Reply to responses

C.F.W. Higham*

The principal point of my debate paper was to stress the importance of anchoring the chronology of the Neolithic to the Iron Age cultural sequence in north-east Thailand by applying Bayesian analysis to large, third-generation sets of radiocarbon determinations. Three of my respondents agree not only with this proposition, but also with the results of the AMS dating of bone, shell and charcoal from the five prehistoric sites in question.

Oxenham stresses the evidence from Vietnam, of an eruption of Neolithic settlement from about 2000 BC, and has not found the alternative long chronology model (LCM) convincing. He draws particular attention to the remarkable vessel 1 from burial 28 at the Vietnamese Neolithic site of Man Bac that seems to resemble the form of a Shang Dynasty drum. If this were indeed the case, it would lend strong support to the short chronology model (SCM) by placing this cemetery in the later second millennium BC. He also refers to the issue of heterarchical or hierarchical social organisation as being a debate in itself as to which is the more valid. In my view, one can have both: a hierarchy can exist within a heterarchical context. Certainly, Oxenham's wish to view such ideas with fresh eyes reflects precisely my comment that once the chronology is in place, one can move on to more interesting issues.

Bellwood agrees that, in his words, chronology is the 'master key', and accepts our SCM, again referencing supporting evidence from his Vietnamese sites. He also notes that "the suggestion that indigenous hunter-gatherers still occupied Ban Non Wat in the early Neolithic requires more of a leap of faith, given that no cranial analysis has been undertaken on the relevant flexed Neolithic 1 burials" (pp. 1224–25). When excavating Ban Non Wat, we encountered 12 burials in which each individual was interred in a flexed position. The few mortuary offerings were quite distinct from the extended supine early Neolithic burials. One plain pottery vessel was found, together with a stone adze and shell beads unmatched elsewhere in my experience. Given that a flexed position is characteristic of most hunter-gatherer groups in Southeast Asia, I consider it necessary to explore the possibility that the flexed individuals might also represent hitherto elusive hunter-gatherers on the Khorat Plateau. To this end, we have employed isotopes to identify possible immigrants and evaluate their diet. The results so far indicate that some came to the site from elsewhere, and had a diet that probably did not include rice. Preliminary results of cranial variation analysis, however, have failed to reveal any significant differences from the early Neolithic. The jury is currently out on this issue, but I would emphasise that I do not consider all flexed burials to come from indigenous hunter-gatherers.

Bellwood also explores inputs other than metallurgy to explain the sudden dramatic rise in mortuary wealth seen at Ban Non Wat with the initial Bronze Age. He asks (p. 1225):

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"Were the initial roots of this efflorescence of apparent ranking connected with factors of land ownership and food production, rather than being a result of metallurgy?" This is indeed a most interesting possibility. A millennium after the initial Bronze Age, I have cited irrigation, ploughing and the ownership of improved land to explain a second sharp social change towards the end of the Iron Age (Higham 2014). I have found no evidence, however, that a similar event took place with the initial Bronze Age and prefer at present, at least, the proposition that the potential to gain social leverage came through the ownership not only of copper artefacts, but also exotic stone and marine shell ornaments, doubtless along with other items that have not survived. Rice surpluses and animals, such as domestic cattle, might also be in question (Higham 2011).

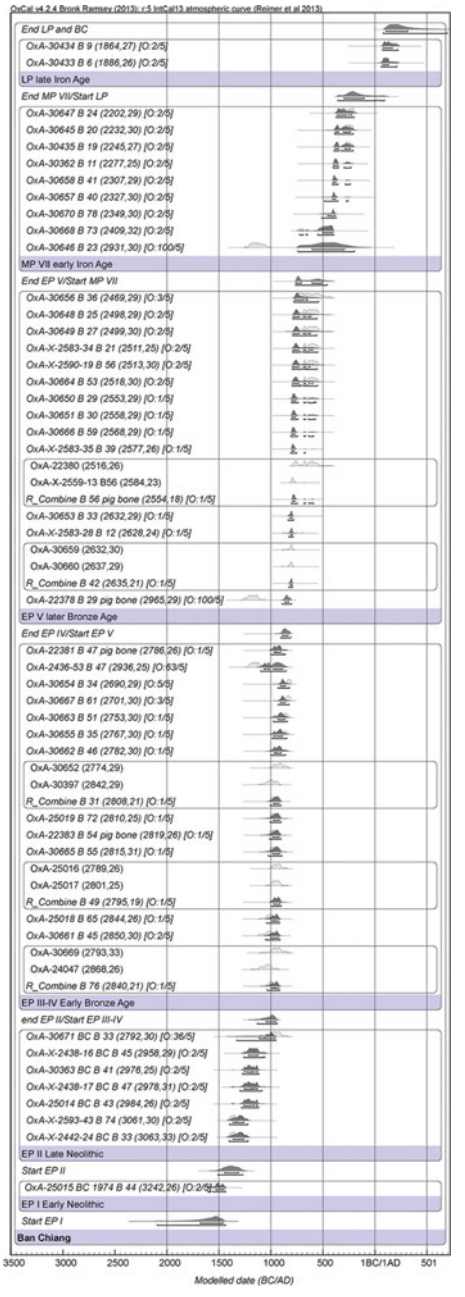

Figure 1. Probability distribution of dates relating to the cultural sequence of Ban Chiang (OxCal. v4.0.5 Bronk Ramsey (2001 [36]); r:5 IntCal04 atmospheric curve (Reimer et al. 2004 [37]).

Pryce concludes that continued objection to the SCM by a minority of colleagues is not realistic, but also notes that much of the new evidence cited comes from a cluster of sites in north-east Thailand. My research, however, is designed to cover all mainland Southeast Asia and southern China. I have obtained determinations from key sites in Central Thailand, and further samples are being dated from Vietnam, Myanmar and China. The results currently available, which will be published in due course, support the SCM.

In contrast, White questions the validity of the new radiocarbon determinations and the Bayesian statistics that we have used to identify, with high precision, the start and end periods of the multiple-phase Neolithic to Iron Age sites in question (Figure 1). My research has been designed precisely to remedy the previous problems of imprecision. White raises a series of technical concerns underlying her resistance to the results of multiple new, third-generation Bayesian radiocarbon determinations.

The first of these is the assertion that the shell determinations from Ban Non Wat were not checked for contamination. This was, however, checked in the ORAU prior to

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any shell carbonates being dated, as stated in Higham and Higham (2009), by using Feigl's solution, which tests for the presence of secondary calcite on aragonitic carbonates. All available information, both on the sites and their chronology, has been published, including the source material for each date from Ban Non Wat. Furthermore, leaving aside the shell dates, it should not be overlooked that 25 of the 53 determinations for Ban Non Wat come from well-contextualised charcoal samples that fit consistently within the overall Bayesian model. If, as White suggests, the former should be *termini ante quem*, the latter are presumably *termini post quem*. But the results are virtually identical in almost all cases.

Other technical issues concerning the reliability of the new dates are also refuted. The articles by Webb *et al.* (2007) and Busschers *et al.* (2014) are concerned with the dating of Pleistocene age shells close to the limit of the method (30 000–50 000 years ago) and beyond, from locations in Australia and the North Sea. Neither of these cases is relevant to Ban Non Wat, in terms of location, site geochemistry or age. The claim that the soil chemistry of Ban Non Wat contains extremely high magnesium levels that would affect shell preservation and cause the precipitation of younger carbon in the shell structure is contradicted by the data of King *et al.* (2011). Similarly, in the case of bone collagen contamination, the paper of Fiedel *et al.* (2013) describes the challenge experienced by four AMS laboratories in dating a highly contaminated 11 000 BP elk bone from Germany. This specimen was found in waterlogged and humic-rich dark sediments. The bone was almost black and tar-like due to this burial environment and the collagen was excessively contaminated by cross-linked humic compounds. Apart from being much younger in age, within the first radiocarbon half-life, and with nothing exceptional in their appearance, the collagen quality of the Ban Chiang bones was assessed at all stages of the AMS dating as being acceptable. Furthermore, amino acid profiles were not necessary because such profiles uniformly show a consistent composition of amino acids until the bone is reduced to <0.5% weight collagen, after which the profiles sometimes show slightly lowered levels of some of the amino acids. This is not a useful method for assessing collagen quality in routine bone dating (see van Klinken 1999).

The AMS determinations that form the basis of the SCM are considered to be reliable and reproducible. Science, of course, is all about testing hypotheses and exploring alternatives and to this end I have now obtained more than 160 determinations on bone collagen, charcoal and shell from five Thai sites, and I continue to expand this project to many more sites in several other Southeast Asian countries. The results do not by any means falsify the model that I have published.

The alternative to the SCM is based upon seven dates from Ban Chiang (selected from a total of 20 from that site), supported only by an interpretation of the chronology for Non Nok Tha that is now superseded by our new human collagen results. The seven Ban Chiang dates come from an experimental attempt to date carbon in potsherds, employing a technique now viewed as unreliable due to the unquantified amount of old carbon in the clay and the, as yet unpublished, very high combustion temperature involved. The remaining 13 determinations have been ignored, as being unrealistically early or inconveniently late (Glusker & White 1997).

There is nothing "selected, simplified, and flawed" about 168 samples covering the cultural sequences in the five sites that I have chosen for dating, nor have I chosen them "to fit pre-determined social and chronological models". I am not the only person to use the

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Three Age system, criticised as being 'Eurocentric': all four respondents employ them either in this debate or elsewhere (e.g. White 1982; White & Hamilton 2009: 357).

Furthermore, the bone dates for Ban Chiang and the shell dates for Ban Non Wat agree in placing the initial Bronze and Iron Ages at each site virtually within the same century, with identical spans. The incised and impressed (I & I) Neolithic ceramics from the four sites in question also fall within the same centuries. Detailed inter-site comparisons of vessel forms and motifs await the publication of relevant data from Ban Chiang.

I am convinced that one has to open very large areas of prehistoric sites in north-east Thailand to come to grips with what was actually happening in prehistory. Our excavations at Ban Non Wat lasted for two years over seven seasons. Identifying three early phases of immensely wealthy Bronze Age burials was a sea change in our understanding of this period. I do not believe that I "[ignore] the evidence that metal production in prehistoric Thailand was decentralised and community-based with no evidence of elite control" as White alleges (p. 1232). Looking constructively to future research, and conscious of the tiny areas of the production sites that have been excavated, we do need to strengthen research into the social organisation of copper extraction, and explore whether elites also controlled mining, smelting and the exchange of ingots.

In summary, I am much encouraged by the generally positive and constructive comments of my fellow debaters. I conclude that these new dating determinations constitute a welcome advance, taking us beyond the "chronological fuzziness" (White 2008: 101) that Southeast Asian archaeologists have hitherto been obliged to tolerate, opening up new issues to pursue.

References

Bronk Ramsey, C. 2001. Development of the radiocarbon calibration program OxCal. *Radiocarbon* 43: 355–63.

Busschers, F.S., F.P. Wesselingh, R.H. Kars, M. Versluijs-Helder, J. Wallinga, J.H.A. Bosch, J. Timmner, K.G.J. Nierop, T. Meijer, F.P.M. Bunnik & H. De Wolf. 2014. Radiocarbon dating of late Pleistocene marine shells from the southern North Sea. *Radiocarbon* 56: 1151–66. http://dx.doi.org/10.2458/56.16505

Fiedel, S., J.R. Southon, R.E. Taylor, Y.V. Kuzmin, M. Street, T.F.G. Higham, J. van der Plicht, M.-J. Nadeau & S. Nawalade-Chavan. 2013. Assessment of interlaboratory pretreatment protocols by radiocarbon dating an elk bone found below Laacher See tephra at Miesenheim IV (Rhineland, Germany). *Radiocarbon* 55: 1443–53. http://dx.doi.org/10.2458/azu_js_rc.55.16239

Glusker, D. & J.C. White 1997. Comment. *Archaeometry* 39: 259–60.

Higham, C.F.W. 2011. The Bronze Age of Southeast Asia: new insight on social change from Ban Non Wat. *Cambridge Archaeological Journal* 21: 365–89. http://dx.doi.org/10.1017/S0959774311000424

Higham, C.F.W. 2014. From the Iron Age to Angkor: new light on the origins of a state. *Antiquity* 88: 822–35. http://dx.doi.org/10.1017/S0003598×00050717

Higham, C.F.W. & T.F.G. Higham. 2009. A new chronological framework for prehistoric Southeast Asia, based on a Bayesian model from Ban Non Wat. *Antiquity* 83: 125–44. http://dx.doi.org/10.1017/S0003598×00098136

King, C.L., N. Tayles & K.C. Gordon. 2011. Re-examining the chemical evaluation of diagenesis in human bone apatite. *Journal of Archaeological Science* 38: 2222–30. http://dx.doi.org/10.1016/j.jas.2011.03.023

Reimer, P.J., M.G.L. Baillie, E. Bard, A. Bayliss, J.W. Beck, C.J.H. Bertrand, P.G. Blackwell, C.E. Buck, S. Burr, K.B. Cutler, P.E. Damon, R.L. Edwards, R.G. Fairbanks, M. Friedrich, T.P. Guilderson, A.G. Hogg, K.A. Hughen, B. Kromer, G. McCormac, S. Manning, C. Bronk Ramsey, R.W. Reimer, S. Remmele, J.R. Southon, M. Stuiver, S. Talamo, F.W. Taylor, J. van der Plicht & C.E. Weyhenmeyer. 2004. IntCal04 terrestrial radiocarbon age calibration, 0–26 cal kyr BP. *Radiocarbon* 46: 1029–58.

https://doi.org/10.15184/aqy.2015.128 Published online by Cambridge University Press

VAN KLINKEN, G.J. 1999. Bone collagen quality indicators for palaeodietary and radiocarbon measurements. *Journal of Archaeological Science* 26: 687–95.

WEBB, G.E., G.J. PRICE, L.D. NOTHDURFT, L. DEER & L. RINTOUL. 2007. Cryptic meteoric diagenesis in freshwater bivalves: implications for radiocarbon dating. *Geology* 35: 803–806. http://dx.doi.org/10.1130/G23823A.1

WHITE, J.C. 1982. *Ban Chiang. The discovery of a lost Bronze Age*. Philadelphia: University of Pennsylvania Press.

– 2008. Dating early bronze at Ban Chiang, Thailand, in J.-P. Pautreau, A.-S. Coupey, V. Zeitoun & E. Rambault (ed.) *From* Homo erectus *to the living traditions:* 91–110. Bougon: European Association of Southeast Asian Archaeologists.

WHITE, J.C. & E.G. HAMILTON. 2009. The transmission of early bronze technology to Thailand: new perspectives. *Journal of World Prehistory* 22: 357–97.

https://doi.org/10.15184/aqy.2015.128 Published online by Cambridge University Press