

DENDROCHRONOLOGICAL INVESTIGATIONS AT HERCULANEUM AND POMPEII

Peter Ian Kuniholm

Dendrochronology is the scientific technique of identifying patterns of tree-ring growth in ancient wood or charcoal samples and matching them with known dated sequences to provide information of use to archaeologists in dating buildings, furniture, and other wooden objects. Sixteen partially burned timbers from Herculaneum and seven from Pompeii, mostly fir (*Abies* sp.) but with an admixture of spruce (*Picea* sp.), have been combined into a tree-ring chronology that extends for 362 years, beginning in 290 B.C. and ending in A.D. 72. The ring-growth patterns show that the wood is Alpine, possibly from western Austria. We believe that this wood may have been floated down the Adige River to the Po estuary from which it could have been easily transported by ship to the port cities of Herculaneum and Pompeii. So far most of the timbers that have been studied appear to have been imported, but additional timbers that we have sampled from Herculaneum do not fit the Alpine curve and may be locally grown material from high in the Apennines.

In twenty-five years of trying to build tree-ring chronologies for the eastern Mediterranean region, we have found our two biggest problem periods to be the Roman and Hellenistic, simply for lack of suitable samples.¹ In the summer of 1996 our Roman period wood supply increased dramatically when we acquired fifty-four timbers from Herculaneum and four from Pompeii. These were supplemented in 1997 by an additional eleven timbers from Herculaneum and sixteen from Pompeii, and in 1998 by thirteen timbers, all from Herculaneum. In the vaulted Roman cellars of the so-called *Scavi Novi* at Herculaneum was a carpenter's workshop stacked with timbers, some showing signs of use and reuse, all of which have now been stored for safekeeping in the excavation *cantieri*. When Mount

Vesuvius erupted in A.D. 79, those timbers started to burn, but the burning was almost immediately extinguished by some 30 m of ash and tephra that fell on the site, protecting the wood until the present day. The reducing atmosphere (lack of oxygen) created by the smothering tephra had the same effect as a charcoal kiln, preventing total combustion of the wood; and the beams, a mixture of fir, spruce,² and pine, with occasional cypress and a bit of oak, were splendidly preserved. From this carpenter's pile alone we collected forty-two specimens. The tephra cover over the last two millennia must also have made the environment more or less anaerobic, for the unburned parts of the timbers were extraordinarily well preserved.

Even before measurement began (see Stokes and Smiley 1968; Schweingruber 1988; Eckstein 1984; Baillie 1995; and Kuniholm forthcoming for discussions of the various techniques of tree-ring matching), we knew that we would have a tree-ring data set that should show various end dates with A.D. 79 as the latest possible terminus. We now have a 362-year chronology for Herculaneum beginning in 290 B.C. and ending with one timber with a last ring grown in A.D. 72, only seven years before the Big Bang that brought the life of the two communities to an end. Other timbers in the same woodpile, particularly the ones showing signs of use and reuse, were cut over a period of two centuries. End dates of all of them are 123, 121, 89, 87, 86, 23, 18, 15, 9, and 6 (two samples) B.C., and A.D. 3, 9, 10 (two samples), 13, 20, 51, and 72, not really surprising since this was a carpenter's timber supply. How we determined these dates will be explained later on.

In the current excavations south of the Villa dei Papiri and immediately adjacent to it a deep trench has revealed Roman buildings preserved up to the roof,

also buried under some 30 m of lapilli, ash, and tephra. From several of these buildings we have now collected another forty-four timbers, many of which crossdate with the material from the carpenter's shop. The last existing ring in this trench is 49 years earlier than the last ring in the workshop, that is, A.D. 23. Since the bark is missing in both cases, we do not have a difference in felling years between the one lot and the other, but this is a promising start and we trust that future collection from the Herculaneum excavations and other locales will reinforce and extend this new Roman chronology.

At Pompeii we were able to collect burned wood in 1996 from the House of the Chaste Lovers (Casa dei Casti Amanti). This was not as long-lived as the Herculaneum wood, and until now it has resisted all our attempts to date it. A second set of wood samples from Pompeii, acquired in 1997, begins in 99 B.C. and has a last-preserved ring at A.D. 37. Since this latter Pompeian wood is without provenance (i.e., from anywhere in the old excavations), the archaeological information that could be acquired by measuring it is minimal.

Although the destruction date at Herculaneum and Pompeii is well known, it has been difficult on purely archaeological grounds to determine when any given building was constructed (for an up-to-date discussion and current bibliography of these houses see Wallace-Hadrill 1994). We hope to be able to provide answers to these and other questions as collection and measurement continue at these two sites. It is particularly gratifying to see that more of the newly emerging wood at Herculaneum is being saved for future study. Now that our colleagues in the Soprintendenza know what we need, there is every hope that we will be able to add to the datable material collected thus far. Already we can point to end dates for timbers with known provenances in the new excavations near the Villa dei Papiri of 41 B.C., 22 B.C., 17 B.C., 6 B.C., and A.D. 23. In order to understand what this means archaeologically and architecturally for the specific parts of the specific buildings from which they were retrieved, we must consult with the excavators who are now preparing their preliminary publication.

The dates quoted here deserve explanation. That the Romans were cutting wood at all times is no surprise to anybody (Ciarallo et al. 1993). But at both Herculaneum and Pompeii we can now tell, with a fairly high degree of certainty, from where they probably imported some of it, and that is a piece of worthy new information, indeed exciting. The fit that allows us to derive these dates is between fir (*Abies* sp.) and some spruce (*Picea* sp.) from Herculaneum/Pompeii matched against the previously established South German oak chronology. When Maryanne Newton, one of our graduate students, first spotted this extraordinarily

good fit, we tried to determine whether the published ring sequences from any fir forests in Italy fit with the Alpine oaks. Starting with modern forests in Calabria, we examined *Abies* tree-ring data from the entire length of the Apennines all the way to north of Florence, and the result was always the same: no fit at all – until we got to the Black Forest near Freiburg in southern Bavaria, where the local firs and oaks fit splendidly with each other and with the Calabrian firs. So we proposed in 1997 that what we have at Herculaneum, and to a certain extent at Pompeii, is a population of fir and some spruce timbers imported from the Alps.

In 1997 we started our summer's fieldwork by visiting the Stuttgart-Hohenheim dendrochronology lab where most of the South German oak chronologies were built, and our colleagues there agreed that the Herculaneum wood is indeed Alpine. Our proposed fit covering the 362 years between 290 B.C. and A.D. 72 was confirmed by Dr. Michael Friedrich and Dr. Marco Spurk, against several new unpublished Alpine fir chronologies developed in collaboration with a large working group of a dozen researchers in several countries. Enough *Abies* information is in hand in Hohenheim to span the last 3,000 years. The fit between the Alpine fir chronologies and Herculaneum/Pompeii fir, is much better than Alpine oak versus Herculaneum/Pompeii fir as one would expect, with statistical scores somewhat better in the east (their unpublished Hallstatt-3 chronology) than the west.

Before we had found these dendrochronological cross dates, we had sent samples to Dr. Bernd Kromer in Heidelberg for radiocarbon wiggle-matching. He reported a date for what was then the beginning of our sequence at Herculaneum at 240 B.C. \pm 15 years, the center point of which is only two years earlier than the dendrochronologically-derived date of 238 B.C. for the sample that he measured. The agreement between the two dates is so close that we have concluded there is no need to perform any further radiocarbon determinations.

All of this means that some enterprising Roman timber merchant could have gone north to a seaport like Venice or Genoa and brought wood south from there to Herculaneum and Pompeii. We have no literary testimony for this specific trade route, but here at Herculaneum/Pompeii is the mute evidence for its existence. It is difficult to imagine any timbers, much less ones the size of those we saw excavated at Herculaneum (maximum dimension 4.51 m \times 0.37 m \times 0.15 m), being transported over the Alps. A quick look at the available river systems in northwest Italy does not show an obvious fluvial transport mechanism. But now Dr. Kurt Nicolussi at the University of Innsbruck kindly reports (personal communication 1997) that he has a peat bog in the valley of Lermoos near the Austrian/German

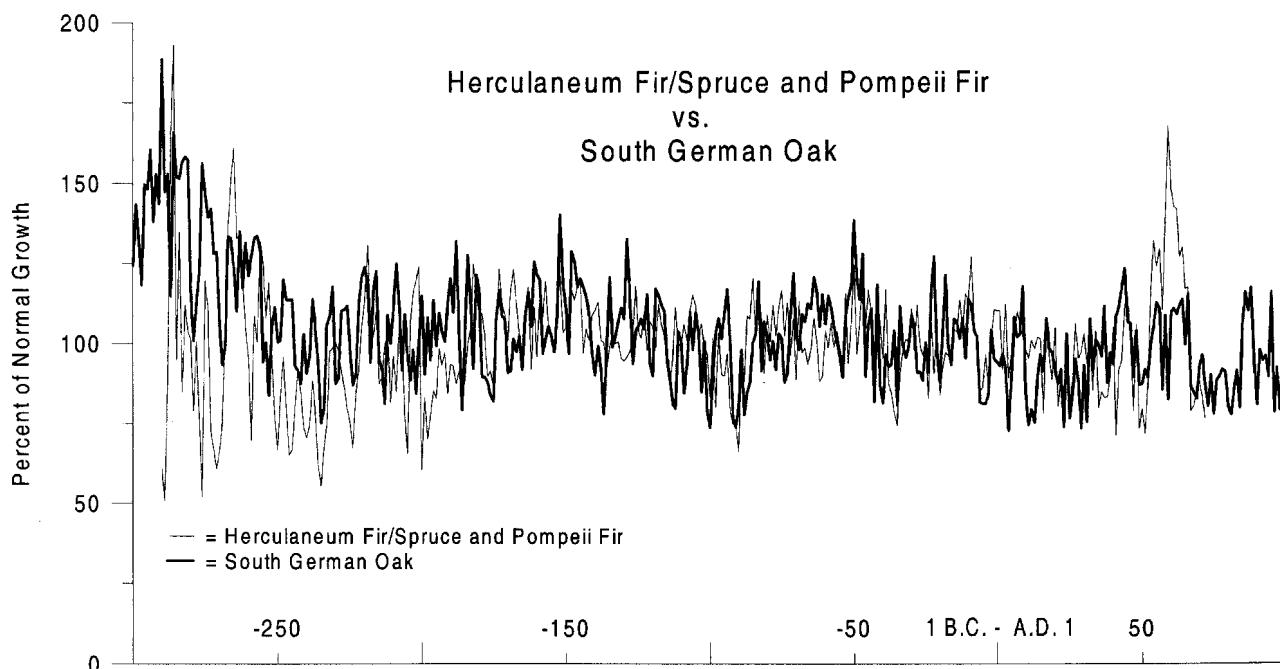


FIGURE 188 Growth profiles for fir and spruce from Herculaneum and Pompeii compared with South German oak.

frontier beyond where the Via Julia Claudia crossed the River Inn, from which he has constructed a 500-year-long *Abies* chronology that forms part of the long, absolutely dated Alpine sequence previously cited. If a fir tree growing in the Dolomites or anywhere in western Austria could have been dragged to the headwaters of the Adige and floated downstream to the Po, or, similarly, a fir growing in the Carnic Alps could have been floated down the Piave to Venice, it would have been a relatively easy matter for Roman timber merchants to have transported them, either as timbers still in the round or as sawn planks, to Herculaneum, Pompeii, or anywhere else in the Mediterranean, for that matter.

All of this information is the good news. Now for the bad news: what we have at Herculaneum is Alpine fir, but that does not help us with the b.c./a.d. transition period in the Aegean, which is why we went to sample the wood at Herculaneum in the first place. All is not lost, however. There are additional timbers that we sampled at Herculaneum that do not fit very well, if at all, with the Alpine curve, and they just might be the locally grown (or at least non-Alpine) material we wanted all along. It is these samples that we are using to try to find fits with Roman-period wood from Greece and Turkey, so far without success.

SIGNIFICANCE FOR FUTURE WORK

Excavators at all Italian archaeological sites need to be on the lookout for wood or charcoal. Figure 188 shows the Herculaneum/Pompeii fir and German oak graphs compared. For readers who prefer quantification, the t-score

between fir and oak is 4.44, the overlap is 362 years, the trend coefficient is 59.0 percent, and the D-score is 40. Figure 189 shows an unburned cross section of spruce with tree rings from 291 b.c. to 129 b.c., and Figure 190 shows a burned cross section of fir with rings from 145 b.c. to a.d. 11. Absolute dates for the Roman period are now possible. Care needs to be taken to ensure that any fragments preserving the bark (and therefore the cutting year) are not discarded. For information regarding sample collection, please see specific guidelines on our Web site: www.arts.cornell.edu/dendro/. A final note is that our earliest end dates for the wood at Herculaneum and Pompeii are all *Picea* (spruce), and the latest are *Abies* (fir). In the current excavations south of the Villa dei Papiri the end dates for spruce timbers are 129, 112, and 85 b.c.; and the end dates for fir are 60, 48, 41, 30, 24, 17, 11, 11, 6, 6, and 2 b.c., and a.d. 26, 28, and 46. Does that mean the Romans chose spruce over fir during the Republic, and imported fir only when spruce was no longer available? Our data base is small, but there is so far not one exception to the spruce-equals-early-and-fir-equals-late rule. The notion that the Campanian timber merchants could have been selective in their choice of wood, either to import or to use, should not be surprising, and it will be worth keeping statistical track of details like this as more wood of the Roman period is excavated.

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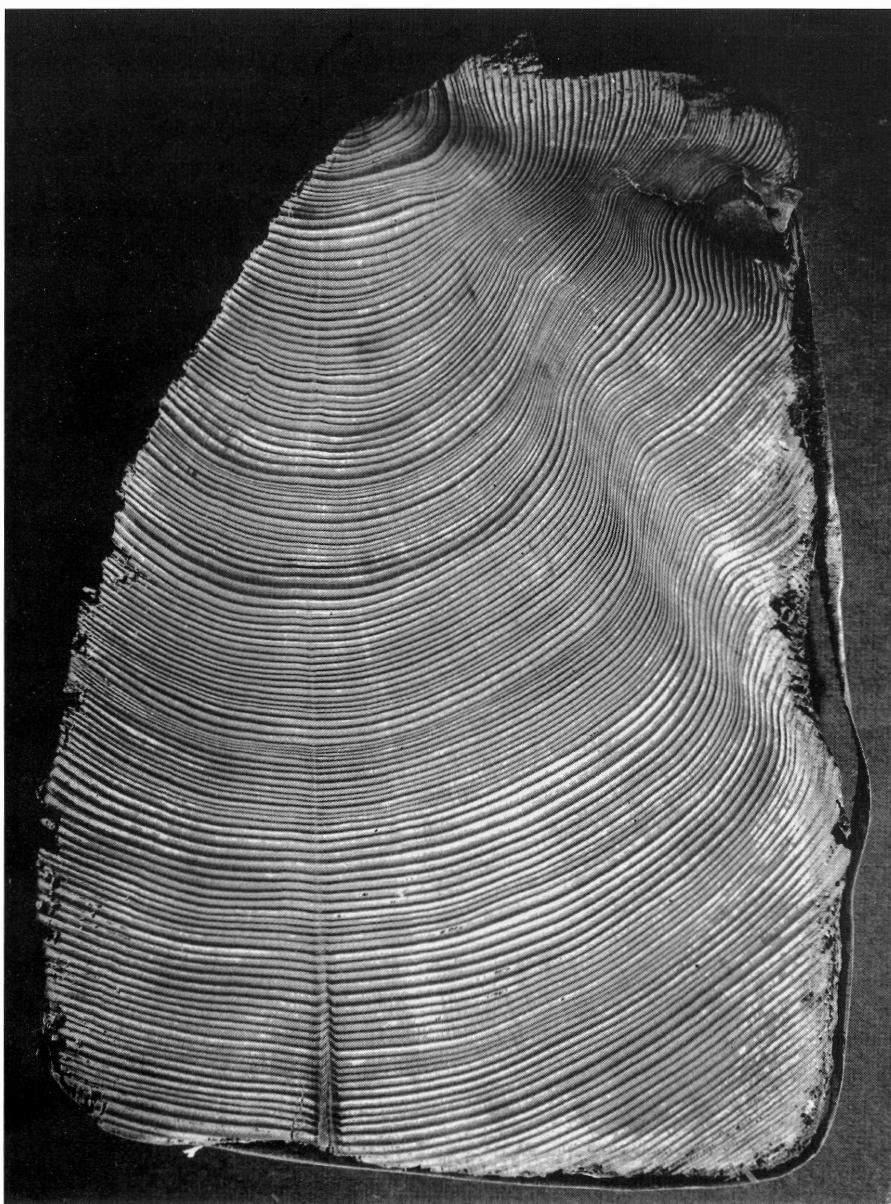


FIGURE 189 An unburned cross section of spruce with tree rings from 291 B.C. to 129 B.C.

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NOTES

- 1 Hundreds of stone buildings survive from these periods, many with beam holes that are usually empty.

Stroll around the Baths of Caracalla in Rome, for example, and see hundreds of places where beams once upon a time *were*. Now, at best, they contain only pigeon nests. Until 1996 most of our Roman period wood had come from oak pilings salvaged from the River Kupa in Pannonia at Siscia (modern Sisak or Celtic Segestica, unpublished); from boxwood logs that formed part of the cargo of the Comacchio ship (Kuniholm et al. 1992); from miscellaneous coffins throughout the Balkans and the Aegean (Kuniholm and Striker 1987; Kuniholm 1996); and from oak pilings from the bridge where the Appian Way crosses the Garigliano River or ancient Liris (Ruegg 1995).

- 2 *Abies alba*, the only fir at present in northern, central, and eastern Europe, ranges south along the Apennines; *Picea abies*, the only spruce widespread in northern and central Europe, does not occur in peninsular Italy but ranges in the Alps and in the mountains of the northern Balkans south to the Pindus Range in Epirus and Greek Macedonia.

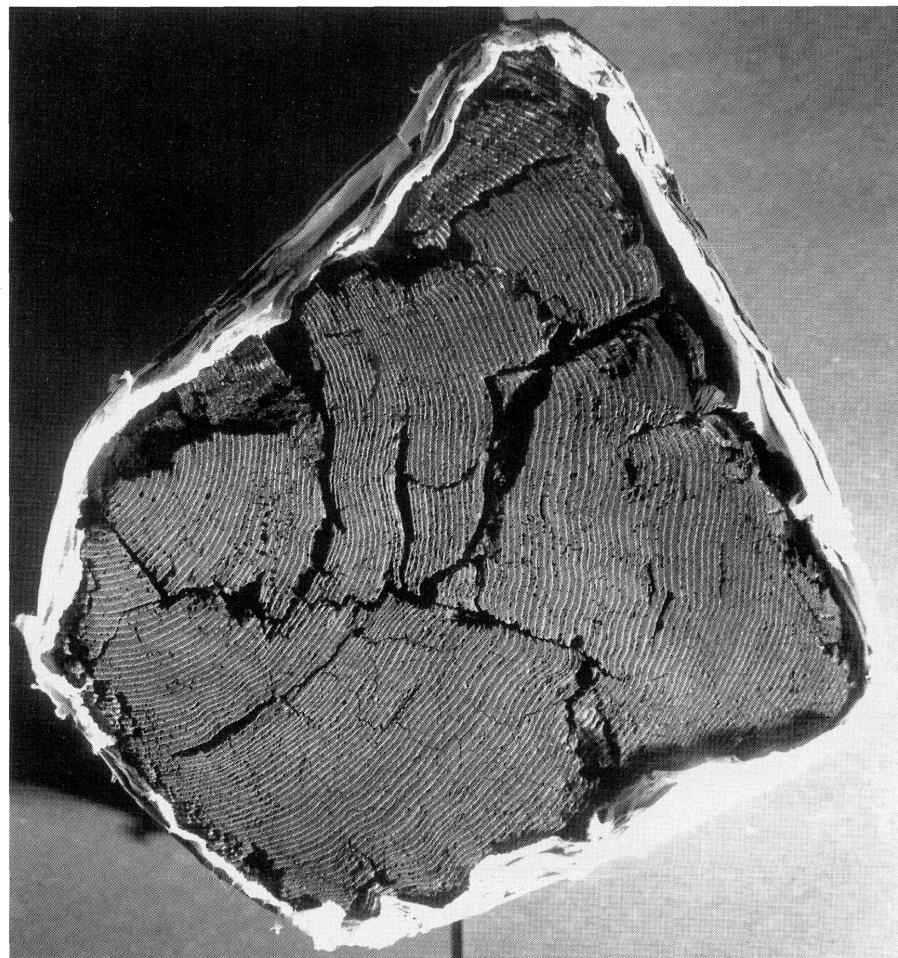


FIGURE 190 A burned cross section of fir with tree rings from 145 B.C. to A.D. II.

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