	

Table 52*(cont.). Mandible measurements (mm)*

Burial	Maximum condylar breadth		Minimum ramal breadth		Body height	
	Left	Right	Left	Right	Left	Right
60	17.48					
65					27.28	26.67
75						34.48
81			34.15		30.41	31.27
83	22.34			27.57		30.18
84					29.77	28.52
85	37.43					
86			34.66		28.25	29.41
105				31.08		28.31
106				30.17	28.45	28.01
109	21.53	21.21				37.58
112					28.60	29.43
116					28.23	
126						31.29
129		20.90				
133						23.98
136					31.72	
138					24.24	23.54
140					32.80	31.82
141			27.2	26.57		29.13
148	20.35		32.27	32.05	27.48	26.40
151			20.05		22.40	

Table 53. *Tibia diameter at the nutrient foramen (mm) and cnemic index (medio-lateral (M-L) antero-posterior (A-P)x100) (Bass 1987: 233)*

Burial	M-L diameter		A-P diameter		Cnemic Index	
	Left	Right	Left	Right	Left	Right
2	25.96		38.35		67.69	
19	20.29		29.70		68.32	
24	20.11		30.38		66.19	
26		22.90		32.88		69.65
35	19.48		29.63		65.74	
37		19.70		29.02		67.88
40	23.36		33.33		70.09	
47	27.69		38.53		71.87	

Table 53 *(cont.). Tibia diameter at the nutrient foramen (mm) and cnemic index [medio-lateral (M-L)/antero-posterior (A-P) x100] (Bass 1987: 233)*

Burial	M-L diameter		A-P diameter		Cnemic Index	
	Left	Right	Left	Right	Left	Right
67	23.02		32.32		71.23	
77		23.97		32.08		74.72
81		25.33		36.71		69.00
83	22.00	21.83	31.97	34.94	68.81	62.48
87		23.87		36.28		65.79
93	19.82		33.37		59.39	
100	23.84	25.30	32.62	32.83	73.08	77.06
101	21.33		34.17		62.42	
102		21.44		31.44		68.19
105		22.03		31.69		69.52
106	23.71		34.83		68.07	
112	21.33		37.43		56.99	
133		19.23		29.78	64.57	

Table 54. *Field Long Bone Measurements (mm) and stature estimates (cm)*

No.	Sex	Humerus		Radius		Ulna		Femur		Tibia		Stature (cm)
		R	L	R	L	R	L	R	L	R	L	
23	male				238							161.6 (R)
24	female									340	343	
35	female	291	289						407			154.3 (F)
37	female										372	162.1 (T)
39	?female	298						433	429	367		161.0 (F+T)
40	?male	310							444			
44	?female	290										153.8 (H)
47	male	350		266		299				427	425	180.7 (rT)
51	male	309					279					163.3 (H)
52	?female	279		217								1 5 0 . 7 (H+R)
58	?female	306				263						158.2 (H)
60	female							411				155.3 (F)
61	female	283										151.9 (H)
67	?male									356		161.1 (T)
75	male			245	241							163.9 (rR)
77	?male							419			341	160.6 (F)
79	?									356		
81	male	345	342		277				473	403		

Table 54 *(cont.). Field Long Bone Measurements (mm) and stature estimates (cm)*

No.	Sex	Humerus		Radius		Ulna		Femur		Tibia		Stature (cm)	
		R	L	R	L	R	L	R	L	R	L		
83	male		295					442	443		366		
84	female								436			161.8	(F)
86	?male				267				457	365	371	167.3	(F+T)
87	male								463				
93	male									358	364		
105	?male	316	322				263					165.5	(rH)
107	?male		326	250		263							
109	male		344	279	280			492	490		440		
112	male	336						504			425	181.6	(F+T)
124	male		294									158.8	(H)
138	?female				231							154.3	(R)
141	?female		300	233								156.7	
145	male		331					455	455	398		170.8	(F+T)
148	female	288										153.3	(H)
165	female					256						156.4	(U)

Table 55. *Laboratory long bone measurements (mm) and stature estimates (cm)*

No.	Sex	Humerus		Radius		Ulna		Femur		Tibia		Stature	
		R	L	R	L	R	L	R	L	R	L		
2	male	311							437			163.7	(F)
24	female									350		155.6	(rT)
40	?male	317										165.8	(H)
81	male	337		278	276	297						174.9	(H+R)
83	male										372	165.5	(T)
87	male							467				168.9	(F)
93	male									361		162.5	(T)
107	?male			249								165.3	(R)
109	male			277				497				174.1	(F)

Key: r = right, l = left; H = humerus, R = radius, U = ulna, F = femur, T = tibia.

XX. THE HUMAN BURIALS

C.F.W. Higham and R.Thosarat

THE burials at Nong Nor were found in graves cut into the shell midden, or into the riverine alluvium, layer 1, which seals the midden (Fig. 112, see end pocket). They are described sequentially by number. This has no bearing on their relative chronology or distribution, subjects which will be treated after each burial has been described. Following each burial number, the location within the excavated area, sex and age, depth below datum and orientation are provided.

The following burials are not illustrated due to their fragmentary condition.

Burial 3. J2-4, adult, -57 cm, 90°. This is a badly disturbed grave containing a few scattered limb bones.

Burial 7. J20, adult, -33 cm. Disturbed adult limb bones. A fragment of a form 1 bronze bangle (cat. 38) and a disc and a barrel shell bead (cat. 39) found in the vicinity. These bones have been amalgamated with burial 10 on the principle that they are most likely to have belonged to it than any other.

Burial 11. J15, a scatter of human bone only.

Burial 12. J9, a scatter of human bone only, three shell disc beads (cat. 58) and two fragments of a form 1 bronze bangle (cat. 59) were found in the vicinity.

Burial 13. J8, a scatter of human bone only. Twenty shell disc and three barrel beads (cat. 60) were found in the vicinity.

Burial 30. G1. Only the eastern edge of this grave was present in the excavated area. A dog's cranium (cat. 167) and the remains of two pottery vessels were recovered (cats. 296, 302).

Burial 31. F5, 95°. Only the western end of this grave was present in the excavated area.

Burial 38. T22, -94 cm. A large vessel in a group of four at the eastern edge of the cemetery, probably an infant burial (cat. 824).

Burial 46. I22, adult. A femur and a tibia, not in anatomical relationship, were found on an east-west orientation. They may not be a burial.

Burial 59. K-L17, adult male, -40 cm, 85°. Only the bones of the forearm are in anatomical position, the remainder being fragmented and disturbed, including the cranium, mandible, pelvis and long bones. Two shell barrel beads and parts of a dog's cranium were found in the area of the skeleton (cats. 323-4).

Burial 62. P9, adult, -56 cm, 90°. All that remains are two femoral shafts, and tibia shaft and fibula. Two shell disc beads were found in the general area (cat. 336). They had been cut into and disturbed with the interment of burial 63 to the east.

Burial 80. L12, adult, -68 cm. Only a few rib fragments were found in place. The area contained

nine shell disc beads and fragments of bronze form 1 bangle (cats. 418-9).

Burial 95. Q7, adult, -63 cm. This extremely fragmentary concentration of human remains was probably the result of disturbance with the interment of B36. The general area also yielded a piece of red ochre and a cervid molar (cats. 526-7).

Burial 108. Adult, O15, -58 cm, *c*. 90°. Just the tibiae were in place.

Burial 115. Adult, N18, A scatter of human remains adjacent to burial 114. A pottery vessel (cat. 734) lay in the grave fill.

Burial 121. Young adult female, T-U17, -95 cm. This partial interment lay alongside and to the east of B145. A stone flake was discovered among the bones, but this may not have been associated with the burial.

Burial 154. Adult female, S23, -96 cm. A few adult bones.

Burial 159. Infant, R10, -45 cm. A very fragmentary infant's burial jar (cat. 937). A single shell barrel bead was found among the remains (cat. 947).

Burial 161. Infant, S10, -63 cm. A very fragmentary infant's burial jar (cat. 939).

Burial 168, N19, infant, -1.02m. Infant jar burial (cat. 995) at the head of burial 163.

Burial 169, N19, infant, -1.02m. Infant jar burial (cat. 1116) at the head of burial 163.

Burial 170, S23, infant, -92 cm. A large pottery vessel lying in a group of four, considered likely to have been an infant burial although no human remains were identified (cat. 1240).

THE ILLUSTRATED BURIALS

Burial 1. G5, ?adult, -41 cm, 90°. Only the tibiae are found in the excavated area. A fragment of bronze (cat. 12) found in the grave fill.

Burial 4. F80. C1, child under 15 years. -55 cm, 95°. The right proximal femur was found articulating with a fragment of pelvis. Distal radius lies alongside the pelvis. Part of the ilium also recovered.

Burial 5. A1, adult, -46 cm, 90°. Earlier than burial 6.

Burial 17. M5, adult female, -39 cm, 100°. Only the tibiae and fibulae were present, lying face down with the legs crossed.

Burial 18. D3, -46 cm. Skull fragments and some left arm bones were found in what was subsequently identified as a looters pit cut into burial 24. These bones probably result from the activity of the looters.

Burial 19. I23, adult female, -43 cm, 93°. Only a portion of the shaft of the right femur and lower legs in place. The left foot is lying over the tibia, and the right foot is disturbed, but still in the correct anatomical position.

Burial 21. I20, adult female, -29 cm, 110°. Very fragmentary remains of the cranium, clavicle, a few ribs and vertebrae found *in situ*.

Burial 22. J3-4, middle aged male, -54 cm, 102°. The bones are in aproximate anatomical order, but the cranium is missing. There is a pottery vessel adjacent to the left humerus (cat. 104). A stone flake and a shell disc bead were present in the vicinity (cats. 107, 103). The former probably has no relationship to the burial.

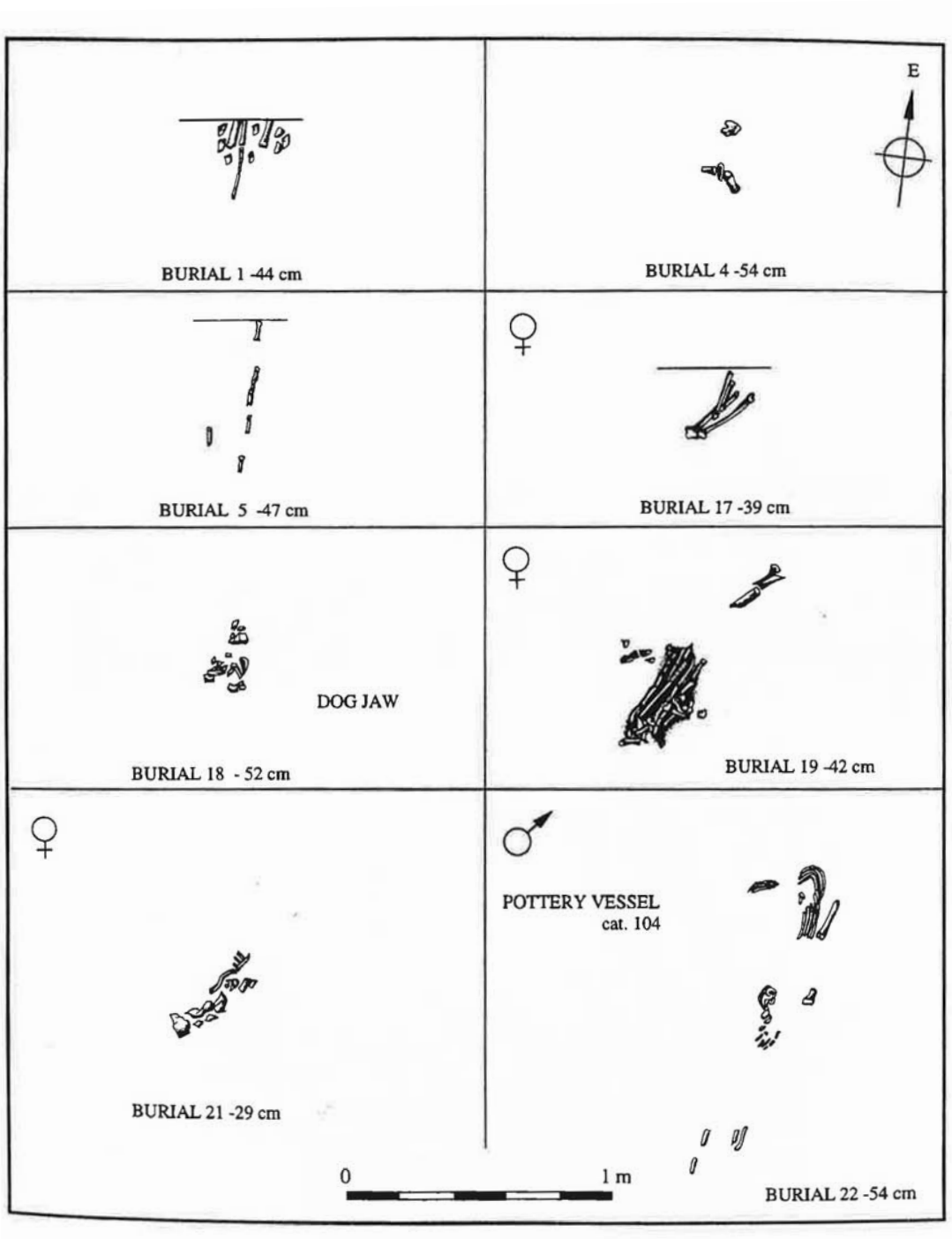


FIG. 113. Burials 1, 4, 5, 17, 18, 19, 21 and 22

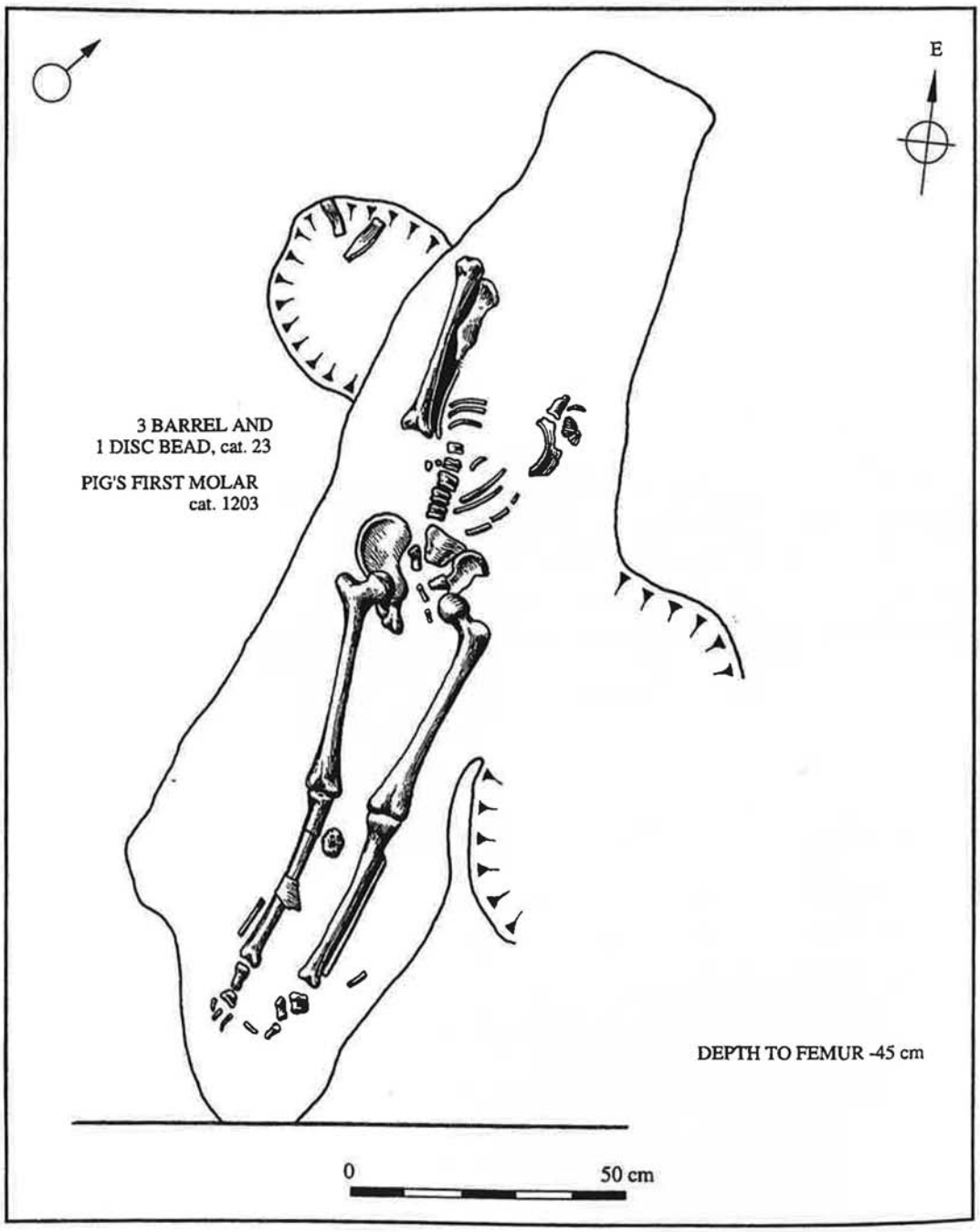


FIG. 114. Burial 2. I1-2, middle aged male, -45 cm, 105°. Complete except for the cranium and left humerus, probably due to looting. Four shell barrel beads and two disc beads (cat. 23) were found in the chest area, together with a young pig's lower first molar (cat. 1203).

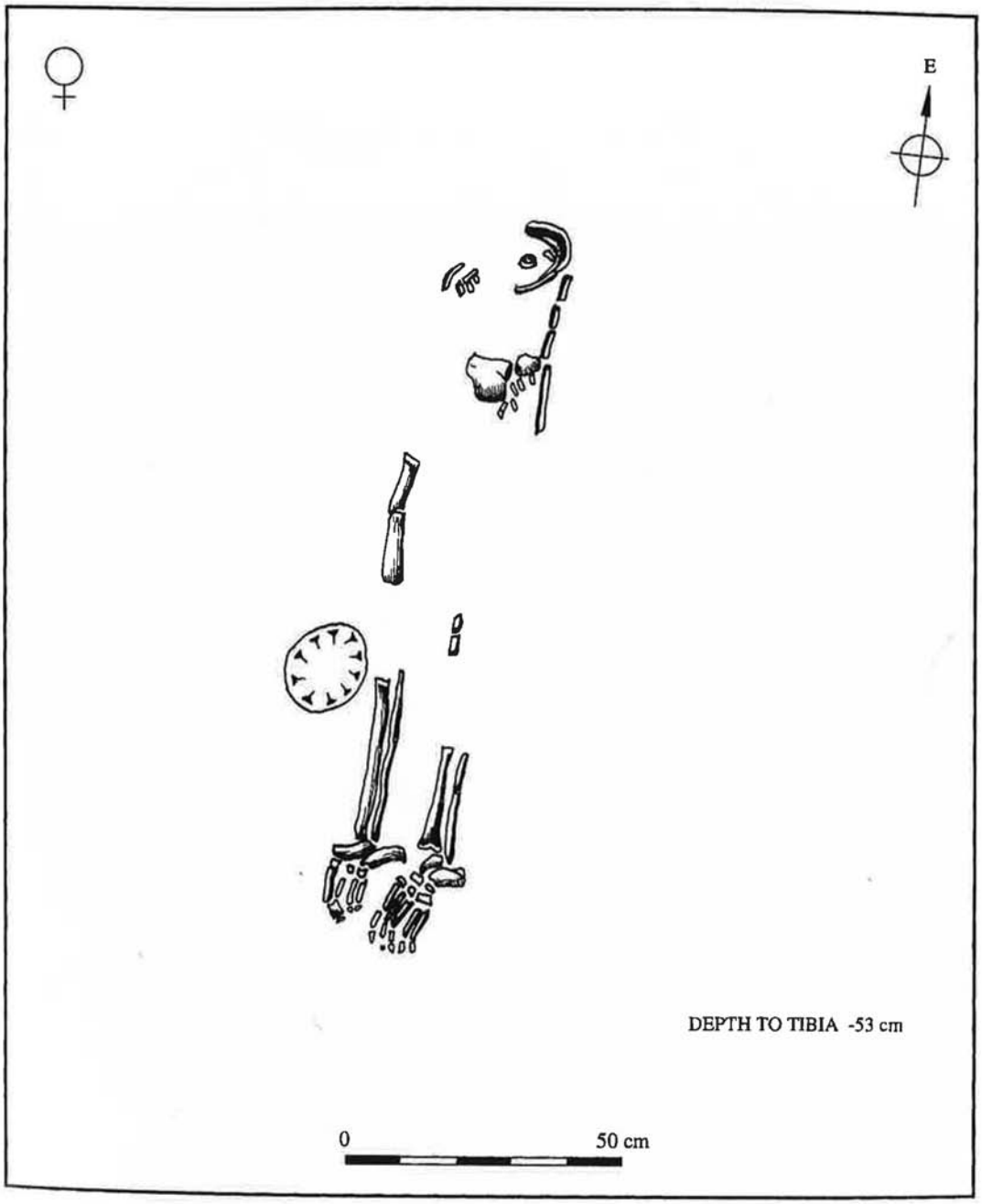


FIG. 115. Burial 6. A1, middle aged female, -53 cm, 90°. The left tibia and foot bones supine, the right tibia, fibula and foot bones prone and in articulation. Ribs, part of pelvis and left arm bones present.

FIG. 116. Burial 8 looking east. From left to right, burials 29, 20, 25, 8, 28, 9 and 10

Burial 8 *(above and opposite)*. J20-1, young adult, -39 cm, 130°. A complete grave, found within the shell midden with no apparent grave cut. The left lower arm was placed across the abdomen. There was a form 5 shell bangle fragment over the left tibia (cat. 124), nine barrel and 22 shell disc beads in the foot area (cat. 123), and a fragment of a form 5 bronze bangle (cat. 137) by the right femur. Two form 2 serpentine beads were found, one in the mouth and the other in the neck area (cat. 237). Five pottery vessels were associated, three beyond the head (cats. 141-2, 172) and two beyond the feet (cats. 165, 191). Many small pieces of bronze, probably coming from bangles, were found in the vicinity of this grave. A pig's second phalanx was found in the vicinity of the skull (cat. 1196). Burial 8 overlies burial 47, and was probably contemporary with burial 28, an infant interred in a jar beyond the feet.

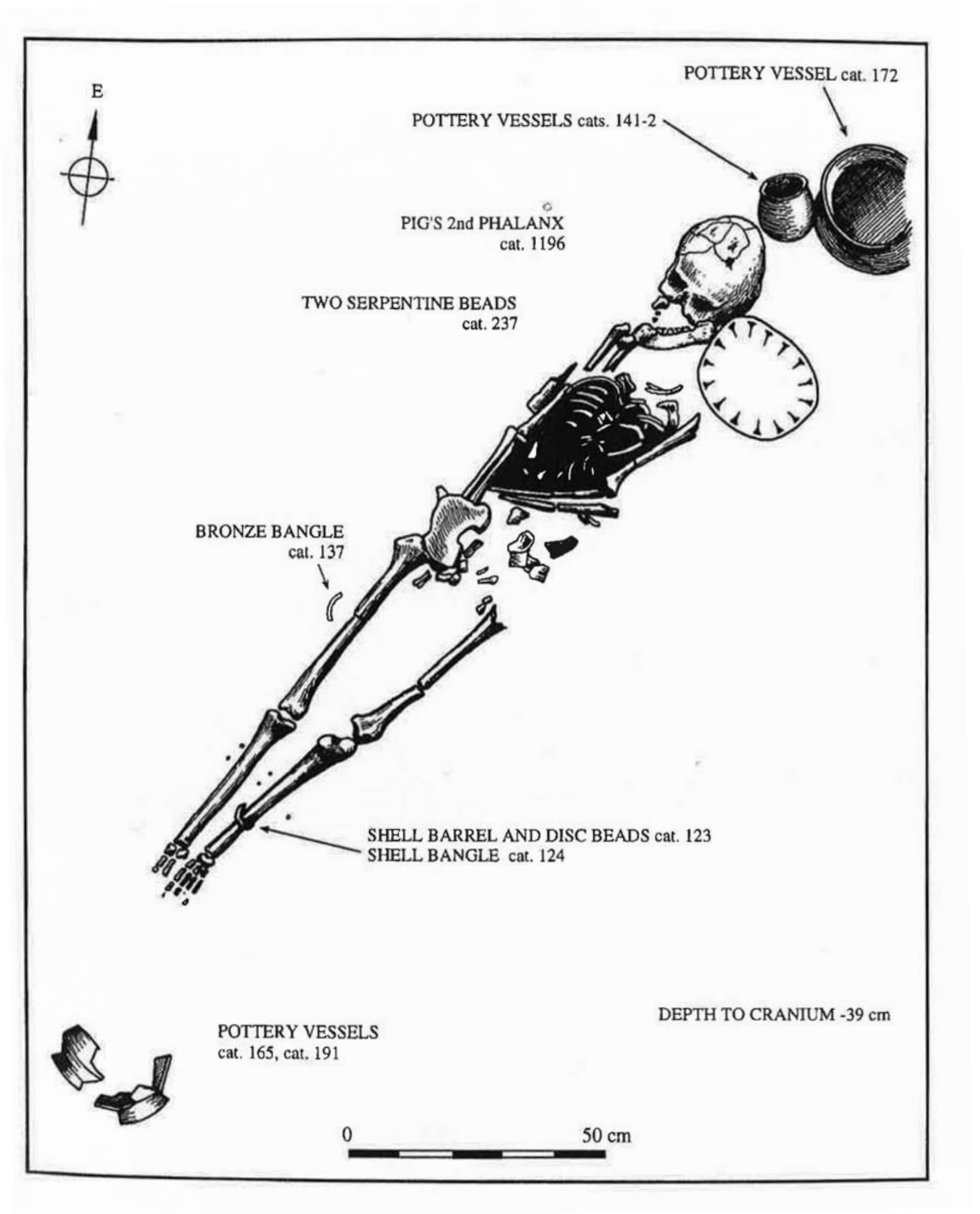


FIG. 117. Burial 8

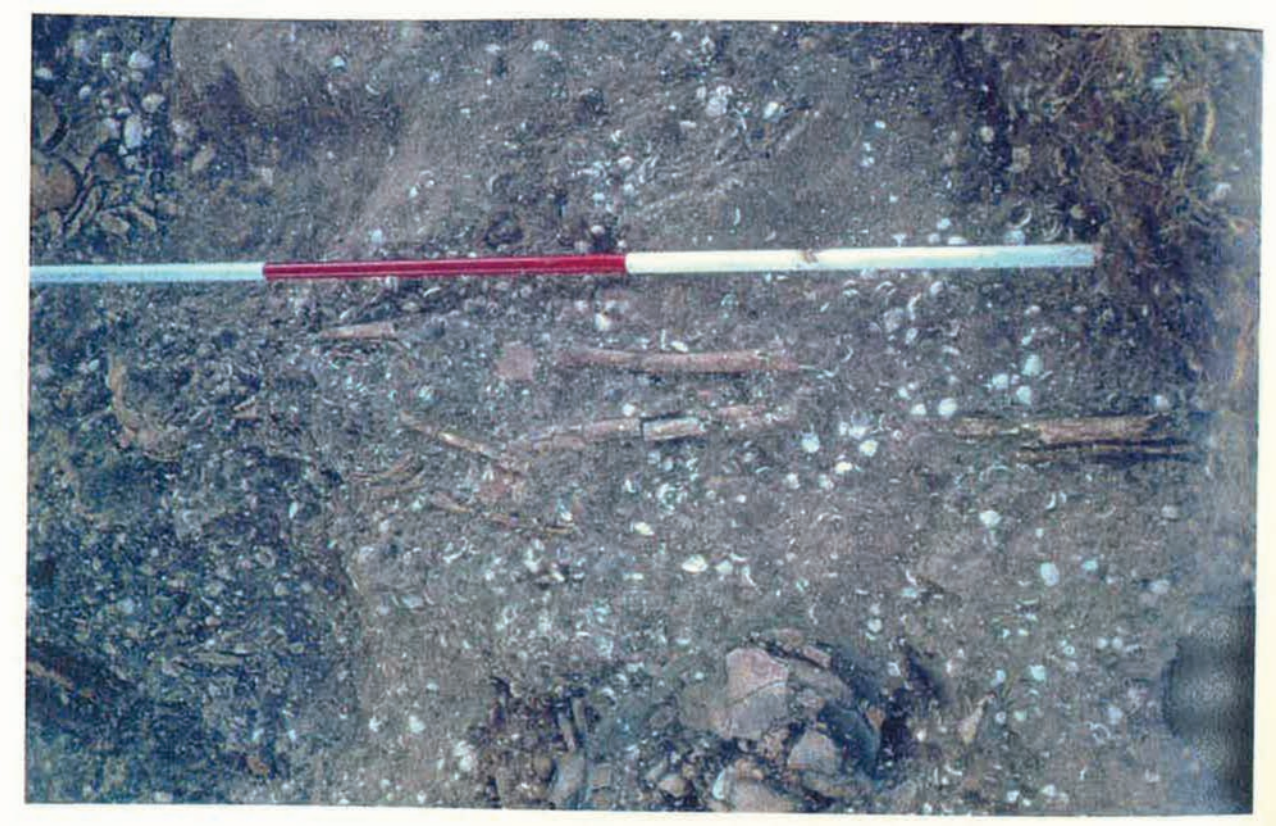


FIG. 118. Burials 9 and 10, showing parts of burials 8 and 28

Burials 9 and 10 *(above and opposite)*. Burial 9. J19-20, child about 13-15 years, -29 cm, 110°. A complete skeleton with the left forearm placed over the abdomen. A shell disc bead found in the neck area (cat. 149), and 17 further such beads (cat. 202) in the form of a bracelet in the left hand area. Five further disc beads were recovered from near the femora (cat. 1186). Two pottery vessels were associated, both beyond the cranium (cats. 145-6).

Burial 10. J19-I20. adult male, -28 cm, 105°. A partial skeleton, lying alongside the upper body of burial 9. A shell pendant and two shell barrel beads (cats. 74, 73) were found to the left of the skull. A pottery vessel (cat. 166) was found over the arm and ribs.

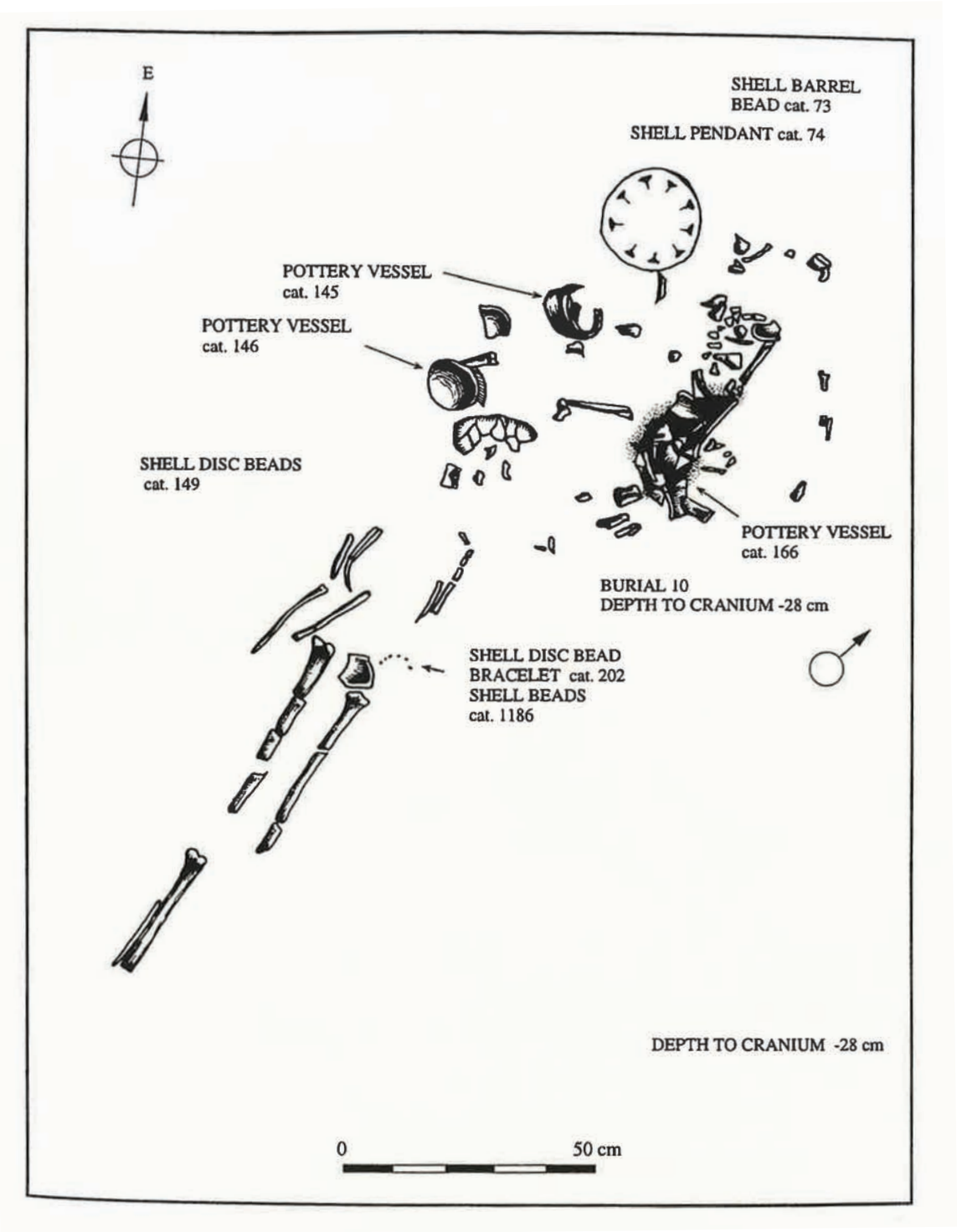


FIG. 119. Burials 9 and 10

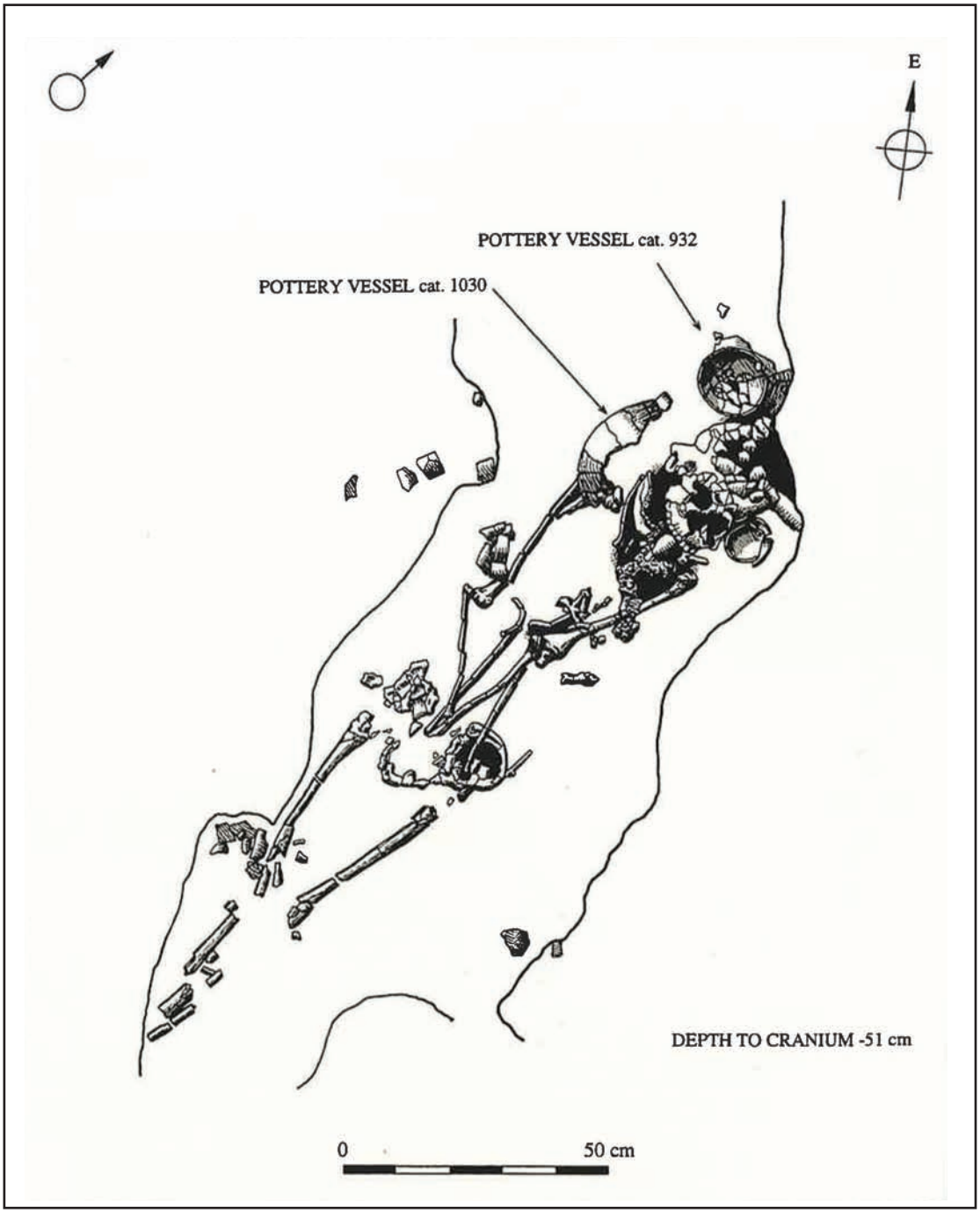


FIG. 120. Burial 14. I25-6, young male, -51 cm, 120°. A virtually intact burial, with the wrists crossed over the abdomen. Two pottery vessels (cats. 932, 1030) found adjacent to the cranium.

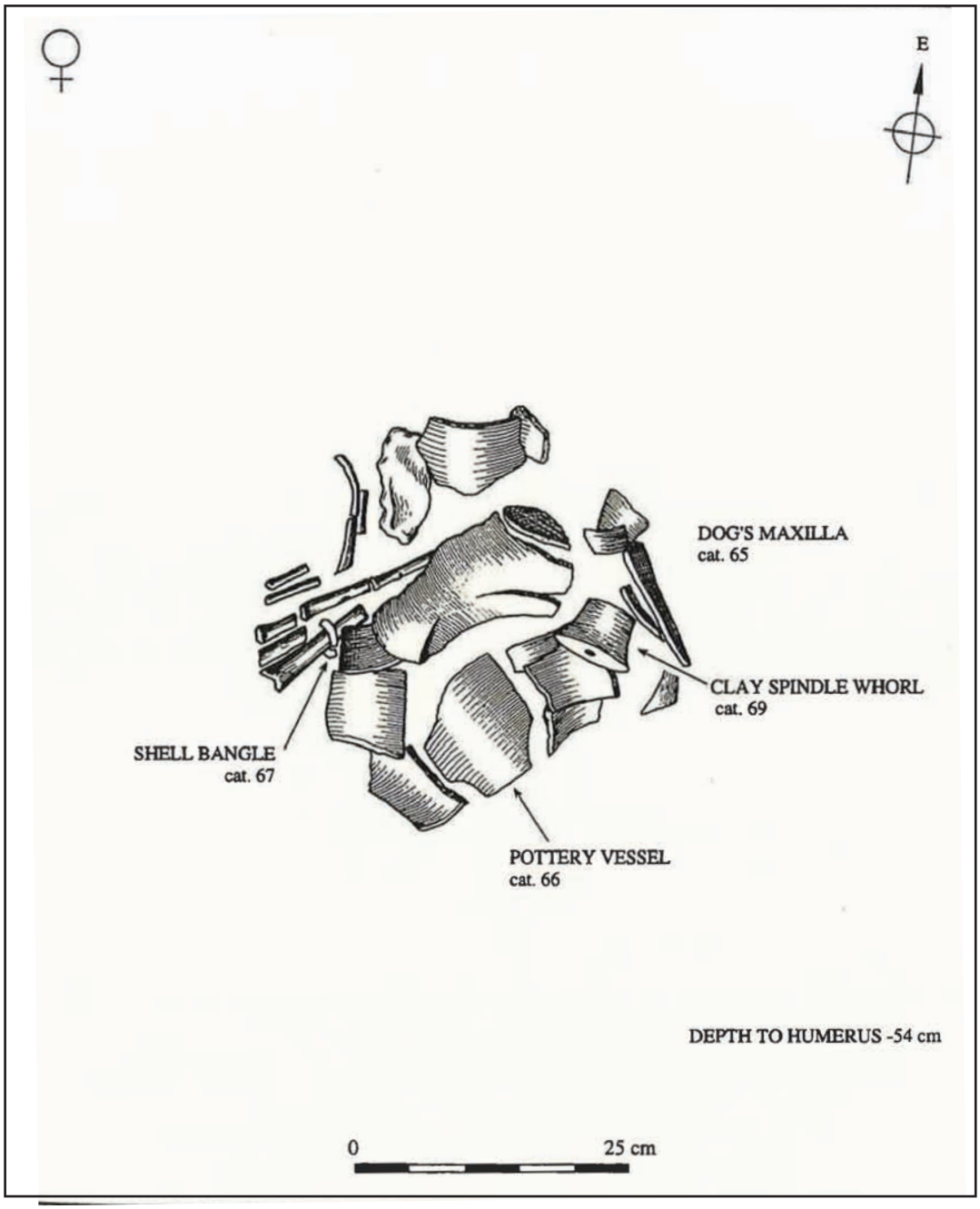


FIG. 121. Burial 15, G-F1, adult female, -54 cm, 150°. The upper left shoulder bones, radius and ribs survive, accompanied by a pottery vessel (cat. 66), a form 5 shell bangle and a probable spindle whorl (cats. 67, 69). A fragmentary maxilla from an adult dog was found in the vicinity

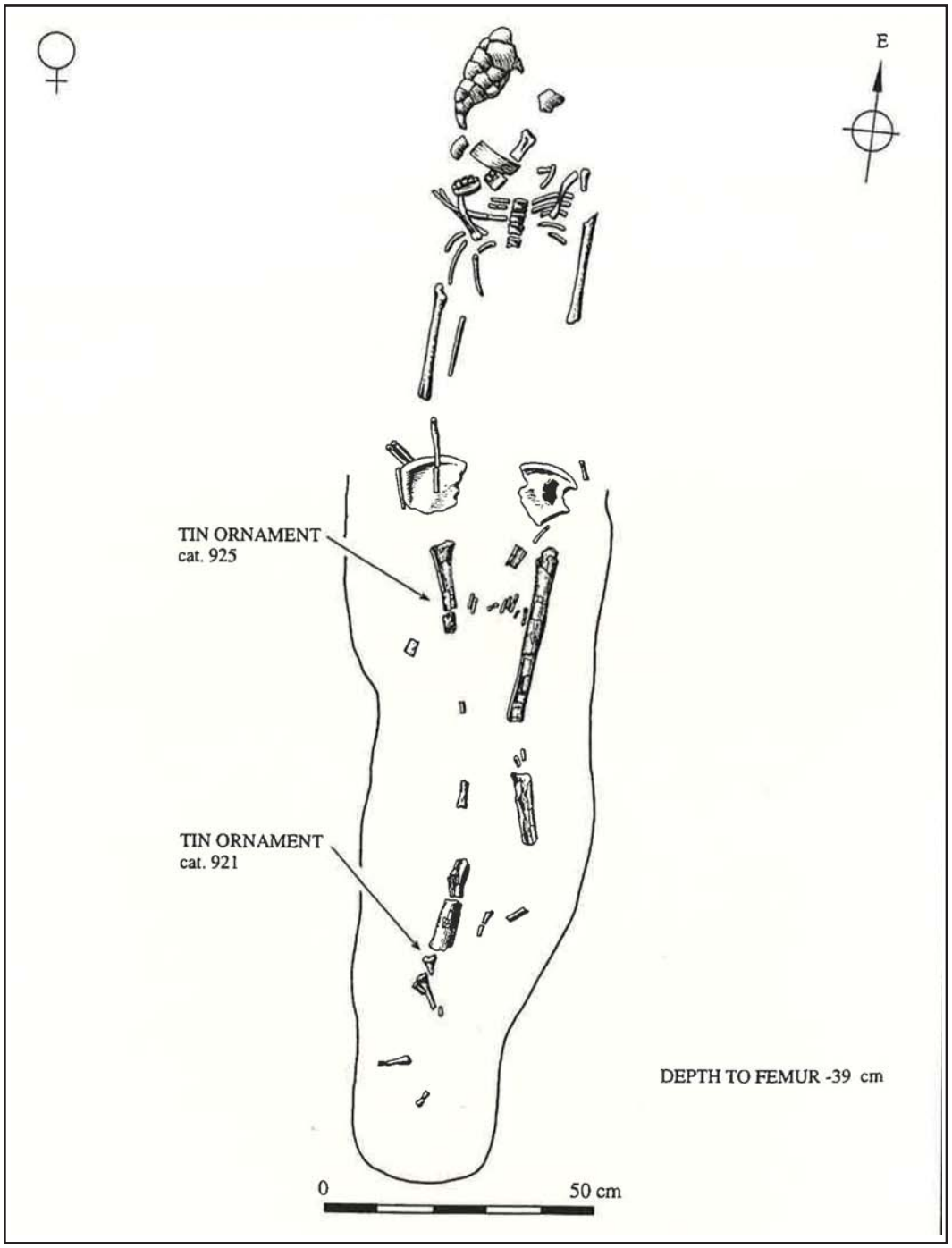


FIG. 122. Burial 16. O4-5, middle aged female, -39 cm, 85°. A complete burial, fragments of tin ornaments were found in the vicinity of the right hand and left ankle (cats. 925, 921).

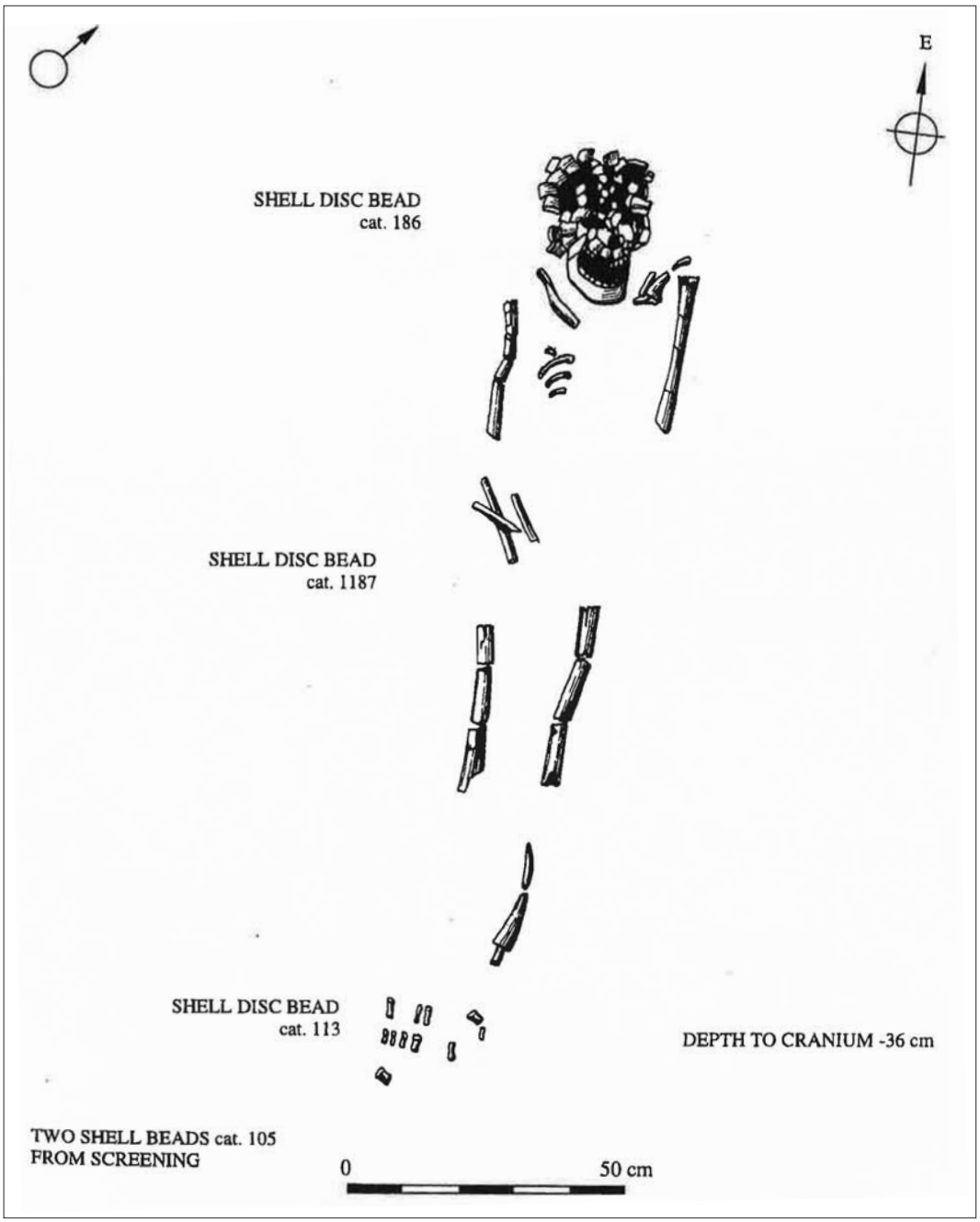


FIG. 123. Burial 20. K22, young male, -36 cm, 110°. A complete burial, associated with five shell disc beads, two from the screening, one from the ankle, the third from the vicinity of the head and the last from the area of the pelvis (cats. 105, 113, 186, 1187).

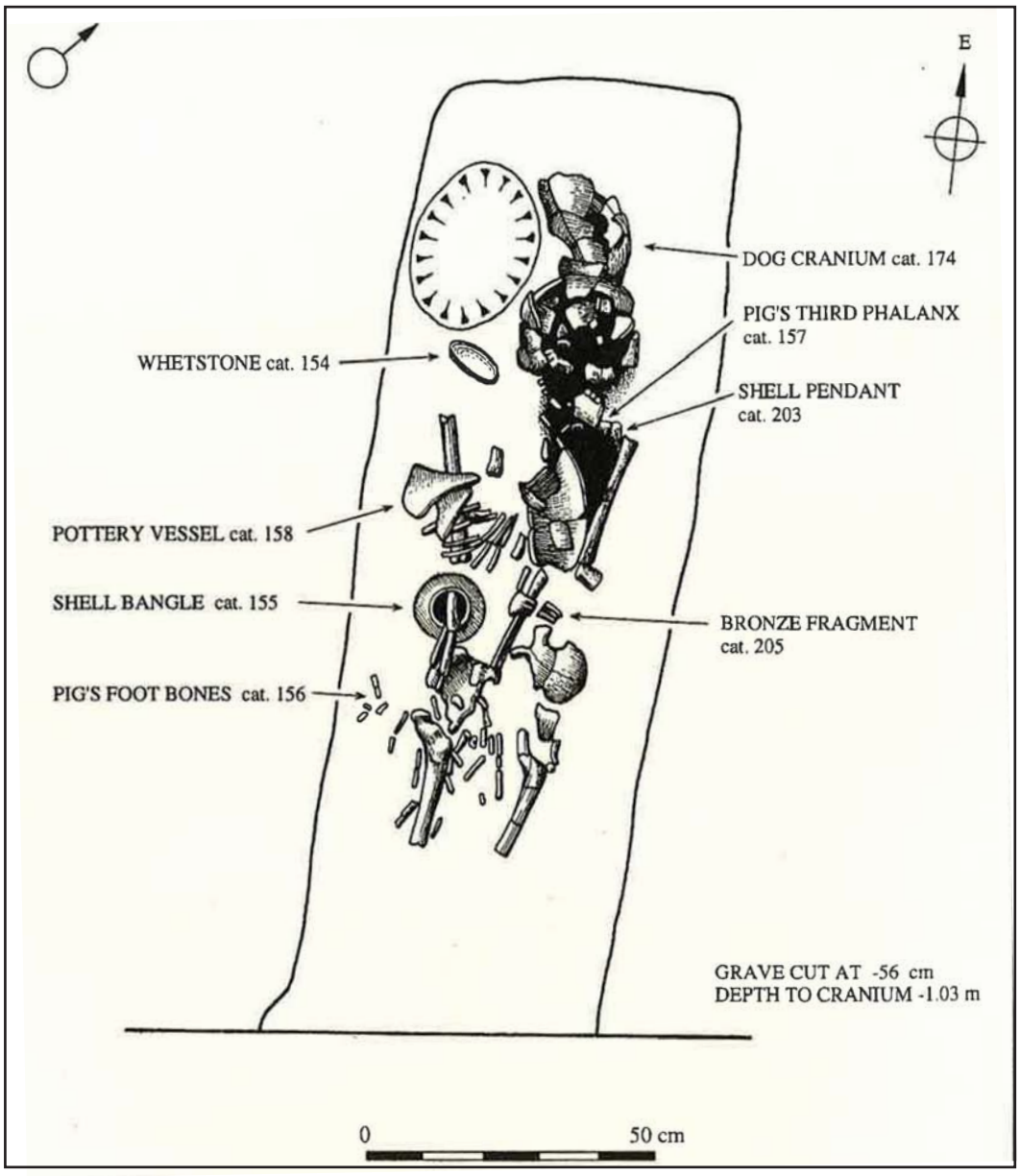


FIG. 124. Burial 23. C1, middle aged male, -1.03 m, 90°. This burial, found in a grave cut from at least -56 cm, was only partially located within the excavated area, and the area below the mid femur had been looted. However, the upper part of the body was complete. A dog's skull was found beyond the human cranium (cat. 174), and pig's foot bones were present by the right and and left shoulder (cats. 156-7). Shell jewellery included a large form 1 shell bangle on the right wrist and a long neck pendant (cats. 155, 203), while a single pottery vessel had been placed over the chest (cat. 158). A fragment of bronze by the left wrist, cat. 205, probably represents a bangle. Finally, a complete whetstone was found at the right shoulder (cat. 154).

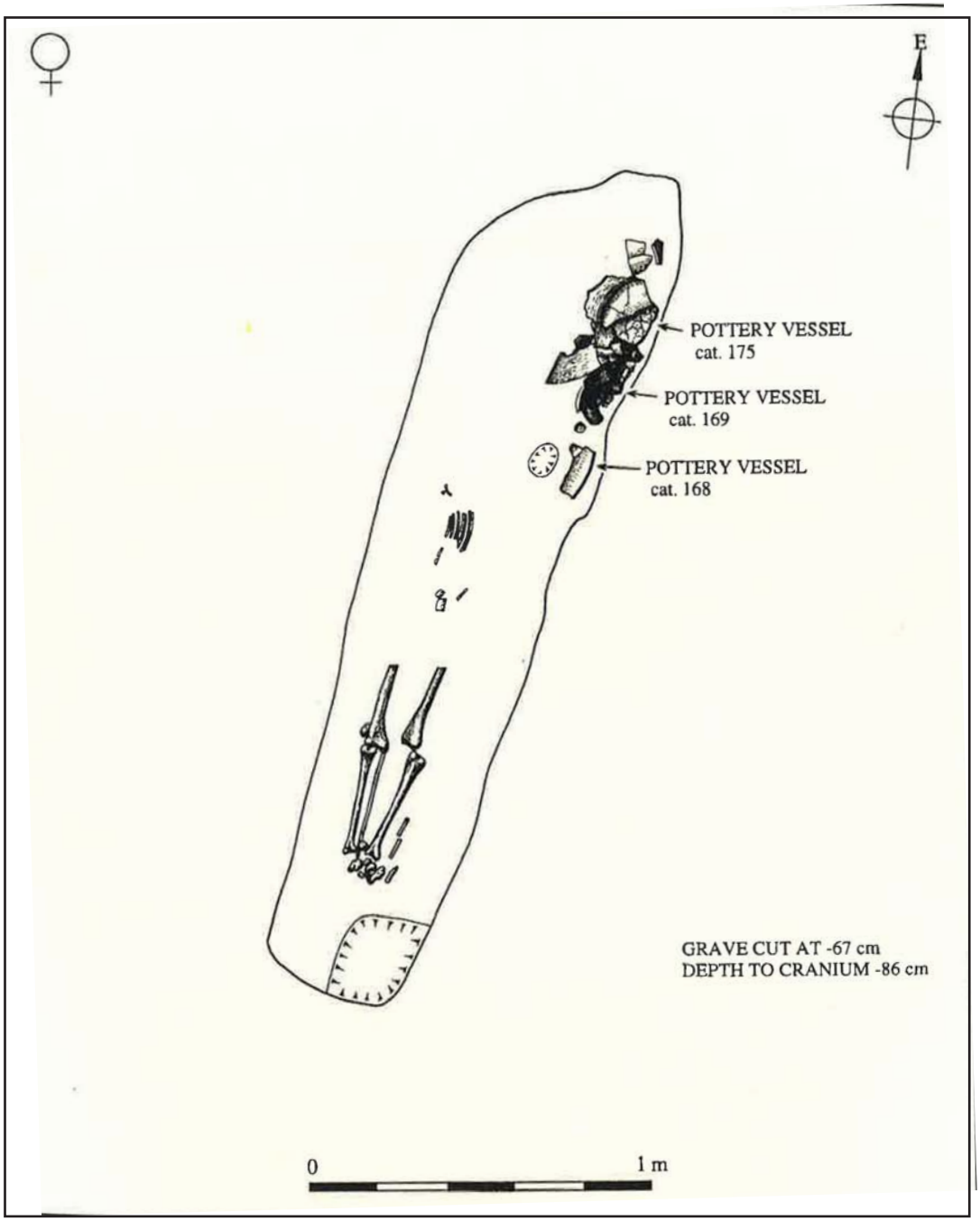


FIG. 125. Burial 24. E2-D3, adult ? female, -86 cm, 100°. The middle part of the body has been looted, but the grave is clearly seen cut into the natural from a depth of at least -67 cm. Three pottery vessels were present beyond and to the left of the cranium (cats. 168-9, 175).

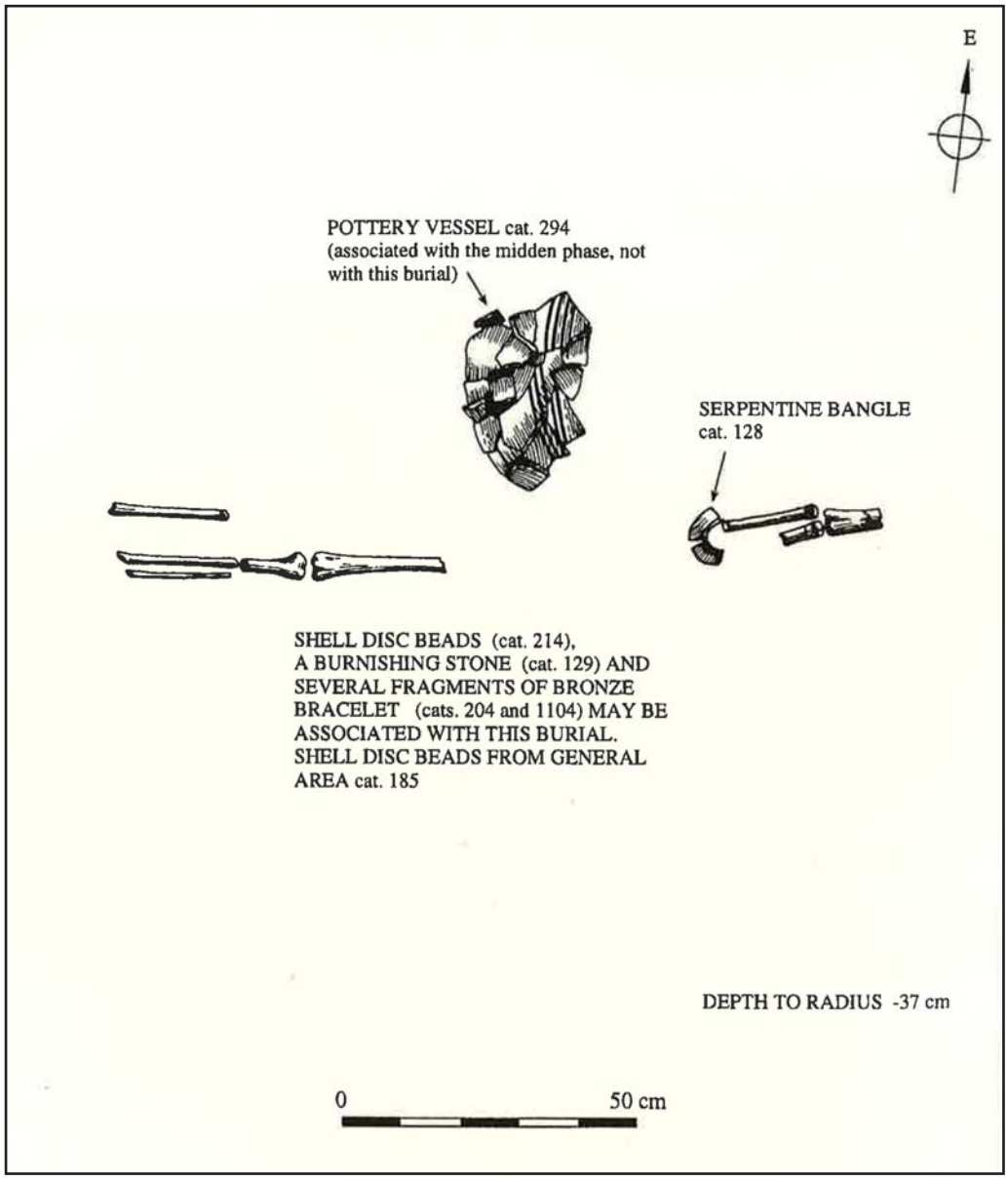


FIG. 126. Burial 25. K-J21, adult, -37 cm, 180°. This burial overlies and is later than B 47, and may well have been disturbed with the interment of B 8, which lies immediately to the south. Only some leg and arm bones survive. A serpentine bangle was found over the hand area (cat. 128), and a burnishing stone in the same area (cat. 129) may have been associated with this burial, along with two form 1 bronze bangles (cats. 204, 1104). Twenty-nine shell disc beads were recovered from between the tibiae (cat. 214) and three further shell disc beads were found in the general area (cat. 185).

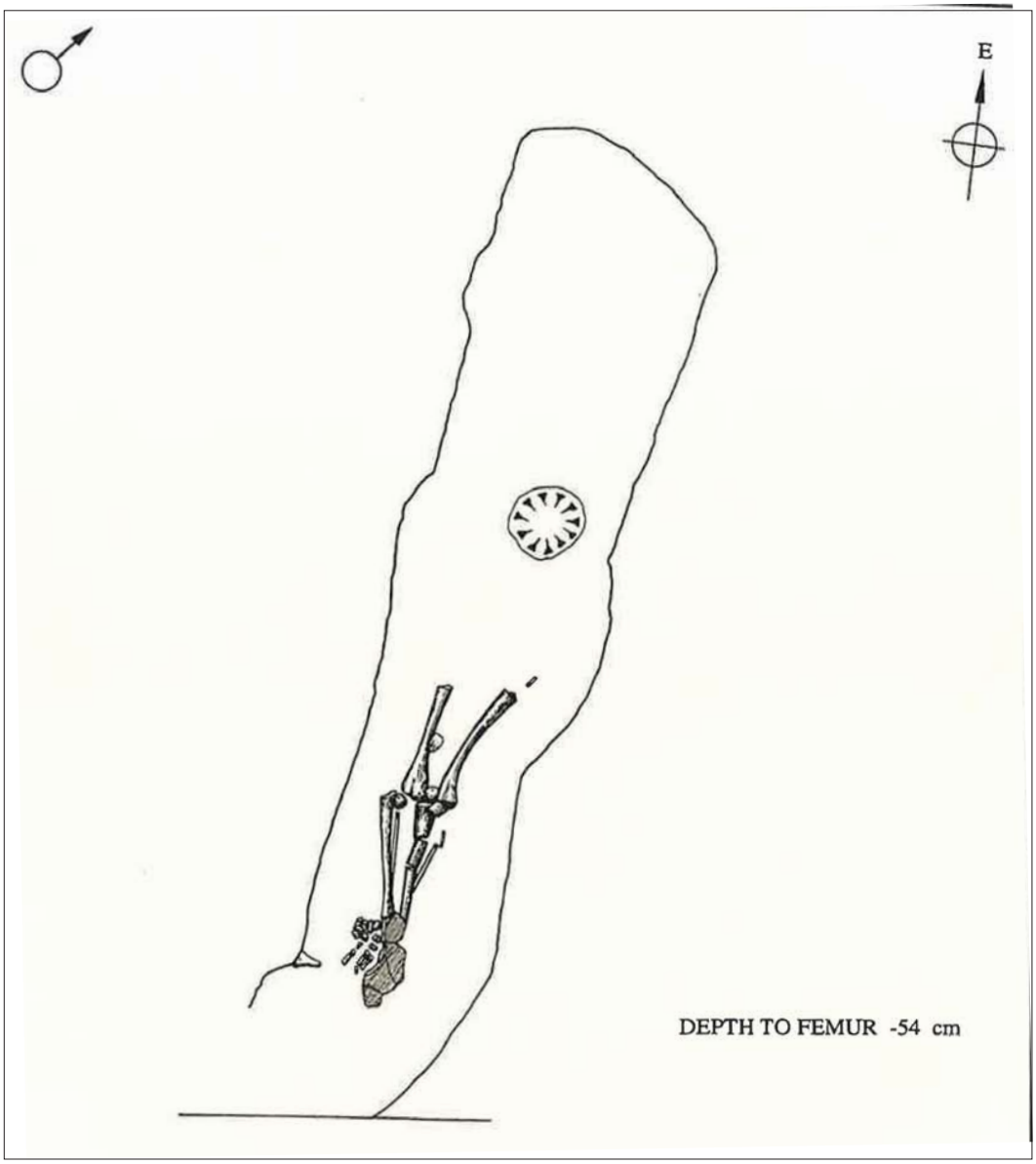


FIG. 127. Burial 26. H2-3, adult male, -54 cm, 100°. The upper part of this burial, which lies within a clear grave cut, has been lost to looting. The lower limbs are intact.

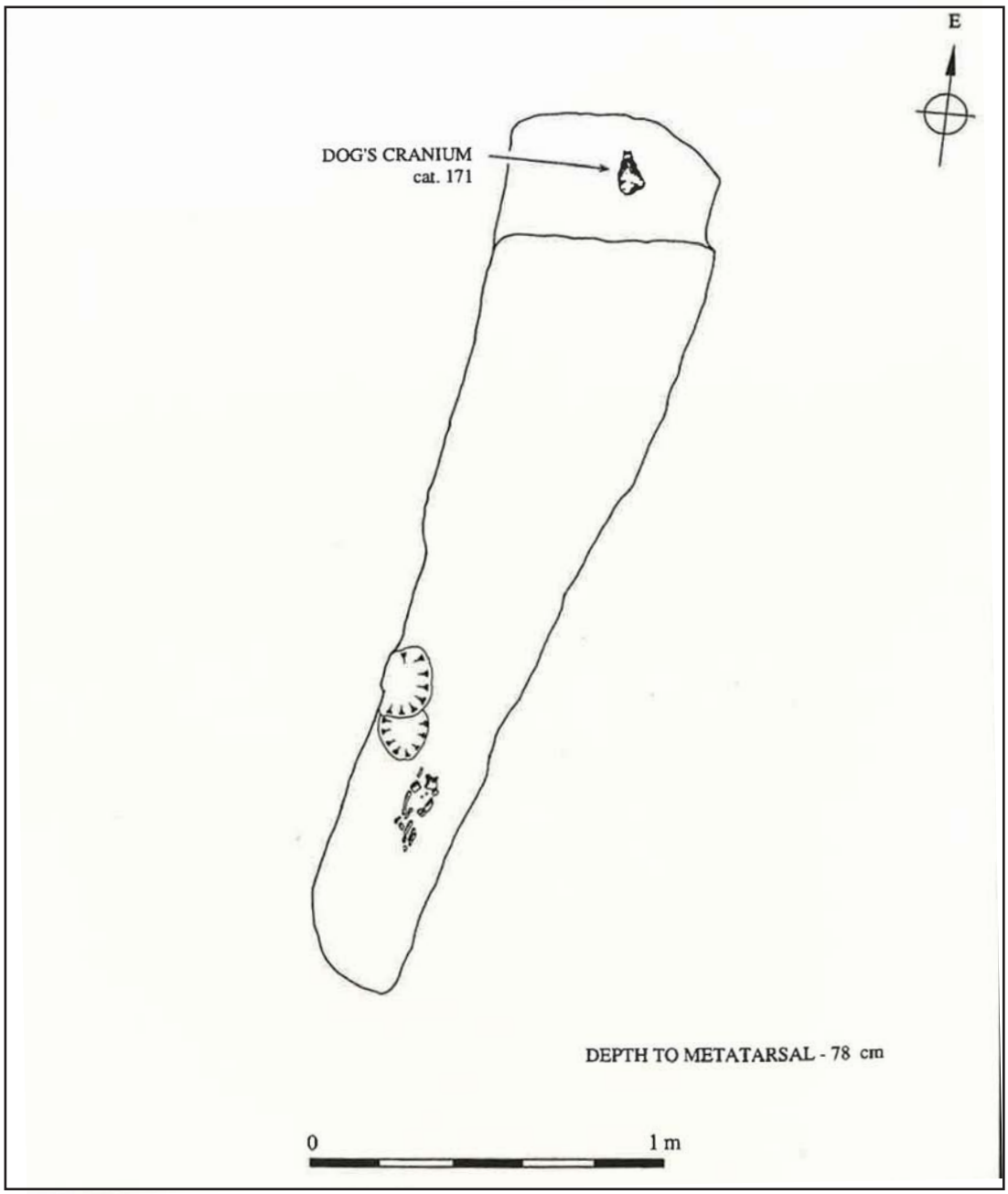


FIG. 128. Burial 27. F-E1-3, adult, -78 cm, 100°. Only the ankle bones and a dog's cranium (cat. 171) located beyond the area of the human head have survived looting. The grave is clearly cut into layer 3, the natural substrate.

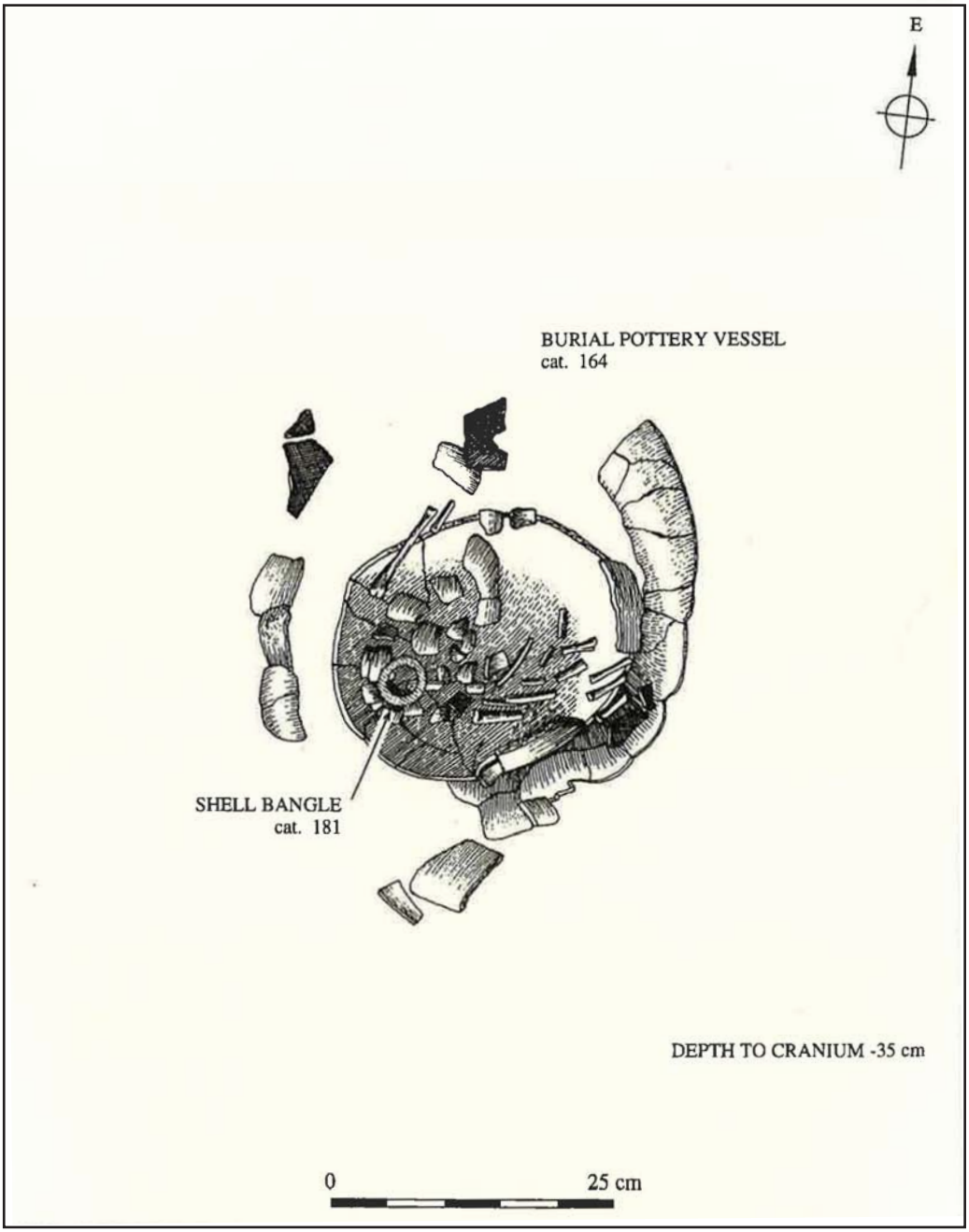


FIG. 129. Burial 28. K19, infant, -35 cm. This is a jar burial (cat. 164) containing the remains of an infant, which lies at the feet of B 8. It directly overlies burial 47. The bones were associated with a form 2 shell bangle (cat. 181).

FIG. 130. Square X1 looking west, showing burials 20, 8, 9, and 28

FIG. 131 *(opposite)*. Burial 29. K22, adult, -37 cm, *c*. 100°. Only the ulna lies on its probable orientation. Part of a complete pottery vessel (cat. 134) lies alongside it.

Burial 34. M-L3-4, adult female, -70 cm, *c*. 90°. The grave cut is very clearly seen into natural. Part of the cranium was recovered in 1991. The rest of the grave was found in 1993, and it was empty although no evidence for looting was noted.

Burial 41. L21, adult, 90°. This disturbed burial lies under B 37. The bones are disarticulated, and only those from the right femur to the feet were present. No grave goods were found in association.

Burial 42. L19, adult female, -56 cm. The bones of the right elbow of an adult were found just west of burial 44. Four shell disc beads were associated (cat. 291).

Burial 55. L11, adult female, -50 cm, 120°. Includes the forearm, fragments of pelvis, femora and loose fragments of tibiae. A dog's upper fourth premolar was found in the vicinity (cat. 1202), and a glass bead might have been in association (cat. 304), though looting activity rules out a definite conclusion.

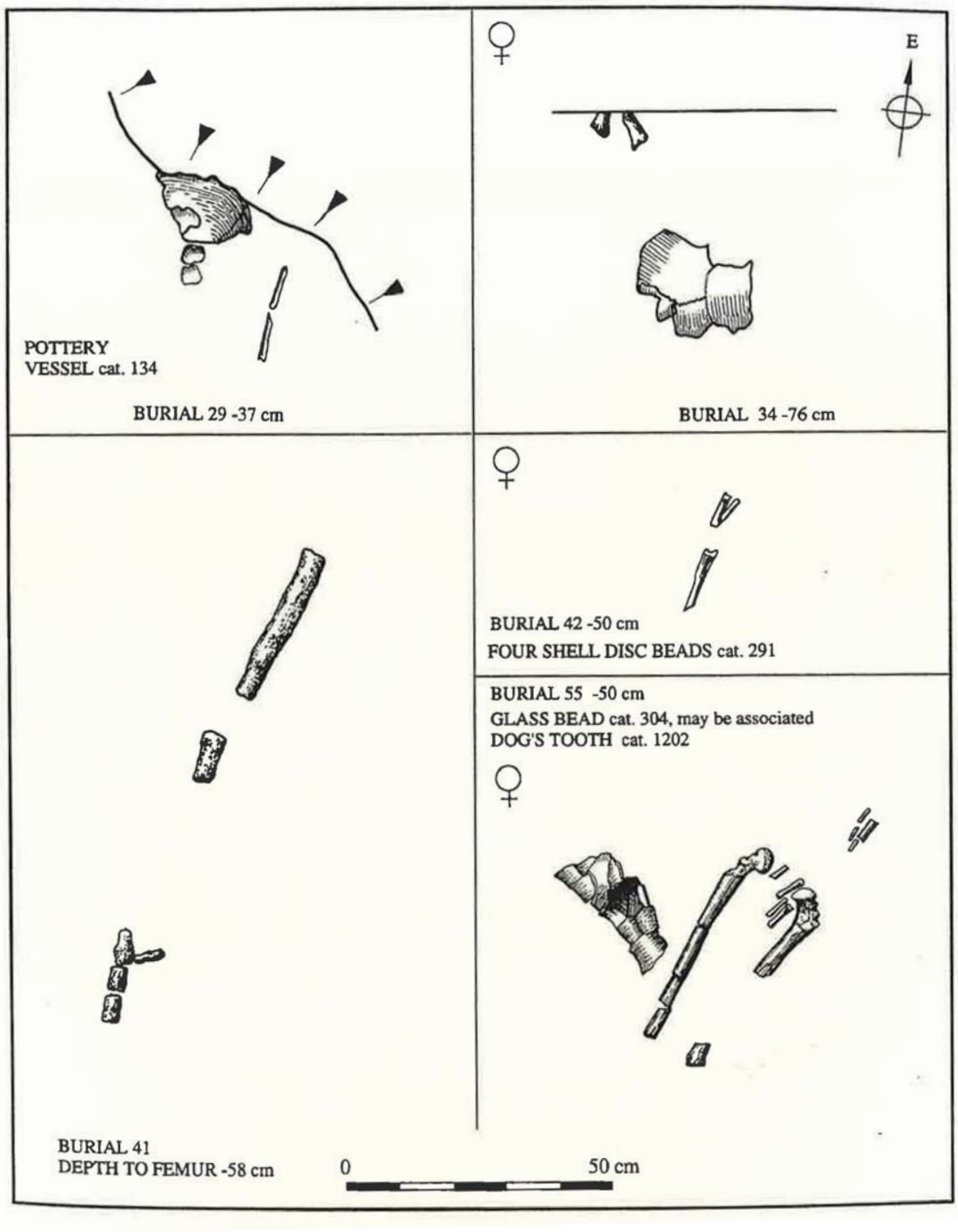


FIG. 131. Burials 29, 34, 41, 42 and 55

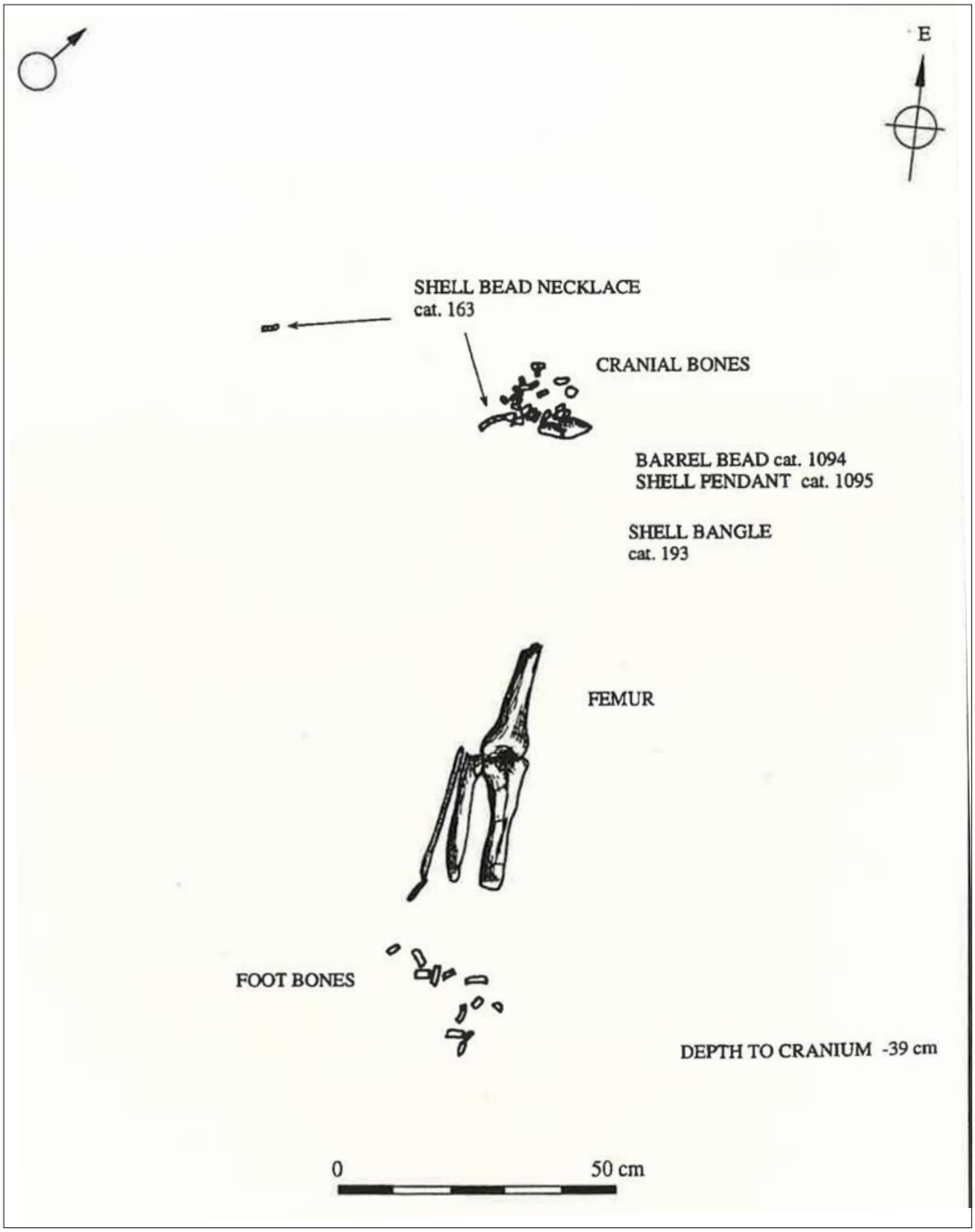


FIG. 132. Burial 32. I21-2, adult male, -39 cm, 90°. Only the mandible, femur, tibia and foot bones survive. The burial might well have been disturbed with the interment of B 8, which lies immediately to the north. A shell bead necklace represented by 58 disc beads, a shell bangle, a barrel bead and shell pendant were found, the last in the neck area (cats. 163, 193, 1094-5).

FIG. 133. Burial 33, view to the east

Burial 33 *(above and overleaf)*. I3-4, 9-12 year-old child, -1.00 m, 100°. The grave cut from at least 63 cm below datum to a depth of just over a metre. A fragment of bronze was found in the grave fill (cat. 180). Jewellery included two shell pendants in the neck area (cats. 196-7) and a form 5 shell bangle on the right wrist (cat. 198). A pottery vessel was found over the upper part of the cranium (cat. 199), while beyond the head, two further vessels were in place (cats. 206-7), together with the cranium of an adult dog (cat. 195). A further pottery vessel was present beyond the ankles (cat. 178). The grave measures *c*. 2.8 m in length, considerably longer than the corpse and associated offerings.

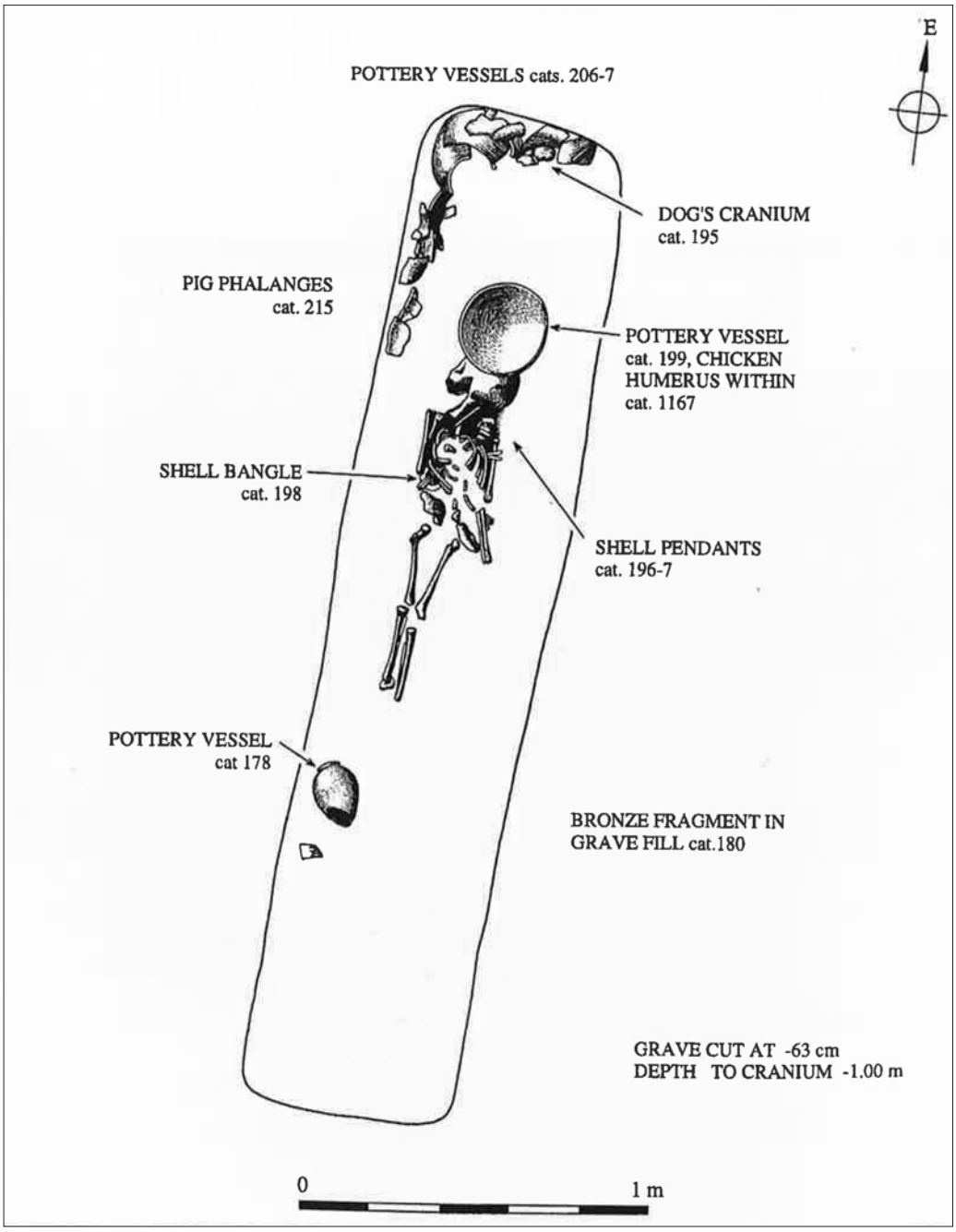


FIG. 134. Burial 33

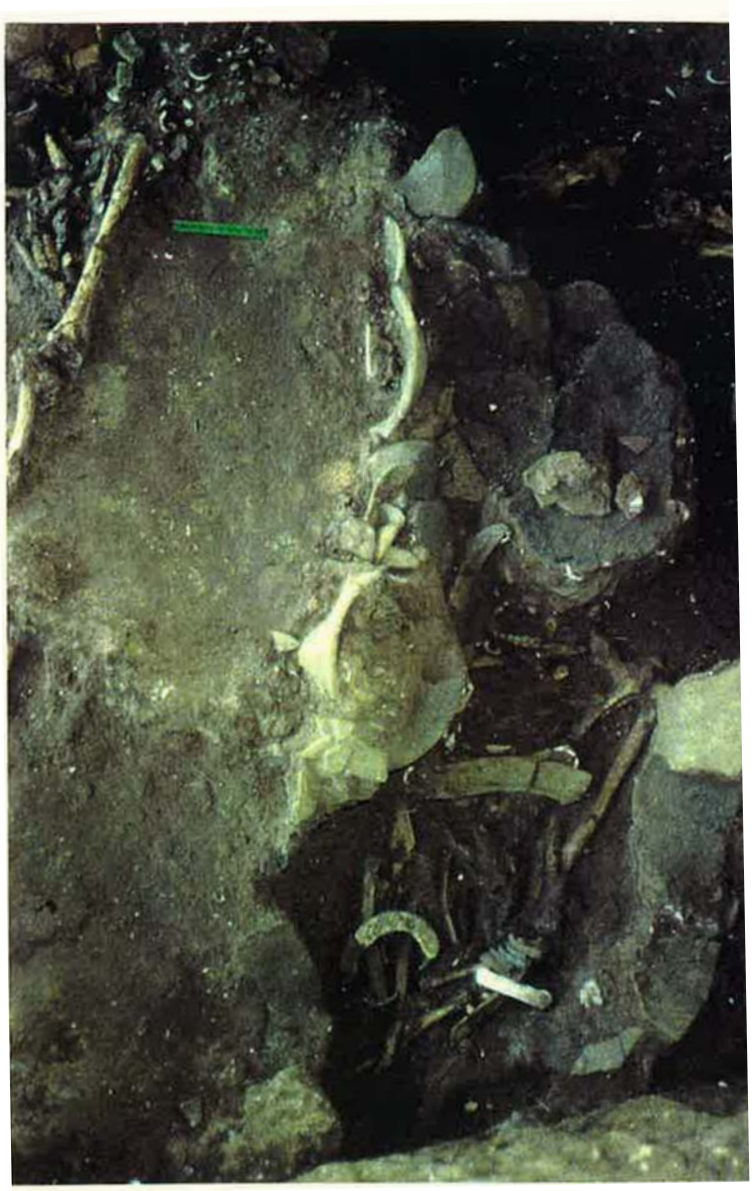


FIG. 135. Burial 35 *(above right)*, looking east. The lower limbs were recovered two seasons before the main part of the burial

Burial 35 *(above and overleaf)*. O5-6, middle aged female, -83 cm, 100°. This complete interment was found with the following items of jewellery: a form 1 bronze and a form 1 marble bangle on the right wrist (cats. 370, 517) and six form 1 bronze and a form 4 shell bangle, together with a possible bracelet of which 6 disc and 4 barrel beads have survived, on the left wrist (cats. 389-93, 1097, 406 and 514). Two shell pendants and a bead necklace were found in the neck area (cats. 518-9, 1243). Two dog's crania were present beyond the head (cats. 338, 513). Pottery vessels were found beyond the head (cats. 479-481, 483), and others beside the right upper arm (cat. 485), and the left knee (cat. 182). The grave cut into part of B 60.

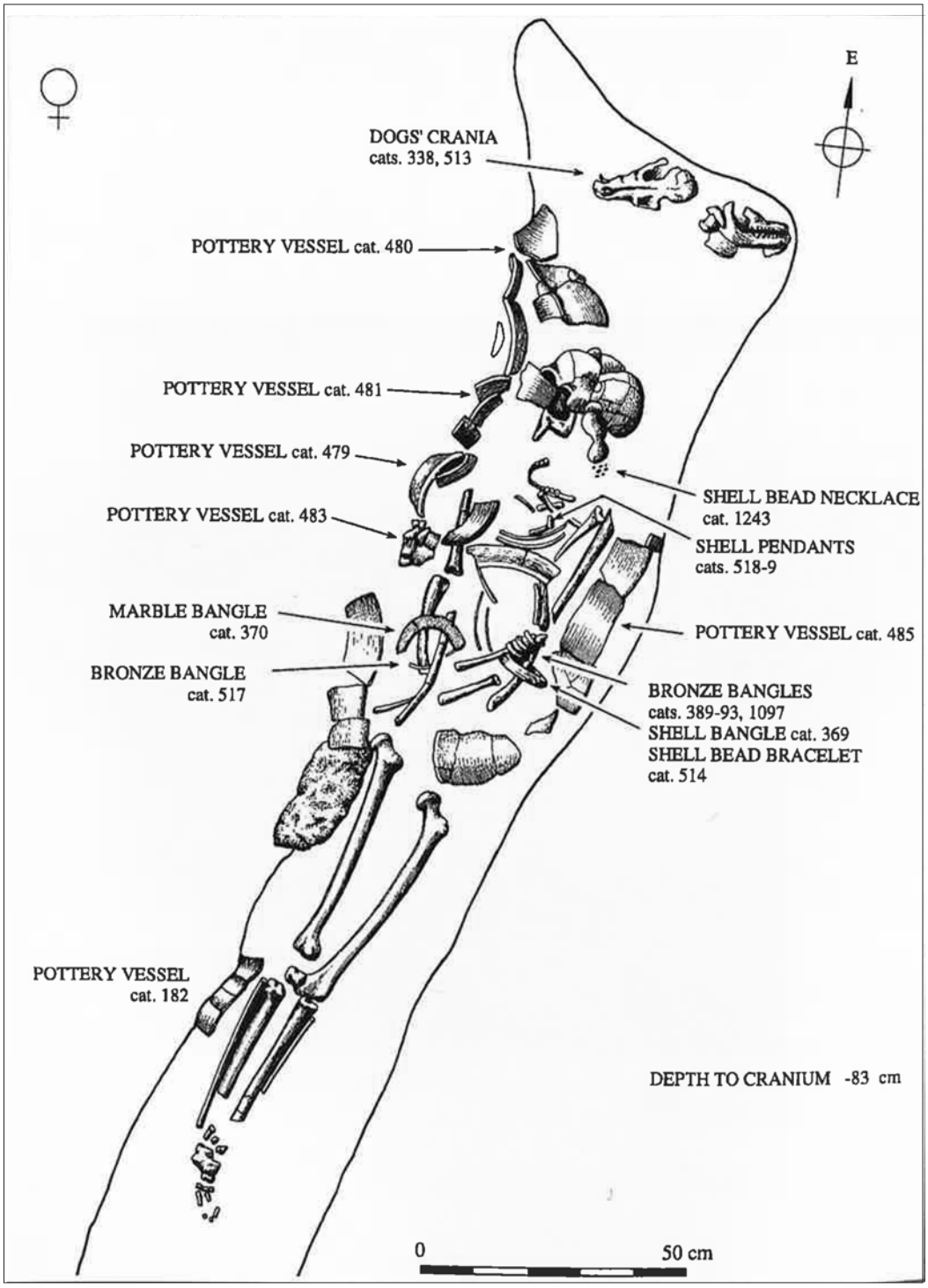


FIG. 136. Burial 35

FIG. 137. Burial 36, in the foreground, looking south. Beyond, burials 67, 39, 60 and 35

Burial 36 *(above and overleaf)*. Q5-6, old female, -1.02 m, 95°. A complete skeleton which disturbed burial 67 and is therefore later. Since B 67 overlies part of the grave for B 39, this burial is later than both. Grave goods included seven pottery vessels, two beyond the head (cats. 593-4), three by the left arm and shoulder (cats. 434, 437 and 453) and two beyond the feet (cats. 210-1). There were also three pieces of red ochre, beyond the head, by the right shoulder and the right elbow (cats. 595, 435-6). Jewellery included two form 1 marble and a form 4 shell bangle on the right wrist (cats. 379-381) and two further form 1 marble bangles on the left wrist (cats. 382-3). A possible belt of 550 shell disc and 63 barrel beads was present (cat. 438).

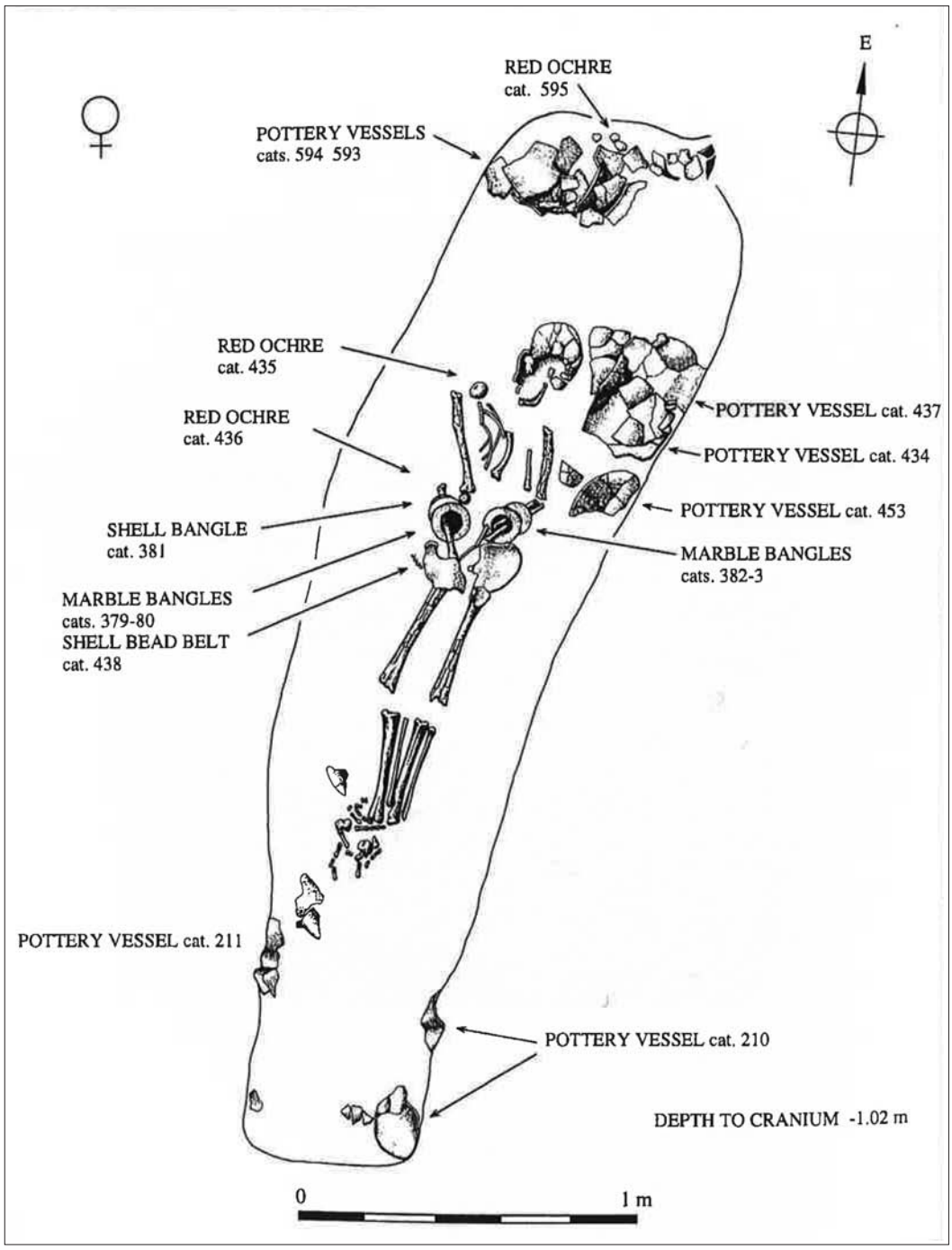


FIG. 138. Burial 36

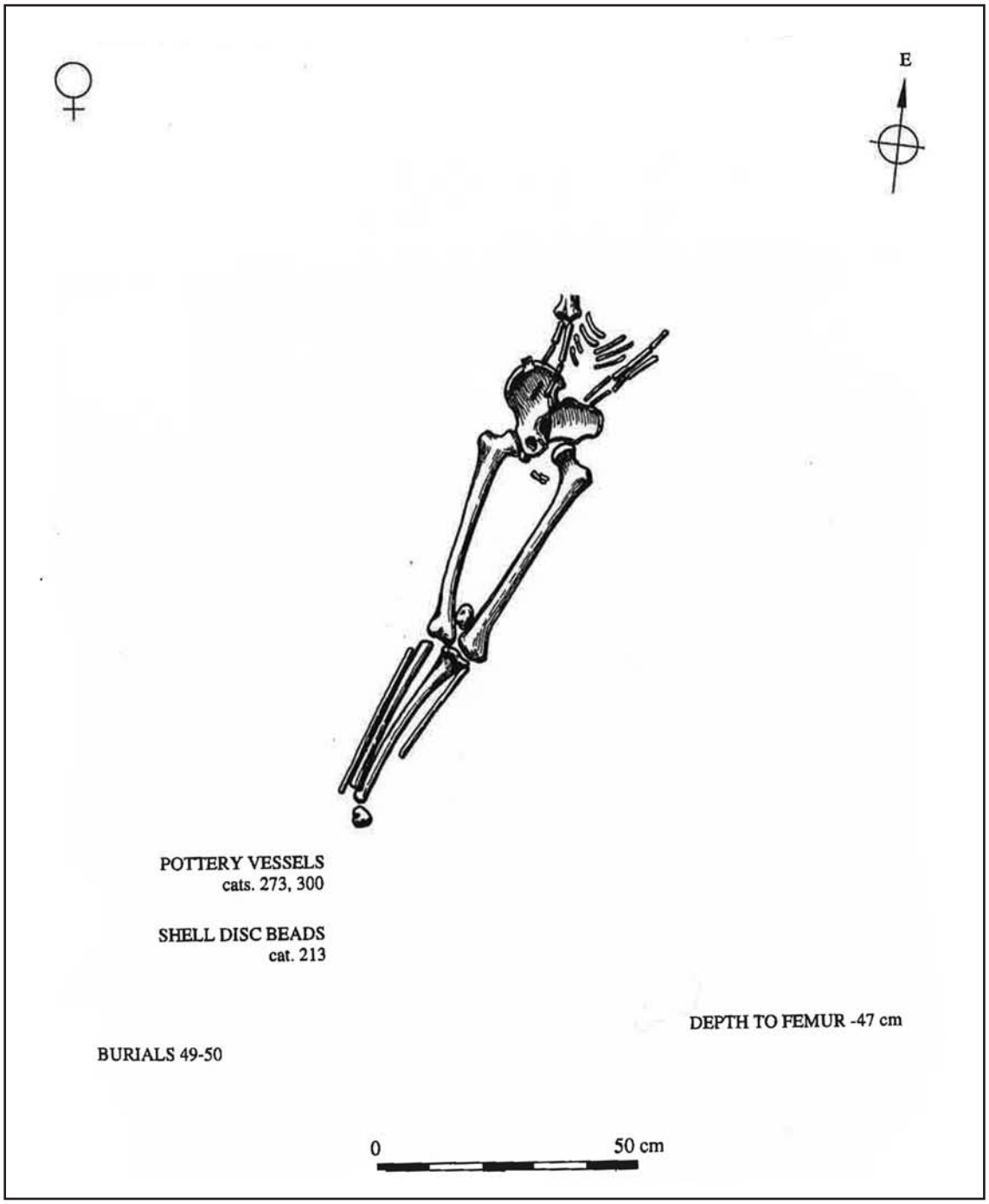


FIG. 139. Burial 37. L21, middle aged female, -47 cm, 100°. The lower half of the body was present and four shell disc bead was found in association (cat. 213). Two infant burials in jars lie at the feet (burials 49 & 50). A pottery vessel (cat. 273) was found next to burial 49, and probably belongs to burial 37, and part of a second vessel (cat. 300) falls into the same category.

FIG. 140. Burial 39, looking east

Burial 39 *(above and opposite)*. P5-6, young female, -1.03 m, 90°. This burial was associated with eight pottery vessels located beyond and beside the head (cats. 441, 597-8, 600-1, 603, 605) and beside the right arm and knee (cat. 439). There were three form 1 bangles on the left wrist, two of bronze and one of marble (cats. 384-6) and two further form 1 marble specimens on the right wrist (cats. 387-8). A row of 143 shell disc beads in the form of a belt were found in the hip area (cat. 443), and a shark vertebra lay under the pelvis, though this might have been fortuitous and disturbed from the midden when the grave was dug. Two shell disc and two barrel beads were found in the neck area (cat. 626), and a dog's cranium lay under the pottery vessels beyond the head (cat. 609). During laboratory cleaning, the distal epiphysis of a very young pig's metapodial and the associated first phalanx were recovered (cat. 1117).
Burial 67*(opposite)*. Q5, adult, -85 cm, 90°. Only the tibiae and fibulae are present, the grave having been cut into and disturbed by B 36.

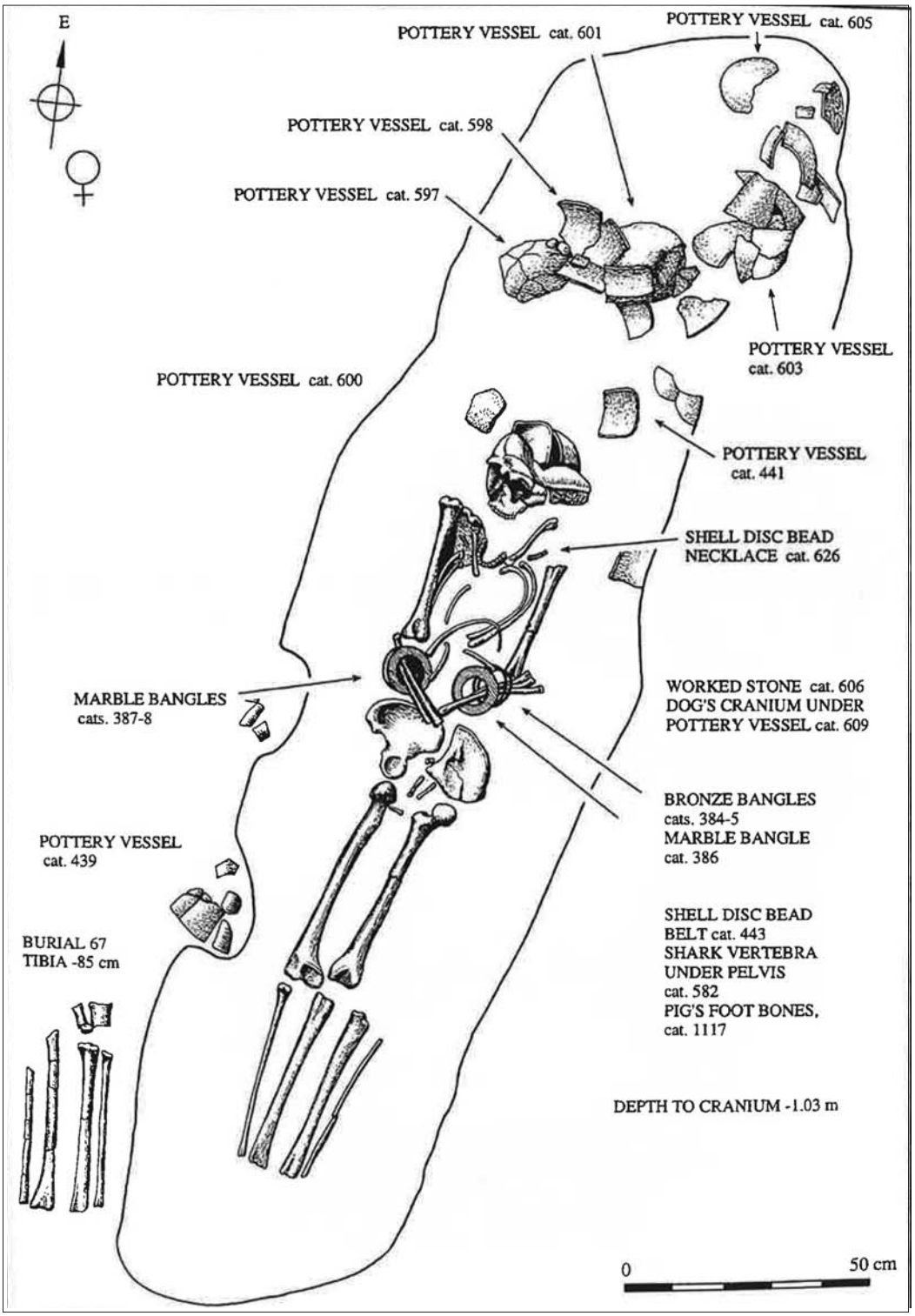


FIG. 141. Burials 39 and 67

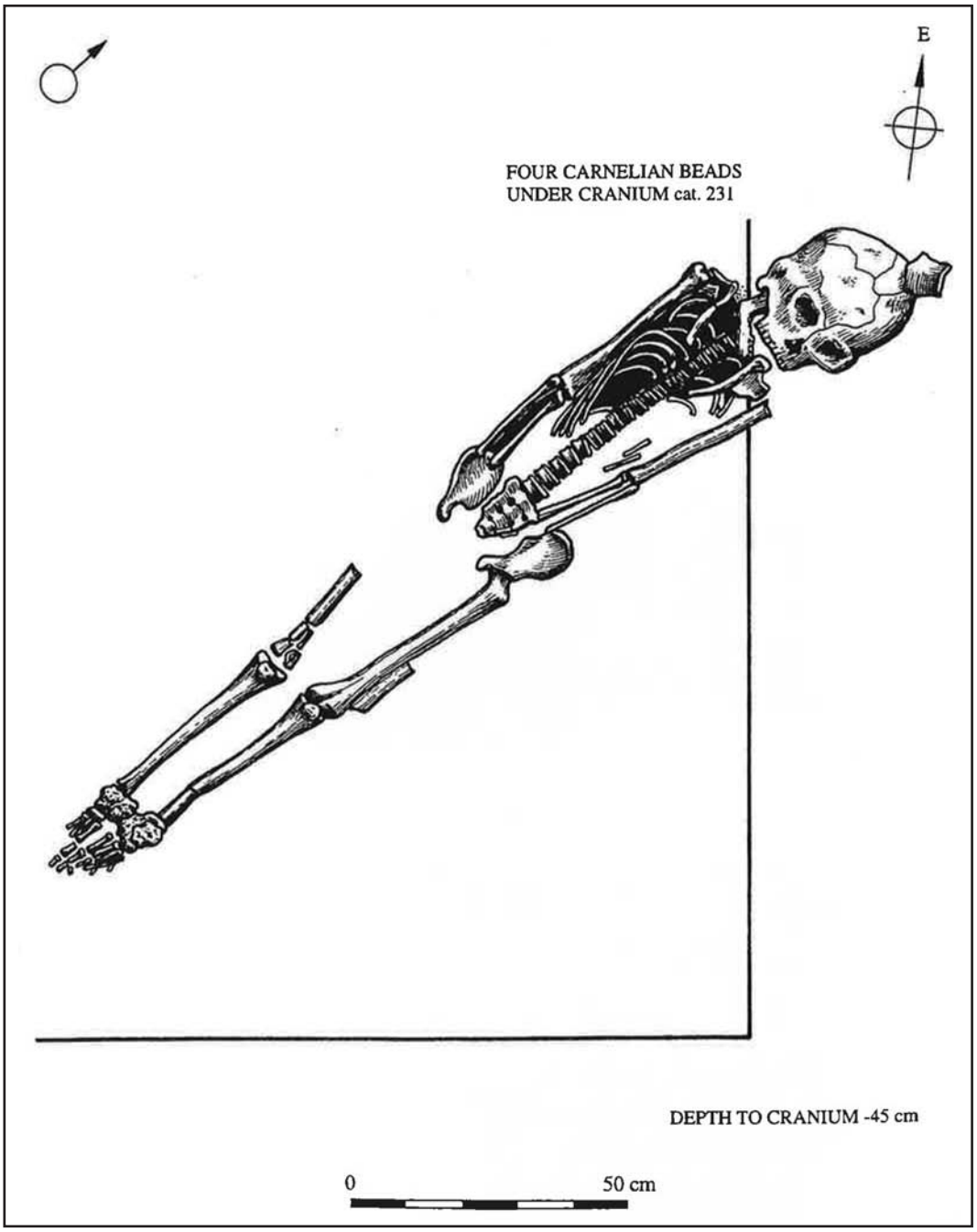


FIG. 142. Burial 40. I19-20, middle aged male, -45 cm, 125°. Four carnelian beads were found under the cranium, one of form 2 and three of form 3 (cat. 231). The head lay just beyond the excavated area and a small extension was made to uncover it. It is possible that further grave goods lie in the unexcavated area beyond.

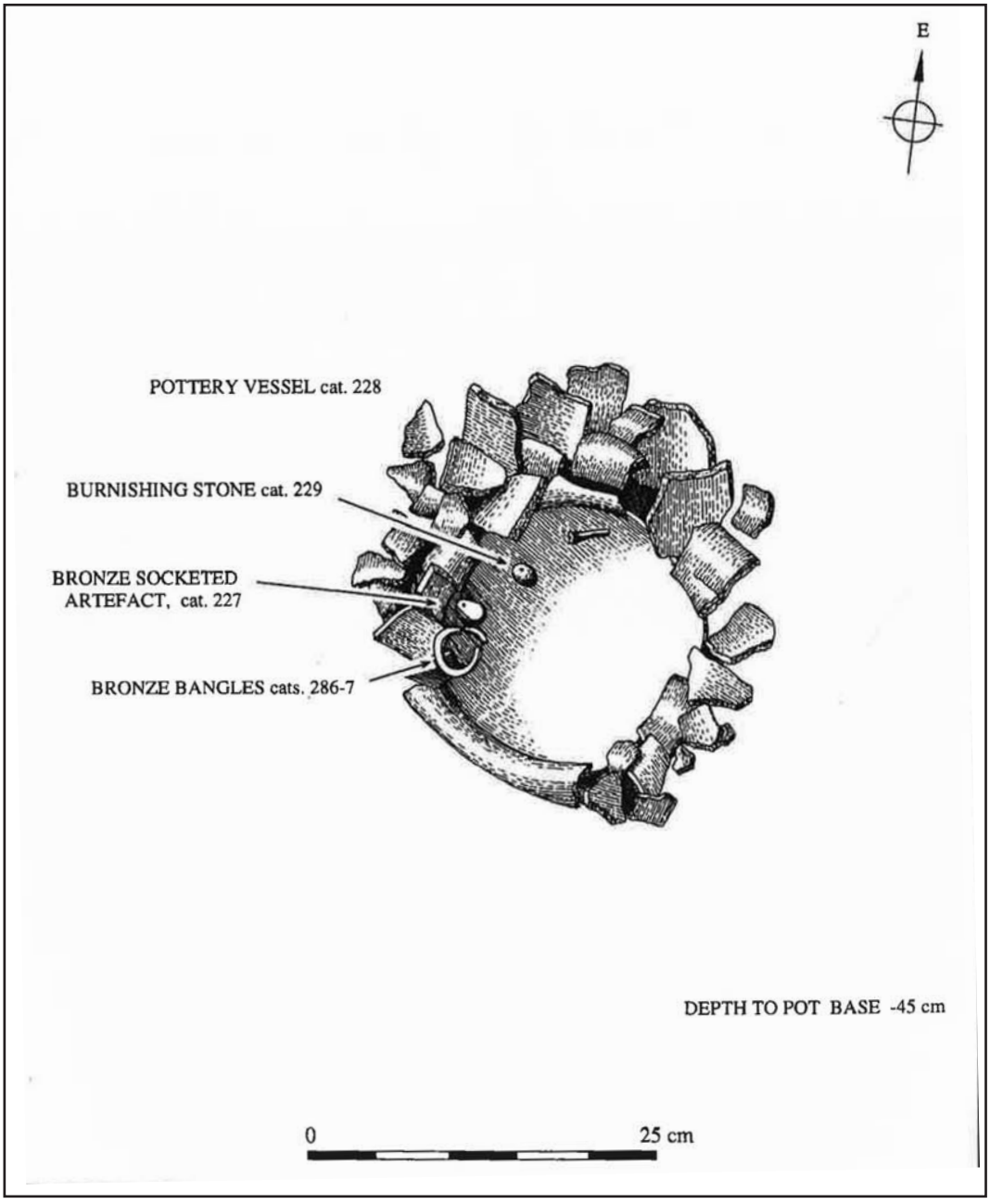


FIG. 143. Burial 43. K20, 9 month old infant, -54 cm. This is an infant jar burial (cat. 228) at the feet of B8. It contained a burnishing stone (cat. 229), two form 1 bronze bangles (cats. 286-7) and a bronze socketed implement (cat. 227).

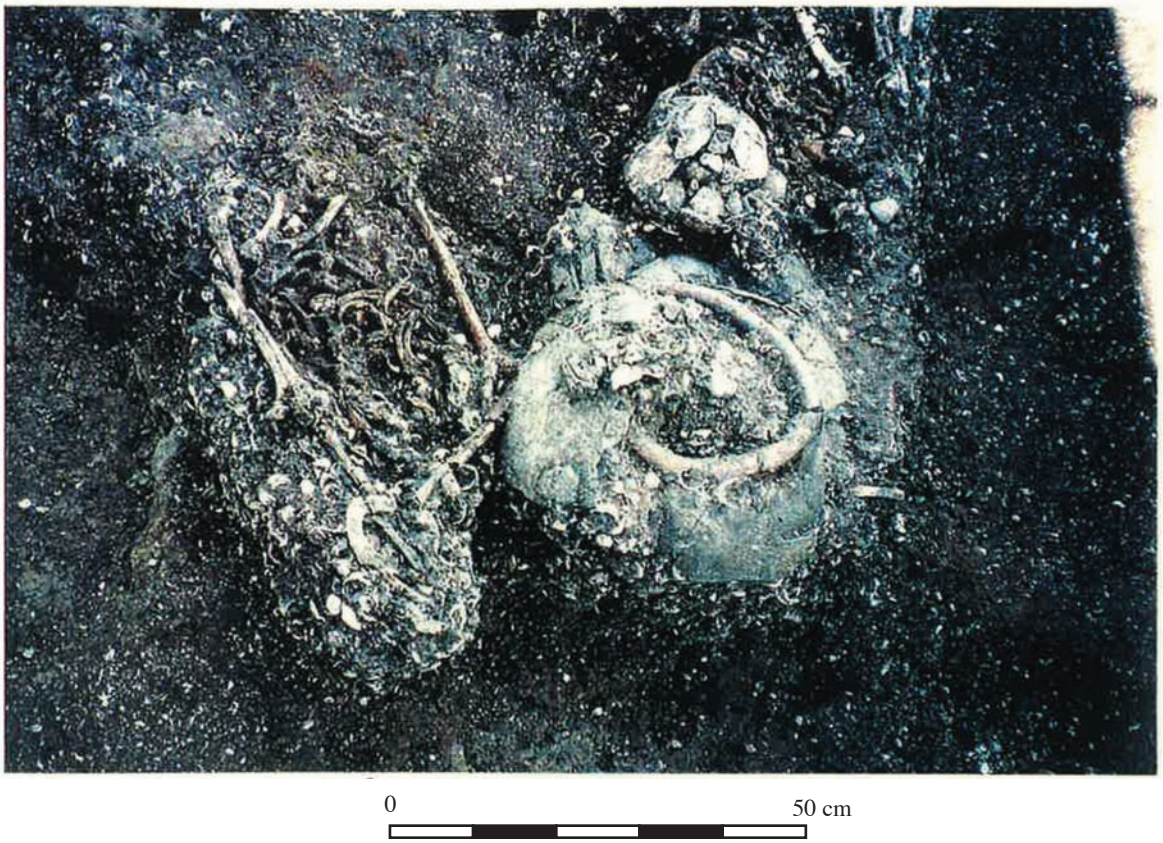


FIG. 144. Burial 44, looking west. The pottery vessels associated with burial 45 are seen to the right of the picture.

FIG. 145 *(opposite)*. Burial 44. L19, old female, -54 cm. *c*. 230-40°. This burial has one leg (femur, tibia) articulated, and other long bones were bundled beside the leg but clearly repositioned with deliberation. This is probably evidence that the grave was disturbed by the subsequent burial of B 45. Removal of the upper leg revealed the upper body in position. Sherds which might belong to three pottery vessels were found in the head area (cats. 241-3) near a dog's skull (cat. 240). A serpentine form 1 earring was recovered during the cleaning of the bones in the laboratory (cat. 1078), and other jewellery included a serpentine form 2 bead under the cranium (cat. 245), 15 shell disc beads beside the leg (cat. 244), a shell bangle on the right wrist (cat. 271), 149 shell disc beads by the arm and round the neck (cat. 253), a cylindrical shell artefact beside the skull (cat. 239), 40 shell disc and five barrel beads in the general area (cat. 255), 424 shell disc beads in the area of the neck (cat. 424), four disc beads in the leg area (cat. 1184), 472 shell disc beads, probably representing a belt, in the pelvis area (cat. 1182), 28 disc beads from the rib-pelvic region (cat. 1183) and five shell disc beads which could belong to this burial or to burial 45. The pottery vessel (cat. 257) was found in the general area of this grave, and could belong to this burial, or equally to either burial 42 or 45.

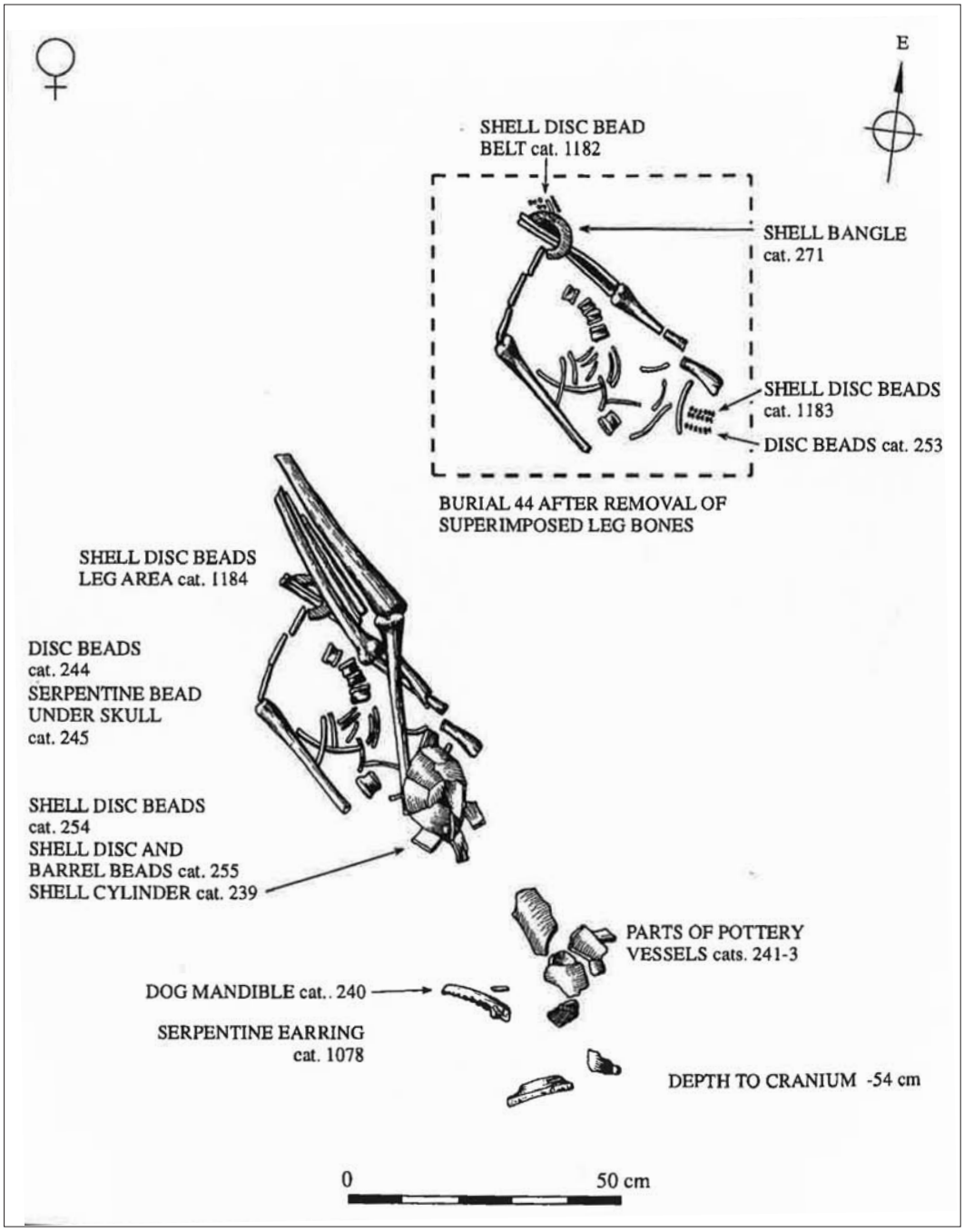


FIG. 145. Burial 44

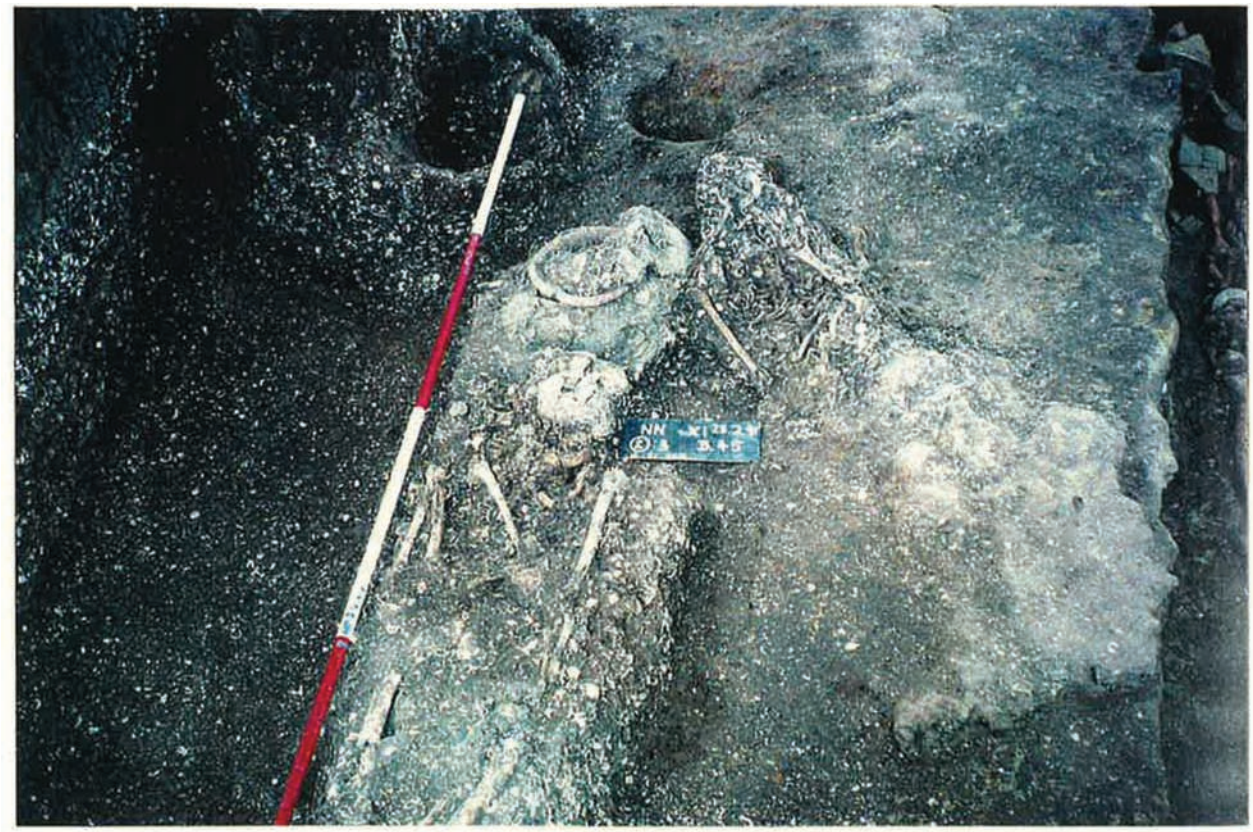


FIG. 146. Burials 45, 167, 44 and 47, looking east. The large jar beyond the cranium of burial 45 is a jar burial, 167

FIG. 147 *(opposite)*. Burial 45. M19, old male, -65 cm, 92°. This burial cuts and is later than B 44. A large infant jar burial, burial 167 (cat. 269) lies beyond the head. A burnishing stone lay beside the right shoulder, and nine shell disc beads were present by the left ear (cats. 270, 290). During laboratory cleaning, two tin earrings were found in the area of the mouth (cats. 1108-9).

Burial 82. M18, adult male, -67 cm. Only the skull fragments and a few limb bones were present.

Burial 167, M19, infant, -65 cm. An infant jar burial at the head of burial 45 (cat. 269).

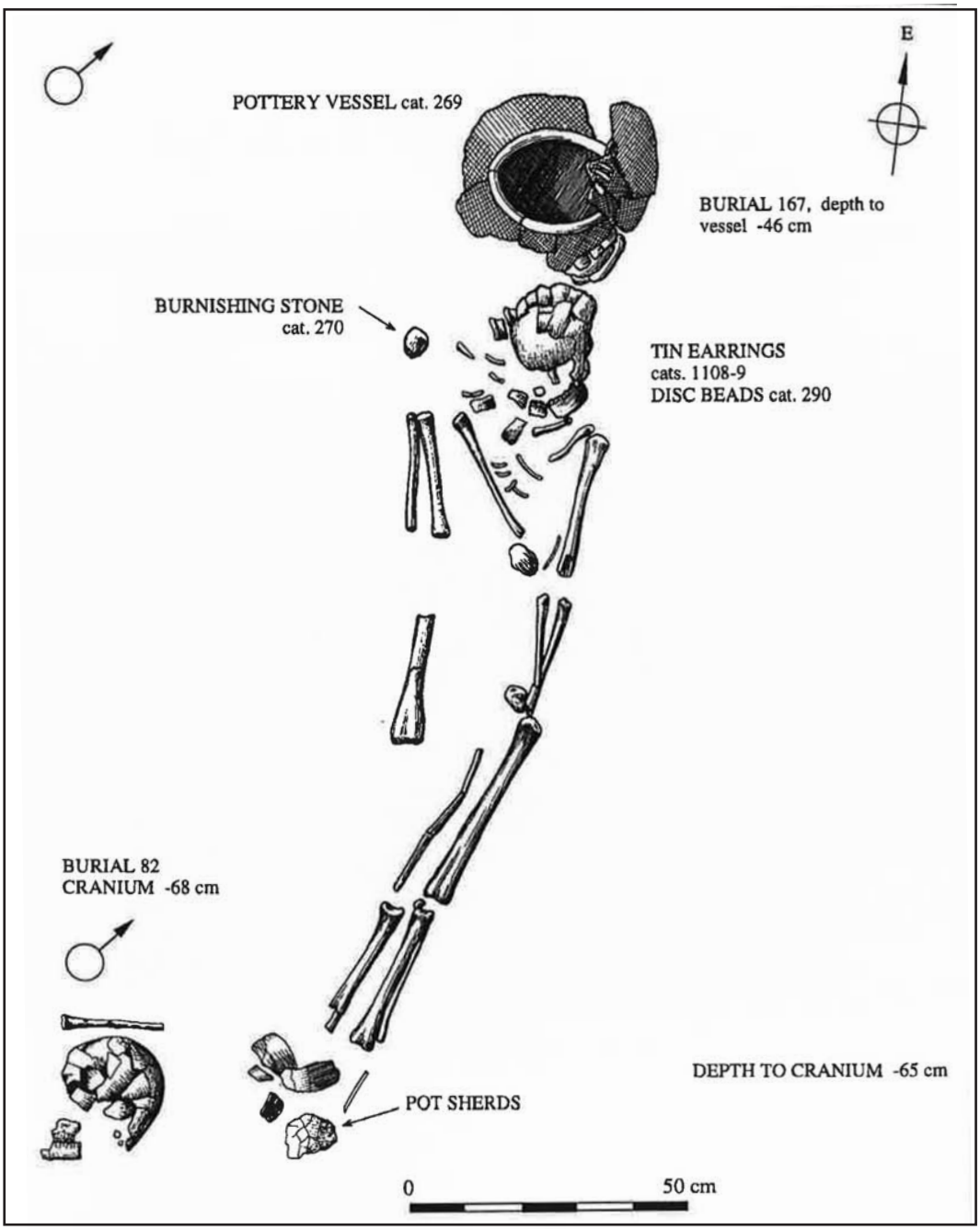


FIG. 147. Burials 45, 82 and 167

FIG. 148. Burial 47, looking east

Burial 47 *(above and opposite)*. L19-20, middle aged male, -69 cm, 90°. The grave cut was recognized in the field at -57 cm, but later re-examination of the section of the grave at L-K18 clearly showed a higher cut, which severed the shell midden. Burial 47 underlay burials 8, 9, 25, 28 and 43. Six pottery vessels had been placed round the cranium (cats. 264-7, 272, 275), and a further pot (cat. 282) was found beside the left thigh, in the vicinity of a burnishing stone (cat. 248). A dog's skull was present also beyond the head (cat. 278). The man wore a marble bangle on the right wrist (cat. 262), a shell ornament at the neck (cat. 263) and 449 shell disc beads were found over the chest and in the neck area (cat. 261).

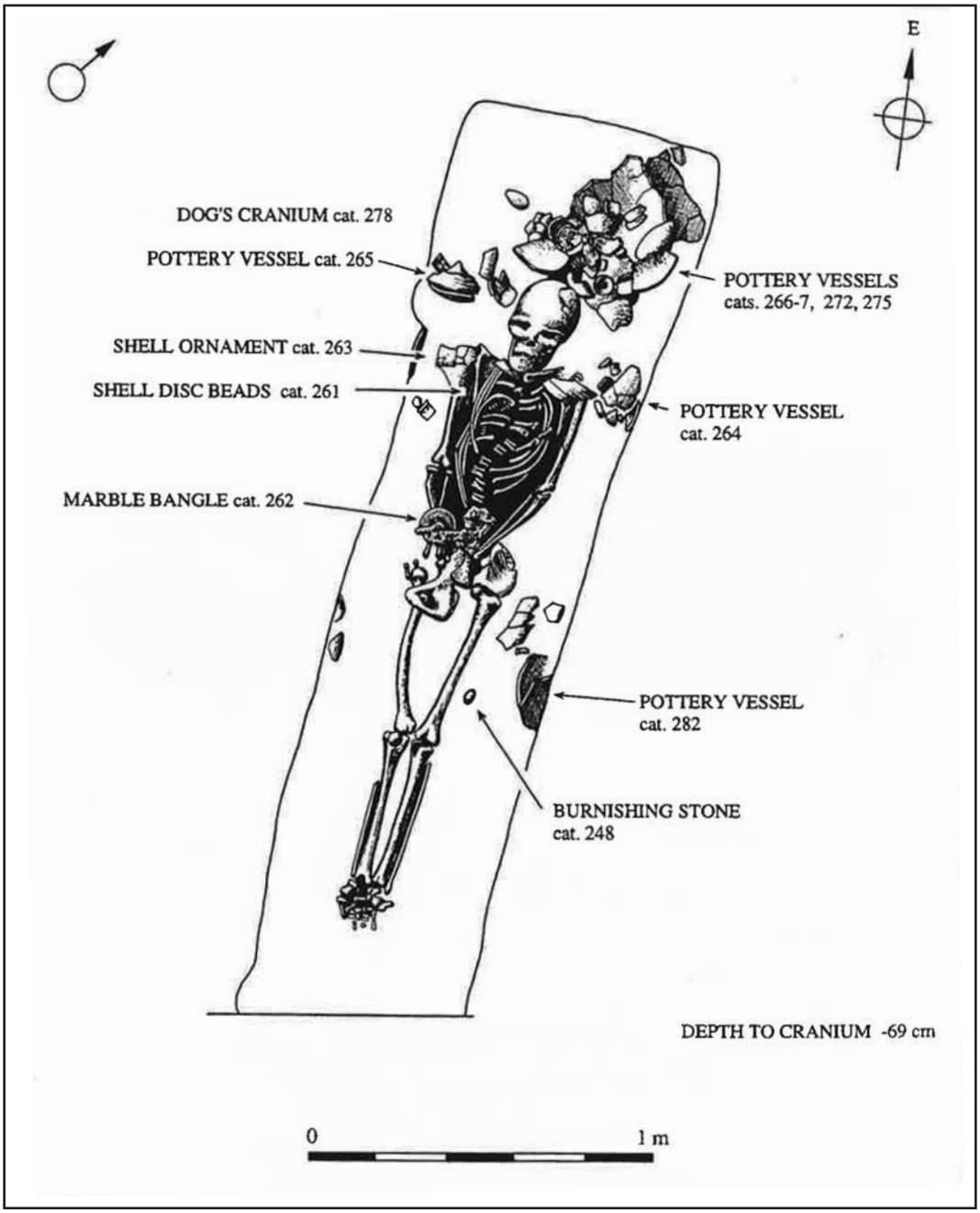


FIG. 149. Burial 47

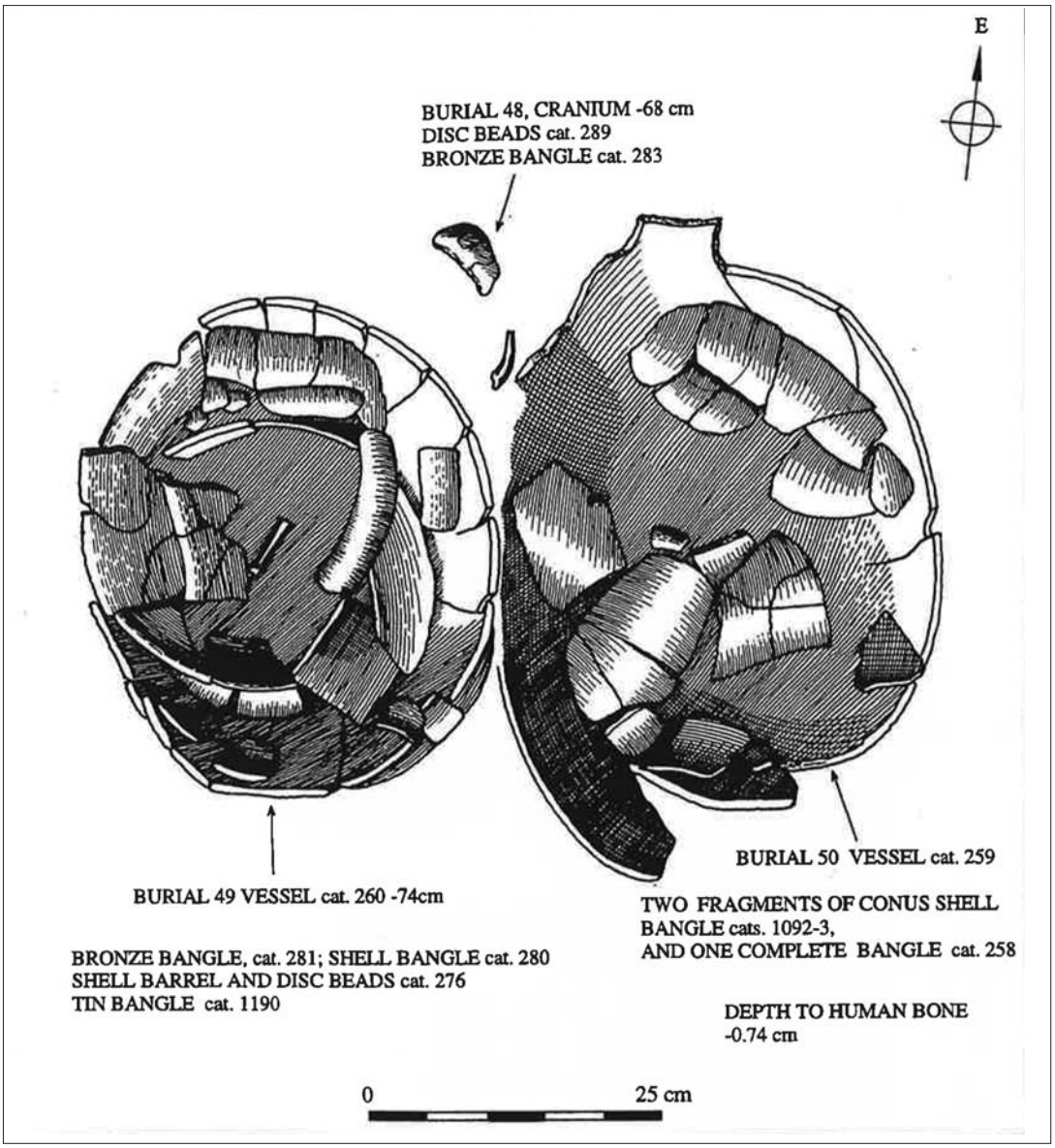


FIG. 150. Burials 48, 49 and 50

Burial 48. L20, adult, -70 cm. The remains of a cranium were found next to the infant jar burials 49-50. Thirty shell disc beads and a form 4 bronze bangle were found in the vicinity (cats. 289, 283).

Burial 49. M20. -74 cm. This infant jar burial (cat. 260) lay alongside a second, B 50, at the feet of B 37. Apart from a few pieces of human bone, it contained a form 5 bronze bangle, a form 7 shell bangle and 10 shell disc and two barrel beads, respectively (cats. 281, 280 and 276). Part of a tin bangle also survived (cat. 1190).

Burial 50. L20, -74 cm. This second infant burial (cat. 259) at the feet of B 37 contained two form 6 conus shell bangles (cats. 1092-3.

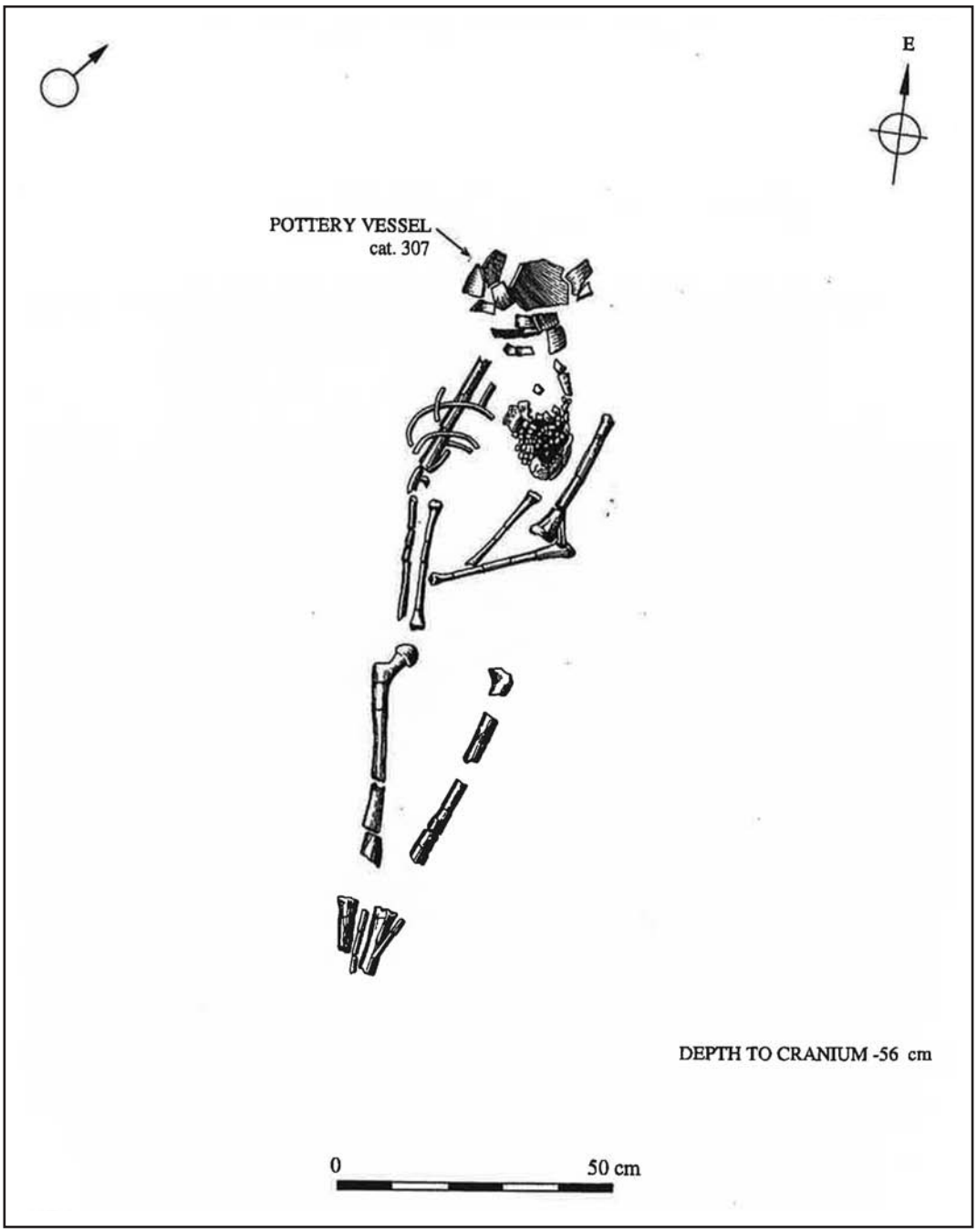


FIG. 151. Burial 51. N17-18, young male, -56 cm 95°. This burial overlies and is therefore later than B 107. A pottery vessel (cat. 307) was found in the head area.

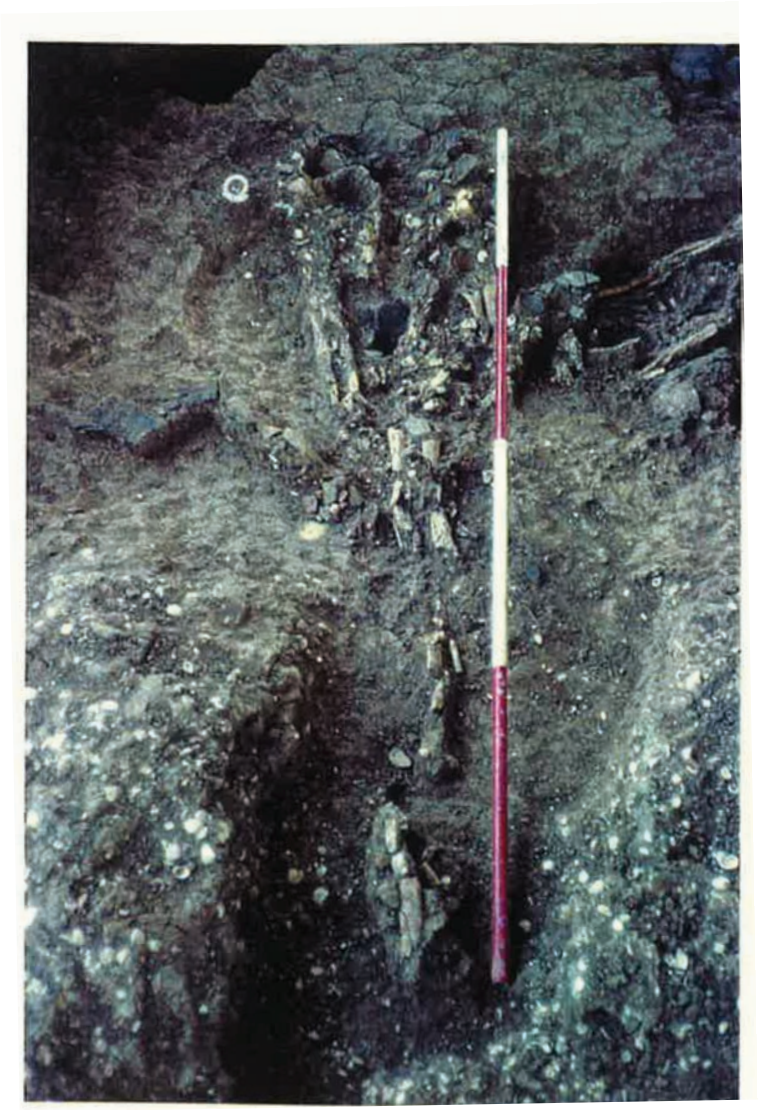


FIG. 152. Burials 52 and 56, looking west

Burial 52 *(above and opposite)*. P-O14, middle aged female, -78 cm, 55°. This burial lies at an unusual angle, and probably cuts into the grave of burial 56. Grave goods comprise three pottery vessels, all in the vicinity of the cranium (cats. 351-2, 358) although there may have been more grave goods, for the lower part of the body is missing.

Burial 56. P14-15, middle age male, -78 cm, 280°. This burial was disturbed by B 52. The skull is present but damaged, the left arms, both femora and the tibiae are *in situ* and other limb bones are present but disturbed. One pottery vessel lies to the left of the left wrist (cat. 359) and another is found beyond the skull (cat. 355). A serpentine bangle (cat. 1090), a second serpentine bangle of form 2, and a serpentine bangle fragment (cats. 356-7) together with a form 6 trochus shell bangle were found in the skull area (cats. 1090, 357 and 354). A shell disc bead and a form 1 bronze bangle (cats. 404, 360), lay to the left of the skull.

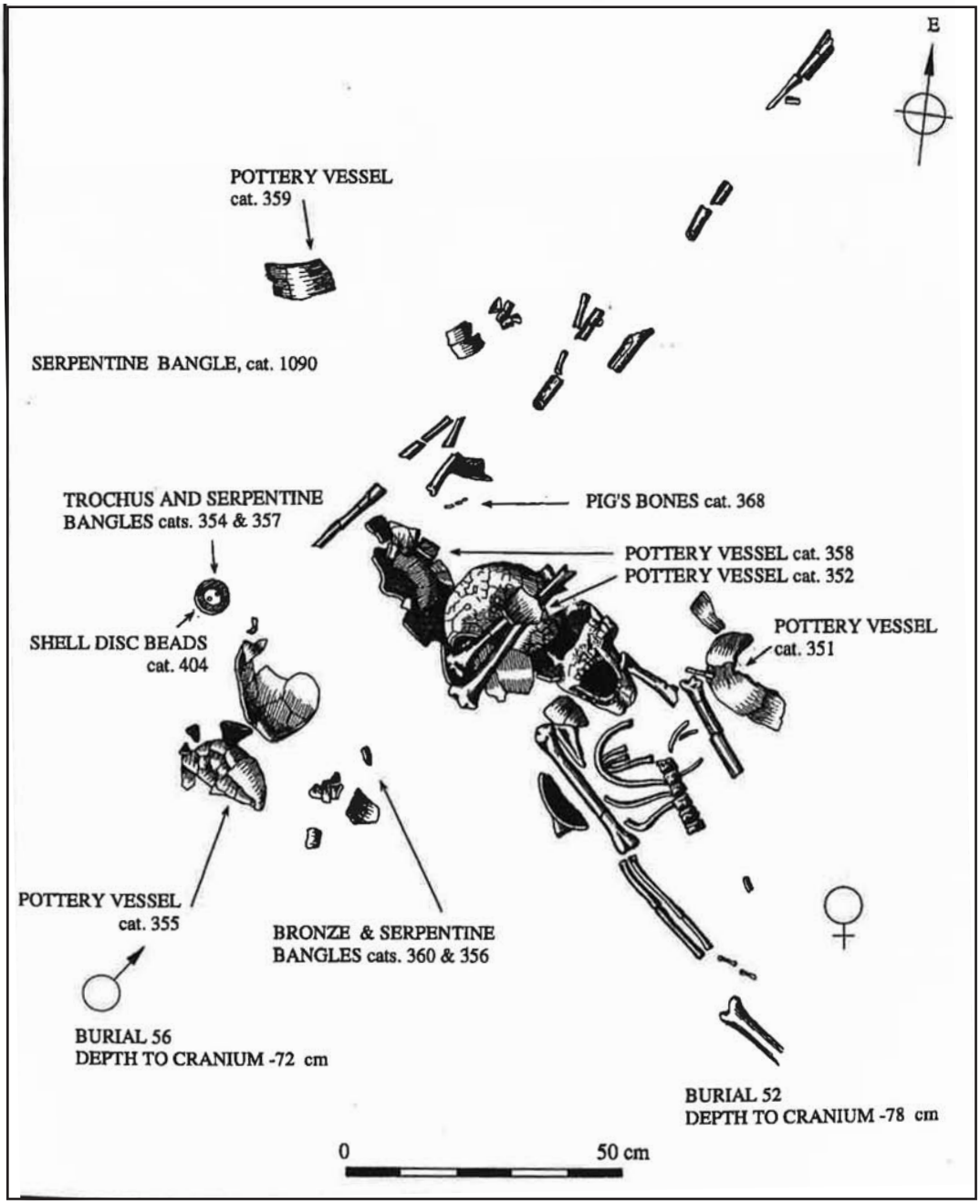


FIG. 153. Burials 52 and 56

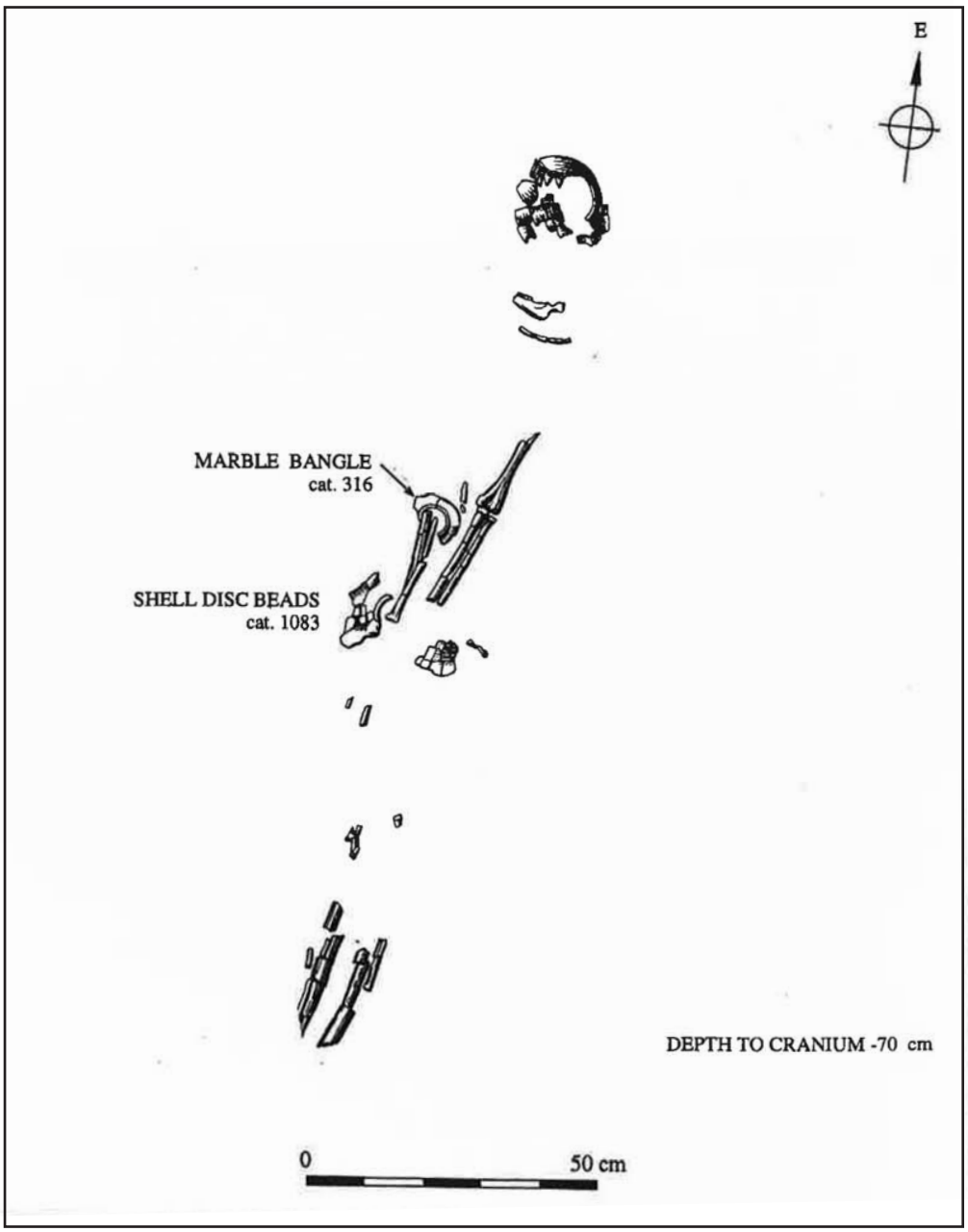


FIG. 154. Burial 53. Q11, middle aged adult, -70 cm, 95°. The skeleton is incomplete, although the bones which survive are all in anatomical position. There is a form 2 marble bangle on the left wrist (cat. 316) and four shell disc beads in the general area (cat. 1083).

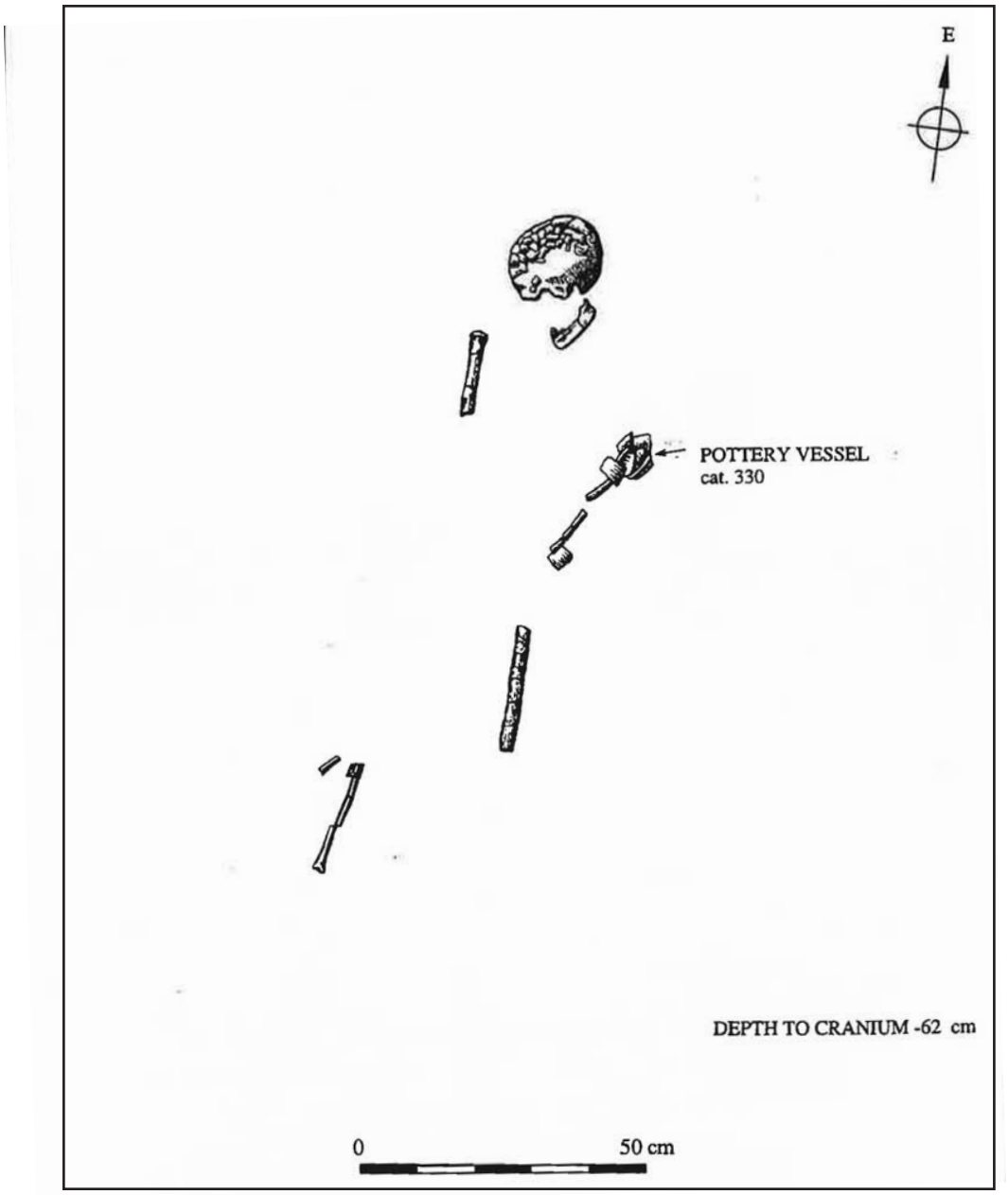


FIG. 155. Burial 54. Q8-9, middle aged adult, -62 cm, 90°. The burial comprises the very degraded remains of the skull, humeri, left forearms and femur. Parts of a probable pottery vessels are present by the left elbow (cat. 330).

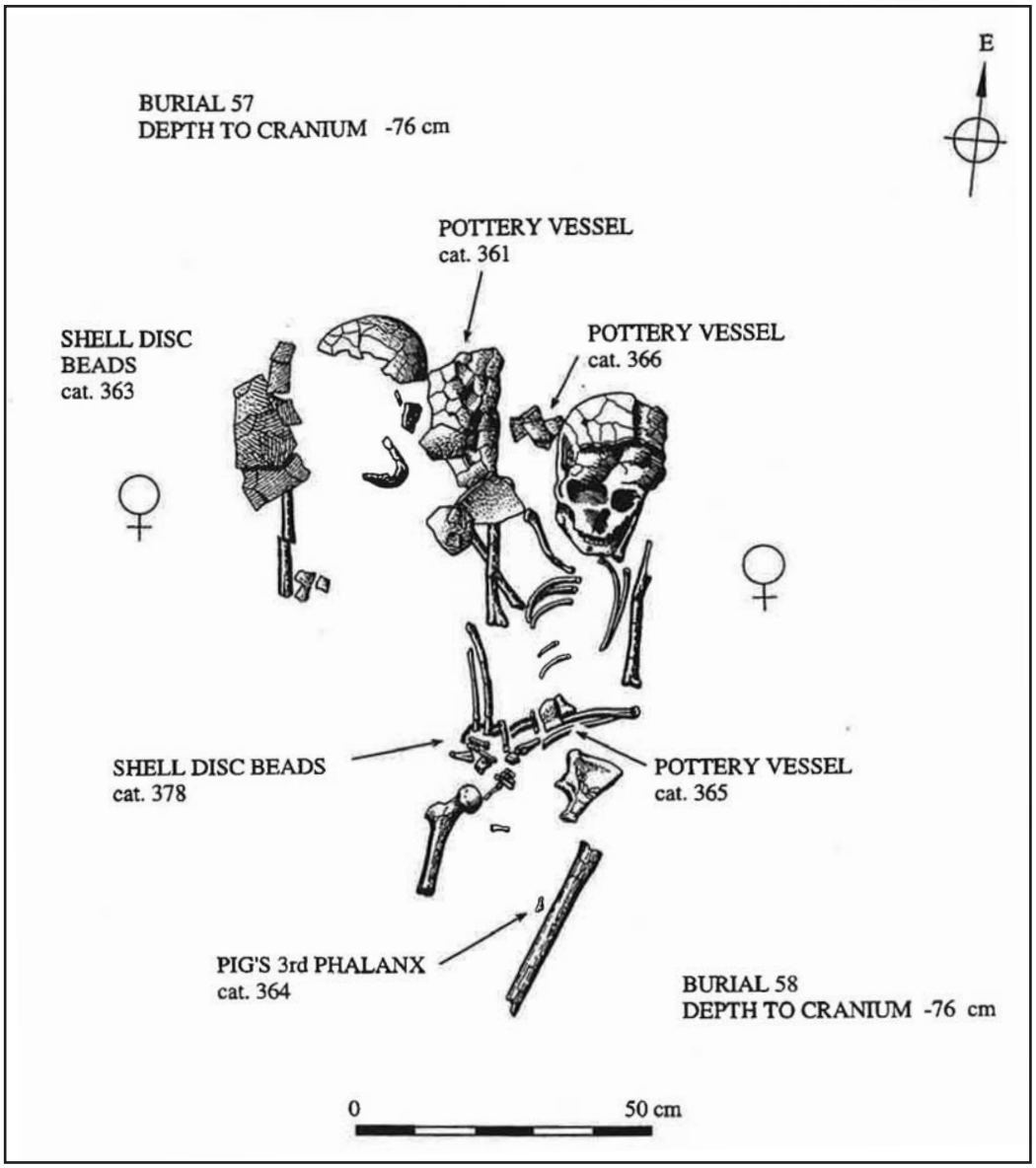


FIG. 156. Burial 57 and 58

Burial 57, P12, old female, -76 cm, 90°. This burial is represented by a calvarium, mandible and left humerus. It lies adjacent and later than B 58. There were some shell disc beads in the area of the body (cat. 363) and a mortuary vessel (cat. 361) at the left shoulder.

Burial 58, O12, young female, -76 cm, 90°. The human remains are intact from the cranium to the mid femur. Two pottery vessels were associated, one over the abdomen (cat. 365), the other to the right of the cranium (cat. 366). The 49 shell disc beads the pelvic area might represent a belt, and a pig's third phalanx lay beside the femur (cats. 378, 364).

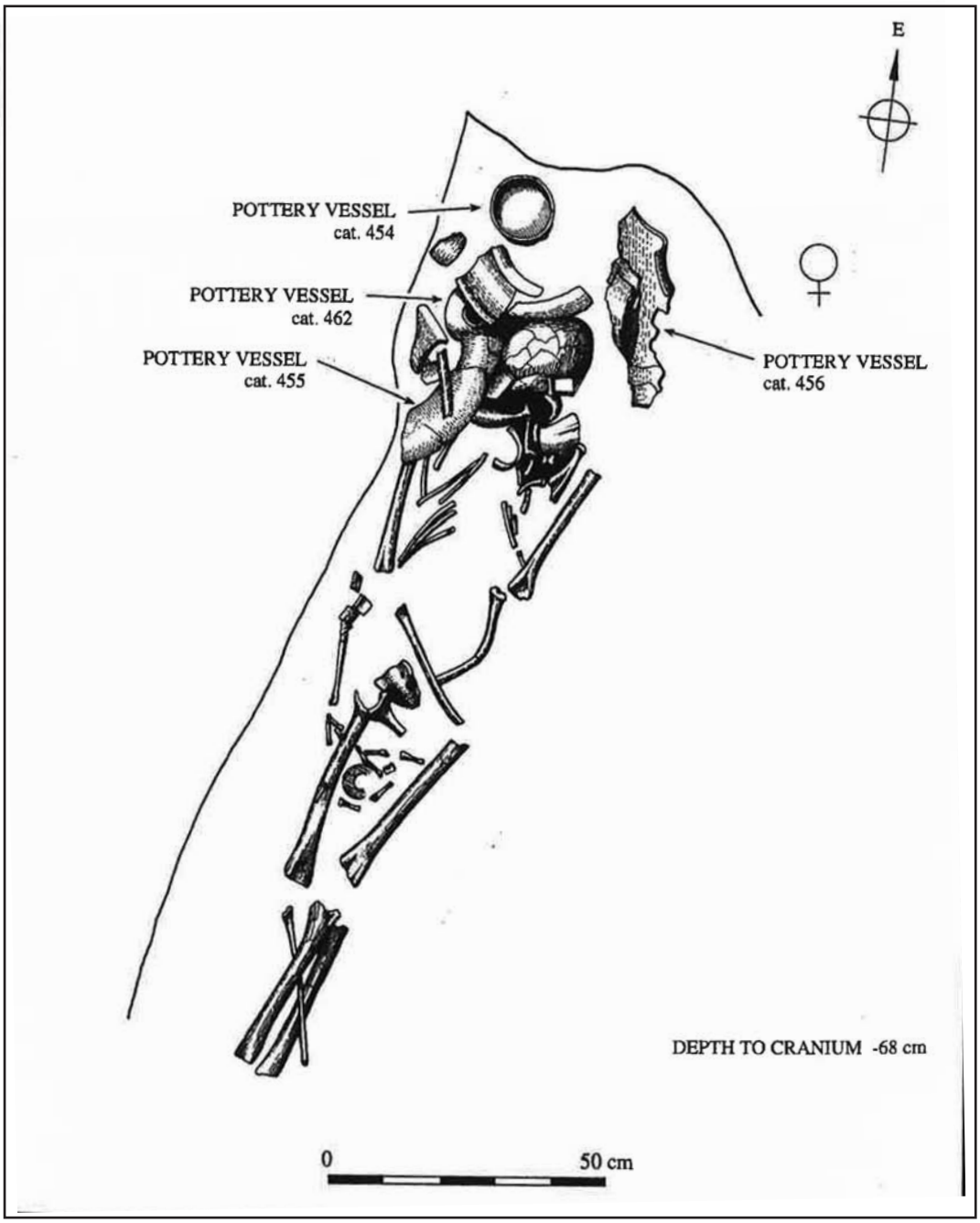


FIG. 157. Burial 60. P5-O6, middle aged female, -68 cm, 90°. The complete skeleton overlay part of B 39, and was in turn cut by part of B 35. Four pottery vessels lie round the cranium (cats. 454-6, 462).

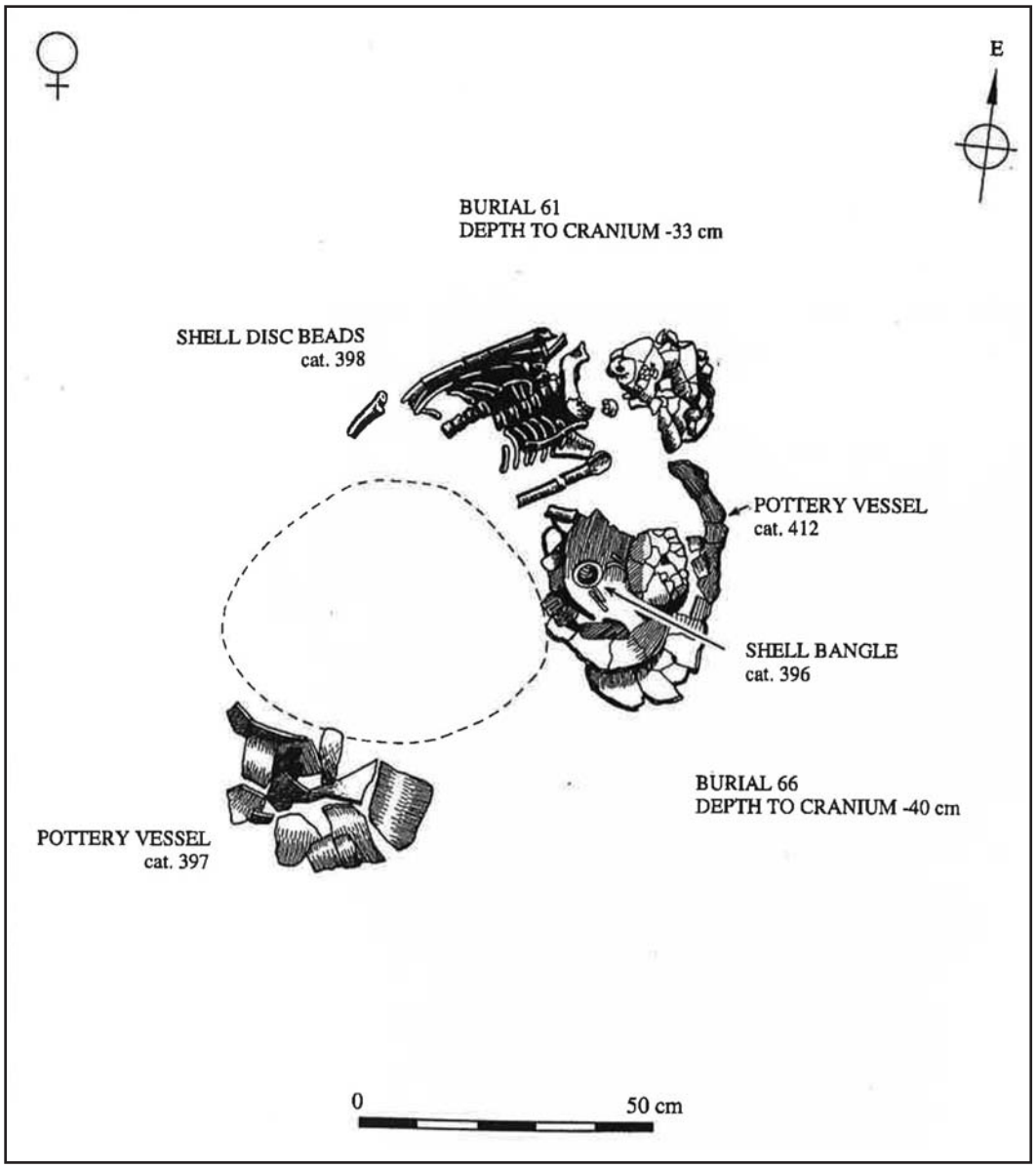


FIG. 158. Burials 61 and 66

Burial 61. N-M16, young female, -33 cm, 150°. The skeleton is present from the cranium to the mid chest area, the rest having been disturbed by looter's pit. Three shell disc beads were present in the general area (cat. 398) and a pot (cat. 397) was found left of the abdomen. Burial 66, an infant jar burial, lay at the left shoulder.

Burial 66. M16, infant, -40 cm. This crouched infant was found in a jar (cat. 412) at the left shoulder of B 61. A form 3 shell bangle (cat. 396) was present.

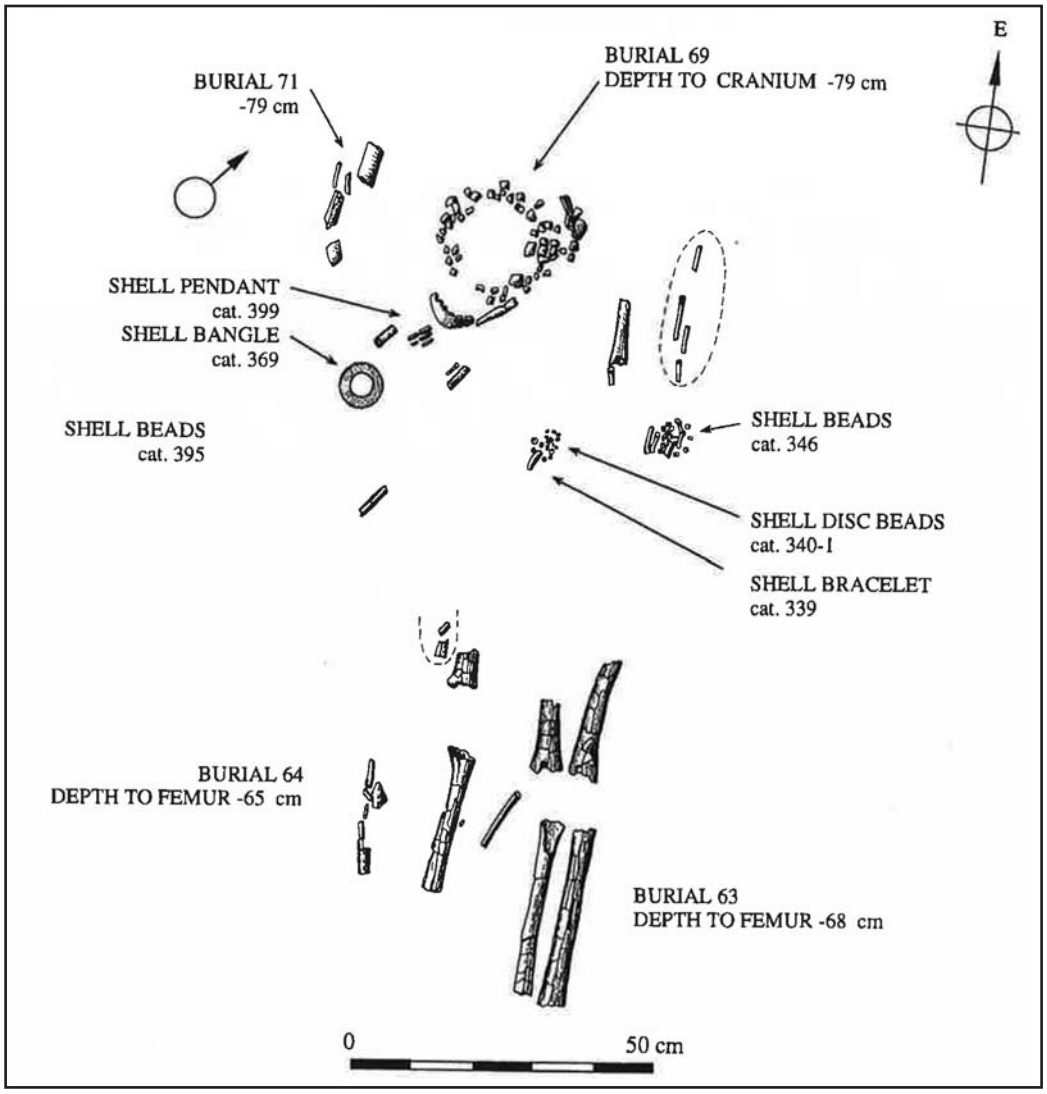


FIG. 159. Burials 63, 64, 69 and 71

Burial 63. P11, adult, -68 cm, 90°. A form 8 shell bangle and what might have been a shell bracelet, comprising at least 166 disc beads, were found in the area of the left hand (cats. 339, 340). A further 33 shell disc beads, probably in the form of a second bracelet, were present in the area of the right wrist (cat. 346). Burial 64. P11, adult, -65 cm, 90°. Only the distal left femur and both tibial shafts survive. The individual lay alongside B 63. Burial 69. Q11, male, 2 year old infant, -79 cm. The cranium, arm bone fragments and leg bones of a child adjacent to the femur of B 64. The grave goods incorporate a form 5 shell bangle in the vicinity of the right wrist, a shell pendant repaired with bronze round the neck and 10 shell disc beads in the abdomen area (cats. 394, 399 and 395). Burial 71. P12, adult, -68 cm, *c*. 90°. The right tibia and fibula shafts and some right hand bones alone survive.

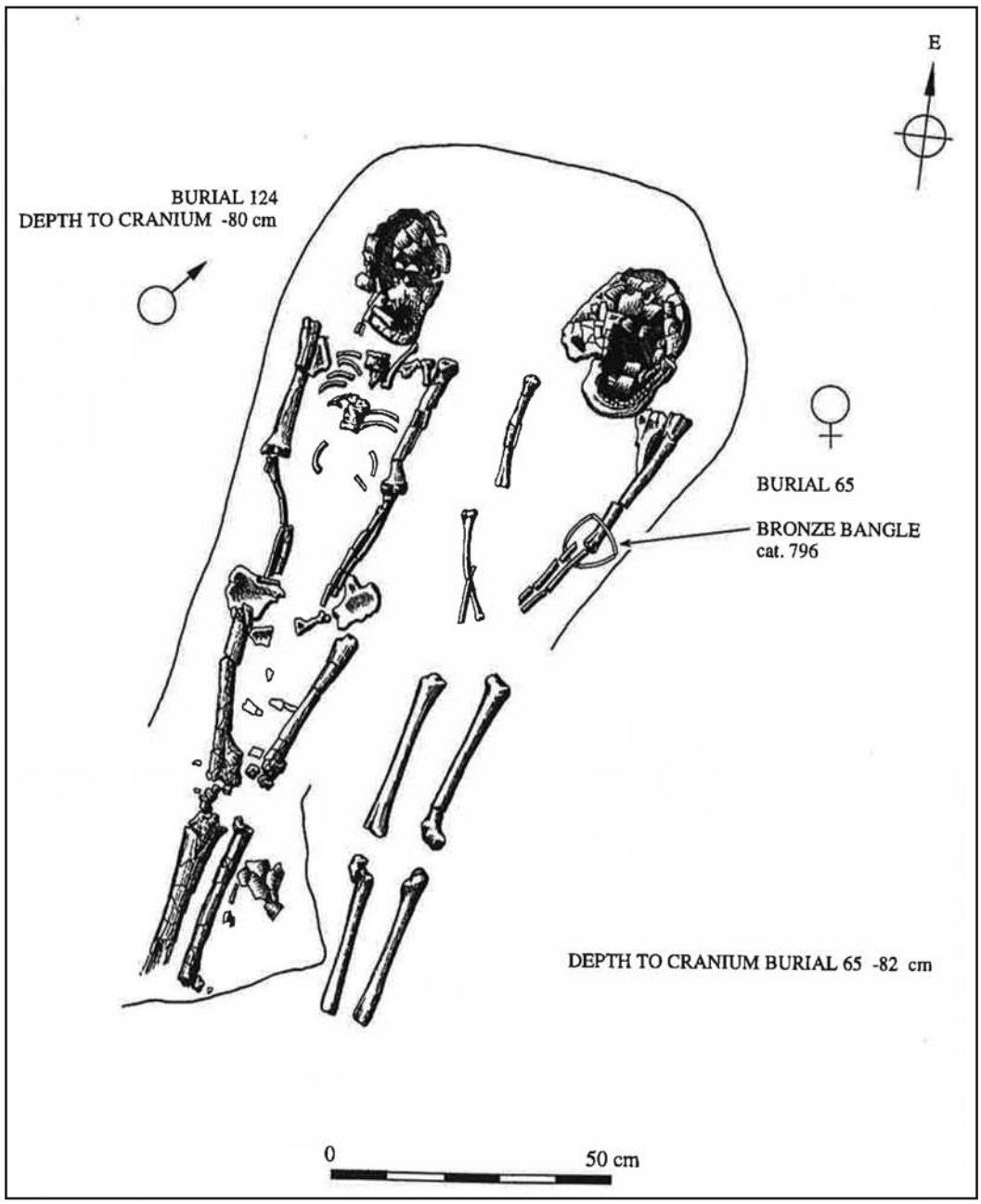


FIG. 160. Burials 65 and 124

Burial 65. Q18, old female, -82 cm, 95°. A complete interment, found alongside B 124. There was a form 1 bronze bangle on the left wrist (cat. 796).

Burial 124. Q18-19, old male, -80 cm, 110°. This complete interment lay alongside B 65. It overlies B109. No grave goods were encountered.

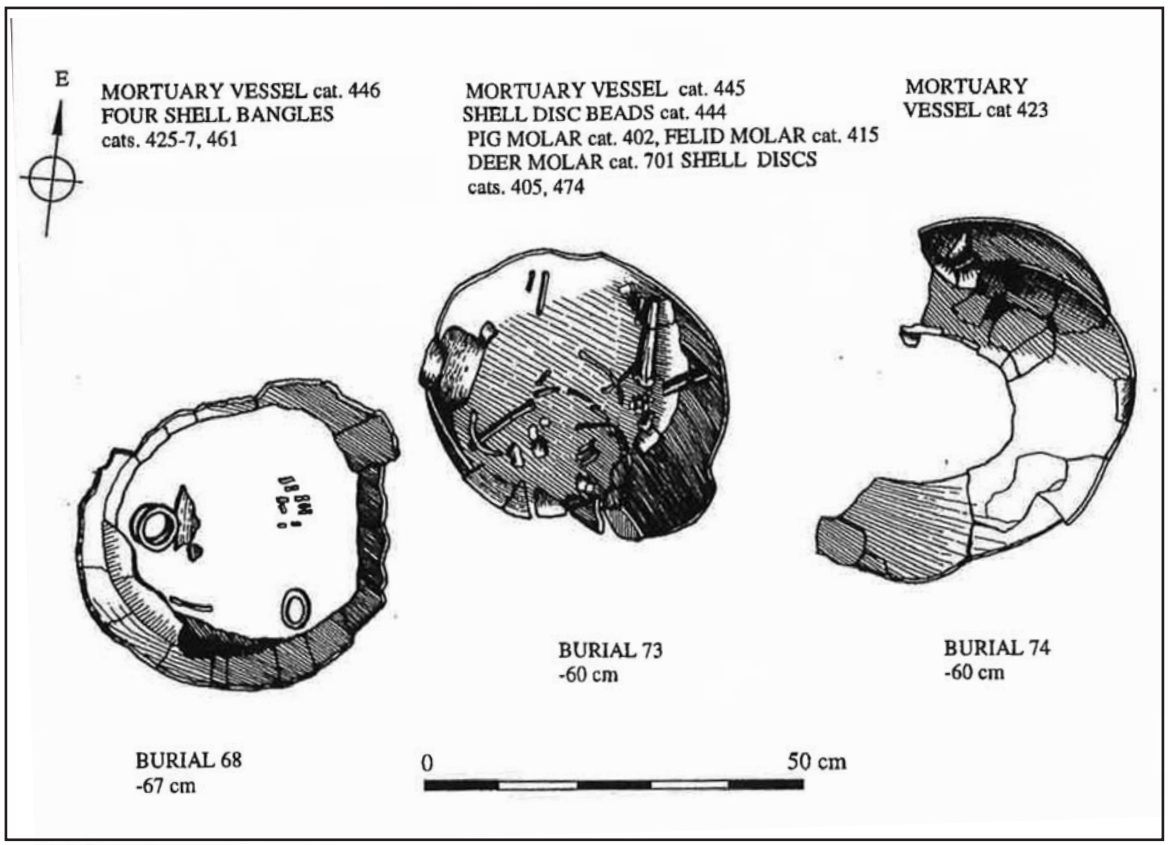


FIG. 161. Burials 68, 73 and 74

Burial 68. P8, 18-month-old infant, -67 cm. This infant jar burial (cat. 446) is one of a row of three located to the east of burials 36, 39, 60 and 35. It contained four form 2 shell bangles, (cats. 425-7 and 461.

Burial 73. P8, 18-30 month-old infant, -60 cm. This complete vessel (cat. 445) is the central infant burial in a row of three, disposed on a north-south axis. It contained three shell disc beads (cat. 444), a pig molar (cat. 402), a second molar of an unidentified small felid (cat. 415), the molar of a cervid (cat. 701) and a circular shell artefact in the form of a bracelet, but in very poor state of preservation (cat. 474). A further shell disc was also found (cat. 405).

Burial 74. P8, 0-3-month-old infant, -60 cm. This was a very fragmentary mortuary vessel for an infant (cat. 423). The cranium and mandible fragments of a dog were found in the area, but it is unlikely that they were associated with this burial in particular.

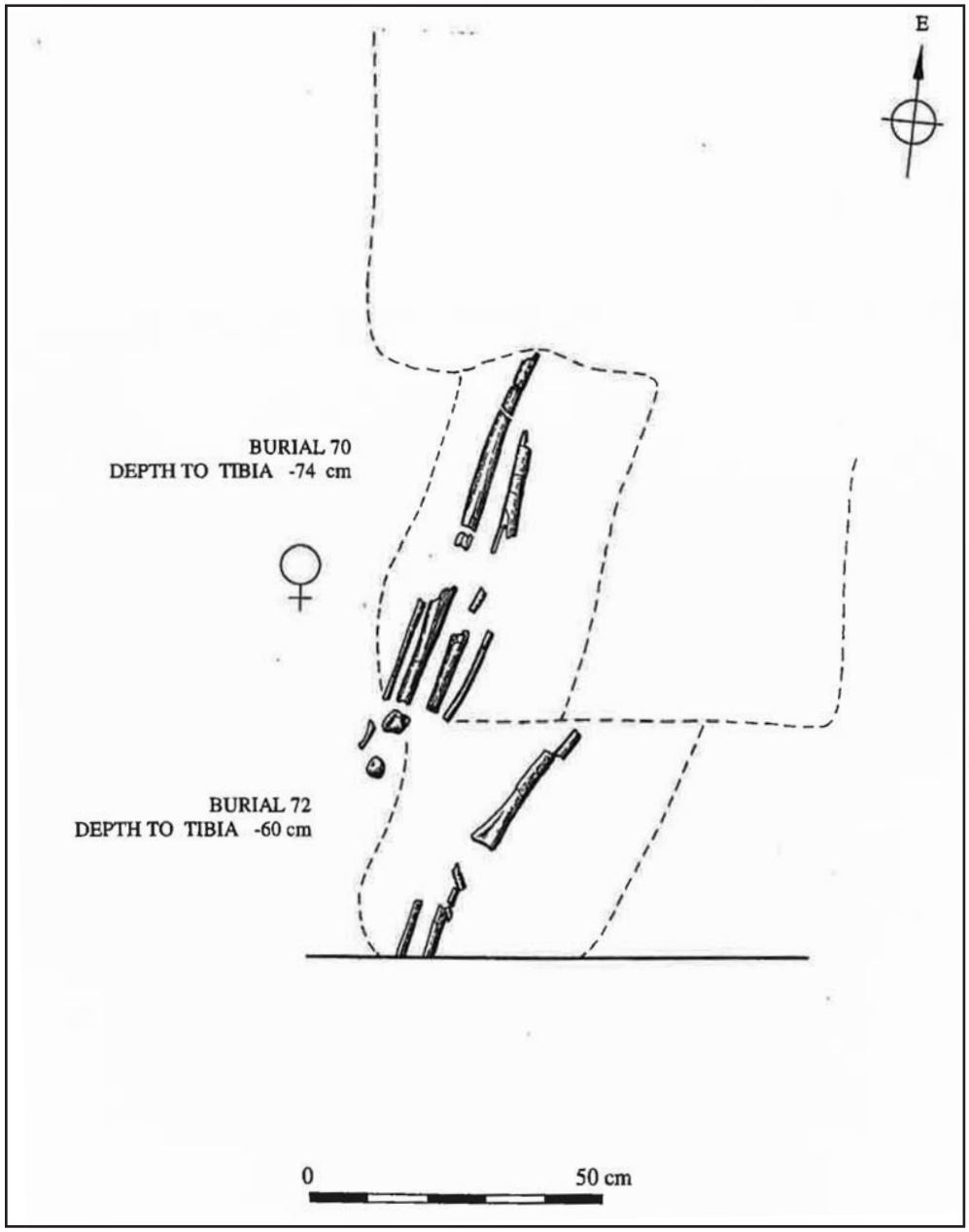


FIG. 162. Burials 70 and 72

Burial 70. N12, adult female, -74 cm, 95°. The shafts of the leg bones survive in this burial, which is later than B 77, and precedes B 72.

Burial 72. N11, adult, -60 cm, 95°. Only the right femur shaft and both tibia and fibula shafts survive in this burial which overlies burials 70 and 77.

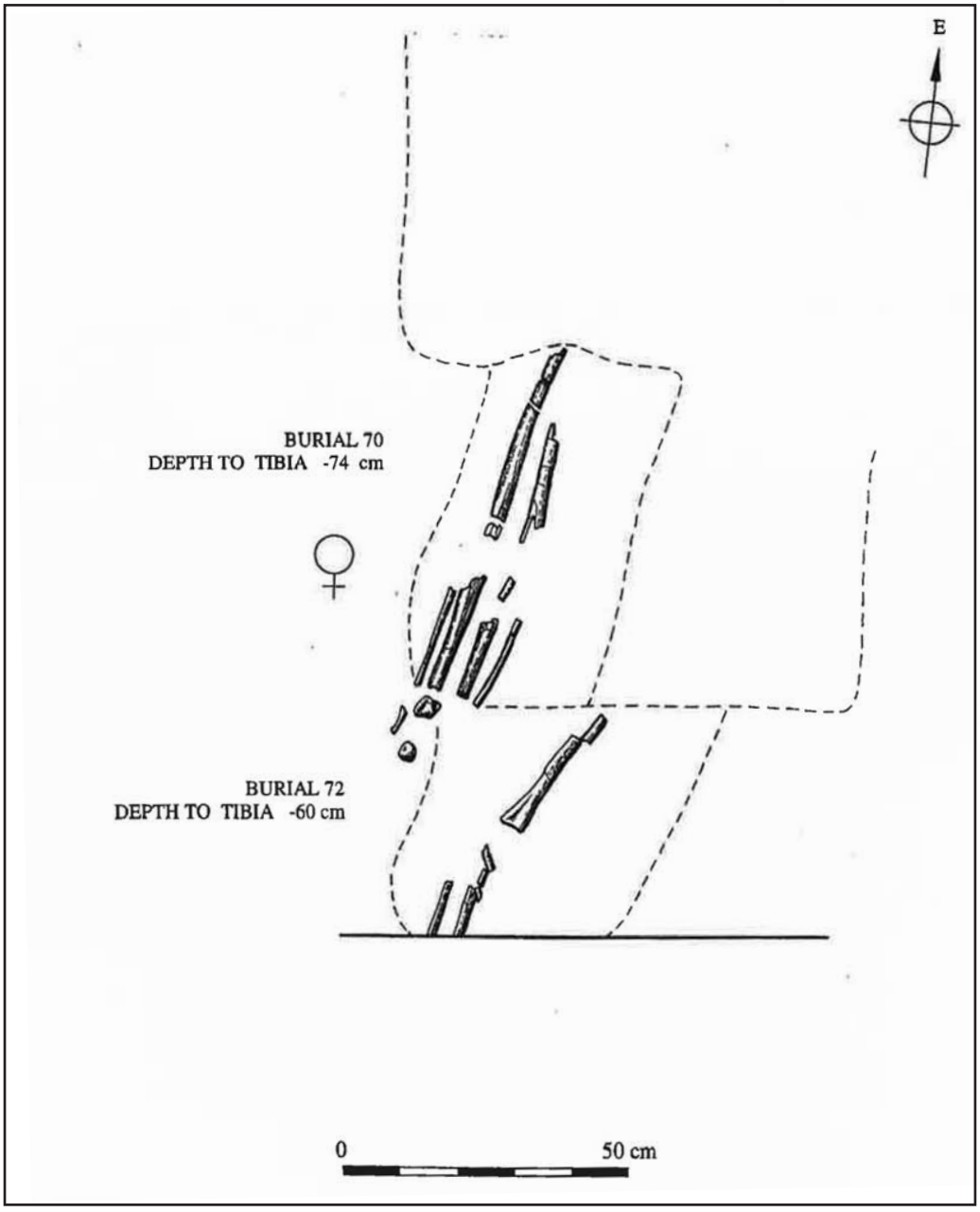


FIG. 163. Burial 75. Q18, middle aged male, -77 cm, 95°. This is the complete burial, which overlies B 85 and B 109. A whole pottery vessel had been placed upside-down over the abdomen, and probably contained some red ochre (cats. 544, 548). A second vessel was found beyond the head (cat. 545). Two tiger canines were in place beside the right hand (cat. 546), while three shell disc and three barrel beads were found under the head and round the neck (cat. 547).

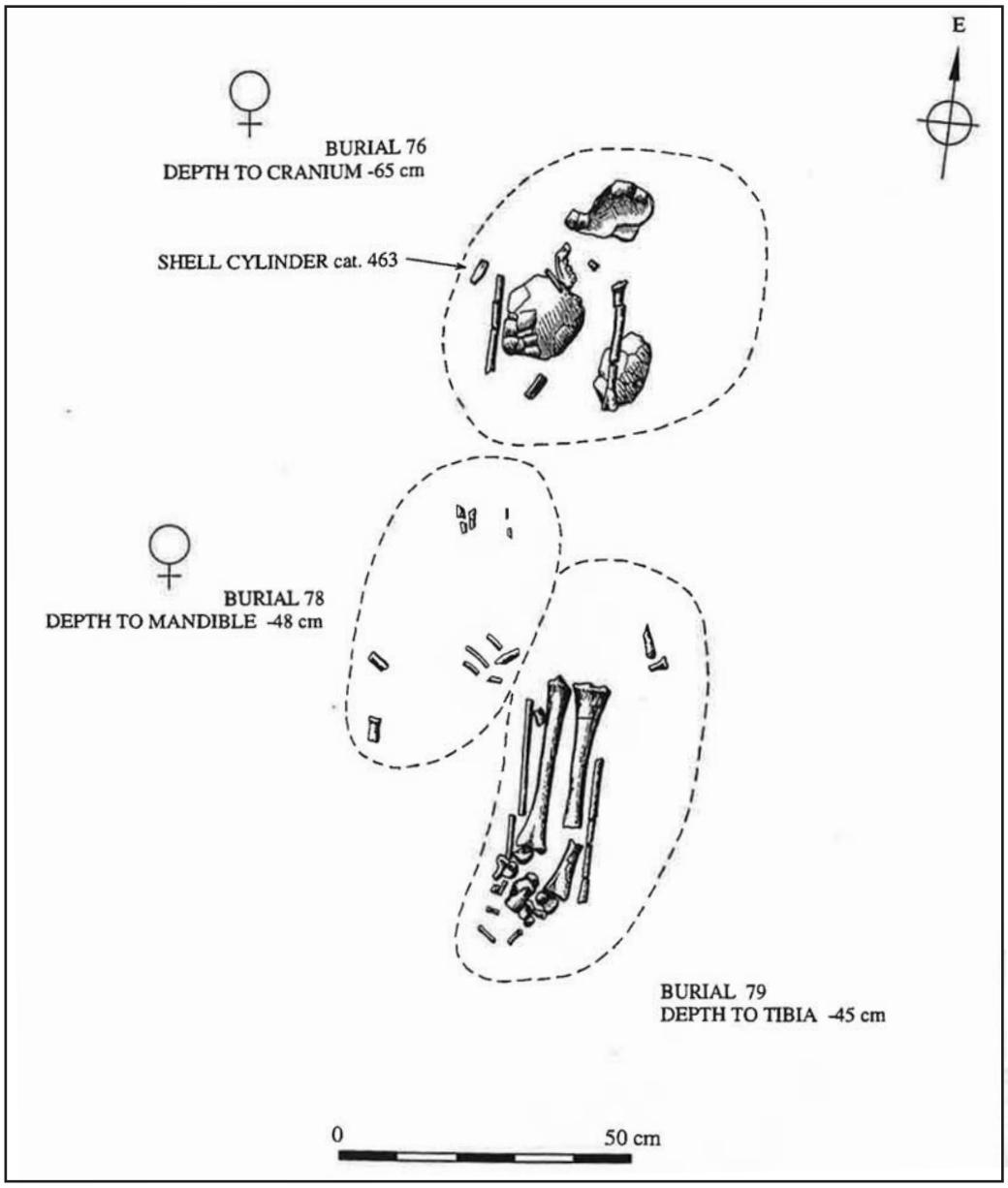


FIG. 164. Burials 76, 78 and 79

Burial 76. O18, young female, -65 cm, 85°. This burial is later than B 78 and B 112. Only cranial fragments, the mandible and humeri survive. A shell cylinder was found near the cranium (cat. 463).

Burial 78. O17, adult female, -48 cm, 85°. This burial was found under B 76, but over B 112. The mandible, ribs and fragments of humeri and skull survive.

Burial 79. O17, adult, -45 cm 85°. The tibiae, fibulae and foot bones are in place. The burial precedes Bs 76 and 78.

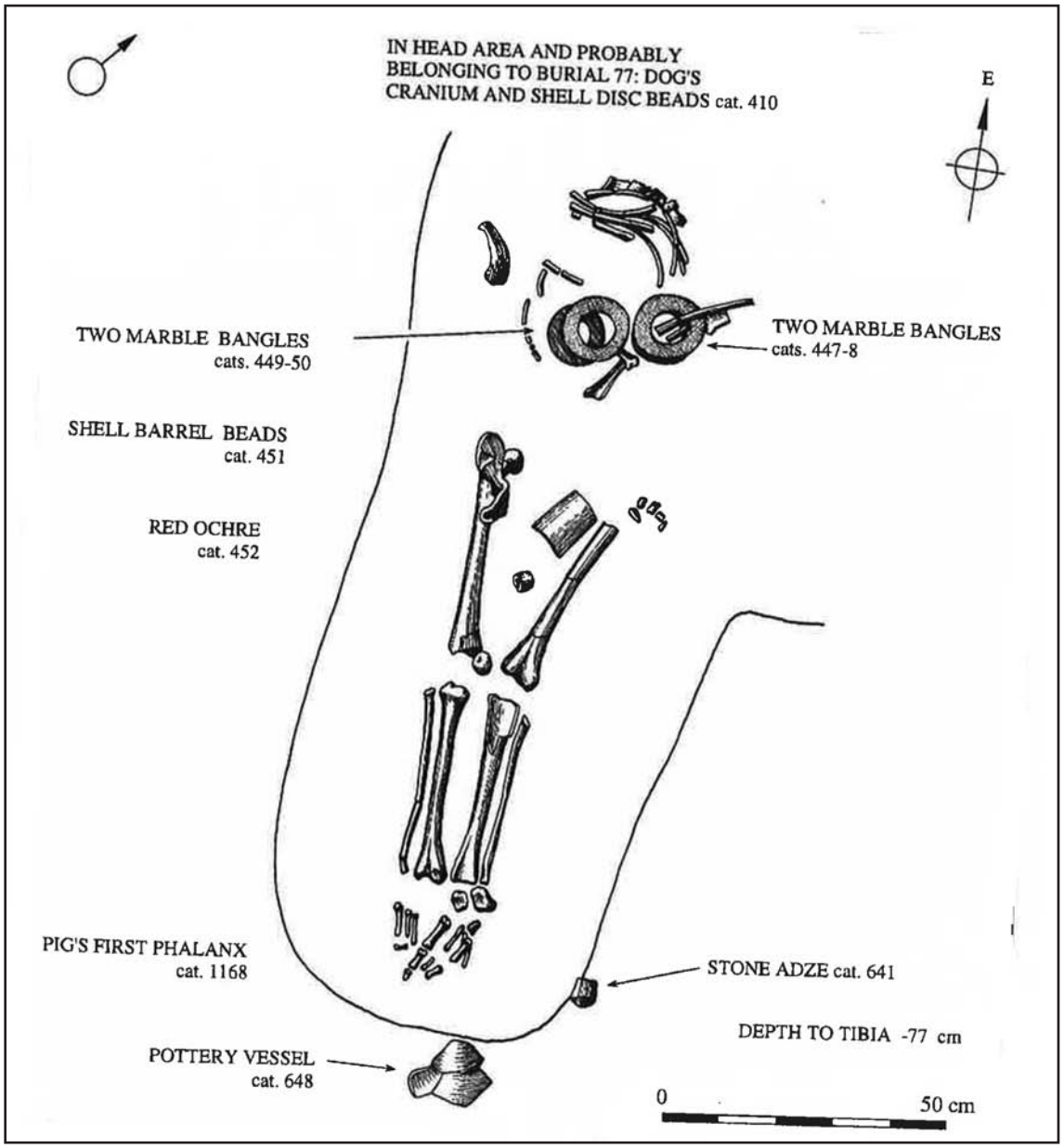


FIG. 165. Burial 77. N10-12, young male, -77 cm, 85°. The skeleton is present from the waist down, and the area beyond the cranium is probably also intact, for a dog's skull was found there, together with a concentration of 40 shell disc beads (cat. 410). There were two marble form 1 bangles on each wrist (cats. 447-50), and two barrel beads in the abdomen area (cat. 451). Some red ochre (cat. 452) was also present in this same region, while a stone adze was found beyond the feet and just outside the line of the grave (cat. 641). It is possible that the latter was not part of the grave offerings. A pot which might be associated with this burial was found beyond the ankles (cat. 648). A pig's phalanx II-V was found in the grave area (cat. 1168).

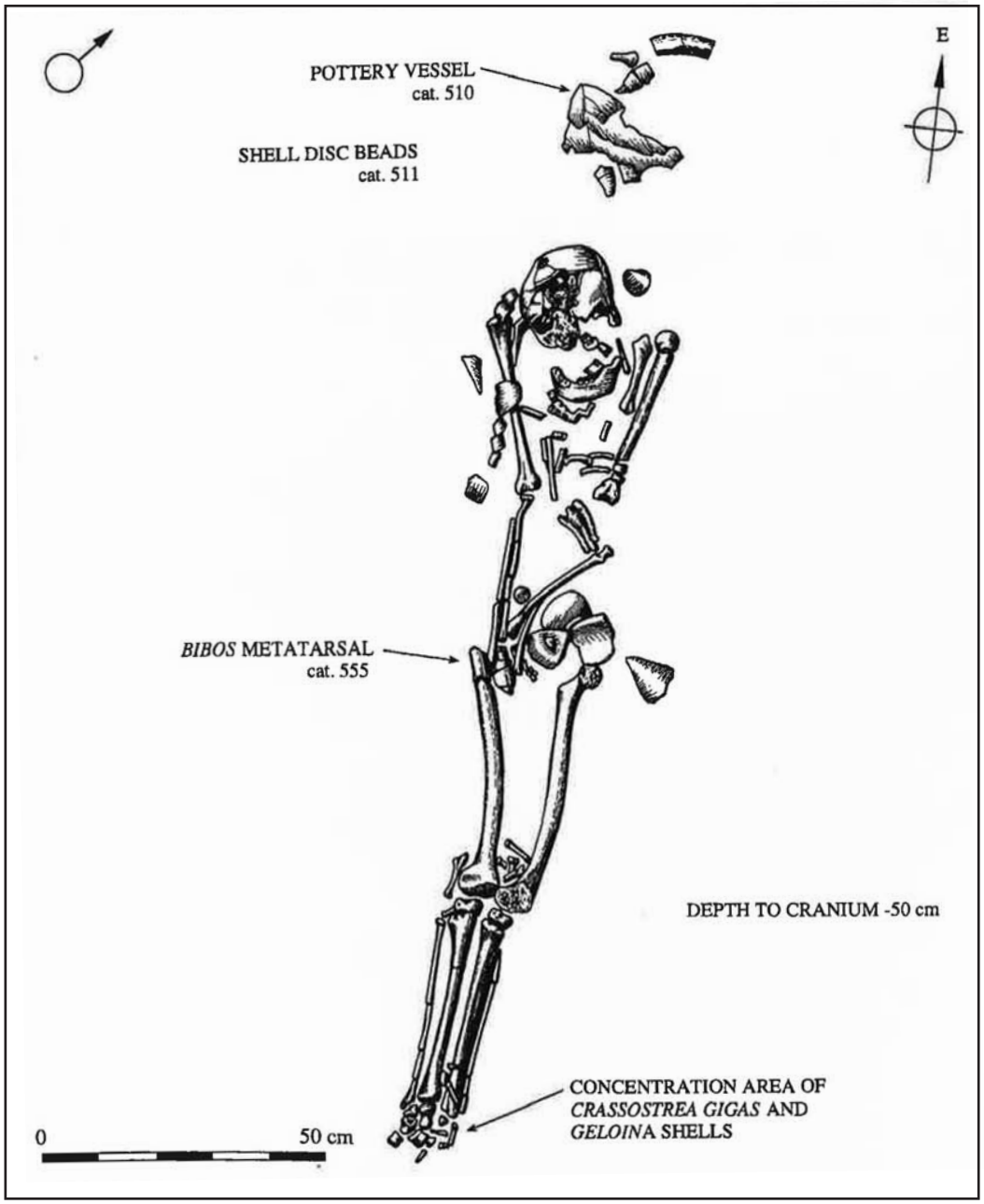


FIG. 166. Burial 81. L6-7, middle aged male, -50 cm, 90°. This is an intact grave. A pottery vessel (cat. 510) was found beyond the head, together with one shell disc and a barrel bead (cat. 511). A bovid metatarsal (cat. 555) had been placed by the right hand, and there was a concentration of valves from *Crassostrea gigas* in the vicinity of the left ankle. These may or may not have been a grave offering, for they were found incorporated in the midden disturbed with the digging of the grave.

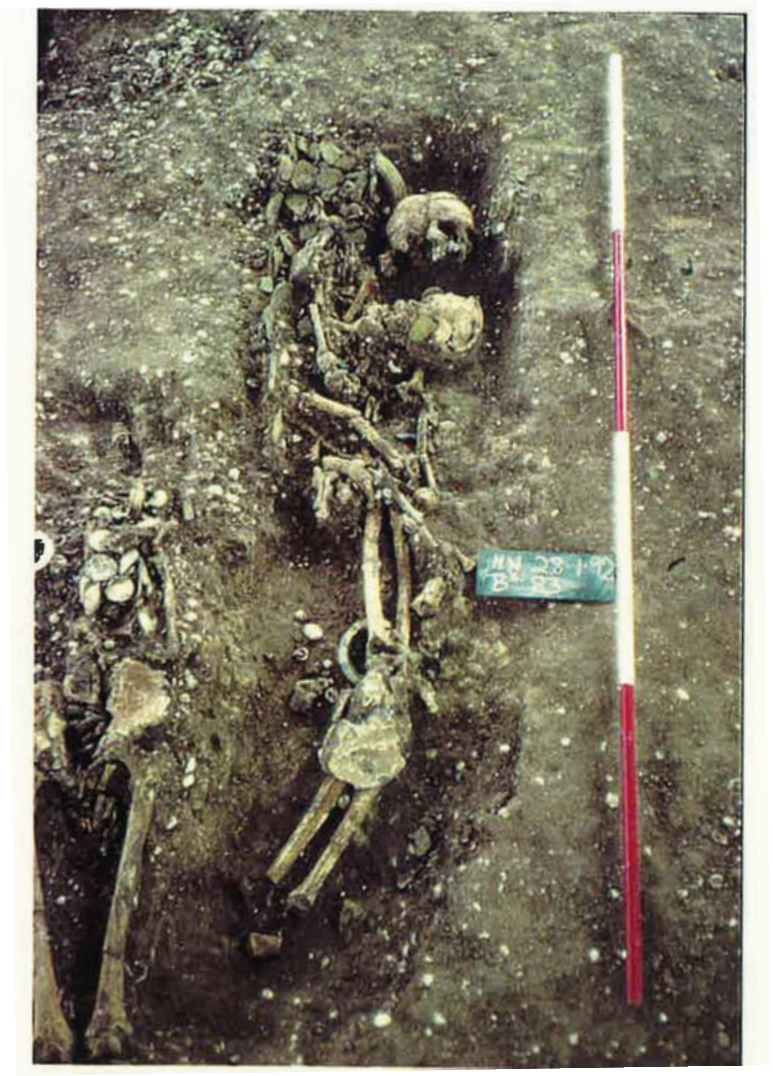


FIG. 167. Burial 83, looking east. Burial 87 is seen to the left

Burial 83 *(above and overleaf)*. M16-17, old male, -60 cm, 95°. This individual was buried on the back with the right forearm placed across the abdomen. A dog's skull was found beyond the human cranium (cat. 540) and three pottery vessels were likewise present in the vicinity of the head (cats. 496-7, 541). A form 2 serpentine bangle lay in the chest area, two halves of a second were recovered from the vicinity of the wrists, and a serpentine belt ornament was found under the pelvis (cats. 495, 1087 and 522). A large boar's tusk was located under the knees, near a bovid tibia (cats. 484, 521). Finally, a fragment of bronze was identified near the skull.

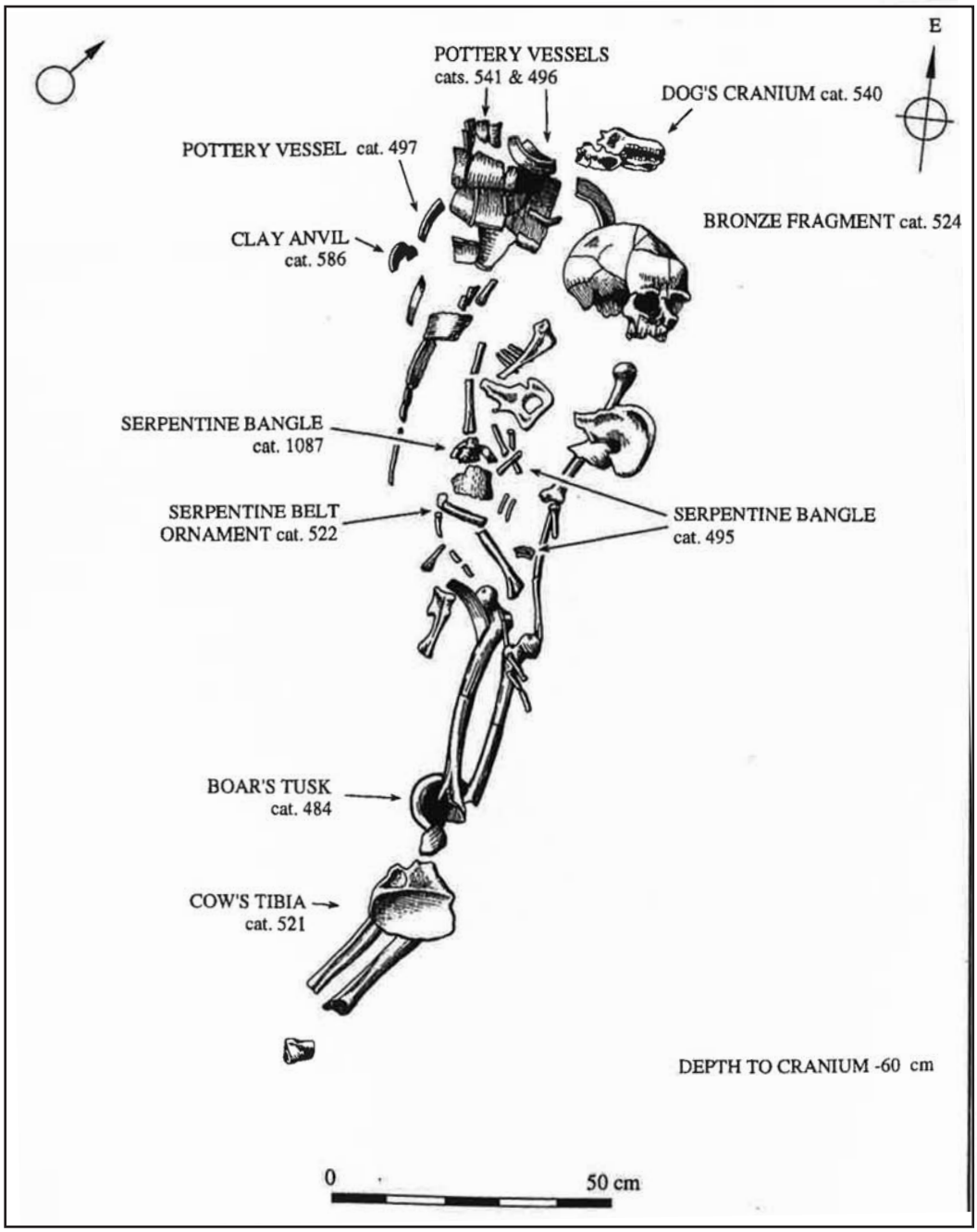


FIG. 168. Burial 83

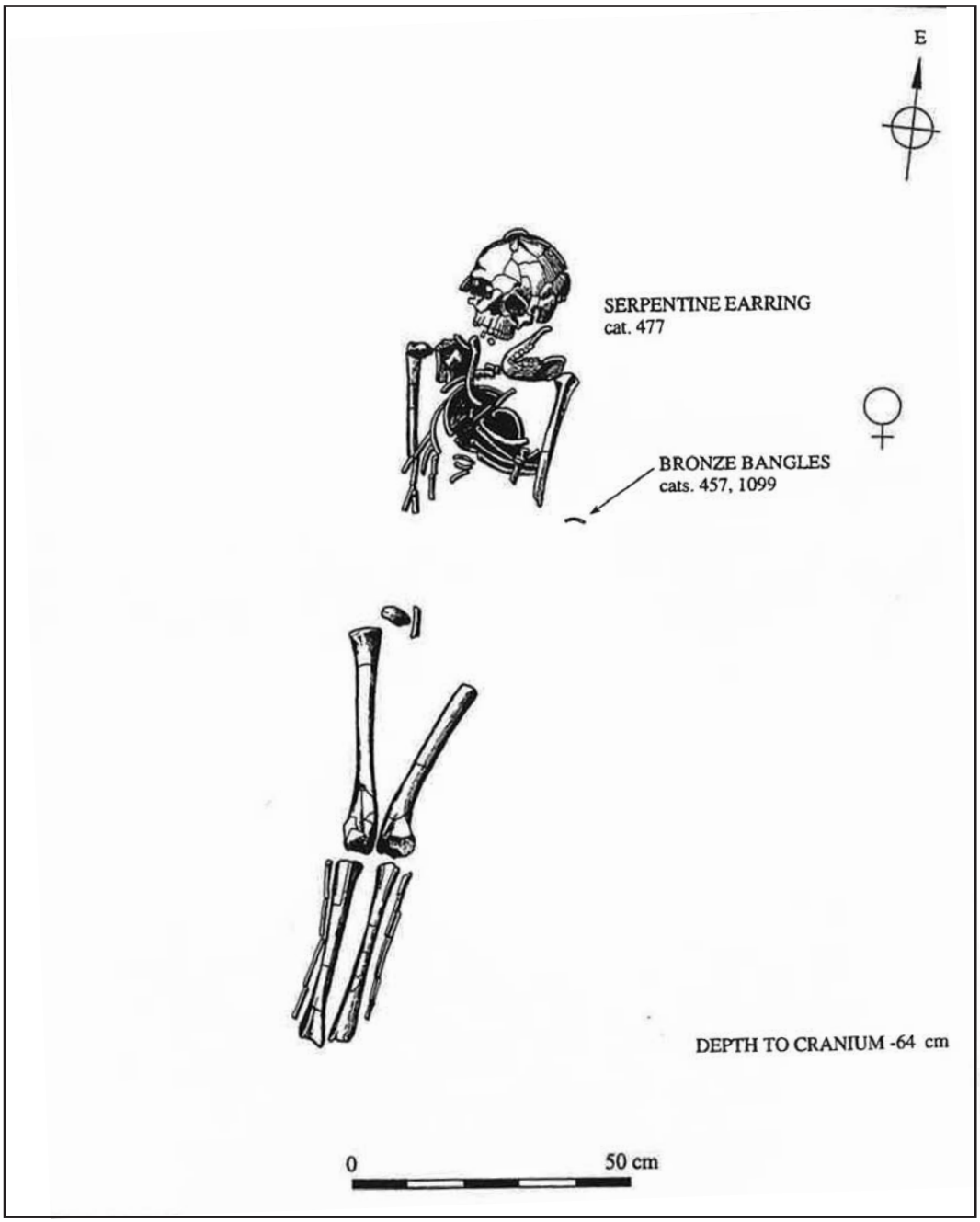


FIG. 169. Burial 84. M9-10, young female, -64 cm, 95°. This individual was found with a serpentine earring (cat. 477) and two bronze bangles, one of form 1 and the other of form 8 (cats. 457, 1099).

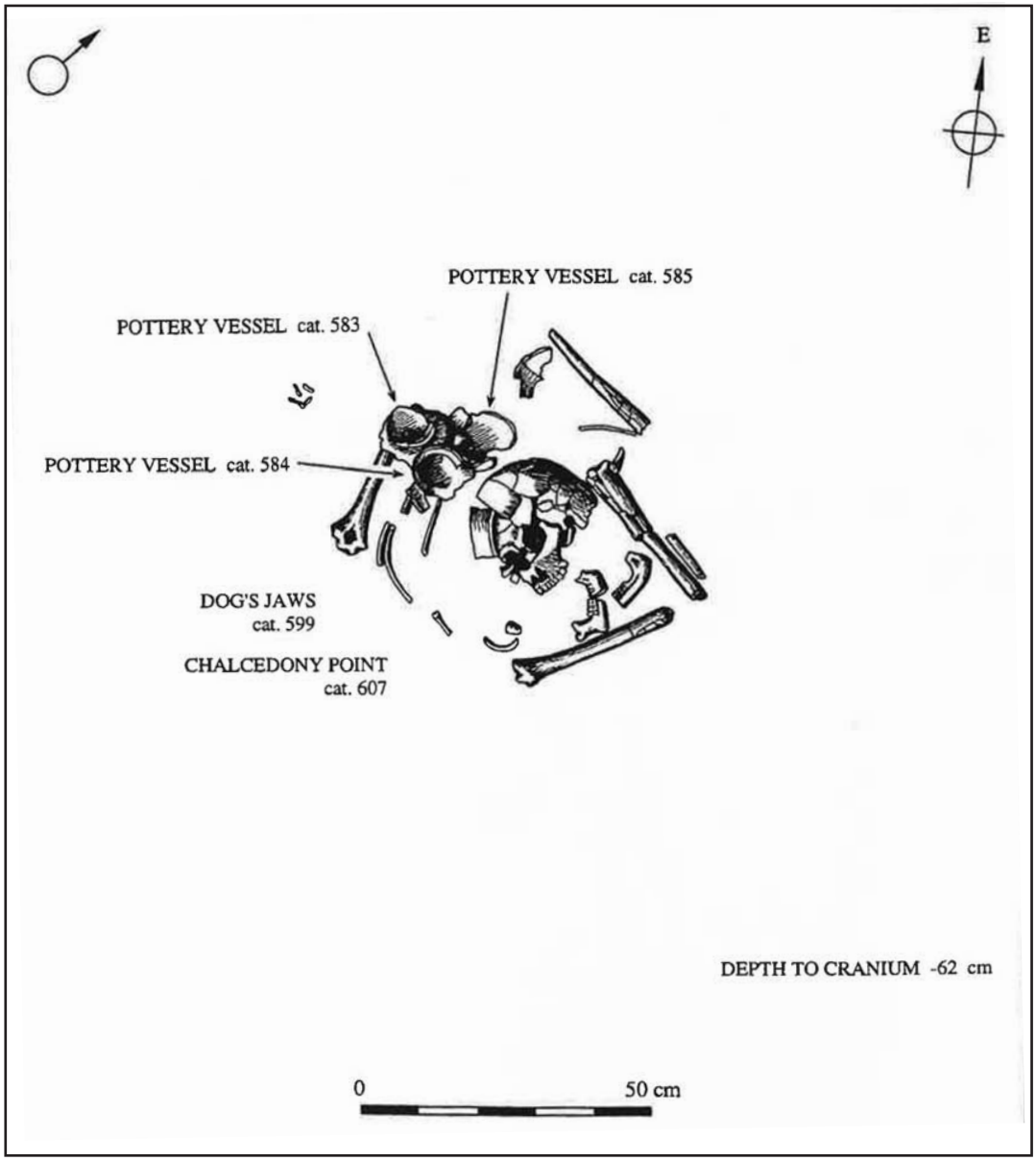


FIG. 170. Burial 85. Q18, old male, -62 cm. The limb bones were arranged in a circular configuration with the skull in the middle. It is likely to have been a secondary burial, which lay over B 109 and under B 75. It was associated with a group of three small pots (cats. 583-5), a dog's jaw (cat. 599) and a drill point of chalcedony (cat. 607).

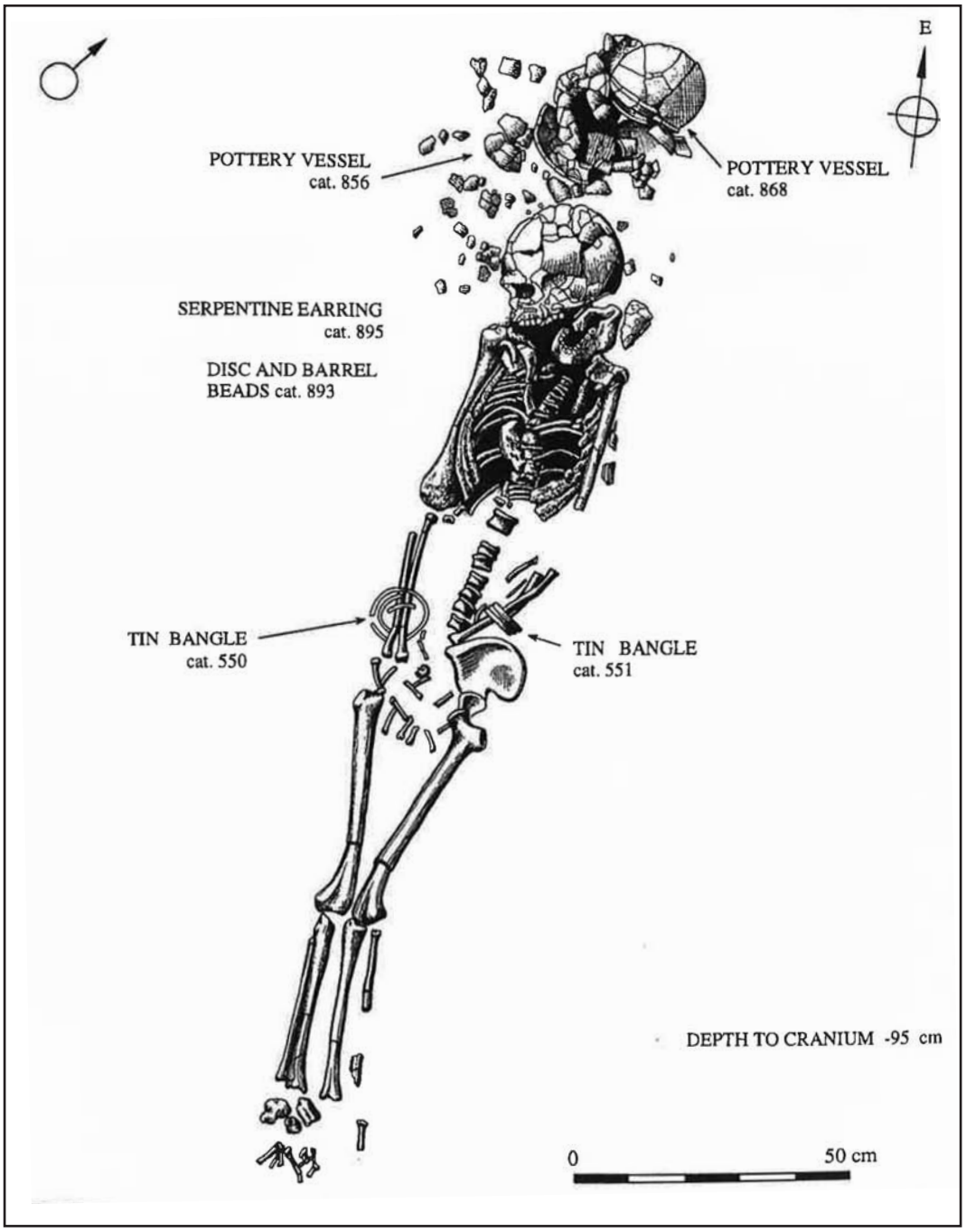


FIG. 171. Burial 86. P18-19, middle aged male, -95 cm, 95°. This male wore two spiraliform tin bangles, one on each wrist (cats. 550-1). He also had a form 1 serpentine earring (cat. 895), five shell disc and five barrel beads in the neck area (cat. 893) and two pottery vessels beyond the head (cats. 856, 868).

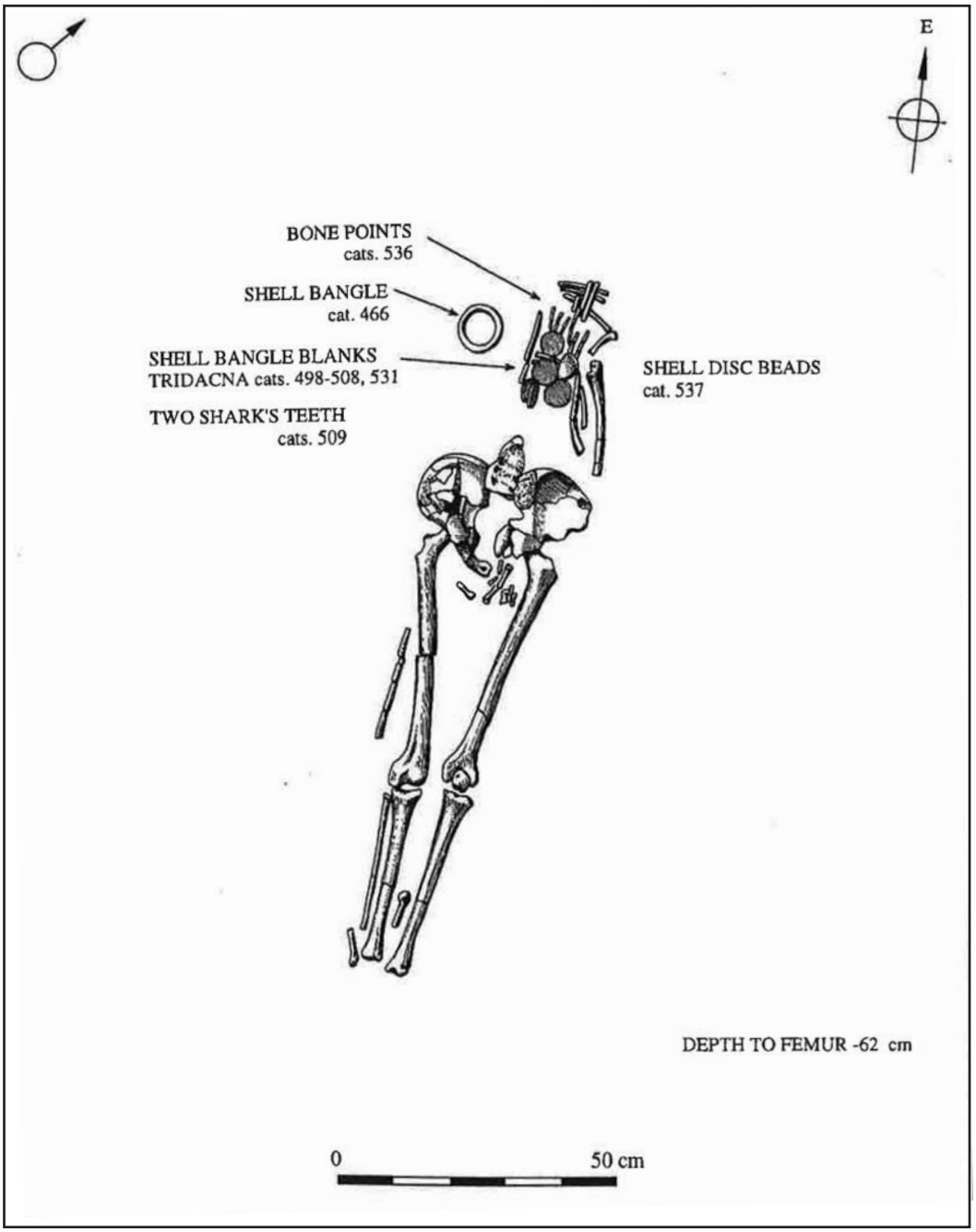


FIG. 172. Burial 87. M16-17, middle aged male, -62 cm, 90°. This burial is complete except for the cranium and beyond. The man was interred with a form 4 shell bangle in the vicinity of the right wrist (cat. 466), and 13 shell (tridacna) bangle blanks were found over the chest (cat. 498-508, 531). Two shell disc beads and two shark's teeth were in the same region (cats. 537 and 509), and several bone points were in position over the chest (cat. 536).

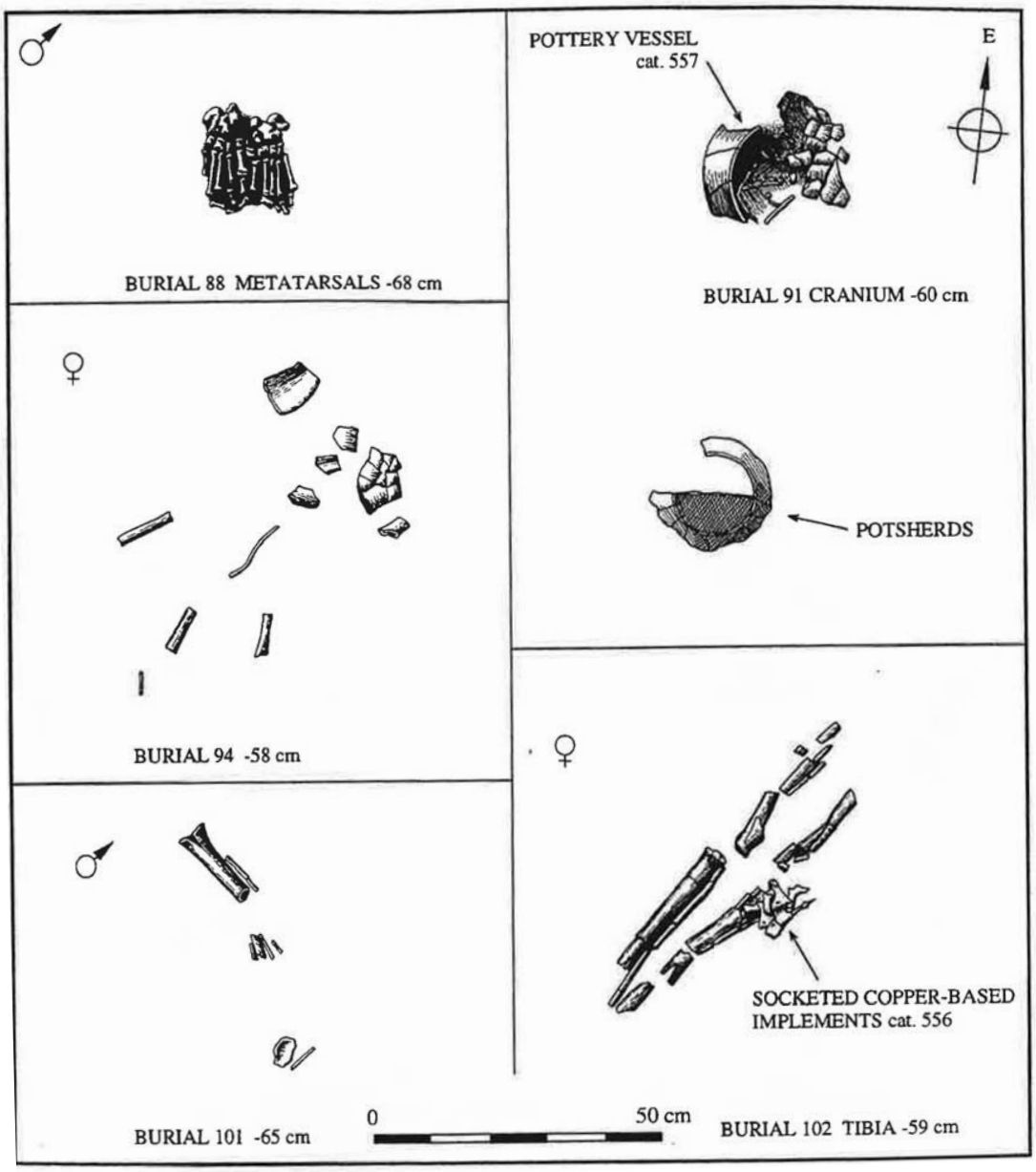


FIG. 173. Burials 88, 91, 94, 101 and 102

Burial 88. L13, old adult male, *c*. 90°. Only the ankles of this burial were found. Burial 91. M18, -68 cm, infant jar burial (cat. 494). The remains of an infant within a mortuary vessel, located beyond the feet of B 45. Burial 94. M6, adult female, -60 cm. Only the skull fragments, part of the right humerus, ribs and the forearm survive. A shell barrel bead was recovered from the general area (cat. 571). Burial 101. M10, middle aged male, -84 cm, 40°. Only the tibiae and associated bone fragments were recovered. Burial 102. O16, adult female, -59 cm, 130°. The femora and tibiae survive in place. A cache of socketed copper-based implements lay beside the left knee (cat. 556).

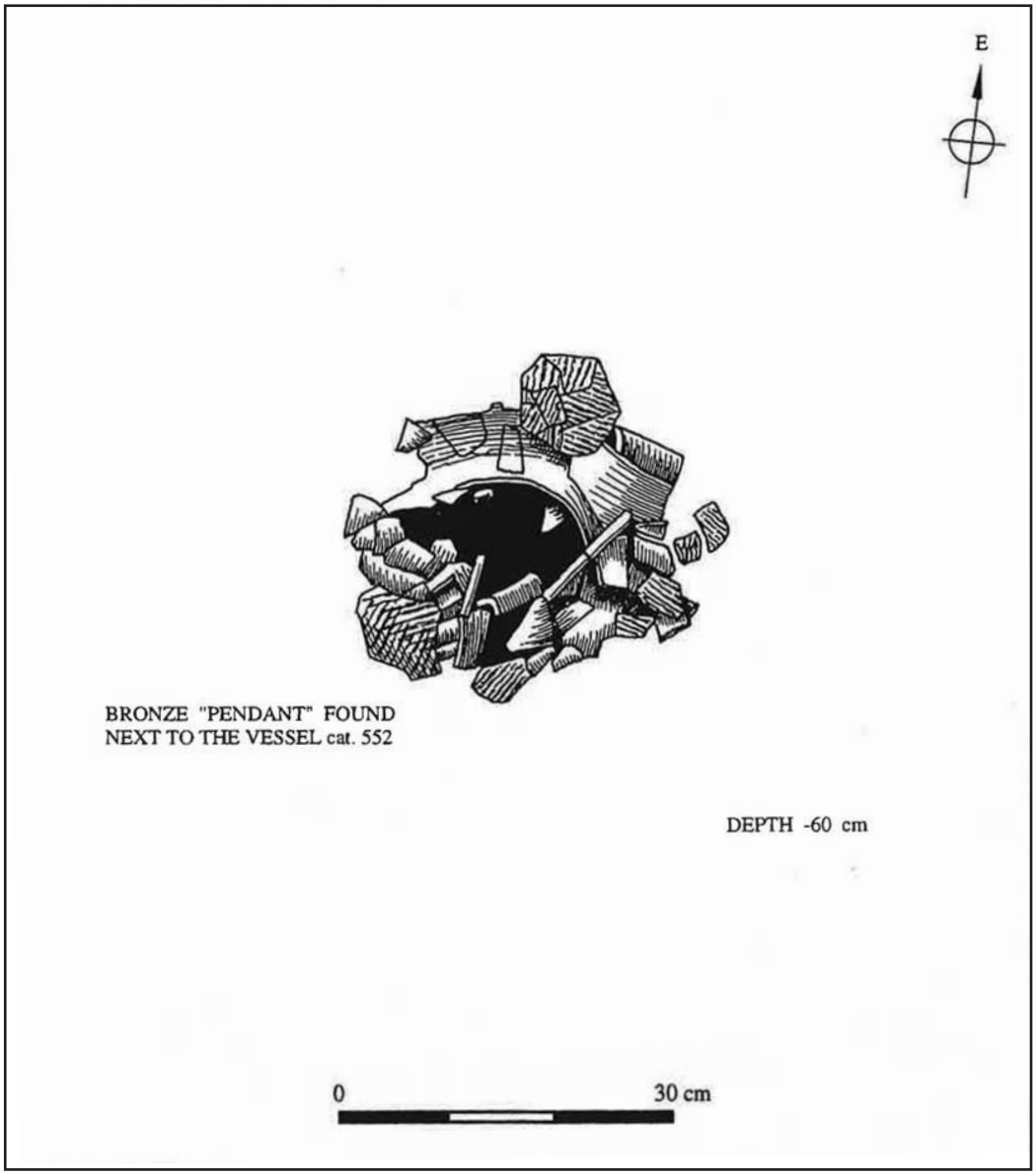


FIG. 174. Burial 89. O17, infant jar burial, -60 cm. A mortuary vessel (cat. 590). A bronze pendant lay alongside the jar, and may not have been in association (cat. 552).

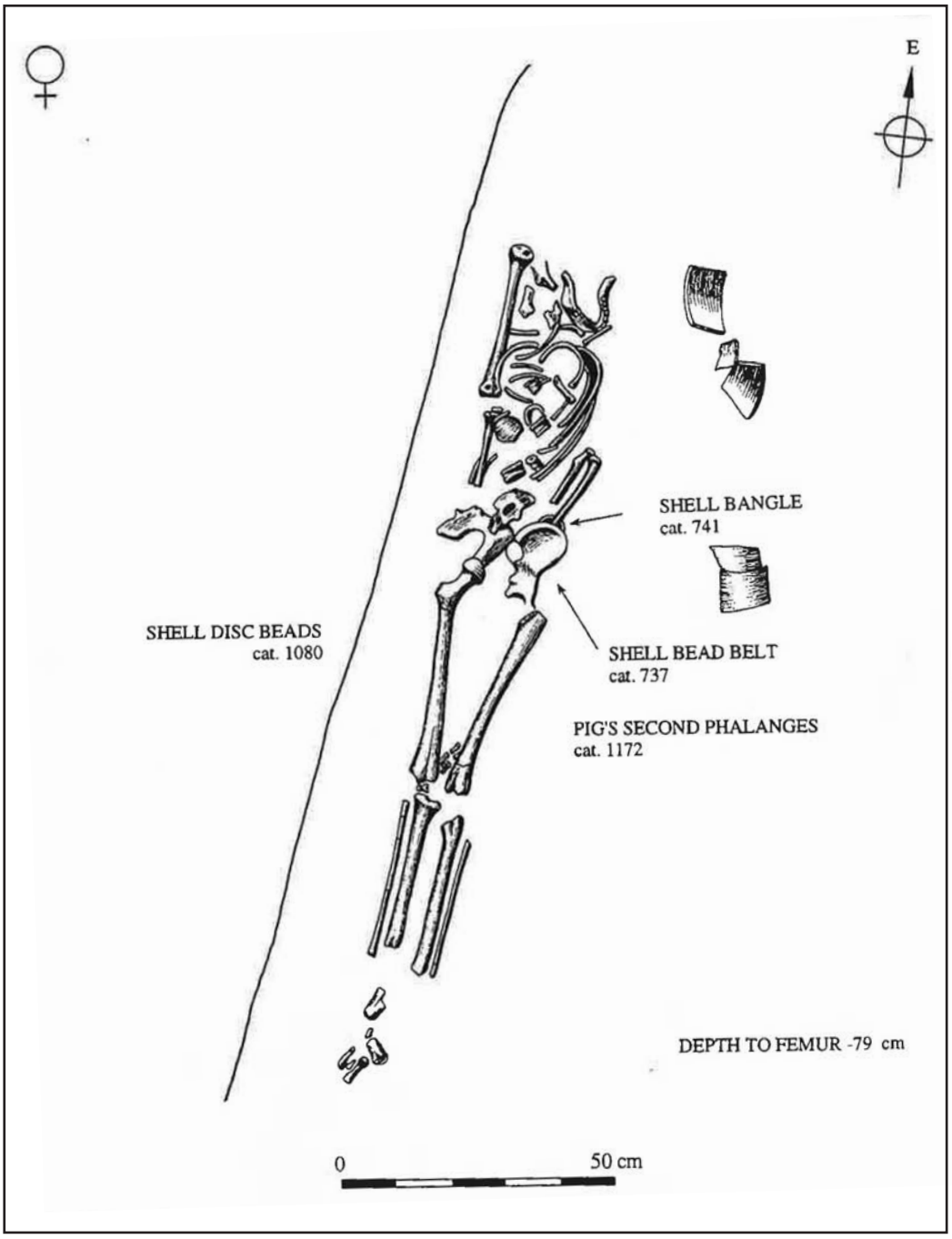


FIG. 175. Burial 90. J6-7, young female, -79 cm, 90°. This person wore a form 5 shell bangle on the left wrist (cat. 741). There were 77 shell disc beads in the pelvic area, which might have been a bead belt (cat. 737). A further scatter of 38 shell disc beads were present in the vicinity of the skeleton (cat. 1080). Two pig's first phalanges were found during laboratory analysis (cat. 1172).

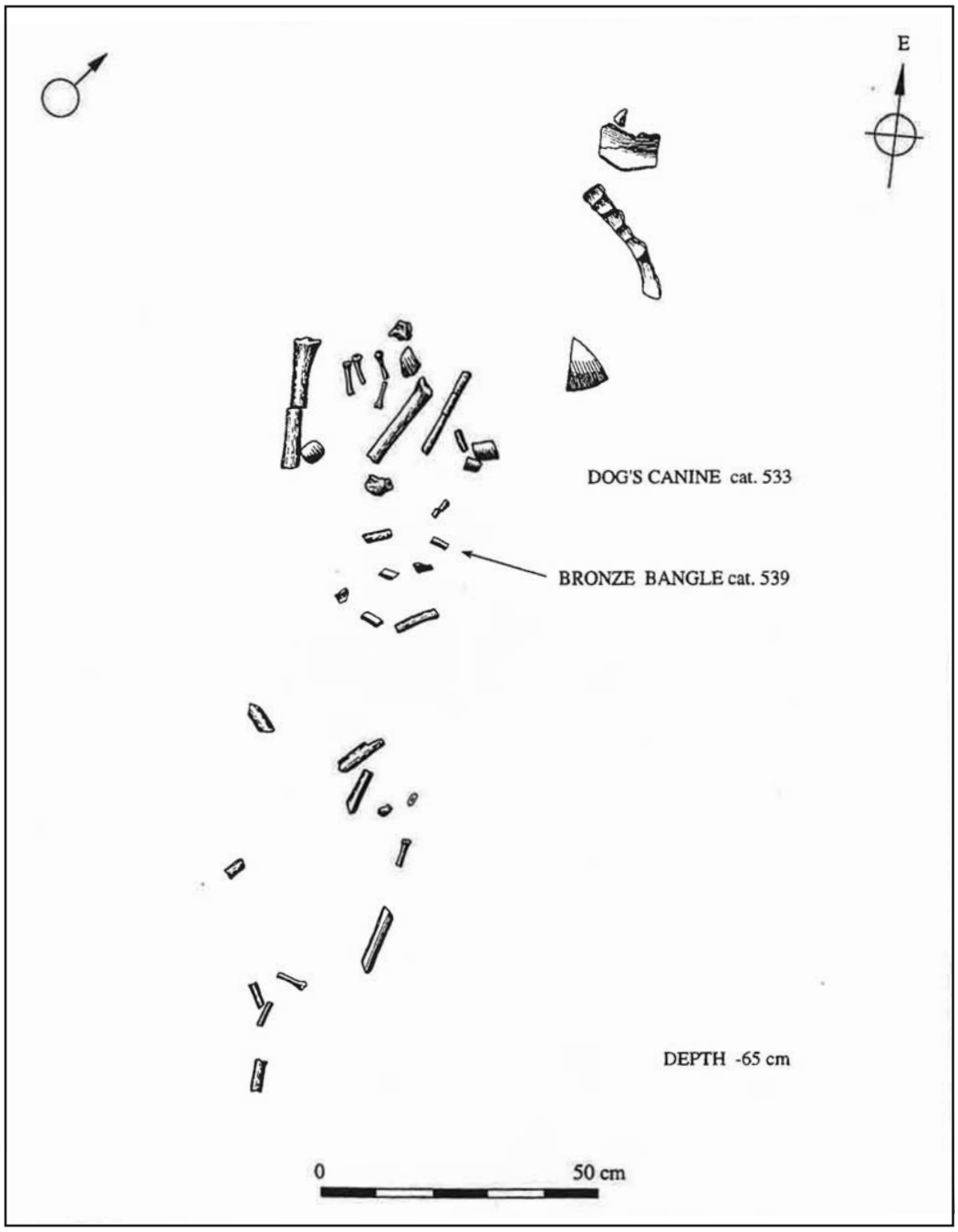


FIG. 176. Burial 92. L10-11, adult male, -65 cm. Only the femora, part of the left pelvis and the hand bones were found in place. A dog's canine and a form 1 bronze bangle fragment were located in the general area of the bones (cats. 533, 539).

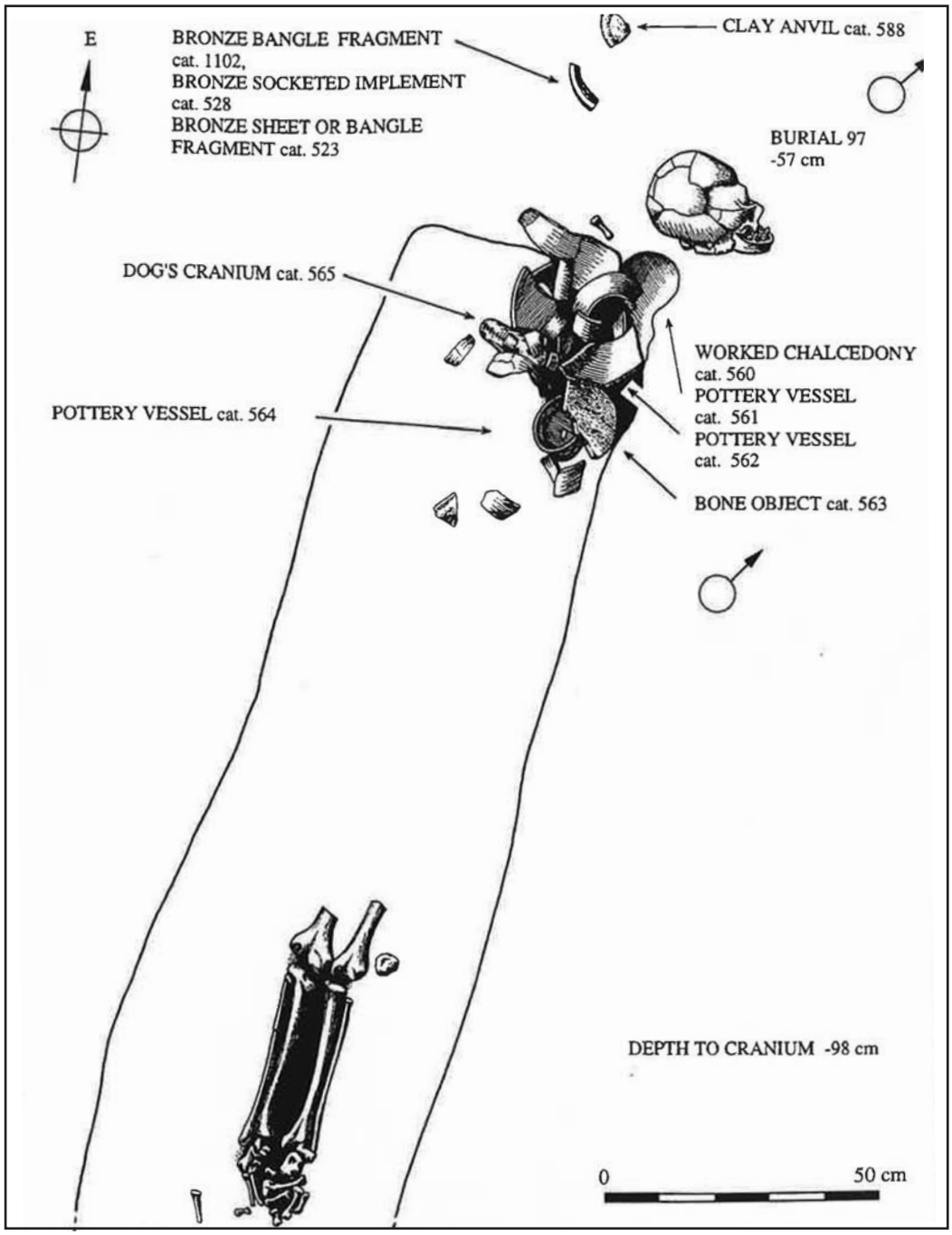


FIG. 177. Burial 93. M8, middle aged male, -98 cm, 90°. Three pottery vessels and a piece of chalcedony were found beyond the head (cats. 560-2, 564), together with a dog's skull (cat. 565). A piece of bronze was found in the grave fill (cat. 523). Burial 97. L8, young adult male, -57 cm. A cranium alone. A clay anvil lay next to the skull (cat. 588). A bronze socketed artefact and a form 1 bronze bangle fragment were found in the vicinity (cats. 528, 1102).

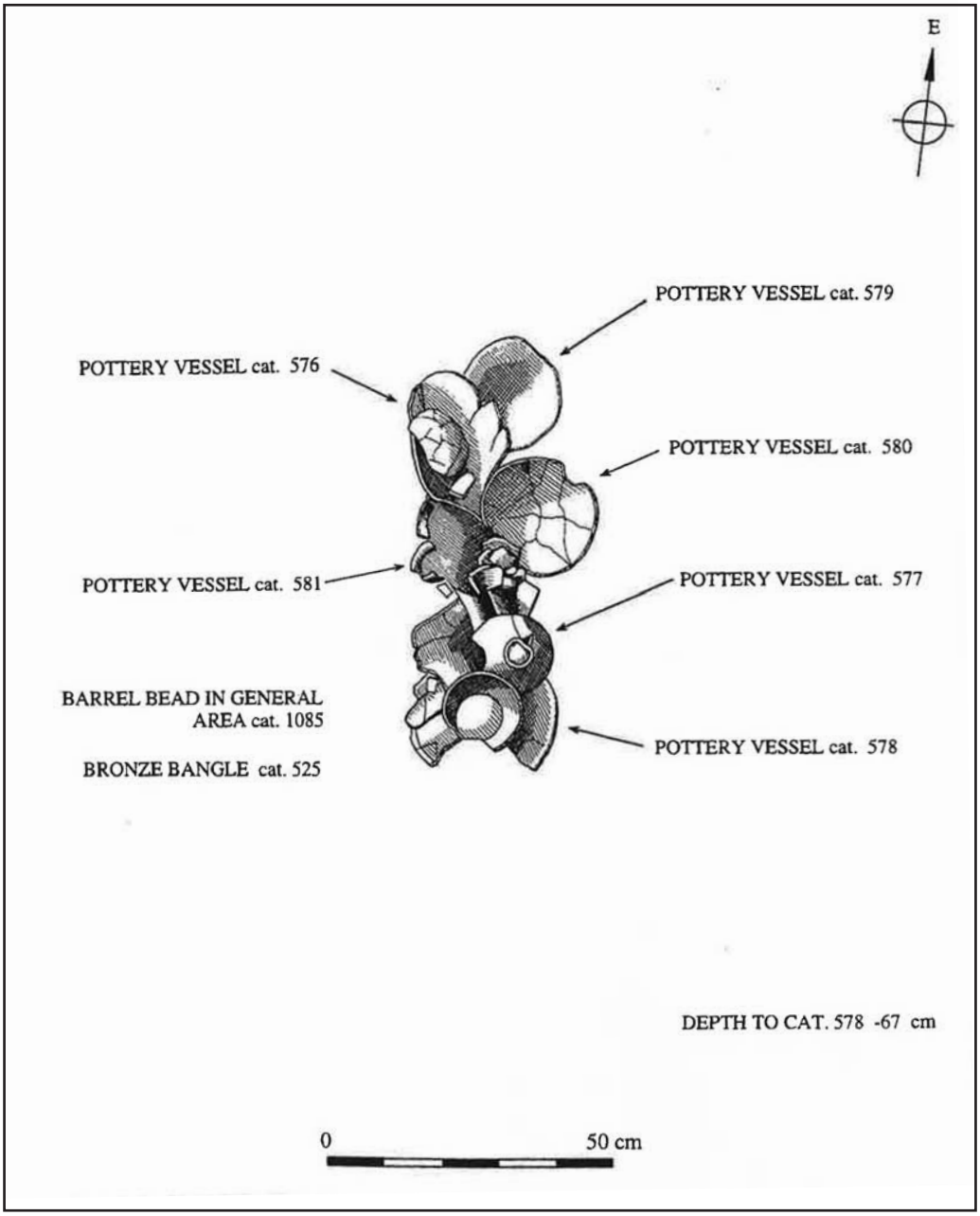


FIG. 178. Burial 96. K9, -67 cm. This feature comprises a row of six pottery vessels (cats. 576-81), together with a form 1 bronze bangle (cat. 525) and a barrel bead (cat. 1085). It lies alongside B 99, but no bones were found in primary association. It might represent a mortuary offering.

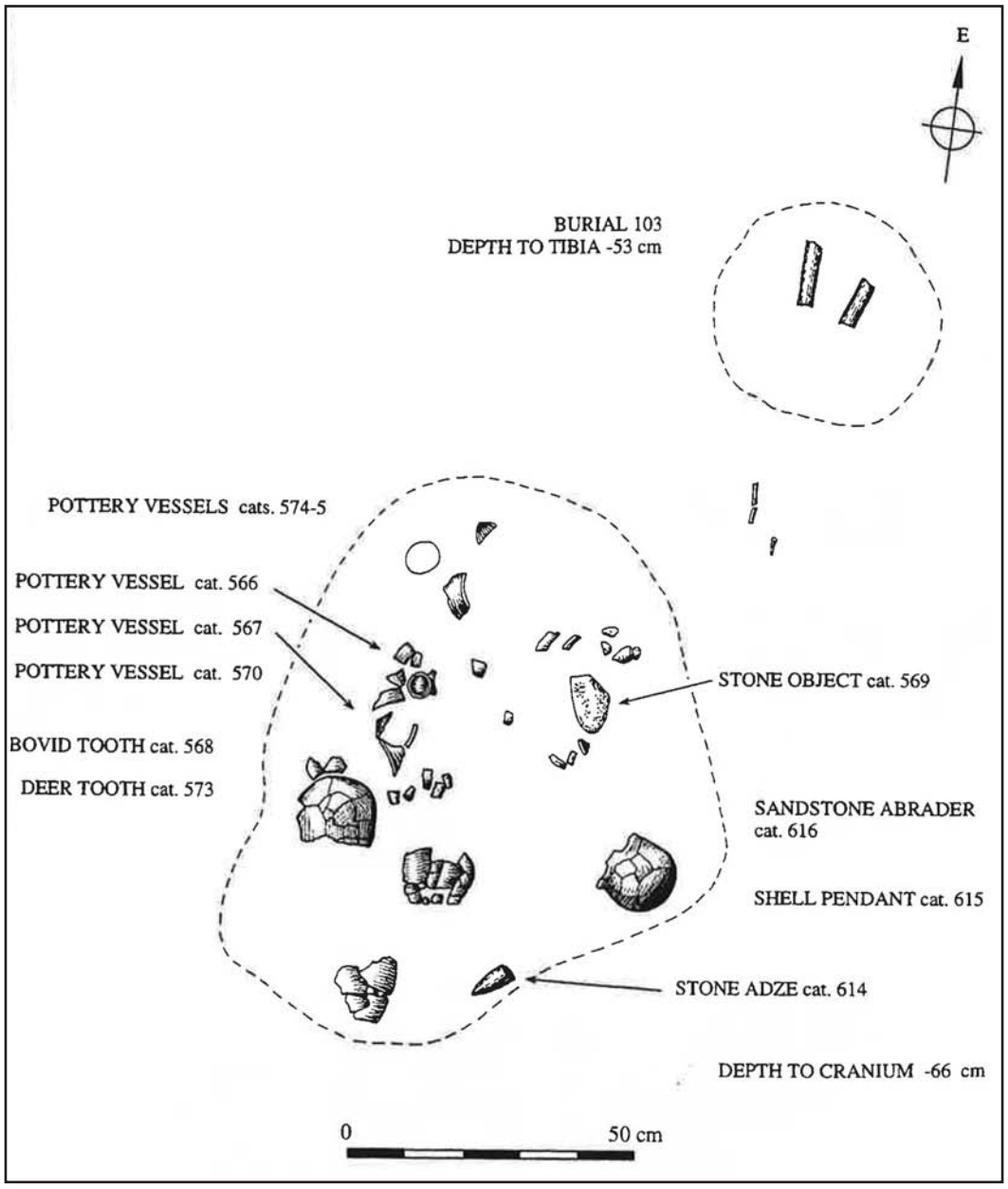


FIG. 179. Burial 98. O7, adult, -66 cm. The disarticulated remains of an individual whose bones might well have been disturbed when Bs 36 and 39 were interrred. Parts of five pottery vessels were found in the area of the bones (cats. 566-7, 570 and 574-5), and other artefacts probably associated were a stone object (cat. 569), a stone adze (cat. 614), a shell pendant (cat. 615) and a sandstone abrader (cat. 616). One bovid and a cervid tooth were also present (cats. 568, 573).

Burial 103. O7, adult, -53 cm, 95°. The tibiae and associated bone fragments lie near the eastern end of the grave for B 60. The latter might have disturbed part of this burial.

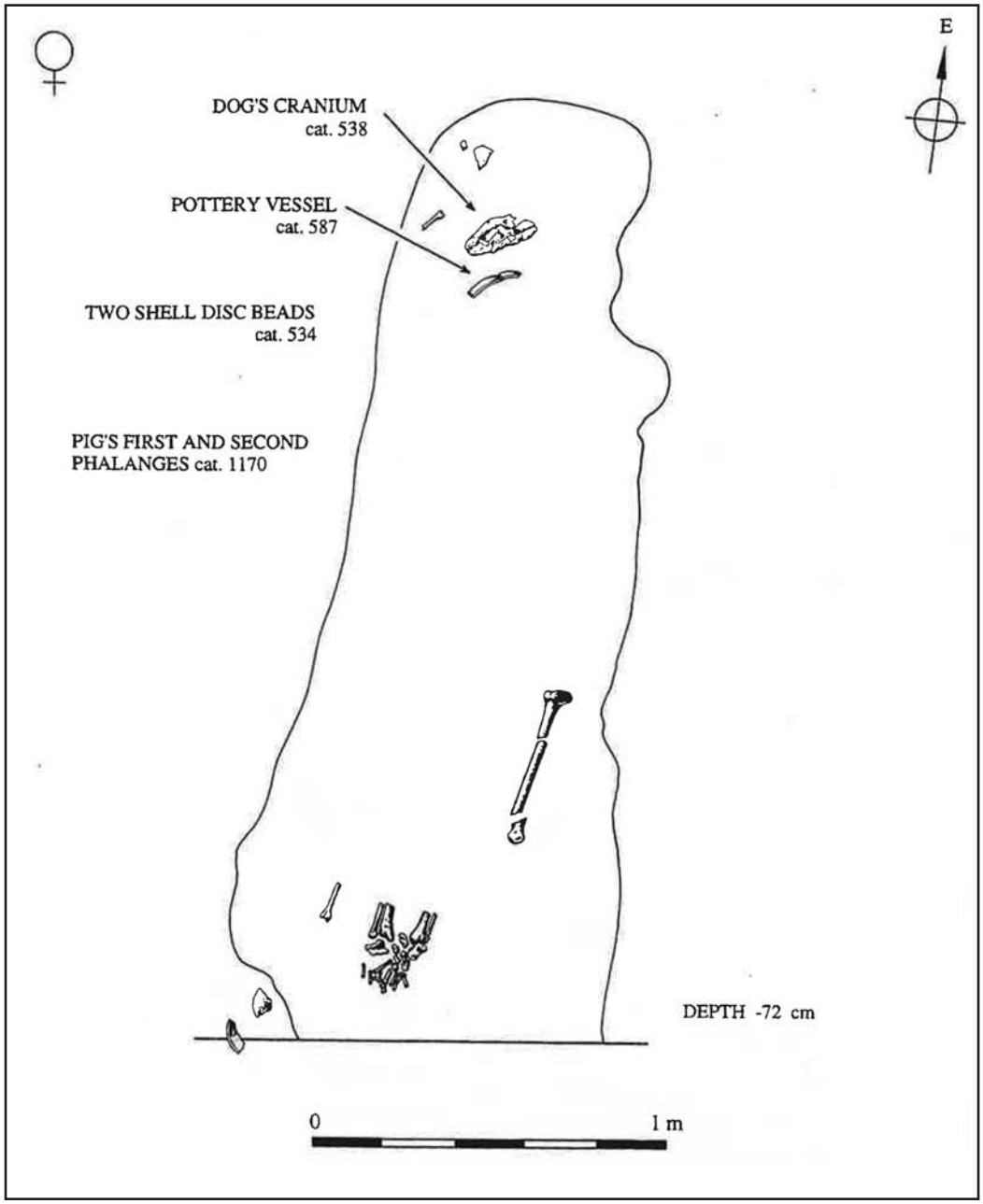


FIG. 180. Burial 99. K9-11, young female, -72 cm, 90°. A badly looted grave. A dog's skull was present at the eastern end of the grave (cat. 538), near which were sherds from a pottery vessel (cat. 587), and two shell disc bead (cat. 534). Articulating pig's first and second phalanges were found when sorting the bones recovered from this grave (cat. 1170).

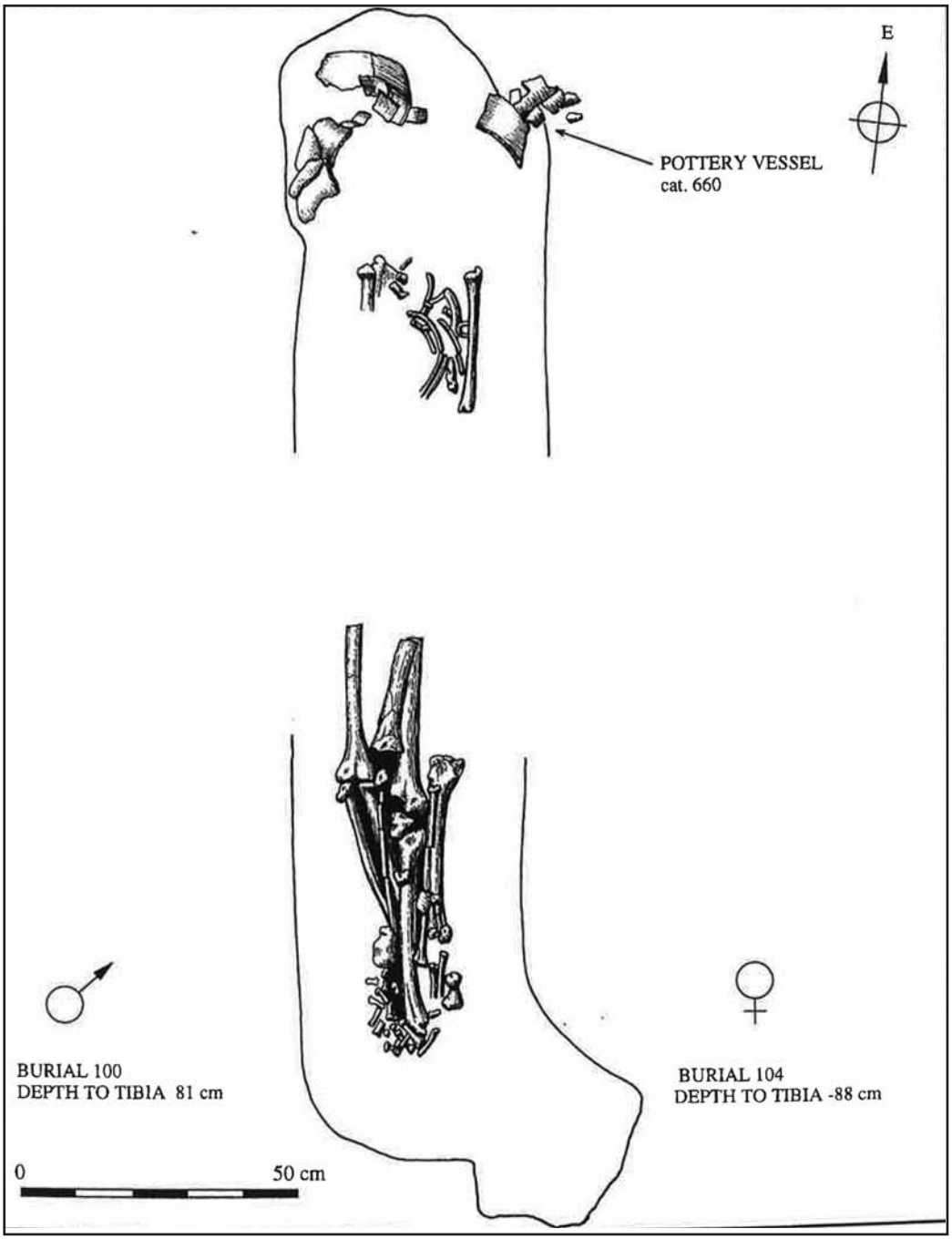


FIG. 181. Burials 100 and 104

Burial 100. K13-14, old male, -88 cm, 265°. This is a double grave, in which burials 100 and 104 face in opposite directions, the former to the west, the latter to the east. Burial 104. K13-14, middle aged female, -88 cm, 85°. This person shares the same grave as B 100. The central part has been lost to looting, but a complete pot lies beyond the cranium (cat. 660).

FIG. 182. Burial 105, looking east

Burial 105 *(above and opposite)*. N6-9, middle aged male, -89 cm, 80°. This grave is almost 4 m in length. It contains a male, centrally placed with a series of pottery vessels placed beside and beyond the head (cats. 617-19, 621 and 629). There was a large, T-cross sectioned form 3 bronze bangle on the right wrist (cat. 604), and a form 1 marble bangle on the other (cat. 623). A pig's tibia had been placed to the right of the cranium and a large valve of *Crassostrea* on the opposite side (cats. 653, 622). The cranium of a very young dog was found under pot (cat. 620 (cat. 681). Other items of jewellery included a shell neck pendant and a form 1 tin earring (cats. 624, 652). The grave cut was particularly clearly in evidence, and was cut completely through the shell midden into the natural substrate. The grave was partly cut into by B 35, and is therefore earlier.

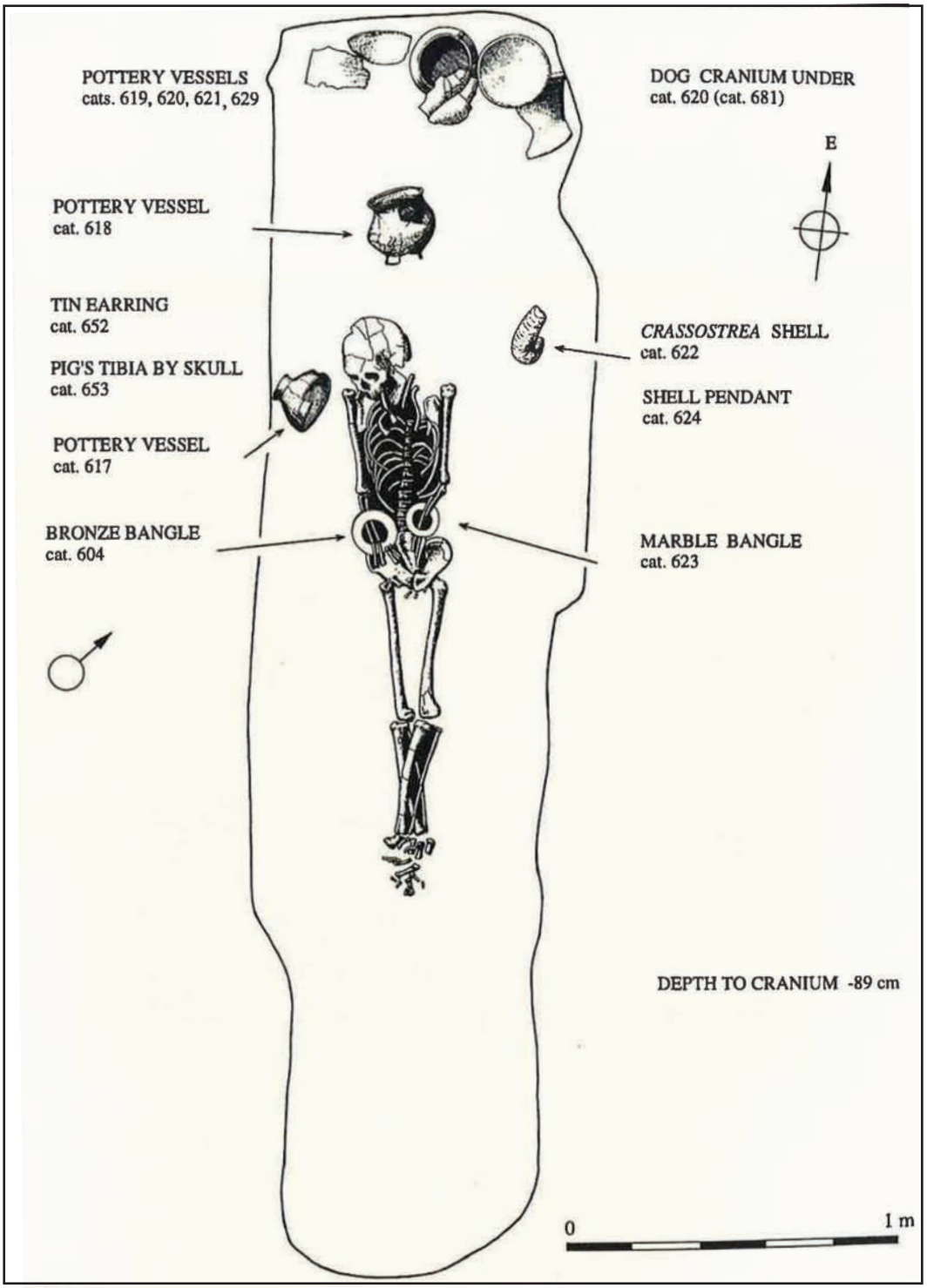


FIG.183. Burial 105

FIG. 184. Burial 106, looking east

Burial 106 *(above and opposite)*. N16-17, middle aged male, -70 cm, 80°. This man was interred with five pottery vessels beyond or in the vicinity of the cranium (cats. 631, 638, 651, 658 and 665), one of which had been smashed and parts distributed over the body (cat. 637). Three shell disc and three barrel shaped beads were recovered (cat. 558). The second phalanx of a pig had been placed beside the upper body (cat. 663) and there was some red ochre by the left femur (cat. 669). A form 1 marble bangle was recovered from over the chest (cat. 664). This burial was later than Bs 102 and 111.

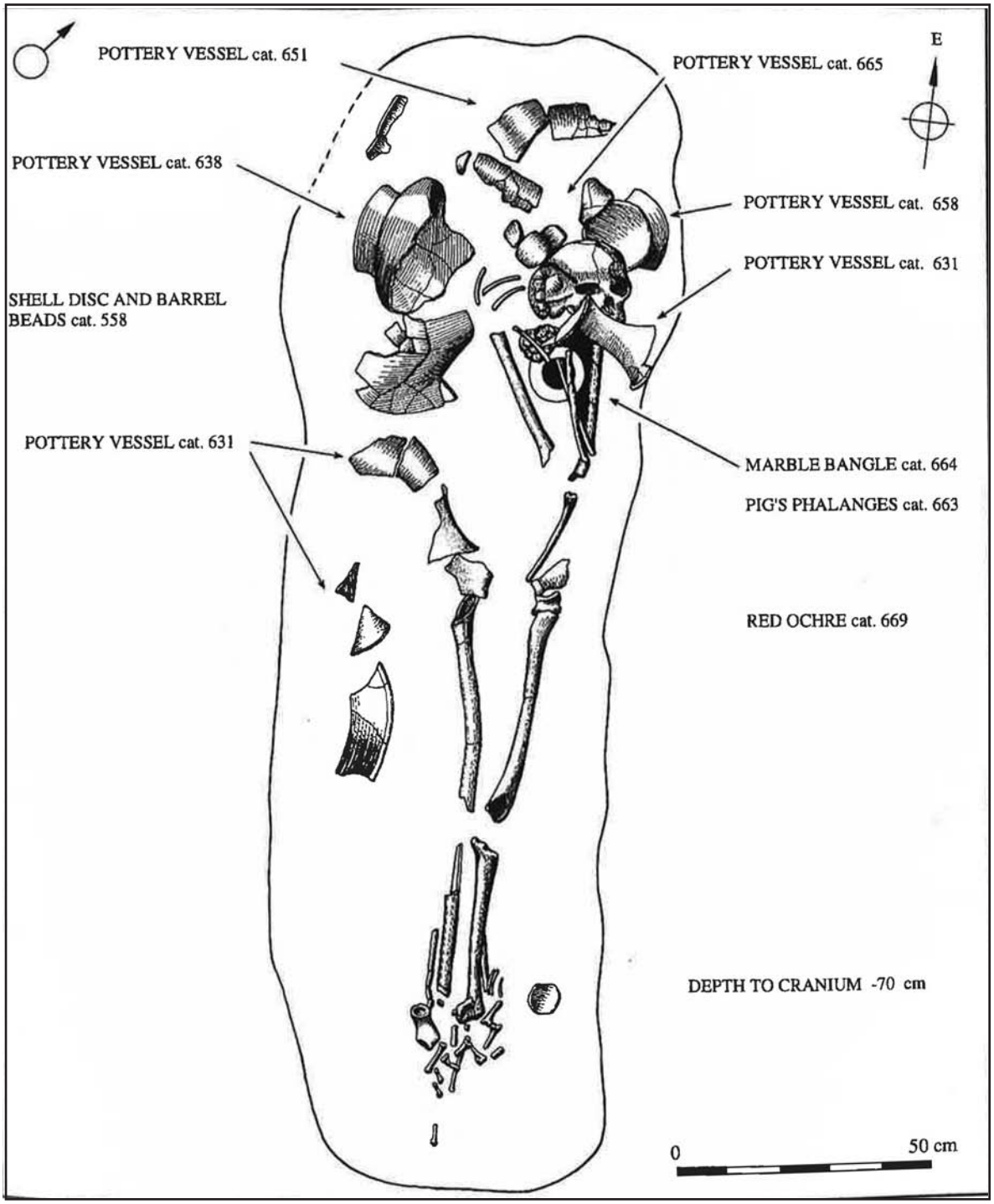


FIG. 185. Burial 106

FIG. 186. Burial 107, looking south, with part of burial 106 to the right

Burial 107 *(above and opposite)*. O-N18, young adult male, -83 cm, 170°. This burial has an unusual orientation, and precedes B 51. It is associated with eight pottery vessels, five of which are miniatures which lie in a row covering part of the head area (cats. 632-6). Two larger vessels lie beyond the head (cats. 640 and 643) and another pot was found beyond the feet (cat. 650). A pig's second phalanx had been placed under the right arm, where it was found with a fish bone (cats. 687-8). 326 shell disc and 16 barrel beads were found by the left, and 186 disc beads by the right arm (cats. 559, 667), and a further linear arrangement of 188 beads present over the pelvis. 458 shell disc and 60 barrel beads were in place round the neck (cats. 668, 670), the latter being associated with form 3 beads of serpentine and clay (cats. 674-5). A piece of chalcedony was present under the skeleton (cat. 673).

Burial 113. O18, middle aged adult, -75 cm. This burial was found in a particularly dense area of interments, and only the skull, femur and radius were recovered. It was almost certainly disturbed by later burials, such as Bs 112, 107, 106 and 114.

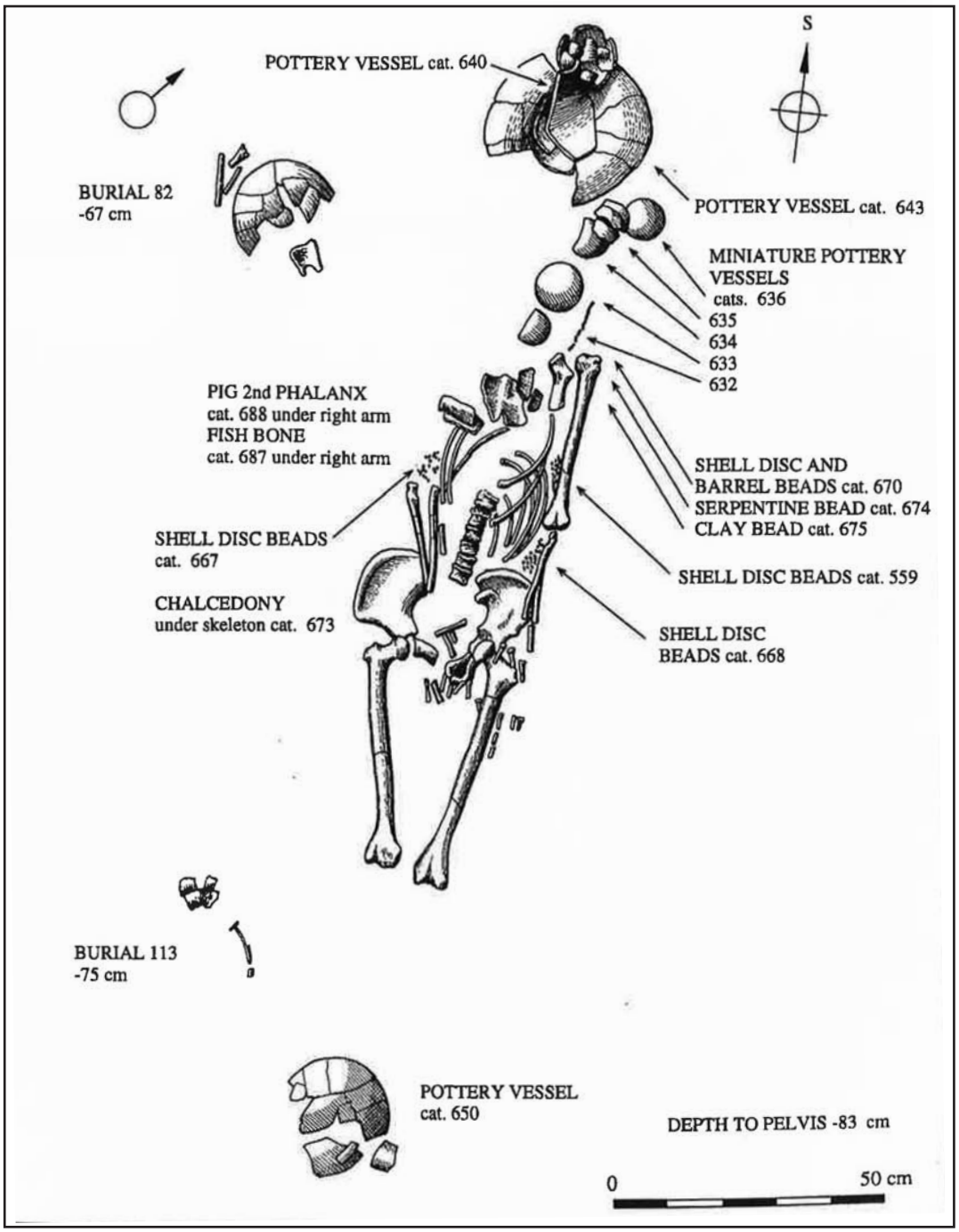


FIG. 187. Burials 107 and 113

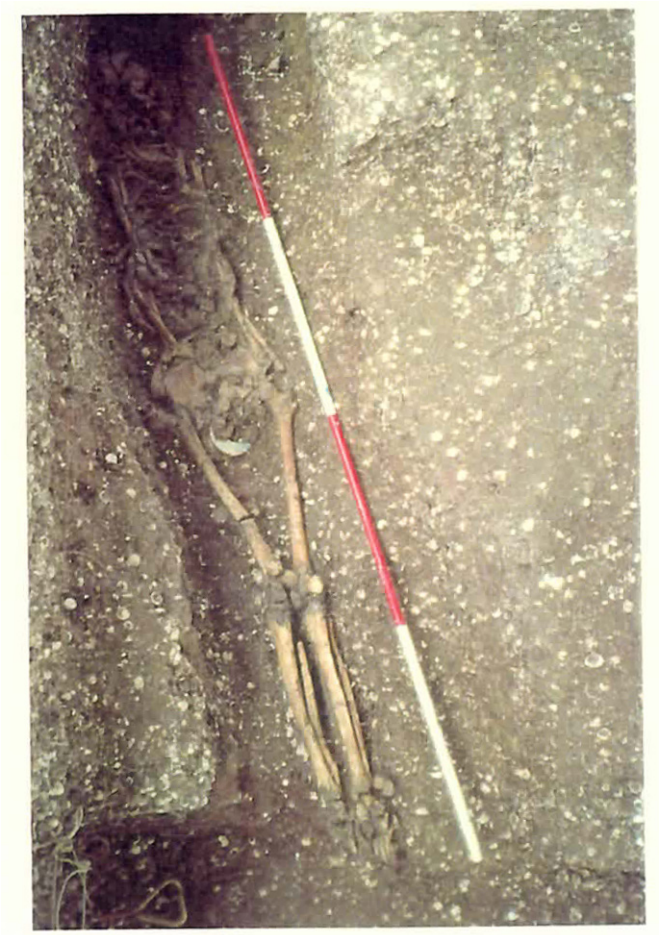


FIG.188. Burial 109, looking east. Note the loose shelly grave fill, while the skeleton lies on hard, compacted midden

Burial 109 *(above and opposite)*. R-Q17-18, mid adult male, -1.10 m, 75°. This skeleton was found within a deep grave cut right through the midden into natural. A concentration of *Crassostrea cucullata* valves was found beside the grave, which is later than B 122, but underlies Bs. 85, 65 and 75. It is associated with a series of pottery vessels, arranged in a circle round the head (cats. 682-3, 698, 1032-3) or beyond the head in the fill of the grave (cats. 611-3). One was also in the grave fill, over the abdomen (cat. 645). Four cone shells were placed in a line beyond the skull (cat. 686), and the first phalanx of a very young pig (cat. 705) was located next to the skull. A whetstone lay at the left shoulder (cat. 695), two more under the left hand (cats. 735-6) and a shark vertebra by the right hand (cat. 696). Ten shell disc beads were found in the area of the body (cat. 707), and other jewellery included a charred serpentine bangle which had been repaired with bronze cast in the form of wire and placed between the hands (cat. 697) and a shell neck pendant (cat. 742). A piece of worked stone lay beside the skull (cat. 699).

Burial 110. Q17, infant, -85 cm. This infant cranium was found within the grave fill for B 109.

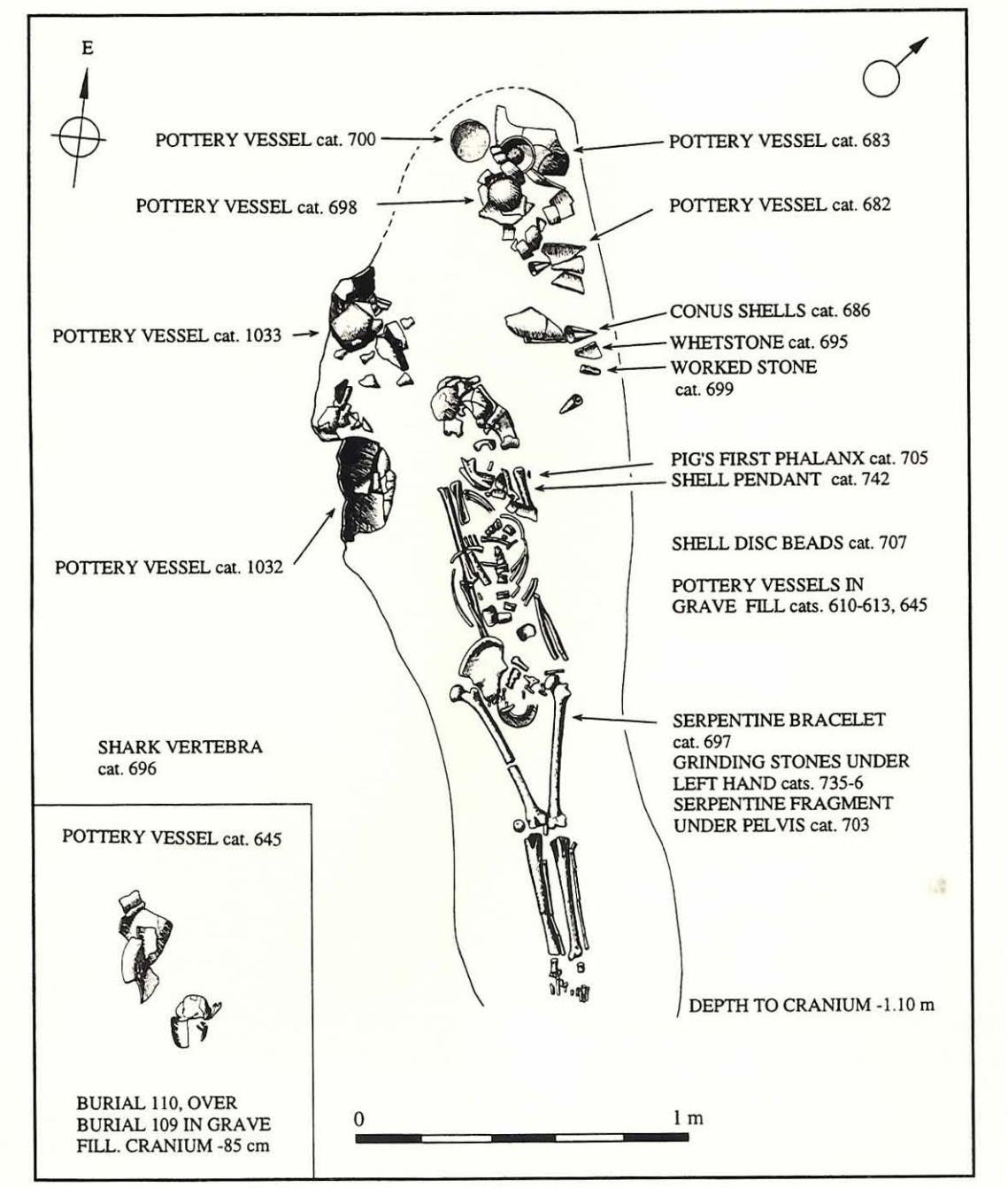


FIG. 189. Burials 109 and 110

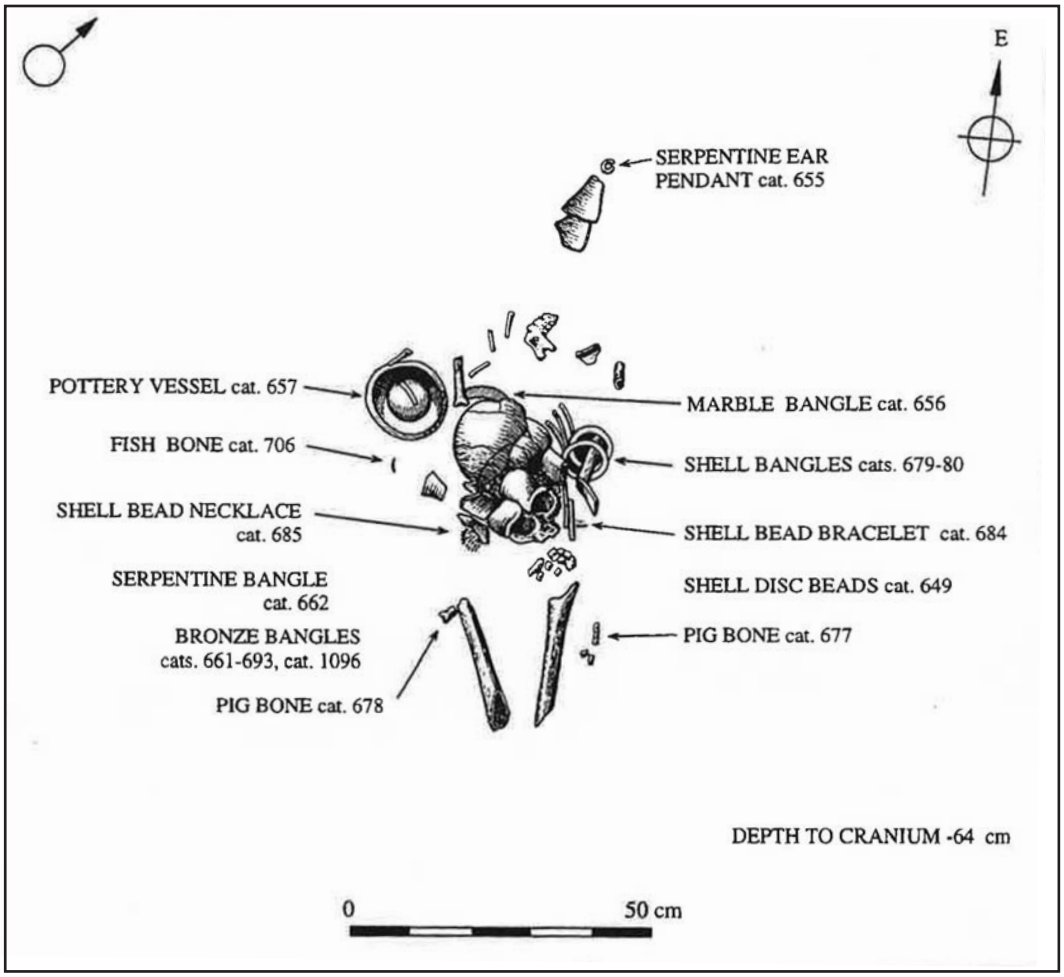


FIG. 190. Burial 111

Burial 111. O16, old male, -64 cm, 75°. This burial had been disturbed or reburied in antiquity probably with the interment of B 102. If this is the case, it lies at the beginning of a sequence of burials which progressed in an easterly direction and which included Bs 106, 107 and 51. The skull was then placed over the abdomen. Sherds which probably represent a pottery vessel was present near the skull (cat. 657), but this burial was notable for the quantity of jewellery in association. There were 15 shell disc beads in the general area of the human remains (cat. 649), as well as 106, indicating a possible shell disc bead bracelet, on the left wrist, and 257 representing a necklace (cats. 684-5). Two form 4 shell bangles were still present on the left (cats. 679-80), and a form 2 serpentine, a form 1 marble and two form 2 bronze examples were found on the right wrist (cats. 662, 656, 661 and 1096). A serpentine earring lay next to the skull (cat. 655). Pig bone had been placed beside the left and the right arms (cats. 677-8) and fish bone, possibly in association, underlay the body (cat. 706).

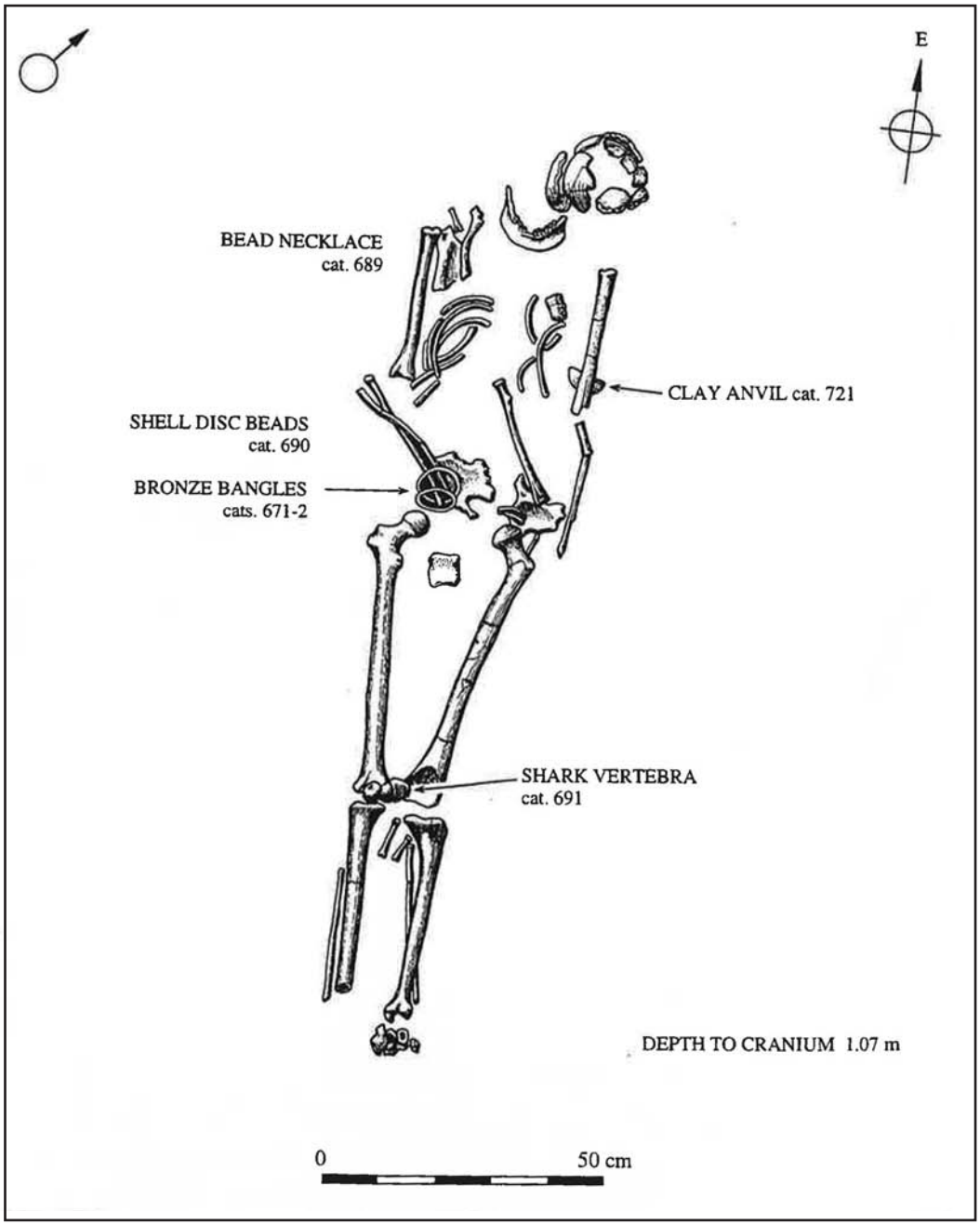


FIG. 191. Burial 112. O17-18, young male, -1.07 m, 85°. This complete burial was probably disturbed by B 114, and underlay Bs 76, 78 and 79. The man wore two form 2 bronze bangles on the right wrist (cats. 671-2) and a shell bead necklace comprising 8 disc and 11 barrel beads (cat. 689). Seventy-eight shell disc beads were found by the right arm (cat. 690). A shark vertebra was present beside the left knee (cat. 691) and half a clay anvil lay under the left arm (cat. 721).

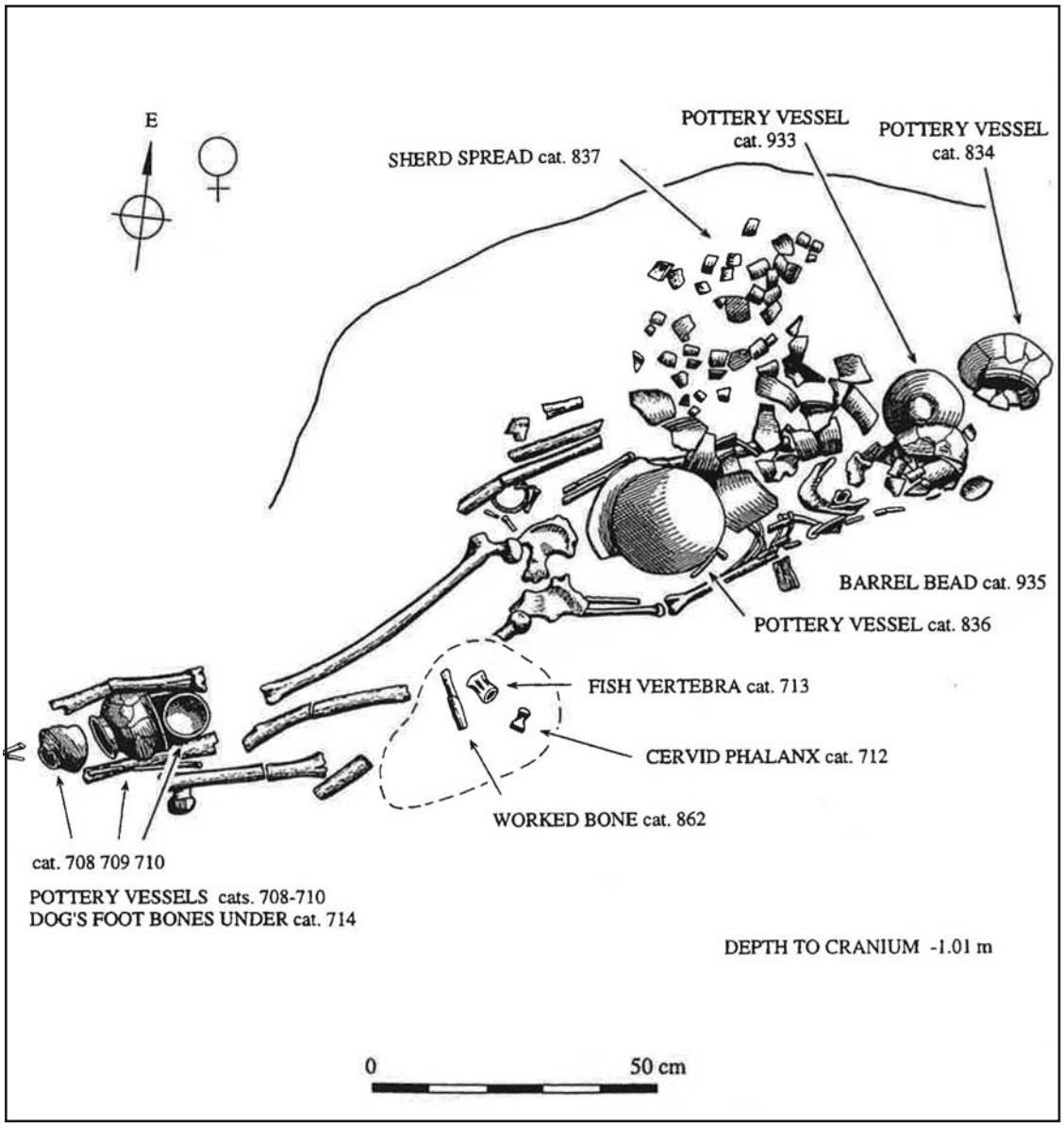


FIG. 192. Burial 114. O-N18, young female, -1.01 m, 140°. This burial is most unusual, as the body had been buried prone. Two whole pots were found beyond the head (cats. 834, 933) and a large vessel had been placed upside down over the abdomen (cat. 836), adjacent to a spread of sherds beside the left shoulder (cats. 837). Three further vessels were disposed in a row between the shins (cats. 708-10), under which there were articulating dog's foot bones (cat. 714). A barrel bead was found in the neck area (cat. 935). The second phalanx of a cervid and a large fish vertebra, possibly in association with the burial, were found in the same area (cats. 712-3). An item of worked bone was located in the vicinity of the left hand (cat. 862).

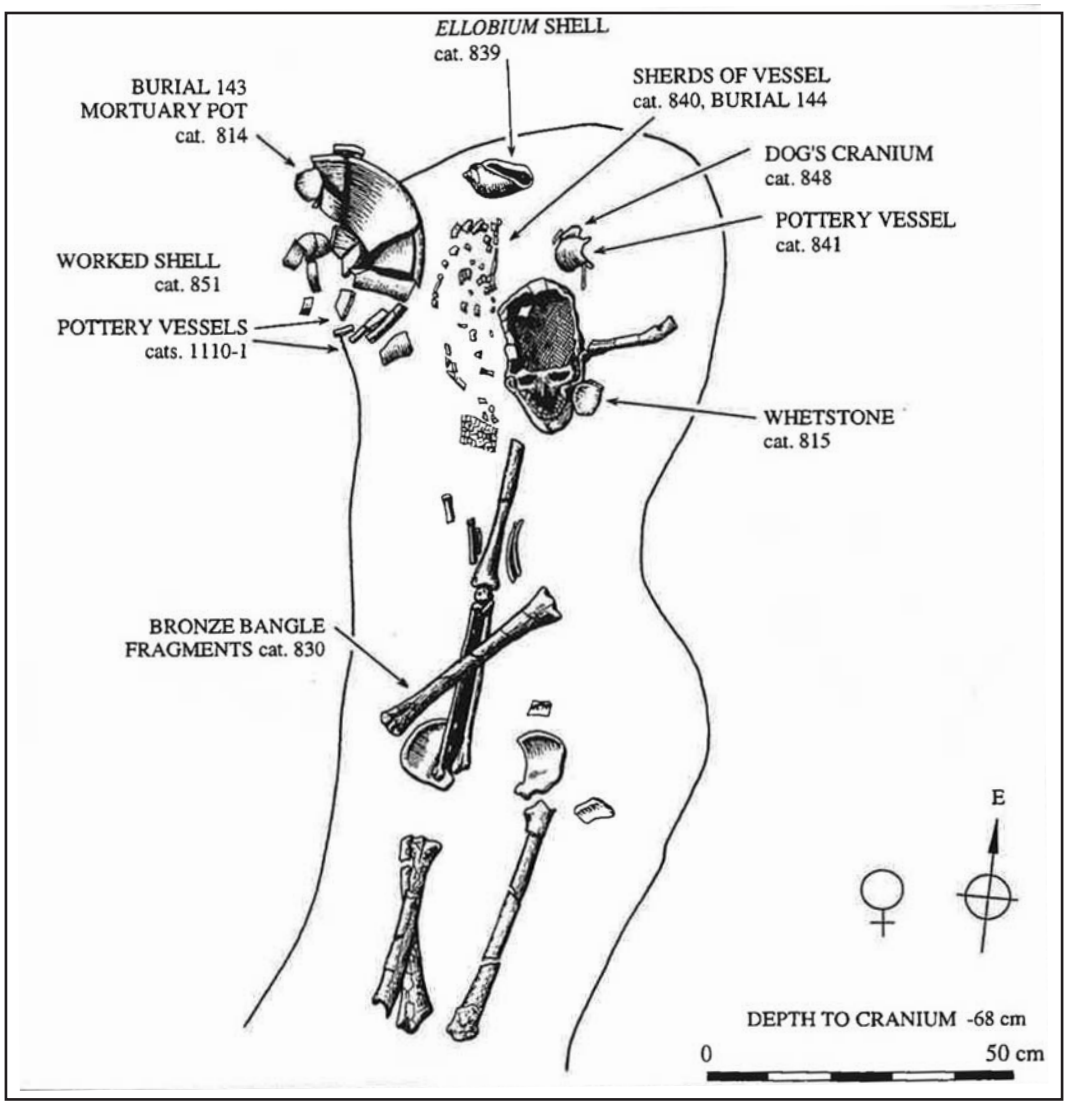


FIG. 193. Burials 116, 143 and 144

Burial 116. N21-2, middle aged female, -68 cm, 105°. This burial lay supine, possibly with the left hand crossed over the body. A miniature pottery vessel, a dog's cranium and a large *Ellobium aurismidae* gastropod shell lay beyond the head (cats. 841, 848, 839), and a whetstone lay adjacent to the skull (cat. 815). Two miniature vessels were found at the right shoulder (cats. 1110-1). A form 1 bronze bangle lay by the right wrist (cat. 830). The infant burial jars for Bs 143-4 were found just north of the skull.

Burial 143. N22, infant jar burial, -68 cm. This jar was found (cat. 814), next to that for B 144, at the right shoulder of B 116.

Burial 144. N22, infant jar burial, -68 cm. This jar was found (cat. 840), next to that for B 143, at the right shoulder of B 116.

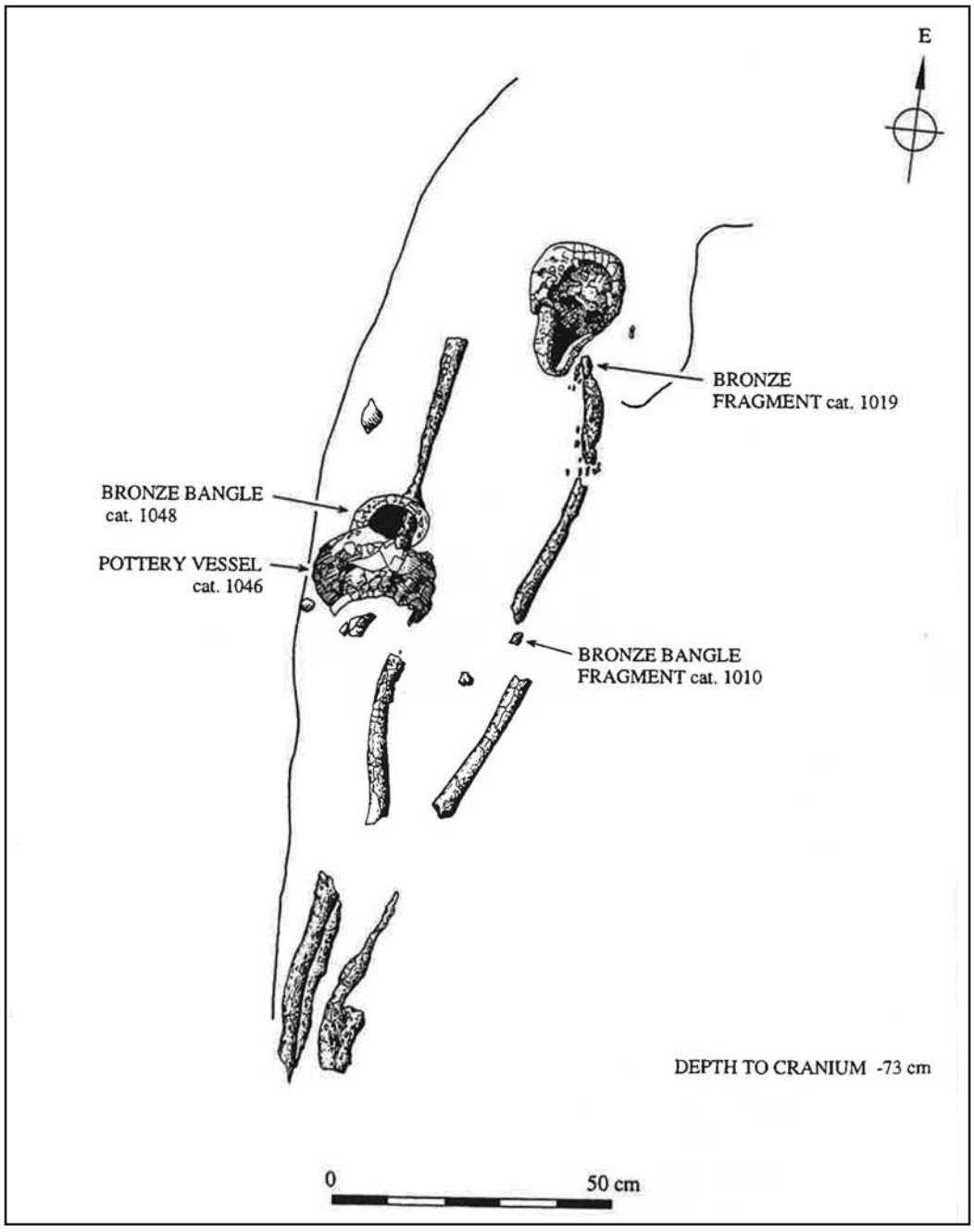


FIG. 194. Burial 117. T-U18-19, middle aged adult. -73 cm, 100°. Just off the shell midden area, the bone is very poorly preserved. Three items of bronze were identified: fragments of a bangle on the right wrist, part of a bangle near the left, and a fragment in the area of the neck (cats. 1048, 1010, 1019). A pottery vessel lay beside the right elbow (cat. 1046).

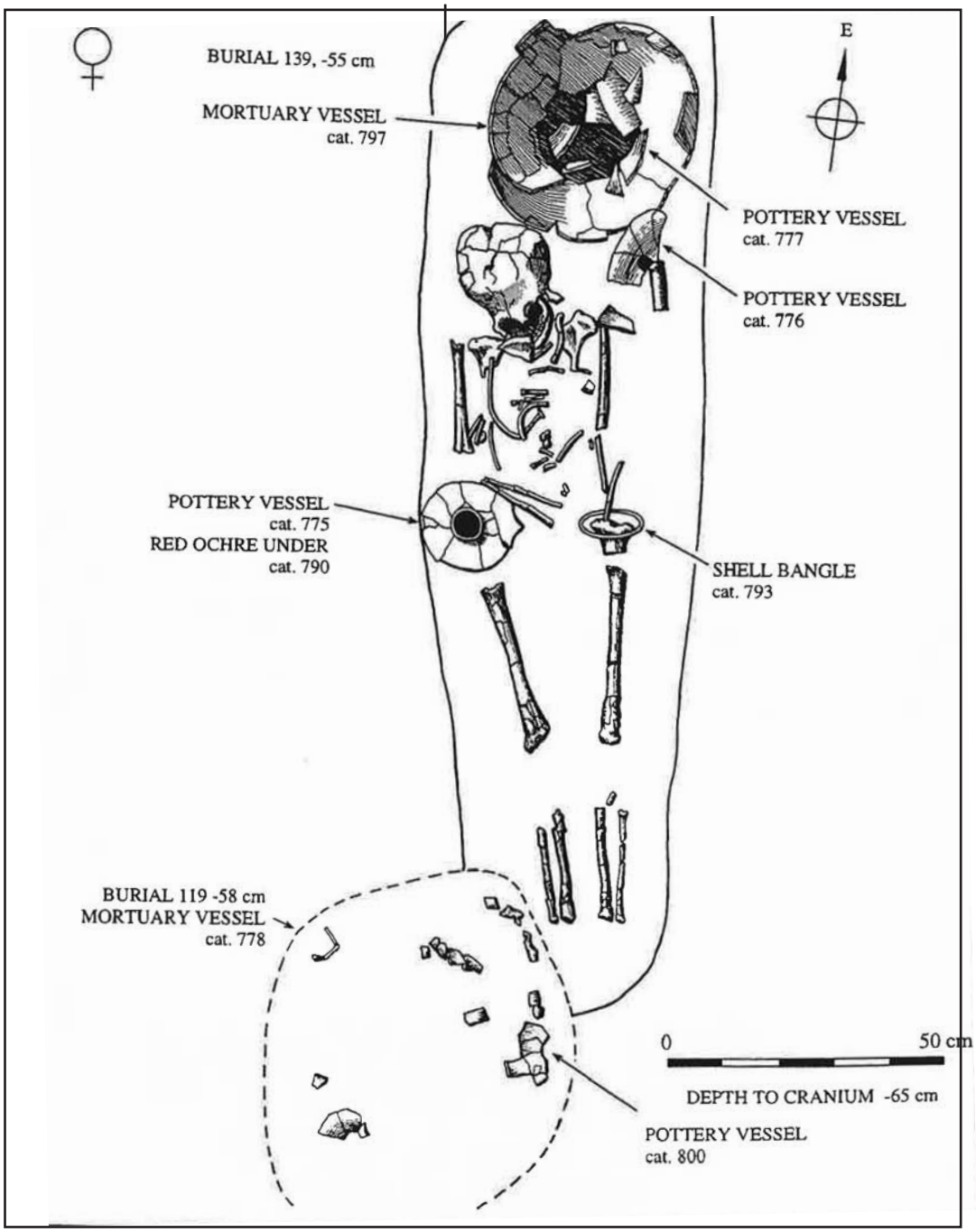


FIG. 195. Burial 118. R16-17, middle aged female, -65 cm, 70°. A pottery vessel lies beyond the head (cat. 777), with others beside the left shoulder (cat. 776), the right hand (cat. 775) and the right ankle (cat. 800). Some red ochre was found under the pelvis, and the woman wore a shell form 5 bangle on the left hand (cats. 790, 793). Burials 119 and 139, infant jar burials at the feet and shoulder of B 118 (cats. 778 and 797 respectively).

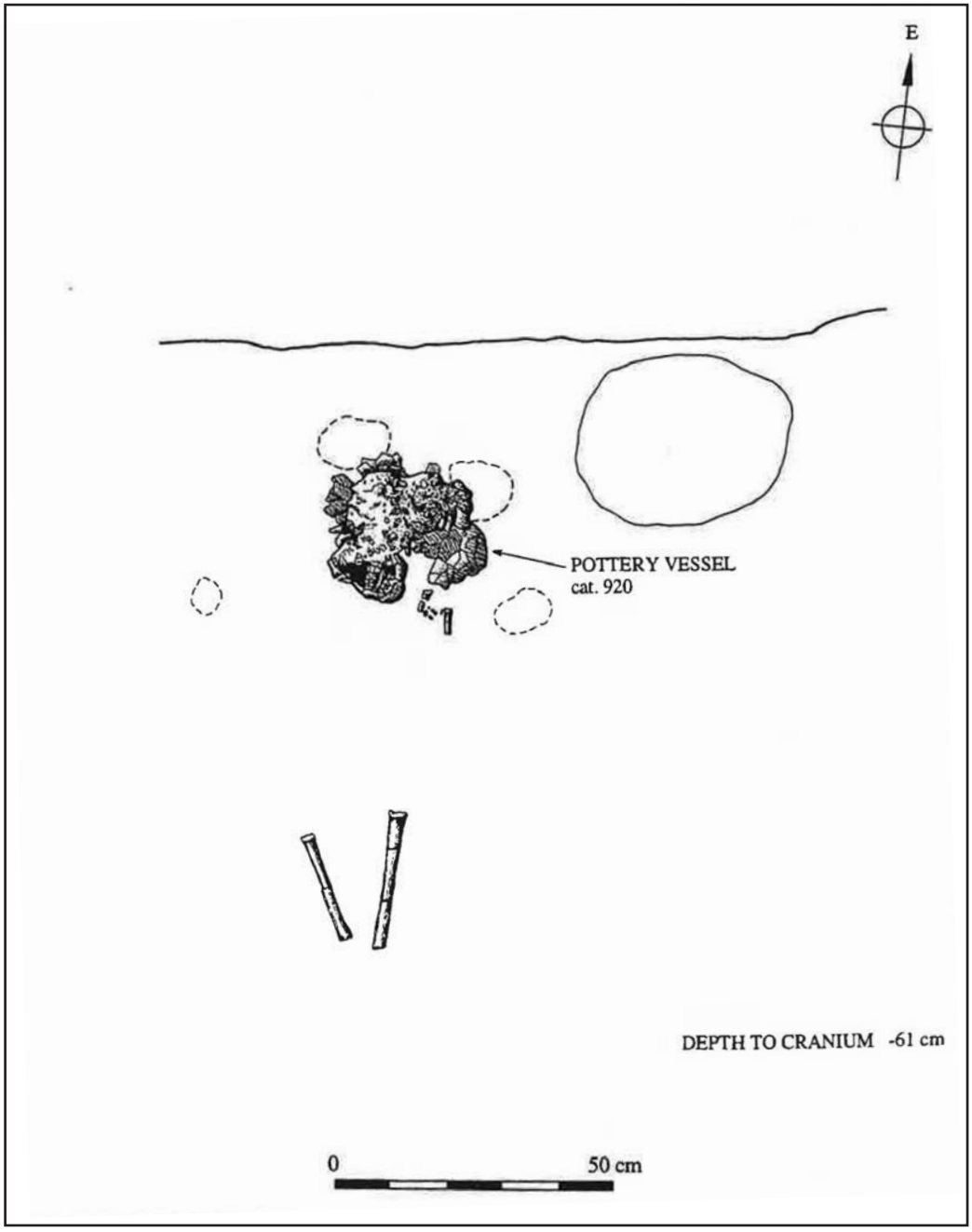


FIG. 196. Burial 120. S-R18, child, 12-15 years, -61 cm, 70°. The partial remains of the skeleton are associated with a single pottery vessel under the cranium (cat. 920).

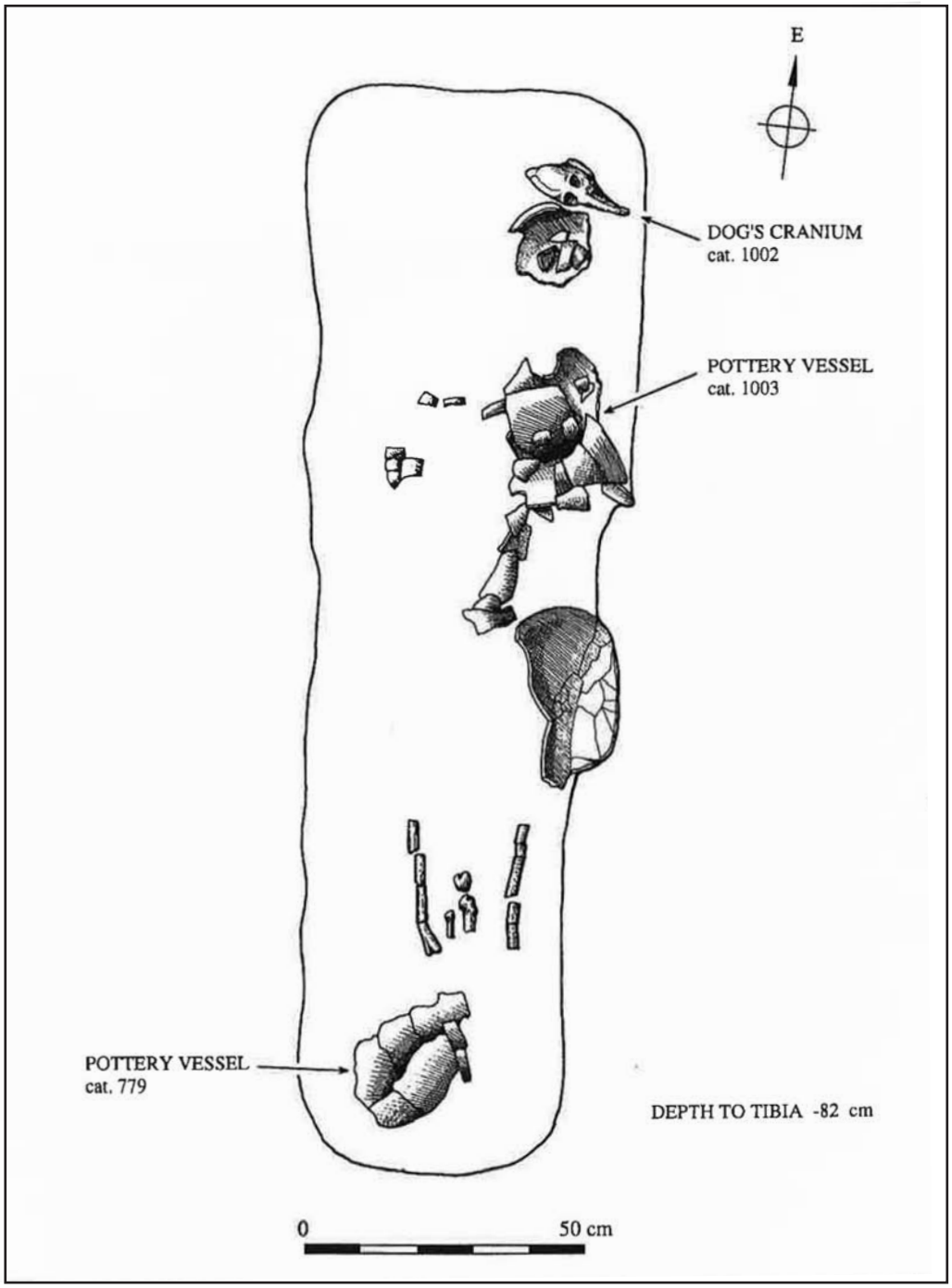


FIG. 197. Burial 122. R16-17, adult, -82 cm, 70°. A dog skull was in place beyond the human cranium (cat. 1002), and two pottery vessels are represented, one also beyond the cranium, the other over the ankles (cats. 1003, 779).

FIG. 198. Burials 123 and 125, looking south. Burial 127 lies beyond the grave for burial 125, and burial 126 is seen to the right

Burial 123 *(above and opposite)*. S-R20, middle aged female, -68 cm, 180°. This is one of three burials found on a north-south axis, each to some extent being disturbed by another. Eight pottery vessels were found in almost certain association. All were found beyond the cranium (cats. 761-3, 784-7 and 816). Animal bones were also located near the head: two mandibles of a young dog and a pig's humerus, scapula and first fore phalanx (cats. 822, 817). The man wore a form 1 nephrite earring which had been converted from a bangle with a T-section, and three shell disc beads were found in the chest area (cats. 805, 804). He also wore a form 2 marble bangle on the right wrist (cats. 802). A burnishing stone and the fragment of an anvil were located among the pottery vessels beyond the head, and there was a sandstone abrader by the left arm (cats. 764, 765 and 923).

Burial 125. S20, middle aged female, -75 cm, 155°. This body was disturbed with the burial of B 123. No grave goods can be ascribed to it with certainty, although some of the pots which lie beyond the head of B 123 might have been associated.

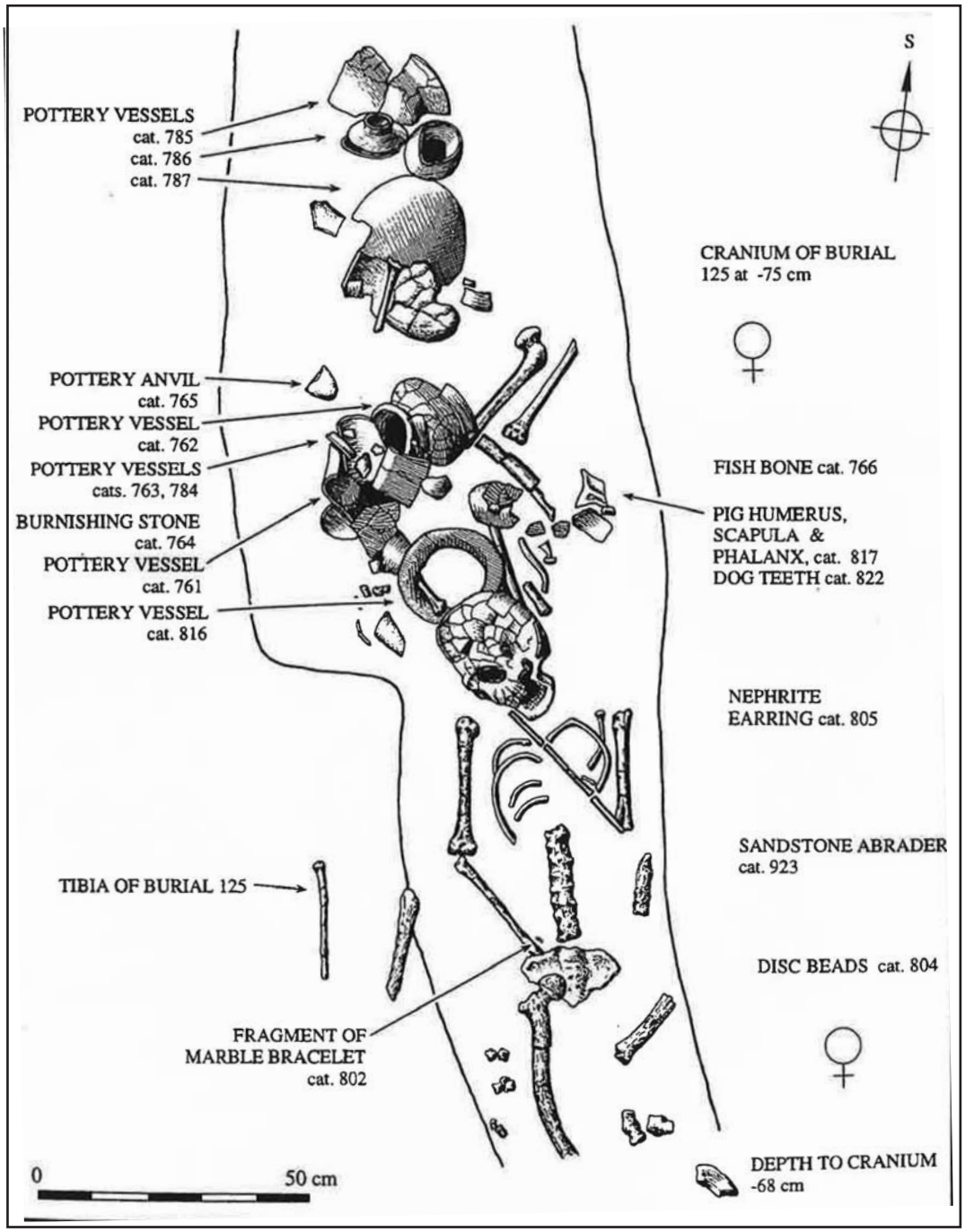


FIG. 199. Burials 123 and 125

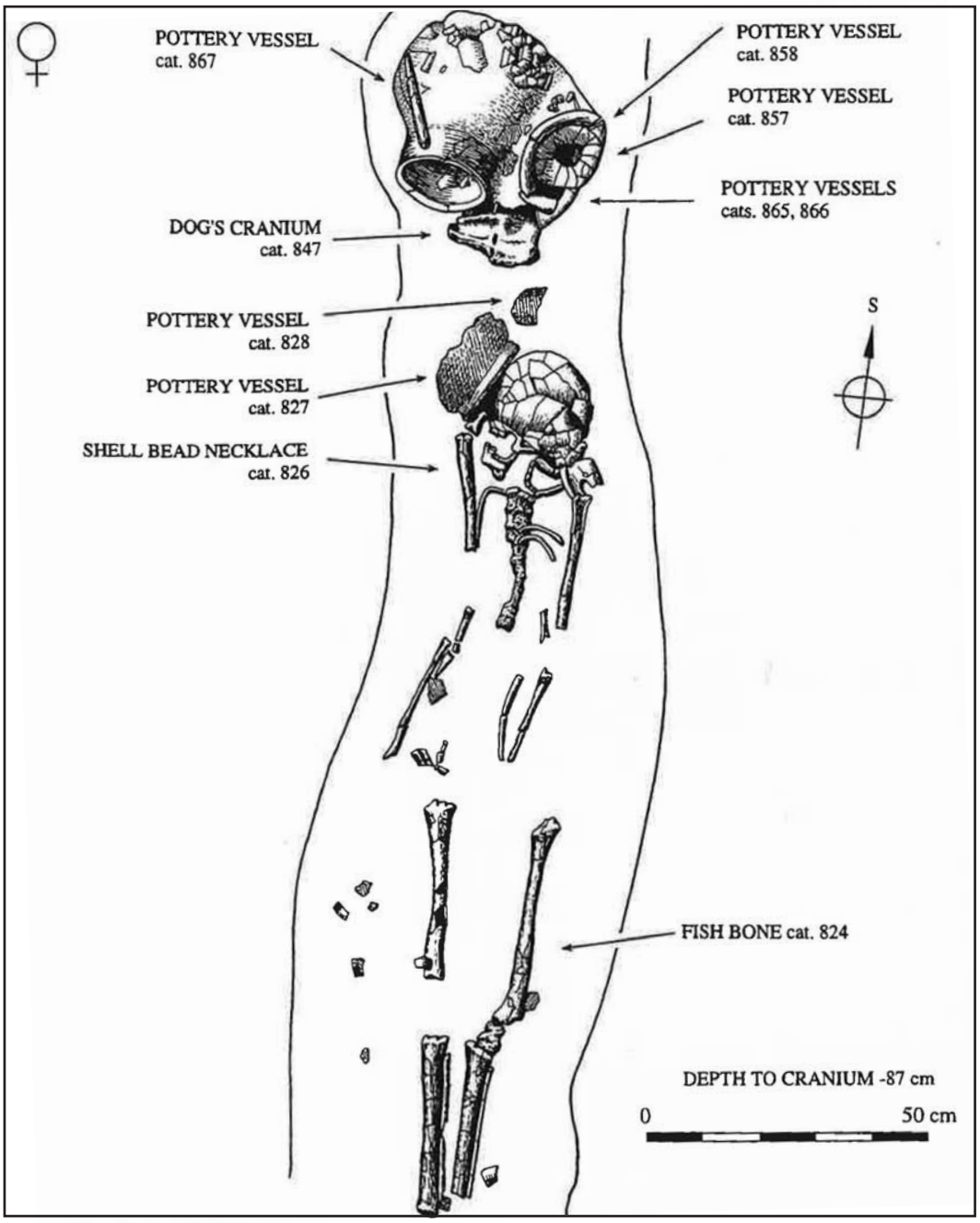


FIG. 200. Burial 126. S-R19, middle aged female, -87 cm, 180°. The grave lies parallel and alongside that for B 123. Seven complete pots were recovered, all from the vicinity or just beyond the cranium (cats. 827-8, 857-8, 865-7). A dog's cranium was found in the same area (cat. 847) and five shell barrel beads lay in the neck area (cat. 826). Some fish bone, possibly associated with the burial, were recovered beside the left femur (cat. 824). The burial cut into and is later than B 141.

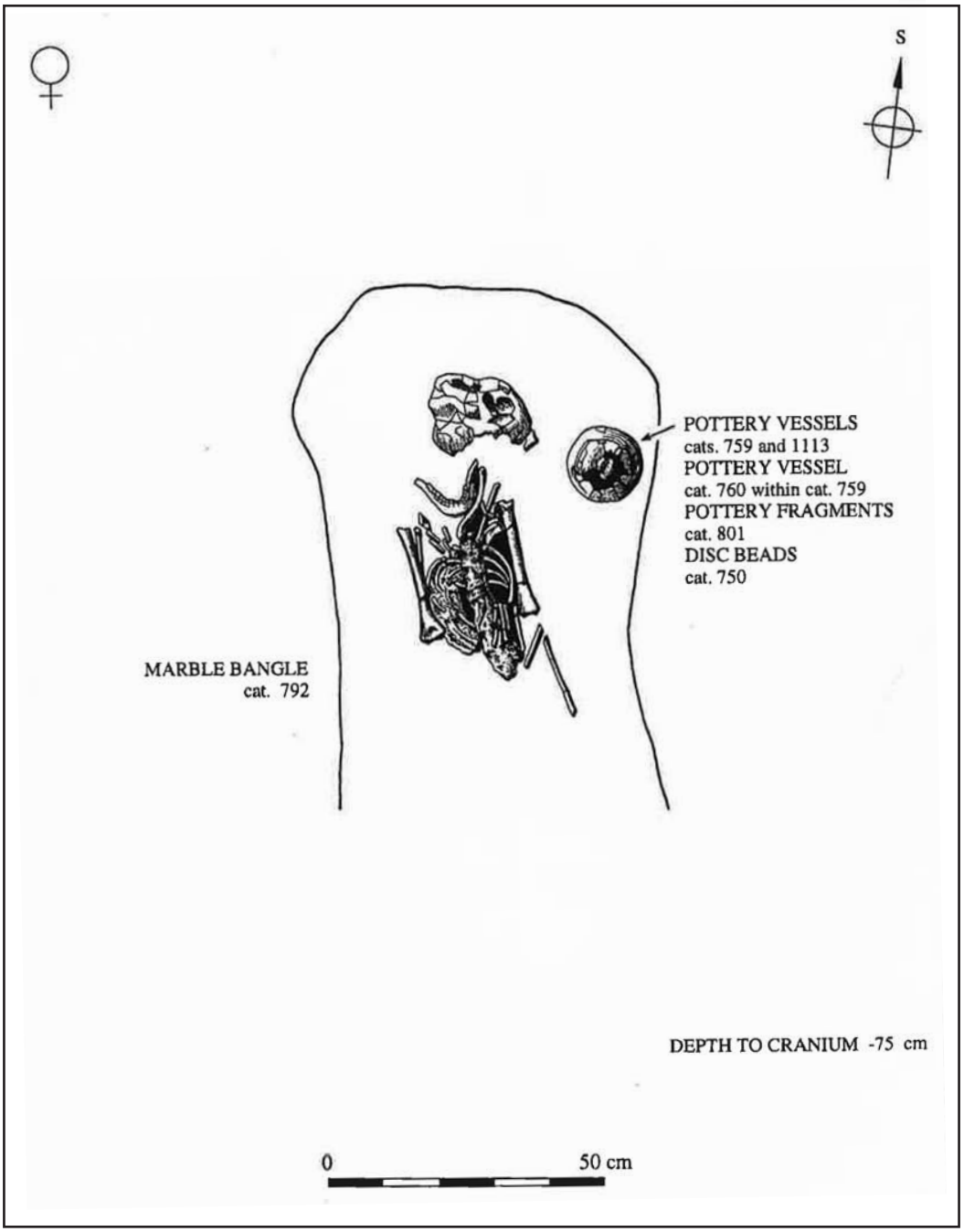


FIG. 201. Burial 127. R-Q20, middle aged female, -75 cm, 180°. The grave lies to the south of Bs 123 and 126, and may have been disturbed by either or both, because the lower limbs are missing. In turn, this grave cut into B 141. Four pots have been found, all in the vicinity of the cranium (cats. 759-60, 801, 1113). A form 2 marble bangle lay in the region of the hands (cat. 792), and 40 shell disc beads were present at the left shoulder (cat. 750).

FIG. 202. Burials 128, 129 and 130, looking east

Burial 128. S13-14, young adult, -58 cm. An extremely disarticulated burial, lying above the level of the shell midden. The base of a pottery vessel was probably associated (cat. 782), and there was also an impressive assemblage of bangles in the area of the human remains: a form 1 and two form 4 examples of shell (cats. 746-7, 794) and three form 1 examples in marble (cats. 752-3, 755). Fifty shell disc beads and a canid mandible were also found (cats. 749, 754).

Burial 129. T13-14, young male, -61 cm, 85°. Like B 128, this interment lies above the shell midden and is very fragmentary. Two pottery vessels were found, one near the area of the right hand and the other beyond the cranium (cats. 758 and 783). A group of three grinding or abrading stones was located left of the head (cats. 772-4). There was also a pig's second phalanx and a dog's mandible (cats. 756-7).

Burial 130. T12, infant, -60 cm. A group of infant bones by the feet of B 129. A small form 6 shell bangle in this area might belong to this interment (cat. 748).

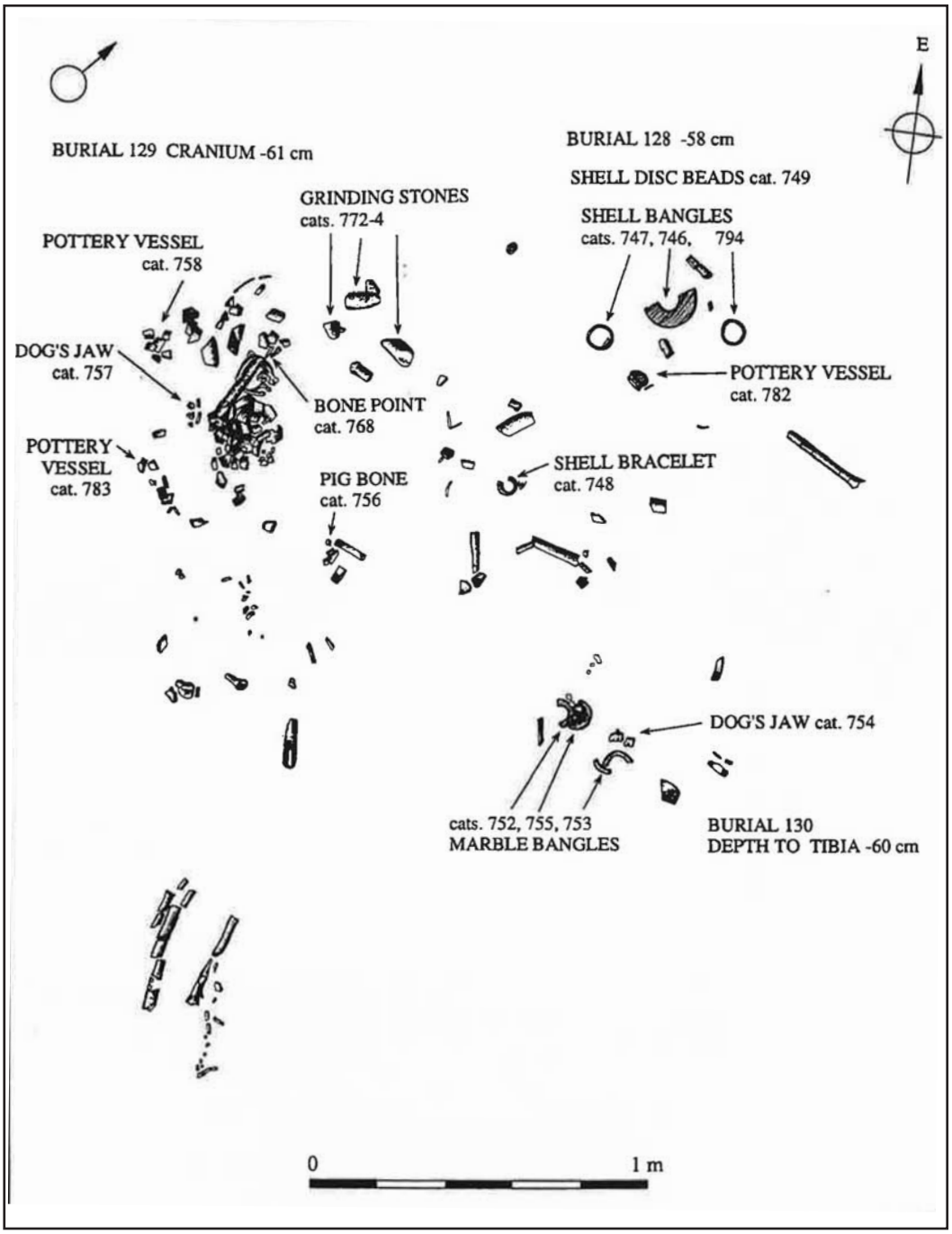


FIG. 203. Burials 128 and 129 and 130

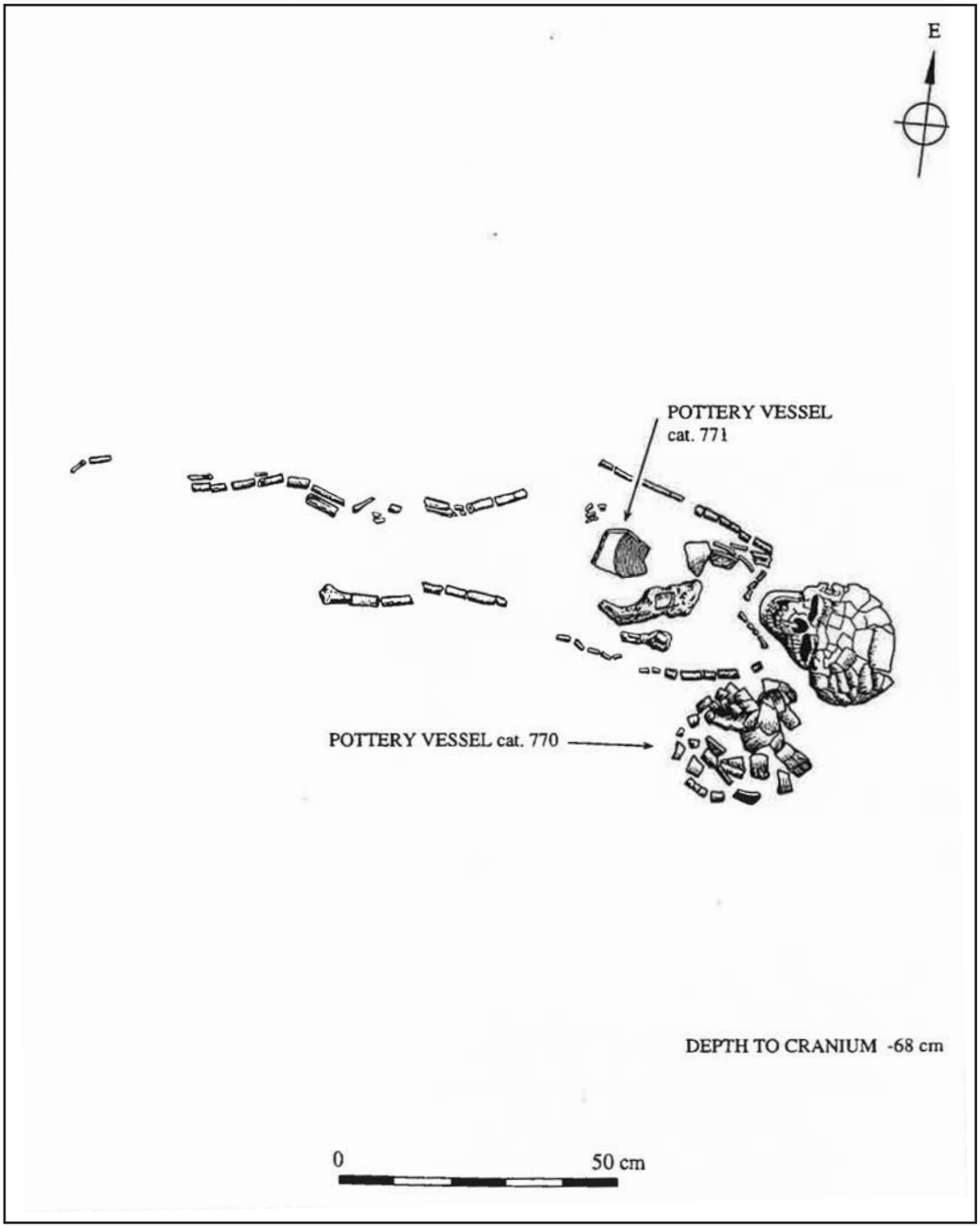


FIG. 204. Burial 131. T-S8-9, 11-12 year-old child, -68 cm, 200°. This is a further example of a burial stratified above the level of the shell midden. The child was interred alongside and parallel with B137 at the northern edge of the excavated area, associated with two pottery vessels, (cats. 770-1. One was placed over the chest, the other beside the head.

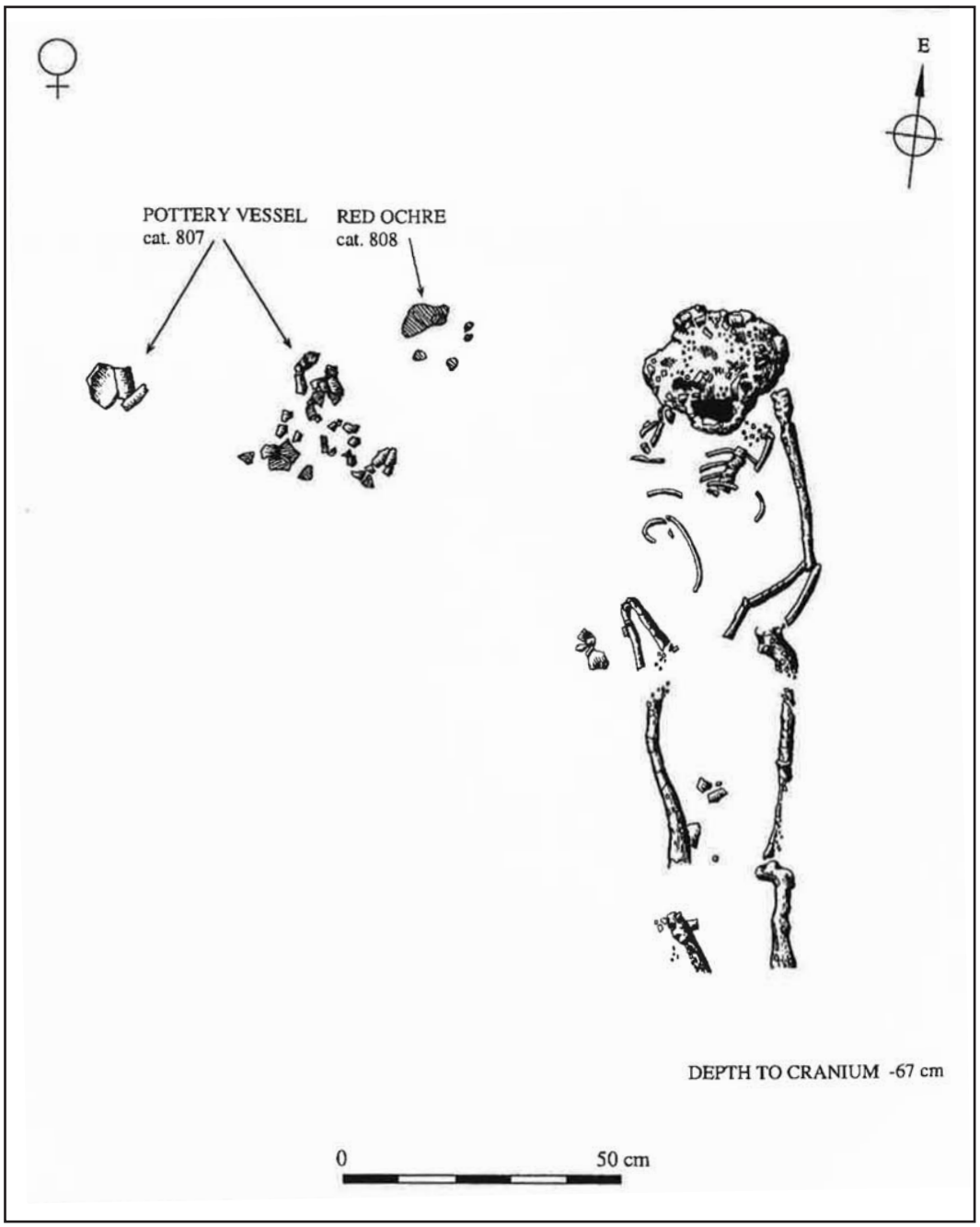


FIG. 205. Burial 132. R6-7, middle aged female, -67 cm, 80°. Burial 132 is the most northerly interment in a row which stretches at least 17 m to B 5 at the southern extremity. A pottery vessel, (cat. 807, lies about a metre to the north, and some red ochre was present among the sherds.

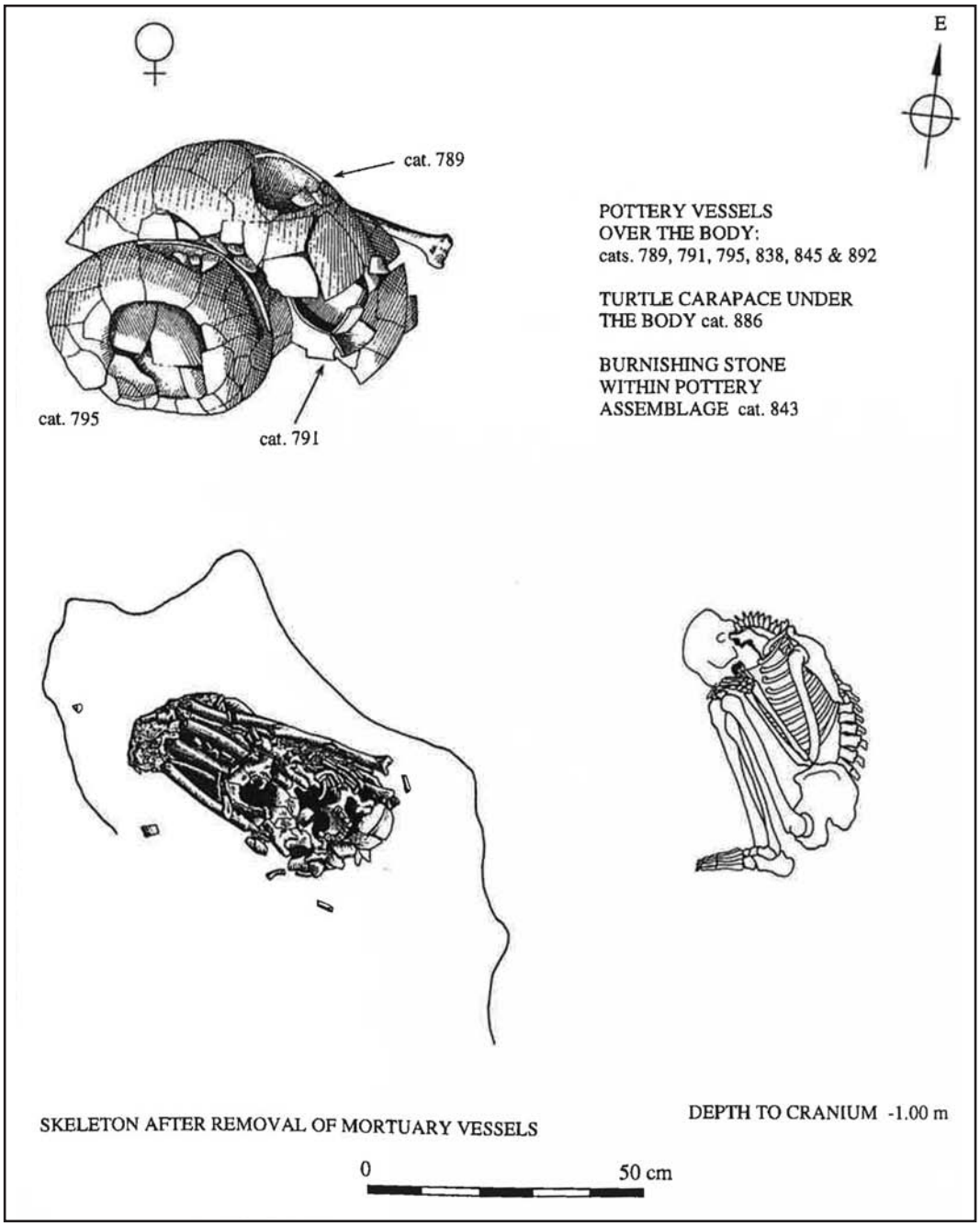


FIG. 206. Burial 133. T16, old female, -1.00 m. This is a unique burial in terms of the treatment of the body. The corpse was interred in an upright squatting position, under six pottery vessels (cats. 789, 791, 795, 838, 845 and 892). A turtle carapace fragment was found under the body, and a burnishing stone was incorporated among the pots (cats. 886, 843). This entire assemblage lay over the surface of the shell midden. It is considered highly likely that this burial dates to phase 1 (*c*. 2450 B.C.).

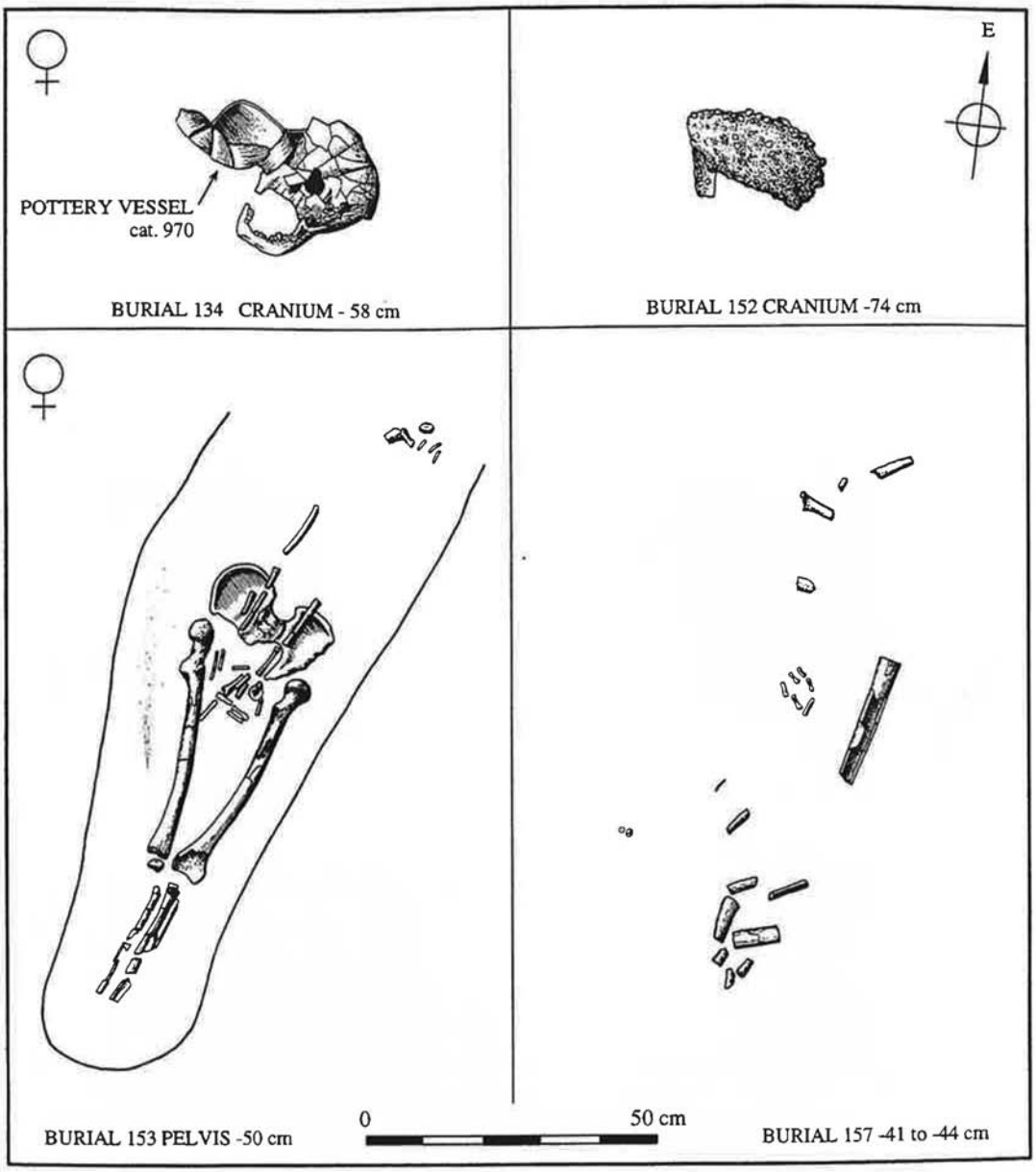


FIG. 207. Burials 134, 152, 153 and 157

Burial 134. O24, young female, -58 cm. Just the cranium survived, together with a pottery vessel (cat. 970). Burial 152. T-U18, young adult, -84 cm. Only the skull was present, lying just east of the grave for B 145. Burial 153. M24-5, middle aged female, -50 cm, 115°. No grave goods were found in association with this interment, which lies on the same axis and just beyond the eastern edge of B 135, that of a young child. Burial 157. K2-3, middle aged adult, - 49 cm, 90°. A very fragmentary skeleton with no grave goods.

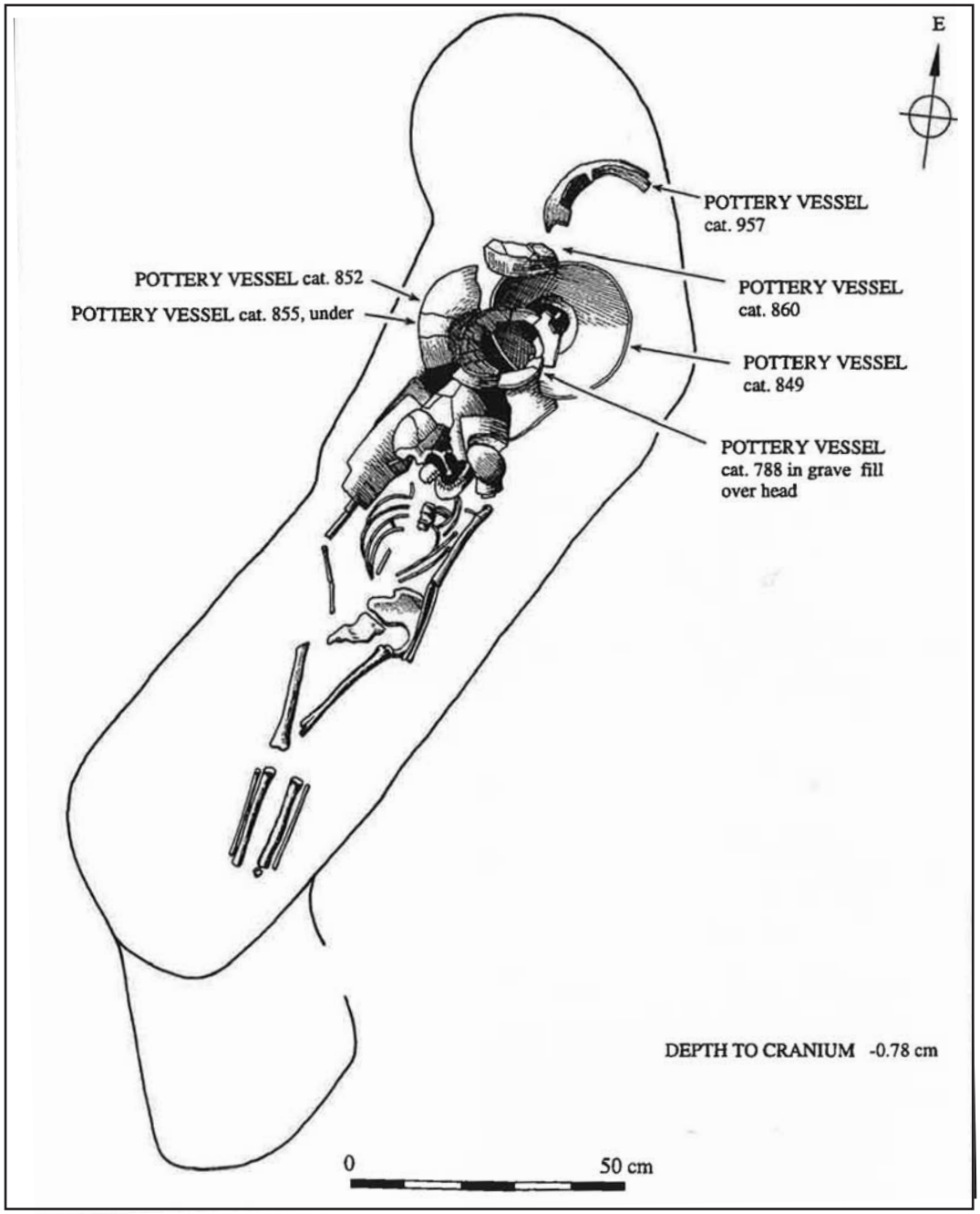


FIG. 208. Burial 135. N23, 4-6 year-old child, -78 cm, 120°. A complete interment, the child was associated with at least six pottery vessels clustering over and beyond the cranium (cats. 788, 849, 852, 855, 860 and 957).

FIG. 209. Burial 136, looking west. Burial 138 lies beyond the cranium, and burial 140 is seen to the right.

Burial 136 *(above and overleaf)*. O21-2, old male, -86 cm, 75°. A pottery vessel lay beyond the cranium (cat. 863). A clay anvil was found to the left of the cranium (cat. 891) and 28 shell disc and a barrel bead recovered from the abdomen area (cat. 781). The man wore a form 2 marble bangle on his right wrist (cat. 890), and was accompanied by some pig's bones beyond the head (cat. 907). During laboratory cleaning, a tiger and nine canid canines were found round the neck, in the form of a necklace (cat. 1116).

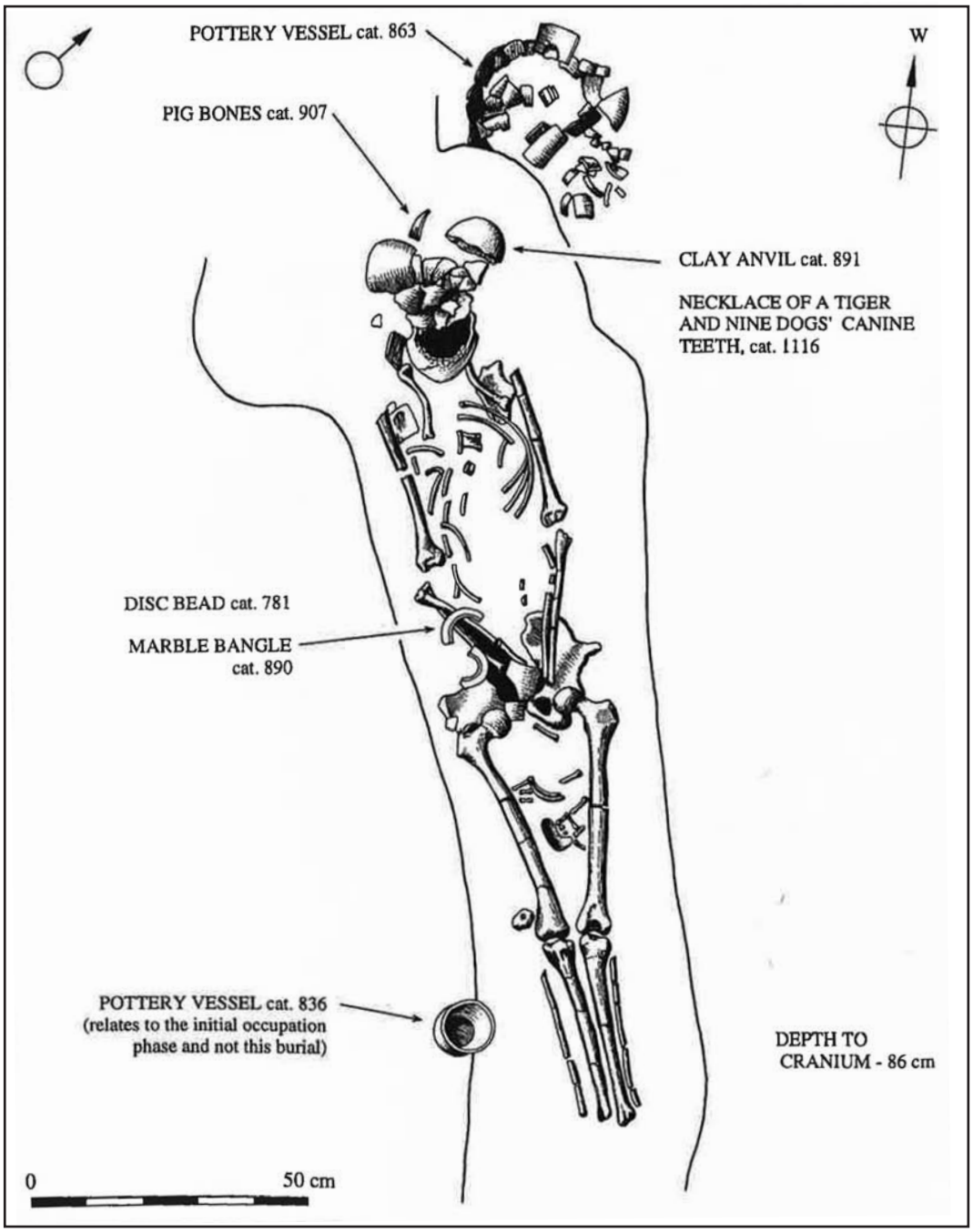


FIG. 210. Burial 136

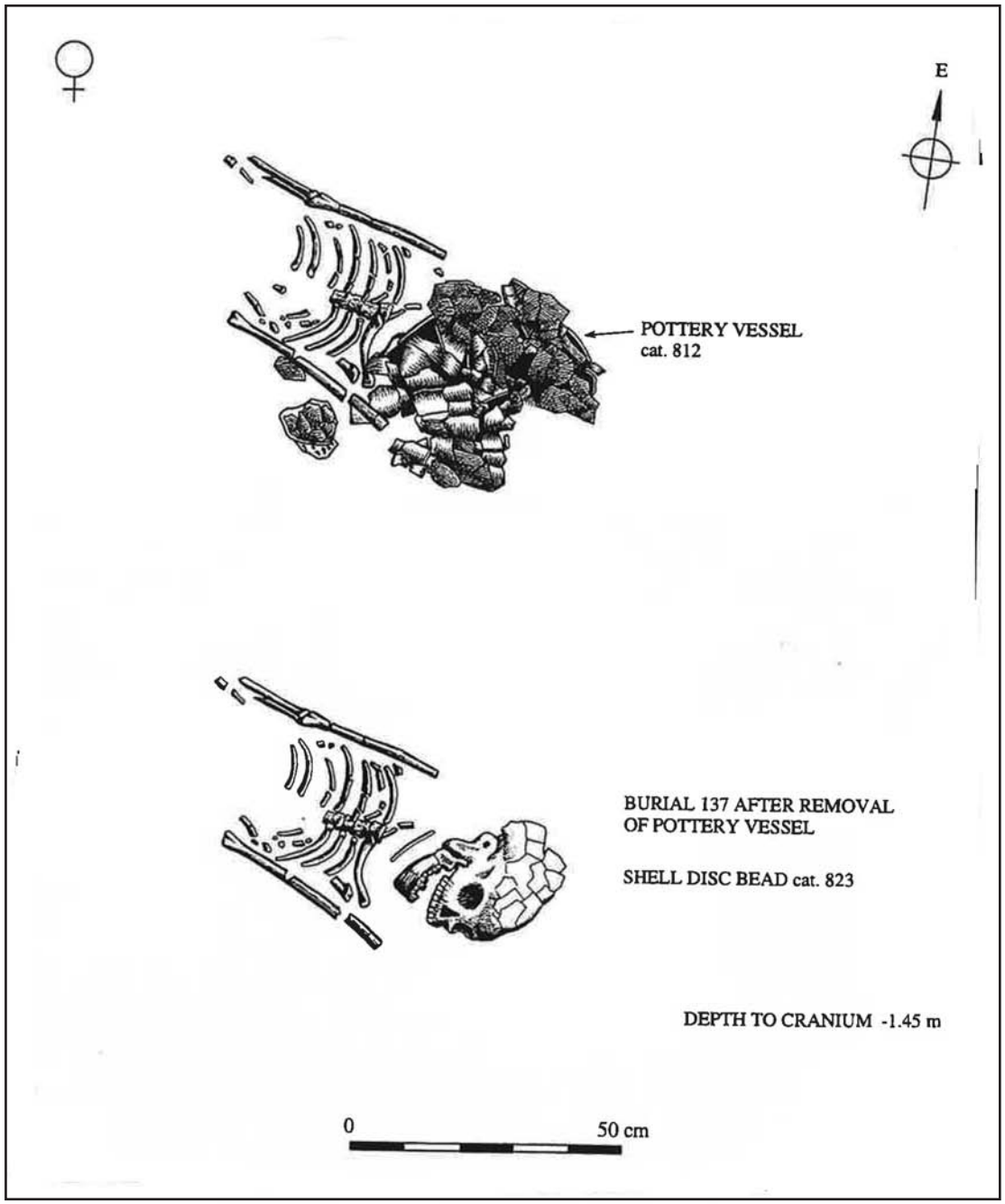


FIG. 211. Burial 137. T8, middle aged female, -1.45 m, 210°. One of the lowest graves encountered, this burial lay over the shell midden next to B 131 but in the opposite orientation. Only the upper body was present in the area excavated, and a pottery vessel lay over the skull (cat. 812). One disc bead was found in the neck area (cat. 823).

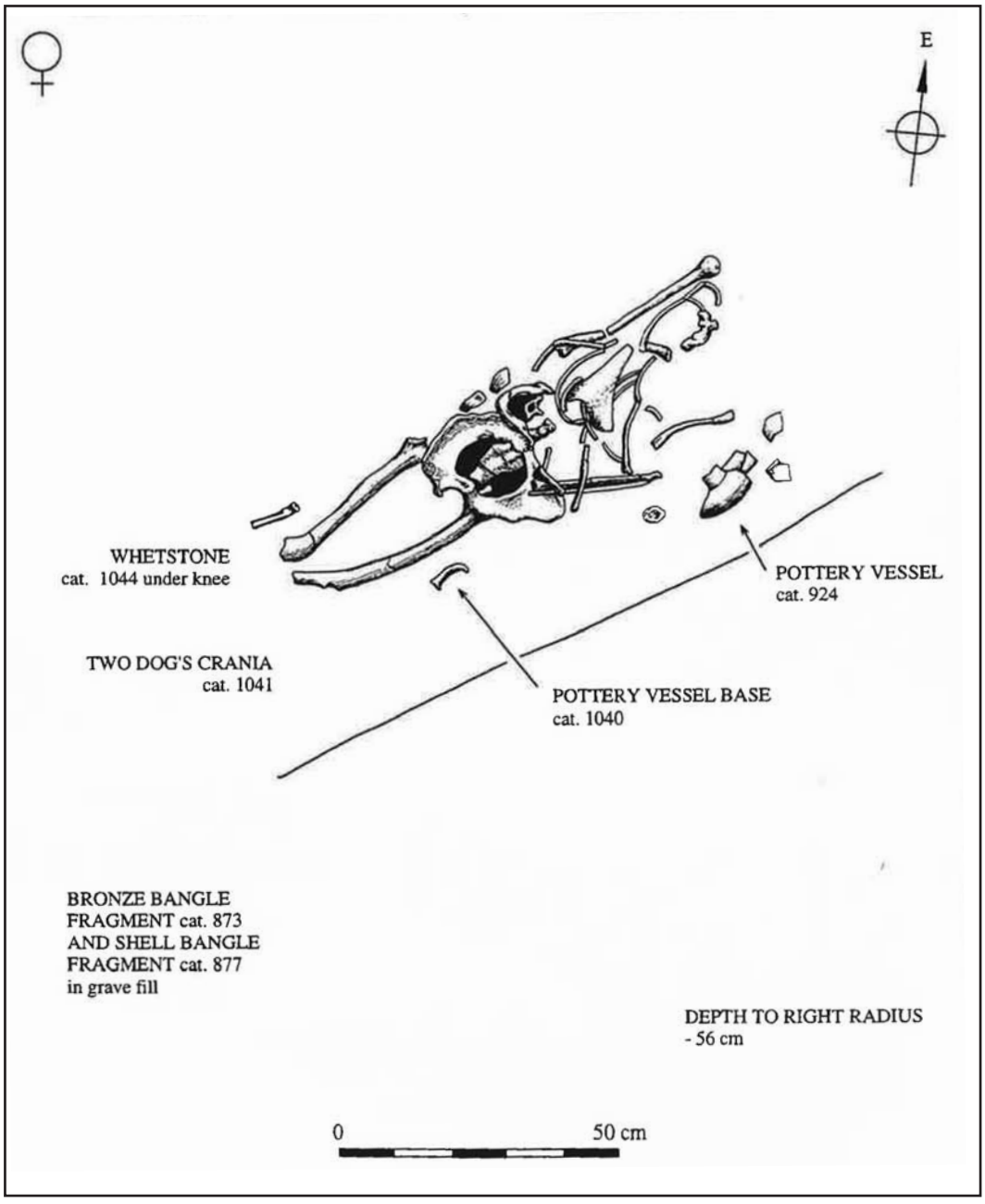


FIG. 212. Burial 138. O20, middle aged female, -56 cm, 150°. This burial was probably later than Bs 140 and 136. It was found in a disturbed condition, but still associated with two pottery vessels (cats. 924 and 1040), two dog's crania (cat. 1041) and a whetstone under the right knee (cat. 1044). A fragment of a form 1 bronze bangle and a form 3 shell bangle was recovered from the grave fill (cats. 873, 877), but this area had a dense concentration of burials, and their association remains in doubt.

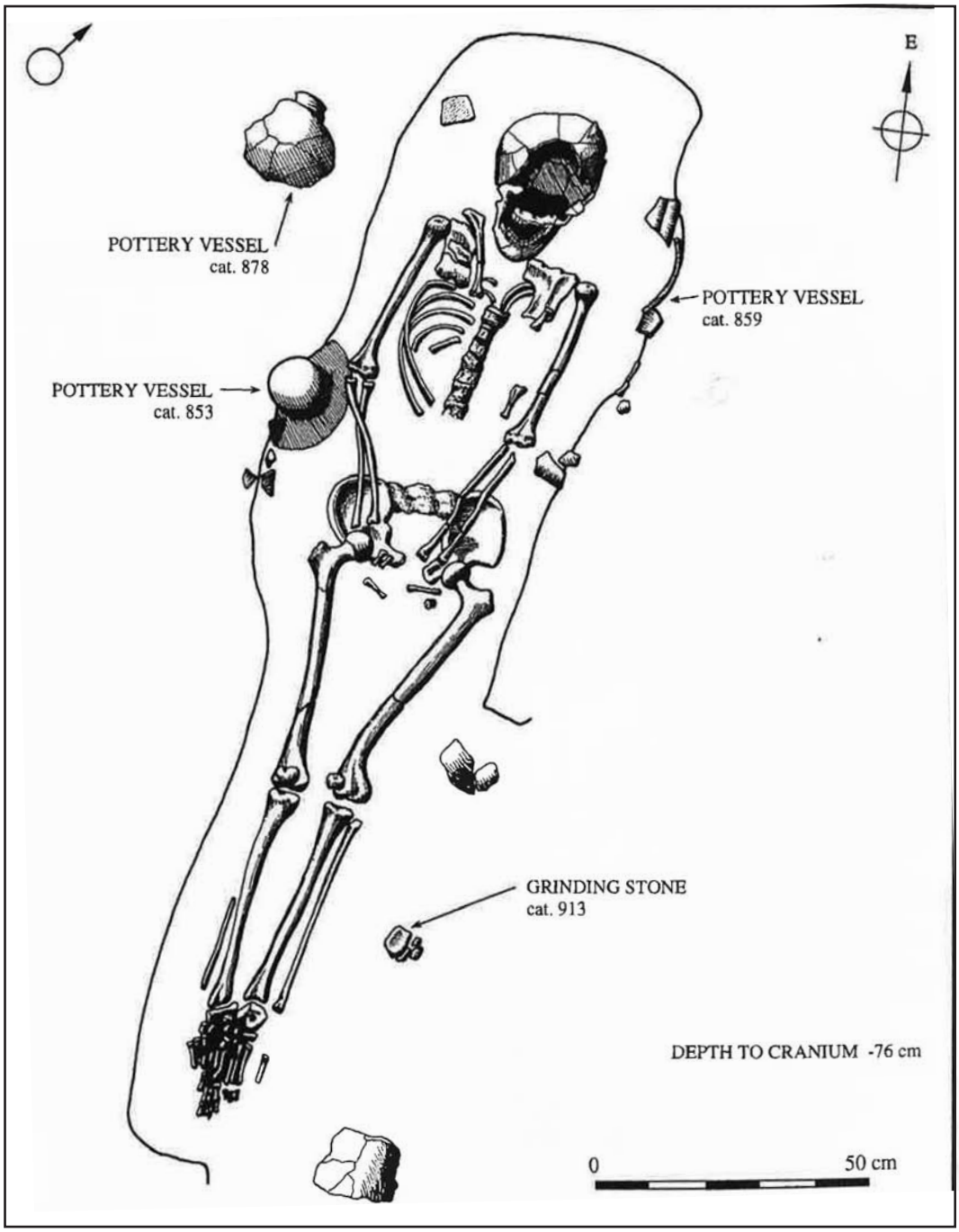


FIG. 213. Burial 140. P20-1, middle aged male, -76 cm, 100°. This grave probably cut into that for B 138. Three pottery vessels were associated, located the left and right of the arms and to the right of the skull (cats. 859, 853 and 878). A grinding stone was found beside the left leg (cat. 913).

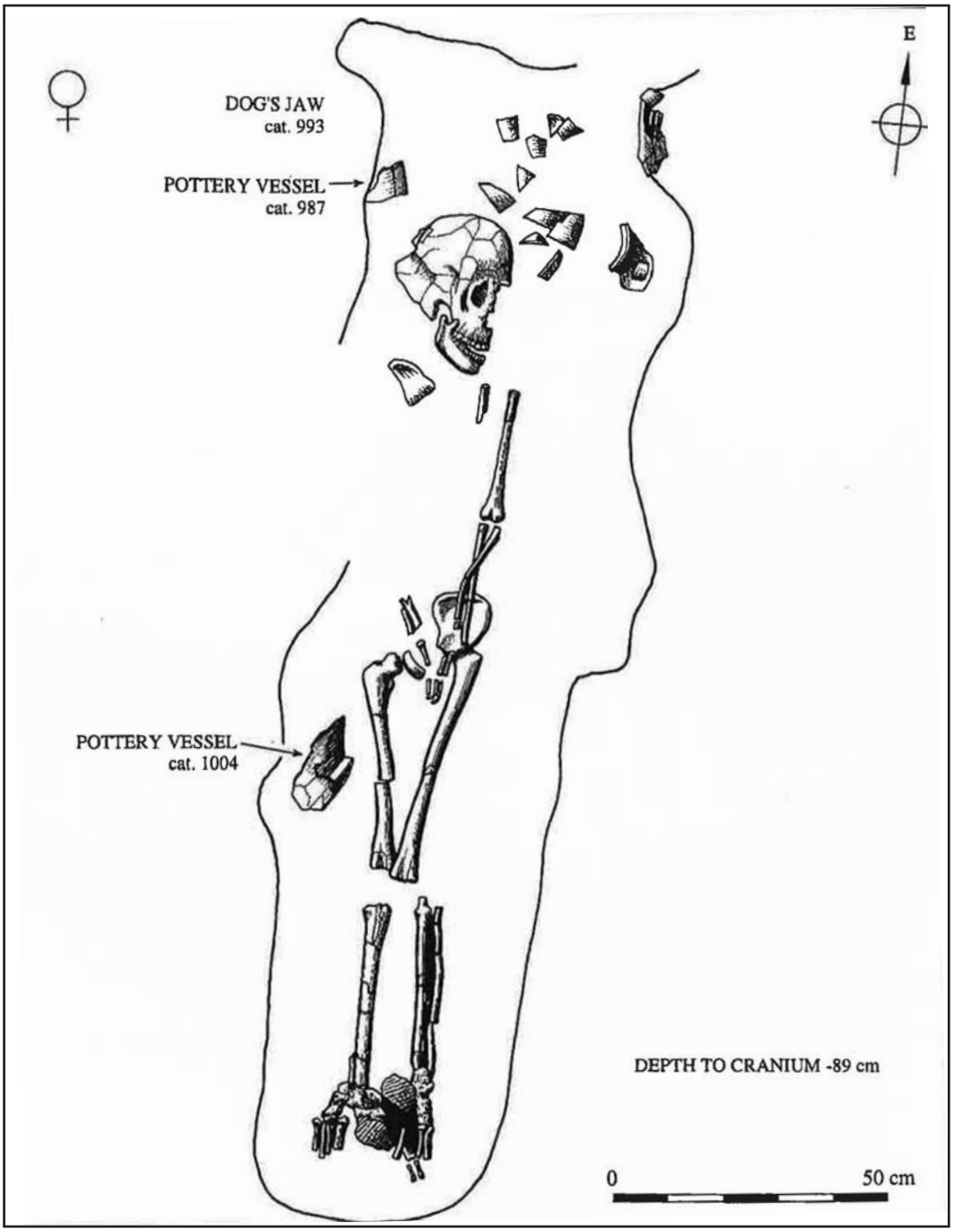


FIG. 214. Burial 141. Q18-19, young female, -89 cm, 80°. This burial lies under B 124, and precedes B 126. Some grave goods might have been lost with this disturbance. A painted pottery vessel lay in pieces beyond and beside the head, and a dog's cranium and mandible were found in the same area (cats. 987 and 993). A second pot was found beside the right thigh (cat. 1004).

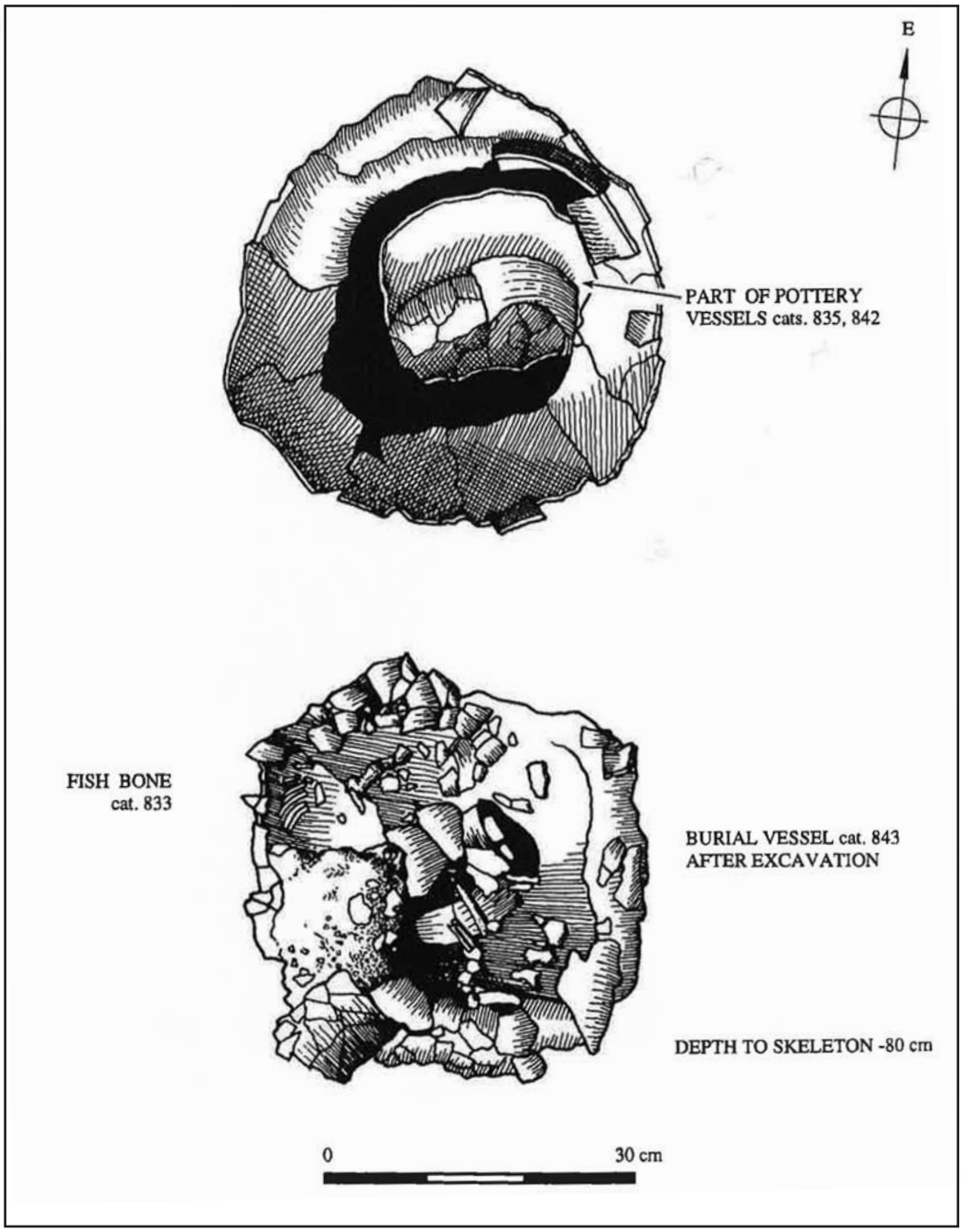


FIG. 215. Burial 142. Q22, 6-month-old infant, -80 cm. An infant jar burial (cat. 843), found containing some fish bone (cat. 833) and associated with two other pedestalled vessels (cats. 835, 842). It is not in any obvious association with an adult burial, as is often the case with such infant jar burials.

FIG. 216. Burial 145 looking west, detail showing the cranium and bull's horns

Burial 145 *(above and the following two pages)*. U-T16-17, young male, -1.09 m, 135°. This man lay in a grave clearly visible as it cut through the shell midden. Eight miniature pots were grouped within the grave fill (cats. 901-6, 908-9). One vessel lay to the right and another to the left of the skull (cats. 922, 942), and a bowl was found at the left shoulder, extending over the chest (cat. 928). A further pot was found upturned over the ankles (cat. 931). A striking feature of this burial, was the set of bovid horns placed round the skull (cat. 1115). These covered a group of fish bones (cat. 1042).

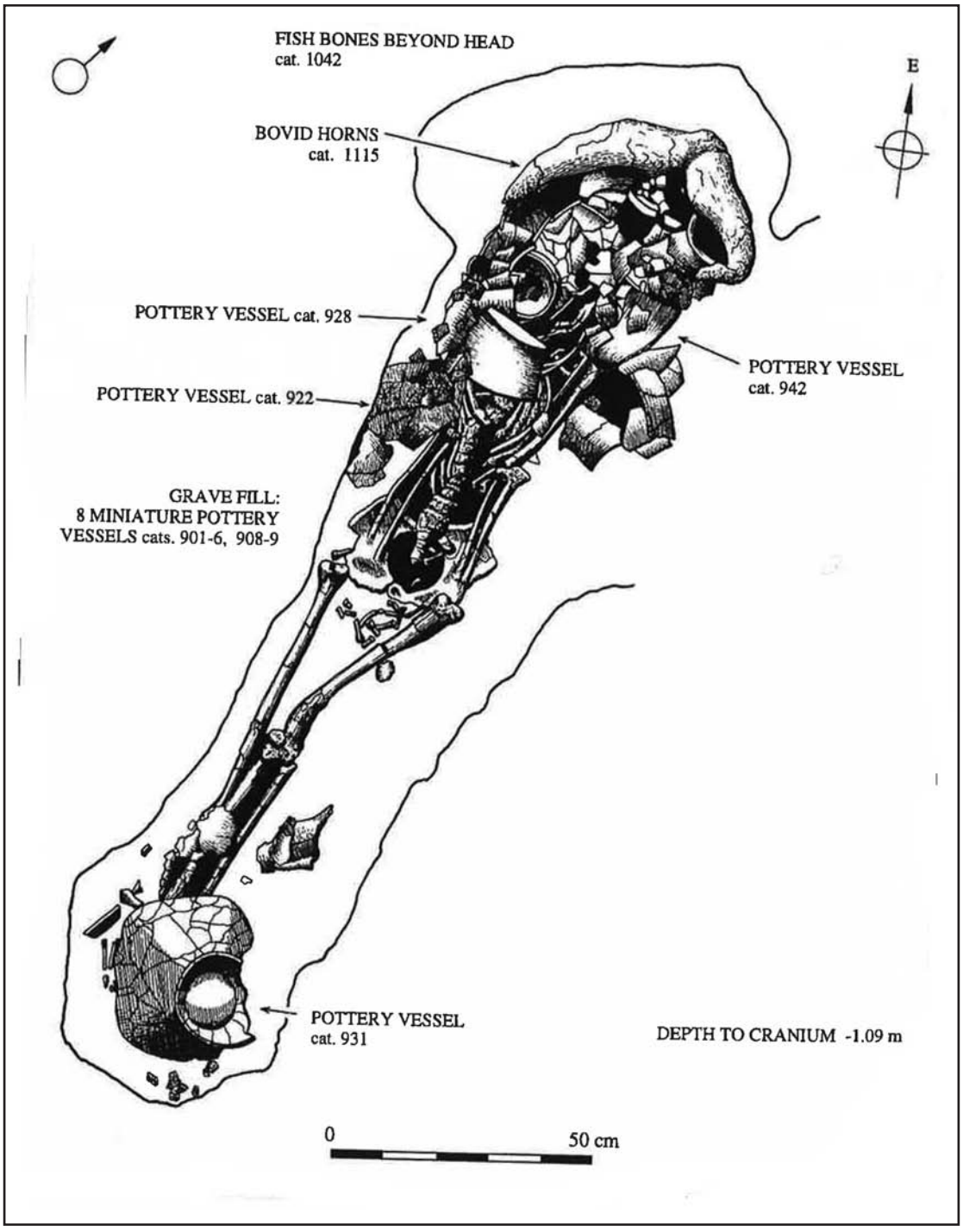


FIG. 217. Burial 145 including grave goods

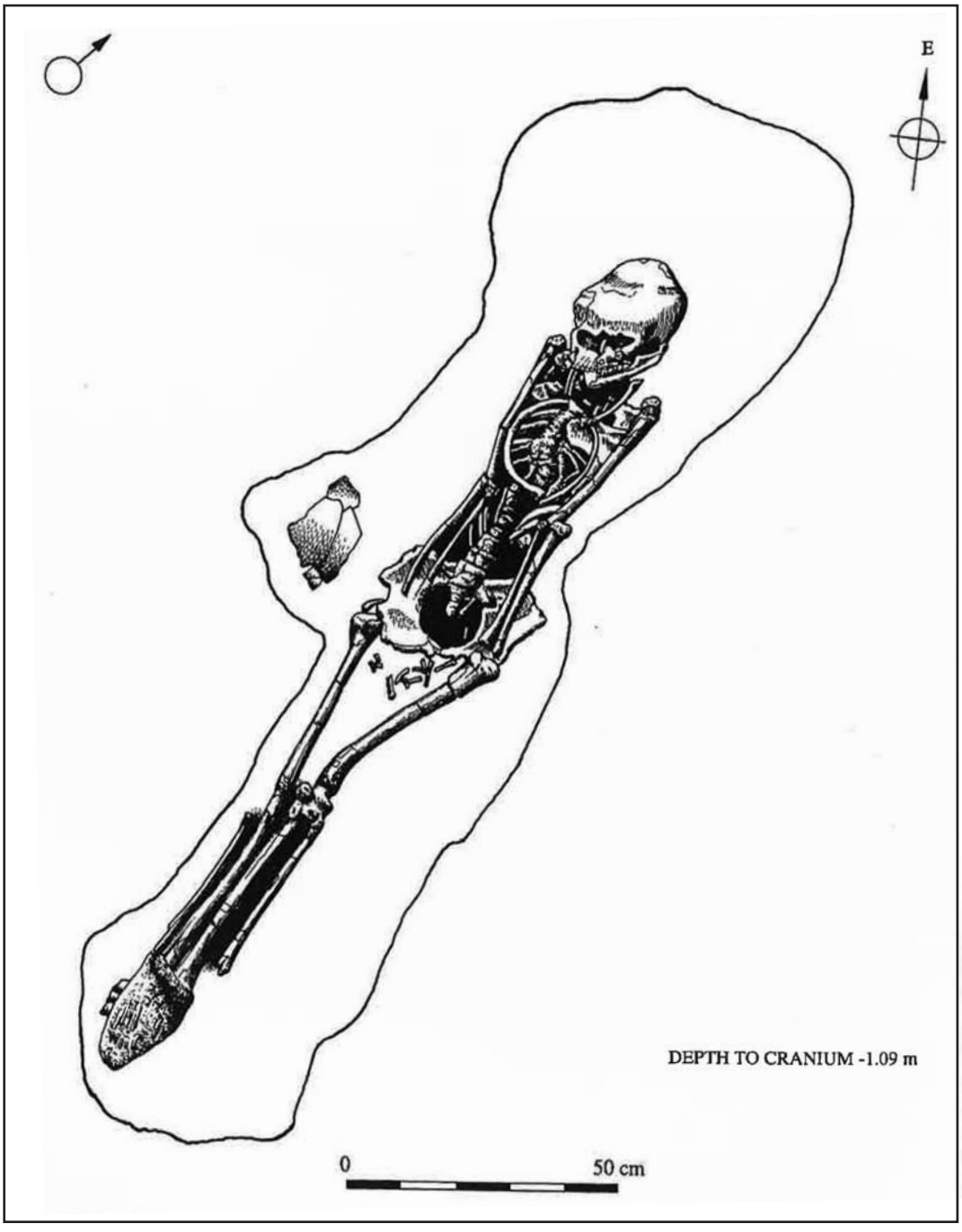


FIG. 218. Burial 145, after the removal of grave goods

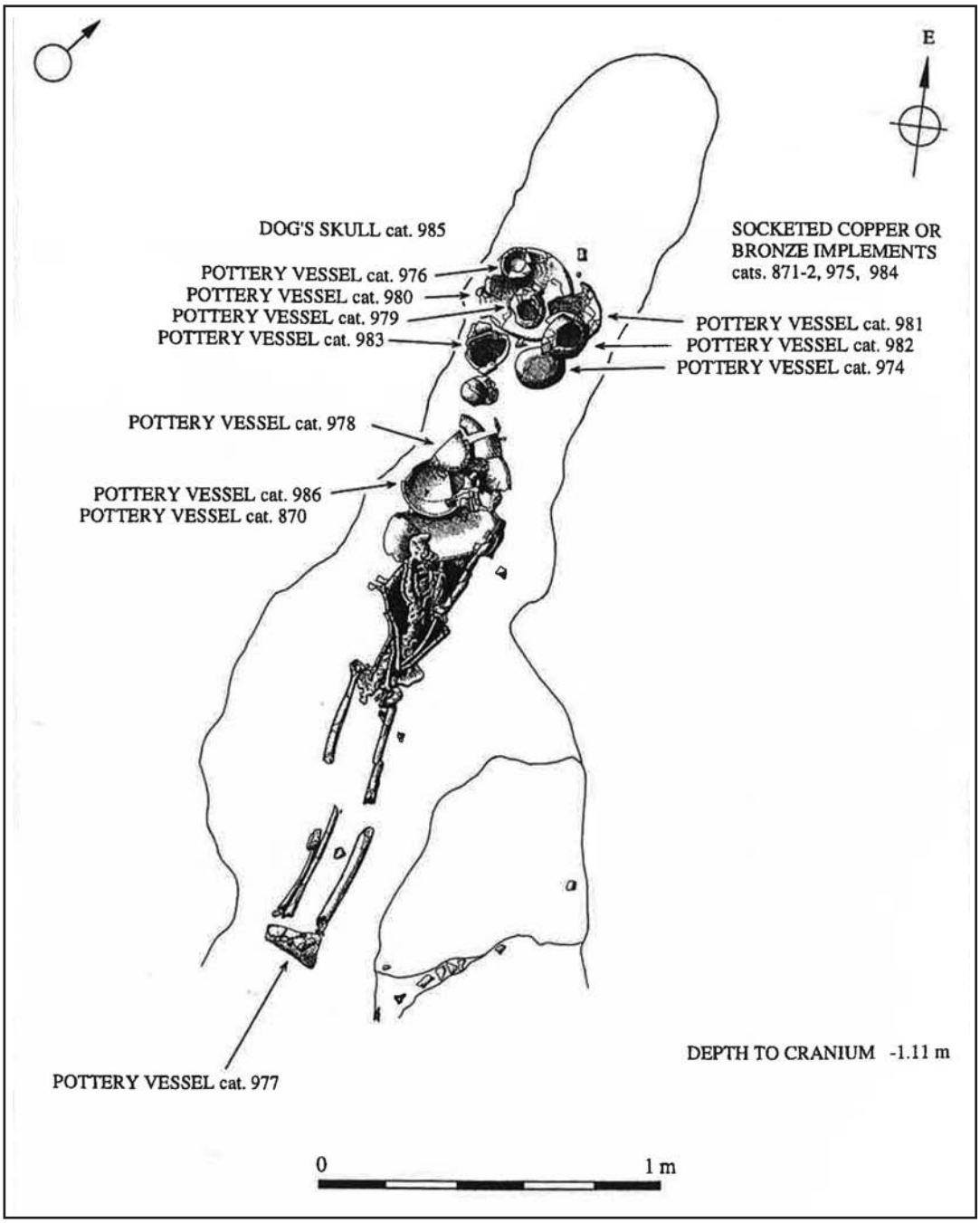


FIG. 219. Burial 146. X-Z13-14, middle aged male, -1.11 m, 120°. This burial lies at the extreme edge of the cemetery. It lay on the same axis and line as B 145, and was associated with 11 pottery vessels. Most concentrated in the grave beyond or over the head (cats. 870, 974, 976, 978-983, 986), but one was found over the ankles (cat. 977). A dog's skull was also present beyond the cranium (cat. 985), as were four copper-based socketed implements (cats. 871-2, 984, 975).

FIG. 220. Burial 148 looking east, showing infant burial jar (burial 147) over feet

Burial 147 *(above and opposite)*. N20, 4 month-old infant, -79 cm. The jar containing the human remains (cat. 912) lies over the ankles of B 148, an adult female. Some fish bone was recovered from within the jar, and a form 1 bronze bangle was located at its mouth (cat. 882). A second, smaller pot was also located at the neck of the burial jar (cat. 911). To the south of the burial jar, a further eight form 1 bronze bangles and a possible bronze earring were encountered (cats. 963-7, 999-1001 and 998). The bangles were disposed as if they had been on the wrists, but no human remains were found in association, and there is no reason to link them with this burial.

Burial 148 *(above and opposite)*. Middle aged female, N20-21, -84 cm, 65°. This burial is partially covered by B 116. A pottery vessel lay beyond the cranium, and some fish bone was found under it (cats. 861, 869). A second pot (cat. 911) lay at the neck of the infant mortuary vessel for burial 147 (cat. 912).

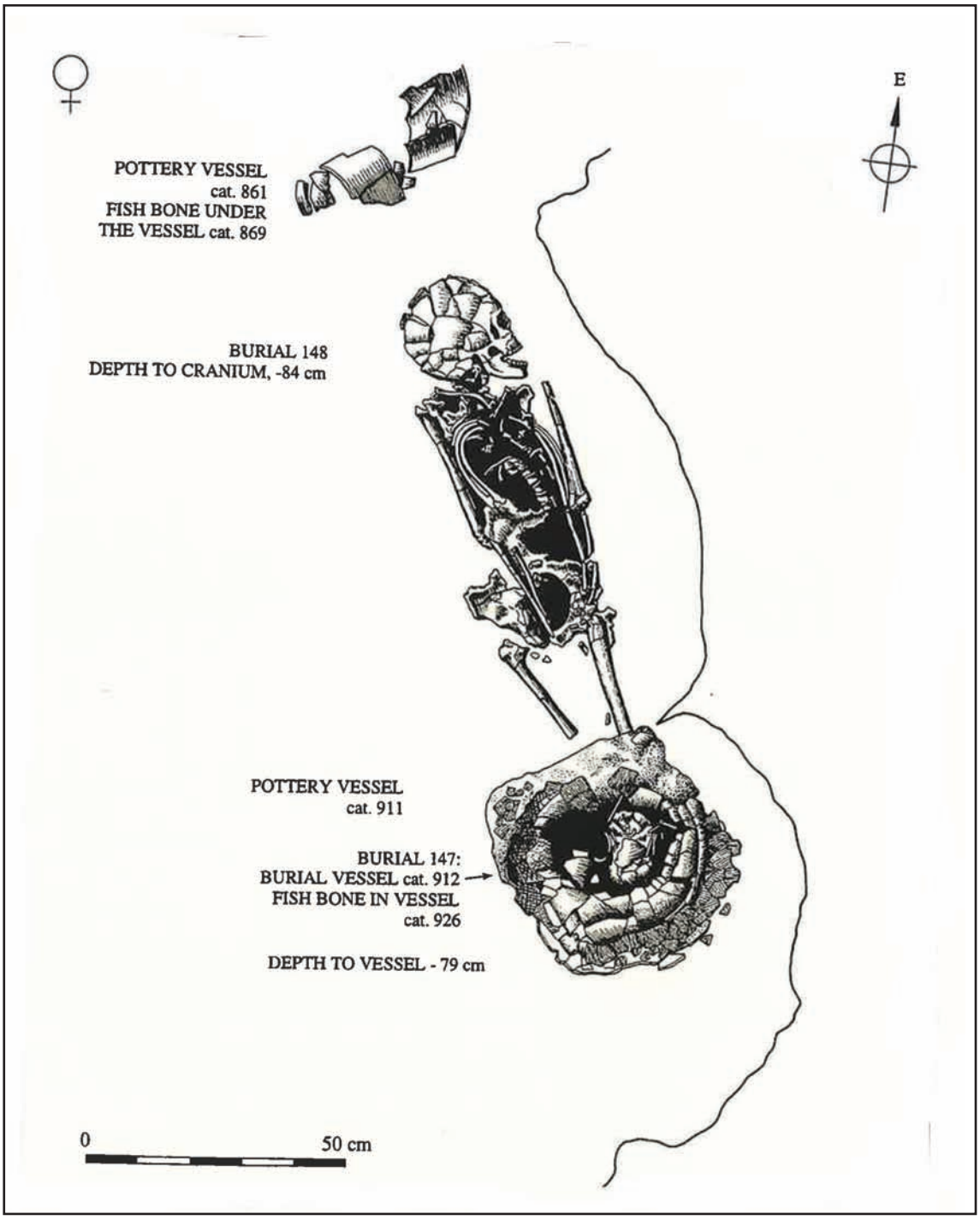


FIG. 221. Burials 147 and 148

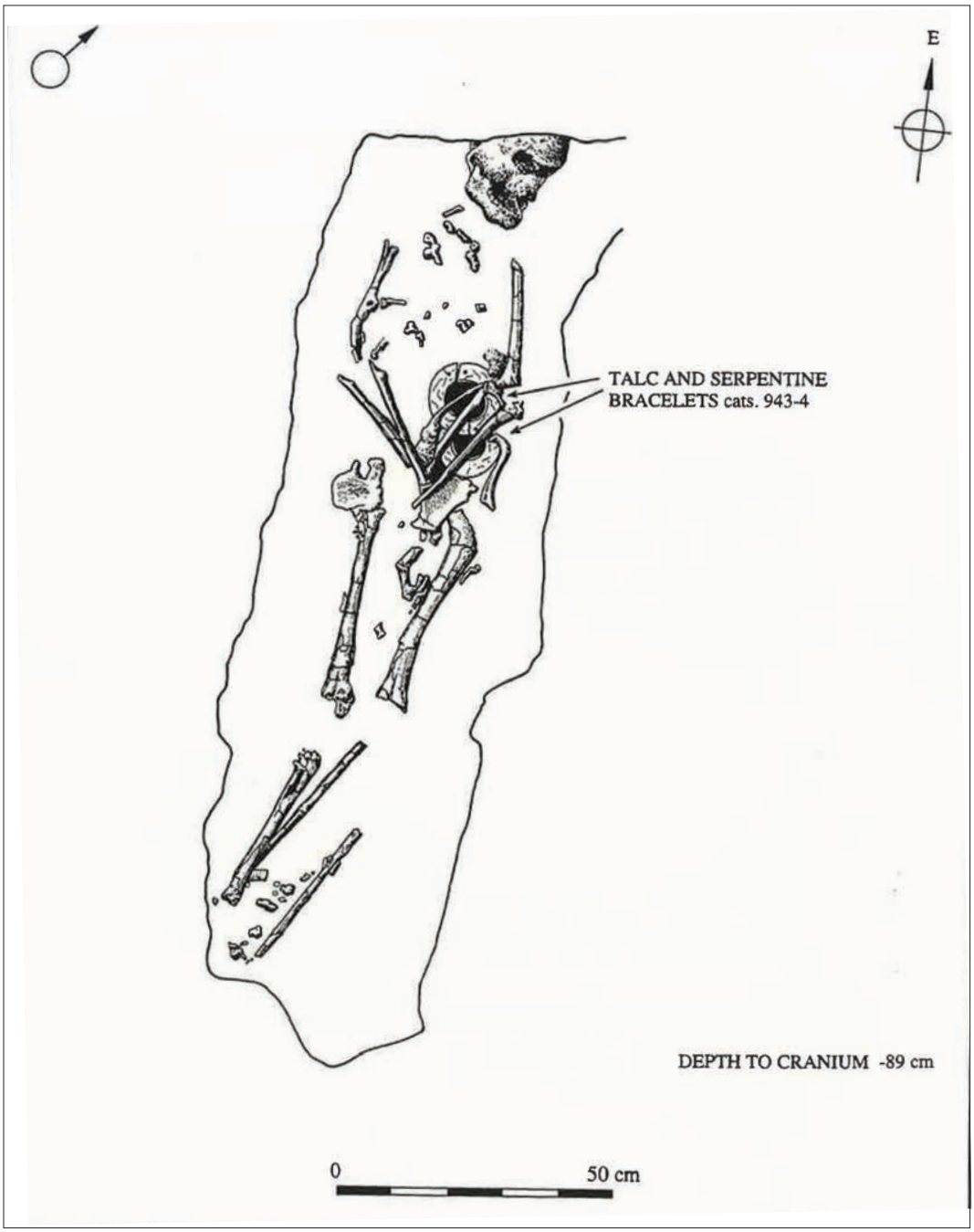


FIG. 222. Burial 149. R-S26, adult male, -89 cm, 95°. This interment lies at the eastern edge of the cemetery, and being beyond the limit of the shell midden, is very poorly preserved. Two stone bangles were found under the left arm, one of talc and the other of serpentine (cats. 943-4). The arms were crossed.

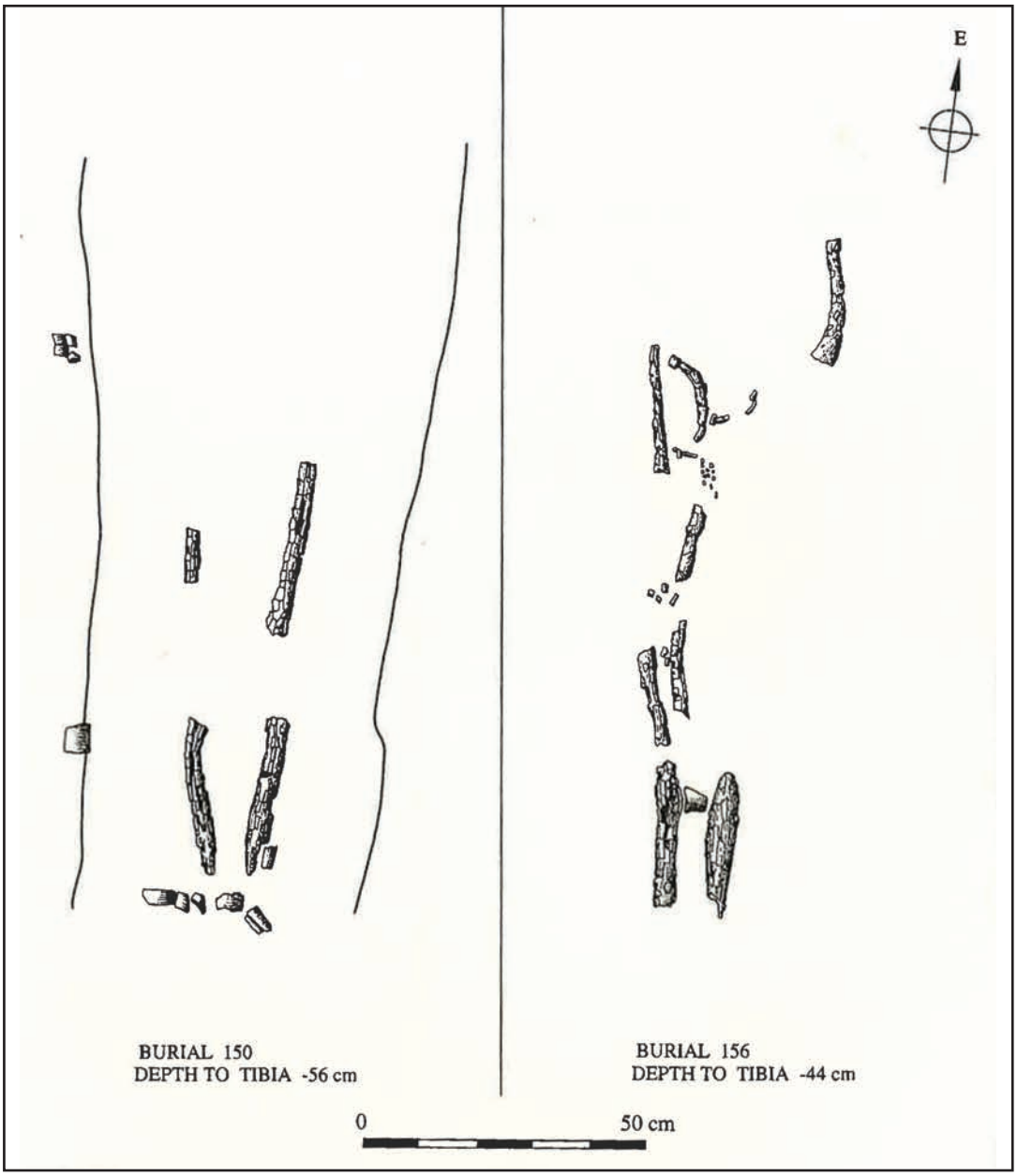


FIG. 223. Burial 150. P26, adult, -56 cm, 90°. Burials 149 and 150 lie alongside each other at the eastern extremity of the cemetery. Only the lower limbs of the latter fall within the excavated area. No grave goods were found.

Burial 156. Adult, R3-4, -51 cm, 80°. No grave goods were found with this poorly preserved skeleton, which lay at the northwest edge of the cemetery.

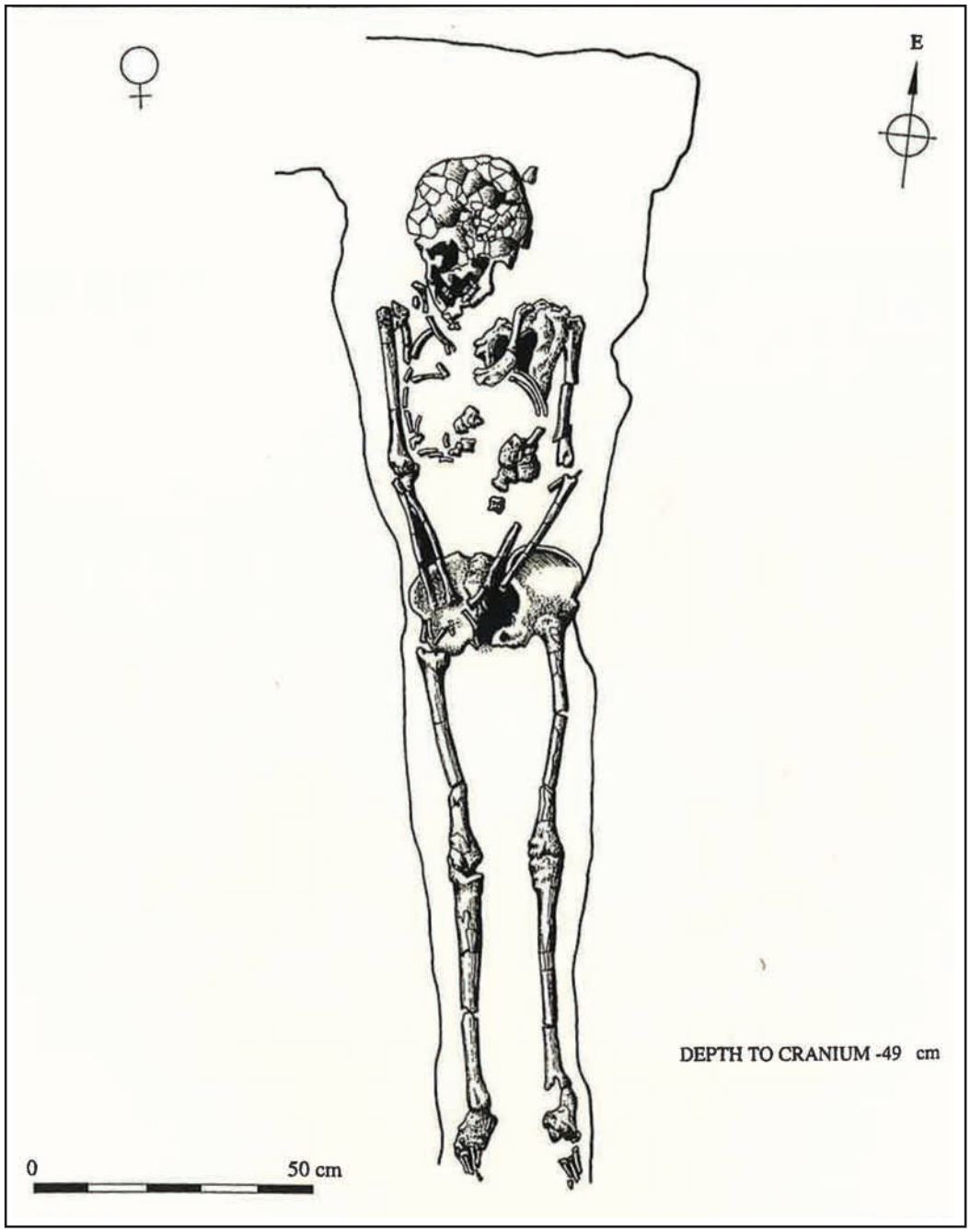


FIG. 224. Burial 151. N25-26, middle aged female, -49 cm, 80°. Like burials 149 and 150, this burial lies at the eastern edge of the cemetery. The left hand is folded over the abdomen. No grave goods were encountered.

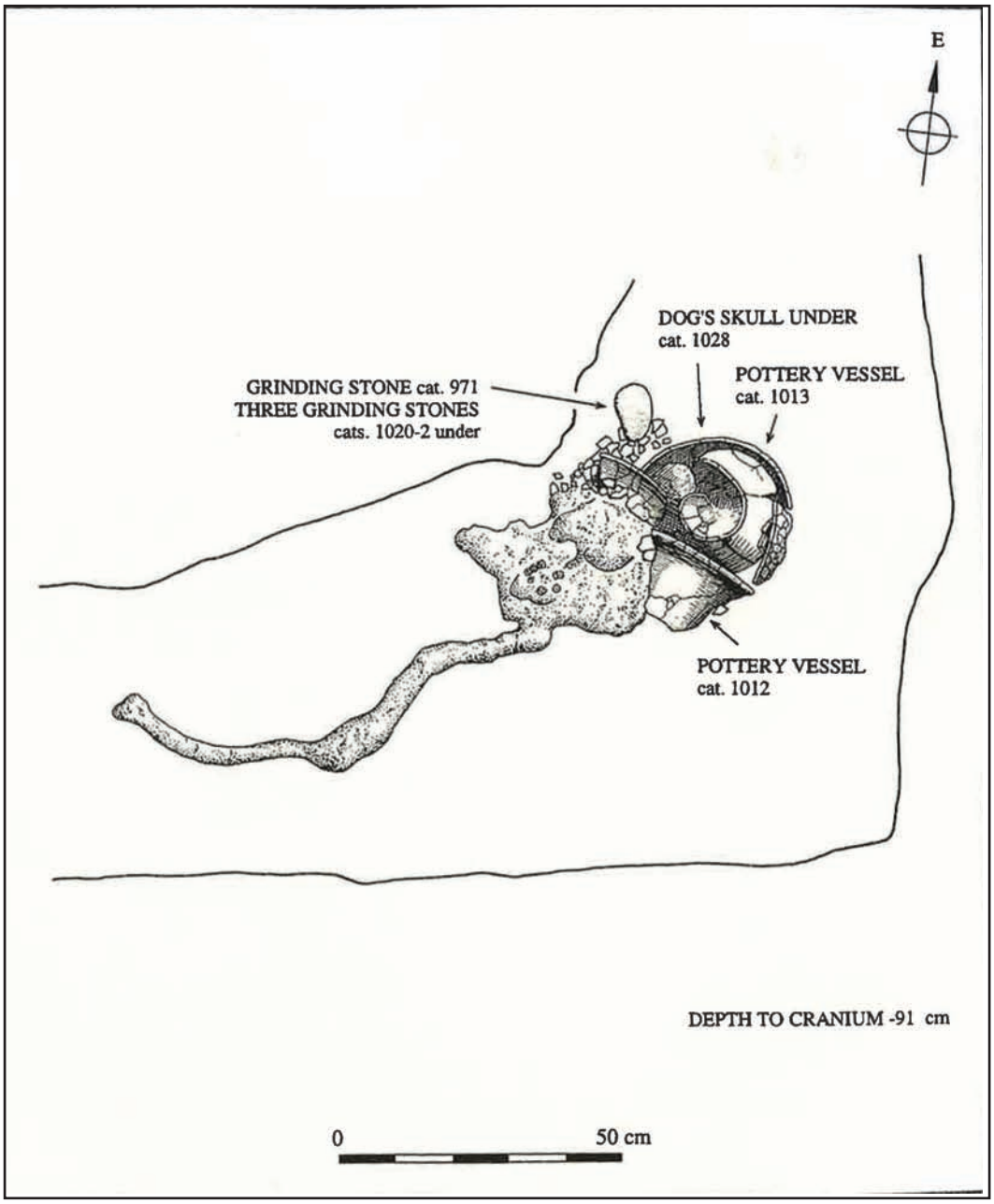


FIG. 225. Burial 155. Y-X14-15, 13-14 year-old child, -91 cm, 60°. Located beyond the shell midden, the bone was in a very poor state of preservation. Two pottery vessels, three grinding or whetstones and a dog's skull were located beyond the head (cats. 1012-3, 971, 1020-1 and 1028). A fourth stone artefact was also recovered from the same area (cat. 1022).

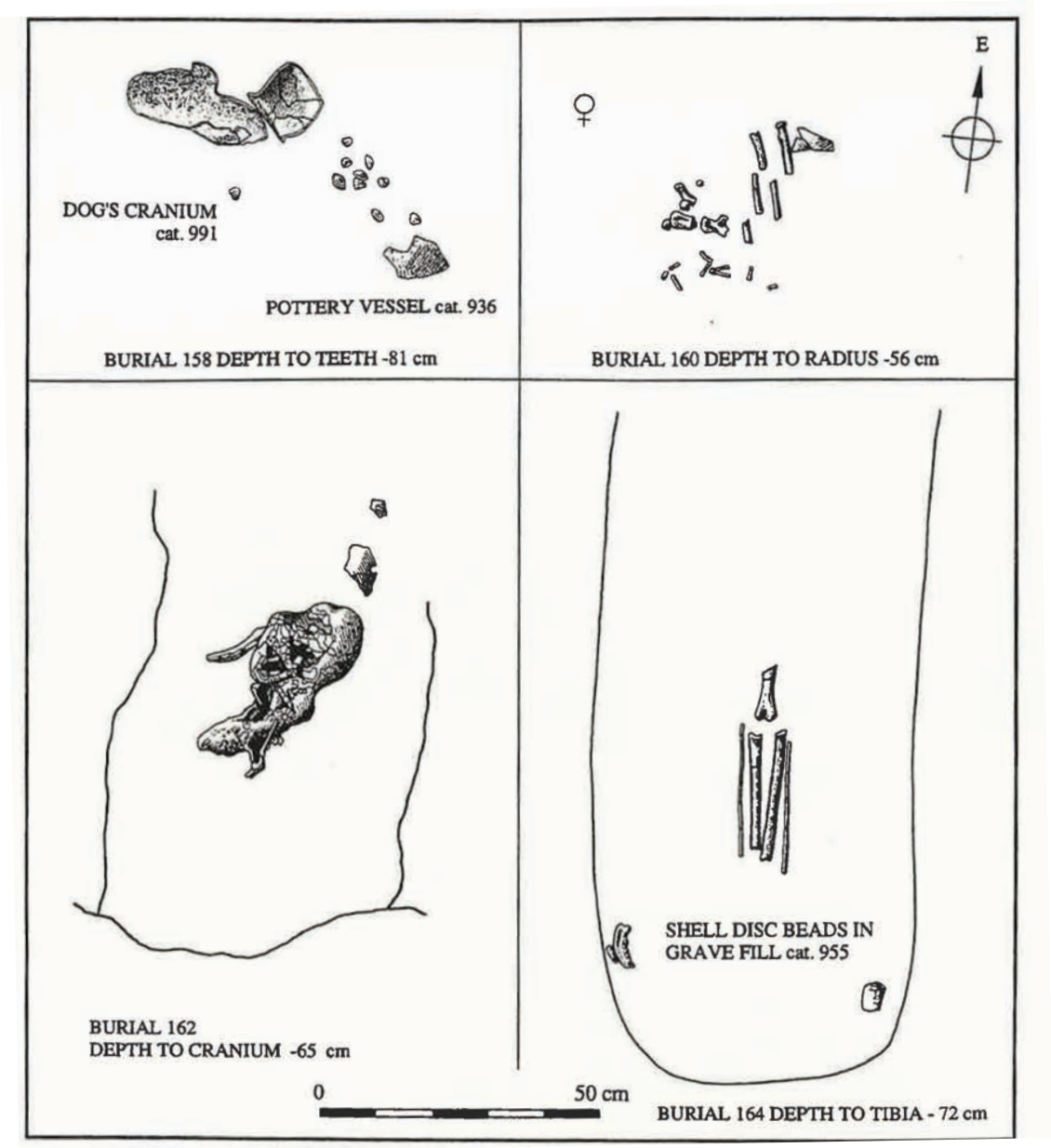


FIG. 226. Burials 158, 160, 162 and 164

Burial 158. U17, 15 month-old infant, -81 cm. This infant was found associated with a whole pot near the head (cat. 936). A dog's skull lay alongside (cat. 991). Burial 160. M3-4, adult female, -56 cm, 90°. The left arm, pelvis and part of the femur survive. There were no grave goods. Burial 162. P24, 3-4 year-old infant, -65 cm. An infant's cranium only survives. Burial 164. L3-4, 6-8 year-old child, -72 cm, 90°. A clear grave cut through the shell midden was identified, but only the tibiae and fibulae were found in place. Twenty-one shell disc beads were recovered from the grave fill (cat. 955).

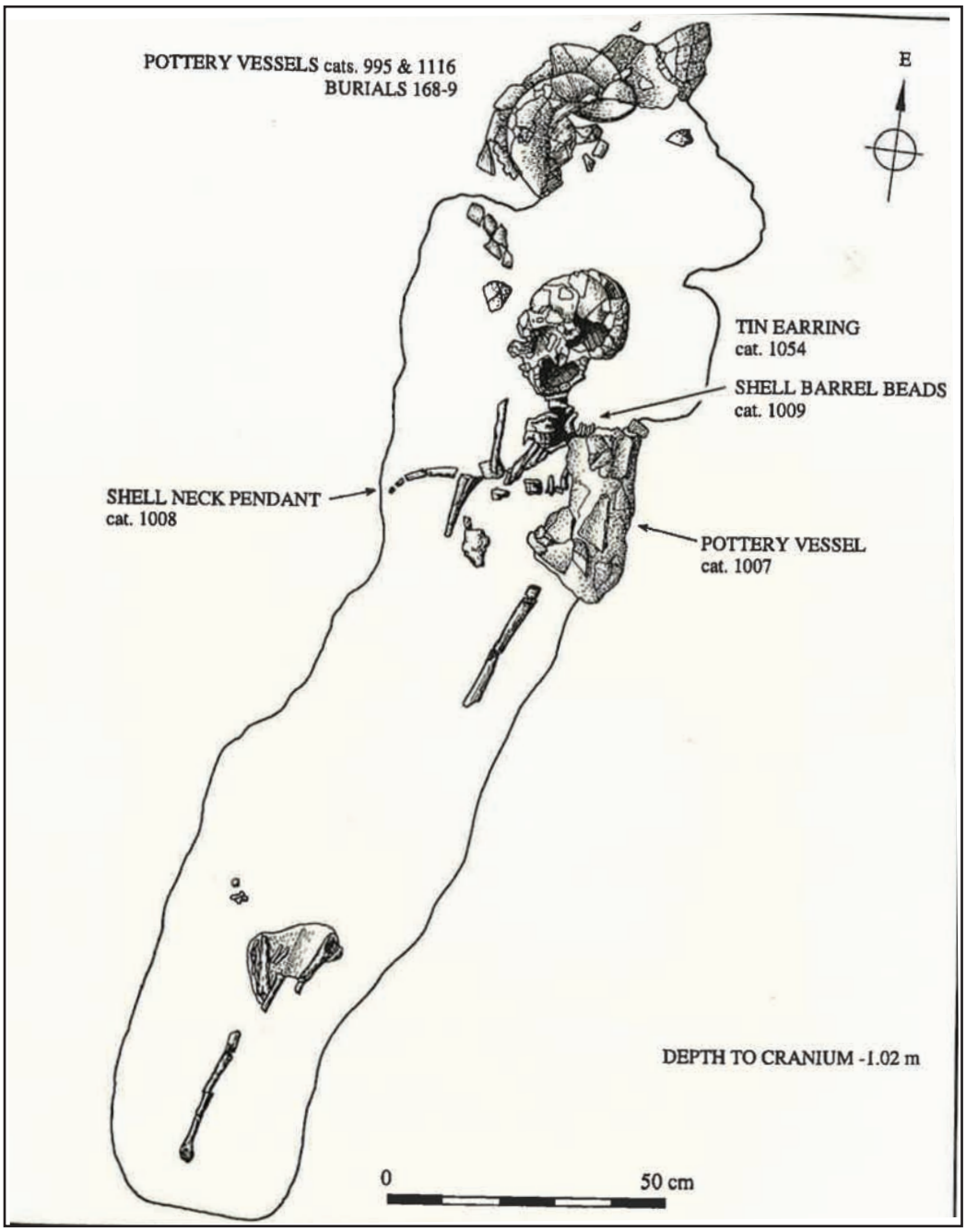


FIG. 227. Burial 163. N19-20, 6-8 year-old child, -1.02 m, 110°. This grave is partially covered by B 114. Two infant burial jars lie beyond the skull (cats. 995 and 1116), and another vessel was present on the left shoulder (cat. 1007). The person wore a shell neck pendant repaired with bronze ties (cat. 1008), two shell barrel beads in the neck area (cat. 1009) and a probable tin earring (cat. 1054).

FIG. 228. Burial 165, looking east. Burial 166, an infant, lay on the chest area

Burial 165 *(above and opposite)*. Q19-21, young female, -96 cm, 80°. This burial is the earliest in a group which includes Bs 127 and 124. Two pottery vessels were located respectively over and under the abdomen (cats. 1045, 1070). There were also two form 1 marble bangles, one in the area of the left arm, but not in a position suggesting that it had been worn at interment, the other over the right wrist (cats. 1025, 1059). Twenty-seven disc beads were found in the neck area, suggesting a former necklace and a further 60 probably come from a bracelet (cats. 1067-8). Finally, a shark vertebra lay by the pelvis (cat. 1064).

Burial 166 *(above and opposite)*. Q20, Infant, -96 cm. The remains of an infant skeleton were found in the chest area of B 165.

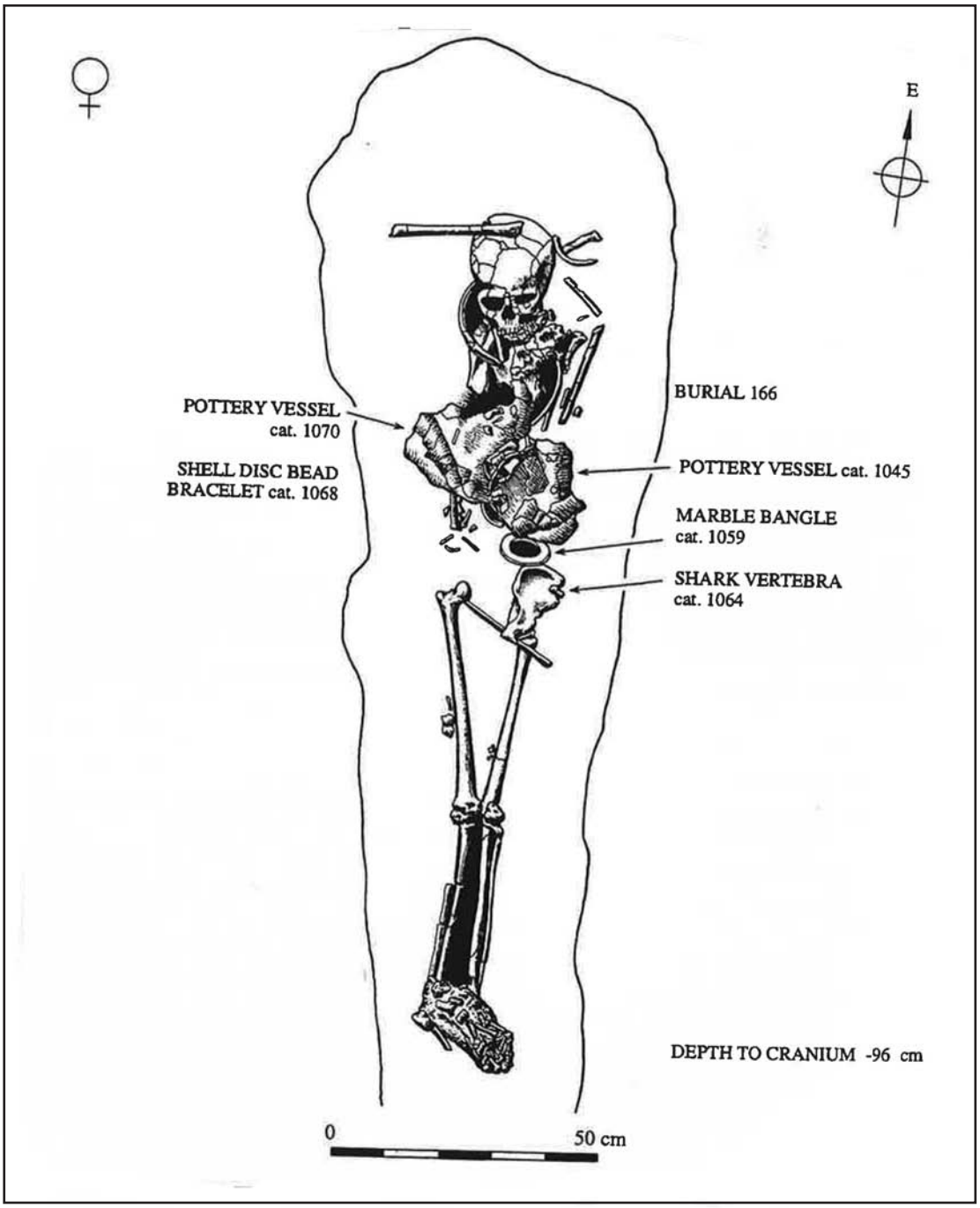


FIG. 229. Burials 165 and 166

DISCUSSION

With one exception, the burial technique for adults follows a consistent pattern. The body was interred within a grave usually orientated in an easterly direction, associated with a range of grave goods. These include pottery vessels, items of personal jewellery made from shell, stone, bronze and tin, the remains of animals, particularly the dog, and grinding or polishing stones. Cataloguing these offerings has not been straightforward, because graves were often cut through phase 1 deposits, providing the possibility that some objects found with the dead may have been there fortuitously. In the initial stages of this analysis for example, burnishing stones and anvils were ascribed to certain burials. When the distribution of these artefacts from undisturbed midden contexts was considered, however, it was found that they concentrate towards the eastern periphery of the phase 1 occupation. As it happens, only graves in this sector were found with burnishing stones or clay anvils. Moreover the latter were often broken, did not follow a patterned relationship with the body, and were of the same form as those found undisturbed in phase 1 contexts. Consequently, these items have been excluded from the analyses below. The same condition applies to a handful of pottery vessels which were recovered near human remains, as in the case of a complete vessel found at the upper edge of the grave cut for burial 136. This, again, matches the sherds from undisturbed midden contexts rather than the mortuary vessels. On occasion, fish bones were found near human remains but these almost certainly were relocated during grave digging. It is possible to check this situation to a degree by noting that where graves did not disturb the midden below, none of the above items was found.

The exception referred to above is burial 133. It was interred in an upright, squatting position under a number of pottery vessels and one burnishing stone. This position was preferred in shell midden sites located on former shorelines behind the present coast of Vietnam (Bui Vinh 1991). Burial 133 was found on the surface of the Nong Nor shell midden, and there is no stratigraphic indication that it belongs to this early phase of the site's occupation. However, there is no reason to exclude on stratigraphic grounds the possibility that the interment relates to the initial occupation phase because the midden might have accumulated elsewhere on the site at the time of burial. The pottery vessels were of a distinct form compared with those found in the other burials, and the fabric also differs from the range encountered in other mortuary vessels. Moreover, the surface ornament on some of the burial 133 vessels includes incised lines more consistent with the phase 1 assemblage than with the Bronze Age pottery at this site. While we cannot be conclusive, burial 133 probably belongs to the mid third millennium B.C.

The extended inhumation technique with a variable assemblage of grave goods was widely favoured during the prehistoric period in Southeast Asia. We find it only a few kilometres from Nong Nor at Khok Phutsa and Khok Phanom Di (Pisnupong 1982, Higham and Bannanurag 1991, Higham and Thosarat 1994). It is not uncommon, where a sufficient area has been uncovered, to recognise a spatial pattern. At Khok Phanom Di, this involved clusters and rows. Rows are also seen at Non Nok Tha and Ban Na Di (Bayard 1971, Higham and Kijngam 1984). These rows have social implications. It has been argued that the clusters at Khok Phanom Di comprise individuals related to each other consanguinally and possibly, affinally as well.

The spatial distribution of graves at Nong Nor also suggests an element of planning, although it is not as clear as at Khok Phanom Di. Some of the graves, particularly in the western part of the

cemetery, were laid out in rows. Infants were interred in lidded ceramic vessels, either in small clusters or at the head or feet of an adult. Children were given the same treatment as adults. In some cases, earlier burials were apparently disturbed, and the bones relocated with some care. In the eastern half of the cemetery, there is a less clear pattern of rows, and more superpositions. In the latter area, therefore, it is possible to order some groups of graves into a sequence. The thinning out in the number of graves at the northern, eastern and western edges of the excavated area suggests that the edge of the cemetery was being reached. Test pits beyond failed to reveal any further interments. In order to examine the nature of the rows and other groupings in rather more detail, the cemetery has been divided into a number of groups on the basis of layout and apparent clustering.

Group 1. This group has been identified on the basis of a row of graves on a similar orientation at the western end of the excavation. It begins at the northern end, with burial 132 and then includes, as one proceeds to the south, burial 156 adult, 36 female, 67 male, 39 female, 60 female, 35 female, 16 female, 94 female, 17 female, 34 female, 160 female, 164 child, 22 male, 33 child, 26 male, 15 female, 27 adult, 24 female, 4 child, 23 male, 5 adult and 6 female. It is not possible to order these graves sequentially, except in the case of burials 36-35, where their juxtaposition reveals that they were interred from north to south. The sex ratio is 4 males to 12 females. There are no infants in clear association with any of these individuals, but three jar burials were found a metre east of burials 36 and 39, and these might belong to this group.

Group 2 lies to the east of group 1, and is distinguished by a slightly different orientation. It comprises burials 54 adult, 95 adult, 98 adult, 103 adult, 105 male, 93 male, 97 male, 81 male, 90 female and 13 adult. The fact that the first four were seriously disturbed, possibly by the interment of group 1 burials, suggests that this row might be the earlier. This is supported by the fact that the grave for burial 35 overlies the western edge of the grave for burial 105.

Group 3. The third and last row in the western half of the excavation contains very badly disturbed graves, numbering from north to south, 129 male, 130 infant, 128 adult, 161 infant, 159 infant, 53 adult, 57 female, 64 adult, 71 male, 62 adult, 63 adult, 69 infant, 58 female, 77 male, 72 adult, 70 female, 101 male, 55 female, 84 female, 92 male, 99 female and 96 no bone recovered. Two are infant jar burials, and two infant skeletons were found without a ceramic container. The rest are adult, of which five are thought to be male and six, female. Burial 77 underlay burials 70 and 72, indicating an element of relative chronology. Burials 131 and 137, a female and a child, lie alongside each other on a north to south axis to the west of the group 3 interments.

With the eastern part of the cemetery, the palimpsest of burials makes ascription of graves to groups a capricious and possibly meaningless exercise. There is a central group of interments with many superpositions, and a peripheral number of graves where the density thins. Four infant jar burials, nos. 38, 170, 154 and 142 cluster to the east of the central group. We can also distinguish four burials to the west which lie on a north-south axis and post date burial 141, a member of the central group on a more conventional orientation.These four, burials 123 female, 125 female, 126 male and 127 female will be ascribed to group 4. Lying along the eastern margin of the excavation, there is a string of isolated graves, nos. 149 male, 162 child, 150 adult, 151 adult, 153 female and 14 male.

The rest of the graves in this eastern area will be ascribed to group 5, although it is possible on various criteria to propose many sub-groupings which might have some social significance.

There are several instances where graves are superimposed on earlier ones, but not over a sufficient area to permit us to identify any possible chronological sequence within the group as a whole. The relative sequences are set out in figure 230. In one case, it is possible that four graves may be ordered on the basis of superpositions, in two others, three phases of interment can be recognized and the last example only has one superposition. It could be argued that such disturbances indicate a relatively long time interval between burials, such that the location of earlier interments was unknown. But this seems unlikely. The material culture, particularly the pottery forms, show few significant changes from first to last, and the cases of burials 44 and 85, disturbance seems to have resulted in rearrangement rather than dispersal of the bones. Within this large group males and females are found in approximately similar numbers. In some cases, males and females appear juxtaposed, burials 65 and 124 for example, comprise a man and a woman in the same grave. Burial 145, a male, was found associated with a female burial 121. Burials 8 and 40 lay alongside each other on the same orientation, the former being a young adult, the latter a male. Burial 8 was found with two infant burial jars at the feet and a child immediately next to the body. Males and females in proximity to each other are also seen with burials 20 and 37, 107 and 114, as well as burials 136 and 138. Burial 148, a female, was found associated with three infants and a child. It is suggested on the basis of this mixture of the sexes, children and infants, that these graves have a social and biological coherence, and belong to a relatively brief period of time, perhaps measured in generations rather than centuries.

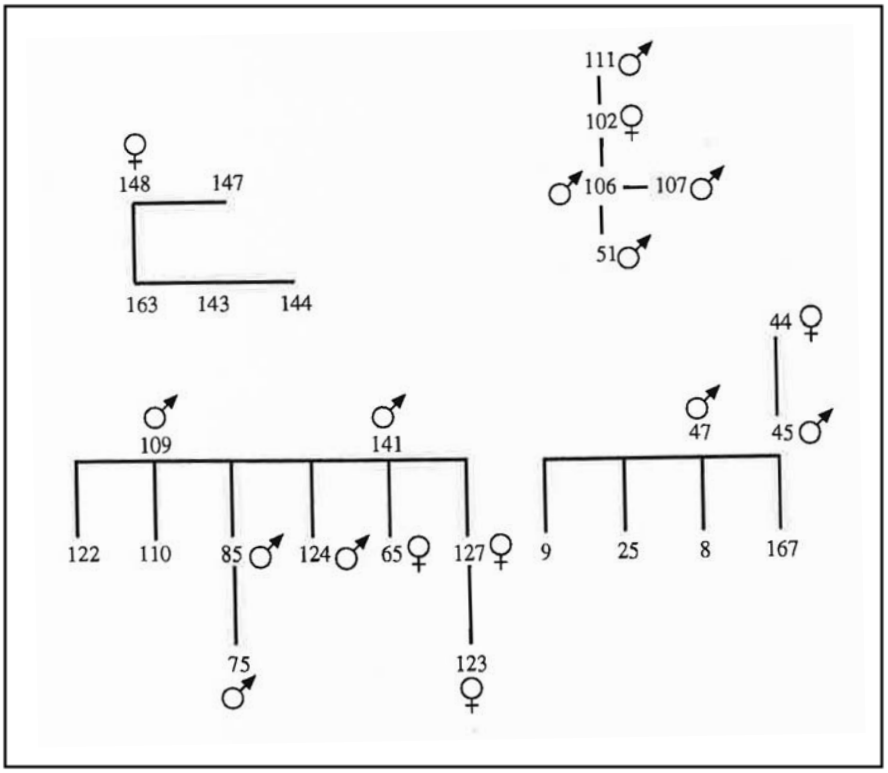


FIG. 230. The temporal relationships between certain groups of burials

XXI. A STATISTICAL ANALYSIS OF THE BURIALS

J. Debreceny, C.F.W. Higham and B.F.J. Manly

INTRODUCTION

The 49 intact burials have ben employed in a series of multivariate statistical analyses in order to identify any possible groupings or combinations of artefacts which might allow insight into distinctions based on chronology, social attainment or gender. Previous analyses, as for example at Khok Phanom Di, revealed not only a seriation of graves on the basis of changing artefact styles, but also a growing distinction between some individuals over time (Manly 1996). One of the reasons why we chose to open such a large area of the Nong Nor cemetery, was the possibility that any spatial variations might have social significance.

This chapter has two related sections. In the first, J. Debreceny considers the distribution of ceramic vessels in the cemetery. This is followed by a review of the grave goods as a whole.

THE DISTRIBUTION OF CERAMIC VESSELS IN THE CEMETERY

J. Debreceny

In exploring the relationship between ceramics and the burials, it is assumed that any significant patterns may reveal chronological and/or social distinctions. The relationships between the number of ceramic vessels, decoration, form and placement of vessels and different groups of burials are outlined below. If one group of burials has a higher average number of vessels than other group, or only has certain forms or methods of decoration, then such patterns might reflect underlying social structures or temporal change. Again, the restriction of more vessels, rarer forms, and more elaborate decoration to one part of the cemetery, might reflect status differences. Such relationships, if identified, will then contribute to the overall analysis of the mortuary ritual.

In terms of the males, there is no difference between the average number of vessels in the graves of young or middle aged individuals, but there appears to be a decline in the frequency for older individuals. This is not matched in the case of females, where the average number increases with age. There is not a major difference when the sexes are compared, the average number for men is 4.2, against 3 for women.

Red slipping and cord marking were the most common forms of decoration. A large number of vessels were undecorated. By relating the distribution of decoration to the burial groups, there are no apparent relationships with either the age or the sex of the interment (Table 57).

TABLE 56. *Total and average number of pots by age and sex (complete burials only)*

Age	Sex	N burials	N pots	Average pots
Infant	Unknown	28	28	1.00
Child	Unknown	6	17	2.83
Young adult	Male	6	30	5.00
Young adult	Female	6	17	2.83
Mid-aged adult	Male	11	55	5.00
Mid-aged adult	Female	8	28	3.50
Old adult	Male	4	3	0.75
Old adult	Female	3	17	5.66

A number of studies have been made on the placement of mortuary artefacts in prehistoric graves in Thailand in order to identify regularities between the location of artefacts and the age and sex of the dead. Generally, the only such relationships have involved jewellery, and this determined where artefacts were worn. At Nong Nor, most pottery vessels were placed beyond the head. There does not appear to be any significant variation in the placement of pottery vessels by sex or age. This appears consistent with the pattern seen in a number of Bronze Age sites in Thailand. The location of pottery vessels in graves does not appear to vary significantly within identified mortuary traditions. Any apparent variation occurs between sites. Continued excavations may be able to confirm this. The expansion of categories beyond 'head end' and 'foot end' may reveal more subtle variations.

TABLE 57. *Distribution of decoration in complete burials by age and sex*

Age and Sex	RS	N	RS,CM	CM	CM,S	S	RS,I	CM,S,I	S,A,I	S,IP	RS,S	
Female young adult	5	4	3	3	1	-	1	-	-	-	2	1
Female mid-aged adult	11	8	2	4	1	1	-	-	-	-	-	-
Female old adult	7	-	2	2	4	-	-	-	-	2	-	-
Male young adult	7	21	1	2	-	1	2	1	1	-	-	-
Male mid-aged adult	19	10	-	2	-	1	-	1	-	-	-	-
Male old adult	5	2	1	2	1	-	-	-	-	-	-	-
Total	65	45	9	15	7	3	3	2	1	2	2	1

RS: red slipped, N: none, CM: cord marked, S: smoothed, I: incised, A: appliqué, ST: stamping, P: punctation

STATISTICAL ANALYSIS

Multivariate analyses have been used to identify any possible groupings or combinations of artefacts or burials that would allow insights into social or temporal distinctions. Such methods have been used at a number of sites, including Khok Phanom Di, where they revealed a chronological

seriation of graves on the basis of changing artefact styles, and a growing disparity in the wealth of some individuals over time. By applying such methods to Nong Nor, it is hoped to confirm more intuitive analyses, such as those above.

Two tests were applied to the 49 intact graves to identify any groupings with particular reference to age, gender and spatial distribution. Principal component analyses were applied to the ceramic vessels that had been attributed a form. The results on the basis of forms shows that burials are not clearly differentiated, with the majority clustering together and the numerous outliers being grouped individually (Fig. 231A). Status distinctions were not marked or ritualised to any great extent.

TABLE 58. *Placement of vessels in graves at selected prehistoric sites*

Site	H	F	O	Site	H	F	O
Ban Kao	10	57	8	Non Nok Tha 1966	56	24	31
Ban Na Di	23	16	75	Non Nok Tha 1968	80	40	85
Khok Charoen	82	17	98	Non Pa Kluay	12	9	17
Khok Phanom Di	3	51	81	Nong Nor	116	9	66

H: Head end, F: Foot end, O: Other

The analysis of the presence and absence of vessel forms shows patterning, mainly with principal component 1. Mapped against all other components a clear negative / positive split is shown, with at least two groups being present (Figs. 231-2). The cause of this division is accounted for by the presence or absence of the form 1 vessels. In general, the plots of other components based on presence and absence show less patterning. The plot of principal components 2 and 3 for example show a main cluster of burials with a large number of outliers (Fig. 232B). It is particularly noted that burials 33, 35, 36 and 39 are relatively close together in the plot, and are also buried near each other. Burials 8, 9, 114, 126, 135 and 146 also appear to cluster together. These burials and vessels they contain are summarised in table 59.

TABLE 59. *Vessel forms found with selected burials.*

Burial	Location	Sex	Age	F1	F5	F7	F10.2	F13	F15	F16	F?
8	J20	?	Young adult	2	2	-	-	-	-	-	1
9	J19	?	Child	-	-	1	-	-	-	-	1
114	O18	Female	Young adult	2	1	-	-	-	1	1	2
126	S19	Male	Mid-aged	4	-	-	1	2	-	-	-
135	N23	?	Child	2	-	-	1	-	-	-	3
146	X13	Male	Mid-aged	6	-	-	3	-	-	-	2

F: Form

This group of burials includes a range of ages, and both males and females. All are in the

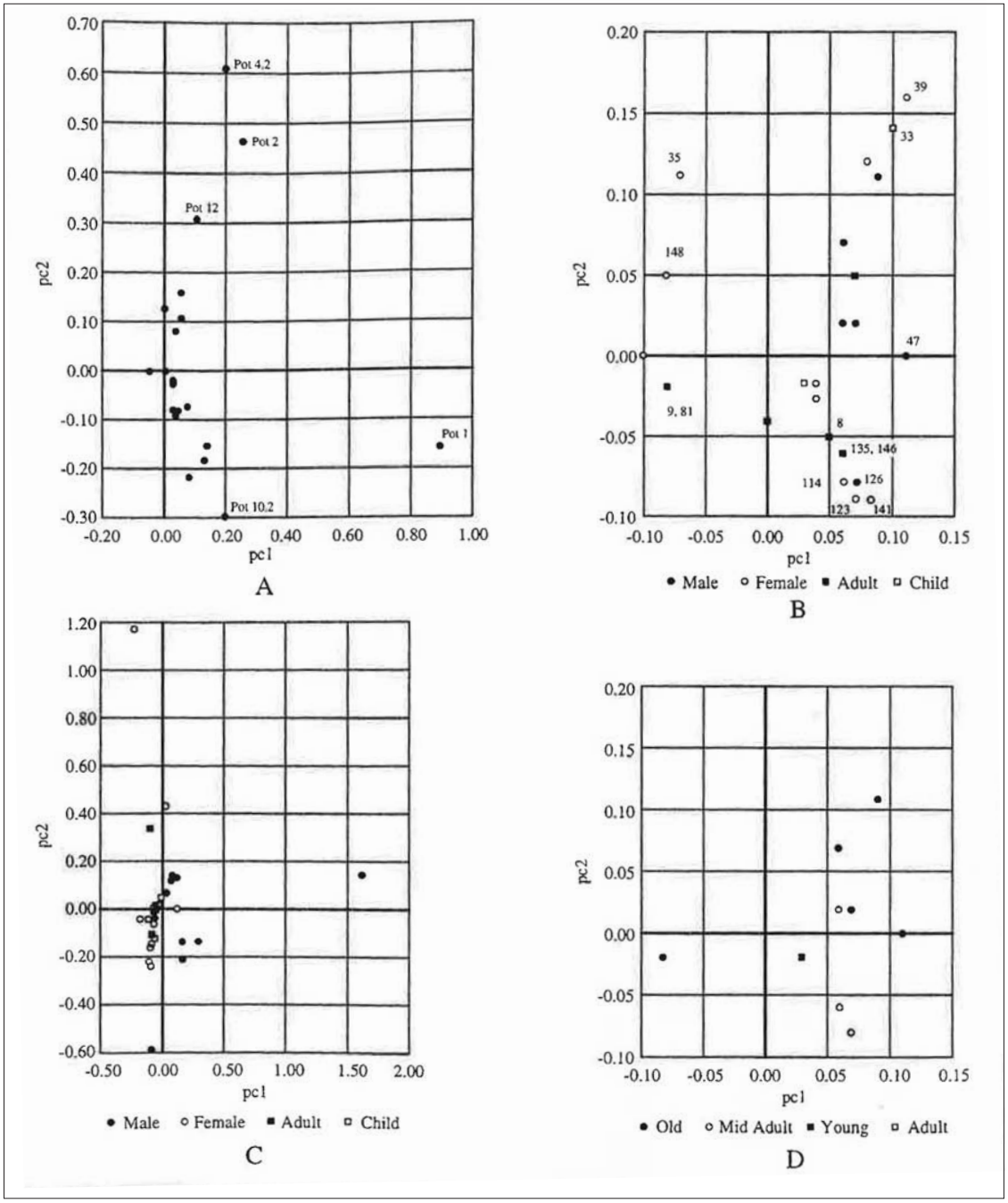


FIG. 231. The values of principal components for the analysis of the Nong Nor ceramic assemblage. A: on the basis of the presence or absence of ceramic forms. B: based on the presence and absence of ceramic forms and vessels. C: on the number of ceramic forms and vessels. D: for each of the intact male graves, based on the presence and absence of ceramic forms and vessels.

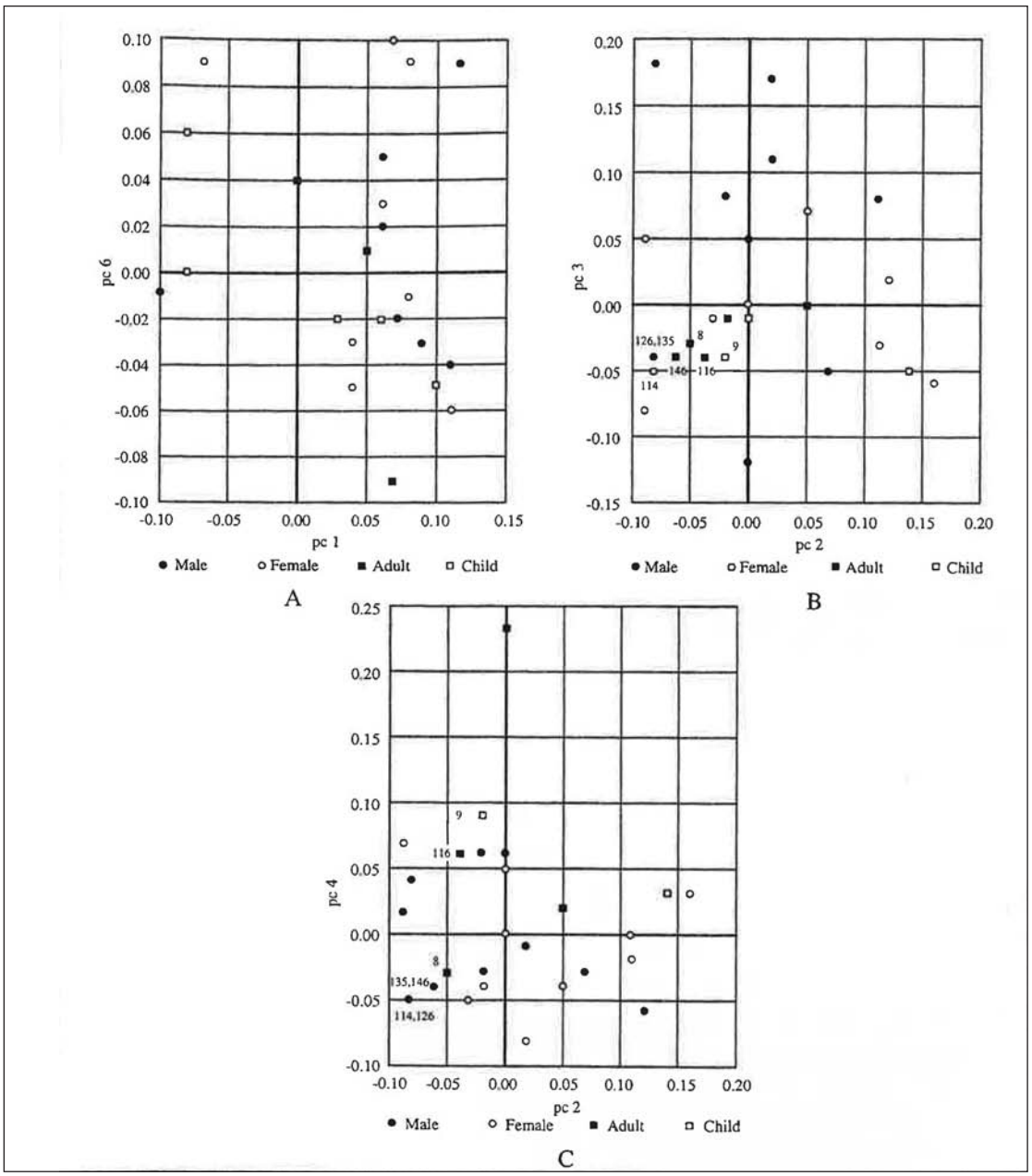


FIG. 232. The values of principal components for the analysis of the Nong Nor ceramic assemblage. A: The values of principal components 1 and 6 for each of the intact graves, based on the presence and absence of ceramic forms and vessels. B: The values of principal components 2 and 3 for each of the intact grave based on the presence and absence of ceramic forms and vessels. C: The values of principal components 2 and 4 for each of the intact burials, based on the presence and absence of ceramic forms and vessels.

eastern part of the cemetery. Burials 8 and 9 are stratigraphically older in a sequence of three burials. Burial 126 is on an unusual north-south orientation. It shares this feature with burial 123, which, like burials 8 and 9, is stratigraphically older in a sequence of graves. These burials may also cluster in other plots. When the presence and absence of vessel forms is plotted at the level of principal components 2 and 4, five of the seven burials group together (Fig. 232C). Burials 9 and 116 are further away from the group. Nevertheless, it may be that this is a group of chronologically later burials that are linked by the presence of similar vessel forms.

THE STATISTICAL ANALYSIS OF OF THE MORTUARY ASSEMBLAGE

C.F.W. Higham and B.F.J. Manly

In applying statistical analyses to the complete set of graves, we seek to identify patterns in the treatment of individuals on the basis of gender, age and their location in the cemetery. In a relatively large exposure, it is possible that there are also chronological changes in artefact style or availability which various statistical procedures might identify with more precision than visual inspection.

We begin with principal component analysis and multidimensional scaling (Manly 1994). These analyses can be applied to both the number of artefacts or to their presence in a burial. In order to appreciate the discriminatory value of each of the 53 variables which are employed first for the presence or absence, the eigenvectors resulting from the principal component analysis are illustrated in figure 233. An artefact found but once will have less discriminatory value than one which is present frequently. Assessing the graves relative to each other will be greatly influenced by few types of mortuary offering. These include the remains of dogs and pigs, the presence of marble and bronze bangles, shell pendants and necklaces made of disc and barrel beads, shell belts, grinding stones and certain varieties of pottery vessel, particularly forms 1, 4 10 and 12. In figure 2, these variations are portrayed graphically, with the major contributors to variation labelled. This does not necessarily exclude other variables from playing a significant role in the interpretation of the mortuary remains, but in the case of unique or very rare items, such as a jade earring or four carnelian beads, we cannot expect them to contribute much information within the context of a multivariate statistical analysis.

Figure 234A-B shows the distribution of the complete graves on the basis of the first and second components computed on the basis of their presence or absence. These account for 24 per cent of the total variation in the data. The group with values in the vicinity of -0.10 for component 1 have few or no grave offerings. As one proceeds to the right in figure 234A, there is a wide scatter of graves incorporating five males, three females and a child. They are distinguished by the presence of one or more of the following: a marble bangle, a shell pendant and the remains of dogs. To the top of the plot, with values over 0.1 for principal component 2, we encounter group 6 males and one female with pot form 10, all of which were located in the eastern part of the cemetery. There thus appears to be a group of relatively wealthy graves, a second distinguished by a specific form of pottery vessel, and a third with few or no grave goods. The rich graves involve five males and three females.

Figure 234B shows the plot for principal components 4 and 5. These account for nearly 16 per cent of the observed variation, and have been illustrated because of the high contribution

of grinding stones. These are the only artefacts found at Nong Nor in any abundance which differentiates between the graves of males and females. Graves with these artefacts occupy the lower left part of the spectrum. The presence of marble bracelets and pig bones also pulls some males away from the cluster of poorer graves.

The results of the principal component analysis on the basis of analysing the number of artefacts in each grave shows that shell and marble bangles, shell pendants, grinding stones, conus shells and pot forms 13 and 14 are the principal contributors to variability (Fig. 234C). Five graves stand out, four of which are found in close proximity in the cemetery (burials 35, 36, 39 and 105). These are particularly well endowed with multiple sets of bangles and many pottery vessels. Burial 109 is also set apart, and it has four conus shells and several pottery vessels. The majority of the graves cluster tightly, showing little variability in the quantity of mortuary offerings.

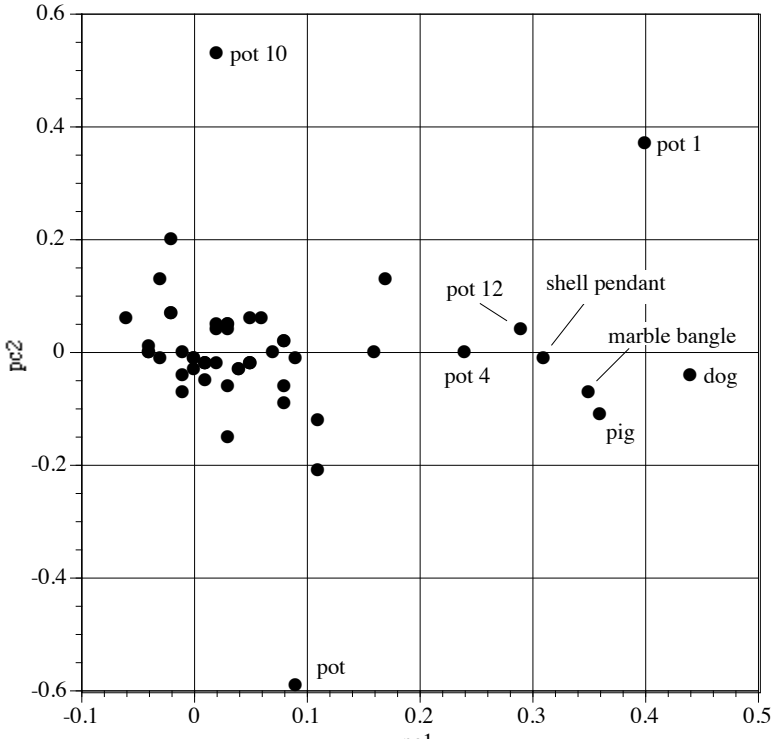


FIG. 233. The values of principal components 1 and 2 for the each item found as a mortuary offering in the intact graves from Nong Nor, based on their presence or absence

Consideration has been given on the basis of this statistic, as to whether men and women were distinguished in death on the basis of their age. On the basis of the variation and quantity of artefacts in each grave, there is no obvious favouring of old males with richer grave goods, indeed the contrary is the case. Burials 47, 105, 23 and 106 appear to be separated from the majority and each is mid aged. Burials 107 and 109, both young males, also stand out (Fig. 235A). There is a wider scatter of graves when the presence or absence of grave goods is the basis for computa-

tion, but again, there is no obvious relationship with age at death (Fig. 235B). It is interesting to note that in the case of females, the burials which form a tight cluster in the western part of the cemetery, burials 35, 36 and 39, consistently group together although they comprise a young, mid aged and an old person (Fig. 235C-D).

Were there any differences in terms of space? Two groups were employed, those clustering in the eastern part of the cemetery, and those to the west (Fig. 234D). It is seen that some of the former have values in excess of .05 for the second principal component. Inspection of these revealed the common presence of pot form 10. Further consideration also shows that they have a virtual monopoly of exotic talc, nephrite and serpentine jewellery. This differentiation might well be the result of chronological change in which a new pottery form was contemporary with an opening of new exchange connections and thus a novel range of ornaments.

Multidimensional scaling based on the presence or absence of particular artefacts reveals a large group of graves with few goods, distinguished from those with a greater variety. The following fall into the latter group (Fig. 236A): males, burials 105, 47, 106, 136, 109, 107 and 123. Four females are also set apart: burials 35, 36, 39 and 44. When multidimensional scaling was applied to the number of artefacts rather then only their presence or absence, graves 105 and 109, both males, were strongly separated, burials 149, 47, 83, 145 and 84 less so. Of the females, burials 35,123, 114 and 36 were distributed away from the concentration of poor graves (Fig. 236B).

ANALYSIS OF CO-OCCURRENCES

This section considers whether the pattern of co-occurrences of different artefacts (i.e., the number of times that different pairs of artefacts occur together) is likely to result from chance, and, if not, which particular artefacts seem to have non-random distributions with respect to the other artefacts. This was tested using a randomization test that compares the pattern of co-occurrences in the real data with what is obtained from alternative sets of data that might have occurred by chance (Manly 1995). The alternative sets of data are constrained to have the same number of artefacts in each burial and the same total number of occurrences of each artefact as for the real data.

All analyses were conducted on the presence or otherwise of the artefacts. Two data sets were used. The full data set contains 53 artefacts. The partial data set contains results for the 14 artefacts that were each present in at least five burials. The latter was examined with the idea that patterns in the results for the most frequently occurring artefacts may be obscured to some extent by the presence of many more artefacts that were seldom seen. In table 60, the artefacts are numbered from 2 to 55. Variable 1 is the number of the burial, and 53 is pot form 3, which did not occur in any of the complete burials analysed. This numbering corresponds to the following descriptions, where abbreviations are also given for the 14 most frequently occurring artefacts.

The test statistic used is $S = \sum(o_{ij}-e_{ij})^2/n^2$, where o_{ij} is the observed number of co-occurrences of artefacts i and j, e_{ij} is the expected number of co-occurrences that will occur by chance, n is the number of artefacts being considered (in this case 53), and the summation is for i = 1 to 53 and j = 1 to 53. The numerical value for the full data set is S = 13.8. The test was carried out using 100 replications of the generation of 10000 random co-occurrence matrices from the original matrix. It yielded an estimated significance level of 1.31 per cent, with a standard error of 0.06. Hence there is clear evidence of non-randomness in the observed co-occurrences.

The randomization test procedure makes it possible to examine the pattern of co-occurrences

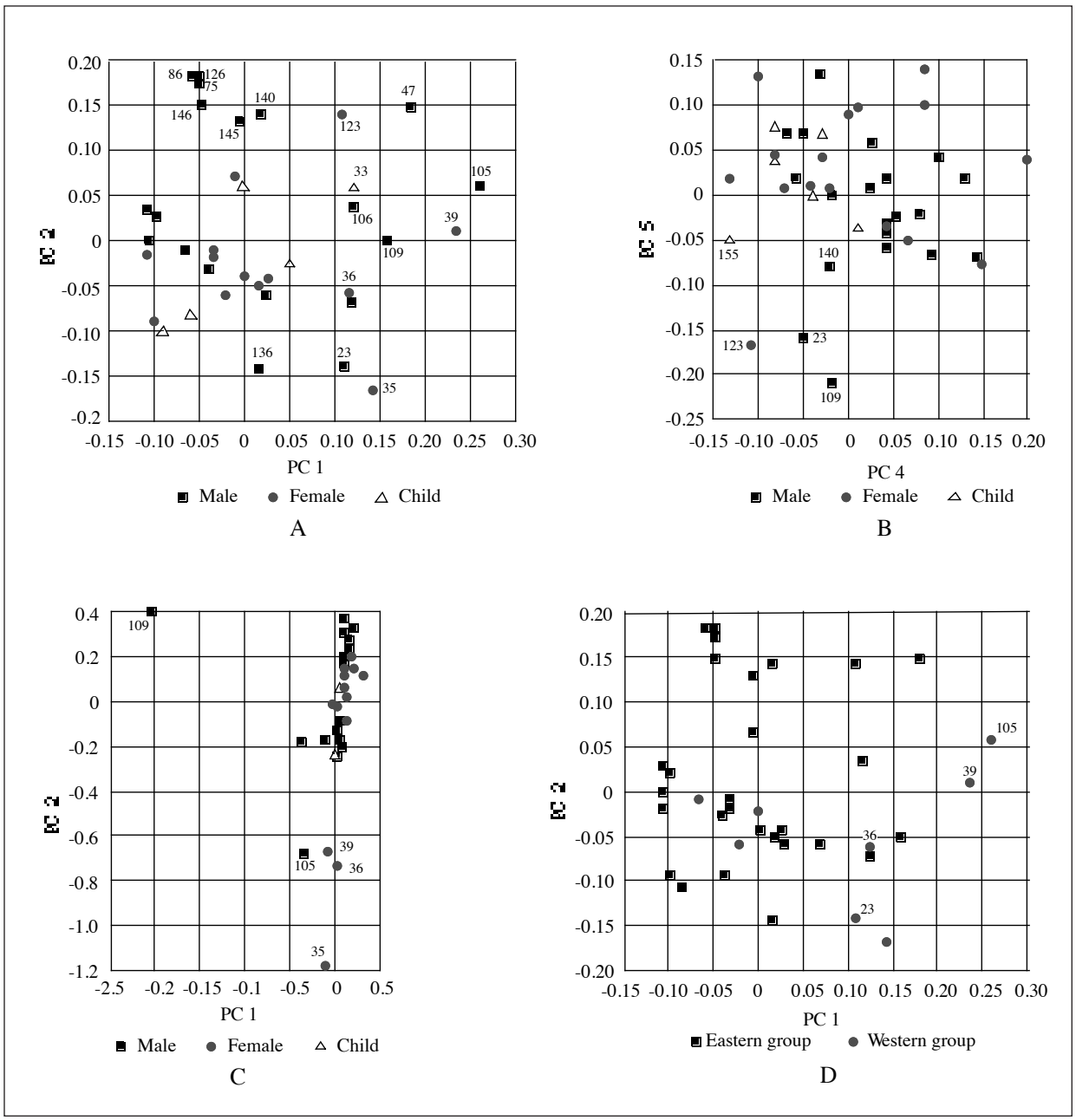


FIG 234. Values for principal components from 49 intact burials from Nong Nor

A. Principal components (PC) 1 and 2 for males, females and children, based on the presence or absence of grave goods. B. PC 4 and 5 for the intact male, female and child graves from Nong Nor, based on the presence or absence of grave goods. C. PC 1 and 2 for each of the intact male, female and child graves, based on the number of grave goods. D. PC 1 and 2 for graves in the eastern and western sections of the cemetery

of each individual artefact with all of the other artefacts. From this point of view only Pot Form 10 stood out as having an unusual pattern, with an observed total number of co-occurrences of 50 in the real burial data, compared to an expected total of 63. Hence it has a tendency not to occur with other artefacts. An examination of the co-occurrences of this artefact with all the others shows, in particular, that it occurred slightly more often than expected with Pot Form 1 (observed 9, expected 6.6), and much less often than expected with artefact 51, pottery vessels which have not been assigned a form (observed 1, expected 5.7).

Because rare offerings may mask patterns created from more common artefacts, the randomization test was repeated on the partial data set. The test statistic was then found to be S = 24.4, which is significantly large at the 0.21 per cent level. This shows strong evidence on non-randomness in the distribution of the common artefacts. It is still Pot Form 10 that stands out as having an unusual pattern, particularly in respect of occurring less often than expected with vessels without a specific form designation.

TABLE 60. *The artefacts from the Nong Nor complete graves*

No.	Artefact	No.	Artefact
2	shell bangle form 1	29	belt of disc beads (BDB)
3	shell bangle form 4	30	grindstone (GRST)
4	shell bangle form 5	31	bronze socketed implements
5	bronze bangle form 1 (BBF1)	32	pot form 1 (PF1)
6	bronze bangle form 2	33	pot form 2
7	bronze bangle form 3	35	pot form 4 (PF4)
8	bronze bangle form 5	36	pot form 5
9	bronze bangle form 8	37	pot form 6
10	marble bangle form 1 (MB1)	38	pot form 7
11	marble bangle form 2	39	pot form 8
12	tin bangle	40	pot form 9
13	talc bangle	41	pot form 10 (PF10)
14	serpentine bangle form 1	42	pot form 11
15	serpentine bangle form 2	43	pot form 12 (PF12)
16	earring tin	44	pot form 13
17	earring serp	45	pot form 14
18	earring jade	46	pot form 15
19	bead carnelian	47	pot form 16
20	bead serpentine form 1	48	pot form 17
21	bead serpentine form 2	49	pot form 18
22	serpentine belt ornament	50	pot form 20
23	shell pendant (SHPE)	51	pot (POT)
24	conus shells	52	dog remains (DOG)
25	necklace of dog and tiger canines	53	cattle remains (CTL)
26	necklace of disc beads	54	pig remains (PIG)
27	necklace of disc & barrel beads (NDBB)	55	tiger teeth
28	bracelet of shell beads		

MANTEL RANDOMISATION TESTS

Two types of analysis have been carried out to examine whether the distribution of artefacts seems to have been related to the age and the gender of burials. The first involved comparing the differences between burials with differences between age and gender classes using matrix randomization tests (Manly 1995). For example, the first analysis of this type was based on a comparison between a matrix of artefact differences (A) and a matrix of age class differences (B). Here the element in the ith row and the jth column of A (a matrix of size 49 by 49) was the number of artefacts either in burial i but not burial j, or vice-versa, and the corresponding element in B was 1 if the burials were in the same age class (child, young, adult, mid-aged or old), or otherwise 0. A negative association between the elements in the two matrices indicates that burials in the same age class tend to have the same artefacts. It was found that there is no evidence of artefact similarity between burials of either the same age class or the same gender class (child, male, female or unknown). Furthermore, the same result was obtained with the full data set and the most common artefacts.

LOGISTIC REGRESSION

This analysis considered the 14 most common artefacts one at a time. Logistic regression equations were fitted to see whether the probability of an artefact occurring seems to be related to one or both of the age and gender classes of a burial (Manly 1995). In this case some possibly significant results were obtained. The occurrence of shell pendants appears to favour males and children, only one intact female burial being associated with such an ornament. Shell bead bracelets appear most commonly with people of middle age. No other significant adhesions between age and gender on the one hand, and mortuary goods on the other were identified.

TABLE 61. *The data set for the 14 artefacts that occurred at least five times in complete graves*

Bur.	Age	Sex	PF1	Pot	Dog	PF4	Pig	PF10	MB1	NDBB	PF12	SHPE	BBF1	BDB	GRST	CTL	Total
109	Y	M	1	1	0	0	1	0	0	0	1	1	0	0	1	0	6
105	MA	M	1	0	1	0	1	0	1	0	1	1	0	0	0	0	6
39	Y	F	1	0	1	1	1	0	1	1	1	0	1	1	0	0	9
47	MA	M	1	0	1	1	0	1	1	0	0	1	0	0	0	0	6
123	MA	F	1	0	1	0	1	1	0	0	0	0	0	0	1	0	5
35	MA	F	0	1	1	1	0	0	1	0	0	1	1	0	0	0	6
44	O	F	1	1	0	0	0	0	0	1	0	0	0	1	0	0	4
83	O	M	1	1	1	1	1	0	0	0	0	0	0	0	0	1	6
36	O	F	1	1	0	1	0	0	1	0	1	0	0	1	0	0	6
23	MA	M	0	1	1	0	1	0	0	0	0	1	1	0	1	0	6
107	Y	M	1	1	0	0	1	0	0	1	0	0	0	1	0	0	5
33	C	?	1	0	1	1	0	0	0	0	0	1	0	0	0	0	4
116	MA	F	1	1	1	0	0	0	0	0	0	0	1	0	1	0	5
8	Y	?	1	1	0	1	0	0	0	0	0	0	0	0	0	0	3
114	Y	F	1	1	1	0	0	0	0	0	0	0	0	0	0	0	3
136	O	M	0	1	0	0	1	0	1	0	0	0	0	1	0	1	5
106	MA	M	1	0	0	0	1	0	1	0	1	0	0	0	0	0	4
165	Y	F	1	1	0	0	0	0	1	0	0	0	0	0	0	0	3

TABLE 61 *(cont.). The data set for the 14 artefacts that occurred at least five times in complete graves*

Bur.	Age	Sex	PF1	Pot	Dog	PF4	Pig	PF10	MB1	NDBB	PF12	SHPE	BBF1	BDB	GRST	CTL	Total
86	MA	M	1	0	0	0	0	1	0	1	0	0	0	0	0	0	3
145	Y	M	1	0	0	1	0	1	0	0	0	0	0	0	0	1	4
75	MA	M	1	0	0	0	0	1	0	1	0	0	0	0	0	0	3
140	MA	M	1	0	0	0	0	1	0	0	1	0	0	0	1	0	4
126	MA	M	1	0	0	0	0	1	0	1	0	0	0	0	0	0	3
135	C	?	1	1	0	0	0	1	0	0	0	0	0	0	0	0	3
155	C	?	1	1	1	0	0	0	0	0	0	0	0	0	1	0	4
141	Y	F	0	0	1	1	0	1	0	0	0	0	0	0	0	0	3
60	MA	F	1	1	0	0	0	0	0	0	1	0	0	0	0	0	3
118	MA	F	1	1	0	0	0	0	0	0	0	0	0	0	0	0	2
163	C	?	1	0	0	0	0	0	0	0	0	1	0	0	0	0	2
9	C	?	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1
90	Y	F	0	0	0	0	1	0	0	0	0	0	1	1	0	0	3
133	O	F	1	1	0	0	0	0	0	0	0	0	0	0	0	0	2
146	MA	M	1	0	0	0	0	1	0	0	0	0	0	0	0	0	2
84	Y	F	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1
132	MA	F	0	1	0	0	0	0	0	0	0	0	0	0	0	1	2
14	Y	M	1	1	0	0	0	0	0	0	0	0	0	0	0	0	2
131	C	?	0	1	0	1	0	0	0	0	0	0	0	0	0	0	2
81	MA	M	0	0	0	1	0	0	0	0	0	0	0	0	0	1	2
112	Y	M	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1
122	A	?	0	1	1	0	0	0	0	0	0	0	0	0	0	0	2
45	O	M	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
117	A	?	0	1	0	0	0	0	0	0	0	0	1	0	0	0	2
148	MA	F	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1
149	A	M	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
40	MA	M	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
151	MA	F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20	Y	M	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
124	O	M	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
156	A	?	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		Total	28	24	13	11	10	10	8	7	7	7	7	6	6	5	149

O: Old, MA: Mid adult, Y: Young, A: Adult, C:Child, M: Male, F: Female,

CONCLUSIONS

1. Some individuals were interred with more grave goods than others. Spatially, a group comprising burials 35, 36, 39 and 105 stand out in the results of most statistical manipulations. This group involves a male, burial 105, interred in the largest grave encountered, who wore a bronze bangle unique within the site. His grave was located adjacent to a row of female interments, all of whom were unusually well endowed with grave offerings. It is considered possible that these graves are relatively early in the sequence, but there is no stratigraphic nor chronometric

evidence for this.

2. There is no evidence for gender or age bias in terms of mortuary wealth.
3. Children were accorded a similar burial rite and range of grave goods as adults.
4. Grinding stones are the only artefact found in the main with one sex (males).
5. There is no sign of a relationship between metal artefacts and wealth.
6. In terms of spatial differences, it is noted that pottery vessel form 10 is restricted to burials in the eastern part of the cemetery.
7. Certain items of jewellery were manufactured from exotic serpentine, jade, talc and carnelian. They were found so rarely that they have not had a detectable influence on the statistical results. The three burials with carnelian, talc or jade ornaments are respectively a mid aged male, adult male and mid aged female. Of the ten burials with serpentine jewellery, three are old males, one a mid aged male and one is a young male. Three females also had serpentine, all three ages being represented. With one exception, all the exotic jewellery came from graves in the eastern part of the cemetery

TABLE 62. *The relationship between gender, age and the presence of selected grave offerings*

	Male				Female			
(17)	O (4)	MA (11)	Y (6)	T (21)	O (3)	M (8)	Y (6)	T
bronze	-	5	2	7	-	9	4	13
serpentine	3	1	4	8	2	-	2	4
marble	1	3	-	4	4	2	5	11
shell bangle	-	2	-	2	1	2	1	4
shell pendant	-	2	1	3	-	2	1	3
shell belt	1	-	1	2	1	-	2	3
shell necklace	1	4	2	7	1	-	2	3
shell belt	1	-	1	2	2	-	1	3
dog	1	3	-	4	-	2	2	4
cattle	2	1	1	4	-	-	-	-
pig	2	2	2	6	-	1	2	3

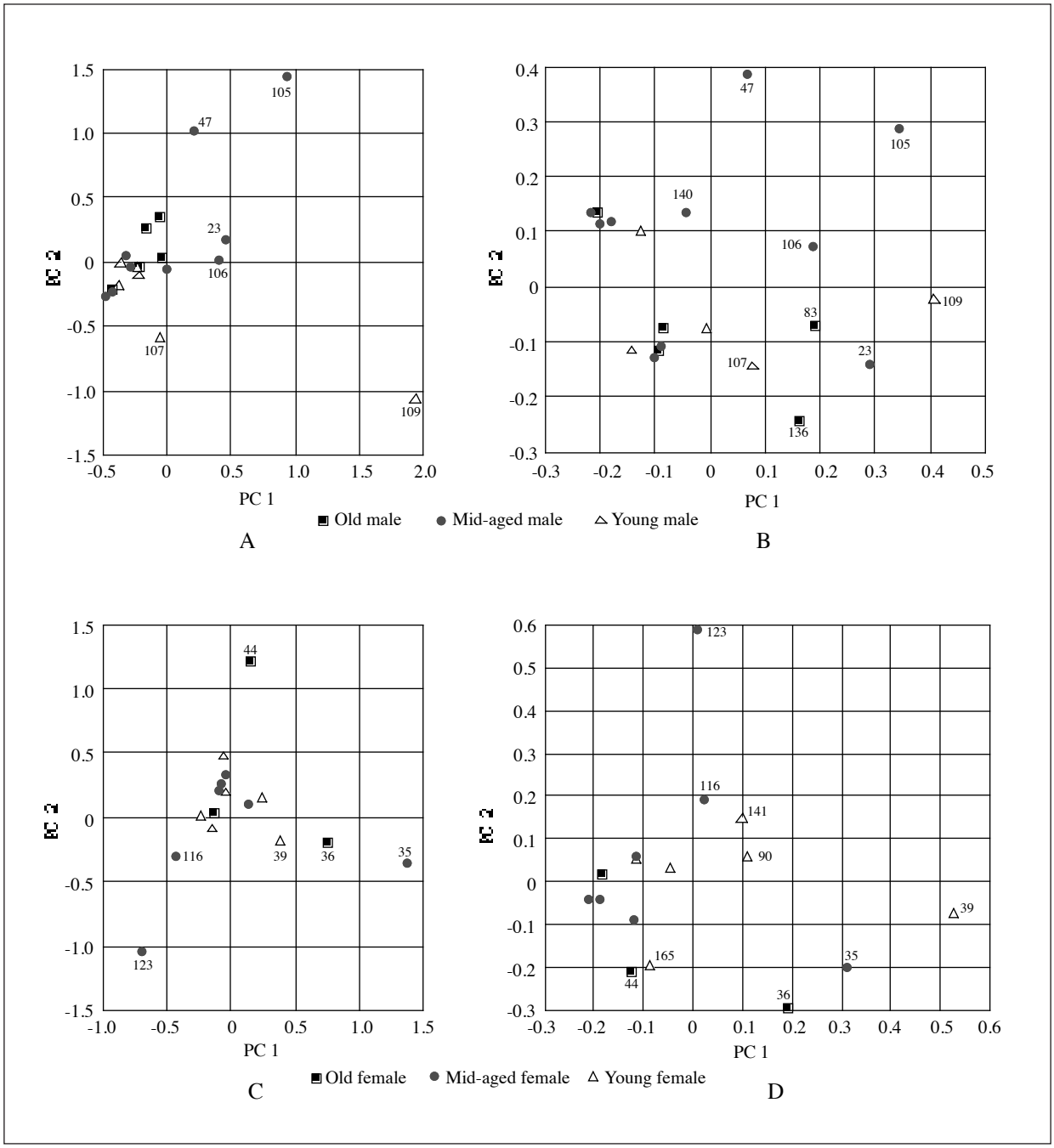


FIG. 235. The distribution of male and female graves on the basis of principal component scores. A: males (number of artefacts), B: males (presence or absence of artefacts), C: females (number of artefacts), D: females (presence or absence of artefacts)

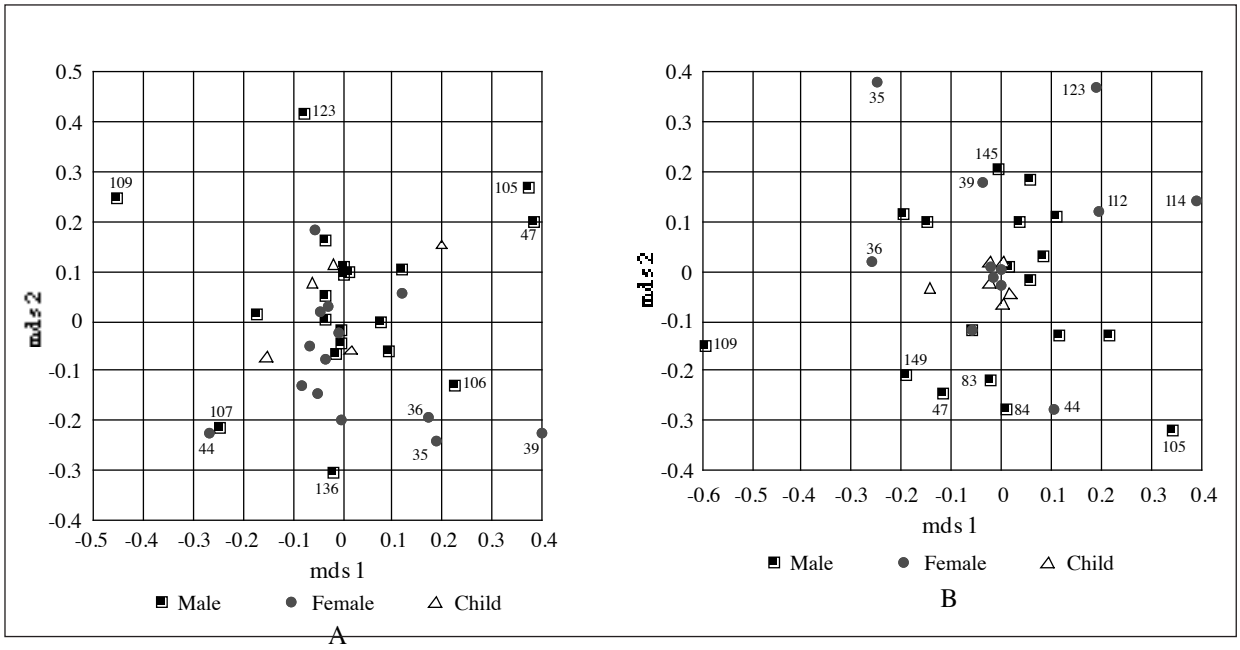


FIG 236. The distribution of 49 intact Nong Nor graves based on multidimensional scaling A. Values 1 and 2 for the presence or absence of grave goods. B. Values 1 and 2 for the number of grave goods.

TABLE 63. *The distribution of grave goods in the complete graves of adults*

Artefact type	45	83	124	136	40	47	75	86	124	105	106	126	140	146
old male	*	*	*	*	-	-	-	-	-	-	-	-	-	-
mid aged male	-	-	-	-	*	*	*	*	*	*	*	*	*	*
shell bangle	-	-	-	-	1	-	-	-	1	-	-	-	-	-
marble bangle	-	-	-	1	-	1	-	-	-	1	1	-	-	-
serpentine bangle	-	2	-	-	-	-	-	-	-	-	-	-	-	-
tin bangle	-	-	-	-	-	-	-	2	-	-	-	-	-	-
bronze bangle	-	-	-	-	-	-	-	-	-	-	-	-	-	-
jade earring	-	-	-	-	-	-	-	-	-	-	-	-	-	-
tin earring	2	-	-	-	-	-	-	-	-	1	-	-	-	-
serpentine earring	-	-	-	-	-	-	-	1	-	-	-	-	-	-
shell pendant	-	-	-	-	-	1	-	-	-	1	-	-	-	-
shell bead necklace	1	-	-	-	-	1	1	1	-	-	-	1	-	-
canine necklace	-	-	-	1	-	-	-	-	-	-	-	-	-	-
shell bead bracelet	-	-	-	-	-	-	-	-	-	-	-	-	-	-
shell bead belt	-	-	-	1	-	-	-	-	-	-	-	-	-	-
serpentine bead	-	-	-	-	-	-	-	-	-	-	-	-	-	-
carnelian bead	-	-	-	-	4	-	-	-	-	-	-	-	-	-

TABLE 63 *(cont). The distribution of grave goods in the complete graves of adults*

Artefact type	45	83	124	136	40	47	75	86	124	105	106	126	140	146
serp. belt ornament	-	1	-	-	-	-	-	-	-	-	-	-	-	-
conus shells	-	-	-	-	-	-	-	-	-	-	-	-	-	-
bronze implements	-	-	-	-	-	-	-	-	-	-	-	1	-	4
grinding stone	-	-	-	-	-	-	-	-	-	-	-	-	1	-
pot form 1	-	1	-	-	-	3	1	1	-	1	2	4	1	6
pot form 2	-	-	-	-	-	1	-	-	-	1	-	-	-	-
pot form 4	-	1	-	-	-	1	-	-	-	-	-	-	-	-
pot form 5	-	-	-	-	-	-	-	-	-	-	-	-	-	-
pot form 6	-	-	-	-	-	-	-	-	-	-	-	-	-	-
pot form 7	-	-	-	-	-	-	-	-	-	-	-	-	-	-
pot form 8	-	-	-	-	-	-	-	-	-	-	-	-	-	-
pot form 9	-	-	-	-	-	1	-	-	-	-	-	-	-	-
pot form 10	-	-	-	-	-	1	1	1	-	-	-	3	1	3
pot form 11	-	-	-	-	-	-	-	-	-	-	1	-	-	-
pot form 12	-	-	-	-	-	-	-	-	-	2	1	-	1	-
pot form 13	-	-	-	-	-	-	-	-	-	-	1	-	-	-
pot form 14-18	-	1	-	-	-	-	-	-	-	1	-	-	-	-
dog bones	-	1	-	-	-	1	-	-	-	1	-	-	-	1
cattle bones	-	1	-	1	-	-	-	-	-	-	-	-	-	-
pig bones	-	1	-	1	-	-	-	-	-	1	1	-	-	-
tiger teeth	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Artefact type	14	20	107	109	112	145	36	44	133	35	60	116	118	123	132
young male	*	*	*	*	*	*	-	-	-	-	-	-	-	-	-
old female	-	-	-	-	-	-	*	*	*	-	-	-	-	-	-
mid aged female	-	-	-	-	-		-	-	-	*	*	*	*	*	*
young female	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
adult	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
child	-	-	-		-	-									
shell bangle	-	-	-	-	-	-	1	-	-	1	-	-	1	-	-
marble bangle	-	-	-	-	-	-	4	-	-	1	-	-	-	1	-
serpentine bangle	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-
bronze bangle	-	-	-	-	2	-	-	-	-	7	-	1	-	-	-
jade earring	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-
tin earring	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
serpentine earring	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-
shell pendant	-	-	-	1	-	-	-	-	-	2	-	-	-	-	-
shell bead necklace	-	-	1	-	1	-	-	1	-	-	-	-	-	-	-
canine necklace	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
shell bead bracelet	-	-	2	-	-	-	-	-	-	1	-	-	-	-	-
shell bead belt	-	-	1	-	-	-	1	1	-	-	-	-	-	-	-

TABLE 63 *(cont). The distribution of grave goods in the complete graves of adults*

Artefact type	14	20	107	109	112	145	36	44	133	35	60	116	118	123	132
serpentine bead	-	-	3	-	-	-	-	1	-	-	-	-	-	-	-
carnelian bead	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
serp. belt ornament	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
conus shells	-	-	-	4	-	-	-	-	-	-	-	-	-	-	-
bronze implements	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-
grinding stone	-	-	-	3	-	-	-	-	-	-	-	-	-	1	-
pot form 1	1	-	5	3	-	5	1	1	1	-	-	1	2	5	-
pot form 2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
pot form 4	-	-	-	-	-	1	2	-	-	1	-	-	-	-	-
pot form 5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
pot form 6	-	-	-	-	-	-	-	-	2	-	-	-	-	1	-
pot form 7	-	-	-	-	-	5	-	-	-	-	-	1	-	1	-
pot form 8	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-
pot form 9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
pot form 10	-	-	-	-	-	1	-	-	-	-	-	-	-	1	-
pot form 11	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-
pot form 12	-	-	-	1	-	-	1	-	-	-	1	-	-	-	-
pot form 13	-	-	-	1	-	-	-	-	-	1	-	-	-	-	-
pot form 14-17	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-
dog bones	-	-	-	-	-	-	-	-	-	-	-	1	-	1	-
cattle bones	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-
pig bones	-	-	1	1	-		-	-	-	-	-	-	-	1	-
tiger teeth	-	-	-	-	-		-	-	-	-	-	-	-	-	-

Artefact type	148	151	39	84	90	114	141	165	149	122	156	117	8
mid aged female	*	*	-	-	-	-	-	-	-	-	-	-	-
young female	-		*	*	*	*	*	*	-	-	-	-	-
adult male	-	-	-	-	-	-	-	-	*	-	-	-	-
adult	-	-	-	-	-	-	-	-	-	*	*	-	-
middle aged	-	-	-	-	-	-	-	-	-	-	-	*	-
young adult	-	-	-	-	-	*	-	-	-	-	-	-	*
shell bangle	-	-	-	-	1	-	-	-	-	-	-	-	1
marble bangle	-	-	3	-	-	-	-	2	-	-	-	-	-
serpentine bangle	-	-	-	-	-	-	-	-	1	-	1	-	-
bronze bangle	-	-	2	2	-	-	-	-	-	-	-	2	1
jade earring	-	-	-	-	-	-	-	-	-	-	-	-	-
tin earring	-	-	-	-	-	-	-	-	-	-	-	-	-
serpentine earring	-	-	-	1	-	-	-	-	-	-	-	-	-
shell pendant	-	-	-	-	-	-	-	-	-	-	-	-	-
shell bead necklace	-	-	1	-	-	-	-	1	-	-	-	-	-
canine necklace	-	-	-	-	-	-	-	-	-	-	-	-	-

TABLE 63 *(cont). The distribution of grave goods in the complete graves of adults*

Artefact type	148	151	39	84	90	114	141	165	149	122	156	117	8
shell bead bracelet	-	-	-	-	-	-	-	1	-	-	-	-	-
shell bead belt	-	-	-	-	1	-	-	-	-	-	-	-	-
serpentine bead	-	-	-	-	-	1	-	-	-	-	-	-	2
serp. belt ornament	-	-	-	-	-	-	-	-	-	-	-	-	-
conus shells	-	-	-	-	-	-	-	-	-	-	-	-	-
bronze implements	-	-	-	-	-	-	-	-	-	-	-	-	-
pot form 1	-	-	2	-	-	2	-	1	-	-	-	-	2
pot form 2	-	-	-	-	-	-	-	-	-	-	-	-	-
pot form 4	-	-	2	-	-	-	1	-	-	-	-	-	2
pot form 5	-	-	-	-	-	2	-	-	-	-	-	-	-
pot form 6	-	-	-	-	-	-	-	-	-	-	-	-	-
pot form 7	-	-	-	-	-	-	-	-	-	-	-	-	-
pot form 8	-	-	-	-	-	-	-	-	-	-	-	-	-
pot form 9	-	-	-	-	-	-	-	-	-	-	-	-	-
pot form 10	-	-	-	-	-	-	1	-	-	-	-	-	-
pot form 11	-	-	-	-	-	-	-	-	-	-	-	-	-
pot form 12	1	-	1	-	-	-	-	-	-	-	-	-	-
pot form 13	-	-	-	-	-	-	-	-	-	-	-	-	-
pot form 14-17	-	-	-	-	-	2	-	-	-	-	-	-	-
dog bones	-	-	-	-	-	1	1	-	-	1	-	-	-
cattle bones	-	-	-	-	-	-	-	-	-	-	-	-	-
pig bones	-	-	-	-	1	1	-	-	-	-	-	-	-
tiger teeth	-	-	-	-	-	-	-	-	-	-	-	-	-

TABLE 64. *The distribution of grave goods in the complete graves of children*

Artefact type	9	33	131	135	155	163
shell bangle form 5	-	1	-	-	-	-
tin earring	-	-	-	-	-	1
shell pendant	-	2	-	-	-	1
shell bead bracelet	1	-	-	-	-	-
grinding stone	-	-	-	-	3	-
pot form 1	-	2	-	2	1	1
pot form 2	-	1	-	1	-	-
pot form 4	-	1	1	-	-	-
pot form 7	1	-	-	-	-	-
pot form 10	-	-	-	1	-	-
pottery vessel unkown form	1	-	1	2	1	-
dog bones	-	1	-	-	1	-

XXII. NONG NOR PHASE ONE IN A REGIONAL CONTEXT

D.J.W. O'Reilly

CHAPTERS VIII-X served to describe, interpret and catalogue the material culture excavated from the first occupation phase at Nong Nor. Many similarities to the material recovered from the deepest strata at Khok Phanom Di have been noted. The two sites differ, however, in that cultivated rice remains were only found at Khok Phanom Di (Thompson 1996). An examination of Nong Nor in its regional context will serve to place the site in perspective, chronologically and geographically. On the one hand, Meacham (1977) has stressed material continuity from the Palaeolithic into the Neolithic and advocated indigenous cultural development in southern coastal China. On the other, Blust (1996), Bellwood (1994) and Higham (1996a) have suggested the possibility of foreign influence. To what extent can Nong Nor contribute to weighing the validity of the opposing views?

Following the Holocene sea level rise, there is abundant evidence for coastal settlements in Southeast Asia. These are regionally distinct and display chronological variability in which differences are restricted to geographical areas and contemporaneous sites within a limited area have many features in common. The terminology employed to describe these groups is controversial. In his initial definition and use of the term Neolithic, Avebury (1913) noted it as "... the later or polished stone age; a period characterised by beautiful weapons and instruments of flint and other stone, in which however we find no traces of the knowledge of any metal...". Childe (1936) expanded this notion to include the introduction of agriculture, domesticated animals, pottery, polished stone tools and the use of textiles. Vietnamese and Chinese archaeologists have applied the term Neolithic to these coastal assemblages because they incorporate polished stone tools and pottery. This is compatible with the initial use of the term, but not with that proposed by Childe because there is at best only fugitive evidence for cultivated plants or animal domestication. Consequently it is necessary to employ the term Neolithic in Southeast Asia judiciously and follow a specific definition. A case in point, being the shell midden sites around Hedan in the Zhujiang River delta. These were occupied by hunter-gatherers, while at contemporaneous shell midden sites, evidence for agriculture is well represented (Li Guo 1994). A survey of contemporary coastal occupations in Southeast Asia will be useful in that it will demonstrate a distinct regional variability between southern China, Vietnam, Thailand and Malaysia. Local homogeneity will, on the other hand, be recognised in the various 'cultures' of coastal Vietnam.

LINGNAN

In recent years a great deal of archaeological research has taken place in Hong Kong and Guangdong Province. It has become clear that by 6000 B.P., when raised shorelines were being formed, there was a mature tradition of coastal settlement (Meacham 1983:154). A number of shell mound and sandbar sites have been excavated which contain pottery and edge-ground tools. While described as Neolithic (Zhu Feisu 1984, Li Guo 1994, Qiao Xiaoqin 1994), many lack evidence for agriculture. Chisholm and Shutler (cited in Qiao Xiaoqin 1991) have noted that stable carbon isotope analysis evidence from Hong Kong suggests that the coastal dwellers relied primarily on plant food, with the implication that this was derived from agricultural sources. This evidence is tenuous, as it is not unusual for hunter-gatherers living in a coastal environment to obtain less than half their dietary protein from marine sources (Meehan 1977:504).

The sandbar sites of Lingnan have a number of features in common, most notably their location behind a sandbar in small bays. Lagoons are usually found nearby, as are streams and small hillocks (Zhao in Qiao Xiaoqin 1991:2). Shell midden sites are located in the eastern coastal area of Guangdong, and infrequently on the south coast, in Shenzhen, Zhuhai or Hong Kong. Xiaoqin Qiao (1991:8) suggests that this may be due to the adoption of an alternative subsistence strategy brought on by the influence of agriculturists. It is more likely that the location of sites was influenced by environmental factors, such as seasonality and the availability of natural resources.

There is some disagreement over the chronology of these sites. Zhu Feisu (1984) and Xiaoqin Qiao (1991, 1994) believe that there are three broad phases, although their dating schemes differ. The first phase according to Zhu Feisu (1984) dates to *c*. 10000-6000 B.P., early sites being aceramic. Two shell mounds, one located at Shiweishan and another at Chenqiaocun, both in Chao'an county, belong to the end of the early period. Another site, Dongwan on Lantau Island, belongs to the same period. The cultural characteristics are represented by stone tools which are made from "river gravels". These are chipped alternately on either side to form hand axes and choppers. At Chenqiaocun, polished adzes are found, leading to speculation that it may be a later site than Shiweishan. The pottery from both is coarse tempered, being basket impressed or burnished. Most vessels are of the round bottomed variety. There was a vigorous bone-working industry at all sites: awls, needles, knives and other implements were fashioned from the bones of ox, pig, deer, tortoise and fish.

The second or middle phase is represented in Guangdong at several sites including the lower layers at Jinlansi and Wanfu'an as well as at Luoshanzui, Baidong, Lianxin, Chongnan and Hedan (Fig. 237). Most of the stone tools were made from river cobbles, but polished stone implements are also present, including the shouldered adze. The amount of pottery recovered increased from the basal layers and painted vessels came into use, although most pottery was cord marked and basket impressed. The majority of these sites in Guangdong are small with thin cultural layers indicating short periods of habitation. It is also apparent that the economy was "maintained by fishing, food gathering and hunting" (Zhu Feisu 1984). These sites date between 6000 and 5000 B.P. Other shell mound sites in Dongsin prefecture near Vietnam contained bifacially flaked lithic tools with points. These made up 80 per cent of the lithic assemblage. There were also partially polished adze-axes, shouldered adzes and grooved sandstone abraders. Bone and shell tools including awls, points and shovels were found in large quantities as was paddle-impressed pottery (Nishimura 1994:15). Similar artefacts were also unearthed from three shell mounds in Chao'an county (Bakusui 1961

in Nishimura 1994:15). A widely diversified ceramic industry is found at such sites as Xizhaoshan near Guangzhou (*c*. 7000-5000 B.P.) and Fuguodun on Quemoy (*c*. 6200-5900 B.P.). Burnished and slipped pottery as well as cord- and basket-impressed designs are seen to be derived from an unknown tradition of the lowland, delta-coastal area (Meacham 1977:424).

On Lantau Island the middle phase is found in layers three and four at Dongwan. Xiaoqin Qiao (1991) breaks the cultural sequence into two sub-phases. The first beginning *c*. 5000 B.P., has much the same material culture as that described above. The second sub-phase appears *c*. 4500 BP and is marked by technological advance in the creation of stone tools and the refinement of ceramic production and decoration. The middle stage lasts until *c*. 3500 B.P. at Dongwan by which time bronze technology had appeared.

The late phase, as described by Zhu Feisu (1984), lasts from *c*. 5000 to about 2500 B.P. The most recognisable feature being the appearance of geometric-impressed pottery, often termed soft geometric. The diversification of vessel shapes gradually increased with time. The stone tools are small polished implements, including stepped adzes, trapezoidal axes, chisels and arrowheads. In the Zhujiang Delta, shell mound sites of the late period are known as Hedang type culture sites, dating to *c*. 5000-3900 B.P. (Zhu Feisu 1984:40). Even though they are classified as late Neolithic, the main productive activities were food gathering and fishing. "The wet sub-tropical weather, rivers, sandy bays and dense forest provided the primitive people with abundant material sources, so that primitive agriculture developed slower than it did in northern (inland) Guangdong" (Zhu Feisu 1984:39).

VIETNAM

As was the case in the Chinese literature, many shell midden sites in Vietnam are classified as Neolithic on the basis of artefacts with possible agricultural affiliation, such as stone 'hoes', the relative abundance of pottery and the presence of mortars and pestles (Bui Vinh 1991). It is suggested, as it has been elsewhere (Higham 1989, 1996a), that judgement on the presence of agriculture at Vietnamese and other coastal sites be suspended until such time as archaeobotanical evidence can be secured. The Vietnamese coastal 'Neolithic' sites are postulated to date to *c*. 9500-4300 B.P. based on radiocarbon determinations from Quynh Van, Tham Hai, Da But and Cai Beo (Bayard 1984b).

The coastal middens of Vietnam consist largely of bivalve molluscs and other marine species. Many correspond in size to Nong Nor. The Vietnamese and Thai sites may be differentiated on the basis of pottery and lithic assemblages. The former fall within a number of distinguishable "cultures" based on their location and chronology. Vietnamese archaeologists (Ha Van Tan 1980:17, 1984:144) assert that the sites may all be assigned to the same broad developmental system, devoid of external intrusion and demonstrating cultural continuity, as Meacham (1983:160) illustrates:

> "… a description of common traits reads like a catalogue of excavated material: rectangular, stepped, and shouldered adzes; heavy chipped pebble tools; cord, incised, and painted pottery; footed bowls and pots, often with perforated foot rims; slotted stone rings, perforated pendants, and bracelets; spindle whorls of a wide variety; multi-grooved sandstone polishers; and so on. Only minor variations in pottery and stone material allow regional cultures to be distinguished."

Two sites, Da But in Thanh Hoa province and Ha Lung in Quang Ninh province comprise what some archaeologists term the post-Bacsonian Neolithic (Bayard 1984b) and others know as the Ha

Lung culture (Ha Van Tan 1980). Da But dates to *c*. 7035 B.P. and Ha Lung to *c*. 7340 B.P. (Bayard 1984b). The former is characterised by flexed inhumation burials and a great deal of pottery in a marine shell midden which was 5 m deep and covered a little over 1.5 ha (Bui Vinh 1987). The artefactual assemblage also consisted of Bacsonian edge-ground tools, adzes and mammal bone including dog (Bellwood 1978).

Another "culture" has been defined by the eponymous site of Quynh Van located in Nghe An province. This marine shell midden covers 7400 m^2 and attains a depth of 5m (Bellwood 1978). It is dated to *c*. 5515 BP (Bayard 1984b), yet has many elements of the much earlier Hoabinhian tradition represented in its lithic assemblage, especially the bifacial chipped stone tools which are tortoise shell, horseshoe and diamond shaped. Very few polished axes are associated with the sites of the Quynh Van culture (Nguyen Van Hao 1981, Nguyen Trung Chien 1992). The pottery is largely cord marked and basket impressed, often with pointed bottoms. Other artefacts identified include grinders, pestles and pounders.

Cai Beo is located on Cat Ba island in the Gulf of Bac Bo and has been distinguished as a separate culture by Nguyen Van Hao (1979). There are two cultural layers present, the first dating to 6475±295 B.P., the upper layer dating to *c*. 3500 B.P. Nguyen Khac Su (1986) surmises that the first occupation had its origins in the Hoabinhian-Bacsonian and that the first inhabitants of Cai Beo were fishing, hunting and growing plants for threads. The second occupation belongs to what the author terms the Ha Long culture, a group of cultivators and fishers belonging to the Bronze Age. A different interpretation is presented by Nguyen Tuan Lam (1989), who recognises three occupation phases, the earliest belonging to the Da But culture. The second occupation is thought to be pre Ha Long and the final phase, Ha Long proper.

In Quang-Binh province, the site of Bau Tro was excavated by Patte (1925) during the early 1920s. Since that time the Vietnamese have continued research in this area, identifying three regional variants, Thach Lac, Bau Tro and Minh Cam. There is some variation in the ecological exploitation strategies of these sites. Four types, including shell middens, sand dune sites, hill sites and lithic workshops have been identified (Pham Thi Ninh 1991). Bau Tro itself is situated in sand dunes. It comprises marine shells interspersed by two layers of sand in a sequence 3 m deep. The material culture consists of polished adzes of Duff types 2 and 8. Grooved grinders, probably used to sharpen adzes were also present (Bellwood 1978:179). The pottery was mostly cord marked, some being impressed and some painted. Appliqué was also a fairly common decorative element. Many of the ceramic vessels are thought to have been round bottomed globular jars. Other sites of the Bau Tro culture include Phoi Phoi and Phai Nam. The latter contained more polished type 8 adzes, as well as polished 'hoes'. All Bau Tro sites share a similar ceramic assemblage.

CAMBODIA

Just one marine site has been reported from Cambodia, Kbal Romeas. It is a rock shelter with shell deposits in front, located near Kampot in southern Cambodia only a few kilometres from the sea. The deposit of marine shells is about 50 cm in depth. Although the site has never been excavated, a radiocarbon date of 5370±140 B.P. was obtained from samples collected during a site survey. This date may be tentatively assigned to the potsherds in the cultural layer of the shell mound (Mourer 1977:47).

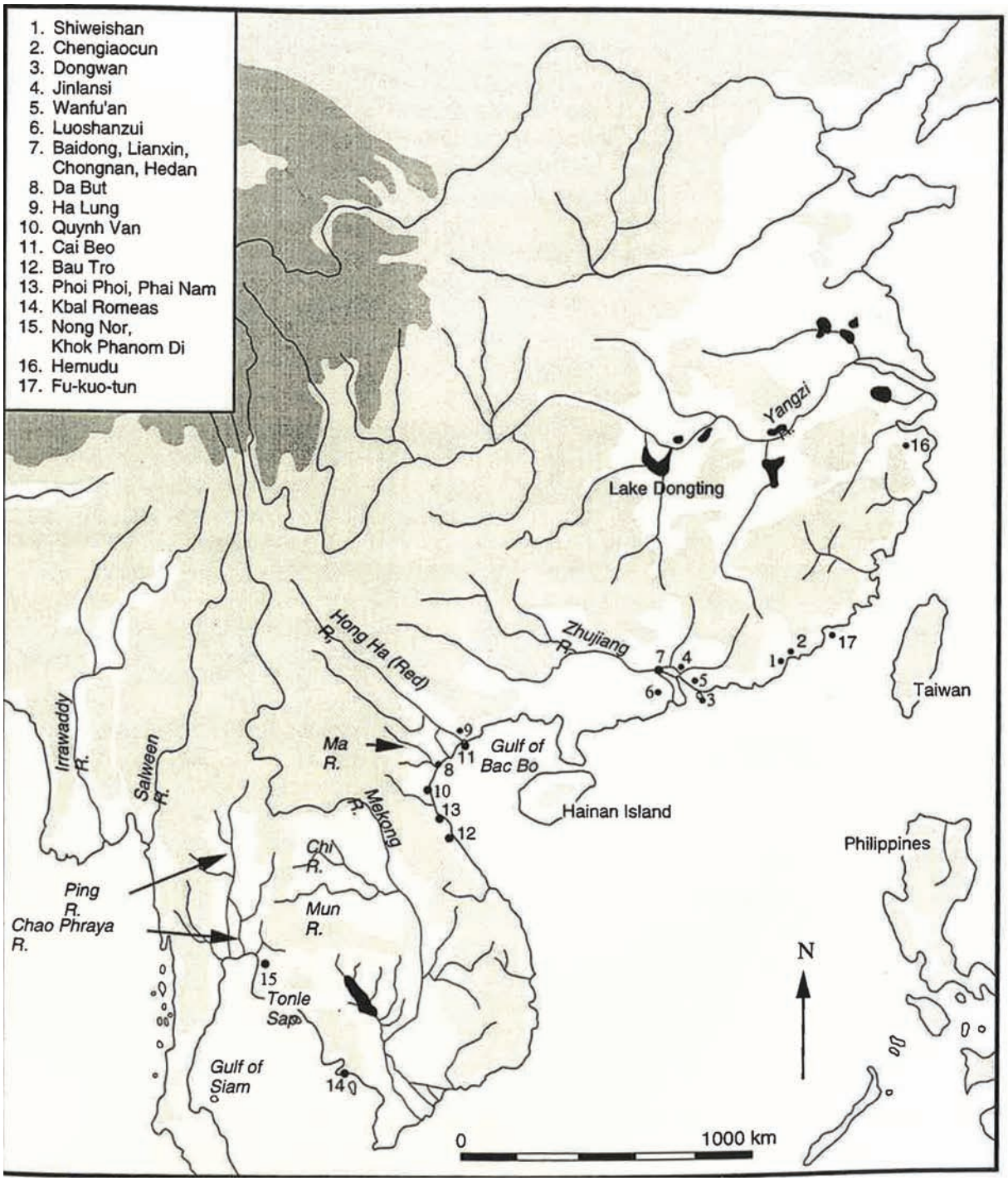


FIG. 237. Map showing the sites mentioned in the text.

PENINSULAR MALAYSIA

In Malaysia the evidence for shell middens is limited. There are two coastal shell mounds ascribed to the Hoabinhian on the west coast at Gua Kepah and Seberang Perak. There is also a cave site with an associated shell midden at Gua Bintong (Bellwood 1985:166, 1993:41). Gua Kepah is located in Province Wellesley and consists of three distinct middens on a sand ridge which was once part of a coastal beach (Dunn and Dunn 1977:19). Unfortunately, due to the activities of modern lime collectors, the middens have been considerably reduced, from a height of about 5 m (Matthews 1968:5 in Dunn and Dunn 1977:19). The shell mound is comprised mostly of *Batissa* and *Anadara* shells (Bellwood 1985:171) which are generally found in a sandy environment. Fish and mammal bone were also recovered during an investigation by Callenfels (1936). The tool assemblage comprises sumatraliths, grindstones, pounders and both plain and cord-marked pottery was present. An interesting point is the presence of both Hoabinhian tools and ground stone implements in the same midden (*ibid*. 1936:33). Judging from the artefactual assemblage, this site represents a considerable time depth for marine exploitation in peninsular Malaysia.

The living floor inside the cave at Gua Bintong is characterised by sumatraliths and other flaked implements. Overlying these deposits are pottery bearing strata. Edge-ground bone tools are present in all the layers at Gua Bintong (Collings 1937:99). There is no mention of the correlation between the shell midden and the cave deposits but this may be assumed because the cave would have been located near the sea during the time of its occupation (Bellwood 1993:42). Some of the artefacts from this site are similar to those found at Nong Nor, parallels evident in the rim forms as well as in the bone tool assemblage.

Seberang Perak has been examined more recently by Adi Haji Taha (1987). The site is a shell mound, about 5 m in height and 15 m in diameter, in which three cultural layers were distinguished. The lithic artefacts recovered were all of Hoabinhian affiliation

The preceding account demonstrates that coastal adaptations were widespread throughout Southeast Asia and that they were successful, indeed, they still are. The Chaw Lay subsist along the coasts of Thailand and Malaysia and various aboriginal groups rely heavily on this lifestyle in Northern Australia. These groups have adapted to the marine environment because it provides many benefits in a tropical climate. Most notably, food is abundant. Marine species such as fish and shellfish as well as terrestrial mammals provide amply. Edible plants, such as coconuts, bananas and various tubers make permanent agricultural activity unnecessary for smaller groups. Such abundance not only decreases the amount of time invested in collecting and hunting, but allows for a degree of sedentism. This may encourage technological innovations such as the production of pottery as well as the development of watercraft, which serve for transport, and may facilitate contact with other coastal dwellers, resulting in exchange. It is contended that reliable agricultural production would only have been necessary to sustain larger populations or to fulfil new social needs, such as feasting.

PREHISTORIC CULTURAL DEVELOPMENTS IN SOUTHEAST ASIA

Holocene human adaptations are a contentious issue. There has been considerable debate over the transition from the Hoabinhian to the so-called Neolithic in Southeast Asia (Gorman 1971, 1977, Dunn and Dunn 1974, Enzheng and Hutterer 1989, Bellwood 1985, 1990, 1993, Nishimura 1994). A major issue is whether the Hoabinhian 'culture' was supplanted by a tradition which developed

elsewhere in Southeast Asia (Gorman 1971, Bellwood 1985, 1990, 1993, 1994, Nishimura 1994) or whether there was continuous indigenous development of the Hoabinhian tool types which eventually resulted in 'Neolithic' assemblages (Heine-Geldern 1932, Ha Van Tan 1990:354).

Developmental continuity may be recognised at inland Palaeolithic-Hoabinhian sites up to the point where fully polished stone tools and stepped/shouldered adzes appear in many cave sites. This supercession of tool forms has been interpreted as the introduction of entirely foreign items "from a different complex into the continuing Hoabinhian expression...these introductions indicate that considerable cultural developments were occurring elsewhere in Southeast Asia" (Gorman 1971:314). The inception of these tool forms is also associated with the debate over the beginnings of rice agriculture. Polished, stepped tools are often cited as evidence for rice production in Vietnam, as is the case with Bau Tro culture sites (Ha Van Tan 1981:13). Heine-Geldern (1932) has linked the appearance of this tool assemblage to the arrival of intrusive populations belonging to another language group, bearing advanced technologies and an agricultural tradition.

The present evidence lends some support to the possibility that the technological developments represented at later coastal sites were the result of a gradual evolution from the Hoabinhian, a concept first considered by Solheim (1972). The differential rate of technological change between inland foragers and coastal dwellers conceivably occurred of necessity. The environmental differences may have resulted in the development of alternative adaptive strategies at different rates. The need for watercraft and shelter would have been greater in coastal environments, where a significant portion of the subsistence was obtained from the sea. It is suggested that this coastal environment would have been more likely to foster the development of increasingly sophisticated tool forms. The inland dwellers had little need to advance their technology, caves provided protection from the elements and flaked lithic implements were all that were required to crush bone and cut bamboo. Rather than indicating the arrival of agriculturalists from the northern regions of Southeast Asia (Chang 1963:50, Gorman 1971, Bellwood 1985, 1990, 1993, Nishimura 1994), the appearance of advanced tool forms and ceramics could have been an indigenous coastal development.

The sudden appearance of new artefact types in late Hoabinhian deposits (Dunn 1964:121, Gorman 1971:331, Bellwood 1993:46) may be linked to sea level fluctuations. If Sinsakul (1992) is correct, the peoples of the early coastal Hoabinhian (represented by the Malaysian sites of Gua Kepah, Seberang Perak and Gua Bintong, Quynh Van in Vietnam, and Shiweishan, Chenqiaocun and Dongwan in China) would have moved seaward as the sea level began to drop from its maximum transgression, *c*. 6000 B.P. This regressive trend lasted until about 4700 B.P. (Somboon and Thiramongkol 1990:6, Sinsakul 1992:16, Boyd this volume). During these centuries, the Hoabinhian tool forms and ceramic technology could well have been evolving among the coastal dwellers, resulting in ground stone implements and perhaps shouldered adzes. A period of transgression culminated *c*. 4000 B.P. with the sea level being about 2.5 m above the present level (Sinsakul 1992:16). This transgression would have gradually forced the coastal dwellers to retreat inland with the coastline which resulted in the appearance of their material culture in archaeological contexts at such sites as Bau Tro, Phoi Phoi, Phai Nam and the upper layers at Cai Beo as well as Nong Nor phase one and the lower layers of Khok Phanom Di. It is also notable that the location of later 'Neolithic' sites are situated closer to the coast than are the older ones (Jamieson 1981:190), illustrating the continued attachment of these peoples to the marine environment as the sea level dropped during the period 3700-2700 B.P. (Sinsakul 1992:16). The pattern of movement is well illustrated by the

location of the Vietnamese sites both spatially and chronologically. The oldest sites of a coastal adaptation are Ha Lung (*c*. 7275-7443 B.P.) and Da But (midpoint 7035 B.P.) where edge ground tools make an appearance among a largely Hoabinhian flaked tool assemblage. The lower layers of Cai Beo which date to about 6000 B.P. also contain Hoabinhian tool types. During this period the sea level was high, reaching its maximum level at around the same time as Cai Beo was first occupied. The sea level began to drop around 6000 B.P. after which point there is little evidence for occupation on the old coastal fringe in Vietnam. Around 5000 B.P. another transgressive phase began, inundating all the sites that were established on the coast after 6000 B.P. The sites of Bau Tro, Phoi Phoi and Phai Nam were established at the second high point of sea level transgression around 4700 B.P. All contain fully polished stone tools and stepped adzes of Duff type 2 and 8 (Ha Van Tan 1990:355). This point is echoed by Meacham (1977:423), in his interpretation of the situation in Lingnan:

> "…where it is assumed that the exposed continental shelves were inhabited until their submergence, climaxing *ca*. 4000 B.C. By this time several distinctive Neolithic cultures were flourishing in the present coastal and delta regions, and it is probable that much of their antecedent development occurred in areas now offshore. The creation of an archipelago environment in the later phases of the transgression probably increased the reliance on boats and accelerated the information flow, while the rapid retreat and readaptation of the inhabitants must have significantly increased the likelihood of experimentation, chance discoveries, and their immediate exploitation... The rectangular adze, may have emerged through a series of innovations from more refined and distinctively shaped pebble tools (Late Hoabinhian) through edge ground, oblong pebble axes (early Bacsonian, Hsein-jen-tung?) and round or lentoid axe-adzes well polished on the edge and/or crudely polished all over (late Bacsonian Hsi-chao-shan?) to subrectangular (semilentoid) and rectangular forms (coastal shell mounds, Lungshanoid)."

The point of course, is moot, because under this model, sites which contain the intermediate forms between the classic Hoabinhian and the polished adzes would be inundated by the sea or located beneath alluvial deposits associated with marine transgression. If it is correct that Shixia and Phung Nguyen are the earliest intrusive agricultural settlements in Lingnan and Vietnam, there is no evidence for a migration of people from anywhere else prior to their establishment (Higham and Thosarat 1993:10).

There may be those who argue that the appearance of new tool forms is related to the inception of agriculture and perhaps the arrival of Austroasiatic speakers in Southeast Asia. The absence of rice and the presence of polished stone tools at Nong Nor suggests that the bond between lithic technology and rice agriculture may be broken. The similarities demonstrated in the artefactual assemblages of Nong Nor and Khok Phanom Di hamper the attribution of the new tool technology with the arrival of Austroasiatic speakers. If the hypothesis that populations possessing agricultural technology gradually advanced down the major river valleys of mainland Southeast Asia (Blust 1996, Higham 1996b) is valid, one may expect to find a sharp differentiation in the material culture of these peoples and the hunter-gatherer populations in the path of the migration. As has been demonstrated in the preceding chapters, no such differentiation can be discerned concomitant with the presence of rice. In fact, comparisons of the assemblages from Khok Phanom Di and Nong Nor demonstrate continuity. This being the case, there is still the issue of language distribution in mainland Southeast Asia to be considered.

The preceding survey of archaeological sites has confirmed that Nong Nor conforms to a broad regional pattern, apparent in the morphology and location of the sites as well as the technology of the inhabitants. The pottery is sand tempered and largely cord marked, the adzes are polished and the bone tools from the various coastal sites are nearly identical. It is further likely that the coastal sites contemporaneous with Nong Nor are pre-agricultural.

LINGUISTIC AND ARCHAEOLOGICAL CONSIDERATIONS

The distribution of languages is of considerable relevance to archaeologists and genetic biologists because they may be utilised to trace the movement of peoples and reconstruct their material culture. The union between archaeological, linguistic and biological data has recently gained prominence in reviewing prehistoric population dispersals. Each, however, draws on its own data and it seems unreasonable to expect cohesion after the passage of many millennia.

Several models for linguistic replacement have been advanced over the years, but perhaps the most plausible has been the combination of genetic and archaeological evidence, resulting in the 'wave of advance model' (Ammerman and Cavalli-Sforza 1979). This model of population diffusion discounts the validity of other explanations of agriculturally related population expansion. These usually focus either upon the deliberate colonisation of a specified area by a dominant group or the acquisition of agricultural expertise by hunter-gatherers through casual contact with sedentary agriculturalists (Renfrew 1987:126). The wave of advance theory is a mathematically demonstrable model which posits that the adoption of farming results in population increase, rapid at first then slowing as the carrying capacity for the geographic area is reached. This in turn results in a demand for further cultivatable land which is found in close proximity to existing farm land. Expansion is thought to occur in a radial fashion. The model estimates that for each generation there will be a migration of 18 km. The result is a very subtle migratory event lasting many centuries or even millennia.

Renfrew (1987:131) states that the 'wave of advance model':

> "… is eminently visible archaeologically. It is a relatively straightforward matter to determine, by excavation, whether a community enjoyed a farming economy or was based on hunting and gathering...It is sometimes less easy to decide whether the first farming settlements in an area were occupied by people who were already resident there and who adopted techniques of farming from their neighbours, or whether the first farmers were newcomers...in some cases we see aspects of the material culture of the hunter-gatherers continuing in use alongside the new farming community. That may be an indication that the original population has survived and has taken up farming."

The nature of agricultural expansion and the fate of indigenous populations in its path has been considered by Bellwood (1994). He posits that the hunter-gatherer populations may "(1) have adopted just agriculture alone without language shift, or (2) have adopted both agriculture and language from the newcomers..., or (3) have adopted neither and simply been absorbed or pushed away by the larger inmoving agricultural population." To these may be added a fourth possibility, that agricultural technology preceded the agriculturalists. In this last model, language change would have occurred sometime after the adoption of agriculture by the hunter-gatherers, due to contact with the expanding agriculturalists. Linguistic transition being facilitated by a shared subsistence strategy.

The present distribution of languages in Southeast Asia hints at the complicated processes

of linguistic development and the effects of intrusion on indigenous populations. There are three widely accepted language families in the region, Austroasiatic (AA), consisting of Munda, Mon-Khmer (MK) and the language spoken on the Nicobar Islands. The (Sino-Tibetan ST) language family is made up of the Chinese, Tibetan and Karen languages. The last family has traditionally been Tai-Kadai (TK), but Benedict (1975) has proposed an enlargement of this family, including Thai, Kadai, Hmong-Mien and the Austronesian (AN) languages in the superfamily, Austo-Tai (AT).

More recently, the revival of a wider language grouping, with a greater time depth has been proposed. The Austric phylum, is thought to have been the root grouping of the AA and the AN languages. The concept of the Austric phylum was largely dismissed when it was first introduced (Schmidt 1906), as the affix similarities and lexical comparisons "failed to exhibit systematic phonological correspondences" (Blust 1996). The hypothesis has been re-examined after Reid's (1993) consideration of elements of the Nancowry languages of the Nicobar islands revealed similarities between MK, an AA language and AN languages that are unlikely to have occurred by chance.

Based upon Reid's (1993) proposed link between AA and AN, Blust (*op. cit.*) has advanced a scenario to explain the present distribution of language in Southeast Asia. A significant portion of the reconstruction is based upon the theory that the area which exhibits the greatest diversity in the primary subgroups of languages, will be the most likely centre of origin (Sapir 1916, Dyen 1956 in Blust 1996). Blust suggests the upper Burma-Yunnan area as the centre of Austric origins. This is based upon the supposition that these languages must have radiated from the same region several millennia before the establishment of Proto-Austronesian (PAN) languages on Taiwan, an event tentatively dated to *c*. 6500 B.P. Diffloth (1991) has proposed the existence of Proto-Austroasiatic (PAA) in the upper Burma-Yunnan region *c*. 7500 B.P. These language families are reunited in Blust's (1996) paper, through a regressive process, beginning on the island of Taiwan, to which the PAN speakers migrated from the Fujian coast on mainland China. The next step in the reunification sees these PAN speakers moving from the mouth of the Yangzi River, down to the Fujian coast, the only viable route, based on current archaeological evidence for the cultivation of rice. Blust (1996:9) states that it is "abundantly clear that rice was grown by speakers of PAN, and hence was present on Taiwan by about 4500 B.C." and the only earlier dates for its use are found to the north of the island, at Hemudu, near the Yangzi Delta. The third chronologically regressive step involves the movement from the middle reaches of the Yangzi to the mouth. Blust (1996) suggests that the populations of these middle regions were PAT and were farming rice around Lake Dongting *c*. 8000 B.P. The latter has been confirmed (Chang 1986) but this is where the trail goes cold archaeologically. From this point Blust extrapolates that, if the cultural tradition leading to the AN settlement of Taiwan was present there and on the Chinese mainland by 6500 B.P., it was probably present at Hemudu 500 years earlier, and at Lake Dongting 2000-1500 years before that. He argues against the adoption of Lake Dongting as the homeland of Austric, based on the fact that up river travel on the fast running Yangzi seems unlikely. The migrants would also have been abandoning an abundant landscape in favour of the unknown. Blust (*op.cit.*) speculates; by 9000 B.P., sedentary populations were utilising if not cultivating rice in the upper Burma-Yunnan region. Shortly after this the ancestors of AN speakers entered the Yangzi basin and gradually followed it to the coast. Somewhat later the division between the Munda and MK speakers occurred, one

population migrating westward and the other entering Southeast Asia.

The AT super family, made up of TK, Hmong-Mien and AN has come to be widely accepted by most linguists. Recent investigations of the sub groupings which contribute to the TK family have revealed that the upper Wu River is the most likely centre of primary dispersal. A second centre has been pinpointed in southern Yunnan, particularly the coastal areas of China adjacent to Hainan (Thurgood 1993 in Blust 1996). Based on these findings, Blust posits that the rice growers of Lake Dongting spoke PAT and that the split between AN and TK occurred when one segment of the population chose to move south, up the Wu Valley while the pre-PAN branch remained in the Yangzi Valley and followed it to the coast. It is interesting to note that the present distribution of the AT languages is congruent with a mainland riverine spread, in a southerly direction from an original centre of rice cultivation (Higham 1996b).

The implications of the validity of the Austric hypothesis are far reaching. As Higham (1996b) notes, it would imply a common origin for an early population expansion in association with rice cultivation in Southeast and East India. There are, however, those who feel that the relationships illustrated by linguists such as Blust and Reid are at best, dubious. Although not a linguist, Meacham (1985:91) discounts the possibility "that cereal culture led inexorably to population growth, which in turn led to pressure, expansion and eventual migration into the islands of Southeast Asia"... stating that the hypothesis is "untenable archaeologically, seriously flawed theoretically and unnecessary." It is clear that Meacham vigorously objects to the notion of South China as the homeland for any pre AN language groups. If South China were the pre AN homeland it would mean that peoples from the interior had infiltrated the area, however slowly and either absorbed or eliminated the indigenous hunter/gatherer populations of the coastal regions, an idea Meacham believes archaeologically unsound. He favours a model in which continuity of development is represented among the coastal populations of South China and one in which rice agriculture is divorced from AN expansion. According to Meacham (1985:100), North China, South China and Indo-China all have some evidence for Pleistocene occupation, Palaeolithic to Neolithic transition and stable populations.

Meacham identifies several problems with the theoretical advance of intrusive agriculturalists from the Yangzi Valley..; If AN expansion was motivated by population pressure, related to rice agriculture (Bellwood 1985:108), he believes that this would be represented archaeologically. The suggested route of the AN languages is also problematic in Meacham's view, in that these peoples did not continue down the coast into Vietnam but chose a seemingly more difficult route, migrating instead to the Pacific islands (*op. cit.* 1985:94). The linguistic validity of the AN hypothesis is likewise questioned. The languages of South China, prior to sinicization (*c.* 200 B.C.) were probably TK and AA of which there are still remnants today, yet there is no evidence for any AN languages having been spoken there (*ibid.* 1984-85:100). If these objections to the origins of the AN languages prove accurate, the validity of the entire Austric hypothesis falters and the scheme proposed for the dispersal of languages in Southeast Asia must be rethought.

Bellwood (1994) proposes an origin of rice agriculture in the middle and lower reaches of the Yangzi River. He believes the region bounded by the Yellow River to the north and Northern Coastal Vietnam, to the south, was the home of the ST, AA, Tai, HM and AN peoples. Sometime around 4000-3000 B.C. the speakers of early forms of these languages began an expansive process.

The evidence from Nong Nor may clarify these issues. Acceptance of the Austric hypothesis would indicate that the occupants of Nong Nor spoke a language which existed in Southeast Asia prior to the expansion of the rice cultivating peoples. This is based on the lack of evidence for either the cultivation or the use of rice at the site. If the expansionist theory is valid, one would expect to find the indigenous material culture supplanted by that of the intrusive agriculturalists. It has been demonstrated at Nong Nor that polished stone adzes were present in non-agricultural contexts, and it has been shown elsewhere that the links between peoples and adze forms, proposed by Heine-Geldern are untenable (Bellwood 1978:175). Furthermore, there seems to be strong evidence for a continuity in the development of cultures in coastal Southeast Asia (Meacham 1977, Ha Van Tan 1980). Evidence for continuity has likewise been demonstrated for coastal Thailand, from Nong Nor to Khok Phanom Di, where similarities are apparent in the ceramic and tool assemblages.

NONG NOR AND RICE CULTIVATION

As we have seen, there is no evidence for rice cultivation at phase one Nong Nor, either indirectly in the form of artefacts or in botanical remains. Khok Phanom Di on the other hand, has provided much evidence for the use of rice. It is found in the temper of pottery and in the soil matrix. The local harvesting of rice is suggested by the presence of shell knives. The argument that Khok Phanom Di was an intrusive agricultural AA settlement may be advanced, on this evidence alone. The fallibility of such a conclusion is readily apparent, however, when the full range of evidence from Nong Nor and Khok Phanom Di are compared. The survey of the material culture from either site has demonstrated a marked similarity. It is unlikely that such similarity would be represented at sites 500 years removed with one populated by an intrusive group.

The internal sequence at Khok Phanom Di may provide a suitable explanation. The excavators divided the stratigraphy into three zones, each representing a phase of occupation, within which there were a number of layers. The zones were differentiated by the material culture, mortuary practices and the nature of the environment. Zone A consists of Layers 10 and 11, which demonstrate striking parallels with Nong Nor in terms of the material culture. There is abundant evidence for rice in these layers indicating that the grain was collected in large quantities, if not cultivated. It is suggested that during the period which separates the abandonment of Nong Nor and the occupation of Khok Phanom Di, between 2500 and 2000 B.C., that an important transition to an agricultural lifestyle took place. Based upon the evidence presented above, which demonstrates continuity in the material culture of these two sites, it is possible that this transition was an indigenous event. That is to say, it preceded the arrival of AA agriculturalists in the region. The catalyst for this transition is enigmatic. Environmental stress, evidenced at the juncture of zones A and B, may have resulted in a greater dependence upon rice leading to purposeful planting and harvesting. Alternatively, rice cultivation could have preceded the advance of AA speakers down the river valleys of Southeast Asia.

There is a change in the material culture beginning late in Layer 10 and it becomes marked in Layer 9. The replacement of the 2G adzes occurs in this layer and it is at the same juncture that significant changes in the ceramic assemblage occur. Heavy stone hoes appear just as the bone awls and fishhooks begin to disappear. Shell harvesting knives also begin to appear with increasing frequency. It is conceivable that these changes in material culture at Khok Phanom Di are indicative of the arrival of an intrusive population in the area around Khok Phanom Di, possibly AA

speakers. The continued habitation of Khok Phanom Di and the lack of archaeological evidence for social stress at the juncture of zone A and B suggest that the advent of AA peoples was probably slow and passive, over many generations. The acculturation of the indigenous population may have been further eased, due to a shared subsistence strategy, that of rice agriculture.

It is impossible to resolve the issue of language dispersal based upon evidence from just two sites. The role of Nong Nor and Khok Phanom Di in the interpretation of population movement on the Southeast Asian mainland is, no doubt important. Yet, resolution of these issues will come only through further excavation, especially in the proposed linguistic homelands, as well as in coastal Southeast Asia. Evidence garnered through archaeological investigation combined with biological and linguistic evidence may eventually contribute to the understanding the prehistory of Southeast Asia.

XXIII. CONCLUSIONS AND SUMMARY OF RESULTS

C.F.W. Higham and R. Thosarat

INTRODUCTION

THE excavation of Nong Nor began with limited horizons, but these changed and broadened as research progressed. We sought a small settlement, near to and contemporary with Khok Phanom Di, in order to illuminate the prehistoric social and environmental landscape between 2000-1500 B.C. (Higham and Thosarat 1994). Were the more opulent graves of later Khok Phanom Di, for example, constructed for a social elite which exercised influence over smaller communities in their orbit? Was their settlement significantly larger than its contemporaries? Were exotic shell ornaments the preserve of the highest echelon in this coastal society? Did the command of the Bang Pakong Estuary enable the inhabitants of Khok Phanom Di to control the movement of goods across the landscape? Our initial examination of pottery sherds found at Nong Nor, and the reported inhumation graves with heads pointing to the east, all suggested contemporaneity between the two sites. The shellfish from Nong Nor indicated a marine orientation, as at Khok Phanom Di.

All our expectations were confounded, a situation we have come to expect when excavating in Thailand. Instead of a small one-period Neolithic settlement, we encountered a site with two phases of occupation. The first has been dated to about 2450 B.C., when the site was located on a raised ridge, perhaps a chenier, adjacent to the shore of an extensive marine embayment fringed with mangroves, but also with access to a sandy shore. It was a small settlement, the cultural layers largely comprising the results of food collection and the manufacture and firing of pottery vessels. The second period of use involved a Bronze Age inhumation cemetery, dated within the period 1100-700 B.C. This sequence opened new possibilities. We do not know of any other excavated third millennium B.C. coastal settlement on the raised shorelines behind the present Gulf of Siam. Our first objective, therefore, was to define the cultural characteristics of this community, and then compare it with Khok Phanom Di.

As we progressed with the excavation over three seasons, so we uncovered a sufficient area of the Bronze Age cemetery to illuminate its spatial dimension and consider, through the mortuary ritual, some aspects of the community's social organisation. Again, comparison with Khok Phanom Di provides insight into the social changes between the coastal hunter gatherer and Neolithic of this area, and the subsequent Bronze Age.

THE CHRONOLOGY

Before proceeding to a summary of our findings at Nong Nor, it is necessary to consider the radiocarbon chronology. Figure 238 sets out the dates obtained, in conjunction with those from layers 11 and 10 at Khok Phanom Di. It could be argued that the later phase 1 determinations from Nong

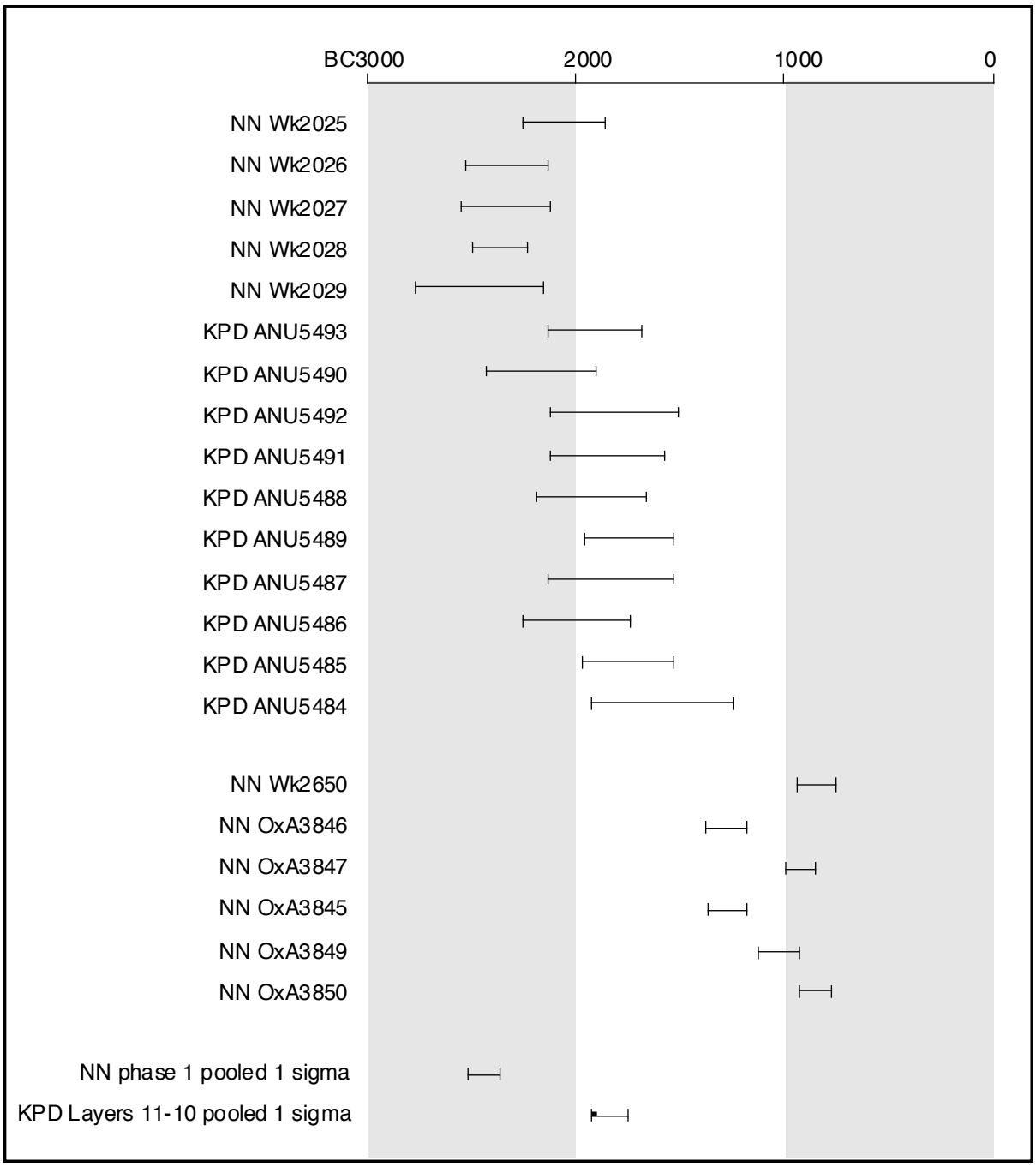


FIG. 238. The radiocarbon dates from Nong Nor and Khok Phanom Di layers 11-10, expressed at 2 sigma. One date from phase 1 Nong Nor is not included because it is based on shell, and the calibration is questionable for lack of data on the reservoir effect. It is Wk 2847 3780±60, 1847-1693 B.C.

Nor overlap at 2 sigma with the earlier results for basal Khok Phanom Di, and that there was little if any interval between the occupation of the two sites. On the other hand, the five samples from Nong Nor are thought to come from a site occupied for little more than a season, and they pool significantly to provide a mean range, at 1 sigma, of 2459 B.C. (2478-2333 B.C.).The ten dates for Khok Phanom Di layers 11-10 pool significantly and the result at 1 sigma is 1846-1773, and at 2 sigma, 1929-1745 B.C. It is suggested that such a gap between the mean values is consistent with an interval of about 500 years between the occupation of Nong Nor and the initial settlement of Khok Phanom Di. The date of the Bronze Age cemetery has been placed within the period 1100-700 B.C. by Higham and Hogg, and this span has been adopted within the text. It is, however, based largely on AMS dates from rice chaff in mortuary vessels. This technique remains in the early stages of development. The span seems to us a little earlier than expected, particularly given the presence on the site, though in undetermined contexts, of a few glass beads. We would feel more comfortable with a dated range a couple of centuries later than 1100-700 B.C., but must await further refinement of the technique employed.

PHASE ONE: COASTAL SETTLEMENT DURING THE THIRD MILLENNIUM B.C.

For several decades, research in mainland Southeast Asia has been lured by the prospect of identifying and explaining the transition to rice cultivation. During the 1960s, many small village sites were identified in northern Vietnam and Thailand (Sørensen and Hatting 1967, Bayard 1971, Watson 1979, Ha Van Tan 1980). Excavations encountered evidence for domestic cattle, pigs and dogs, and rice was often used as a ceramic temper. Two conflicting interpretations were presented. One sought local origins for an indigenous transition to these sedentary agricultural communities represented at Non Nok Tha, Ban Chiang and Phung Nguyen (Solheim 1972, Gorman 1977). The other suggested that rice cultivators expanded their area of settlement from southern China into Southeast Asia (Sørensen and Hatting 1967).

Several programmes of fieldwork in Thailand have been directed to testing models for such a local transition. The first saw a possible location in the hilly uplands of northern Thailand, in the context of the Hoabinhian hunter-forager tradition. Evidence from Spirit Cave and Banyan Valley Cave were advanced to support this hypothesis, particularly the botanical remains, ground stone adzes, polished knives and pottery from the upper layers of the former (Solheim 1972). The possibility of such an indigenous transition has recently been given further consideration, in the form of a model designed for field testing, by Shoocondej (1996). We think that the evidence to support this transition is insufficient and barring further discoveries by Shoocondej, find the upland Hoabinhian an unlikely milieu. No evidence for cultivated rice has been forthcoming, and the ascription of the pottery sherds, polished adzes and slate knives from Spirit Cave to the 6th millennium B.C., based as it is on a thin, late layer from a small and rermote rockshelter, is less than satisfactory.

Gorman (1977) has proposed that the transition to sedentary rice cultivation was located in the marshy piedmont where the uplands of, for example the Phetchabun Range, merged with the flat landscape of the Khorat Plateau. Here, in naturally low-lying areas, monsoon rains fed by mountain streams would form seasonal swamps ideally suited to the proliferation of wild, annual grasses such as rice. This possibility was tested in the field by Penny (1982). No sites or other evidence for such a transition have been isolated.

We suggested a third possibility as a reason for the excavation of Khok Phanom Di. Conscious

of the lack of any evidence to sustain either of the two hypotheses described, we suggested that the transition could have taken place among sedentary coastal communities which faced stressful environmental changes (Higham and Bannanurag 1990). In so doing, we were conscious of the radiocarbon dates obtained for early Khok Phanom Di burials by Noksakul (1983) on the basis of human bone, which suggested occupation by the fifth millennium B.C. Our discussions with Noksakul also revealed that rice remains had been found deep in the sequence there. On this basis, we felt some justification for our hypothesis, since such dates comfortably preceded the inland agricultural settlements, and were on a par with the then earliest contexts for cultivated rice anywhere. While subsequent research proved beyond doubt that the inhabitants of Khok Phanom Di during mortuary phase 4 had access to freshwater swamps, cultivated rice, used shell knives for harvesting and fashioned granite hoes, our radiocarbon dates showed that the site was initially occupied two thousand years later than we had been led to believe, at about 2000 B.C.

This later date must be considered in conjunction with the clear evidence for burning episodes revealed by Maloney's (1991) analysis of sediment cores taken from the vicinity of the site. These have been AMS dated to 5870-4515, 5370-4515 and 4770-4040 B.C., and were associated with rises in the frequency of fern spores. White (1997) has suggested that similar burning phases from Lake Kumphawapi cores evidence very early agriculture in Northeast Thailand. There are several alternative explanations for such periods of burning and associated vegetation changes. One is that there were natural conflagrations, as often occur during the dry season in tropical Southeast Asia, followed by the natural succession: open indicators first, then forest regeneration (Stott 1988). Alternatively, fires may have been set by hunter-foragers to encourage conditions which favoured hunting and collecting. This is widespread in Southeast Asia (Hill, R. pers. comm.). Freshened grass growth after burning attracts deer and other game like iron filings to a magnet. A third alternative is that forest was cleared to open land to rice cultivation. When Maloney's findings were made available, we had no evidence for local groups of hunter-foragers, a gap has now been filled by the excavation of Nong Nor.

There is, then, no satisfactory evidence for a transition to rice cultivation in tropical Southeast Asia. In 1993, however, after we had completed our excavation at Nong Nor, new evidence came from an unexpected quarter. Reid (1994a) produced linguistic evidence which sustained Schmidts's (1906) suggestion that Austroasiatic (AA) and Austronesian (AN) languages share a common ancestor in the Austric phylum. Blust suggested on this basis that AA languages could have been introduced into Southeast Asia by expansionary movement down the river systems from a source which would accommodate also the known distribution of and relations between AA languages (Blust 1996). This region, he indicated, could on linguistic grounds be located in the upper valley of the Yangzi River. Thirty years after his initial statement on the issue, Sørensen's hypothesis received a new lease on life. In microcosm, we were challenged to relate our archaeological findings with this grand synthesis.

AA languages are distributed from eastern India to southern China, with an outlying group in the Nicobar Islands. One of the earliest subdivisions divides the Munda languages of India from Mon-Khmer and Vietnamese, and all commentators assign a considerable time depth to this divergence (Diffloth 1991). Yet there are cognates for rice and aspects of its processing and cultivation which link Munda with languages to the east (Zide and Zide 1976). The distribution of AA languages lacks continuity, because of more recent intrusions bringing AN, Indo-European (IE), Austro-Tai (AT) and Sino-Tibetan (ST) languages into the region (Fig. 239). The potential of linguistic pal-

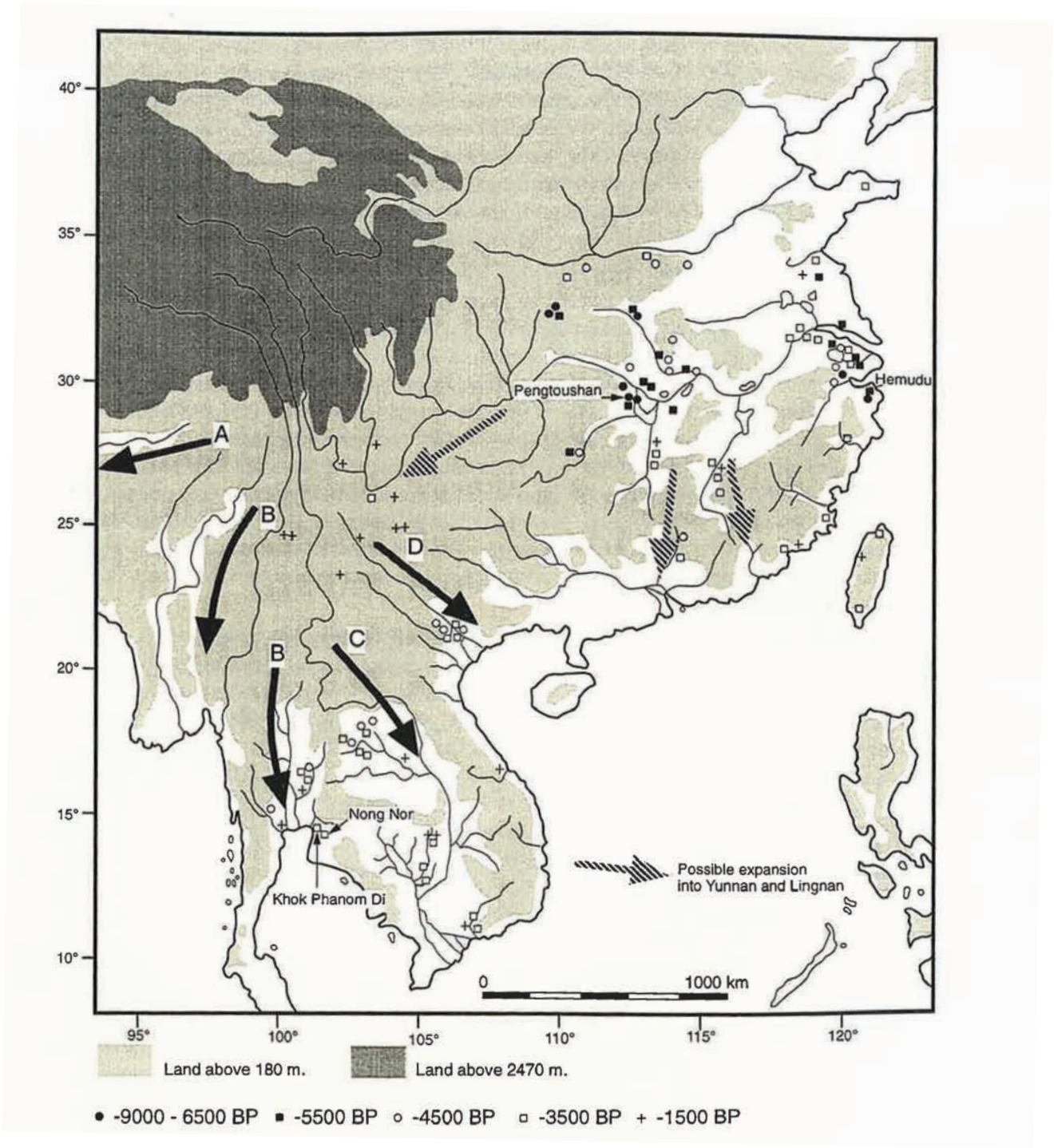


FIG. 239. The possible expansion of Austrasiatic speakers in Southeast Asia and India. Sites shown include rice remains and approximate date of earliest settlement.

aeontology to identify the origins and spread of people as, for example, in a diaspora of Neolithic farming communities, has received much attention, particularly in the wake of Renfrew's (1987) conjunction of the spread of farmers with the distribution of IE languages. In Southeast Asia and the island world to the east and west, this linkage has a long history of fruitful inter-disciplinary research seen in the process of expansion by early speakers of AN languages (Blust 1985, Bellwood 1989). But events on the mainland have not received the same attention until more recently (Bellwood 1992, Higham and Thosarat 1994).

The archaeological record which must be considered in the light of Blust's proposal that AA languages were introduced into tropical Southeast Asia by communities versed in rice cultivation and stockbreeding incorporates two contrasting areas and settlement forms. The first comprises deeply-stratified sites, incorporating thick shell middens located on raised beaches. These assume archaeological visibility only after the major Holocene marine transgression, because until then the rising sea inundated sites in its path. The settlements in question are numerous, cover many millennia, and present a number of widely-recurrent features: pottery manufacture, polished stone implements and inhumation burials often in a crouched, seated posture. The presence of pottery and ground stone tools has encouraged Chinese and Vietnamese specialists to label these groups "Coastal Neolithic" (Bui Vinh 1991). Yet a futher link between these settlements is the lack of any biological evidence for the cultivation of plants. It is true that stone hoes have been found in Vietnam (Ha Van Tan 1980), but such implements can be used to obtain wild plants just as well as to cultivate domestic species.

The second broad grouping of sites offers a stark contrast. The settlements are usually located in inland stream valleys. They incorporate graves for extended inhumations, often grouped and aligned on the same orientation. Grave offerings include pottery vessels and personal ornaments. Rarely larger than 2-3 ha in area, such settlements provide ample evidence for domestic cattle, pigs and dogs, and often, for rice remains. The earliest are found in the marshlands of the central Yangzi Valley, where Pengtoushan has been dated to between 7500-6500 B.C. (Yan Wenming 1991). As one moves down and upriver, and so into Taiwan and the Philippines, or into the tropical mainland of Southeast Asia, so sites are later. In the latter area, we encounter the settlements of the Phung Nguyen culture in Vietnam (Hoang Xuan Chinh and Nguyen Khac Su 1978) which probably dates from about 2500 B.C. In Northeast Thailand, the earliest contexts Non Nok Tha and Ban Chiang are representative. The AMS dating of pottery vessels has now superceded evidence based upon poorly provenanced charcoal. In the case of the former, the earliest dates suggest initial occupation in the early second millennium B.C. Two AMS dates from the second mortuary phase at Ban Chiang lie within the period 2190-1500 B.C., so the very small exposure of the Early Period 1 material might take the initial occupation back to about 2300 B.C. (White 1997). In Central Thailand, the Ban Kao cemetery and the basal occupation of Non Pa Wai have been dated to about 2300 B.C. (Natapintu 1991), while Samrong Sen in Cambodia might represent this settlement form lower down the Mekong River (Fig. 239). Bellwood (1992) has suggested that the early settlers of Ban Chiang and Non Nok Tha probably spoke an AA language.

This brings us to the threshold of Khok Phanom Di and Nong Nor. In the introduction to this report, we outlined four alternative hypothesis to explain how these sites relate to each other and to the wider scene.

Hypothesis 1

Khok Phanom Di represents an intrusive group of agriculturalists. They brought an early AA language, the dog and domestic rice, and intruded into territory long occupied by communities which were sedentary over periods of at least months, possibly years. The latter subsisted on the rich coastal resources available. This hypothesis would be supported if the material culture of phase 1 Nong Nor and early Khok Phanom Di are radically different. Further support would be provided if human remains revealed different phenotypes and DNA sequences. Again, the marked change in subsistence involving cultivation and the arrival of an exotic domesticate, the dog, would support a basic distinction.

The analysis of the material culture of the two sites by O'Reilly has identified close links between the ceramic, bone and stone industries. It is considered extremely unlikely, given these parallels, that the initial occupation of Khok Phanom Di represents an intrusive group of agriculturalists. The dog made its first appearance at Khok Phanom Di almost a metre above the initial occupation layer. Not only the form and style of the material culture were similar, their uses were also the same: clay anvils for shaping pots, stone adzes, the shape of some pottery vessels, the weaving implements and one-piece fishhooks portray a sedentary coastal community given to exchange to obtain some raw materials. While rice was found in the basal contexts at Khok Phanom Di, it is possible that grain was obtained through exchange. The low-lying estuary, muddy mangrove shore and adjacent saltflats are not suited to cultivating this plant.

Hypothesis 2

The initial occupation of Khok Phanom Di could have involved a community with its origins in phase 1 Nong Nor and related but as yet unexcavated sites. This would be supported if the material culture, particularly nuances of ceramic form and decoration, were shown to be similar, and if the people displayed a similar phenotype and DNA sequence. In this situation, the presence in the later site of cultivated rice could reflect either a local transition to agriculture, or its adoption following contact with intrusive Neolithic groups. This last medium of exchange could also account for the presence of the exotic dog. This hypothesis, being the converse of the first, is supported by the evidence drawn from the material culture. The rice remains could indeed have been locally cultivated, or obtained through exchange. The sequencing of DNA remains for the future.

Hypthesis 3.

The initial settlement of Khok Phanom Di might represent direct continuity in terms of both material culture and subsistence with phase 1 Nong Nor. With the passage of time, rice cultivation and access to domestic dogs might have been incorporated into the range of activities undertaken at Khok Phanom Di. This hypothesis would be sustained if the material culture of the two sites were similar, and would require a minute examination of the stratigraphic contexts within Khok Phanom Di of all evidence for the presence of domestic rice, agricultural implements and the dog.

The material culture provides many instances of similarity in form, function and style. At Khok Phanom Di, however, there are two artefact types which have not been recovered from Nong Nor. These are shell knives and granite hoes. Both appear at about the same part of the sequence,

towards the top of layer 10. Higham (1993) has shown that the wear marks on the former match that obtained on experimental knives when used to harvest rice. The stone hoes could have been used to turn the soil. It is intriguing to note that the distribution of these artefacts is complementary to that for fishhooks and net sinkers. The first knives and hoes also occurred at a point in the sequence where Mason (1992), Tayles (1992, 1997) and Thompson (1996) have noted congruent evidence for an environmental change, differences in the wear on human teeth and other trends in health and infant mortality. These have been ascribed to a modification in the environment as sedimentation distanced the site from the open sea and it is thought, the river relocated to a new channel away from the site. Thompson has also advanced evidence from the charcoal and the seeds which suggests the opening of access to freshwater habitats. It is suggested that all these avenues are compatible with a hypothesis that local rice cultivation superceded exchange in rice with the transition from layer 10 to 9, and mortuary phase 3 to 4. Further testing of this hypothesis could involve pursuing the possibility that rice chaff temper was found only in exotic ceramics up to this part of the sequence, but was later incorporated in local wares.

Hypothesis 4.

Nong Nor might represent a dry season temporary occupation, in which a group exploited a marine habitat before returning to an agricultural base with the rains. This hypothesis would be sustained by demonstrating the presence of such agricultural bases by the middle of the third millennium B.C. in the orbit of Nong Nor, and through an examination of the biological remains from Nong Nor, identifying only dry season indicators.

Both these avenues of research will require either further fieldwork to identify possible sites, or fundamental research on bio-rythms among tropical shellfish and fish which are reflected in their physical remains.

We can compare these two sites in terms of their location, the subsistence, place within a regional settlement pattern, mortuary practices and the material culture of the inhabitants. If Khok Phanom Di is distinct in all these variables, then it would tend to support the hypothesis that its inhabitants were intrusive to the area, and impinged upon societies represented at Nong Nor which were long adapted to the marine eco-system of tropical Southeast Asia. Alternatively, continuity between the two in terms of material culture and mortuary behaviour would favour a model of local changes in subsistence without necessarily involving a Neolithic "wave of advance" into the area. These two, however, are polar alternatives. The situation might have been more subtle. For example, the coast of the Gulf of Siam may have been occupied by communities of sedentary hunter-foragers who, through exposure to intrusive Neolithic groups, exchanged ideas, goods and by degrees adopted some agricultural practices. Equally, Khok Phanom Di might represent a Neolithic wave of advance and Nong Nor, the seasonal settlement where people who cultivated rice during the wet season spent part of the dry season exploiting marine resources.

Both sites gave access to marine resources. Khok Phanom Di commanded the estuary of a major river, although sedimentation and a probable change in its course during the 500-year occupation saw marked modifications in the habitat. Nong Nor was located near the landward margin of an extensive marine embayment. We find clear evidence for a mangrove environment, but Khok Phanom Di also gave access to freshwater swamp or lake resources which are so far lacking in the

faunal spectrum of Nong Nor. Where Khok Phanom Di was occupied for centuries, Nong Nor was settled only briefly. We do not know for how long, but O'Reilly's work on the pottery assemblage, together with the homogeneity of the midden deposit and continuity of spatial patterning of activities hint at an occupation of months rather than years. Khok Phanom Di covers about 5 ha, Nong Nor only about .1 ha. It seems reasonable to ascribe a much greater population to the former.

There is only a single phase one burial from Nong Nor. Its seated, crouching posture conforms to a pattern noted in coastal hunter gatherer settlements in Vietnam. The human remains were associated with a burnishing stone and were covered with pottery vessels. In contrast, the dead at Khok Phanom Di were inhumed in an extended position orientated to the east. The latter is matched in many of the village communities in southern China and Southeast Asia associated with rice agriculture and stock raising, although the preferred orientation of the grave varies markedly. On the other hand, there are many general as well as specific parallels in material culture between the two sites. The form and decoration on pottery vessels is so similar that in some cases, it would be hard to assign specimens with confidence to one site rather than the other. These vessels were also made using the paddle and anvil technique, and some were burnished in a similar manner with round pebbles. Most anvils from Nong Nor differ from those of Khok Phanom Di in lacking a handle. The bone industry also provides close similarities in the techniques of manufacture and in the form of the fishhooks and shuttle. The same sandstone abraders were used and the adze forms are similar. The differences are measured more in certain new forms at Khok Phanom Di rather than distinctions based on style. Only the later site includes shell knives probably used in cutting grass stems, and granite hoes.

While there is much evidence for the collection of shellfish and line fishing at both settlements, rice remains are absent from Nong Nor, but abundant at Khok Phanom Di. No dogs are represented at Nong Nor, though they are found at Khok Phanom Di. Nong Nor has provided evidence for a wooden spear haft, and the remains of marine mammals. It is beyond doubt that rice was cultivated at Khok Phanom Di. The presence of the dog is also important, because it is exotic. The prehistoric Thai domestic dog is descended from the wolf, *Canis lupus,* and China is the nearest area where the wolf is native (*C. l. chanco*).

Let us return to the alternative hypotheses. If Khok Phanom Di represented an intrusive group of agriculturalists, their material culture should contrast with that of Nong Nor. The situation is that the preferred forms of some pottery vessels, and the techniques and decorative patterns, are similar even after an interval of half a millennium. Alternatively, could there have been an indigenous transition to the cultivation of rice in this coastal area between 2500-2000 B.C.? This could have been the case, but there are some indications that it is unlikely. Taking a broader perspective, this period is also one which saw the establishment of inland Neolithic communities in tropical Southeast Asia. At Non Pa Wai, there are two radiocarbon dates which indicate initial settlement in the vicinity of 2300 B.C. Ban Kao was probably occupied by the end of the third millennium. It seems unlikely that an indigenous and independent transition to rice cultivation took place on the coastal tract simultaneously with the intrusion of Neolithic groups bringing early AA languages. Moreover, the presence of the dog at Khok Phanom Di suggests some form of contact with such new communities, for it is unlikely that this animal would have instituted an independent wave of advance from China.

This leaves us the more subtle interaction between indigenous coastal foragers and intrusive agriculturalists, wherein the former had a long history and were at least seasonally sedentary. These

could have been responsible for some of the episodes of forest burning witnessed in Khok Phanom Di cores. We know, for example, that the inhabitants of Nong Nor were burning the vegetation, for the site contains much charcoal, many hearths and evidence for firing pottery vessels. If, as Bellwood (1992) has suggested, the expansion of agriculturalists into tropical Southeast Asia brought AA languages and southern Mongoloid populations, then there would necessarily have been interaction with the indigenous inhabitants. In the case of Khok Phanom Di, this could have taken any of a number of courses. Through the exchange of goods, ideas, even people, the local communities could have incorporated rice cultivation into their range of economic pursuits, and acquired the domestic dog.

The interaction model, based on present evidence, is favoured over the alternative wave of advance or local transition models. But it must be tested through further research. This will require the identification and excavation of more coastal sites dating between 4000-2000 B.C. in order to evaluate more fully the pattern of settlement and subsistence base, and to acquire good samples of human remains. If such a programme were to confirm a series of coastal forager communities with no concern for cultivation or the presence of dogs, then comparisons with the farming groups seen at Ban Kao, Non Pa Wai and Khok Phanom Di will be founded on more complete and secure information. Perhaps the most promising means of testing the interaction model will then involve the extraction of human mtDNA in order to identify sequences in Neolithic remains which relate either to local populations or to donor groups to the north.

THE BRONZE AGE

The chronology and culture of the Bronze Age in tropical Southeast Asia are poorly documented and in some respects, controversial. Both have been treated in detail by Higham (1996a), and only the main issues will be summarised. Conservatively, there is a consistent thread of evidence from Lingnan to Central Thailand in favour of a Bronze Age lasting about a millennium, from 1500-500 B.C. Exotic jade halberds, *yazhang* blades and late Shang bronzes in Lingnan and Bac Bo found in late Neolithic contexts provide evidence for exchange contact with emerging states in the *zhongyuan* (Central Plain of China) and the Yangzi Valley. Higham has argued that such exchange could have been a mechanism whereby knowledge of the properties of copper and tin ore reached Southeast Asia. On the other hand, there remain claims for early contexts for bronze metallurgy, and with them for a local and indigenous industry, at two sites in Northeast Thailand, Non Nok Tha and Ban Chiang. In the case of the former, a series of AMS dates on rice chaff temper indicates a later second millennium date (Higham 1996a). AMS dates from Ban Chiang, taken in conjunction with the few conventional dates of secure provenance, indicates that bronze there was much later than earlier claims, and might well postdate about 1500 B.C.

The dating of the Bronze Age cemetery at Nong Nor is based upon such a series of AMS dates, together with one determination from charcoal sealed within an infant mortuary jar. The results, which fall between about 1100-700 B.C., are fully consistent with the vast majority of available dates from related Southeast Asian Bronze Age contexts, including the copper smelting and casting complex at Non Pa Wai, 170 km to the northwest.

Our analyses of the intact graves at Nong Nor suggests that those in the eastern part of the excavated area are later than the rows found in the western sector. This finding is based on the restriction of certain pot forms and virtually all the serpentine, carnelian, talc and nephrite jewellery

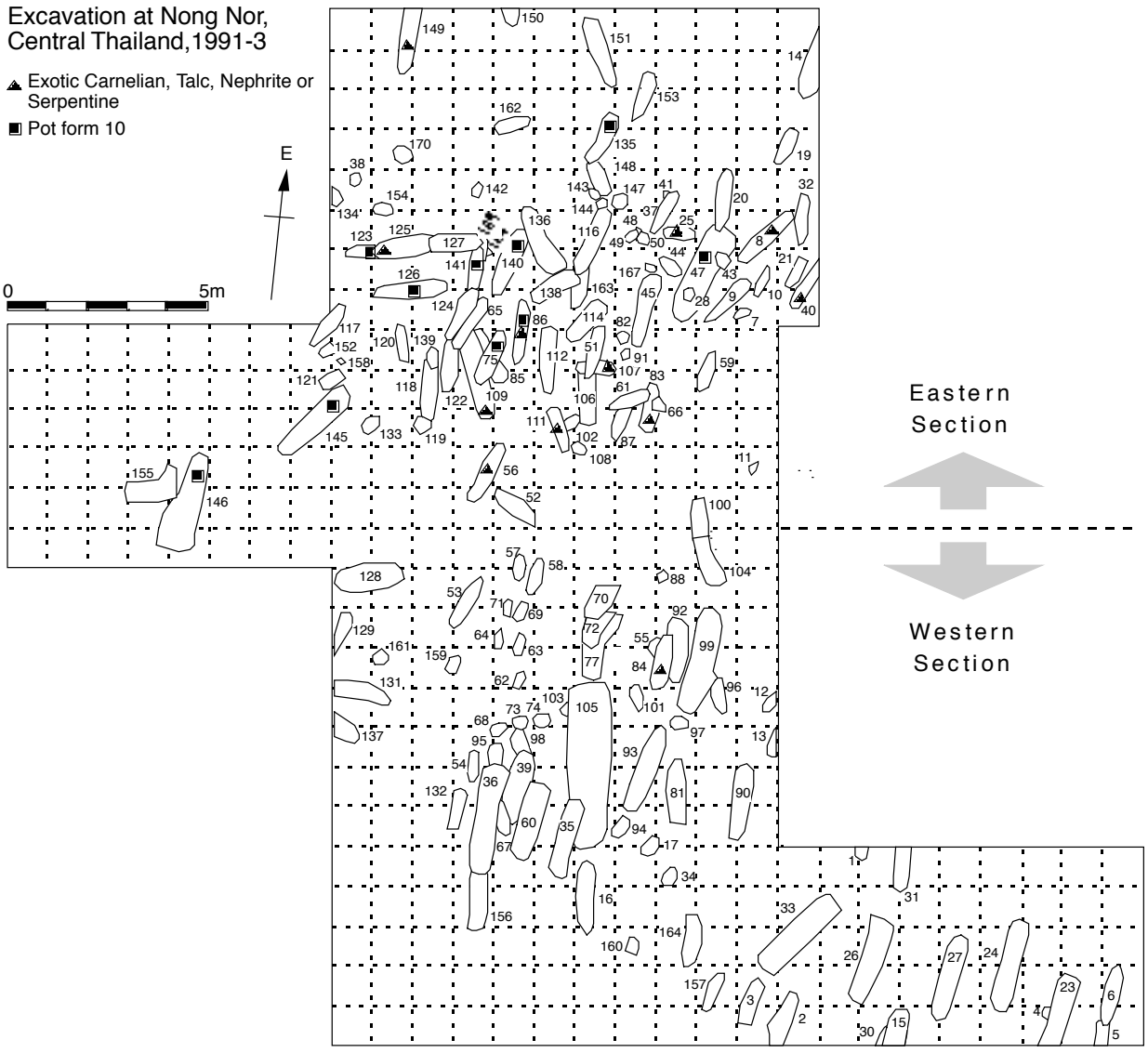


FIG. 240. The distribution of exotic stone artefacts and of pot form 10 in the Nong Nor cem-

to the former (Fig. 240). The putative earlier graves incorporate a group comprising a man and four women which stand out in all statistical applications as being unusually wealthy in terms of grave goods, including pottery vessels, marble and bronze bangles, shell ornaments and dogs' skulls. There are also a few burials in the eastern part of the excavated area which stand out in this manner, one having a set of bull's horns placed round the human cranium. There is, however, no evidence to suggest that men or women were the richer overall in terms of mortuary wealth. Nor was the age of the deceased a factor in the disposal of the dead. Bronze, copper and tin offerings were not exclusive to or even a feature of otherwise rich graves.

The mortuary ritual at Nong Nor is similar to that documented at other bronze age sites in Thailand (Fig. 241). There is a common theme, with local variations. At the most extensively excavated cemeteries, Non Nok Tha, Ban Chiang, Ban Na Di, Ban Lum Khao, and Ban Prasat (Bayard 1984a, Higham and Kijngam 1984, Monkhonkamnuanket 1992), we find males, females and the young interred in proximity to each other (Fig. 242). There is usually a common, but not rigidly observed, orientation which varies between sites. At Ban Na Di, it was north-south, but at Nong Nor, east-west. Pottery vessels are the commonest grave good, disposed round the head, over

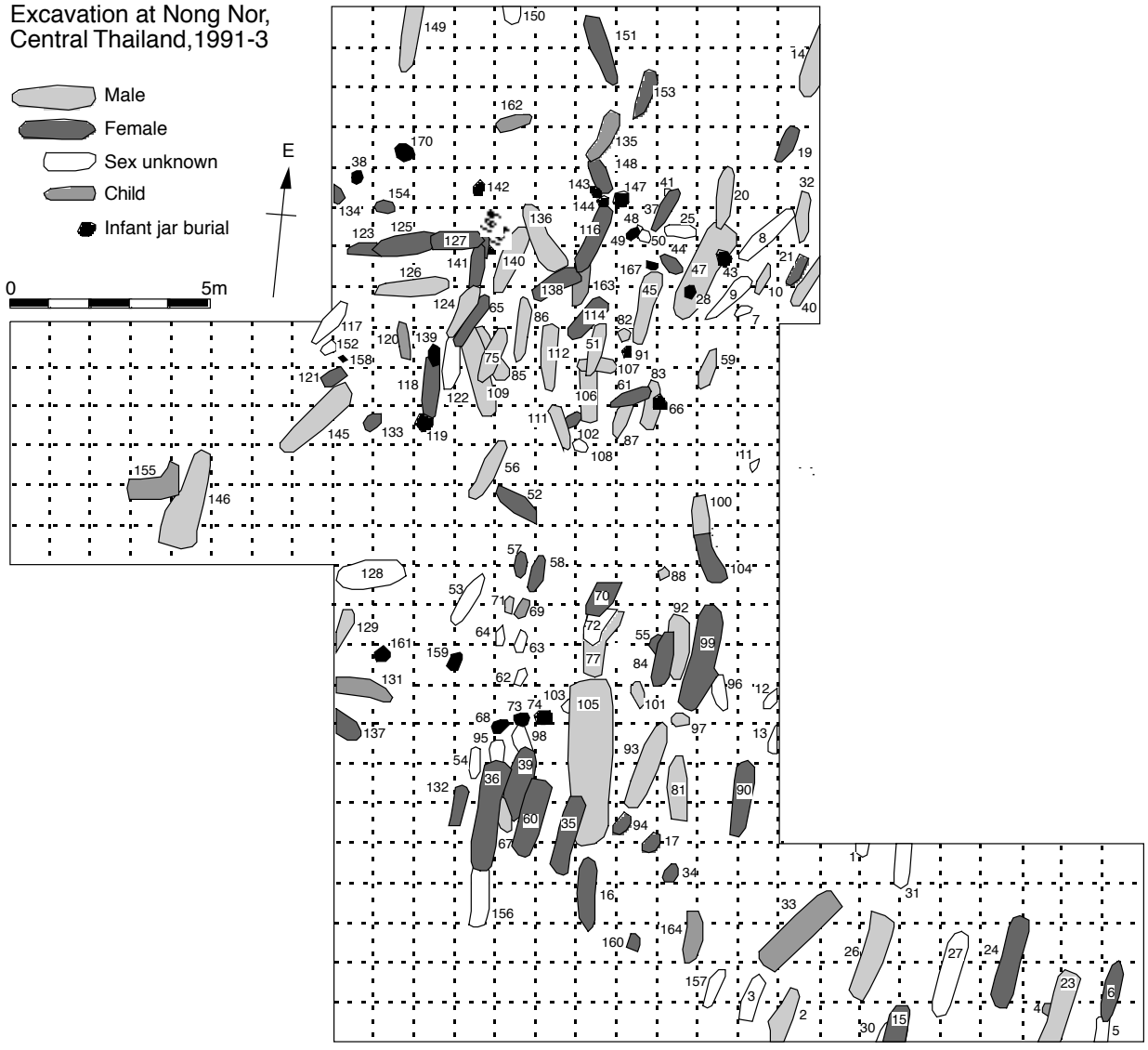


FIG. 241. The distribution of graves in the Nong Nor cemetery according to the age and gender of the deceased

the body or beyond the feet. There were also items of jewellery, some of exotic origin. Bangles predominate. Bronze specimens are exotic to all the sites mentioned. At Ban Na Di, trochus shell, slate and marble bangles were also obtained from some distance. Nong Nor is unusual for such cemeteries in the range of exotic stone and metal employed, particularly the serpentine, talc and the tin examples. Some offerings remain unique to specific sites. Ban Na Di has produced the only large clay animal figurines, whereas Nong Nor is the only site to yield tin jewellery.

The bronze artefacts are dominated numerically by bangles (Table 65). There is no obvious relationship between bronzes and males or females, nor with individuals of greater than average wealth or age. Relatively few individuals were associated with bronzes, a situation which is again matched at Non Nok Tha and Ban Na Di. Of all graves at Nong Nor, 12 per cent were associated with bronze. The corresponding figure at Ban Na Di is 10 per cent. Of the burials from Non Nok Tha listed by Bayard (1984a), 13 per cent were associated with bronzes, crucibles or moulds. None of the 110 graves excavated at Ban Lum Khao contained a bronze offering.

At Nong Nor, dog skulls were often interred with the dead. The incorporation of animal remains in graves, and it is presumed some form of ritual killing of animals, is again found in other Bronze Age sites. At Non Nok Tha, complete pigs, dogs and limbs of cattle were encountered. Pigs' jaws were common at Ban Chiang, while the left forelimbs of cattle and pigs were preferred at Ban Na Di. At Ban Lum Khao, pigs' foot bones were often encountered.

As a relatively crude index of mortuary wealth, figure 243 shows the number of intact graves at Nong Nor against the actual number of grave offerings. It is seen that a handful are set apart, and that the three in question include a man and two women. The complete graves at Ban Na Di also include two rich outliers, one male and the other female. At this site, we also have some evidence for a rich enclave of burials which included most exotic grave goods. The pattern recurs at Non Nok Tha, again with a male and a female being unusually well endowed. If grave goods are a measure of individual attainment, there is a reasonable case for supposing that some men and women achieved high status within their community.

During the millennium of the Bronze Age in Thailand, the dead were interred with locally-manufactured and exotic goods and animal remains. From about 500 B.C., when iron became available and the area was exposed to trade items originating in India, we find evidence for a further quickening of social divisions. When looking backward to the Neolithic, we encounter a major problem. There are very few exposures available for comparison. Ban Kao is the best example of an inland site (Sørensen and Hatting 1967). Once again, we find that the dead were interred in inhumation graves of regular but not fixed orientation. They were associated with pottery vessels, stone adzeheads, shell jewellery and animal remains. No individuals stand out spatially or in terms of mortuary wealth. The same may be said of Khok Charoen (Ho 1984). Khok Phanom Di might be an unusual case because of its strategic location. The mortuary sequence there has been described in some detail (Higham and Thosarat 1994). Suffice it to say that during the fifth and sixth mortuary phases, some individuals were interred with outstandingly rich grave assemblages. In the case of burial 15, this included over 120,000 shell beads and other large and exotic shell ornaments. We also find a raised mortuary structure, and evidence for wooden collective mortuary buildings. This is not the place to probe further into the social system at Khok Phanom Di. For the purposes of this review, it is only noted that no graves from Nong Nor even approach the complexity and wealth of some of the later interments at Khok Phanom Di.

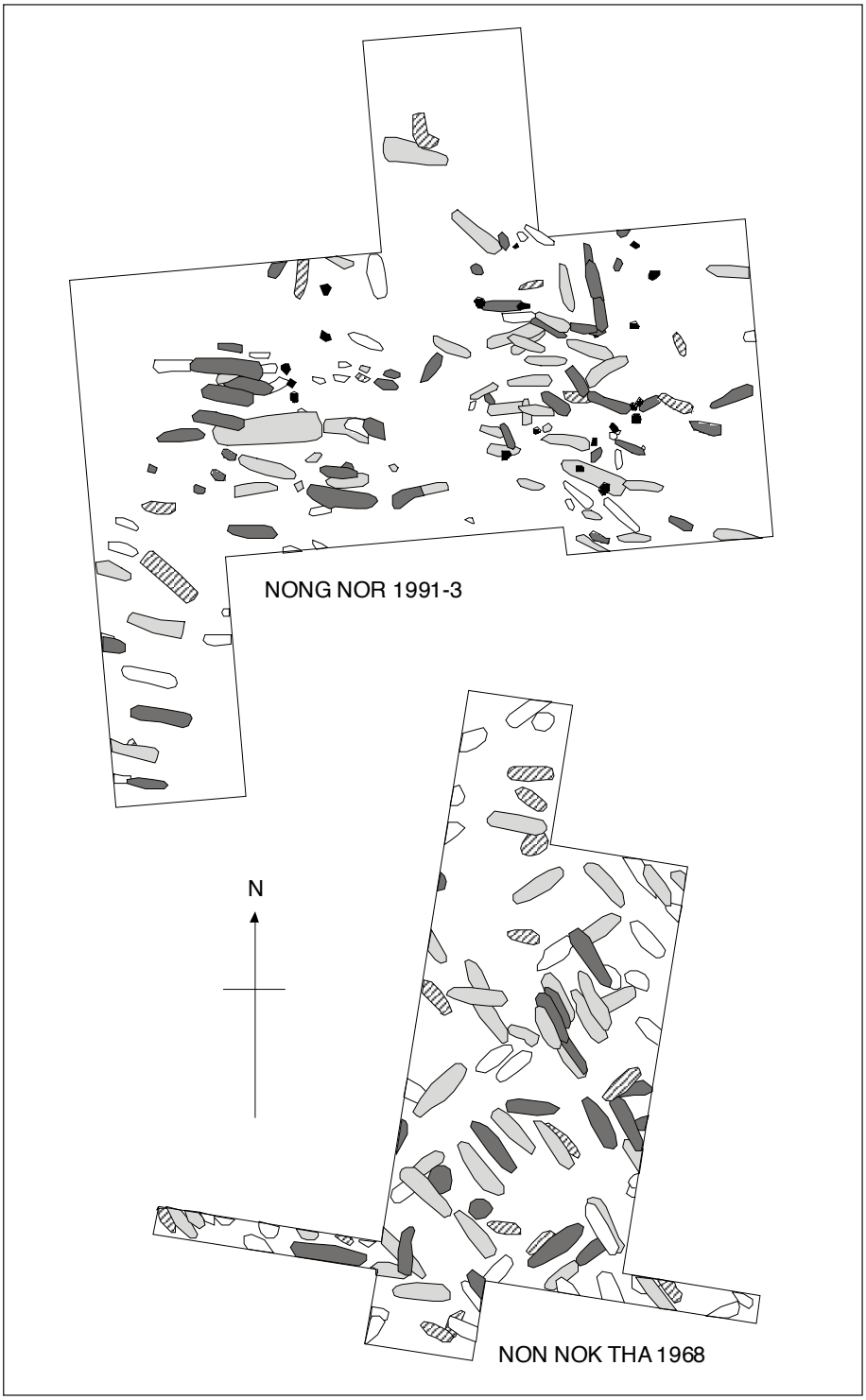
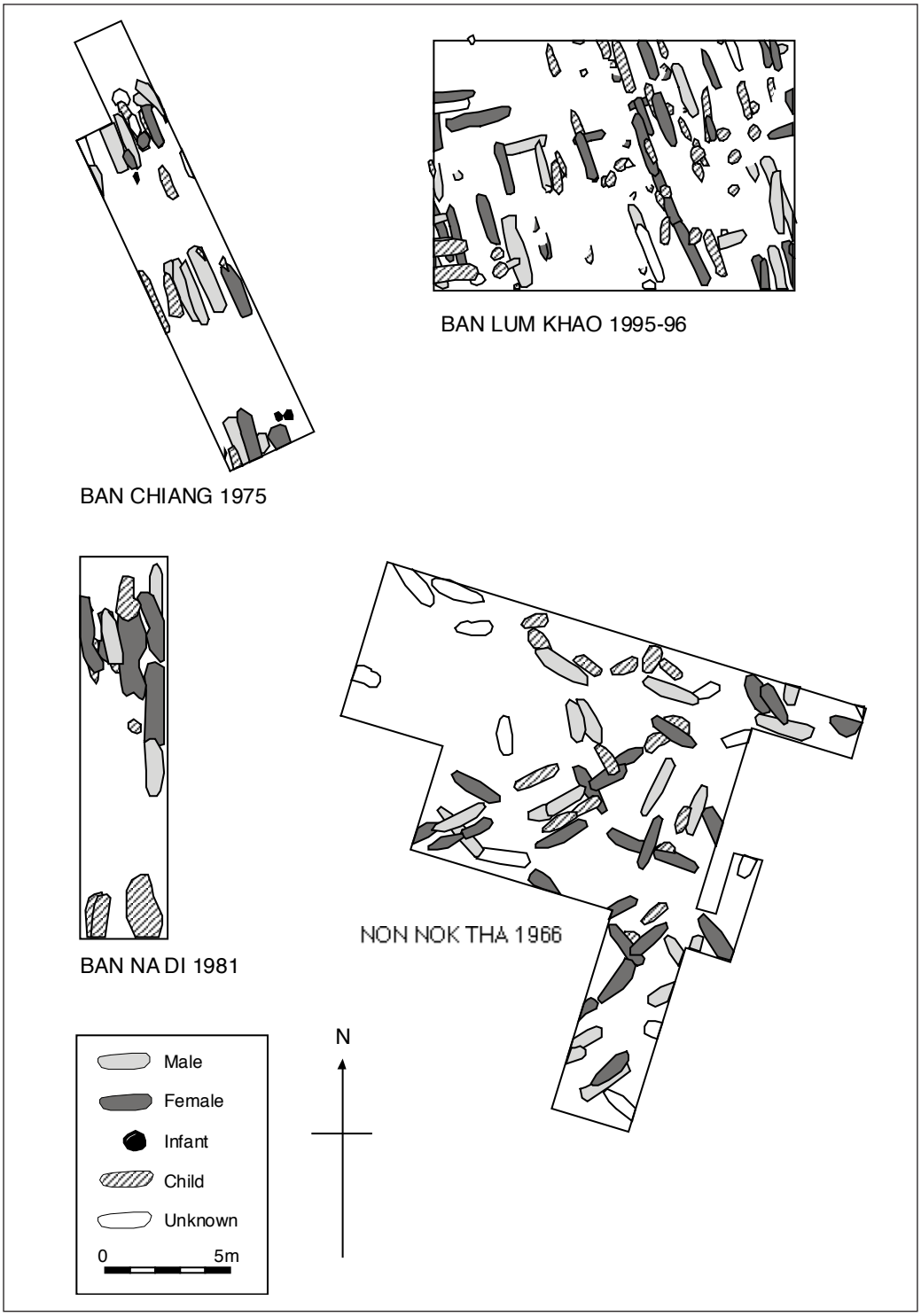


FIG. 242. The plans of Bronze Age cemeteries in Thailand


BAN CHIANG 1975
BAN LUM KHAO 1995-96
BAN NA DI 1981
NON NOK THA 1966
Male
Female
Infant
Child
Unknown
0
5m
N

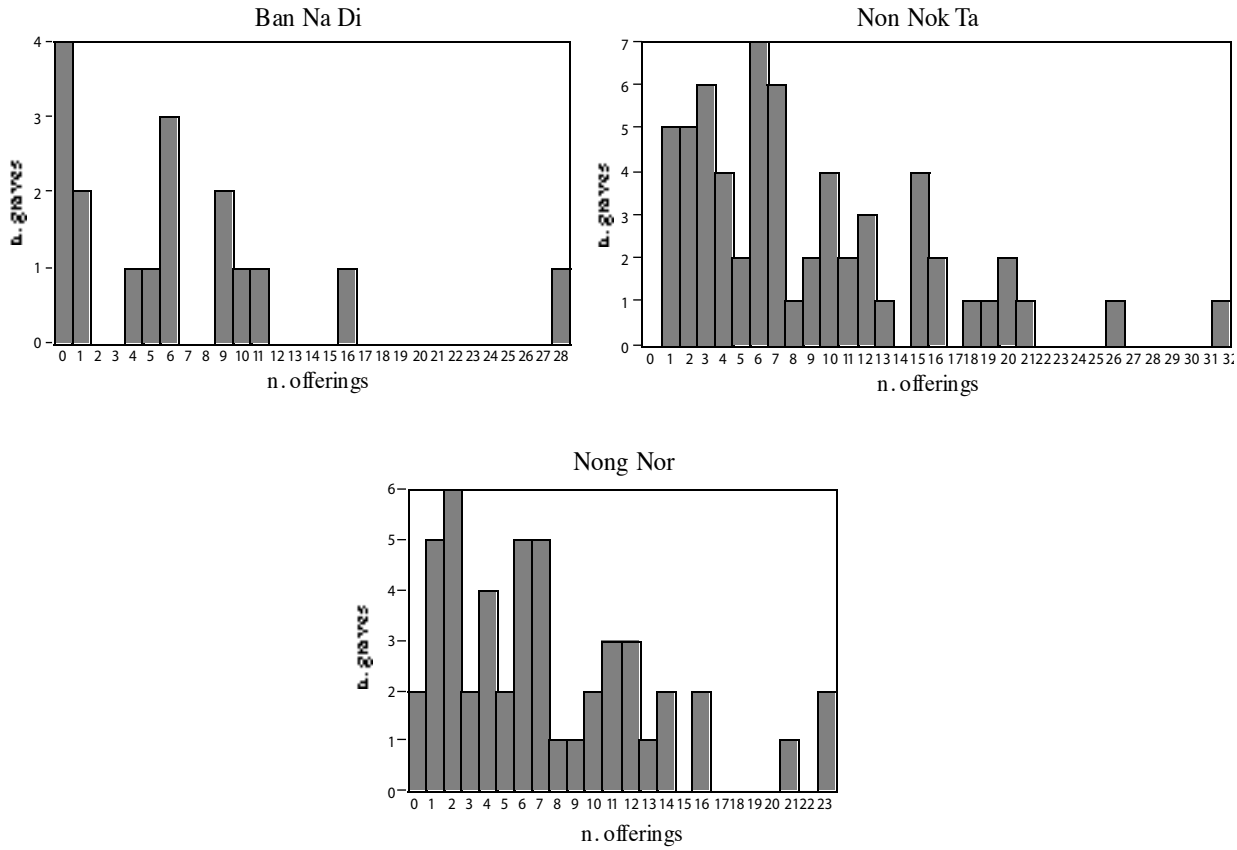


FIG. 243. The number of grave goods found in intact graves at Nong Nor, Non Nok Tha and Ban

Higham (1983, 1996a) has suggested that the Bronze Age communities of Southeast Asia were small, autonomous, and expressed individual status through the ownership of exotic valuables. Nong Nor fits this pattern. We find that value was being added to shell resources in the local manufacture of ornaments. Some of these might well have entered exchange networks, for marine shell bangles and beads are commonly found in inland contexts. Several varieties of exotic stone found their way to Nong Nor, including jade, carnelian, serpentine and talc. One of the research imperatives facing prehistorians in this area is to define the sources of these materials. At present, the most we can say is that the inhabitants of Nong Nor during the Bronze Age obtained copper, tin and those stones through exchange, and employed them in their mortuary rituals.

TABLE 65. *The number of graves with bronzes, and the total number of each artefact type in each of three Bronze Age cemeteries*

Site	Sex/Age	Bangle	Earring	Anklet	Axe	S.I.	Coil	Mould	Crucible
Nong Nor	male	8	2	-	-	2	2	-	-
(n=170)	female	7	1	1	-	1	-	-	-
	child	-	1	-	-	1	-	-	-
	infant	4	-	-	-	-	1	-	-
	adult	7	-	-	-	-	-	-	-
Total artefacts		38	4	-	-	15	3	-	-
Non Nok Tha	male	2	-	-	3	-	-	2	2
(n=86)	female	2	-	-	-	-	-	1	-
	child	1	-	-	-	-	-	-	-
	adult	2	-	-	1	-	-	-	-
Total artefacts		38	-	-	4	-	-	3	2
Ban Na Di	male	1	-	-	-	-	-	-	-
(n=60)	female	4	-	-	-	-	-	-	-
	child	-	-	2	-	-	-	-	-
Total artefacts		26	-	2	-	-	-	-	-
Total artifacts all sites		102	4	3	4	15	3	3	2

S.I. socketed implement. Sources: Bayard, D.T. (1984a), Higham and Kijngam (1984)

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