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The Prehistoric Aegean: Dendrochronological Progress as of 1995

Peter Ian Kuniholm

1. General Nature, Significance, and History of this Project:

The work of the Aegean Dendrochronology Project has been for 23 years and continues to be the building of long tree-ring chronologies for the eastern half of the Mediterranean with the aim of helping to bring some kind of rational order to Aegean and Near Eastern chronology from the Neolithic to the present (Kuniholm 1993, 1996); Kuniholm and Kromer (in press (Sofia)); Kuniholm and Newton 1990; Kuniholm and Striker 1983, 1987). See the summary bar graph (Fig. 1), map (Fig. 2), and crossdating grid (Fig. 3) of the Project's achievements as of Autumn 1995 for reference throughout this narrative. The numbers, whether for sites visited, sites dated, or length of chronologies built, speak for themselves. The net 6500 years of tree-ring chronologies shown on the bar graph are a composite of over eight million microscope measurements made by 400 Project participants in well over 50,000 hours of lab time.

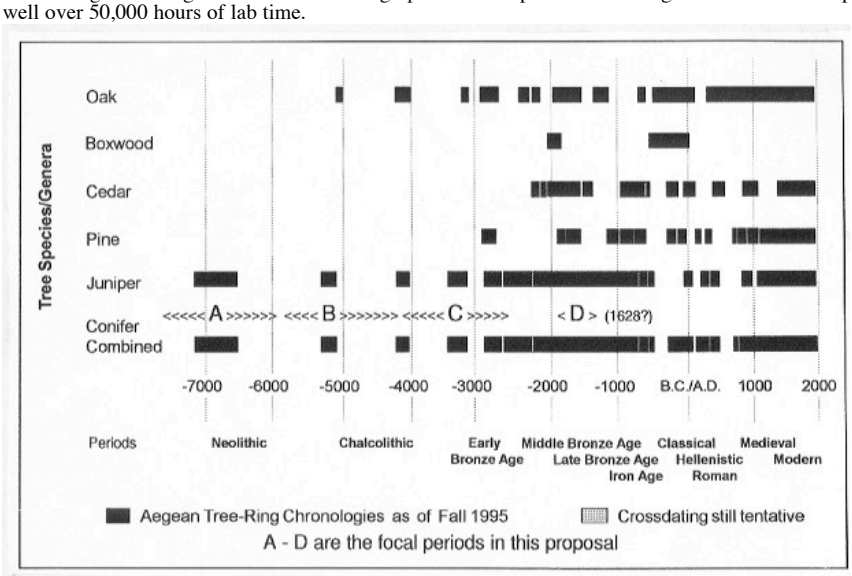

Figure 1: Bar-graph of Aegean tree-ring chronologies as of Fall 1995.

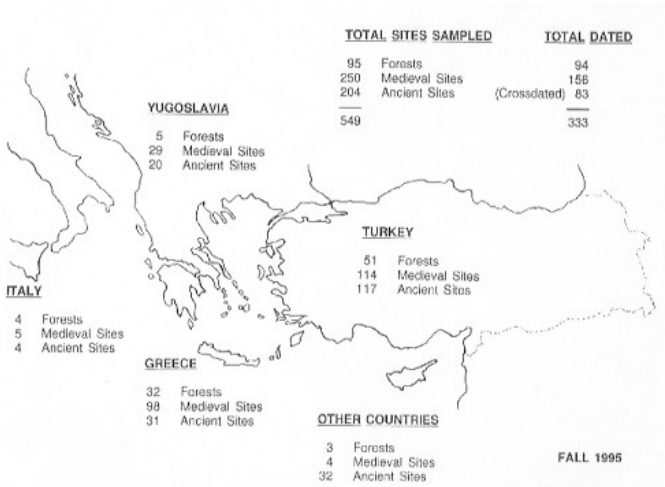

Figure 2: Sites sampled and dated by the Aegean Dendrochronology Project as of Fall 1995.

Figure 3: Quality of Crossdating among Aegean Trees

Species	t-score (parametric)	Years of overlap (n=)	Trend Coefficient (non-parametric)	D-score [t-score + (trend% - 50%)]
Oak vs. Pine	11.62	841	64.4%	167.3
Pine vs. Juniper	10.31	841	59.9%	101.9
Oak vs. Juniper	9.87	886	59.2%	90.9
Juniper vs. Cedar	7.42	619	67.6%	130.8
Oak vs. Cedar	5.92	619	57.6%	45.0
Pine vs. Cedar	4.59	619	58.6%	39.4

These chronologies did not develop in any logical order. Rather, we have worked on whatever seemed most important or useful in the annual excavations of over 300 teams who work in the Aegean and who provide us, as it is unearthed, with the material which we then study. Indeed, we have found Chalcolithic wood while looking for Byzantine, and vice versa. We feel that important progress has been made on all fronts in the past several years, and it is time to report in some detail the prehistoric part(s) of our sequence.

2. Specific Focus of this Report:

Four critical periods in prehistory (shown with arrows marked A-D on the bar-graph, Fig. 1) deserve attention, both for what we have already developed and for what we expect to be able to collect during the next several years. They are all characterized by several common features: 1) they are periods of major archaeological/anthropological significance; 2) they have already been partly studied and published, so there is already a significant base of information available, both chronological and non-chronological, on which to build; 3) we have already developed dendrochronological sequences several centuries long which are suitable for extension and connection; 4) at least a dozen archaeological excavations are currently being conducted on major sites from each period which means that interpretations will not be limited to results from a single site; and 5) there is an excellent likelihood that wood or charcoal will be forthcoming for dendrochronological analysis. Thus, there is the distinct possibility of linking periods, even though the spans of time are considerable. We report here both what has been accomplished and what prospects we have for the immediate future.

PERIOD A. NEOLITHIC

KEY SITES: Çatal Höyük (576 year chronology); Kösk Höyük (224 year chronology and counting); Asikli Höyük; Hallan Çemi; Çayönü; Kastoria/Dispilio (300+ Late Neolithic samples expected in 1997); Yumuktepe/Mersin; Bademagaci; Asagipinar; Ilipinar; Kumtepe; Amuq Survey. All are expected to produce material for us.

The so-called Neolithic Revolution seems to get longer with each passing year. What was studied as a possibly 1000 year period only 25 years ago appears now to be at least three or four times as long, now that a group of radiocarbon dates from aceramic Asikli Höyük cluster in the 10th millennium BP (uncalibrated) (Esin, unpublished) and ten radiocarbon dates from aceramic Hallan Çemi cluster in the last half of the 11th millennium BP (uncalibrated) (Rosenberg, 1993). The transition from hunting and gathering to settled communities was, apparently, a far more leisurely process than anyone could have guessed 25 years ago.

PRIME EXAMPLE: Central to any dating of the Neolithic, either dendrochronological or radiocarbon, is Çatal Höyük. Maryanne Newton is just about finished with J. Mellaart's wood from Neolithic Çatal Höyük after measuring and analyzing some five hundred very nasty charcoal fragments left over from the radiocarbon work at MASCA/University of Pennsylvania in the early 1960's (Stuckenrath and Ralph, 1965; Stuckenrath and Lawn, 1969; Mellaart, 1967) and kindly furnished to us by the excavator. She has built a 576 year tree-ring chronology (Fig. 4) which she has kindly furnished for this paper (the graphic is quite large, however, so you might have to use your arrow keys to get a full view of the information). The new excavations by Ian Hodder at Çatal Höyük should refine the phasing and add significantly to the sequence. Note that in the absence of bark the end-dates for the different levels are not in fall-back order. The apparent anomalies should be straightened out in Hodder's next several campaigns.

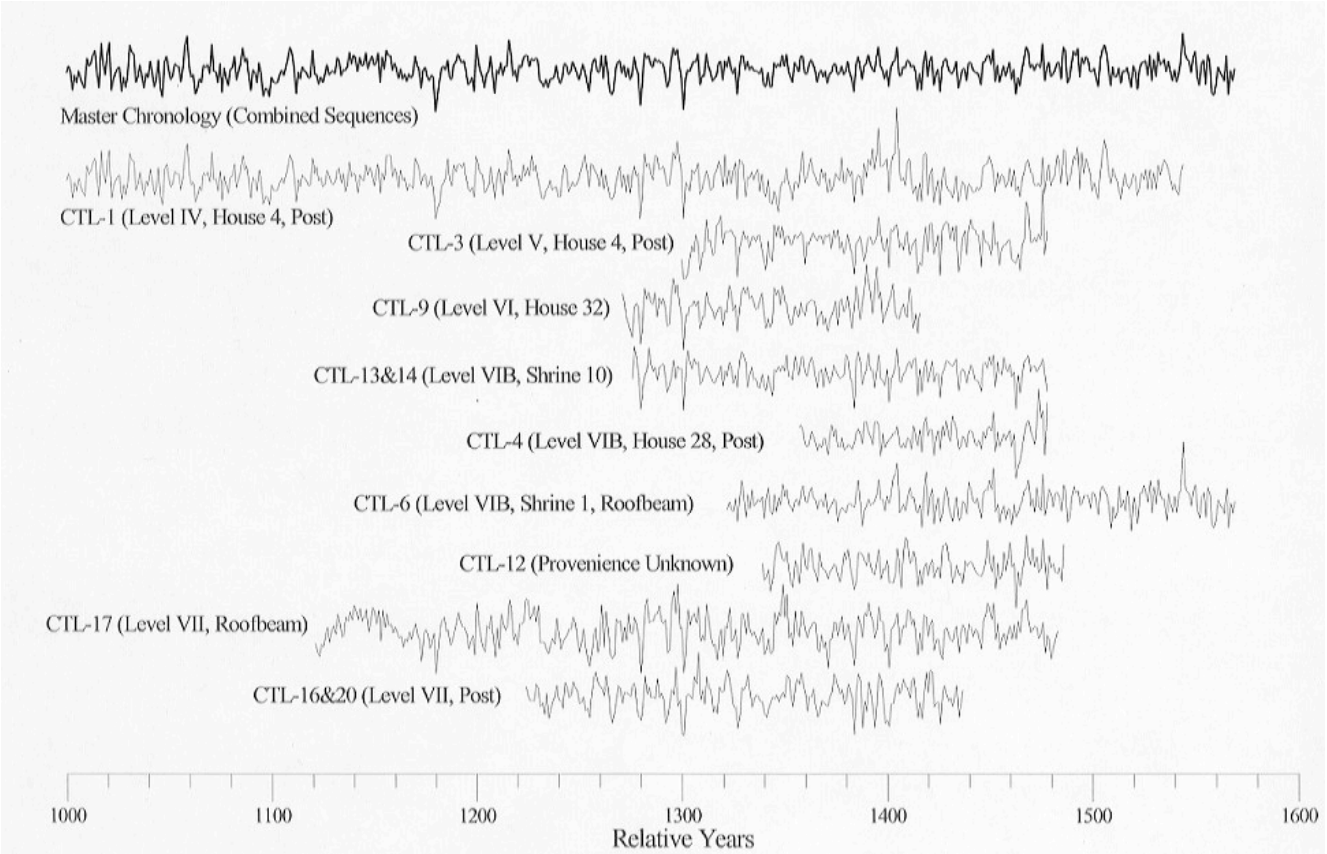

Figure 4: 576-year juniper ring chronology from several occupation levels at Neolithic Çatal Höyük (figure courtesy M. W. Newton).

Since nobody has any idea of which rings were used for the original MASCA radiocarbon measurements at Çatal Höyük in the early 1960s, Miss Newton's next step was to sacrifice some of the charcoal, cutting it into numbered ten-year segments. These fragments were too small for normal 14C dating, so they were sent to the Accelerator Mass Spectrometry (AMS) Laboratory at the University of Arizona for wiggle-matching. Lots A and B from the extreme ends of the Çatal Höyük ring-sequence (Fig. 5) fit roughly at 7020 B.C.±50 years and 6500 B.C.±100 years. Now we have selected eight more lots (C through J) to see whether the dates the Arizona physicists obtain will fit the morphology of the radiocarbon curve. If this works out as expected, we should be able to report in several months a wiggle-matched series that is pinned down to something like ±40 years (±30 if we are lucky). Miss Newton expects to finish her M.A. thesis on "The Dendrochronology of Çatal Höyük" this term depending on when we get the results of the last batch of accelerator dates and when she defends her thesis. This will be the starting point for all Anatolian/Near Eastern/Aegean Neolithic dendrochronological dates from now on. Dr. Hodder has promised 100% retrieval of charcoal fragments, and his example should spur on his colleagues at at least 11 other sites. Indeed, last summer we were given 222 samples from Late Neolithic Kösk Höyük (Öztan and Faydali, in press (Ankara)), and the Kösk ring sequence is already over 224 years and rapidly growing. Miss Newton was on the staff at Çatal Höyük last summer, and we expect to have a Project member there for as long as Hodder keeps excavating.

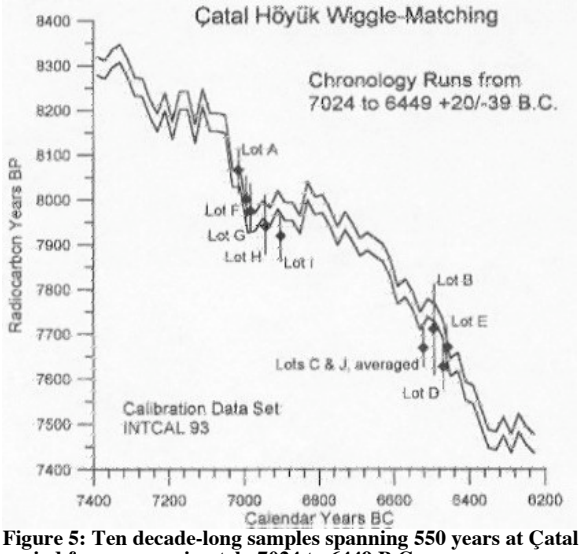

Figure 5: Ten decade-long samples spanning 550 years at Çatal Höyük have been successfully wiggle-matched so that the chronology covers the period from approximately 7024 to 6449 B.C.

Even in this preliminary state, this is a remarkable improvement on what we have had until now for any stratified Neolithic site (cf. van Andel and Runnels, 1995, where their best starting dates for the Thessalian Neolithic are EN 7000, MN 6000, LN 5500). We think we can do better than that. Not only will the new dendro dates provide a precision hitherto inconceivable, but the wood and the calibrated dates might even help clear up some problems and debate with the radiocarbon calibration curves themselves, especially if we were to work up our own calibration curve for the Aegean.

PERIOD B. CHALCOLITHIC:

KEY SITES: Arslantepe (298 year chronology, and more expected); Sozopol (224); Can Hasan (212 plus six additional chronologies); Hacilar (159); Kuruçay (94); Seyitömer (88, but much more expected); Beycesultan (50); Hacinebi; Ilipinar; Hassek Höyük; Kazane Höyük; Bulgarian Eneolithic sites. At least nine Chalcolithic excavations are actively in progress.

The Chalcolithic means different things to different scholars: at worst, a vague period of uncertain length (5th? 5th/4th? 4th? millennia B.C.) between Neolithic and Early Bronze; at best, the consolidation in sedentism, agriculture, and domestication after their establishment in the Neolithic; a whole transformation in economy, settlement, and society, (Andreou and Kotsakis, 1986); as well as the emergence of such industries as incipient metal-working (at least that of arsenical bronze at Arslantepe) (Frangipane, 1993); and see now Nakou (1995) for changes in deposition practices and 'use' of metals in the 4th-3rd millennia B.C. The Chalcolithic is thus an important, even if almost totally dark, age which might be said to lack any chronology at all.

PRIME EXAMPLE: After six years of trying to obtain long-lived specimens from the Late Uruk site of Malatya, Arslantepe (Level VIA, late 4th millennium B.C.) (Frangipane, 1983-1994), and getting nothing more than a few decades of wood per sample, we were rewarded in 1994 by a splendid set of finds from Temple B, almost all of them carbonized fragments of juniper, totalling 298 years and ending in bark. The number of fragments we had to measure in order to build this chronology was more than 400. Our best guess is that a minimum of a dozen very long- lived trees are represented. Since we do not yet have comparative material from the late fourth millennium B.C. with which to try to crossdate the Arslantepe sequence, we have sent seven sets of specifically selected and numbered decade- long samples to Arizona for AMS dating and subsequent wiggle-matching (Fig. 6). The radiocarbon samples from Arslantepe Level VIA until now have ranged from around 3300 to 3000 B.C. We now have a construction date for Temple B at 3374±8 B.C.(at 1 sigma) or 3374±30 B.C. (at 2 sigma). This in turn will form the foundation for any future fourth millennium B.C. crossdating.

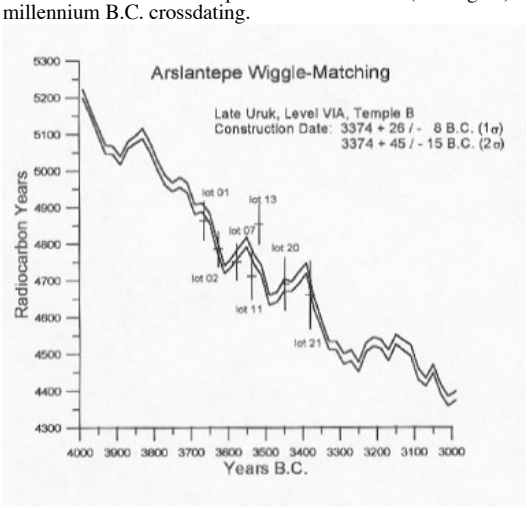

Figure 6: Seven wiggle-matched samples from Arslantepe Level VIA show that Temple B was constructed in approximately 3374 B.C.

PERIOD C. EARLY BRONZE AGE:

KEY SITES: Acemhöyük Early (503 year chronology); Kiten (285); Bent Pyramid at Dashur (265 and 193); Troy I (226); Karahöyük Early (198); Troy II (164) and more coming; Demircihöyük (139); Göltepe-Kestel (104); Arslantepe; Kazane Höyük; Büyüktepe; Ikiztepe, Harmanören; Ilipinar, Üçtepe; Gâvurtepe; Kültepe, Eski Saray; Amuq Survey. Wood from the excavations 60 years ago of Alacahöyük has now been reported in the depot of the Alaca Museum. Over a dozen EBA sites are currently being excavated.

In the Early Bronze Age we find an explosion of sites with 1520 recorded in the latest tabulation (Korfmann, Baykal-Seeher, and Kiliç, 1994), incipient nation-states (Manning, 1995), with records of writing, palatial architecture, increasingly complex exchange systems, even possibly the first documented case of fraud in international trade: Sneferu, the first Pharaoh of Dynasty IV, tells us on the Palermo Stone how he imported 60 shiploads of cedar from the Lebanon. All the timbers in Sneferu's tomb chamber in the Bent Pyramid at Dashur (from which we have two long chronologies) are, however, juniper (Kuniholm, in press (Oxford)).

PRIME EXAMPLE #1: Twenty-four juniper timbers from the Northwest trench at Acemhöyük (two burnt ones were illustrated in our 1993 Annual Report with only a guess as to their possible date which in fact came surprisingly close to the mark) excavated by Prof. Aliye Öztan, mainly longitudinal stretchers inside walls near the floor levels of a series of service buildings, have been combined into a 503-year long chronology. The associated small finds such as pottery, sealings, and the like, were entirely Middle Bronze Age. We were unable to fit this sequence with our existing MBA chronology, so we sacrificed two of the longer pieces and sent them to Heidelberg for radiocarbon wiggle-matching. To our delight they fit right into a five century gap in our long third millennium tree-ring sequences from 2671 B.C. to 2169 B.C.±10 (Fig. 7). Indeed, they probably overlap with the long MBA/LBA/IA chronology announced in previous years (Kuniholm, 1993) by some 50 years, but the overlap is not yet long enough for us to prove it on dendrochronological grounds. Several timbers show signs of burning on one end. Thus, we were able to predict in advance of the 14C results that we were working with reused material.

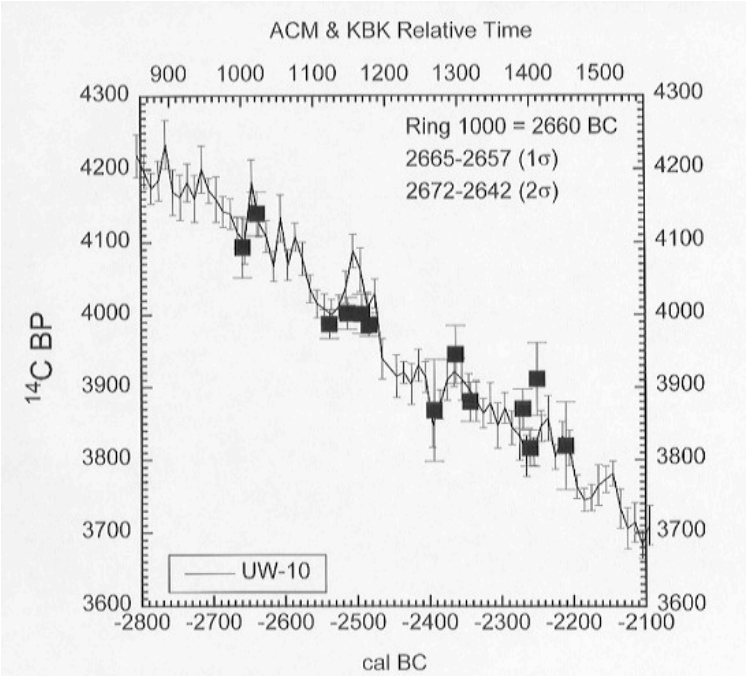

Figure 7: 503-year Acemhöyük Early (EBA) juniper sequence fits into a five-century gap between our long third millennium tree-ring sequences from 2671 to 2169 B.C. Â±10 (fig. courtesy B. Kromer)

We conclude, especially after looking at the distribution of the end-dates, that these timbers must have formed part of perhaps only a single EB III building which was partially destroyed by fire. The wood was recovered and saved for future use. In contrast to the Sarikaya Palace and the Hatipler Tepesi Building nearby, where no reused wood at all was employed, these more humble structures (perhaps kitchens?) are built entirely from recycled material. If the Middle Bronze Age tree-ring chronology with which to compare the dendrochronological results from the Northwest Trench had not existed, and if we had not paid attention to the signs of burning, we might have incorrectly concluded that the MBA belonged in the 22nd century B.C. and earlier,...in other words four centuries too early.

PRIME EXAMPLE #2: An Early Bronze Age settlement now under the waters of the Black Sea near Sozopol yielded a 285 year oak sequence in five phases, now wiggle-matched (Fig. 8) so that phase one is 2778 B.C. ±10 years and phase five is 2715 B.C. ±10 years. The site is thought by the excavators to date from the middle of the Early Bronze Age, or about the same time as Ezero. The decade-long samples of oak which Dr. Kromer measured cluster neatly around a big radiocarbon anomaly in the 29th century B.C. (Kuniholm and Kromer, in press (Sofia)). Note the highly satisfactory way in which Dr. Kromer was able to fit our tree-rings against the radiocarbon curve. The EBA tree-ring chronology from Demircihöyük, excavated by M. Korfmann (Korfmann, 1983-1988; Kuniholm, 1987), dates ten years after the end of Sozopol.

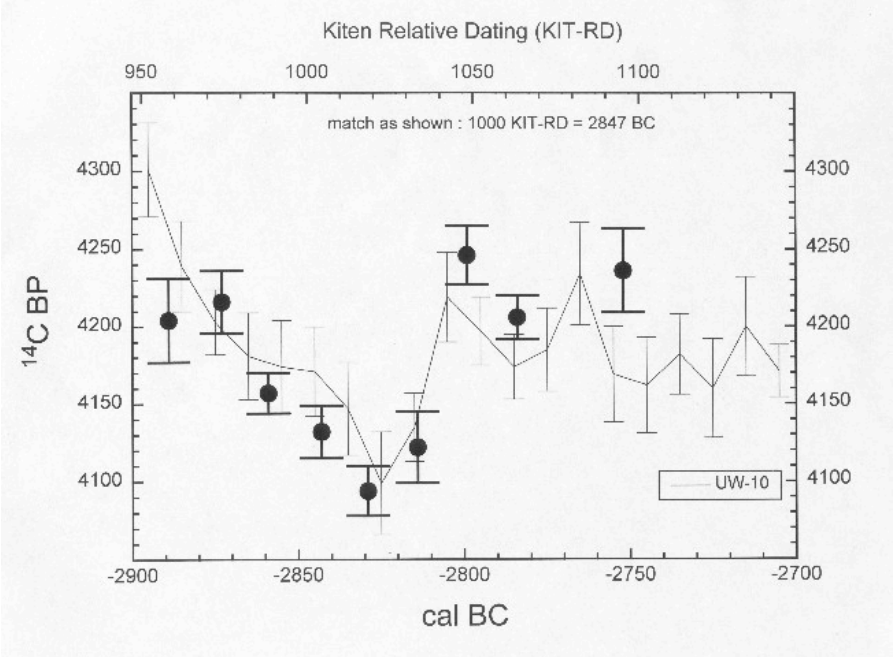

Figure 8: EBA Kiten (Bulgaria) oak rings and the radiocarbon curve. Note the way in which the segments cluster around the big anomaly in the 29th century B.C.

PRIME EXAMPLE #3: Over 150 fragments of *Pinus brutia* from the east side of Schliemann's great trench at Troy (Troy I) were collected and turned over to us by the excavator, M. Korfmann. From them we built a 226-year sequence which again was wiggle-matched successfully by B. Kromer in Heidelberg. The pine chronology at Troy, ending at 2699 B.C.±15, showed an excellent fit around the same 29th century anomaly as did the Kiten oak (Fig. 9) (Korfmann and Kromer, 1993).

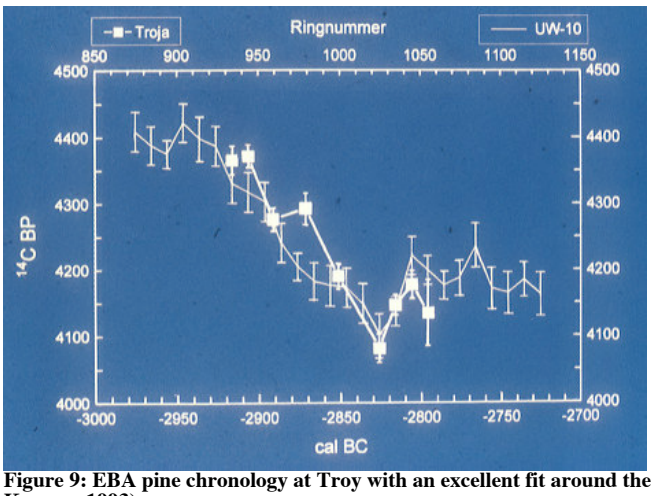

Figure 9: EBA pine chronology at Troy with an excellent fit around the same 29th century anomaly as does the Kiten oak (Korfmann and Kromer 1993).

PERIOD D. MIDDLE BRONZE AGE/LATE BRONZE AGE/EARLY IRON AGE:

KEY SITES: over twenty sites in Turkey, Greece, Syria, Egypt, Cyprus, possibly Iraq (if Saddam goes away), and the Balkans (if they stop fighting) are producing material for us every year.

Here we verge at last on history, where dates that are accurate to the century, even to the quarter-century, are no longer satisfactory. Now we are achieving synchronizations between our tree-ring dates and well-known pottery classes (and their chronologies which are not always in accord with one another) of the Assyrian Colony Period, Minoan, Mycenaean, Hittite, Phrygian, Greek, and Urartian; also with systems of writing, namely the Hittite documentary record (Ortaköy, where the archive now exceeds 2000 tablets, and Bogazköy and Kusakli), the Old Assyrian king-list (Acemhöyük, Konya-Karahöyük, and Kültepe), and the Neo-Assyrian king-list (Ayanis/Agarti) and Çavustepe, with possibilities also at Bastam, Iran, and Karmir-Blur, Armenia). The large quantity of burned wood received last Autumn from Troy VIIA should be of interest not only to the community of Aegean scholars but to the wider community of scholars who concern themselves with prehistory from Europe to Egypt.

Egyptian dendrochronological work has progressed in fits and starts for several years, due in part to curators' nervousness about letting us drill or cut samples. Now that we have found we can crossdate cedar and juniper from the Lebanon, collection of wood samples from the Egyptological reserve collections of museums of the western world (Metropolitan, Brooklyn, Boston, Field, University of Pennsylvania, Oriental Institute, British Museum, Louvre, etc.) has become a serious priority for reasons that follow in the next paragraph.

E. 1993 WIGGLE-MATCHING RESULTS FOR THE LONG BRONZE AGE/IRON AGE CHRONOLOGY:

We have a 1574-year continuous chronology for this period from 2224 B.C.± very little to 651 B.C. This is lower than we claimed in 1993 by some 39 years for two reasons. The first effect of applying the 1993 radiocarbon curve to our data from the Bronze Age and Iron Age was to move the chronology down (i.e., make it more recent) by over three decades from where it had been pinned by the 1986 calibration curve (Fig. 10).

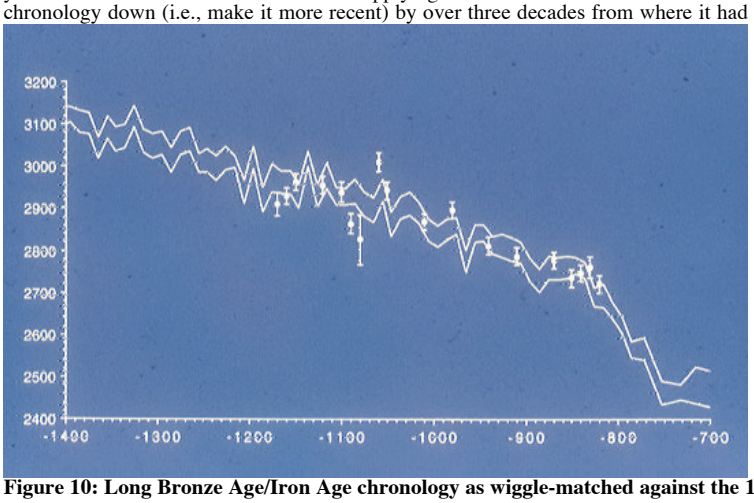

Figure 10: Long Bronze Age/Iron Age chronology as wiggle-matched against the 1993 radiocarbon curve (figure courtesy S.W. Manning).

Secondly, we believe we have evidence of the effect on our tree-ring record of the eruption of Thera/Santorini between 1641 +45/-14 B.C. as wiggle-matched, and more specifically in 1628. A brief outline of this working hypothesis is in press elsewhere (Kuniholm, et al.,1996), and a longer study is in progress (Kuniholm, Kromer, Manning, and Newton, forthcoming), as well as an estimate of what this might mean for Bronze Age/Iron Age dates for the entire eastern half of the Mediterranean.

The whole matter of the absolute placement of this tree-ring chronology bristles with wide-ranging chronological implications for prehistory, proto-history, and history; for traditional pottery chronologies; for interpretation of the Egyptian calendar(s) (Ward, 1992), etc. We suggest, therefore, that there are a number of serious problems with Egyptian chronology that only the tree- rings are going to solve (Kuniholm, 1993; Baillie, 1995; Manning, in press (Tufts)). The next several years should be both controversial and entertaining.

F. WHAT THE ABOVE COULD (OR OUGHT TO) MEAN FOR OUR UNDERSTANDING OF PREHISTORY:

These Aegean tree-ring chronologies do not exist in a bristlecone-pine-type of isolation (no insult to the Arizona workers intended) but rather in a human or cultural context from the aceramic neolithic to the present. Dating is central and critical to nearly all major syntheses, analyses, and debates in a century of archaeology, history, and art of the Near East, the Eastern Mediterranean, and Aegean, and from there to the Western Mediterranean and South Europe (see Manning 1993, 1994; in press (Tufts); in press (Antalya); see also his 1995 book with its Table 1, p.35, in which the Early Bronze Age begins, according to 54 authors, anywhere from circa 4000 B.C. to circa 2300 B.C.!).

One needs to make a pro forma apology here to readers who are specialists in any one of the periods mentioned above. This hasty excursion through all these 'periods', if indeed they are true periods, in prehistory runs the risk of sounding too general or simplistic, but at the rate of a millennium per page, one is forced to make sacrifices.

This gallop through prehistory is a simple way of demonstrating what we think tree-ring dating is going to be able to do for our understanding of it. The point I wish to make is that a big part of a very long work is already done, and long tree-ring sequences from wood yet to be excavated are going to have to fit somewhere.

3. COMMENT ON OTHER PORTIONS OF THIS PROJECT - IMPLICATIONS FOR THE FUTURE:

We continue to provide dating services free of charge to approximately fifty or sixty other archaeological excavations and projects for other periods in history. Every museum director and excavator in Turkey and Greece is on our mailing list, as are geologists, soil scientists, meteorologists, and the like, and we get regular requests for help with dates.

In the field we are fortunate to have the support of every archaeological service in the region, the clergy (both Muslim and Christian), the foresters, the geologists, the state waterworks engineers, the meteorologists, in short: almost everybody we have approached. More importantly, every year we have a larger and growing number of collaborators, both excavators and museum officials, who have at last caught the dendrochronological "bug," without whose active support none of this would be possible.

In the past three years (1994-1996) the Aegean Dendrochronology Project has been able to extend its long chronologies by about 1000 years. With help from our colleagues and a bit of luck we hope to be able to fill in more gaps in the reasonably near future.
