Kings, tree rings and the Old World

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Chronologies of the earliest history of the Near East have depended on interpretation of lists of Egyptian kings and such. But the best prospect for an absolute timescale lies in dating wood from Anatolia (modern-day Turkey).

THE goal of constructing a precise, reliable chronology for the archaeology of the eastern Mediterranean, based on tree-ring dating and supported by radiocarbon determinations, is now clearly in sight. It is Anatolia that has yielded the necessary samples of ancient wood. So when the Anatolian tree-ring sequence can confidently be used to give absolute dates for the time range from 3000 BC, the entire prehistoric and early historic chronology of Egypt and the Near East will have to be revised, using the more secure chronological framework that dendrochronology can offer.

On page 780 of this issue[1], a team from Cornell, Heidelberg and Reading present the latest work towards anchoring the 1,503-year floating dendrochronology produced for Anatolian wood samples over a time span covering the whole of the second millennium BC, and several further centuries both before and after. Kuniholm *et al.*[1] use radiocarbon-based 'wiggle-matching' to try to fix the absolute dates for this floating sequence more precisely. (Wiggle-matching involves matching specific irregularities on the master tree-ring calibration curve with irregularities in a series of known-interval radiocarbon dates from a given archaeological wood sample.) A second step in their argument is to equate an exceptional growth event recorded in trees at Porsuk in south-central Anatolia with a widely recognized special marker event seen at 1628 BC in the already well-established tree-ring chronologies for the Northern Hemisphere. If correct, this would indeed anchor their Anatolian chronology to within a single year, with wide-ranging archaeological consequences. In the last section of their article, they revive the suggestion that the cause of this special marker event was the volcanic eruption of the island of Thera, near Crete, during the Aegean late Bronze Age[2] thereby rekindling an already heated archaeological controversy[3].

There is nothing more tantalizing than a 'floating' tree-ring chronology, Secure overlaps may be obtained from long-lived wood samples from a number of sites, so that relative ages are securely established, with a precision of just a year or so. But to 'anchor' a floating chronology securely, a continuous sequence of samples spanning the entire period ranging back from the present to the time in question is ideally required. This task, which is indeed the long-term objective of the Cornell Dendrochronology Laboratory, will one day be accomplished. But meanwhile, the much less precise technique of radiocarbon dating must be invoked in place of a secure and precise absolute dating. It can be made more precise by using it as a link, through the technique of wiggle-matching[4], to existing long tree-ring sequences, which are now available in Europe (both from Irish[5,6] and Central European oak[7] and in the United States (bristlecone pine[5,6]).

Kuniholm and his colleagues have been remarkably successful in obtaining wood and charcoal samples from a wide range of archaeological contexts in Anatolia and the Aegean[8]. Their absolute tree-ring sequence now runs back from the present to AD 362, allowing the precise dating of a whole range of early Byzantine buildings. In addition, they have further floating sequences before the 1,503-year Bronze and Iron Age sequence discussed in this issue. Among these is a 570-year floating chronology for the early Neolithic site of Çatalhöyük (dated from about 7000 BC to about 6500 BC by radiocarbon determination) and a 300-year floating sequence from the important Turkish site of Arslantepe, which has strong links with the Uruk culture of Mesopotamia around 3000 BC. One day, these floating chronologies will be integrated into, and form part of, a master absolute chronology for Anatolia and the Near East, on which the remainder of the absolute dating for much of Old World later prehistory and early history will come to rest.

Already, many scholars will be content to use the arguments presented here by Kuniholm *et al.* as the basis for an absolute chronology which, following their wiggle-matching and their long-range special marker link for 1628 BC, can currently be given a beginning in 2220 BC and an end in 718 BC (until the chronology can be lengthened by further relevant tree-ring samples from suitable archaeological deposits). In the first place, their chronology naturally dates those Anatolian sites from which their samples come, most notably the Old Assyrian trading station at Kültepe for the earlier part of the time range, and the great burial mounds at Gordion for the later part of the range (see photograph). Hitherto, the *karum*[9] (trading centre) at Kültepe has been dated by the documents there, written on clay tablets, which allow synchronisms to be established with the historically based Old Assyrian chronology of the Near East. But the stage is now being reached at which the greater precision, and perhaps the greater reliability, of the Anatolian tree-ring chronology will lead to a reversal of the procedures of dating.

Hitherto, it has been the historical chronologies of Egypt and the Near East, laboriously worked out by generations of scholars through careful interpretations of the Egyptian and Near Eastern king-lists and annals (with all their various problems of historical exegesis), which have offered the bedrock for the absolute chronology of

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The Midas Mound tumulus at Gordion, which lies about 100 km southwest of Ankara in Turkey and was constructed around 718 BC. The mound is made-made and massive (53 m high), and contains a burial chamber for a wealthy man — hence the Midas connection. Tree-ring data from timbers inside the mound provided the foundation of the chronology of Kuniholm and colleagues[1], which runs from 2220 to 718 BC.

the eastern Mediterranean[10,11]. Areas such as Anatolia, which could be considered peripheral, and which certainly lacked sufficient written records to offer an independent chronological system, were inevitably dated on the basis of the links which could be established with those well-dated areas of Egypt and the Near East.

All this is now on the brink of being reversed. As soon as we are entirely confident that the Anatolian absolute chronology is soundly based, it will offer a more secure and a more precise chronological route. Anatolia will be the chronological 'known', and the historical chronologies of Egypt and the Near East will assume a secondary status, being calibrated according to the links which they can establish with what will in future be the primary area for the master chronology.

But has that day yet been reached? The wiggle-matching, based on 18 radiocarbon determinations made in the Heidelberg laboratory on samples from a single juniper log from the Midas Mound tumulus at Gordion, looks sound enough, but not as precise as one might wish. Kuniholm *et al.* claim that the chronology is anchored by the "remarkable growth anomaly", seen in the 36 trees from Porsuk in south-central Anatolia, which they choose to equate with the major growth anomalies at 1628/1627 BC in Europe and the United States. But before re-structuring the entire chronology of the Near East on the basis of the new primacy of this Anatolian chronological system, we must ask just how compelling is this equation between the Porsuk growth event and the widespread event of 1628 BC?

The generally accepted explanation for the 1628 BC event is that it was caused by a major volcanic eruption, providing a dust mantle which drastically reduced solar radiation reaching the Earth's surface, thus generally impairing tree growth, and leading to the frost damage seen in 1627BC in the Californian bristlecone pines". What Kuniholm *et al.* have not sufficiently explained is how this dust mantle will have produced the "remarkable growth anomaly", where the individual juniper trees put on annual rings greater in width than normal growth by a factor between 3 and 8. They argue that this came about through "unusually high and sustained soil moisture content and a sharp reduction in mid-summer evapotranspiration". Such may have been the case, but a fuller explanation of the Porsuk growth event is clearly needed before it can be accepted as the product of a reduction of received solar radiation.

Kuniholm *et al.* complicate the story further by reasserting the long-standing suggestion[12] that the special Northern Hemisphere marker event of 1628 BC was itself caused by the eruption of Thera, conventionally dated more than a century later than this. The alternative cause might be an as yet unidentified volcano, whether in Iceland or Alaska or elsewhere in the Northern Hemisphere. Recently the advocates of the conventional (lower) chronology have taken great comfort from the discoveries of pumice[13], presumably deriving from the great eruption at Thera, in strata which follow those of the late Hyksos palace recently unearthed at Tell Dab'a in Lower Egypt. Deposits associated with that palace contained fragments of fresco paintings of Minoan character closely resembling some of those found in Thera and dating from the period there immediately before the great eruption[14].

Because these pumice finds seem to link the Theran eruption securely with a time at the beginning of the XVIIIth dynasty of Egypt (usually[15] set at about 1550 BC), to adopt the date of 1628 BC proposed by Kuniholm *et al.* would imply very substantial changes to the historical chronology of Ancient Egypt. That cannot be ruled out, but such changes would need to be based upon more than a suppositious correlation between the Thera eruption and the 1628 BC event seen in the Northern Hemisphere tree rings and ice cores (although the ice cores were initially interpreted[16] as indicating a global event at 1645 BC). One grain of Theran tephra at the appropriate point in a single Greenland ice core would be enough to establish a sound link going beyond mere supposition. Alternatively, an unassailable causal link between the Theran eruption and the growth anomaly in the Porsuk trees would do very nicely.

Until we have these necessary linking data, there is too much supposition in the arguments for one to feel that all doubt has been banished. One day we shall have such data, and very probably it will be provided by Kuniholm and his colleagues in the Cornell laboratory. Their work offers the best hope we have for a really sound chronology for the later prehistory and history of the Near East and Egypt, and indeed the eastern Mediterranean in general. But their work is not yet complete.

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1. **Kuniholm. P. I.** *et al.* **Nature 381,** 780-783 (1996).
2. **Hardy, D. A. & Renfrew, A. C. (eds)** *Thera and the Aegean World III Vol. 3, Chronology* (Thera Foundation, London, 1990).
3. **Discussion. in** *Thera and the Aegean World III* Vol. 3, Chronology (**eds Hardy, D.A. & Renfrew, A. C.)** 236-241 (Thera Foundation, London, 1990).
4. **Manning, S. W. & Weninger, B.** *Antiquity 66, 636-663 (1992).*
5. **Stuiver, M. & Pearson, G. W.** *Radiocarbon 35 I-24 (1993).*
6. **Pearson, G. W. & Stuiver, M.** *Radiocarbon 35, 25-35 (1993).*
7. **Becker, 6.** *Radiocarbon 35,201-213 (1993).*
8. **Kuniholm, P.** I. **in** *Aspects of Art and Iconography: Anatolia and its Neighbors. Studies in Honor of Nimet Özgüç* (eds. Mellink. M. J., Özgüç T. & Porada, E.) 371-374 (Turkish Historical Society, Ankara, 1993).
9. Lewy, **H. in** *Cambridge Ancient History* **I Pt** *2* **(eds Edwards, I. E. S., Gadd. C. J. & Hammond, N. G. L.)** 707-728 (Cambridge Univ. Press, 1971).
10. **Edwards, I. E. S., Gadd. C. J. & Hammond, N. G. L. (eds)** *Cambridge Ancient History I* Pt2 (Cambridge Univ. Press, 1971).
11. **Edwards, I. E. S.. Gadd, C. J.. Hammond. N. G. L. & Sollberger. E. (eds)** *Cambridge Ancient History II* Pt 1 (Cambridge Univ. Press, 1973).
12. **Renfrew, C. & Bahn, P.** *Archaeology: Theories, Methods and Practice* 153-156 (Thames & Hudson. London, 1996).
13. **Discussion.** *Egypt and the Levant 5. 129-132 (1995).*
14. **Bietak, M. & Marinatos, N.** *Egypt and the Levant 5, 49-62 (1995).*
15. **James, T. G. H. in** *Cambridge Ancient History II* Pt 1 **(eds Edwards,** I. **E. S., Gadd, C. J. Hammond, N. G. L. & Sollberger, E.)** 299 (Cambridge Univ. Press, 1973).
16. **Hammer, C. U., Clausen, H. B., Friedrich, W. L. Tauber, H.** *Nature* **328,** 517-519 (1987).