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DENDROCHRONOLOGY AND RADIOCARBON DETERMINATIONS FROM ASSIROS AND THE BEGINNING OF THE GREEK IRON AGE

Synopsis

Charred construction timbers collected during the excavation at Assiros have provided the first direct near-absolute dates for the start of the Early Iron Age in Macedonia and of the Protogeometric period in Southern Greece. For the first time in mainland Greece, definitive results have been obtained by techniques of dendrochronological cross-dating and dendrochronological 14C wiggle-matching applied to well stratified archaeological charcoal samples. The close correspondence between the dates obtained by these two independent methods for the felling of the trees used in building is particularly encouraging. The samples under study here come from Assiros Phases 3 and 2 but other samples from several successive late Bronze building levels offer the opportunity in the near future to expand on the results presented here.

A 104-year sequence of tree rings based on four separate building timbers which grew during this period, can be matched with the Anatolian master dendrochronology sequence to give a probable cutting date of 1080 BC+4/-7 for the trees used in the construction of the Phase 3 settlement and a date of 1070 BC+4/-7 for the trees used in the buildings of the Phase 2 settlement which was constructed shortly after the Phase 3 structures had been destroyed by fire. In addition, a series of 7 roughly bidecadal 14C dates determined from two of the Assiros building timbers provides a best fit for the last ring with the INTCAL98 calibration curve 1090±22 BC at 1σ. The 14C dates do not allow any other fit to the calibration curve at either an earlier or a later date.

Large parts of a Protogeometric amphora were found broken but securely stratified on the Phase 3 destruction floor. Its breakage can thus be dated to the period between 1080 and 1070 BC. This amphora is of an early type with a northern Aegean distribution which, according to R. W. V. Catling, should post-date the earliest appearance of the Protogeometric style by several decades.

The start of the Protogeometric period in Greece as a whole must certainly therefore be set before 1070 BC, and perhaps even as early as 1100 BC. Until now, the date assigned to the transition from Bronze Age to Iron Age (Mycenaean to Protogeometric) has been notionally set at 1050/1025BC but this has been based on the best estimates of the lengths of the various periods and the amount of material

representing each ceramic style. There are, moreover, no secure Egyptian or Near Eastern historical dates which can be transferred to the Aegean area during the previous 100 years or subsequent 300 years.

These results are inherently more precise and more reliable than those from the single 14C samples or groups of stratigraphically related single 14C samples which have been available until the present study for any part of Greece. Fixing the end of the LH IIIC period and start of Protogeometric at least 50 and more probably -75 years earlier than the 1025 BC date currently accepted, will require the re-evaluation of the lengths of these periods and a reassessment of the related or derived chronologies of adjacent areas.

Introduction

In this paper we present the results of the study of charred timbers collected during excavation at Assiros and their implications for the chronology of the beginning of the Iron Age in Greece. The progress of this work is followed from the collection of the samples, via the methods of dendrochronology as applied to them and confirmed by the use of 14C wiggle-matching, to their significance in the wider Aegean area[1].

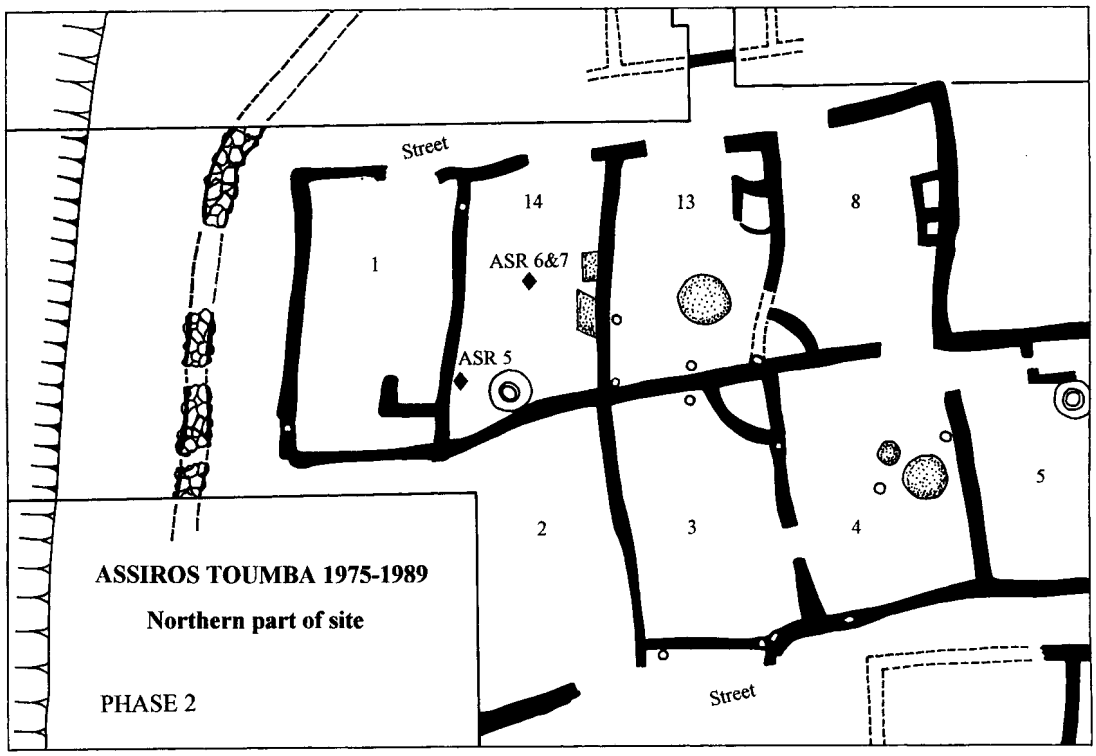
The Samples and their Stratigraphy

During the research conducted at Assiros by the British School at Athens under the direction of K. A. Wardle between 1975 and 1989[2], samples of charred building timbers were collected from each of the destruction levels at the site (Phases 9, 6, 5, 3 and 2, from lowest [earliest] to highest [latest]) and set aside for possible 14C and/or dendrochronologicaly determinations. A selection of these were transferred to the Malcolm and Carolyn Wiener Laboratory for Aegean and Near Eastern Dendrochronology at Cornell University at the instigation of its Director, Professor Peter Ian Kuniholm, where they are under study by Maryanne Newton. The samples discussed here are ASR 15 and ASR 16, both used in the construction of Phase 3, and ASR 5 and ASR 6&7 (parts of the same timber) which were both used in the construction of Phase 2, (i.e., in the second and third building horizons of the Iron Age). None of these timbers had been dressed to shape, but had been used with little preparation beyond stripping off the bark.

The first Iron Age Phase at Assiros (Phase 4) was defined by the appearance of new elements in the local pottery repertoire. It, represents a period when the structures on the site seem to have been less substantial than those of the preceding Bronze Age, with a rather irregular plan, and areas where a considerable depth of soft grey deposit rich in animal bones collected in the (disused?) yard areas. At least

1. We would like to thank D. Wardle for her critical comments on this paper, for the plan (Fig. 1) and for the drawing of the Protogeometric amphora (Fig. 8).

2. K. A. Wardle, "Excavations at Assiros Toumba 1988: A preliminary Report", BSA 84, 1989, 447-463 ff.



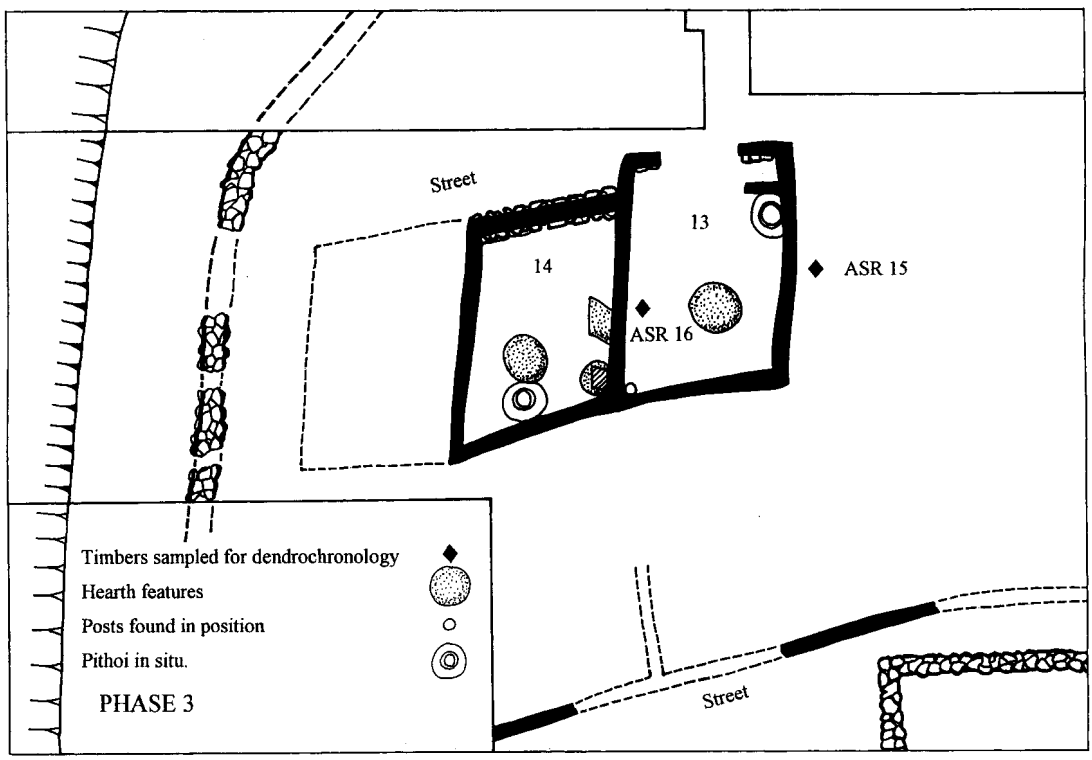


Fig. 1a,b. Assiros Phases 2&3: location of samples ASR 5 and ASR 6&7.

at the southern end of the site, the street of this phase continued the alignment of its Phase 5 predecessor[3]. After a period of unknown length, the settlement was reconstructed with timber-framed mud-brick houses in a rather more regular plan (Phase 3). The buildings of this phase were destroyed by fire, and rebuilding followed quite rapidly at a level some 20 cm higher using many of the same wall alignments (Phase 2 Plan Fig. 1a). Another fire followed, leaving charred timbers in situ (such as the central post seen in Pl. 1) and fallen on the floor (presumably roof joists and wall supports).

Two of the timbers came from the debris above the floor level of Phase 3, one from Room 13 (ASR 16) and the other from an apparently open yard area to the east (ASR 15). Neither of these was in situ but had, presumably, fallen to the floor as the timbers in the roof or walls burned. Two other timbers come from Phase 2, Room 14. One (ASR 5) lay against the W wall dividing it from Room 1 and the other from the centre of the same room where it was in situ as one of the roof supports (ASR 6 & 7, Pl. 1). The floor level of Phase 2 sealed the underlying burnt debris of Phase 3 (Fig. 1b).

It is difficult to judge from the archaeological evidence how long the Phase 3 buildings stood before they were burned, but there is no sign of any associated level of long-term occupation debris. In reports already published, the dates assigned to each of these phases of construction were: Phase 3, 1000-950 BC; Phase 2, 950-900 BC. These estimates were based, i) on the generally accepted date of 1050/25 BC for the start of the Protogeometric period in Southern Greece, ii) the presence of large parts of an amphora decorated with compass-drawn concentric circles on the Phase 3 floor (Fig. 2, Pl. 2) which is assigned to the early/middle stage of this period by Catling[4] and iii) the rough division of the time span between 1050 and 850 BC to accommodate four phases of construction (4, 3, 2 and 1.5[5]) before the abandonment of the site[6]. These estimates were broadly compatible with the single 14C sample from Phase 2 in the small group determined by the British Museum (BM 1426: 2800± 75BP, calibrated at 1σ[7] between 1020 and 830 BC, but, in consideration of the new evidence and noting the large error margin on this date, we note the 2σ range puts the date between 1190 and 800 BC)[8].

3. K. A. Wardle, AEMΘ 10A, 1997, 443-460, where a brief outline of the stratigraphy, phases, and conventional dates has already been set out.

4. R. W. V. Catling, "The typology of the Protogeometric and Subprotogeometric Pottery from Troia and its Aegean context", Studia Troica 8, 1998, 153-64, esp. 161. See further discussion below.

5. This phase was first observed at a late stage of the excavation after the other phases had been defined and numbered.

6. The rationale of this chronology is discussed at greater length in AEMΘ 10A, 1997, 443-460.

7. For those unfamiliar with statistical conventions, 1σ denotes the first range (one standard deviation) of probability (68.2%) and 2σ the second range (94.5%). Only when differences determined statistically are beyond the 2σ range are they necessarily significant.

8. Richard Burleigh, Keith Matthews, and Janet Ambers, "British Museum Natural Radiocarbon Measurements XIV", Radiocarbon 24, 1982, 243-4. The large range in the calibrated date, partly exacerbated by the large error on the 14C date, is the residual effect of the shape of the calibration curve in these centuries.

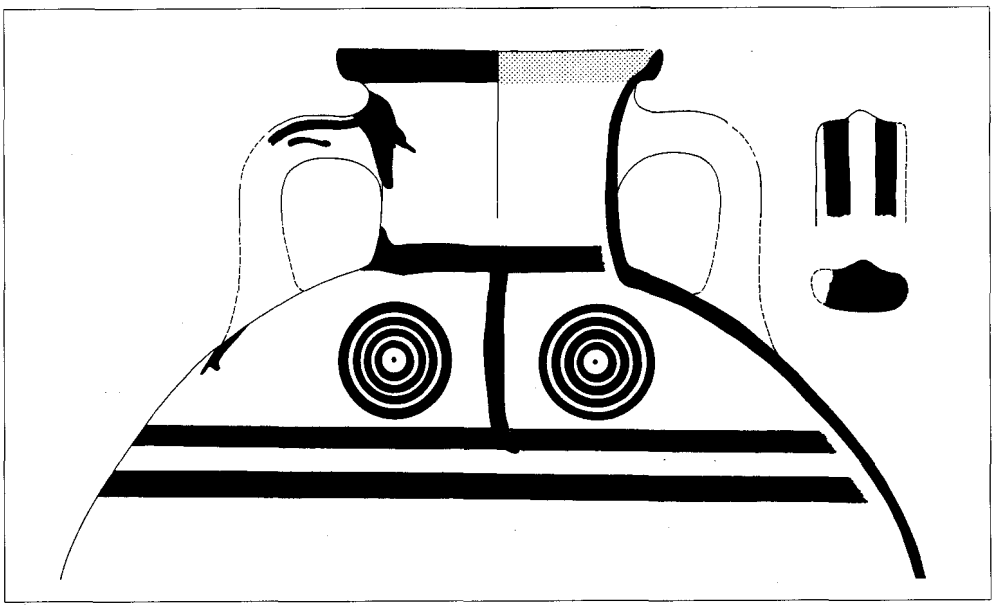


Fig. 2. Protogeometric amphora of Catling's Group I from Assiros.

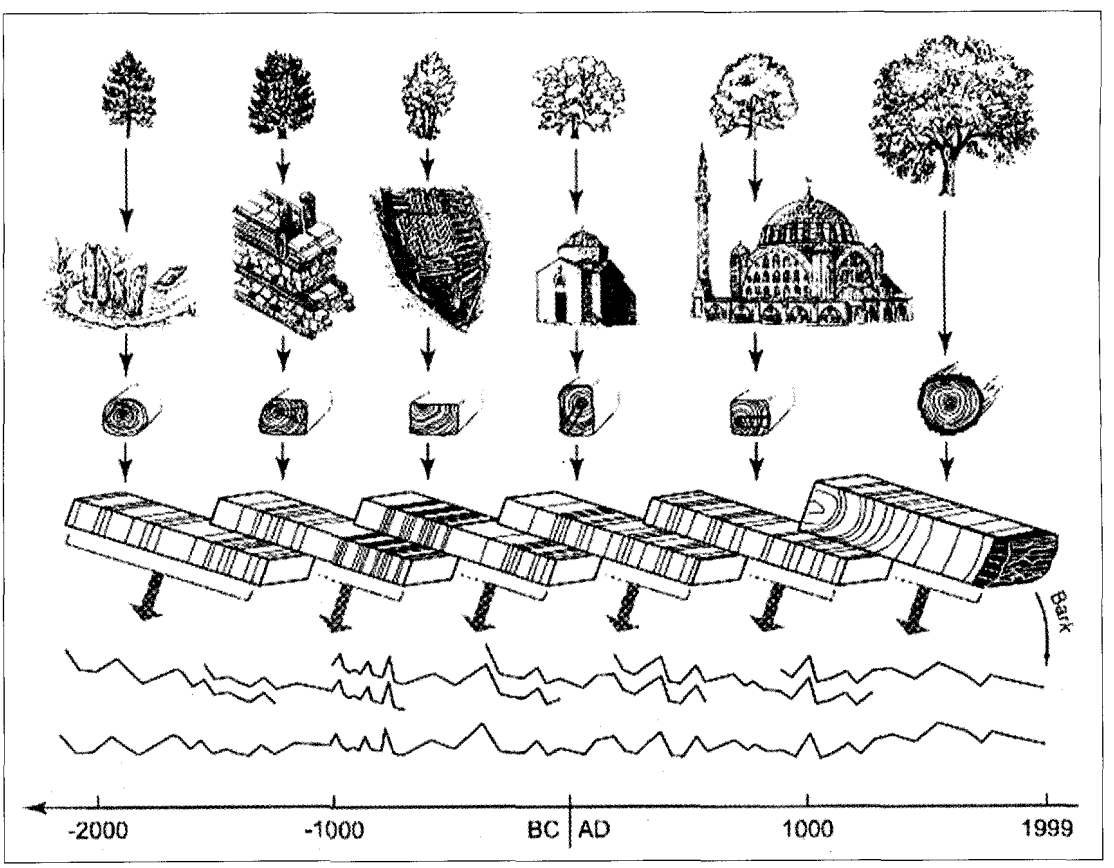


Fig. 3. Constructing a tree-ring sequence.

Dendrochronology: a primer

Dendrochronology is, in principle, fairly simple. If tree-rings can be counted, and have similar growth patterns to other tree-rings that are also counted, then those patterns can be correlated, and the last preserved growth ring from the first sample given a date in relationship to the other. In many ways, tree rings are like historical annals, and the study of tree-rings works for any tree that grows in a temperate climate (that is, a tree that puts on leaves or needles according to an annual seasonal cycle.

Fig. 3 illustrates how we build chronologies from trees that are still alive, and from which we can count the most recently preserved date. If, today, I core or cut a tree in my back yard, I will see some spring growth for 2004. In New York, Spring has just arrived. The first full ring I will see, just inside the bark and earlywood cells of the partial ring for 2004, will be the complete growth of last year, 2003. By counting backwards, with each ring representing an annual cycle, I go back in time, year by year, until I you get to the pith of the tree). Once we have built a chronology from many trees that exhibit similar growth patterns, we can compare it with a newly discovered timber (whether charred or not). If we have the bark preserved from any tree in the steadily enlarging group of dated patterns, we can provide, to the year, the date when the tree was cut down. It is this method of dendrochronological cross-dating upon which the following study of the Assiros samples is based.

Dendrochronology: results for Assiros Phases 3 and 2

Dendrochronological analysis of the wood charcoal samples by the Aegean Dendrochronology Project at Cornell (henceforth ADP) and its colleagues[9] permit the oak tree-ring sequences from Phases 3 and 2 at Assiros to be accurately cross-dated not only against long, replicated, juniper and pine tree-ring sequences from Gordion and environs, but also dated absolutely within narrow margins via dendrochronological 14C wiggle-matching[10], (methodology and results published in Science 2001)[11]. It should be noted that where a dendrochronological cross match is

9. We thank members of the ADP, especially Nicole Riches and Pamela Sullivan for helping us meet the deadline for the publication.

10. Not to be confused with "archaeological" wiggle-matching, see below, "Significance: evidence for absolute Iron Age dates at Kastanas".

11. Sturt W. Manning – Bernd Kromer – Peter Ian Kuniholm – Maryanne W. Newton, "Anatolian Tree Rings and a New Chronology for the East Mediterranean Bronze-Iron Ages", Science 294, 21 December 2001, 2532-2535. The dates are qualified by +4/-7 years BC. The ADP has since its inception in 1977 been pursuing the goal of providing a continuous tree-ring chronology, in many species, for the shared climate region of the eastern Mediterranean. Once this is completed, the current qualifying +4/-7 to all dates linked to the long Bronze Age-Iron Age chronology (primarily built from conifer species that grew in Anatolia) will be dispensed with.

In the meantime, the ADP continues to pursue dendrochronological investigations of material that falls within the cross-dating zone in the eastern Mediterranean. This zone is outlined in publications starting with Peter Ian Kuniholm and Cecil L. Striker in 1987 "Dendrochronological Investigations in the Aegean and Neighboring Regions 1983-1986" Journal of Field Archaeology 14, 1987, 385-398), and expanded upon in Kuniholm 1996 ("Long Tree-Ring Chronologies for the Eastern Mediterranean", Archaeometry 94, the Proceedings of the 29th

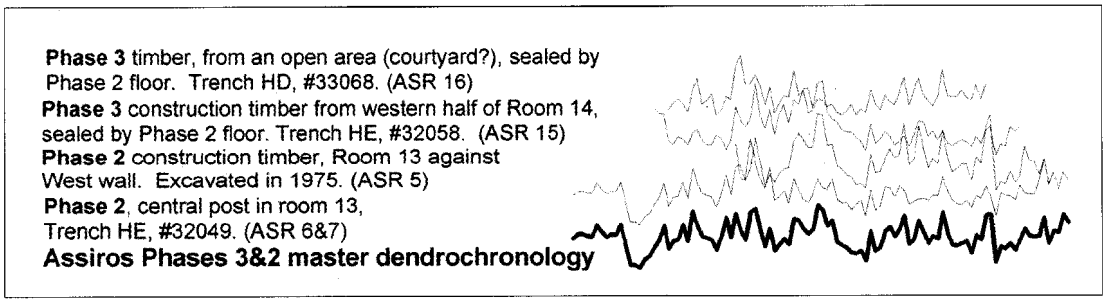


Fig. 4. Assiros Phases 3&2 master dendrochronology (in bold) and its components.

obtained this provides a real date in calendar years with a very slight margin of error for ring loss etc, whereas a 14C date, even as part of a wiggle-match, is always subject to a statistical margin of error. The mid point date cited is no more likely to be correct than any other within the 1σ (one standard deviation) range.

The tree-ring chronology for Phases 3 and 2 at Assiros is built from the measured ring series compiled from four oak timbers. It is 104 years long, and the four component ring series are illustrated in Fig. 4, together with the master tree-ring chronology for Assiros Phases 3 & 2. It is this master dendrochronology that is compared to the master tree-ring chronologies from Anatolia (See Fig. 5).

However, analysis of the Assiros wood was not an entirely straightforward matter. Since some 15 years had elapsed between the time of excavation and the time of collection for dendrochronological analysis, the wood had dried out, and the timbers had shattered into hundreds of tiny fragments. It was the task of rejoining the fragments and making the longest possible ring-sequences that consumed the time of ADP laboratory personnel in 1999 through 2001. While the ADP hopes to reconstruct the samples to their excavated dimension, we must allow for the possibility that when the measured dimension does not match the excavator's estimate, and furthermore when no bark is preserved after the last measured ring, some rings may have been lost. In that case, the date for the cutting of the tree under analysis is given an estimate derived by dividing the estimate of the amount of radial wood missing by the average annual ring growth for that tree. There were estimated measurements on only two of the collected samples in the Phase 3 & 2 chronology. The excavators

International Symposium on Archaeometry, Demirci, A. M. Özer and G. D. Summers, Eds., Tübitak) and Kuniholm 2001 ("Archaeological Dendrochronology", Dendrochronologia 20/1: 63-68). A study of the climatic conditions that drive the responses recorded in tree rings throughout this region appeared in Hughes et al., 2001 (Malcolm K. Hughes – Peter Ian Kuniholm – Jon K. Eischeid – Gregg Garfin – Carol B. Griggs – Christine Latini, "Aegean Tree-ring Signature Years Explained," Tree Ring Research 57/1, 67-73.

The ADP has established that trees growing in northern Greece (Thrace, Thessaly, and Macedonia) crossdate convincingly not only with trees of the same species, but also with trees of different species, growing both in Turkey to the east and into the Balkans to the north. While the quality of crossdating over longer distances varies with distance and at altitudinal gradients, there is every reason to expect crossdating between wood growing on the Anatolian Plateau and that growing in north Greece. This has been well illustrated in numerous examples for modern forest wood, as well as for many medieval monuments in both countries (Kuniholm and Striker 1987, ibid., and 1990: "Dendrochronology and the Architectural History of the Church of the Holy Apostles in Thessaloniki", Architectura: Zeitschrift für Geschichte der Baukunst 1990, 1-26, and Kuniholm supra.)

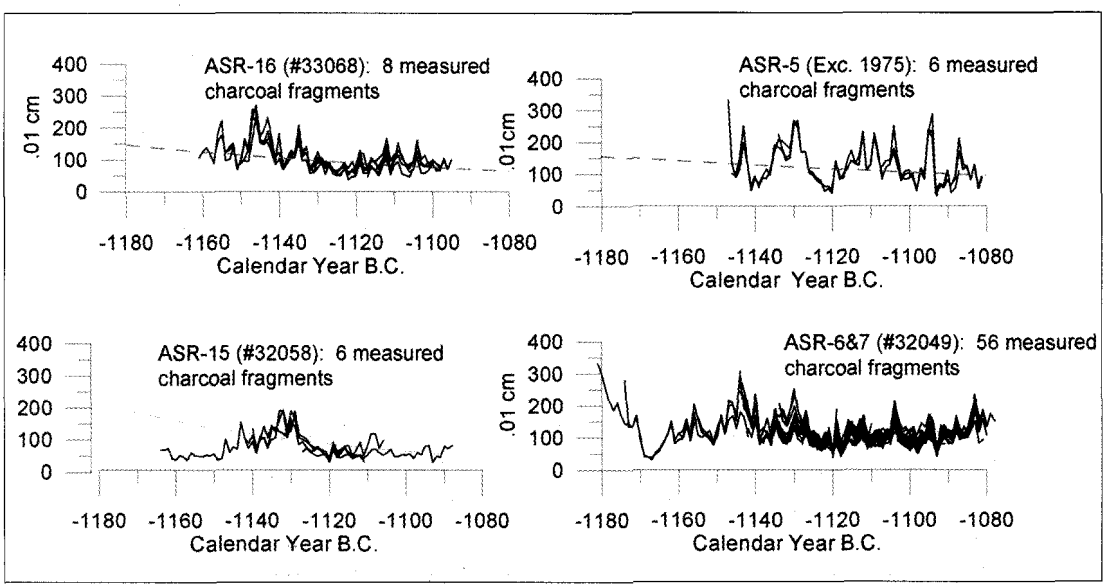


Fig. 5. Raw data from measurement of numerous fragments for the four standardized tree ring curves illustrated in Fig. 4.

estimated sample ASR 5 as having a radius of 10 cm, but the measured fragments (ADP nomenclature ASR 5, A to G) together have a preserved radius to the hundredth of a millimetre of only 8.58 cm. The estimated number of rings missing from the exterior is therefore 11[12]. For ASR 6 and ASR 7 (which are part of the same timber), the dimension of the radius estimated by the excavators was 14cm, while the measured dimension is 12.98 cm; the estimated number of rings missing from the exterior is 8.

All of these chronologies have been compiled from the measurement of the rings preserved on numerous fragments of charcoal. Fig. 5 illustrates the curves that have been combined to provide the continuous tree-ring sequences illustrated in Fig. 4.

In compiling the Phase 3 & 2 master dendrochronology (see Fig. 4) we use only standardized data from each tree rather than the raw measurements because this allows for the removal of the growth trend from each individual tree. This is shown in Fig. 5 by the "standardization" line drawn through each series. The process involves running an exponential curve (usually negative exponential) through an average of the raw data in order to reduce variation that might be due to biological responses peculiar to one tree but that are not related to the shared climate-driven variation which we seek to identify.

Dendrochronology: interpretation of Assiros results

The last existing ring of ASR 6 & 7 (Phase 2: central post in Room 14, excavation context #32049) is thus measured at 1078 BC. If allowance is made for the estimated missing 8 rings at the end, the likely cutting date may be put at 1070 BC.

12. Based on the average ring width in the preserved adjacent section of the timber.

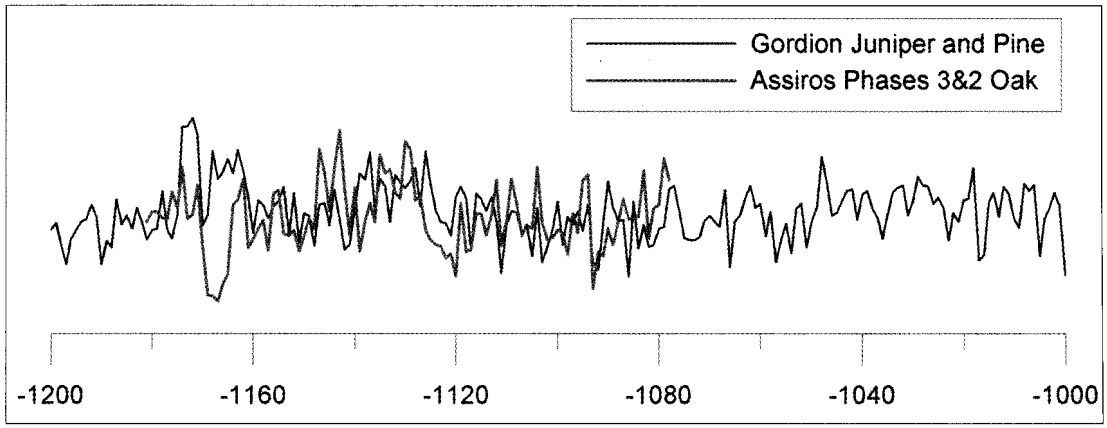


Fig. 6. Comparison of the Assiros Phases 3&2 dendrochronology with the Anatolian

The last existing ring of ASR 5 (Phase 2: fallen timber in Room 14, excavation context #1471), is 1081 BC, If allowance is made for the estimated missing 11 rings at the end, the likely cutting date may also, interestingly, be put at 1070 BC.

The last existing ring of ASR 15 (Phase 3: fallen timber in Room 13, excavation context #32058) is 1088 BC.

The last existing ring of ASR 16 (Phase 3: fallen timber to east of Room 13, excavation context #33068) is 1095 BC.

In the absence of bark or identifiable sapwood these must be understood as terminus post quem dates for the felling of the trees. However, the dendrochronological results do show that the dates for the last preserved rings of the Phase 3 timbers are earlier than the cutting dates for the timbers in the Phase 2 construction. If a similar loss of the outer rings is estimated for the Phase 3 timbers, the cutting date for them is likely to be c. 1080 BC. The stratigraphic relationship of the samples for the two phases ensures that they provide a terminus ante quem date for artefacts sealed under the Phase 2 floor which must fall in the interval between c 1080 BC and 1070 BC[13].

Dendrochronology: confirmation through 14C derived wiggle-matching

Fig. 6 illustrates the quality of the visual match of the master dendrochronology for Assiros Phases 3 & 2 against the Bronze Age-Iron Age master dendrochronology composed principally of juniper and pine trees from Gordion and environs. Statistically, the best fit of these two sequences using the t-test value also has the last preserved ring at 1078 +4/-7 BC (t-test: 4.46)[14]. Given the significance of the pro-

13. All these dates have, of course the same small uncertainty of +4/-7 derived from the Gordion sequence but this does not affect the interrelationship between them. Cf. also footnote 11.

14. The use of this test in tree-ring dating was first presented in 1973 by M. G. L. Baillie – J. R. Pilcher, "A Simple Crossdating Program for Tree-Ring Research", Tree-Ring Bulletin 33, 1973, 7-13. It continues to be used as the standard measure of the cross-correlation of tree-ring series by dendrochronologists in tree-ring laboratories throughout the EU, and is the principal measure used by the ADP.

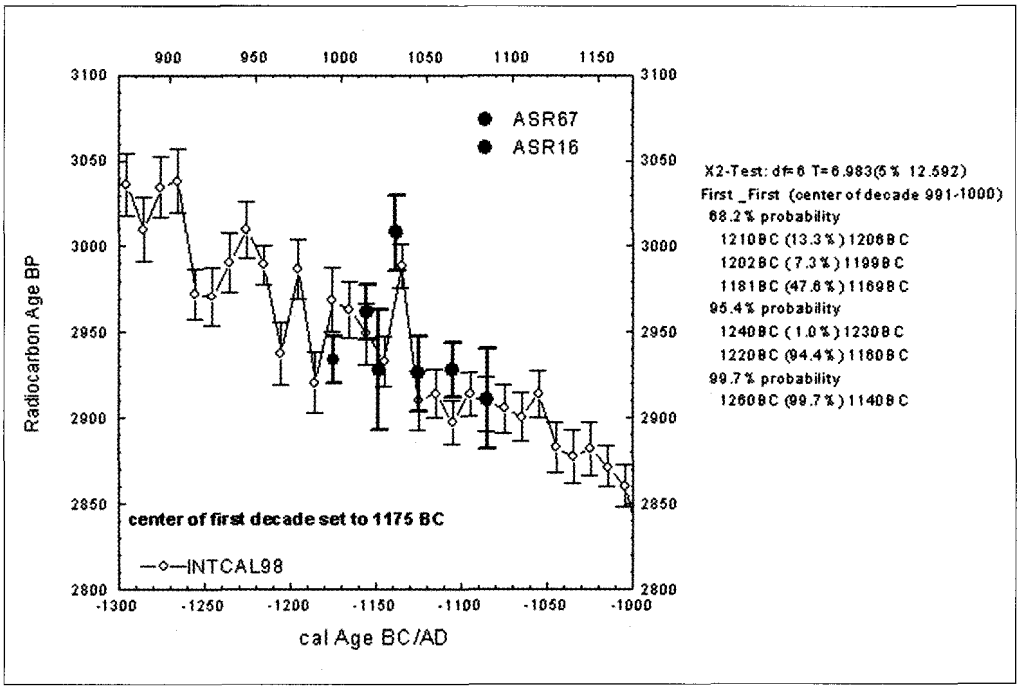


Fig. 7. Assiros Phases 3&2 dendrochronological 14C wiggle-match showing the "best fit" of the seven determinations against the INTCAL98 calibration curve.

posed date and the fact that it is based on not ideal tree-ring data, (in terms of the number of trees in the Assiros sample and the relatively short length of the time series), we selected a series of decadal samples for radiocarbon analysis to seek independent confirmation of the result.

Where rings from a single timber can be sampled at standard intervals for 14C determinations, these can be correlated statistically to reduce the margin of error well below the level that applies to a single sample. In combination, they allow far more precise, and quantifiable, match against the wiggles on the standard internationally recommended calibration curve (INTCAL98).

Altogether seven decades (or "near" decades, as limited by availability)[15] from the 104 year Assiros sequence have been submitted to the Radiocarbon Facility at the Institut für Umweltphysik at the University of Heidelberg (see BP dates tabulated in Fig. 7, 8). Two of these were run in 1999 in an earlier test of the suitability of the material for dendrochronological wiggle-matching, and five more were then selected from the 104-year sequence to try to replicate the radiocarbon calibration curve in this difficult period[16]. Fig. 7 illustrates how these seven samples are grouped to-

15. The seven samples are taken are from the charcoal fragments of two trees, ASR-6 & 7 and ASR-16. The decades are from the same relative years according to the dendrochronology. ASR-16 was used only because ASR-6 & 7 could not provide sufficient material for the relevant decades (i.e., conventional gas counting at the Heidelberg Laboratory requires at minimum 4g of material, and the ADP laboratory personnel were able to gather sample only 3.11g total from this decade from ASR-6 & 7, but 4.75g from ASR-16).

16. This period is difficult only because of the "wiggly" nature of the calibration curve, and not for any

Heidelberg Sample #	*Assiros Sample #*	*Dendrochronological relative years of selected decades*	*BP date*
	ASR 6 & 7 (2003)	991-1000, Midpoint 995.5	2934±14
	ASR 6 & 7 (2003)	1010-1020, Midpoint 1015	2962±16
Hd-21076	ASR 16 (2000)	1016-1028, Midpoint 1022	2928±35
	ASR 16 (2004)	1026-1038, Midpoint 1032	3008±22
	ASR 6 & 7 (2003)	1040-1050, Midpoint 1045	2926±22
	ASR 6 & 7 (2003)	1060-1070, Midpoint 1065	2937±21
Hd-21077	ASR 6 & 7 (2000)	1079-1091, Midpoint 1085	2911±29

Fig. 8. 14C determinations for Assiros Phases 3&2 dendrochronological wiggle-match.

gether on the calibration curve. Since they are linked according to an absolute time-scale, if one datum is moved within the limits of its error range, then the other six must move with it. No other 'fit' can be supported by this sequence of dates[17]. The calendar date for the last preserved ring of the Assiros Phases 3 & 2 dendrochronology must therefore, from radiocarbon alone, be set at 1090 ± 22 BC at 1σ, or 1104 ± 43 BC at 2σ.

The dendrochronological 14C wiggle-match date for the latest preserved ring at 1090 ± 22 BC (i.e a 68.2% probability of falling between the years 1112 and 1068 BC) is perfectly consistent with the dendrochronological date at 1078 BC+4/-7 and provides independent confirmation that this is a real calendar date.

Significance: the absolute dates determined for Assiros[18]

Given the uncertainties of the currently accepted relative chronological framework for the end of the Aegean Bronze Age, it would have been a great advance to correlate a single absolutely dated sample from a good archaeological context with artefacts representing a readily recognisable material culture. The dating of four

problems with its compilation. The 100 years between 1200 and 1100 BC are in fact replicated by other data sets. For the archaeologist looking at 14C dates for this period, any single date can have equal probabilities at a number of places on the curve. And furthermore, until the availability of a single-year calibration curve, the precision of a single radiocarbon date, or group of samples presumed to be dating the same event, cannot be much improved by increased sample depth.

17. We are grateful to Dr. Sahra Talamo and Dr. Bernd Kromer for measuring these samples, and particularly to Dr. Talamo for one final sample in time for the submission deadline for this paper. This was the fourth sample, chronologically, in the series which, determined at 3008±22 BP, closely matches the peak in the INTCAL98 curve at 1135 cal BC and provides striking confirmation of the fit already determined on the basis of the other six samples.

18. KAW is grateful for the interest and enthusiasm of colleagues and students at the Institute of Archaeology and Antiquity of the University of Birmingham when presented with the story as it has gradually unfolded during the past six months and especially for the pertinent and searching questions they put. In the process of answering these queries we hope we have been able to make the paper more intelligible and forceful.

samples from closely correlated contexts which can be associated with a short-lived and distinctive type artefact (in this case a Protogeometric amphora, Fig. 2, Pl. 2) is an unique achievement in archaeology and archaeometry for any period of Greek prehistory. Before proceeding to examine the significance of these dates for Macedonia, the Aegean and other areas, it is important to address some of the objections which might be raised to the accuracy of these dates since, once accepted, they demonstrate that the start date of Protogeometric should be set before 1070 BC, perhaps by as much as 30-50 years.

a) Can the cutting date of the timbers be established? – Yes, since, even though the bark is no longer present, and the outer rings cannot clearly be demonstrated as being sapwood[19], the timber on which the date is based was used as an unshaped post (Pl. 1). This makes it likely that the only processing of the wood before use was removal of the bark. Furthermore, the estimates for the slight ring loss from mechanical causes after burning suggest that both trees in the Phase 2 construction were cut in the same year, presumably for the same purpose, i.e., to build the Phase 2 structure.

b) Can reuse of the timbers from earlier buildings be ruled out? - Not absolutely, but the buildings of the previous Bronze Age phases (6 & 5) were destroyed by devastating fires right across the site, as indeed were those of Phase 3[20]. That one or two timbers might survived such fires and be available for reuse is possible but that all four samples had survived in this way is very improbable.

c) Can we be sure that these timbers provide an absolute date for the Protogeometric amphora (Fig. 2) rather than a terminus post quem? – Yes. The felling date for the Phase 3 timbers is indeed a terminus post quem, but most fragments of the amphora came from Phase 3 Room 13 (as did sample ASR 15) and were sealed below the Phase 2 floor[21]. The construction timbers of this Phase give an equally firm terminus ante quem. The breakage of the amphora can thus be set during the short period from 1080-1070 BC. It must, of course, have been made before this but there is nothing to show how long it might have been in use.

This amphora, which is decorated with concentric compass-drawn circles on the shoulder, has already been placed by Catling in a definitive study of PG pottery from the northern Aegean in his Group I which is distributed from Macedonia to Troy and

19. The number of sapwood rings can, for oak, provide a valuable tool for dating the end of a tree's life. If any sapwood rings are present, an estimate for the total until bark can be added. Such an estimate for oak from north Greece and western Anatolia was presented in Kuniholm and Striker 1987. With charcoal, however, we are missing the most useful feature for identifying sapwood, i.e., color change. The only anatomic feature that might be discernible in charcoal is the infilling of tyloses, but none of this was observed in the Assiros samples.

20. No evidence survives to show why the rather makeshift settlement of Phase 4 was rebuilt. Even if all the timbers were reused from this phase, the start of the Iron Age in Macedonia would still be set before 1070 BC.

21. The fact that some of the sherds were found widely scattered, above the Phase 2 floor levels, shows only that they were brought up to this level during the building operations to construct Phase 2, (or 1.5). While most of the sherds came from Room 13, a few were from Room 14 (Phases 3 and 2) and isolated sherds were also found in the debris in Phase 2 Room 2, immediately to the south and in Room 17 on the other side of the street to the south.

may well have been manufactured in northern Greece. The stylistic comparison of details of shape and decoration indicate that this group is found with EPG groups of material at Kalapodi, EPG and MPG material at Elateia and with MPG material in the fill over the great Toumba building at Lefkandi, as well as at Troy VIIb3. At the latter site he suggests "according to the prevailing current views... the date... is likely to fall around the turn of the 11th or early 10th century"[22].

Catling regards the Assiros piece as a later stage in the evolution of the type but does warn that it has some unusual characteristics, notably the handles. "It should indicate that Phase 2[23] of EIA Assiros is no later than the mid-tenth century". On the basis of the conventional dates for Protogeometric he placed this amphora between 1025 and 975 BC with a preference for the later end of this span[24]. If the 1070 BC date presented in this paper is accepted and the duration of the Protogeometric period is much as currently believed this would imply that the start of PG should now be set at around 1120 BC (50 years earlier than the cutting date of 1070 BC). To argue that it belongs to the very beginning of Protogeometric would still leave the start date of Attic Protogeometric before c 1070 BC (unless, which we and Catling[25] doubt, a case can be made for the origin of this style in Macedonia or the northern Aegean). To argue that the amphora might be later than he suggests would have the effect of raising the date for the start of Protogeometric even further.

Significance: evidence for absolute Iron Age dates at Kastanas

At present, relative dates for other excavated Iron Age sites in Central Macedonia are difficult to establish since the local hand made pottery developed so slowly. Absolute historically based dates are a matter of informed guesswork. Only the presence of Protogeometric style pottery which is close to its southern Greek prototypes enables rough dates to be offered[26].

The original single Iron Age radiocarbon date from Assiros[27] is broadly compatible with the new evidence, as are the majority of those from Kastanas Schichten 12-10[28] –if taken at face value. All fall within the limits of probability at 2σ con-

22. Catling, loc.cit., 155.

23. This should probably read Phase 3 since, as stated above, the majority of the fragments came from the earlier phase, cf. Catling, loc.cit., 161.

24. We are grateful to Richard Catling for helpful comments about these issues. His view is repeated by Lemos in her recent study of the Protogeometric period: Irene S. Lemos, The Protogeometric Aegean (2002) 57.

25. Loc.cit., 163.

26. The Protogeometric pottery from Kastanas has been discussed by Catling in its Aegean context (loc.cit., 159-161) and that from Schichten 12-10 has been published by Reinhard Jung (Kastanas die Drehscheibenkeramik der Schichten 19-11 PAS 18 Kiel 2002) as part of his account of each shape of the wheelmade pottery whether Mycenaean or Protogeometric in style. Dating pieces which sometimes combine decorative elements from both styles is a complex issue (226-9).

27. Burleigh et al., loc.cit.

28. Exact correlation between Assiros Phases and Kastanas Schichten depends on the imported pottery, whether Mycenaean or Proto-Geometric. Since Kastanas Schicht 12 includes Protogeometric pottery as well as Mycenaean, the duration of the Phase is likely to overlap with Assiros Phases 6, 5, 4, and 3, while Assiros Phases

fidence. Only the new dendrochronologically wiggle-matched results, however, can be related to the specific wiggles which are such a feature of the calibration curve in the centuries bracketing the transition from the Late Bronze to Early Iron Age.

At Kastanas, however, most of these phases have been dated with reference to the currently accepted "historical dates" which are ultimately derived from Egypt and the Levant[29]. Jung and Weninger have devoted a lengthy discussion to explaining the discrepancy between the excavator's expected "historical" date and the 14C dates obtained[30]. The argument for an "old wood" effect is presented on two grounds. Firstly rings may be lost in the process of a destruction by fire (which is uncontroversial). Secondly, in the case of charcoal samples which are fragments of larger timbers, their relationship to the sapwood/bark is not usually determinable but they may reasonably be assumed to be provide a date earlier than the cutting date. Jung and Weninger propose that, on average, this may be assumed to be approximately two thirds of the way through the life of the tree. However, an additional series of short-lived samples from cattle bone has been processed giving dates which again are older than expected. That these samples also have unusually high δ13C levels leads the authors to suggest that this may result from an atypical diet that might have biased the results for 14C towards an earlier date[31]. We are, however, unconvinced by these arguments for rejecting the 14C determinations. Indeed, even when the proposed correction factors are applied, there remains some 50-70 years discrepancy to be accounted for in many of the samples while others need none at all.

While it is true that there is a valuable cluster of determinations from Schicht 12, there seems to be no way of relating these to each other within the 150 year span allotted to this level, other than to calculate a mean for the group, the deviation from it, and possibly to exclude one or two outliers as erratic. In any case this mean determination for the set from Schicht 12 can equally well be placed on any of the three peaks in the calibration curve between 1200 and 1100 BC and there seems to be no good reason for preferring any of these matches above the others without independent evidence.

Predictions of the length of the different building phases at Assiros and Kastanas to create what has been termed an archaeological wiggle-match have been used to support the conventional chronology[32]. The methodology is unconvincing and the

2 and 1.5 could be contemporary with Kastanas Schichten 11 and 10. Jung, op.cit., 218-229, and 285-7.

29. The justification for the absolute dates used is given in a paper to be published in the proceedings of the 2002 Oxford Radiocarbon conference. We are grateful to Reinhart Jung and Bernhard Weninger for allowing us to see an early version.

30. Appendix to Jung, op.cit. Reinhard Jung and Bernhard Weninger, "Appendix: Zur realität der Diskrepanz zwischen den kalibrierten 14C-Daten und der historisch-archäologischen Datierung in Kastanas", 281-298.

31. Jung and Weninger, forthcoming, (footnote 29).

32. Sturt. W. Manning – B. Weninger, "A light in the dark: archaeological wiggle matching and the absolute chronology of the close of the Aegean Late Bronze Age", Antiquity 66, 1992, 636-63 especially 648. In this paper the authors used standardised estimated durations of each building horizon at both Assiros and Kastanas to create an "archaeological" wiggle-match to the to the then internationally accepted radiocarbon calibration curve (which in 1992 was UW10 86), but the premise on which their argument was based now seems questionable, at

results should not be given greater weight than dendrochronological wiggle-matches.

Significance: the date of the start of Protogeometric in Southern Greece

If, as argued above, a date of 1070 BC is accepted for the deposition of the Protogeometric amphora at Assiros, the inescapable corollary is that the date of the start of the Protogeometric period must be raised, perhaps by as many as 70 years (depending on which view is taken of the current start date) to allow time for the style to develop and be disseminated.

The current start date has the distinction of a length of discussion in inverse proportion to the available evidence. The basis of the discussion, however, has for years depended on a small number of relatively remote parallels and a chain of logical argument for lack of concrete information. Desborough, for example, first proposed (1952) a 1025 BC date on the basis of the estimated length of time that must have passed since the beginning of the LH IIIC period (traditionally set at c 1200 BC) via the time span allocated for Sub-Mycenaean, and on tentative dates for finds of PG pottery in the Levant[33]. In his The last Mycenaeans and their successors, he preferred at date of 1050 on additional evidence from Cyprus –which was itself dependent on dates in the Levant[34]. Warren and Hankey took this argument a stage further and proposed that there were seven distinct styles of pottery which represented seven generations of potters between the start of LH IIIC and the end of Sub-Mycenaean. Allowing 25 years per generation, they calculated a Protogeometric start date of 1025 BC[35]. Similar evidence has been used by Lemos in her recent study of the Protogeometric period[36]. Some support for these dates was provided by examples of Protogeometric pottery in contexts in the Levant associated with the campaigns of King David as reported in the Old Testament, which were thought to be of early 10/th c. date. In a recent article, Nicolas Coldstream, reviewing Greek imports in the Levant, presents two schemes for understanding these centuries from the perspective of an Aegeanist working with Greek ceramics. He prefers a "low" chronological scheme, but the primary reason he offers is that the "high" chronology would present "an uncomfortable congestion" for the long development of LH IIIC and Sub-Mycenaean before the appearance of Protogeometric[37].

The absolute dates upon which the chronological schemes presented by Coldstream are based come from finds of Greek imports at sites in the Levant, but these dates have been the subject of much discussion recently and this not the place for a

least with respect to the supposed "absolute dates" they were using in their models. The assumptions used by Jung and Weninger specifically for Kastanas are no more secure.

33. V. R. d'A Desborough, Protogeometric pottery (1952) 294.

34. Idem, and The last Mycenaeans and their successors (1964) 240-1.

35. Peter Warren – Vronwy Hankey, Aegean Bronze Age Chronology (1989) 168.

36. Lemos, op.cit., 26.

37. Nicolas Coldstream, "Some Aegean Reactions to the Chronological debate in the Southern Levant," Tel Aviv 30:2, 2003, 253-254. Cf. also Nicholas Coldstream – Amihai Mazar, "Greek Pottery from Tel Rehov and Iron Age Chronology", Israel Exploration Journal 53/1, 2003, 29-48.

detailed review of the arguments and counter arguments which affect the whole of Levantine chronology[38]. It may however be noted that for some years those who reject links to a mythological Davidian chronology based on Biblical texts have been aware of the discrepancy between the 'low' dates proposed by Aegean specialists for this ware with higher ones preferred in Israel, for example. Currently, there has been a move to lower the 'high' tenth century dates by 50-100 years, and it will be of interest to see the results of 14C determinations said to support this[39].

Significance: the start date of LH IIIC

Setting the beginning of the Protogeometric period as early as 1100 BC as we propose on the basis of the evidence presented above from Assiros has a significant impact on the length of the LH IIIC period. The start of this is taken to be relatable to the campaigns of Rameses III against the Sea Peoples –a "fixed" historical point around 1186 BC– but set by different authors as early as 1200 BC or as late as 1185 BC[40]. Dates for the final stages of the Bronze Age in Macedonia have indeed, so far, been based on these conventional dates for LH IIIC, and the 14C determinations have been regarded as unhelpful since many fall in the 13th century BC[41]. Preliminary evaluation of the Assiros Phase 6 dendrochronological samples, however, also indicates a 13th century date[42]. It may well be time to reassess the basis for the 1200/1185 BC date in the light of this fresh evidence.

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38. A. Fantalkin, "Low Chronology and Greek Protogeometric and Geometric Pottery in the Southern Levant", Levant 33, 2001, 117-125; Günter Kopcke, "1000 B.C.E.? 900 B.C.E.? A Greek vase from Lake Galilee", in Erica Ehrenberg Ed., Leaving no stones unturned: Essays on the ancient Near East in honor of Donald P. Hanson (2002) 109-118. We are particularly grateful to Alexander Fantalkin for his comments on and reactions to the implications of the new start date for Protogeometric and for information about recent publications and the extensive discussions currently in progress in the Levant.

39. Cf. Ayelet Gilboa – Ilan Sharon, "An Archaeological Contribution to the Early Iron Age Chronological Debate: Alternative Chronologies for Phoenicia and Their Effects on the Levant, Cyprus, and Greece", BASOR Nov. 2003, Iss. 332: 1-75; H. J. Bruins – J. Van der Plicht – A. Mazar, Science 300, 315-318, and the responses thereto by Israel Finkelstein and Eli Piasetsky, with reply by Bruins et al., in Science 302, 568.

40. E.g. Warren and Hankey, op.cit., 159-67 for an account of the complexities and uncertainties of the problem.

41. See discussion in Jung and Weninger, loc.cit., Two recent determinations for Phase 4 with LH IIIC pottery at Toumba Thessaloniki (DEM 1284 and 1285, S. Andreou, pers. com.) are comparable and we understand that additional samples are currently being processed.

42. Additional analyses including "short-lived" samples should help to clarify this and we hope to present further results at the 2005 AIA conference.

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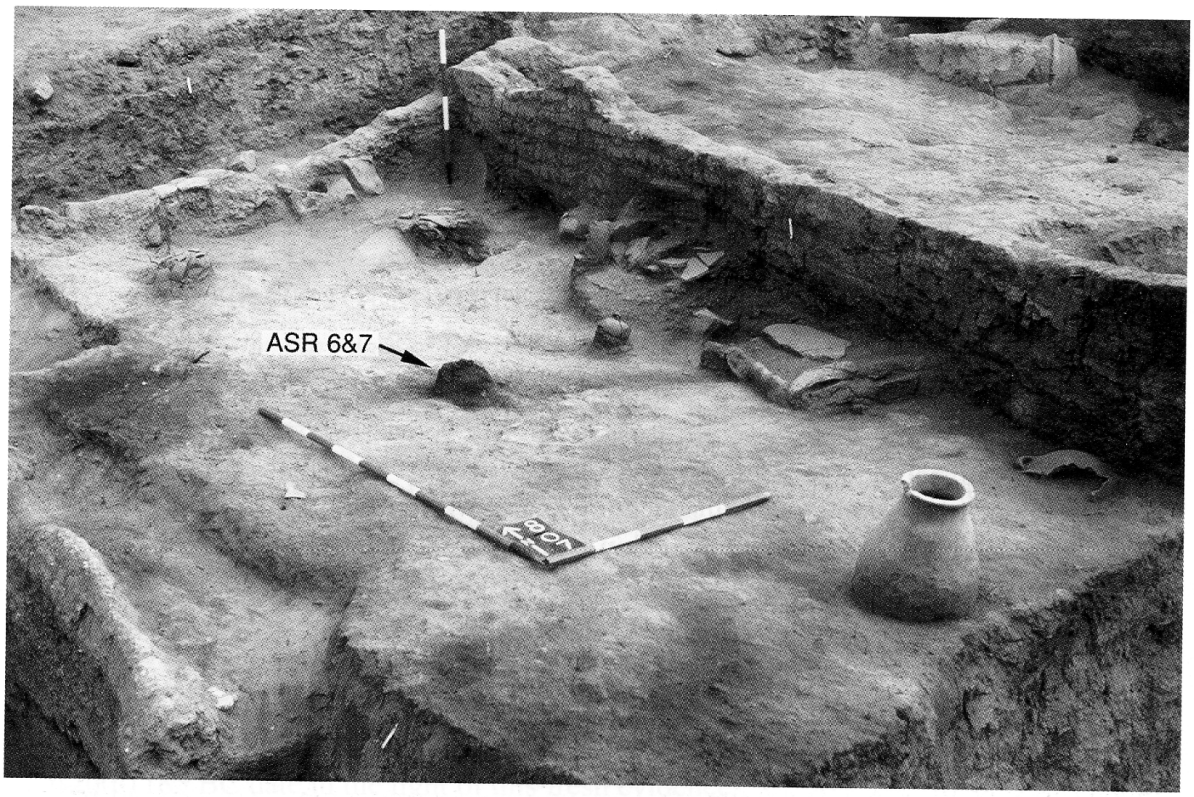
ΔΕΝΔΡΟΧΡΟΝΟΛΟΓΙΚΑ ΚΑΙ ΡΑΔΙΟΧΡΟΝΟΛΟΓΙΚΑ ΑΠΟΤΕΛΕΣΜΑΤΑ ΑΠΟ ΤΗΝ ΑΣΣΗΡΟ ΚΑΙ Η ΑΡΧΗ ΤΗΣ ΕΠΟΧΗΣ ΤΟΥ ΣΙΔΗΡΟΥ ΣΤΗΝ ΕΛΛΑΔΑ

Στην ανακοίνωση παρουσιάζεται μια καινούργια χρονολόγηση για την έναρξη της πρωτογεωμετρικής περιόδου στην Ελλάδα. Μολονότι τα δείγματα δενδροχρονολόγησης με 14C δίνουν στα συμφραζόμενά τους ένα terminus ante quem για την εμφάνιση της πρωτογεωμετρικής περιόδου, πρέπει αυτή σαφώς να γίνει κατανοητή σε σχέση με τη συνολική ιστορική διαδρομή των φάσεων κατά τις οποίες τα δένδρα χρησιμοποιήθηκαν σαν δοκάρια για την κατασκευή κτισμάτων. Η ραδιοχρονολόγηση με 14C χρονολογεί το σύντομης διάρκειας υλικό από όλες τις φάσεις της Ασσήρου και η δενδροχρονολόγηση με 14C δίνει χρονολογήσεις στο ξύλο από τα επίπεδα των πρώιμων κατασκευών και, παράλληλα, μια πληρέστερη εικόνα της χρονολόγησης των ύστερων φάσεων της εποχής του χαλκού στην Άσσηρο. Αυτό μας προμηθεύει με καλύτερα δεδομένα κατανόησης των χρονολογήσεων με 14C από τον Καστανά και την Τούμπα Θεσσαλονίκης, ενώ, ταυτόχρονα, συμβάλλει σε μια καινούργια συζήτηση για τη χρονολόγηση της εποχής του χαλκού στο Αιγαίο. Ελπίζουμε ότι έτσι θα ανασκευαστούν οι προτάσεις του James και άλλων με την εξάλειψη περίπου 250 χρόνων από τις χρονολογήσεις των σκοτεινών χρόνων[43].

43. P. James – I. J. Thorpe – N. Kokkinos – R. Morkot – J. Frankish, Centuries of Darkness (1991).



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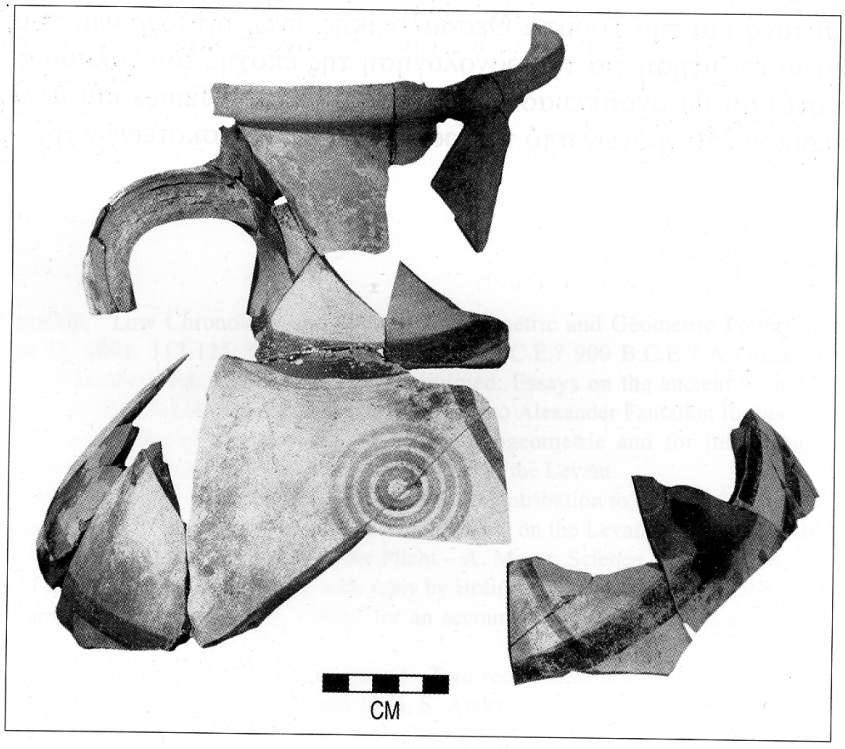

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Pl. 1. Phase 2 Room 13 with post in situ.
Pl. 2. Protogeometric amphora of Catling's Group I from Assiros.