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TESTING THE LIMITS: RADIOCARBON DATING AND THE END OF THE LATE BRONZE AGE

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ABSTRACT. Archaeometry is becoming an increasingly important tool in chronological research related to events in the Ancient Near East during the 2nd millennium BCE. This paper is a review of recently published radiometric results in an attempt to establish the probable dating range for one particular event that occurred during the last quarter of that millennium, the end of the Late Bronze Age. The conclusion is that in spite of significant improvements in methodology in recent years, the quantity and quality of radiocarbon data are still insufficient to define the range of that date to much better than a century. It is concluded that the most likely date of the Late Bronze/Iron Age transition (here defined by the arrival of Mycenaean LH IIIC:1b pottery in the Levant) is somewhere in the 8-decade range between ~1170 to 1100 BCE. A comparative study of archaeological and historical evidence would appear to favor the lower value.

INTRODUCTION

Almost 20 years ago, it was realized that an assumption which had long been used to calculate the chronology of the Ancient Near East (ANE) during the 2nd millennium BCE was invalid. At that time, Helck (1987) demonstrated that it is invalid to use astronomical data from the time of the Egyptian New Kingdom for precise chronological calculations. Prior to 1987, it was widely accepted that New Kingdom dating could be strictly defined within a narrow range of about 25 yr and that the reign of Ramesses II began no earlier than 1304 or later than a low date of 1279 (all dates given here are BCE). Although this conclusion has been thoroughly tested, it has not been disproved, and a review of the relevant data contained within the Egyptian Ebers Calendar concluded that "existing theories . . . have tried to find in the document a certain sophistication or deeper historical meaning that . . . it does not have" (Depuydt 1996:85). This challenge to the absolute Egyptian chronology has wide ranging consequences, for much of the dating of the Late Bronze and Iron Ages in the Ancient Near East and Aegean is dependent on these absolute dates. This development resulted in some quite radical proposals, including that of James et al. (1991) who argued that the dating of the Late Bronze Age (LBA) should be lowered by several centuries. Although this proposal was severely critiqued[1] and has not subsequently been accepted, one of the more severe opponents did concede that the absolute dates of the New Kingdom depend not on Sothic dating but on records of king-lists and synchronisms with historical data in Syro-Palestine and western Asia (Kitchen 1991:237). The critical reaction to James et al. included 2 reviews of radiometric data by Manning and Weninger (1992) and Manning et al. (2001) in which the authors concluded that the Conventional chronology was "approximately correct" and that their work had brought an end to "radically lower LBA chronologies in the eastern Mediterranean and Near East" (Manning et al. 2001:340). Since then, the conventional Egyptian chronology has been generally retained, with the Low version of the allowed astronomical range increasingly preferred (Wente and Van Siclen 1976). Nevertheless, various historiological uncertainties remain, and the phrase "approximately correct" remains to be defined. Elsewhere I have suggested that the historical and archaeological data from Egypt, Mesopotamia, and Syro-Palestine would be better served if the absolute dating of the Egyptian New Kingdom were to be lowered by about 70–80 yr (Hagens 1996, 1999, 2002, 2005). According to this "Ultra-low chronology" (ULC), the 8th year of Ramesses III would be lowered from 1175 to ~1100 BCE.

[1]Various authors. 1991. Review Feature: Centuries of Darkness. *Cambridge Archaeological Journal* 1(2):227–53.

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In a related development, several Syro-Palestinian archaeologists argue that the relative dating of the Iron II period should be lowered by about the same degree. There are 2 aspects to this very active debate. In the first of these, Ussishkin (1985:222–3) and Finkelstein (1996) have questioned the conventional wisdom that the Philistines arrived in Canaan in the 8th year of Ramesses III, arguing that this event may have occurred later in the Ramesside period. Later, Finkelstein and others suggested that the Iron II archaeological material in Syro-Palestine formerly associated with the 10th century reigns of David and Solomon should in fact be attributed to the 9th century Omride period. The latter aspect has since dominated the debate, with support being provided by radiometric data from a number of archaeological strata in the Levant. These chronological ideas do, however, remain highly controversial.[2] The proposed revision of the early Iron I chronology is of particular concern to a number of critics who argue that it would require a severe, even idiosyncratic, revision of the early Philistine period (Na'aman 2000:4; Ben-Shlomo 2003:103–4; Bunimovitz and Lederman 2001:140–1; Dever 2003:266–7). These concerns have not been answered by its supporters, and there is growing support for the conventional view that the Philistines arrived in the Levant after their battle with the Egyptians in the Ramesses 8th year. Since the Low Iron II chronologists do not admit the possibility that the absolute dating of Ramesses III should also be adjusted, one consequence of the approach is that it would extend some poorly represented stratigraphic phases to an unacceptable degree. It would thus exacerbate problems with early Iron Age chronology, which were only partially eased by the acceptance of the Low Egyptian chronology of Wente and Van Siclen (1976) by Palestinian archaeologists. The objections to the Low Iron II theory are such that 2 of its supporters recently conceded that the debate has reached a stalemate, and beyond some "stunning find in the future," the only hope for resolving the question is radiocarbon dating (Finkelstein and Piasetzky 2003a:773).

OBJECTIVE

This paper is a review of the earlier work of Manning and coauthors and of more recent ^{14}C data related to the Low Iron II debate, with the objective of determining whether radiometry is capable of differentiating 2 alternate chronological models of the end of the LBA: the Conventional Low Egyptian dating and the Ultra-low chronology. A secondary objective of this review is to determine the most probable dating range for the end of the LBA that emerges from the radiometric data presently available.

Defining the End of the Late Bronze Age

Since I will be examining radiometric data from a number of different locations in the Ancient Near East (ANE), it is appropriate to review the terminology and the assumptions commonly used to describe the different archaeological phases in Syro-Palestine, Greece, and Cyprus within the time frame of interest. Note that the terms Bronze Age and Iron Age are used in different ways. Syro-Palestinian scholars define the Late Bronze/Iron Age (LB/IA) transition either by the cessation of international trade associated with the destruction of the Mycenaean palaces and the widespread wave of destruction that followed (Mazar 1990:295–6) or by the appearance of LH IIIC:1b in Palestine. The latter definition, which associates the commencement of the Iron Age period with the arrival of the Philistines in the 8th year of Ramesses III, appears increasingly popular and will be used here. In Aegean and Cypriot studies, however, the term Iron Age is reserved for a technological change that

[2]The literature is extensive. Recent articles supporting the lower dating include Coldstream 2003; Finkelstein 1996, 1998, 1999; Finkelstein and Piasetzky 2003a,b; Finkelstein and Singer-Avitz 2001, 2004; Gilboa and Sharon 2001; Gilboa et al. 2004; Na'aman 2000; Ussishkin 1995, 2000. For opposing views: Ben-Tor and Ben-Ami 1998; Ben-Tor 2000; Bunimovitz and Faust 2001; Bunimovitz and Lederman 2001; Dever 2003; Gal 2003; Mazar 1997a; Zarzeki-Peleg 1997.

occurred considerably later. A brief summary of some commonly accepted, in some cases very approximate, synchronistic phases in these regions is shown in Table 1.[3]

Table 1 Synchronisms for the Ancient Near East.

Dates BCE	Palestine	Greece	Cyprus	Egypt (excerpt)
1400–1350	LB IIA	LH IIIA1	LC IIA/B	
1350–1300	LB IIA	LH IIIA2/B	LC IIB	
1300–1250	LB IIB	LH IIIB	LC IIC	Ramesses II, 1279
1250–1175	LB IIB	LH IIIB	LC IIC	Merneptah, 1212
1175–1150/30	Iron IA	LH IIIC (early)	LC IIIA	Siptah/Twosret, 1193 Ramesses III, 1182
1150/30–1100	Iron IB	LH IIIC (mid)/ Sub Mycenaean	LC IIIB	Ramesses IV, 1151
1100–1050	Iron IB	LH IIIC (late)/ Protogeometric	LC IIIB	Ramesses XI, 1098
1050–1000	Iron IB	Protogeometric	Cypro-Geometric I	
1000–900	Iron IIA	Late Protogeomeric/ Early Geometric	Cypro-Geometric I	

The absolute dating of the LB/IA transition in the Levant is based on a relatively small number of cases in which imported LH IIIB or slightly later LH IIIC:1b ware has been found in association with datable Egyptian items in unambiguous stratigraphic contexts. This procedure is subject to various sources of error. For example, one chronological anchor that has been employed for this purpose is a vase inscribed with the cartouche of the Egyptian Queen Twosret (1193–1186), which was found near some LH IIIB pottery at a shrine at Deir ‘Alla. Since the items appear to have been functional vessels used in the service of the sanctuary, it is conjectured that LH IIIB trade ceased around the time of Twosret (Drews 1993:6–7). There are several weaknesses in this argument. One is that LH IIIA pottery was also present in the treasury, which suggests that some or all of the ware could have been heirlooms. The second is that since there was a hiatus in international trade after the fall of Mycenae, it is not clear how long such imported pottery may have been kept in service during a time when no other ware of such quality was available to replace it. Another synchronism used to date the wave of destruction that followed the fall of the Mycenaean palaces derives from evidence that Ugarit was still standing when Twosret was on the throne. Moreover, the king of Ugarit was in urgent communication with Alashiya in Cyprus immediately after this city was destroyed (Drews 1993:6). Unfortunately, this correspondence allows no clear association between the fall of Ugarit and the LC IIC/LC IIIA transition in Cyprus, since it is seems likely that Alishiya may have escaped destruction at that time.[4] Indeed, the Cypriot evidence suggests that trade in LH IIIB goods was interrupted some time prior to the end of the LC IIC period, and that the decline in the Late Bronze may have been an extended process rather than a brief wave of destruction (Karageorghis 2002:71, 74, 84). It may also be noted that Libyan tribes began making their way to the delta as a result of famine in their homeland several decades prior to the time of Twosret, during the reign of

[3]Low Egyptian dating after Wente and Van Siclen (1976:218); Syro-Palestinian data: Mazar 1990:242, 301, 372. Aegean: Manning and Weninger 1992:637; Coldstream 2003:254. For a sense of the uncertainty of these ranges: Snodgrass 2001: 106–35.

[4]Alashiya may been protected from attack by the sea by its inland location (Goren et al. 2003:250–1), and if as suggested Alashiya it is to be identified with Alassa-Palaeotaverna, it may have avoided destruction completely. There is evidence that a large palatial building constructed at that site during LC IIC was remodeled during LC IIC/IIIA (Karageorghis 2002:73).

Ramesses II (1279–1212). These invaders were later joined by groups of marauding Sea Peoples during the reign of Merneptah (1212–1202; Faulkner 1975:233–4) at a time roughly contemporary with the evidence of destruction in Mycenae. If these examples of piracy are an indication of a general breakdown in maritime law and order, it is possible that trade in LH IIIB materials could have ceased as early as ~1220–1210. Another anchor used to establish these transitions involves the appearance of Mycenaean LH IIIC:1b pottery in the Levant during the first decade of Ramesses III (1175). This synchronism cannot, however, be used to precisely define the end of the LH IIIB/IIIC transition because the duration of the intermediate LH IIIC:1a phase is unknown. For these reasons, production and trade in LH IIIB pottery could have ceased 2 or more decades prior to the destruction of Ugarit some 40–50 yr prior to the arrival of the Philistine IIIC:1b pottery during the first decade of Ramesses III.

The objective of this article, therefore, is to explore whether ^{14}C dating can determine whether the cessation of LH IIIB trade and the arrival of the Philistines in the Levant occurred closer to the Conventional or ULC dating range for these events. These alternatives are illustrated in Table 2.

Table 2 Alternate chronological options (all dates BCE).

	Mycenae LH IIIB/IIIC	Cyprus LC IIC/IIIA	Syro-Palestine LB/IA
High Egyptian	1245–1225	1235–1225	1200
Low Egyptian	1220–1200	1210–1200	1175
Ultra-low	1145–1125	1125	1100
	Mycenae LH IIIB/IIIC	Cyprus LC IIC/IIIA	Syro-Palestine LB/IA

Before proceeding, it should be noted that the Ultra-low chronology arises as the consequence of suggested dynastic overlap in Egypt and Mesopotamia during the 10th century BCE, and thus only affects dating prior to about 1000 BCE. During the 1st millennium, the Ultra-low chronology does not deviate from the Conventional chronology, which derives from historical sources such as king-lists, the continuous Assyrian eponym canon, and ceramic typology.

SOURCES OF ERROR

It is necessary to pay attention to a number sources of error that are known to affect the interpretation of radiometric data. Four factors that are of particular importance are "Old Wood," Context, Calibration, and Analytical methodology.

1. Old Wood: Very often the only wood that survives the passage of time is from the center of large trees, and in many cases both the age of the tree when it was felled and the length of time the timber had been in place prior to being preserved is uncertain. Thus, a piece of wood might be centuries older than other material with which it was found, particularly if it had been reused in construction. Although the importance of short-lived samples is emphasized in more recent publications, the interpretation of some earlier data appears to have been affected by this phenomenon.
2. Context: The relationship between the carbonaceous material and the context in which it was found is obviously of crucial importance. Not only should the samples have clear and unambiguous provenance, but the relationship of the items to chronologically well-defined objects, such as distinctive pottery or inscriptions, must be secure. Samples not sealed before discovery or retrieved from dumps are to be avoided, and small items such as seeds, which are capable of migrating between layers, should be considered suspect (Finkelstein and Piasetzky 2003b:284).

3. Interpretation of the calibration curve: In spite of numerous improvements in the development and utilization of ^{14}C calibration curves in recent years, significant statistical challenges remain. Of relevance is the fact that between ~3000–2900 BP, the period of interest here, the curve exhibits a nearly flat slope interspersed with sharp peaks. Consequently, even perfect samples within this range yield calibrated error ranges of more than a century.[5]
4. Analytical methodology: The possibility exists that variations between testing laboratories may introduce a source of error. This is illustrated in Table 3, in which the results of 3 different samples of grain originating in the same location the Iron II Stratum V at Tel Rehov were analyzed at 3 different laboratories. The average ^{14}C dates shown to within 1 standard deviation appear to exhibit statistically significant differences when weighted, although this significance does disappear if the data are not weighted.

Table 3 Interlaboratory comparison (Mazar 2004:33).

Laboratory	Analytical equipment	Average (nr of tests)[a]	Calendar range
Weizmann (Rehovot)	Liquid scintillation counter	2708 ± 64 (9)	920–800
Univ. of Arizona	Accelerator mass spectrometry (AMS)	2753 ± 50 (8)	970–830
Groningen	Proportional gas counting	2788 ± 18 (2)	975–905

[a]Not weighted.

These variances are being subjected to an ongoing investigation, and the preliminary results do suggest that there is no statistically significant difference between the results obtained by these laboratories, in spite of slightly different methods of sample preparation and analytical hardware (Boaretto et al. 2005). These observations are a cautionary reminder of the dangers of utilizing error ranges of 1 standard deviation.

REVIEW

This review will be restricted to the examination of radiometric data chronologically close to the Late Bronze and Iron I periods in the Aegean, Cyprus, and Syro-Palestine. It will not extend to the Iron II period both because the ULC hypothesis primarily applies to the late Bronze and Iron I periods, and also because such material is well covered in the literature pertaining to the Low Iron II debate. In this article, ^{14}C ages have been converted to calendar years using the IntCal 2004 (Reimer et al. 2004) and OxCal v3.10 calibration programs (http://www.rlaha.ox.ac.uk/O/oxcal.php). Unless otherwise stated, all probability ranges are 68.2% and dates are BCE. Because some primary data was absent from the references cited, not all averages shown are weighted.

Greece and the Aegean

In an article written in direct response to the chronological proposal of James et al. (1991), Manning and Weninger (1992) reviewed a number of ^{14}C determinations from Late Bronze Age contexts in Greece and the Aegean. Unfortunately, much of the data derives from constructional timbers and is thus compromised by the presence of old wood. Although difficult to quantify, this influence is ever-present when determinations are carried out on long-lived species. One example, which may, however, be used to illustrate the magnitude of this effect, derives from the Late Minoan II period in Knos-

[5]The OxCal v3.10 calculation for a ^{14}C date of 2950 ± 0 BP yields ranges of 1210–1125 BCE at 68.2% and 1260–1120 BCE at 95.4% probability.

sos, Crete. As shown in Table 4, comparison of 2 sets of data derived from long-lived charcoal and short-lived barley samples from the same context during the LM II period suggests that the charcoal was almost 2 centuries older than the barley (Manning and Weninger 1992:661).

Table 4 ^{14}C dates from the Crete LM II period.

Sample	^{14}C date BP	Calibrated, BCE
Charcoal (Hv-)	3300 ± 65	
Charcoal (Hv-)	3250 ± 95	
Charcoal (Hv-)	3365 ± 50	
Charcoal average	*3305 ± 58*	*1670–1510*
Barley (OxA-2096)	3070 ± 70	
Barley (OxA-2096)	3190 ± 65	
Barley (OxA-2096)	3220 ± 65	
Barley average	*3160 ± 79*	*1530–1310*

Another indication of old-wood contamination derives from Pylos. Analyses of 4 samples from constructional beams found in the palace, which is believed to have been constructed around the LH IIIA/IIIB transition, yielded an average ^{14}C date of 3322 ± 103 BP (Manning and Weninger 1992: 653–4, 663). This converts to a calibrated dating range of 1740–1490 BCE, which is several centuries higher than the Conventional mid-14th century dating of this phase transition.

Another illustration is found in a series of analyses of constructional timbers from a number of archaeological layers spanning the LH IIIA and Geometric periods at Kastanas. These data are summarized in Table 5 (Manning and Weninger 1992:645, 648, 661).

Table 5 ^{14}C dates from Kastanas.

Phase	Period	Conventional	^{14}C date BP	Samples	Calibrated
18	LH IIIA	1400–1350	2860 ± 60	1	1130–930
17	LH IIIA	1400–1350	3180 ± 55	1	1510–1405
16	LH IIIB	1350–1200	3136 ± 17	9	1435–1405
14	LH IIIB	1350–1200	3121 ± 24	5	1435–1385
13	LH IIIC	1200–1050	2949 ± 29	4	1260–1120
12	LH IIIC	1200–1050	2982 ± 15	9	1270–1130
11	LH IIIC	1200–1050	2965 ± 45	2	1270–1110
10	Protogeometric	1050–900	2920 ± 46	1	1210–1040
10	Protogeometric	1050–900	2860 ± 65	1[a]	1130–920
9	Protogeometric	1050–900	2980 ± 50	1	1300–1120
8	Protogeometric	1050–900	2952 ± 33	3	1260–1120

[a]Short-lived chestnut.

Although Manning and Weninger (1992:643–50) attempted to organize these data by estimating the time differences between the strata by a process they call "archaeological wiggle matching," the correlation between the layer numbers and ^{14}C date is far from perfect. The fact that most of the ranges are higher than the Conventional dates raises suspicion about the old-wood factor, a concern which appears to be confirmed by the difference in values provided by long- and short-lived species in Layer 10. The authors recognize, and attempt to deal with, the old-wood problem by making the arbitrary assumption that construction wood may be "50 ± 50 years older than its context of cultural employment" (Manning and Weninger 1992:648). In spite of that, it is clear that these data are incapable of resolving the chronology of these periods to the degree of accuracy required in this exercise.

Table 6 contains a summary of data derived from different strata at Assiros. Although the authors make some effort to rationalize the data, the main point of interest appears to be the very low correlation between ^{14}C dates and the commonly accepted dating of the periods.[6]

Table 6 ^{14}C dates from Assiros.

Phase	Period	^{14}C date BP	Calibrated	Conventional	ULC
	MBA?	2930 ± 55	1260–1040	about 1500	14th cent
	Pre-Mycenaean	2960 ± 40	1260–1120	about 1450	14th cent
11	LH IIIA	2840 ± 45	1060–920	1400–1300	1330–1230
8	LH IIIB	2930 ± 50	1260–1050	1300–1200	1230–1130
7	LH IIIB/C	2940 ± 80	1270–1020	1270–1150	1200–1080
6	Late LH IIIC	2900 ± 70	1220–990	1220–1100	1150–1050

This series exhibits extremely poor correlation between the stratigraphic context and radiometric calendar age of the samples. In most cases, the calibrated dates are significantly lower than both the Conventional and ULC models, but closer to the latter. To provide one illustration, the results from the LH IIIB/C Phase 7 (Figure 1) yield a wide probability range that embraces both the Conventional (about 1220–1180) and ULC (1150–1110) chronological models in spite of the presence of old wood.

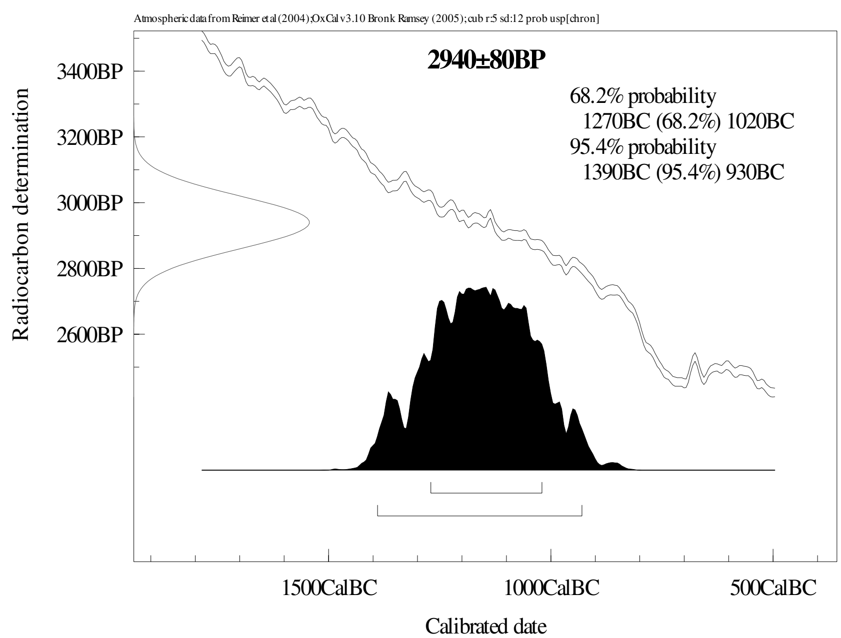

Figure 1 Assiros, Phase 7

[6]After Manning and Weninger 1992:639–42, 660; and recent revisions in http://artsweb.bham.ac.uk/aha/kaw/Assiros/stratchron.htm.

The ^{14}C dates from LH IIIB strata at Mycenae (see Table 7) also reveal wide calibrated ranges (Manning and Weninger 1992:652, 662). Since all but one derive from constructional material, the non-quantifiable influence of old wood must again be acknowledged, but as was the case with previous examples from Assiros, interpretation of these data is also hampered by the uncertainty of context. In spite of these problems, a comparison of the Conventional and ULC dates reveals that the radiometric values overlap both chronological models.

Table 7 ^{14}C dates from Mycenae.

Context	Sample	^{14}C date BP	Calibrated	Conventional	ULC
'Mycenaean'	Charcoal	2873 ± 57	1130–930	1350–1200?	1280–1130?
Mid LH IIIB building	Charcoal	2974 ± 49	1300–1120	~1300	~1230
Mid LH IIIB building	Charcoal	3035 ± 65	1400–1210	~1300	~1230
Mid LH IIIB building	Charcoal	2948 ± 49	1260–1050	~1300	~1230
'Mycenaean'	Charcoal	2961 ± 50	1290–1080	1350–1200?	1280–1130?

It is evident that the predominance of old wood in the samples combined with the uncertain context of many of the examples significantly compromises the chronological validity of nearly all the data presented by Manning and Weninger. Although these authors did provide a few examples from short-lived species, these unfortunately suffer from very large standard deviations. Thus, a sample of wheat from the final LH IIIC destruction of the granary at Mycenae gave a ^{14}C age of 2970 ± 130 BP (1380–1020 calibrated), which encompasses both the Conventional (1170–1150) and ULC dating of this event (1100–1080 BCE) (Manning and Weninger 1992:662). Similar results were obtained from analyses of carbonized figs from Midea.[7] In order to eliminate the influence of old wood, the following sections will only examine results derived from short-lived specimens.

Cyprus

Excavations in the Maroni Valley have yielded a number of ^{14}C dates from coastal sites that were suddenly abandoned sometime before the Cyprus-wide end of the LC IIC. Results obtained from analysis of short-lived olive seeds from the final use horizon of buildings at Vournes and Tsaroukkas in the Maroni area are shown in Table 8. Items from poorly defined contexts involving collapse, abandonment, and dumping are not included (Manning et al. 2001:331, 334).

Table 8 ^{14}C dates from Maroni.

Location	Sample	^{14}C date BP	Calibrated range
Vournes	KN-4647	2969 ± 44	1270–1120 (67.3%)
Tsaroukkas	OxA 8265	2960 ± 35	
Tsaroukkas	OxA 8266	2985 ± 35	
Tsaroukkas	OxA 8267	2940 ± 35	
Tsaroukkas	OxA-8324	2930 ± 40	
Tsaroukkas average (unweighted)		*2954 ± 24*	*1260–1240 (6.1%)* *1220–1120 (62.1%)*

[7]Figs from the LH IIIB destruction layer at Midea had ^{14}C ages of 2935 ± 70 and 3005 ± 100 BP (Manning and Weninger 1992: 662), which convert to 1200–1040 and 1400–1120 BCE, respectively.

The calibrated distribution derived from the average of the Tsaroukkas data shown in Figure 2 appears to favor a 12th century dating range for the destruction of that site.

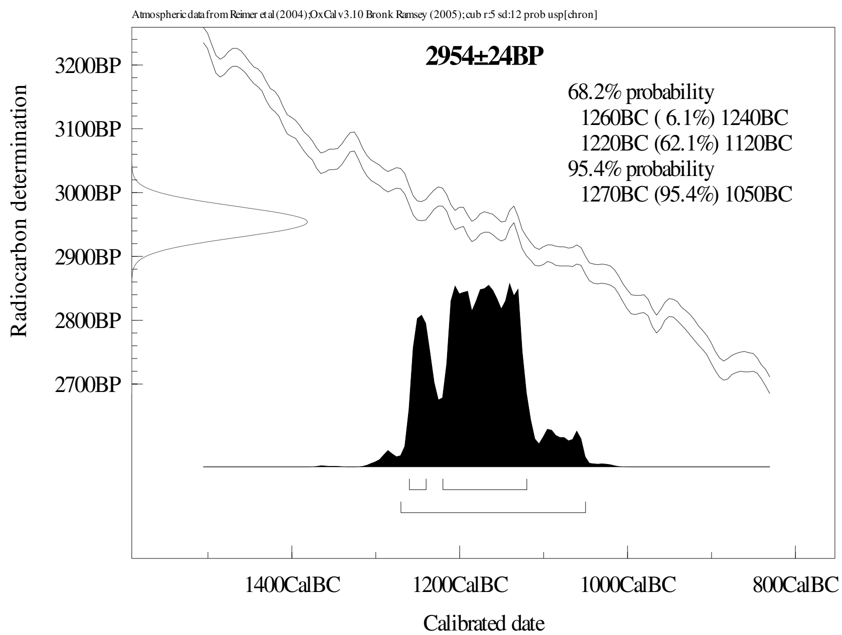

Figure 2 Maroni Tsaroukkas average

It is not certain how much time elapsed between the abandonment of the Maroni sites and the Cyprus-wide end of the LC IIC period. If occupation had ceased at about the same time that piratical Sea Peoples began raiding the Egyptian delta early in the reign of Merneptah, the Conventional dating would have been ~1210, with the equivalent date of the ULC model being ~1140 BCE. The Conventional and ULC dates lie in the upper and lower ranges of the calibrated probability distribution.

Radiometric determinations were also obtained from the remains of a basket from a house in Apliki Karamallos, which is believed to have been destroyed sometime after the Maroni sites were vacated. The results are shown in Table 9 (Manning et al. 2001:332).

Table 9 ^{14}C dates from an Apliki basket.

Sample	^{14}C date BP	Calibrated BCE
AA 33440	2990 ± 55	
AA 33441	2960 ± 60	
AA 33442	3015 ± 55	
AA 33443	3050 ± 55	
AA 33444	2955 ± 55	
Average (weighted)	*2995 ± 21*	*1310–1130*

The calibrated dating of the weight average of these 5 sets of data reveals a wide 13th century dating range (Figure 3).

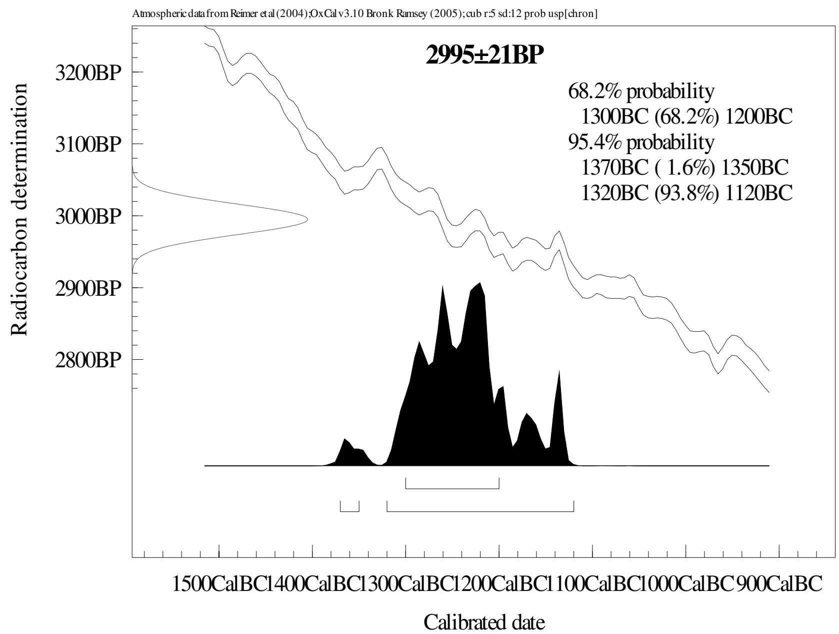

Figure 3 Apliki basket

Since the context of the Apliki basket is considered to be historically later than the Maroni sites, the apparent higher value requires explanation. The authors note that the branches of the basket appear to have less than 5 year's growth, so the variance cannot be attributed to old wood. It is, however, possible that the basket may have been in existence for some decades before the building was destroyed. This suggestion is reinforced by results obtained from hulled barley from the LC IIC/IIIA transition at Apliki shown in Table 10 (Manning et al. 2001:332).

Table 10 ^{14}C dates from Apliki barley.

Sample	^{14}C date BP	Calibrated date BCE
AA 33450	2990 ± 45	
AA 33451	2960 ± 45	
AA 33452	2930 ± 60	
AA 33452A	2945 ± 50	
AA 33453	2960 ± 50	
AA 33454	2955 ± 65	
Average (unweighted)	*2956 ± 20*	*1260–1240 (6.3%);1220–1120 (61.9%)*

The calibrated distribution illustrated in Figure 4 appears to support the earlier evidence from Maroni that the LC IIC/LC IIIA transition probably occurred during the 12th rather than the late 13th century BCE.

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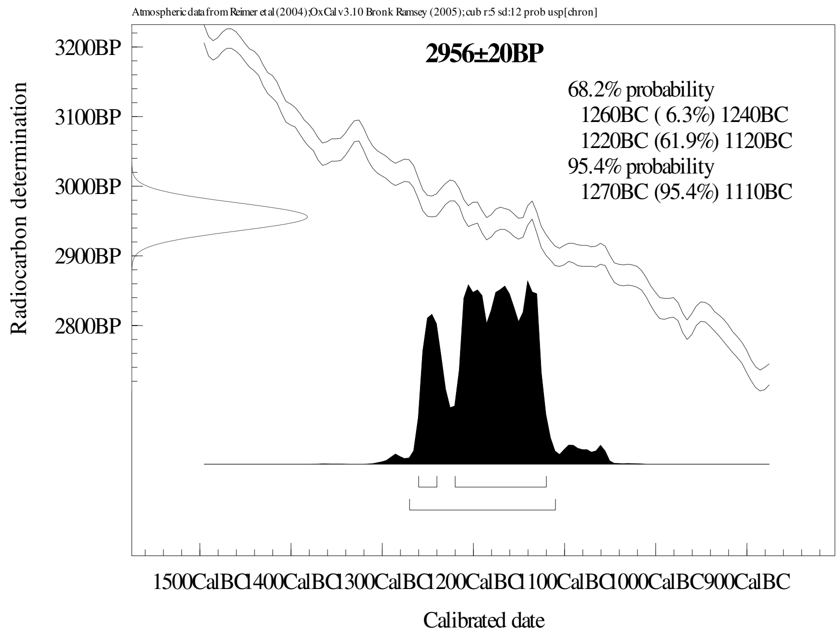

Figure 4 Apliki barley

Syro-Palestine

The quantity of ^{14}C data available from LBA and early Iron strata in Syro-Palestine is quite sparse. I will here review results obtained from the analysis of short-lived material from 3 locations in that region: Dor, Beth Shean, and Tel Rehov.

Dor

A significant quantity of ^{14}C data has recently appeared from well-defined stratifigraphic contexts at this important archaeological site on the Levantine coast. One of the key transitions during the Iron I period at Dor is a massive burnt layer that ended the contemporary phases B1/12 and G/9 layers in Phase Ir 1a(l), a sub-section of the conventional Iron IB period (Gilboa and Sharon 2003: 55). It has been suggested that this destruction ended the occupation of that site by one of the Sea Peoples known as the Sikils (Stern et al. 1997:52); and on the basis of comparative ceramic typology, the B1/12 and G/9 phases have been dated to approximately 1120–1090/1050 BCE (Gilboa et al. 2003:55; 2004:40). According to the ULC chronology, these phases would have existed between 1050 and 1020 BCE. Seven ^{14}C analyses of charcoal samples from phases B1/12 and G/9 yielded an average value of 2806 ± 69 BP (Sharon 2001:346), 1050–840 BCE calibrated (Figure 5). In spite of the possibility that the charcoal samples may have contained old wood, this range is significantly lower than the Conventional dating and lies within the ULC range.

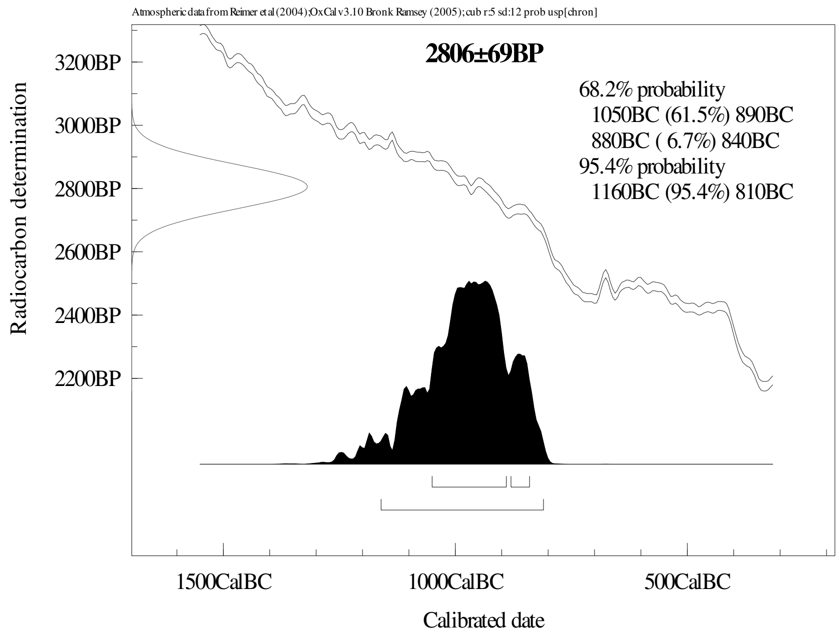

Figure 5 Dor phases B1/12–G/9

On the basis of comparative stratigraphy, Gilboa and Sharon assign the Late Iron IB (or Ir 1a/b and Ir 1b) phases G/8, G/7, D2/10, and D2/9 a Conventional range between 1090–1000/980 BCE (2003: 55). The ULC model would lower this to 1020–10th century. The ^{14}C dates from these phases shown in Table 11 appear to support the lower chronology.

Table 11 Dor Iron Age strata (Sharon 2001:346).

Phase	^{14}C date BP	Calibrated range	Conventional	ULC
G/8	2850 ± 40	1110–1100 (1.6%), 1080–930 (66.6%)	1090–1070	1020–1000
G/7	2795 ± 40	1005–900	1050–1000/980	980–10th cent.
D2/10	2792 ± 40	1010–900	1050–1000/980	980–10th cent.
D2/9	2725 ± 30	900–835	1050–1000/980	980–10th cent.

Note that although most these data were derived from charcoal that may have represented long-lived species, intercomparison with some analyses of olive pits suggests that old wood was not a significant factor (Gilboa and Sharon 2003: Table 22, RT-2960; 2961).

Beth Shean

The last Egyptian occupational phase at Beth Shean, Stratum Lower VI, commenced shortly after the Late Bronze/Iron Age transition. The precise date at which this phase emerged is not clear, but it does appear to have been a fairly peaceful development of the previous Stratum VII and could have involved local phased construction. The excavators found small amounts of charred wheat in a small room in Area N, Level 4 of Stratum VII. On the basis of pottery finds at that location, Mazar (1997b:69–70) speculated that the building had been destroyed towards the end of the 19th dynasty, possibly during the reign of Merneptah (1212–1202). Analysis of 3 samples of this grain yielded an average ^{14}C age of 2950 ± 15 BP (Mazar and Carmi 2001:1334), which yields a calibrated range of 1210–1125 BCE. As illustrated in Figure 6, this range lies between the Conventional (1212–1202) and ULC (1140–1130) dating of Merneptah.

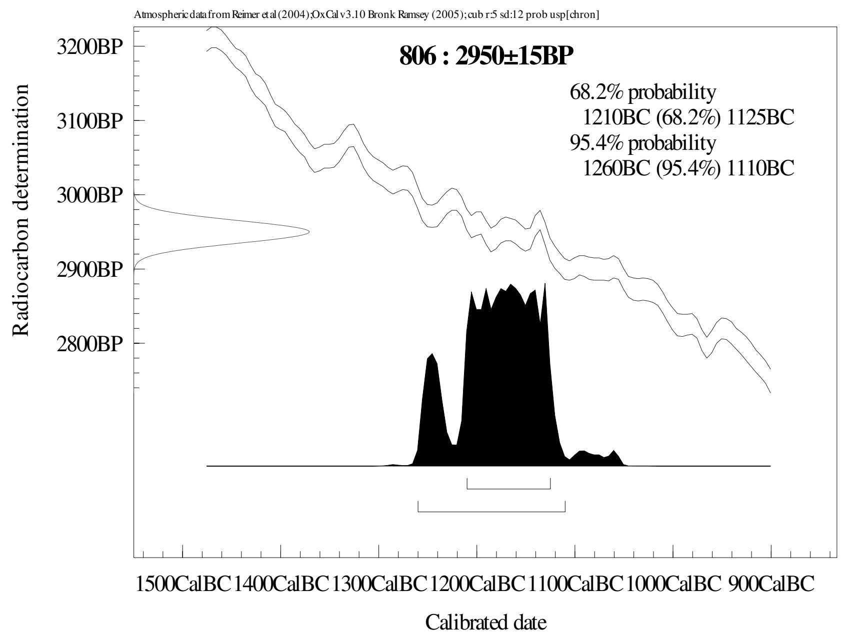

Figure 6 Beth Shean N/4

An assembly of charred linen seeds and grains was found in a small bin located within Stratum S-3, which with the earlier S-4 represents the last phase of the Egyptian presence at Beth Shean, Stratum Lower VI (Mazar 1997b:69–70). Although the commencement and termination of these phases is somewhat uncertain, some of the buildings were erected during the reign of Ramesses III (1182–1151), and the presence of small quantities of Mycenaean IIIC ware within S-4 places them after the cessation of the LH IIIB period. Since the final destruction of Stratum Lower VI is believed to have occurred some time between the reigns of Ramesses IV to VIII, Levels S-4/S-3 would have a Conventional dating range from ~1180–1150/30 BCE. Analysis of 4 samples of grain from S-3 yielded an average ^{14}C value of 2940 ± 15 BP (Mazar and Carmi 2001:1335), which converts to a calendar range of 1210–1120 BCE. If these samples date from the time that S-3 was destroyed, these values appear to be closer to the Conventional dating range of this event (1150–1130). However, the commencement of the constructional phase S3 is not clearly defined, and the close similarity to the date of the previous N-4 sample (2950 ± 15 BP) suggests that this particular assemblage may have derived from earlier in the duration of this period, which according to the ULC would have been from ~1110–1080/60 BCE.

Tel Rehov

Tel Rehov is a 10-hectare mound located in the center of Beth Shean Valley, south of the Sea of Galilee. Recently, some of the radiometric data from Tel Rehov has been subjected to close scrutiny in an attempt to resolve some of the questions relating to the Low Iron II chronology, with particular attention being paid to variances between analytical results from different laboratories (see Table 3 above). Although rather few determinations are available from the earlier Iron I period, there are sufficient data to test the Ultra-low chronology hypothesis.

Stratum VII/D6. Stratum VII at Tel Rehov embraces the Late Bronze, Iron I and II periods, i.e. from before the time of Ramesses III until the United Hebrew Monarchy. Local phase Stratum VII/ D6 is assumed to be roughly equivalent to Beth Shean VII and/or Lower VI, and thus probably commenced before the Late Bronze/Iron Age transition and had a duration, according to the Conventional chronology, of ~1220/1200 to 1150/1130, or an ULC range of ~1140–1070. Unlike Beth Shean, however, there are no clear markers, such as inscribed Egyptian objects to anchor the range of this phase. Table 12 contains a summary of several sets of analyses of short-lived samples from Stratum VII/D6.

Table 12 ^{14}C dates from Tel Rehov, Stratum VII/D6.

Source	Material	^{14}C date BP
Mazar and Carmi 2001:1336	Olive pit	2685 ± 40
Mazar 2004:32	Grain	2920 ± 30, 2950 ± 50, 2935 ± 45, 2880 ± 30
Bruins et al. (2003, TableS1), Lower	Olive pits	2880 ± 30, 2935 ± 45
Bruins et al. (2003, Table S1), Upper	Olive pits	2920 ± 30, 2950 ± 50
Average (not weighted)		*2895 ± 78*

The calibrated dating derived from the average of these results (assuming no statistically significant variation between the laboratories, after Boaretto et al. 2005) illustrated in Figure 7 would appear to favor the ULC dating.

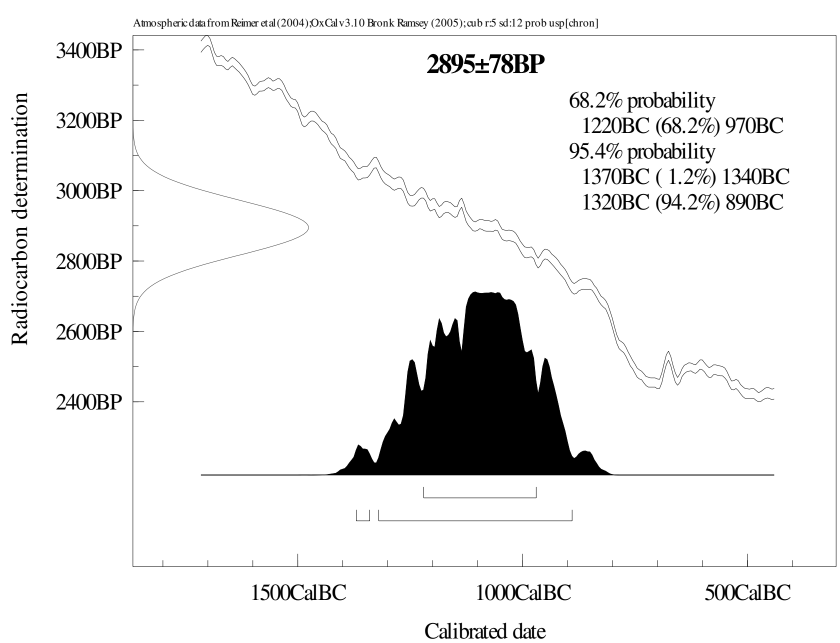

Figure 7 Tel Rehov VII/D6

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Even if the low ^{14}C value from Mazar and Carmi (2001) is considered an outlier, the unweighted average 2918 ± 28 BP still yields a distribution that includes the Conventional dates only as a minor probability contribution: 7.6% 1200–1170; 60.6% 1160–1050.

Stratum VII/D4. Tel Rehov Stratum D-4 contains ceramic assemblages suggestive of the Iron IB period. A summary of radiometric determinations from this context is shown in Table 13 and the average calibrated probability distribution in Figure 8. The Conventional dating of Tel Rehov VII/D4 would be in the higher side of the range 1150–1050 BCE, which in the Ultra-low model would be revised to ~1080 to the early 10th century. As illustrated in Figure 8, the average probability distribution of the ^{14}C determinations from Tel Rehov VII/D4 overlaps both chronological models, but once again favors the ULC hypothesis. The data relating to Stratum VII-VI/D3, the transition from Iron I to Iron II, have been extensively discussed in the literature cited, and most appear to support the Low Iron II chronology.[8] Since the ULC and Conventional chronologies converge at ~1000 BCE, these results will not be reviewed here.

Table 13 ^{14}C dates from Tel Rehov VII/D4.

Source	Material	Tests	^{14}C date	Calendar range
Mazar and Carmi 2001:1336	Olive pit	1	2800 ± 40	
Mazar 2004:32	Grain	5	2905 ± 35	
			2945 ± 35	
			2920 ± 50	
			2890 ± 30	
			2870 ± 50	
Average		*6*	*2888 ± 50*	*1160–990 (64.4%)*

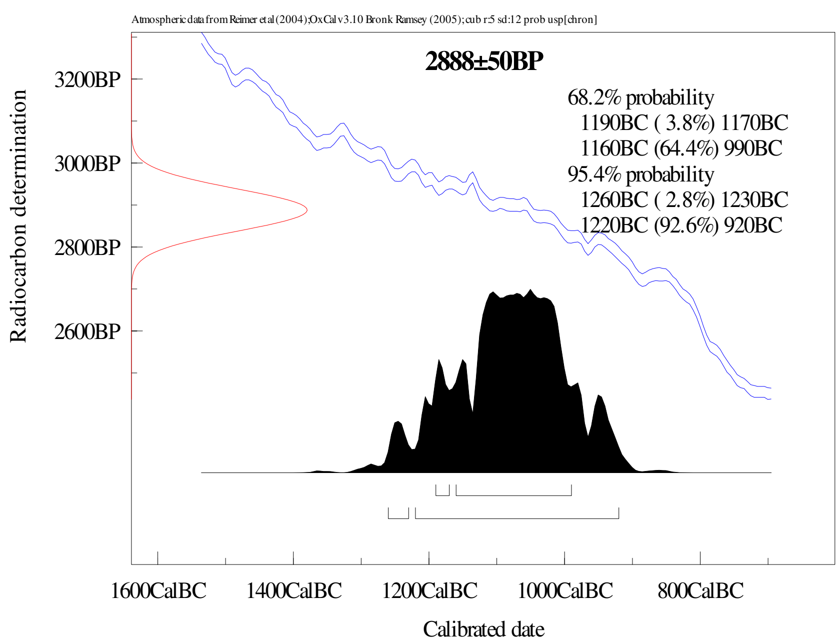

Figure 8 Tel Rehov VII/D4

[8]Charred grain from Tel Hadar Stratum IV equivalent to Tel Rehov D4-3 yielded an average ^{14}C date of 2780 ± 25 (975–895 BCE), and a similarly low value was obtained from the contemporary phase K-4 at Megiddo (Finkelstein and Piasetzky 2003a:774–5; 2003b:291).

SUMMARY AND CONCLUSIONS

Although textbooks typically provide precise dates for historical events, it is well known that the chronology of the ancient world may only be described in terms of probability ranges. For much of the ANE prior to the 1st millennium BCE, the magnitude of this range is quite large due to the absence of firm historical anchors, such as the continuous Assyrian Eponym Canon, which does not extend beyond 911 BCE. In this paper, I have reviewed some recent radiometric data from the ANE in an attempt to estimate the probable dating range of one particular historical event of the late 2nd millennium BCE, the end of the Late Bronze Age. For the purpose of this exercise, the Syro-Palestinian convention is followed, according to which the Late Bronze/Iron Age transition is defined by the arrival of Mycenaean LH IIIC:1b (Philistine) material culture in the Levant at approximately the 8th year of Ramesses III. Archaeological and historical evidence suggests that production and trade in LH IIIB pottery ceased sometime earlier, perhaps during the reign of the Egyptian Queen Twosret, or possibly as much as 2 decades earlier. The chronological uncertainty is exacerbated by the possibility that the absolute dating of these Egyptian rulers may be in error, and that much historical and archaeological data from across the eastern Mediterranean and western Asia would be better served if the absolute chronology of that period were to be lowered. Faced by radical challenges to the conventional chronological system, Manning and coauthors reviewed a large body of radiometric data from Greece and Cyprus. From this, they concluded that the Conventional chronology is "approximately correct" and that their work was sufficient to eliminate "suggestions of radically lower LBA chronologies in the eastern Mediterranean and the Near East" (Manning et al. 2001: 340).

Since the word "approximately" was left undefined by those authors, one objective of this paper has been to determine whether radiometry is able to distinguish 2 chronological models that differ by less than a century. The first model is the conventional "Low Egyptian" dating according to which the LBA/IA transition occurred ~1175, while the second is an Ultra-low version according to which this event occurred some 70–80 yr later. This exercise was carried out by re-examining the papers of Manning et al. and some more recent radiometric material from Iron Age Syro-Palestine. The conclusion is that in spite of significant improvements in methodology in recent years, the quantity and quality of the data is still insufficient to clearly differentiate between the 2 models. On balance, however, much of the ^{14}C data does appear to favor the ULC model.

Various factors contribute to errors that thus far prohibit a more precise estimate of that transition. For example, the interpretation of much of the radiometric data from Greece and the Aegean by Manning and Weninger (1992) is invalidated by the dominance of large constructional timber. This resulted in an "old wood" bias of greater magnitude than the difference between the 2 models. While the material from Cyprus (Manning et al. 2001) is of more value in that it contains a significant number of short-lived examples, the error range was still too large to clearly distinguish between the Conventional and Ultra-low models. A further contributing factor in the case of the Cypriot data involves the uncertainty of the timing of the destruction or abandonment of various Cypriot centers near the end of the LC IIC period. Thus, while it is often assumed that the destruction of the Mycenaean palaces, the interruption in maritime trade in LH IIIB pottery, and the LC IIC/IIIA transition occurred almost simultaneously, these separate events could have been several decades apart. When this is taken into account, radiometric analysis of short-lived samples from Cyprus appears to favor the Ultra-low chronological dating over the higher Conventional model.

Although much of the radiometric data from Iron Age Syro-Palestine derives from Iron II contexts, there is sufficient material from the earlier Iron I period to reach a tentative conclusion concerning the absolute date of the LBA/IA transition. As in the case of Cyprus, ^{14}C determinations on short-lived material from Syro-Palestine reveals that radiometry is as yet incapable of clearly differentiating the Conventional and Ultra-low chronological models, but the majority of examples cited do, however, appear to support the lower chronology. It must therefore be concluded that the probable dating range for the end of the LBA must be extended to about a century. At the high end, it appears unlikely that Ramesses III's 8th year was much earlier than 1175, while the low end might easily be extended to 1100 BCE. Similarly, the cessation of production and trade in LH IIIB pottery should be placed somewhere in the 1200–1120 range.

Undoubtedly, more testing is required. In commenting on the conclusion of Manning et al. (2001), Karageorghis remarked that "while I do not doubt the validity of their method I believe that many more data are needed from as many sites as possible that fall within the chronological range of LC IIC-LC IIIA" (Karageorghis 2002:74). As I have argued elsewhere, the historical and archaeological evidence from Egypt, Mesopotamia, and Syro-Palestine would be better served if the absolute date of the end of the LBA were to be lowered from ~1180/1170–1110/1100 BCE. Such a reduction would also ameliorate a number of stratigraphic concerns associated with the increasingly popular Low Iron II chronology, and would also appear to be supported by scholars of the ancient Aegean world (Snodgrass 1991; Coldstream 2003). At this time, radiometric analyses do not provide any reason to reject this Ultra-low hypothesis.

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