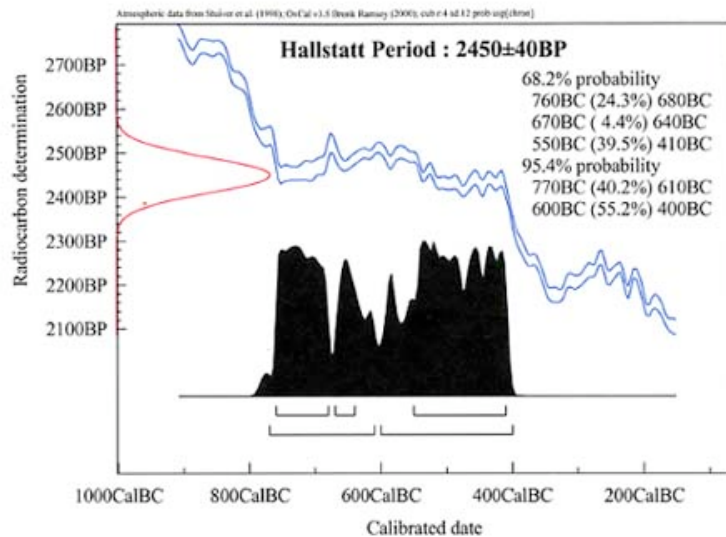
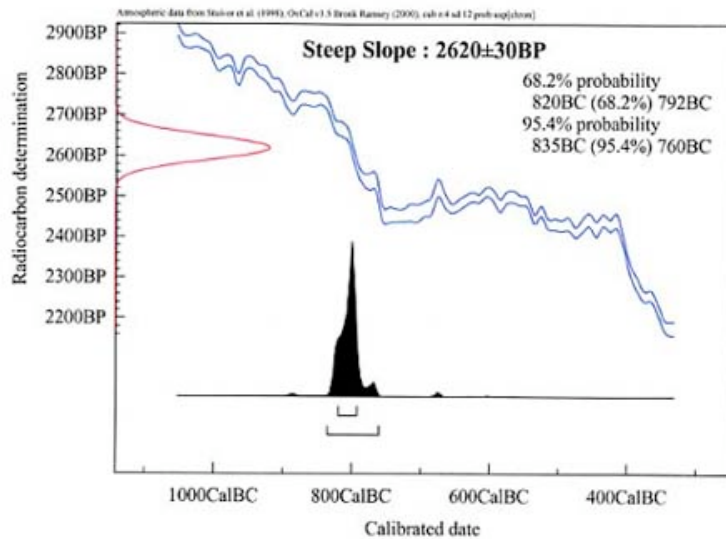

Agean Dendrochronology Project December 2003 Progress Report

WHY DENDRO? Visitors to the lab sometimes ask why we bother to spend our days measuring thousands of tree-rings when there are such wonderful alternative techniques like radiocarbon which will give an answer in a couple of weeks. Well, I'll tell you why. Look at the two graphs below. The one on the left (titled "Steep Slope"), which has a BP (Before Present) date of 2620 ± 30 , happens to intersect the steeply-sloping radiocarbon curve pretty close to 800 BC. The excavator who turns that sample in is going to be very pleased with the radiocarbon results.

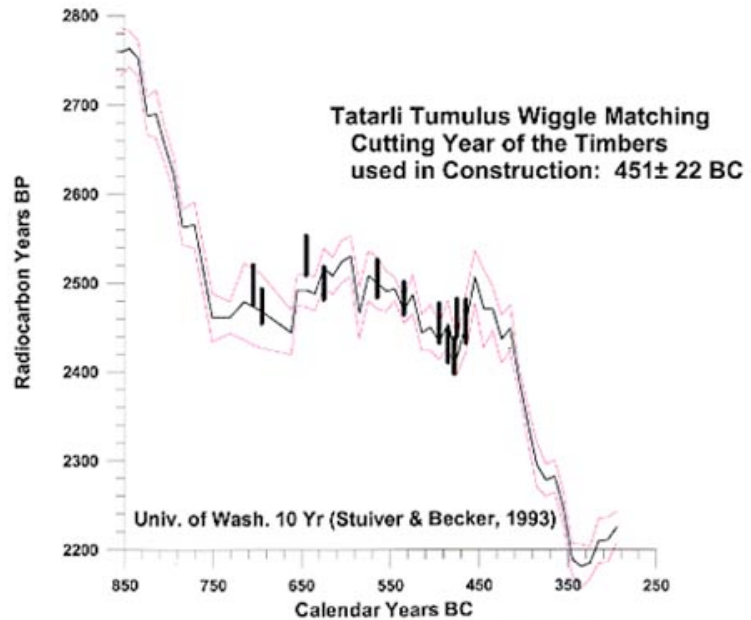


But now take a look at the graph on the right which has a radiocarbon date of 2450 ± 40 BP. That happens to intersect the radiocarbon curve almost everywhere from 770 BC to 400 BC. See how the curve shown above is practically flat for those years? A classical archaeologist who turns in material from anywhere within that date range is going to get pretty much the same radiocarbon result (2450 BP): an almost four-century spread. All the careful collecting and handling with plastic gloves, all the packing in aluminum foil, all the money spent in express postage, is not going to help, EVER. This does not mean that the classical archaeologist is immoral or that the radiocarbon lab is incompetent. The excavator is the victim of the shape of the radiocarbon curve. Just before 770 and just after 400 (where there is another steep downslope) the

situation improves dramatically. Unfortunately, just at the beginning of the Early Bronze Age there is another similarly flat stretch, so many Aegean archaeologists get gloomy when the word radiocarbon is mentioned.

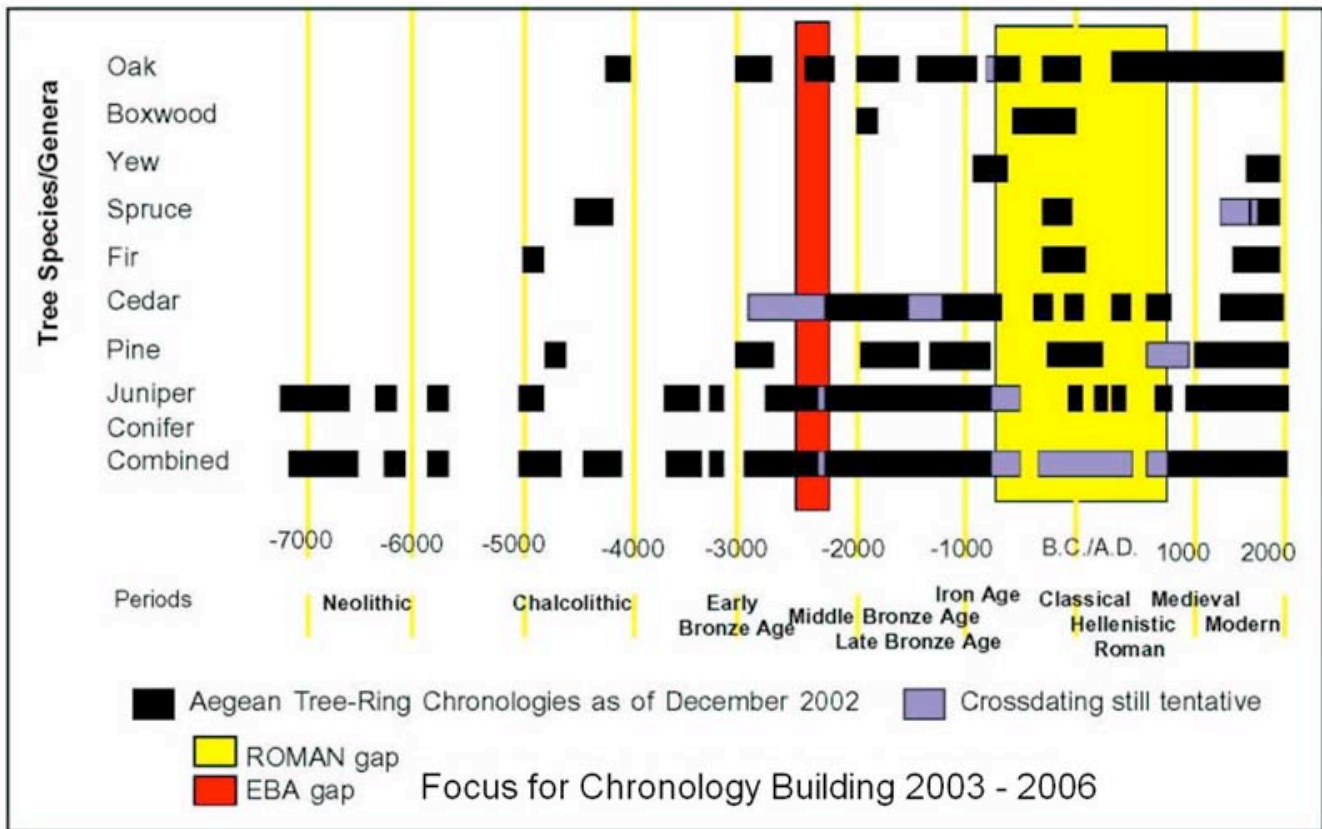
WIGGLE-MATCHING: There is a solution to this predicament, and I add a fuzzy graph from 1996 (pinched from our web-site and tweaked by Tania Lemos because I cannot find the original) which shows how to get around nasty flat stretches. Here again are Bernd Kromer's 11 dates for the Tatarli tumulus near Afyon. Since we told him the exact difference between one decade-long sample and another, he was able to plot them out in a very satisfactory fashion with an end-date for the timbers of 451 BC±22. The zig-zag pattern or wiggle of the Tatarli wood matches the zig-zag of the radiocarbon curve: thus the term 'wiggle- matching.'

AND: we can then use the approximately-dated tree-ring sequence to date other samples to within a very narrow time-range.



Almost nothing we have done over the years either in the field or in the lab worked out exactly as planned. In 1978 I told NSF, NEH, and the National Geographic Society that I wanted to develop a single continuous 3500-year tree-ring chronology back to 1500 BC. Instead we have 6600 years worth of discontinuous chronologies from a variety of tree species going back to just before 7000 BC.

In 1978 I told the foundations that I would focus on the Central Anatolian Plateau simply because it then seemed unrealistic to expect long-distance crossdating. Instead we have been able to build tree-ring chronologies for the region which includes the Adriatic and Aegean basins, the southern shores of the Black Sea, and the entirety of the eastern Mediterranean including the Greek islands and Cyprus, extending through Georgia almost to the Caspian Sea in the east and Lebanon in the south from which cedar and juniper were exported to Egypt—in short the entire birthplace of literate civilization as we know it.



Bar graph of ADP chronologies: Vertical band on the right is the "Roman gap" on which our current work is focused. The EBA "problem" is not really one after all.

This year we asked for (and received) NSF support to try complete the continuous, absolute tree-ring chronology for the eastern Mediterranean region from the present back to the Early Bronze Age (c. 3000 BC). Between our long floating chronology spanning the Bronze and early Iron Ages from the 3rd to 1st millennia BC lies what we call the Roman gap. We are currently addressing our major problem area (open box in the figure above) between this 2294-year floating chronology on the left and the 1639-year absolute chronology on the right, so that we end up with an absolute chronology for the last five millennia. We are using data already in hand in the form of some forty-odd floating tree-ring chronologies aided by material coming out of two dozen new sites, reinforced by radiocarbon analysis, to help us forge the links that will enable us to complete the tree-ring chronology from the present back to c. 2944 BC.

THE "ROMAN GAP": Successful dating of Roman wood found in and around the Mediterranean faces two problems. First, not all Roman wood found in the Mediterranean (e.g., found in shipwrecks) grew there. A ship (actually 18 of them) whose sunken remains are found in the harbor in Pisa could easily have been built anywhere from the Near East to England. Second, Roman technology (cement) and geo-politics (relative peace) had the unfortunate consequences of leaving very few remains of wood and mudbrick buildings. There is simply less Roman charcoal to excavate. The first problem we have already begun to address through collaboration and data-sharing arrangements with colleagues in Germany, Austria, Italy, Slovenia, Croatia, Hungary, Poland, Israel, and Romania. The second problem could resolve itself by some chance discovery of significant quantities of long-lived wood (for instance, another Herculaneum, albeit with local wood), but this is neither likely nor foreseeable. Therefore, we proposed to NSF last December an alternative solution to our long-standing problem. This involves working with tree-ring datasets already in hand that are of species that we may reasonably expect to be local to the Mediterranean. Working with collaborators Dr. Bernd Kromer, Institut für Umwelt Physik, Heidelberg, and Dr. Sturt Manning, University of Reading, who have generously shared their expertise in radiocarbon dating and archaeological statistics respectively, we are using radiocarbon analysis to wiggle-match the available but limited tree-ring

sequences and by so doing help to constrain the range of possible crossdates for a variety of presently floating chronologies. Note: it is not as if we have a vacuum for this period. The measured wood already available for this analysis is shown schematically as follows:

Estimated Start Date: 7th/6th centuries B.C.

Site	Species	Number of rings
Tamassos	<i>Cupressus</i>	n =194
Elaia Tumulus	<i>Taxus baccata</i>	n =307
Tatarli Tumulus	<i>Juniperus foetidissima</i>	n =259
Tatarli Tumulus	<i>Cedrus libani</i>	n =237
Samos, Heraion	<i>Pinus</i> sp.	n =117
Bogazköy, Phrygian well	<i>Juniperus</i> sp.	n = 81
Sardis, Lydian wall	<i>Quercus</i> sp.	n = 94
Spina necropolis	<i>Quercus</i> sp.	n =170
Athens, Parthenon	<i>Juniperus</i> sp.	n =152

Estimated Start Date: 6th/5th/4th centuries B.C.

Site	Species	Number of rings
Sounion, Poseidon Temple	<i>Buxus</i> sp.	n =107
Sounion, Poseidon Temple	<i>Juniperus</i> sp.	n = 64
Comacchio, Roman ship	<i>Buxus</i> sp.	n =513
Zaton shipwreck	<i>Quercus</i> sp.	n = 91
Zaton shipwreck	Conifer	n =116
Sos Tepe, Hellenistic levels	<i>Pinus</i> sp.	n =174
Becker's Greek oaks Early	<i>Quercus</i> sp.	n =170
Garigliano A	<i>Quercus</i> sp.	n =237
Pella	<i>Quercus</i> sp.	n =103
Sisak (Siscia) Celtic	<i>Quercus</i> sp.	n =213
Florina	<i>Quercus</i> sp.	n =105
Ravenna	<i>Larix</i> sp.	n =364
Athlit, ram (Hellenistic ship)	<i>C. libani</i>	n =182
Kyrenia, Hellenistic ship	<i>Pinus</i> sp.	n =158
Spina necropolis	<i>Quercus</i> sp.	n = 81

Estimated Start Date: B.C./A.D. transition

Site	Species	Number of rings
Sisak (Siscia) Roman	<i>Quercus</i> sp.	n =363
Alexandria Harbor	<i>Pinus</i> sp.	n =187
Caesarea Maritima, Caissons	<i>Pinus</i> sp.	n =151
Becker's Greek Late	<i>Quercus</i> sp.	n =130
Ravenna	<i>Abies</i> sp.	n =119

Athens, Agora Late	<i>Abies</i> sp.	n =213
San Francesco del Deserto	<i>Abies</i> sp.	n =157
Tosya	<i>Pinus</i> sp.	n =173
Enez, Roman graves	<i>Quercus</i> sp.	n = 70
Thessaloniki, Octagonal Tower, Roman barrel staves	<i>Quercus</i> sp.	n =153
Pakleni wreck	<i>Buxus sempervirens</i>	n =121
Darende Tumulus	<i>Cedrus</i> sp.	n =117
Seyit Ömer Höyük	<i>Pinus</i> sp.	n = 71
Thrace, Roman grave	<i>Abies</i> sp.	n =120
Vrhnika	<i>Fagus silvatica</i>	n =132
Ravenna	<i>Larix</i> sp.	n =265

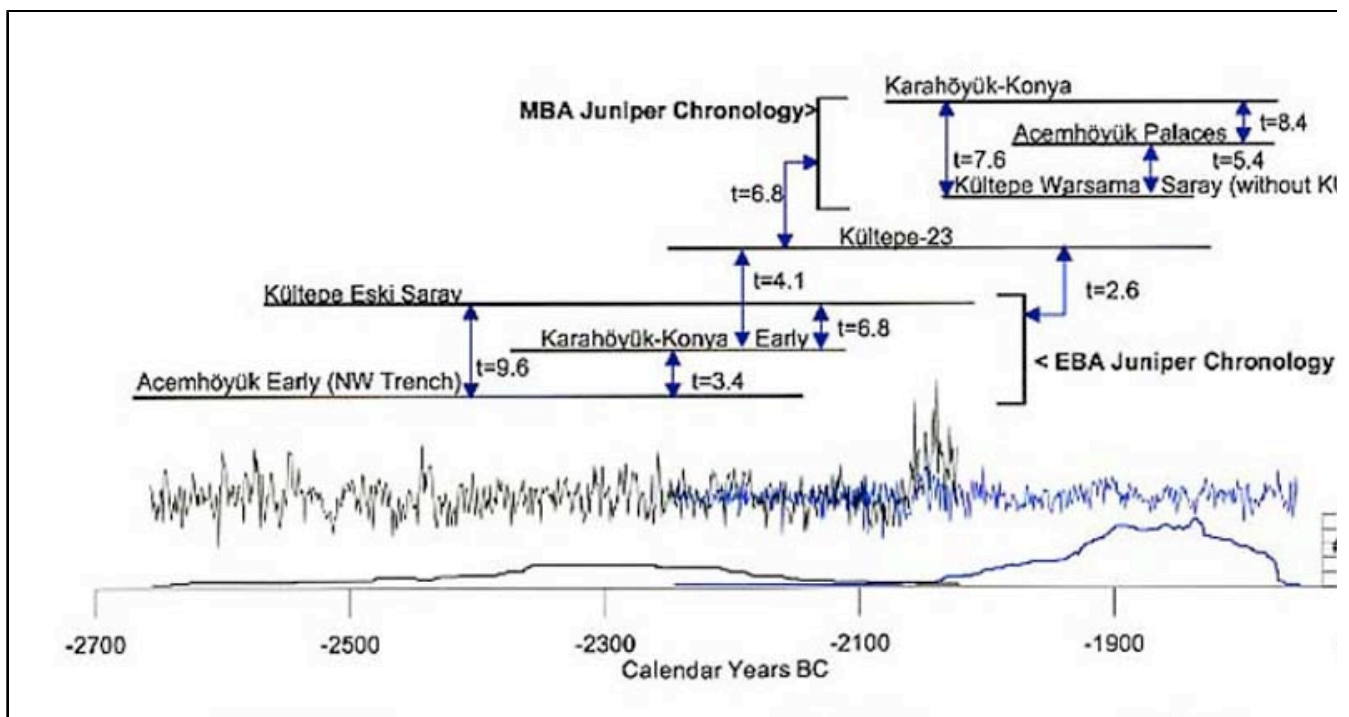
Estimated Start Date: 1st/2nd/3rd centuries

A.D.

Site	Species	Number of rings
Amorium, late Antique	<i>C. libani</i>	n =226
Amorium, late Antique	<i>Quercus</i> sp.	n =130
Aphrodisias	<i>Quercus</i>	n =106
Aphrodisias	<i>Pinus</i> sp.	n =100
Sagalassos	<i>C. libani</i>	n =105
Garigliano B	<i>Quercus</i> sp.	n =151

We think some of these sequences overlap and crossdate, but the overlaps are so short that we are reluctant to claim a complete chronology until confirming evidence (the radiocarbon wiggle-matching) is found. The new site of Poggiomarino, reported here a year ago, has produced a 651-year chronology that runs from about 1200-549 BC, and we have submitted our dating results to the Superintendent at Pompeii. At least a couple of these data sets look good against Poggiomarino.

Anybody with knowledge of wood/charcoal in the eastern Mediterranean from any time on either side of the Year One not on the list above, please let us know!



A THOUSAND YEARS OF EARLY-TO-MIDDLE BRONZE AGE CHRONOLOGIES: Above, you see Maryanne Newton's latest brainchild, born only yesterday (and Maryanne *will* get her dissertation done by May). She shows you the first half of a 2009-year tree-ring chronology for Anatolian juniper, pinned in place, fairly tightly, by some 65 radiocarbon dates. The links between the Early Bronze Age and the Middle Bronze Age are three pieces of charcoal from Kültepe, one from the Warsama Palace, and two from door-sills in the Eski Saray, and we know where to go to look for more to make sure we have it (the connection) right. We have reported some of these dates, but one at a time and over many years, and the sequences were disconnected, so it is a real pleasure to see it all come together like this. The additional 1121 years of the Late Bronze Age and Iron Age tree-ring chronology are not shown. The sequence thus runs from 2657 BC to 649 BC.

PUBLICATIONS: The year 2003 saw our first venture into electronic publishing. We have two articles on the web in *Antiquity*: <http://antiquity.ac.uk/ProjGall/Manning/manning.html> which in conventional notation would read: Sturt W. Manning, Bernd Kromer, Peter Ian Kuniholm & Maryanne W. Newton, "Confirmation of near-absolute dating of east Mediterranean Bronze-Iron Dendrochronology," *Antiquity* Vol. 77 No. 295, March 2003.

<http://antiquity.ac.uk/ProjGall/devries/devries.html> which in conventional notation would read: Keith DeVries, Peter Ian Kuniholm, G. Kenneth Sams & Mary M. Voigt, "New dates for Iron Age Gordion," *Antiquity* Vol. 77, No. 296, June 2003.

There is a third recent piece available electronically in many university libraries. If yours does not have the electronic link, and if you have the stomach for a serious radiocarbon argument, I can send you a hard copy: Sturt W. Manning, Mike Barbetti, Bernd Kromer, Peter Ian Kuniholm, Ingeborg Levin, Maryanne W. Newton, Paula J. Reimer, "No Systematic Early Bias to Mediterranean 14C Ages: Radiocarbon Measurements from Tree-Ring and Air Samples Provide Tight Limits to Age Offsets," *Radiocarbon* 44:3, 739-754.

Most current Patrons should also have received P. I. Kuniholm, Nancy H. Ramage, and Andrew Ramage, *A Guide to the Classical Collections of Cornell University* (Ithaca: Cornell University 2003).

DISAPPOINTMENTS: The gorgeous Bronze Age room with the fallen ceiling at Acemhöyük, shown you in last December's report, turned out to be a bummer. Almost all the wood was poplar, and we do not have any dates. Similarly, the wood from Allianoi, although it comes from Roman/Byzantine times (precisely what we were looking for), was much shorter-lived than we were hoping it would be. Barely a half-dozen out of the 51 samples are going to be candidates for

dating.



SOMEWHAT BETTER: At Kerkenes Dag Geoffrey Summers opened half of his city gate, finding a Phrygian inscription and glyptic art, but the wood, especially from the center of the gate, was so badly and almost completely burned that Whitney Tassie is having a dickens of a time putting it together. Defne Bozkurt's 197-year piece of burned pine from 2002 is still the best thing on the site. On the left Turkish government representative Nilüfer Babacan helps with the removal of burned debris.

EVEN BETTER: Pam Sullivan is finishing off a new building at Hittite Ortaköy, the one with the orthostate that looks like the relief of Tudhaliyas at Yazilikaya. It does not have timbers as long as one might wish, but I think she is going to be able to report a date in the very early 14th century BC. Pam also found that the tiniest pieces from Zeugma were cedar and measurable and crossdate with a cedar sarcophagus in a Roman tomb at Darende, west of Malatya. Unfortunately, most of the really big pieces from Zeugma turned out to be Platanus or plane tree, and I have a suspicion that one really weird specimen might be pistachio. Anyway, the excavator now knows what to look for next year.

MUCH BETTER: Nicole Riches has been struggling with Aphrodisias, but the last time I looked she had a 208-year sequence of oak from the North Agora and thought by the excavators to be circa AD 700. This is precisely what we have been looking for, although heaven only knows what this lunate slab of oak on the right might have been. The excavators say they expect to find more in the summer of 2003. Nicole also has been working on oak timbers from Celano, a Byzantine flat water-mill from Abruzzo, thought to date from the late 6th/early 7th century. We had hoped to have all this wrapped up by letter-writing time, but we haven't.





SUMMER TRAVELS: We did the usual roundtrip from Zürich to Van (in eastern Turkey), 14,410 kilometers in all, or 9,006 miles if you'd rather, without anything more exciting than Pam's taking over the wheel on one arresting occasion (see left). The one piece of personal 'excitement' (if one could call it that) was one night when I thought I had had a heart attack and could no longer breathe. We were fogged in on top of a 2000 meter high mountain at Ağaçbasi above Sürmene, and driving down to the coast in zero visibility was out of the question. I wrote out a set of instructions for Pam, called Eleanor, and prepared to pack it in. After negative hospital tests in Trabzon the next day, it appeared that I had inhaled a serious dose of lignite coal smoke. The chimney of our so-called hotel leaked into my room. For you MD types: in Trabzon a full physical and EKG costs \$21.



ROMANCE: For readers convinced that we lead a wild and dissolute life in the summer, you are ever so right. We show you evidence of Parisian nightlife in downtown Gaziantep (actually the football stadium), and in the mountains above Sürmene we got mixed up with a formal wedding party. The license plate on the thoroughly waxed and polished purple wedding chariot on the right reads "Just Married."

CEDAR: Although *Cedrus libani* has not been a major focus for this project, we collect it as we find it, including some this summer from Hinzir Dag west of Gaziantep. The other day we sat down to calculate how much all our cedar added up to: about 3600 years' worth. In January 2004 Maryanne and I will be meeting with the Austrians (Professor Manfred Bietak's SCIEM Project) in Vienna to try to sort out our various cedar chronologies.



VISITING DIGNITARIES: This fall we had our first-ever visit from a chief of state, Süleyman Demirel who was Prime Minister of Turkey four times and President for seven years. This was a new kind of encounter for the 19 people working in the lab. He gave us some useful tips on where to go look for wood (the GAP Project in southeastern Turkey where enormous trenches are being dug by several thousand workers to accommodate pipelines and water lines and electrical cables). 2003 was a good year. 2004 ought to be even better.

Peter Ian Kuniholm
Cornell University

[Back to Index](#)

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