Prehistoric Investigations in Northeastern Thailand

Part i

Charles Higham and
Amphan Kijngam

BAR International Series 231(i)
1984

Prehistoric Investigations in Northeast Thailand

Excavations at
Ban Na Di, Non Kao Noi, Ban Muang Phruk, Ban Chiang Hian,
Non Noi, Ban Kho Noi and site surveys in the Upper Songkhram and
Middle Chi Valleys

Charles Higham and
Amphan Kijngam

With contributions from
Payom Chantaratiyakarn, Warrachai Wiriyaromp, Philip Houghton,
Metha Wichakana, Warankhana Rajpitak, Nigel Seeley, T.T. Chang,
E. Loresto, Brian Vincent, Jacqui Pilditch, Ingrid Adamcyzk,
Richard McGovern-Wilson, P.D. Jones, Robert Maddin and Y. Q. Weng

Part i

BAR International Series 231(i)
1984

B.A.R.

5, Centremead, Osney Mead, Oxford OX2 0ES, England.

GENERAL EDITORS

A.R. Hands, B.Sc., M.A., D.Phil.
D.R. Walker, M.A.

B.A.R.-S231, 1985: 'Prehistoric Investigations in Northeast Thailand'.

Price £ 45.00 post free throughout the world. Payments made in dollars must be calculated at the current rate of exchange and $3.00 added to cover exchange charges. Cheques should be made payable to B.A.R. and sent to the above address.

© Charles Higham and Amphan Kijngam, 1984

ISBN 0 86054 300 5

For details of all B.A.R. publications in print please write to the above address. Information on new titles is sent regularly on request, with no obligation to purchase.

Volumes are distributed from the publisher. All B.A.R. prices are inclusive of postage by surface mail anywhere in the world.

Printed in Great Britain

TABLE OF CONTENTS

VOLUME ONE

ACKNOWLEDGEMENTS xiv

INTRODUCTION 1

SECTION ONE

CHAPTER ONE Charles Higham and Amphan Kijngam
PREVIOUS RESEARCH IN NORTHEAST THAILAND 4
The present research strategy..... 12
The cultural and chronological framework..... 13

CHAPTER TWO Charles Higham and Amphan Kijngam
THE EXCAVATION OF BAN NA DI, BAN MUANG PHRUK AND NON KAO NOI 22
Ban Na Di: the excavation levels..... 23
The stratigraphic sequence: summary..... 29
Ban Na Di: the radiocarbon chronology..... 30
The test excavation at Non Kao Noi 32
The test excavation at Ban Muang Phruk..... 34
The excavation: summary 35

CHAPTER THREE Charles Higham and Amphan Kijngam
THE MATERIAL CULTURE FROM BAN NA DI..... 57
Jewellery..... 58
The evidence for metallurgy..... 81
The insect wax.....124
The remains of fabric.....126
The clay seals.....148
The clay anvils.....152
The clay figurines.....158
The clay ladles.....173
The bone and antler artefacts.....175
The whetstones.....187
The stone flakes.....192
Miscellaneous clay artefacts.....193
The applique ornament on potsherds.....203
The clay pipes.....215
The material culture from Ban Muang Phruk.....217
The material culture from Non Kao Noi.....221

CHAPTER FOUR Metha Wichakana
THE RIMS FROM BAN NA DI AND RELATED SITES.....223
Detailed description of rim types.....228
The rim types: summary.....256

table of contents

VOLUME TWO

CHAPTER FIVE Charles Higham and Amphan Kijngam
THE BURIAL POTTERY FROM BAN NA DI....291
The multivariate analysis of round based vessels...293
The multivariate analysis of pedestalled vessels...300
Manufacturing techniques....304

CHAPTER SIX Charles Higham and Amphan Kijngam
THE BIOLOGICAL REMAINS FROM BAN NA DI....353
....353
Bovidae....359
Suidae....363
Cervidae....364
Canidae....367
Manidae....367
Felidae....367
Mustelidae....367
Ranidae....368
Aves....370
Varanidae....370
Crocodylidae....370
Trionychidae....370
Viverridae....372
Leporidae....372
Muridae....375
Herpestes javanicus....376
Ophicephalidae....376
Anabanditidae....377
Claridae....377
Bagridae....378
Siluridae....378
Cyprinidae....378
The Ban Na Di faunal spectrum....379
The faunal material from human burials....382
The molluscan remains....384
The rice remains....391

CHAPTER SEVEN Philip Houghton and Warrachai Wiriyaromp
THE PEOPLE OF BAN NA DI....391
Introduction....391
Methods of analysis....393
Findings....399
Discussion....413

CHAPTER EIGHT Charles Higham and Amphan Kijngam
THE MORTUARY RITUAL AT BAN NA DI....416
Mortuary phase one....433
Mortuary phase two....434
Mortuary phase three....435
Review of the mortuary evidence....

table of contents

CHAPTER NINE Metha Wichakana
THE ANALYSIS OF UPPER SONGKHRAM SETTLEMENT PATTERNS.....546

CHAPTER TEN Payom Chantaratiyakarn
THE RESEARCH PROGRAMME IN THE MIDDLE CHI VALLEY.....585
Aims and methods.....585
General research strategy.....588
Summary.....571

SECTION TWO

CHAPTER ELEVEN Payom Chantaratiyakarn
THE EXCAVATION OF BAN CHIANG HIAN AND BAN KHO NOI.....576
Introduction.....576
The stratigraphy of Ban Chiang Hian.....577
The radiocarbon chronology.....578
The material culture.....579
The excavation of Ban Kho Noi.....583
The biological remains.....583
Summary.....585

CHAPTER TWELVE Payom Chantaratiyakarn
THE POTTERY FROM BAN CHIANG HIAN AND RELATED SITES.....590
The rim types from Ban Chiang Hian.....590
The pottery from Ban Kho Noi.....599
Rims with parallels at Non Chai and Non Dua.....601
The rims from Non Noi.....601
Ban Chiang Hian: the body sherds.....610
The applique decoration from Ban Chiang Hian.....613
Conclusions.....617

CHAPTER THIRTEEN Payom Chantaratiyakarn
THE MIDDLE CHI AREA: SETTLEMENT PATTERNS.....622

CHAPTER FOURTEEN Payom Chantaratiyakarn
THE MIDDLE CHI AREA: CONCLUSIONS.....638

VOLUME THREE

SECTION THREE

CHAPTER FIFTEEN Brian Vincent
THE MINERALOGICAL ANALYSIS OF POTTERY FROM BAN NA DI AND RELATED SITES.....644

table of contents

Introduction.....644
Former studies in prehistoric Thai ceramics.....644
Ethnographic studies.....648
Style analysis and fabric analysis.....649
Methods employed.....652
Definition of Sakon Nakhon Basin ceramic traditions: preliminary considerations.....653
Ceramic analysis.....655
Ban Na Di mortuary phase 1 pottery.....655
Ceramic anvils from levels 6 and 7.....668
Ban Na Di mortuary phase 2 pottery.....669
Firing temperatures.....671
The clay used for burial figurines.....674
XRD analysis.....675
Electron microprobe analysis.....675
Ban Na Di non-burial pottery.....677
Ban Na Di rims.....678
Ban Na Di exotic fabrics.....682
The affinities of the exotic fabrics.....684
Alkali water filters.....684
Ban Na Di ceramics: summary.....685
Pottery from sites related to Ban Na Di.....688
Conclusions.....689

SECTION FOUR

CHAPTER SIXTEEN Charles Higham and Amphan Kijngam
THE CULTURAL AND CHRONOLOGICAL FRAMEWORK FOR NORTHEAST THAI PREHISTORY.....698
Introduction: the significance of Ban Na Di.....698
Ban Na Di: summary.....701
Ban Chiang and Ban Na Di.....703
Ban Na Di and Non Nok Tha.....705
Ban Na Di and the Chi Valley sites.....705
Ban Na Di and Ban Chiang: chronology.....707
Three regional groups.....710
The Middle Chi area.....712
Elements of a model for the development and explanation of centralised polities in Northeast Thailand.....713
The late period at Ban Chiang: was there centralisation?.....719
The Chi Valley and the emergence of chiefdoms.....720
The articulation of the Middle Chi and Upper Songkhram areas.....723
Northeast Thailand and Southeast Asian Prehistory..725
Comparison with other regions.....726

APPENDIX ONE Charles Higham and Amphan Kijngam
CHECKLIST OF RADIOCARBON DATES.....731

APPENDIX TWO Philip Houghton and Warrachai Wiriyaramp
THE PEOPLE OF BAN NA DI: CENSUS AND BONE SIZES.....737

SUMMARY IN THAI.....746

WORKS REFERRED TO IN THE TEXT.....896

INDEX 914

VOLUME ONE:TABLES

3-1 Ban Na Di: the dimensions of shell disc beads..... 58
3-2 Ban Na Di: the dimensions of large shell beads..... 60
3-3 Ban Na Di: the dimensions of shell bracelets..... 63
3-4 Ban Na Di: the dimensions of stone bracelets..... 69
3-5 The glass beads from burial 8..... 77
3-6 The orange glass beads from Ban Na Di..... 78
3-7 Ban Na Di: the clay moulds..... 82
3-8 The crucible fragments from level 7 square A2..... 85
3-9 The crucible fragments from level 7 square A3..... 86
3-10 The crucible fragments from level 7 baulk A3/4.....87
3-11 The crucible fragments from level 7 square A4..... 88
3-12 The crucible fragments from level 7 square F6..... 88
3-13 The crucible fragments from level 6..... 89
3-14 The crucible fragments from level 5..... 89
3-15 Ban Na Di: the fragments of corroded bronze..... 91
3-16 Ban Na Di: the bronze bracelet fragments..... 96
3-17 Ban Na Di: the bronze finger rings..... 97
3-18 Ban Na Di: the bronze arrowheads..... 98
3-19 Ban Na Di: the bronze beads..... 99
3-20 Ban Na Di: the bronze bowls..... 99
3-21 Ban Na Di: the percentage frequency of trace elements in the bronzes.....103
3-22 Element concentration of the matrix of the "wire" from stone bracelet found in Ban Na Di burial 45.....115
3-23 Hardness gradient through the bronze "wire" from a stone bracelet found in Ban Na Di burial 45.....115
3-24 Composition of copper bead and copper slag found within a level eight crucible from Ban Na Di.....116
3-25 Ban Na Di: the sorted rotated factor loadings based on the analysis of all elements identified.....117
3-26 Ban Na Di: the sorted rotated factor loadings based on the frequencies of Cu, Sn, Pb, and As.....117
3-27 Ban Na Di bronzes: the factor scores for each bronze specimen based on an analysis of all elements identified.....118
3-28 Ban Na Di: the iron fragments.....121
3-29 Ban Na Di: the fabric remains.....126
3-30 Ban Na Di: the clay seals.....148
3-31 Ban Na Di: the clay anvils.....152
3-32 Ban Na Di: the cattle figurines from mortuary contexts.....158
3-33 Ban Na Di: the cattle figurines from occupation contexts.....164

3-33 173
3-34 Ban Na Di: the clay ladles 187
3-35 Ban Na Di: the whetstones 193
3-36 Ban Na Di: the pear shaped pendants 194
3-37 Ban Na Di: the clay rings 196
3-38 Ban Na Di: the clay discs 197
3-39 Ban Na Di: the clay pellets 202
3-40 Ban Na Di: the perforated rice steamers 205
3-41 Ban Na Di: the applique forms and associated fabric by level 215
3-42 Ban Na Di: the clay pipes 258

4-1 Ban Na Di: the density of rim types per level 259
4-2 Ban Na Di: the stratigraphic context of Om Kaeo rim types 262
4-3 The relationships between rim types from Ban Na Di and Ban Muang Phruk 263
4-4 A proposed chronological framework for Non Kao Noi, Ban Na Di and Ban Muang Phruk 291

VOLUME TWO: TABLES

5-1 Ban Na Di: the three burial phases and their dates 300
5-2 Ban Na Di: the factor scores for the analysis of pedestalled vessels 306
5-3 The dimensions of the complete pots from Ban Na Di 354

6-1 Ban Na Di: the bovid dentition 356
6-2 Ban Na Di: the bovid second fore phalanges 357
6-3 Ban Na Di: the bovid magna 357
6-4 Ban Na Di: the complete bovid metacarpals 357
6-5 Ban Na Di: the bovid first fore phalanges 359
6-6 Ban Na Di: the suid mortality frequencies 361
6-7 Ban Na Di: the suid mandibles 362
6-8 Ban Na Di: the suid maxillae 363
6-9 Ban Na Di: the small deer mandibles 363
6-10 Ban Na Di: the mandibles from *Cervus eldi* 365
6-11 Ban Na Di: the mandibles from *Canis familiaris* 366
6-12 Ban Na Di: the maxillae from *Canis familiaris* 367
6-13 The bones from *Melogale personata* 368
6-14 The bones from *Rana tigrina* 371
6-15 The chicken bones from Ban Na Di 371
6-16 The bones from *Hemigalus derbyanus* 372
6-17 The bones from *Viverricula rasse* 373
6-18 The bones from *Lepus peguensis* 375
6-19 The murid bones 376
6-20 The bones from *Herpestes javanicus* 377
6-21 The bones from Ophicephalidae 377
6-22 The bones from Anabantidae 377
6-23 The bones from Claridae 377

6-24 The bones from Bagridae.....378
6-25 The bones associated with human burials.....381
6-26 Ban Na Di: the shellfish remains.....382
6-27 Ban Na Di: the rice kernels.....384

7-1 Ban Na Di: mean age of death for adults from mortuary phase 1 burials.....393
7-2 Ban Na Di: the combined life table for mortuary phase 1.....394
7-3 Limb proportions in Ban Na Di adults.....395
7-4 Ban Na Di: mean cortical thickness and Nordin's score for the second metacarpal.....395
7-5 The mean number of lines of arrested growth in the Ban Na Di population.....395
7-6 Ban Na Di: the mean dimensions of male teeth.....397
7-7 Ban Na Di: the mean dimensions of female teeth.....397
7-8 Comparative tooth morphology for Ban Na Di and Non Nok Tha...403
7-9 The mean stature for men and women from several Thai populations.....403
7-10 Mean mandibular dimensions for three prehistoric Thai groups.404
7-11 Cortical thickness for the 2nd metacarpal and Nordin's score for the males from several groups.....405

8-1 Summary of the burial data.....418

9-1 The area of different soils within given distances from prehistoric sites and random points in the Upper Songkhram area.....550
9-2 The Upper Songkhram area: the mean areas of different soil types within given distances from prehistoric sites and randomly chosen points 553
9-3 The yields of rice under different methods of cultivation 554
9-4 Production, population levels and areas under rice for the Blue Meo.....555

11-1 Ban Chiang Hian: details of the burials.....577
11-2 Ban Chiang Hian and Ban Kho Noi: the radiocarbon dates 578
11-3 Ban Chiang Hian: suggested chronological sequence by layer.....579
11-4 Ban Chiang Hian: incidence of bronze fragments by layer 580
11-5 Ban Chiang Hian: incidence of iron by layer 580
11-6 Ban Chiang Hian: the rice steamers.....582
11-7 Ban Chiang Hian: the faunal spectrum 584

12-1 Ban Chiang Hian: the mean square contingency coefficients between layer assemblages.....617

13-1 The different areas of soil types within one and three km radii of prehistoric sites and random points.....626
13-2 The yields of rice/ha under different methods of cultivation.....630
13-3 The relationship between rice consumption and population.....632

VOLUME THREE: TABLES

15-1 Temper types previously identified from archaeological sites in Thailand.....651
15-2 Modern Northeast Thai potting clays: their characteristics and distance from Ban Na di.....658
15-3 Shrinkage tests on modern potting clay from Sakon Nakhon Basin sources.....659
15-4 The relationship between goblet form and fabric at Ban Na Di.....660
15-5 Ban Na Di: the manufacturing techniques of "Om Kaeo" vessels.662
15-6 The differences in construction and finish between pots 62 and 63.....664
15-7 The associations between individual burials and both vessel form and fabric.....666
15-8 Ban Na Di: the relationships between levels 6 and 7 anvils and fabrics.....668
15-9 Mortuary phase 2 burial urns: details of fabric and grave goods.....670
15-10 Electron microprobe analysis of clay 3.....676
15-11 The proportions of exotic burial pots with respect to forms and sample size.....677
15-12 Ban Na Di: the fabrics from occupation level rim forms.....678
15-13 Ban Na Di rim sherds: details of methods of analysis and total number of thin sections examined.....679
15-14 The temper types associated with different categories of surface finish from Non Chai.....687

16-1 Population size and social organisation among Southeast Asian rice cultivators.....717

VOLUME ONE: FIGURES

1-1 General Map of Mainland Southeast Asia 15
1-2 Cross section of the principal landforms found in the Khorat Plateau 16
1-3 The principal climatic variables found on the Khorat Plateau compared with the Red River Delta and Kuala Lumpur 17
1-4 The Sakon Nakhon Basin..... 18
1-5 The Chi Valley..... 19
1-6 The cultural and chronological framework for Northeast Thai prehistory..... 20
1-7 The chronological relationships between different sites in

Northeast Thailand..... 21

2-1 Plan of the village of Ban Na Di..... 36
2-2 The central area of Ban Na Di..... 37
2-3a-n The sections through the excavated area of Ban Na Di..... 38-51
2-4 The Ban Na Di radiocarbon chronology 52
2-5 The stratigraphy of Non Kao Noi 53
2-6 The burial plan of Non Kao Noi 54
2-7 The stratigraphy of Ban Muang Phruk 55
2-8 The burial plan of Ban Muang Phruk 56

3-1 Ban Na Di: the large shell beads 62
3-2 Ban Na Di: trochus shell bracelets 65
3-3 Ban Na Di: trochus shell bracelets from burial 32 66
3-4 Ban Na Di: trochus shell bracelets from burial 32 (cont.) 67
3-5 Ban Na Di: jewellery of stone, shell and tooth..... 68
3-6 Ban Na Di: stone bracelets 72
3-7 Ban Na Di: ornaments of ivory, tooth and bone..... 75
3-8 Ban Na Di: the blue and orange glass beads 80
3-9 Ban Na Di: the clay moulds 128
3-10 Ban Na Di: the stone moulds 129
3-11 Ban Na Di: a clay crucible from level 6 130
3-12 Ban Na Di: a clay crucible from level 6 131
3-13 Ban Na Di: bronze bracelets and coil 132
3-14 Ban Na Di: bronze bracelets 133
3-15 Ban Na Di: bronze rings 134
3-16 Ban Na Di: bronze artefacts 135
3-17 Ban Na Di: the bronze bracelet catch.....111
3-18 SEM view of 'wire' from burial 45 stone bracelet.....136
3-19 Transverse view of the 'wire' from burial 45 stone bracelet.....137
3-20 Skeleton of cast structure of the 'wire' from the burial 45 stone bracelet (x1000).....138
3-21 Cross-section through a level 8 crucible fragment.....139
3-22 Scatter plot of the Ban Na Di bronzes on the basis of lead against tin 141
3-23 Scatter plot of the Ban Na Di bronzes on the basis of a factor analysis of copper, tin lead and arsenic 143
3-24 Scatter plot of the Ban Na Di bronzes on the basis of a factor analysis of all metals 143
3-25 The cross sections of bracelets from Ban Na Di.....144
3-26 Ban Na Di: iron artefacts 145
3-27 Ban Na Di: iron artefacts 146
3-28 The fabrics from Ban Na Di.....147
3-29 Ban Na Di: the clay seals 151
3-30 Ban Na Di: the clay anvils.....154
3-31 Ban Na Di: the clay anvils 155
3-32 Ban Na Di: the clay anvils 156
3-33 Ban Na Di: the clay anvils 157
3-34 Ban Na Di: the cattle figurines from

the burials....168
3-35 Ban Na Di: the cattle figurines from burial 47....169
3-36 Ban Na Di: cattle, elephant, deer and human figurines....170
3-37 Ban Na Di: cattle figurines from burials....171
3-38 Ban Na Di: cattle, human and fish figurines....172
3-39 Ban Na Di: the clay ladles....174
3-40 Ban Na Di: the bone points from level 7....181
3-41 Ban Na Di: the bone points from level 6 and 7....182
3-42 Ban Na Di: the bone points from levels 4-6....183
3-43 Ban Na Di: the bone artefacts from level 7....184
3-44 Ban Na Di: the worked bone and antler....185
3-45 Ban Na Di: the bone artefacts from burials....186
3-46 Ban Na Di: the whetstones....190
3-47 Ban Na Di: the whetstones....191
3-48 Ban Na Di: the stone flakes....192
3-49 Ban Na Di: miscellaneous clay artefacts....198
3-50 Ban Na Di: miscellaneous clay artefacts....199
3-51 Ban Na Di: clay matting impressions and clay rings....200
3-52 Ban Na Di: clay points and discs....201
3-53 Ban Na Di: the perforated rice steamers....208
3-54 Ban Na Di: the applique ornament on potsherds....209
3-55 Ban Na Di: the applique ornament on potsherds....210
3-56 Ban Na Di: the applique ornament on potsherds....211
3-57 Ban Na Di: the applique ornament on potsherds....212
3-58 The frequencies per level of the different types of applique ornament at Ban Na Di....213
3-59 The relationships between levels at Ban Na Di on the basis of a cluster analysis of the applique decoration....214
3-60 Ban Na Di: the clay pellets....218
3-61 Ban Na Di: the clay pipes....219
3-62 Ban Muang Phruk: the material culture....220
3-63 Non Kao Noi: the complete pots....221
3-64 Ban Na Di: a summary of the main changes in material culture by level....222
4-1 The principal areas of the rim, after Bronson....227
4-2 Pottery rim types from Non Kao Noi and Ban Na Di level 8....264
4-3 Pottery rim types from Ban Na Di level 7....265
4-4 Pottery rim types from Ban Na Di levels 6 and 7....266
4-5 Pottery rim types from Ban Na Di level 6....267
4-6 Pottery rim types from Ban Na Di level 6....268
4-7 Pottery rim types from Ban Na Di levels 6 and 5....269
4-8 Pottery rim types from Ban Na Di level 5....270
4-9 Pottery rim types from Ban Na Di level 5....271
4-10 Pottery rim types from Ban Na Di level 5....272
4-11 Pottery rim types from Ban Na Di level 4....273
4-12 Pottery rim types from Ban Na Di level 4....274
4-13 Pottery rim types from Ban Na Di levels 4 and 3....275
4-14 Pottery rim types from Ban Na Di level 3....276
4-15 Pottery rim types from Ban Na Di level 3....277
4-16 Pottery rim types from Ban Muang Phruk....278

4-17 Pottery rim types from Ban Muang Phruk.....279
4-18 Pottery rim types from Ban Muang Phruk.....280
4-19 Pottery rim types from Ban Muang Phruk.....281
4-20 The complete vessels from Ban Na Di with the common rim types identified in levels 6-8 282
4-21 The common rim types identified in levels 4-5 at Ban Na Di...283
4-22 The results of a cluster diagram, showing the degree of affinity between rim samples from the levels at Ban Na Di and Ban Muang Phruk 284
4-23 Histogram showing the frequency occurrence of rim types by layer at Non Kao Noi 285
4-24 Histogram showing the frequency occurrence of rim types by level at Ban Na Di 286
4-25 Histogram showing the frequency occurrence of rim types by layer at Ban Na Di (cont.).....287
4-26 Histogram showing the frequency occurrence of rim types by layer at Ban Muang Phruk.....288
4-27 Histograms showing the frequency occurrence of temper types by layer at Non Kao Noi, Ban Na Di and Ban Muang Phruk.289
4-28 Cluster diagram showing the relationships between the levels Ban Na Di on the basis of temper types.....290

VOLUME TWO: FIGURES

5-1 The results of a factor analysis of round based pots from Ban Na Di.....310
5-2 The clusters of round based vessels resulting from a factor analysis.....311
5-3 Ban Na Di: pot form 1a 312
5-4 Ban Na Di: pot form 1a.....313
5-5 Ban Na Di: pot form 1b 314
5-6 Ban Na Di: pot form 1b 315
5-7 Ban Na Di: pot form 1c.....316
5-8 Ban Na Di: pot form 1c 317
5-9 Ban Na Di: pot form 1c 318
5-10 Ban Na Di: pot form 2.....319
5-11 Ban Na Di: pot form 2.....320
5-12 Ban Na Di: pot form 2 321
5-13 Ban Na Di: pot form 3.....322
5-14 Ban Na Di: pot forms 3 and 4.....323
5-15 Ban Na Di: pot form 4 324
5-16 Ban Na Di: pot form 4.....325
5-17 Ban Na Di: pot form 4 326
5-18 Ban Na Di: pot form 4 327
5-19 Ban Na Di: pot form 4 328
5-20 Ban Na Di: pot form 4 329
5-21 Ban Na Di: pot forms 4 and 5 330
5-22 Ban Na Di: pot form 6 331
5-23 Ban Na Di: pot forms 7 and 9.....332

5-24 Ban Na Di: pot form 9 333
5-25 Ban Na Di: pot forms 10-13.....334
5-26 Factor analysis for pedestalled vessels.....335
5-27 Results of a cluster analysis for pedestalled vessels.....336
5-28 Ban Na Di: pot form 14a 337
5-30 Ban Na Di: pot form 14b 338
5-29 Ban Na Di: pot form 14b 339
5-31 Ban Na Di: pot form 14b 340
5-32 Ban Na Di: pot form 14b.....341
5-33 Ban Na Di: pot form 14b.....342
5-35 Ban Na Di: pot forms 15 and 17 343
5-34 Ban Na Di: pot forms 14b and 14c.....344
5-36 Ban Na Di: pot forms 16 and 18.....345
5-37 Ban Na Di: pot form 19.....346
5-38 Ban Na Di: pot form 19.....347
5-39 Ban Na Di: pot form 19.....348
5-40 Ban Na Di: pot form 20.....349
5-41 Ban Na Di: pot form 21.....350
5-42 Stability/access diagram for round based vessels.....351
5-43 Stability/access data for the pedestalled vessels.....352

6-1 Ban Na Di: the faunal spectrum excluding small fish.....386
6-2 Ban Na Di: the faunal spectrum for levels 4-8, including small fish and frog.....387
6-3 Ban Na Di: scatter plot of the dimensions of bovid second fore phalanges.....388
6-4 Ban Na Di: scatter plot of the dimensions of bovid first fore phalanges.....389
6-5 Ban Na Di: scatter plot of bovid magna.....389
6-6 Ban Na Di: scatter plot of bovid metacarpals.....390
6-7 Ban Na Di: outline of the rice grains.....390

7-1 Graph showing age at death of the people of Ban Na Di.....406
7-2 Ban Na Di: survivorship curve for mortuary phase 1.....407
7-3 Ban Na Di: mortality curve for mortuary phase 1.....408
7-4 Ban Na Di: life expectancy curves for mortuary phase 1.....409
7-5 Ban Na Di: survivorship curves for Ban Na Di and comparative samples.....410

8-1 Ban Na Di: the mortuary phase 1a burials in squares A1-4.....443
8-2 Ban Na Di: the mortuary phase 1b burials in squares A1-4.....443
8-3 Ban Na Di: the mortuary phase 1c burials in squares A1-4.....443
8-4 Ban Na Di: the mortuary phase 2 burials in squares A1-4.....445
8-5 Ban Na Di: the mortuary phase 3 burials in squares A1-4.....445
8-6 Ban Na Di: the mortuary phase 1a burial 47 in square F6.....447
8-7 Ban Na Di: burials 40, 45 and 46 (mortuary phase 1a) and burial 42 (mortuary phase 1b) in square F6.....448
8-8 Ban Na Di: burials 41 and 44 (mortuary phase 1a) and burials 37-8 (mortuary phase 1b).....449
8-9 Ban Na Di: burial 36 (mortuary phase 1b) in square F6.....450
8-10 Ban Na Di: burials 19 and 21 (mortuary phase 1b) in square F6.....451
8-11 Ban Na Di: burials 24 (mortuary phase 1b) and 27 (mortuary

phase 1c) in square F8.....452
8-12 Ban Na Di: burials 31 and 32 (mortuary phase 1c) in square F8.....453
8-13 Ban Na Di: burials 16 and 17 (mortuary phase 1c) in square F8.....454
8-14 Ban Na Di burial 47 square F8 (mortuary phase 1a) 455
8-15 The grave assemblage from burial 47 (mortuary phase 1a).....456
8-16 Cattle figurines from burial 47 457
8-17 Cattle figurines from burial 47 (cont.).....458
8-18 Ban Na Di burials 40, 45 and 46 square F8 (mortuary phase 1a).....459
8-19 Ban Na Di: the grave assemblage from burial 45 460
8-20 Ban Na Di: the grave assemblages from burials 40 and 46 461
8-21 Ban Na Di burials 37 and 39 square F8 (mortuary phase 1b)....462
8-22 Ban Na Di The grave assemblages from burials 37, 39 and 21..463
8-23 Ban Na Di burial 42 square F8 mortuary phase 1b.....464
8-24 Ban Na Di: the grave assemblages from burials 50 and 42.....465
8-25 Ban Na Di burial 38 square F8 mortuary phase 1b.....466
8-26 The grave assemblage from burial 38.....467
8-27 Ban Na Di burial 41 square F8 mortuary phase 1a.....468
8-28 Ban Na Di burial 44.....469
8-29 Ban Na Di burial 38 square F8 mortuary phase 1b.....470
8-30 Ban Na Di: the grave assemblage from burial 38.....471
8-31 Ban Na Di: burials 31-32 square F8 mortuary phase 1c.....472
8-32 Ban Na Di: the grave assemblage from burial 31.....473
8-33 Ban Na Di burial 35 square F8 mortuary phase 1c.....474
8-34 Ban Na Di: the grave assemblage from burial 35.....475
8-35 Ban Na Di: the grave assemblage from burial 32.....476
8-36 Ban Na Di: the grave assemblage from burials 30 and 32 477
8-37 Ban Na Di burial 27 square F8 mortuary phase 1c.....478
8-38 Ban Na Di burials 19 and 21 square F8 mortuary phase 1b.....479
8-39 Ban Na Di burials 19 and 21 square F8 mortuary phase 1b.....480
8-40 Ban Na Di burial 24 square F8 mortuary phase 1b.....481
8-41 Ban Na Di: the grave assemblage from burial 19.....482
8-42 Ban Na Di burials 16 and 17 square F8 mortuary phase 1c.....483
8-43 Ban Na Di: the grave assemblage from burial 16.....484
8-44 Ban Na Di: the grave assemblage from burial 17.....485
8-45 Ban Na Di: burial 22 square A2 mortuary phase 1a.....486
8-46 Ban Na Di: the grave assemblages from burials 20, 22, 34 and 25.....487
8-47 Ban Na Di: burial 26 square A3 mortuary phase 1a.....488
8-48 Ban Na Di: the grave assemblage from burial 26.....489
8-49 Ban Na Di: burial 28 baulk A3/A4 mortuary phase 1a.....490
8-50 Ban Na Di: burial 33 baulk A3/A4 mortuary phase 1a.....491
8-51 Ban Na Di: burial 43 square A4 mortuary phase 1a.....492
8-52 Ban Na Di: burial 23 baulk A3/A4 mortuary phase 1b.....493
8-53 Ban Na Di: burial 49 square A4 mortuary phase 1b.....494
8-54 Ban Na Di: burial 25 square A3 mortuary phase 1b.....495
8-55 Ban Na Di: burial 30 square A4 mortuary phase 1b.....496
8-56 Ban Na Di: burial 12 square A3 mortuary phase 1b.....497
8-57 The grave assemblage from burial 12 498
8-58 The grave assemblage from burial 12 (cont.).....499
8-59 Ban Na Di: burials 13 (mortuary phase 1B) and 18

(mortuary phase 1C) square A4.....500
8-80 Ban Na Di: the grave assemblage from burial 18.....501
8-81 Ban Na Di: the grave assemblage from burial 18 502
8-82 Ban Na Di: burial 48 baulk A3/A4 mortuary phase 1c.....503
8-83 Ban Na Di: the grave assemblage from burial 48.....504
8-84 Ban Na Di: the grave assemblage from burial 48 (cont.).....505
8-85 Ban Na Di: the grave assemblage from burial 48 (cont.).....506
8-86 Ban Na Di: the grave assemblage from burial 50 507
8-87 Ban Na Di: burial 20 square A4 mortuary phase 1c.....508
8-88 Ban Na Di: burial 29 square A4 mortuary phase 1c.....509
8-89 Ban Na Di: the grave assemblage from burial 29 510
8-90 Ban Na Di: burials 10 and 11 squares A3/A4 mortuary phase 1c.511
8-91 Ban Na Di: burial 10 squares A3/A4 mortuary phase 1c.....512
8-92 Ban Na Di: the grave assemblages from burials 10 and 11.....513
8-93 Ban Na Di: burial 34 square A1 mortuary phase 1a.....514
8-94 Ban Na Di: burial 14 square A1 mortuary phase 1b.....515
8-95 Ban Na Di: the grave assemblage from burial 14.....516
8-96 Ban Na Di: burial 15 square A1 mortuary phase 1b.....517
8-97 Ban Na Di: the grave assemblage from burial 15.....518
8-98 Ban Na Di: burials TS 19-22 square F5 519
8-99 Ban Na Di: the grave assemblage from burials TS 15 and TS 19.520
8-100 Ban Na Di: the grave assemblages from burials 13, TS3, ...521
TS16 and TS21.....522
8-101 Ban Na Di: burials TS15-18 square F5. All are
mortuary phase 1b.....523
8-102 Ban Na Di: burials TS7-14. All are mortuary phase 1c.....524
8-103 Ban Na Di: the grave assemblages from burials TS7
TS13 and TS17.....525
8-104 Ban Na Di: burial TS 12 mortuary phase 1c.....526
8-105 Ban Na Di: the grave assemblage from burial TS12.....527
8-106 Ban Na Di: the grave assemblage from burial TS12 (cont.).....528
8-107 Ban Na Di: the grave assemblage from burial TS12 (cont.).....529
8-108 Ban Na Di: burials TS4-6 square F5 mortuary phase 1c.....530
8-109 Ban Na Di: the grave assemblage from burial TS5.....531
8-110 Ban Na Di: the grave assemblage from burial TS6.....532
8-111 Ban Na Di: burials TS1-3 square F5 probably
mortuary phase 1c.....533
8-112 Ban Na Di: burial 4 square A1 mortuary phase 2.....534
8-113 Ban Na Di: the grave assemblage from burial 4.....535
8-114 Ban Na Di: burial 5 square A1 mortuary phase 2.....536
8-115 Ban Na Di: the grave assemblage from burial 5.....537
8-116 Ban Na Di: the grave assemblage from burial 6
mortuary phase 2.....538
8-117 Ban Na Di: burial 7 square A2 mortuary phase 2.....539
8-118 Ban Na Di: the grave assemblage from burial 7 540
8-119 Ban Na Di: burial 8 square A1 mortuary phase 2.....541
8-120 Ban Na Di: the grave assemblage from burial 8.....542
8-121 Ban Na Di: the grave assemblage from burial 8 (cont.).....543
8-122 Ban Na Di: burial 2 square A4 mortuary phase 3.....544
8-123 Ban Na Di: burial 1 square A3 mortuary phase 3.....545
8-124 Ban Na Di: burial 3 square A3 mortuary phase 3.....546

9-1 The distribution of all identified prehistoric

sites in the Upper Songkhram survey area.....560
9-2 The distribution of prehistoric sites and random points relative to the area under soil types 3 and 5 561
9-3 Map of the Upper Songkhram survey area showing the distribution of presumed salt working mounds.....562
9-4 Map of the Upper Songkhram survey area showing the distribution of Early Period sites.....563
9-5 Map of the Upper Songkhram survey area showing the distribution of Late Period sites.....564

10-1 The Chi Valley: site location map.....572
10-2 The Chi Valley: rainfall isohyets.....573
10-3 The Middle Chi survey area.....574
10-4 Plan of Ban Chiang Hian.....575

11-1 Ban Chiang Hian: the stratigraphy.....587
11-2 Ban Chiang Hian: the material culture.....588
11-3 Ban Kho Noi: the material culture.....589

12-1 Ban Chiang Hian: rim types from layer 11.....602
12-2 Ban Chiang Hian: rim types from layer 10.....603
12-3 Ban Chiang Hian: rim types from layer 9 604
12-4 Ban Chiang Hian: rim types from layers 7-10.....605
12-5 Ban Chiang Hian: rim types from layer 7.....606
12-6 Ban Chiang Hian: rim types from layer 6.....607
12-7 Ban Chiang Hian: rim types from layers 6 608
12-8 Ban Chiang Hian: rim types from layers 5 and 6 and surface finish types from layers 10-11.....609
12-9 Ban Chiang Hian: surface finish types from layers 5-10 and applique types from layer 11 615
12-10 Ban Chiang Hian: the types of applique decoration from layers 9 and 11.....616
12-11 Ban Chiang Hian: the percentage of rim types per layer.....619
12-12 Ban Chiang Hian: the percentage of surface finish types per layer.....620
12-13 Ban Chiang Hian: cluster diagram of rim types and body finish per level.....621

13-1 The relationships between sites and soil frequencies in the Middle Chi Valley.....624
13-2 The relationship between site size and catchment productivity in the Middle Chi Valley.....625
13-3 The main variables in the development of a chiefdom in the Chi Valley (after Higham 1984).....637

VOLUME THREE: FIGURES

.....693
15-1 Map of the geology of the Khorat Plateau.....
15-2 Map showing the location of clay sources in the Upper

Songkhram Valley.....657
15-3 Sections through modern and prehistoric sherds to illustrate fabric characteristics.....694
15-4 Pot 35, (form 1a, fabric 3) showing shrinkage crack.....695
15-5 Example of surface finish of "Om Kaeo" ware.....657
15-6 Comparison of vitrification structures between modern clay and prehistoric Ban Na Di local ware.....696
15-7 XRD spectra of modern Sakon Nakhon pottery clays.....697

16-1 The Red River Delta, showing the location of the distribution of Phung Nguyen sites.....727
16-2 The interrelationships between the variables thought to underlie the transition from Go Mun to Dong Son phases.....728

ACKNOWLEDGEMENTS

The fieldwork leading to this report was undertaken as part of the Thai Fine Arts Department's Northeast Thailand Archaeological Project. This represents a continuation of the research begun at Ban Chiang and continued at Non Chai, and owes much to the planning and supervision of Pisit Charoenwongsa, the director of research in the Archaeology Division of the Fine Arts Department. Amphan Kijngam was the then director the the Northeast Thailand project, and he invited Charles Higham to co-direct the fieldwork as part of the Ford Foundation's continuing support to the training of Thai archaeologists. The Foundation subsequently supported Amphan Kijngam as well as Metha Wichakana, Warrachai Wiriyaromp and Payom Chantaratiyakarn, in postgraduate study on the material excavated at the University of Otago.

During the course of the fieldwork, the co-directors were conscious of the support provided by the Fine Arts Department, not least from Pisit and the then Director-General, Dejo Saowananon.

In November 1981, 11.5 tonnes of excavated material reached Dunedin. Thirty-five New Zealand students then undertook the initial sorting of all finds, funded by the N.Z. government. This involved sorting all pottery into rim, base or body sherds, reconstructing funerary vessels, scrutinising the material recovered from the fine screening for organic remains, sorting the faunal material and a host of other necessary tasks. The New Zealand government also funded ten assistants for periods of six months each to work on the excavated material. This involved the drawing of all artefacts recovered, the preparation of over 1,000 thin sections of pottery, and the further recovery of material from the fine-soreening operation. As a final act, further assistance was provided for the packing and despatch of material back to Thailand. This assistance, which cost in the order of $200,000, made the completion of this report possible.

The technical staff of the University of Otago Anthropology Department worked like Trojans throughout the project. Martin Fisher oversaw the preparation of illustrations, and Richard Newell took on technically the most demanding drawings. Chris Moisa drew nearly all the complete pottery vessels, while Lisa Ponweiser was responsible for most of the rim and sherd drawings. Graeme Mason prepared all samples for radiocarbon dating and helped in the conservation of shell and other fragile artefacts.

Many colleagues have contributed to the substance of this report. Warankhana Rajpitak, Nigel Seeley, Robert Maddin, Y.Q. Weng and Jacqui Pilditch have looked at various aspects of the bronze remains, and Jacqui Pilditch also restored the bronzes and cattle figurines. Philip Houghton supervised Warrachai Wiriyaromp's Master's thesis on the human remains, and is responsible for bringing this work to its present format. Brian Vincent has begun the awe-inspiring task of analysing the ceramics through the study of over 1000 thin sections, and his preliminary findings are found below. T.T. Chang and E. Loresto made available their time and the resources of the International Rice Research Institute to look at the prehistoric rice remains for us. Many colleagues have contributed advice and criticism. Tony Reay, David Craw and Charles Landis advised Brian Vincent with the interpretation of the geological aspects of his work, and David Peacock of the University of Southampton guided him through

some of the minefields with beset the aspiring ceramicist. Bryan Manly was at hand to advise with the statistical procedures, and the staff of the University of Otago Computing Centre were most supportive in the preparation of the text.

The careful reader of the text below will notice gaps. Frank Fahy has not been able to complete his analysis of the iron artefacts, and we await his specialist report with great anticipation. Joyce White likewise, has not been able to complete her work on the palaeoenvironment in time for inclusion and again, we must bridle our impatience to read her findings. Despite such lacunae, we hope the contents of this book will be seen as a contribution, however slight, to our understanding of the prehistory of Northeast Thailand.

The text of this report was prepared with the University of Otago computer-aided "prose" programme. Final copy has proceeded directly to the publisher without the intervening prodedure of sub-editing. We are grateful to Graeme Mason for proof reading at least once, but remain conscious that typographic or other errors still lurk in the text. We feel that this is a small price to pay for expeditious publication of results, and hope our readers will agree. We are deeply indebted to Dr. Anthony Hands for making the publication of our findings in Northeast Thailand possible.

It has always been an axiomatic part of this programme, that the results should be available to the Thai people. The Wenner Gren Foundation greatly assisted this aim by awarding Amphan Kijngam a Richard Carley Hunt Fellowship, to enable him to work on this report to completion. Indeed, this report represents a cordial and mutually beneficial liaison between the Fine Arts Department and the University of Otago. We are most grateful to our respective institutions for their support and to the Ford and Wenner Gren Foundations for making it possible for us to work together both in Thailand and New Zealand.

Charles Higham
Department of Anthropology
University of Otago
Dunedin
New Zealand

Amphan Kijngam
Research Division
Fine Arts Department
Sri Ayuthaya Road
Theves, Bangkok 10300.

acknowledgements

For Chet, who pushed the boat out.

INTRODUCTION

This volume sets out to scrutinise the prehistory of the Northern Khorat Plateau, a small part of monsoonal sub-tropical lowland Southeast Asia, between *c.* 2000 BC and 300 AD. This is a particularly interesting period because it encompasses the transition from autonomous to centralised societies. The fieldwork upon which the study is based, began in 1980. It would be fair to say that the models we held of later Southeast Asian prehistory then are diametrically opposed to those suggested below. Let us briefly recapitulate the situation in 1980. There had been three major excavations in Northeast Thailand, the first at Non Nok Tha in 1966-8, the next at Ban Chiang in 1974-5 and the last at Non Chai in 1978. The first two underwrote claims for an extremely early and indigenous development of metallurgy: bronze during the fourth millennium BC, and iron by 1500 BC (Bayard 1972, Solheim 1968, Gorman and Charoenwongsa 1976).

These claims and indeed counterclaims for the primacy of Northeast Thailand as a centre of metallurgy dominated thinking and diverted energy from exploring the area's prehistory from a broader base. In a word, Northeast Thailand became the focus of sensation and polemic. In no case, was the evidence for early dates matched by the publication of the evidence necessary for a scholarly assessment. Such a review would entail not only the precise source of the dated matter, but also statements on the stratigraphic integrity of the location of metal within the sites. This concern with early dates for metalworking was but one of the problems facing us in 1980. We both inclined to accept the early chronology, but only because we had both worked at Ban Chiang and appreciated the professional skills with which all three major excavations were conducted.

Consider the importance of such early chronologies for metallurgy. In China, the richly documented sequences revealed a pattern of growing social complexity and technological sophistication. Firstly there was the Shang Bronze Age, followed by the 6th century BC advent of iron and its proliferation during the Warring States and Han periods. While the Red River Valley was fully exposed to Han expansion, Northeast Thailand lay west of the Annamite Range, known to the Chinese as the "Fortress of the Sky". Then as now, it was geographically isolated from maritime exchange routes. The scientific community was invited to accept the indigenous development of bronze and iron working in inland Southeast Asia, in a context of unchanging, stable, small-scale village communities. Such a juxtaposition, if validated, would run counter to any notion of even the most general regularities of culture process. We shall address this issue at length.

It is also necessary to consider briefly, the nature of the Southeast Asian sites. The area is subject to the southwest monsoon, which brings periods of intense rainfall between May and October. The inhabitants raise their houses on wooden posts. This also occurred during the late prehistoric period in the Red River Delta and in Yunnan. To judge from the number and size of postholes found in the excavated Thai sites, the same building technique was practiced there during prehistory. Now, this situation has ruled out the formation, let alone the preservation, of clearly

stratified building levels. Bioturbation and human disturbance, not to mention the erosive power of the monsoon rains, have further blurred stratigraphic clarity. Excavation is therefore always demanding and often unrewarding.

The prehistorian working in Northeast Thailand is also confronted with a serious problem in the lack of published comparative data. The luxury of those concerned with the Aegean, Yucatan or the Valley of Mexico is viewed enviously by the few workers in Northeast Thailand, because in each of those areas, there is an established chronological and cultural framework for reference and if necessary, refinement. As will be seen, such a framework is only now being established in our area.

This lack of comparative data is matched by the rarity of debate on theoretical issues in Southeast Asian prehistory. Nearly all the authors who have contributed to this volume were educated in a non-Western tradition and in 1980, had received little exposure to the growing debate on theoretical issues in prehistory. Moreover, their research and learning were conducted in a foreign language, about a subject replete with arcane jargon.

Last in this litany of problems, is the near absence of palaeoecological data. This lacuna was to have been partially filled by research undertaken by Joyce White, of the University of Pennsylvania. During the excavation of Ban Na Di, she was undertaking detailed environmental research in the vicinity of Ban Chiang. She kindly agreed to include the Ban Na Di site territory in her field studies, and in view of her participation, our own detailed research plans were set aside. Unfortunately, we heard in mid 1983 that she would be unable to complete her research in time for inclusion in this volume. The absence of her important contribution will be self evident to any reader of the chapters below.

There are however, many advantages to working in Northeast Thailand which redress the problems enumerated above. The area remains a virtual *fabula rasa*, yet to anyone working there who has a European background, it provides several potentially important variables. There is clearly a prehistoric sequence measured in millennia. The variables too, are arresting in their likely significance and interplay. There is a subsistence base incorporating rice, the cultivation of which is susceptible to considerable intensification. The area including its surrounding hills is rich in the ores of tin, lead and copper while the plateau itself bears laterite iron ore. These same hills yield the high quality stone in which the plateau is deficient. The terrain there incorporates two major river valleys with extensive flood plains, but the distribution of soils amenable to the various techniques of rice cultivation presents a mosaic, good tracts being circumscribed by middle and high terraces which to this day, are largely under scrub forest. The area is removed from the sea, yet the prehistoric inhabitants obtained marine products. They were also exposed albeit indirectly to the expansion of Indian and Chinese culture.

All these variables have been to a greater or lesser extent, considered seminal in the process of increased cultural complexity in more intensively studied regions. A particular attraction of Northeast Thailand is its potential as a further area for the consideration of processes involved in the change from first acephalous societies to centralised chiefdoms, and then on to the development of the state.

While this volume is not an appropriate vehicle for major theoretical departures, the position adopted must be made explicit. When the research was being formulated, there were several simple models purporting to describe the prehistoric sequence as it was then understood (Gorman 1977, Higham 1977). It was planned to test these models against newly acquired data, and this testing procedure as will be seen, represents the main thrust of much of our work. A basic tenet of the programme is that the understanding of Northeast Thai prehistory will advance only by constantly proposing, testing and reformulating models. The more general the model becomes, the greater will be its reliance on what Binford (1982) has termed "middle range" theory. While the formulation of a specific model is set out in the final chapter, each of the intervening studies incorporates examples of such middle range theory. These involve *inter alia* the predictability of social structure from mortuary behaviour and settlement patterns, the role of imported rarities and the implications of a sharp and pervasive change in material culture. While each constituent study is an entity in its own right, all underpin and contribute to the ultimate formulation of a specific model for the change from autonomy to hierarchy.

The model was pieced together with two objectives in mind. The first was to identify the variables underlying the process of change to centralised societies. The second was to lay the initial and tentative foundations for the presentation of the area as one which may with profit be incorporated into any general explanatory model for increased complexity. The sites are known, the problems isolated. Only time and effort stand in the way of this last objective.

We will focus on two areas. The first straddles the watershed between the Pao and Songkhram rivers and will be described as the Upper Songkhram area. It incorporates Ban Chiang and the major excavated site to be described, Ban Na Di. The second area lies in the middle reaches of the Chi Valley. It begins with the southern bank, extends across the flood plain and continues into the network of tributary streams which lace the low and middle terraces. It will be described as the Middle Chi area. The former area is treated in section one and the latter in section two. Section three contains the results of Vincent's analyses of ceramic thin sections, and is placed towards the end of this report because its subject matter covers sites described in the previous two sections. Section four comprises an overall synthesis.

We have adopted one firm principle: that models are heuristic and require stringent testing. This makes it axiomatic that all relevant data are available to the scientific community. The following chapters have attempted to honour this axiom.

SECTION ONE

CHAPTER ONE

INTRODUCTION: PREVIOUS RESEARCH IN NORTHEAST THAILAND

Planning for this research programme began in the second half of 1979. At that time, the prehistory of Northeast Thailand was based on the preliminary reports from the major excavations at Non Nok Tha and Ban Chiang (Bayard 1971, Gorman and Charoenwongsa 1976). Supplementary information was available for smaller investigations at about a dozen sites. The principal theme of the preliminary reports was that Northeast Thailand was a tradition of bronze working (Solheim 1968, Gorman 1978). The excavations at Ban Chiang also led to claims for an equally early development of iron working. These claims are well known and need not be enlarged upon at present. Until the definitive excavation reports from those two sites are available, the claims made for each site cannot be reviewed in a scholarly manner.

In 1979, two objectives were formulated. The first, was to undertake a site survey to establish the settlement pattern of sites akin to Ban Chiang. The second was to excavate one of the sites in order to expand our knowledge of the prehistoric people in question. It must be stressed that at the outset of this research project, there was a wide gap between claims for an extremely early and significant metallurgical tradition and the published data. There was no information at all on settlement size, population levels, trends in settlement patterns, site hierarchies in terms of size or architectural complexity, social organisation or the role of metallurgy in cultural terms. In a word, the type of information which made it possible for Renfrew (1972) to consider the Aegean bronze age and Flannery (1976), the formative period in Mesoamerica, was practically nonexistant in Thailand.

It is often the case, that general geographies of Southeast Asia stress the contrast between the uplands and the river plains (Burling 1965). Northeast Thailand does not fall neatly into either category. It includes uplands, and the flood plains of two major rivers, the Mun and the Chi (fig 1-1). Its essential character however, is that it is an inland, elevated plateau, subdivided into two major drainage basins. The smaller or Sakon Nakhon Basin, centres on the Songkhram River and the larger incorporates the Mun and Chi valleys. The basic bedrock of the plateau is sandstone, though there are a few outcrops of limestone and basalt in the southern sector. Moorman *et al.* (1964) have subdivided the terrain into five principal landforms (fig 1-2). The first comprises the present river flood plain, beginning with the incised channel, extending through river levees and oxbow lakes to the backswamp. Under natural conditions, the low parts of the flood plain bear permanent lakes and swamps. All this landscape however, is prone to severe seasonal flooding. Smaller tributary streams commonly have narrower flood plains and lack the levees and oxbow lakes. An important feature of the main rivers, is the presence of relatively narrow plains between lengths of deeply incised riverbed. This situation fosters flooding of considerable

intensity. The low terrace takes the form of slightly undulating terrain, normally fringing the present flood plains. It is broadest near the confluence of the Mun and Chi rivers, and more restricted in smaller tributary regions. The low terrace is probably of upper Pleistocene date, and the soils are river transported sediment. The surviving middle terrace areas have an uneven distribution due to local forces of erosion and redeposition. They comprise sandy surface soils, overlying lateritic concretions and an increasingly clayey substrate. The high terrace has been subjected to considerable erosion, and often survives only as slightly elevated islands of high ground. These sandy soils probably date to the early Pleistocene time. Hills demarcate the plateau to south and west, but there are also isolated outcrops of high country within the plateau, nearly all of which comprise weathered sandstone.

The soils of the three terraces and flood plains vary according to their degree of permeability, salinity, slope, texture and fertility. Their qualities are further subdivided on the basis of micro-relief and susceptibility to flooding. From the viewpoint of growing rice, the soils have been subdivided into five major groups, with seven sub-units (Robinson and Steel 1972).

A further important environmental variable in Northeast Thailand is the difference between the wet and the dry seasons. The onset of the southwest monsoon in May brings intermittent, heavy rainfalls which last until November. This is the period of maximum plant growth. There is an abundance of water and much flooding, but it is important to note that the incidence of rainfall is not predictable and the possibility of insufficient rain to bring rice to maturation cannot be ruled out. The dry season lasts from November to the onset of rains the following year. As may be seen from fig 1-3, there is a marked deficiency of water during this period.

Five millennia of human modification make it difficult to assess the vegetation of the plateau in detail. Being a monsoonal climate with a long dry season, the principal forest type is described by Holdridge (1967) as subtropical moist. This comprises variably open, or fairly dense stands, with a canopy height of *c.* 15 m in drier areas and 25 m where moister conditions prevail. Many species are deciduous. The transition to a subtropical wet forest with fewer deciduous trees takes place at 400 m, and so hardly concerns the study of prehistoric settlement patterns. Dipterocarp species are physiologically adapted to strong variations between dry and wet conditions, and predominate in the deciduous moist forest. This tree cover was probably present on the low to higher terraces during prehistory. The nature of the vegetation on the river flood plains is more problematical. If the historic vegetation of the Chao Phraya Flood Plain is any guide however, it was probably dominated by swamp grasses with tree growth being scattered and stunted (Boonsong and McNeely 1977). Narrower river valleys however, may have sustained a moist gallery forest.

Soils and vegetation also affect the associated animal communities. Boonsong and McNeely (1977) note that the grasslands of the river flood plains are adaptive for the elephant, rhinoceros, water buffalo, pig deer and Schomburgk's deer. The moist monsoon forest on the other hand, favours wild cattle, pig, the sambar deer, muntjak, and the large carnivores such as the tiger. The fauna and landsnails from early prehistoric contexts at Ban Chiang indicate exploitation of the latter faunal group: elephant and wild

water buffalo were absent, and rhinoceros very rare (Higham and Kijngam 1979).

This chapter concentrates on the Upper Songkhram Valley, but will also refer to recent excavations in two nearby areas, the Middle Chi Valley and the Upper Chi Valley (figs 1-4, 1-5).

PREVIOUS RESEARCH IN NORTHEAST THAILAND

The first serious archaeological research in the area commenced in 1963, and was undertaken by the Fine Arts Department and the University of Hawaii under the overall direction of W.G. Solheim. The aim of this programme was to survey the archaeological sites threatened by flooding due to dam construction. In the first year, more than twenty sites of historic or prehistoric origin were identified (Solheim 1968). Among them was Non Nok Tha in the Upper Chi Valley. The second season incorporated the test excavation of Non Nok Tha. The recovery of human skeletal remains and bronze artefacts encouraged further work at the site, and major excavations were undertaken in 1966 and 1968.

Non Nok Tha is a small prehistoric site located about 500 m south of the village of Ban Na Di in Northwestern Phu Wiang district, Khon Kaen province (Solheim 1968, Bayard 1970, 1971, 1972, 1977, 1984). It is about 100 by 100 m in extent, and stands up to 1.5 m above the level of the surrounding rice fields. These rice fields comprise the Roi Et sandy loam soils which are suited to rice cultivation. 340 m^2, or about 3.2% of the mound has been excavated. Nine cultural layers were identified in 1.4 m of cultural deposit. These nine layers have been grouped by Bayard into three major periods, the early (EP), middle (MP) and late (LP). The EP comprises three phases, the MP eight, and the LP, six. Bayard (1984) has recently renamed these phases, but to avoid possible confusion, the older and more familiar names will be employed.

Bayard maintains that bronze technology appeared during EP 3. There is some evidence for the raising of domestic cattle, pig and dog as well as the consumption of rice during the EP. Hunting deer and wild cattle was also undertaken, although the lack of any screening of excavated soils has ruled out the retention of small animal bones or microfauna (Higham and Leach 1971, Higham 1972, 1975, 1977). In the MP, the evidence for bronze technology increased markedly, most of the metal artefacts being found as grave goods (Bayard 1984). There is no evidence for the MP use of iron, but the grave assemblages suggest continuity of the site's use as a cemetery over a considerable time span. After a period of abandonment which probably commenced some time during the period 500 - 0 BC., the site was reoccupied by people who possessed iron tools, cremated the dead, and had little use for bronze. Bayard identified 217 burials at Non Nok Tha, and the human remains have been analysed by Brooks and Brooks (1983) and Pietrusewsky (1974, 1974a).

Among their principal conclusions, was the finding that the level of health and diet were reasonably high, and that mortality among the young was generally higher in the earlier assemblage of graves. In his analysis of the mortuary practices at Non Nok Tha, Bayard (1984) has suggested that the distribution of grave goods, particularly in the MP assemblage, reflects a ranked society.

Although the excavators have submitted 26 radiocarbon or TL samples to various laboratories, the results are internally inconsistent and still most controversial (Higham 1984). Bayard feels that the end of the EP, with its associated bronze, belongs towards the end of the third millennium BC, with the MP dating between 2000 and 500 BC.

The proposed early dates for bronze working attracted considerable interest, and further excavation in the area soon followed. Late in 1969, an expedition from the University of Otago commenced site surveys and excavations in the Phu Wiang district of Khon Kaen Province and Suwannaphum district of Roi Et Province. The former is located in the Upper Chi Valley, and the latter is in the lower reaches of the same river. Four sites were tested in the former area: Non Nong Chik, Don Sawan, Don Kok and Don Wat Koo. In terms of pottery analysis and radiocarbon dating, it was shown that Non Nong Chik and Don Sawan were occupied by people related to Non Nok Tha during the MP and LP respectively.

Three sites were tested in the Roi Et area (Higham 1977). They are Bo Phan Khan, Don Taphan and Non Dua. Non Dua is located within a set of moats. Bo Phan Khan lies adjacent to an extensive, exposed salt deposit while Don Taphan is a large mound next to the Lam Siao Yai River. Cultural deposits at all sites extended to a depth of approximately six m. The cultural material and radiocarbon dates reveal initial occupation of the area during the middle of the first millenium BC. Higham (1977) had divided the occupation of Non Dua into three phases, the distinctions resting on changes in pottery typology. Phase one lasted from *c.* 500–0 BC, phase two from 0–700 AD and the last phase from 700–1000 AD. Deposits at Bo Phan Khan and Don Taphan relate in the main, to phase two at Non Dua. At the time of writing, Higham was unable to identify any clear parallels in terms of pottery styles with other Northeast Thai sites, but it was clear, that the Non Nok Tha and Roi Et assemblages were quite different.

In 1972, Silpakon and Thammasat Universities undertook research in the Nong Han district of Udorn Thani province (Preecha and Pukajorn 1974, Kethutat 1976). This area was chosen because of its proximity to the looted site of Ban Chiang, painted pottery from which was reported as being up to 6000 years old on the basis of TL dating. Two sites were excavated, Ban Om Kaeo and Ban That. The former is very close to Ban Chiang itself, and was test excavated in 1972 and 1973. Ban That, six km south of Ban Chiang, was excavated in 1973. The excavators recovered evidence for bronze and iron technology at both sites, including two axe halberds at Ban That. Incised and painted pots which are generally known as "Om Kaeo" ware were found in the basal levels of both sites. This style is found in the Middle Period at nearby Ban Chiang. At present, only preliminary reports are available, and no dates nor descriptions of the biological material have been published.

In 1973, the Fine Arts Department and the University Museum, Philadelphia, established a major research project at Ban Chiang under the direction of Pisit Charoenwongsa and Chester Gorman. Excavations followed in 1974 and 1975. A site survey and test excavations in the general area were at the same time undertaken by William Schauffler (Schauffler 1976). Ban Chiang had, at that time, already been examined on several occasions by officers of the Fine Arts Department, beginning with Vidya Intakosai in 1967. He reported that plain and painted wares were associated with bronze artefacts in the inhumation graves there. Three sherds were sent for TL dating analysis, and the results suggested

occupation during the fourth millennium BC. Further squares were excavated in 1972 by Nikhom Sutiragsa and Pote Geangoon. Their failure to excavate burials however, ruled out any definitive conclusions on the sequence or cultural characteristics of the site. Sutiragsa (1979) reported that burials in the lower levels were associated with black pottery bearing incised designs and tools and ornaments of stone placed round the body. In later layers, pottery covered with cord-marking as well as painted ware were placed near the head and feet, along with tools and ornaments made of bronze or iron. Cultural material from the occupation layers included crucibles, sandstone moulds for bronze casting, cattle figurines made of clay and curious deeply incised circular rollers made of clay. No insight into either the chronology or the economy has been provided by either excavator.

Ban Chiang itself is a substantial village, covering approximately twenty ha. Only a small part however, has revealed prehistoric remains, and the maximum extent of the prehistoric mound is unlikely to have exceeded 3.5 to 5 ha. Of this, Gorman and Charoenwongsa excavated 180 m^2. In a preliminary report, they subdivided the cultural sequence into six prehistoric phases on the basis of changing material culture and burial rite. During their phases 1 and 2 (*c.* 3,600 to 2,900 BC), the excavators found a crouched burial associated with a socketed bronze spearhead. Black to grey burnished and incised pottery is a characteristic of these two phases. In phase 3, dated to a few centuries before and after 2000 BC, cord-marked vessels with elaborate curvilinear designs predominated. Incised and painted pottery matching that found at Ban Om Kaeo, as well as two bi-metallic spears, were found in phase 4, which was tentatively dated to the period 1600 to 1200 BC. The well known red on buff painted pottery belongs to phase 5, with dates of *c.* 1000 to 500 BC. The last prehistoric phase, which is characterised by red slipped and burnished pottery, has been dated to the latter half of the first millennium BC. The Ban Chiang excavations reopened the issue of early bronze technology in Southeast Asia, and further, added claims for extremely early iron working. Both proved highly controversial (Loofs-Wissowa 1983, Bayard and Charoenwongsa 1983, Solheim 1983).

Higham and Kijngam (1979) have analysed the faunal material from the 1975 excavations. The evidence indicated that the prehistoric inhabitants maintained domestic cattle, pigs, chickens and dogs, hunted large mammals and obtained, perhaps through trapping, a range of smaller species. Aquatic fauna included shellfish, turtles, fish and frogs. The earliest evidence for the water buffalo was found in phase 4 contexts, and was thus contemporary with the first evidence for iron artefacts. The possibility that iron and the water buffalo were associated with the development of wet rice cultivation in fixed fields was considered likely.

The human remains from the Ban Chiang excavations have been analysed by Pietrusewsky (1981). He divided the assemblage into two groups, an early and a late. The former he dated to the initial occupation to the end of phase 4, and the latter to the equivalent of phases 5 and 6. He reported that in the earlier group the remains of infants and children were found more frequently than in the later one. Moreover, the average age at death in the earlier burial group is lower than in the later group. Evidence for various disorders was also noted, but these were neither common nor debilitating, and in general, the levels of diet and health were high.

During the course of the Ban Chiang excavations, Schauffler both site-surveyed and undertook test excavations. Three sites were examined: Ban Phak Top, Ban Tong and Don Klang. Ban Phak Top is located about 25 km west of Ban Chiang. The site had been severely looted and a square was opened toward the edge of the mound. No burials were found there, but villagers' reports and the number of complete pots for sale confirmed the presence of a considerable assemblage of prehistoric burials. The pottery from the site was characteristically dark grey to black in colour and bore incised, curvilinear decoration. No red on buff painted ware or other artefacts, such as clay rollers characteristic of later Ban Chiang, were found there. The material culture, including clay figurines, worked bone and pellet-bow pellets are all paralleled at Ban Chiang. Radiocarbon dates from Ban Phak Top suggest initial occupation during the middle of the third millennium BC (appendix 1).

Don Klang is located about 30 km northeast of Non Nok Tha and 90 km southwest of Ban Chiang. The test excavation revealed at least three distinct phases. The uppermost is radiocarbon dated to between approximately 500 BC - 200 AD. It thus corresponds to the period of abandonment at Non Nok Tha. The lower phases correspond in terms of material culture with that known at Non Nok Tha. The burials of the latest phase were found associated with iron and bronze artefacts, while one pit contained numerous water buffalo skulls. Glass beads were also found in the later burials.

The last site to be excavated by Schauffler is located only five km southeast of Ban Chiang. Ban Tong had a cultural stratigraphy three m deep, and two burials were found. The latter was associated with an incised and painted pot similar to those characteristic of Ban Chiang phase 4. The lower burial was cut into sterile, and was associated with cord-marked pottery whose affinities may well lie with Ban Chiang phase 3. Only a brief and preliminary report is available for these three sites, which makes the interpretation of the radiocarbon dates a most tentative exercise (appendix 1).

In 1978, a further joint programme between the Fine Arts Department and the University Museum, Philadelphia, was undertaken under the direction of Penny (1982, 1984). It centred on the area between Amphoe Phu Kradung, Loei Province and Amphoe Phu Khieo, Chayaphum Province. It set out to test a hypothesis advanced by Gorman (1977) that transitional sites between the upland Hoabinhian and the lowland agricultural villages represented by Ban Chiang and Non Nok Tha would be found in the piedmont ecotone between the plain and the Petchabun Mountains. An extensive archaeological site survey resulted in the recognition of forty-five sites and three were test excavated. Non Nong Khaw Wong is located in the valley of the Choen River. The 2x2 m test square revealed about one m of cultural deposit. Bronze was found in the lower part of the square, but no iron. Several crucible fragments were also located, but the radiocarbon dates of 400 BC, and 0 AD shed little light on the chronology of bronze working or of early adaptation to a plains environment. Perhaps the most interesting result of this test excavation was the recovery of a pot lid which is very similar to the material from Don Klang and Non Chai. A similar situation was found at Ban Puan Phu, a site located in the valley of the Phong Ko River. The metre of deposit there revealed both bronze and iron, as well as a small number of glass beads. Again, the initial hypothesis could not be examined in detail.

The last site was Ban Puan Phu. Again, stratigraphy was shallow, the deposits being just less than one m thick. In addition to several enigmatic domed clay features, a burial associated with an iron axe and several glass beads was found. An unprovenanced charcoal sample from the vicinity of this burial provided a determination of approximately 900 BC. Penny (1982) has concluded that, far from providing evidence for early adaptation to a lowland riverine environment, the Petchabun Mountain piedmont was occupied late in the prehistoric period. The most likely date for this expansion is 500 to 0 BC.

In 1976, the Fine Arts Department undertook test excavations at two sites. Ban Sa Baeng is about 13 km northwest of Ban Chiang, and Non Na Sang, two km north of Ban Sa Baeng. The excavations at the latter revealed about one m of cultural deposit which was subdivided into two cultural levels (Srisuchat and Thosarat 1976). One burial was recognised in the upper level, associated with pottery, bronze ornaments and an iron axe. The cultural material from both levels included bronze and iron artefacts, clay pellets, glass beads, clay figurines, fragments of crucible, clay anvils and clay ladles. The pottery in the lower level is characterised by cord-marking with serpentine applique decoration at the shoulder and painting and incising. Red on buff painted ware was found in the upper level. There are five radiocarbon dates (appendix 1). They are clearly internally inconsistent.

Non Chai was, before its destruction, a large prehistoric settlement site located on the outskirts of Khon Kaen. Urgent rescue excavations were undertaken there under the direction of Pisit Charoenwongsa in 1977-8 prior to the removal of the site to facilitate road construction. The excavators encountered a stratigraphy to a depth of about five m and divided the cultural sequence into six phases (Charoenwongsa and Bayard 1983). The charcoal samples which were collected from hearths and localised concentrations of burnt material, revealed occupation between about 300 BC and 200 AD. The pottery styles are dominated by red slipping and red on buff painted decoration. Bronze and iron were found throughout the sequence, but glass beads made their initial appearance in the second lowest layer. Fragments of clay moulds for the casting of bracelets and bells attest to local bronze working.

These findings at Non Chai resemble those from Ban Kok, which is located about two km southwest of Khon Kaen. Red slipped pottery was found throughout the layers there, but iron appeared about half way through the sequence. A radiocarbon sample from the base of the site provided a date of 930 ±90 BC.

After the present research programme began, two further test excavations were undertaken in the Sakon Nakhon Basin. In 1980, Sod Daeng-iet worked at Ban Waeng, a site located in Waeng district of Amphoe Sawang Daeng Din, Sakon Nakhon Province. This site is approximately 41 km east of Ban Chiang. He found cultural deposits to a depth of 1.5 m. The lowest burials which were found contained both iron and bronze artefacts, while other artefacts, such as clay rollers and fragments of iron recalled the later material at Ban Chiang (Daeng-iet 1980). Finally, Staporn Kwanyuen opened a test square at Non Khi Kling in 1981, but no reports are yet available.

In 1979, three major excavations had been undertaken, at Non Nok Tha, Ban Chiang and Non Chai. No definitive reports, however, were available. There had also been a considerable number of small test

excavations, none of which covered an area exceeding 16 m^2. Practically nothing was known about settlement patterns, site size or hierarchy, the health of the prehistoric people or even the nature of the sites excavated. There were and are no prehistoric house plans. Nor was it possible to advance any serious attempt at a regional chronological or cultural framework. There were, however, some simple exploratory models, based on the limited knowledge then available. The first such attempt was advanced by Higham (1972, 1977), and was based on research undertaken at Non Nok Tha and in Roi Et Province. It was a very simple, settlement expansion model in which Higham related the initial settlement of the Lower Chi Valley to a combination of environmental and technological variables. Noting that the settlement of Non Nok Tha preceded that of the Lower Chi Valley by several millennia, he suggested that wet rice cultivation using iron technology and the buffalo drawn plough were necessary prerequisites to the expansion of settlement into the dry middle and lower reaches of the Chi River. This model has been tested by fieldwork at and near Ban Chiang Hian as part of the present research programme, and rejected (see below).

Following the analysis of the Ban Chiang faunal remains, Higham and Kijngam proposed that the conjunction of iron and water buffalo bones there during what was then known as phase four, now renamed EP d, was consistent with the practice of wet rice plough agriculture. This is a change of considerable economic and social significance. The plough permits a more intensive and productive form of rice cultivation and as Goody (1976) has observed, ploughing and rising social complexity present adhesions. This model of economic change, which would place this major change some five centuries earlier than in China, will be reviewed below and found wanting. The second overview was presented by Gorman (1978). Crucial to his model, was the presumption that bronze technology existed at such sites as Ban Chiang and Non Nok Tha for at least two or three millennia, but that there were no discernible changes in social complexity. He then sought ecological and economic reasons for this, suggesting that wet swidden rice cultivation, hypothesised as the technique employed at Ban Chiang, favoured small and dispersed settlements:

"An urbanised settlement pattern seems to have been technically dysfunctional; the dispersion required by swidden cultivation, and the reliance on a monsoon-structured inundation agriculture system both mitigated against urban concentrations" (Gorman 1978:48).

The present research programme began with these models in mind, and set out to test them against newly acquired data derived both from site surveys and excavation. Before outlining the research design, it is important to stress that two further models were published during the course of the present research programme. The first follows Gorman's closely. White (1982) emphasised continuity in the Ban Chiang cultural tradition over a period of four millennia. Within this long timespan, she follows Gorman in identifying:

"peaceful, agrarian village societies .... no complex, stratified social organisation appears to have been a cause or consequence of the development of metal technology."

MacDonald's (1980) model takes a diametrically opposite view. He proposed the development of chiefdoms in the Sakon Nakhon area by 1500 BC, and of a state somewhere in the southern half of the plateau during the first millennium BC. He applied notions on site size and catchment productivity advanced by Steponaitis (1978) to the available data, assuming that Ban Chiang covered about 20 ha from early in the prehistoric sequence. A site of this size could not have sustained its estimated population from its own catchment. Therefore, he asserted, it had to depend on client villages which made up a hierarchic settlement structure. His data on the origins of the state basically comprise the existence of very large, superordinate sites at Phimai and perhaps, Non Chai. These two models are susceptible to scrutiny in the light of the information gained during the present research programme.

THE PRESENT RESEARCH STRATEGY

The models available at the commencement of the present programme rested on shaky foundations. They were based on impressions gained while excavating single sites, and failed to conform to the four principles advocated by Renfrew and Wagstaff (1982) in their consideration of Melian prehistory. These begin with a defined area of study, simple in the case of an island and more difficult when confronted with an extensive sedimentary basin such as the Khorat Plateau. In the event, the identification of a discrete area was resolved on the basis of two factors. In the case of the Upper Songkhram area, it was felt wise to undertake research in an area contiguous with one of the few extensively excavated sites in the Khorat Plateau, namely Ban Chiang. Secondly, it seemed sensible to work in an area comprising all the major environmental zones of the plateau as a whole. Consequently, the land surrounding an extensive lake was selected. It incorporates the lacustrine flood plain and within a manageable area, the soils of the lower, middle and high terraces each laced with a network of small streams.

The Middle Chi Valley was selected for a site survey because it incorporates a large moated settlement, Ban Chiang Hian, and also contains a wide variety of different soil types and drainage regimes.

The second requirement involves a diachronic perspective, since a long time period is more likely to involve either cultural change or indeed, the stability described by Gorman (1978) and White (1982). The sequence at Ban Chiang provided an assurance that at least three millennia of occupation were present in the study area.

Renfrew and Wagstaff (*op.cit.*) then propose a "*concrete ecological approach within a systematic framework*". One of the weaknesses of the data base in 1980, was the absence of any information on settlement patterns. Spacial archaeology within a delimited, environmentally diverse area was the initial strategy of the research programme, and some results have been described (Kijngam, Higham and Wiriyaromp 1980). Finally, a

deductive approach based on specific assumptions is recommended. The Northeast Thai data available in 1980 had not been considered in an overall, systematic manner. Indeed, prehistoric research was and largely remains in an initial exploratory phase characterised by conflicting claims on the presence or absence of an unusually early phase of bronze working. Many propositions and problems are in question. It is necessary to establish the nature of the prehistoric settlement patterns and identify any changes which bear on processes of cultural change. There are two further issues which require excavation as well as survey data. These begin with an assessment of the initial models advanced by Higham (1977), Gorman (1978), MacDonald (1980) and White (1982). The second adopts a comparative stance. The prehistoric cultural adaptation to the Khorat Plateau has been regarded as distinctive to the point of uniqueness. Gorman (1978) and White (1982) have both stressed the conservative, unchanging and peaceful nature of the "Bronze Age" societies there. Examination of this proposition is the principal objective of the research to be described. It will be found to be an excellent example of the course of archaeological research described by Salmon (1982). Thus, whereas it is not difficult to refute hypotheses on the basis of newly acquired data, the presentation of new ones often provide only partial explanations. These must in turn, be testable and refutable.

THE CULTURAL AND CHRONOLOGICAL FRAMEWORK EMPLOYED

As the number of excavated sites in Northeast Thailand has increased, so has the range of suggested chronological and cultural subdivisions. The present situation is not conducive either to the pursuit of order or of a judicious consideration of cultural processes. Consider the key site of Ban Chiang. In addition to Gorman and Charoenwongsa's (1976) six phases, we now have White's (1982) subdivision into Early, Middle and Late Periods, the first having four subdivisions based principally on changes in the style of mortuary pottery. The three well known periods of site use at Non Nok Tha, known as the Early, Middle and Later Periods, have no particular correlation with those suggested for Ban Chiang. Moreover, Bayard (1984) has recently re-named them the Phu Wiang, Non Nok Tha and Don Sawan phases in contrast to MacDonald's (1980) new ascription of six successive phases. At Non Chai, there are five phases, at Ban Chiang Hian three, and there are three again at Non Dua in the Lower Chi Valley. The situation is chaotic. Faced with such a plethora of sub-divisions, an understanding of structure is not easy.

Bayard (1984) has recognised this, and proposed a series of regional phases. His scheme is reproduced below (fig 1-6). Essentially, he identifies six regions with archaeological sequences, respectively the Loei, Western Khon Kaen, Sakon Nakhon, Upper Chi, Lower Mun-Chi and Upper Mun. In this study, the Western Khon Kaen area is referred to as Upper Chi, and his Upper Chi is referred to as the Middle Chi (figs 1-4 and 1-5). Each area is given its own set of phase names. The scheme is described as heuristic and for the use of specialists familiar with the data. Since

the number of such specialists is minute, the scheme is regarded as too unwieldy for the present purpose. Again, most if not all the subdivisions are based on changes in pottery typology which might reflect a variety of underlying causes singly or in combination.

The principal aim of the present work is to test current models and suggest an alternative one. This requires the use of phases defined on the basis of the variables which are to used in the model: social organisation, technology, exchange patterns, intensification, demography and warfare. Bayard (1984:163) does in fact allude to four such general periods, as follows:

GENERAL PERIOD A. The development of at least semi-sedentary agricultural communities (although the type of agriculture practiced is still a matter of debate; see White 1984) during the period 3500-2500 BC, with noticeable but fairly weak social ranking.

GENERAL PERIOD B. The appearance of bronze technology (and presumed strengthening of already present trade links) during the period 2500-1800 BC) with an increase in social ranking, but still a simple ranked level.

GENERAL PERIOD C. The introduction of iron technology and intensive wet rice farming during the mid-First Millennium BC, with a more marked increase in ranking.

GENERAL PERIOD D. Shortly thereafter the rise of incipient states, or at least the complex chiefdoms Wheatley posits (1983:419), and the development of true states by a fusion of these indigenous organisms with Indian socio-political and religious concepts, commencing shortly after the beginning of the present era.

It is clearly recognised that not all sub-regions in Northeast Thailand proceeded contemporaneously through these four general periods. But this phenomenon is foremost among the factors we seek to explain. Older archaeologists too, will recognise a correspondence between the first three general periods and the three age system. In the following pages, the four general periods proposed by Bayard will be used as a convenient shorthand notation. The relationships between individual sites is set out in fig 1-7. It is the latter which will be used when discussing individual sites and their relationships. It will be seen that Bayard's chronology has been modified to our own interpretations, for which arguments are presented in section three below. It is most refreshing however, to find that the claims for remarkably early dates have now subsided, and been replaced by a more realistic assessment. Indeed, a broad concensus is nearly upon us.

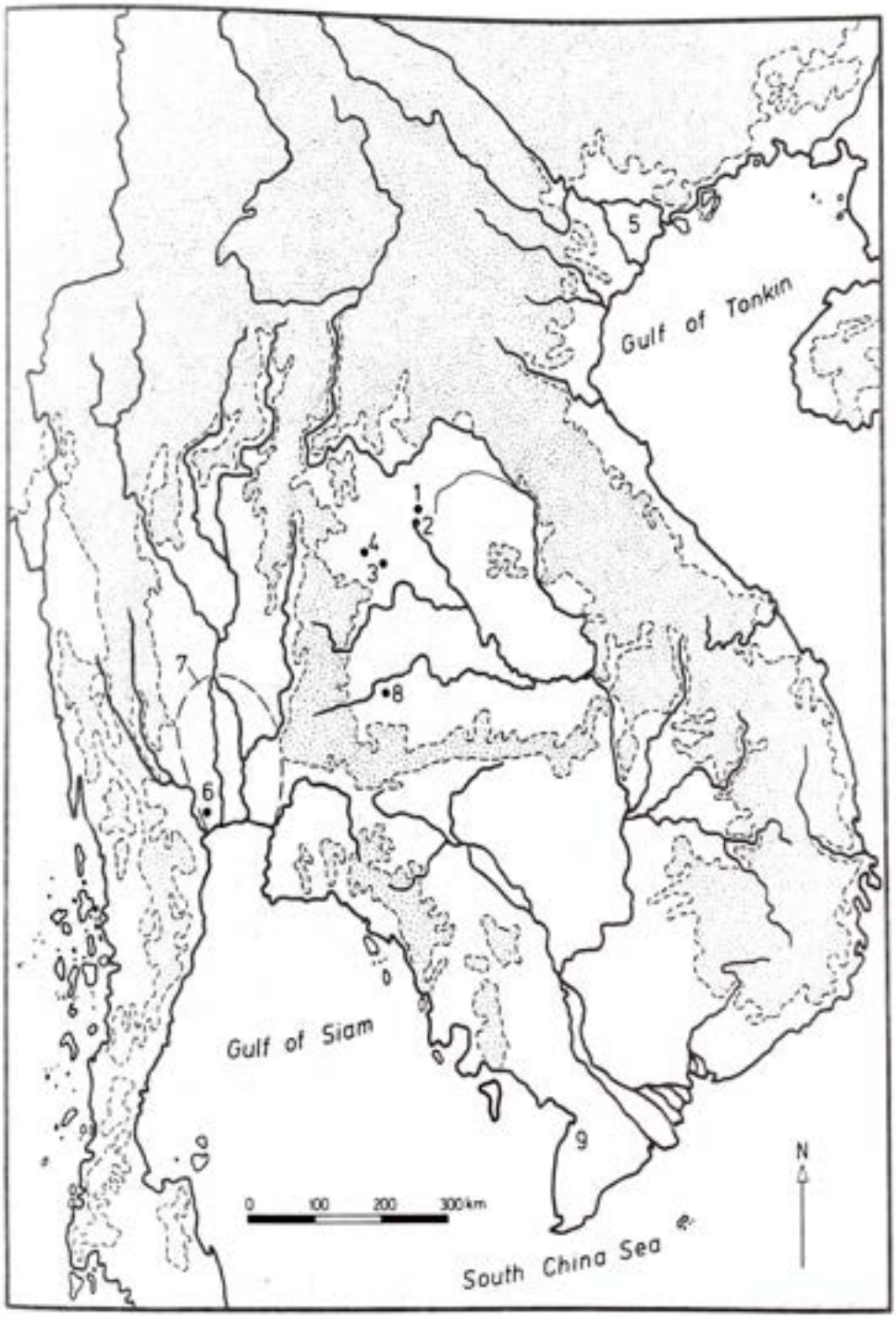


FIGURE 1-1

General map of Southeast Asia: 1, Ban Chiang 2, Ban Na Di 3, Non Chai 4, Non Nok Tha 5, the Red River Delta 6, Ban Don Ta Phet 7, the Lower Chao Phraya Valley 8, Phimai 9, the Transbassac area.

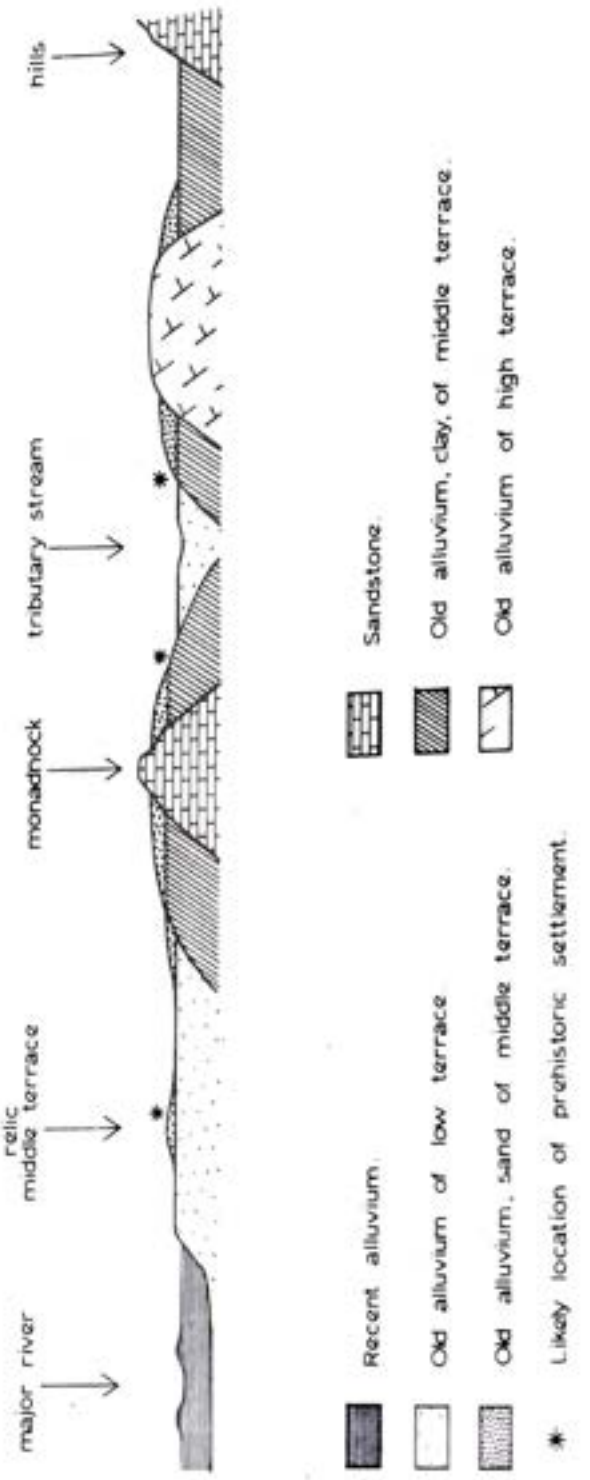


FIGURE 1-2

Cross section of the principal landforms found in the Sakon Nakhon Basin

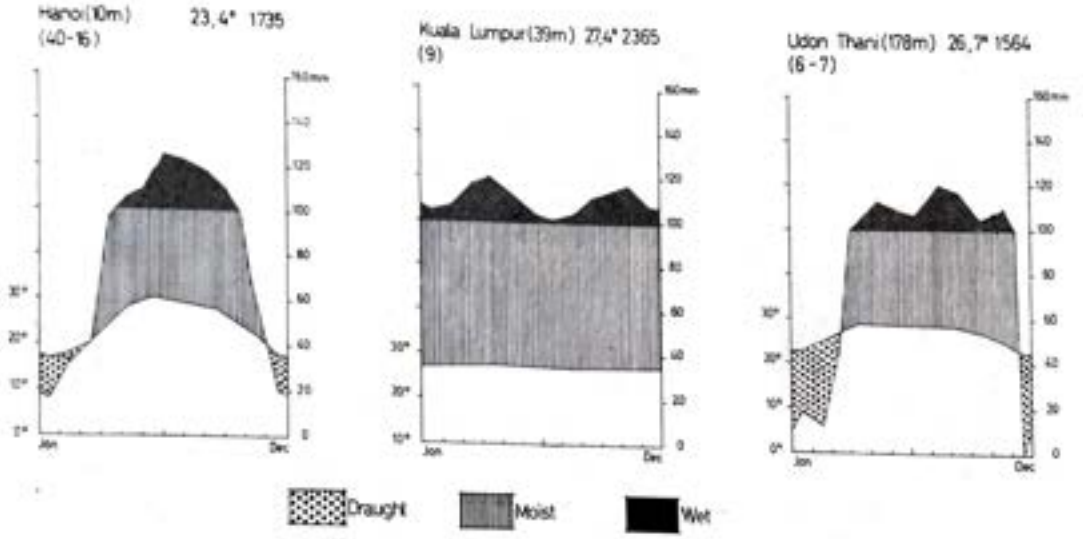


FIGURE 1-3

The principal features of the climate in Northeast Thailand



FIGURE 1-4

The Sakon Nakhon Basin

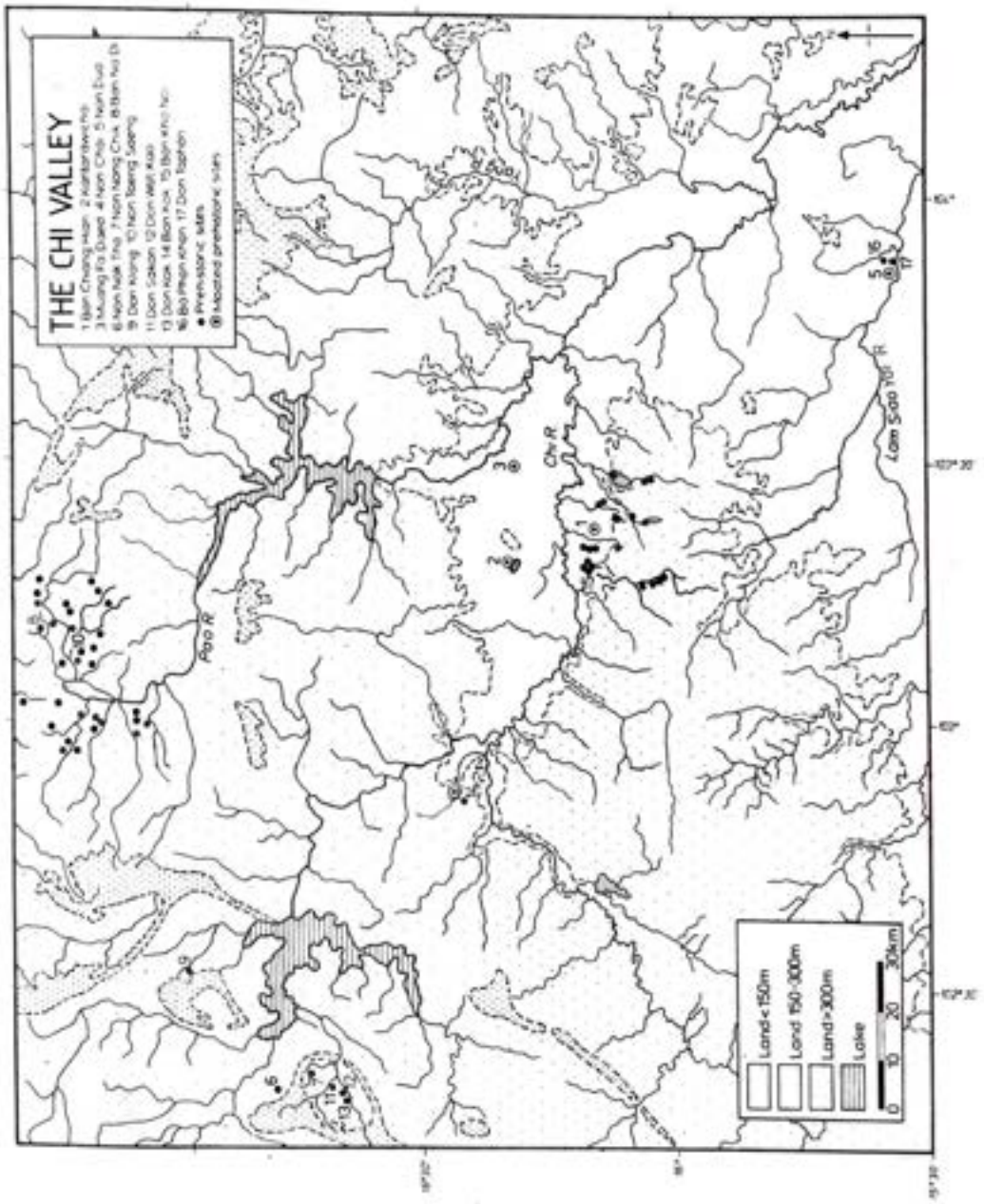


FIGURE 1-5

The Chi Valley

FIGURE 1-6

A scheme showing the cultural and chronological framework for Northeast Thailand after Bayard 1984. His Upper Chi area is described in this report as the Middle Chi.

The cultural and chronological framework

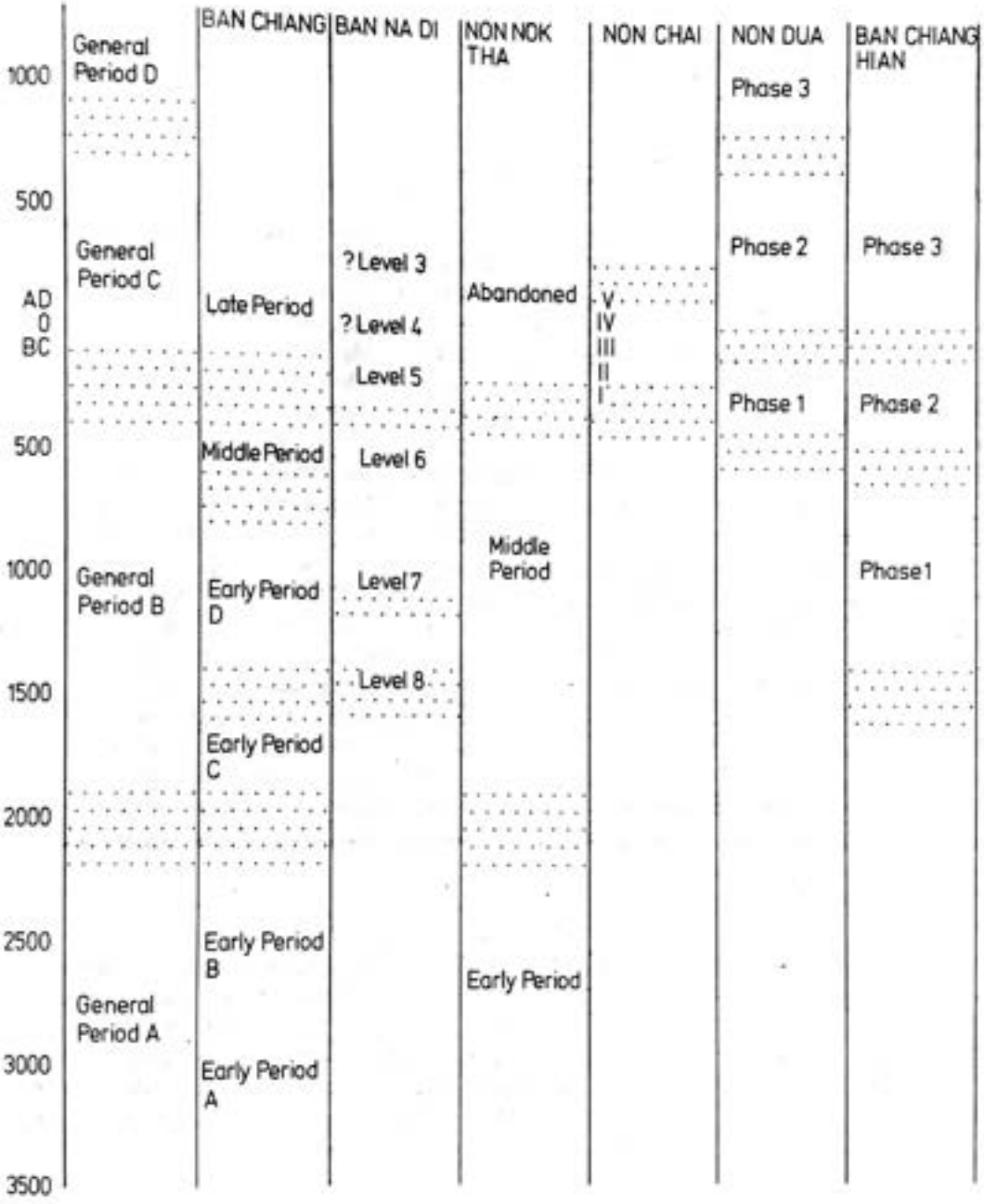


FIGURE 1-7

The chronological relationships between excavated sites in Northeast Thailand

CHAPTER TWO

THE EXCAVATIONS OF BAN NA DI, BAN MUANG PHRUK AND NON KAO NOI

Ban Na Di is one of the prehistoric sites in the Upper Songkhram survey area identified in 1980. During that same year, it was subjected to a test excavation, and the discovery of a deep and intact cultural deposit lead to the decision to undertake a major excavation there. The location of such village settlements is discussed more fully in chapter nine. At this juncture, it is stressed that Ban Na Di is typical of most prehistoric sites in the survey area, in terms of its proximity to two small streams, and immediate access to the soils of the low terrace. These are the soils best adapted to the cultivation of rice in the area to this day. Its location is set out in fig 9-1.

Figs 2-1 and 2 show the present village and the central portion of Ban Na Di. The contours are set out as less than 25-100 cm below the datum which is located at X. Square F5 was excavated between November 1980 and May 1981. The excavation technique was essentially that developed by Charoenwongsa and Gorman at Ban Chiang in 1974-75, but experience gained there made possible some refinements. Ban Chiang was a stratigraphically demanding site due to bioturbation by a species of beetle as well as the process which led to the build up of deposits there. The former accumulates soil to build a subterranean nest measuring 60-70 mm in diameter. Its activities were reflected at Ban Chiang in a marbled soil in the upper 2-3 m of deposit within which the recognition of culturally significant layers was virtually impossible. Nor was it possible to recognise the edge of inhumation graves or the point from which they were cut. Indeed, upper burials there were recognised only when bone or offerings were encountered.

The response to this situation was to excavate the site in 10 cm unit levels until a clear change in soil colour or texture was recognised. After the removal of each 10 cm thick level, the surface in each square was scraped clean and all "features" noted were recorded by drawing and photography. Such features included pits, animal disturbance, post holes and graves. Naturally, all features were excavated as discrete units and the contents separately labelled and bagged for later analysis. Only when all features were excavated, was the next 10 cm level removed. All soils at Ban Chiang were screened.

There is no doubt that at least during the period 500-0 BC, houses raised on stilts were used in the Red River area of Vietnam and Yunnan province of Southern China. This type of structure is a response to intense seasonal rains and the prevalence of flooding. It is the traditional method of house construction in Northeast Thailand today. The size and depth of some of the post holes found at Ban Chiang and Ban Na Di are very similar to those excavated for modern houses although no house plans are known from either site due to the limited areas so far opened up. Such a house design provides for living space raised several feet above the ground. Clearly therefore, the recovery of actual occupation floors in archaeological sites cannot be expected. During its life span

however, a house may provide a protected environment for detritus which accumulates under its floors. Some modern house floors are raised sufficiently high to provide working space or animal stables underneath. The latter are regularly cleared of manure, and the former undergo regular traffic. All these facts initiate the build up of clearly stratified occupation levels corresponding to those documented in archaeological contexts where activities regularly took place at ground level.

It was anticipated that the nature of the archaeological deposits at Ban Na Di would correspond to those encountered at Ban Chiang, but this was only partially the case. As will be seen, several clear levels were encountered as well as structures documenting activities undertaken at ground level. Moreover, the clarity of stratigraphy in the basal two m at Ban Na Di was provided by the deposition of numerous clean lenses of sand by floodwater.

The principal refinement to the excavation technique developed at Ban Chiang was the recognition of eight tolerably clear occupation levels. The second was the retention of a sample from each unit level for passing through a 1 mm mesh screen. This enabled micro-organic remains to be recovered in considerable quantities and provided new insight into subsistence activities throughout the prehistoric period there.

BAN NA DI: THE EXCAVATION LEVELS (Fig 2-3)

(Level is defined here as a stratigraphic unit or layer built up as a result of prehistoric activity and recognised on the basis of colour, texture and contents)

Eight levels were recognised during the excavation of squares A1-4. The upper levels of square F6 had been subjected to levelling by a bulldozer, and then looting. Consequently only level 7 material was encountered, there being no level 8 occupation in this square. The levels are numbered from the top: level 8 is the earliest and level 1 is the latest. A description of each follows, beginning with the latest.

Level 1

This is a thin, superficial level varying between 15-20 cm in depth. It comprises a compacted soil coloured dark reddish brown (Munsell 5YR 3/3-3/4). Several post holes and pits were found cut from level 1. The contents of this level include nails, glass, plastic and essentially modern pottery. The remains clearly reflect the past few years build up of occupation material and will not be considered further.

Level 2

Level 2 varies in thickness between 10-40 cm. According to the present villagers, the squares A2-4 were covered by a house until *c.* 10 years ago and the postholes within level 2 may have belonged to it. The area covered by square A4 was formerly a garden and several holes formed by tree roots, together with a particularly soft soil, were noted.

The soil texture is softer and moister than that comprising the compacted level 1, but the colour is similar, being in general, dark reddish brown (Munsell 5YR 3/3). The contents of this level include most of the mould-made clay smoking pipes recovered. These suggest that the level built up from *c.* 1550 AD at the earliest.

Level 3

This level varies between 20 and 55 cm in depth. The distinction between levels 2 and 3 is basically in soil colour. The earlier one is variable, but tends more towards a light yellowish brown (Munsell 10YR 6/4) with areas of yellowish brown (Munsell 10YR 5/4). When excavating, intrusions, such as post holes cut into level 3 were clearly delineated because their dark reddish brown contents contrasted with the apparently lighter colour of level 3. Indeed some areas of level 3, particularly in squares A3 and A4, were coloured greyish brown (Munsell 10YR 4/2). This may reflect the admixture of ash from hearths in the cultural deposits. Level 3, is honeycombed by post holes and pits cut into it at a later period.

During excavation it was noted that many sherds in level 3 were rolled and worn. This finding suggests that the deposits reflects occupation (Calder 1972). There were also three inhumation burials within basal level 3, or upper level 4. In no case was a grave cut visible but the nature of the grave goods, depth relative to level 3 and clearly late (from 1550 AD) date ascribed to level 2, makes it clear that they could only have been cut during the occupation period represented by level 3. A description of the burials is found below.

Level 4

Again, this level is variable in depth (10-75 cm). The interface between levels 3 and 4 is fugitive, being characterised by a slightly darker soil (to Munsell 10YR 4/3 - 7.5YR 4/4: dark brown). During excavation, the soil appeared harder and more friable, but the distinction was clearer in A2-4 than in the other squares. The surface of level 4 in A2 comprised a clearly darker soil matrix within a dense carpet of potsherds. Indeed, it was thought at first that these sherds were so abundant that they represented a sherd sheet over an inhumation burial. As it happens, they clearly derive from another occupation level.

Structural evidence again comprised pits and post holes, together with examples of a new type of feature. This takes the form of large (*c.* 15-20 cm long) irregularly shaped blocks of partially fired clay mixed with potsherds and charcoal. The level 4 feature in question was associated with a concentration of bronze fragments. A second smaller concentration of clay blocks was found in A4, but this one was not ringed by bronze fragments. The function of such features will be discussed below.

In square A3, there were the complete skeletons of two young pigs, found lying in a shallow depression in a crouched position. They were not associated with anything nearby.

Five burials have been ascribed to this layer. Four lie in level 5, and were probably cut down from level 4, and the last was definitely cut from level 4, since the cut is visible. All five (nos. 4-8) comprise lidded jar burials of children (see below for a detailed description). The grave goods included small bronze bracelets, a tanged iron knife, socketed iron hoe, cutting implements and blue-glass beads. The pots were cord-marked on the outside and red slipped on the interior.

Level 5

This level varies in thickness between 25 and 70 cm. The colour is 5YR 4/4 - 5YR 3/4 (dark reddish brown). The layer includes many pit features and deep (*c.* 1.0 m) post holes. The former contains a soil matrix incorporating pottery sherds, fragments of shellfish and charcoal. The latter have a clearer, sandy matrix with few artefacts. A characteristic of level 5 is the number of concentrations of partially fired blocks of clay. Those distributed in squares A1-4 as follows:

No. 1 A4 16

This feature comprises blocks of clay which have been subjected to considerable heat. It measures *c.* 40 x 30 cm, and is *c.* 30 cm deep and seems to lie on top of a pit.

No. 2 A4 16

This clay feature is located just over one m from no 1 described above. It measures *c.* 37 x 30 cm and comprises a set of irregularly shaped blocks of partially fired clay, mixed with potsherds and pieces of charcoal.

No. 3 A4 16

This feature is located about a m west of no 2. It measures 45 x 22 cm is *c.* 40 cm deep.

These features are ringed by pieces of crucible and bronze fragments. It is important to stress that the 67 bronze fragments found in this square were only the recoverable ones. These features were also surrounded by soil stained dark with the products of bronze corrosion and tiny flecks of green copper corrosion.

No. 4 A3 14

This feature, on being cross sectioned, comprised loosely packed clay blocks of irregular shape, together with pieces of charcoal. It measures 45 x 30 cm and was *c.* 40 cm deep. The clay blocks appeared first as the contents of a pit, but it seems that the pit was at least partially excavated to place the blocks into. The blocks lie entirely within the build up of level 5, though they first appeared on the interface between levels 4/5. There is a concentration of bronze fragments and flecks of bronze corrosion round it.

No. 5 A2 20

This feature was cut into level 6 deposits from basal level. It was *c.* 40 cm in extent and 30 cm in depth.

No. 6 A1 15

This feature comprises a small cluster of fired clay blocks measuring *c.* 30 x 30 cm and c. 30 cm deep.

No. 7 A1 18

This clay feature is slightly lower, and 1.2 m north of no. 5. It appeared first on the surface of spit 18 and attained the unusual depth of 90 cm. It measured 40 x 40 cm in circumference and comprised loosely packed blocks of clay. These could most readily have been retained together if contained within a pit. Level 5 in A1 is particularly rich in fragments of bronze corrosion. One piece of clay from this feature bore the impressions of fibre matting.

No. 8 A1 21

This feature measures *c.* 40 x 40 cm and reaches a depth of *c.* half a m. It was ringed by many flecks of charcoal and bronze corrosion.

In considering the function of these features, two points need to be stressed. All those described in level 5 were excavated by removing half the clay blocks to reveal a complete cross section through their centres. In each case, the centre contained a loosely packed accumulation of blocks, concentrations of charcoal and fragments of bronze corrosion. They were also surrounded by soil darkened by bronze corrosion, and charcoal. Many crucible fragments, still containing fragments of bronze, were found in association, and the broken clay moulds were particularly characteristic of this level.

It is highly likely that these features were concerned with bronze metallurgy. Although bronze is no longer smelted or cast in this part of Northeast Thailand, iron is worked in small village smithies. The procedure is to excavate a shallow pit and line it with clay. Tuyeres cut through the clay are fed from bellows made of bamboo tubes, and the forced air is directed towards a bed of charcoal retained by the clay walls of the pit. Iron is placed in the charcoal and soon becomes red hot once the tuyeres are operated.

Most of these activities are matched in the Ban Na Di clay features. There is no direct evidence for the tuyeres or bellows, but these could have been made of perishable substances. The abundance of bronze, crucibles, moulds and charcoal all suggest that during the build up of level 5, this part of Ban Na Di was devoted to the manufacture of bronze artefacts.

Level 6

This level varies in thickness between 15 and 80 cm. Its colour is principally dark brown (Munsell 7.5YR 3/4), but areas ascribed to level 6 are more dark yellowish brown (Munsell 10YR 4/4) and dark reddish grey

(Munsell 5YR 4/2).

Squares A1-4 contain level 6 material cut into by clay furnaces cut down from the level above. It is notable however, that such furnaces cut and used during the build up of level 6 are rare. The incidence of bronze, crucible, and mould fragments declined accordingly. There is very little evidence for structures cut during the build up of level 6 soil. In the level 6/7 interface of square A4, the complete, articulating skeleton of a calf was recovered. Another was found in the lowest parts of level 6 in square A3. Both skeletons were complete save for the head. There was no evidence that either was protected by being placed in a pit. Their survival in perfect articulation suggests an absence of occupation or industrial activity at this part of Ban Na Di during the accumulation of level 6 deposits there. Although there are no further articulating animal skeletons in squares A1-2, they also have little evidence for structures.

Level 7

The general matrix of level 7 is coloured dark yellowish brown (Munsell 10YR 3/4) to dark reddish brown (5YR 3/3). There are however, several features which distinguish it from level 6. In the first place level 7 contains a considerable number of sand lenses devoid of material culture. These vary in thickness between 1 or 2 and 20 cm. In one or two cases, a lense may run for eight - ten m in length, in others they clearly filled hollows in the ground when the water bearing the sand in suspension slowed and deposited the detritus. The southern section in baulk A3/4 reveals a series of fine lenses which probably slumped into the grave fill below. Although some lenses cover a considerable extent and are quite discrete, most have been cut and their contents mixed when graves and post holes and pits were cut through them.

The distinctiveness of level 7 is, then, provided by such lenses and relative to level 8 below it, an absence of shell midden deposits. The excavation of square F6 revealed a similar pattern. Below the looted horizon, the section displayed numerous sand lenses which were relatively more intact than those in squares A1-A4.

The deposits and structures found in level 7, which is approximately 1.3 m deep, suggest a range of activities. In square F6, the SW quadrant was used exclusively as a cemetery. Burials were interred beside and on top of each other throughout level 7 deposits. The balance of the square contained many practically intact, superimposed sand lenses. There are post holes within the sand lenses, but they could have been used for mortuary structures rather than dwellings, since there is no evidence there for occupation refuse.

This pattern is repeated in squares A3 and A4. Burials were numerous, laid out in parallel rows and often too, were superimposed one on another. There is one exception to this use of the area for burials. Stratified between burials 12 and 28 was a bronze-working facility. This example was the best preserved at Ban Na Di. It was structurally different from level 5 examples, in having a central hollow full of large pieces of charcoal, and a channel through the external wall which could have admitted the tuyeres. The furnace is surrounded by two charcoal stained lenses no more than 5 - 10 mm thick which probably represent rake out of the furnace before re-firing. These are very rich with flecks of bronze corrosion.

As one proceeds south to squares A1 and A2, burials became most infrequent. Evidence for occupation activities, however, increased. These took the form of pits, post holes, and hearths, and a rarity of surviving sand lenses. The clearest example of a pit was found in A2 (feature 6,surface of 40). It was first recognised as an oval patch of reddish yellow sandy soil (Munsell 5YR 6/6) set in a matrix of the brown or dark brown coloured level 7 material (Munsell 7.5YR 4/4). The fill of this pit was built up of six layers. The topmost comprised the sand referred to above. This was probably deposited in the hollow top of the pit by floodwaters. The second level was characterised by a white encrustation which resulted from the burning of a deposit of bamboo. The four lower levels included successive deposits containing pottery and organic material such as shell, animal bone and charcoal. Some further concentrations of burnt bamboo fibre and fragments of bronze were also found. The pit attained a depth of 468 cm below datum, making it 80 cm deep. The shape of the pit was bell-shaped as its diameter increased to 1.34 m towards the base. It was discovered later that this was the biggest of a group of four inter-cutting pits, the remaining three having been cut during the build up of level 8. A second pit was found in square A1 (1, surface of 34) This one had practically straight edges, and attained a depth of about 80 cm. It contained two layers. The lowest was packed with shellfish of the genera *Pila* and *Filopaludina*. This 20 cm thick level underlay a dense concentration of charcoal. This pit sealed B.34 (burial 34) and underlay B.14. A second pit was found in this square, this one cut into level 7 from the lowest horizon of level 7 (feature 1, surface of 40). Only about 1/4 of the pit was present in the excavated area. It was circular, reaching a depth of 70 cm. Its fill comprised four layers comprising ashy lenses, pottery and fragments of shell and animal bone.

Level 7 in square A1 also incorporated several *in situ* hearths. Those took the form of circular concentrations of densely packed charcoal, with a diameter of *c.* 50 cm. The thickest was 25 cm deep. Thinner hearths took the form of patches of hard soil packed with small flecks of charcoal. These refuse pits, hearths and the number of circular post holes recovered in squares A1 and A2 contrast with the clear mortuary use of squares A3 and A4, and suggest that a cemetery was located close to an area in which domestic activities were undertaken. In this context it is important to note that the two adult burials in squares A1/2 were early, both antedating the cutting of the pits. B.14 and 15 were young children, and post dated pit use by quite a length of time.

Level 8

This is the lowest cultural level at Ban Na Di. It varies in thickness between 30 and 50 cm, and is distinguished from level 7 by being rather greyer in colour (Munsell 10YR 4/2, dark greyish brown). It comprises in essence, a diffuse shell midden interspersed with hearths and flood lenses. During the course of the build up, several large pits were excavated and ultimately filled with refuse. There are three early burials (nos 22, 26 and 34) cut into natural, but the stratigraphical relationship to the sand lenses indicates that they were cut through level 8 from basal level 7. In the case of B.22 (A2), the grave was clearly cut through feature 1 sp.47, a pit belonging to level 8. The grave cut for B.26 was clearly visible 20 cm higher than the surface of level 8, and that for B.34 was also noted within

level 7. A particular characteristic of level 8 in square A2 was the number of small sand lenses interspersed with thin, discrete charcoal spreads. This square also contains a cluster of four circular pits, three cut within level 8 and the fourth, cut down level 7 through them. The three level 8 examples have diameters of 94, 98 and 100 cm respectively. A further pit, probably cut from upper level 8 was found in square A4. It had a diameter of *c.* 1.10 m. The surface of natural, which comprises a sandy loam coloured Munsell 5YR 7/3 ("pink"), bears the outlines of these pits as well as post holes and areas of disturbance.

THE STRATIGRAPHIC SEQUENCE: SUMMARY

The cultural deposits at Ban Na Di basically comprise a sandy loam matrix but colour, content and textures vary sufficiently to allow the recognition of eight levels numbered 1 – 8 from top to bottom. The basal two incorporate a number of thin lenses of sand laid down by flood water. The build up of cultural material reflects several processes. Clearly, water deposition was important. The site was rich in material and organic remains reflecting human activities. The size and abundance of post holes suggest strongly that houses were raised above the ground, and this rules out the recovery of occupation floors. Nevertheless, some activities were undertaken at ground level, and these make it possible to suggest that the eight levels reflect distinct patterns of activity.

Level 8 comprises an ashy soil build up incorporating several flood lenses and charcoal concentrations. Several pits were excavated, and found to contain organic refuse and pottery sherds. No burials were cut from this level, which is held to reflect occupation activities. No level 8 material was found in square F6, which may indicate localised activity during this period of use.

Level 7: Squares A3–4 and F5–6 were reserved for mortuary use, and are rich in superimposed burials. Squares A1–2 continued the occupation activities found in level 8, but shellfish remains were rarer.

Level 6: There is some evidence to suggest that squares A3–4 were not used for occupation during this level build up. Two decapitated calf skeletons were found over the mortuary area, which fell into disuse during the level 6 period. There are no level 6 remains from square F6 due to recent looting.

Level 5: The entire area of squares A1–4 has evidenced bronze-casting. The level is rich in furnaces, fragments of bronze, crucibles, moulds, and charcoal.

Level 4: Bronze casting continued into level 4 in square A4, but in squares A1–2, there was a concentration of five jar burials containing the remains of children.

Level 3: This level reflects occupation activity, although three burials found in squares A3 and A4 belong to level 3 occupation.

Level 2: This level too, reflects use for occupation. There are numerous post holes cut from level 2 into 3.

Level 1 : Comprises the build up of cultural material reflecting the activities of the present villagers and their recent ancestors.

BAN NA DI: THE RADIOCARBON CHRONOLOGY (fig 2-4)

The dating of settlement and cemetery sites like Ban Na Di has proved difficult and the results from Non Nok Tha and Ban Chiang, controversial. The selection of radiocarbon samples from Ban Na Di was based on the reliability of their provenance. If insufficient well-provenanced charcoal was available from a given layer, no sample was submitted for analysis. During the excavations a house was being constructed nearby. As the postholes were dug, so pieces of charcoal were brought to the surface. Clearly, charcoal samples scattered in occupation matrices at Ban Na Di would not necessarily date the level in which they were assembled.

Obtaining an internally consistent radiocarbon chronology for Northeast Thai occupation and burial sites has not been straightforward. This in part is due to serious bioturbation by burrowing beetles. In a situation where graves intercut each other and pits and postholes relocated charcoal in prehistory, the importance of dating only clearly *in situ* contexts is clear. Radiocarbon samples from Ban Na Di come from five sources: charcoal rich hearths, thick layers of charcoal sealing pits, charcoal from bronze-working furnaces, charcoal sealed within a pit and in one case, a large piece of charcoal from the base of a posthole. The dates obtained are as follows (bp date is uncorrected 5568 year half-life; 2-sigma BC/AD ranges use Klein corrections):

LEVEL 8

Sample No. 1: square A1, feature 2, surface of spit 40, dry weight 2.5 g:
NZ-5377 (R9345/5) 3150±180 bp; range (corrected): 1735-1105 BC

This feature comprised a lens of compacted charcoal-rich soil, interpreted as an *in situ* hearth. It is located *c.* 30 cm above the natural substrate.

Sample No. 2: A1, spit 42, dry weight 10.49 g:
NZ-5242 (R9251/5) 2840±80 bp; range (corrected): 1330-805 BC

This sample was collected from a charcoal-rich midden lens located practically on the natural substrate.

LEVEL 7

Sample No. 3: A3, feature 1, spit 35, dry weight 10.98 g:
NZ-5241 (R9251/4) 2420±80 bp; range (corrected): 775-395 BC

This feature comprised a bronze working furnace containing much charcoal.

Sample No. 4: A1, feature 1, surface of spit 34, dry weight 18.59 g:
NZ-5240 (R9251/3) 2370±70 bp; range (corrected): 760-385 BC

This sample was taken from a thick layer of charcoal which sealed a pit.

Sample No. 5: A4, spits 32 and 33, dry weight 11.0 g:
NZ-5378 (R9345/6) 2600±80 bp; range (corrected): 850-805 BC

This sample came from a circular concentration of fire-hardened red soil containing many small fragments of charcoal.

Samples No. 6-9: A2, feature 6, surface of spit 40

The following four dates all come from successive layers in this large, bell-shaped pit. There is no doubt that the pit was cut during the occupation of level 7. The dates are, from bottom to top:

Level	Dry Weight (g)	NZ- No.	Date (bp)	corr. range BC/AD
1	5.0	NZ-5474	1830±145	155 BC-450 AD
2	6.15	NZ-5473	2130±170	420 BC-205 AD
3	4.9	NZ-5475	1930±145	370 BC-380 AD
4	4.9	NZ-5376	1810±135	150 BC-530 AD

LEVEL 6

Sample No. 10: A2, feature 4, surface of spit 26, dry weight 18.14 g:
NZ-5239 (R9251/2) 2300±70 bp; range (corrected) 565-185 BC

This sample was taken from a posthole cut from towards the base of level 6 into level 7.

LEVEL 5

Sample No. 11: A4, feature 5, surface of spit 15, dry weight 19.49 g:
NZ-5375 (R9345/3) 1610±75 bp; range (corrected) 240-585 AD

Three large pieces of charcoal were removed from the interstices of clay blocks comprising this bronze working furnace.

Sample No. 12: A3, feature 5, surface of spit 14, dry weight 4.1 g:
NZ-5238 (R9251/1) 1885±55 bp; range (corrected) 0-240 AD

This feature comprises a concentration of clay blocks interpreted as a bronze working furnace. It was first noted at the surface of level 5 and therefore rightly belongs to the level 4 and 5 interface.

LEVEL 4

Sample No. 13: A3, feature 1, surface of spit 12, dry weight 3.7 g:
NZ-5374 (R9345/2) 1755±120 bp; range (corrected) 35 BC-455 AD

The Radiocarbon Chronology

This feature comprises a shallow pit, recognised first on the surface of spit 12; it underlies B.3.

Comments on the radiocarbon chronology

With the exception of samples 6-9 above the dates conform reasonably well with their relative stratigraphic positions. Samples 6-9 are set aside because they are at such variance with all others, and if accepted as reasonable, would provide a most bizarre chronological basis for prehistoric technological development in Southeast Asia. The remaining nine dates suggest the following chronology for the successive layers at Ban Na Di:

Level 8: The basal horizon belongs to the second half of the second millennium BC until *c.* 900 BC
Level 7: belongs between *c.* 900 BC and *c.* 500 BC
Level 6: is dated between *c.* 500 BC-100 BC

Level 5: is dated between *c.* 100 BC-200 AD

Level 3: is dated after 200 AD

THE TEST EXCAVATION AT NON KAO NOI

Non Kao Noi is a relatively small and low mound in the rice fields on the northern margins of the Lake Kumphawapi Flood Plain (fig 2-5). The precise extent of this site has to be determined but superficial impressions are that it is small, measuring perhaps only 75 x 50 m. It lies near the confluence of two streams, and a test square excavated in 1980 revealed five inhumation burials, one at least laid out in a flexed position. The cultural deposits are only 1.5 m deep. This site was probably used as a cemetery because of the extreme rarity of postholes encountered.

The test square was laid out approximately ten m from the margin of the mound, and measured 3 x 3 m. Test excavation began in March 1980. The reason why the central part of the mound was not selected for test excavation is that it was apparently looted.

Excavation at Non Kao Noi revealed five clearly distinct levels (fig 2-5). They are numbered from the top: level 5 is the earliest and level 1 is the latest. A description of each follows, begining with the latest.

Level 1 is a thin, superficial level varying between 10-12 cm in depth. It comprises a very soft soil coloured pinkish grey (Munsell 7.5 YR 6/2). Several root holes were noted there.

Level 2 varied in thickness between 20-40 cm. The soil texture is much more compact than that comprising the soft level 1. The contents of this level include a small number of tiny potsherds that were clearly rolled and worn. In this level a few pieces of burnt clay began to appear. The soil colour contrasts with level 1, being in general, light brown (Munsell 7.5YR 6/4).

Level 3 varies between 15-35 cm in depth. There is no clear distinction between levels 2 and 3. The soil colour remains light brown (Munsell: 7;5 YR 6/4), but the texture is softer and moister than level 2. Sherds and groups of scattered burnt clay are more abundant than in the previous levels.

Level 4 varies in depth between 35-45 cm. The distinction between levels 3 and 4 is primarily in soil colour and materials recovered. Pink (Munsell: 5 YR 7/3) characterises the soil colour in this level. Potsherds are still found in great numbers but their size exceeds that for the upper levels. A lump of laterite about 10 cm wide and 20 cm deep was encountered. This stone may have been used in mortuary rites. Apart from potsherds and laterite, part of a polished stone adze was recovered.

Level 5 varies in thickness between 20-45 cm. The general soil matrix is coloured light brown (Munsell: 7.5YR 6/4). The soil appeared harder and stickier, while fragments of potsherds became rare. These findings reflect the initial occupation level above sterile.

Five inhumation burials have been ascribed to this level (fig 2-6). All of them lay at the base and there is no clear evidence that any burial was cut down from an upper layer. However these burials were found in association with grave goods such as whole pots and stone beads. The description of each burial is as follows

Burial 1

This burial lay close to the middle of the east section of the test square. It was incomplete, only part of upper and lower limbs being found in association with three complete pottery vessels. One of these is a big vessel and it bears a thick applied band at the mid point and coarse cord-marking on the lower part. The other two are relatively small bowls with thin applied bands at the mid point and cord-marking at the lower part. One small bowl is decorated with red painted motifs.

Burials 2-3

Both burials 2 and 3 were disturbed by burial 4. Only the lower limbs of burial 2 were recovered while the upper parts of the skeleton of burial 3 lay in the section. These burials were found in association with light green stone beads which were placed near the ankle of the dead.

Burial 4

This burial is incomplete, and was found in association with three broken pottery vessels. One vessel is black and similar to the early vessels found at Ban Chiang (Ban Chiang Early Period). It bears incised motifs and a thick applied cordon at the mid point. The lower part is cord-marked. The other two consist of cord-marked pots with everted rims and thin applied bands at the mid point, and a small bowl with red painted motifs. There was a lump of laterite placed over and to the right hand side of the skull. It may well have been used as part of the mortuary rite.

Burial 5

This burial comprises only the two tibias and it lay partially at the corner between the north and east section. No grave goods were definitely found in association.

The Radiocarbon Chronology

Unfortunately the charcoal samples collected during the test excavation were not well enough provenanced for radiocarbon dating. Although absolute chronology could not be established, it is possible to propose a relative ceramic typology for comparison with related sites.

THE TEST EXCAVATION AT BAN MUANG PHRUK

Ban Muang Phruk is a village located on a mound rising about five m above the plain and only 3 km east of the present dry-season bank of Lake Kumphawapi. It is particularly prone to seasonal flooding. Road cuttings and tracks of the village yield substantial numbers of pottery sherds. The precise extent of the site has to be determined. The test excavation area was selected at the highest part that lies near the centre of the mound, and the excavation square measured 2 x 2 m.

Six levels were recognised during the test excavation (fig 2-7). The levels are numbered from the top. Level 6 is the earliest and level 1, the latest. A description of each follows, beginning with the latest.

Level 1 is a thin, superficial level varying between 15-20 cm in depth. It comprises a soft soil coloured reddish brown (Munsell 5YR 5/3). Tree roots in this level are abundant. One bronze bracelet was recovered.

Level 2 varied in thickness between 20-30 cm. The soil texture comprises light sandy loam soil, coloured light reddish brown (Munsell 5YR 6/3). Tree roots became rare, while a few pottery sherds were encountered.

Level 3 varies in thickness between 40-60 cm. Soil texture and soil colour are exactly the same as level 2, but potsherds are more common.

Level 4 varies in thickness between 70-80 cm. It consists of soft soil coloured light yellowish brown (Munsell 10YR 6/4). Materials recovered in this level comprise pottery sherds, clay pellets, clay counters and fragments of iron. Red slipped potsherds are the most frequently encountered.

Level 5 varies in thickness between 80-100 cm. The colour is light yellowish brown (Munsell 10YR 6/4). The soil appears much darker but it is still soft. The layer includes three pit features. They contain a soil matrix incorporating pottery sherds, fragments of shellfish and charcoal. The descriptions of each are as follows.

No.1 (17)

This feature comprises a dark matrix soil and groups of sherds which are red painted and slipped. It measures *c.* 130 x 30 cm and is *c.* 19 cm deep.

No.3 (17)

This feature consists of light sandy loam soil. It measures *c.* 50 x 40 cm and is *c.* 29 cm deep. Groups of red slipped potsherds, a small lump of laterite and small flecks of bronze corrosion are scattered in this feature.

No.2 (19)

This feature consists of a dark matrix soil, fragments of shellfish, charcoal and a few pot-sherds.

Level 6 varies in thickness between 25-45 cm. The colour is light brown (Munsell 7.5YR 6/4). The soil is still soft and comprises yellow stained sandy loam with many lenses of lighter material. At the same time potsherds are extremely rare: only one rim of indeterminate status was found. Four pit features and one inhumation burial were recognised. Descriptions of each are as follows.

No. 4 (23)

This feature has a dark soil fill. It measures *c.* 80x50 cm and is *c.* 55 cm deep. A few pottery sherds were recovered in it.

No.5 (23)

This feature measures *c.* 75x35 cm and is *c.* 64 cm deep. Materials recovered are the same as feature 4 (17)

No.6 (23)

This feature measures *c.* 38x20 cm deep. Materials encountered comprise a few pottery sherds and animal bone.

No.7 (24)

This feature is apparently bigger than the previous ones. It measures *c.* 190x45 cm. Materials encountered include a few potsherds and an incomplete skeleton of a child (burial 1: fig 2-8).

The Radiocarbon Chronology

Unfortunately, no securely provenanced charcoal was found at Ban Muang Phruk so we cannot present any dates. However rims from the basal deposits encountered there match very closely in form, those found in level 5 at Ban Na Di, and therefore date the initial occupation to the period from *c.* 100 BC.

THE EXCAVATIONS: SUMMARY

The three sites described above are constituent parts of a settlement pattern which will be considered below. All three have yielded evidence for the practice of inhumation burial and of occupation. The chronological and cultural relationships between the sites is largely dependent on the results of a detailed analysis of the material culture. The next two chapters will therefore, be devoted to a description of the artefacts found during the excavation of the Upper Songkhram sites.

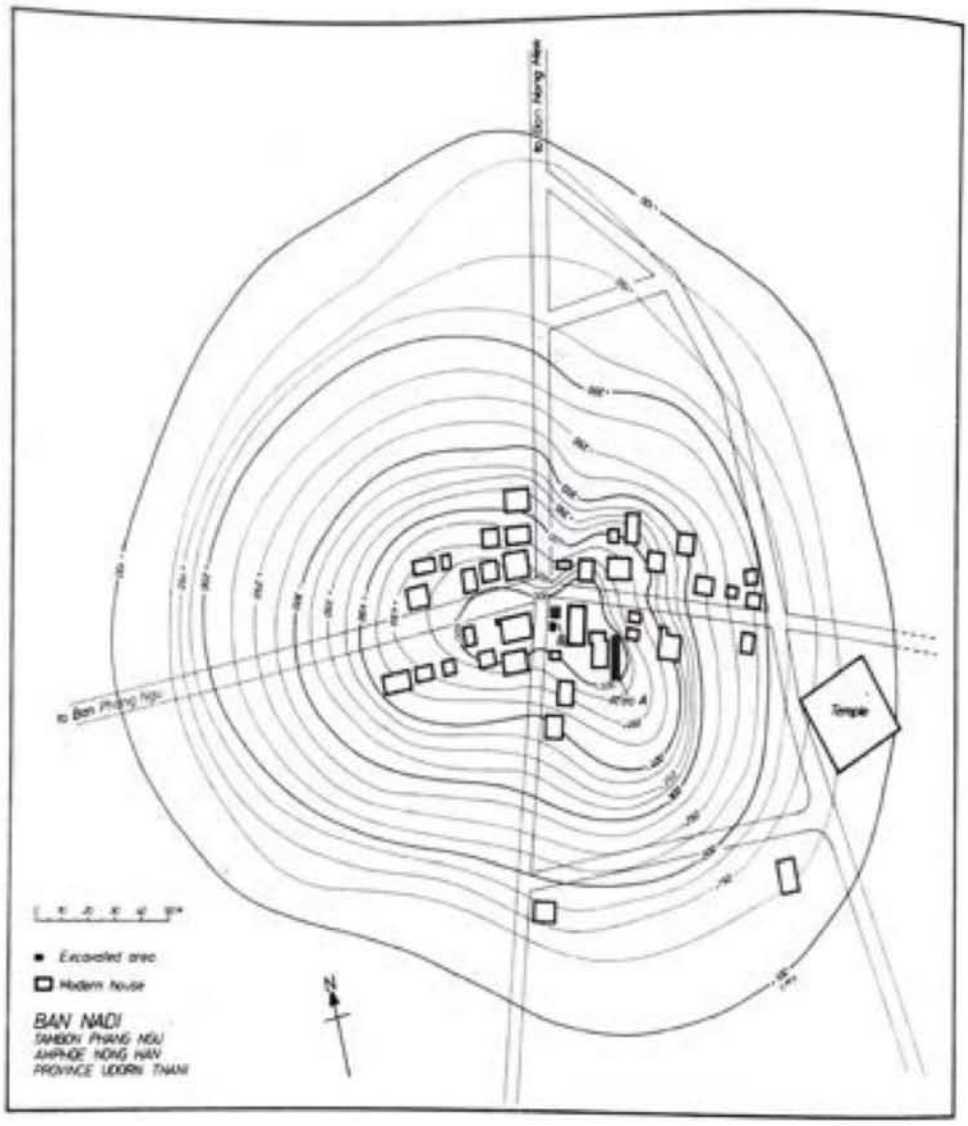


FIGURE 2-1

Plan of the village of Ban Na Di

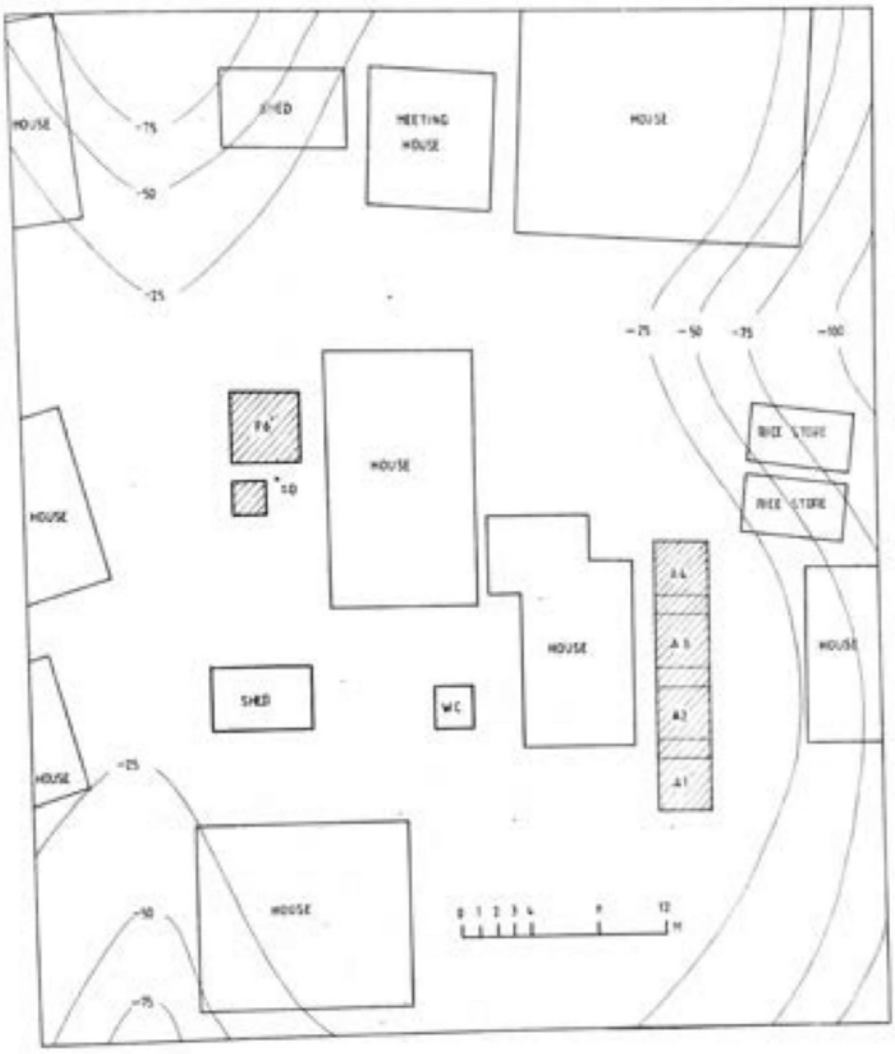


FIGURE 2-2

The central area of Ban Na Di

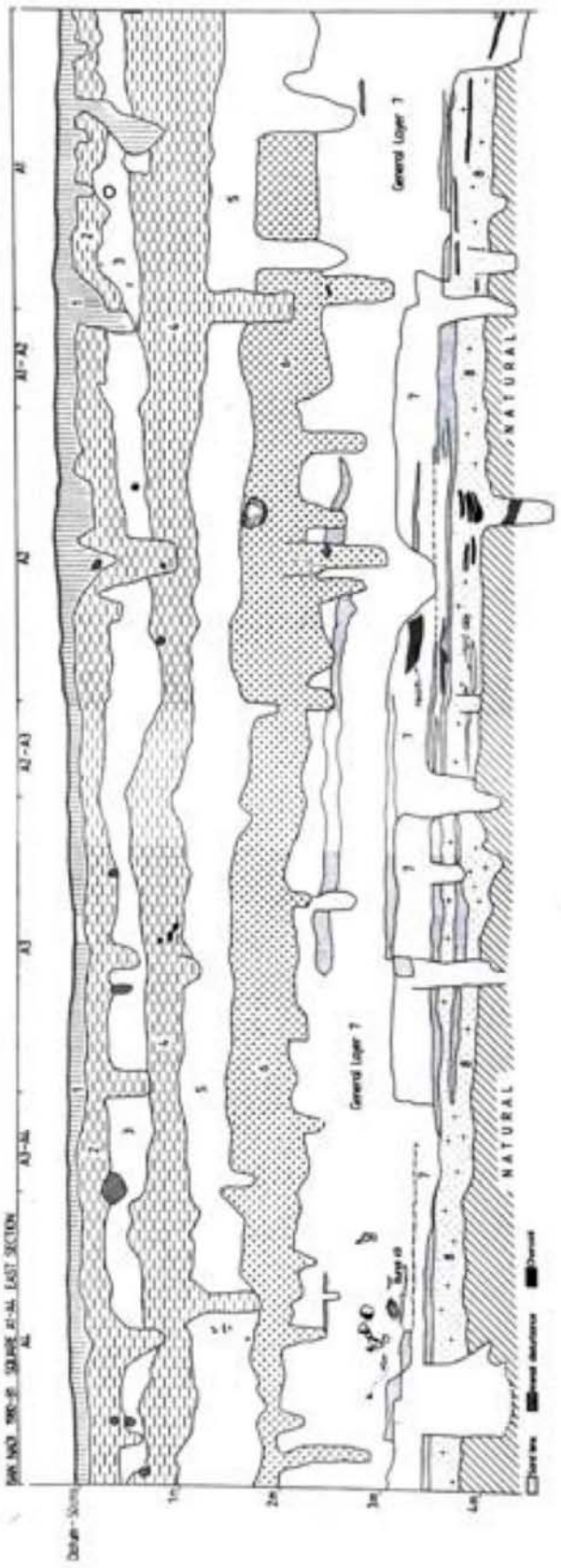


FIGURE 2-3A Ban Na Di: A1-4, east section

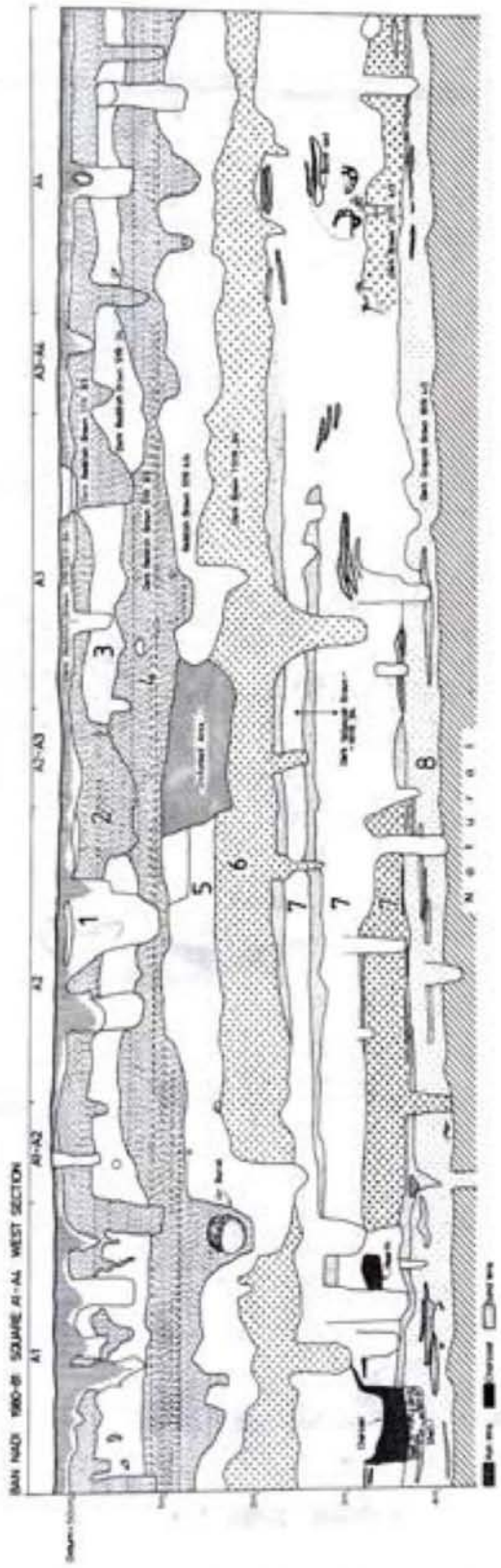


FIGURE 2-3B Ban Na Di: A1-4, west section

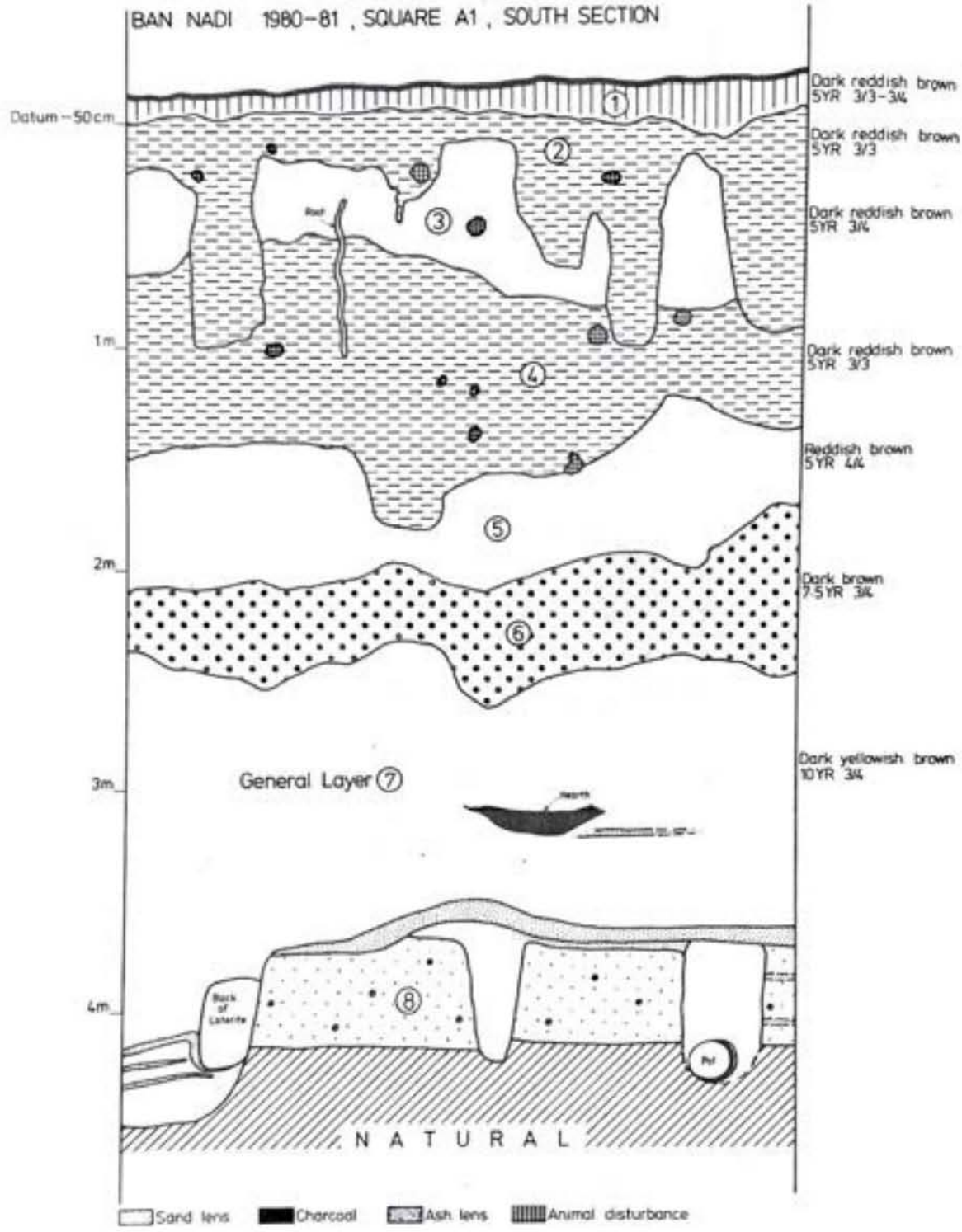


FIGURE 2-3c

Ban Na Di: A1, south section

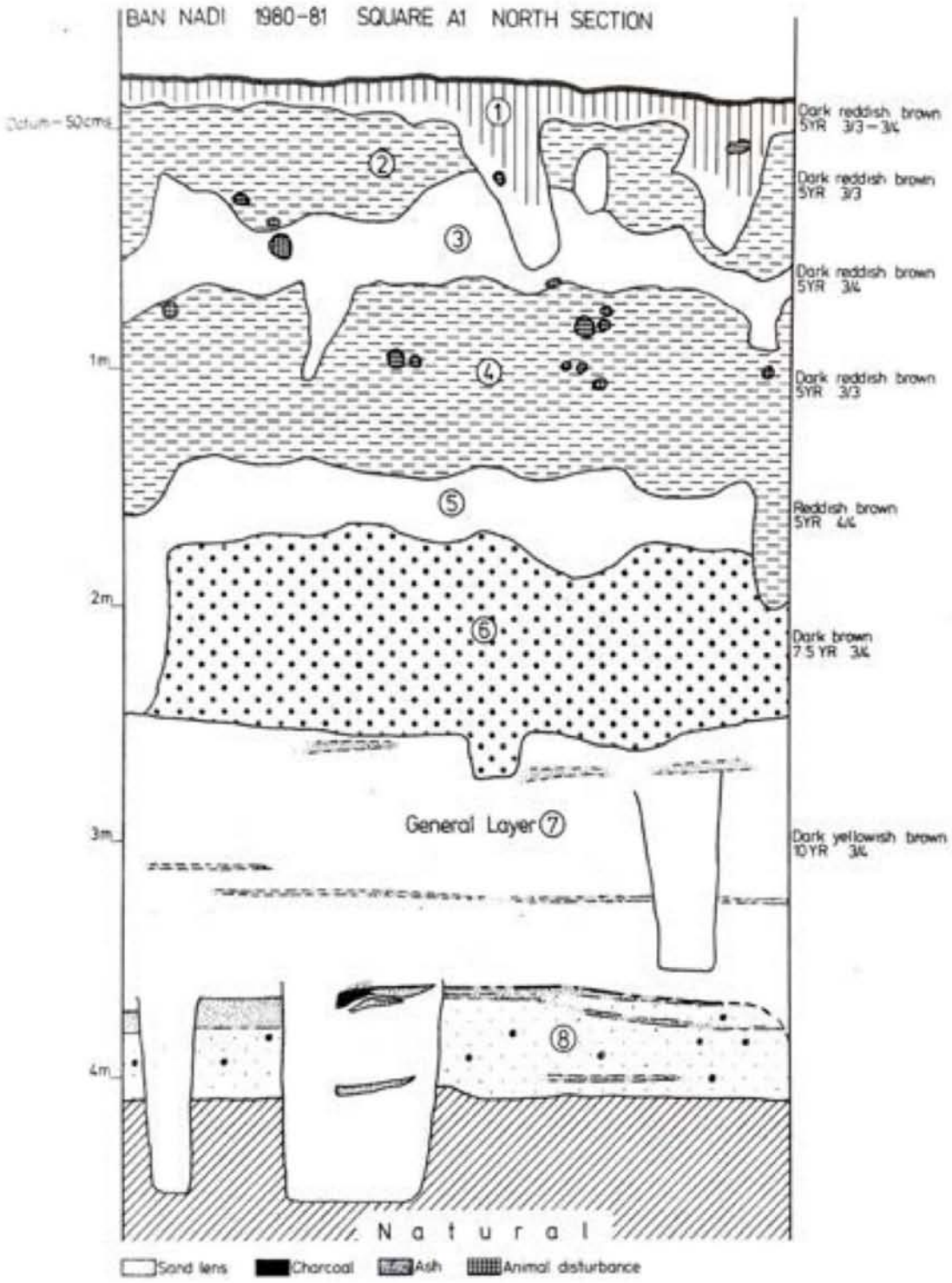


FIGURE 2-3d

Ban Na Di:A1, north section

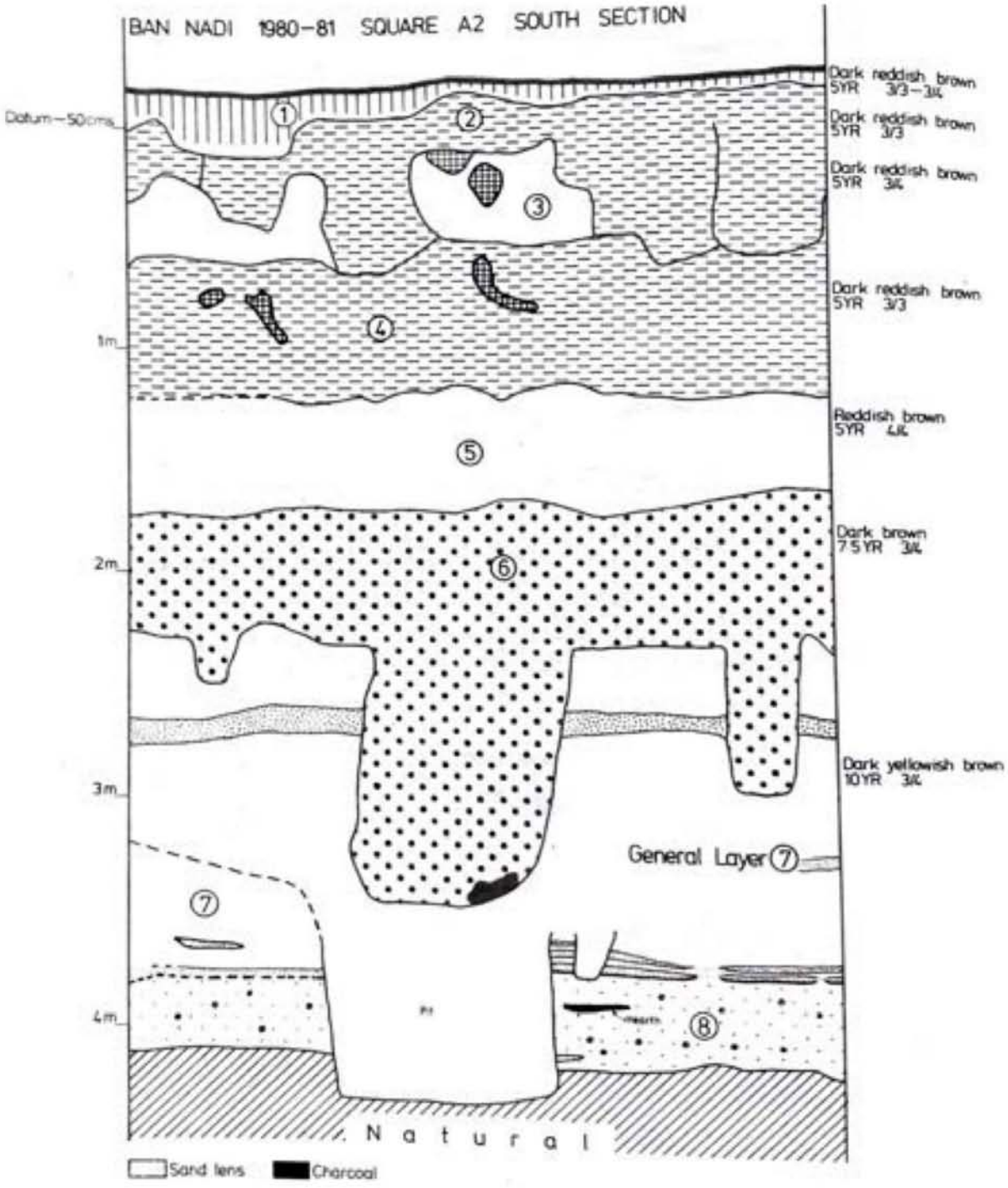


FIGURE 2–3e

Ban Na Di: A2, south section

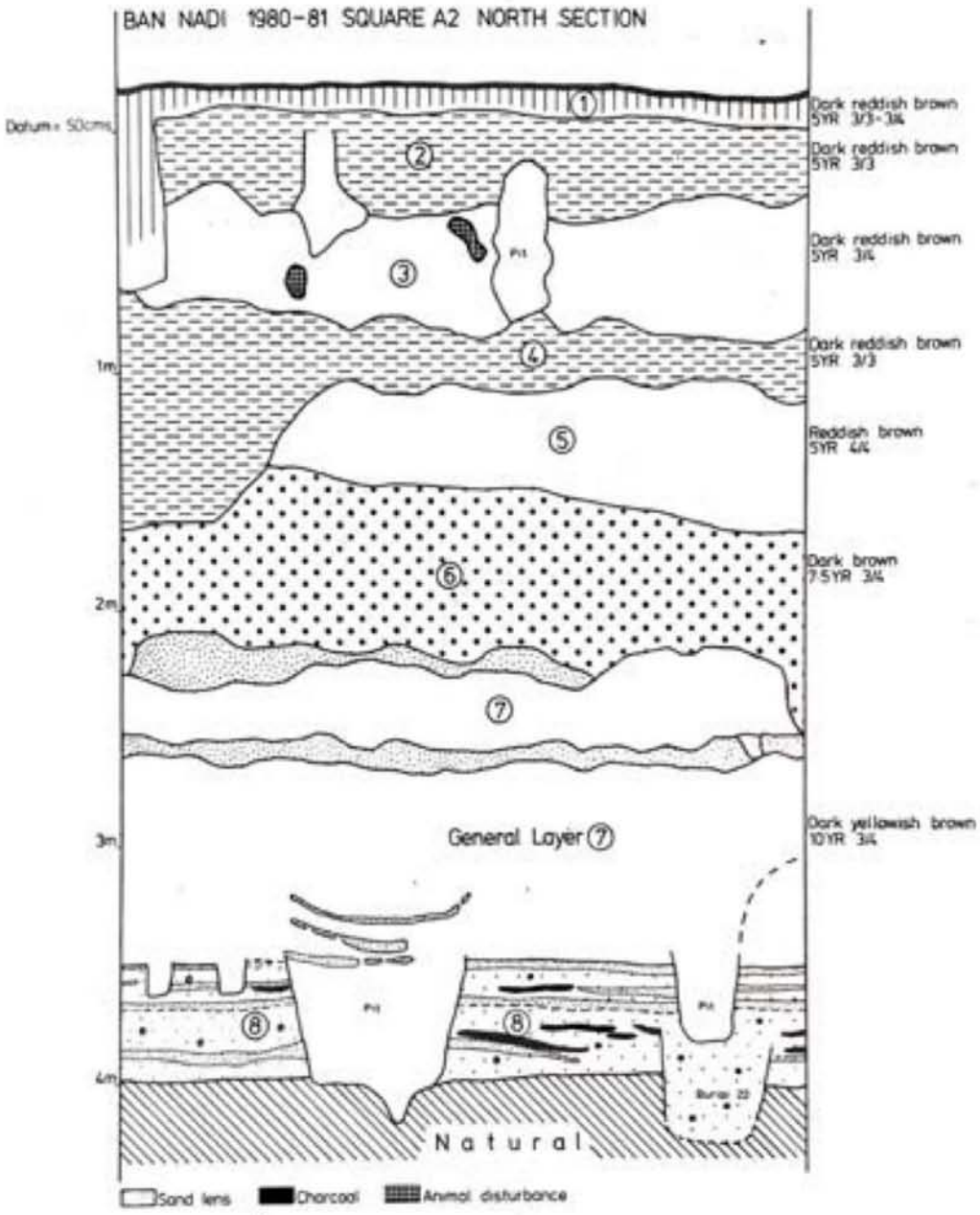


FIGURE 2-3f

Ban Na Di: A2, north section

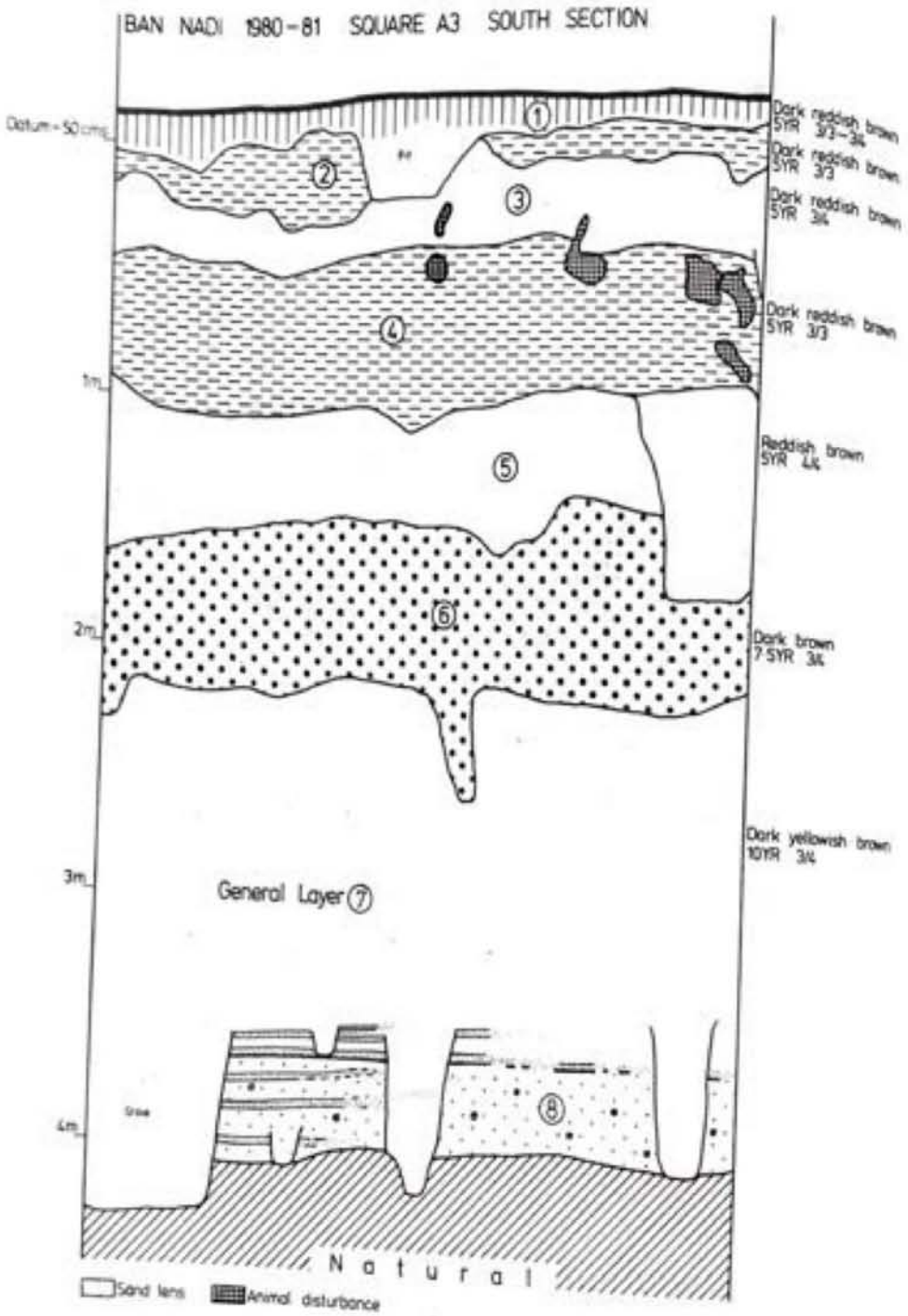


FIGURE 2-3g

Ban Na Di: A3, south section

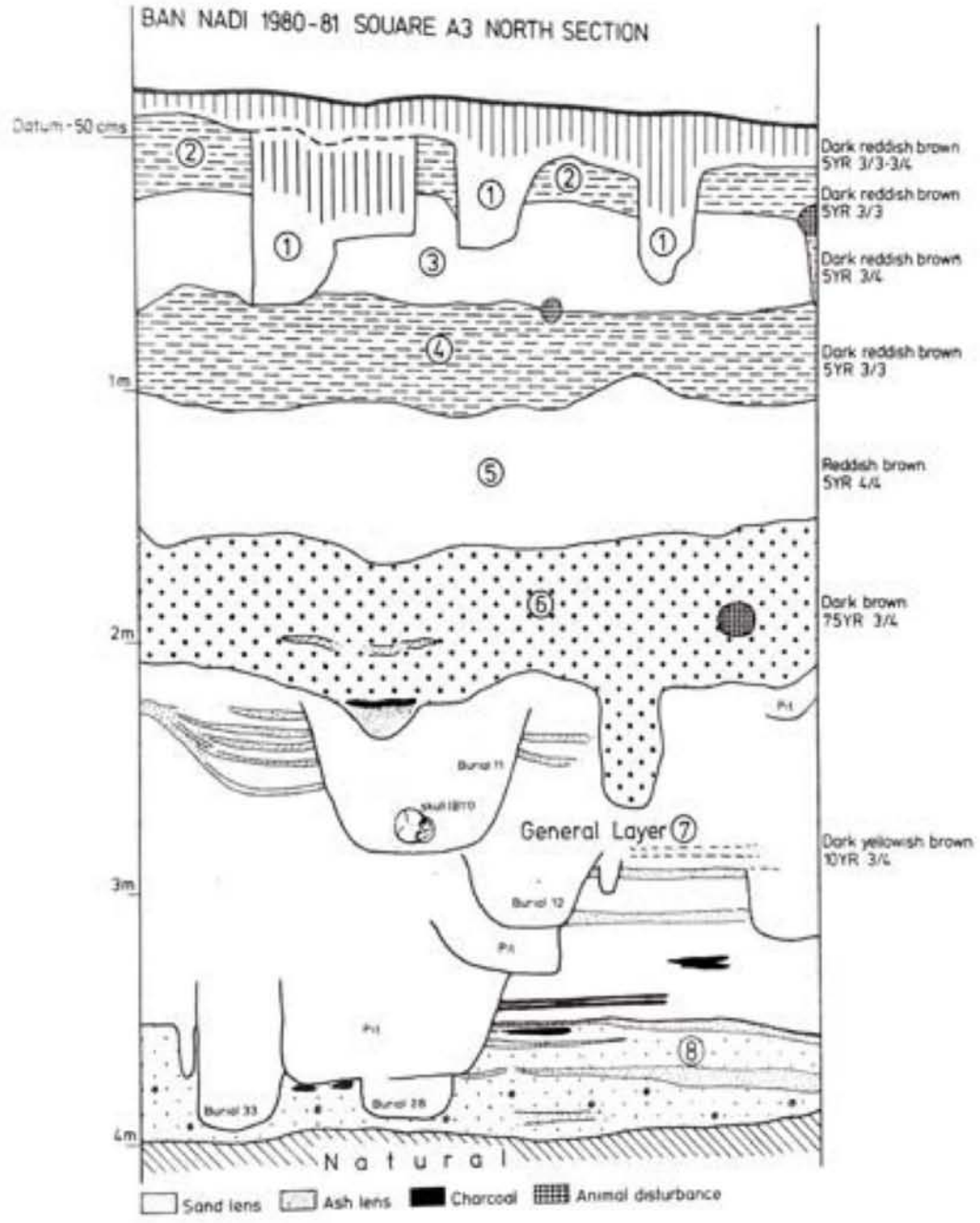


FIGURE 2-3h

Ban Na Di: A3, north section

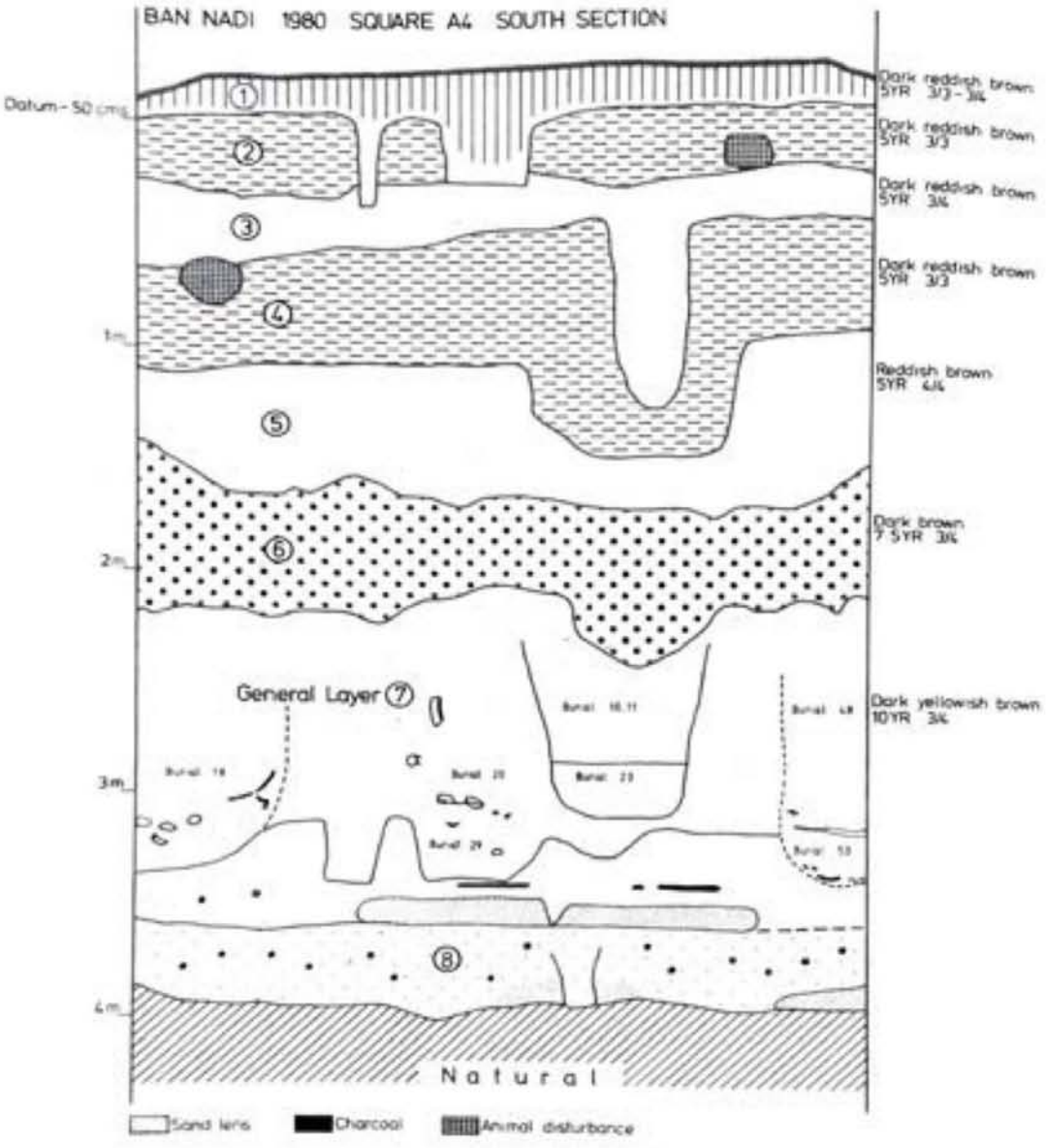


FIGURE 2-3i

Ban Na Di: A4, south section

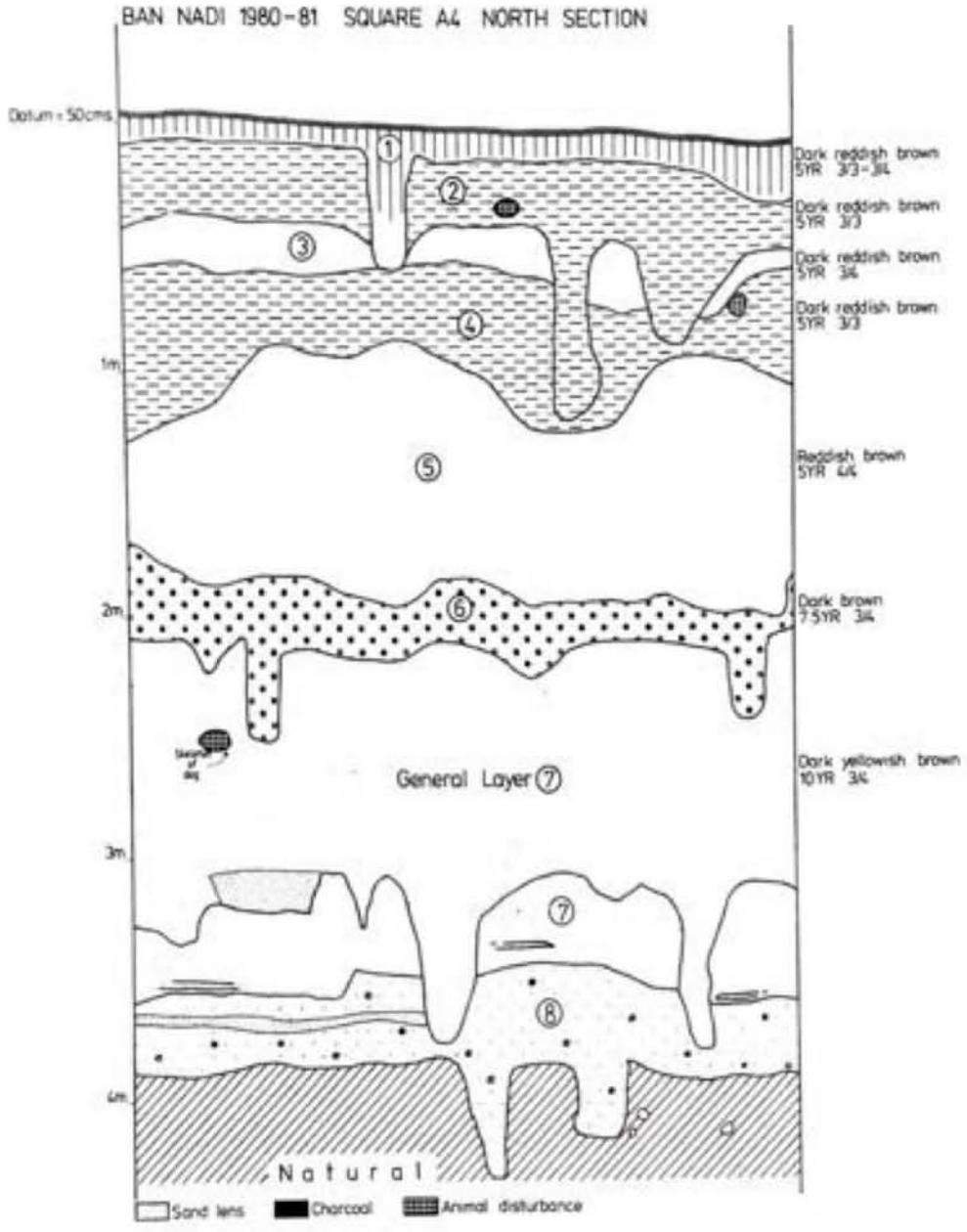


FIGURE 2-3j

Ban Na Di: A4, north section

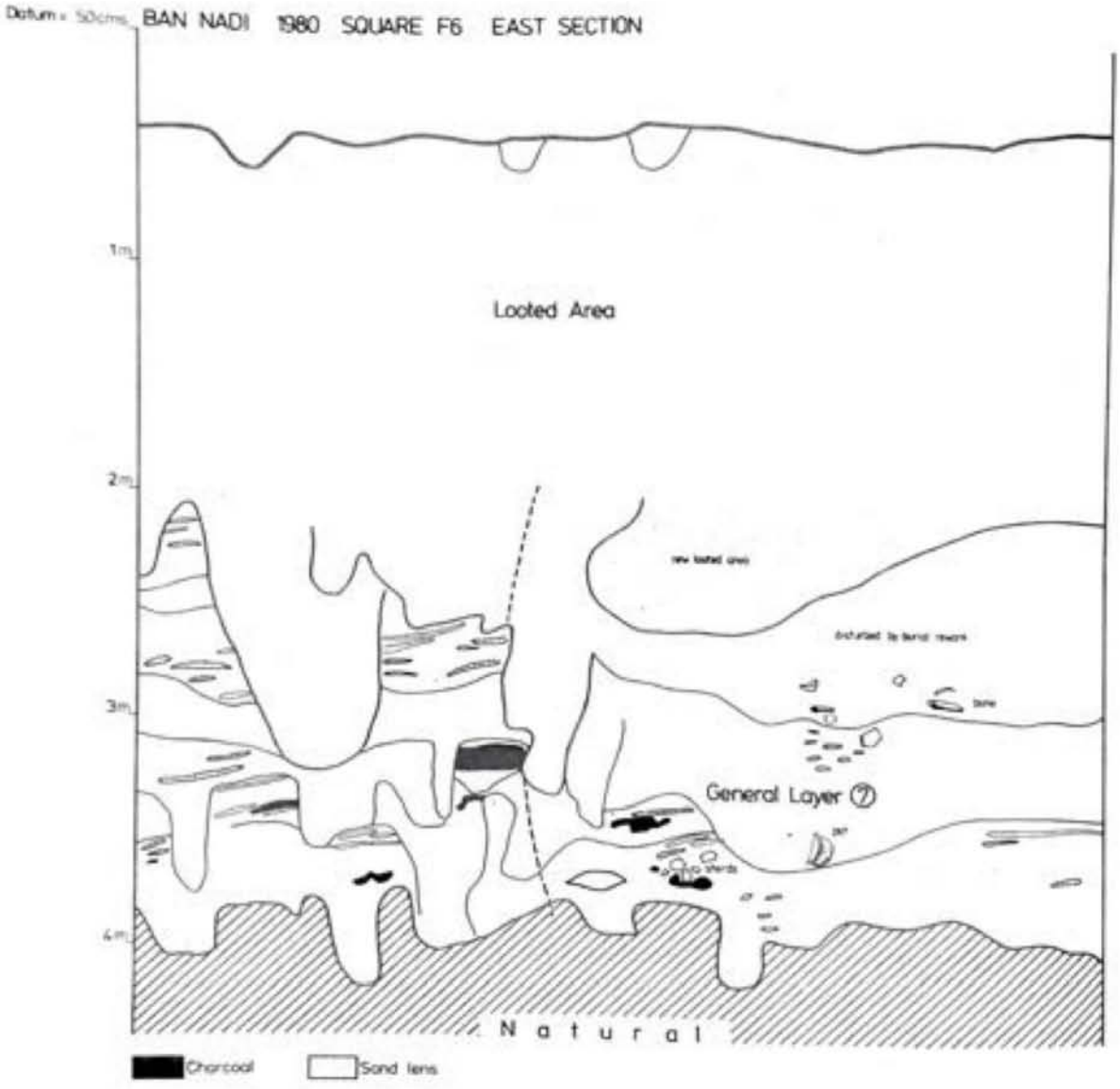


FIGURE 2-3k

Ban Na Di: F6, east section

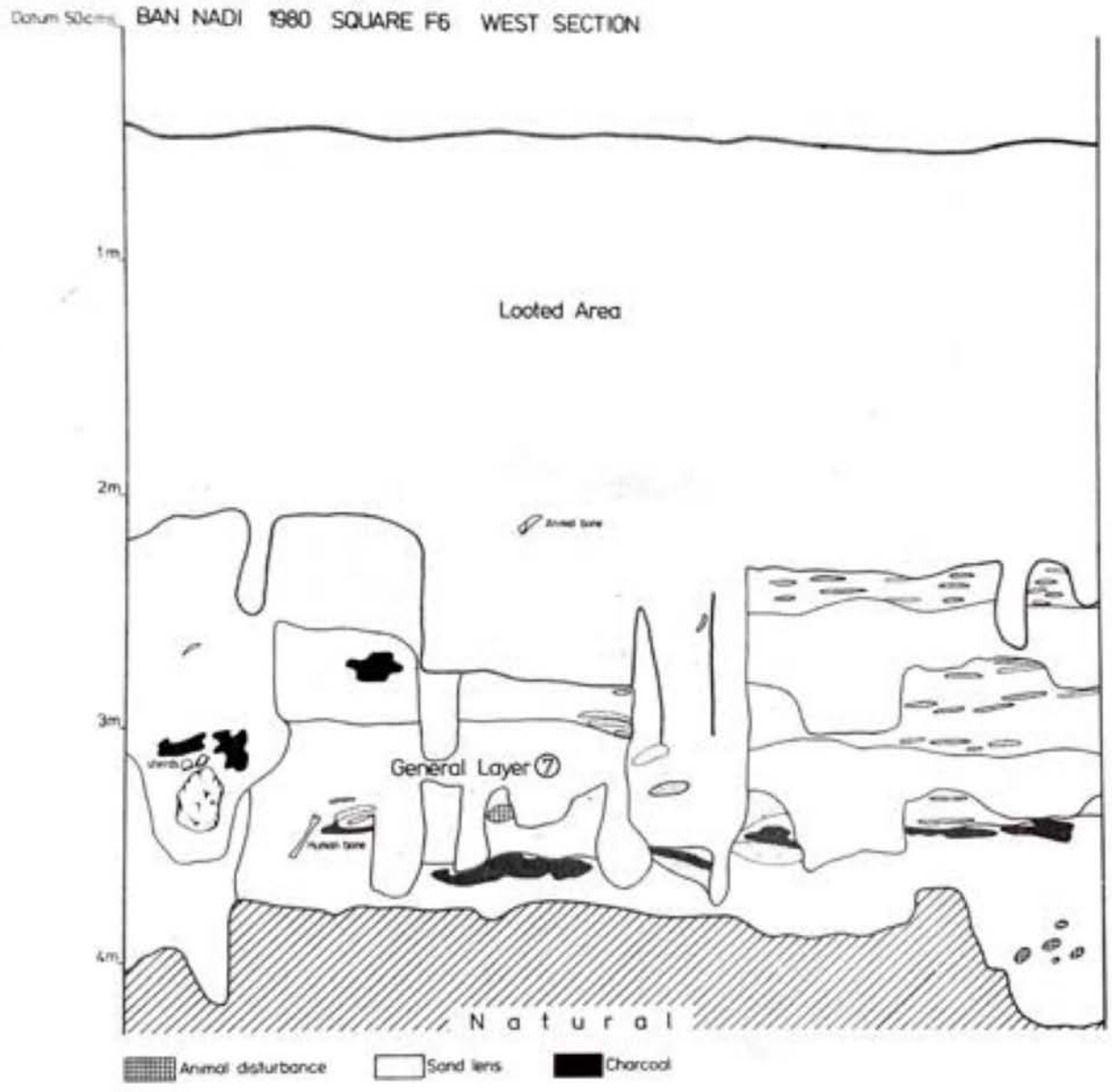


FIGURE 2-3l

Ban Na Di: F6, west section

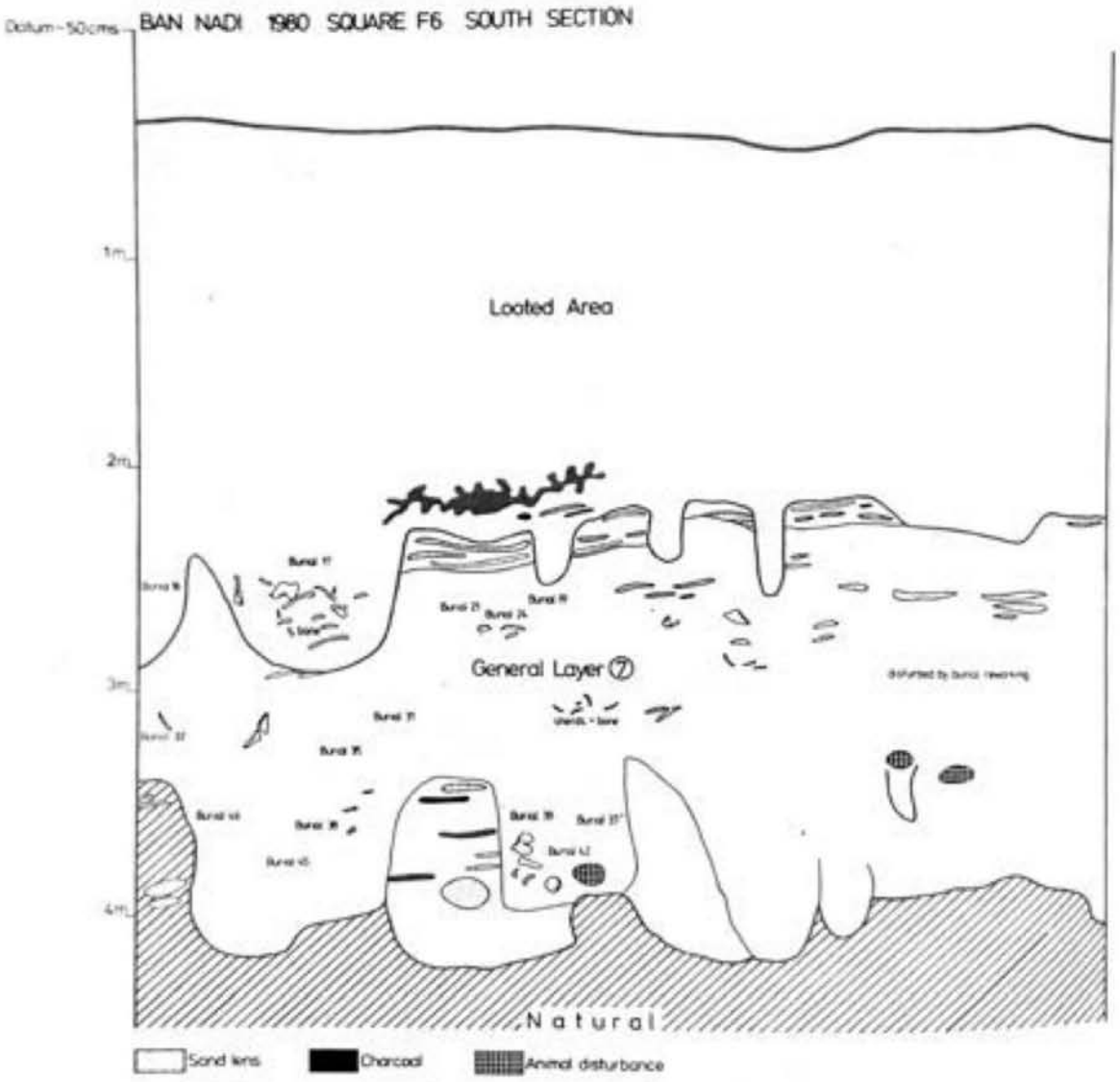


FIGURE 2-3m

Ban Na Di: F6, south section

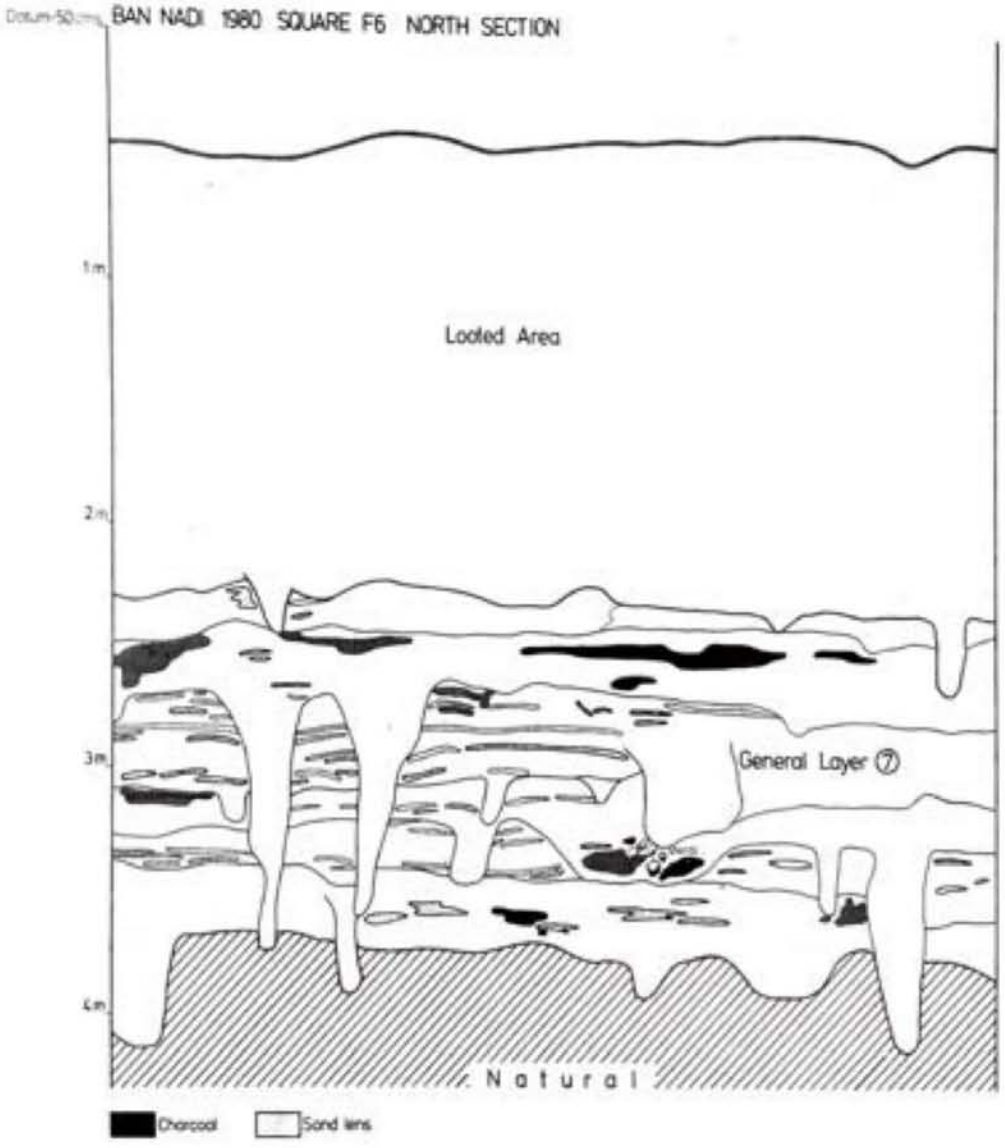


FIGURE 2-3n

Ban Na Di: F8, north section

The radiocarbon chronology from Ban Na Di

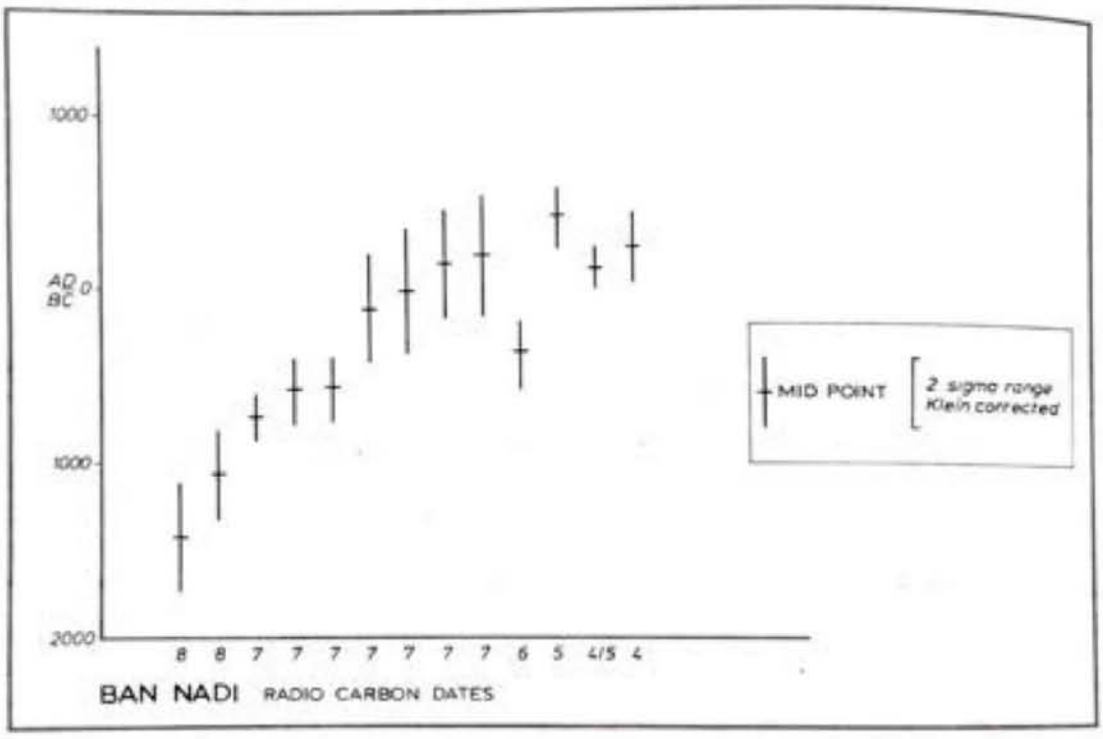


FIGURE 2-4

The radiocarbon chronology from Ban Na Di

The stratigraphy of Non Kao Noi

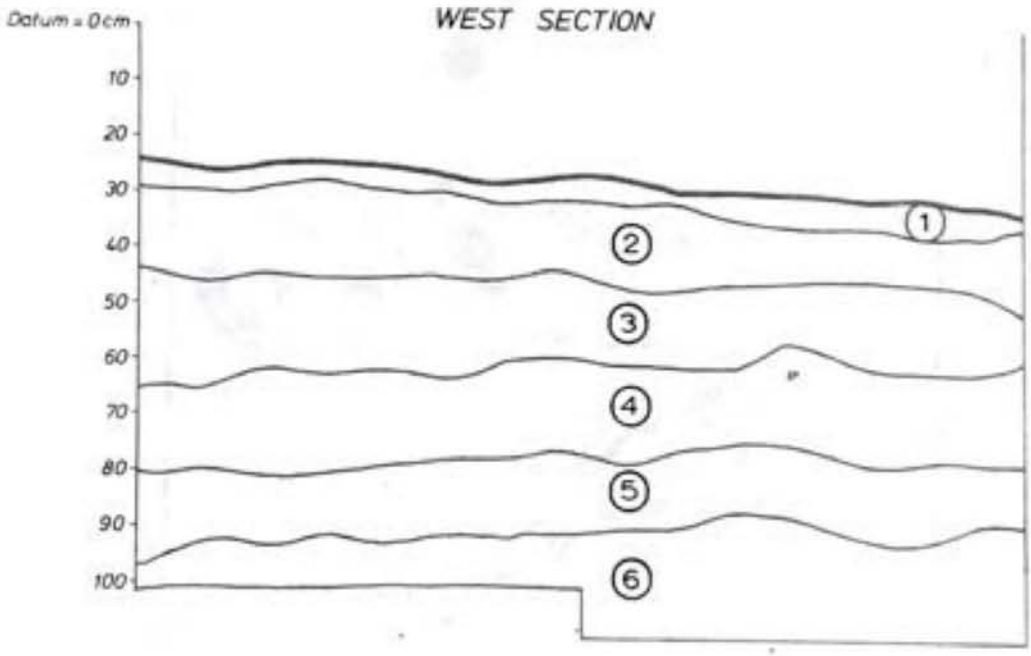


FIGURE 2-5

The stratigraphy of Non Kao Noi

The burial plan for Non Kao Noi

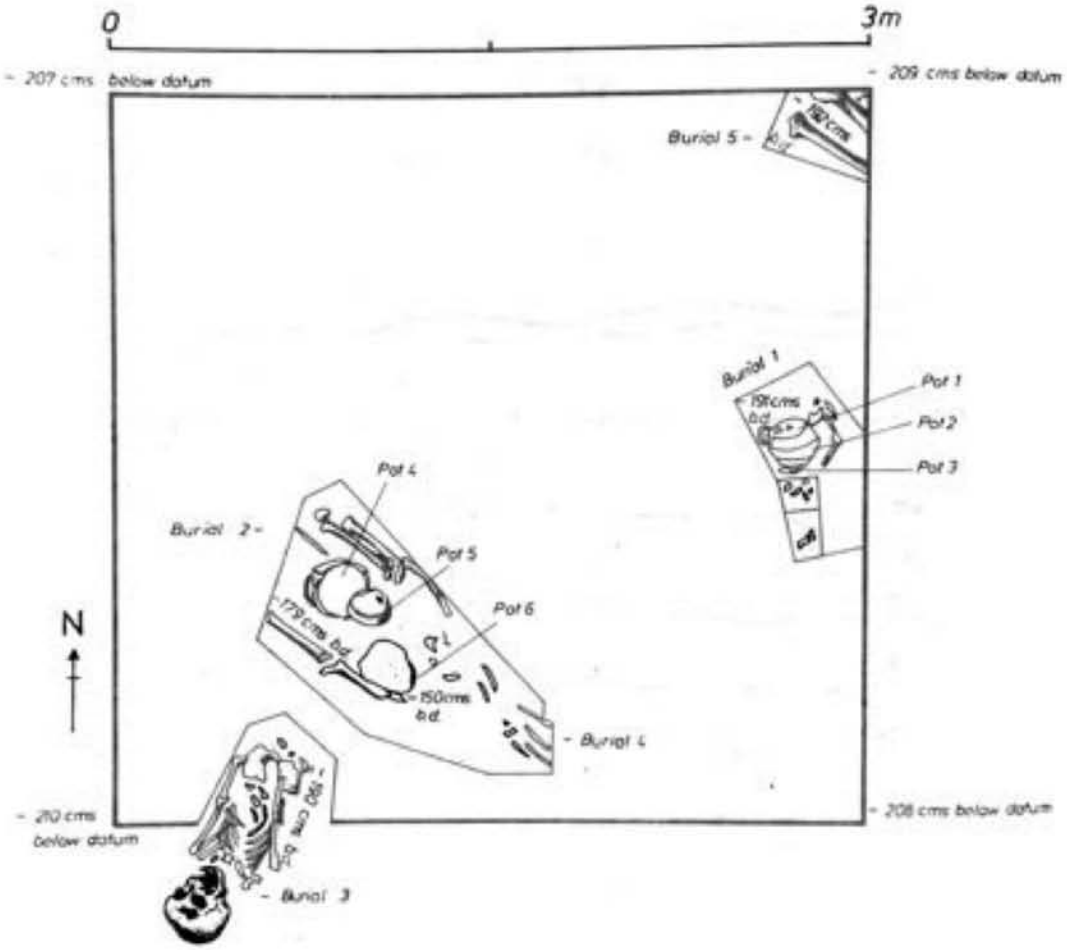


FIGURE 2-6

The burial plan of Non Kao Noi

The section and plan of Ban Muang Phruk

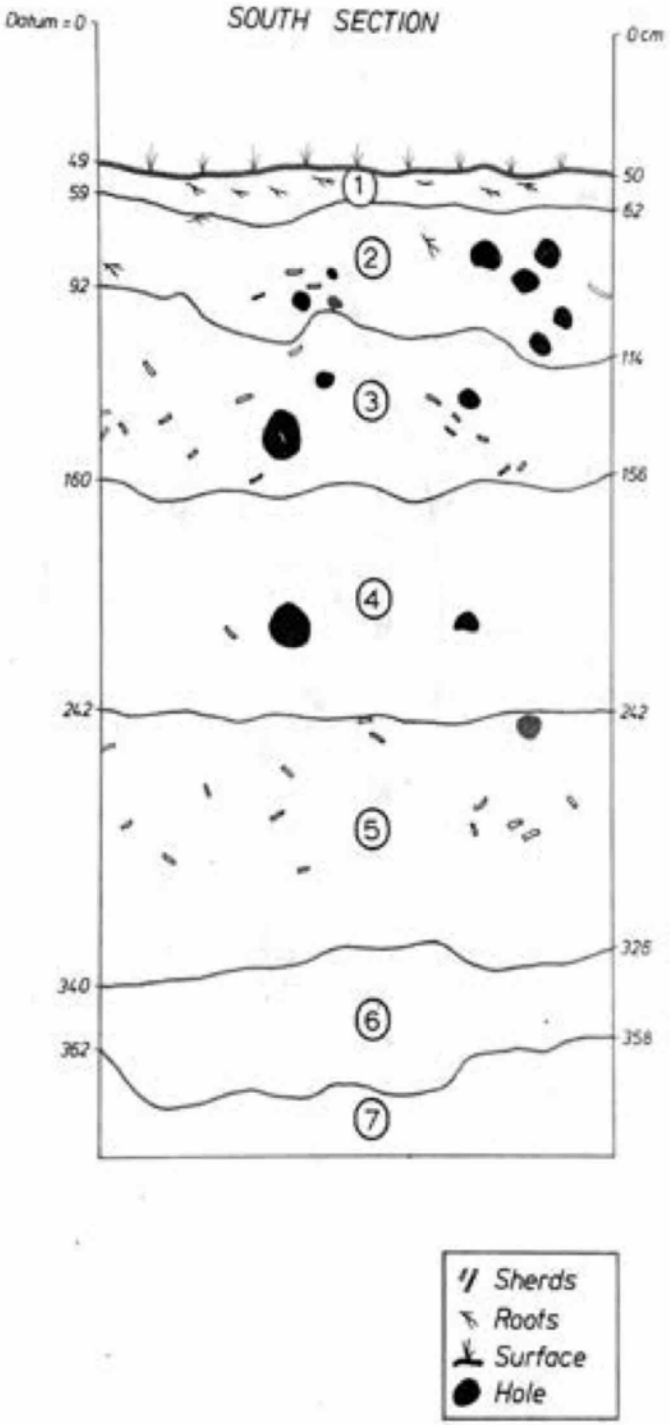


FIGURE 2-7

The stratigraphy of Ban Muang Phruk

The section and plan of Ban Muang Phruk

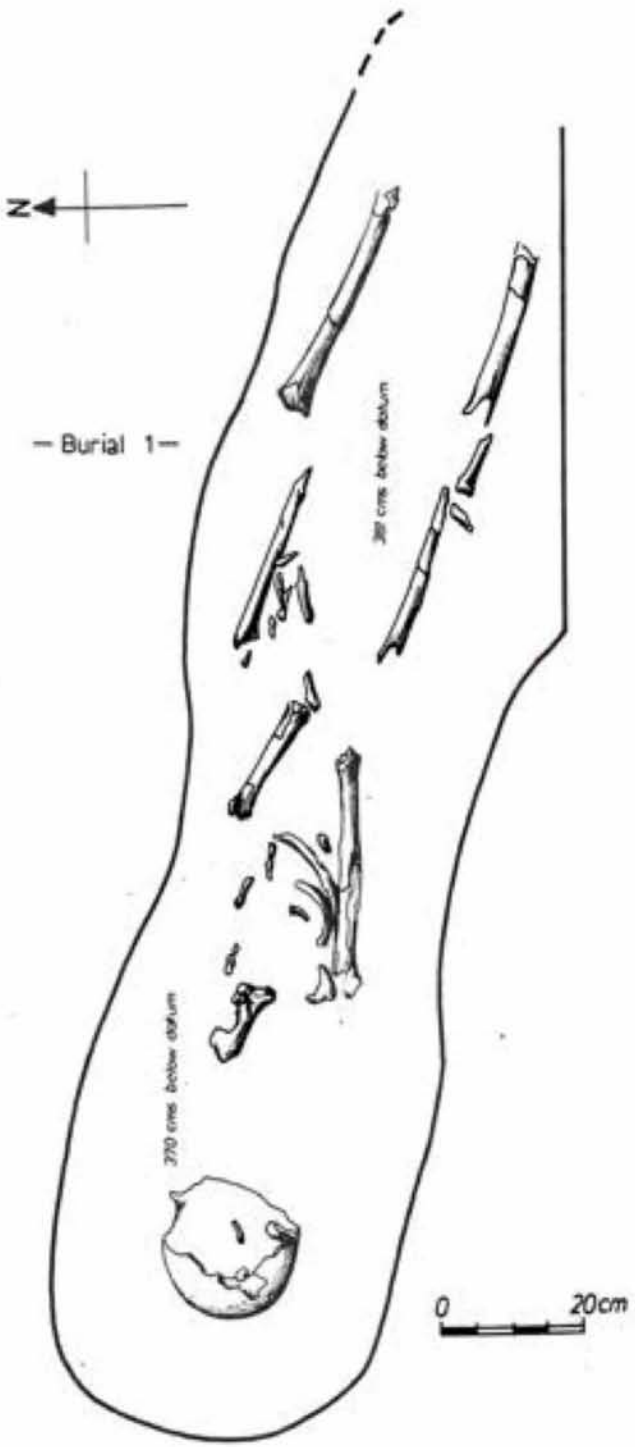


FIGURE 2-8

The burial plan of Ban Muang Phruk

CHAPTER THREE

THE MATERIAL CULTURE FROM BAN NA DI, BAN MUANG PHRUK AND NON KAO NOI

N.B. Most of this chapter was prepared by Higham and Kijngam. J. Pilditch wrote the sections on the stone and shell jewellery, glass beads, clay bead, insect wax, bronze bracelet typology and the textiles. The contributions by Maddin, Seeley Rajpitak, McGovern-Wilson, Adamczyk and Jones are noted in the appropriate parts of the text.

The excavations at Ban Na Di yielded a rich material culture, both from occupation contexts and the burials. The following description is ordered on the basis of twelve major groups for Ban Na Di, including for example jewellery, evidence for metallurgy and objects of bone. Within each grouping, there is a further subdivision by artefact type and the material used in manufacture. Each item described is placed in chronological order by level or mortuary phase. It is noted here that the principal mortuary remains at Ban Na Di were interred during the build up of levels 6 and 7. They are subdivided into three phases, the approximate dates of which are:

Mortuary phase 1a	900-700 BC	(lower level 7)
phase 1b	700-500 BC	(mid level 7)
phase 1c	500-400 BC	(upper level 7)
phase 2	from 200 AD	(level 4)
phase 3	after 500 AD	(level 3)

Each artefact when recovered, was given a sequential catalogue number. In the following text then, each specimen is described according to its provenance within a square, its layer and "spit" number, level or mortuary phase designation, and its catalogue number. Spits are the excavators designation of units within cultural levels. There follows a brief review of material items recovered at Ban Muang Phruk and Non Kao Noi

JEWELLERY

SHELL BEADS (fig 3-1)

Approximately 12,600 shell artefacts were found at Ban Na Di, of which the overwhelming majority were small disc beads from burial contexts (fig 3-1). These vary little in size or shape, being circular, approximately 5.0 mm in diameter and having a central perforation about 1.2 mm wide. Thickness is more variable, the thinnest measured being 0.25 mm and the thickest, 0.9 mm. The ends or faces of the beads are flat in most cases and the edges are usually straight, though occasionally they have slight convex curves. This may well reflect wear. Some of the beads are badly corroded and fragile. When viewed under a microscope they appear to have an open cellular structure and are often cemented together. Others are in good condition and and have a denser structure. The latter are not cemented together.

These are very small beads and no vestiges of the shells' outer structure have survived. At present, we have no information on the species used in their manufacture. A close study of the beads has allowed some insight into manufacturing techniques. Some misshapen beads indicate that thin pieces of shell were broken into small square shapes, which were then drilled approximately through the centre and usually from both sides with a cone shaped drill bit. Numbers of these square blanks were then threaded onto a fine stick or cord and ground down to a circular shape. Occasionally the beads were ground down in such a way that the holes were not central and where roughs were not quite square or were somewhat smaller than the others, the resulting beads were made with one or more straight edges but with rounded corners. The beads were then ready to be strung. In the case of the Ban Na Di beads, a two ply thread was used, fragments having been recovered from some necklaces (fig 3-28).

Details of individual necklaces are as follows-

TABLE 3-1

Ban Na Di: the shell disc beads (dimensions in mm)

Provenance	Cat.	MP	n	diam.	thickness
A3 burial 26	1377	1a	242	4.0-4.5	0.5-0.9
F6 burial 47	1891	1a	15	3.2	
F6 burial 46	1886	1a	790	2.7-5.0	0.5-1.0
F6 burial 44	1890	1a	165	3.0-4.3	0.6-1.2
F6 burial 45	1889	1a	215	3.0-5.8	0.5-1.2
F5 bur TS19	TS40	1a	7850	3.2-4.7	0.2-1.1
F5 bur TS21	TS38	1a	776	4.0-4.9	0.2-0.5
F5 bur TS22	TS37	1a	220	2.8-4.9	0.2-0.8
F6 burial 36	1887	1b	127	3.9-5.0	0.4-1.6
F6 burial 38	1888	1b	219	3.2-5.0	0.2-1.2

F6 burial 49		1b	5		
F5 bur	TS15	TS46	1b	24	3.0-4.2	0.4-0.9
F5 bur	TS16		1b	6		
F5 bur	TS17	TS69	1b	400	2.6-5.0	0.4-1.5
A4 burial 29	1019		1c	236	2.0-3.6	0.2-0.7
A4 burial 48	1369		1c	78	2.4-4.8	0.4-0.9
F5 bur	TS 8	TS68	1c	900	3.0-4.4	0.3-0.7
F5 bur	TS12	TS67	1c	170	2.7-3.4	0.4-0.6

These disc beads were strung with large shell beads, of which twenty four were found. These vary in size and shape, but only one specimen stands out is being markedly different. The majority of these large beads have irregularly shaped cross sections, varying from oval to blunt triangles. The longitudinal sections range from oblate to long cylindrical. These large shell beads vary in length between 11.1 and 36.0 mm and in diameter, between 5.5 and 9.5 mm. The one distinct bead is rectangular in longitudinal section, and narrow and oval in transverse section.

All specimens were made in the same way. Blocks of shell more or less rectangular in shape were cut either transversely or laterally from a shell with a thickness in excess of 0.5 mm. The block of shell was then ground down until all the edges were rounded off and a roughly cylindrical shape was obtained. The blanks were then polished, perhaps by tumbling and perforated using a cone shaped drill bit from both ends, so as to leave a waisted channel. The majority of these large beads were cut laterally from the shell. With one exception, all these beads were found associated with five burials in square F6, in conjunction with the smaller disc beads.

F6 B.44 Cat. 1210a-d

This burial yielded four large beads. The dimensions are set out in table 3-2. Cat. 1210a has been shaped to a sub-rectangular cross section. The microscopic examination reveals slight abrasions which may be due to the manufacturing process, but the surface is in general, smooth. The other three from this burial are of similar length. Cat. 1210b has an oval cross section, cat. 1210c has one particularly flat edge and cat. 1210d is almost sub-triangular.

F6 B.38 Cat. 1861

The surface of this specimen has been corroded and only part of the original polished portion has survived. It is circular in cross section.

F6 B.36 Cat. 1147a-n

All fourteen large beads from B.36 bore traces of a polished surface which, where worn, revealed an eroded interior. These beads were bored through with a circular drill, the regularity and clean cuts

suggesting the use of metal. Most have a circular cross section, though cats. 1147a-b are sub-triangular, and cats. 1147e and k more oval.

F6 B.45 Cat. 1863

This specimen was formerly polished. Much survives, but parts of the surface are now eroded. The cross section is circular and the ends taper, as in cat. 1861 (B.38).

F6 B.46 Cat. 1862a-b

Cat. 1862a has a circular cross section, while cat. 1862b is sub-triangular. The latter is particularly thin, suggesting that the hole was bored before the final shaping and polishing.

F6 B.17 Cat. 1065

This specimen is both later and has a quite different shape from preceding ones. It is sub-rectangular in cross section. Most of the polished surface has survived, but the rest is pitted and eroded.

TABLE 3-2

Ban Na Di: the dimensions of the large shell beads (in mm)

Provenance	Level or burial phase	Cat.No.	Length	Maximum Diameter	Perforation Diameter
F6 Burial 44	1a	1210a	38.5	7.4	2.5 - 4.0
F6 Burial 44	1a	1210b	22.2	8.5	4.0 - 4.0
F6 Burial 44	1a	1210c	18.5	7.1	3.5 - 3.5
F6 Burial 44	1a	1210d	20.2	7.2	3.2 - 3.5
F6 Burial 45	1a	1863	34.0	6.0	3.0 - 3.0
F6 Burial 46	1a	1862a	19.5	5.7	2.9 - 3.0
F6 Burial 46	1a	186b	16.2	5.5	3.2 - 3.2
F6 Burial 38	1b	1861	35.7	5.3	2.5 - 2.7
F6 Burial 36	1b	1147a	11.7	9.5	3.8 - 4.5
F6 Burial 36	1b	1147b	11.6	8.6	4.0 - 4.0
F6 Burial 36	1b	1147c	11.8	8.5	3.1 - 4.2
F6 Burial 36	1b	1147d	12.6	8.5	3.6 - 4.0
F6 Burial 36	1b	1147e	11.0	8.7	3.0 - 3.0
F6 Burial 36	1b	1147f	13.1	9.1	4.0 - 4.1
F6 Burial 36	1b	1147g	15.0	8.4	3.9 - 4.1
F6 Burial 36	1b	1147h	14.1	8.1	3.8 - 4.0
F6 Burial 36	1b	1147i	12.6	7.9	3.5 - 3.5
F6 Burial 36	1b	1147j	15.0	8.7	3.6 - 3.9
F6 Burial 36	1b	1147k	20.6	8.5	2.6 - 3.1
F6 Burial 36	1b	1147l	10.6	8.6	3.8 - 3.8
F6 Burial 36	1b	1147m	11.8	8.1	3.5 - 3.8

F6 Burial 36	1b	1147n	11.6	7.0	3.6 - 3.6
F5 Burial TS12	1c	TS66	7.5	5.8	4.0 - 4.2
F6 Burial 17	1c	1872	26.4	22.2	6.4 - 6.4
F6 Burial 17	1c	1065	26.4	22.2	6.4 - 6.4
A4 36	Level 7	1141	11.2	4.3	3.0 - 3.0

A4 36 Level 7 cat. 1141

This bead is polished all over the outside surface. It has a very thin wall (0.5 - 0.7 mm).

Shell beads: summary

Elongated large beads are most frequently found in phase 1a and 1b burials. They are further confined to a small group of interments in square F6. They were worn in conjunction with shell disc beads which numbered about 12,500. The majority of these were found in squares F5-F6 burials (95.2%), the rest in A3-A4 burials. These small disc beads are found in burials from phases 1a-c. The broad shell bead from B. 17 (cat.1872) is set apart on account of its shape.

CLAY BEAD (A3 16 Level 5 Cat. 284)

This bead is light brown with dark grey patches. The perforation is along the larger axis and shows longitudinal grooves. At one end the opening is slightly raised and then flattened while at the other there is a pronounced oblique flattening. Under 20x magnification, no temper was apparent although there were some very small irregular black inclusions.

Several experiments in the making of clay beads were undertaken. The method that most consistently made beads with the appearance of that above was as follows:

A ball of wet clay was pushed down onto a pointed stick of split bamboo held at an angle on a bench. Where the ball of clay came in contact with the bench it became flattened. The stick was then pulled up through the clay leaving a raised, ragged opening and grooved lines like those seen in the original. The ragged edge was then trimmed before the bead was left to dry for several days after which it was lightly fired in an open kiln.

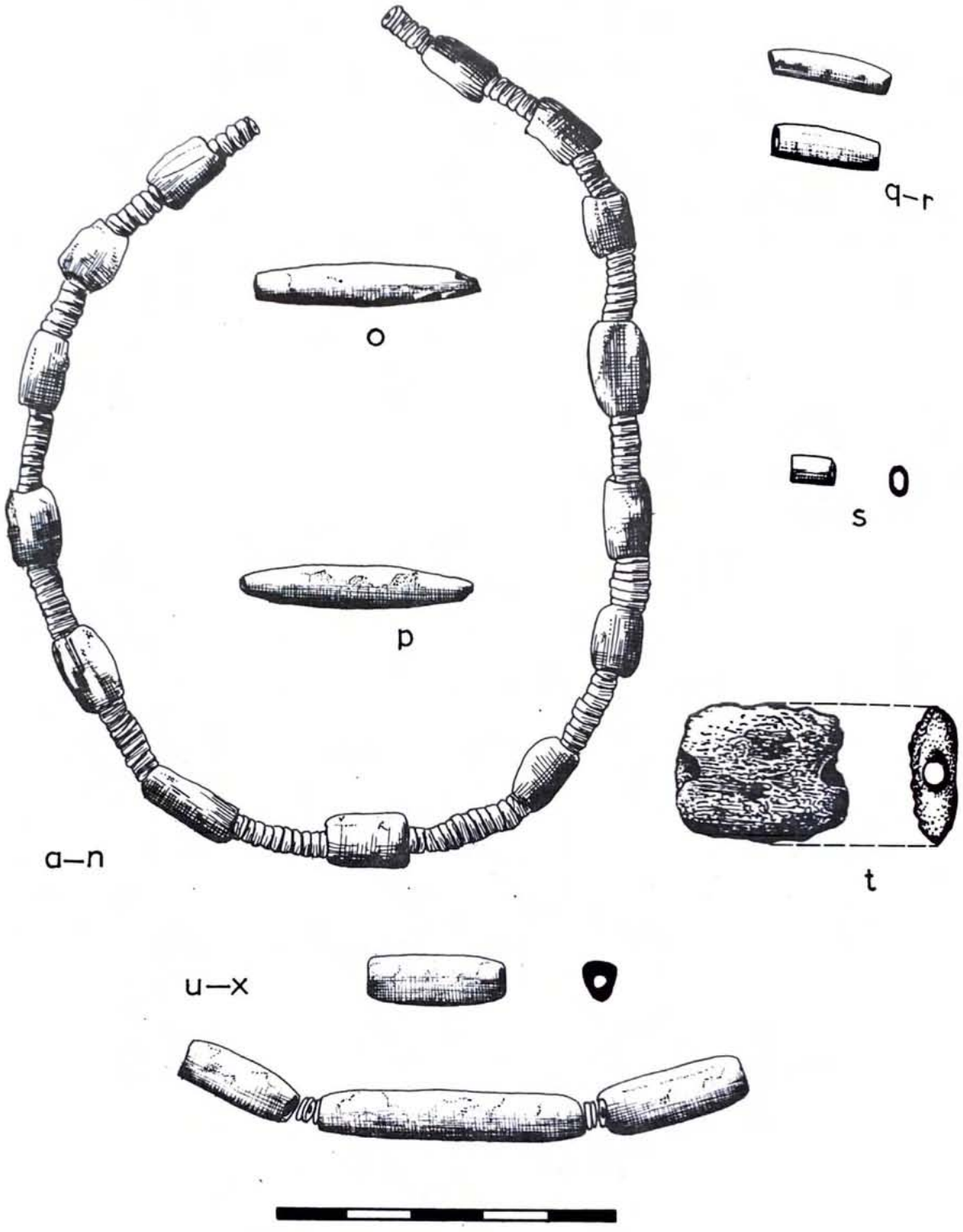


FIGURE 3-1

Ban Na Di: the large shell beads
A-N. B.36 Cats.1147a-n O. B.45 Cat.1863 P. B.38 Cat.1861
Q-R. B.46 Cats.1862a-b S. A4 36 L.7 Cat.1141 T. B.17 Cat.1065
U-X. B.44 Cats.1210a-d

BRACELETS OF TROCHUS SHELL (figs 3-2/4)

Several bracelets of shell were recovered, again mainly from funerary contexts. They are approximately circular with an uneven sloping circular surface. There is a diagonal groove running transversely across one side. The internal surface has a ridge running almost concentrically around part of it. This is less pronounced in the bracelets which have been worked to a greater extent. The cross section varies because of the initial shape of the shell. The maximum diameter of the bracelets varies between 90.1 and 105.9 mm, while the height range is 20.2 to 6.4 mm. The group of thirteen bracelets from one burial are of a fairly standard size. There is a variation of less than 1 cm between the diameters. This indicates that only one bracelet was made from the basal portion of each trochus shell.

The bracelets were made by taking a transverse slice from the base and removing the centre portion of the shell so as to leave a circular band. This could then have the edges smoothed off or it could be further worked until the nacre was exposed. These bracelets were usually narrower than the others. Fourteen complete specimens and several fragments were found at Ban Na Di (table 3-3).

TABLE 3-3

Ban Na Di: the dimensions of shell bracelets (in mm)

Provenance	Phase/ level	Cat. no.	Outer Diameter	Maximum Height
F6 Burial 36	1b	1146	*c*.85.7	7.7
F6 Burial 38	1b	1194a	89.0	8.4
F6 Burial 38	1b	1194b	*c*.88.0	8.0
F6 Burial 32	1b	1859a	104.3	15.6
F6 Burial 32	1c	1859b	106.0	17.0
F6 Burial 32	1c	1859c	100.5	17.3
F6 Burial 32	1c	1859d	102.9	16.8
F6 Burial 32	1c	1859e	98.0	17.9
F6 Burial 32	1c	1859f	98.2	16.3
F6 Burial 32	1c	1859g	97.2	16.2
F6 Burial 32	1c	1859h	97.0	16.5
F6 Burial 32	1c	1859i	105.2	17.1
F6 Burial 32	1c	1859j	96.0	16.5
F6 Burial 32	1c	1859k	95.1	15.6
F6 Burial 32	1c	1859l	97.3	17.0
F6 Burial 32	1c	1859m	96.4	18.3
A2 36	Level 7	747	–	–
A4 27	Level 7	789	*c*.73.0	10.8

A1 40	Level 8 988	*c.*84.5	10.0
A1 43	Level 8 1103	86.0	6.3

OTHER SHELL BRACELET (fig 3–5)

A fragmentary bracelet was found in A1/A2 43 (Level 8) cat. 1309. Its outer circumference is *c.* 2.0 mm. It is 33 mm broad and 5 mm thick. Like some of the stone bracelets, it was repaired in prehistory by boring a hole through the edge of the broken segment and tying the pieces together with metal wire. The groove which was worn by the metal binding is clearly visible in fig 3–5a. The care with which this bracelet was repaired hints that it was an object of some value.

SHELL DECORATIVE OBJECT A1 41, Level 8 cat. 1066 fig 3–5b

This circular disc has been cut from a single piece of shell. It is not pierced, so it is hard to envisage its use as a bead or pendant. The nacreous surface of the shell survives. The diameter is 32 mm and it is *c.* 1 mm thick.

DOG TOOTH NECKLACE Burial TS 12 TS cat. 25 (fig 3–5)

This burial contained the remains of a male aged 40 – 50 years at death. He wore a necklace made of both upper and lower canine teeth from the domestic dog. All have been bored laterally through the root. The use of animal canines as necklace beads recurred at Ban Chiang (EP d), though the animal in question was the tiger.

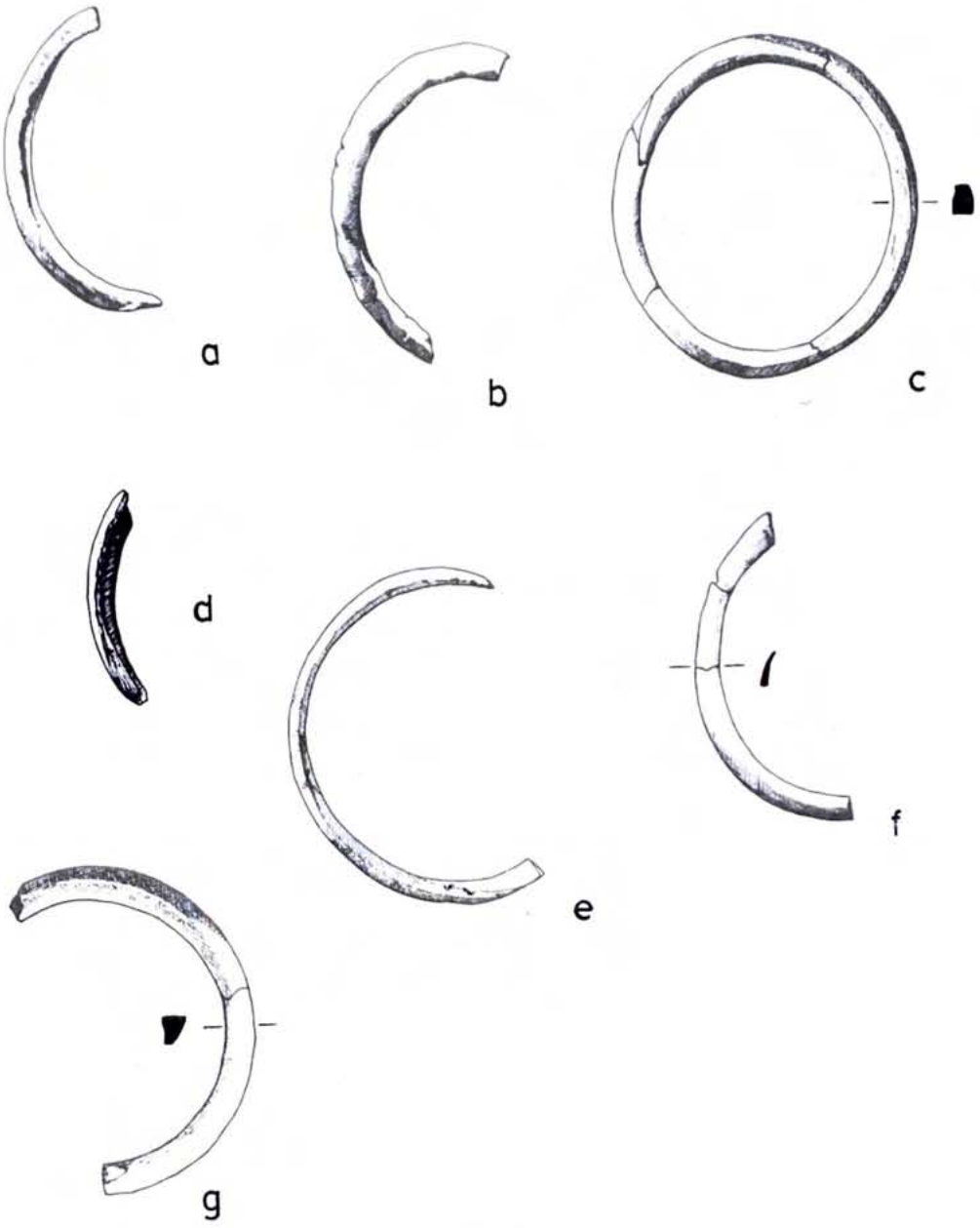


FIGURE 3-2

Trochus shell bracelets from Ban Na Di
A. A4 27 L.7 Cat.789 B. A1 40 L.8 Cat.988 C. Bur.38 Cat.1194a
D. A2 36 L.7 Cat.747 E. A1 43 L.8 Cat.1103 F. Bur.38 Cat.1194b
G. Bur.36 Cat.1146

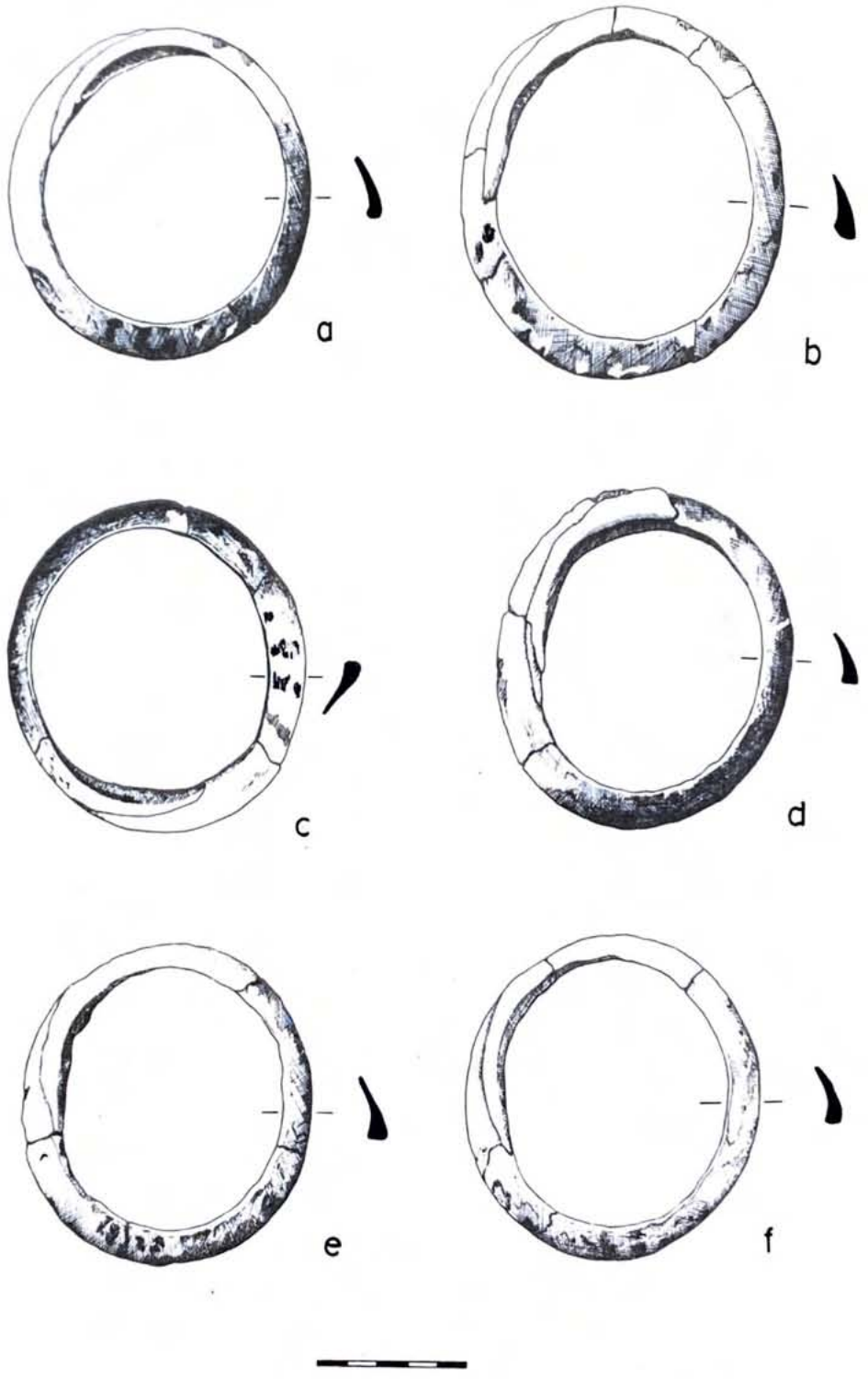


FIGURE 3-3 Ban Na Di: trochus shell bracelets from burial 32
A. Cat.1859h B. Cat.1859i C. Cat.1859j D. Cat.1859k
E. Cat.1859m F. Cat.1859l

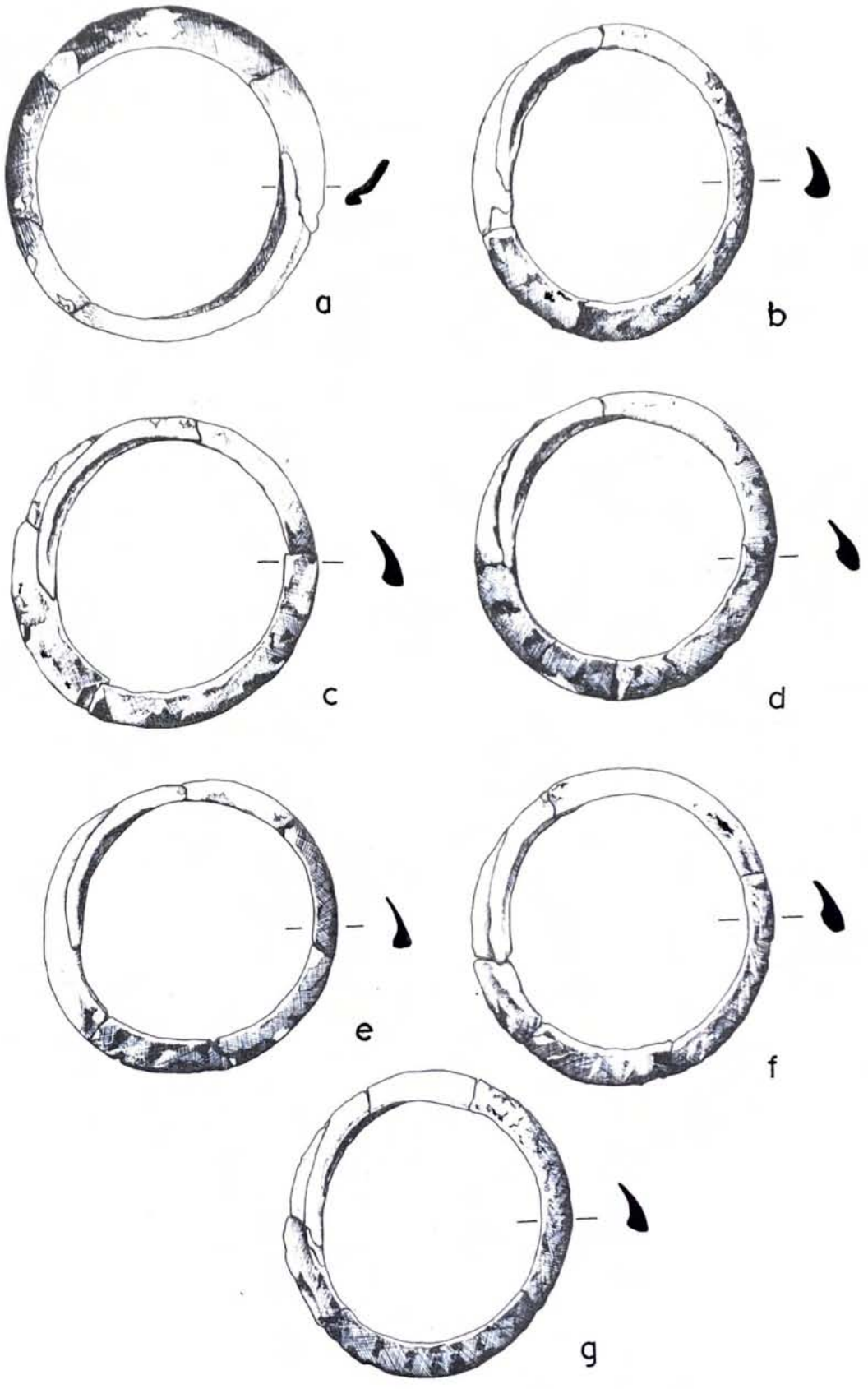


FIGURE 3-4

Ban Na Di: trochus shell bracelets from burial 32 (cont.)
A. Cat.1859a B. Cat.1859b C.Cat.1859c D. Cat.1859d E. Cat.1859e
F. Cat.1859f G. Cat.1859g

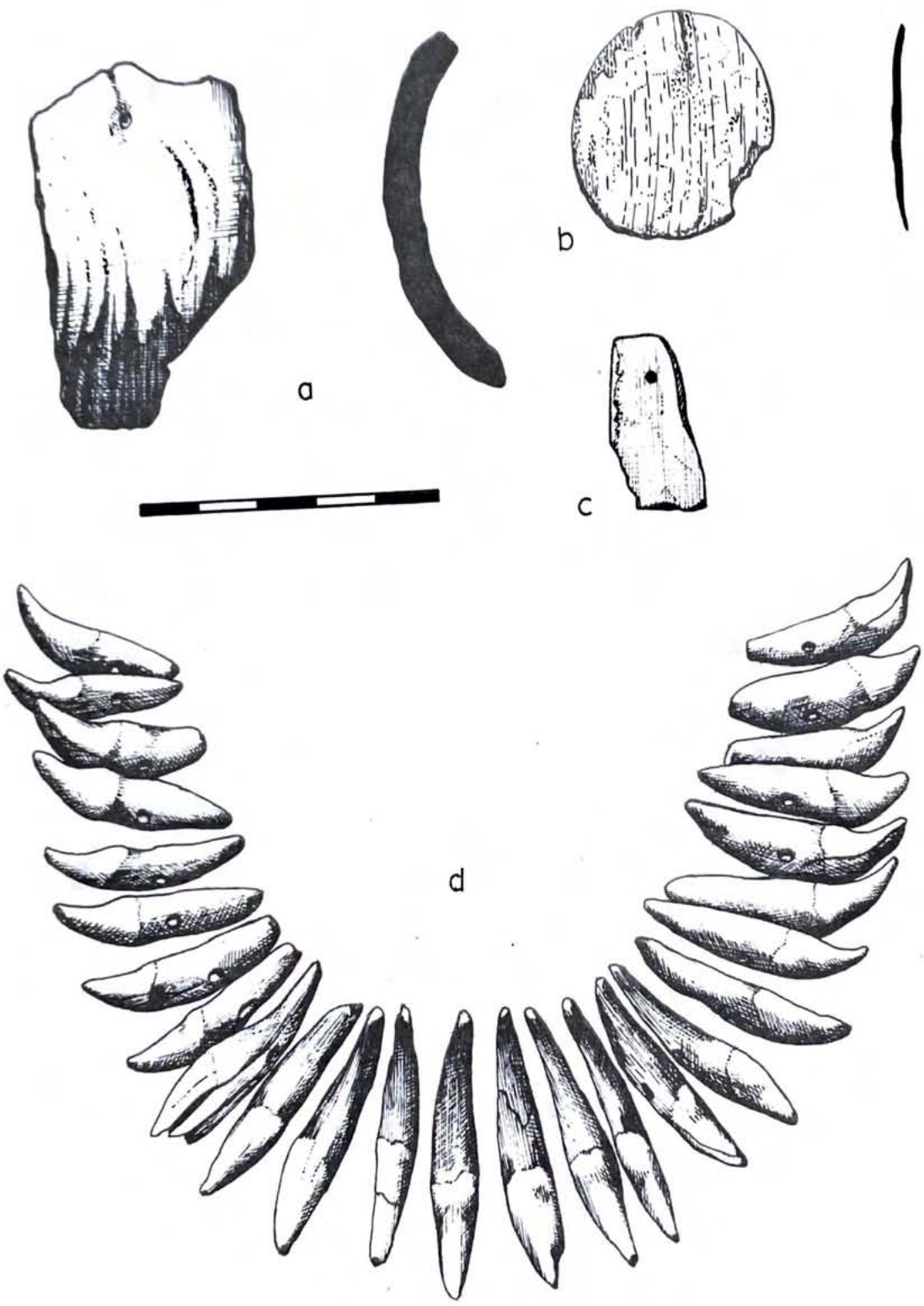


FIGURE 3-5

Ban Na Di: jewellery of stone, shell and tooth
A. Shell bracelet showing hole bored for repairs. A1/2 43 L.8 Cat.1309 B. Shell plaque A1 41 L.8 Cat.1066 C. Pierced stone bead Bur.47 Cat.1297 D. Dog tooth necklace Bur. TS12 Cat.TS25

STONE BRACELETS (fig 3-6)

Nine complete or partial stone bracelets were found at Ban Na Di. Dimensions are set out in table 3-4.

TABLE 3-4

Ban Na Di: the dimensions of the stone bracelets (in mm)

Provenance	Mortuary phase or level	Cat.no.	Outer Diameter	Inner Diameter	Maximum Height
F6 B. 45	1a	1417	106.5	53.0	7.8
F5 25	1a	TS 41	116.0	58.5	8.9
F6 B. 47	1a	1307	95.8	57.5	10.1
F5 B. TS 17	1b	TS 33a	114.3	53.9	15.7
F5 B. TS 17	1b	TS 33b	113.0	58.2	14.5
F6 B. 16	1c	1441	–	58.8	14.2
A1/A2 38	level 7	1291	136.0	71.0	8.1
A3/A4 35	level 7	1426	*c.* 100.0	*c.* 36.0	3.3
A1 36	level 7	852	–	–	–

All specimens have a broad projecting section and a central ribbed segment which was raised by as much as 4 – 5 mm in some cases but vestigial in others.

B.TS 17 Mortuary Phase 1b Cats. 33a and 33b (figs 3-6, a and d)

These specimens were found in the area of the right hand shoulder of the body. The former is made of a light grey slate on the surface of which there are numerous fine striations. These are probably the result of using a grinding stone to complete shaping the bracelet. The interior edge of the bracelet in particular bears numerous parallel striations. The latter is made of calcite, and is of very similar size and proportion. It also bears numerous manufacturing striations on all surfaces.

B.45 Mortuary phase 1a Cat 1417 (fig 3-6b)

This bracelet was found lying in association with an infant's skeleton. This appears to have been a secondary burial within the grave of an adult female, and the bracelet may have been relocated when the adult remains were disturbed. It is made of marble. The bracelet was twice broken in antiquity. On each occasion, a hole was drilled about 4 mm from the breakage and a piece of bronze wire was placed through each hole to join the broken segments. The holes in question measured just over 1 mm in diameter. The bronze wire has survived though in a corroded condition. There is no sign of a clasp or stud to facilitate removal of the bracelet from the wrist in situations where the hand was too large to permit putting the ornament on or taking it off. The most likely interpretation is that the bronze wire was used to repair the bracelet when it was broken. Again, fine striations on the surface result from fashioning the bracelet with an abrader.

F5 25 TS Cat. 41 equivalent of Mortuary phase 1a (fig 3-6c)

This bracelet was found in a feature thought to be a grave cut, but in which no skeleton was found. There is, however, human bone adhering to its exterior. It was broken three times in antiquity and repaired with bronze wire on each occasion. The holes and the wire are *c.* 1.7 mm in diameter. Fine striations cover the surface of this ornament.

B.47 Cat. 1307 Mortuary phase 1a (fig 3-6e)

This specimen was found on the right wrist of an adult male. It is made of marble. The internal diameter of the bracelet is so small, that it would have been impossible for the man to have put the bracelet on. The only way of doing so, or removing it would have been to untie the bronze wire in opposite parts of the bracelet. The bracelet had in fact, been broken and repaired twice. Two of the bronze fastenings however, were placed so as to secure a broken chip of marble from the outer edge. This finding is interesting because it indicates that once on, the bracelet could not have been removed without breaking it again. In a word, it must have been worn at all times, and initially placed on the wrist when the person was much younger.

B.16 Cat. 1441 Mortuary phase 1c (fig 3-6f)

This specimen is made of limestone. It was found in a group of redeposited bones beyond the feet of B.16. It is fragmentary and clearly broken during the prehistoric period.

A1/A2 Level 7 Cat. 1291 (fig 3-6g)

Only a small section of this bracelet was found. It is probably made of travertine or tufa. The central ribbed area is very shallow.

A3/A4 Level 7 Cat. 1426 (fig 3-6h)

Again, only a small piece of this bracelet was found. It was made of marble. The central ribbing is very shallow. A hole 2 mm wide has been drilled through the flange of the bracelet, presumably to effect repairs. There are numerous striations along the surfaces.

A1 Level 7 Cat. 852 (fig 3-6i)

This fragmentary specimen was found in occupation level 7. It was made of calcite. It bears no evidence of striations on the surface.

STONE BRACELETS: MANUFACTURING METHODS

Several of the central holes are slightly off centre. This suggests that the disc shape was roughed out of the stone and then embedded in sand or clay or some other medium for holding it firm. The edges of the disc may have been covered so that an exact centre could not be seen. The hole was drilled out using some form of cylinder and sand. The final shape was then ground out using sand, stone or some other abrasive medium, and then polished. In the case of cat. TS33a the stone is so soft that a knife could have been used to carve it. The straight sides of the hole indicate that it was drilled from one side only.

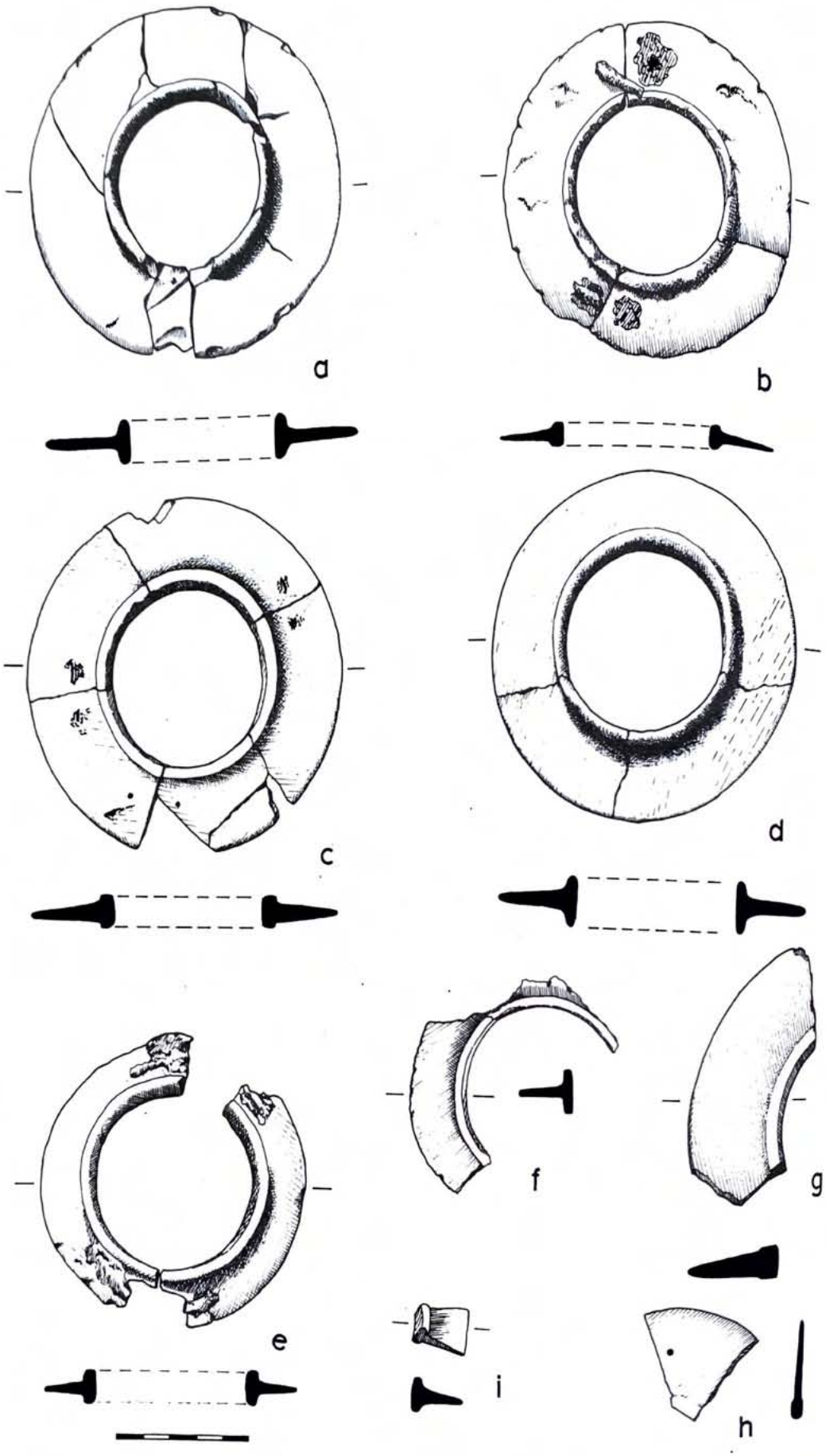


FIGURE 3-6 Ban Na Di: the stone bracelets. A. Bur. TS 17 Cat.TS33a B. Bur. 45 Cat.1417 C. F5 25 L.7 Cat.TS41 D. Bur. TS 17 Cat.33b E. Bur. 47 Cat.1307 F. Bur. 16 Cat.1441 G. A1/2 38 L.7 Cat.1291 H. A3/4 35 L.7 Cat.1426 I. A1 36 L.7 Cat.852

IVORY ORNAMENTS (fig 3-7)

Levels 5 and 6 have yielded the remains of a few bracelets made of ivory.

A2/A3 19 Level 6 Cat. 1355 (fig 3-7a)

This section of an ivory bracelet had a diameter of *c.* 75 mm. It has depth of 27 mm and a thickness of 2.9 mm. The surface is very smooth but undecorated. Under a microscope there are fine striations on the surfaces, which results from polishing. The edges have a rounded cross section.

A2 17 Level 5 Cat. 442 (fig 3-7b)

Only a small section of this bracelet has survived, so it is hard to estimate its diameter with accuracy. It is certainly larger than cat. 1355 perhaps by as much as 25 mm. The edges end with a sharp point. Again, fine striations run across the surfaces, due to the polishing process. It is 37.5 mm deep and has a maximum thickness of 2.5 mm.

A4 13 Level 5 Cat. 820 (fig 3-7b)

Only a small fragment of this ivory bracelet has survived. It had a diameter of *c.* 75.0 mm and maximum thickness of 3.5 mm. The surviving edge is rounded.

A1 19 Level 5 Cat. 522 (fig 3-7d)

This section of bracelet, while having a similar shape to cats. 1355 and 442, was decorated with parallel grooves running across its short axis. One edge, which is rounded, has a series of nicks cut across it. The other edge is cut off square. The bracelet has a diameter of 75.0 mm, height of 23.0 mm and maximum thickness of 2.9 mm.

OTHER ORNAMENTS OF BONE, IVORY OR TOOTH (fig 3-7)

A4 27 Level 7 Cat. 582 (fig 3-7e)

This bead was made by boring a hole through the root of a dog's canine tooth. The hole has a diameter of 2.0 mm.

A2 30 Level 7 Cat. 578 (fig 3-7f)

This bead is similar to cat. 582. It was made from dog's canine tooth with the hole pierced through the root. The diameter of the hole is approximately 2 mm.

A1 19 Level 5 Cat. 1839 (fig 3-7g)

This artefact may have been a very small bracelet, a neck pendant or an ear pendant. It is circular, and cut from bone. If a bracelet, it would have had an internal diameter of only 26 mm. It has a depth of 17 mm, breadth of 3.5 mm, and the edges are rounded.

A4 16 Level 5 Cat. 2365 (fig 3-7h)

This bone item was cut to shape but only partially ground. It may have been broken before completion. Essentially, it comprises a central section which tapers to a narrow constriction before being cut to the shape of a lozenge. The other end shows signs of having a similar construction, but was broken in antiquity. One edge of the central section was ground to a rounded profile, the other was quite roughly cut to shape. The lozenge-shaped projection also bears cut marks. It is now 58.2 mm long and has a maximum width of 10.5 mm.

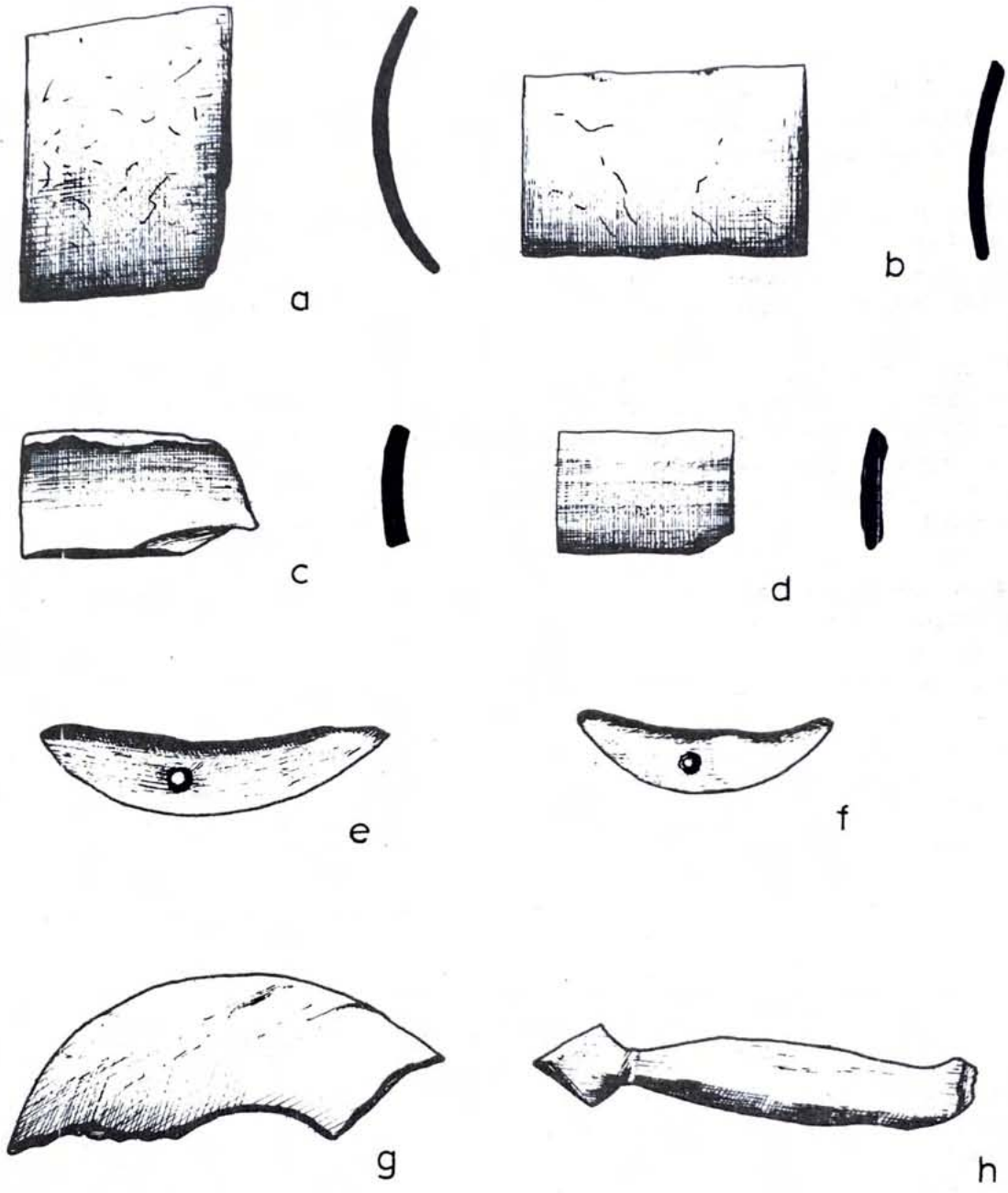


FIGURE 3-7

Ban Na Di: ornaments of ivory, tooth and bone
A. A2/A3 19 L.6 Cat.1355 B. A2 17 L.5 Cat.442 C. A4 13 L.5 Cat 820
D. A1 19 L.5 Cat.522 E. A4 27 L.8 Cat.582 F. A2 30 L.7 Cat. 578
G. A1 18 L.5 Cat.1839 H. A4 16 L.5 Cat.236

GLASS BEADS (fig 3-8)

Burial 8 (A1) was a jar burial containing the remains of an infant. It was cut from level 4, and grave goods included five blue-glass beads. These are individually described below:

Cat. 1430a has a very regular sharply formed profile. Perforation has transverse striations and two small lumps of frit enclosed in it. The glass has a large number of small air bubbles embedded in it which may account for the fact that it differs from the rest of the set in colour.

Cat. 1430b: the profile shows many faint facets. There is a flaw running along one side of the perforation and obliquely into the body of the bead. One end is at an angle from the transverse and the perforation shows signs of having been re-opened after a flange had collapsed onto it. The transverse striations on the surface of the perforation are not found on the reworked area.

Cat. 1430c: this specimen has a smooth profile, the lower end is pitted and the upper end shows a collapsed flange inside the perforation. The whole bead is slightly off vertical. There are transverse striations along the length of the perforation.

Cat. 1430d: the specimen has a smooth profile but with a flaw running along the length of one side of the perforation. The flattened ends are not parallel, but the perforation is roughly at right angles to the central ridge. There are transverse striations along the length of the perforation.

Cat 1430e: the last bead has a smooth profile with one end oblique and the other straight. A longitudinal flaw and transverse striations are found on the surface of the perforation.

BLUE GLASS BEADS: MANUFACTURING TECHNIQUE

Several methods are known to have been used to produce this style of bead, including grinding and moulding. In the case of these particular beads, moulding is unlikely because there is no trace of mould junction lines. Grinding cannot be entirely ruled out, especially in the case of cat. 1430a. However, since the flattened ends were not produced by grinding, it seems unlikely that the profile was. In each case, the ends of the beads show signs of having been flattened as a final or penultimate step in the production by pressure between two flat surfaces.

The manufacturing method described below is one which produces the result which is consistent with appearance of these beads, and at present, it is considered to be the most likely one.

A rectangular piece of plastic glass was wrapped round a rod which was either made of baked clay or a medium coated thinly with clay or fine sand to prevent the glass sticking to it. The glass while in a pliable but not too molten state was formed into a double cone by a flat object, perhaps a planishing hammer. This tool was used in such a way that it

not only flattened the cone's sides but rotated the bead at the same time around on the rod causing one edge of the fold to spread out over the other and leaving the transverse striations on the perforation. The ends of the cones may well have been partially formed at this stage of the process. While still pliable the bead was slipped from the rod onto a flat surface and compressed between it and another flat surface. On occasion this caused a small flange of glass to collapse into the opening. This was overcome by a rod being pushed into the opening to flatten the flange against the sides of the perforation.

An alternative to the use of the hammer as a means of forming the cones could be that the glass beads were forced to rotate at an angle on a flat surface, the slightly faceted appearance of the beads being caused by the glass being not quite hot enough.

TABLE 3-5

Ban Na Di: the glass beads from burial 8

Cat.No.	Max. L.	Max. br.	Diameter aperture	S.G.*	Weight (gm)	Munsell colour
1430 a	13.9	17.0	6.5	2.3429	4.042	7.5B 4/8
1430 b	11.4	13.3	6.0	2.3328	2.250	10BG 5/6
1430 c	9.8	12.9	5.6	2.3552	1.919	10BG 5/6
1430 d	10.4	13.9	5.0	2.3594	2.338	10BG 5/6
1430 e	12.4	14.5	5.0	2.3529	2.841	10BG 5/6

* specific gravity

A few small orange glass beads were found. All but one came from level 3. None was found in association with burials. The beads are straight sided tubes with thin walls and large perforations. The ends are usually flat. The colour is a matt orangey-brown and has the appearance of terra-cotta. Small pits can be seen on the surface and where chipping has occurred the new surface is shiny. Under microscopic examination some of the pits are seen to contain minute grains of quartz and the matrix of the bead is poorly mixed. The uneven colours generally flow diagonally or laterally through the matrix and show little or no distortion at the ends. The shiny surface of the chips shows the colloidal stress marks typical of glass. The old surface on the other hand is pitted and ridged. This may be due to corrosion rather than treatment during manufacture, as poor mixing may have resulted in areas of solubility.

The colouring pigments were roughly mixed with finely ground quartz and an alkali and then heated sufficiently for most of the materials to become plastic. The resulting mass was then drawn out into a tube and

when it had cooled, the tube was cut into short lengths and the ends smoothed. The smoothness of the outer surface may also be due to some grinding. The matt surface may have been caused by corrosion due to bad mixing giving rise to lack of sufficient calcium in some parts to prevent the glass from being soluble. Certainly the matt surface is in marked contrast to the smooth shiny surface of the new chips.

TABLE 3-6

The orange glass beads from Ban Na Di

Provenance	Level	Cat.No.	Length	Breadth	Diameter of aperture
A3 12	4	210	3.5	4.6	2.5
A3/A4 7	3	1158	4.9	4.5	2.6
A1/A2 7	3	1142	3.9	4.9	2.8
A3/A4 8	3	1170	5.5	4.7	3.1
A3/A4 6	3	1148e	4.1	4.1	2.5
A3/A4 6	3	1148a	2.0	4.9	2.1
A3/A4 6	3	1148c	5.1	4.6	2.6
A3/A4 6	3	1148b	4.0	4.0	2.7
A3/A4 6	3	1148d	4.6	4.6	2.6
A4 5	3	53	2.1	3.3	1.1
A4 6	3	58	2.0	4.1	2.0
A4 6	3	64	1.4	3.0	1.1
A3/A4 8	3	1171	2.5	3.9	2.3

THE GLASS BEADS: COMMENT ON ORIGINS

There are two different styles of bead, both postdating *c.* 200 AD. During this period, two different recipes were generally in use to make glass. The western product was probably introduced into Southeast Asia from India and contained soda, an alkali such as potash, and lime. The second recipe seems to have originated in China, and contained as well as soda and alkali, up to 40% of lead or lead and barium. These heavy salts greatly increased the specific gravity of the glass. The comparative proximity of China to Ban Na Di might favour a Chinese origin. The specific gravities of the Ban Na Di beads however, ranged between 2.3 and 2.46, which favours a Western type and hence a possible origin in India or one of the Indian influenced port and manufacturing centres fringing the Gulf of Siam.

Both types of bead are relatively common in Northeast Thailand and the orange beads also have an extremely wide range of distribution, reaching even into Africa. The blue beads are not represented at Oc Eo, the best known port centre in Southeast Asia, but similar ones have been recovered from Taxila. Identifying such beads more closely to their source is one of the critical steps necessary to assessing early first millennium AD exchange in Southeast Asia.

STONE BEADS (fig 3-5c)

Stone beads were extremely rare at Ban Na Di. Two were recovered. The earlier, a flat stone spacer bead, was found in association with the human skeleton (F6 B.47, mortuary phase 1a Cat. 1297). It was broken in antiquity. It was rectangular in shape, the hole piercing it having a diameter of 1 mm. The break lies along the second perforation.

The second bead is fragmentary. It comprises an orange-white banded agate, one surface being polished and domed. The general appearance suggests that it is part of a fairly large spherical bead, though no perforation is evident. It was found associated with burial 8, mortuary phase 2 and therefore was contemporary with the glass beads just described. It probably originated in India.

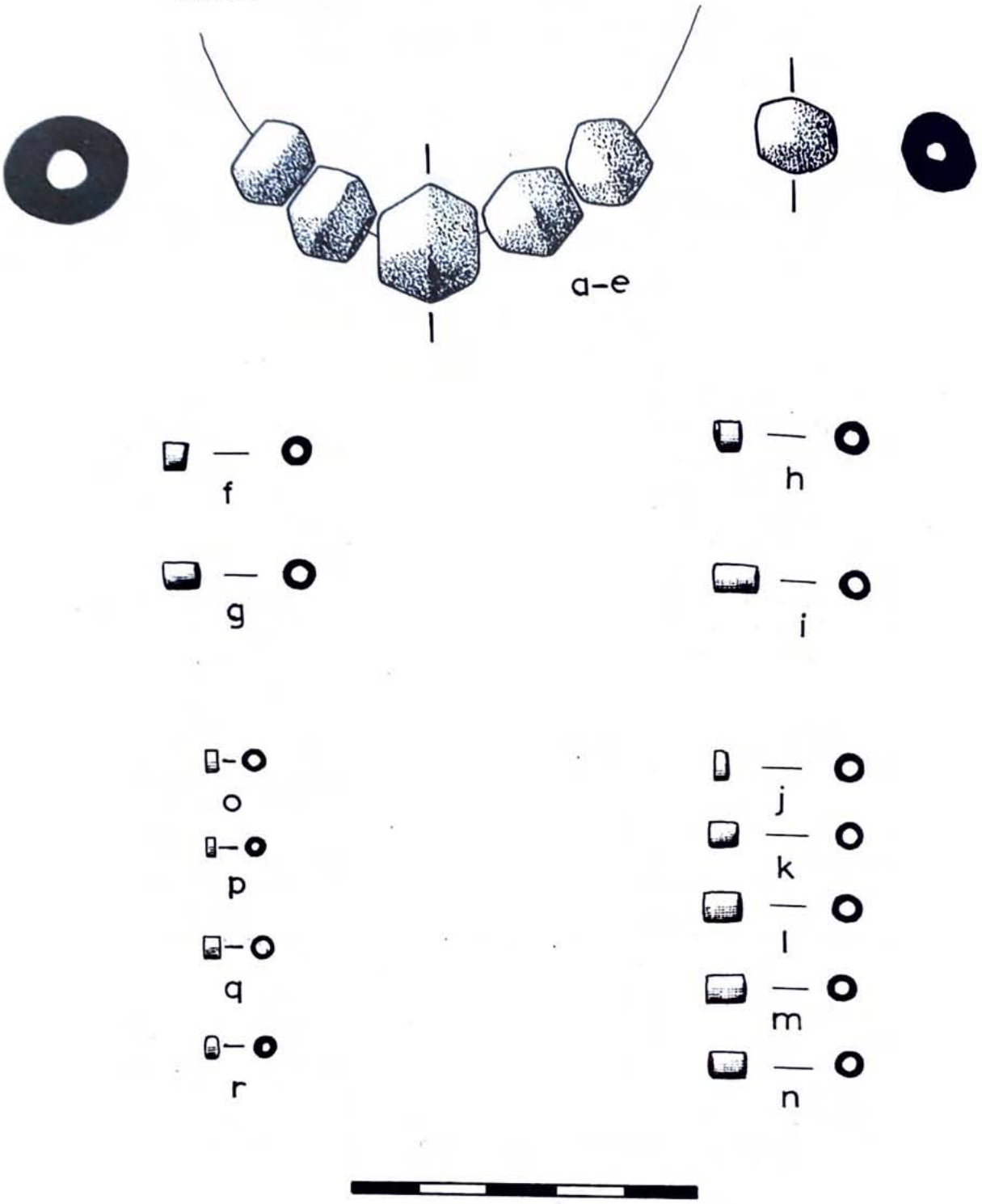


FIGURE 3-8

Ban Na Di: blue glass beads (a-e) and orange glass beads (f-r)
A-E. B.8 Cats.1430a-e I. A3/A4 8 L.3 Cat.1170
J. A3/A4 6 L.3 Cat.1148a K. A3/A4 6 L.3 Cat.1148b
L. A3/A4 6 L.3 Cat.1148c M. A3/A4 6 L.3 Cat.1148d
N. A3/A4 6 L.3 Cat.1148e O. A4 6 L.3 Cat.58
P. A4 6 L.3 Cat.64 Q. A3/A4 8 L.3 Cat.1171
R. A3 5 L.3 Cat.53

THE EVIDENCE FOR METALLURGY

THE CLAY MOULDS (fig 3-9)

Several broken fragments of clay moulds were found at Ban Na Di. Cat. 643a (A4, 14, level 5: table 3-7) is the most complete, and will be described first. It was clearly made as part of the process involved in casting a metal, presumably bronze, bracelet. It is the only specimen of this type found with the full outer edges of the mould intact. The interior edge of the mould bears a ribbed design which could only have been made were the clay impressed over an existing patterned template. This could have been made of wax or a metal with a low melting point, such as lead. The template was then covered with a fine layer of clay *c.* 4 mm thick. This in turn, was surrounded by a different, coarser clay with much rice chaff temper. The exterior of the mould is circular in cross section with a diameter of 24 mm. It is probable that the template melted and flowed out of the mould when the clay was fired. Since the mould would have been broken to remove the completed bracelet, this particular specimen was clearly never used.

A3/A4 19 Level 6 Cat. 1871

This is a small fragment of the interior section of a bracelet mould. There is no sign of the outer section which characterises those already described.

A4 14 Level 5 Cat. 643b (fig 3-9b)

This specimen closely resembles cat. 643a except that it was a double mould, used to cast two bracelets. The completed inner mould sections already enclosing the template were placed together and packed round with the outer clay. Each bracelet mould bears the impression of a ribbed design of parallel lines each about 0.3 mm across.

A4 14 Level 5 Cat. 643c (fig 3-9c)

This specimen was probably intended to be a double mould but only one inner section has survived. It resembles the first two in every way except that the pattern comprises faint ridges running at 90 degrees across the outside edge of the bracelet.

A1 14 Level 5 Cat. 643d (fig 3-9d)

This is a small and fragmentary specimen. There is no evidence for decoration on the interior mould piece.

A1 19 Level 5 Cat. 1528 (fig 3-9e)

This mould fragment was designed to make a much broader bracelet than cats. 643a-d. In all variables other than size, however, it is similar. There is an inner mould surrounded by an outer one with a considerably coarser clay. The decorative grooves in the interior mould are about 0.6 - 0.7 mm wide.

A1 14 Level 5 Cat. 1699 (fig 3-9g)

The interior mould surface does not bear any decoration, nor does it have the round, tubular shape of a bracelet. It does however, correspond in all other respects to the bracelet mould configuration of an internal clay section surrounded by a coarser, chaff tempered material. The intended bronze object cannot be recognised.

A3 16 Level 5 Cat. 1730 (fig 3-9h)

This mould was used for a smooth-surfaced bracelet or anklet. It has the characteristic inner mould of fine clay surrounded by a skin of clay heavily tempered with rice chaff. The interior of the mould is very smooth and coloured light grey.

A4 14 Level 5 Cat. 1862 (fig 3-9i)

This mould comprises an entire section and cannot therefore, have been used in casting. The bracelet would have had a ribbed exterior decoration. It comprises an inner core of fine clay enclosed by an outer section of much coarser clay.

A4 15 Level 5 Cat. 205 (fig 3-9j)

This specimen closely resembles cat. 1682. It retains a complete section, was intended for a ribbed bracelet and comprises an inner core of fine clay and outer covering of coarse clay containing much rice chaff.

A1 9 Level 4 Cat. 1535 (fig 3-9k)

Half a section of this specimen remains. It was designed for a ribbed bracelet. It is also noted, that during the unpacking of the non burial ceramics, two pieces of clay moulds used for casting small ribbed bells were recognised from level 5 contexts. Unfortunately, these specimens were subsequently misplaced.

TABLE 3-7

Ban Na Di: the clay moulds (in mm)

Provenance	Level	Cat.No.	Maximum diameter of bracelet
A3/A4 19	6	1871	*c.* 5.5
A4 14	5	643a	7.1
A4 14	5	643b	*c.* 7.0
A4 14	5	643c	7.0
A4 14	5	643d	*c.* 6.5
A1 19	5	1528	*c.* 14.0
A4 14	5	1699	–
A3 16	5	1730	*c.* 13.0
A4 14	5	1682	6.7
A4 15	5	205	6.0
A1 9	4	1535	5.0

THE STONE MOULDS (fig 3-10)

There are two broken pieces of mould made of sandstone. Both were halves of what was formerly a double mould. The first comes from A3 20 level 6 cat. 576 (fig 3-10b). The outer surface of the mould had been shaped to an oval cross section, 33 mm deep at its greatest extent. The inner surface was ground to a straight plane, and within it, was cut the outline of part of an axe blade. Half the cutting edge has survived, and the shape reveals a lunate edge characteristic of axes and moulds from Non Nok Tha, Ban Chiang, Doc Chua and sites in the Red River Valley. The maximum depth of the blade measured from the inner surface of the mould was *c.* 3 mm.

The second fragment comes from A1/A2 35 level 7 cat. 1299 (fig 3-10a). Like that described above, the outer surface was ground to an oval shape. Its maximum depth was 25 mm. The inner surface was ground to a flat surface into which was cut two conduits each leading to the mould for an arrowhead. Unfortunately only part of the outline of one arrowhead has survived, but there is enough to see that there was a central rib on the blade. The upper surface of the mould is present, and there is a clear enlargement there to facilitate the pouring of molten metal into the mould when both halves were joined.

Three further pieces may derive from a mould. The first is a fragment of sandstone cut straight and smooth on two edges, which join at a right angle. The beginnings of a central depression for the object being cast is visible. This piece comes from A2 level 7 cat. 1460 (fig 3-10d). The second sandstone piece comes from A2/3 level 5 cat. 1865. It is flat on both sides, with a rounded end. The flat face has all the hallmarks of a mould, though there is no obvious incised area to take the poured metal. It is, however, a fragment only and the incised section may be missing.

The last specimen comes from A3 level 7 cat. 1443 (fig 3-10c). It has the characteristic rounded exterior contour, and flat top. The interior surface had been ground, but not to the point of being completely flat. There is no sign of the incised area for receiving the molten metal, but only part of the presumed mould has survived. The exterior is darkened and cracked as if it had been subjected to heat. This may well reflect pre-heating of the mould to lessen the risk of fracture due to thermal shock.

The discovery at Ban Na Di of a casting sprue made of a lead-tin alloy, albeit in level 4, hints at the use of stone moulds in the casting process. It seems probable that the stone moulds were used for casting a lead implement. These were then covered in clay moulds before the lead was melted out to make way for bronze. Given the high melting point for bronze, it is thought that thermal shock would have destroyed stone moulds during casting.

THE CRUCIBLES (fig 3-11 and 12)

Two complete crucibles were found at Ban Na Di. They were made of a clay heavily tempered with rice chaff. The first (cat. 480) was found in the base of a post hole in square A2, which was cut from level 6 (fig 3-11). It measures 125 mm in length, is 89 mm wide and 54 mm deep. The basal thickness is 20 mm, but the walls progressively taper to no thickness at all. When full, it would have contained about 80 ml of molten metal. The crucible has a moulded spout for pouring and several flecks of bronze adhere to its inside surface.

The second crucible (cat. 343 fig 3-12) came from an occupation context in level 6, square A4. It is larger than the first, being *c.* 150 mm and 116.5 mm wide. It is also extremely thick at the base (*c.* 24 mm), and would have held 75-80 ml of metal. The unusual shape and temper of these crucibles, as well as the presence of metal adhering to their surfaces, makes it possible to recognise fragments of pottery as originating from crucibles.

Fragments of crucible: level 8

Square A1

There are five fragments of crucible. All have bronze corrosion adhering to them. One comes from a shallow pit cut 30 cm above the natural substrate. The rest come from occupation contexts (two from sp. 40, two from sp. 42). One piece comes from the spout, three from rims and one from a body piece.

Square A2

There are seven fragments of crucible from this square, all being found in spit 46. This is *c.* 20 cm above the natural substrate. All have fragments of bronze adhering to them.

Baulk A2/3

There are three small pieces from this baulk. One has a 3-4 mm thick layer of corrosion containing many flecks of copper or bronze. A second has a layer of slag up to 8 mm thick with a fleck of metal measuring 2.5 x 2 mm.

Square A3

There are five pieces of crucible from this square. Two come from the pouring spout and have bronze corrosion adhering to them. The remaining three are from rim sections. All were found on or within 25 - 30 cm of the bottom of the site's occupation layers.

Baulk A3/4

This baulk produced five pieces. One is an almost complete pouring spout. The cross section reveals three layers of corrosion suggesting that this crucible was used at least three times. There were also spots of metal. The second piece has bronze slag to a depth of 6 mm. The remaining three pieces all come from small sections of rim.

Square A4

The seven pieces from this square all contain bronze corrosion on the surface. Two pieces come from features cut into natural. One was a pit, the other probably a post hole. One piece comprises the pouring spout of a crucible and has a layer of bronze slag 7 mm thick containing numerous small fragments of metal. A further piece, found in a pit cut from sp. 34, is particularly rich in metal, the largest piece measuring 4.5 x 1.5 mm.

Level 8 crucibles: summary

It is clear that metallurgy was practiced from the earliest occupation of Ban Na Di. The ceramics used for crucibles during level 8, and the processes which underlay the deposition of slag in the crucibles are undergoing specialist analysis. It is notable at this stage, that only seven of the crucible fragments from this level contain rice chaff temper. The remainder were tempered with grog and were a much harder ceramic. The fragments from level 8 were found across the entire excavated area of squares A1 - A4.

Crucibles from Level 7

Square A1

There are two rim fragments, both from sp. 32 within level 7. Each bears a 1-2 mm thick layer of bronze slag. One piece is tempered with rice chaff, the other with clay.

Baulk A1/A2

Both fragments have slag adhering to the inner surfaces, and are tempered with clay. They come from the surface of sp. 41, that is towards the base of level 7.

Square A2

All the twelve fragments of crucible from square A2 come from occupation deposits. Details are as follows:

TABLE 3-8

Ban Na Di: the crucible fragments from level 7 square A2

Ban Na Di: crucibles

Spit	n	n clay temper	n chaff temper	n with slag adhering
45	2	1	1	2
43	1	1	–	1
42	1	1	–	1
41	4	1	3	4
40	1	1	–	1
38	1	1	–	1
36	1	1	–	1
35	1	–	1	1
33	–	–	1	1

Baulk A2/A3

There are two pieces of crucible from this baulk. The larger comprises a practically complete cross section from the base to the rim. The basal thickness is *c.* 15.0 mm. There is a 2 mm thick layer of bronze slag lining the entire interior. It is clay-tempered, and comes from a pit cut from sp. 36. The second rim piece was found in sp. 34. It is liberally tempered with rice chaff, and has a layer of slag 9 mm thick. This accretion contains several flecks of copper or bronze, the largest measuring 1.4 x 1.9 mm. Some of this slag is adhering to the outer part of the crucible as well.

Square A3

This square and layer contained the remains of a clay lined furnace, surrounded by charcoal staining and many fragments of corroded bronze. Its interior was rich in pieces of charcoal. One of the crucible fragments was found associated with this furnace. It is the rim section, and has bronze slag to a depth of 4.0 mm adhering to it. The clay is richly tempered with rice chaff.

TABLE 3-9

Ban Na Di: the crucible fragments from level 7 square A3

Spit	n	n clay temper	n chaff temper	n with slag adhering

39	1	1	–	1
34	3	2	1	3
31	1	1	–	1
30	1	1	–	1
29	2	1	1	2
27	1	1	–	1
25	1	1	–	1
21	1	1	–	1

Three further fragments were found in the upper part of the grave fill for B.26. Two are rim fragments and the other a body sherd. All bear traces of slag. Two were tempered with clay, the other with chaff. Details of the remaining fragments are set out in the attached table.

Baulk A3/A4

There are eight fragments of crucible from level 7 on this baulk. All but one were found in the grave fill for B.18, the last specimen being found in sp. 24. Details are as follows:

TABLE 3-10

Ban Na Di: the crucible fragments from level 7 baulk A3/4

Spit	n	n with clay temper	n with chaff temper	n with slag adhering
30	7	6	1	–
24	1	1	–	1

Square A4

There are six crucible fragments, one being an almost complete pouring spout, another the complete cross section from rim to base. the base is 12.5 mm thick.

TABLE 3-11

Ban Na Di: the crucible fragments from level 7 square A4

Spit	n	n clay temper	n chaff temper	n with slag adhering
36	1	1	-	1
25	2	2	-	-
26	1	1	-	-
31	2	2	-	2

Square F6

There are ten fragments of crucible from square F6. All derive from level 7 contexts. There is a piece of spout from sp. 12, encrusted inside and out with slag. The other nine crucible fragments from body (7) and rim (2) sections. Details are as follows:

TABLE 3-12

Ban Na Di: the crucible fragments from level 7 square F6

Spit	n	n clay temper	n chaff temper	n with slag adhering
13	2	2	-	2
12	1	1	-	1
11	3	3	-	3
10	1	-	1	1
9	1	1	-	1
2	2	-	1	2

Crucibles: Level 6

Consideration of the crucibles found, strictly speaking, within level 6 must be considered in the light of the abundant evidence for local bronze working in level 5 above. The technique employed was the construction of clay-lined pit furnaces. Now these pits were often sunk *into* level 6, and most of the crucible fragments found in level 6 clustered round the bases of these level 5 furnaces. Thus, the remains of furnaces in square A1/2 sp. 20-22, and square A4 sp. 18-20 originated in level 5 above. The following fragments are therefore, ascribed to "uppermost level 6, but originating from level 5".

TABLE 3-13

Ban Na Di: the crucible fragments from level 6

Square	Spit	n	n clay temper	n chaff temper	n with bronze adhering
A1	22	2	-	2	2
A1	20	4	-	4	2
A2	23	1	-	1	1
A2	25	1	-	1	1
A2	25	-	-	1	-
A2	22	1	-	1	-
A2*	21	7	-	7	2
A3	20	1	1	-	1
A3/4	19	1	-	1	1
A4	19	6	-	6	3
unprovenanced		1	-	1	1

* These fragments could all come from one crucible

There are three differences between the level 6 crucibles and earlier ones. They are with one exception, liberally tempered with rice chaff. At the same time, they have thicker bases, varying between *c.* 25.0 and 30.0 mm. Finally, they have very little bronze slag adhering to them. When present, it is a small nodule, or very thin film of corrosion rather than the thick concretion characteristic of the earlier levels.

TABLE 3-14

Ban Na Di: the crucible fragments from level 5

Square	Spit	n	n clay temper	n chaff temper	n bronze stained
A1	16	1	–	2	–
A1	18	2	–	2	1
A1	19	4	–	4	2
A2	17	1	–	1	–
A2	18	1	–	1	–
A2	19	7	–	7	–
A2	20	3	–	1	1
A2/3	14	1	–	1	1
A3	15	1	–	1	–
A3	16	4	–	4	1
A3/4	15	1	–	1	–
A3/4	17	1	–	1	–
A4	13	1	–	1	–
unprovenanced	14	1	–	1	–
unprovenanced	15	10	–	10	1
unprovenanced	16	6	–	6	1
unprovenanced	17	2	–	2	–

Crucibles: Level 5

Square A1

There are five fragments of crucible. All come from vessels with a very thick base (up to at least 22 mm), tapering to a thin edge at the rim. This particular horizon contained two clay furnaces surrounded by charcoal stained soil rich in flecks of bronze.

Square A2

Spits 19-20 in this square contained a clay furnace, many flecks of bronze and charcoal stained soil. They also yielded twelve fragments of crucible, all of which contain a dense admixture of rice chaff.

Baulk A2/A3

One fragment was found, containing a layer of bronze slag *c.* 4.5 mm thick. It is unusual to find such thick slag in this level or level six.

Square A3

This square contained a clay furnace presumably used in bronze casting. Five crucible fragments were found nearby. One piece had a basal thickness of 24 mm.

Baulk A3/A4

There are only two small fragments of crucible from this baulk.

Square A4

Level 5 contexts in this square were rich in large pieces of fired clay from bronze furnaces, bronze detritus and charcoal. In addition, twenty pieces of crucible were found. The largest piece comprises a complete spout and most of the adjoining body. The basal thickness is 23.0 mm. The outer skin of clay is burnt to an orange colour and had clearly been subjected to intense heat. The clay is thick with rice chaff. The other 19 pieces were small and fragmented.

The crucible fragments: summary

Level 5 and 6 crucibles are similar in the clear preference for a heavy admixture of rice chaff in the clay, a thick basal section and rarity of bronze slag adhering to them.

BRONZE: ARTEFACTS AND PIECES OF CORRODED METAL (figs 3-13/16)

During the course of excavating Ban Na Di, numerous pieces of heavily corroded bronze were found. Some comprised tiny flecks of green corrosion and were not retained. The recoverable pieces were catalogued and their provenances set out in the table below.

TABLE 3-15

Ban Na Di: fragments of corroded bronze

LEVEL	SQUARE							
	F6	A1	A1/2	A2	A2/3	A3	A3/4	A4
8	2	1	2	-	11	4	2	-

This square contained a clay furnace presumably used in bronze casting. Five crucible fragments were found nearby. One piece had a basal thickness of 24 mm.

Baulk A3/A4

There are only two small fragments of crucible from this baulk.

Square A4

Level 5 contexts in this square were rich in large pieces of fired clay from bronze furnaces, bronze detritus and charcoal. In addition, twenty pieces of crucible were found. The largest piece comprises a complete spout and most of the adjoining body. The basal thickness is 23.0 mm. The outer skin of clay is burnt to an orange colour and had clearly been subjected to intense heat. The clay is thick with rice chaff. The other 19 pieces were small and fragmented.

The crucible fragments: summary

Level 5 and 6 crucibles are similar in the clear preference for a heavy admixture of rice chaff in the clay, a thick basal section and rarity of bronze slag adhering to them.

BRONZE: ARTEFACTS AND PIECES OF CORRODED METAL (figs 3-13/16)

During the course of excavating Ban Na Di, numerous pieces of heavily corroded bronze were found. Some comprised tiny flecks of green corrosion and were not retained. The recoverable pieces were catalogued and their provenances set out in the table below.

TABLE 3-15

Ban Na Di: fragments of corroded bronze

LEVEL	SQUARE							
	F6	A1	A1/2	A2	A2/3	A3	A3/4	A4
8	2	1	2	-	11	4	2	-

7	46	16	4	21	4	40	9	27
6	-	13	-	5	4	5	1	26
5	-	23	9	2	3	20	19	87
4	-	2	2	4	-	4	1	19
3	-	1	1	5	-	4	-	11
2	-	-	-	2	-	-	2	-

The bronze artefacts from Ban Na Di have been found in both mortuary and occupation contexts. The will be described by artefact type, beginning with the most abundant: the bracelet.

THE BRONZE BRACELETS FROM MORTUARY CONTEXTS

(* indicates artefact has been analysed for composition: see table 3-21)

F6 Cat. 1183 Burial 38 Mortuary Phase 1b

This bracelet has a plano-convex cross section. The flat side is on the lower edge. The outer edge is decorated with large tesselations that are also flat on the lower edge and domed on the upper one. Twentytwo knobs remain intact, the rest having been corroded or broken. Remnants of vegetable fibres are present on both surfaces. They have an internal diameter of 60.0 mm and the cross section measures 9.5 by 6.0 mm.

F6 Cat. 1228 Burial 36 Mortuary Phase 1b

A set of nineteen bracelets fused together. Though heavily corroded, they can be seen to be plain bracelets with a square cross section. Small pieces of cloth adhere to the surface. The maximum internal diameter is 54.0 mm and the cross section measures 2.5 by 2.5 mm.

F5 Cat. TS 62a-c Burial TS 16 Mortuary Phase 1b *

These three bracelets are fused together in one area. Their cross sections are in the form of a figure of eight, and parallel grooves run transversely round the outer surface. The maximum internal diameter measures 50.9 mm and the cross section, 2.9 by 10.9 mm.

F6 Cat 941 Burial 17 Mortuary Phase 1c

This plain bracelet has a circular cross section and an internal diameter of 92.4 mm. It has a barbed bevel clasp and the outer half of the surface is decorated with a pattern having the appearance of short square section wires set side by side and at an oblique angle to the vertical. This is described below as the false filigree technique.

F6 Cat. 1348 Burial 17 Mortuary Phase 1c

This specimen comprises a rolled coil of bronze, with a circular cross section. It is too small to be considered a bracelet, yet too large to be a finger ring. Its internal diameter is 33.0 mm.

A4 Cat. 1061 Burial 18 Mortuary Phase 1c

This is a small bracelet with a circular cross section. Its internal diameter is 55.0 mm and the cross section measures *c.* 3.5 mm. Matting and rice kernels were found adhering to the outer surface.

A3/4 Cat. 1378a-b Burial 48 Mortuary Phase 1c

These are hemispherical bracelets with a clay core. The upper quarter of the outer surface has a concentric row of knobs of *c.* 5 mm diameter, supported by a square wire running beneath them. The base has a pattern of rectangular ridges grooved concentrically and transversally. The inner surfaces of the bracelets are almost completely corroded away and flaws in both the bronze and the core caused by uneven firing can be seen in identical positions on each specimen. Woven fabric adheres to the surface of one of the bracelets. The maximum internal diameter is 52.0 mm.

A1 Cat. 427a-b Burial 5 Mortuary Phase 2 *

These are two fragmentary circles discovered in association with the jar burial of an infant. One appears to be a helix or coil with an oval cross section, the second is a rectangular band. The former has a maximum internal diameter of 27.0 mm and the latter, 26.0 mm. Cross section measurements are 3.5 by 3.0 and 3.9 by 2.0 mm respectively. It would be hard to fit these as bracelets onto a one or two year old child.

A1 Cat. 1431 Burial 8 Mortuary Phase 2 *

This tiny bracelet was found in association with the infant jar burial. It has an internal diameter of 20.0 mm and the cross section is plano-convex, measuring 1.0 by 2.6 mm.

A3 Cat. 231 Burial 3 Mortuary Phase 3

This heavily corroded bracelet is broken, but all pieces have survived. The band shaped cross section has grooves cut transversely into the narrow upper and lower edges. It is not an even width all the way round but it is possible that this is due to corrosion. Its internal diameter is 58.0 mm and the cross section measures 1.5 by 6.0 mm.

THE BRONZE BRACELETS FROM OCCUPATION CONTEXTS

F8 Level 7 Cat. 771

This specimen was found in the mortuary area of square F6, but was not found associated with any particular interment. It has a circular cross

section measuring 5.0 by 4.5 mm, and the internal diameter is *c.* 80.0 mm.

A2 40 Level 7 Cat. 802

These are very fragmentary and corroded pieces, some are fused together indicating more than one bracelet. The cross sections are circular.

F6 Level 7 Cat. 779

Only a short fragment of this bracelet remains. The exterior surface has a slight convex curve. The original flat inner surface has been lost but a thin core of yellowish clay remains. The bracelet original would have had a plano-convex cross-section. It has a cross section of 3.0 by 12.5 mm.

A2/3 Level 7 Cat. 1290

Four fragments of corroded bronze remain. Two of them are fused together which indicates either that they come from a coil or from more than one artefact. The cross section was probably circular. It measures *c.* 4.0 mm in diameter.

A4 19 Level 6 Cat. 360

The cross section of this bracelet has a marked convex-concave curve. There is no apparent clay core. It has an internal diameter of 51.0 mm and a depth of 7.5 mm.

A2 24 Level 6 Cat. 439

A piece of bracelet with a circular cross section. The diameter was *c.* 51.0 mm.

A3 18 Level 6 Cat. 349

This fragment has a circular cross section

A1 19 Level 5 Cat. 359

Four fragments of badly corroded bracelet appear to have an oval cross section. However the corrosian may have removed the original rectangular shape. The greater diameter is along the longitudinal axis.

A2/A3 14 Level 5 Cat. 1188b-c

Two fragments of bracelet. The first had a diameter of *c.* 67 mm and was *c.* 7.8 mm thick with a circular cross section. The second has a diameter of *c.* 55 mm and the cross section measures 2.8 by 3.4.

A1 14 Level 5 Cat. 200a-b

There are several fragments of badly corroded bronze. It is not easy to be sure what sort of artefact they come from. The internal diameter is

25.0 mm and the cross section measures 2.8 by 2.2 mm.

A2 20 Level 5 Cat. 305

This fragment of bronze has a bevel and barb at one end. The cross section is circular and fragment appears undecorated. It measures 3.4 by 3.4 mm.

A3 10 Level 4 Cat. 143

A rectangular cross-sectioned bracelet fragment, with a slightly convex outer surface. The long axis lies along its height. The internal diameter is 60.0 mm and the cross section measures 3.3 by 1.7 mm.

A2 16 Level 4 Cat. 202

A fragment of bronze rod with one end bevelled. The tip of the bevelled surface is rough which may denote a break. The unworked end has a circular cross section.

A2 17 Level 4 Cat. 214

A fragment of a bracelet with oblique transverse grooves on the outer surface. The pattern may have been formed using round cross-sectioned wax wires but it is much less precise in detail than other examples of this false filigree pattern found at the site, where the original wires used appear to have been square. One end of the fragment is pointed with one surface of the point flattened and the tip, broken and bent.

A4 8 Level 4 Cat. 90a-b

Laboratory analysis disclosed two items. The first is a slim oval cross-sectioned rod with a bevel and barb clasp at one end. Both the tips of the bevel and the barb have been lost. Its cross section measures 9.3 by 2.2 mm. The second object has a diameter of only 10.0 mm. It has an oval cross section, and was probably a ring.

A2 15 Level 4 Cat. 170

This specimen has a square cross section. The circle it forms is irregular and its ends are open. Whether the uneven form is due to its method of manufacture or whether it was broken under stress in unclear. The internal diameter is 16.0 mm and the cross section measures 4.5 by 4.5 mm.

A3 6 Level 3 Cat. 46a-b

Several completely mineralised fragments of narrow disc bracelets constitute this group. Two pieces fused together suggest that there were originally two specimens. The cross sections were apparently triangular and there is no decoration visible.

A3/4 7 Level 3 Cat. 1160a-b

The first of the two specimens has a small, uneven interior diameter. The

outer edge of the rectangular cross section has had grooves impressed transversely into the surface while it was still pliable. Presumably this occurred during the forming of the wax template. It measures 38.0 mm in internal diameter and has a cross section of 12.5 by 3.2 mm. The second set of fragments comes from a rectangular cross sectioned circlet with the long axis lying along its height. Its internal diameter of only 40.0 mm make it a very small specimen if indeed, it is a bracelet. The cross section measures 8.0 by 3.0 mm.

In addition to the relatively complete specimens which have been described individually, the following bracelet fragments were also identified:

TABLE 3-18

Ban Na Di: the bronze bracelet fragments

	Cat.	Provenance	Level	Diam. of c/s	Internal Diameter
*	203	A2 16	4	4.0 by 2.7	–
*	176	A2 15	4	fragment	
*	84	A3 8	4	fragment	
*	139	A3 11	4	fragment	
*	187	A3 13	4	fragment	
*	168	A2 15	4	1.6 by 1.6	–
*	141	A1 12	4	1.0 by 2.5	–
*	99	A4 9	4	2.0 by 2.5	–
*	145	A3 11	5	3.0 by 3.6	–
*	234	A4 16	5	3.2 by 2.8	–
*	229	A4 16	5	5.0 by 5.1	–
*	192	A4 14	5	4.0 by 4.0	–
*	200a,b	A1 14	5	2.5 by 2.0	–
*	215	A3 14	5	4.5 by 4.5	–
*	161	A1 13	5	2.8 by 2.8	–
*	275	A2 19	5	4.6 by 4.0	–
	1215	A3/4 13	5	– –	46.0
*	305	A2 20	5	3.4 by 3.4	–
*	182	A4 14	5	3.6 by 3.3	–
*	348	A3 18	6	3.0 by 8.0	–
*	349	A3 18	6	4.0 by 4.0	–
*	1088	A4 33	7	4.0 by 3.5	–
*	693	A3 24	7	2.0 by 14.0	–
*	1370	A3/4 30	7	3.4 by 3.8	*c.*20.0
*	830	A2 43	7	fragment	
*	828	A3 32	7	fragment	
*	869	A3 34	7	fragment	
*	1036	A3 41	8	fragment	

c/s: the breadth dimension is expressed first,
the depth dimension is expressed last.

THE BRONZE FINGER RINGS

No finger rings were found *in situ* in mortuary contexts, and indeed, no finger rings at all were found in levels 8–6. Table 3–17 sets out the details of this class of ornament.

TABLE 3–17

Ban Na Di: the bronze finger rings

Cat.	Provenance	Level	Diam. of c/s	Internal Diameter
* 62	A4 6	3	3.0 by 4.6	–
* 75	A2 8	3	3.7 by 3.4	15.7
* 79	A3 8	3	1.6 by 2.1	–
1868	A3/4 5	3	3.7 by 3.7	22.6
1159	A3/4 7	3	2.5 by 3.2	17.5
* 195	A2 16	4	2.0 by 5.2	16.8
* 193	A3 13	4	3.6 by 4.0	19.0
* 126	A1 11	4	2.8 by 4.0	11.2
*1162	A2/3 9	4	3.0 by 3.5	–
* 170	A2 15	4	4.6 by 4.8	14.0
* 154	A1 12	4	2.8 by 4.5	–
*1175	A2/3 11	4	2.0 by 2.9	–
* 174	A1 13	5	2.3 by 2.8	–

the first measurement expresses the breadth,
the second measurement expresses the depth.

THE BRONZE ANKLETS

Burial 29, that of a young child, was found wearing two solid bronze anklets, one on each ankle. They are identical, and particularly heavy. There is no apparent decoration, although one had the impression of textile on the inner surface and the other bore the remains of fabric and some matting. The internal diameter is 41 mm, and the cross section, which is circular, measures 12.1 mm.

BRONZE ARROWHEADS

There are at least three and possibly four quite distinct types of arrowhead.

F6 10 Level 7 Cat. 1884

This arrowhead was found in the vicinity of burial 38, but not in primary association. It has a tang and barbs, and the blade has central ribs for added strength. It is at least 40.0 mm long, but the tang is broken, so the actual length cannot be ascertained. The maximum breadth is 26.0 mm.

F6 7 Level 7 Cat. 1014 *

This specimen was also found in the mortuary area of F6. It has a concave base and no tang. It is 27.0 mm long and 22.5 mm wide.

A2 43 Level 7 Cat. 818 *

This specimen has a narrow blade, and no barbs. The tang is broken, so the length cannot be determined. It is 12.0 mm wide.

The function of the following four artefacts is not definite. They have in common a flat tang, and broad cutting edge with a convex shape. One specimen has a projection on the tang to facilitate hafting. It is possible that they were used as chisels, but this seems unlikely given their convex cutting edge. A more likely explanation, is that they represent specialised projectile points. The mould described above (Cat. 1299) was designed for the manufacture of this class of artefact. Details of provenance and size are as follows:

TABLE 3-18

Ban Na Di: the bronze arrowheads

Provenance	Level	Cat.	Length	Max width of cutting edge
F6 5	7	953	*c.* 48.0	28.0
A3 35	7	903	42.0	28.0
A1 32	7	752	55.0	40.0
F6 7	7	1014	*c.* 63.0	*c.* 54.0

THE BRONZE FISH HOOKS

F6 8 Level 7 Cat. 1867

This artefact takes the form of a small hook, probably intended for fishing. It has a clear point, but no surviving barb. It is 19 mm in length and 7.2 mm wide.

F6 11 Level 7 Cat. 1090 *

This specimen too, is probably a fish hook. There is a swelling at the end of the shank to assist in securing the line. Again, the barb end is missing.

THE BRONZE BEADS

These two artefacts are shaped like an inverted comma. Both come from the mortuary area of square F6 and they are cautiously interpreted as beads, because conservation has revealed in each case, a hole for suspension and the remains of thread in each. Details are set out in table 3-19.

A further specimen comes from A4 5 level 3 (cat. 54).* It is circular, and has the form of a hollow tube. It outer diameter is 11 mm and the inner hole, which runs lengthwise through the bar, is 4 mm in diameter. It purpose is unknown, but it may be a decorative bead.

TABLE 3-19

Ban Na Di: the bronze beads

Provenance	Cat.	Level	Length	Width
*F6 11	1261	7	25.0	16.0
*F6 4	1885	7	25.0	16.0

THE BRONZE BOWLS

The purpose of these deep ribbed artefacts is not known for sure, but they were broken along one edge, which makes it seem likely that they were the rim fragments of bronze vessels. Moreover, cat. 56 shows structural features which are consistent with quenching. Most known quenched objects are vessels.

TABLE 3-20

Ban Na Di: the bronze bowls

Provenance	Cat.	Level	Diameter	Depth
* A3/4 6	1153	3	*c.* 140.0	30.5
* A3 6	56	3	-	-
* A3 8	83	4	*c.* 128.0	33.0

THE BRONZE BELLS

A2/A3 14 Level 5 Cat. 1188a

Part of a small bell, with a perforated handle. It was formed from square-sectioned wax filaments. Two parts of a hemisphere formed the lower half while a third capped them. A double coil of wax was then placed on top to form a loop. The bell has a maximum height of 21.0 mm and maximum circumference of 14.0 mm. The surface of the bell has raised, curvilinear decoration.

A1 3 Level 2 Cat. 1597

A bell, complete with a handle. It was formed from two domed ellipses joined only on the upper half. A flat, irregular rectangle with an equally irregular oval hole through it forms the loop. It is patterned with grooves running laterally but whether formed from sheet or wax filaments is not clear. A piece of iron is attached to the side, probably without intention. The maximum width is 31.7 mm, and height 33.5 mm.

A1 1 Level 2 Cat. 1877

This small bell is in the form of an uneven ovoid. It was formed by winding wax filaments round a clay core starting at the shoulder and then down the front and back in a narrow oval. The coiling continued in this way until the waxen form of the bell was complete. The handle is a loop of bronze with a piece of bronze standing perpendicularly from it rather in the manner of a forked twig. An iron ring is attached to the loop.

These three bells show quite considerable differences in size, shape and decoration. All three use the false filigree patterns, but differ in the manner of execution. One and possibly two were made by intricately coiling fine wax filament around a clay shape which may contain a small stone. The third appears to have been made from two domed ellipses being moulded over the core and joined with wax across the top half leaving the lower portion open. It would probably be at this stage that impressions were made.

Each of the bells has a different type of loop or handle. Cat. 1188a has a double spiral loop set with the hole parallel to the long axis. Cat. 1877 appears to have a handle set onto a loop which in turn has

the hole at right angles to the long axis and the rather irregular rectangle of cat. 1597 is also set in this manner. These differences may well indicate different uses.

When the bell was cast, the clay core was removed and the stone remained as the clapper. None of these bells have stones in place, but all are broken to the point that the stone could have been lost.

THE LEAD-TIN ALLOY CASTING SPRUE

This most interesting artefact comes from A3/4 12 level 4. It comprises the remains of the alloy which, it is held, was used to fill a stone mould in creating a template. This template would then have been covered in clay, and the lead melted out in a process similar to the *cire perdue* technique. This procedure would have safeguarded stone moulds from cracking because lead has a much lower melting point than bronze. It is most unusual for such an object to survive since of its very nature, it would have been melted or reused. This particular specimen has a flat top, tapering to a circular end which would have filled the casting vent. It is 15.3 mm high, and the casting vent was circular, with a diameter of 2.8 mm.

THE BRONZE TECHNOLOGY

(N. Seeley and W. Rajpitak)

In examining prehistoric copper alloy artefacts and related material from an excavation, the main questions to which an answer may be sought include the following. What types of metal ore were used, and what was their provenance? How was the smelting, refining, alloying and fabricaton carried out? Were particular alloys selected for specific functional or decorative purposes? Can a chronology be established for the introduction of particular alloys or fabrication processes? Is there any evidence for trade in metal artefacts, or for the borrowing of techniques? It is rare that all these questions can be answered for any particular site, as one would not normally expect to find contexts containing metal extraction, occupation, and burials together. Nevertheless, it has been found possible to answer a significant number in the case of Ban Na Di, as we have evidence of occupation and burials over an extended period, with finds proving the presence of secondary metallurgical operations such as alloying and casting.

The copper alloy artefacts from Ban Na Di fall into three functional categories. The great majority consist of personal ornaments, especially bracelets and rings. Utilitarian artefacts with cutting edges are represented by a group of arrowheads, and the third category comprises fragments of containers, which would have served both a decorative and utilitarian function. The reason for considering these as a separate category will become apparent later. The very limited number and range of utilitarian artefacts is probably explained partly be the nature of the site, with many of the finds coming from burials, and partly from the fact that for much of the occupation period iron was available, and would have been preferred for such artefacts for both technological and economic reasons.

THE CONDITION OF THE COPPER ALLOY ARTEFACTS AND THE RELIABILITY OF THE QUANTITATIVE ELEMENTAL ANALYSES

The conditions for the preservation of metals at Ban Na Di are not very favourable, and the majority of the copper alloy artefacts are badly if not completely corroded. Table 3-21 shows the analyses for copper as measured, and also by difference from 100%. For uncorroded artefacts, the latter is generally more accurate, but where corrosion exists, indicated in table 3-21 by one, two or three asterisks corresponding to its extent, the first figure should be taken. In the case of the more corroded artefacts, it is dangerous to place any reliance on the numerical values theselves, as the component elements may be leached out to differing extents, but rather one may use the analyses as indicators of the type of alloy used. As will be shown below, this usually gives all the information which is required.

TABLE 3-21

The composition of the analysed bronze artefacts from Ban Na Di

level	prov	cat.no	artefact	Cu	Sn	Pb	As	Sb	Fe	Ag	Ni	Co	Bi	Zn	Cu (100-x)
***8	A2/3	33 1290	bracelet	66.279	4.968	.0	.0	.0	.007	.007	.0	.0	.0	.0	95.018
***8	A3	41 1036	bracelet	54.934	8.556	.0	.0	.0	.265	.0	.034	.0	.012	.077	91.057
***8	A1	40 987	fragment	24.633	12.357	.0	.013	.0	.291	.052	.0	.0	.445	.0	87.242
7	F6	4 1885	comma pendant	96.464	.157	9.129	.065	.118	.051	.340	.012	.002	.002	.021	90.105
7	F6	4 1885	comma pendant	96.758	.0	8.787	.110	.105	.049	.323	.012	.012	.014	.0	90.596
* 7	F6	11 1261	comma pendant	74.359	7.051	.158	.035	.041	.237	.278	.030	.0	.0	.0	92.169
***7	A2	43 818	arrowhead	26.631	2.372	.0	.0	.0	.202	.627	.0	.0	.0	.0	86.091
** 7	F6	5 953	arrowhead	40.799	.754	.0	.0	.0	.358	.0	.0	.0	.0	.0	98.888
***7	F6	7 1012	arrowhead	57.914	.981	.0	.0	.0	.093	.0	.0	.0	.0	.0	98.926
7	A3	35 903	arrowhead	61.084	7.646	.0	.0	.0	.131	.096	.001	.0	.016	.0	92.114
***7	A1	32 752	arrowhead	53.826	1.436	.0	.0	.0	.083	.0	.0	.0	.017	.0	98.463
***7	F6	11 1090	fish hook	1.878	.0	.0	.0	.0	.328	.0	.0	.0	.0	.0	99.671
***7	F6	1 799	bracelet	8.845	.797	.0	.0	.0	.456	.0	.0	.0	.0	.0	98.751
***7	A2	43 830	bracelet	12.619	5.438	.0	.0	.0	.176	.0	.0	.0	.033	.0	94.352
7	A3/4	30 1370	bracelet	71.896	7.808	1.163	.772	.006	.064	.341	.019	.0	.064	.0	89.759
***7	A3	32 826	bracelet	43.502	2.952	.0	.0	.0	.199	.023	.0	.0	.0	.0	96.826
** 7	A2	40 802	bracelet	56.668	4.677	.0	.0	.0	.207	.0	.0	.0	.0	.0	95.116
***7	A3	34 869	bracelet	50.061	5.582	.0	.0	.0	.080	.0	.0	.0	.0	.0	94.338
***7	A3	24 893	bracelet	38.137	7.796	.0	.0	.0	.124	.0	.0	.0	.0	.0	92.079
***7	A4	33 1086	bracelet	57.724	4.824	.0	.0	.0	.008	.0	.0	.0	.0	.0	95.167
***7	F6	9 1048	two spheres	59.394	7.002	.0	.005	.016	.277	.222	.004	.0	.009	.0	92.464
***7	F6	5 983	fragment	57.304	.491	.0	.0	.0	1.984	.0	.0	.0	.0	.0	97.525
***7	F6	10 1084	fragment	48.806	10.362	.0	.166	.0	.221	.092	.0	.0	.020	.0	89.139
***7	A2	38 726	fragment	72.684	3.559	.0	.0	.0	.0	.0	.0	.0	.0	.0	96.441

level	prov	cat.no	artefact	Cu	Sn	Pb	As	Sb	Fe	Ag	Ni	Co	Bi	Zn	Cu (100-x)
6	A3	18 349	bracelet	93.867	3.958	.746	.058	.041	.048	.538	.013	.0	.051	.015	94.531
***6 F 5	B.TS16	Cat.TS62a	bracelet	91.588	4.584	.0	3.557	.0	.087	.0	.0	.0	.0	.0	91.521
***6	A3/4	20 1258	bracelet	62.411	6.461	.0	.0	.0	.005	.0	.0	.0	.0	.0	93.533
** 6	A4	19 1126	bracelet	39.212	.049	2.303	.082	.0	.038	.0	.0	.0	.0	.0	97.427
***6	A3	18 348	bracelet	55.285	9.578	.193	.0	.002	.061	.0	.008	.0	.008	.0	90.149
***6	A4	19 345	fragment	39.930	3.802	.0	.787	.049	.086	.0	.0	.0	.0	.0	95.475
***6	A4	19 361	fragment	60.799	5.944	.0	.0	.0	.017	.0	.0	.0	.0	.0	94.039
***6	A3	17 294	fragment	55.507	.855	.704	.0	.0	.119	.0	.0	.0	.0	.0	98.320
5	A4	14 192	bracelet	89.897	3.129	1.164	.030	.027	.069	.153	.017	.0	.012	.0	95.399
5	A4	16 229	bracelet	75.905	5.919	9.009	.105	.037	.069	.069	.009	.0	.009	.0	84.771
5	A2	19 275	bracelet	91.501	8.511	2.387	.219	.080	.046	.102	.026	.0	.008	.025	88.595
* 5	A2	20 305	bracelet	74.274	8.427	8.858	.129	.062	.109	.201	.014	.0	.011	.0	82.187
5	A4	14 182	bracelet	75.342	8.137	22.107	.165	.095	.057	.387	.030	.0	.011	.0	69.011
5	A4	16 234	bracelet	92.619	4.248	.255	.078	.064	.054	.164	.018	.0	.015	.023	95.081
***5	A3	14 215	bracelet	68.012	.925	4.589	.036	.0	.059	.0	.0	.0	.0	.0	94.379
5	A1	13 161	bracelet	91.564	6.404	1.099	.056	.0	.064	.0	.0	.0	.0	.0	92.378
***5	A1	14 200	bracelet	53.629	14.318	.0	.0	.124	.023	.0	.0	.0	.0	.0	85.534
***5	A	13 174	ring	44.711	26.999	.0	.0	.0	.088	.0	.0	.0	.0	.0	72.912
***5	A4	1 298	fragment	42.709	11.660	.568	.0	.035	.008	3.761	.0	.0	.0	.0	83.967
5	A4	8 298	fragment	73.003	12.028	12.831	.136	.511	.021	.0	.0	.0	.0	.0	74.473
***5	A4	15 222	fragment	53.060	4.593	6.090	.130	.0	.050	.0	.0	.0	.0	.0	89.136
***4	A1	B.5 427	bracelet	52.219	11.456	.0	.0	.021	.093	.0	.0	.0	.0	.0	88.431
***4	A3	11 139	bracelet	21.285	.0	8.494	.0	.0	.230	.043	.0	.0	.0	.0	91.233
***4	A3	8 84	bracelet	9.543	7.928	.0	.0	.0	.443	.0	.0	.0	.0	.0	91.629
4	A4	8 90	bracelet	68.778	16.019	26.117	.073	.021	.058	.234	.012	.0	.024	.0	57.442
** 4	A2	15 188	bracelet	82.085	3.398	11.439	.470	.029	.111	.348	.027	.0	.065	.0	84.112
** 4	A4	9 99	bracelet	69.824	5.460	4.012	.806	.068	.186	.148	.034	.0	.136	.0	89.148

level	prov	cat.no	artefact	Cu	Sn	Pb	As	Sb	Fe	Ag	Ni	Co	Bi	Zn	Cu (100-x)
* 4	A1 12	141	bracelet	62.691	10.627	13.609	.449	.115	.091	.338	.021	.0	.089	.0	74.661
4	A3 11	145	bracelet	77.197	10.179	4.060	.526	.109	.077	.344	.034	.0	.111	.0	84.549
* 4	A3 10	143	bracelet	64.681	9.936	15.353	.803	.116	.070	.104	.037	.0	.183	.0	73.396
***4	A3 8	83	bowl	57.374	12.106	.091	.045	.062	.101	.077	.0	.0	.0	.0	87.517
***4	A4 9		bracelet	48.366	14.265	.042	.016	.087	.176	.0	.009	.0	.0	.0	85.404
4	A2 16	203	bracelet	82.189	9.145	10.977	.202	.0	.405	.022	.0	.0	.0	.0	79.249
***4	A2 16	214	bracelet	43.627	20.888	.0	.0	.0	.0	.0	.0	.0	.0	.0	79.112
***4	A3 13	187	bracelet	56.642	14.928	.022	.0	.051	.061	.0	.0	.0	.0	.0	84.938
***4	A1 B.8	1431	bracelet	52.813	14.621	.0	.0	.0	.005	.0	.0	.0	.0	.0	85.374
* 4	A3 B.1	79	ring	70.065	11.898	8.119	.221	.077	.109	.406	.023	.0	.100	.0	79.045
***4	A1 12	154	ring	32.309	8.694	3.098	.039	.0	.416	.0	.0	.0	.0	.0	87.753
4	A3 13	193	ring	96.678	1.148	.720	.049	.037	.058	.157	.013	.0	.015	.005	97.798
***4	A2 15	170	ring	41.789	2.288	.0	.0	.0	.453	.0	.0	.0	.0	.0	96.758
***4	A2 16	195	ring	54.681	5.040	.215	.097	.0	.065	.0	.0	.0	.0	.0	94.582
***4	A2/3 9	1162	ring	37.202	12.248	.0	.0	.0	.0	.0	.0	.0	.0	.0	87.752
***4	A1 11	126	ring	49.145	18.272	.234	.017	.0	.815	.0	.0	.0	.0	.0	80.660
***4	A2/3 11	1175	ring	52.118	3.132	6.124	.018	.0	.326	.0	.0	.0	.0	.0	90.399
***4	A3 9	98	fragment	28.257	.982	.0	.0	.0	.248	.121	.0	.0	.0	.0	98.648
4	A4 12	133	fragment	62.057	29.455	.0	.109	.012	3.598	.0	.009	.0	.0	.0	66.815
4	A2 15	176	bracelet	59.132	20.210	.0	.0	.0	.023	.0	.0	.0	.0	.0	79.766
3	A4 5	54	? bead	89.907	14.099	.197	.078	.036	.209	.281	.049	.0	.025	.0	85.026
***3	A3/4 6	1153	bowl	42.132	3.929	.0	.0	.0	.209	.184	.001	.0	.017	.0	95.681
***3	A3 6	56	bowl	55.078	6.703	.007	.0	.034	.134	.198	.0	.0	.0	.0	92.924
** 3	A3/4 7	1160	ring	56.053	15.776	3.240	.271	.066	.163	.021	.039	.9	.063	.0	80.359
***3	A4 6	62	ring	33.812	5.876	1.233	.032	.003	.207	.0	.0	.0	.0	.057	92.590
***3	A2 8	75	ring	55.333	14.024	.0	.0	.051	.058	.0	.0	.0	.0	.0	84.866

*-*** indicates degree of corrosion from light to heavy

MICROSTRUCTURAL EXAMINATION

Samples of several of the artefacts were examined by the techniques of optical metallography and electron probe microanalysis. The latter is of value for carrying out analyses for ascertaining from the structure of the metal, the extent of mechanical and heat treatment it has undergone, and hence the methods of fabrication which have been used in antiquity. In most cases, the technological information can be gleaned from surface examination of the artefact, but in case of doubt, or where unusual alloys were known or suspected to have been used, a small fragment of metal was cut out, mounted in polyester resin, ground, polished and examined with the aid of these techniques. The most important general conclusion relating to the Ban Na Di metalwork, and early Thai bronzes in general, is that decorative objects were fabricated by casting wherever possible, and other fabrication techniques such as cold working and joining were strenuously avoided.

COPPER ALLOYS UTILISED

UNALLOYED COPPER: there is as yet very little evidence for the use of unalloyed copper for artefact fabrication in Thailand during the prehistoric period. Those artefacts from Ban Na Di which show the lowest tin content are highly corroded, and were probably all normal low tin bronzes. The reason for this lack of copper artefacts is not so clear. Given that the knowledge of alloying with tin existed at a very early stage in copper metallurgy in Thailand, there would still have been decorative and functional occasions for the use of nominally pure copper. One possibility is that the copper ores exploited in Thailand in the early period usually contained a small amount of tin, but this does not explain items like cat. 2281, which, while not of pure copper, but a copper-lead alloy, contains a negligible quantity of tin. It will only be possible to resolve this question completely when primary metal smelting sites can be properly excavated and investigated, and ore analyses carried out.

LOW TIN BRONZE: forty-two of the objects from Ban Na Di (54%) were binary low tin bronzes, containing originally between 2% and 14% tin. These were largely bracelets, but also included all five of the arrowheads analysed, and six of the pieces of scrap bronze or casting spills. This alloy is suitable for both cold working or both, and is a better colour than leaded tin bronze although the latter is better for precision castings.

LEADED COPPER: This rather unusual alloy was represented by three objects (3.8%) Cats. 139 and 360, both highly corroded bracelet fragments, may originally have contained more tin than the analyses indicate. Cat. 2281, a comma-shaped bead, is most interesting because it is almost identical with cat. 1261, which is however, a normal low tin bronze. Leaded copper may be cast easily, but the main point of interest of these items is their lack of tin, suggesting that relatively pure copper was available, at least from time to time.

LEADED TIN BRONZE: this alloy was found in twenty-five objects (32%), all rings or bracelets except for three pieces of casting scrap. From a technological point of view, this is the optimum alloy for casting

decorative objects as it produces a metal of reasonable colour, with an improved fluidity and hence ease of casting conferred by the presence of lead. The alloy has poor mechanical properties, tending to fracture along the grain boundaries, and is therefore not normally used for the manufacture of tools and weapons. It would be interesting to determine whether or not there is a chronological implication in the introduction of leaded tin bronzes in Thailand, whether it has any regional significance, or whether it merely reflects the fluctuating availability of lead, as it certainly does not relate to the function of the artefacts cast in it (see below for an analysis of this point).

HIGH TIN BRONZES: three items (cats. 12, 58 and 133) were certainly binary high tin bronzes, and two further items (cats. 83 and 1153) were probably also of this type. We have shown elsewhere (Rajpitak and Seeley 1979) that this alloy was probabaly chosen because it had a closer resemblance to gold than any other copper alloy known before the advent of brass. It was however, most difficult to fabricate, requiring to be hot worked in a very critical temperature range, and then quenched from that temperature in order to prevent it becoming extremely brittle. The composition range was also highly critical, ideally very close to 24% tin, thus necessitating considerable precision in alloying. For these reasons, the alloy was only used for certain luxury wares, principally vessels and items of jewellery, at a period around the beginning of our era. It appears probable that the alloy was first produced in Southeast Asia, where tin was plentiful, and utilised to a limited extent in parts of South and East Asia and the Near East up to about the 12th century, when brass became readily available. It appears to have been completely unknown to the prehistoric and classical civilizations of Europe or Western Asia.

THE TRACE ELEMENTS

In addition to the technologically significant elements which were added intentionally in order to modify the properties of the copper, in this case tin and lead, analysis was carried out for a further eight elements, namely arsenic, antimony, zinc, silver, bismuth, iron, cobalt and nickel. The first four of these may be found as intentional components of copper alloy formulations, the last four occur only as accidental traces in these alloys.

ARSENIC: No intentional arsenical bronzes are known from Thailand, although most of the copper alloy artefacts analysed contained 0.1–0.5% arsenic, and a few as much as 1.6%. This is perfectly in line with analyses from other parts of the world, where arsenic as an impurity in copper ores may give trace concentrations varying up to about 2%. One apparent anomaly is found in cat. 137, a rectangular section bracelet. This was highly corroded, but the analysis of an area of relatively sound metal gave arsenic 3.56% and tin 4.85%. The presence of tin shows that this was not an arsenical bronze in the accepted sense, and if the arsenic were added intentionally it was probably done in order to whiten the surface of the metal. It is considered more likely, this is an example of an exceptionally high arsenic level accidentally derived from the particular metal ore used.

ANTIMONY AND BISMUTH: Arsenic, antimony and bismuth are chemically similar, and tend to occur in the same mineral suites. It is not therefore surprising that many of the artefacts contained both antimony and bismuth, generally in levels below 0.1%. In the absence of detailed information about possible ore sources, nothing further can be gained from the concentrations of these elements, although they are potential markers for ore source identification.

ZINC: Zinc occurs in traces in several of the artefacts, but with no observable correlations. It is probably widespread in the ores, but on extraction and refining, is usually retained in quantities below the limit of detection. It is however, present in more artefacts from Ban Na Di than from other sites in Thailand from which artefacts have been analysed.

SILVER: Silver was found in many of the samples analysed, in quantities ranging up to about 0.5%. One sample (cat. 298) showed 3.76% silver, but this was highly corroded, and local enrichment is the probable cause, although the accidental incorporation of a little silver in scrap metal cannot be excluded. Silver was certainly used for the manufacture of decorative objects in Thailand during the later prehistoric period.

IRON: The presence of iron in bronze is of no significance with regard to ore sources, rather, it is indicative of the reducing conditions within the smelting furnace, and the type and extent of the refining process. With one exception, the iron content of the artefacts from Ban Na Di falls within the range normally observed for copper smelted in small primitive furnaces. In one sample (cat. 133, a high tin bronze), 3.6% of iron was found. This also showed up in the microstructure, as white inclusions of metallic iron. Although iron concentrations as high as this, or even higher, are common in copper of the late period from many areas, e.g. Northern India in the protohistoric period, we have not previously observed it in a high tin bronze. Its presence here is certainly not intentional, and probably results from the utilisation of copper smelted in a furnace of improved design, which is quite consistent with the relatively late date of this type of alloy.

COBALT AND NICKEL: These are both common impurities in copper ores, and may be of some value for provenancing purposes. It is perhaps significant that cobalt is absent from most of the Ban Na Di bronzes, although present more ofen than not in material from other sites. Again, detailed ore analyses are required before any interpretation can be offered for these data.

FUNCTIONAL CHOICE OF ALLOY

EDGED TOOLS: The only copper alloy edged tools from Ban Na Di were the arrowheads. As might be expected, all five which were analysed were found to be binary tin bronzes, and although they were badly corroded, the metallographic evidence points to their having been cast, annealed, and

cold worked on the cutting edge to harden and sharpen them. The absence of lead from all five strongly supports the view that he choice of alloy was firmly based on a knowledge of its properties, and in critical applications the most appropriate formulation was selected.

DECORATIVE ARTEFACTS: Most of the artefacts examined were decorative, and were fabricated by casting. Almost all consisted of low tin bronzes (60.5%), or leaded tin bronzes (36%). This is completely in line with what has been found at other prehistoric sites in Thailand.

LUXURY ITEMS: A small number of artefacts were found to be quenched high tin bronzes, with a nominal composition of copper, 76% tin, 24%. These occur on a number of later prehistoric sites in Thailand, and date from probably the second and first centuries BC and AD. They almost always comprise vessels, or small personal ornaments. None of them had completely normal microstructures for this class of alloy, and they may represent an early or degenerate aspect of this specialised metallurgical technique. As explained above, the difficultiues in producing and fabricating this particular alloy must place these objects in a category of their own, reserved for certain luxury decorative items.

THE METALWORKING TECHNOLOGY

There is no evidence of extractive metallurgy at Ban Na Di, nor would this be expected at a normal habitation site. There is, however, ample evidence of secondary metallurgical operations, in the form of crucible fragments, moulds, metal spills and furnaces. This is consistent with local alloying and casting operations, using metal brought in from outside.

The size of the crucibles, as deduced from the fragments and the two complete specimens, is such that melting and alloying was probably carried out on a scale which would have allowed the casting of only one of the larger, or several of the smaller, ornaments at a single pouring. Although at least two piece mould were found in the excavations, the majority of the items were certainly cast using the *cire perdue* process, and the existence of piece moulds does not prove that the final casting was carried out in them, as it is certain that in some cases they were used to replicate wax models for casting by the lost wax process.

The great majority of the decorative artefacts were cast, and no doubt surface finished, but not annealed or mechanically worked in any way. There are however exceptions, e.g. cat. 176, which has been heavily worked and annealed, but it is just possible that this is not, as was originally thought, a fragment of bracelet, but rather, part of an edged tool.

Although only a limited number of the metal spills were analysed, it would seem likely that the few items of high tin bronze identified were fabricated elsewhere and imported, rather than being of local manufacture.

THE LEAD-TIN CASTING SPRUE

An important and enigmatic item, cat. 1208, is certainly the solidified metal from the pouring cone of a mould. Its composition is approximately one part of tin to three of lead, which would have solidified between about 180 and 270°C. This can be only one of two things: the sprue broken from an object cast in this particular alloy, or part of a pattern made of a low melting alloy instead of wax, for casting purposes. Although a few small objects of tin have been found in a burial at Ban Don Ta Phet, artefacts of lead-tin alloy are so far unknown from prehistoric Thailand. This of course does not mean that they did not exist. On the other hand, over a century ago Sir John Evans discussed finds of prehistoric lead artefacts associated with remains from casting workshops, and evidence for lost lead casting has recently been reported in Vietnam. In a hot climate, such a process would doubtless have advantages over one using wax, and the molten alloy would not damage sandstone or even wooden moulds.

THE BRACELET CATCHES

Of particular technological interest are the bracelets with catches (fig 3-17). These are notably "modern" in style, and the first examples of such a device we have observed from a prehistoric context. The simpler bracelets are circular in section, with bevelled ends incorporating an undercut, allowing them to be pressed together and locked. The decorated, flattish sectioned, bracelets are more sophisticated. The ends each terminate in half a mortise joint, which when locked together is largely concealed by the decoration. These form a not insignificant achievement in metalworking technique, requiring both precision in manufacture, and the use of tools capable of cleanly cutting or abrading the metal.

METALOGRAPHIC STRUCTURE

Many of the artefacts from Ban Na Di were corroded to the point that no useful analysis of the metalographic structure could be undertaken. The following seven specimens were however, analysed.

A2 43 Level 7 Cat. 818

This specimen is an arrowhead. The structure consisted of equiaxial grains, with a lot of corrosion product. The object was cast, then annealed; the edge may have been worked.

F8 4 Level 7 Cat. 1885

This specimen is a pierced bead or pendant. The structure comprised cored dendrites in (α+δ) eutectoid. The eutectoid was present in a small amount due to the low content of the tin in the alloy. There are also small black lead globules. The object was cast.



FIGURE 3-17

The bronze bracelet catch from Burial 17 (Cat. 941). Scale 2:1.

A1 13 Level 5 Cat. 161

This object is a bracelet recovered in three pieces. The structure consisted of cored dendrites with very little $\alpha+\delta$ eutectoid. There are a few black lead globules, and the object was cast.

A4 12 Level 4 Cat. 133

This object is a fragment only, and may derive from a bracelet. The structure revealed a large grain of β_2 phase (β_1 or γ phase in some texts) with $\alpha+\delta$ eutectoid inside the grain, the α-phase forming along the original β grain boundaries. The leaf-like phase is αphase. The α-phase seems to form a Widmanstatten pattern in the β-grains. The decomposition of β-grains into $(\alpha+\beta)$ eutectoid is only partial. The very dark dots are iron inclusions; before etching these appear as silvery metallic inclusions. From the analytical results, the composition of tin in this sample was 29 wtpercent tin. The object was cast and quenched from the β_2 region (β_1 ordered region or γ region at around 600°C into water.

A2 15 Level 4 Cat. 176

This specimen comes from a bracelet. The structure consisted of twinned α phase in $(\alpha+\delta)$ eutectoid, the α-phase is small. The object was cast, then worked and annealed.

A4 5 Level 3 Cat. 54

The structure of this circular bead consisted of cored α-dendrites with a small amount of $(\alpha+\delta)$ eutectoid in the interdendritic space. The object was cast.

A3 6 Level 3 Cat. 58

This object was possibly a neckring. It was very badly corroded. The structure is α-phase in the corroded unidentified background. In some areas, the corroded background showed features of β-martensite. This object was probably cast and quenched from the $(\alpha+\beta)$ region (588-798° C into water.

THE ANALYSIS OF BRONZE WIRE

R. Maddin and Y.Q. Weng

The observations reported on were made by Y.Q.Weng in a study in partial fulfillment of the requirements of a laboratory course given by R. Maddin at the University of Pennsylvania in the autumn of 1983. We are most grateful to Professor Maddin for allowing us to include this section, and it must be clearly appreciated that it is a highly tentative statement produced as part of his on-going research on the Ban Na Di 'wire' and crucible fragments. Unfortunately, five illustrations which were to have appeared on pages 138-141, remained unavailable at the time of going to press. Consequently, these pages do not appear below.

The stone bracelets are illustrated in fig 3-6. In four cases, it is noted that holes were bored adjacent to fractures across the bracelet, and the pieces were held together with a metal wire. In one instance, (cat. 1307), a segment from the outer edge of the bracelet was secured in the same manner. In the last case, the action was clearly intended to effect a repair. In the balance, there are two possible explanations. One is that the bracelets were repaired when broken accidentally. The second, is that they were deliberately fractured and the bronze wire was inserted in order to facilitate periodic removal from the wrist. Certainly, the diameter of the bracelet was so small that without such a technique, it could not have been removed at all.

The presence of a metal wire at Ban Na Di during mortuary phase 1a, that is the early first millennium BC, is intriguing, and steps were taken to investigate the alloy used and the method of working the metal. It is here emphasised that the results described below are extremely preliminary and tentative, and much more research is necessary to confirm or modify the conclusions which are offered.

The bracelet from burial 45, mortuary phase 1a was chosen for detailed analysis.

Following the cleaning of the area in the vicinity of the join and the 'wire' of corrosion products a series of metallurgical observations were made. These included the measurement of hardness, observation with the aid of the scanning electron microscope equipped with EDAX (Energy Dispersive X-Ray Analysis) and the determination of the chemical composition of the metal using EDAX. These observations were augmented by use of optical microscopy to determine various aspects of the metallurgical structure as well as to determine whether shaping of the bracelet by cold forging methods was used.

As shown by the S.E.M. (scanning electron microscope) in fig 3-18, the cross-section of the wire is semi-circular rather than circular. The height is 3.2 mm, the width about 6.0 mm. The microstructure of both the transverse and longitudinal sections is the same, i.e., a fine equi-axed grain size about 10 microns (0.01 mm) in diameter (the transverse section is seen in fig 3-19). If the metal had undergone cold hammering in the shaping process the grains would have been elongated in the longitudinal direction. At a still higher magnification, (x1000), the skeleton of a cast structure surrounds the grains (fig 3-20). We conclude, therefore, that the 'wire' was cast in place in the bracelet. The chemical composition of the grain boundary area was obtained with use of the EDAX and standards within the apparatus. This method of determining the chemical composition is doubtful even as a semi-quantitative indication of the elements and certainly does not give the exact composition. It is, however, accurate to say that the alloy used in the join of the parts of the bracelet consists of a ternary alloy of copper-arsenic-tin, i.e., a copper-base alloy "high" in tin and with notable amounts of arsenic. Such an alloy was most likely made from smelting a copper mineral high in arsenic by adding the mineral cassiterite to the copper arsenic ore. To have added the metal tin to the molten copper-arsenic alloy would have required a reducing atmosphere to prevent the loss of arsenic by evaporation, a sophisticated process we consider unlikely in those times. The chemical composition of the matrix, determined by the same method (EDAX), is shown in table 3-22. The arsenic is lower and the copper higher by about the same amount indicating that much of the arsenic has formed a second phase situated in the grain boundary areas.

There is a notable difference in the microstructure from the centre to the near surface regions of the 'wire' as shown in fig 3-19. In that figure, a demarcation line is detectable. The difference in the microstructure however, is in the form of a rod-like microstructure in the centre but a more equi-axed grain size in the area adjacent to the surface. We consider this difference to have been caused by a different cooling rate during solidification.

Table 3-23 shows the microhardness readings across the metal from the surface to the centre (after removing the corrosion layer). The difference in the readings is consistent with the variation in the grain size. If the 'wire' had been made by a cold working method there would not have been any difference in the microhardness readings.

CRUCIBLE FRAGMENT

A typical crucible fragment is shown in fig 3-21. The crucible comes from A4, level 8 and is dated to *c.* 1500-800 BC. It was made of clay in a circular form with an outside diameter of 75 mm and an inside diameter of 55 mm. A sample, shown in fig 3-21, was removed from the crucible. There were many small copper droplets surrounded by clay and pieces of green and blue slag. One of these droplets shows a typical dendritic pattern characteristic of a cast metal.

Since the crucible could have been used either for smelting or for melting, use of the EDAX apparatus associated with the SEM was employed. The sample shown in fig 3-21 was analysed and gave the elemental results shown in table 3-24. The analysis shows that the bead is essentially copper with about 3% arsenic.

The slag, also analysed by the same method, gave the results shown in table 3-25. Oxygen was determined in association and shows substantial amounts, e.g., the copper (in the slag) was essentially CuO.

We believe that the crucible was used for melting rather than smelting for the following reasons:

1. It would have been impracticable to smelt in such a small crucible (55mm inside and 75mm outside diameters).

2. The high content of the copper (28.6% by weight) as CuO in the "slag" and the low content of the iron (0.154% by weight) in the copper bead indicate a strong oxidising condition in the melting process. In a smelting process there would have been a much smaller content of copper in the real slag and a higher iron content in the copper bead.

3. The magnesium and calcium, in the forms of MgO and CaO respectively, were either added in the melting process to increase fluidity of any slag or, more likely, came from the clay of the crucible.

For these reasons we consider the crucible as having been used for melting. Furthermore, since the excavation reports mention many such crucible fragments, all very much the same as analysed herein, with no indication of more extensive and decisive smelting scoriae, the people of Ban Na Di were involved with the melting of alloys, most likely obtained as alloys rather than making alloys since no pieces of copper and tin were discovered in association with the crucibles.

DISCUSSION

These studies indicate that the people of Ban Na Di were very much acquainted with an alloy melting technology as well as a casting tradition certainly by the middle of the second millennium. There may have been an interrelation between the inhabitants of Ban Na Di and the nearby peoples of Ban Chiang (see fig 9-1). On their own these analyses show a unique method for either repairing or creating a stone bracelet which could be expanded as the wearer required by separating the bracelet and connecting it by casting a thin D-shaped 'wire' of a ternary alloy (Cu-Sn-As) in small drilled holes. The ternary alloy, having a relatively low melting temperature, allowed the solidification of the casting technology without much evaporation of the arsenic volatile at the melting point of the copper. It is of interest that the alloy used in the repair technology is the ternary Cu-Sn-As whereas the metal from the crucible was copper with less arsenic. The bracelet, excavated from a burial dated

to ca. 900–700 BC, was at least 300 years later than the crucible. Does this indicate a realization of the castability of a ternary alloy obtained by the metalsmiths of Ban Na Di not available 300 years earlier? We assume that there must have been some sort of clay or stone arrangement to direct the molten metal into the hole. Each of the bracelets examined superficially in addition to the one analysed showed an overflow of metal on the surface above the hole, again indicating a mould casting operation. It was furthermore shown that the 'wire' does not show any elements of a cold working operation such as distorted grain structure. While not a sophisticated technology, the repair was a unique way of repairing or expanding a stone bracelet.

TABLE 3-22

Element concentration of the matrix of the bronze wire (burial 45, mortuary phase 1a, cat. 1417)

element	weight %	atomic %	S.E. %
Al	2.90	7.44	4.83
Sn	24.19	14.13	1.41
Cu	66.21	72.23	0.67
As	6.71	6.21	5.19

TABLE 3-23

Hardness gradient for bronze 'wire' from stone bracelet located in burial 45, mortuary phase 1a, cat. 1417. (200 g load, surface region-Hv 184-260)

(from surface to centre)	Hv
1	166
2	154
3	153
4	152
5	152

TABLE 3-24

Chemical composition of the copper slag and elemental composition of the copper bead within the slag from a level 8 crucible fragment

element	chemical composition of slag (weight %)	elemental composition of copper bead (weight %)
As	-	2.84
Si	41.52	0.31
Ag	-	0.65
Sn	9.61	0.40
Fe	0.44	0.15
Cu	26.62	95.55
Mg	4.19	-
Al	10.53	-
P	0.88	-
S	9.61	-
Ca	5.82	-
Ti	0.08	-
Zn	0.11	-

VARIATIONS IN THE ASSEMBLAGE WITH TIME

A simple scatter plot of the percentages of lead and tin (fig 3-22) indicates considerable variation in the quantities of these metals. Because of the long time span involved, it was decided to subject the percentage figures for the different metals in table 3-25 to two factor analyses. The first was based only on the metals which were in all probability, deliberately added together to form an appropriate alloy. These are copper, tin, lead and arsenic. The second included all the sample, including the trace elements. The initial assumption of the factor analyses was that there was no variation in alloys used with time, or with the individual artefact types which were cast.

As may be seen in figs 3-23 and 24, there is considerable variation in the values for each factor. The sorted rotated factor loadings for each of the analyses are set out in tables 3-25/6. For the distribution in fig 3-23, that is the one based only on the four principal metals, factor one reflects high scores for copper, with both tin and lead being low and arsenic unimportant. Factor two on the other hand, reflects high values for lead and arsenic. In the case of fig 3-24, the analysis based on all metals traced identifies lead as important in determining the values of factor 1 and tin for factor 2. Two further factors were identified, factor 3 reflecting high values for nickel and bismuth and factor 4, a high value for zinc.

Since most of the objects in question are bracelets or rings, it was decided to commence interpreting the two figures from a chronological stance. To this end, two chronological subsets were established. These comprise specimens from levels 8 to 6 inclusive, the balance coming from levels 5 to 3. This choice was made on three grounds. The distinction corresponds to that proposed by White (1982a) for the transition from the middle to the late period at Ban Chiang. Secondly, it has been shown that

there was a major change in the fabric used in making crucibles, and it is felt desirable to test whether there were related changes in metallurgical processes. Finally, there was clearly a major change in the use of this part of the site during the change from level 6 to level 5. The cemetery was abandoned, and the area was given over to bronze working. Again, was this change in behaviour matched by a different bronze technology?

TABLE 3-25

Ban Na Di bronze artefacts: the sorted rotated factor loadings, based on the analysis of all elements identified

		FACTOR 1	FACTOR 2	FACTOR 3	FACTOR 4
Pb	2	0.803	0.000	0.000	0.000
Sb	4	0.689	0.000	0.000	0.000
Sn	1	0.000	0.862	0.000	0.000
Cu	11	-0.663	-0.673	0.000	0.000
Fe	5	-0.300	0.666	0.000	0.000
Ni	7	0.359	0.000	0.634	0.455
Bi	9	0.000	0.000	0.624	0.000
As	3	0.000	0.000	0.577	-0.320
Co	8	0.000	0.000	0.567	0.000
Zn	10	0.000	0.000	0.000	0.880
Ag	6	0.391	0.000	0.000	0.000

The above factor loading matrix has been rearranged so that the columns appear in decreasing order of variance explained by factors. The rows have been rearranged so that for each successive factor, loadings greater than .5 appear first. Loadings less than .25 have been replaced by zero.

TABLE 3-26

The Ban Na Di bronzes: sorted rotated factor loadings based on the analysis of the frequencies of Cu, Sn, Pb and As

		FACTOR 1	FACTOR 2
Cu	11	0.960	-0.265
Sn	1	-0.869	0.000
As	3	0.000	0.797
Pb	2	-0.508	0.840

The above factor loading matrix has been rearranged so that the columns appear in decreasing order of variance explained by factors. The rows have been rearranged so that for each successive factor, loadings greater than .5 appear first. Loadings less than .25 have been replaced by zero.

TABLE 3-27

Ban Na Di bronzes: the factor scores for each bronze specimen, based on an analysis of all elements identified (columns 1-4) and on the basis of Cu, Sn, Pb and As (columns 5-6)

	FACTOR 1	FACTOR 2	FACTOR 3	FACTOR 4	FACTOR 1	FACTOR 2
8 A2 33 1290 bracelet	-0.537	-0.484	-0.405	-0.214	0.621	-0.430
8 A3 41 1036 bracelet	-0.254	-0.068	0.146	5.751	0.108	-0.560
8 A1 40 987 fragment	-0.843	0.402	2.729	-1.101	-0.409	-0.680
7 F6 4 1885 comma pendant	1.283	-1.077	-0.354	1.370	0.417	0.874
7 F6 11 1261 comma pendant	0.025	-0.150	0.316	0.666	0.299	-0.425
7 A2 43 818 arrowhead	0.018	-0.281	-0.694	-0.205	0.320	-0.173
7 F6 5 953 arrowhead	-0.845	-0.650	-0.397	-0.164	1.180	-0.268
7 F6 7 1014 arrowhead	-0.712	-0.884	-0.383	-0.173	1.164	-0.280
7 A3 35 903 arrowhead	-0.483	-0.074	-0.324	-0.228	0.241	-0.528
7 A1 32 752 arrowhead	-0.708	-0.849	-0.263	-0.209	1.101	-0.297
7 F6 11 1090 fish hook	-0.856	-0.769	-0.390	-0.157	1.285	-0.240
7 F6 1 799 bracelet	-0.891	-0.549	-0.402	-0.161	1.168	-0.268
7 A2 43 830 bracelet	-0.638	-0.288	-0.177	-0.276	0.546	-0.445
7 A3/4 30 1370 bracelet	-0.127	-0.454	1.189	-0.358	0.345	0.866
7 A3 32 826 bracelet	-0.684	-0.547	-0.411	-0.187	0.886	-0.352
7 A2 40 802 bracelet	-0.646	-0.331	-0.412	-0.207	0.650	-0.417
7 A3 34 869 bracelet	-0.557	-0.348	-0.410	-0.219	0.533	-0.453
7 A3 24 693 bracelet	-0.506	-0.040	-0.426	-0.240	0.227	-0.535
7 A4 33 1086 bracelet	-0.547	-0.509	-0.401	-0.214	0.641	-0.425
7 F6 9 1048 two spheres	-0.358	-0.042	-0.356	-0.101	0.315	-0.491
7 F6 5 983 fragment	-1.628	0.919	-0.486	-0.116	1.123	-0.236
7 F6 10 1084 fragment	-0.449	0.281	-0.180	-0.412	-0.083	-0.355
7 A2 38 726 fragment	-0.584	-0.668	-0.393	-0.201	0.815	-0.378
6 A3 18 349 bracelet	-0.105	-0.772	0.033	1.075	0.669	-0.205
6 F5 B.TS16 Cat.TS82a br.	-0.978	-1.708	3.103	-2.830	1.804	5.426
6 A3/4 20 1258 bracelet	-0.492	-0.317	-0.411	-0.230	0.417	-0.488
6 A4 19 1126 bracelet	1.062	0.057	0.013	-0.116	-0.663	0.638
6 A3 18 348 bracelet	-0.462	-1.023	-0.301	-0.281	1.100	0.145
6 A4 19 345 fragment	-0.343	0.096	-0.147	-0.043	-0.033	-0.581
6 A4 19 361 fragment	-0.435	-0.902	0.335	-0.762	1.056	0.914
6 A3 17 294 fragment	-0.515	-0.367	-0.409	-0.224	0.487	-0.487
5 A4 14 192 bracelet	-0.649	-0.858	-0.386	-0.188	1.113	-0.197
5 A4 16 229 bracelet	-0.159	-0.716	0.118	0.258	0.759	-0.180
5 A2 19 275 bracelet	0.766	-0.219	-0.073	-0.244	-0.329	0.706
5 A2 20 305 bracelet	0.502	-0.257	0.321	1.950	-0.033	0.065

5	A4	14	182	bracelet	2.973	0.173	0.365	0.049	-1.862	2.178
5	A4	16	234	bracelet	0.025	-0.735	0.032	1.770	0.703	-0.243
5	A3	14	215	bracelet	-0.182	-0.834	-0.360	-0.308	0.754	0.290
5	A1	13	161	bracelet	-0.405	-0.260	-0.362	-0.295	0.337	-0.270
5	A1	14	200	bracelet	0.457	0.512	-0.566	-0.265	-0.669	-0.778
5	A	13	174	ring	0.133	2.217	-0.539	-0.431	-2.404	-1.254
5	A4	1	298	fragment	2.289	-0.192	-2.128	0.134	-0.566	-0.565
5	A4	8	298	fragment	4.015	0.081	-0.790	-0.510	-1.534	0.957
5	A4	15	222	fragment	0.099	-0.404	-0.293	-0.449	0.142	0.472
4	A1	B.5	427	bracelet	-0.253	0.345	-0.464	-0.270	-0.274	-0.672
4	A3	11	139	bracelet	0.177	-0.682	-0.430	-0.355	0.493	0.700
4	A3	8	84	bracelet	-0.654	0.290	-0.444	-0.232	0.191	-0.535
4	A4	8	90	bracelet	3.050	1.353	-0.081	-0.650	-3.335	2.173
4	A2	15	168	bracelet	1.086	-0.636	1.099	-0.091	-0.115	1.674
4	A4	9	99	bracelet	0.312	-0.663	2.204	-0.116	0.406	1.326
4	A1	12	141	bracelet	1.998	0.172	0.959	-0.390	-1.321	1.611
4	A3	11	145	bracelet	0.934	-0.161	1.604	0.121	-0.342	0.897
4	A3	10	143	bracelet	2.012	-0.062	2.549	-0.415	-1.267	2.409
4	A3	8	83	bowl	0.050	0.365	-0.494	-0.289	-0.365	-0.810
4	A4	9		bracelet	0.232	0.676	-0.267	-0.021	-0.667	-0.744
4	A2	16	203	bracelet	0.634	0.570	-0.294	-0.650	-0.938	0.966
4	A2	16	214	bracelet	-0.023	1.401	-0.498	-0.373	-1.561	-1.026
4	A3	13	187	bracelet	0.047	0.698	-0.509	-0.295	-0.752	-0.799
4	A1	B.8	1431	bracelet	-0.228	0.658	-0.460	-0.311	-0.702	-0.792
4	A3	B.1	79	ring	1.266	0.320	0.882	-0.072	-1.058	0.582
4	A1	12	154	ring	-0.271	0.410	-0.419	-0.342	-0.190	-0.157
4	A3	13	193	ring	-0.232	-0.998	0.015	0.481	1.078	-0.124
4	A2	15	170	ring	-0.825	-0.314	-0.414	-0.181	0.895	-0.343
4	A2	16	195	ring	-0.554	-0.456	-0.311	-0.291	0.620	-0.249
4	A2/3	9	1162	ring	-0.303	0.369	-0.446	-0.287	-0.376	-0.703
4	A1	11	126	ring	-0.471	1.890	-0.511	-0.343	-1.265	-0.863
4	A2/3	11	1175	ring	-0.064	-0.267	-0.410	-0.345	0.288	0.350
4	A3	9	98	fragment	-0.709	-0.747	-0.445	-0.156	1.148	-0.276
4	A4	12	133	fragment	-1.348	5.901	-0.394	-0.171	-2.908	-1.117
4	A2	15	176	bracelet	-0.056	1.342	-0.495	-0.366	-1.470	-1.001
3	A4	5	54	? bead	0.334	0.612	1.049	1.073	-0.658	-0.614
3	A3/4	6	1153	bowl	-0.578	-0.450	-0.328	-0.183	0.742	-0.386
3	A3	6	56	bowl	-0.228	-0.220	-0.536	-0.195	0.363	-0.490
3	A3/4	7	1160	ring	-1.308	1.874	4.876	1.858	-1.096	-0.026
3	A4	6	62	ring	-0.386	-0.319	-0.753	3.446	0.377	-0.272
3	A2	8	75	ring	0.049	0.625	-0.505	-0.294	-0.683	-0.754

In figs 3-23 and 24, the specimens from the earlier of the two sets are distinguished from the later ones by the symbols employed. It is self evident that the earlier sample displays far less variability. Examination of the data in table 3-21 makes it clear, that these artefacts were made from a relatively low tin-bronze. Only two specimens, a bead and bracelet, have a significant lead content. The five projectile points analysed are characterised by a low to very low tin content and a complete absence

of lead. One bracelet, that from burial TS 16, is set apart by its high arsenic content (3.557%).

The later sample is much more variable. While some of the specimens retain the low tin bronze alloy, there was a major development in the field of lead alloys. This is not as it happens, correlated with a greater complexity of design: indeed some of the later bracelets and rings are of strikingly simple shape. At the same time, at least four specimens display the extremely high tin content which has been identified already both at late period Ban Chiang and at Ban Don Ta Phet (Rajpitak and Seeley 1979). There are therefore, strong grounds for concluding that there is temporal variation in the sample, but that this was not clearly related to a process of internal development in the light of greater complexity of design encouraging the addition of lead for easier casting.

This situation has been further considered on the basis of the typology of the sample of bracelets and rings.

THE TYPOLOGY OF THE BRONZE BRACELETS AND RINGS

Typologically, the designs on the bronze bracelets appears to fall into one of four categories. There are knobs or bosses approximately 5mm in diameter, transverse grooves that run across one or more of the narrow surfaces and another group with transverse and concentric grooves. These are termed cross hatching. The final type are the applied wire or false filigree bracelets. All these are described in detail above.

Level 7 is the only one to yield examples of all four types. The only examples of the knobbed and cross hatched bracelet decorations are confined to this level. One pair of bracelets have both types of decorations on them (cat.1378), indicating that these designs are contemporaneous. One example of the grooved bracelet was found. No further specimens of this type were recovered in levels 6 and 5 so there is a considerable gap in time between the three examples. The gap may be a result of few finds or it may be an accurate record of the times when the designs were popular. A much clearer picture of the false filigree design and their distribution has been gained. Only one bracelet was recovered but with one exception, all the mould pieces bore the same pattern. This form of decoration was current from the very end of level 7 to the end of level 4. The thickness of the bracelets varies, but the pattern with one exception does not. They all appear to be well made in contrast to most of the other decorated bracelets.

The plain bracelets and rings were very much more common. They were categorised in two ways. The artefacts with internal diameters equal to or greater than 2.5 cm were designated bracelets while those with an internal diameter of less than this figure were categorised as rings. This is an arbitrary division as some of the rings may not have been jewellery and some of the smaller bracelets may conceivably have had other uses. These were all further divided on the basis of the cross section. In order to try to determine any chronological changes, histograms were made of the cross sections within each level (fig 3-25).

Six cross sections were recognised: they were, circular, oval, plano-convex, square, rectangular and rectangular with the outer edge convex. No rings were found before level five. The majority of the cross

sections were circular before this time also. This trend continued in level five, where the first of the rings are found. Of the three in this section one is circular, another oval and one is rectangular. In level four, the number of rings increased and the majority of the cross sections are now rectangular. At no stage does the production of circular cross sectioned bracelets cease, and indeed they were the predominant variety.

IRON ARTEFACTS AND FRAGMENTS (figs 3-26 and 27)

Numerous fragments of iron were recovered at Ban Na Di. They were distributed in the occupation levels as follows:

TABLE 3-28

Ban Na Di: iron fragments

LEVEL	SQUARES							
	A1	A1/2	A2	A2/3	A3	A3/4	A4	Slag
8	–	–	–	–	–	–	–	–
7	–	–	–	–	–	–	1	–
6	–	–	–	–	5	–	4	–
5	14	7	1	–	8	4	4	1
4	3	–	4	1	7	2	8	8
3	5	1	5	–	7	–	6	2

It is clear that iron only became abundant at Ban Na Di during level 5. The first evidence for iron smelting also occurred during the build up of level 5.

THE IRON ARTEFACTS FROM BURIAL CONTEXTS

F6 B.16 Cat. 1444a-d Mortuary Phase 1c

These four iron circlets appear to be too large to be bracelets or anklets. Moreover, their open ends would have made them impractical as bracelets. They have a diameter of *c.* 114 mm, which is compatible with their being neck rings. A fragment of woven material adheres to the outer edge of

the neck rings, which have a circular cross section five mm in diameter.

F6 B.16 Cat. 1442 Mortuary Phase 1c

This artefact is a fragment of an iron spear blade. It has a central rib and a maximum depth of *c.* 34 mm.

F6 B.16 Cat. 1883 Mortuary Phase 1c

This badly corroded piece is a band bracelet with a rectangular cross section. There is no obvious decoration but rice grains and fabric adhere to the surface.

F6 B.17 Cat. 992 Mortuary Phase 1c

This circular band of iron has been coiled to form a double ring. It was found in the grave for Burial 17, though prehistoric re-use of the grave probably led to its relocation. The outer diameter measures *c.* 23 mm and the inner, which incorporates much corrosion, has a diameter of 16 mm. The band itself is circular and 6 mm across.

F6 B.17 Cat. 991 Mortuary Phase 1c

This nearly complete knife has the same provenance as the iron ring described above. This grave had been opened in antiquity to make successive interments, so its primary association cannot be positively affirmed. The knife has an iron tang with a curved end, a straight cutting edge and curved upper surface. The blade is 29 mm deep, and the total length is estimated as *c.* 150 mm.

A1 B.4 Cat. 379 Mortuary Phase 2

This jar burial contained the remains of an infant, lying in a fetal position, but with legs splayed. An iron artefact was found between the legs. It is a narrow, knife-like implement 73.0 mm long and 27 mm deep. It has a lunate shape with the vestiges of two projections at each end. One edge of the concave side of this artefact has a thin surface band of a yellowish shiny substance. Part of a rice grain is adhering to the side of the tool.

A1 B.5 Cat. 373 Mortuary Phase 2

This burial jar contained a complete, socketed implement which in form, is very similar to the modern Northeast Thai waisted digging stick or "*siem*". Part of the wooden haft has survived. The iron portion of the artefact is covered in rice grains. It has a length of *c.* 125 mm.

A1 B.8 Cat. 1428a Mortuary Phase 2

Like B.4, this complete vessel contained the remains of an infant, associated with iron artefacts. The first of four iron implements from this burial resembles cat. 379 described above. It is a narrow blade, 69.3 mm long 20.8 mm deep. Again, there is a narrow band of a shiny substance, this time running along the concave edge, and extending over each of the

pointed ends. This implement surely was used as a cutting tool.

A1 B.8 Cat. 1428b Mortuary Phase 2

There is no doubt that this complete implement was a knife. It has a tang still covered by the remains of a wooden haft. The surface of the blade bears numerous rice grains. The overall length of the knife is 121.5 mm, the blade itself being 72.8 mm long and 28.5 mm deep. There was formerly a projecting hook at the far end of the blade.

A1 B.8 Cat. 1428c Mortuary Phase 2

This artefact comprises a tanged knife with a long, curved blade. Approximately the last third of the blade is missing, but the surviving length of the cutting edge is 120 mm. The depth of the blade narrowed as it approached the end. A fragment of wood adheres to the cutting edge, as do numerous rice grains. This tool comes closest in size and shape to the modern Northeast Thai rice-harvesting sickle. The remaining two iron implements from this infant's burial jar are corroded to the point that their function and size cannot be determined. Both are substantial pieces of iron, weighing 21 and 103 gm respectively, had a deep, blade-like cross section, and were covered with the remains of rice grains.

A1 B.8 Cat. 1428d Mortuary Phase 2

This artefact was corroded beyond recognition.

A1 B.8 Cat. 1428e Mortuary Phase 2

This fragmentary artefact was probably a part of a knife blade. It is covered with rice grains.

A1 B.8 Cat. 1428f Mortuary Phase 2

This very corroded item probably represents a knife blade with curved ends. It is *c.* 110 mm long and 35 mm deep. Many rice grains adhere to it.

IRON ARTEFACTS FROM OCCUPATION CONTEXTS

A1 15 Level 5 Cat. 1882

This artefact is complete. It is a small knife like implement with a projecting point at each end. In shape, it resembles Han period hand held sickles (Bray 1984). This particular specimen is 68 mm in length and has a maximum depth of 25.5 mm.

A4 10 Level 4 Cat. 105

This heavily corroded implement matches in size and form, the small knives found in Burial 4 and level 5 above (cats. 379 and 1882). The ends of the cutting edge are curved downward in hook-like projections and the cutting edge and back of the implement are parallel with each other. This

specimen is 69 mm long and *c.* 35 mm deep.

A3 11 Level 4 Cat. 146

Exactly the same comments apply to this as for cat. 105 above. This knife is slightly larger, 74 mm in length and *c.* 40 mm deep.

A4 12 Level 4 Cat. 171

This knife is even more fragmentary than those described above, but the characteristic hooked ends are still evident. The length dimension cannot be obtained, but the depth was *c.* 30 mm.

A2 13 Level 4 Cat. 183

This small cross section of the knife blade is again, similar to those hooked specimens just described.

A4 8 Level 4 Cat. 1547

This specimen is probably the section of a knife blade. It is 40 mm long and has a maximum depth of 22 mm.

A2 13 Level 4 Cat. 1502

Again, this specimen is a section of knife blade, but in this case, it comprises the distal end. It is equipped with a pointed, hook-like end.

A1 8 Level 3 Cat. 82

This artefact, though very fragmentary, clearly comes from a large, socketed implement.

THE REMAINS OF INSECT WAX

There has been much speculation in the past about the medium used to form the templates required for the lost wax casting process as it was carried out in the Northeast of Thailand during prehistory. The finding of a tin/lead casting sprue and the knowledge that lead was used for this purpose in Vietnam suggested that it also may have been in use in Ban Na Di. Against this theory was the decoration on the bracelets. The fine details could be produced much more easily in wax than lead and in some cases grooves had been incised in a pliable substance such as warm wax.

In order to make a careful study of the styles and manufacturing methods employed, the ornaments were cleaned. As few of the objects retained any of their original metal this had to be achieved mechanically rather than chemically. The various layers of corrosion were carefully removed using fine dental tools and a binocular microscope. While cleaning the surface copper salts from a bracelet (cat.1228), a dark grey substance was revealed between the salts and the surface of the bracelet. Further

cleaning uncovered more of this substance caught between the central clay core and the completely corroded metal. While it was being removed its waxy texture was noted. More of the substance was found during the cleaning of the pair to the above bracelet and a third bracelet revealed a thin layer of it trapped within the bronze when the artefact broke during cleaning.

The substance was not soluble in water but appeared to dissolve when a few drops of carbon tetrachloride were applied to it. On the strength of this it was decided to subject the substance to detailed analysis. This was undertaken by Paul D. Jones of the Otago University Biochemistry Departement, and his report is reproduced below.

"ANALYSIS OF LIPIDS EXTRACTED FROM A THAI ARTIFACT

Lipids were extracted by washing the bracelet in hexane followed by chloroform. Lipid components were identified by thin layer chromatography on silica gel G developed with Hexane:Diethyl-ether:acetic acid(85:15:1) solvent. Lipid spots were visualised in iodine vapour.

Gas Liquid Chromatography was performed on a column of sp 2300 on Chromosorb WAW support. The column was programmed from 110 to 210 C° at 15 degrees a minute followed by 25 minutes at 210 degrees. The results are as follows:

1) Thin Layer Chromatography Analysis.

The samples extracted with hexane and chloroform were run against various lipid standards and the results show that the extracted substance is clearly a wax. The migration distance of the sample compared to the Bees' wax and Orange Roughy *(Hoplostethus atlanticus)* wax indicates that the sample wax is most likely of insect origin. The presence of detectable amounts of triglyceride in the sample may indicate that the sample wax was used in a relatively unrefined form.

2) Gas Liquid Chromatography:

Comparison between the chromographs of the sample wax and bees' wax shows that both waxes have chains of 16 to 18 carbons long. However at longer chain lengths there seems to have been considerable breakdown of the sample wax which makes identification of the fatty acids present in the sample impossible.

SUMMARY

1) Thin Layer Chromatography of the sample shows it to be wax.

2) Gas Liquid Chromatography shows the presence of fatty acids with chain lengths of 16 to 18 carbons. This is a good indication that the wax is of insect origin. "

The combination of decoration on the bracelets and the finding of wax that had been trapped during the manufacturing process seems to establish it as the casting medium used for ornaments and bells in this region during prehistory. It cannot however be said with any degree of certainty that the stone moulds were used to produce wax shapes and it is still a probability that they were used to cast directly in bronze.

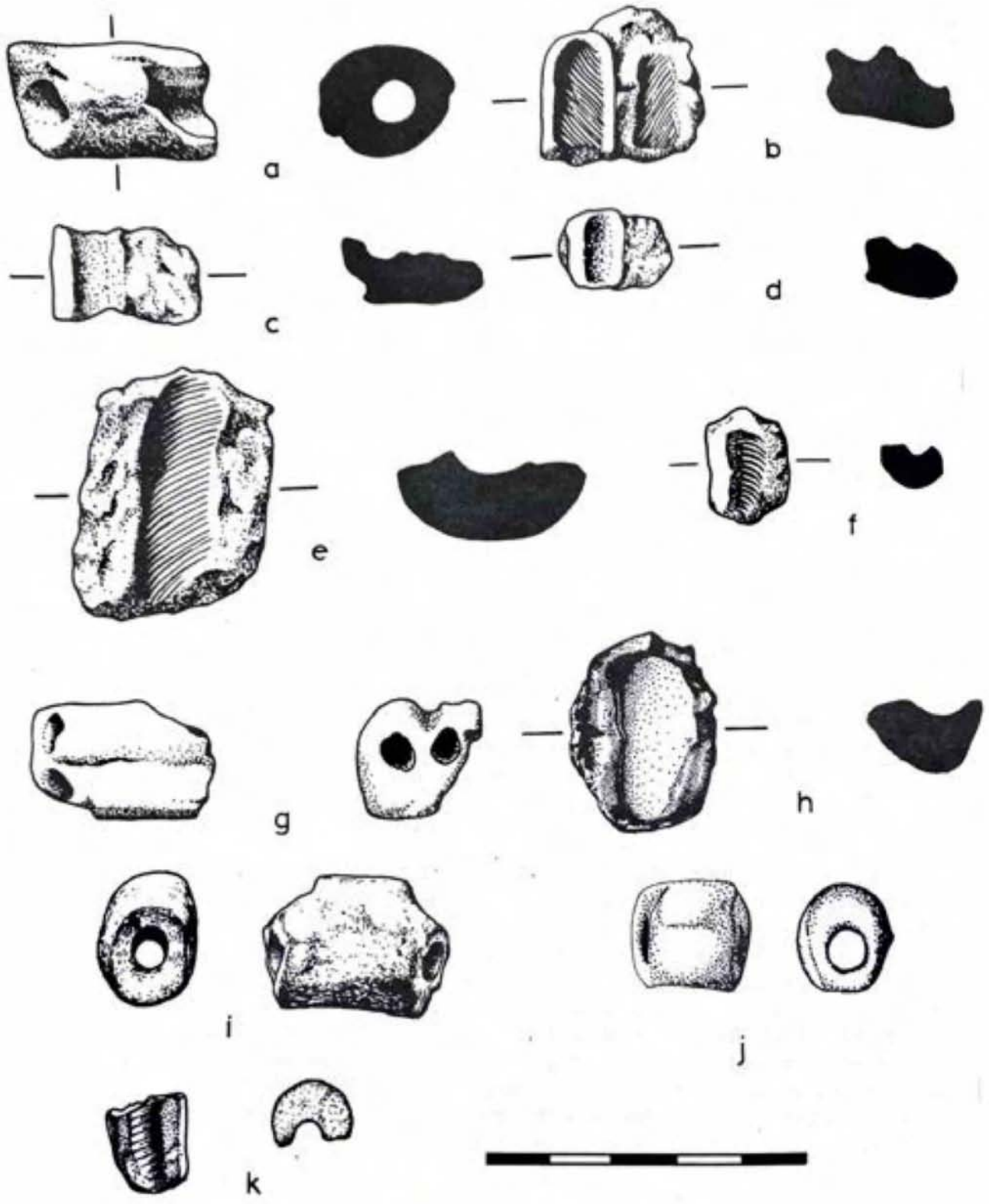


FIGURE 3-9

Ban Na Di: the clay moulds
A. A4 14 L.5 Cat.643a B. A4 14 L.5 Cat.643b C. A4 14 L.5 Cat. 643c
D. A4 14 L.5 Cat.643d E. A1 19 L.5 Cat.1528 F. A3/A4 19 L.6 Cat.1871
G. A1 14 L.5 Cat.1699 H. A3 16 L.5 Cat.1730 I. A4 14 L.5 Cat.1682
J. A4 15 L.5 Cat.205 K. A1 9 L.4 Cat. 1535

Ban Na Di: illustrations of stone moulds

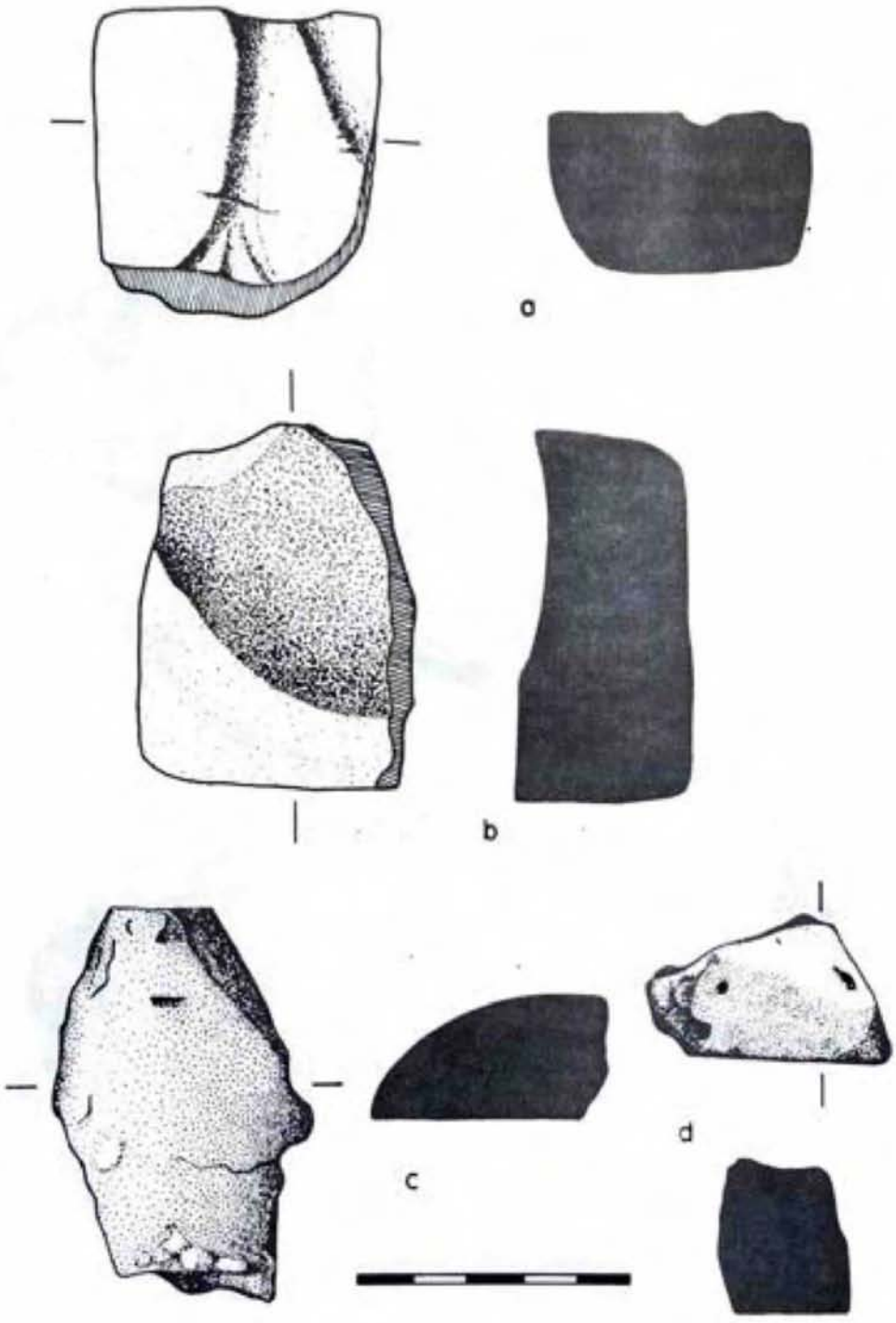


FIGURE 3-10

Ban Na Di: the stone moulds
A. A1/A2 35 L.7 Cat.1299 B. A3 20 L.6 Cat.576 C. A3 24 L.7 Cat.1443
D. A2 29 L.7 Cat. 1460

Ban Na Di: illustration of clay crucible

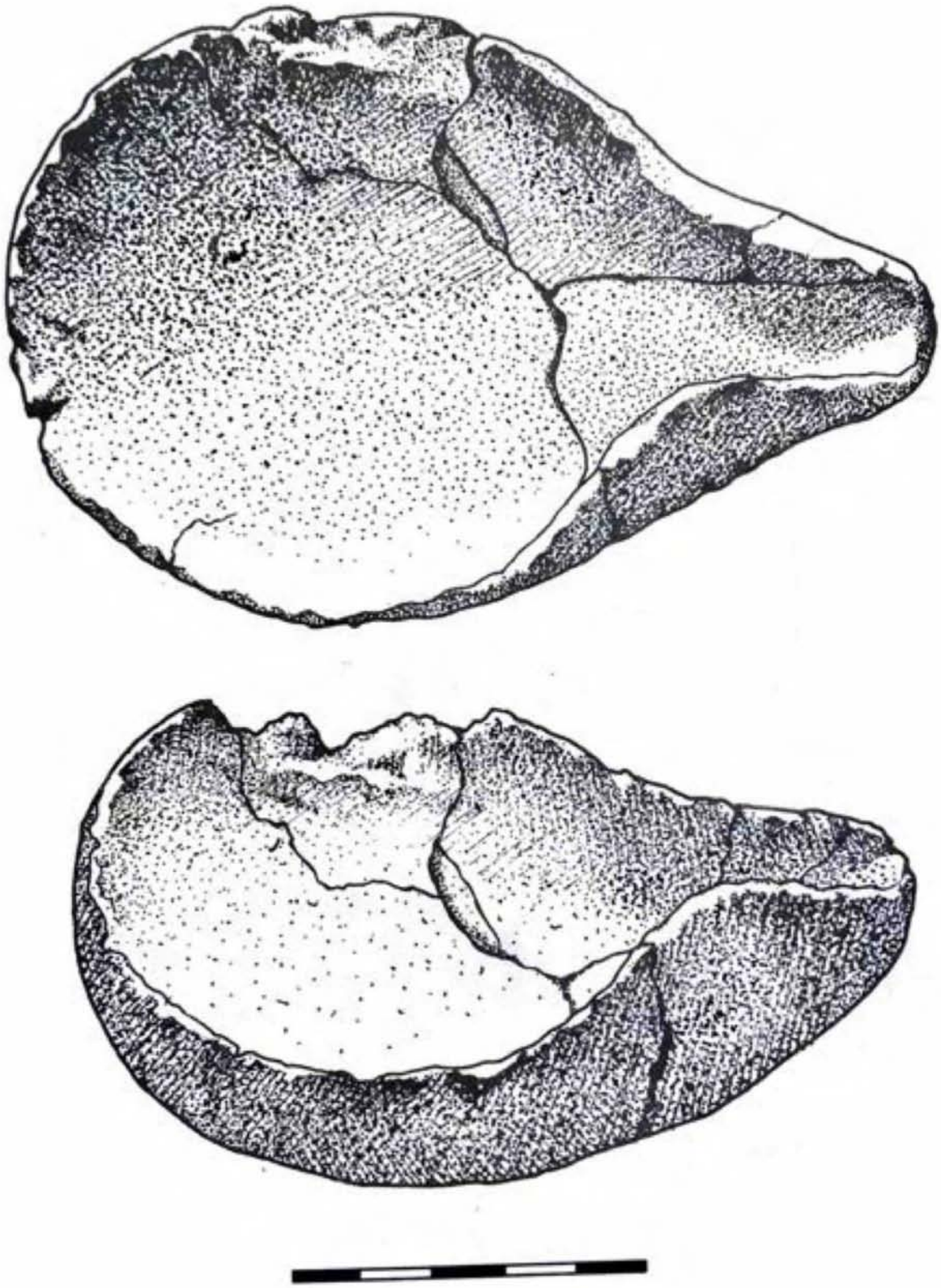


FIGURE 3-11

Ban Na Di: the clay crucible from A2 26 L.6 Cat.480

Ban Na Di: illustration of clay crucible

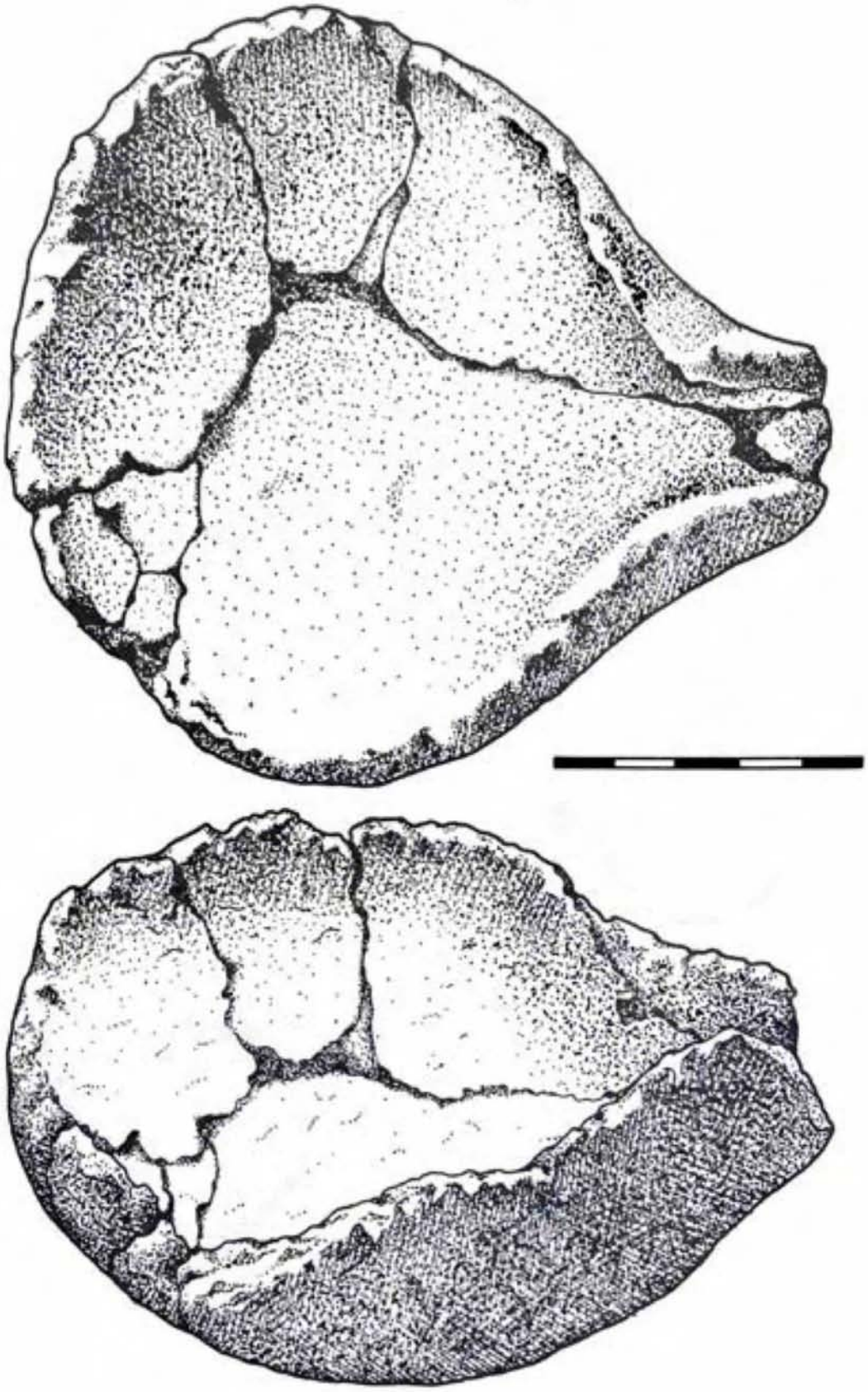


FIGURE 3-12

Ban Na Di: the clay crucible from A4 19 L.6 Cat.343

Ban Na Di: illustrations of bronze artefacts

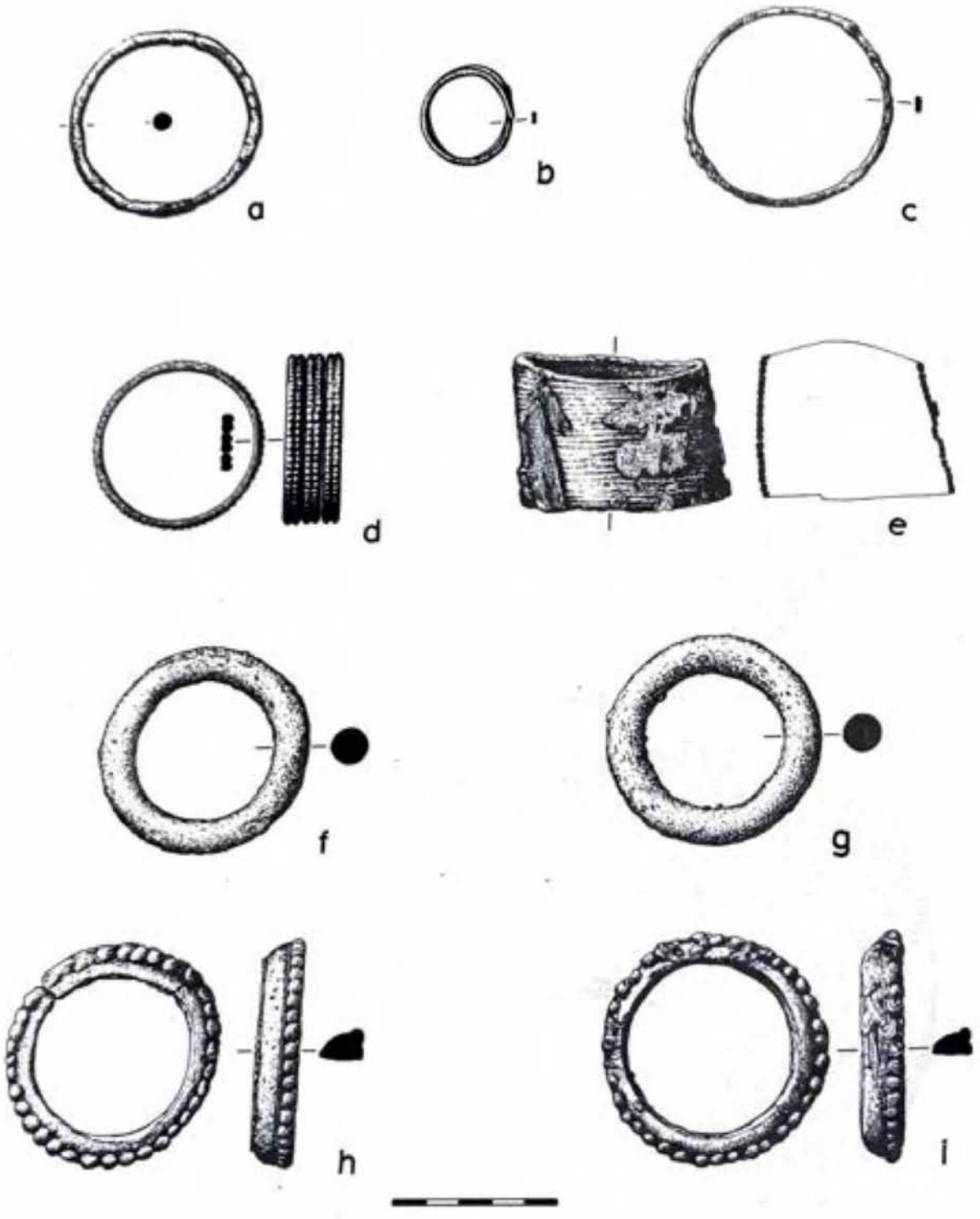


FIGURE 3-13

Ban Na Di: bronze bracelets and coil (b).
A. B.18 Cat.1061 B. B.5 Cat.427 C. B.3 Cat.231
D. B.TS16 Cats.TS62a-c E. B.36 Cats.1228a-s F. B.29 Cat.1018a
G. B.29 Cat.1018b H. B.48 Cat.1378a I. B.48 Cat.1378b

Ban Na Di: illustrations of bronze artefacts

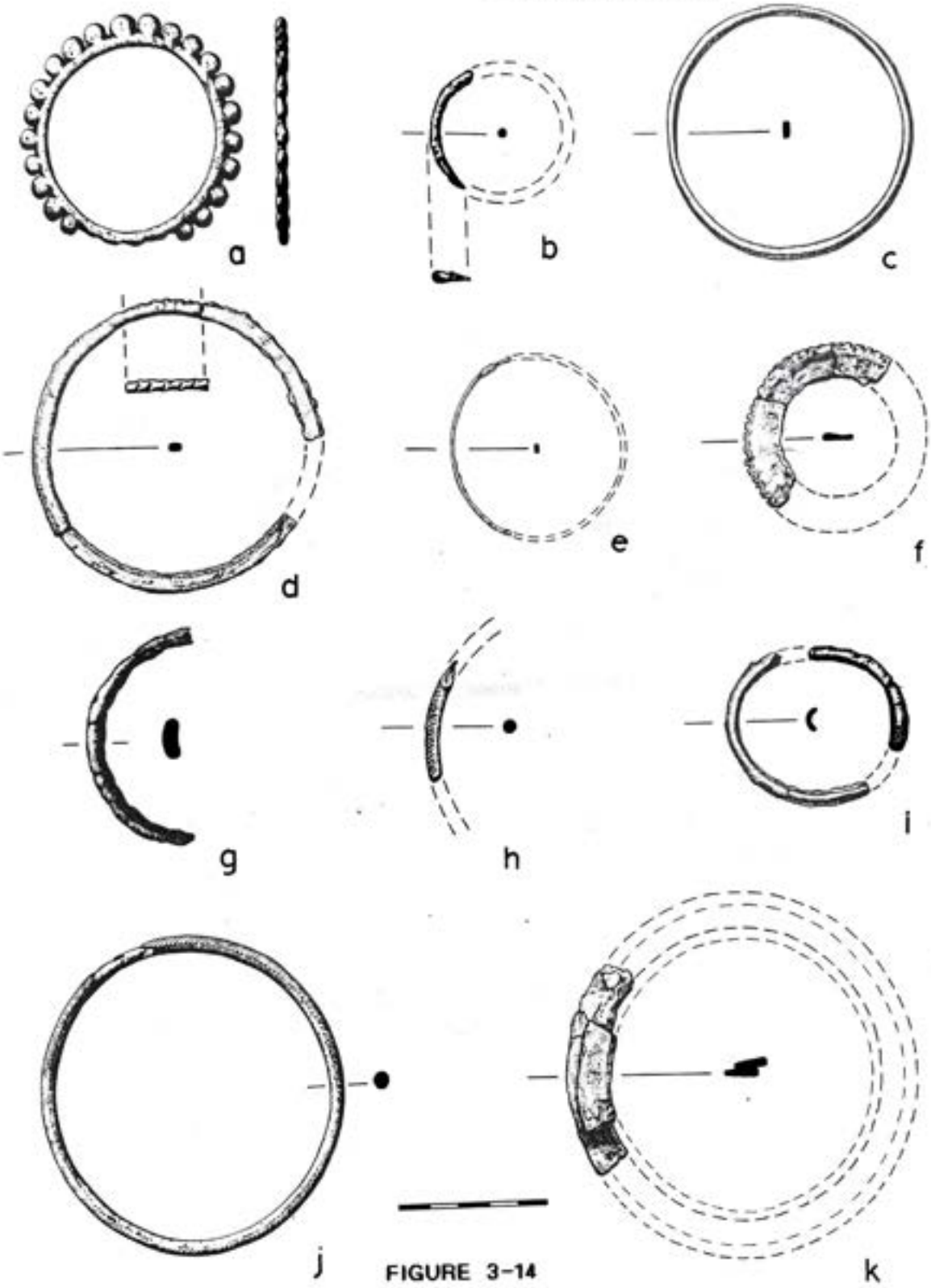


FIGURE 3-14

Ban Na Di: bronze bracelets.
A. B.38 Cat.1193 B. A2 20 L.5 Cat.305 C. A3 8 L.4 Cat.84
D. F6 u/p Cat.771 E. A3 10 L.4 Cat.143 F. A2 31 L.7 Cat.1160
G. A1 19 L.5 Cat.359 H. A2 17 L.5 Cat.214 I. A4 19 L.6 Cat.360
J. B.17 Cat.941 K. A3 6 L.3 Cat.46

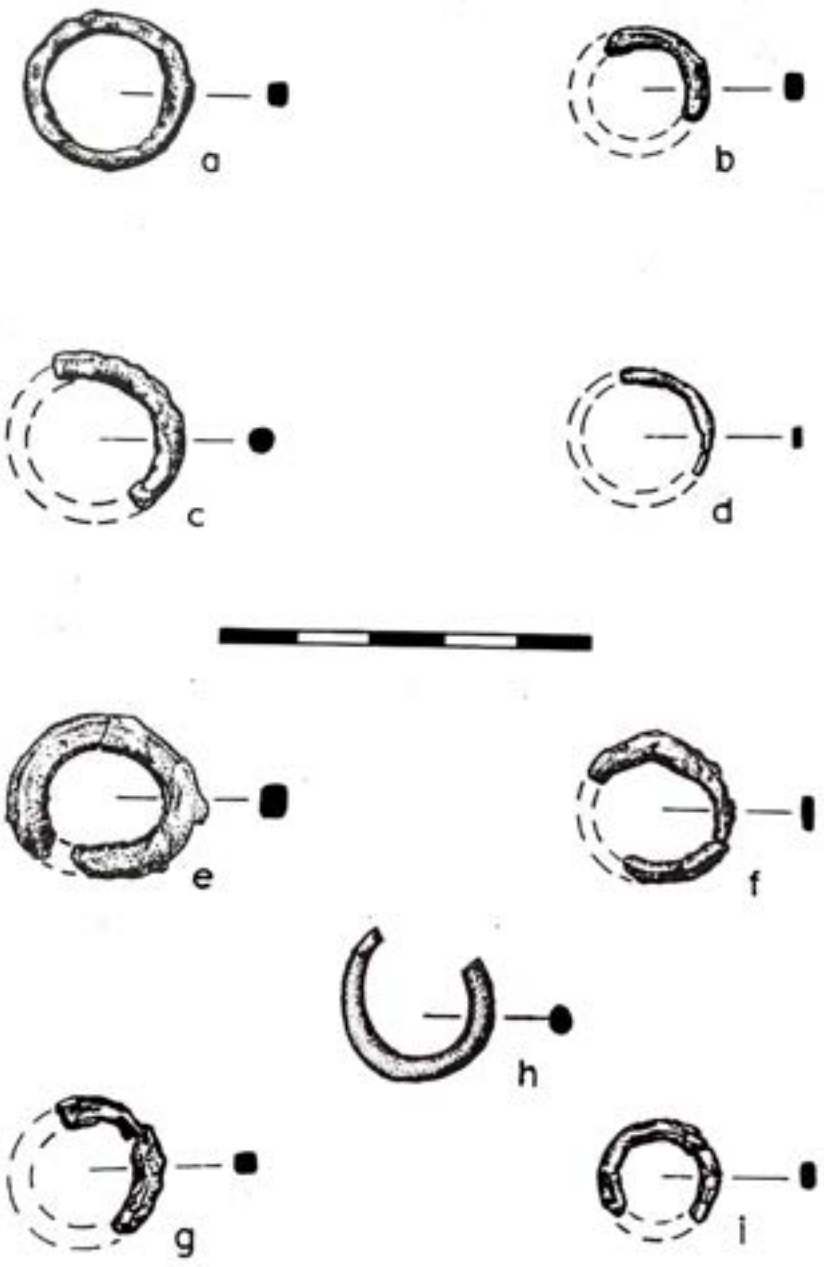


FIGURE 3-15

Ban Na Di: bronze rings.
A. A3/4 7 L.3 Cat.1159 B. A1 12 L.4 Cat.154 C. A3 13 L.4 Cat.193
D. A2/3 11 L.4 Cat.1175 E. A2 15 L.4 Cat.170 F. A2 16 L.4 Cat.195
G. A2 8 L.3 Cat.75 H. A3/4 5 L.3 Cat.1868 I. A1 11 L.4 Cat.126

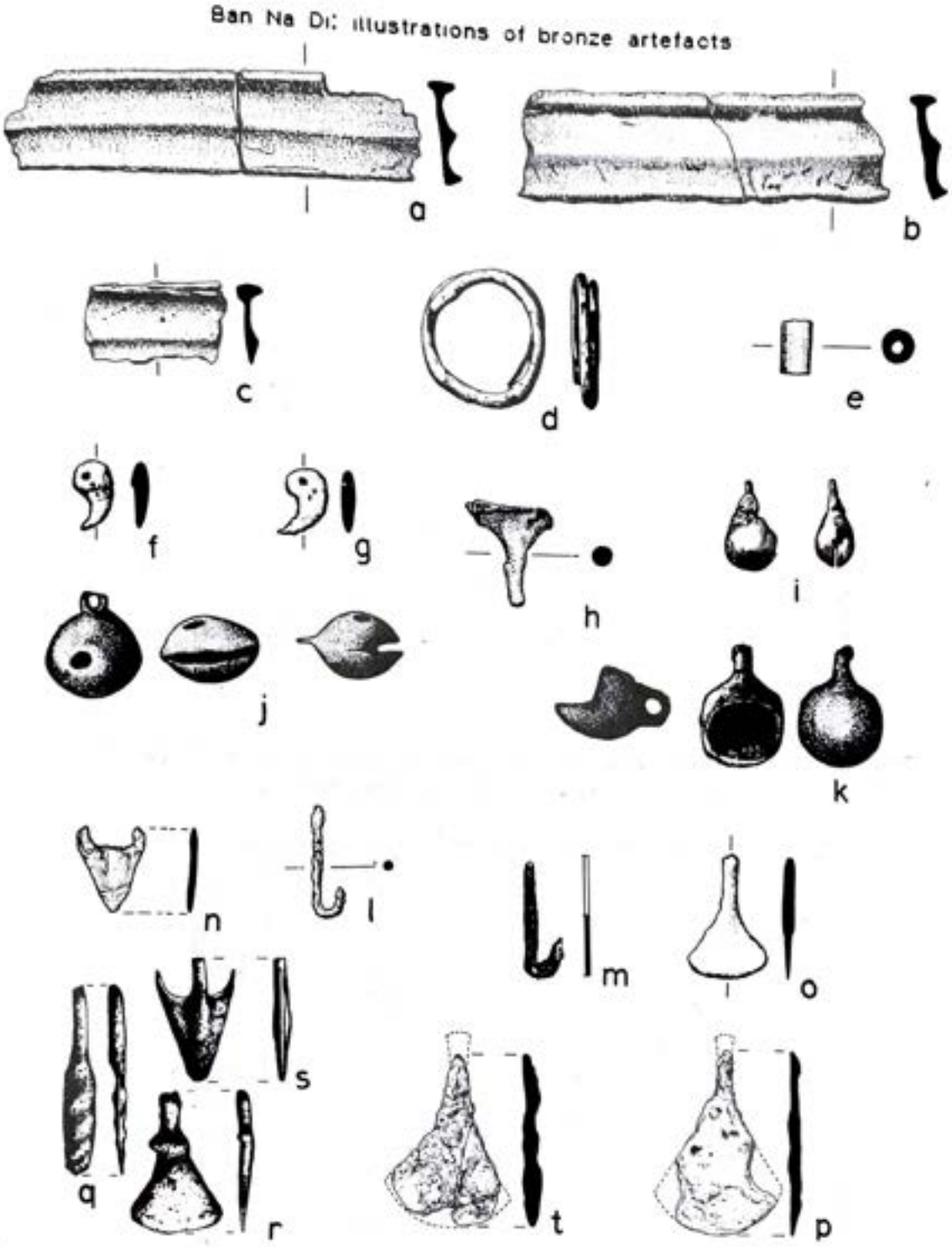


FIGURE 3-16 Ban Na Di: bronze artefacts. A-C. Section of container D. Coil E-G. Beads H. Lead/tin alloy casting sprue I-K. Bell L-M. Hook N-T. Arrow head a. A3/4 6 L.3 Cat.1153 b. A3 8 L.4 Cat.83 c. A3 6 L.3 Cat.56 d. B.17 Cat.1348 e. A4 5 L.3 Cat.54 f. F6 11 L.7 Cat.1261 g. F6 4 L.7 Cat.1885 h. A3/4 12 L.4 Cat.1206 i. A1 1 L.2 Cat.1877 j. A1 3 L.2 Cat.1597 k. A2/3 14 L.5 Cat.1188a l. F6 11 L.7 Cat.1090 m. F6 8 L.7 Cat.1867 n. F6 7 L.7 Cat.1014 o. A3 35 L.7 Cat.903 p. A1 32 L.7 Cat.752 q. A2 43 L.7 Cat.818 r. F6 5 L.7 Cat.953 s. F6 10 L.7 Cat.1884 t. F6 7 L.7 Cat.1014

scale: h, k and m: 1:1 All others are 1:2



FIGURE 3-18 S.E.M. view of cross section of bronze 'wire' (for scale and explanation, see page 113)



FIGURE 3-19 Transverse section of the bronze 'wire' (for scale and explanation, see page 113)

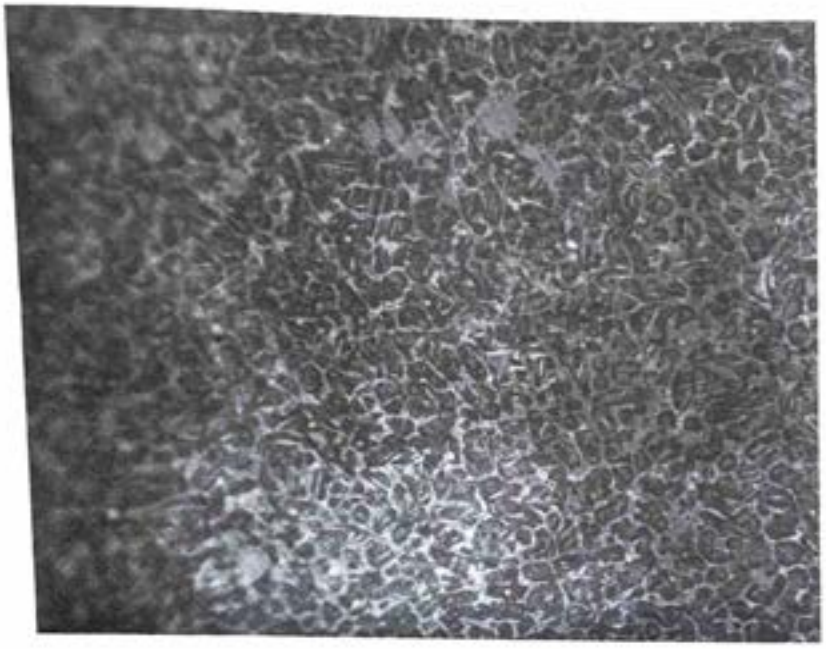


FIGURE 3-20 Skeleton of cast structure from the bronze 'wire'
(for scale and explanation, see page 113)



FIGURE 3-21 Cross section of a crucible fragment showing bronze scoria.

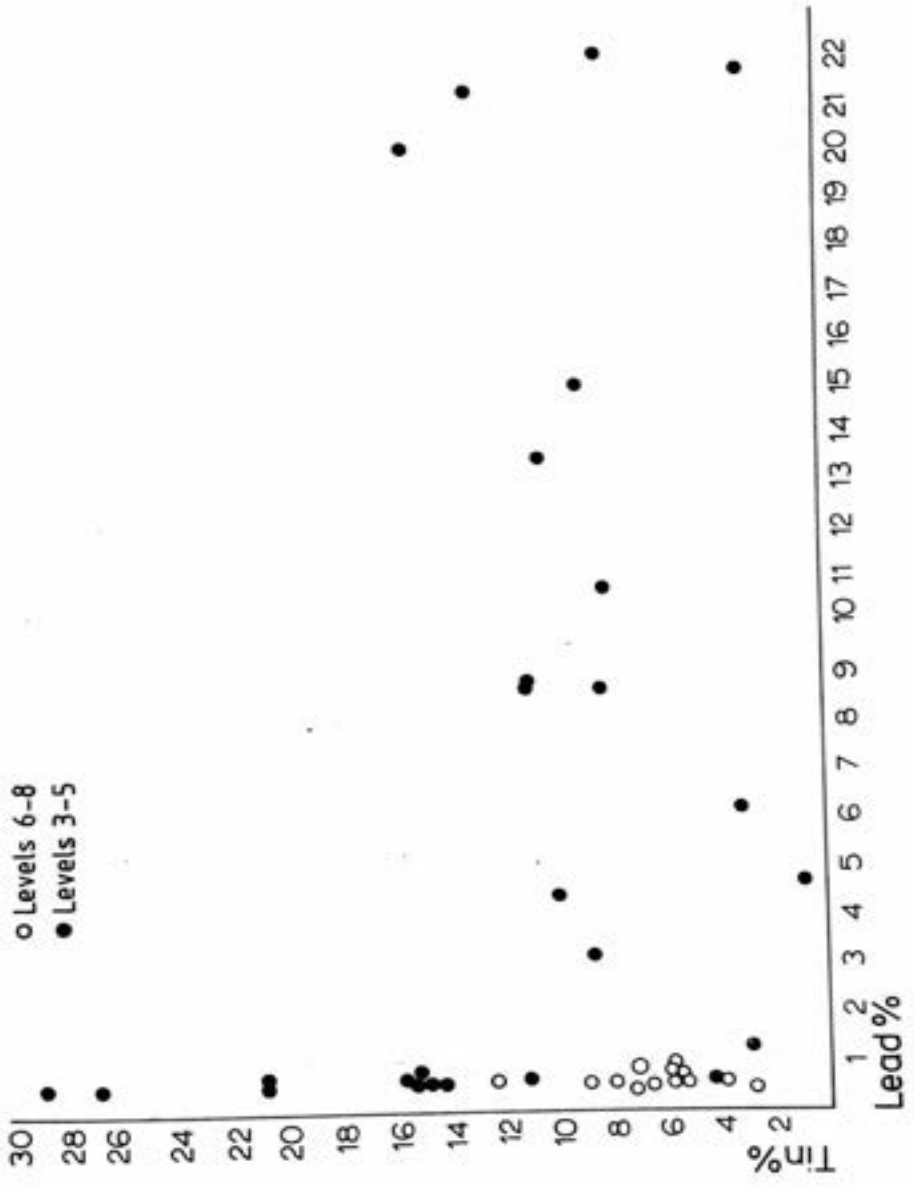


FIGURE 3-22

Scatter plot of the Ban Na Di bronzes on the basis of the percentage frequencies of lead and tin

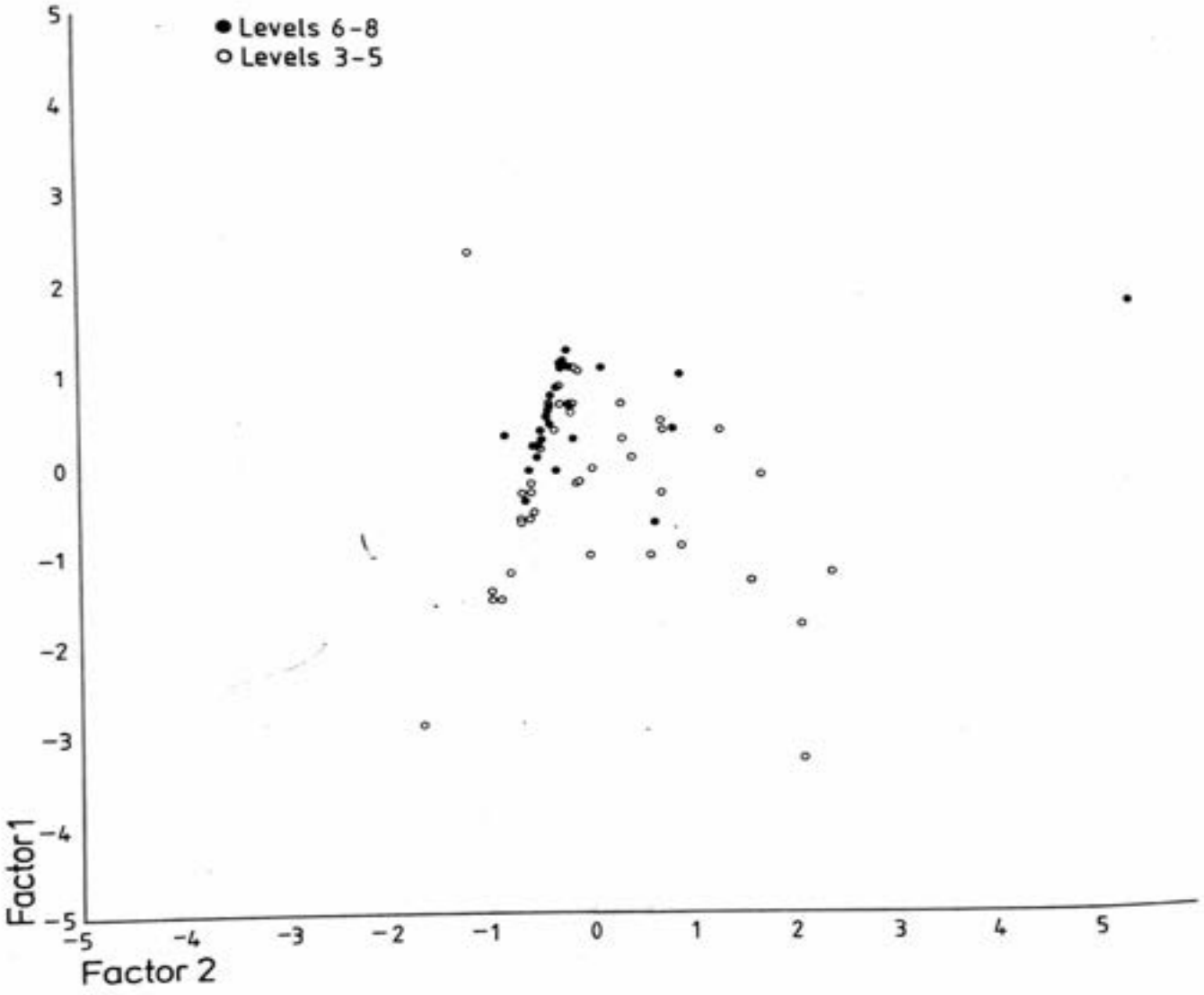


FIGURE 3-23

Scatter plot of the Ban Na Di bronzes on the basis of a factor analysis of the frequencies of copper, tin, lead and arsenic

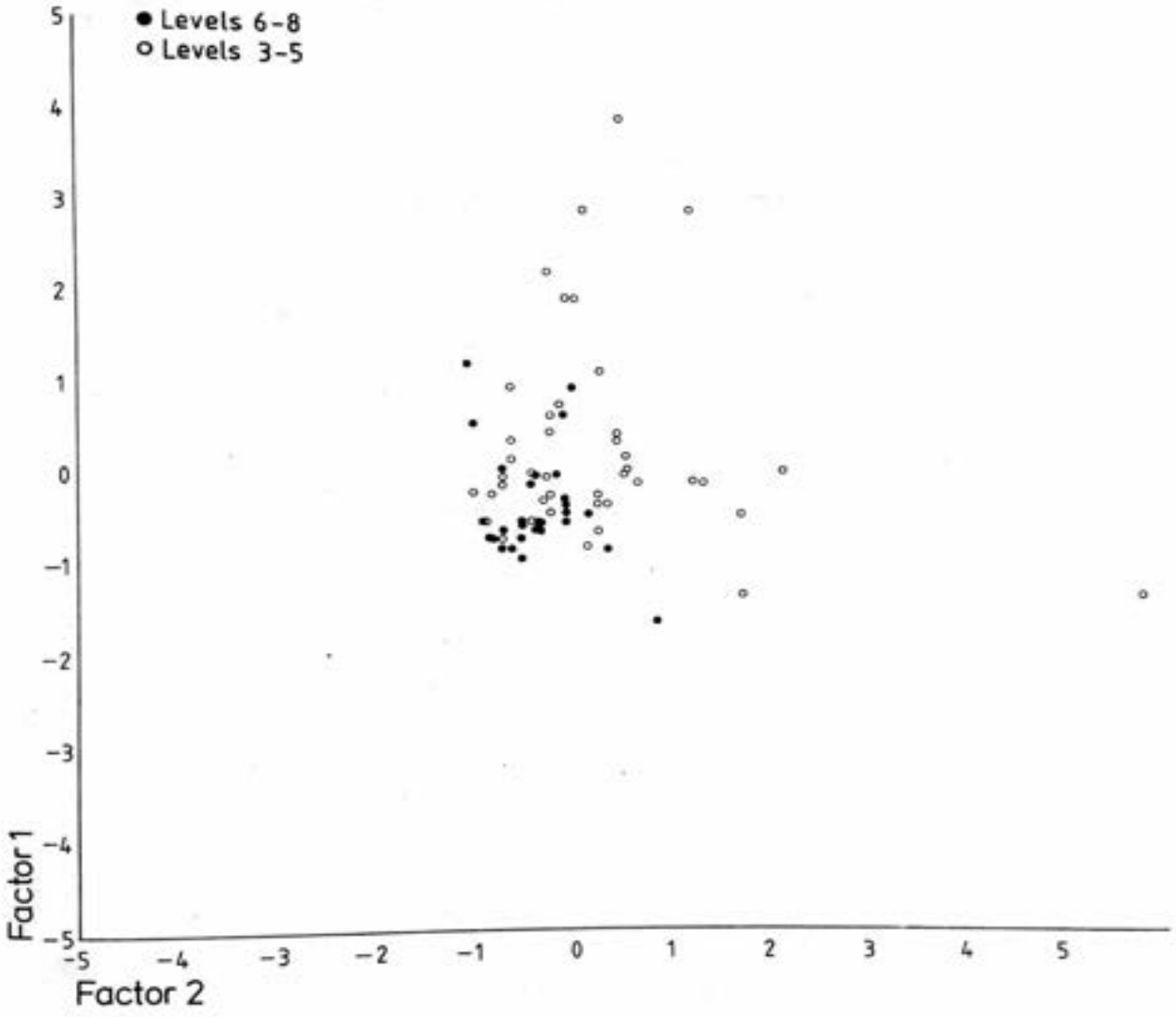


FIGURE 3-24

Scatter plot of the Ban Na Di bronzes on the basis of a factor analysis of all metals identified

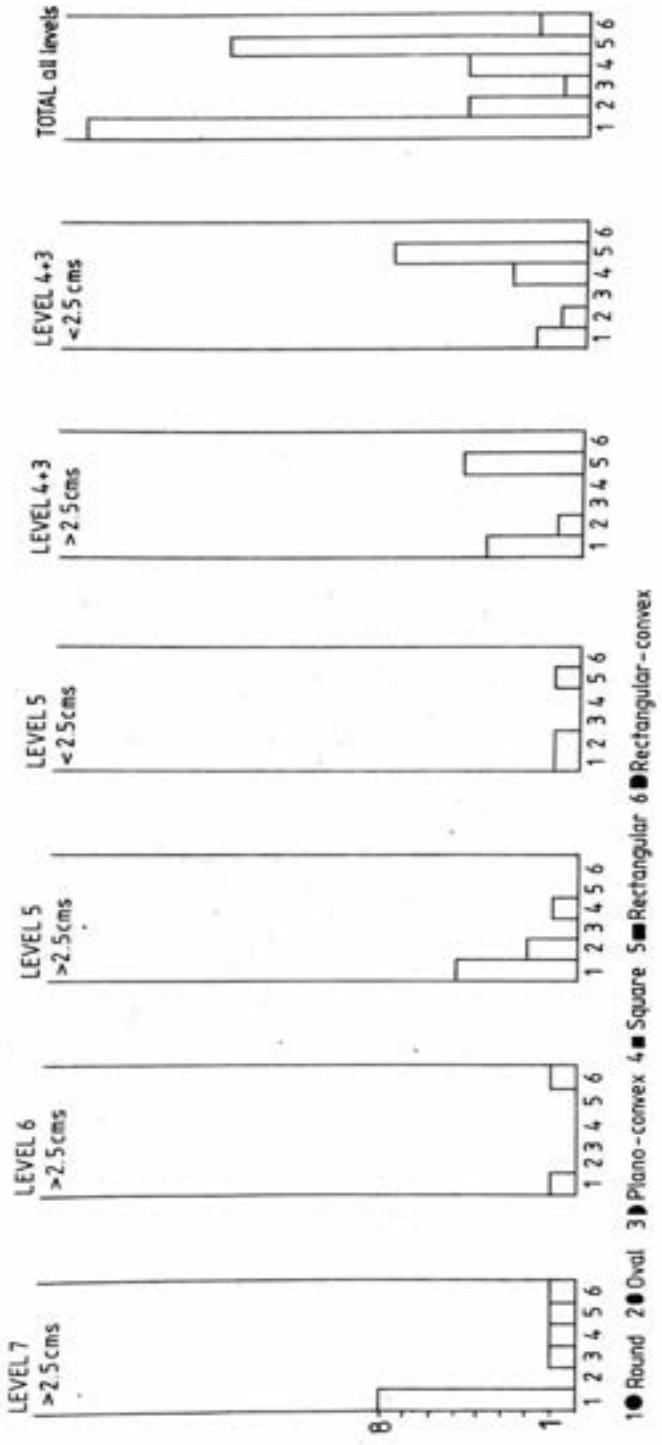


FIGURE 3-25

Histogram showing the frequency occurrence of different types of bronze bracelet and ring from Ban Na Di

Ban Na Di: illustration of iron artefacts

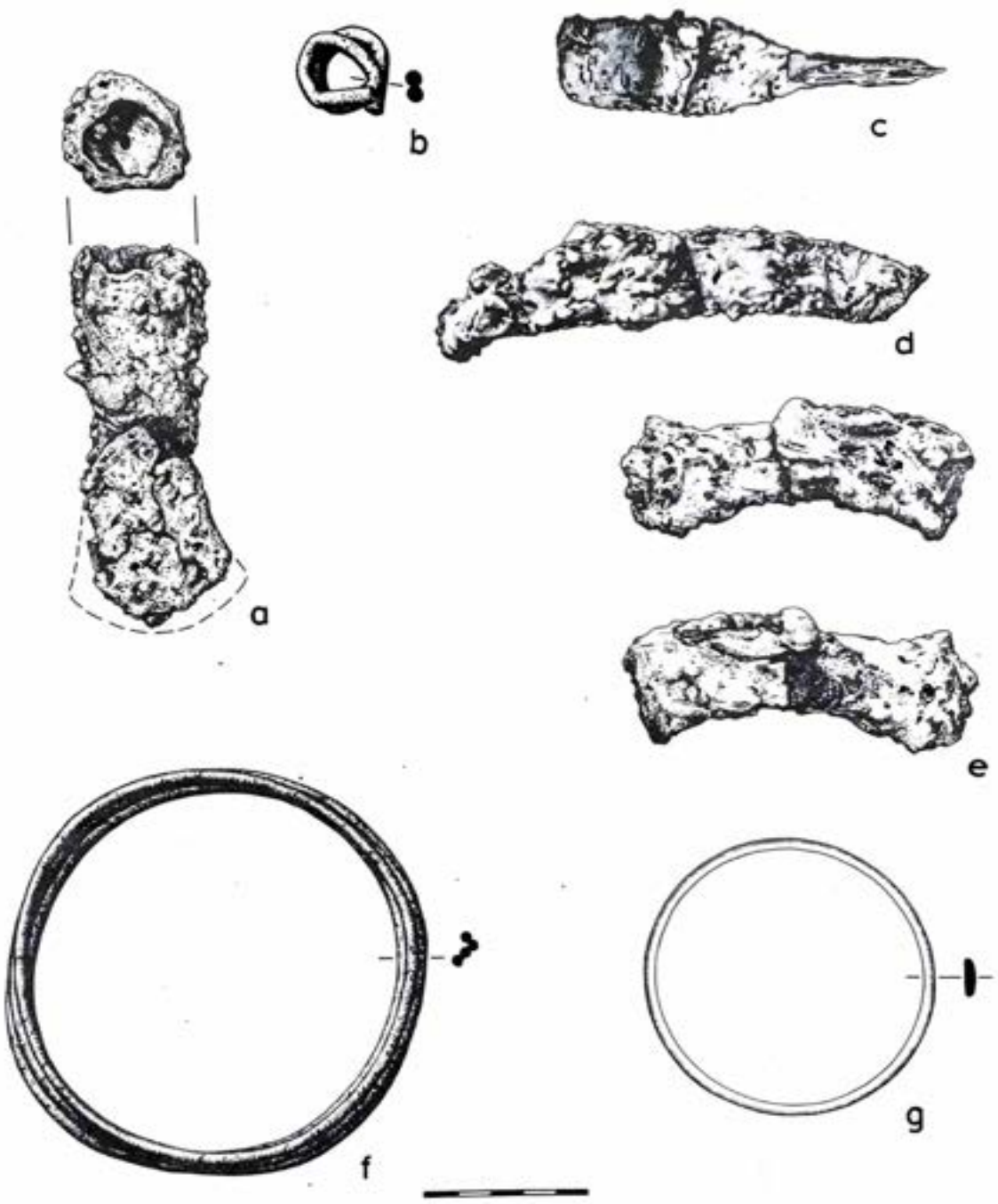


FIGURE 3-26

Ban Na Di: iron artefacts.
A. Socketed digging stick or hoe B.5 Cat.373
B. Iron coil B.17 Cat.992 C.Tanged knife B.8 Cat.1428b
D. Tanged knife B.8 Cat.1428c E. Knife blade B.8 Cat.1428f
F. Four necklaces B.16 Cat.1444a-d G. Bracelet B.16 Cat.1883

Ban Na Di: illustrations of iron artefacts

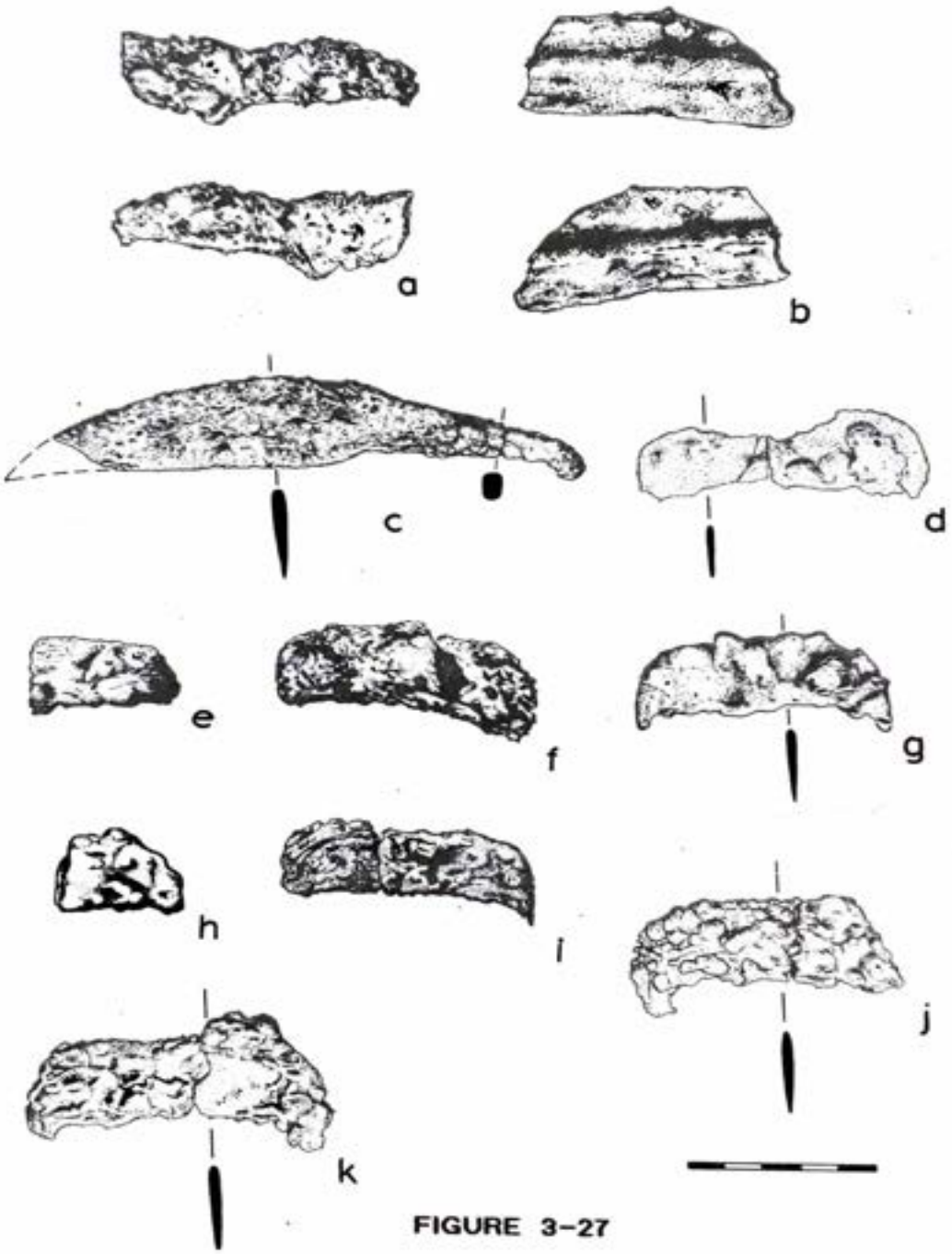


FIGURE 3-27

Ban Na Di: iron artefacts.
A. Part of a cutting implement B.8 Cat.1428e
B. Part of a spear blade B.16 Cat.1442
C. Tanged knife B.17 Cat.991
D-K. Lunate knifes d. A4 12 L.4 Cat.171 e. A4 8 L.4 Cat.1547
f. B.4 Cat.379 g. A1 15 L.5 Cat.1882 h. A2 13 L.4 Cat.1502
i. B.8 Cat.1428a j. A4 10 L.4 Cat.105 k. A3 11 L.4 Cat.146

Ban Na Di: illustrations of fabric remains

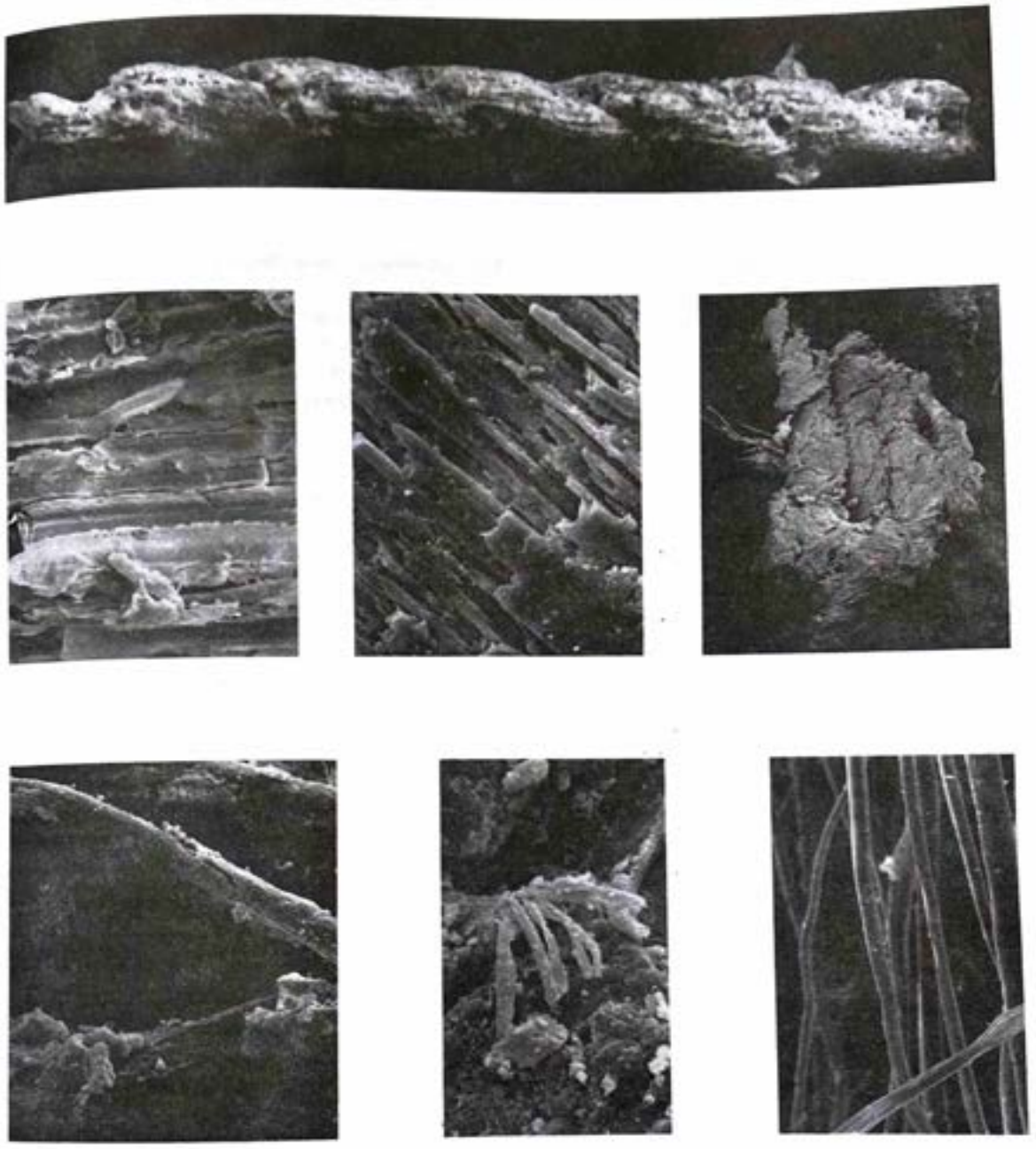


FIGURE 3-28

The remains of fabric from Ban Na Di
A. Vegetable fibre thread from necklace cat. TS40, burial TS 19 (x20). B. Cell structure of thread cat. TS40, x400. C. Cell structure of woven matting from bracelet cat. 1378, x700. D. Fragment of woven silk from bracelet cat.1228, burial 38, x10. E. Individual fibres from fragment cat.1228 x700. F. Silk fibres from anklet cat.1018b, burial 29 x600. G. Modern silk fibres from Northeast Thailand x600.

THE CLAY SEALS

(fig 3-29)

There are nine artefacts from Ban Na Di which are treated under the heading "clay seal". These are subdivisible into two types. Seven specimens are circular, and have a hole bored through the centre. They match those found at Ban Chiang, where they have been described as rollers, used perhaps to impart a dyed pattern onto cloth. The second has a handle with an expanded end bearing incised patterns.

A3 20 Level 6 Cat. 411 (fig 3-29b)

This roller has six rows of deeply incised ridges in a chevron design. The outer edge is markedly convex. One end has had a piece of rather crudely modelled clay attached to it. The other end bears the incised pattern to the central hole, such that when impressed into clay, the pattern of a flower is formed.

A4 10 Level 4 Cat. 122 (fig 3-29a)

This roller has six crenelated bands running round its circumference. These were fashioned by cutting out the clay. The resulting pattern is etched about 5 mm deep. The outer surface of the roller has a convex contour.

TABLE 3-30

Ban Na Di: the clay seals

Provenance	Level	Cat.No.	Max. L	Max. Width	Diameter of central perforation
A3 20	6	411	41.0	31.1	4.1
A4 10	4	122	51.5	34.7	8.0
A4 8	4	89	–	27.1	4.7
F5 7	4	TS 63	–	*c.* 30.0	–
A1/2 16	4	1534	–	*c.* 38.0	c. 6.0
A4 5	3	1647	–	–	–
A1 7	3	73	54.2	38.3	5.3

A4 8 Level 4 Cat. 89 (fig 3-29d)

This roller was broken across the middle. The design comprises six or seven straight lines left after the intervening clay was excised. The central ribbing is *c.* 7.0 mm deep, but the outer one only *c.* 4.5 mm.

A1/A2 16 Level 4 Cat. 1534 (fig 3-29f)

This is only a small fragment. Enough survives to note an excision of *c.* 5.0 mm, but the pattern is not clear.

A4 5 Level 3 Cat. 1647 (fig 3-29g)

This fragmentary specimen bore a deeply ribbed design.

A1 7 Level 3 Cat. 73 (fig 3-29c)

This specimen was broken down the middle. The design was made by excising clay to a depth of *c.* 2 mm. It has a chevron design running the length of the roller. If the half which survives parallels the missing part, there would have been 14-15 such lines of raised chevrons. The surface is slightly convex.

A4 8/9 Level 4 Cat. 101 (fig 3-29h)

This seal is quite different from those already described, because it is not circular, and has a handle. Half of the surface has been broken. It was found when removing the remains of B.2, though the association is not definite. The design was produced by excising the clay to leave a curvilinear pattern surrounded by rays. The patterned surface of the seal is convex. It would have been *c.* 78 mm long.

F5 7 Level 4 Cat.TS 63 (fig 3-29e)

Only a fragment of this roller has survived. There is enough of the outer surface however, to note that the pattern was curvilinear. The clay was excised to a depth of *c.* 2.5 mm.

A4 11 Level 4 Cat. 1864 (fig 3-29i)

The last seal also had a handle, though the functional end is circular and has a design comprising concentric circles. The face of the seal had a circumference of *c.* 50 mm.

There has been some controversy over the function of the cylindrical seal-like objects. In particular, it has been suggested that they were used to impart a dyed pattern onto cloth. This seems unlikely on two counts. Firstly, they are convex and therefore it would be hard to effect continuous contact with the material. Secondly, the dye would be distributed most unevenly, and require fresh inking with each revolution. It should be noted that there is no trace of dye on any of the Ban Na Di rollers. It does seem more likely that they were used to imprint a

recognisable pattern onto a flexible medium, such as clay. Certainly the last two to be described could hardly be anything other than a seal.

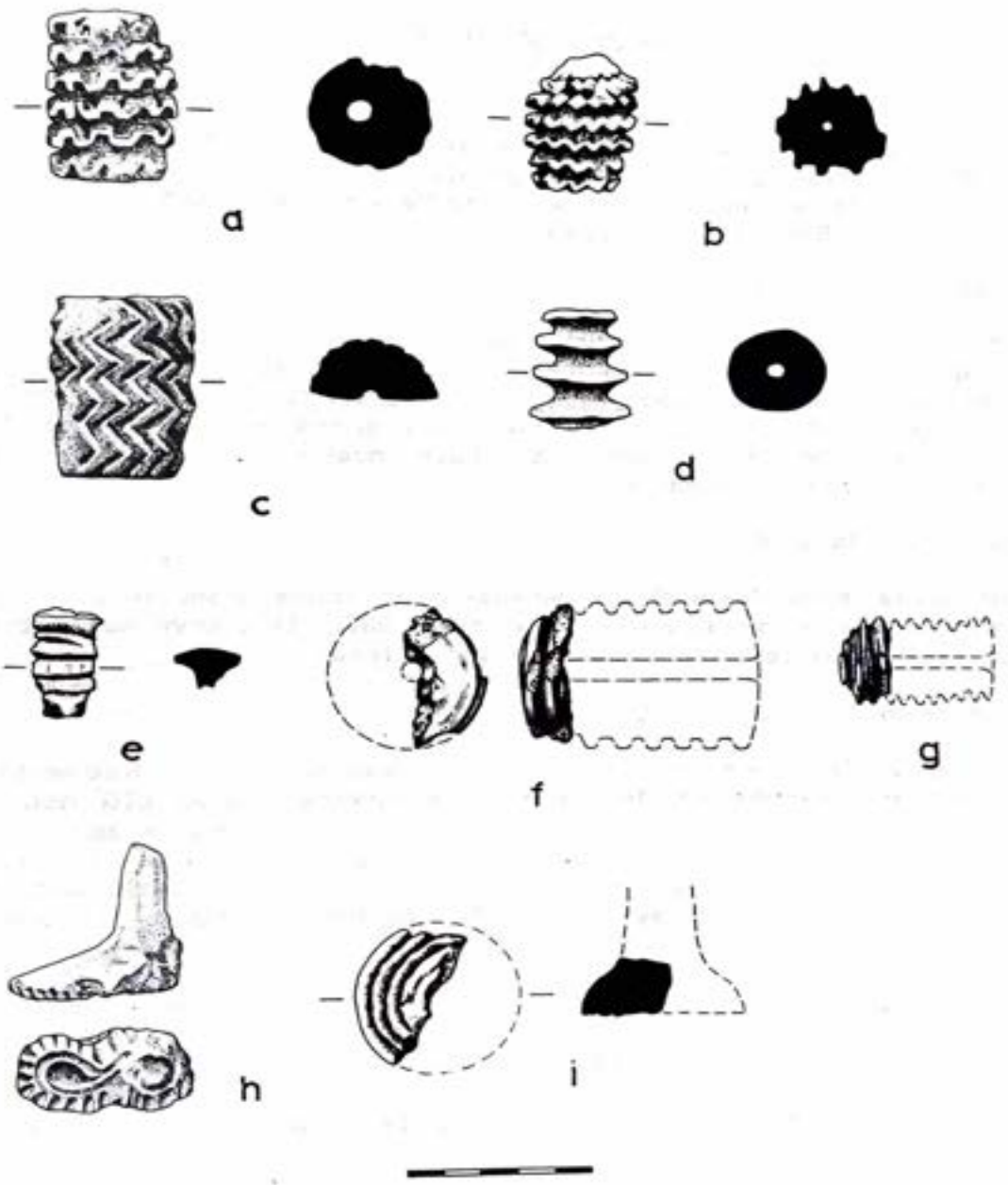


FIGURE 3-29

Ban Na Di: the clay seals
A. A4 10 L.4 Cat.122 B. A3 20 L.6 Cat.411 C. A1 7 L.3 Cat.73
D. A4 8 L.4 Cat.89 E. F5 7 L.4 TS 63 F. A1/A2 16 L.4 Cat.1534
G. A4 5 L.3 Cat.1647 H. A4 8/9 L.4 Cat. 101 I. A4 11 L.4 Cat.1864

THE CLAY ANVILS

(figs 3-30 to 33)

This type of artefact is still in regular use in Northeastern Thai pottery making villages. It is the clay anvil, used in conjunction with a wooden paddle, to shape clay vessels. Table 3-30 sets out the principal dimensions of the Ban Na Di specimens.

Specimens from level 7

There are no such anvils from the site's lowest cultural level. The earliest found comes from level 7. A feature of all specimens is the slight concavity on the upper part of the anvil face, and the pointed junction between it and the lower part. All specimens are fragmentary. The most complete (Cat. 507) has been neatly chipped round the periphery to reduce its diameter.

Specimens from level 6

All anvils from level 6 are smaller than those from level 7. The surfaces are more convex, particularly cat. 557. This anvil has a black, reduced handle and red, presumably oxidised, face.

Specimens from level 5

This level has yielded one complete specimen, two fragments of handles and one section of the face. The complete anvil (TS cat. 22) resembles those from level 6 rather than level 7. A flake of pottery has detached from the surface, presumably rendering it worthless. The handle of cat. 180 is unusual in having a squared rather than rounded end. The fragment of face has been systematically chipped to reduce its diameter (cf. cat. 507).

TABLE 3-31

Clay anvils from Ban Na Di (in mm)

Provenance	Level	Cat.No.	Max. height	Max. diam. face	Max. diam handle
A4 25	7	507	–	75.0*	38.0
A2 37	7	1851	–	*c.* 115.0	–
A4 35	7	1850	–	–	–
A1 32	7	760	–	*c.* 110.0	–

A4	34	7	1447	109.3	80.3	47.0
F8	10	7	1217	–	99.5	–
F6	1	7	858	–	73.5	–
A1	21	6	557	–	*c.* 100.0	–
A2	25	6	623	–	56.0	–
A1/A2	25	6	1238	82.8	57.2	37.0
A2	23	6	605	68.8	50.8	29.3
A3	17	6	556	–	*c.* 71.0	–
A2	24	6	683	–	*c.* 80.0	–
F5	8	6	TS 22	–	–	34.0
A4	14	5	180	117.0	80.7*	44.0
A4	13	5	156	–	–	40.8
A4	17	5	268	–	–	40.3
A3	15	5	1681	–	*c.* 67.0*	–
A2	17	4	464	–	*c.* 55.0	–
A2	16	4	421	–	*c.* 85.0	–
A4	12	4	387	–	*c.* 82.0	*c.* 40.0
A2	13	4	137	–	*c.* 80.0	–
A1	4	2	50	–	*c.* 67.0	–

* after being deliberately reduced by chipping the periphery.

Specimens from Level 4

There are four broken fragments from level 4 all from the face rather than the handle. Cat. 464 is unusual in having a very small face relative to the width of the handle.

Specimen from Level 2

Only the face of this specimen survives.

Specimens from burial contexts

Three anvils were found in or near burials, but in no case was there a firm association suggesting that anvils were used as grave offerings. A complete specimen was found near B.49 (Cat. 1447 Mortuary Phase 1b). The face of a large anvil was found in the grave fill of B.37 (cat. 1217), and a small fragment of a face was found in the grave fill of B.17 (cat. 858).

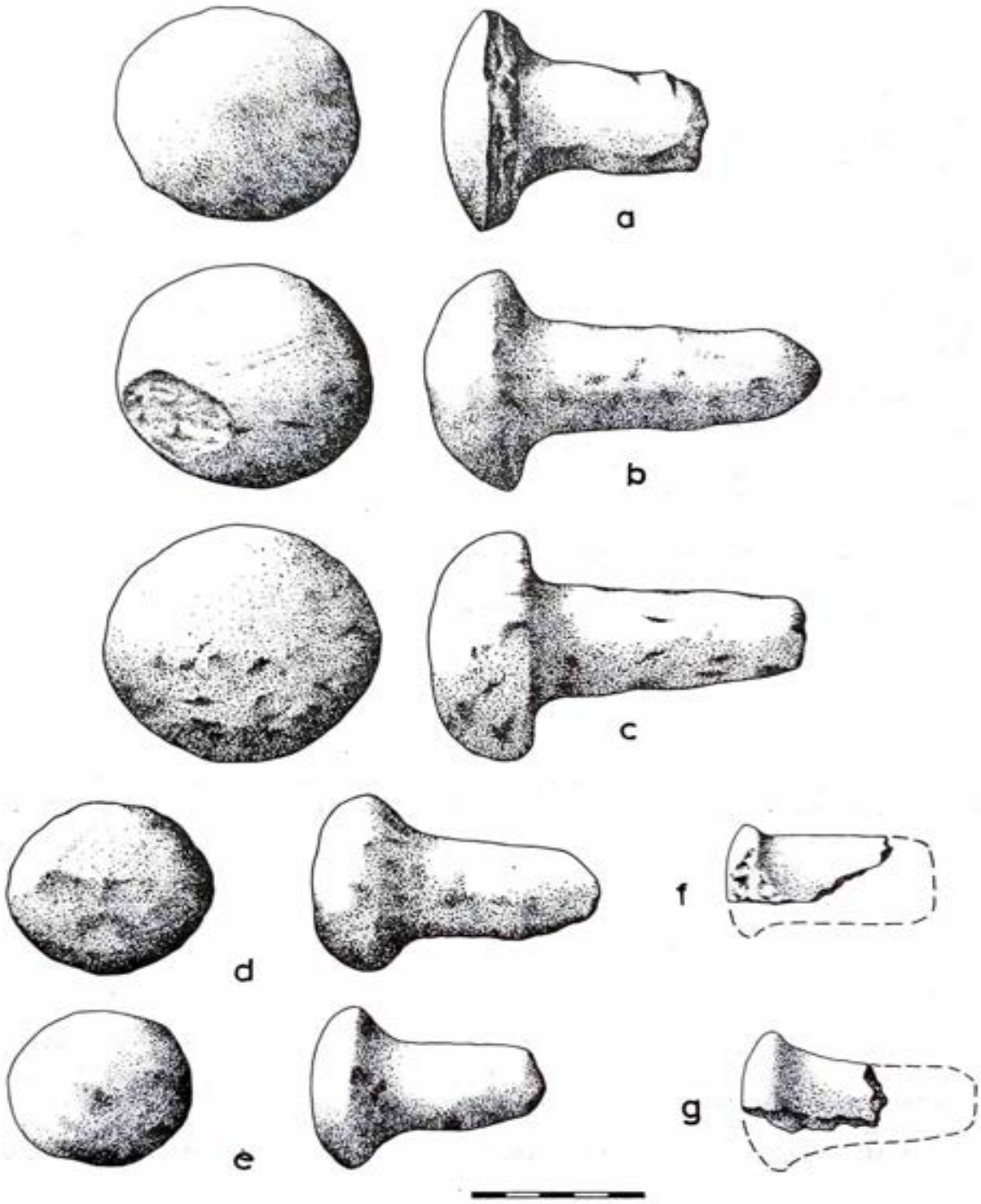


FIGURE 3-30

Ban Na Di: the clay anvils
A. A4 25 L.7 Cat.507 B. A4 14 L.5 Cat.180 C. A4 34 L.7 Cat.1447
D. A1/A2 25 L.6 Cat.1238 E. A2 23 L.6 Cat.605 F. A2 17 L.4 Cat.464
G. A2 16 L.4 Cat.421

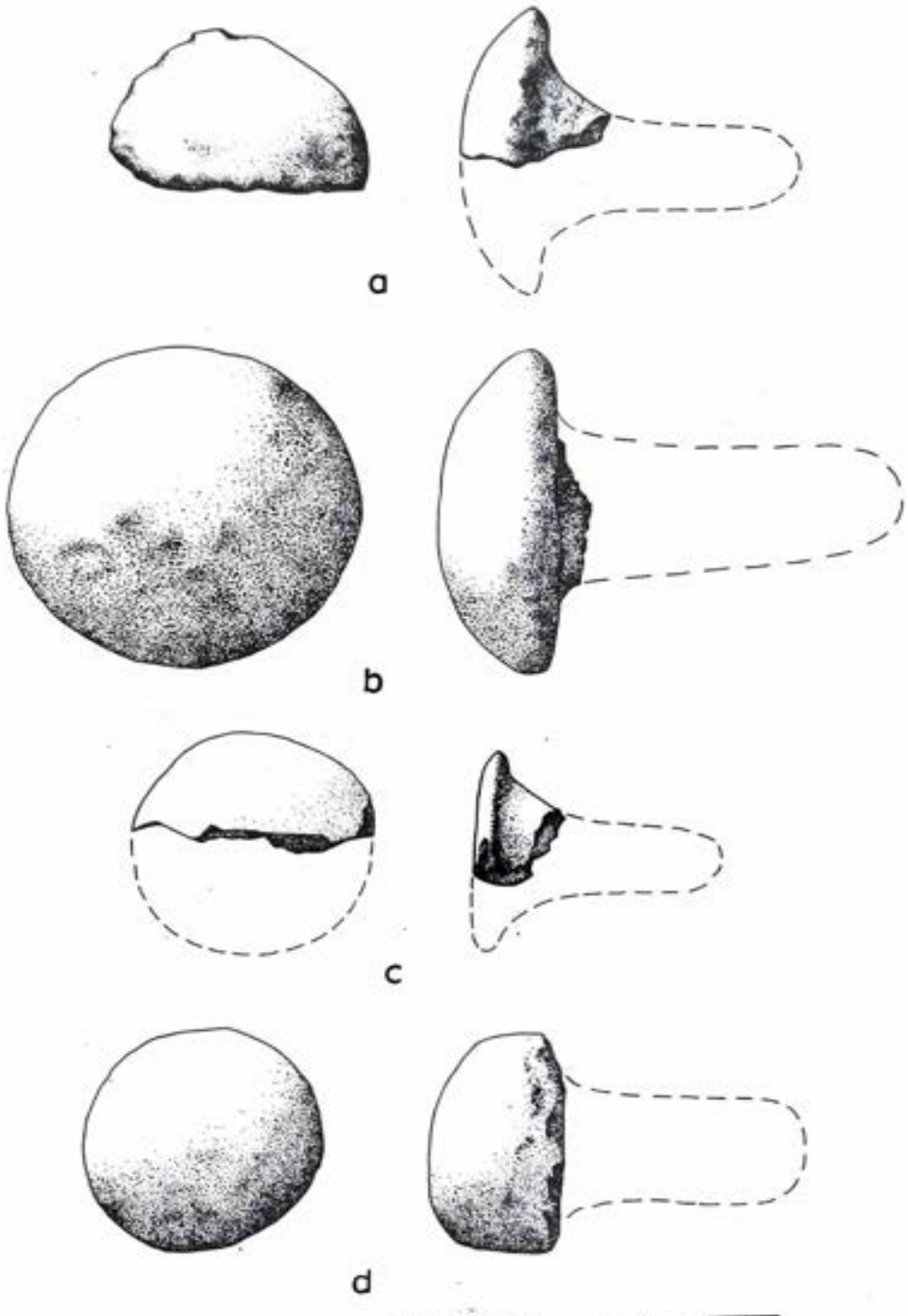


FIGURE 3-31

Ban Na Di: the clay anvils
A. A2 13 L.4 Cat.137 B. F6 10 L.7 Cat.1217
C. F6 1 L.7 Cat.858 D. A1 4 L.2 Cat.50

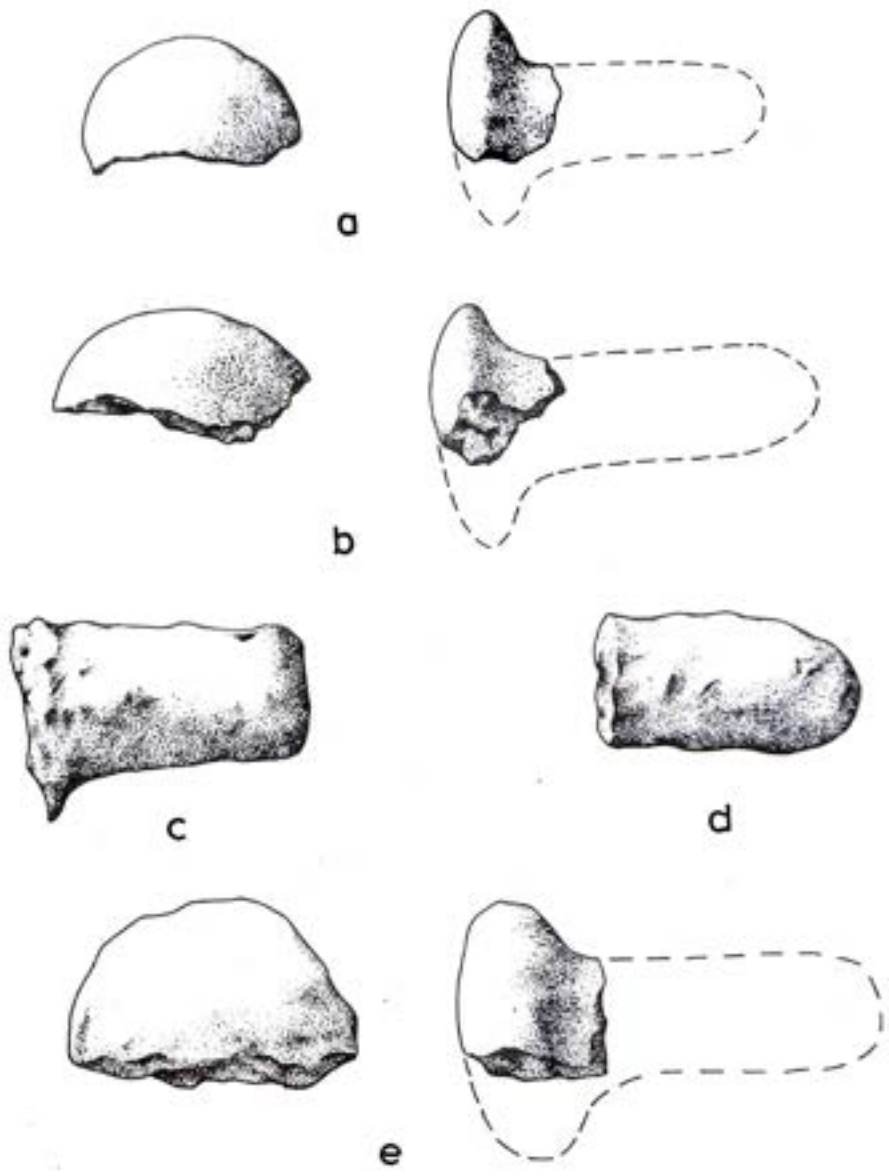


FIGURE 3-32

Ban Na Di: the clay anvils
A. A2 25 L.6 Cat.623 B. A3 17 L.6 Cat.556
C. A4 13 L.5 Cat.156 D. A4 17 L.5 Cat.268
E. A4 12 L.4 Cat.387

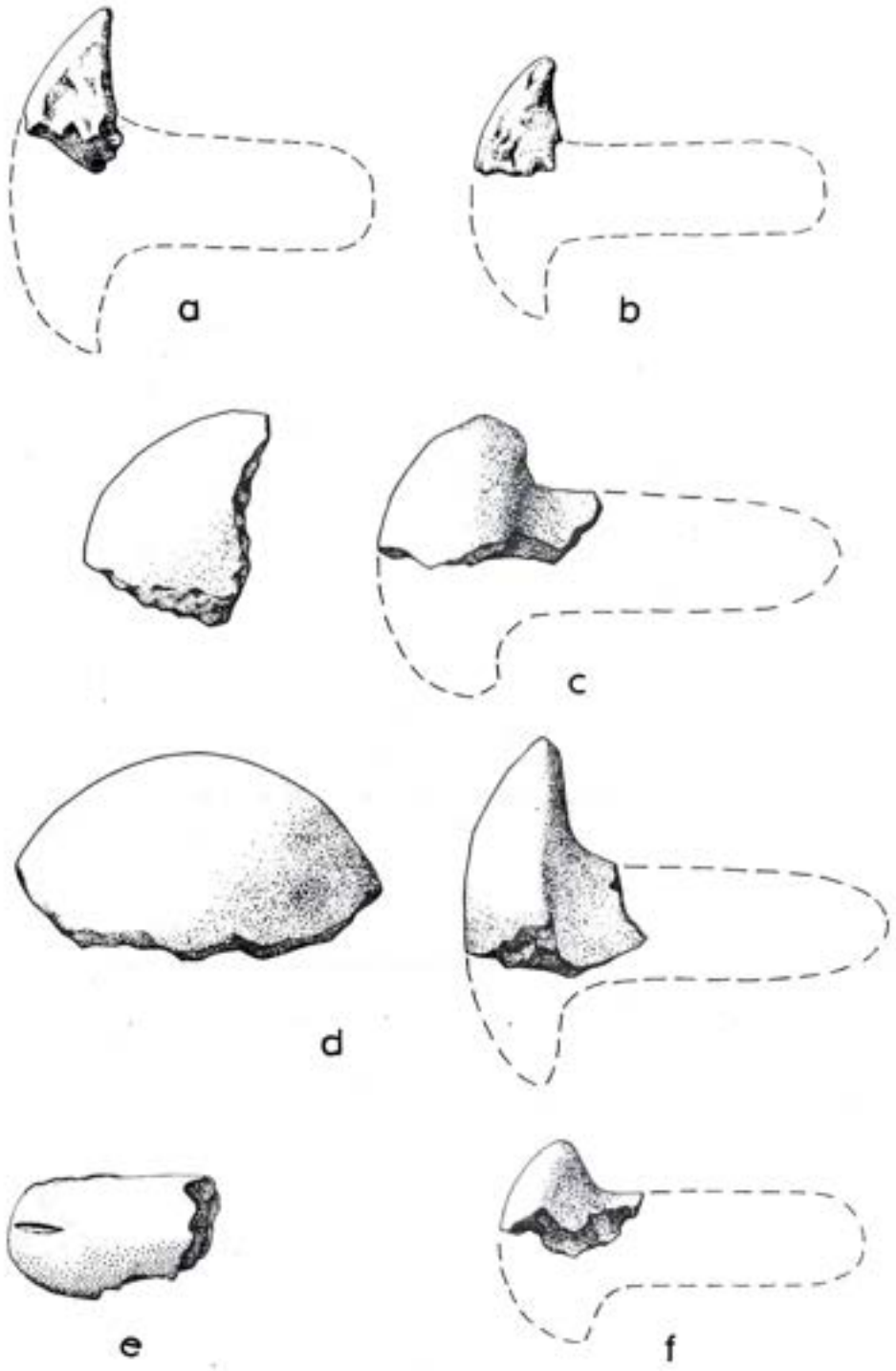


FIGURE 3-33

Ban Na Di: the clay anvils
A. A2 37 L.7 Cat.1851 B. A4 35 L.7 Cat.1850
C. A1 22 L.6 Cat.557 D. A1 32 L.7 Cat.760
E. F5 8 L.6 Cat.TS22 F. A2 24 L.6 Cat.683

THE CLAY FIGURINES

(figs 3-34 to 38)

CATTLE FIGURINES FROM BURIALS

Clay figurines were found from both funerary and occupation contexts. They represent cattle, deer, elephant, fish and human beings. The funerary specimens all come from a restricted set of graves from squares F5-6. The funerary figurines will be treated first.

The cattle figurines were moulded by hand and probably lightly fired before interment. In some cases, fingerprints are visible on the surface of the clay. The animal form was moulded without close attention to anatomical detail with the exception of the horns. Where these have survived intact, they were modelled with delicacy and attention to the curvature.

TABLE 3-32

Ban Na Di: the cattle figurines from mortuary contexts (in mm)

Provenance	Mortuary Phase	Cat.No.	Max. Length (exclud. horns)	Max. height (excl. horns)	Ht.of Neck
F6 Burial 47	1a	1397	124.3	51.0	27.1
F6 Burial 47	1a	1399	*c.* 150.0	86.0	22.0
F6 Burial 47	1a	1401	148.0	71.0	21.0
F6 Burial 47	1a	1396	*c.* 175.0	*c.* 75.0	31.0
F6 Burial 47	1a	1388	*c.* 170.0	*c.* 77.0	29.5
F6 Burial 47	1a	1389	154.0	*c.* 72.0	22.1
F6 Burial 47	1a	1418	–	–	*c.* 23.0
F6 Burial 47	1a	1402	–	–	–
F6 Burial 40	1a	1439	*c.* 164.0	*c.* 80.0	29.5
F6 Burial 40	1a	1438	–	–	–
F6 Burial 40	1a	1440	–	–	–
F6 Burial 45	1a	1384a	138.0	77.0	26.5
F6 Burial 45	1a	1384b	–	–	–
F6 Burial 45	1a	1385	–	–	–
F6 Burial 45	1a	1387	–	–	–
F6 Burial 45	1a	1383	123.0	61.0	23.0
F6 Burial 45	1a	1386	–	–	31.0
F6 Burial 46	1a	1437	–	66.5	–
F6 Burial 46	1a	1436	–	–	*c.* 30.0
F5 Burial TS19	1a	TS 34a	–	–	–

F5 Burial TS19	1a	TS 34b	–	–	–
F6 Burial 38	1b	1419a	145.0	77.0	32.5
F6 Burial 38	1b	1419b	–	–	33.0
F6 Burial 35	1c	1280	–	–	26.5

F6 B.47 Cat. 1397 (fig 3-35a)

This bovid figurine was found on the man's stomach area. It is complete except for the horns and tail, and stands easily on the feet. These were modelled as one piece, the rear legs being little more than a rounded nubbin. The ridged back and dewlap were modelled with three and two finger pinches respectively. Fingerprints are clearly visible.

F6 B.47 Cat. 1399 (fig 3-35b)

This specimen was found in the genital area, the animal's head facing towards the human knees. It is considerably larger than cat. 1397 yet moulded in the same manner. It has pronounced muscular ridging over the neck, a feature suggesting that it represents a bull. There is no other attention to sexual dimorphism.

F6 B.47 Cat. 1401 (fig 3-35c)

This figurine was found standing upright beside the left ankle. It has pronounced muscular ridging along the shoulders and neck. The dewlap too was large, to judge from its base, although most of it was broken and lost. The basal section of the right horn is in place. It curves back from the skull before turning forward.

F6 B.47 Cat. 1398 (fig 3-35d)

This specimen was found standing upright and running parallel and adjacent to the right thigh. The forelimbs are set further back from the face than in cats. 1397, 1399 and 1401, revealing a deep and powerful neck. There is no raised ridge along the back.

F6 B.47 Cat. 1388 (fig 3-35e)

The face on this specimen was found complete, together with the basal part of the right horn. It had been placed over the person's neck. Treatment of the face was schematised. Viewed from the front, it has a triangular shape, the two sides being very slightly concave and ending in a point. These sides arc into the lower edge of the horns. The right hand horn is angled back from the skull, but enough survives to reveal a forward change of angle. Finger or palm prints are clearly visible on the neck. The ridge on the back is fairly pronounced. The rear legs, which are complete, are represented as a small nubbin.

F6 B.47 Cat. 1389 (fig 3-34a)

This figurine was found adjacent to the upper left arm. It is distinctive because of a clear raised ridge running along the top of the head and directly into the horn. In this case, the left horn slopes back before bending sharply forward. There is a large and pronounced ridge running along the shoulders. The neck is quite slender.

F6 B.47 Cat. 1418

This fragmentary specimen was found placed inside the left elbow. Only part of the torso and a piece of horn survive.

F6 B.47 Cat. 1403 (fig 3-34b)

This very large but fragmentary figurine was found over the left arm. It is hard to determine whether it does in fact, represent a bovid, but this species seems the most likely.

F6 B.35 Cat. 1280 (fig 3-34c)

The head and legs of this figurine are missing, but it is still clearly a bovid. The vestiges of the dewlap were finger pinched, but the shoulder and neck area is rather carefully moulded. This specimen was found at the left shoulder.

F6 B.38 Cat. 1419a (fig 3-34d)

This figurine is unusual for its robustness, and its size has led to almost complete survival. The head is schematic; the face and jaw area is triangular when viewed from in front, and ends with a point. The eyes, nostrils and mouth are ignored. The frontal part of the head has a weak ridge quite unlike that in the wild gaur or banteng. Neither the dewlap nor the neck are treated as in B.46 specimens, by finger pinching. They are on the contrary, carefully moulded and smoothed. The horns are massive and have the curvature characteristic of cattle rather than water buffalo. The belly area is treated as a graceful concave arc terminating in the rear limbs. As usual, the limbs take the form of solid protuberances, though the forelimbs in this specimen have a central concavity recalling the presence of two feet. The tail is shaped into a small bump. Of all the mortuary figurines from Ban Na Di, this one exhibits most aesthetic sensibility. It was found, placed upside down, on the left elbow.

F6 B.38 Cat. 1419b (fig 3-34e)

This second specimen from B.38 was found *c.* 20 cm beyond the right foot. Although it is fragmentary, enough survives to conclude that it was moulded in just the same manner and to the same shape as cat. 1419a.

F6 B.40 Cat. 1439 (fig 3-37a)

The most complete of the three specimens from B.40 was found adjacent to a redeposited concentration of disarticulated bones. It is worth recording that this burial cut contained these relocated bones (B.40), part of the skeleton of a young child (B.46) and the final interment, that of an infant (B.45). All three burials are associated with cattle figurines. It is possible that these figurines too were relocated when fresh burials were placed into this grave.

This specimen displays some unusual features. Both fore and rear limbs survive and both bifurcate rather in the manner of a seal's rear flippers. There is a pronounced ridge along the back, created by finger-pinching. A similar ridge is found along the fore part of the belly. The face, which is detached from the body, is markedly triangular.

F6 B.40 Cats. 1438 and 1440

Only fragments of these two bovid figurines have survived.

F6 B.45 Cat. 1384a (fig 3-37b)

Burial 45 comprises the remains of an infant surrounded by five bovid figurines. The best preserved has particularly long forelimbs, the distinction between right and left legs being represented by a shallow incised line. The triangular head has a pronounced frontal ridge and a sharply pointed nose. A single pinch of the fingers was used to represent the ridge along the back. This specimen was found lying on the infant's right side.

F6 B.45 Cat. 1384b (fig 3-37c)

This rear part of the torso was found under cat. 1384a. Two specimens are represented.

F6 B.45 Cat. 1385

Only the torso of this bovid has survived. The ridge on the back was raised by finger pinching.

F6 B.45 Cat. 1387

It is unfortunate that this figurine was damaged in antiquity. The rear quarters and torso of a robust specimen have been preserved, together with two horns, facial fragments and the forelimbs. The rear limbs are little more than a splayed stump, and the tail is a small moulded nubbin. The horns were moulded with considerable skill and are clearly bovid. This specimen was found by the child's left ankle.

F6 B.45 Cat. 1383 (fig 3-37e)

This figurine is complete save for the tail and tip of one horn. It has all the principal features of the assemblage: schematic feet, triangular shape to the head and pronounced carefully moulded horns. As in cat. 1834a, the ridge on the back was created with a single pinch of the finger and thumb. The fingerprints are clearly visible there, near the dewlap, and

round the tail area. It was found at the infant's right shoulder.

F6 B.45 Cat. 1386

Only fragments of this figurine survive. It was clearly bovid, because pieces of the horns were found. A series of finger pinches raised the ridge along the back. It was found on the child's left hand.

F6 B.46 Cat. 1437 (fig 3-36a)

This specimen is complete except that the head is detached. The rear limbs comprise two small nubbins. The body is moulded and smoothed. There is no finger pinching to render the ridge along the neck and shoulders. The dewlap however, is finger-pinched. The figurine has considerable artistic merit in its economy of style and simplicity.

F6 B.46 Cat. 1436

The torso alone remains of what would have been a particularly large bovid figurine. The shoulders were powerful and accentuated by a ridge drawn up by finger pinching.

F5 B. TS 19 Cat. TS 34a-b (fig 3-36b)

The broken remains of two figurines were found in association with this burial. The torso and rear limbs of one represent a bovid rather smaller than those found in the square F6 burials but the treatment is the same. The rear feet are moulded into two small protuberances. There is a fragment of a head, two sets of fore limbs and three horns. One has survived complete. It is moulded with careful attention to anatomical accuracy. The two remaining pieces were broken and only basal sections survive.

The cattle figurines were found only in the F5-F6 graves. They predominated in the earliest mortuary phase, but were also present in phase 1b and 1c contexts. In cases where intact graves were found, the figurines were placed with some care relative to the body. This is particularly so for B.47. They were moulded in a stylised manner, the rear feet represented by small nubbins, the forelimbs by a single piece of clay, often with two small projections. Particular attention was paid to moulding the horns and shoulders. The complete specimens stand upright easily. They were made of solid clay which was fired to a low temperature.

Where moulding was stylised, it is not possible to be sure what type of animal is represented. There is no doubt that we are dealing with cattle rather than water buffalo, because the horns belong to the former. The robusticity of the shoulder area suggests that most animals were male rather than female: sexual dimorphism in this area is marked both in the gaur *(Bibos gaurus)* and the banteng *(Bibos javanicus)*. The male gaur has a massive frontal projection between the horns. The absence of this feature hints that the modeller had in mind a male banteng or domestic bull.

DEER AND ELEPHANT FIGURINES FROM BURIALS (fig 3-36)

Burial 47 contained the clay figurines of a deer (cat. 1402 fig 3-36d) and an elephant. The former is complete save for the rear limbs. It stands 110.5 mm high and has a slender neck with a minimum width of 9.5 mm. The modelling technique and conventions used are the same as for cattle. The forelimbs are depicted as a single projection of clay splayed at the end into two nubbins. The back rises to a small ridge and the dewlap is pinched out. Unfortunately the head is incomplete, but the broken areas are large enough to have supported antlers. This figurine was found under and between the calves.

The elephant (cat. 1405 fig 3-36c) is a massive figurine in which the clay has splintered laterally across the body. The neck is *c.* 35 mm broad and the shoulders 54.0 mm across. The length from the frontal bone to hind quarters was approximately 150.0 mm. Again, the moulding technique matches that used for the cattle. There is a pinched ridge running the entire length of the back. Part of one broad ear survives, as does most of the trunk. This figurine was found overlying the left forearm.

HUMAN FIGURINES FROM BURIALS (fig 3-36)

Burial 47 contained two human figurines. The first is present only from the waist up. Only the stumps of the arms survive. They appear to have been outstretched. The eyes, nostrils and nose are formed by jabs with a sharp implement into the wet clay. The surviving portion is 70 mm in height. It was found on the left forearm (cat. 1394 fig 3-36f).

The second, more complete specimen, was found in the left hand. It has lost the extremities of arms and legs but is otherwise substantially complete. The arms were formerly outstretched. As in the first specimen, the eyes and mouth were created when a sharp implement was jabbed into the clay. The ears were pinched out, as were the male genitalia. The surviving portion stands 80 mm high (cat. 1404 fig 3-36e).

CATTLE FIGURINES FROM OCCUPATION CONTEXTS (fig 3-38)

Stylistically, nearly all the figurines from occupation deposits parallel those from the burials. They are, however, far smaller.

A4 Level 7 Cat. 1847 (fig 3-38a)

This figurine only lacks the head. It is hand-moulded, prominence being given to the massive shoulders. The feet received less emphasis, though they bifurcate at the base into two tiny nubbins. It stands easily.

A2 Level 7 Cat. 794 (fig 3-38b)

Again, only the head is absent. There is a small, upright tail and straight back to an accentuated hump at the shoulders. It stands easily on four tiny feet. There is a clear finger print on the back.

A3 Level 7 Cat. 801 (fig 3-38c)

This figurine is very crudely modelled, and lacks all the care and style of cats. 1847 and 794 above. The feet are roughly rounded lumps of clay. Some care has been taken, with a sharp instrument, to distinguish the short tail from the body. There is a raised lump at the shoulders, but the head has been lost.

A3 Level 7 Cat. 446a (fig 3-38d)

This figurine is complete except for the horns. It is meticulously modelled adopting the conventions for a vestigial tail, bifurcated legs and triangular-shaped head. The horns were angled out and then forward from the occiput.

A3 Level 7 Cat. 446b (fig 3-38c)

This figurine is very similar to cat. 446a in size and treatment, althought the face and forelimbs are missing.

A3 Level 7 Cat. 876 (fig 3-38f)

This specimen is complete except for the horns. It is rather crudely modelled, a single pinch of finger and thumb being employed to highlight the neck ridge.

TABLE 3-33

Ban Na Di: the cattle figurines from occupation deposits (in mm)

Provenance	Level	Cat.No.	Max. Length	Max. Height	Max. Width neck
A4 34	7	1847	*c.* 59.0	*c.* 29.0	14.0
A2 40	7	794	*c.* 40.0	25.0	11.0
A3 33	7	801	*c.* 64.0	39.5	20.0
A3 21	7	446a	46.3	25.0	11.5
A3 21	7	446b	*c.* 44.0	–	13.9
A4 30	7	476	41.5	–	15.0
A3 29	7	690	–	–	29.0
A3 24	7	539	–	–	–

F6 12	7	1270	–	–	–
F6 6	7	981	–	–	–
F5 21	7	TS54	–	–	–
A2 23	6	410	–	–	13.5
A3/4 18	6	1315	–	–	–
A1 22	6	528	–	*c.* 23.0	–
A3 20	6	402	42.0	27.0	12.0
F5 8	6	TS23	–	–	–
A1 22	6	701	*c.* 45.0	*c.* 22.0	11.5
Uncertain	6	1881	*c.* 43.0	*c.* 30.0	15.0
A2 18	5	333	–	38.0	–

A3 Level 7 Cat. 690 (fig 3-38g)

Only the head has survived. Its shape is most unusual. The horns point upwards and there is a depression in the area of the frontal bone.

A3 Level 7 Cat. 539 (fig 3-38h)

This specimen is represented only by the head and horns. The latter point upwards from a face with a triangular outline viewed from the front.

F5 Level 7 Cat. TS54 (fig 3-38)

The head and forelimbs of this specimen are missing. The rear limbs are represented by a single nubbin.

F6 Level 7 Cat. 1270 (fig 3-38n)

This is part of a large bovid figurine which was found in the burial area of square F6, but not precisely associated with a burial. In terms of style and size, it falls into the group described under figurines from mortuary contexts. The rear limbs comprise two clay bosses and the tail is vestigial.

F6 Level 7 Cat. 981 (fig 3-38o)

Only the rear limbs of this very small bovid figurine survive.

A2 Level 6 Cat. 410 (fig 3-38i)

This figurine is most interesting, because it has a pronounced hump on the shoulders quite unlike any other bovid figurine described. The shape of the one surviving horn is clearly akin to the water buffalo *(Bubalus bubalis)* rather than wild or domestic cattle.

A3/A4 Level 6 Cat. 1315 (fig 3-38j)

Only the rear limbs and tail area were found. The tail was precisely shaped, probably with a sharp implement.

A1 Level 6 Cat. 528 (fig 3-38k)

This figurine is very small. The rear limbs are represented by two tiny bosses. The raised area above the neck is relatively pronounced, though the head and forequarters are not present.

A3 Level 6 Cat. 402 (fig 3-38l)

This is one of the few complete miniatures. It has a pronounced hump, vestigial legs and no hint of a tail. The face is slender, finishes at a point for the mouth and the horns rise almost vertically above the frontal area.

F5 Level 6 Cat. TS23 (fig 3-38p)

The rear quarters only have survived. They come from a small bovid and conform, in terms of the schematised legs and vestigial tail, to the set found in squares A1-4 from occupation contexts.

A1 Level 6 Cat. 701 (fig 3-38q)

This figurine is extremely stylised. Fore and rear limbs are represented as solitary nubbins. The head is missing.

Cat. 1881 Level 6 (fig 3-38r)

This figurine lacks the head. The fore limbs are splayed in just the same manner as the larger specimens from mortuary contexts. There is a pronounced hump.

A2 Level 5 Cat. 333 (fig 3-38m)

This is the only figurine from a level 5 context. It is rather crudely modelled. The hump over the shoulders is pronounced but the head is missing.

HUMAN FIGURINES FROM OCCUPATION CONTEXTS (fig 3-38)

A4 Level 5 Cat. 248 (fig 3-38t)

This is a small and crudely modelled figurine, but clearly recognisable as human. Only the upper part of the body is present. The arms were outstretched and the chest area moulded with a single pinching of finger and thumb. The same technique was used to mould the nose and face. The surviving piece is 40 mm high and the original must have stood about 50 mm in height.

FISH FIGURINE (fig 3-38)

A4 33 Level 7 Cat. 1085 (fig 3-38u)

This nearly complete figurine represents a fish. It is 39.5 mm long, and would originally have been about 5.0 mm longer. The maximum width is 15.0 mm. The dorsal fin has been raised by finger pinching and the fin spines, represented by five successive notches. The shape of the body suggests that the fish belongs to the family Anabantidae. This is commonly represented in the Ban Na Di faunal spectrum.

Figurines: summary

The same conventions for making the large cattle figurines apply to the small ones. They were distributed through levels 6 and 7 with one specimen being found in the lower part of level 5. One small figurine from level 6 represents a water buffalo. There is also one fish, and one human figurine. The water buffalo comes from the same level as the actual bones of that species, and the fish family is common in the occupation deposits at Ban Na Di. The use of these figurines is not known.

For a consideration of the clay used in the manufacture of these figurines, see page 674.

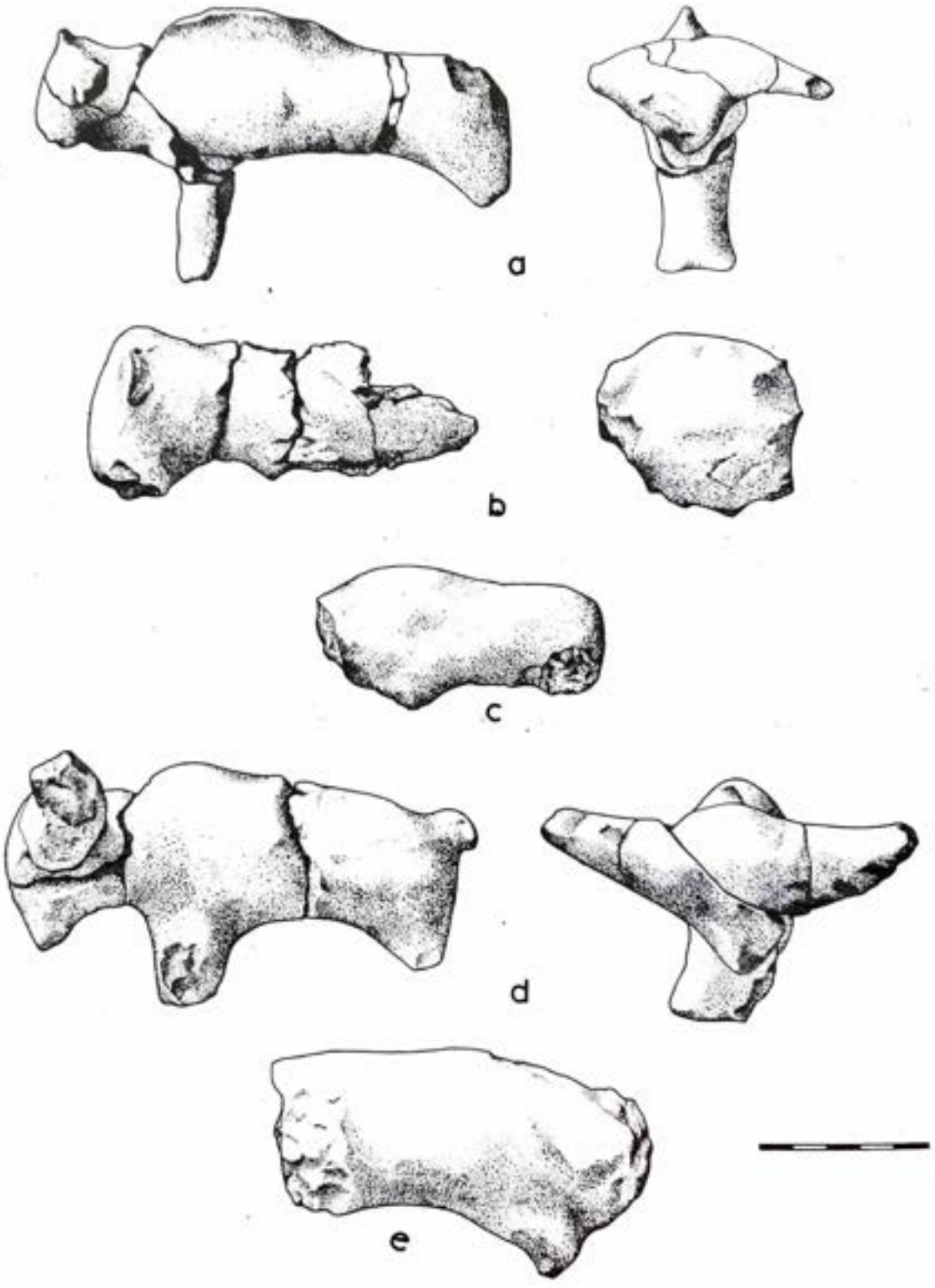


FIGURE 3-34

Ban Na Di: the cattle figurines from the burials
A. B.47 Cat.1389 B. B.47 Cat.1403 C. B.35 Cat.1280 D. B.38 Cat.1419a
E. B.38 Cat.1419b

Ban Na Di: illustrations of the figurines

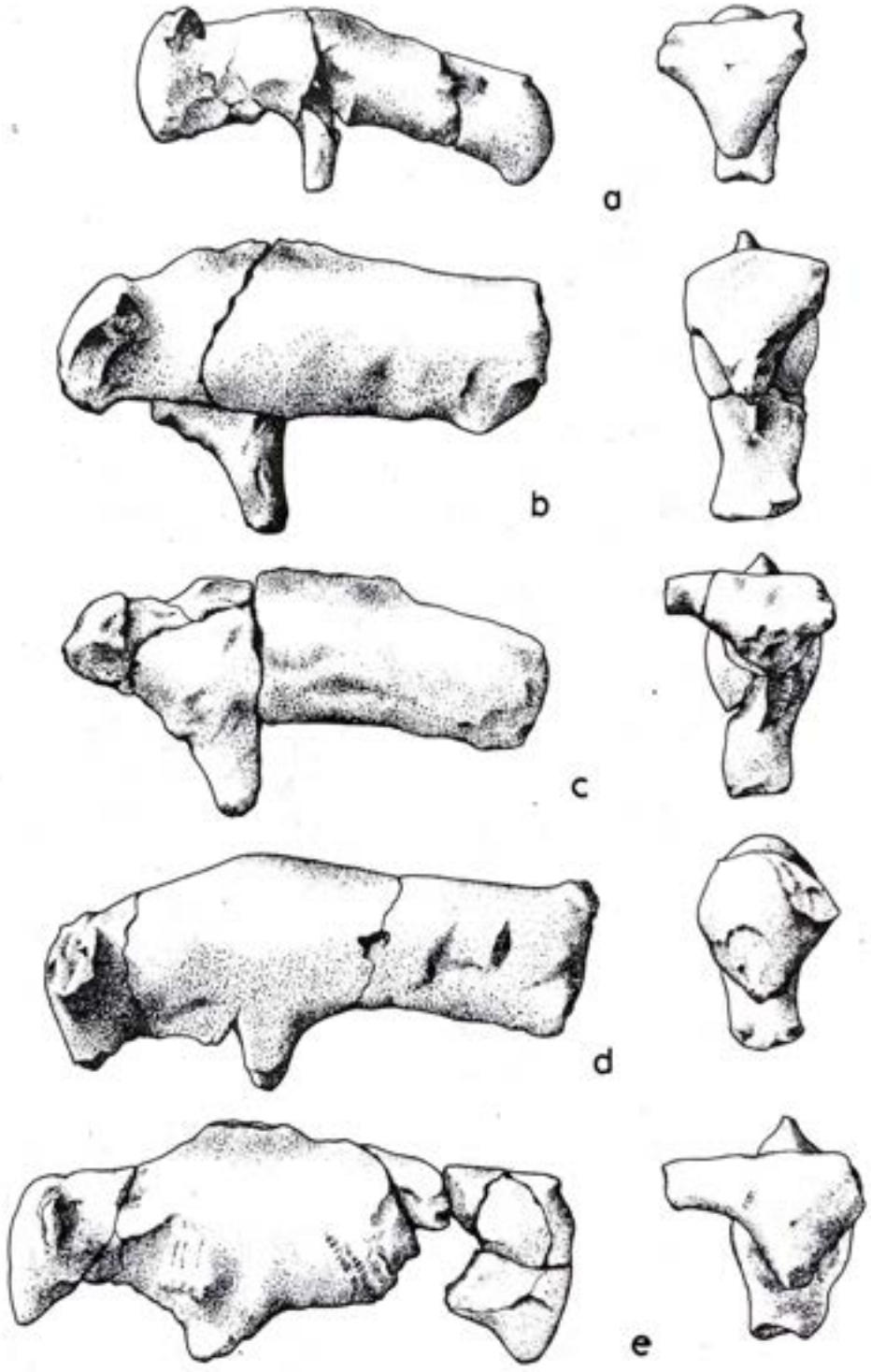


FIGURE 3-35

Ban Na Di: the cattle figurines from burial 47
A. Cat.1397 B. Cat.1399 C. Cat.1401 D. Cat.1396 E. Cat.1388

Ban Na Di: illustrations of the figurines

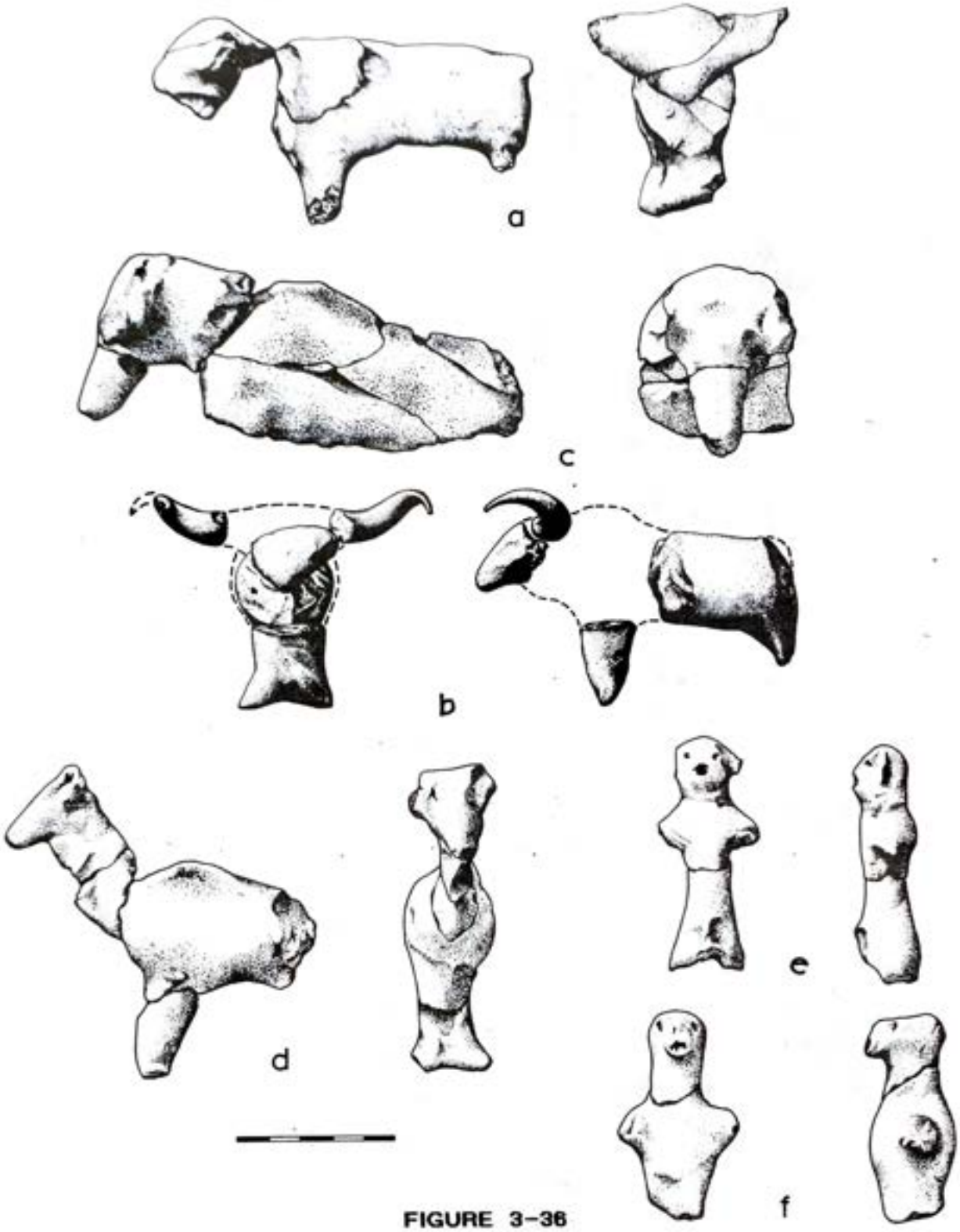


FIGURE 3-36

Ban Na Di: cattle, elephant and deer and human figurines
A. Bur.46 Cat.1437 B. Bur. TS 19 Cat. TS34a-b C. Bur.47 Cat.1405
D. Bur.47 Cat.1402 E. Bur.47 Cat.1404 F. Bur.47 Cat.1394

Ban Na Di: illustrations of the figurines

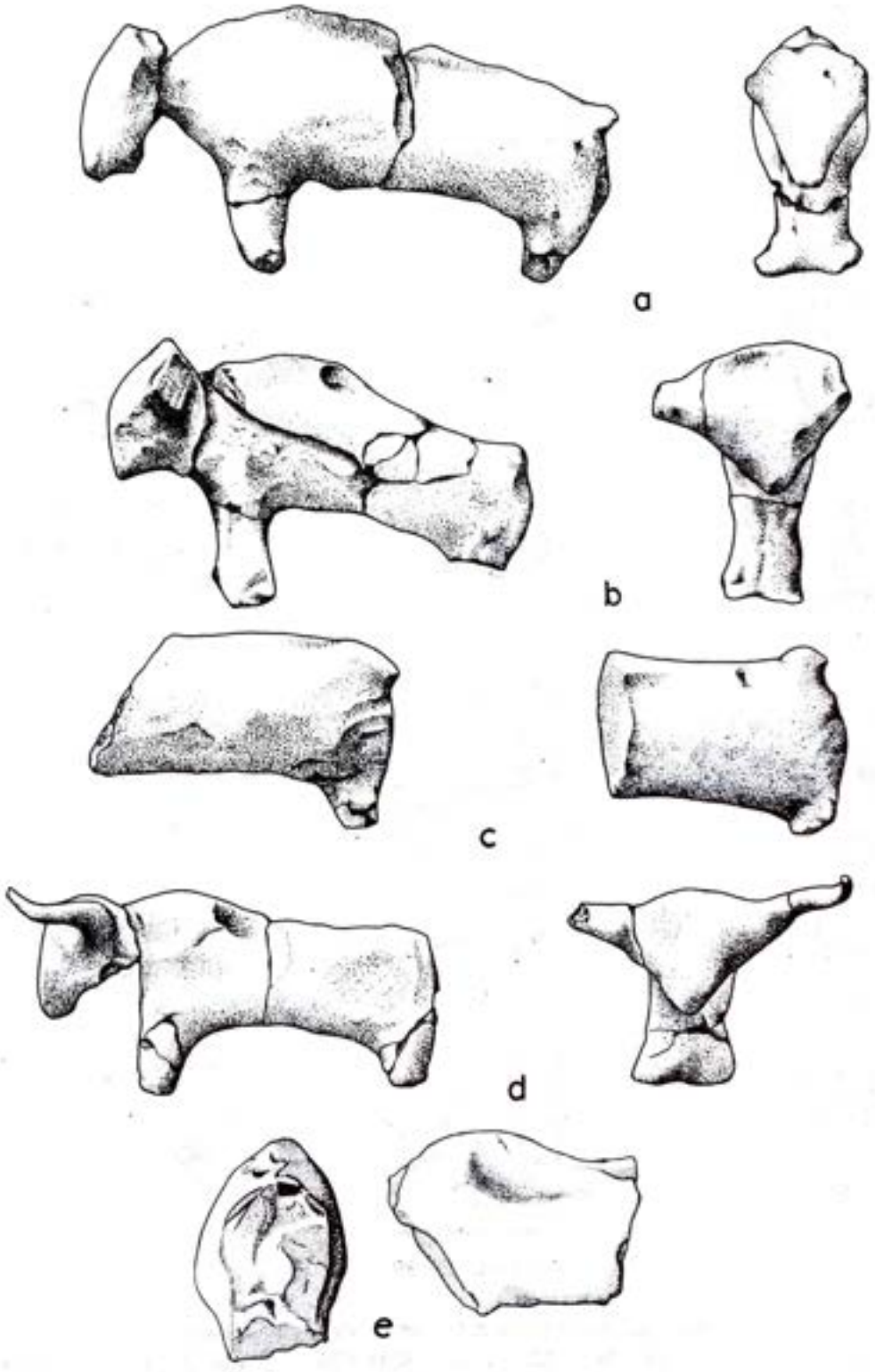


FIGURE 3-37

Ban Na Di: cattle figurines from burials
A. Bur.40 Cat.1439 B. Bur.45 Cat.1384a C. Bur.45 Cat.1384b
D. Bur.45 Cat.1383 E. Bur.46 Cat.1436

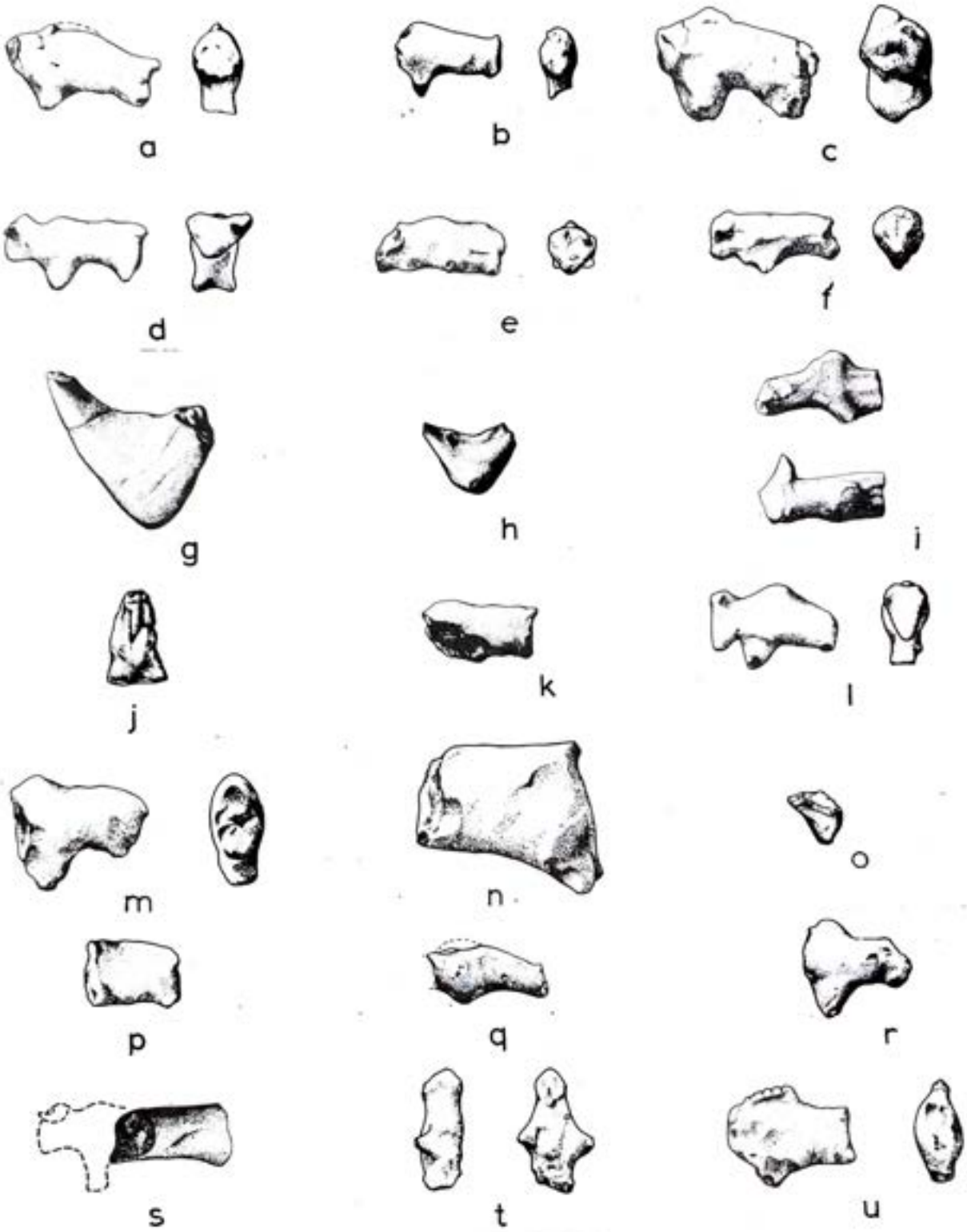


FIGURE 3-38

Ban Na Di: cattle, human and fish figurines
A. A4 34 L.7 Cat.1847 B. A2 40 L.7 Cat.794 C. A3 33 L.7 Cat.801
D. A3 21 L.7 Cat.446a E. A3 21 L.7 Cat.446b F. A4 30 L.7 Cat.876
G. A3 29 L.7 Cat.690 H. A3 24 L.7 Cat.539 I. A2 23 L.6 Cat.410
J. A3/A4 18 L.6 Cat.1315 K. A1 22 L.6 Cat.528 L. A3 20 L.6 Cat.402
M. A2 18 L.5 Cat.333 N. F6 12 L.7 Cat.1270 O. F6 6 L.7 Cat.961
P. F5 8 L.6 Cat.TS 23 Q. A1 22 L.6 Cat.701 R. U/C L.6 Cat.1881
S. F5 21 L.7 Cat.TS 54 T. A4 L.5 Cat.249 U. A4 33 L.7 Cat.1085

THE CLAY LADLES

(fig 3-39)

There are nine complete or fragmentary clay ladles from Ban Na Di. They are characterised by a practically circular bowl and handle rising up from it. The handles end either in a point or in a pair of nubbins. They are rather roughly shaped by hand and smoothed. There is no sign of decoration. Details are as follows:

TABLE 3-34

The Ban Na Di Ladles (in mm)

Provenance	Level	Cat.No.	Max. Length of bowl	Max. width of bowl	Max. depth of bowl
A4 30	7	971	85.7	82.1	46.5
A3 25	7	589	65.5	62.5	41.5
A4 23	7	438	75.0	75.5	44.5
A3 29	7	779	58.0	58.0	38.7
A3 23	7	468	handle only	-	-
F5 14	7	TS38	handle only	-	-
A3 28	7	667	handle only	-	-
A2 27	6	677	handle only	-	-
A1 19	5	1613	handle only	-	-

Ban Na Di: illustrations of the clay ladles

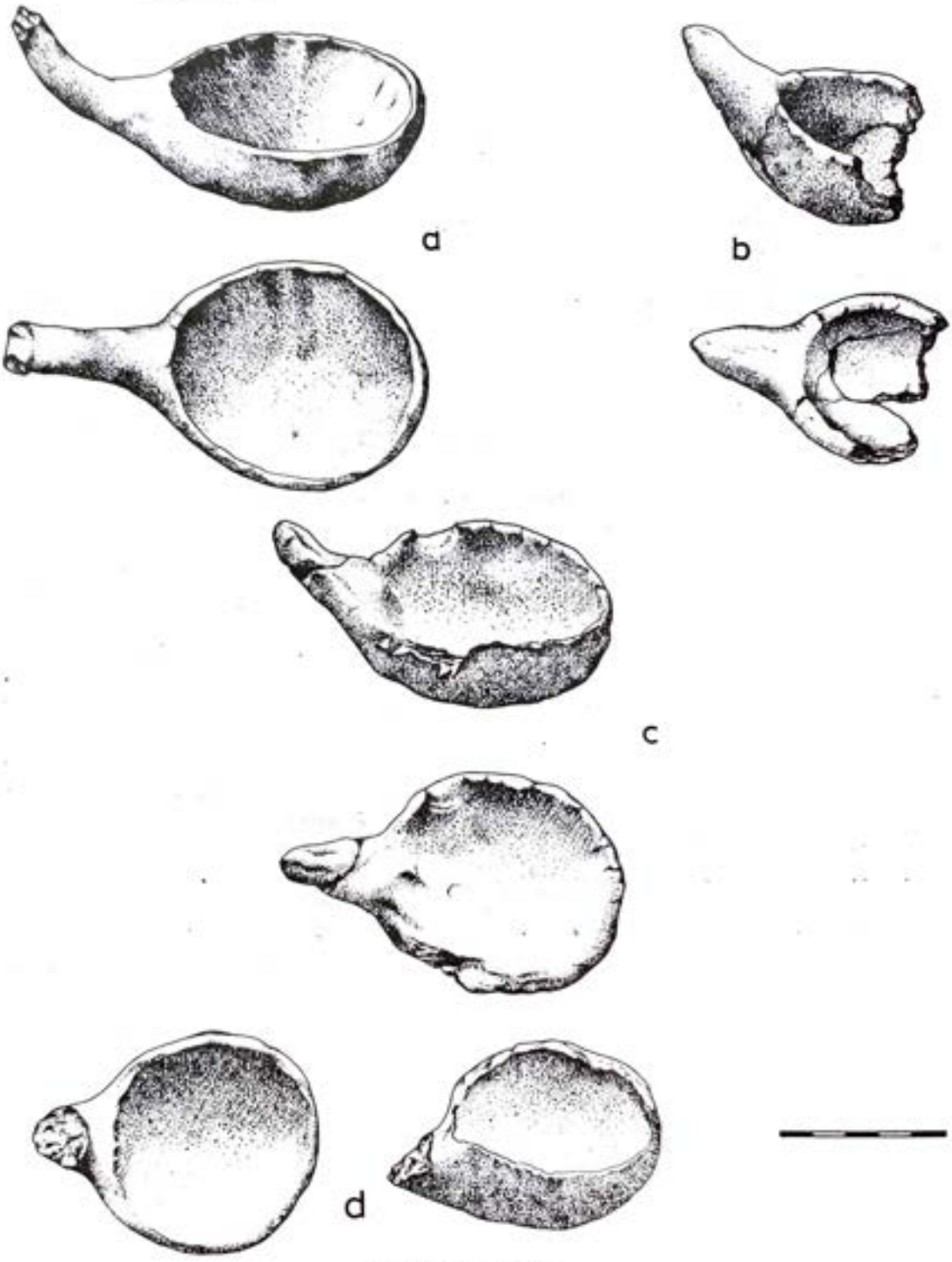


FIGURE 3-39

Ban Na Di: the clay ladles
A. A4 30 L.7 Cat.971 B. A3 29 L.7 Cat.779 C. A4 23 L.7 Cat.438
D. A3 25 L.7 Cat.589

THE BONE AND ANTLER ARTEFACTS

(figs 3-40 to 44)

There is a considerable variety of artefacts made of bone or antler at Ban Ban Na Di. Local manufacture is attested by the presence of worked bone and antler. These pieces are described below. The majority of complete artefacts can be loosely termed "points". It is possible to group these items typologically, although it is conceded that the use of these tools is not known with any degree of certainty.

a. Bone points from Level 7

A3/A4 28 Cat. 1319

This specimen has an intact point, but is fractured along the stem. Its surviving length is 82.5 mm. It bears striations all over its surface which result from shaping, probably with a sandstone abrader. Two attempts were made to drill a hole *c.* 20 mm from the point, and the third was successful. Particular attention was paid to the shape of the functional end. The first 10 mm of its length, including the point itself, are flat on one surface, but circular on the other, the maximum depth across the plano-convex section being 3.0 mm. The area just in front of the perforation flattens to a depth of 2.9 mm. There is a sheen to this part of the artefact, as if it was repeatedly used to pierce a resilient material, such as leather. The hole could have served to bear a thread and expedite stitching.

A3 22 Cat. 482

This bone point bears the marks of an abrader used in shaping it. They run transverse to its long axis. The point itself is not rounded as in cat. 1319, but has three facets. A groove runs the length of the implement, which is probably what remains of the bone's medullary cavity. The shaft was broken in antiquity and the surviving piece is 112 mm long.

A2 26 Cat. 547

This is a rather crudely shaped double pointed implement 65 mm long. Both tips were broken in antiquity. There is no indication that polishing or grinding were undertaken.

A4 34 Cat. 1106

This point was cut from a piece of metapodial bone, the size of which suggests a large deer or small bovid. Part of the exterior surface is still present where the point broadens to a width of *c.* 17.5 mm. The tip of the point is fractured. The implement bears cut marks, but no sign of grinding or polishing.

A2 39 Cat. 732

This is a double pointed implement, one end of which was fractured in antiquity. It would have measured about 70.0 mm before it was broken, and has a maximum breadth of 11.2 and depth of 5.8 mm. Both ends were ground and polished. The surviving complete end has a glossy sheen about 15 mm back from the tip. Both pointed ends dip away from the long axis of the bone.

A2 43 Cat. 844

Only the central part of this implement was found, but it was, to judge from its contour, formerly a point. It has been ground to an almost circular cross-section and the marks resulting from the use of an abrader are clearly visible. They run at an angle of *c.* 45° to the long axis. The point was subjected to heat, and has been charred all over.

A3 22 Cat. 479

This is the terminal end of a deer tine, similar in size to *Muntiacus muntjak*. It was removed by cutting round the perimeter and then snapping it off from the rest of the antler. Part of the exterior has survived, but the rest has been cut and then partially ground. The tip has been broken, leaving a surviving length of 50.1 mm.

A4 35 Cat. 1271

Like cat. 479 this point is fashioned from the tine of a deer antler, though this specimen came from a larger species of deer. The cut marks resulting from the process of detaching the tip from the body of the antler are clearly visible. The antler tip was then cut to shape and ground to an oval cross section. The tip itself has been broken, but there is a clear sheen which probably reflects its use as an awl to puncture a resilient substance, such as leather. It is 64 mm in length.

A3 36 Cat. 827

The pointed part of this artefact projects from a large piece of diaphysis. The point itself has been snapped off, leaving only a projection *c.* 23 mm long. This projection bears a slight sheen.

A2 29 Cat. 692

Again, the pointed end of this artefact has been broken. The diameter at the break is 4.0 mm, and the cross section is practically circular. Away from the point, the artefact broadens and flattens. This area has a cut notch at 90° to the long axis, and two small triangular notches cut above it. The area beyond these notches is broken, the surviving length being 54.0 mm.

F6 7 Cat. 934

This bone artefact has a circular cross section and was formerly pointed at each end. The original length is estimated at 90.0 mm, and the maximum diameter is 7.7 mm.

F8 2 Cat. 853

Only the central part of this burnt bone point has survived. It has been cut to form a circular cross section.

b. Bone points from Level 6

A2 26 Cat. 650

This artefact was probably formerly pointed at both ends, but both are now broken. Its surviving length is 59 mm. It has an oval cross section, the maximum and minimum diameters being 6.7 and 5.5 mm respectively. The surface has been polished all over. On one end, the fracture at the point is slight. There is a band of sheen the colour of which is slightly green. It also appears to have been subjected to heat.

A3 18 Cat. 367

Again, this slender implement has been fractured at both ends. Its surviving length is 80 mm, and it has a rectangular cross section measuring 4.5 x 3.0 mm. There are striations over all four surfaces at an angle of about 45 degrees to the long axis. These reflect the shaping of the bone.

A4 19 Cat. 551

Only the central shaft of this artefact has survived. It has a circular cross section 6.5 mm in diameter and a smooth, polished surface. The surviving length is 71.0 mm.

A2/A3 22 Cat. 1241

This artefact may well be made from antler tine. It has been cut, then smoothed and polished over most of its surface. The tip has fractured. It has been subjected to heat.

A2/A3 20 Cat. 1260

This point was made by modifying a bovid ulna. The *olecranon* and *processes anconaeus* have both been cut and smoothed to provide a convenient handle, while the shaft of the ulna has been ground to a circular cross section. Unfortunately the functional end has been broken. There are five parallel incised lines on one side of the shaft, each *c.* 7 mm long and between 5 and 13.0 mm apart.

Cat. 1860 Provenance unknown

The shaft of this specimen has been cut, but only part of the circular pointed end survives.

c. Bone points from Level 5

A3 18 Cat. 495

This point was fashioned from a metapodial, probably of a medium-sized deer. There are several clear cut marks in the central part of the diaphysis, presumably to remove a piece of bone of convenient size. The diaphysis was then cut and smoothed to a point. The functional end has since fractured, though the truncated end bears evidence for three cuts with a sharp implement. It is now 68 mm long.

A3/A4 17 Cat. 1829

The central shaft of this implement has survived, both ends having fractured in antiquity. It has a circular cross section with a maximum diameter of 5.5 mm. The surface bears many small striations which results from shaping the bone. They are at an angle of about 45° to the long axis.

A1 17 Cat. 600

This is a small (25 mm long) mid section of a bone artefact, which has been burnt all over. It bears many striations, and has a circular cross section 10.0 mm in diameter.

d. Bone points from level 4

A3 11 Cat. 119

This artefact comprises a sharp point on a body with an oval cross section. It terminates with a notch resembling a barb, beyond which the body continued. At this point however, it has broken. The surface of the artefact has been polished smooth and is black from burning. The length from tip to the notch is 36.0 mm.

Bone points: summary

It is noticeable that practically all the bone points were found damaged. They may have fulfilled a variety of functions. There is no evidence that any were used as projectile points. One function was probably that of an awl (cats. 1319, 732 and 1260). Notched and shaped bone is used today as a part of composite fish or small mammal traps, the principal component material being bamboo.

e. Bone artefacts with a circular hole bored through one end (fig 3-41) (all come from level 7)

A2/A3 25 Cat. 1364

This artefact has a circular cross section with a diameter of 8.0 mm. It is fractured 47.0 mm from the end in which there is a hole bored transversely through the shaft. The hole has a diameter of *c.* 3.0 mm and is located 5.5 mm from the surviving end of the artefact. Its surface is smooth and shiny all over.

A4 27 Cat. 1869

This specimen closely resembles cat. 1364. It too is broken across the shaft, 79 mm from the end in which there is a transversely bored hole. This hole has a diameter of 4.3 mm and is located 8.5 mm from the surviving end of the artefact. The edge of the hole is worn to a high and very narrow sheen, as if an element was repeatedly pulled through it.

A3 27 Cat. 740

This last specimen has an elliptoid cross section which may be due to the shape of the original bone from which it was fashioned. The hole at one end is bored through the longest diameter, which is 9.5 mm wide at this point. The point has a diameter of 2.2 mm and is placed 5 mm from the surviving end. The artefact is now 66 mm long. Between 40 and 65 mm from one end, there are seven scarcely perceptible grooves, worn presumably while the artefact was in use. They have an added sheen compared with the rest of the tool's surface. Microscopic examination of the edges of the hole reveal seven or eight very small grooves on each aperture as if the implement was fixed in place as a fulcrum before a second set of elements were moved regularly across it.

f. Spatula-like objects. Both come from Level 7

A3 31 Cat. 774

This artefact comprises a flat piece of bone originally perhaps, a section of scapula. It has been cut to incorporate a handle-like projection. The working edge is practically straight, sharp, and worn to a fine sheen.

A4 23 Cat. 1870

It is possible that this specimen was made for the same function as cat. 774. It too was cut and ground from a naturally flat piece of bone, such as a scapula, and has a handle-like extension. One of the edges is sharp, but lacks the gloss of cat. 774

MISCELLANEOUS WORKED BONE AND ANTLER (fig 3-44)

There are several pieces of bone and antler which bear traces of modification but are not completed artefacts.

A4 27 Level 7 Cat. 1838 (fig 3-44a)

This piece of bone has been cut to a roughly circular section. It is 80 mm long.

A4 33 Level 7 Cat. 1830 (fig 3-44b)

This 134 mm long piece of bone has been cut to the rough shape of a point. The cut marks are clean and straight, suggesting the use of a heavy and sharp implement. There are no signs of further modification by grinding or polishing.

A4 26 Level 7 Cat. 542 (fig 3-44c)

This is an antler from *Muntiacus muntjak*. It was removed from the skull with first four or five cuts from a sharp implement, then a blow to break it free. The smaller tine was then removed in a similar fashion, and the larger tine was cut all round in the mid section, with a sharp tool, but the end was not removed.

BONE ARTEFACTS FROM BURIAL CONTEXTS (fig 3-45)

Only two bone implements have been found in burial contexts. The first (cat. 1852) comes from B.11. It is a bovid ulna in which the *olecranon* has been cut to a rounded profile, resembling the treatment given to the specimen cat. 1260 described above. No other modification is apparent on this mortuary specimen. The second artefact (cat. 1382) was found in association with B.42. The anatomical nature of the bone is unclear because of modification, but the surface of the artefact bears sinuses which resemble the structure of crocodile cranium. The present length of this artefact is 305 mm, and the breadth, 80 mm. The artefact has been cut to shape it. This includes a hole at one end with a diameter of 41 mm. One edge has at least 17 notches, resembling the teeth of a saw. The function of this implement, if it is other than a status object, is unknown. It is worth recalling that this burial was part of the relatively rich mortuary area in square F6, and is located close to a child interred under a crocodile skin.

Ban Na Di: bone and antler artefacts

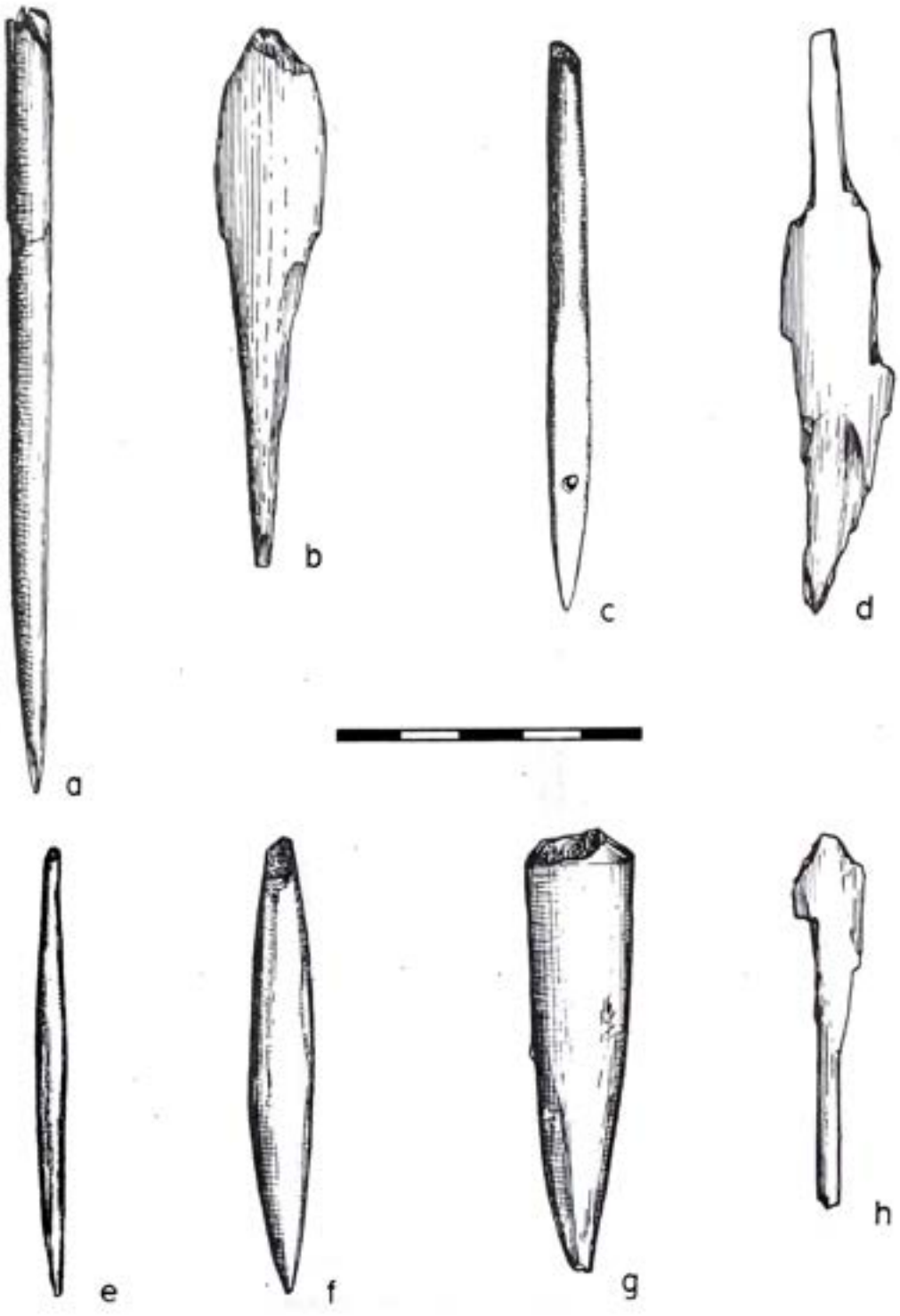


FIGURE 3-40

Ban Na Di: the bone points from level 7
A. A3 22 Cat.482 B. A4 34 Cat.1106 C. A3/4 26 Cat.1319
D. A3 36 Cat.927 E. A2 28 Cat.547 F. A2 39 Cat.732
G. A4 35 Cat.1271 H. A2 29 Cat.682

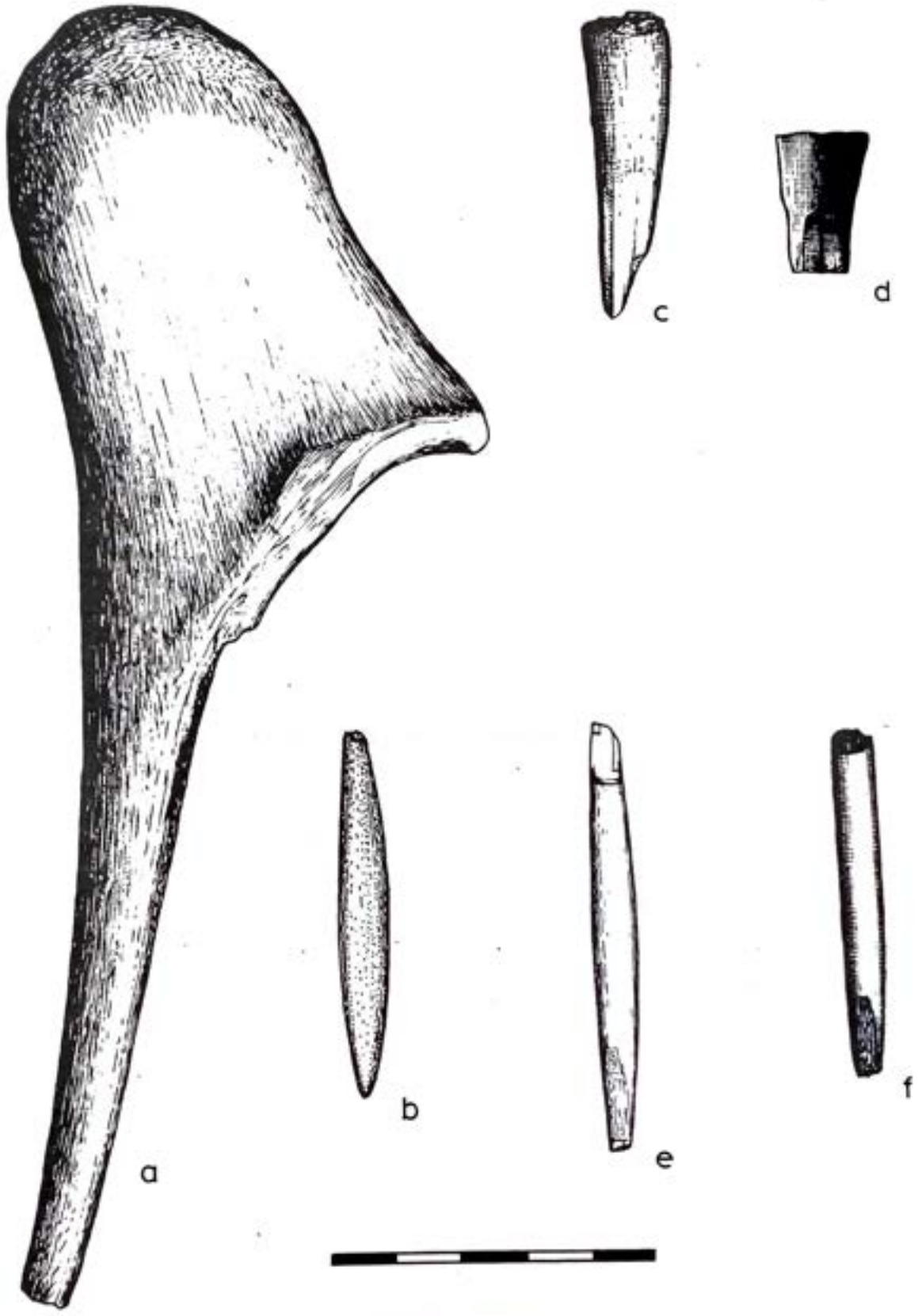


FIGURE 3-41

Ban Na Di: the bone points from level 6 (a-b) and level 7 (c-f)
A. A3/4 20 Cat.1260 B. A2 26 Cat.650 C. A3 22 Cat.478
D. F6 2 Cat.853 E. F6 7 Cat.934 F. A2 43 Cat.844

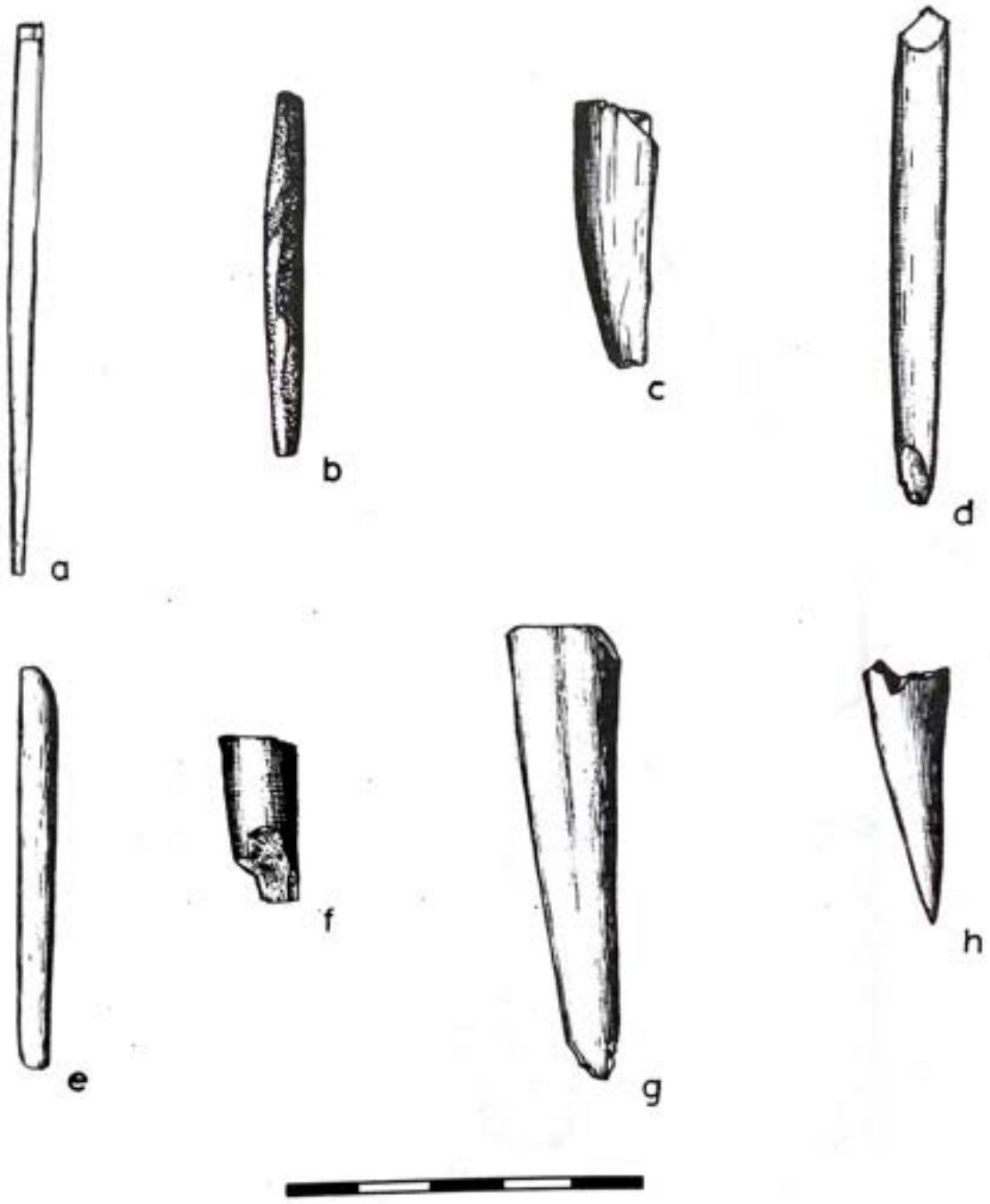


FIGURE 3-42

Ban Na Di: the bone points from level 6 (a-d), level 5 (e-g) and level 4 (h)
A. A3 18 Cat.387 B. U/P Cat.1880 C. A2/3 22 Cat.1241
D. A4 19 Cat.551 E. A3/4 17 Cat.1829 F. A1 17 Cat.600
G. A3 16 Cat.495 H. A3 11 Cat.119

Ban Na Di: bone and antler artefacts

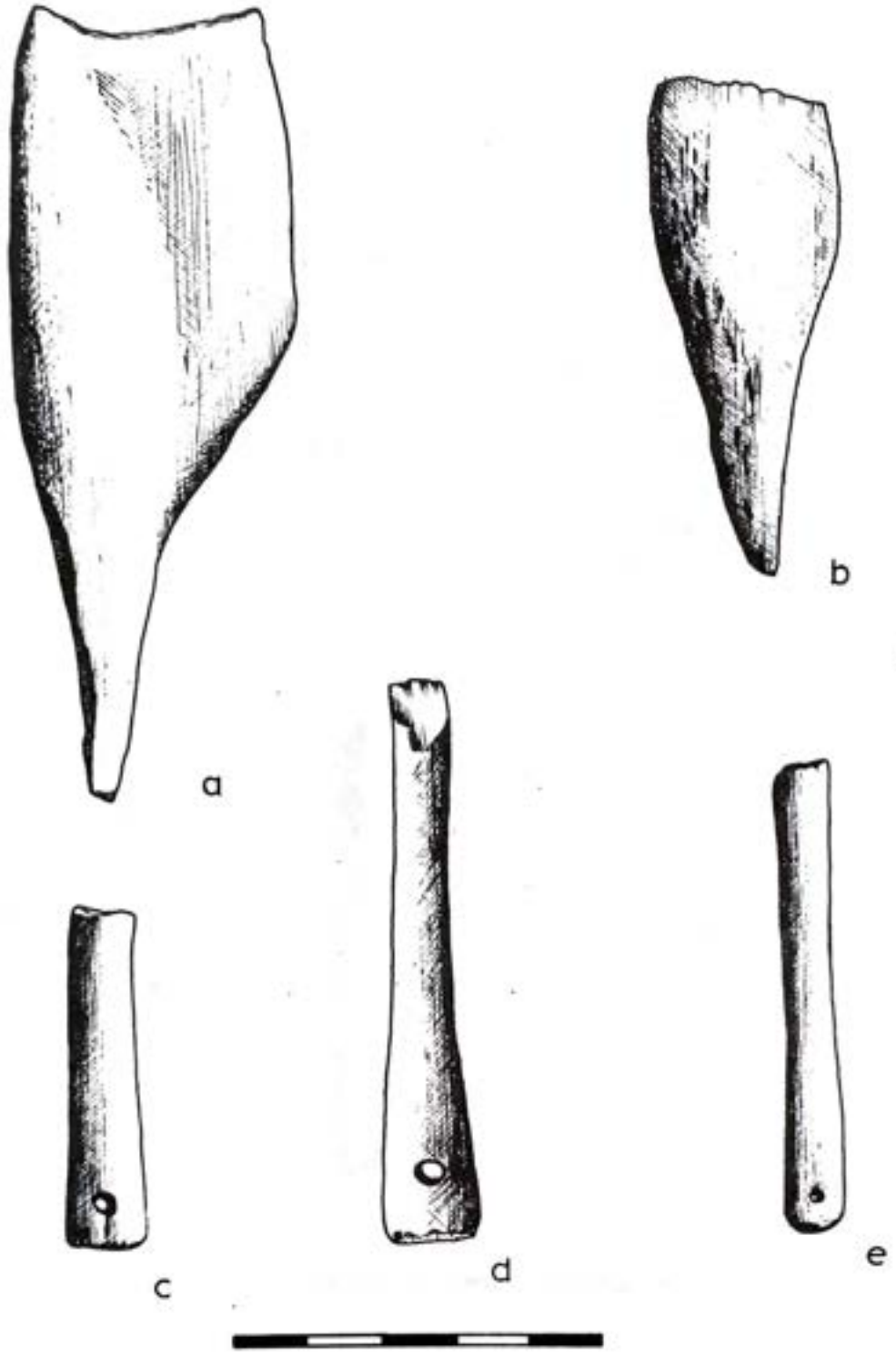


FIGURE 3-43

Ban Na Di: the spatula-like objects (a-b) and bone artefacts with a circular hole bored throgh one end (c-e). All come from level 7.
A.A3 31 Cat.774 B.A4 23 Cat.1870 C.A2/3 25 Cat.1364
D.A4 27 Cat.1869 E.A3 27 Cat.740

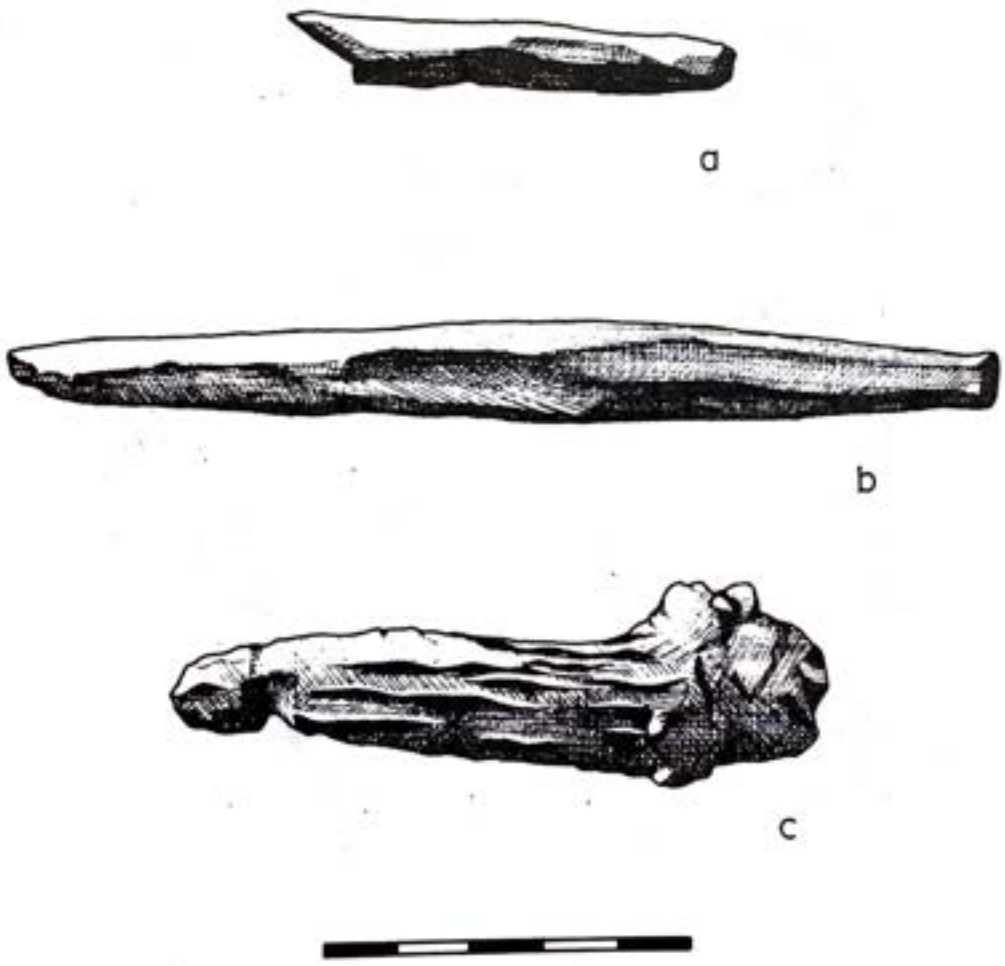


FIGURE 3-44

Ban Na Di: the worked bone and antler
A. A4 27 L.7 Cat.1838 B. A4 33 L.7 Cat.1830 C. A4 26 L.7 Cat.542

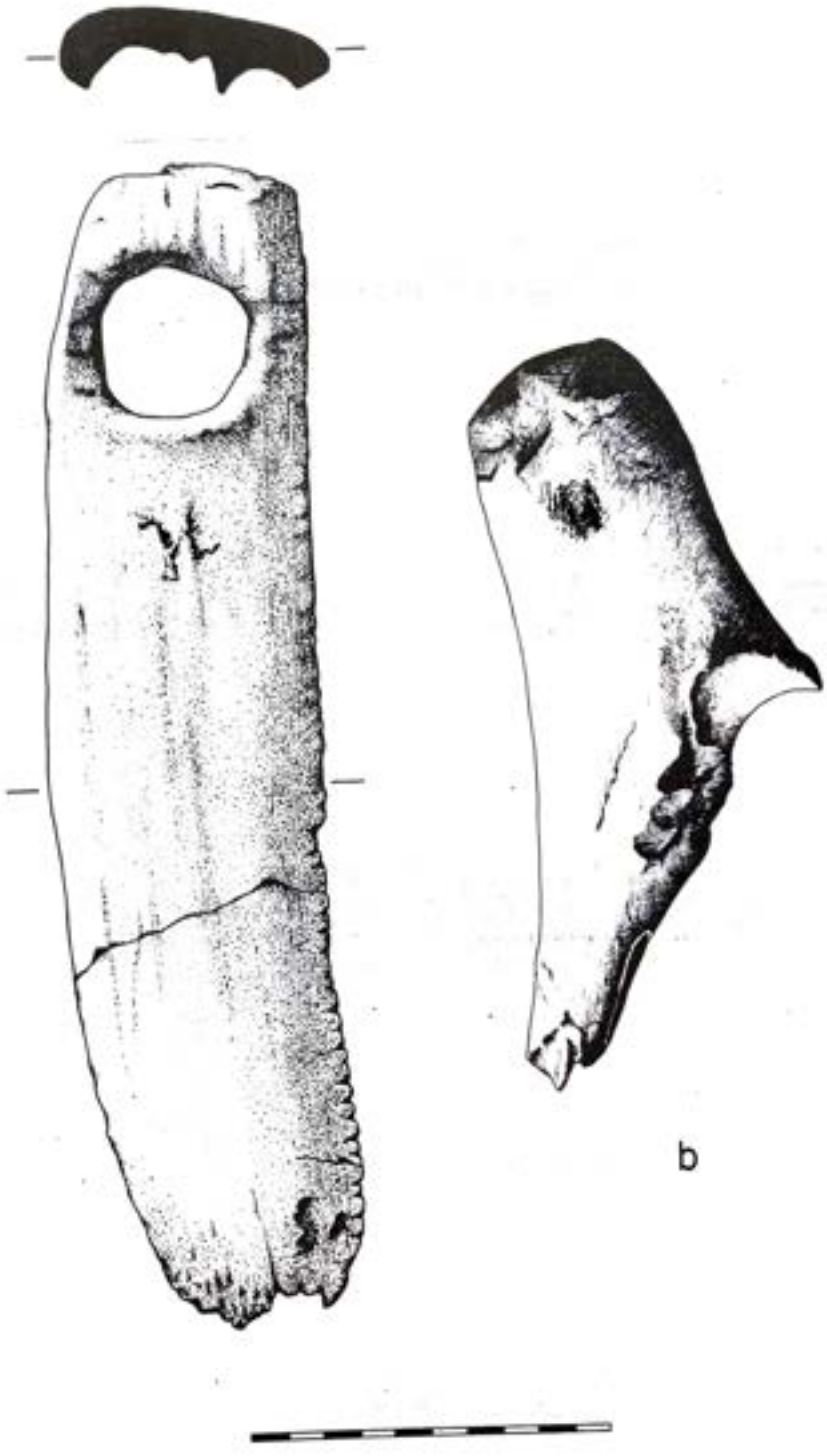


FIGURE 3-45

Ban Na Di: the bone artefacts from burial contexts
A. Cat.1382 B.42 MP1b B. Cat.1852 B.10/11 MP1c

WHETSTONES

(figs 3-46 and 47)

Stone implements are rare at Ban Na Di. The principal artefact type comprises a grooved or flattened piece of red sandstone. The grooves were probably worn by habitual use in re-sharpening or trimming newly cast metal artefacts. Their distribution and characteristics are as follows.

A2 38 Level 8 Cat. 728

This cobblestone, which measures 60 x 60 mm, has a facet worn smooth, on one surface.

TABLE 3-35

Ban Na Di: the whetstones

Prov.	Level	Cat. No.	Raw Material	Maximum Length/ Width (mm)	Comment
A2	8	728	Sandstone	59.0x58.0	
F5	7	TS 34	Sandstone	89.0x64.0	A depression 34 mm wide has been worn to a depth of *c.* 8 mm into the stone. It has a V-shaped cross section
A2 29	7	783	Sandstone	80.0x57.0	A V-shaped groove has been worn to a depth of 9.0 mm on one surface. It is approx. 28 mm wide.
A4 27	7	597	Sandstone	97.0x82.0	A shallow groove 34mm long has been worn on the flat weathered surface of this piece of sandstone.
A4 31	7	1059	Sandstone	90.0x50.0	This piece of

					sandstone has a V-shaped groove 60 mm wide and *c.* 20 mm deep.
A2/A3	7	1866	Sandstone	90.0x86.0	This specimen has a broad, V-shaped depression on one surface which may reflect use as a whetstone. It is *c.* 48.0 mm wide and 7 - 8 mm deep.
A4 20	7	374	Sandstone	53.0x47.0	This piece has three V-shaped grooves on its surface. These are 12.0, 19.0 and 45.0 mm wide respectively
A1 27	7	1747	Sandstone	83.0x64.0	This specimen has a very broad, shallow depression on one surface, which may result from use as a whetstone. There are two cut marks on one edge.
A3 18	7	1128	Sandstone	48.0x20.5	This specimen has been shaped to a circular cross section incorporating a flattened piece bearing grooves as if used for precision grinding.
A3 15	5	226	Sandstone	46.0x22.2	A small piece of sandstone of rectangular shape with a groove worn worn down one edge.
A2/3 10	5	1356	Sandstone	62.8x60.0	This flat surfaced specimen bears several narrow grooves in one

Ban Na Di: whetstones

surface.

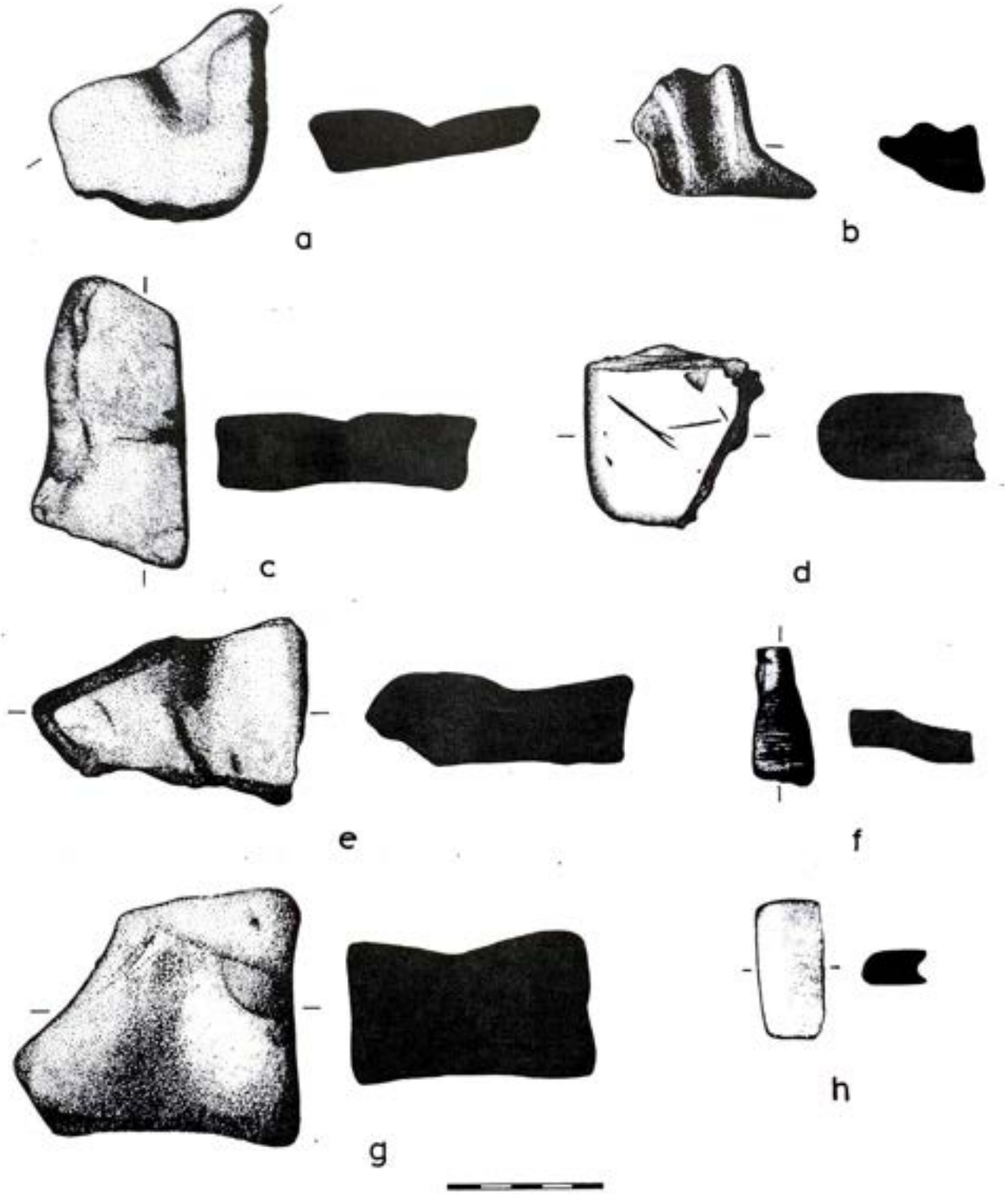


FIGURE 3-46

Ban Na Di: the whetstones
A. A2 29 L.7 Cat.783 B. A4 20 L.7 Cat.374 C. A4 31 L. Cat.1059
D. A2/A3 10 L.5 Cat.1356 E. F5 L.7 Cat.TS 34 F. A3 18 L.7 Cat.1128
G. A2/A3 L.7 Cat.1866 H. A3 15 L.5 Cat.226

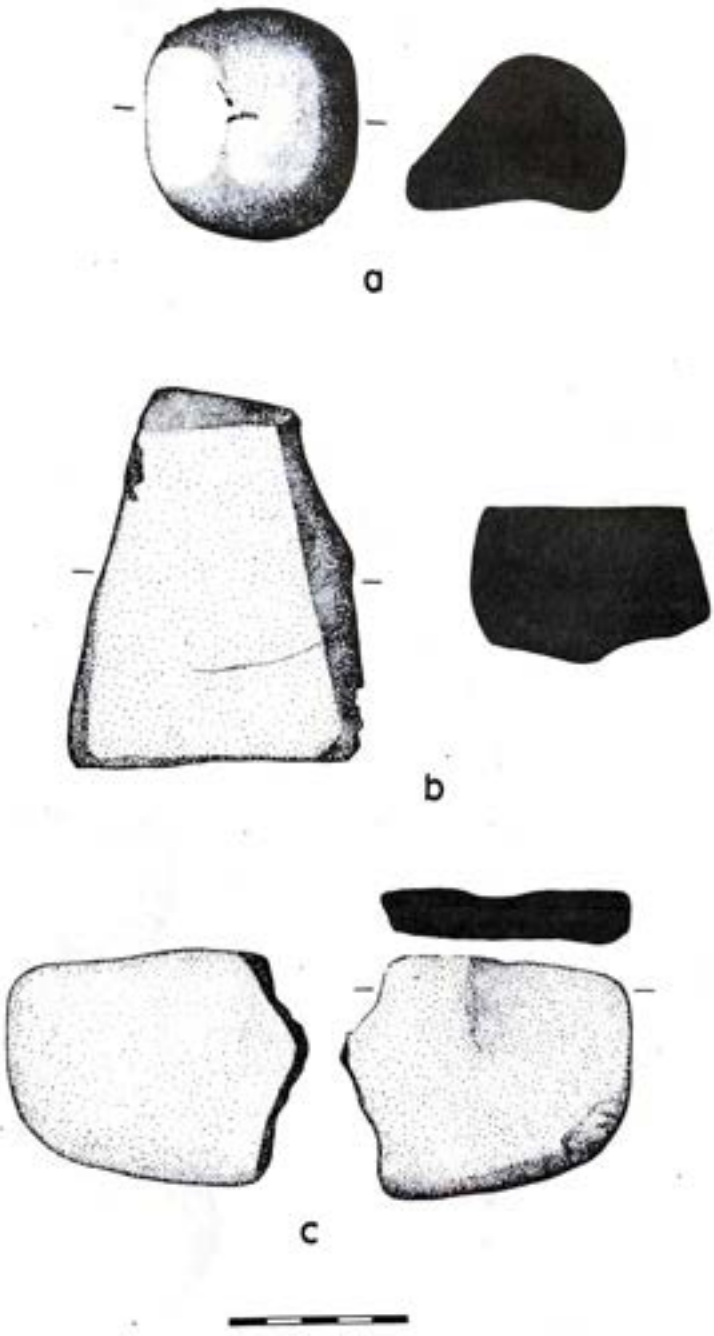


FIGURE 3-47

Ban Na Di: the whetstones
A. A2 38 L.8 Cat.728 B. A4 27 L.7 Cat.597
C. A1 27 L.7 Cat.1747

STONE FLAKES (fig 3-48)

Stone flakes of any sort were practically absent from Ban Na Di. It is clear, that the importation of exotic stone for industrial use was for all intents and purposes, not practiced there at any period. Unlike contemporary sites in the area, no stone axes or adzes were found either. The few flakes found are illustrated below.

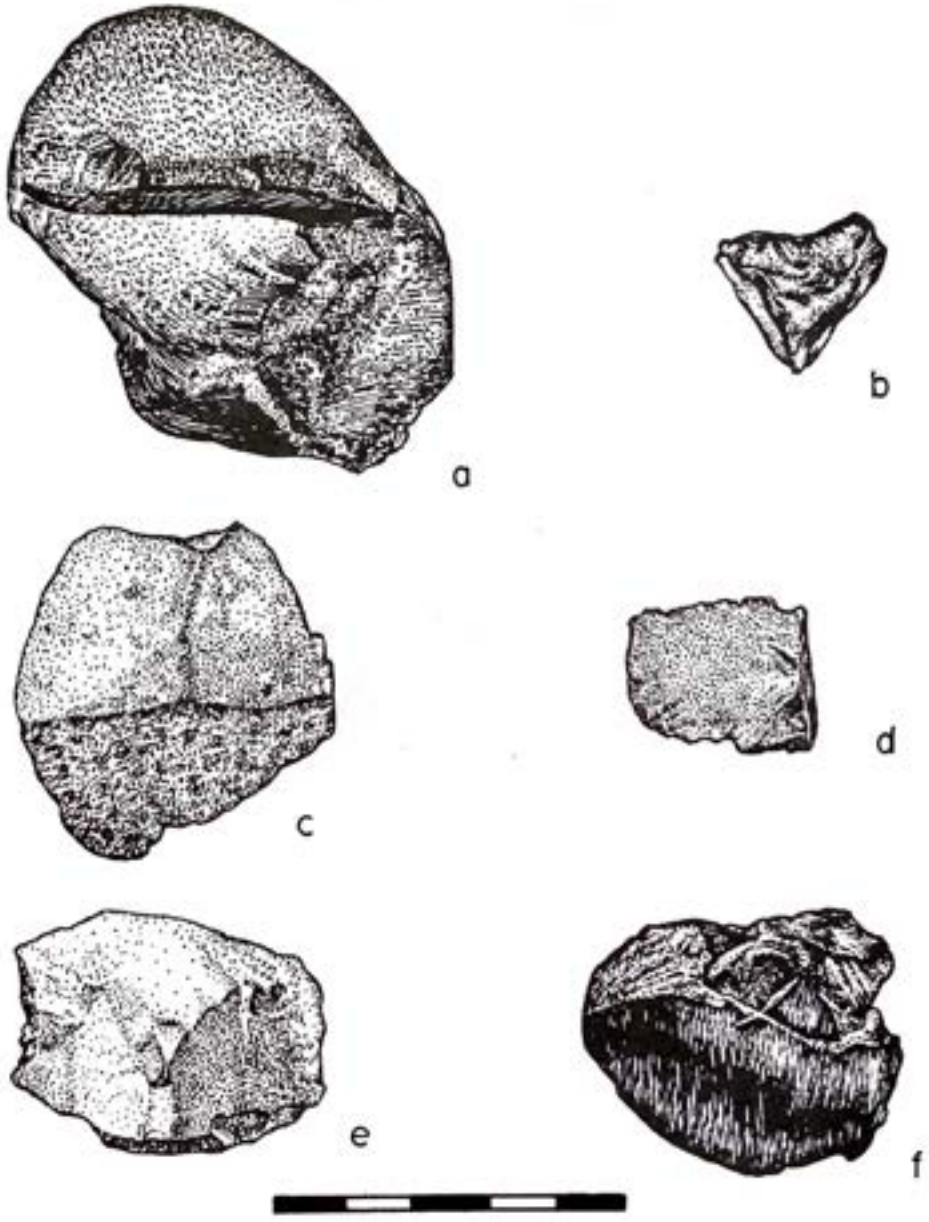


FIGURE 3-48 Ban Na Di: stone flakes from level 5 (a-c) and level 6 (d-f) A. A1 19 Cat.522 B. A4 14 Cat.1712 C. A3 16 Cat.1701 D. A4 20 Cat.1739 E. A3 17 Cat.1760 F. A2 24 Cat.508

MISCELLANEOUS CLAY ARTEFACTS

(fig 3-49)

a. Clay "pendant" (Cat. 1878 level 5)

This artefact is unique at Ban Na Di. It is an oval clay "pendant" with a circular perforation at one end.

b. "Pear" shaped clay pellet

These small, solid balls of clay were moulded to the shape of a pear with a pointed end. The surface is carefully, smoothed. Cat. TS 7 has two notches cut opposite each other at the point of maximum circumference. Their distribution and dimensions are as follows:

TABLE 3-36

Ban Na Di: the pear shaped pendants

Provenance	Level	Cat.No.	Length (mm)	Width (mm)
A1 23	6	492	35.5	18.8
A1 22	6	622a	32.3	19.1
A1 22	6	622b	-	26.1
A3 16	6	277	36.5	24.1
A4 16	5	242	24.5	16.2
F5 6	5	TS14	35.8	21.3
A4 14	5	183	-	-

c. Net weights (fig 3-50b)

A4 22 Level 7 Cat. 572

This artefact comprises a crudely modelled lump of clay with a hole bored lengthwise. It is most plausibly interpreted as a net weight. It is 47.0 mm long and has a maximum diameter of 35.5 mm.

A1 16 Level 5 Cat. 269

This oval clay artefact has a central, lengthwise perforation. The surface reveals tooling with a flat instrument, again running lengthwise over the surface. It is broken at approximately the midpoint. The maximum diameter is 31.5 mm.

d. Clay "Top" (fig 3-49h)

A2 19 Level 5 Cat. 281

This clay object of unknown use, resembles a top in that it has a pointed base, handle and central swelling. The interior is hollow and a circular perforation has been made through to it.

e. Clay bearing mat impressions (fig 3-51)

A3 36 Level 7 Cat. 955

This is a large fragment of partially fired clay which comprised part of a bronze casting furnace. It measures 130 x 92 mm and is 58 mm deep. One surface bears the impression of a woven mat. The individual pieces of material are 6 to 7 mm in width. Matting of similar style in use today is usually made of bamboo. Similar furnaces are still used in Northeast Thailand, to raise iron to the required heat for forging. Similar mats have been observed, being used as wind breaks to constrain flying sparks.

f. Clay rings (fig 3-51)

Ban Na Di has yielded several broken clay objects with a circular or oval cross section and an arc which resembles that of a bracelet. It is not possible to be sure what function or functions these artefacts had. The absence of handles in any of the whole pots argues against the possibility that they come from ceramic vessels. It is conceivable that some are fragmentary handles derived from pottery ladles. Again, they may have been used as bracelets, but the absence of clay bracelets in mortuary contexts at Ban Na Di or any related site renders such an interpretation unlikely. Details of provenance and size are as follows:

TABLE 3-37

Ban Na Di: the clay rings

Provenance	Level	Cat.No.	Maximum Width (mm)
A4 37	8	1875a	15.7
A4 37	8	1875b	16.1
A4 35	7	1849	17.5
A4 35	7	1876	8.4
A2 34	7	1823	16.4

Ban Na Di: miscellaneous clay artefacts

A3	36	7	1818	9.8
A3	25	7	1484	14.3
A4	30	7	1020	10.0
A2	42	7	808	12.0
F5	21	7	TS44	14.5
F5	25	7	TS55	11.5
A4	36	7	1337	15.0
A3	31	7	720	11.6
A1	39	7	977	14.8
F6	1	7	855	24.4
A2	37	7	754	14.9
A1	38	7	1873	11.9
A4	36	7	1874	11.2
A2	43	7	880	16.9
A3	36	7	922	10.0
A1	32	7	777	18.0
A4	14	5	1703	15.1
A2	16	4	197	14.2
A2	15	4	1531	13.0
A3	13	4	1513	13.5

g. Clay "Nubbin" (fig 3-50)

A2 40 Level 8 Cat. 783

This specimen is unique at Ban Na Di. It comprises a complete nubbin which would have been applied to a pottery vessel. It ends with an upturned hook and has a centrally placed vertical perforation.

h. Clay Points (fig 3-52)

There are five clay artefacts with a circular cross section, moulded to form a point. Their use is not known. They may be lugs for a whole vessel, but it must be recalled that none has been found on the complete pots from Ban Na Di. Two specimens (cats. 506 and 216) has a circular hole bored through them with diameters of *c.* 20 mm. Three come from level 7 and one each from levels 5 and 6.

i. Clay Discs (fig 3-52)

The prehistoric inhabitants of Ban Na Di fashioned circular clay discs from potsherds. In some cases, the edges reveal a pattern of successive small fractures to effect a circular shape. In others, the edges are worn smooth. These artefacts are of unknown use. Table 3-38 provides basic data on all discs recovered.

TABLE 3-38

Ban Na Di: the clay discs

Provenance		Level	Cat.No.	Diameter (mm)	Outer surface finish	Inner surface finish
A1/2	29	7	1811	30.7	plain	plain
A1	36	7	854	37.7	cordmarked	cordmarked
A2	38	7	730	50.5	plain	cordmarked
A3/4	35	7	1424	42.5	cordmarked	cordmarked
A3	32	7	825	38.0	cordmarked	cordmarked
A1	39	7	975	38.0	cordmarked	plain
A3/4	18	6	1250	30.0	cordmarked	plain
A2	24	6	436	36.7	plain	plain
A1	22	6	460	57.7	plain	plain
A1	21	6	457	45.0	plain	plain
A3	17	6	565a	27.0	plain	plain
A3	17	6	565b	40.2	cordmarked	plain
A4	14	5	1670	30.0	plain	plain
A1	19	5	1538a	30.4	cordmarked	plain
A1	19	5	1538b	23.0	cordmarked	plain
A1	19	5	1538c	20.4	cordmarked	plain
A1	16	5	679	30.0	plain	plain
A4	16	5	252	51.0	cordmarked	plain
A1	19	5	389	55.1	cordmarked and smoothed	plain
A1	18	5	533	29.0	cordmarked	plain
A1	19	5	631	55.0	cordmarked	plain
A1	18	5	324	43.5	burnished	plain
A1	14	5	642	43.3	cordmarked	plain
A1	17	5	1709	35.0	red slipped	plain
A1	18	5	504	30.0	plain	plain
A3	16	5	1711	24.6	cordmarked & slipped	slipped
A2/3	6	3	1165	49.5	cordmarked	plain

CLAY PELLETS

These small, spheroidal clay pellets were abundant at Ban Na Di. They are thought to have been used, with a pellet bow, as projectiles.

TABLE 3-39

Ban Na Di: the clay pellets

Level	N.	Size Range (diam. in mm)	Average Size (diam. in mm)
1	16	12.0 - 18.0	15.9
2	13	12.0 - 18.0	15.5
3	12	13.0 - 20.0	16.9
4	19	12.0 - 20.0	15.6
5	83	13.0 - 20.0	15.4
6	86	13.0 - 21.0	16.4
7	236	12.0 - 23.0	15.8
8	13	13.0 - 20.0	16.5

In the southern provinces of Thailand, such artefacts are still used, in association with a bamboo bow, to hunt birds. A cache of such pellets was found in association with a middle period burial at Ban Chiang. They clearly have a considerable antiquity in Southeast Asia.

Ban Na Di: miscellaneous clay artefacts

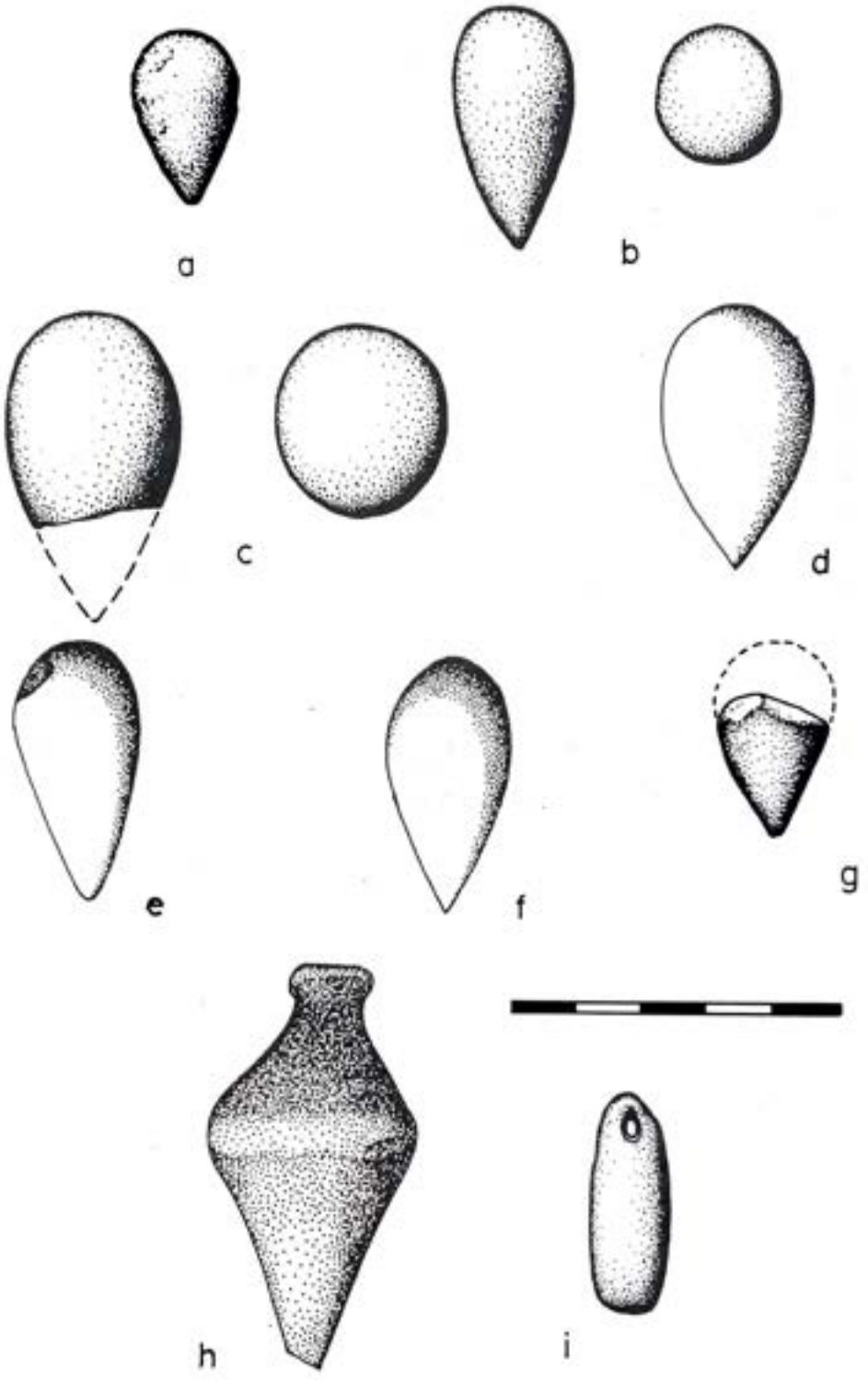


FIGURE 3-49

Ban Na Di: miscellaneous clay artefacts
A. A1 23 L.6 Cat.492 B. A1 22 L.6 Cat.622a C. A1 22 L.6 Cat.622b
D. A3 16 L.6 Cat.277 E. A4 16 L.5 Cat.242 F. F5 6 L.5 Cat.TS 14
G. A4 14 L.5 Cat.183 H. A2 19 L.5 Cat.281 I. U/P L.5 Cat.1878

Ban Na Di: illustrations of miscellaneous clay artefacts

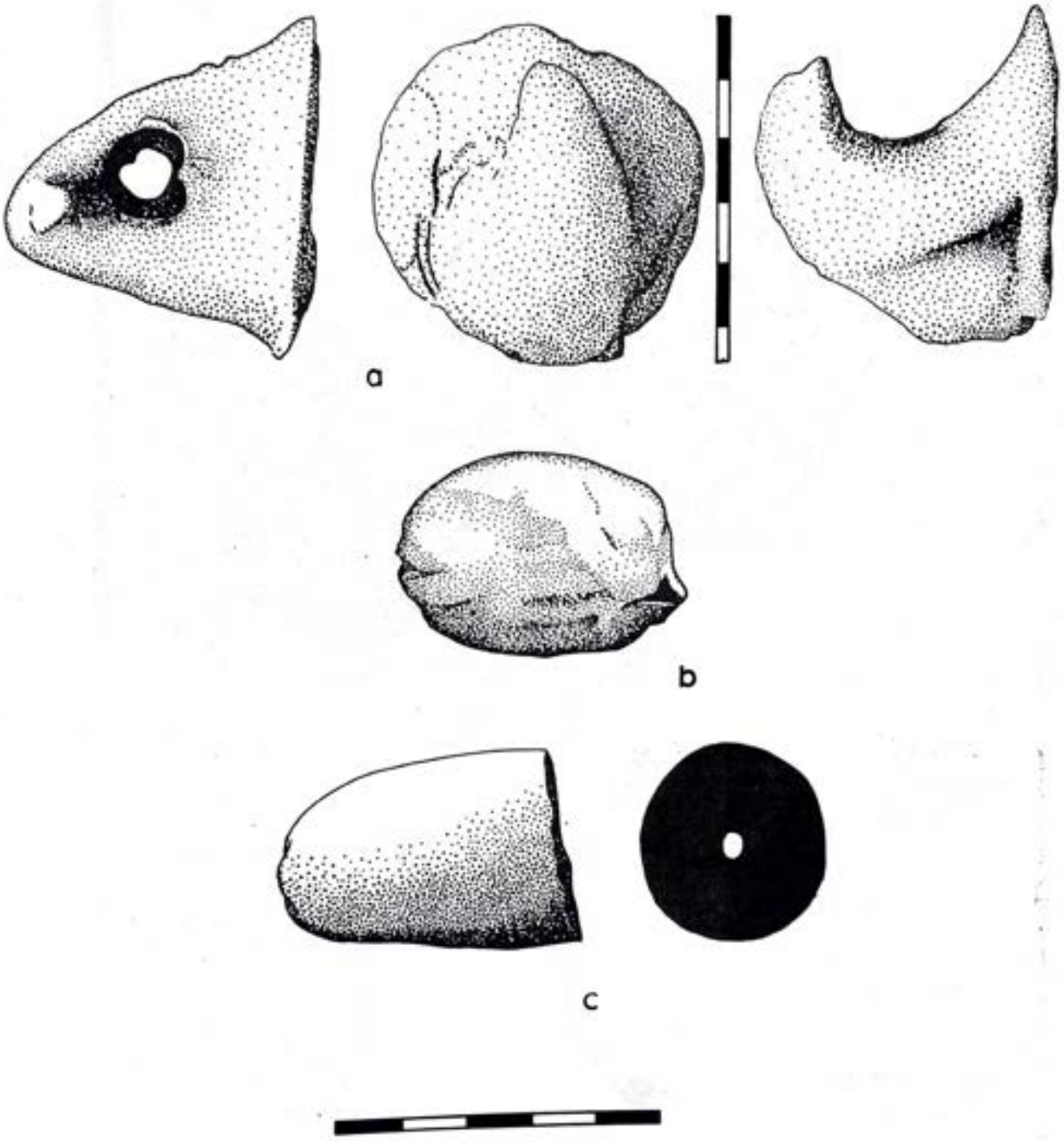


FIGURE 3-50

Ban Na Di: miscellaneous clay artefacts
A. A2 40 L.8 Cat.783 B. A4 22 L.7 Cat.572 C. A1 16 L.5 Cat.269

Ban Na Di: illustrations of miscellaneous clay artefacts

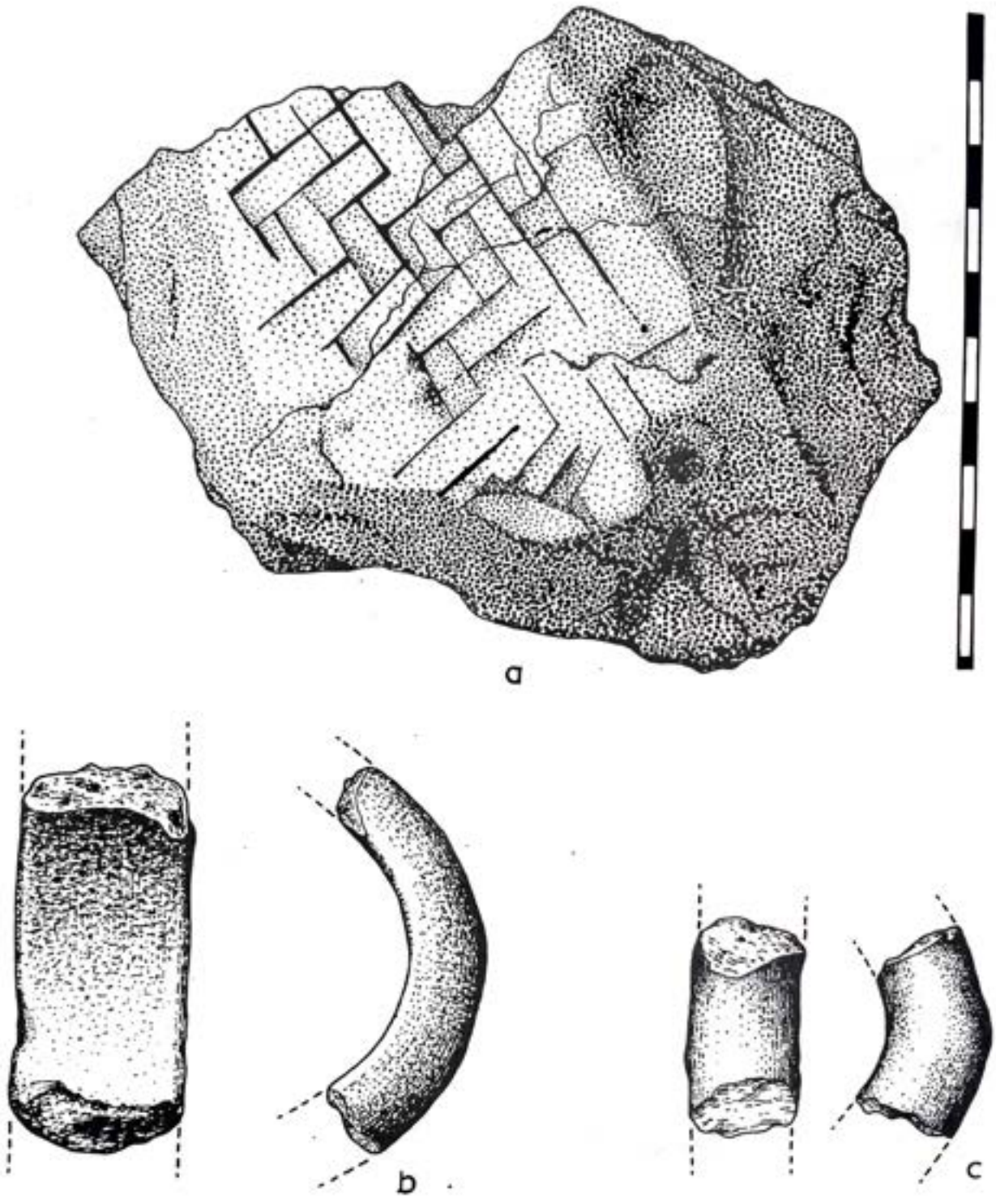


FIGURE 3-51

Ban Na Di: the clay mat impressions from Level 7 (a) and the Clay Rings from Level 7 (b-c).
A. A3 36 cat.955 B. F6 1 cat.855 C. A2 37 cat.1823

Ban Na Di: illustrations of miscellaneous clay artefacts

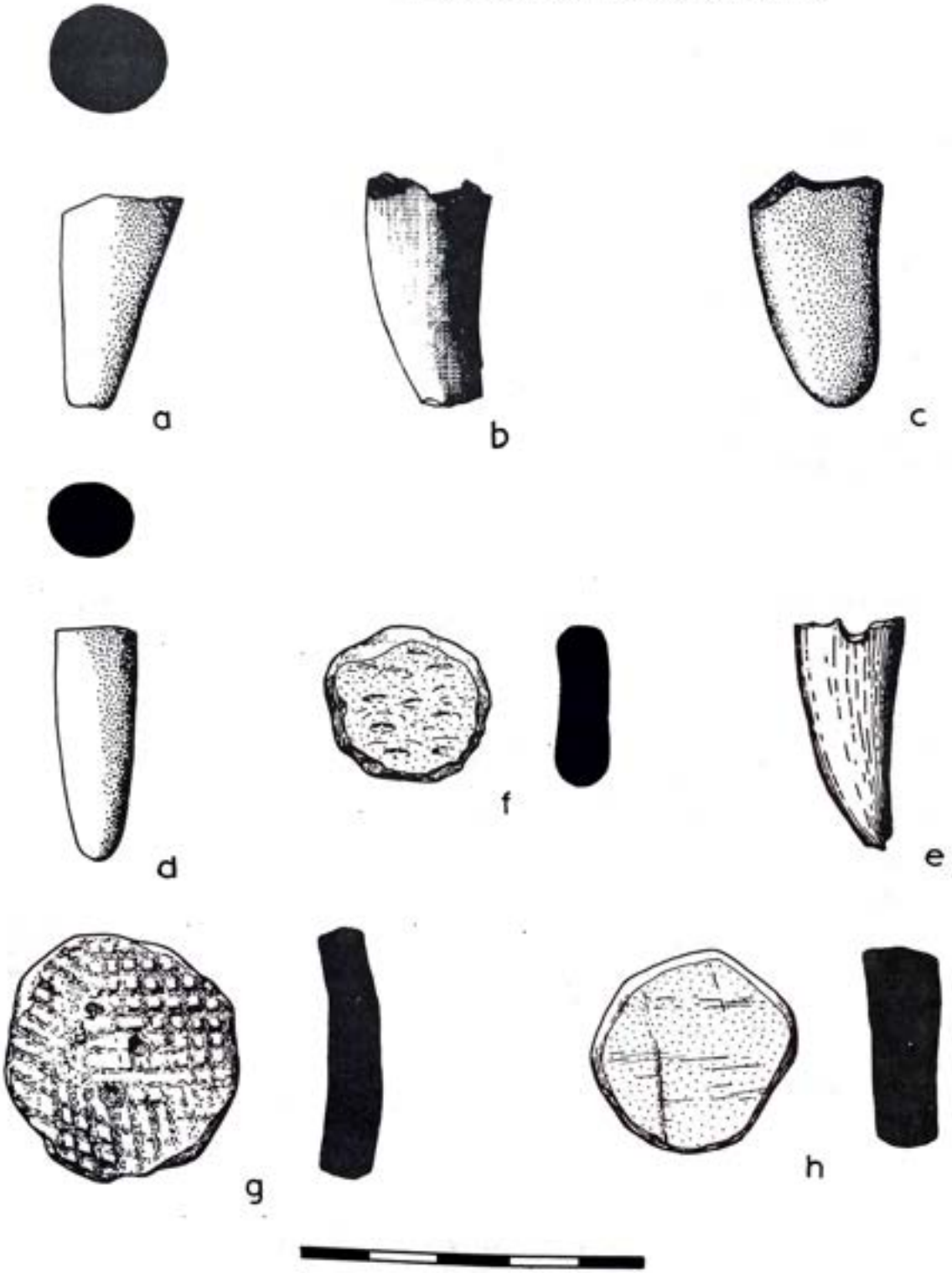


FIGURE 3-52

Ban Na Di: the clay points (a-e) and clay discs (f-h)
A. A4 22 L.7 cat.428 B. A2 25 L.6 cat.506 C. A4 22 L.7 cat.418
D. A4 27 L.7 cat.719 E. A4 15 L.5 cat.216 F. A3 16 L.5 cat.1711
G. A1 39 L.7 cat.975 H. A1/2 29 L.7 cat.1811

PERFORATED POTSHERDS (fig 3-53)

Beginning with level 6, several fragments of potsherds were found with circular perforations. The sherds in question came from a round based vessel, perforations being cut with a circular instrument from the vessel's exterior. The use of such ceramics is conjectural. Similar artefacts have been described from Vietnam and identified as rice steamers (Nguyen Viet 1981). In Northeast Thailand, such steamers are currently associated with the preparation of the local "sticky" rice. The vessel is filled with rice and placed over a container of boiling water. Sticky rice is the dominant variety because of its taste and rapid maturation. It is still cooked by steaming, thought the container used is usually made of bamboo or aluminium.

note: for an alternative possibility that these implements are alkali water filters, see page 684.

TABLE 3-40: The perforated pottery rice steamers

Provenance	Level	Cat.	Diam. aperture	Thickness of sherd	Outer dec.	Inner dec.	Temper group
A1 23	6	663	3.7	7.8	plain	plain	3
A1-2 27	6	1782	5.2	9.1	c/m, inc.	plain	2
TS 8	6	TS84	5.7	8.7	c/m	plain	1
TS 10	6	TS85	5.4	9.5	plain	plain	3
A2 21	6	1879	5.5	8.5	c/m	plain	5
A4 19	6	1764	4.9	12.0	plain	plain	3
A1 21	6	1880	6.5	9.0	plain	plain	2
A4 18	6	513	4.9	8.7	plain	plain	3
A2 23	6	1768	6.5	8.4	c/m	plain	2
A3-3 21	6	1330	5.3	7.1	plain	plain	3
A3-3 22	6	1749	4.7	8.7	c/m	plain	6
TS 10	6	TS28	4.9	9.4	c/m	plain	1
A2 22	6	594a	5.7	5.1	c/m	plain	4
A2 22	6	594b	6.0	5.9	plain	plain	4
unprovenanced	6		7.5	5.9	c/m	plain	4
A2 24	6	1771	6.9	8.9	plain	plain	2
A3 17	6	527	7.9	8.8	plain	plain	2
A4 19	6	639	10.0	8.1	c/m	plain	1
A1 18	5	1675	5.5	7.5	c/m	plain	8
A4 17	5	336	5.5	8.0	plain	plain	2
A1 16	5	1674	11.1	10.5	plain	plain	4
A1 15	5	287	6.9	9.0	plain	plain	7
A4 17	5	339	6.8	7.9	plain	plain	2
A1 19	5	633	7.5	7.8	plain	plain	7
A1 19	5	633	6.7	8.5	plain	plain	7
A1 18	5	1689	7.2	8.2	plain	plain	4
A3 15	5	1727	9.5	5.1	plain	c/m	7

The temper groups are as follows: Group 1: grog and sand. Group 2: grog and sand with a very small admixture of chaff. Group 3: Rare grog and sand and much chaff. Group 4: Very dense clay body with small quantities of grog. Group 5: Fairly large pieces of grog and some sand. Group 6: grog and sand with a small admixture of stone which looks like laterite.

THE APPLIQUE ORNAMENT ON POTSHERDS (figs 3-54/57)

(Ingrid Adamczyk, Richard McGovern-Wilson and Charles Higham)

Three approaches were undertaken in analysing the sherds bearing applique ornament. The first was to subdivide the assemblage into groups based on the characteristics of the applique itself. Each group of sherds was then considered on the basis of the fabric of the clay and the surface finish. The principal objective of the study, other than the simple description of the material, was to determine at which points in the sequence if any, there was a significant change in the style and fabric.

The following groups of applique ornament were recognised:

Form 1 Raised band applied to the pottery with regular fork like indentations. There are four sub-types. 1a has only a flat to slightly raised band. In 1b, the band is more pronounced, rising to about 10 mm. 1c is similar to 1a except that the slashes are at a sharp diagonal while in 1d, the band is fairly wide, half the width being plain.

Form 2 Has circular impressions on the raised band. Again, there are subdivisions. 2a has a flat or slightly raised band. In 2b, the band is raised approximately 5 mm and is pinched to a point between holes. 2c has small holes with the same diameter as the rounded band into which they are impressed. 2d has a very rounded band with relatively deep holes along the centre. 2e has a band pinched to a ridge with holes up to 10 mm in diameter. In 2f, the band is only slightly raised and is smoothed. The impressed holes are about 10 mm apart. Finally in 2g, the band is raised and the holes are very close to each other.

Form 3 Is a simple band pinched to a ridged line and then smoothed

Form 4 Comprises a pinched and raised band with diagonal cuts. 4a has a band less than 5 mm high. In 4b, the band is about 10 mm high and in 4c, the cuts tend to be more vertical than diagonal.

Form 5 This form has gross, deep indentations in the band. 5a has a flat

or slightly pinched band, and 5b has a more pronounced raised band with the slash more often vertical than diagonal.

Form 6 Comprises a chunky band with broad diagonal slashes. In 6a, the band is flattened and in 6b, more raised and pronounced.

Form 7 Has a raised and rounded band. 7b also has a few shallow cuts across the top surface.

Form 8 Is a raised band with diagonal cuts. It is similar to form 6 but the band is chunkier and rounded rather than pinched to a point.

Form 9 The pinched band is between 5–10 mm high with the fingerprints still surviving. In 9b, the same holds except that about half the width of the band has cuts made into it. 9c was also formed by finger pinching, but also has a flattened ridge with cuts on one side of it. 9d is flat but has very pronounced pinching.

Form 10 This band is plain and smoothed and perhaps accidentally, bears occasional cord-marked impressions.

Form 11 Has a row of small dots of clay applied in a band.

Form 12 This type has a pinched band with very fine cuts across the ridge line of the band. 12a looks very like form 3 but bears these cuts whereas 12b is very like 9a but with cuts.

Form 13 The band is pinched, the marks forming a ridge line with a wavy contour. In 13a, the pinch marks are still visible, but they have been smoothed away in 13b.

Form 14 The applique band itself is of a wavy form and smooth. In 14a the band displays a very gradual wave form and is pinched to a ridge point 5–10 mm high. 14b has a very pronounced wave form.

Form 15 A raised band approximately 10 mm high has "arrow" cuts into the band. These impressions cause the ridge to appear slightly wavy.

Form 16 This form has a flat "slab" applied to the surface of the vessel. In the case of 16b, this slab has been applied in the form of a wavy band. In 16c, this wavy band has also been cordmarked.

Form 17 Comprises a raised band which is flattened along the top and has cordmarking applied. 16b is similar except that the band is much more flattened in appearance. 16c also has a cordmarked surface, but is restricted to the rim/body junction. In 16d, there is no obvious raised area, the cordmarking itself forming the band.

Form 18 This variety has very gross diagonal slashes on pronounced band. In 18a, the slashes are only about 10 mm long. 18b has medium sized slashes longer than 10 mm. The slashes in 18c are very thick. In 18d, the band bisected by the slashes has been raised to a central ridge while in 18e, the band has a more rounded cross section bearing slashes of

medium length. The band in 18f is about 20 mm wide with many fine cuts along its length. 18g and f are similar except that the former has more widely spaced cuts.

Form 19 This form is similar to the previous one, but the slashes are vertical rather than horizontal. In 19b, the band has a central ridge line.

POTTERY SURFACE FINISH AND FABRIC

Each sherd bearing applique decoration was also categorised on the basis of the surface finish and the fabric. Clearly, the ultimate analysis of fabric should include the preparation of thin sections for petrographic analysis. This is currently being applied to the Ban Na Di assemblage by Vincent. For the present purposes, temper was categorised very broadly by making a judgement on the basis of a fresh break viewed through a low powered microscope. The principal variables were found to be the presence or absence of grog, chaff and sand in the clay fabric. Sand is of little diagnostic value because of its natural occurrence in local clays. Table 3-41 presents the results of the analysis. Although it simplifies the variety of fabrics, the addition of subtypes does not alter the conclusions.

TABLE 3-41

Ban Na Di: the applique forms and associated fabric by level

Level	Form	n sherds	n Cordmarked	n Plain	n with grog	n with chaff present
8	1a	7	7	–	7	–
8	1b	8	8	–	8	–
8	2a	5	5	–	5	–
8	2b	4	4	–	4	–
8	3	5	5	–	5	–
8	4a	12	12	–	12	–
8	4b	3	3	–	3	–
8	5a	9	9	–	9	–
8	5b	5	5	–	5	–
8	6a	2	2	–	2	–
8	6b	2	2	–	2	–
8	7	2	2	–	2	–
8	8	1	1	–	1	–
8	9a	5	5	–	5	–
7	1a	54	54	–	5	–
7	1b	1	1	–	1	–

7	1c	2	2	–	2	–
7	1d	7	7	–	7	–
7	2a	14	14	–	12	2
7	2b	5	5	–	5	–
7	3	47	47	–	40	7
7	4a	15	15	–	15	–
7	4b	1	1	–	1	–
7	4c	13	13	–	12	1
7	5a	13	13	–	13	–
7	5b	4	4	–	4	–
7	6a	7	7	–	6	1
7	7a	1	1	–	1	–
7	9a	112	112	–	98	18
7	9b	13	13	–	11	2
7	9c	2	2	–	2	–
7	10	1	1	–	–	1
7	11	1	1	–	–	1
7	12a	2	2	–	2	–
7	12b	9	9	–	7	2
7	13	10	10	–	8	2
6	2c	3	1	2	3	–
6	2d	6	5	1	5	1
6	2e	3	–	1	3	–
6	3	20	19	1	11	9
6	4a	4	2	2	1	3
6	4b	1	1	–	1	–
6	7a	4	2	2	4	–
6	7b	1	1	–	1	–
6	9a	34	27	7	30	4
6	9b	4	4	–	3	1
6	9d	2	2	–	2	–
6	10	2	2	–	1	1
6	13a	1	–	–	1	–
6	13b	1	–	1	1	–
6	14a	1	–	1	–	1
6	14b	1	–	1	1	–
6	15	1	1	–	–	1
5	1a	1	1	–	1	–
5	1b	1	1	–	–	1
5	2a	3	1	2	2	1
5	2b	7	7	–	2	5
5	2c	7	6	1	4	3
5	2d	11	5	6	8	3
5	2e	2	–	2	1	1
5	3	8	8	–	5	3
5	4a	2	2	–	2	–
5	4b	4	3	1	4	3
5	5b	2	2	–	1	1
5	9a	9	6	3	6	3
5	9b	1	–	1	1	–
5	10	9	8	1	6	3

5	12a	2	2	–	–	2
5	12b	1	1	–	1	–
5	13a	5	3	2	4	1
5	13b	6	–	6	5	1
5	14b	1	–	1	–	1
5	16a	1	1	–	–	1
5	17a	7	1	6	7	–
4	2b	2	–	2	1	1
4	2e	4	?	2	–	4
4	2f	3	–	3	2	1
4	2g	1	–	1	–	1
4	9a	3	3	–	–	3
4	9b	1	–	1	1	–
4	13b	1	–	1	1	–
4	16a	2	–	2	1	1
4	16b	3	3	–	–	3
4	17a	2	–	2	2	–
4	17b	6	–	6	5	1
4	17c	19	–	19	4	15
4	18a	6	–	6	5	1
4	19a	1	–	1	1	–
3	16a	1	1	–	–	1
3	16b	4	–	4	–	4
3	16c	1	–	1	–	1
3	17b	2	–	2	1	1
3	17c	8	2	6	4	2
3	18a	5	?	4	1	4
3	18b	5	–	5	2	3
3	18c	6	–	6	2	4
3	18d	6	–	6	2	4
3	18e	2	–	2	1	1
3	18f	1	–	1	–	1
3	18g	1	–	1	–	1
3	19a	2	–	2	1	1
3	19b	3	–	3	–	3

The applique decoration: summary

Change with time is evident in the preferred style of applique, the surface finish of sherds bearing applique ornament and the fabric of the clay itself. Fig 3-58 shows the main trends for the first variable. On the face of it, the principal changes are seen from levels 6 and 7 to level 5, and from level 5 to 4 and 3. The former was accompanied by a clear change from cordmarked to an increased proportion of plain sherds and from a fabric incorporating grog to one in which chaff was the commonest tempering material. The changes noted were in fact confirmed when the data were subjected to a cluster analysis of cases (fig 3-59). This separates out levels 6 and 7 and being most similar to each other. Level

6 has greater affinity with level 8 than with level 5.

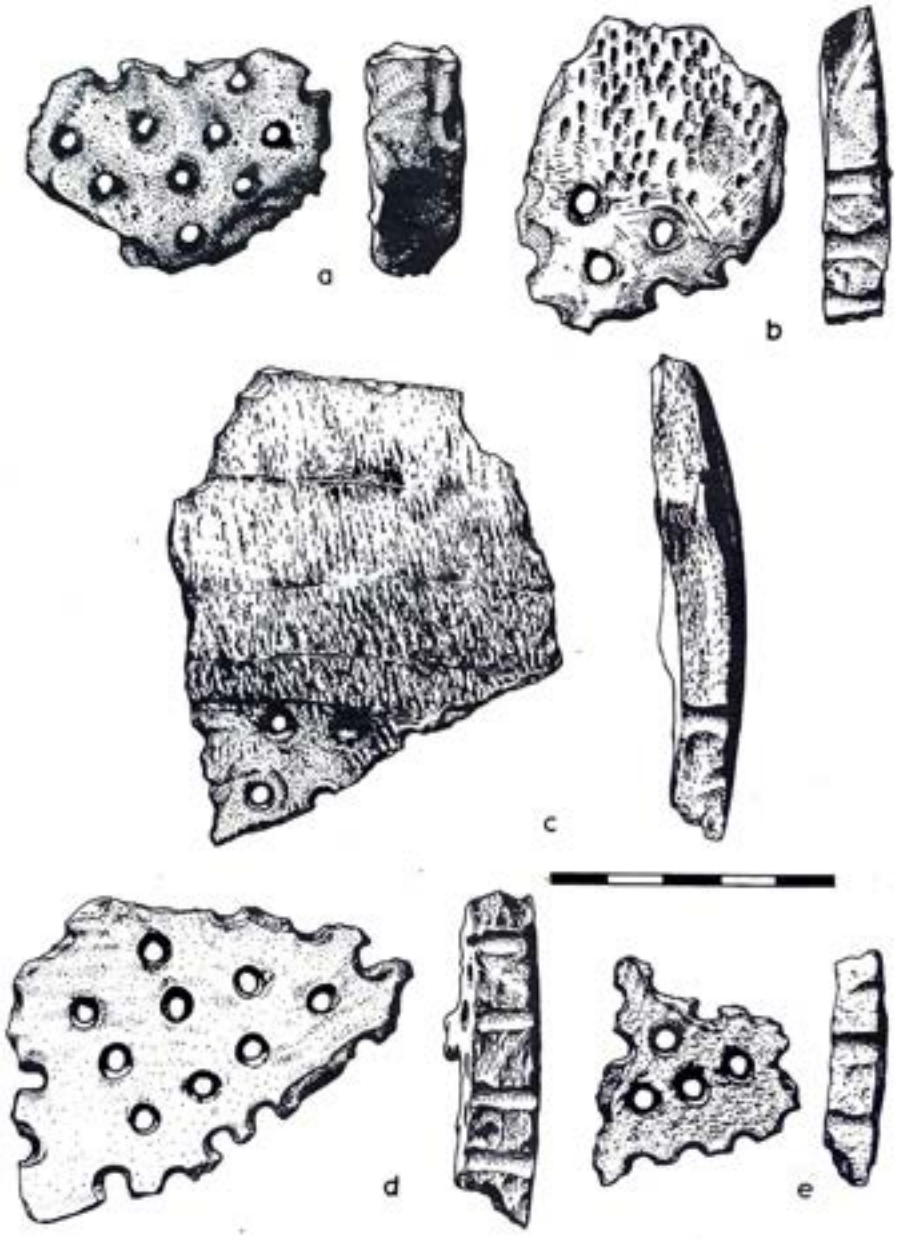


FIGURE 3-53 Ban Na Di: the perforated potsherds
A. A4 19 L.6 Cat.1764 B. A1 18 L.5 Cat.1657 C. A1/2 27 L.6 Cat.1782
D. F5 8 L.5 Cat. TS64 E. A2 21 L.6 Cat.1879

Ban Na Di: illustrations of applique ornament

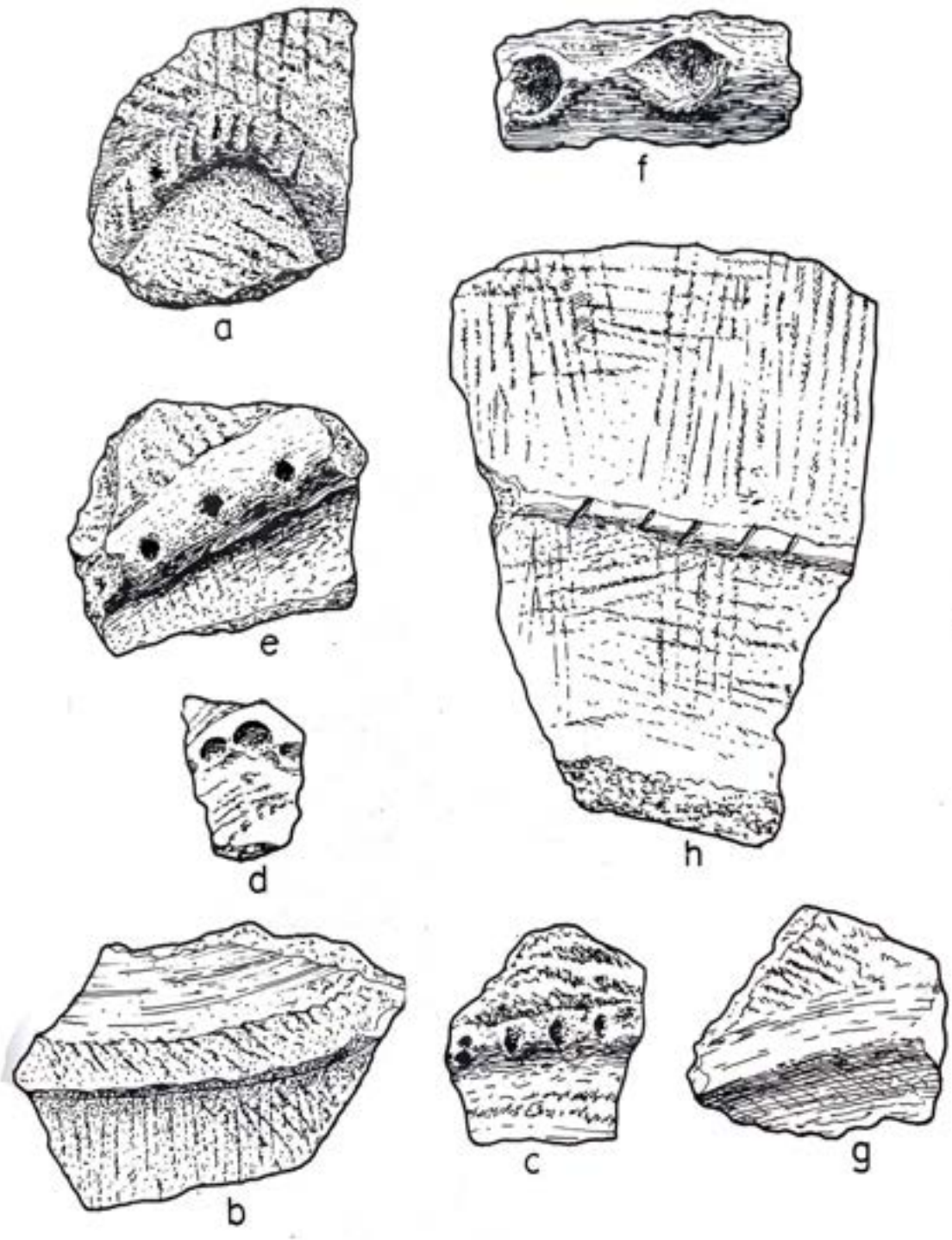


FIGURE 3-54

Ban Na Di: the applique ornament on potsherds.
A. Form 1a L.8 B. Form 1d L.7 C. Form 2a L.8 D. Form 2c L.6
E. Form 2d L.6 F. Form 2e L.6 G. Form 3 L.8 H. Form 4a L.8

Ban Na Di: illustrations of applique ornament

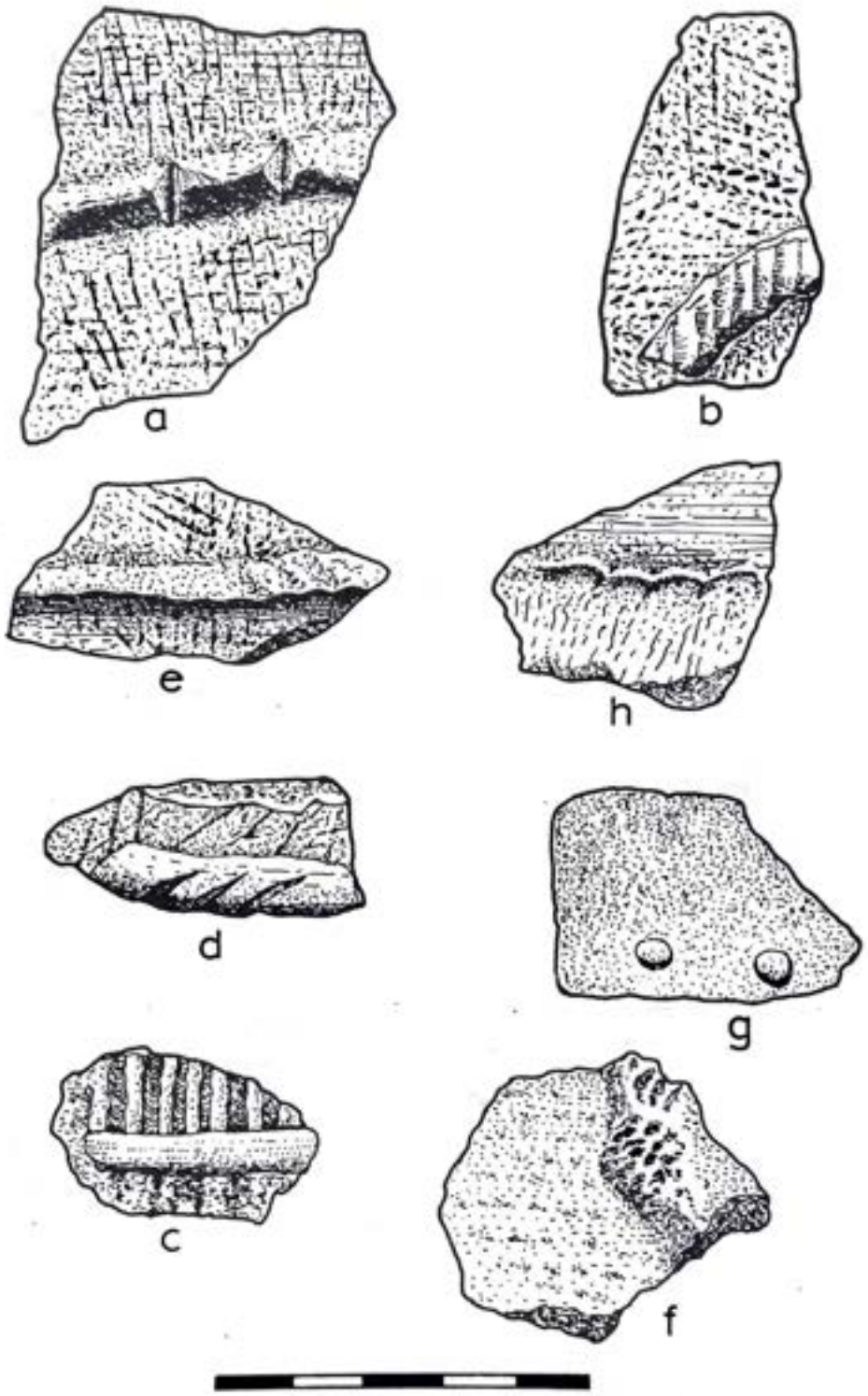


FIGURE 3-55

Ban Na Di: the applique ornament on potsherds.
A. Form 5b L.8 B. Form 6 L.8 C. Form 7 L.8 D. Form 8 L.8 E. Form 9 L.7 F. Form 10 L.6 G. Form 11 L.8 H. Form 13 L.8

Ban Na Di: illustrations of applique ornament

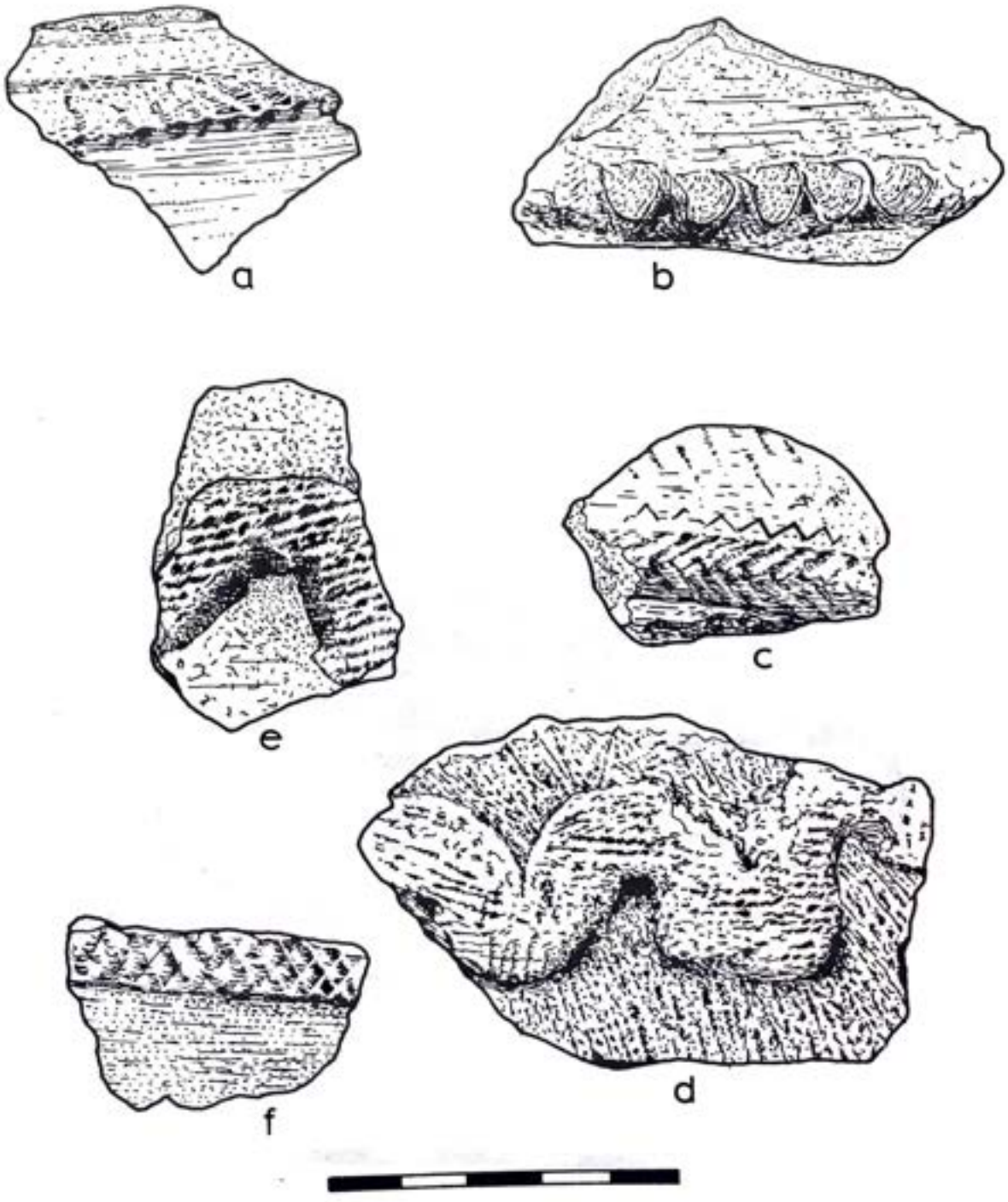


FIGURE 3-56

Ban Na Di: the applique ornament on potsherds.
A. Form 13 L.5 B. Form 14 L.6 C. Form 15 L.6
D. Form 16b L.4 E. Form 17 L.5 F. Form 17c L.4

Ban Na Di: illustrations of applique ornament

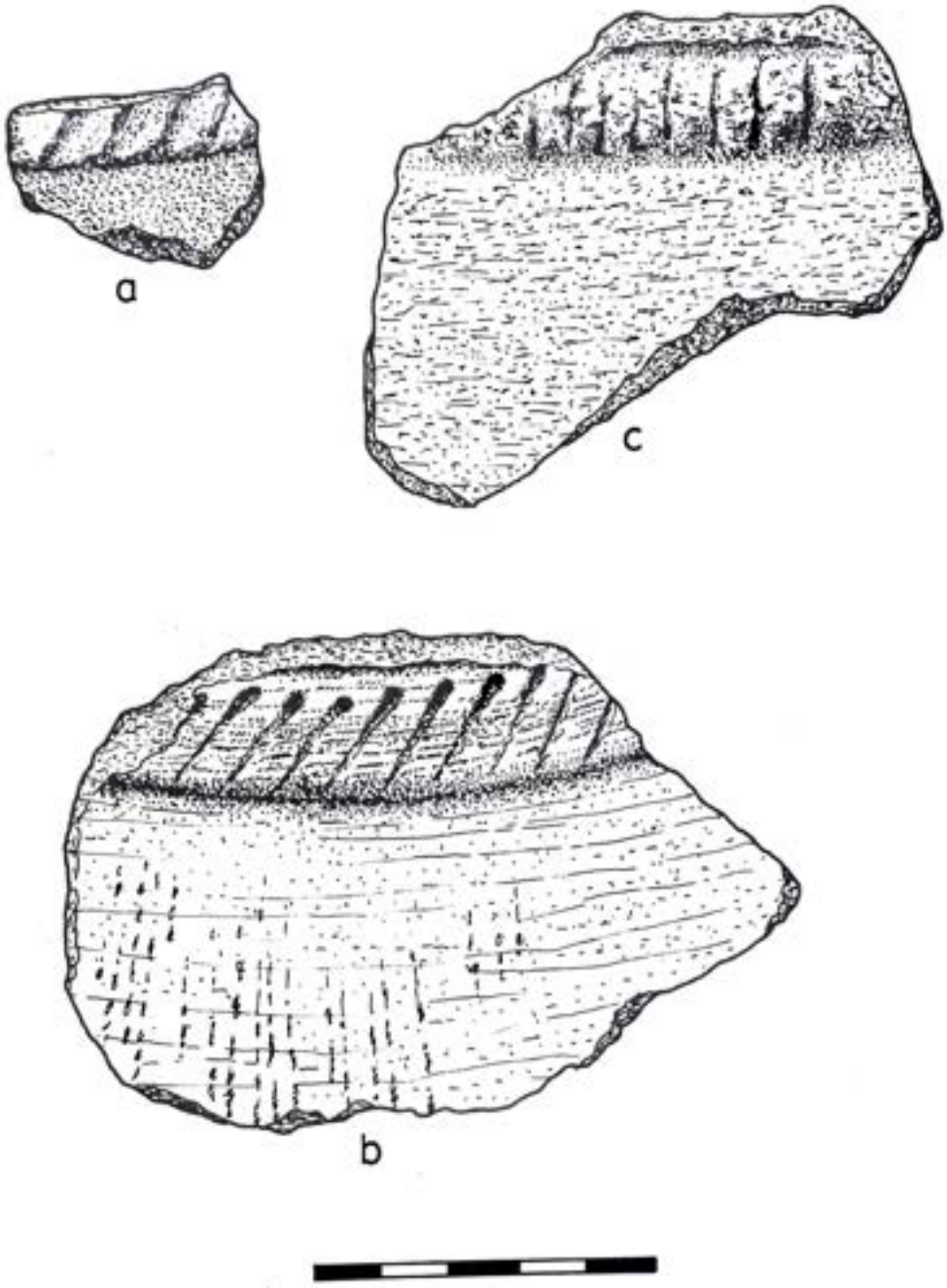


FIGURE 3-57

Ban Na Di: the applique ornament on potsherds.
A. Form 18 L.4 B. Form 18b L.3 C. Form 19 L.3

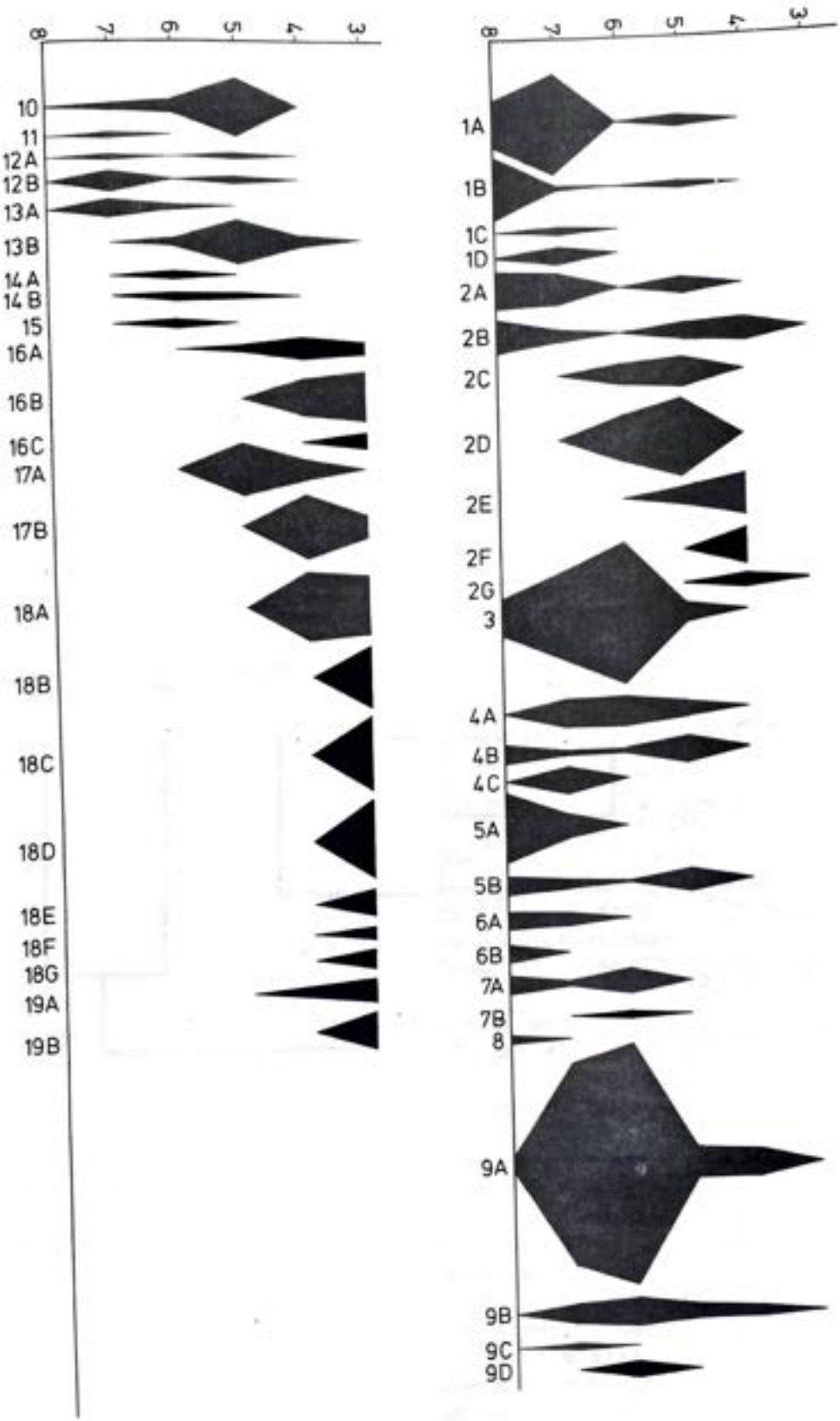


FIGURE 3-58

Frequency plot of the different types of applique decoration at Ban Na Di by level

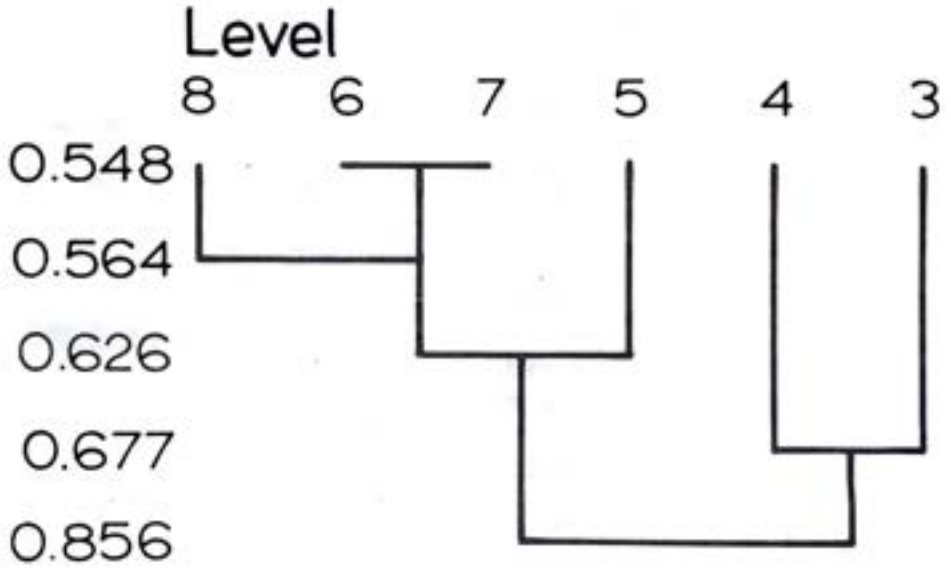


FIGURE 3-59

The relationships between level assemblages of applique decoration at Ban Na Di on the basis of a cluster analysis

THE CLAY PIPES

During Bayard's site survey in Loei Province (Bayard 1980) and Higham and Kijngam's survey in the Kumphawapi area, several specimens of moulded clay smoking pipes were noted. According to Velder (1965), such pipes date from the first half of the 16th century but their duration is not known. At Ban Na Di, specimens of clay pipe were confined to level 2, with the exception of one specimen being found clearly out of context in level 6. Bowls and stems are represented, but all are fragmentary. Details are as follows:

TABLE 3-42

Ban Na Di: the clay pipes

Provenance	Level	Cat.No.	Comment
A1 25	6	655	This stem fragment is clearly out of context.
A4 2	2	7	The bowl alone is present. The maximum width of the bowl is 23.4 mm. A fragmentary section of decoration depicts Velder's "nuages" pattern.
A3/A4 2	2	1202	A fragment of bowl. Max. diam. of bowl 43.0 mm.
A3 1	2	1618	A fragment of bowl.
A2 3	2	22	A fragment of bowl.
A2 2	2	1584	A fragment of bowl with a decorative pattern comprising 2 bands of vertical, parallel lines. This resembles closely the specimen described by Bayard (1980, fig 11j). The latter comes from Pa Cha Nai Mi, Lat 17° 28′ N., 101° 44′ E.
A2 4	2	24	This specimen comprises the stem and basal part of the bowl. The upper stem surface has a perforated boss for attachment to

				a thread.
A1	2	2	10	The stem is complete. The maximum breadth at the point of inserting a bamboo extension is 18.8 mm. The impressed motif is the heavenly swan (Suwannahong). No examples of this motif were found during the Kumphawapi survey.
A1	1	2	5	This stem piece has a ventral hook, and a variation of the nuages design. This underlies a band of parallel, vertical lines.
F5	1	2	TS 2	Only a fragment of stem survives.
F5	S.	1	TS 1	This fragment of bowl bears the nuages design.
F5	3	1	TS 8	This complete specimen is a most unusual example. There is a very small bowl with a pointed base and simple design comprising vertical, incised lines. The maximum diameter of the bowl is 20.3 mm.

THE MATERIAL CULTURE FOUND AT BAN MUANG PHRUK (fig 3-82)

This section is concerned with all small finds found with the exception of pottery.

1. Bronze

Only a small piece of bronze was found in level 5. One bronze bracelet but no other artefacts nor crucibles were recognized from the test excavation.

2. Iron Remains

One piece of iron was derived from level 1. It was very corroded. It is approximately 7.8 cm in length. A piece of iron 5.2 cm in length was also found in level 4. In addition, an iron ring with a diameter of about 1.5 cm as well as one iron bracelet with a diameter of approximately 4.7 cm were discovered in the lower part of level 4.

3. Clay artifacts

There are several categories of clay artefact from the site. The first consists of pieces of broken pot sherds which were chipped into circular counters. Four were found in level 4 and eight in level 5. The second comprises a fired, rounded ball of clay of a type which in living memory, was used as a projectile to hunt small birds. One was found in level 3, two in level 4 and 25 in level 5. The diameters vary between 13.4 and 18.5 mm. The third comprises a shaped piece of fired clay and it was found in layer 4. It is 5.2 cm in length and 1.3 cm in thickness. It was shaped into the form of an animal figurine but it is incomplete. The last comprises a fired, long barrel shape of clay. It was probably used as a sinker for fishing activity. It has a diameter of about 2.5 cm and is 5.8 cm in length.

Illustration of clay pellets from Ban Na Di

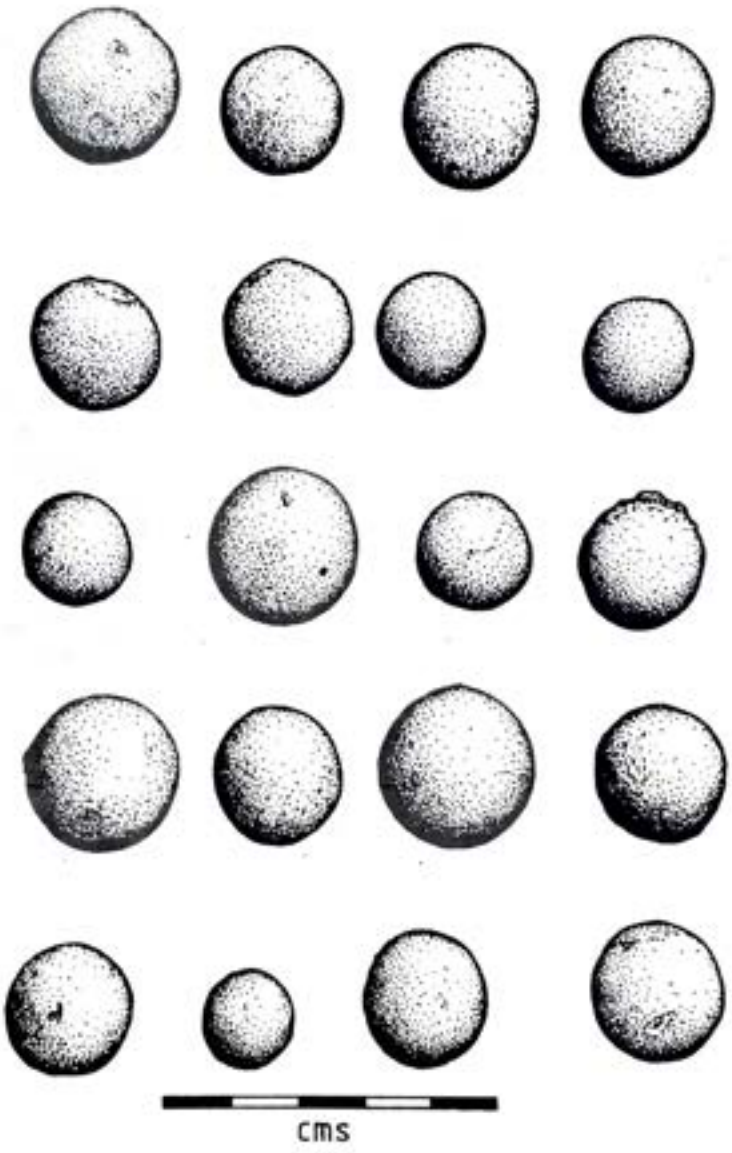


FIGURE 3-80

Ban Na Di: the clay pellets from level 8 to level 4 (bottom to top row)

Illustration of the clay pipes from Ban Na Di

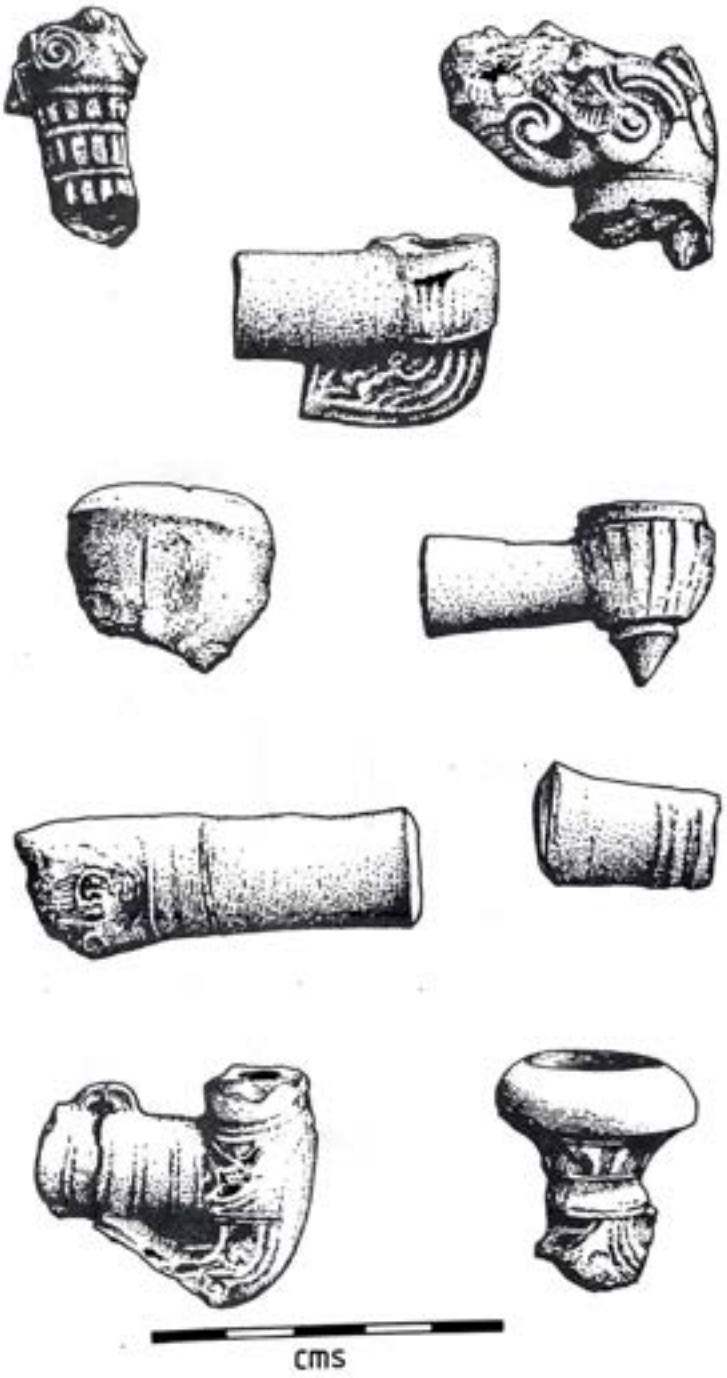


FIGURE 3-61

Ban Na Di: the clay pipes from level 2

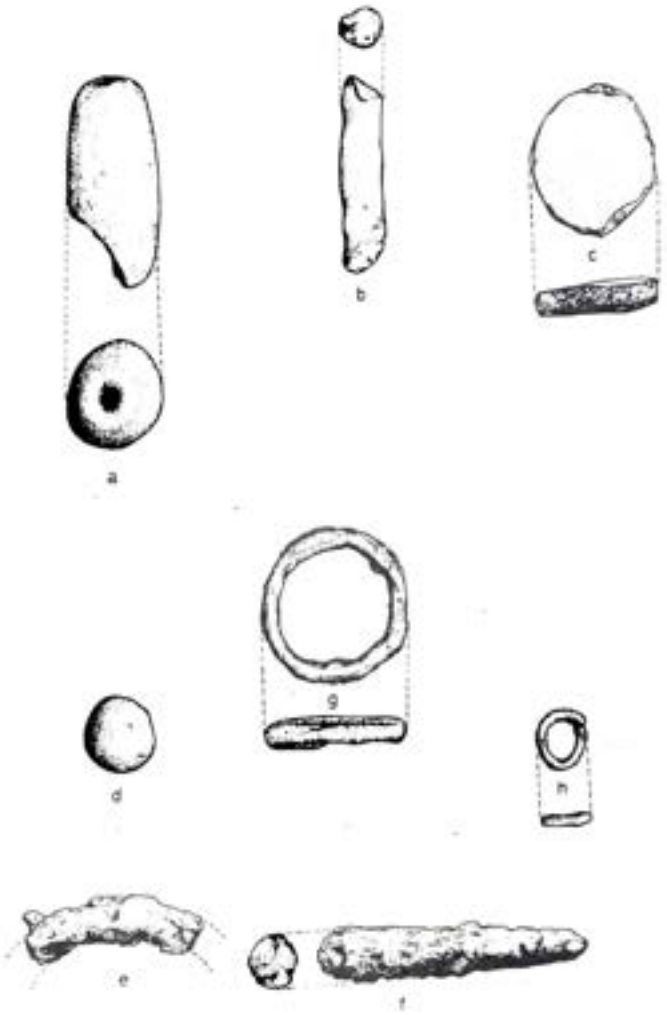


FIGURE 3-62
The material culture from Ban Muang Phruk

A. clay sinker lev.1 B. fired clay lev.4 C. clay counter lev. 5
D. clay pellet lev.3 E. iron fragment lev.4 F. iron fragment lev. 1
G. iron bracelet level 1 H. iron ring lev.5
scale 1:2

THE MATERIAL CULTURE FROM NON KAO NOI

There was very little in terms of material culture at Non Kao Noi other than potsherds and complete vessels found in the burials. These complete vessels are illustrated below, but discussion of the pottery from the site is reserved for the next chapter.

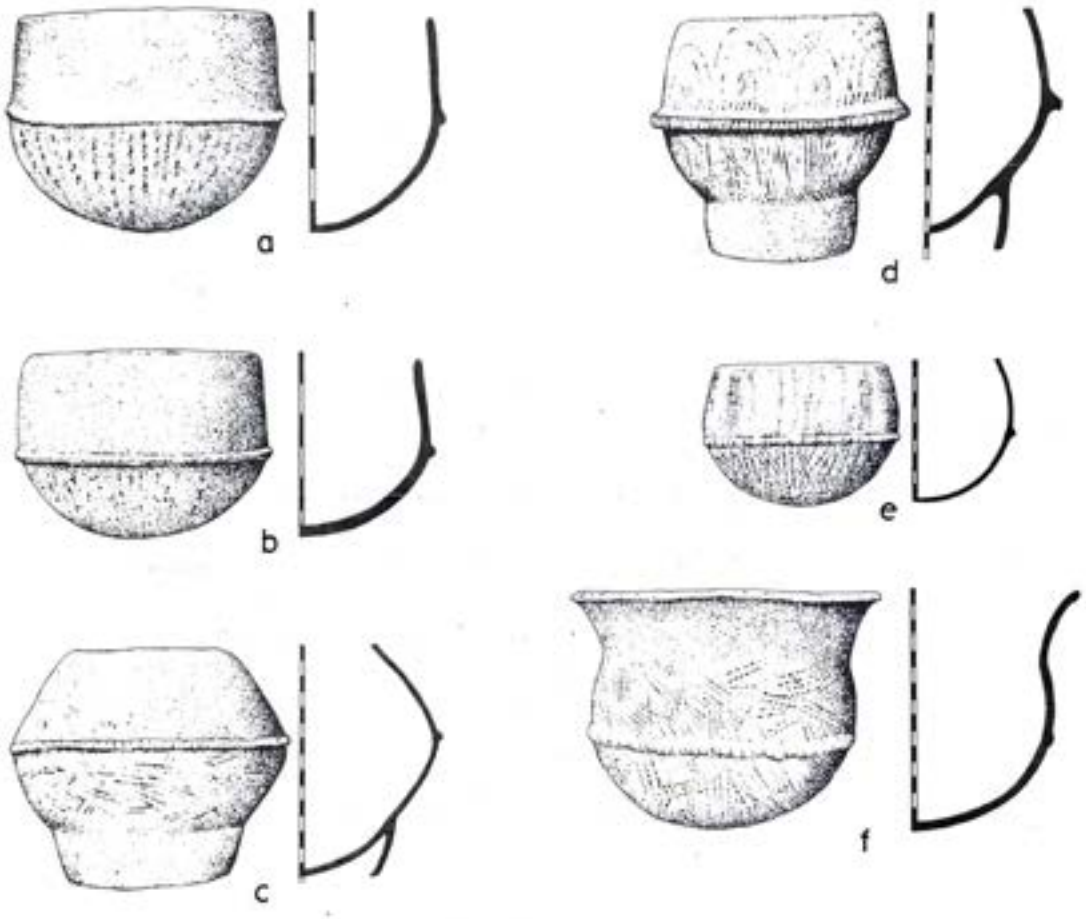


FIGURE 3-63
The complete pots from Non Kao Noi

A. pot 2, B. pot 1, C. pot 3 all from burial 1
D. pot 5, E. pot 6, F. pot 4 all from burial 4
scale in cm see fig 2-6

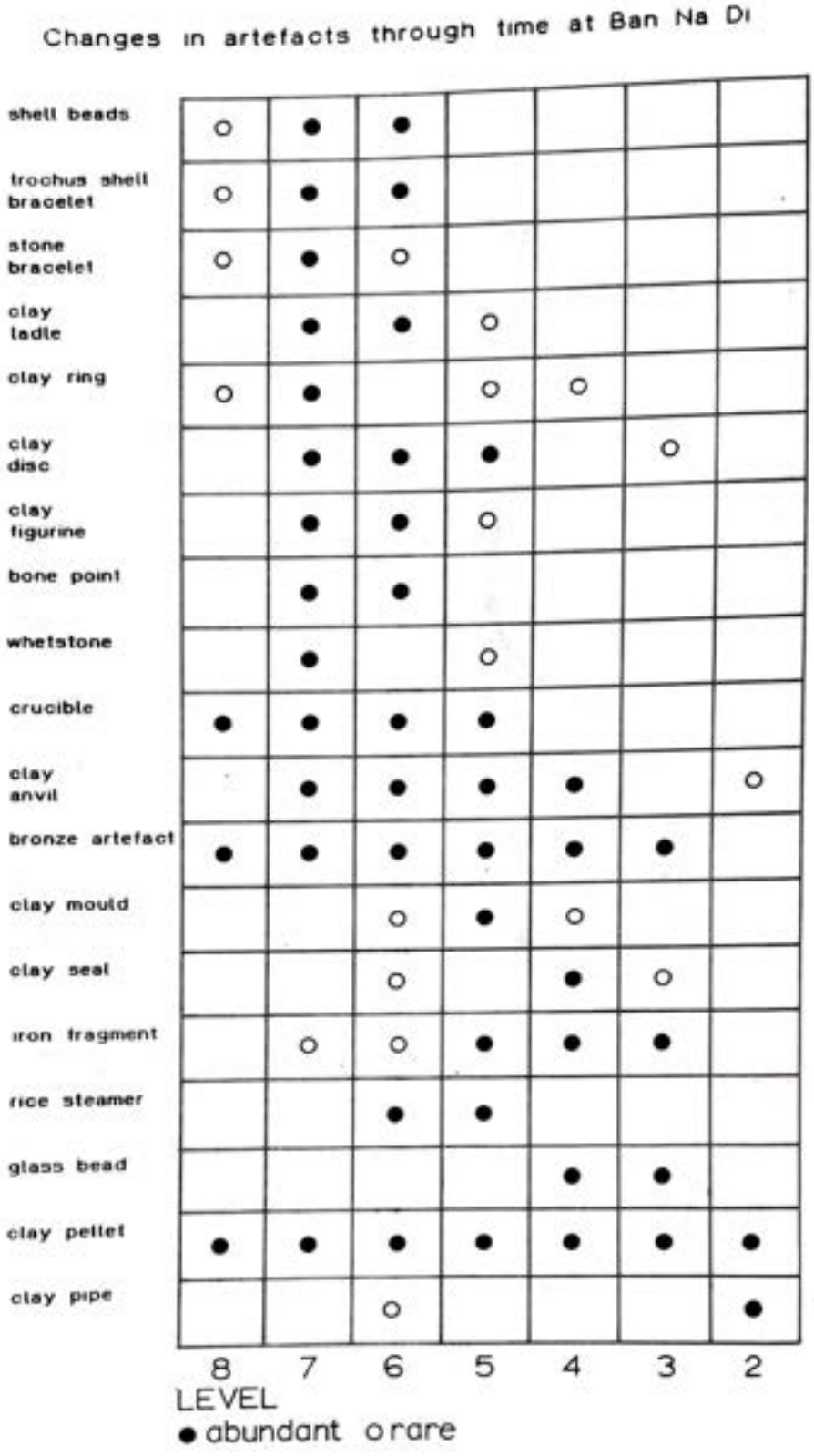


FIGURE 3-64

Ban Na Di: a summary of the main changes in the material culture by level

CHAPTER FOUR

THE RIMS FROM BAN NA DI AND RELATED SITES

Metha Wichakana

The principal objective of the present section is to consider the basic framework for the prehistoric ceramic sequence in the Upper Songkhram survey area. Because this involves the need to compare assemblages between sites, the material from Ban Muang Phruk and Non Kao Noi are considered here in addition to that from Ban Na Di.

There have been four previous published analyses of pottery from prehistoric sites in Thailand. None has yet approached the specialist level of petrographic analysis based on thin sections which is the essential basis of detailed European and American reports (Peacock 1968, Shepard 1956). This has necessarily narrowed the range of results obtained. Such a detailed study is, however, reported on below as a separate but integrated part of the Ban Na Di research programme. This situation has conditioned the present approach and objectives.

The four studies referred to above had in common, the aim of establishing regional phases and then reviewing the cultural implications of change or stability in the pottery repertoire. In all cases, consideration was given to the variables of form, decoration, style and fabric. Higham (1977) was able to establish three phases in the excavated Roi Et sites. Rutnin undertook a detailed study of the rim sherds from one of the four squares excavated by Charoenwongsa at Non Chai. The third study has recently been completed by Chantaratiyakarn (see below, section 2) for sites in the Middle Chi Valley. Again, three phases were identified and their implications for the prehistoric culture in the general area were assessed.

Quite the most complete analysis to date has been that undertaken by Bronson (1976). The very large sample from Chansen was considered on the basis of rims, bases, and body sherds. He was able to isolate six successive phases which superceded the earlier use of such descriptive terms as Dvaravati and Khmer. The relations between the ceramics of successive phases with those in the Chao Phraya Valley as a whole enabled him to advance a most useful model, wherein the advent of broad regional homogeneity in ceramic wares reflected the process of political centralisation.

Bronson (*op.cit.*) gave much attention to the basic principles underlying the analysis of pottery assemblages and his general approach, together with his system of technical terms, has been broadly adopted below. The present study is concerned almost exclusively with rims, and Bronson's definition of an attribute as a single descriptive characteristic has been employed. Four attributes have been considered. They are the rims' form, the characteristics of the surface decoration, vessel size as represented by the diameter of the vessel's mouth and where appropriate, the height of the rim and finally, the broad characteristics of the clay fabric.

Where a given rim or group of rims displays similarity in all four attributes, then they are grouped as a type. In the actual description of rims below, the terms employed by Bronson are used. These are summarised in fig 4-1. Because written descriptions very rarely convey the actual appearance of the rims or the nature of the fabric, much attention has been given to the illustration of every rim type.

The laboratory procedure began with the stratified sample from Ban Na Di. The first step, was to subdivide the sample into rims, bases, shoulders and body sherds. All specimens were labelled to the site and appropriate layer. Most attention was paid to the rims. All the rims were sorted by layer and were then grouped on the basis of form, size and decorative elements. These criteria are those recommended by Shepard (1956) and include a consideration of whether rims come from vessels with open or restricted mouths.

When a series of form-groups was established, each specimen was analysed at a fresh break under a low powered binocular microscope and a decision taken on the characteristics of the fabric. Temper inclusions that characterize broad groups of fabric were incorporated with form, decoration and size to determine the basic rim types found at Ban Na Di. In some crucial cases, rims that resemble each other in form were found to have a distinct fabric. They were therefore separated into different types.

When a series of groups sorted by rim and fabric was obtained, the assemblage as a whole was compared with the samples of the other available sites. In practice, this involved Non Kao Noi, Ban Muang Phruk and Non Chai. The procedure is as follows.

Having categorised each rim type on the basis of type and layer, there followed the question of an appropriate system of nomenclature. Since this analysis was proceeding at the same time as Chantaratiyakarn's closely related study of the rims from the Middle Chi Valley, the same approach was adopted. Initially, it was recognised that to employ a system of nomenclature based on a single site name was inappropriate because it would obscure the presence of similar if not identical rims found in more than one site. In consequence, a regional perspective was employed. All types found in the Middle Chi survey area were given the prefix "MC", followed by a sequential number. Where a rare rim clearly related to one found frequently and already described for another area was encountered, the original name was retained. Thus, several rims found in the Middle Chi area match those described by Rutnin (1978) at Non Chai. Her designation was therefore used. In the case of the present study area, all rim types have been given the prefix "US", standing for Upper Songkhram irrespective of the name of the site in which they were first encountered. As will be seen, some rims parallel those from Non Chai, and the original name is therefore used.

It is clearly recognised, that the isolation of a rim "type" is based on the worker's assessment of several attributes. The most easily assessed, is the shape of the rim, although where specimens are fragmentary and the rim body junction is not present, there is an area of doubt on the original form of the vessel in question. Then there is the decoration or surface finish on the surviving rim. This too is readily ascertained. The size of the vessel in question, or at least its orifice diameter, is measured by extending the arc of the rim. The fourth and most difficult variable, is the nature of the clay fabric. Essentially, this is

the proper domain of the specialist ceramicist able to analyse non plastic inclusions identified in the thin sections of the sherds in question. In practice a thin section of each rim type described below has been prepared and they are now under analysis by Mr B. Vincent. The establishment of temper groups for the present study involved studying the cross section of each rim at a fresh break through a binocular microscope. Temper groups were then set up on the basis of the presence and relative frequencies of three variables: grog, sand and chaff. Grog comprises pre-fired materials, in particular crushed potsherds. Sand is a most unreliable substance, because as Vincent (1984) has shown, it occurs naturally in most if not all the local clay sources he sampled. The admixture of sand as a tempering agent therefore has be demonstrated on the basis of a statistical analysis of variations in grain size linked with an assessment of the varying minerals and degrees of angularity. Therefore, little stress has been placed on sand as a tempering material. Many rims reveal varying amounts of organic temper which in practically all cases, was derived from rice chaff. The following main temper groups were recognised. Groups 1-9 inclusive were only found at Non Kao Noi.

Group 1. This group comprises grog, sand and chaff. The grog is light, almost white in colour and has an uneven shape. There is also some admixture of rice chaff, though the most abundant inclusion comprises sand.

Group 2 This group is distinguished by large inclusions of grog and an abundance of sand. No chaff has been detected.

Group 3. White coloured grog is the predominant temper, and it seems to be regularly disposed in the sherd almost in the form of rows. There is also some sand, but no chaff.

Group 4. Chaff was abundant in this group, with grog and sand being rare.

Group 5. Large, irregularly shaped pieces of sand are characteristic of this group. Grog is rare and chaff absent.

Group 6. Rounded grains of sand and angular pieces of grog are found in this group, together with a few pieces of chaff.

Group 7. This group resembles group 5 fabric, but the sand observed is of smaller grain size.

Group 8. Angular, orange coloured grog is found, with some sand and only a very rare inclusion of chaff.

Group 9. The angular, black coloured grog predominates in this group. Sand is also present, but there is no chaff.

It is realised that it is practically unknown for a potter to mix more than one substance with clay as a tempering material unless as occurs today in Northeast Thailand, the prepared temper incorporates a mixture of materials. Some of the fabric groups just described may well include sand

natural to the clay source itself, and rice chaff when present in small amounts, could well have found its way accidentally into the clay before firing. The same reservations apply to the fabric groups from Ban Na Di and Ban Muang Phruk, which are set out below.

Group 10. Angular pieces of grog predominate, though sand, chaff and red stone which may derive from laterite have also been noted.

Group 11. Grog again predominates, though it is rarer than in group 10 and is predominantly white in colour. Very small quantities of sand and rice chaff are also present.

Group 12. The two types just described are characteristic of level 8 pottery from Ban Na Di. This type is easily distinguished from them although again, grog is the predominant material noted. It is white or orange in colour and rounded in contour. There is also a substantial quantity of sand, but no chaff.

Group 13. This group is characterised by an abundant inclusion of carbonised rice chaff.

Group 14. Again, grog predominates and is easily recognisable on the basis of the extreme angularity of the individual pieces and linear patterns it forms. Chaff is extremely rare.

Group 15. This group, which is particularly characteristic of Ban Na Di during level 5, incorporates grog, sand and chaff though the amount of the last two is variable. The grog too is present in many different colours, but has a consistently highly angular outline. Seven sub-types have been defined. In the case of 15a, the grog is coloured white and black, while chaff is rare. The grog in 15b is orange as well as white and black. Chaff is very rare again. In the case of 15c, only white coloured grog is present, while the next sub-type, 15d, reveals only black coloured grog. 15e is characterised by an orange coloured grog, which is also present in 15f in association with the black material. The last sub-type, 15g, has the orange in association with white grog. In all cases, there is some sand and the odd fragment of chaff as well.

Group 16. The orange coloured grog found in this type is large and very angular in shape. There is a liberal presence of sand, and very small amounts of chaff.

Group 17. Includes small sized grog particles coloured white, black or orange. There is also some sand and very rare fragments of chaff.

Group 18. This type was first found at Ban Na Di level 5. The clay contains much sand, but no grog or chaff. We may be dealing with a very sandy clay, or the use of sand deliberately as a temper.

Group 19. This group includes grog, sand and chaff. The grog itself is coloured orange, black and white and it appears of medium size. Sand in this group is abundant, while chaff is rare.

The following section gives a detailed description of the rim types identified. The abbreviation TG refers to the temper group found in each.

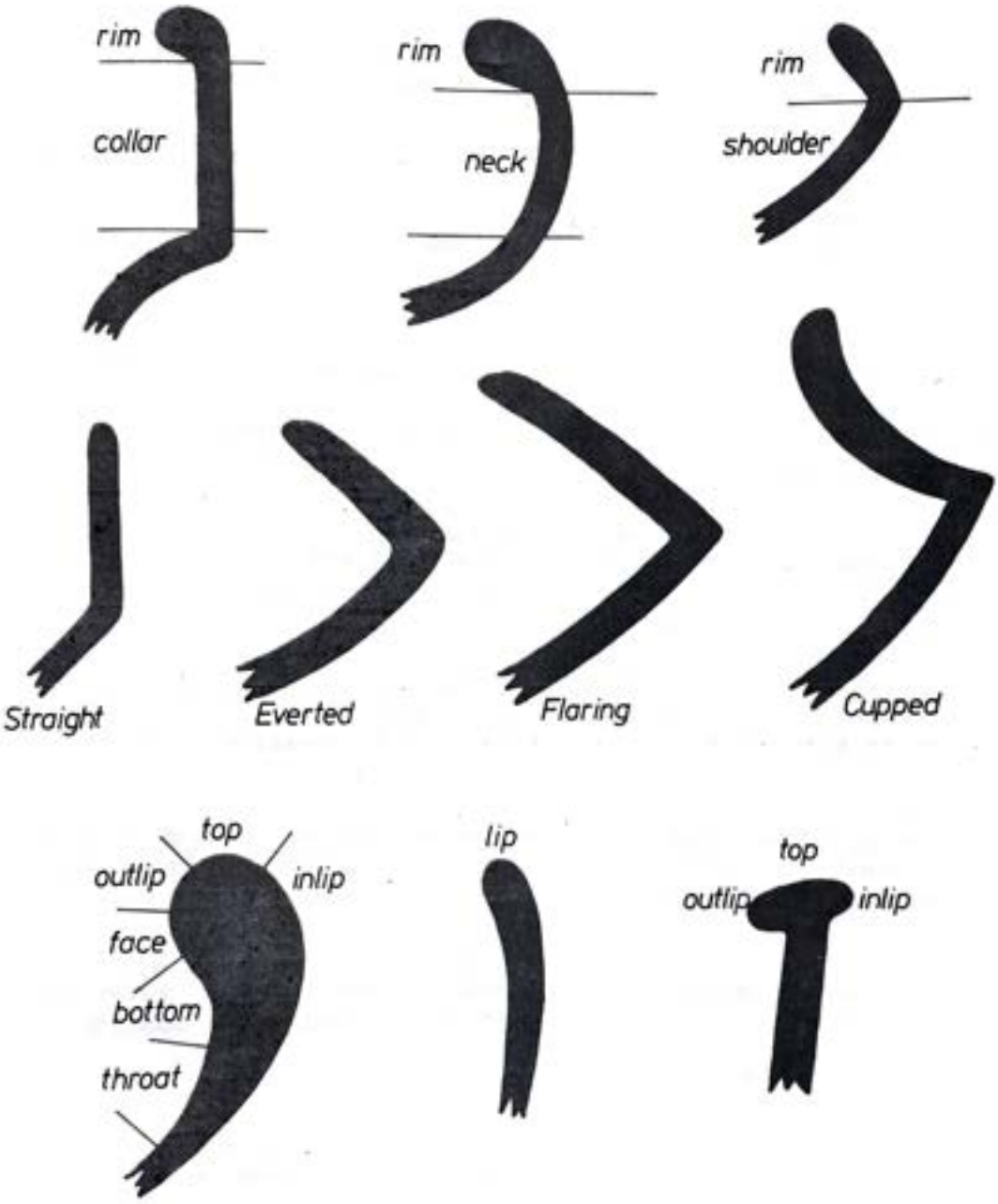


FIGURE 4-1

The principal areas of the rim, (after Bronson 1976)

DETAILED DESCRIPTION OF RIM TYPES

NON KAO NOI

US 1 TG 9 fig 4-2

This type comes from a small bowl found in burial 1 at Non Kao Noi. The bowl bears a thin applied cordon at or near the mid point. It has a constricted orifice and simple squared rim. Both exterior and interior rim finishes are plain and smoothed. It has a diameter of about 140 mm.

US 2 TG 1 fig 4-2

This type probably has a constricted opening and everted rim. The tip is expanded into a triangular bulb and there is a distinct internal groove. Both exterior and interior rim finish are plain and smoothed. It has a diameter of about 360 mm.

US 3 TG 6 fig 4-2

This type probably comes from a vessel with a restricted opening and an everted rim. The top of rim is flat but the interior of the rim, under the rim tip, is grooved. Both exterior and interior rim finish are plain and smoothed. It has a diameter of about 260 mm.

US 4 TG 3 fig 4-2

This type may have a restricted opening and everted rim. The rim section has a pronounced external thickening. It is plain and smoothed on both sides. It has a diameter of about 240 mm.

US 5 TG 6 fig 4-2

This has a restricted opening and beaded rim. It is plain and smoothed on both sides. It has a diameter of approximately 160 mm.

US 6 TG 5 fig 4-2

This probably comes from a vessel with an unrestricted opening and short upturned convex rim. It is plain and smoothed on both sides. It has a diameter of about 200 mm.

US 7 TG 7 fig 4-2

This type is probably of a restricted opening and long everted rim. The rim itself is very thin. It is plain and smoothed on both sides. It has a diameter of about 240 mm.

US 8 TG 4 fig 4-2

This type has a long and thick everted rim and it probably had a restricted opening. It is plain and smoothed on both sides. It has a diameter of about 280 mm.

US 9 TG 8 fig 4-2

This type had a constricted opening and everted rim. It is plain and smoothed on both sides. It has a diametear of about 200 mm.

US 10 TG 1 fig 4-2

This type probably has a restricted opening, cylindrical neck and everted rim. It is plain and smoothed on both sides. It has a diameter of approximately 200 mm.

US 11 TG 1 fig 4-2

This type has a constricted opening and short everted rim.Both exterior and interior rim finish is plain and smoothed. It has a diameter of about 240 mm.

US 12 TG 5 fig 4-2

This rim type has an unrestricted opening and inward swelling on the rim tip. It is plain and smoothed on both sides. The surviving part of the body is decorated with incised, parallel lines. It has a diameter of approximately 200 mm.

US 13 TG 1,2 fig 4-2

This type probably had an unrestricted opening and everted rim. Both exterior and interior rim finish are plain and smoothed. It has a diameter of 160 mm.

US 14 TG 5 fig 4-2

The vessel probably had a restricted opening with complex everted rim. The rim itself is everted to one point and then sharply angled. It is plain and smoothed on both sides. It has a diameter of about 260 mm.

US 15 TG 1 fig 4-2

This type probably comes from a vessel with a restricted opening and everted rim but the rim exterior has a pronounced swelling. Both exterior and interior rim surfaces are plain and smoothed. It has a diameter of approximately 160 mm.

US 16 TG 4 fig 4-2

This rim type has a restricted opening and everted rim. There is a marked groove on the top of the lip. It is plain and smoothed on both sides. It has a diameter of about 260 mm.

US 17 TG 6 fig 4-2

This type has a restricted opening and everted rim. The top of the lip is flat. Both exterior and interior rim finish are plain and smoothed. It has a diameter of approximately 180 mm.

BAN NA DI LEVEL EIGHT

Eight clearly distinct rim types were recognised. They comprise rim types US 18 - US 25.

US 18 TG 10 fig 4-2

This is the most abundant and characterestic type discovered in this earliest level. It closely matches rims from four complete vessels that come from the earliest mortuary phase and the very beginning of mortuary phase 1b. This comprises a pedestalled pot, in which the upper part is a bowl shaped with an unrestricted or slightly restricted orifice. It

was noted that the vessels were mould-made.

In all cases, but one, all of the rims have particular external rim treatment and the exterior cord-marking is carried up to the very edge of the rim. The edge of the rim was usually flat, where it was cut from the parent mould. Where a section was added however, the rim profile was rounded.

US 19 TG 10 fig 4-2

In general this type is similar to US 18. It also corresponds to vessels that come from mortuary phases 1b and 1c. These vessels were also mould made. The lower exterior part of the moulded portion was shaped with a cord wrapped paddle. The added part, however, markedly restricted the orifice size.

All the rims come from the added portion. Both of exterior and interior parts are smoothed and the rim edge is flat.

US 20 TG 11 fig 4-2

This type has, in common, a restricted opening and everted tall rim with a direct, rounded top and a rim diameter of approximately 300 mm. Both exterior and interior surface are plain and smoothed. Again, this type corresponds to vessels derived from the early burial phases at Ban Na Di.These are large, deep bodied pots between 28 and 36 cms broad and 27 - 36 cms tall. All have large, sharply everted rims.

US 21 TG 11 fig 4-2

Since this rim type is not found on complete vessels in association with burials, it is not possible to be sure what form is represented. The rim fragments are everted and have a plain smoothed finish. They probably come from constricted vessels with an everted rim because most specimens were fractured at the same point of presumed weakness at the body rim junction. All eleven specimens have a slightly bevelled rim.

US 22 TG 11 fig 4-2

This rim form is represented by only one specimen, it is restricted to level 8. It resembles US 21 in having an everted form with a bevel, but in considerably thicker. This type has a diameter of approximately 300 mm.

US 23 TG 11 fig 4-2

This form has a tall and everted shape with an external beading on the rim edge itself. The exterior of the neck bears vertical cord-marking, but the interior was smoothed with horizontal strokes. Only one specimen was recovered. This type has a diameter of approximately 260 mm.

US 24 TG 11 fig 4-2

This type closely matches US 23 in shape, but lacks the cord-marking on the neck. It has a diameter of about 240 mm.

US 25 TG 11 fig 4-2

This rim type has an everted shape, but instead of a bevel, the edge of the rim has a shallow groove between two points. Both interior and exterior surfaces were horizontally smoothed with a medium such as a leaf. It has a diameter of approximately 180 mm.

BAN NA DI LEVEL SEVEN

Thirty two rim types were discovered in level 7. Twenty seven clearly new styles were recognised. Five previous ones in level 8 were also traced here. They are rim types: US 18–US 21 and US 23. The new ones comprise types US 26 – US 52.

US 26 TG 16 fig 4-3

This type corresponds to two vessels which bear the distinctive "Om Kaeo" style of decoration. These come from grave 18 (mortuary phase 1c), 21 (mortuary phase 1b) and square F 6 level 1 (the equivalent of mortuary phase 1c). The vessels are large (the widths varying between 41 – 46 cm), and sharply carinated. The Om Kaeo decorative style involves first cord marking the vessel, then incising decorative designs which were then infilled with red paint.

The rim itself has a restricted opening and the exterior is down sloped. The exterior rim bears red paint, with a band along the rim tip. The interior rim finish is plain and smoothed to leave horizontal striations. It has a diameter of approximately 300 mm. Both specimens come from the uppermost contexts of level 7.

US 27 TG 13 fig 4-3

This type relates to vessels found in mortuary phase 1c. This pot is similar in size and shape to those belonging to US 26, except that it is cord marked all over, it was not further incised and painted. The exterior rim finish is plain and smoothed, but the exterior is decorated with a red painted band *c.* 10 mm. deep. Within level 7, specimens were found towards the top. Rims have a diameter of approximately 240 mm.

US 28 TG 11 fig 4-3

This type bears close similarity to type US 27, except the interior rim finish is plain and horizontally smoothed.

US 29 TG 15a fig 4-3

The single specimen has an upright body and an externally beaded rim. It was not associated with a burial. It is most interesting that its exterior rim finish is horizontally smoothed, then red painted, while the interior surface is red slipped. There is a horizontally smoothed area below the external beading, which gives way to vertical cordmarking. This rim has a diameter of about 320 mm.

US 30 TG 11 fig 4-3

This type has an incurving body and marked externally beaded rim. Where the body survives below the neck junction, it bears an applique band on a cord-marked body. The mouth has a diameter of *c.* 150 mm.

US 31 TG 11 fig 4-3

This type has an everted rim but the body rim-junction of this type is unknown. The exterior rim finish is decorated with incised parallel lines, while the interior is plain and smoothed. It has a diameter of about 200 mm.

US 32 TG 14 fig 4-3

This type bears close similarity to mortuary vessels 94 and 95. They are extremely thin, almost spherical in shape and decorated with red paint over most of the body. Each has three concentric painted lines at and just below the interior body-neck junction. The edge of the rim is also painted red. All five specimens have an everted rim but they lack evidence for body junction angle. Both exterior and interior surfaces are decorated with thick red painted band, and one or two small red painted horizontal bands below it. This type has a mouth diameter of about 170 mm.

US 33 TG 11 fig 4-3

The single specimen is similar to US 32, except that the exterior rim finish is decorated with vertical lines ending in a triangle. Its diameter is *c.* 180 mm.

US 34,35 and 36

These types show a close relationship to mortuary vessels. The vessels are spherical with a constricted orifice and everted rim. Vessels vary in width between 150 - 250 mm and between 140 and 220 mm in height. While the size of this type remained similar throughout the mortuary phase, there was a clear decrease in the height of the rim with time.

US 34 TG 11 fig 4-3

These are distinguished by relatively tall, everted rims. Both the exterior and interior of the rims are plain and smooth. This type has a diameter of about 220 mm.

US 35 TG 11 fig 4-3

This type comes from a pot with spherical body of restricted access and a medium-sized, everted rim. Its diameter is *c.* 240 mm.

US 36 TG 11 fig 4-3

Rims from this type are the same as those of mortuary vessels from phase 1b and 1c. The rim is now much shorter than in US 34 and US 35.

US 37 TG 11 fig 4-3

This type includes all the small round based bowls with slightly constricted opening and small, everted rims. The maximum width of the vessels varies between 120 and 140 mm and the maximum height varies vetween 100 and 130 mm. Both exterior and interior rim finish are plain and smooth.

US 38 TG 11 fig 4-4

This type has in common, an everted rim broadening to a flat tip. The exterior rim finish on the flat tip is decorated with parallel red painted lines. Interior rim finish is smoothed horizontally and red painted. Its diameter is *c.* 300 mm.

US 39 TG 12 fig 4-4

One single specimen was recovered, it has a restricted opening but the rim has a marked concavity. It was decorated with a red painted band on the exterior of the rim tip. The interior rim finish is smoothed

horizontally.

US 40 TG 17 fig 4-4

This type probably comes from an open bowl with plain rim. Both exterior and interior rim finish are plain and very crude. It has a diameter of about 160 mm.

US 41 TG 12 fig 4-4

This type probably comes from a vessel with a cylindrical neck and everted rim. All specimens are embellished with two parallel horizontal red painted lines *c.* 1 mm thick at the neck rim junction on exterior. The tip of the rim is red painted. The interior rim finish is plain and smoothed. This type has a diameter of about 280 mm.

US 42 TG 12 fig 4-4

This type is similar to US 41 in form and fabric, except it was only decorated with a red painted band on the rim tip. It has a diameter of approximately 280 mm.

US 43 TG 12 fig 4-4

This type is exactly the same as US 41, but both exterior and interior rim finish are plain and smoothed. It has a diameter of about 280 mm.

US 44 TG 13 fig 4-4

The vessel form has a sharply incurving, restricted opening and everted rim with slight interior and exterior beads. Both exterior and interior rim finish are plain and smoothed. It has a diameter of approximately 200 mm.

US 45 TG 11 fig 4-4

US 45 has a thick everted rim with a slight convexity along the outer edge. Both exterior and interior rim finish are plain and smoothed. It has a diameter of about 320 mm.

US 46 TG 11 fig 4-4

This type has a slightly closed orifice and small everted rim. The surviving part of body is decorated with cross-hatched cord-marking. Both exterior and interior rim finish are plain and smoothed. It has a diameter of about 200 mm.

US 47 TG 11 fig 4-4

This vessel had a restricted opening and everted tall rim. A red band was painted at the rim tip on the exterior but it is plain and smoothed on the interior.

US 48 TG 14 fig 4-4

Again this type is similar to US 32. The exterior rim finish is embellished with a red painted band at rim tip. The interior is plain and smoothed. It has a mouth diameter of about 280 mm.

US 49 TG 11 fig 4-4

This type has an open, unrestricted mouth and small beaded rim which bears a band of red paint. Otherwise, it is plain and smoothed on both sides. It has a diameter of about 240 mm.

US 66 TG 11 fig 4-5

This is of a slightly restricted opening, and beaded rim with a pronounced interior thickening. Both exterior and interior rim finish are plain and smoothed. It has a diameter of about 320 mm.

US 67 TG 19 fig 4-5

The rim-body junction angle of this type is uncertain. It probably comes from an everted rim. The exterior rim finish is plain and smoothed. It is red painted and slipped on the interior. The surviving part of the body has vertical cordmarking.

US 68 TG 11 fig 4-6

This type has a slightly restricted opening and externally beaded rim. It is plain and smoothed on both sides. The surviving part of body bears smoothed over vertical cord-marking. It has a diameter of about 280 mm.

US 69 TG 11 fig 4-6

This type has a restricted opening with externally beaded rim. It is plain and smoothed with a red painted line at rim body junction on the exterior. the interior rim finish is plain and smoothed. It has a diameter of about 200 mm.

US 70 TG 15a fig 4-6

The shape of the rim-body junction of this rim type is unknown. The rim section is sharply everted. The exterior rim finish is red painted while the interior rim finish is red painted at the rim tip but, it is plain and smoothed below the red painted band. Its diameter is about 280 mm.

US 71 TG 19 fig 4-6

US 71 comes from a vessel with an unrestricted opening and large externally round beaded rim. It is plain and smoothed on both sides. Its diameter is *c.* 180 mm.

US 72 TG 11,13,15a,15b,19 fig 4-6

This type has a restricted opening and small externally beaded rim. Both exterior and interior rim finish are plain and smoothed. The surviving part of the body is cord-marked. Its diameter is *c.* 160 mm.

US 73 TG 15a fig 4-6

This is the lid rim for vessels of type 21 from burial contexts. The lid is straight sided at the rim junction. The rim itself is angled at *c.* 90° to the body. The upper part of exterior rim finish is red slipped while the lower part has a plain and smoothed finish. The interior rim finish is plain and smoothed. It has a diameter of about 360 mm.

US 74 TG 11 fig 4-6

The angle of rim to body is unknown. It probably has a restricted mouth. The upper part of exterior rim finish is red slipped and the lower part is smoothed. The internal part of the rim is red slipped. It has a diameter of about 240 mm.

US 75 TG 11 fig 4-6

This type is exactly the same as US 74 but it is plain and smoothed on both sides. Its diameter is *c.* 320 mm.

US 76 TG 11,15b fig 4-6

This type probably has a constricted opening and everted rim with slight external beading at the tip. It is plain and smoothed on both sides. Its diameter is *c.* 200 mm.

US 77 TG 15b,15e,11,19 fig 4-6

This type has a restricted opening and an everted rim. Both exterior and interior rim finish is plain and smoothed. Its diameter is *c.* 280 mm.

US 78 TG 13,11,15a,15c,15d fig 4-6

This rim comes from a small vessel with restricted access and everted, internally concave rim. It is smoothed to form distinct horizontal grooves on both sides. The body below the rim-body junction has fine cord-marking at about 45 degrees to the horizontal. Its diameter is approximately 120 mm.

US 79 TG 11 fig 4-6

This probably comes from a vessel with a restricted opening. The rim is externally folded. It is plain and smoothed on both sides. It has a diameter of about 120 mm.

US 80 TG 11 fig 4-6

This type comes from a vessel with a restricted opening and everted rim with a slightly beaded lip. It is plain and smoothed on both sides. Its diameter is *c.* 320 mm.

US 81 TG 11,15b fig 4-6

This type has a constricted orifice and everted straight rim. Both exterior and interior rim finish are plain and smoothed. It has a diameter of about 280 mm.

US 82 TG 15a fig 4-6

This type parallels US 57 in both form and fabric. It has a very tall, everted rim. The exterior rim finish is plain and smoothed while it is red slipped from rim tip to rim-body junction on the interior. Its diameter is about 280 mm.

US 83 TG 15a,15b,15c,15e,13,11,18,19 fig 4-6

This type probably comes from a vessel with a low footed base. It has an unrestricted opening and simple squared rim. The surface of exterior finish is plain but the tip of the rim red slipped. The interior rim finish is red slipped. It has a diameter of approximately 200 mm.

Rims from Ban Na Di level six

US 84 TG 15d,11 fig 4-6

This type, like US 83, has an unrestricted opening and simple squared rim. Only the tip of the rim is red slipped. It has a diameter of about 200 mm.

US 85 TG 11,19 fig 4-6

This type, like US 81, has an unrestricted opening and simple squared rim but it is impressed with vertical cord-marking on the exterior.

US 86 TG 11,17,19 fig 4-6

This type is also similar in shape to US 83. It has an unrestricted opening and simple squared rim. The exteror rim finish is plain and smoothed with red paint at rim tip. It is plain and smoothed on the interior.

US 87 TG 11,13,15b,15c,15d,15g,19 fig 4-6

This type again is similar to US 83 both in form and fabric but it is plain and smoothed on both sides. The squared tip bears oblique impressions.

US 88 TG 11,15c,15d,15e,15f fig 4-6

This type has a restricted opening and large everted rim. The rim itself is added to the body at rim-body junction. This rim parallels that from burial 6. The exterior rim finish is plain and smoothed and it is red slipped on the interior. Its diameter rises to over 360 mm.

US 89 TG 1 fig 4-7

This type has a constricted body and everted rim with an internal concavity. Both exterior and interior rim finish are plain and smoothed. It has a diameter of about 220 mm.

US 90 TG 13 fig 4-7

This rim comes from a vessel with a restricted opening and everted rim. Both exterior and interior rim finish are plain and smoothed. The diameter is *c.* 160 mm.

BAN NA DI LEVEL FIVE

In this level, red slipped rims become far more abundant than in level 6. Fifty four new rim types have been recovered and nearly all are red slipped.

US 91 TG 11,15c,15f fig 4-8

US 91, like US 83, has an unrestricted opening and simple squared-off rim. Interior and exterior surface finish are red slipped.

US 92 (TG 11), 93 (TG 15c), 94 (TG 15a), 95 (TG 11) fig 4-8

These types are similar in form but they are distinguished by their different decoration. US 92 has a red paint at rim tip and it is plain and smoothed on both sides. US 93 is decorated with red horizontal S motif on the exterior and it is red slipped on the other side. The exterior of US 94 has both cord-marking and red painted design. It is plain and smoothed on interior rim finish. US 95 has a cord-marking and red paint at rim tip. It is plain and smoothed on interior.

Rims from Ban Na Di level five

US 96 TG 15f fig 4-8

This type has a restricted opening and upturned convex rim. Its external surface is plain and smoothed while the other side is red slipped. It has a diameter of about 200 mm.

US 97 TG 15c,15d,15g fig 4-8

This type has a restricted opening and a large down sloping rim. It is red slipped on both sides. It has a diameter of approximately 280 mm.

Non Chai type AA TG 15a fig 4-8

Only one specimen was recognised and it is undoubtedly similar to Non Chai type AA in both form and fabric. It has a constricted mouth with bulbous lip and flat topped rim. The external and internal surfaces of the rim are red slipped. Its diameter rises over 240 mm.

US 98 TG 13,15a,15b fig 4-8

This type has an unrestricted opening and large beaded rim. The exterior rim finish is red slipped and the interior is plain and smoothed. It has a diameter of approximately 280 mm.

US 99 TG 15a fig 4-9

This type has an unrestricted opening and a broad externally beaded rim. It is plain and smoothed on both sides. It has a diameter of about 320 mm.

US 100 TG 11 fig 4-9

This is of a slightly restricted opening and large externally beaded rim. Both sides of the rim finish are plain and smoothed. It has a diameter of about 320 mm.

US 101 TG 15a fig 4-9

This is probably a lid corresponding to mortuary vessels of type US 88. It has a large beaded rim. The interior rim finish and up to the top part of the lip is red slipped while the specimens with surviving parts of the body reveal vertical cord-marking. The diameter rises over 320 mm.

US 102 TG 13,15d,19 fig 4-9

This type has an incurving body with external beaded rim. It is plain and smoothed on both sides. Its diameter is *c.* 220 mm.

US 103 TG 15b fig 4-9

This type is similar to US 30. It has an incurving body and externally beaded rim. Both interior and exterior rim finish are red slipped. The surviving parts of the body have been smoothed and then painted with a red geometric design. It has a diameter of approximately 220 mm.

US 104 TG 15a fig 4-9

This type is similar to US 103 but it is bigger in size. The exterior bead of the rim is smoothed and red painted. The interior is also painted. The surviving part of the body has an applique band at the neck-shoulder junction. Its diameter rises to over 260 mm.

Rims from Ban Na Di level five

US 105 TG 11 fig 4-9

This type is similar to US 78 both in form and fabric but the exterior rim finish is red slipped and polished. The interior is plain and smoothed. It has a diameter of about 160 mm.

US 106 TG 15b fig 4-9

This type is very similar to US 56. It is red slipped on both sides and its diameter is *c.* 200 mm.

US 107 TG 19 fig 4-9

This type, like type US 56, has a constricted opening, cylindrical neck and everted rim. It is decorated with spiral-like design on exterior rim finish. The reverse side is red slipped. It has a diameter of about 200 mm.

US 108 TG 11,13,19,15a,15b,15c,15d,15e,15f,15g fig 4-9

This is probably the lid of mortuary vessel 19 corresponding to mortuary phase 2. It has an unrestricted opening and a triangular beaded rim in cross section. The surviving part of the body is vertically cord-marked.

US 109 TG 15b,15c fig 4-9

This is of an unrestricted opening and internally and externally beaded rim. The exterior rim finish is plain and smoothed while the interior surface is red slipped. It has a diameter of about 280 mm.

US 110 TG 11,13,15b fig 4-9

US 110 has a slightly restricted opening and small triangular rim with flat top in cross section. It is smoothed on both sides and has a diameter of about 210 mm. The body is vertically cord-marked.

US 111 TG 11,13,19,15a,15b,15c,15d,15e,15f,15g fig 4-9

This type has a restricted mouth and a very large externally beaded rim. Both external and internal surfaces of the rim are red slipped. The diameter of this rim rises over 230 mm.

US 112 TG 15a,15f fig 4-9

This rim type has a restricted opening and straight everted rim. The exterior rim finish is plain and smoothed and the interior one is red slipped. It has a diameter of about 270 mm.

Non Chai type 2 AA TG 15a,15c,15d fig 4-9

This type is very similar to Non Chai Type 2 both in form and fabric. The rim is folded and restricted. The external rim finish is burnished and red slipped. The top part of the internal rim finish is red slipped while the lower part is black burnished and slipped. This type has a diameter of about 240 mm.

US 113 TG 11 fig 4-9

This type has an unrestricted opening and small beaded rim. Both sides of rim finish are plain and smoothed. The vessels surface is vertically cord-marked. It has a diameter of about 180 mm.

US 114 TG 11 fig 4-9

This has a restricted opening with round beaded rim. Both exterior and interior rim finish are plain and smoothed. It has a diameter of about 240 mm.

US 115 TG 15d fig 4-9

This type has an unrestricted opening and internally and externally beaded rim. It is plain and smoothed on both sides. It has a diameter of approximately 240 mm.

US 116 TG 11 fig 4-9

This type has an unrestricted opening and a small, externally beaded rim. It is plain and smoothed on both sides. It has a diameter of approximately 190 mm. The surviving part of the body is vertically cord-marked.

US 117 15b,15d fig 4-9

The form of this type is the same as US 116, but its exterior rim finish is plain and smoothed and it is red slipped on the interior. Its diameter is *c.* 240 mm.

US 118 TG 11 fig 4-9

This type comes from a vessel with a restricted opening and small externally beaded rim. The exterior surface and rim bead are red slipped and burnished, and the interior surface is plain. It has a diameter of about 200 mm.

US 119 TG 11,15b,15d fig 4-9

This type has a constricted opening and round beaded rim. Both external and internal rim finishes are red slipped, but the red slip on the former is found only on the upper half of the bead. It has a diameter of about 200 mm.

US 120 TG 15e fig 4-9

This type has a constricted opening and everted rim. It is plain and smoothed on both sides, and has a diameter of about 200 mm.

US 121 TG 13,15a,15d fig 4-9

This type has a restricted opening with a thin convex rim. The exterior rim finish is plain and smoothed. The internal surface is red slipped. It has a diameter of about 200 mm.

US 122 TG 11 fig 4-10

This is similar to US 121. It probably comes from an open bowl, though the lack of a rim-body junction makes this interpretation speculative. The rim tip bears a red painted zig-zag design. The interior and exterior surfaces are plain and smoothed.

US 123 TG 11,15e fig 4-10

This type is very close to US 121 but its exterior rim finish is red slipped. It has a diameter of approximately 220 mm.

US 124 TG 15b fig 4-10

This type is similar to US 121, but the external surface of the rim is decorated with three cross-hatched parallel lines at the body-rim junction.

US 125 TG 15d,15g fig 4-10

This vessel had a constricted opening and tall everted rim. The exterior rim finish is plain and smoothed. The interior is red slipped. It has a diameter of about 200 mm.

US 126 TG 11 fig 4-10

This type has a restricted opening and everted rim. The external surface is decorated with a vertical red painted line from the rim tip to the body-rim junction. It has a diameter of approximately 180 mm.

US 127 TG 11 fig 4-10

This type is similar to US 125 but the rim-body junction is finished with one horizontal red painted line while its interior rim finish is plain and smoothed.

US 128 TG 11 fig 4-10

This type has a constricted opening and everted rim. The exterior rim finish is plain and smoothed but it is decorated with horizontal narrow red painted bands. The internal surface of the rim is red slipped. It has a diameter of about 160 mm.

US 129 TG 15c fig 4-10

This type is similar to type US 127. The exterior rim finish is plain and smoothed. It is red painted at the interior of the rim tip. Its diameter is *c.* 170 mm.

US 130 TG 15c fig 4-10

US 130 has a constricted opening and everted rim. On the exterior rim, there is a red painted band below the rim tip, while it is red slipped on the interior. It has a diameter of approximately 120 mm.

US 131 TG 15a fig 4-10

This is of a constricted orifice with an everted rim. Its exterior rim finish is decorated with a red painted band below rim tip. The interior one is red slipped. It has a diameter of about 120 mm.

US 132 TG 15d fig 4-10

This type has a restricted opening and everted rim. Both the exterior and interior rim finish is red slipped. It has a diameter of approximately 120 mm.

US 133 TG 11 fig 4-10

This type probably comes from vessels with a restricted opening and everted rim. It is red slipped and burnished on the exterior and it is plain and smoothed on interior. Its diameter is *c.* 120 mm.

US 134 TG 19 fig 4-10

This type has a restricted mouth with simple squared rim. The rim tip is red painted and there is a broad red painted band below the exterior surface of the rim. It has a diameter of approximately 200 mm.

US 135 TG 11 fig 4-10

This type has an unrestricted opening with a round externally beaded rim. Both the exterior and interior rim finish is plain and smoothed. The surviving part of body is decorated with a band of applique. It has a diameter of about 160 mm.

US 138 TG 11 fig 4-10

This type has an unrestricted opening with slightly everted, direct rim. The surviving part of body is decorated with a band of applique. Its diameter is *c.* 160 mm.

US 137 TG 11 fig 4-10

This type has an unrestricted mouth with a flat topped rim. Both the exterior and interior rim finish is plain and smoothed but the surviving part of the body is decorated with a band of applique. Its diameter is *c.* 160 mm.

US 138 TG 11 fig 4-10

This type has a constricted opening with a short everted rim. The interior rim finish is plain and smoothed while it is red slipped and burnished on the exterior. It has a diameter of about 240 mm.

US 139 TG 15c fig 4-10

This type has a constricted mouth with rectangular beaded rim. Though the exterior surface of the body is plain and smoothed, it is red slipped on both sides. Its diameter is about 210 mm.

Non Chai Type 22 TG 15a fig 4-10

This type is identical with Non Chai type 22 both in form and fabric. It has a restricted opening and everted rim. The surface of the rim exterior is plain, smoothed and decorated with a vertical narrow band and a horizontal thick band along the rim-body junction. The surviving part of the body is embellished with red cross-hatched lines. The rim tip is red slipped and the interior rim finish is plain and smooth. It has a diameter of about 140 mm.

US 140 TG 15c fig 4-10

This vessel has a slightly restricted opening and square beaded rim. The exterior rim finish is red slipped, but the interior is plain and smoothed. Its diameter is *c.* 240 mm.

BAN NA DI LEVEL FOUR

(see also fig 4-11)

US 141 TG 11,13,19,15a,15c,15e fig 4-12

This type is very similar to type US 83. It is an open bowl with a direct rim. It has a vertical cord-marking on the exterior but a plain and smoothed interior. It has a diameter of about 210 mm.

US 142 TG 11 fig 4-12

This type is exactly the same form as US 83. It has an unrestricted opening and simple squared rim. It is red slipped on the exterior on the rim tip, but it is plain and smoothed on the interior. Its diameter is *c.* 160 mm.

US 143 TG 15a fig 4-12

This type is similar to US 56. It has a constricted opening and cylindrical neck. It is decorated with a red painted spiral design on the exterior and it is plain and smoothed on the interior. It has a diameter of about 140 mm.

US 144 TG 11,13,19,15a,15c,15e fig 4-12

This is again similar to type US 56. Its exterior rim finish is decorated with red painted lines and it is red slipped on the interior. It has a diameter of approximately 160 mm.

US 145 TG 6C,6D fig 4-12

This type is similar to US 121. It has a constricted opening with an everted, convex rim. On the exterior, it is decorated with red painted parallel lines below the rim tip and at rim-body junction. It is red slipped on the interior, and has a diameter of 240 mm.

US 146 TG 11 fig 4-12

This type again resembles US 145. It is decorated with red painted parallel lines below the rim tip and is red slipped on the interior. It has a diameter of about 160 mm.

US 147 TG 15a fig 4-12

This type has a restricted opening, convex and an everted rim. The exterior rim finish is painted with a geometric design. There is a horizontal small narrow groove near the rim tip which is red painted. The interior rim finish is red slipped. It has a diameter of about 200 mm.

US 148 TG 13 fig 4-12

This type has a restricted opening and everted rim but the upper part of rim itself is right angled with the lower one. Both exterior and interior rim finish are plain and smoothed.

US 149 TG 15a,15c,15d,15g fig 4-12

This type has a constricted opening and everted rim. The exterior rim finish is decorated with criss-crossed design while the interior is red slipped. It has a diameter of about 210 mm.

US 150 TG 15a fig 4-12

This type has a constricted opening and a thick, everted rim. It is red slipped on both sides, and has a diameter of approximately 220 mm.

US 151 TG 15d fig 4-13

This type is similar to US 62. The rim tip is red painted and the exterior rim finish is decorated with red circles. The remaining part of the body is painted with spiral designs. It is red slipped on the interior. Its diameter is *c.* 260 mm.

US 152 TG 15b fig 4-13

This is exactly the same form as US 151, but it is decorated with criss-crossed lines on the exterior rim bead while its interior is red slipped. It has a diameter of about 230 mm.

US 153 TG 15a,15c,15d,15g fig 4-13

This type has an unrestricted opening and small beaded rim. Both exterior and interior rim finish are plain and smoothed. Its diameter is *c.* 210 mm.

US 154 TG 13 fig 4-13

This type has a constricted opening and exterior beaded rim. Both sides of rim finish are plain and smoothed. It has a diameter of about 260 mm.

US 155 TG 15b fig 4-13

This type has a restricted opening and low beaded rim. The flat top of the rim is red painted while the interior rim finish is red slipped. It has a diameter of 210 mm.

US 156 TG 15a fig 4-13

This type has a constricted opening and a square beaded rim. Both the exterior and interior rim finish is plain and smoothed. The outer rim edge has a red painted band and the vessel interior is red slipped.

US 157 TG 15c fig 4-13

This rim type has an open mouth and small externally beaded rim. Both rim surfaces are red slipped while the exterior body surface has vertical cord-marking. It has a diameter of approximately 210 mm.

US 158 TG 13,19 fig 4-13

US 158 has very close similarity to US 157. Both exterior and interior rim finishes are plain and smoothed. It has a diameter of about 280 mm.

US 159 TG 15a,15c,15d,15g fig 4-13

US 159 is similar to US 158 but both sides of rim surface are painted. Though the paint stops at a straight line at the outer edge of the rim, it continues into the pot interior. It has a diameter of about 280 mm.

US 160 TG 19 fig 4-13

US 160 has an unrestricted opening and an everted rim. The exterior rim finish is plain and smoothed while the interior rim finish is red slipped. Again, the exterior red paint stops at a straight line just below the rim tip. It has a diameter of approximately 280 mm.

US 161 TG 13,19,15a,15b fig 4-13

This type has a restricted orifice with an externally folded rim. Both exterior and interior rim finishes are plain and smoothed. It has a diameter of about 260 mm.

US 162 TG 11 fig 4-13

This type is very similar to US 161. Its exterior rim finish is red slipped but burnished and red slipped on the interior. Its diameter is *c.* 240 mm.

US 163 TG 11,13,19 fig 4-13

This type again resembles US 161 but both sides of rim surface finishes are plain and smoothed. The body has vertical cord-marking. It has a diameter of about 180 mm.

US 164 TG 15c fig 4-13

This type has a restricted opening and small externally folded rim. Both surface finishes are red slipped but the surviving parts of the body are decorated with spiral designs. It has a diameter of about 200 mm.

US 165 TG 15f fig 4-13

This type is very close to US 161. Both sides of its surface finishes are red slipped. It has a diameter of approximately 160 mm.

US 166 TG 11 fig 4-13

This type has a constricted opening with slightly sloping down rim. Both the exterior and interior rim finishes are plain and smoothed. It has a diameter of about 240 mm.

US 167 TG 15d,19 fig 4-13

US 167 has an unrestricted opening with large horizontally everted rim. Its exterior rim finish is plain and smoothed while its interior is red slipped. It has a diameter of about 330 mm.

US 168 TG 15b fig 4-13

This type has a restricted opening and slightly convex everted rim. It is decorated with diagonal parallel red lines. The interior rim finish is red slipped. The surface of the vessel's body bears vertical cord-marking. It has a diameter of about 190 mm.

US 169 TG 15d fig 4-13

This type has a constricted opening and upturned convex rim. Its exterior rim finish is decorated with two parallel lines which are crossed with a row of red diagonal lines. Its interior rim finish is red slipped. The body bears thin nearly vertical red painted lines. It has a diameter of about 240 mm.

US 170 TG 15a fig 4-13

This type is similar to US 169. Its exterior rim finish is plain and smoothed. Its interior finish is red slipped, the slip stopping at a straight line halfway along the upper surface of the rim edge. It has a diameter of approximately 240 mm.

US 171 TG 11,13 fig 4-13

This type has a restricted opening and everted rim. It is decorated with thick red painted bands on the exterior while its interior rim finish is plain and smoothed. It has a diameter of approximately 210 mm.

US 172 TG 15g fig 4-13

Rims from Ban Na Di level four

This type has a restricted opening and everted rim. It is painted with distinctive circular lines on the exterior and red slipped on interior. It has a diameter of about 180 mm.

US 173 TG 15a fig 4-13

This type has a restricted opening and everted rim. The exterior rim finish is decorated with red cross-hatched lines. The interior rim finish is red slipped. It has a diameter of about 180 mm.

US 174 TG 15f,13 fig 4-13

This type has the form of an open bowl with very slightly beaded rim. Both surface finishes are plain and smoothed, but the vessel surface is vertically cord-marked. It has a diameter of approximately 140 mm.

US 175 TG 15a,15e fig 4-13

This type has an unrestricted opening with a beaded rim. It is plain and smoothed on the exterior and red slipped on the interior rim surface. It has a diameter of approximately 220 mm.

US 176 TG 15a fig 4-13

This type has an unrestricted opening with a rounded lip. It is cord-marked and red slipped on the exterior. Its interior rim finish is also red slipped. It has a diameter of approximately 120 mm.

US 177 TG 15b fig 4-14

This type has a restricted opening and everted rim. The tip of the rim is red painted. The exterior rim surface is burnished, but the interior is plain and smoothed. It has a diameter of approximately 180 mm.

US 178 TG 15a fig 4-14

This type has a restricted opening and everted slightly convex rounded rim. It is plain and smoothed on the exterior and it is red slipped on the interior. It has a diameter of about 160 mm.

BAN NA DI LEVEL THREE

Only eight clearly distinct new pottery rim types were recovered in this level and they are described below.

US 179 TG 11,19,15a,15f fig 4-15

US 179 is similar in form to type US 56. It has a constricted opening with cylindrical neck and everted rim. It has a red painted spiral design on its external surface while it is red slipped on the interior. It has a diameter of approximately 180 mm.

US 180 TG 15a fig 4-15

This rim type is similar to US 164 both in form and fabric. It has a slightly restricted opening and folded rim and it is larger than US 164. It is red slipped on both sides and it has a diameter of about 240 mm.

US 181 TG 13 fig 4-15

This type has a constricted opening with a large, ledge-shaped external bead. It is decorated with a red-painted cross-hatched design on the exterior and its interior rim finish is red slipped. It has a diameter of approximately 220 mm.

US 204 TG 19 fig 4-17

US 204 has a constricted opening with tall everted rim. Its exterior rim finish is painted with complex red geometric designs and it is red slipped on the interior. It has a diameter of approximately 240 mm.

US 205 TG 15a fig 4-17

This type has a restricted opening and everted rim. Its exterior rim finish is plain and smoothed and it is red slipped on the interior. It has a diameter of approximately 260 mm.

US 206 TG 13 fig 4-17

This is of a constricted orifice with down-sloping folded rim. Both its exterior and interior rim finishes are plain and smoothed. It has a diameter of about 180 mm.

US 207 TG 18 fig 4-17

This type probably comes from a vessel with a constricted opening with flat lipped everted rim. Its exterior rim finish is plain and smoothed. Its interior rim finish is red slipped. It has a diameter of about 200 mm.

US 208 TG 13 fig 4-17

US 208 has an unrestricted opening and folded rim. The remaining part of its body is vertically cord-marked. Both the exterior and interior surface finish is plain and smoothed. It has a diameter of about 160 mm.

US 209 TG 13 fig 4-17

This type has an unrestricted opening with a small beaded rim. Both exterior and interior rim finish is plain and smoothed. It has a diameter of about 160 mm.

US 210 TG 15a fig 4-17

This type has an unrestricted opening and down-sloping folded rim. Both sides are plain and smoothed. It has a diameter of about 200 mm.

US 211 TG 15a fig 4-17

This type probably comes from a vessel with a constricted opening with down-sloping rim. Both interior and exterior surfaces are red slipped. It has a diameter of about 240 mm.

US 212 TG 15a fig 4-17

This type comes from a vessel with a most restricted opening and externally everted rim. The remaining part of its body is vertical cord-marked. The rim and internal surfaces are red slipped. It has a diameter of about 220 mm.

US 213 TG 15a fig. 4-17

This type has a constricted opening and short, everted rim. Interior and exterior surface finishes are red slipped. It has a diameter of approximately 180 mm.

US 214 TG 15b fig 4-17

This type has a restricted opening with a very short everted rim. The rim and internal surface are red slipped. It has a diameter of about 160 mm.

US 215 TG 19 fig 4-17

This type has an unrestricted opening and triangular rim in cross-section. Both of its exterior and interior rim finishes are plain and smoothed. It has a diameter of about 200 mm.

US 216 TG 13 fig 4-17

This type has an unrestricted opening with a slight external swelling at the rim tip. Both sides of its surface finishes are red slipped. It has a diameter of approximately 120 mm.

US 217 TG 15a fig 4-17

This type probably has a constricted opening and triangular rim in cross-section. The interior and exterior surface finish is red-slipped. It has a diameter of approximately 180 mm.

US 218 TG 13 fig 4-17

This type probably has a constricted opening and everted rim. The form of the rim-body junction is unknown. It is plain and smoothed on the interior and exterior, and has a diameter of about 120 mm.

US 219 TG 15b fig 4-18

This type has a constricted opening and everted rim. It is plain and smoothed on the exterior and red slipped on the interior. It has a diameter of about 320 mm.

LEVEL THREE

US 220 TG 13 fig 4-18

This type probably has an unrestricted opening with a horizontal everted rim. It is plain and smoothed over all surfaces. It has a diameter of about 200 mm.

US 221 TG 13 fig 4-18

This type has a restricted opening and everted rim. Both exterior and interior are plain and smoothed. It has a diameter of about 220 mm.

US 222 TG 13 fig 4-18

This type has an unrestricted opening and flaring, everted rim. It probably comes from a shallow dish. Both of its exterior and interior rim finishes are plain and smoothed. It has a diameter of about 200 mm.

US 223 TG 13 fig 4-18

This type has a constricted opening and everted rim. Both exterior and interior rim finishes are plain and smoothed. It has a diameter of approximately 150 mm.

US 224 TG 15a fig 4-18

This type probably has an unrestricted opening and beaded rim. Its exterior rim finish is plain and smoothed, but the interior is red slipped. It has a diameter of approximately 140 mm.

US 225 TG 13 fig 4-18

This type has an unrestricted opening and everted rim. The surfaces are plain and smoothed. The surviving part of the body was horizontally burnished. It has a diameter of about 180 mm.

US 226 TG 15c fig 4-18

US 226 probably had a constricted opening and everted rim, but its rim-body junction has not survived. It is plain and smoothed on both sides. Its diameter is *c.* 180 mm.

US 227 TG 13 fig 4-18

This type has an unrestricted opening with small externally beaded rim. It is plain and smoothed on the exterior and interior surfaces. It has a diameter of approximately 180 mm.

US 228 TG 13 fig 4-18

This type probably has a constricted opening and everted rim but its rim-body junction is unknown. It is plain and smoothed overall, and has a diameter of approximately 180 mm.

US 229 TG 13 fig 4-18

This type has a restricted opening and straight everted rim. Both exterior and interior rim finishes are plain and smoothed. It has a diameter of about 200 mm.

US 230 TG 13 fig 4-18

This type has a slightly restricted opening with flat, squared rim top. The exterior is plain and smoothed and the inner surface bears parallel burnished lines at an angle of *c.* 17° to the perpendicular. It has a diameter of approximately 140 mm.

LEVEL TWO

US 231 TG 13 fig 4-18

This type has a constricted opening and everted rim. Both exterior and interior rim finishes are plain and smoothed. It has a diameter of about 180 mm.

US 232 TG 18 fig 4-18

This type has a restricted opening and everted rim. Both exterior and interior rim finishes are plain and smoothed. It has a diameter of approximately 240 mm.

US 233 TG 17 fig 4-18

US 233 has a constricted opening with a thin everted rim. Its exterior rim finish is red slipped. It has a diameter of approximately 180 mm.

US 234 TG 13 fig 4-18

US 234 has a constricted opening and everted rim. The everted rim is relatively thick at the base but tapers to a point. Exterior and interior rim finish is plain and smoothed. It has a diameter of approximately 180 mm.

US 235 TG 13 fig 4-18

This type probably comes from a vessel with a constricted opening and everted rim. The exterior and interior rim finish includes a red painted vertical red line. It is plain and smoothed on the interior with a diameter of about 200 mm.

US 236 TG 17 fig 4-18

This type comes from a bevel with a slightly constricted orifice and a triangular rim in cross-section. Its exterior and interior rim finish is plain and smoothed. It has a diameter of approximately 226 mm.

US 237 TG 13 fig 4-18

This type has a constricted orifice and simple squared lip. Both of its exterior and interior rim finishes are plain and smoothed. It has a diameter of about 120 mm.

US 238 TG 13 fig 4-18

This comes from a vessel with a constricted orifice and a simple squared rim, bearing a groove at the lip. It is plain and smoothed on both sides, and has a diameter of approximately 80 mm.

US 239 TG 13 fig 4-18

This type has an unrestricted opening with an exterior beading at the outer lip. It is plain and smoothed all over and has a diameter of approximately 120 mm.

US 240 TG 15c fig 4-18

This type has a constricted opening and everted, cupped rim. The exterior and interior rim finish is plain and smoothed. It has a diameter of approximately 280 mm.

US 241 TG 13,18 fig 4-19

This type has a restricted opening and everted rim. Both the exterior and interior rim finish is plain and smoothed. It has a diameter of approximately 140 mm.

US 242 TG 13 fig 4-19

This type has a constricted opening and everted, short and broad rim. Exterior and interior rim finish is plain and smoothed. It has a diameter of approximately 220 mm.

US 243 TG 15f fig 4-19

This type probably comes from a vessel with a restricted opening and everted rim. The end of the rim has an external painted bead. Both sides of its surface finishes are plain and smoothed. It has a diameter of approximately 200 mm.

US 244 TG 13 fig 4-19

This type has a constricted opening with a long everted rim which thickens towards the lip. Both interior and exterior surfaces are plain and smoothed. Its diameter is *c.* 240 mm.

US 245 TG 13 fig 4-19

This type has a restricted opening and everted rim. Its interior rim finish is decorated with three parallel grooves, the rim top bears a shallow groove. Both surface finishes are plain and smoothed, the body has vertically applied cord-marking. It has a diameter of about 250 mm.

US 246 TG 13 fig 4-19

This type has a curved everted rim and a cylindrical restricted opening. Both of its surface finishes are plain and smoothed. It has a diameter of approximately 260 mm.

US 247 TG 13 fig 4-19

This is of a constricted orifice, vertical collar and everted rim ending in a point at the out lip. Both sides of its rim surface is plain and smoothed. It has a diameter of approximately 260 mm.

US 248 TG 13 fig 4-19

This type has a restricted opening and a short, broad everted rim. It is plain and smoothed overall, and has a diameter of approximately 140 mm.

US 249 TG 13 fig 4-19

This type has a restricted opening with an outcurving rim. Exterior and interior rim finish is plain and smoothed. It has a diameter of about 120 mm.

US 250 TG 18 fig 4-19

This type has an open mouth with simple squared lip. It is plain and smoothed over all surfaces. This type has a diameter of about 220 mm.

US 251 TG 13 fig 4-19

US 251 has a slightly restricted opening and everted, cupped rim with a grooved top. It is plain and smoothed. It has a diameter of approximately 200 mm.

US 252 TG 13 fig 4-19

This is of an unrestricted opening with simple squared top. It is plain and smoothed on both sides and has a circular hole pierced through the clay *c.* 10 mm. below the top. Its diameter is *c.* 180 mm.

US 253 TG 13 fig 4-19

Ban Muang Phruk rim types

This type had a restricted opening, a tall collar and everted rim. There are two grooves, placed at the inner lip and at the top. It is plain and smoothed on both sides. It has a diameter of approximately 180 mm.

US 254 TG 13 fig 4-19

This type has a restricted opening and an everted rim. It is plain and smoothed on both sides. There is a shallow groove below the inner lip. It has a diameter of approximately 200 mm.

US 255 TG 15c fig 4-19

This type has a constricted orifice and externally beaded rim. It is red slipped on the top and the interior but plain and smoothed on exterior. It has a diameter of about 180 mm.

US 256 TG 13 fig 4-19

This type probably has a restricted opening with outcurving everted rim. The body-rim junction is unknown. It is decorated with lines of six grooves on inner lip but is plain and smoothed on the exterior. It has a diameter of *c.* 180 mm.

US 257 TG 13 fig 4-19

This type probably has a constricted opening and everted rim but its body-rim junction is unknown. Its interior is decorated with four lines of grooves but it is plain and smoothed on the exterior. It has a diameter of about 200 mm.

US 258 TG 13 fig 4-19

US 258 probably comes from a vessel with a constricted opening and short everted rim. Both sides are plain and smoothed. It has a diameter of about 180 mm.

US 259 TG 13 fig 4-19

This type has a constricted opening and everted rim. The top is squared. Both exterior and interior rim finishes are plain and smoothed. It has a diameter of about 200 mm.

US 260 TG 13 fig 4-19

US 260 probably has a constricted opening and short, everted rim. The top bears a shallow groove. Both exterior and interior rim finishes are plain and smoothed. It has a diameter of about 180 mm.

LEVEL ONE

US 261 TG 13 fig 4-19

This type has a constricted opening and everted rim. The top bears a shallow groove. Both sides of its surface finishes are plain and smoothed. It has a diameter of about 240 mm.

THE RIM TYPES: SUMMARY

The establishment of a basic corpus of rim types by layer is a necessary prerequisite to an approach being made to a series of questions. These begin with a consideration of the relative density of sherds in each level. Bayard (1984) has noted the scarcity of pottery at Non Nok Tha relative to Non Chai, and suggested that the low frequency at the former reflects its use as a cemetery rather than for occupation. Secondly, the occurrence of the same type of rim in different levels and sites makes it necessary to apply statistical analysis to detect the degree of affinity between levels. This approach applies not only to the rim types themselves, but also to the changing frequencies of fabric with time and between sites. The establishment of this typological sequence is a critical first step to reviewing the cultural sequence in the Upper Songkhram area.

Even the most casual observer of pottery manufacture in Northeast Thailand today would soon conclude that a given assemblage of rims in a village context might reflect a wide variety of cultural events. Today, hand made pottery manufacture is restricted to a handful of "specialist" villages, in which any number of individuals from a couple of women to some dozens of members of different families are engaged in the manufacture and sale of pottery vessels. These are made specifically for sale, and are taken either to the local villages or markets. A basic prerequisite to the establishment of a pottery-making facility is access to a good clay source. Some pottery villages are located adjacent to such a source, but others import clay from a distance of some km. Vincent has collected clay from all known sources in the survey area and identifying differences in minerals is part of his detailed study. Such an analysis is designed to identify prehistoric manufacturing centres and is well beyond the scope of the present study. Modern practices however, do underline the dangers of naivity in interpreting prehistoric samples.

Thus, while there is a general uniformity in the form of vessels made in the various pottery villages known to the author, there are distinct local differences in decorative style. These serve to stress the importance of noting differences in fabric and decoration as well as form in establishing types. Again, today potters may establish a workshop far removed from the place where they learnt their skills. A village in Roi Et Province described by Higham (pers. comm.) illustrates this point clearly. Two potters in a village in the southwest of the Khorat Plateau married local men and brought their skills as potters with them. Soon, pots in the southwestern style were being bought in the surrounding villages. To take the point a stage further, the possibility of local potters copying such introduced styles would lead to a series of new types linked with little if any cultural change.

According to Higham's (1984) assessment of the prehistoric social organisation in Northeast Thailand during the Early and Middle Periods, affinal and other social obligations involved the circulation of prestige valuables. Some, such as the trochus shell bracelets and bronze jewellery, have been found in the graves. It is quite possible that pottery vessels not to mention their contents, were circulated between the occupants of allied villages in the same manner.

Such a situation demands the most intensive and scrupulous analysis of ceramic fabrics in order to deduce possible interactions. There are two issues of relevance to the present study. The first is the degree to which a sequence of rim forms which sustains a phased sequence for a given site, might be matched in a second, nearby site. Thus, the periods

established by White for Ban Chiang may be quite proper and valid *for that site*, but not for a site, even situated nearby, which comprised part of a different web of affinal or ceremonial affiliations. Conversely, a markedly similar sequence might indicate participation in the same affiliation web. It is stressed that consideration of such possibilities must be set within a contextual approach, in which not only pottery rims, but other artefact types and aspects of behaviour, such as changing activity patterns and mortuary rites, are given weight.

These are major issues. Without detailed petrographic analysis, only a partial and tentative approach is possible. This will become evident as this chapter proceeds.

The rim assemblage from Ban Kho Noi is clearly set apart from the rims found at the other two sites. This sharp distinction is also found in terms of the vessel forms from the burials and the fabric used for tempering the clay. The closest affinities with the vessel form and the incised decoration on the Non Kao Noi vessels, lie with the Early Period 1 material from Ban Chiang which White (1982a) has dated to at least the third millennium BC. There are no hints of this tradition in the basal level at Ban Na Di.

Let us begin this review with a consideration of numerically the commonest rim types from the successive levels at Ban Na Di. For levels 8-6, this is facilitated by the presence in graves of whole vessels corresponding to the fragmentary rims. This correspondence does not recur for levels 3-5.

For level 8, there are three common rim types. The first, (type US 18) corresponds to the "goblet" form found in the early graves. It comprises a bowl placed on a broad pedestalled foot (fig 4-20). The second (type US 20) is also found in the graves. It is derived from a round bowl with a constricted opening and everted rim. It is similar in size and form to type US 21, but this type has a clear external swelling below the out lip and has not been found represented in the grave assemblage.

This combination of a goblet and round based, globular vessel with a restricted opening and everted plain rim dominated numerically, the level 7 assemblage. The latter are incorporated under rim types US 35-6 and 52. These same types continue into level 6, where they are joined by three new common types. The first is also found in three graves, so we have some idea of the shape of the complete vessel. This type (US 26) comes from a thin-walled, carinated vessel of considerable size. It was decorated in the Om Kaeo style (fig 4-20). It is strongly suspected that type US 28 also comes from a vessel the body of which was decorated in the Om Kaeo style, but no complete vessels have been found. Types US 26 and 28 share with the third new and common type in level 6 (US 41), the characteristic of bearing red painted decoration. This last type has two painted lines at the throat.

With level 5, the common types change dramatically. Type US 35 is common to both levels 5 and 6, but those in the former have a distinct fabric. The common types in level 5 are set out in fig 4-21. They include a vessel with a particularly tall everted rim (US 58), a red slipped open bowl (US 83 and 87) and a small vessel with constricted neck and everted rim the inside of which is red slipped. US 62 and 108 are similar but for size. They have a slightly restricted opening and triangular shaped external bead. This assemblage, once established with level 5,

continued to dominate the samples from levels 4 and 3 also. This is set out diagramatically in figs 4-23 to 25.

At Ban Na Di, there is a marked increase in the number of rim types with time. Level 8 has yielded only eight clearly distinct forms. The great majority of rims found there match those found on the early pedestalled vessels found in graves. These comprise a cord-marked bowl joined as it were, to a pedestal. This form has the characteristic of a broad area of junction between body and pedestal, the bowl portion being made on a mould. Since the mould comprised a cord-marked pot, the interior of the bowls bears positive cord-marks. There are 27 new rim types in lower level 7, and 40 in level 6. The second issue concerns the actual density of pottery. Relevant figures are set out in table 4-1.

TABLE 4-1

Ban Na Di: the density of rim sherds per level

Level	n rim sherds	n/m²	rims/m²
8	48	18.2	2.66
7	381	72.0	5.29
6	463	22.5	20.6
5	662	22.5	29.4
4	866	13.5	64.0
3	387	18.2	21.3

It is readily conceded that these data provide a general guide only, because of the difficulty in estimating precisely the volume of soil in each level. There does however, appear to have been a marked increase in the density of rims, from only 2.66 per m^3 in level 8 to a high of 24 times that number in level 4. It has been noted by Higham and Kijngam that level 7 and basal level 6 saw the use of the excavated area as a cemetery, whereas levels 5 to 3 reflect both bronze working activity and occupation. Several alternative hypotheses may be advanced to account for this dramatic increase in sherd density. One is that in the later levels, pottery was used for a wide variety of purposes, a finding which in itself may account for the greater range of forms. Another is that the area was more densely settled during the later prehistoric period. A third is that during the level 8 occupation the area excavated was not used as an area for the accumulation of broken pottery. In this context, it is interesting to note that both in the levels 4-5 occupation and at the contemporary site of Non Chai, there was an extraordinary density of sherds which might reflect a cultural preferance for accumulating occupation detritus in a specific place within the site. There are no particular grounds favouring any of the above alternatives, either singly or

in combination. That most favoured by the author, is that there was less intensive occupation in level 8, and a high density of people and activity during levels 3-5. Level 7 figures are most probably affected by the use of the area as a cemetery.

As has been noted, many of the rim types had a restricted temporal distribution. Before considering the general trends in for example, the clay fabric, it is considered desirable to apply a statistical analysis to the observed distribution of types by level. Consequently, the data were analysed by means of a cluster analysis of cases. The results are set out in fig 4-23. As may be seen, there is a particularly close affinity between the level 6 and 7 assemblages, and those from levels 4 and 5. Level 8 links with levels 6 and 7, and level 3 with 4 and 5. On the face of it, there are reasonable grounds for recognising two broad groups, The first comprises levels 8-6, and the second, rims from levels 5-3. If further splitting into sub-phases were undertaken, then four would seem appropriate, involving in succession levels 8, 7-6, 5-4 and 3.

White's subdivision of the Ban Chiang cultural sequence into Early, Middle and Late Periods is founded basically on the noted changes in mortuary pottery and burial ritual. The transition from the EP phase 4 to the MP reflects the change from a cord-marked style with curvilinear applique ornament to one in which the "Om Kaeo" style predominated. The latter comprises pottery decorated first with cord-marking, then the incision of designs subsequently infilled with red paint. At Ban Chiang, this style characterises Gorman and Charoenwongsa's phase 4, or White's Middle Period. All workers stress that this change was approximately contemporaneous with the first use of iron and the maintenance of the domestic water buffalo.

At Ban Na Di, three vessels decorated in the Om Kaeo style have been found in graves cut either from upper level 7 or from lower level 6. They were found in association with pots whose affinities lie with the earlier level 7 material. The provenance and numerical importance of rims from Om Kaeo vessels in the Ban Na Di occupation contexts may clearly throw light on the alleged distinction between the EP d and MP at Ban Chiang. This issue is of more than passing interest, because the MP, as has been noted, involved the first evidence of iron and the domestic water buffalo. White has dated this Middle Period, and by inference the "iron age" in the Upper Songkhram area, to 800-300 BC. At Ban Na Di, upper level 7 is dated by radiocarbon to *c.* 600-500 BC, with level 6 being dated to 500-100 BC. Level 7 has yielded one fragment of iron and level 6, four. The first regular presence of iron remains came, along with fragments of iron slag, in level 5 (*c.* 100 BC-200 AD). The stratigraphic context of Om Kaeo rims is therefore, important. Three rim types are associated with body decoration in the Om Kaeo style. These are numbers 26-28. The last two are very similar to each other and have been combined in table 4-2.

TABLE 4-2

Ban Na Di: the stratigraphic context of Om Kaeo rim types

Upper Songkhram rim types: summary

Level	n type 26	% of total	n types 27-8	% of total
3	-	-	1	0.25
4	-	-	7	0.81
5	2	0.30	12	1.81
6	53	11.45	95	20.52
7	22	7.09	10	2.62
8	-	-	-	-

It has been mentioned that thick levels were subdivided on the basis of 10 cm thick "spits". Each of the above rims has been assigned to its parent spit. In the case of level 7, all type 26 specimens but one were found in the top two spits. For types 27-8, they were confined to the top three. Since the number of spits in level 7 comprised, depending on its local thickness, between thirteen and seventeen spits, it is very clear that the earliest Om Kaeo context was terminal level 7. In level 6, type 26 was considerably more abundant in the lower third (n=28) than the upper third (n=4). Corresponding figures for types 27-8 are 37 in the lower third, 37 for the middle and 21 for the uppermost. The inference drawn from these facts, is that the Om Kaeo style is confined to uppermost level 7 and level 6, and is dated to *c.* 600-100 BC. During this span, vessels were associated with a range of rims with clear antecedents in early to middle level 7. The earliest iron implements, a spear blade and neckring or large bangle from burial 16, belong to the end of the latest burial phase of a cemetery which had been in use for about eight centuries. At Ban Na Di, there is clear evidence for *continuity* in a context wherein White has drawn a distinction between the Early and Middle Periods.

There was certainly discontinuity at Ban Na Di, but it occurred with the break between levels 6 and 5, and was not confined to the details of rim typology. This break is seen in the advent of iron working, the replacement of a long established cemetery by a bronze working atelier and a sharp discontinuity in material culture. This includes the replacement of older by a new range of rim types (figs 4-20 to 21). These differences in rims involve all three variables. The actual shapes of the rims reveal persistent changes while decoration now involved a preference for red paint, particularly at the rim tip. Finally, the rim fabric changed, in terms of the type of grog employed (fig 4-27). These changes are matched by the new types of applique ornament and the advent of novel artefact types. They are dated to *c.* 100 BC, and clearly relate to the inception of the Late Period at Ban Chiang.

Further insight into this transition is demonstrated by comparing the rims found at Ban Na Di with the assemblage from Ban Muang Phruk. The digging of pits and postholes at Ban Na Di may well have relocated some rims out of their true cultural context. Thus, some Om Kaeo rims have been found in levels four and five, and doubtless an intensive search on the surface of the present village would locate some even in modern

contexts. A comparison between the rims found in the lowest layer of Ban Muang Phruk and level 5 at Ban Na Di has shown many parallels (table 3-3, fig 4-22).

TABLE 4-3

The relationships in rim types between Ban Na Di and Ban Muang Phruk

Rim Type	Ban Muang Phruk	Ban Na Di
US 56	2-5	3-6
US 65	5	6
US 67	3-4	6
US 74	4-5	5-6
US 78	3-5	3-6
US 84	3-5	3-6
US 87	2-5	3-6
US 96	4-5	5
US 99	3-5	5
US101	5	5
US108	3-5	3-5
US110	4	3-5
US108	3-5	3-5
US110	4	3-5
US111	5	3-5
Non Chai 2 aa	3-4	3-5
US119	3	4-5
US164	5	3-4
US168	4	3-4
US174	2-4	3-4
US178	3	3-4
US181	4	3

It is noted that there are twenty rim types with clear parallels in form and fabric between the two sites. The rims from both sites also reveal the same interest in ornamenting with red paint. The interesting point is that Ban Muang Phruk has not yielded *one* example of an Om Kaeo rim, nor one which parallels any of the range of rims which is found in mortuary contexts at Ban Na Di. The break is absolute (fig 4-26).

Red slipped or painted pottery has been observed at basal Ban Muang Phruk and in increasing numbers from level 5 at Ban Na Di. These assemblages contrast markedly with the earlier types. Moreover, there are some rims at Ban Na Di and Ban Muang Phruk which are so similar to those discovered at Non Chai in the Upper Chi Valley that the type names from Non Chai have been retained. At all three sites those rims which do not reveal the same precise shape, still display general similarities in the prevalence of red painted decoration, and the placement of a red painted band at the rim tip, or on the inner surface only of the common everted form of rim. Some characteristic Non Chai types have been recovered at Ban Chiang Hian and Don Khlang. The former site is located in the Middle Chi Valley and the relevant layers are dated to *c.* 200 BC to 300 AD. Don Khlang is to be found in the upper Chi and again, the date of the

appropriate material falls into the same range.

The frequencies of the different types of temper have also been considered through the application of a cluster analysis. Unfortunately, there are insufficient rims from Ban Muang Phruk to incorporate them in the analysis. In fig 4-28, the results of the cluster analysis for the levels at Ban Na Di are set out. It is noted that the material from levels 7-8 are very similar, and that the fabric from levels 3,4 and 5 are likewise grouped together. The level 6 material stands out as distinct. This situation has been examined in some detail, and it has been found that the Om Kaeo style rims have a high fraction of type 19 temper. It is this which sets the level 6 assemblage apart. The relatively few specimens from basal Ban Muang Phruk find their closest parallels in level 5 at Ban Na Di.

The relationships between the proposed phases based on the excavated assemblages and the scheme proposed by White (1982a) is summarised in Table 3-4. The uppermost part of level 7 and level 6 equate, on the basis of the Om Kaeo style rims, to White's Middle Period. Level 5 at Ban Na Di and basal Ban Muang Phruk relate closely to the Late Period at Ban Chiang. This is seen on a buff background. These find parallels in the site of Non Chai and later Don Khlang.

TABLE 4-4

A proposed chronological framework for Non Kao Noi, Ban Na Di and Ban Muang Phruk

White's Phases		Ban Na Di	Ban Muang Phruk	Non Kao Noi	Non Chai
EP 1				*	
EP 2					
EP 3					
EP 4	1400-500 BC	* L. 7-8			
MP	500-100 BC	* Late L.7 & 6			
LP	100 BC -	* L. 3-5	* L. 4-5		* L. 1-5

* = present

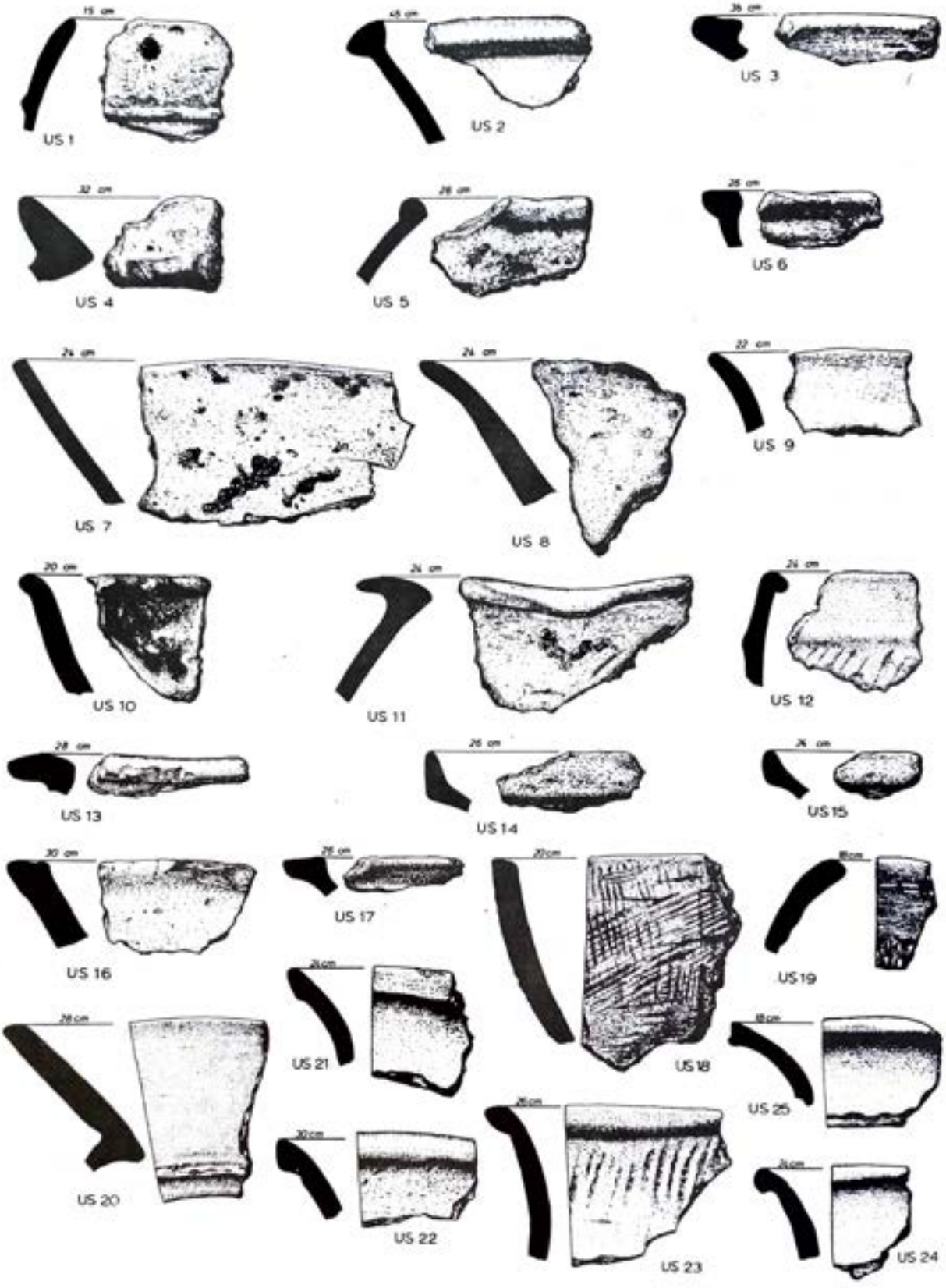


FIGURE 4-2

Pottery rim types from Non Kao Noi (US 1-17) and Ban Na Di level 8 (US 19-25) scale 1:2

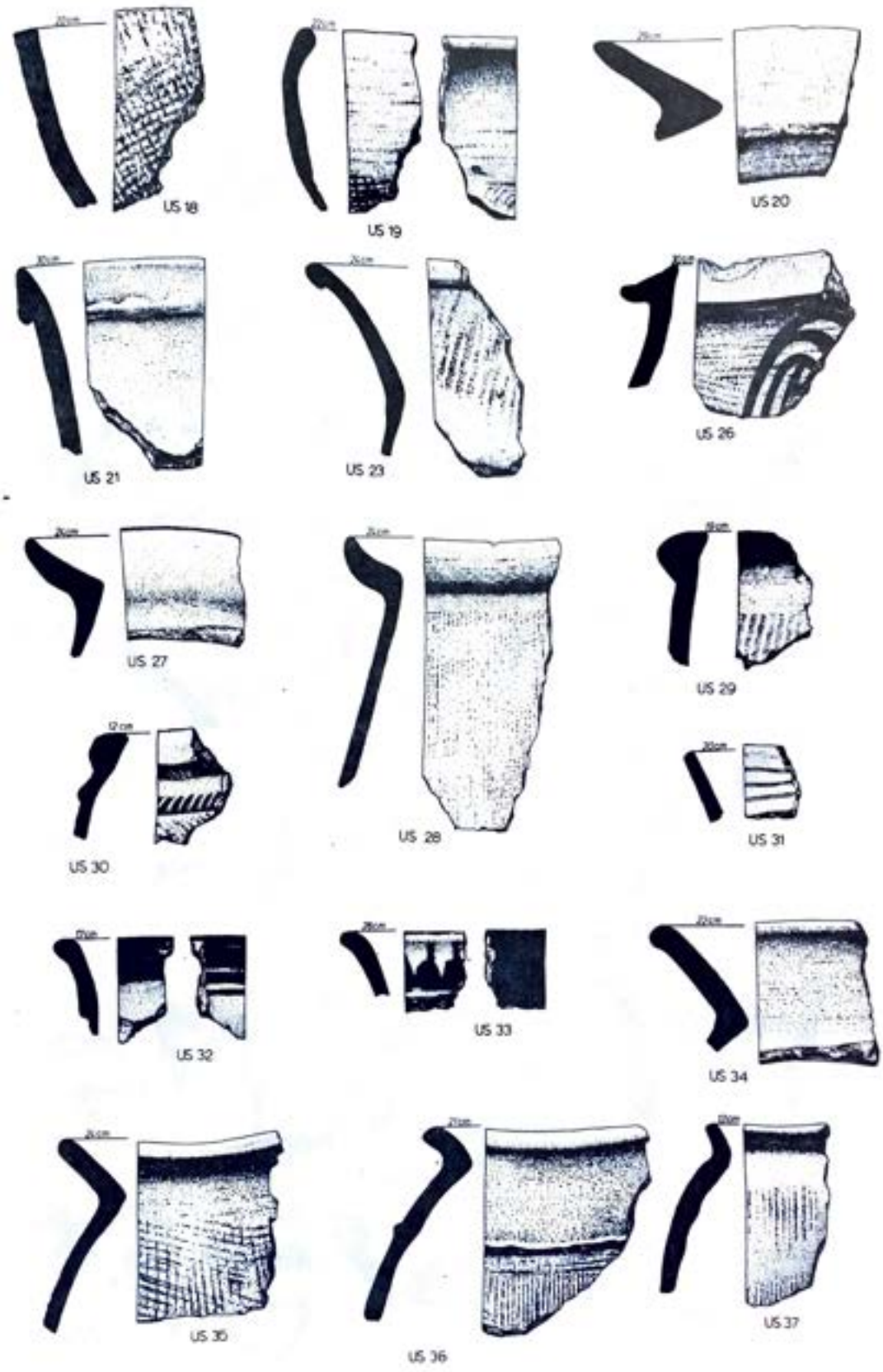


FIGURE 4-3

Pottery rim types from Ban Na Di level 7, scale 1:2

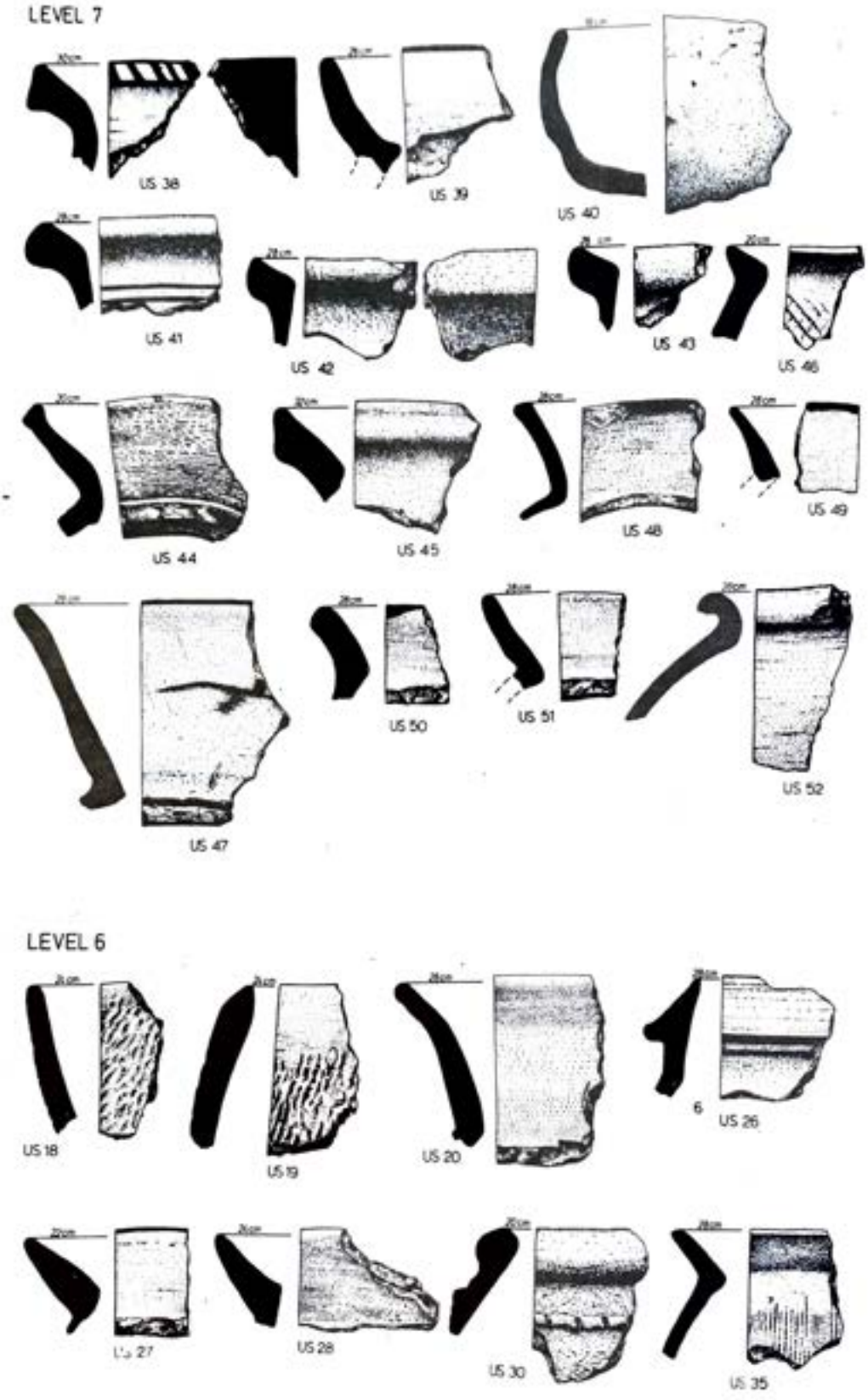


FIGURE 4-4

Pottery rim types from Ban Na Di levels 7 and 6, scale 1:2

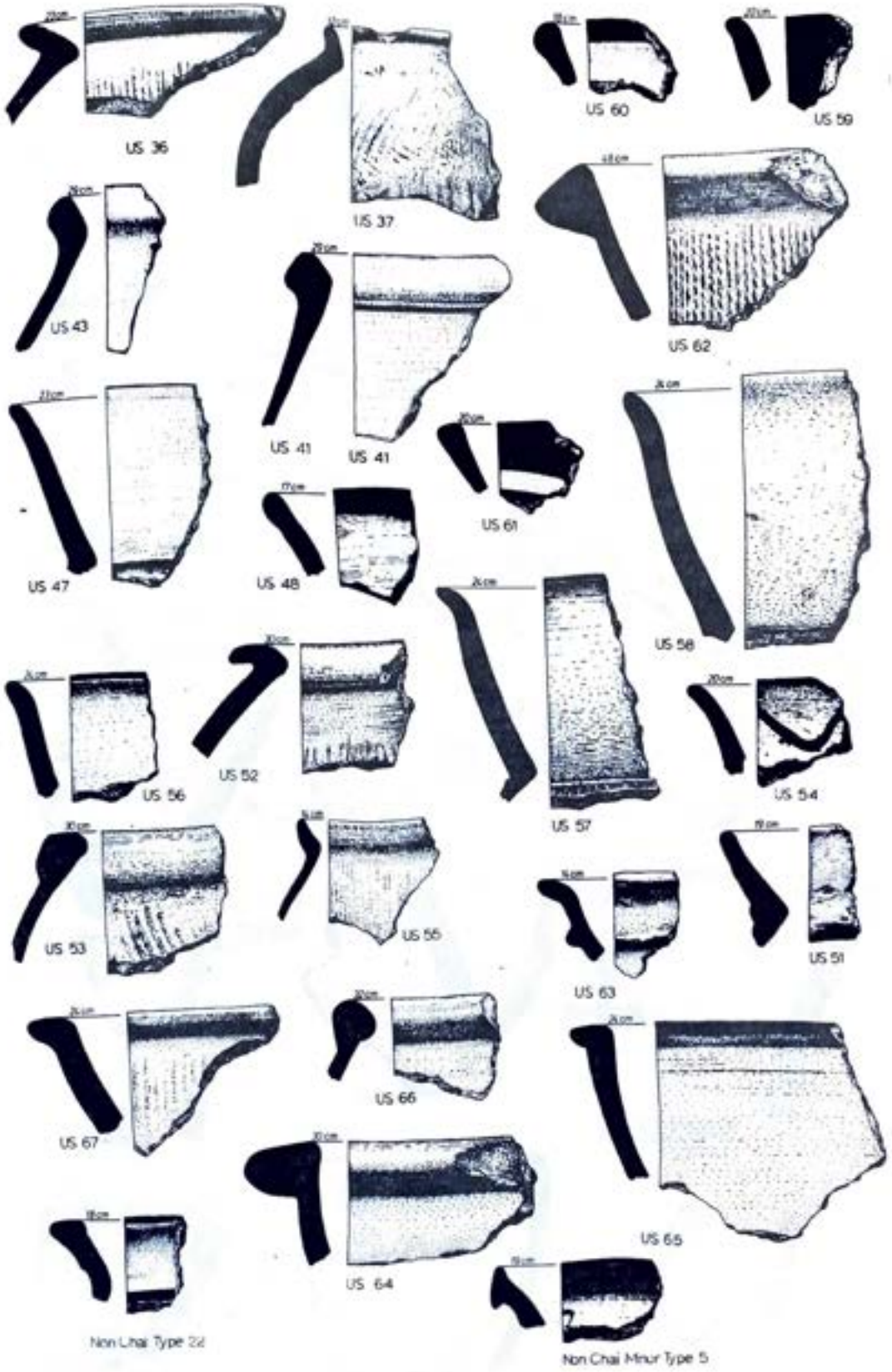
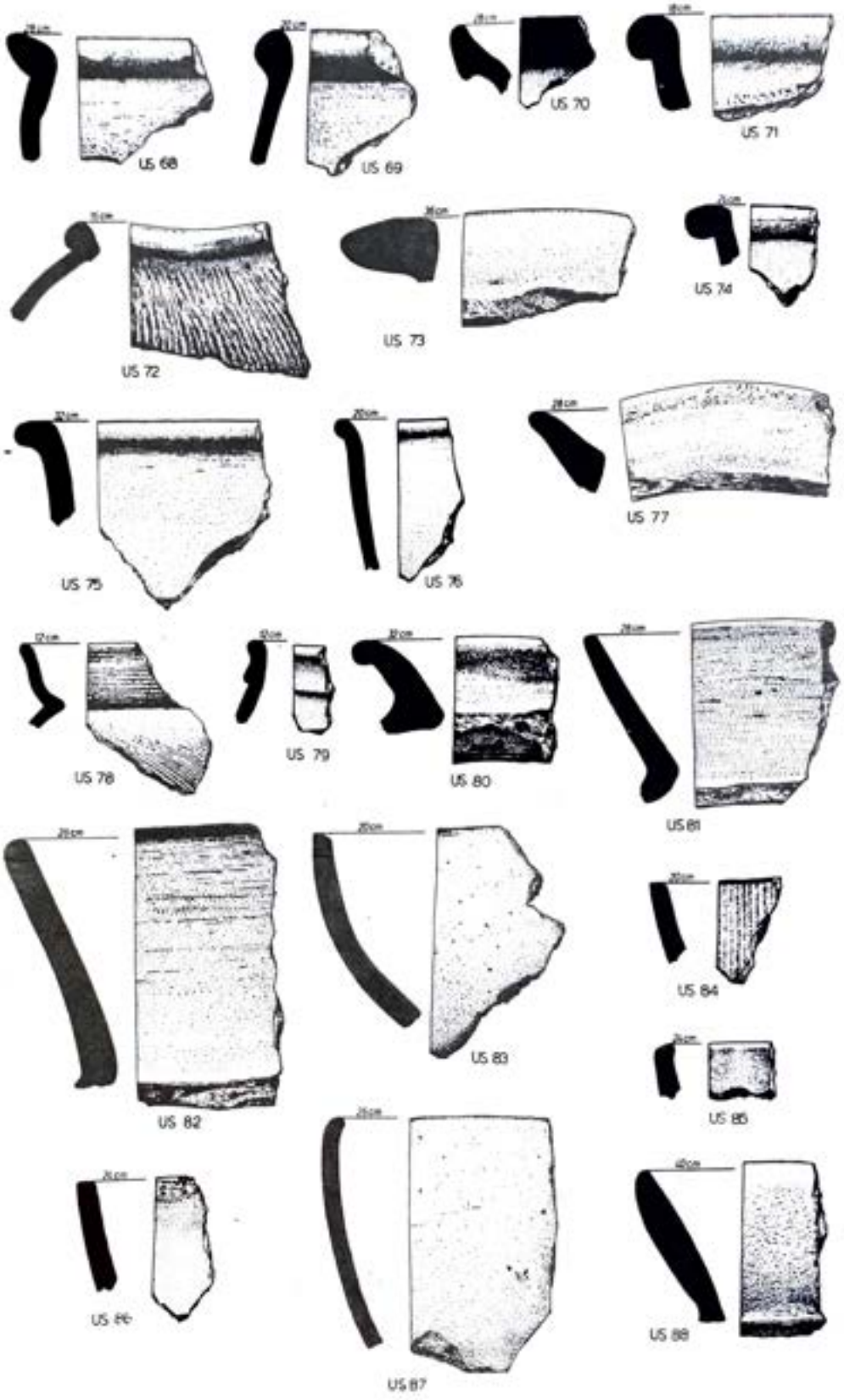


FIGURE 4-5

Pottery rim types from Ban Na Di level 6, scale 1:2



Pottery rim types from Ban Na Di level 6, scale 1:2

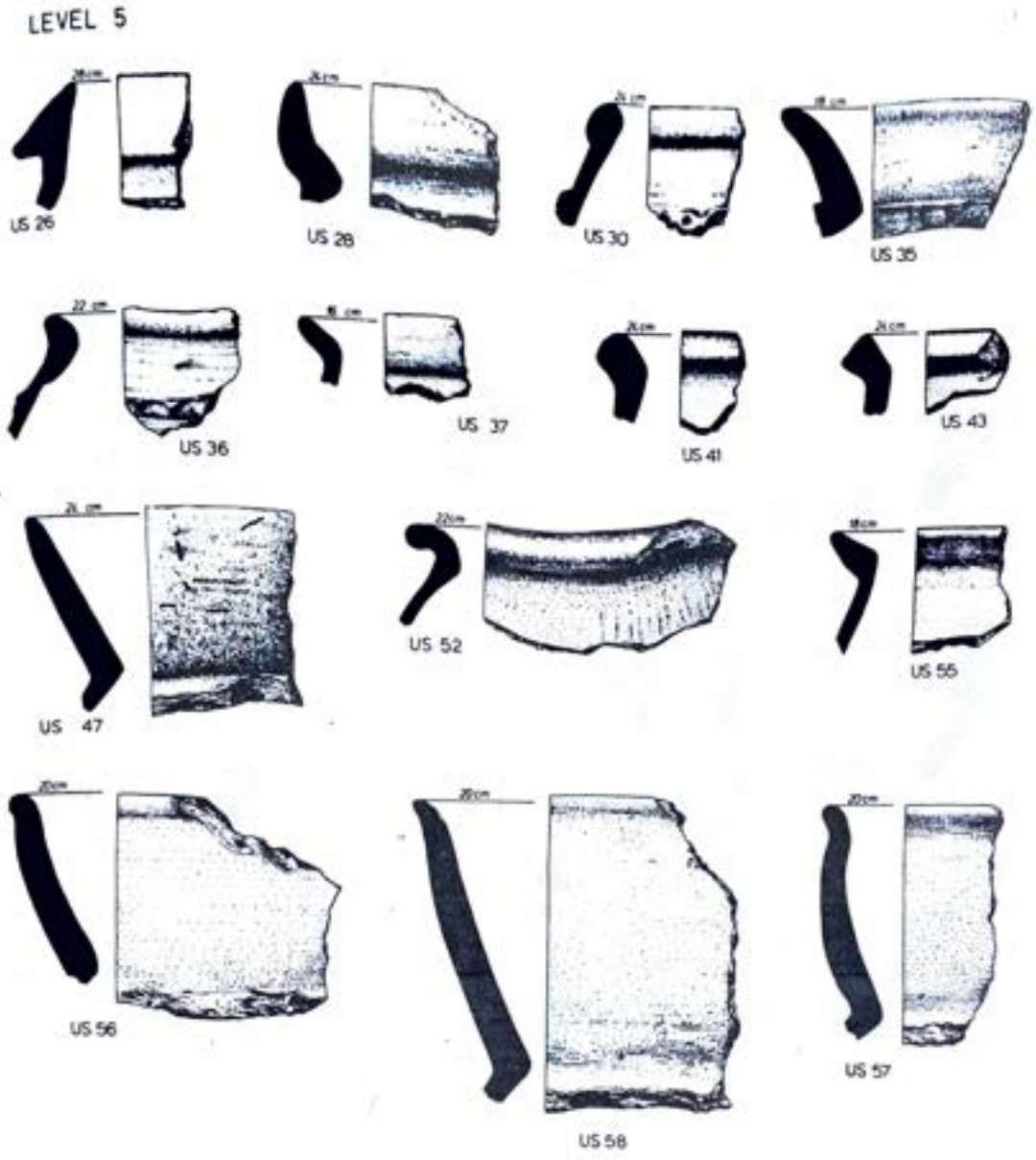


FIGURE 4-7

Pottery rim types from Ban Na Di levels 6 and 5, scale 1:2

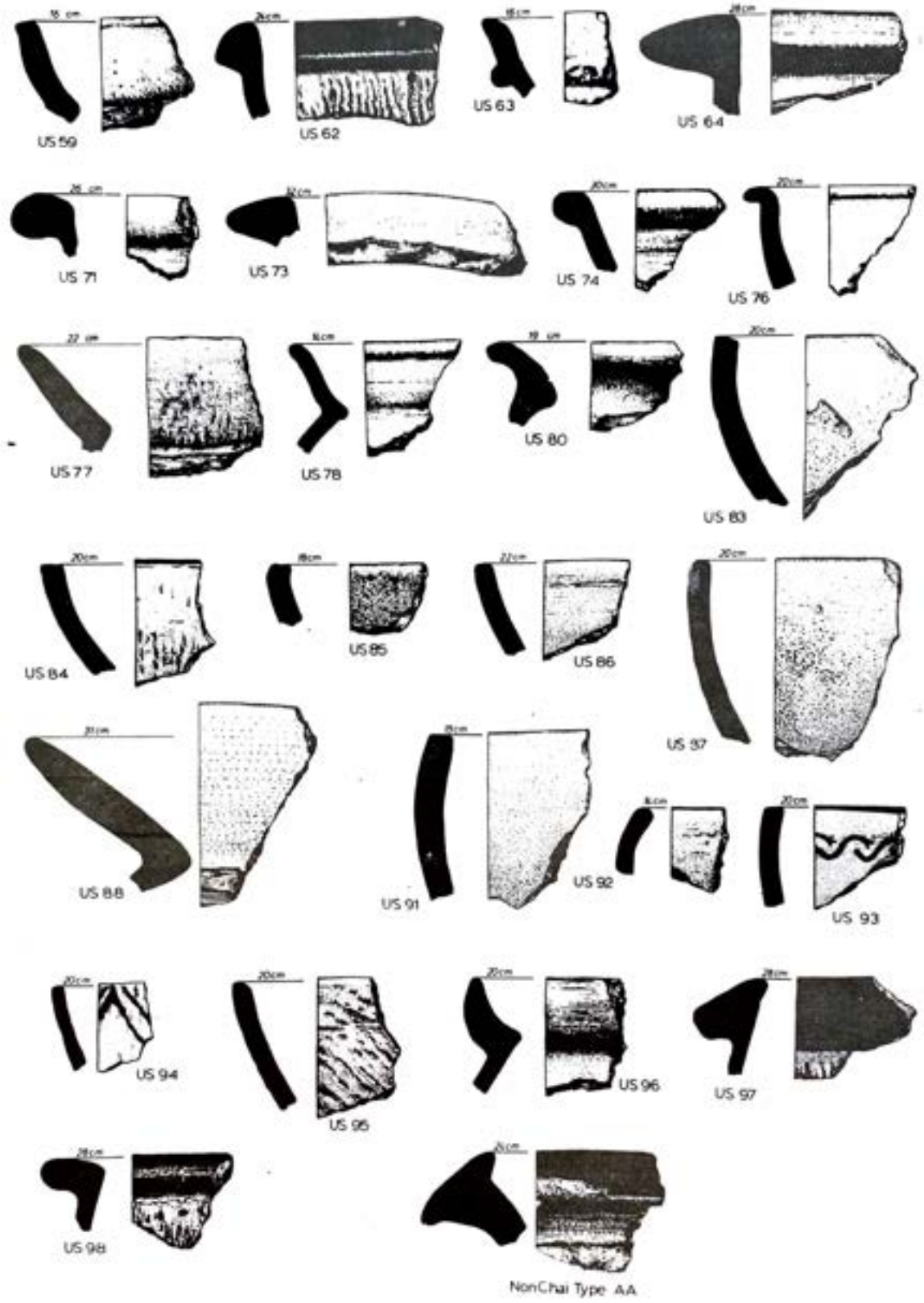


FIGURE 4-8

Pottery rim types from Ban Na Di level 5, scale 1:2

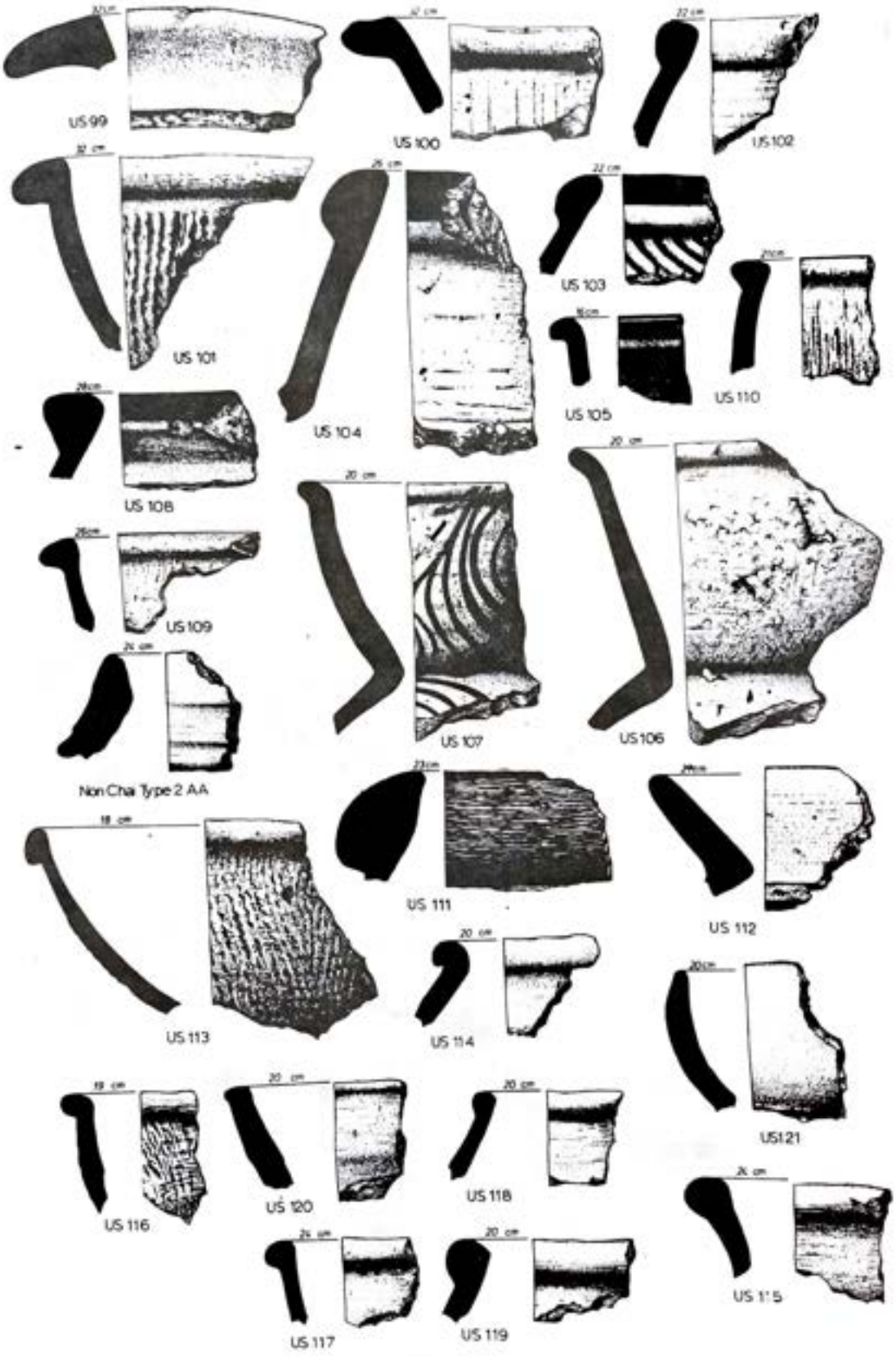


FIGURE 4-9

Pottery rim types from Ban Na Di level 5, scale 1:2

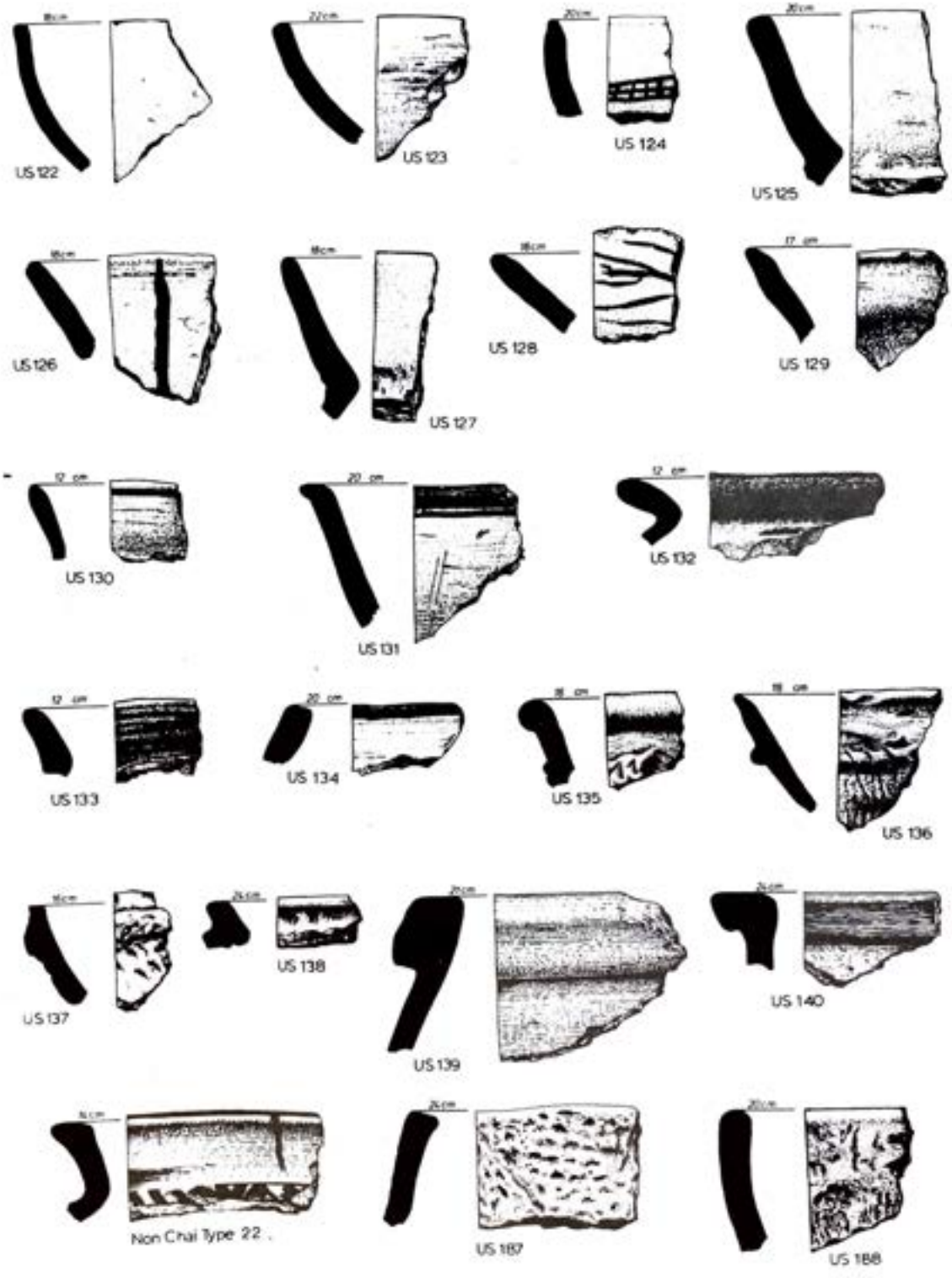


FIGURE 4-10

Pottery rim types from Ban Na Di level 5, scale 1:2



FIGURE 4-11

Pottery rim types from Ban Na Di level 4, scale 1:2

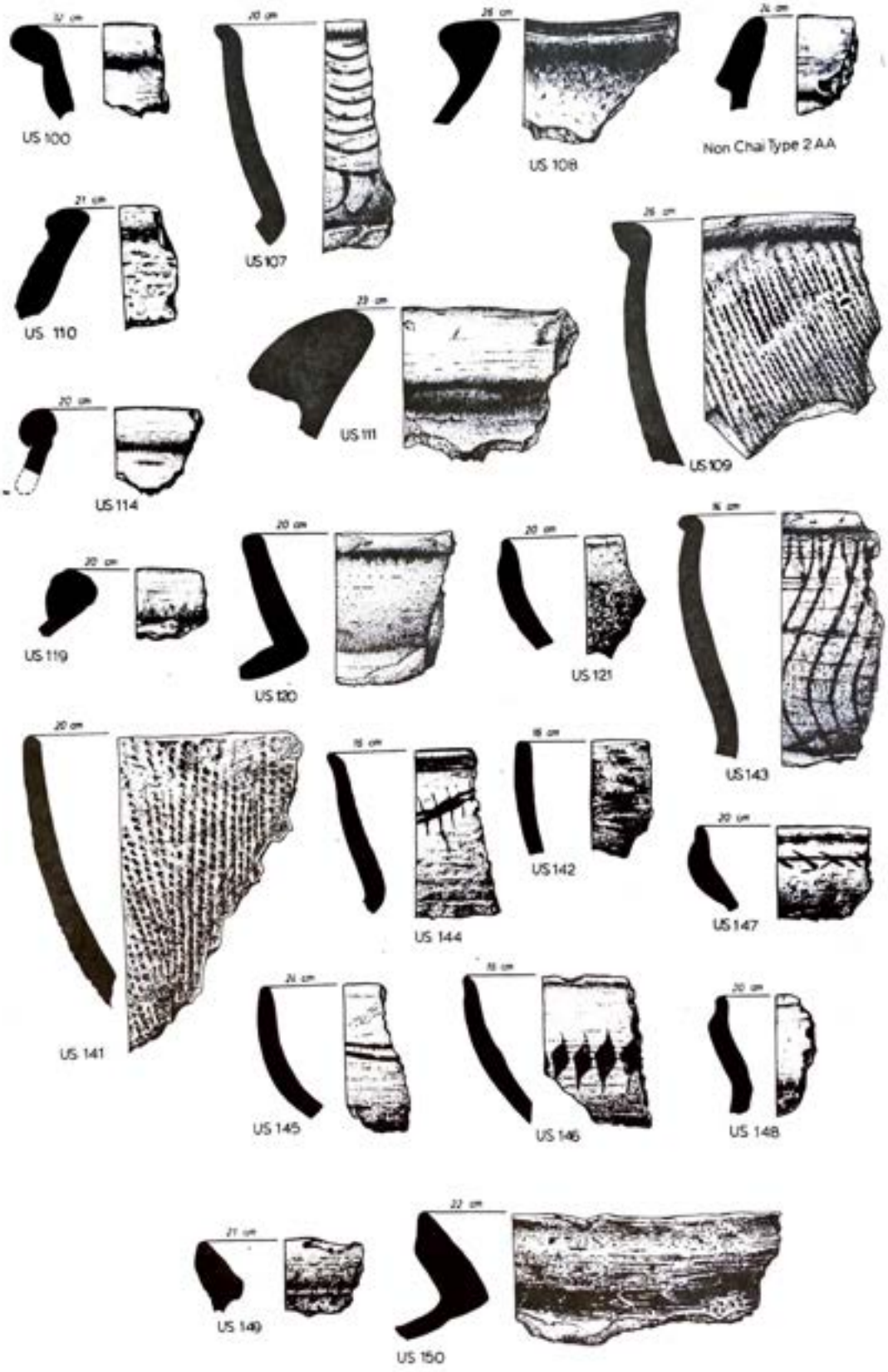


FIGURE 4-12

Pottery rim types from Ban Na Di level 4, scale 1:2

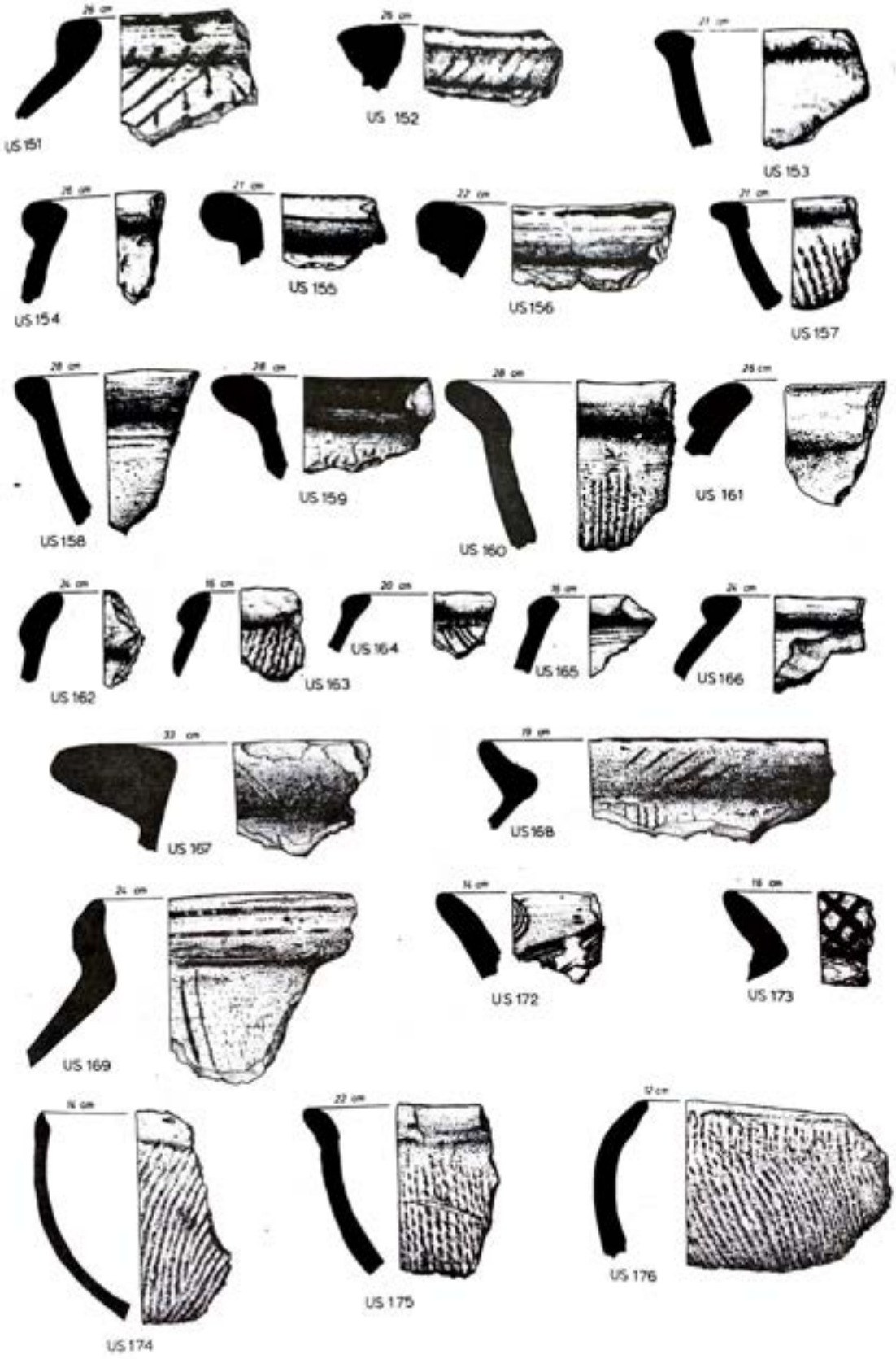


FIGURE 4-13

Pottery rim types from Ban Na Di levels 4 and 3, scale 1:2

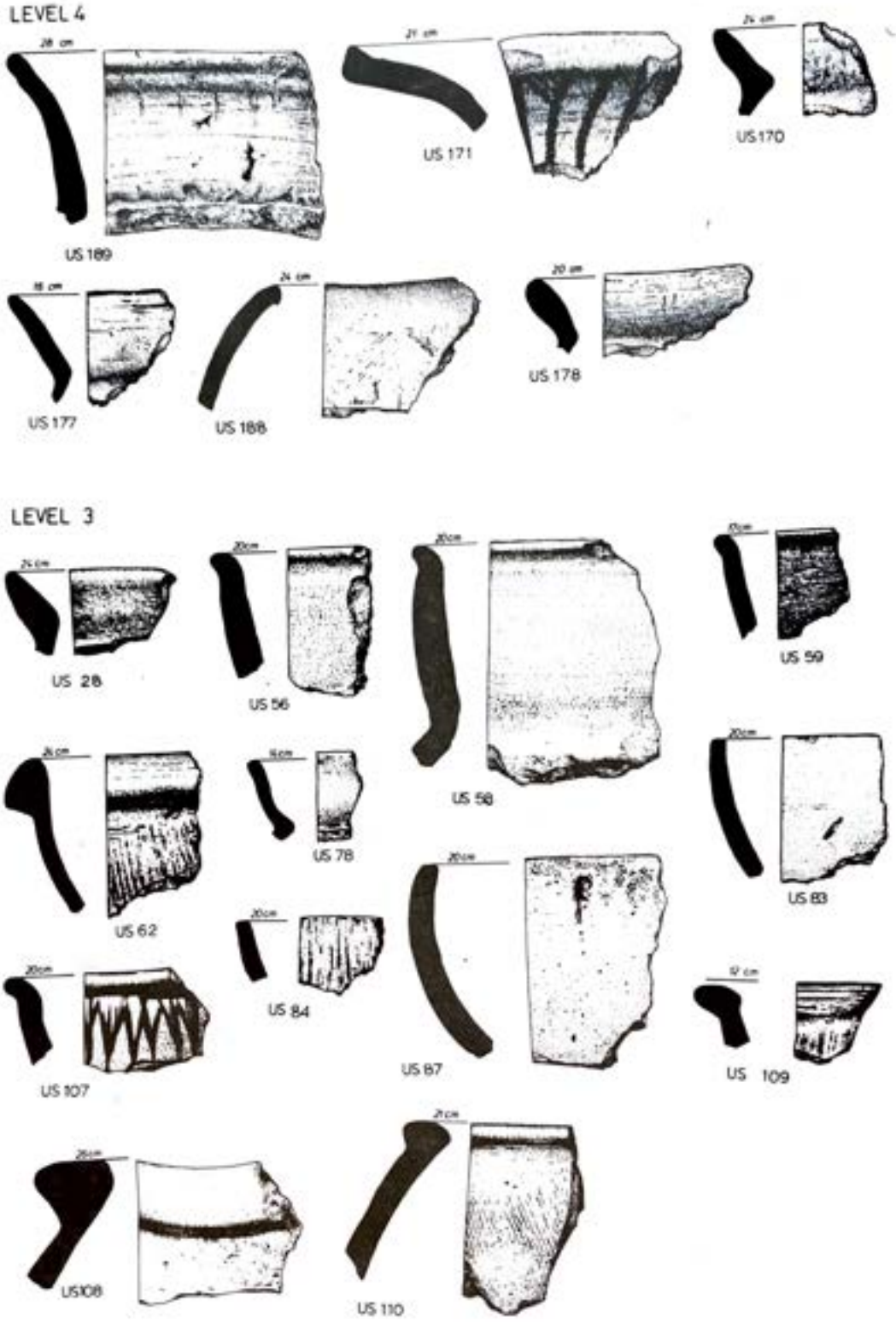


FIGURE 4-14

Pottery rim types from Ban Na Di level 3, scale 1:2

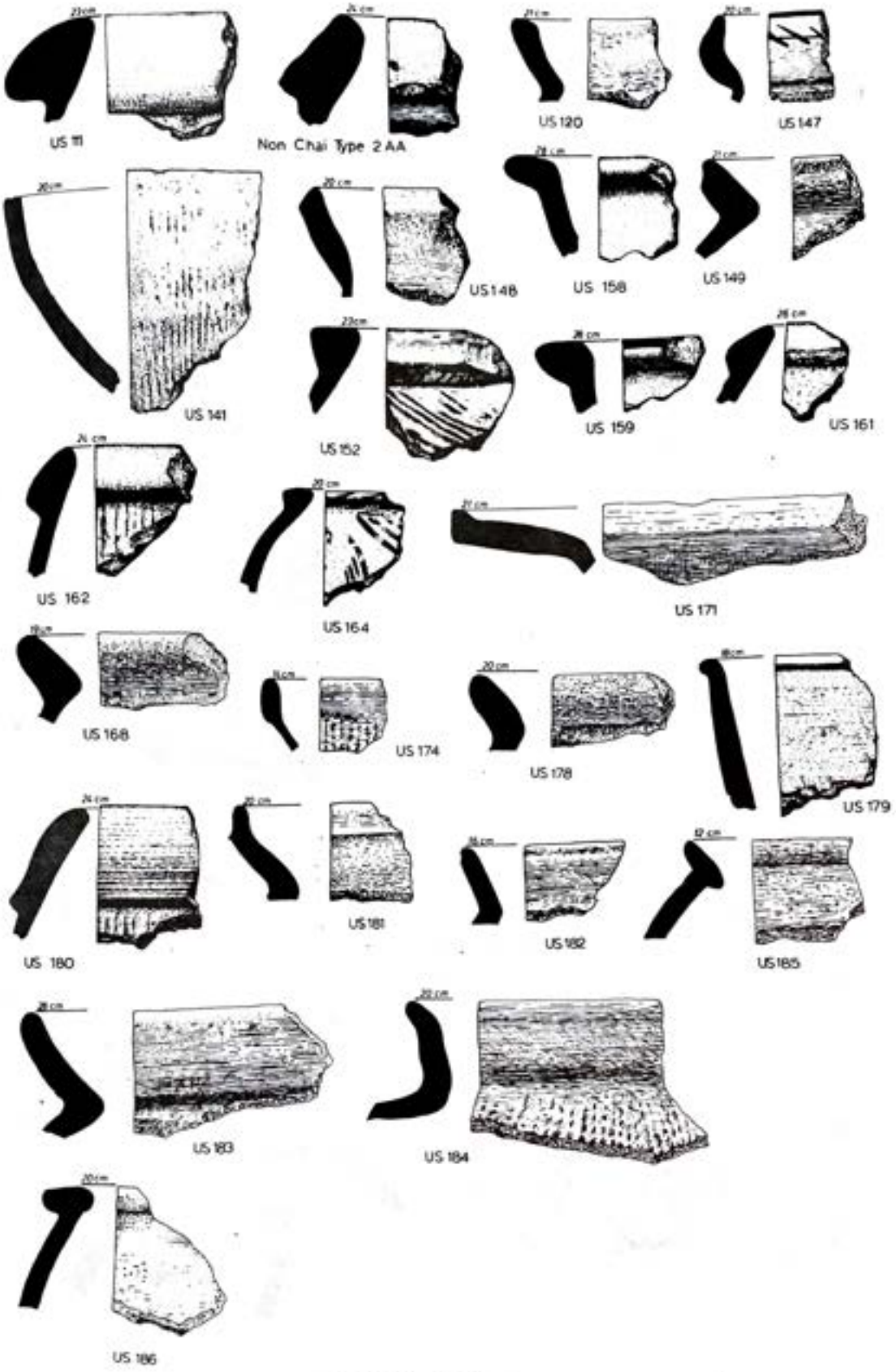


FIGURE 4-1b

Pottery rim types from Ban Na Di level 3, scale 1:2



FIGURE 4-16

Pottery rim types from Ban Muang Phruk, scale 1:2

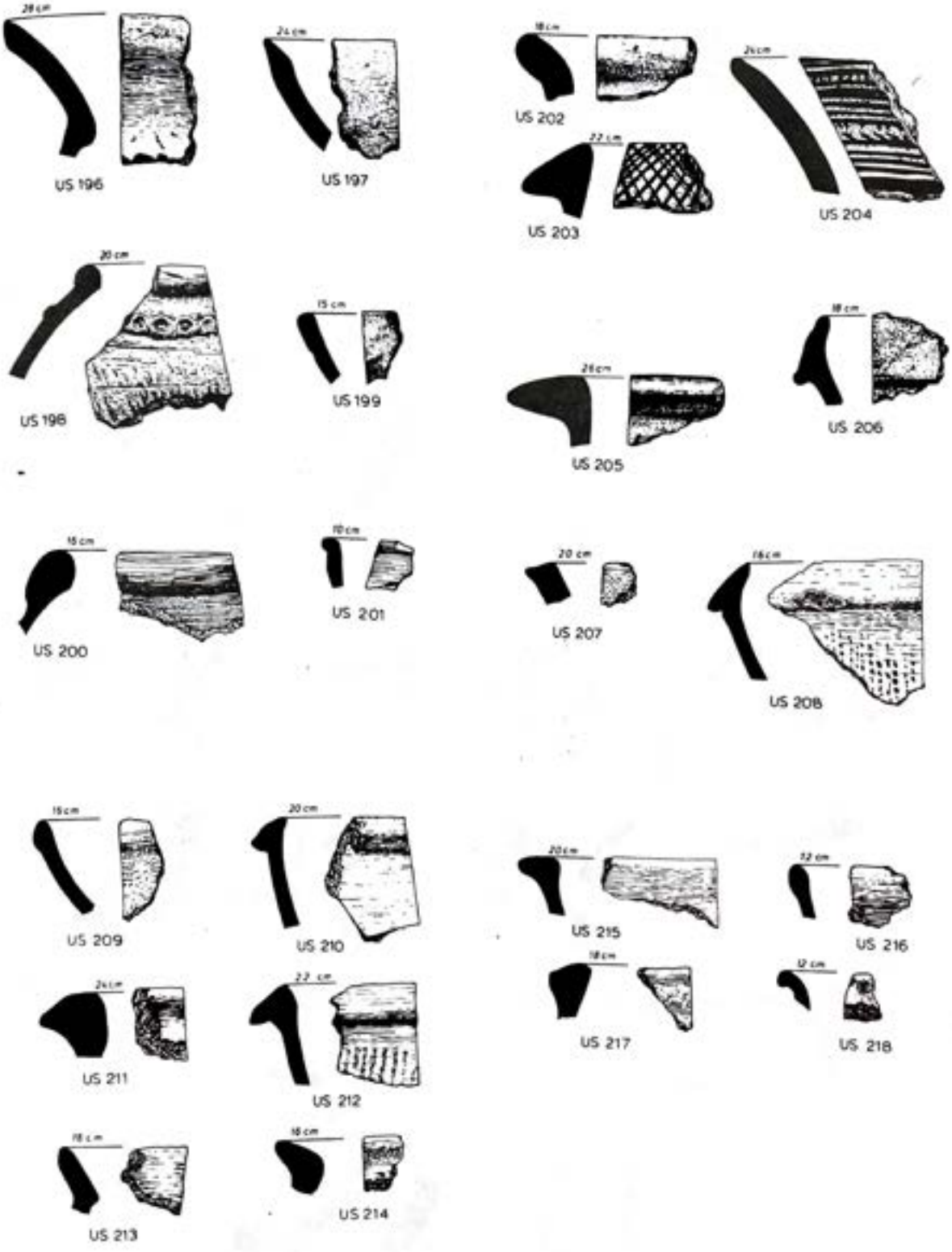


FIGURE 4-17

Pottery rim types from Ban Muang Phruk, scale 1:2



FIGURE 4-18

Pottery rim types from Ban Muang Phruk, scale 1:2

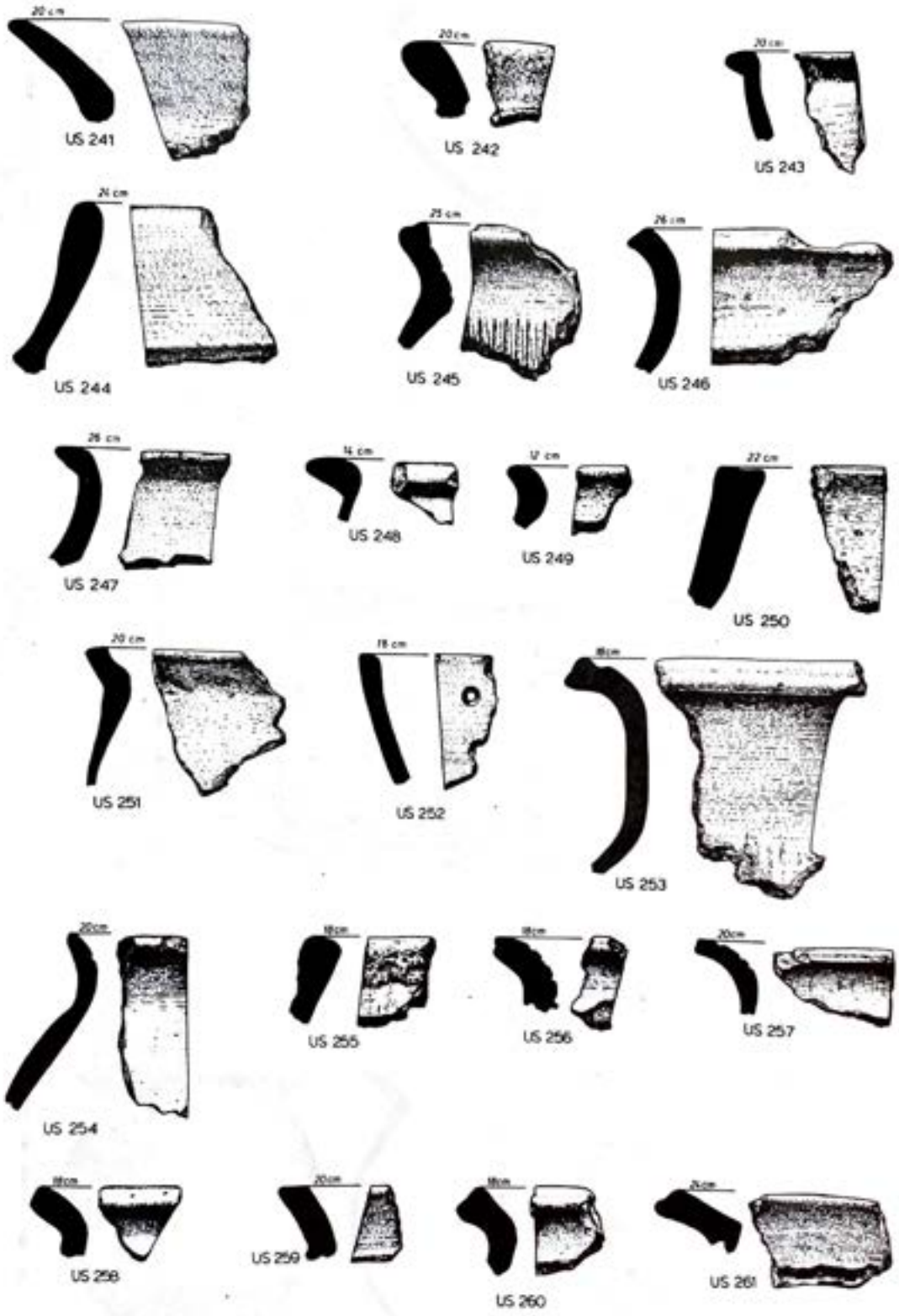


FIGURE 4-19

Pottery rim types from Ban Muang Phruk, scale 1:2

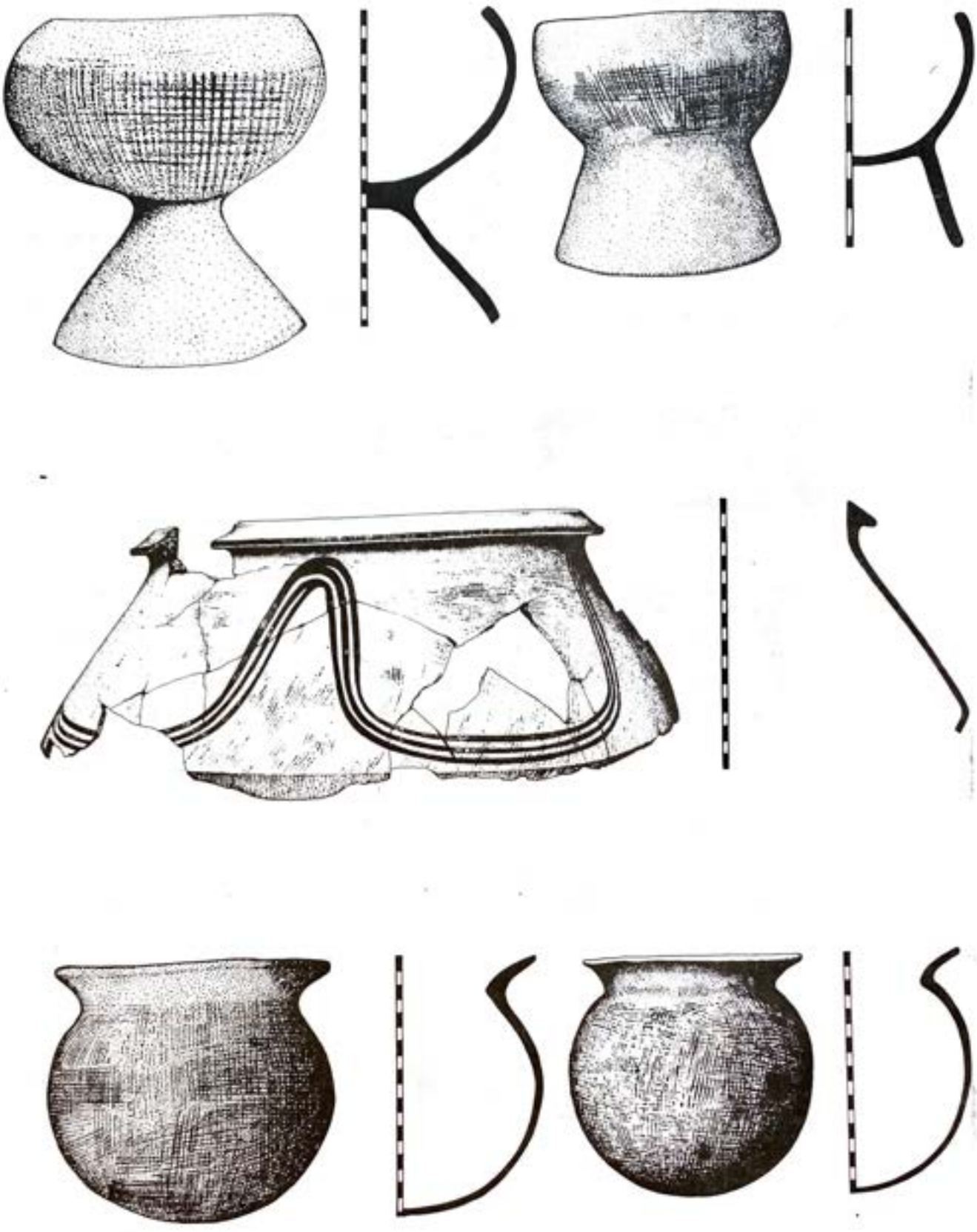


FIGURE 4-20

The complete vessels from Ban Na Di with the common rim types identified in levels 6-8

Illustrations of common Ban Na Di rim types

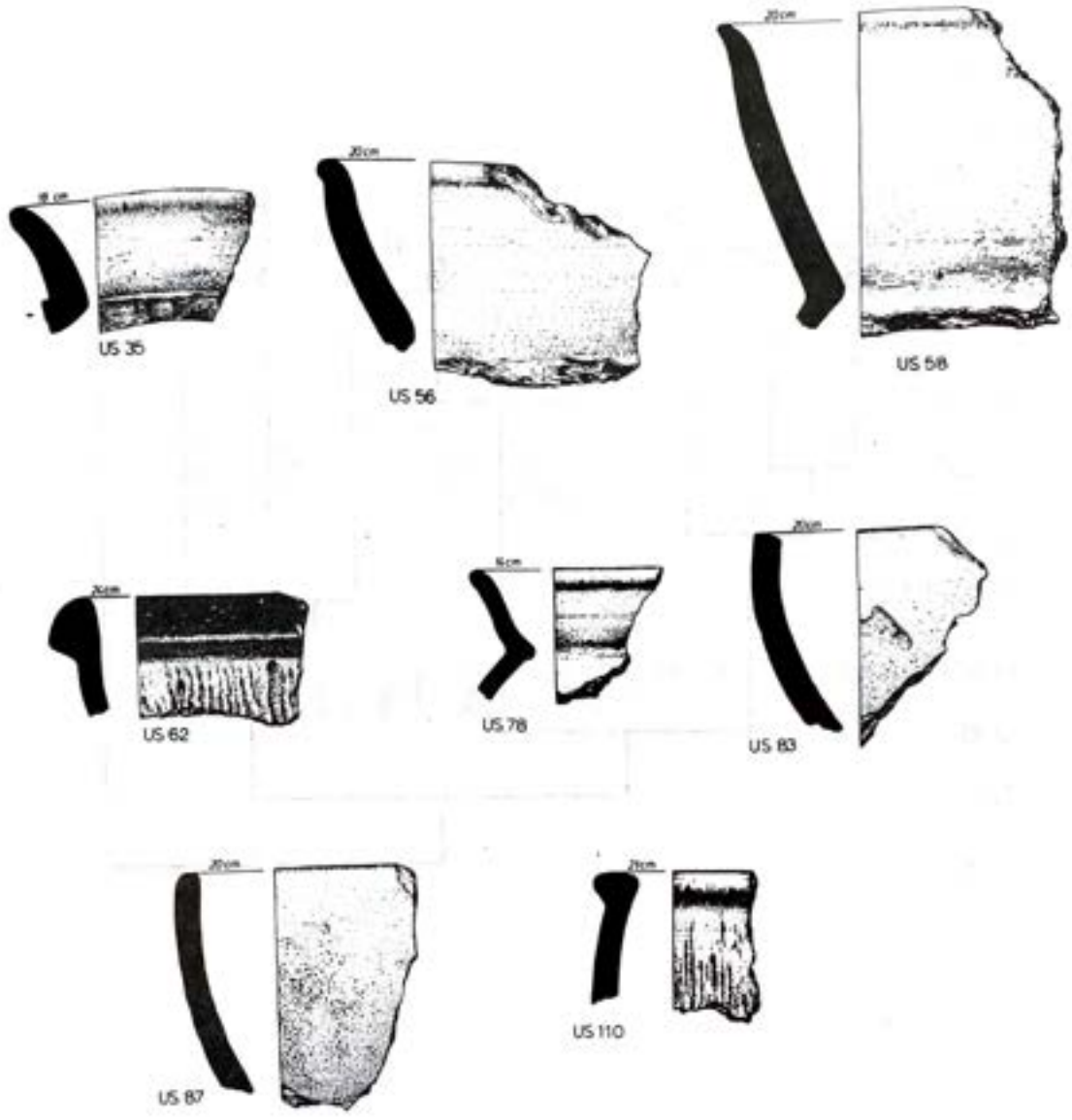


FIGURE 4-21

The common rim types identified in levels 4-5 at Ban Na Di

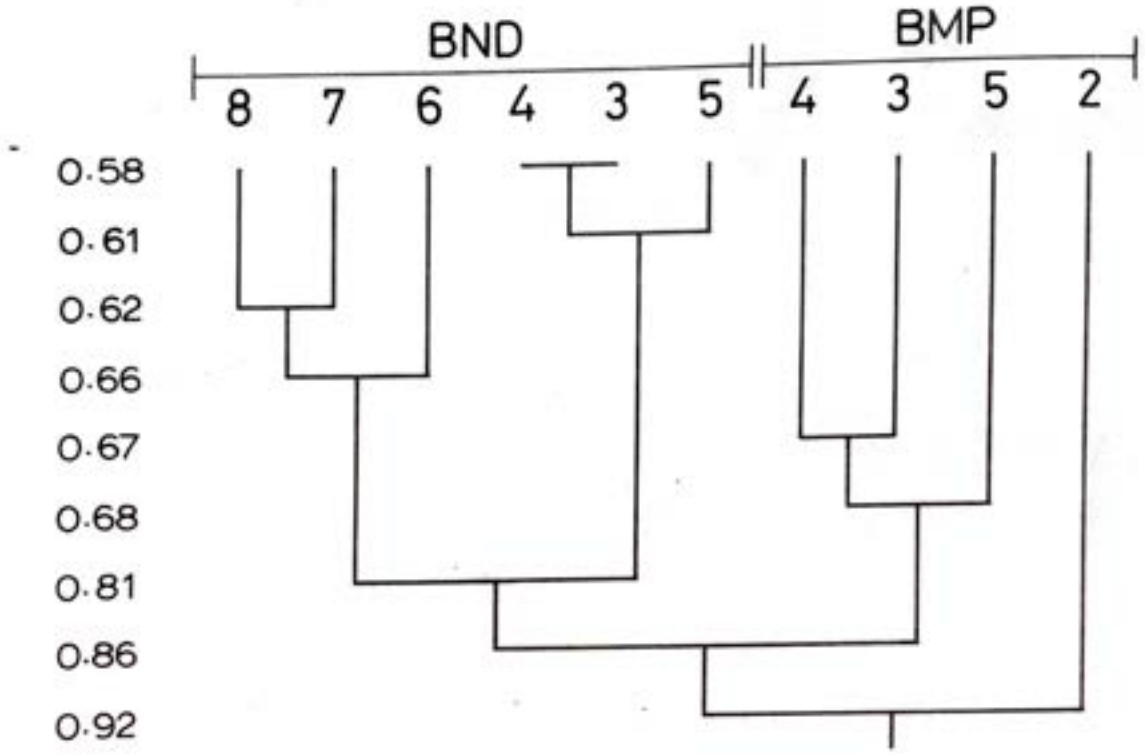


FIGURE 4-22

Cluster diagram showing the degrees of affinity between rims found in different levels at Ban Na Di and Ban Muang Phruk

Analysis of Upper Songkhram rims: illustrations

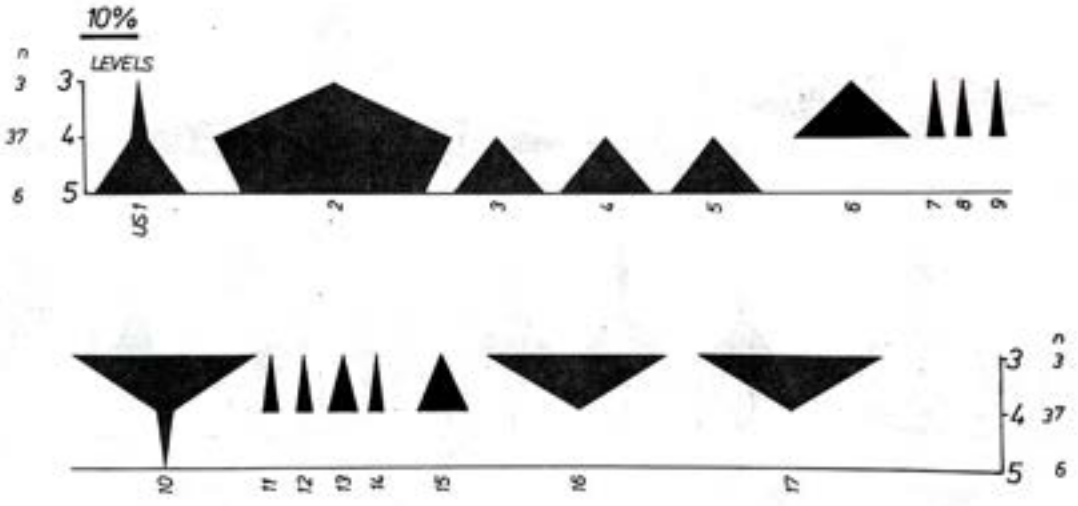


FIGURE 4-23

Histogram of the frequency occurrence of rim types by layer at Non Kao Noi

Analysis of Upper Songkhram rims: illustrations

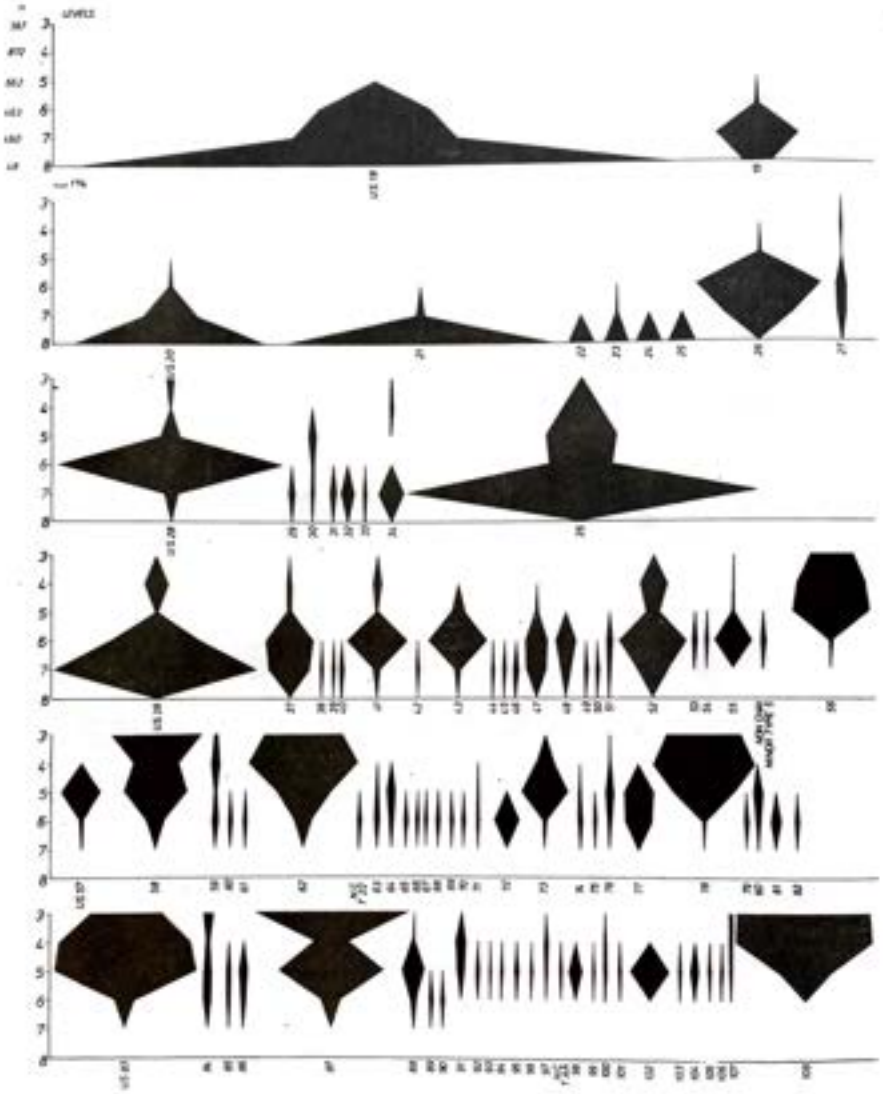


FIGURE 4-24

Histogram of the frequency occurrence of rim types by layer at Ban Na Di

Analysis of Upper Songkhram rims: illustrations

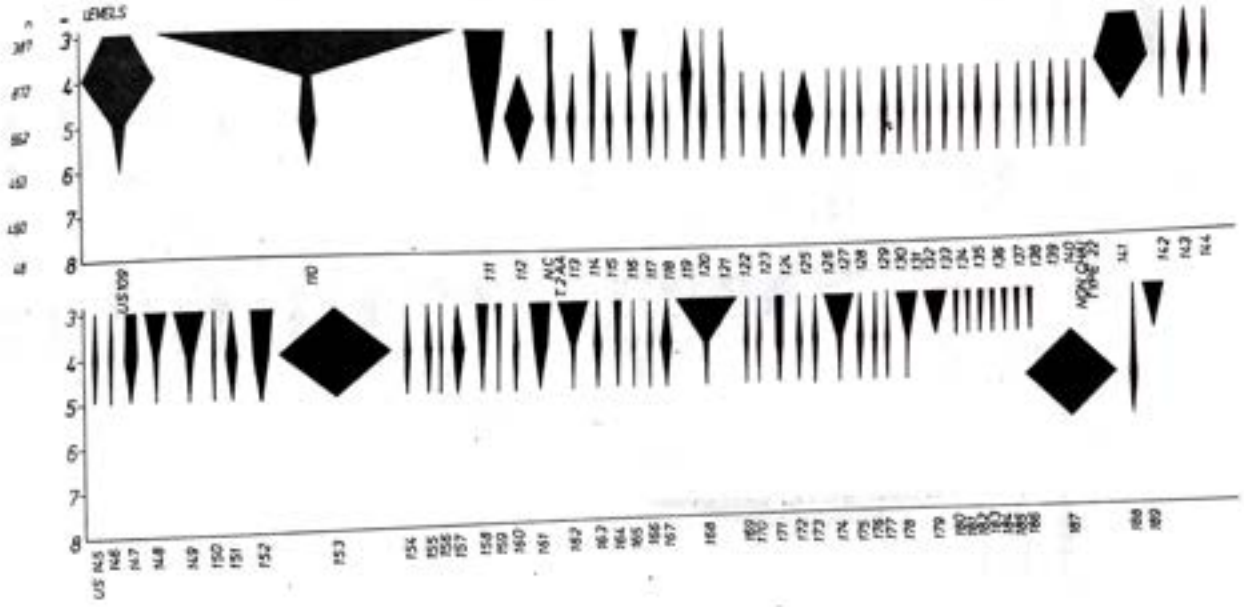


FIGURE 4-25

Histogram showing the frequency occurrence of rim types by layer at Ban Na Di (cont.)

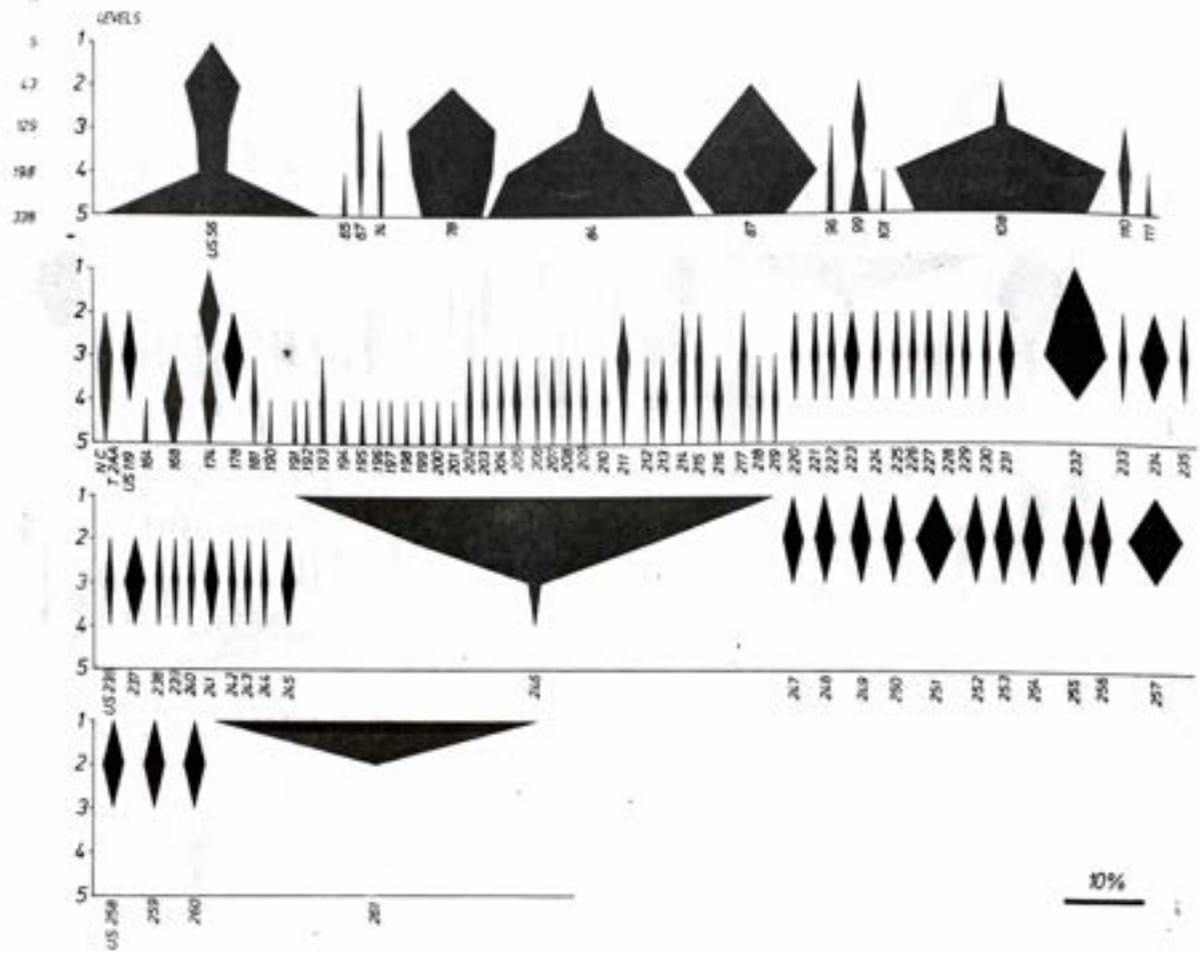


FIGURE 4-26

Histogram showing the frequency occurrence of rim types by layer at Ban Muang Phruk

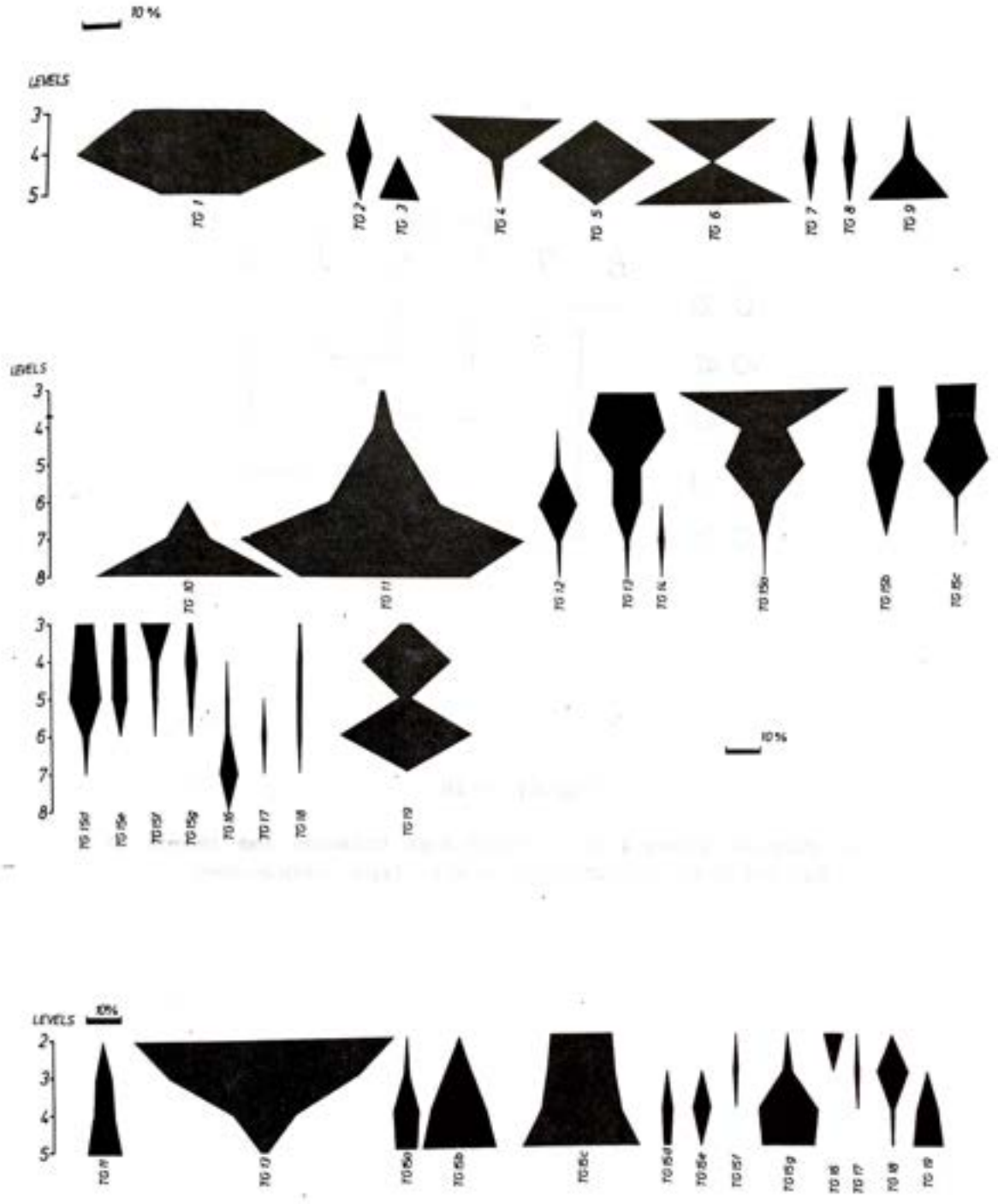


FIGURE 4-27

Histogram showing the frequency occurrence of temper types by layer at Non Kao Noi (top), Ban Na Di (middle) and Ban Muang Phruk

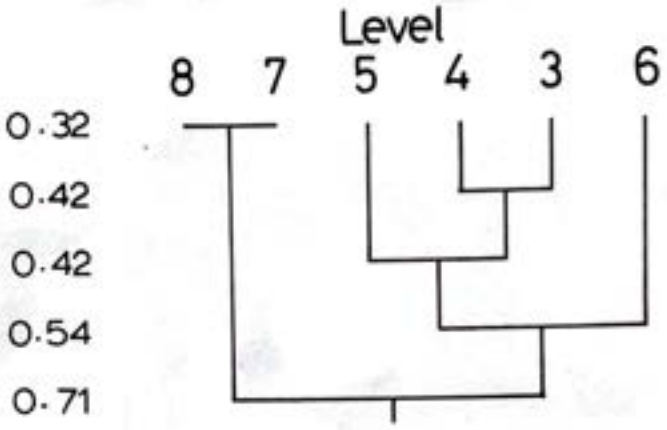


FIGURE 4-28

Cluster diagram showing the relationships between the levels at Ban Na Di on the basis of temper type frequencies