NEW RADIOCARBON DATES FOR IRON AGE NOEN U-LOKE

Charles Higham[1]*, Thomas Higham[2]

1. Department of Anthropology, University of Otago, P.O. Box 56, Dunedin, New Zealand
2. Department of Evolutionary Anthropology, University of Vienna, Djerassiplatz 1, 1030 Vienna, Austria

*Communicating author, charles.higham@otago.ac.nz

Keywords: Radiocarbon dating, Iron Age, Noen U-Loke, climate change, social inequality

ABSTRACT

Noen U-Loke is a large Iron Age settlement located in the upper Mun River floodplain of Northeast Thailand. Excavations in 1996–7 revealed an occupation and mortuary sequence beginning in the Bronze Age and then spanning the entire Iron Age, from ca. 450 BC to AD 500. The third of four mortuary phases stood out for the great wealth of mortuary offerings and associated rituals that accompanied the dead. This was manifested in clay-lined coffins in which the corpse was covered in rice, wearing multiple bronze ornaments, carnelian, agate, glass, gold and silver jewelry and iron knives. One man was found with a socketed iron ploughshare. The published radiocarbon chronology for this site came from 24 charcoal determinations. In this paper we present a further 11 dates from stratified rice grains, and consider their implications in relation to other Iron Age settlements that lie in close proximity.

INTRODUCTION

The excavation of Noen U-Loke involved an area of 220 m^2 and a mechanically opened trench 200 m in length through the five moats and banks that encircle the site (McGrath and Boyd 2001; Higham *et al*. 2007). The mortuary rituals in four phases (MP) varied over time. In the first, the eight graves were distributed across the excavated area save for two that lay alongside each other. Two distinct clusters comprised the second phase, and four for the third phase. With the final phase, graves were dispersed in irregular rows (Figure 1). Burials of all four phases contained a wide variety of mortuary offerings, rising to a marked peak with MP3 and declining slightly in MP4.

Barbara Anderson took samples throughout the excavation seasons for flotation to extract botanical remains. The samples remained in archived storage until 2021, when we decided to return to them, first to send them to Cristina Castillo for analysis, and second, to extract carbonized rice grains for a further series of AMS radiocarbon determinations. In selecting the samples, we paid attention to those that might enable a refinement of the dating of the wealthy burials of MP3. This decision reflects advances in research since the excavations of 1996–7 that have raised new issues, not least the evidence for an agricultural revolution that underwrote a rapid rise of stratified state societies.

The first of these comes from the excavation of Non Ban Jak, another moated settlement lying 8 km to the east (Figure 2). This site was occupied during the fourth and final mortuary phase at Noen U-Loke with occupation extending further into the early historic period. The second is centered on cores taken from the sediments of Lake Kumphawapi. This, the largest lake on the Khorat Plateau, is located 210 km northeast of Noen U-Loke. The cores identified the onset of a period of reduced strength in the monsoon, that involved a marked decline in rainfall from ca. AD 400 until the end

of the Iron Age (Wohlfarth *et al*. 2016). Finally, Castillo's analysis of the plant remains obtained by flotation from Ban Non Wat and Non Ban Jak have shown that rice-field weeds adapted to wet conditions replaced those suited to dryland, rainfed cultivation during the third to the sixth centuries AD (Castillo *et al*. 2018). This was the timespan when there were significant changes in material culture. The only known iron ploughshares yet identified in the broader region, one from Noen U-Loke and two from Non Ban Jak, date to this period of aridity. The dead were regularly interred with iron sickles, and infant mortality soared as one would anticipate if women were increasingly exposed to the host of pathogens, including malarial mosquitoes, that are associated with standing water in the surrounding moats and, as has been suggested, the wet-rice fields beyond.

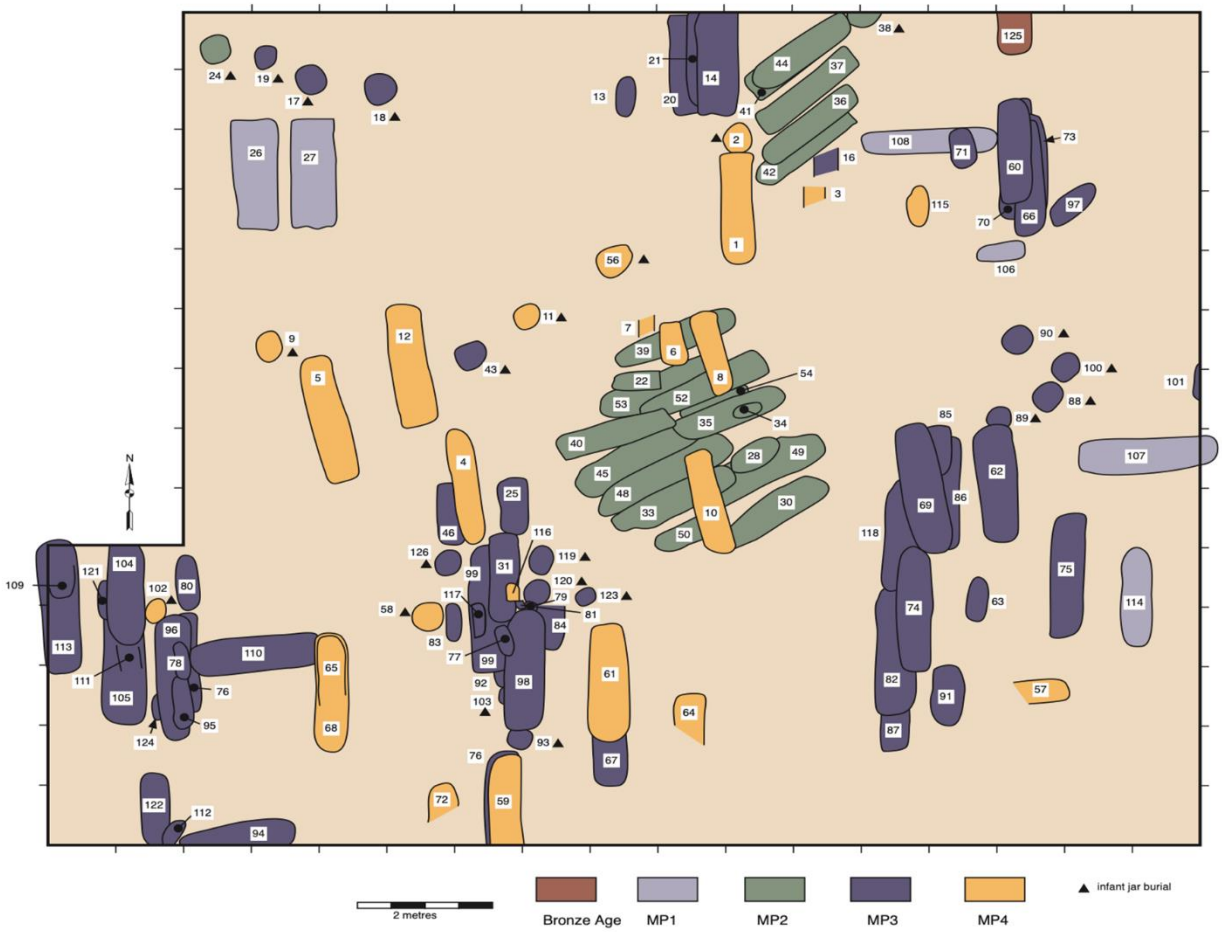

Figure 1. The layout of human burials at Noen U-Loke, Northeast Thailand. Illustration by C.F.W. Higham.

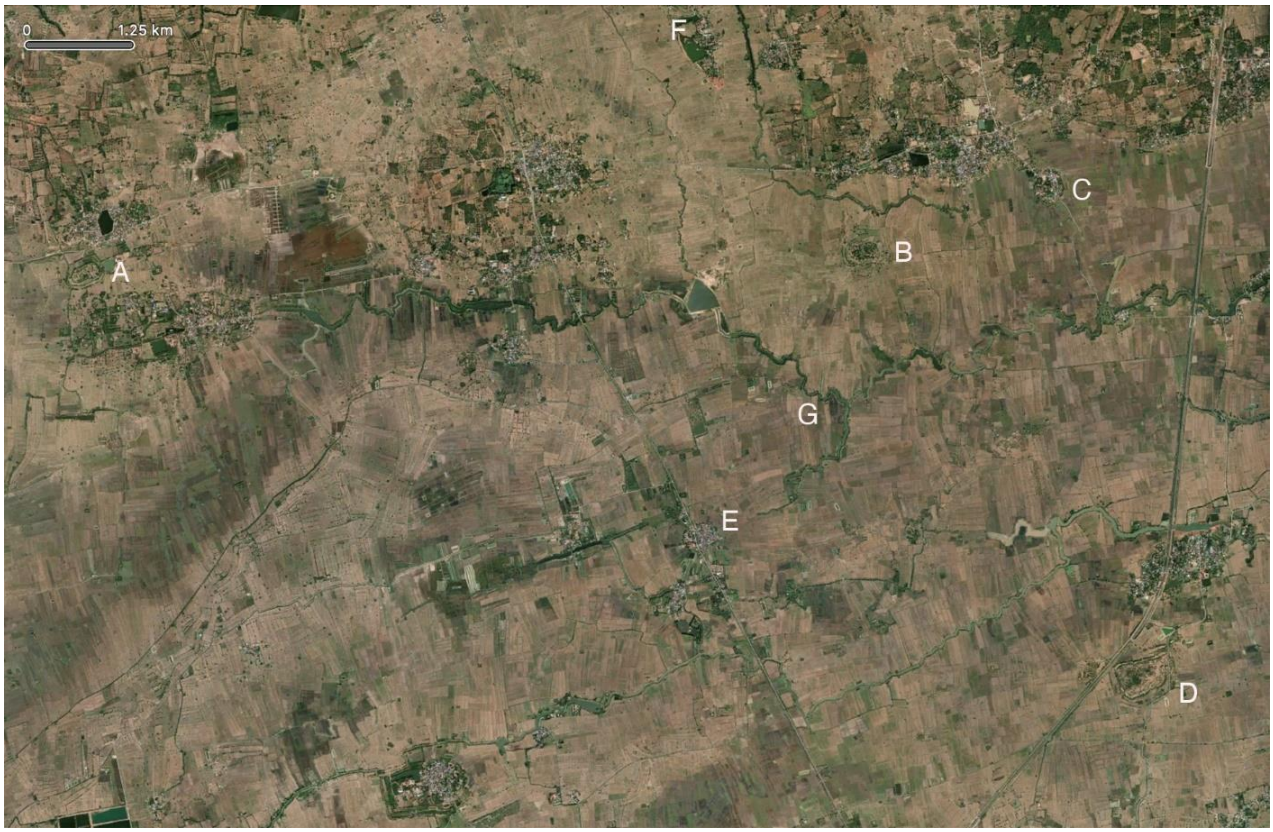

Figure 2. Air photograph showing the locations of the sites mentioned in the text. A. Non Ban Jak, B. Noen U-Loke, C. Ban Non Wat, D. Non Muang Kao, E. Ban Kho Hong, F-G. other moated sites. Illustration by C.F.W. Higham.

These variables have been integrated into a model for an agricultural revolution in the late Iron Age of the Khorat Plateau that involved water conservation in moats to feed bunded rice fields cultivated by buffalo-drawn ploughs. The greatly increased harvests from wet rice fields would have advantaged those who owned improved land, assuming that indeed, land was under restricted ownership. That this occurred is seen in the clear evidence for family ownership only a couple of centuries later under the early Chenla states (Higham 2016). This nexus of change might well help us understand the rise of very wealthy elites during the third mortuary phase at Noen U-Loke, but this relationship could be sharpened or indeed reduced in likelihood, by a sound chronological framework.

THE RADIOCARBON DATES FOR NOEN U-LOKE

The radiocarbon dates for Noen U-Loke are presented in Table 1. The new determinations have the laboratory prefix OxA

The Bayesian model for these determinations is set out in Figure 3. It excludes the two dates for layer 6:7 as these are seen as dating the Bronze Age occupation and the time span between them and the early Iron Age determinations is not known. There are four mortuary phases (MP). Burials 107 and 108 of MP1 were found in layer 6:2 at a depth of ca. 3.80 m below datum (BD), but we do not know the depth of the grave itself. Burial 27 was found as the grave outline 3.76 m BD in layer 5:2, the skull being 4.12 m BD. The grave cut for burial 26 was found at 3.50 m BD, also in layer 5:2. The burials are therefore later than any date from layer 6, the latest of which is 377–102 BC. The two determinations for layer 5 are too inconsistent to offer more precision, being 113 BC–AD 85 and 423–348 BC.

Table 1: Radiocarbon determinations from Noen U-Loke.

Laboratory Code	Context in site	Radiocarbon Age BP	Calibrated Age AD 95.4% probability
OZE-941	Layer 2 0.75 m charcoal	1490±40	534–650
OZE-942	Layer 2 1.6 m charcoal	1490±40	534–650
Wk-5353	Layer 3:2 charcoal in furnace	1470±120	336–777
Wk-5352	Layer 3:2 charcoal in hearth	1680±90	204–590
OxA-40927	Layer 3:9 feature 1 pit rice	1741±19	246–381
OxA-40931	Layer 3:11 feature 1 rice	1746±19	245–376
OxA-40928	Layer 3:12 burial 8 rice	1697±19	259–366
OxA-41099	Layer 3:12 burial 14 rice	1775±17	278–377
OZF-185	Layer 3:14 2.0 m charcoal	1944±56	5–205
OZF-336	Layer 3 2.65 m charcoal	1946±40	4–204
OZF-186	Layer 3 3.15 m charcoal	1944±47	1–210
OxA-41089	Layer 4:1 burial 15 rice	1843±18	153–241
Wk-5359	Layer 4:1 charcoal, on burnt floor	1840±60	60–361
Wk-5354	Layer 4:2 charcoal hearth	1850±70	1–350
OxA-40932	Layer 4:3 feature 8 rice	1757±19	240–361
OxA-41101	Layer 4:3 rice	1738±17	306–383
OxA-41100	Layer 4:3 rice	1771±17	277–338
Wk-5362	Layer 4:3 carbonized rice in pit	1650±70	306–564
Wk-5358	Layer 4:3 charcoal hearth	1830±50	107–265
Wk-5351	Layer 4:4 charcoal on burnt floor	1820±60	107–383
Wk-5360	Layer 4:4 charcoal in pit	1770±60	155–414
Wk-5355	Layer 4:4 charcoal in ash spread	1850±70	17–365
Wk-5361	Layer 4:5 charcoal in hearth	1880±60	10–225
Wk-5357	Layer 4:5 charcoal in hearth	1870±50	58–253
OxA-41047	Layer 4:6 rice	1745±17	246–375
OxA-40930	Layer 4:8 feature 4	1750±19	242–365
Wk-5356	Layer 4:8 charcoal, collapsed daub structure	2090±50	207 BC–27
OxA-40929	A1 layer 4:14 rice	1722±19	288–405
OZF-187	Layer 5 3.7 m BD charcoal	2020±40	113 BC–85
OZF-333	Layer 5 3.6 m BD charcoal	2310±40	423–348 BC
Wk-5363	Layer 6:1 charcoal in hearth	2360±60	593–354 BC
OZF-188	Layer 6 3.75 m BD charcoal	2240±40	395–197 BC
Wk-6148	Layer 6:4. charcoal in pit	2180±45	377–102 BC
Wk-5364	Layer 6:4 charcoal in hearth	2280±130	781–48 BC
Wk-5365	Layer 6:7 charcoal	2720±60	1005–796 BC
OZE-878	Layer 6:7 charcoal hearth	2840±40	1125–899 BC

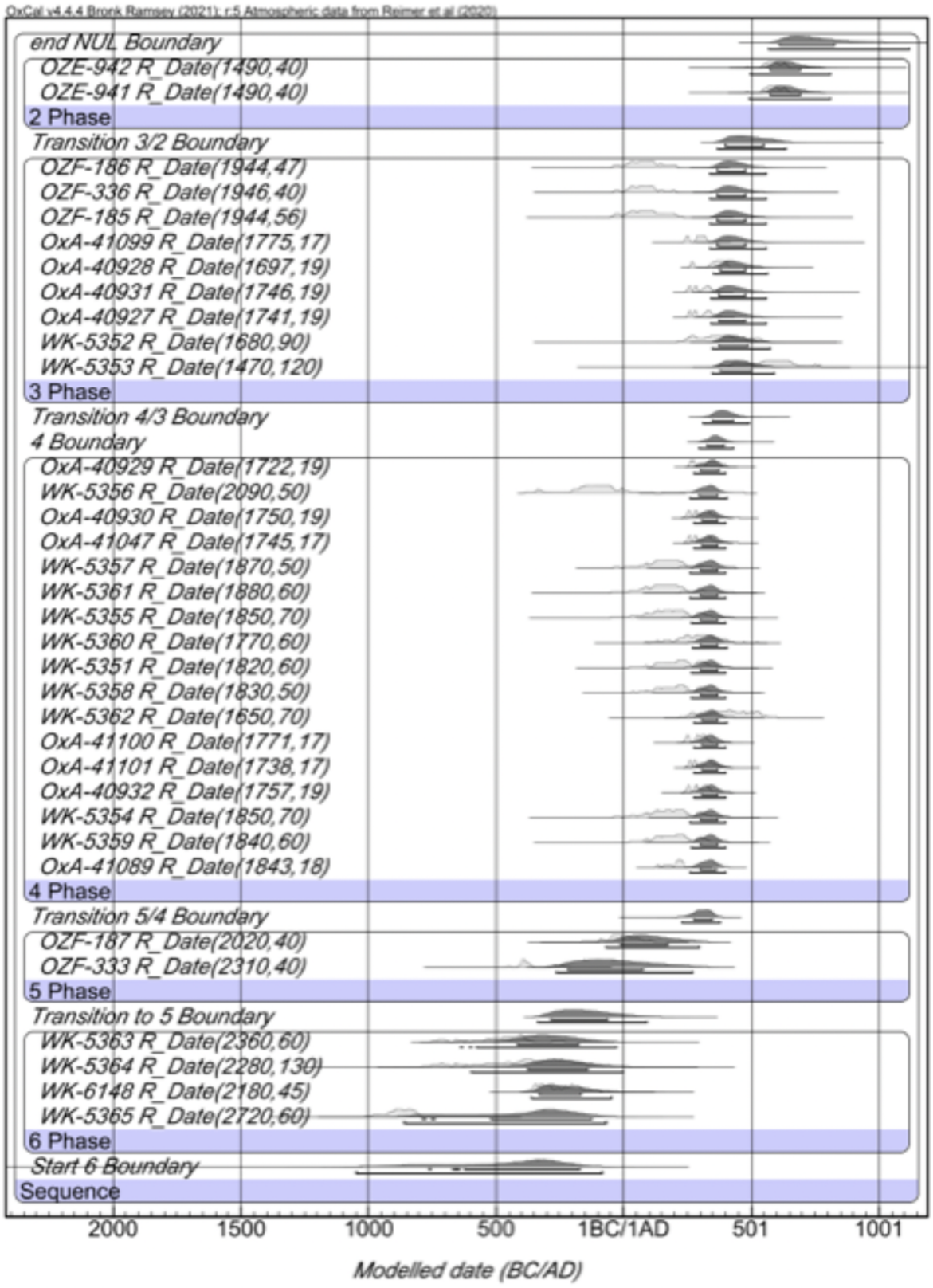

Figure 3. Bayesian plot of the radiocarbon determinations for Noen U-Loke. Illustration by T.F.G. Higham.

MP2 burials were found in two clusters. The earlier comprised burials found in layer 4:11–12 at a depth of ca. 3 m BD. Burials of the later were found in layer 4:7–8 at a depth of 2.9 m BD. Again, we do not know from which depth or layer these graves originated. The new rice grain dates indicate that they are later than AD 242–365, while a charcoal determination provides a terminus *post quem* of 207 BC–AD 27. The former are preferred since built-in age is most unlikely. This is later than the suggested span of 200 BC–AD 200 proposed in the original report (Higham *et al*. 2007).

With MP3, graves comprise four clusters on a new, north–south orientation. The deepest were found ca. 2.7 m BD in layer 4:7, and others were found throughout layer 4 extending into basal layer 3. Most of these graves were cut down into layer 4 from layer 3. Once again, the new rice grain dates, some of which come from the graves themselves as ritual offerings, are deemed the more accurate. These indicate that the extremely wealthy individuals date between AD 250–400, about the same as originally suggested.

The early MP4 graves were found in layer 3:11 at a depth of ł.70 m BD, and they were thereafter encountered up to and including layer 3:1 0.80 m BD. They are therefore definitively later than AD 250-400 and likely to have been interred ca AD 400-600, a century later than originally proposed. The equivalent period of burials at Non Ban Jak, defined on the basis of the layout of graves and their contents, has been dated to the same span (Higham and Kijngam 2020).

CORRELATION BETWEEN THE MORTUARY PHASES AND THE CLIMATE

The new rice dates suggest that the onset of aridity was underway during the period of MP3 and early MP4. We must now turn to the date of the water retention infrastructure, represented by the encircling moats and banks. McGrath and Boyd (2001) have excavated and taken dating samples at four sites. Those most relevant come from the moat banks and moat infill deposits. There are two determinations on rice grains for the moat infill from Noen U-Loke. These are 415–589 cal. BC, and 569–77 cal. BC and postdate the construction of the water control apparatus. There is a close correlation between the occupation, the burials and moat construction at Non Ban Jak. Five shell dates from the bank between the inner and outer moat are virtually identical (Table 2). This indicates that when this site was settled during MP4, quite possibly as a colonizing move from nearby and much bigger Noen U-Loke, a priority was to encircle the site with reservoirs.

Table 2: Radiocarbon dates from the moats and banks of Noen U-Loke and Non Ban Jak.

Laboratory Code	Site	Context	Radiocarbon Age BP	Calibrated Age AD 95.4% probability
OZD-671	Noen U-Loke	Rice from moat	1572±46	415–589
Wk-6490	Noen U-Loke	Rice from moat	1364±63	569–777
OZE-204	Non Ban Jak	Shell from bank	1606±37	405–557
OZE-199	Non Ban Jak	Shell from bank	1610±32	410–454
OZE-205	Non Ban Jak	Shell from bank	1622±39	365–550
OZE-206	Non Ban Jak	Shell from bank	1615±48	354–556
OZE-207	Non Ban Jak	Shell from bank	1638±35	354–541

DISCUSSION AND CONCLUSIONS

The greater accuracy and lower standard errors of the new series of rice grain dates from Noen U-Loke require a re-evaluation of this site's chronology. When integrated with the dates obtained for moat and bank construction and the onset of an arid phase at Lake Kumphawapi, we find confirmation that these events coincided. With the dry phase, banks were built to retain water. There was a significant change in iron production, seen in the forging of weighty ploughshares and tanged sickles. It was during this period that the dead were interred in groups with considerable wealth, particularly measured in decorative bronzes and exotic ornaments. Graves were filled with rice. With the final mortuary phase, burials were more dispersed, and if the evidence from Non Ban Jak is taken into account, graves were located in houses. This period also saw a change from dryland weeds to those adapted to wet conditions. Reservoirs and wet rice fields present a new set of health hazards. These include increased exposure to malaria, bilharzia and several other potentially lethal conditions that particularly affect pregnant women (Higham and Kijngam 2020: 505). At Non Ban Jak, 77% of all graves in one burial ground contained infants, the highest in prehistoric Southeast Asia yet recorded.

We also draw attention to two further issues. It was during the later Iron Age at Noen U-Loke that iron points greatly increased in occupation contexts, and one man was killed when his backbone was severed by an iron arrowhead. Inter-communal conflict seems to have occurred. It was also probably a period of population expansion. Noen U-Loke and Ban Non Wat are separated by just 1.85 km. The particularly large moated site of Non Muang Kao lies 5.6 km southeast of Noen U-Loke and Non Ban Jak is 8.9 km to the east. Non Ban Jak was founded as an Iron Age site as the dry phase began, and presents a virtually identical mortuary record and material culture as MP4 at Noen U-Loke. It is highly likely that its founders moved to a new location from a parent site such as Noen U-Loke, and that they constructed the banks and moats on arrival. In addition to population pressure, one must recall that this region is still renowned for its salt deposits. Many Iron Age sites are surrounded by the mounds that accumulated through the production of salt (Rivett and Higham 2007).

The impact of this episode of climate change had longer-term effects. Our model for this agricultural revolution that took place ca. AD 350–450 was followed in the upper Mun Valley by the rapid foundation of an early state known as Canasapura. The center might well have been Muang Sema, a strategically placed moated Iron Age settlement that underwent at least two phases of expansion that incorporated sacred Buddhist structures. Similar early states arose across the rest of the Mun River catchment into the lowlands of adjacent Cambodia, dating from ca. AD 500. With the advantage of contemporary inscriptions, we know that these were socially complex, inequality being seen in aristocrats owning extensive irrigated rice lands serviced by their tied workers (Vickery 1998; Higham 2016).

ACKNOWLEDGEMENTS

We acknowledge the permission given to the first author by the Thai National Research Council and Fine Arts Department, that allowed him to undertake fieldwork. Funding came from the University of Otago, the Ford Foundation, the Marsden Fund of New Zealand and Earthwatch and its Research Corps. We thank co-directors Rachanie Thosarat and Amphan Kijngam for their invaluable cooperation.

REFERENCES

Castillo, C.C., C.F.W. Higham, K. Miller, N. Chang, K. Douka, T.F.G. Higham and D.Q. Fuller. 2018. Social responses to climate change in Iron Age Northeast Thailand: New archaeobotanical evidence. *Antiquity* 92: 1274–1291.

Higham, C.F.W. 2016. At the dawn of history: From Iron Age aggrandizers to Zhenla kings. *Journal of Southeast Asian History* 47(3): 418–437.

Higham, C.F.W. and A. Kijngam (eds). 2020. *The Origins of the Civilization of Angkor*.

Volume VII. The Excavation of Non Ban Jak. Bangkok: The Fine Arts Department.

McGrath, R.J. and W.E. Boyd. 2001. The chronology of the Iron Age 'moats' of northeast Thailand. *Antiquity* 75: 349–360.

Rivett, P. and C.F.W. Higham. 2007. The archaeology of salt production. In C.F.W. Higham, A. Kijngam and S. Talbot (eds), *The Origins of the Civilization of Angkor. Volume 2. The Excavation of Noen U-Loke and Non Muang Kao*, pp. 589–593. Bangkok: The Fine Arts Department.

Vickery, M. 1998. *Society, Economics and Politics in Pre-Angkor Cambodia*. Tokyo: Centre for East Asian Cultural Studies for UNESCO, The Tokyo Bunko.

Wohlfarth, B., C.F.W. Higham, K.A. Yamoah, A. Chabangborn, S. Chawchai and R.H. Smittenberg, 2016. Human adaptation to mid- to late-Holocene climate change in Northeast Thailand. *The Holocene* 26(4): 614–626.