The radiocarbon samples from the acropolis of Tel Yarmuth

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ANCIENT NEAR EASTERN STUDIES

SUPPLEMENT 56

FOUILLES DE TEL YARMOUTH (1980-2009)

Rapport final

Volume 1

LES FOUILLES SUR L'ACROPOLE

par

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PEETERS
LEUVEN – PARIS – BRISTOL, CT.
2020

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CHAPITRE 23

THE RADIOCARBON SAMPLES FROM THE ACROPOLIS OF TEL YARMUTH

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The Tel Yarmuth acropolis Sounding 2 was excavated during six seasons, exposing a series of levels and contexts from which material was recovered for radiocarbon dating.

A total of ten samples were selected for final radiocarbon dating using either the decay counting method or the accelerator mass spectrometry method. Under the supervision of Dr Israel Carmi four samples were measured by decay counting (RT labelled samples in **Tables 23.1–23.2**) in 1998 and six were measured by Prof. Elisabetta Boaretto by accelerator mass spectrometry (AMS) with the D-REAMS accelerator (RTD labelled samples in **Tables 23.1** and **23.3**) in 2013. All samples were measured at the Radiocarbon Laboratory at the Weizmann Institute of Science (Israel).

23.1. THE SAMPLES

The samples were recovered from floors and from destruction events as identified during the excavation. Samples were wood charred fragments or single seeds and were all botanically identified by Nili Liphschitz.

The archaeological information of the radiocarbon dated samples, their botanical identification and expected age are shown in **Table 23.1**, in which they are ordered according to the stratigraphic sequence, from the youngest (top) to the oldest (bottom).

All samples were pre-treated to remove all contamination. No information could be recovered for the RT samples measured by decay counting beside the ^{14}C age BP (Before Present) and the stable isotope ratio $\delta^{13}C$. All the information about these samples are reported in **Table 23.2** together with the calibrated range for the $\pm 1\sigma$ and $\pm 2\sigma$.

Samples labelled RTD were all short lived (seed or olive pit) and were prepared using the Acid Base Acid pre-treatment procedure to remove all the contamination from the sample prior to the radiocarbon dating. The samples were then prepared for the graphitisation and finally measured by Accelerator Mass Spectrometry method at the D-REAMS radiocarbon dating laboratory. The procedure for the sample preparation is reported in Yizhaq *et al.* 2005 and in Regev *et al.* 2017.

In **Table 23.3**, information about the samples's context, material characteristic, ^{14}C date in year BP and the calibrated range for the $\pm 1\sigma$ and $\pm 2\sigma$ are reported.

The AMS samples (RTD label), although they were charred single seed or olive pit, provided enough material for the AMS measurement. The pre-treatment recovery of the sample or "efficiency percentage" ("Eff. %" in **Table 23.3**) was above 30% for all the samples and the percentage of carbon after pre-treatment ("C %" in **Table 23.3**), was as high as 75% or higher. The high chemical efficiency and carbon percentage indicate a very good state of preservation of the sample material.

Calibrated ranges were obtained using OxCal v4.3.2 Bronk Ramsey (2017) based on Bronk Ramsey 2001 using the IntCal13 atmospheric curve in Reimer *et al.* 2013.

Lab #	Basket No.	Stratum	Locus	Type	Context	Date expected (BCE)
RT-3029	9593	Acr-III	1130	Charcoal	Destruction (beam)	11th cent.
RT-3030	9641	Acr-III	1149-1	Charcoal	Destruction	11th cent.
RT-3031	9716	Acr-III	1171-2	Charcoal	Destruction	11th cent.
RT-3032	10817	Acr-III	1149-1	Charcoal	Mixed	11th cent.
RTD-6998	10888	Acr-III	1149-Floor a	Olive pit	OK : floor	11th cent.
RTD-6697	9649	Acr-III	1149-Floor b	Olive pit	OK : floor	11th cent.
RTD-6702	9653	Acr-IV	1150-Floor a	Olive pit	OK : floor	End 12th cent.
RTD-6999	10621	Acr-V	1186-1	Seed	OK	Mid-12th cent.
RTD-6700	10659	Acr-V	1186-Floor a	Olive pit	OK : floor	Mid-12th cent.
RTD-6701	10683	Acr-V	1186-Floor b	Olive pit	OK : floor	Mid-12th cent.

Table 23.1. Archaeological context, botanical identification and expected age of the samples radiocarbon dated from Sounding 2 on the acropolis of Tel Yarmuth. The order follows the stratigraphic sequence. Samples labelled RT were measured by decay counting method; samples labelled RTD were measured by accelerator mass spectrometry.

Lab #	Field ID.	$\delta^{13}C$ (‰)	^{14}C age year BP	Calibrated range ± 1σ	Calibrated range ± 2σ
RT-3029	Bask. No. 9593 L.1130 Str. Acr-III	-22.2	2980 ± 35	1260 BC (45.1%) 1190 BC 1180 BC (12.8%) 1160 BC 1145 BC (10.3%) 1130 BC	1375 BC (2.1%) 1355 BC 1300 BC (92.8%) 1075 BC 1065 BC (0.6%) 1060 BC
RT-3030	Bask. No. 9641 L.1149-1 Str. Acr-III	-22.5	3125 ± 35	1440 BC (47.0%) 1385 BC 1340 BC (21.2%) 1310 BC	1495 BC (3.1%) 1480 BC 1460 BC (92.3%) 1290 BC
RT-3031	Bask. No. 9716 L.1171-2 Str. Acr-III	-21.7	3020 ± 25	1370 BC (2.7%) 1365 BC 1290 BC (65.5%) 1220 BC	1390 BC (16.7%) 1340 BC 1315 BC (77.9%) 1195 BC 1140 BC (0.9%) 1135 BC
RT-3032	Bask. No. 10817 L.1149-1 Str. Acr-III	-23.5	2910 ± 20	1125 BC (68.2%) 1050 BC	1195 BC (16.2%) 1145 BC 1130 BC (79.2%) 1020 BC

Table 23.2. Wood charcoal samples measured by decay counting method by I. Carmi. For these samples the stable isotope ratio $\delta^{13}C$ was determined by conventional mass spectrometry.

Lab #	Field ID	Type	Eff. %	C %	^{14}C age year BP	Calibrated range ± 1σ	Calibrated range ± 2σ
RTD-6998.1 RTD-6998.2 RTD-6998 combine	Bask. No. 10888, L.1149-floor a Str. Acr-III	Olive pit	66	76.7	2900 ± 40 2880 ± 40 **2890 ± 29**	**1120 BC (68.2%) 1020 BC**	**1195 BC (9.0%) 1140 BC** **1130 BC (86.4%) 980 BC**
RTD-6997	Bask. No. 9649, L.1149-floor b Str. Acr-III	Olive pit	63	80.0	2975 ± 45	1260 BC (68.2%) 1125 BC	1380 BC (4.4%) 1345 BC 1305 BC (91.0%) 1050 BC
RTD-6702	Bask. No. 9653, L.1150, floor a Str. Acr-IV	Olive pit	70	83.6	2775 ±45	980 BC (52.4%) 890 BC 880 BC (15.8%) 845 BC	1025 BC (95.4%) 820 BC
RTD-6999	Bask. No. 10621, L.1186-layer 1 Str. Acr-V	Seed	35	74.6	2985 ± 40	1270 BC (58.0%) 1155 BC 1150 BC (10.2%) 1130 BC	1380 BC (5.3%) 1345 BC 1305 BC (90.1%) 1055 BC
RTD-6700	Bask. No. 10659, L.1186-floor a Str. Acr-V	Olive pit	27	77.0	3010 ± 40	1375 BC (6.9%) 1355 BC 1300 BC (58.9%) 1195 BC 1140 BC (2.3%) 1135 BC	1390 BC (15.7%) 1335 BC 1325 BC (79.7%) 1125 BC
RTD-6701	Bask. No. 10683, L.1186-floor b Str. Acr-V	Olive pit	36	76.4	2855 ±50	1110 BC (4.5%) 1100 BC 1090 BC (54.2%) 970 BC 960 BC (9.5%) 935 BC	1195 BC (6.4%) 1140 BC 1135 BC (89.0%) 900 BC

Table 23.3. Short lived samples measured by AMS by E. Boaretto. Pre-treatment data together with the sample archaeological information, radiocarbon age and calibrated ranges are presented. The samples are ordered according to the stratigraphic sequence.

23.2. Discusssion

The calibrated ranges in year BC are presented in **Fig. 23.1** and are ordered according to the stratigraphic sequence, from the oldest, at the bottom, and the youngest, at the top. Samples of wood charcoal are represented in black, while short lived (seed and olive pit) are shown in green.

According to the archaeological context and stratigraphy:

- Samples from Stratum Acr-III (RT-3029, RT-3030, RT-3031, RT-3032, RTD-6998 and RTD-6997) were expected to date in the 11th century BC;
- The single sample from Stratum Acr-IV (RTD- 6702) was expected to date at the end of 12th century BC;
- Samples from Stratum Acr-V (RTD-6999, RTD- 6700 and RTD- 6701) were expected to date in the middle of the 12th century BC.

In general, there is poor agreement between the archaeological expected age and the calibrated radiocarbon dates. In Stratum Acr-III only two, RT-3032 and RTD-6998, out of six samples are in the expected 11th century BC range. The three charcoal samples, RT-3029, RT-3030 and RT-3031, are older than expected, but it could be due to the so called "old wood effect", as the possibility exists that the tree had a significant age when it was cut for presumably building purposes in antiquity. Also, the re-use of beam for construction is a possibility that should be considered. The short-lived sample, RTD-6997, could possibly be also in the 11th century BC considering the ±2σ calibrated range.

Stratum Acr-IV is represented by a single sample, RTD-6702, which is definitely much later in the 10th and 9th century BC. This olive pit must be an intrusive sample in the context.

Stratum Acr-V has three samples, of which only one (RTD-6999) is in the middle of the 12th century BC. Samples RTD-6700 and RTD-6701 are respectively too old and too

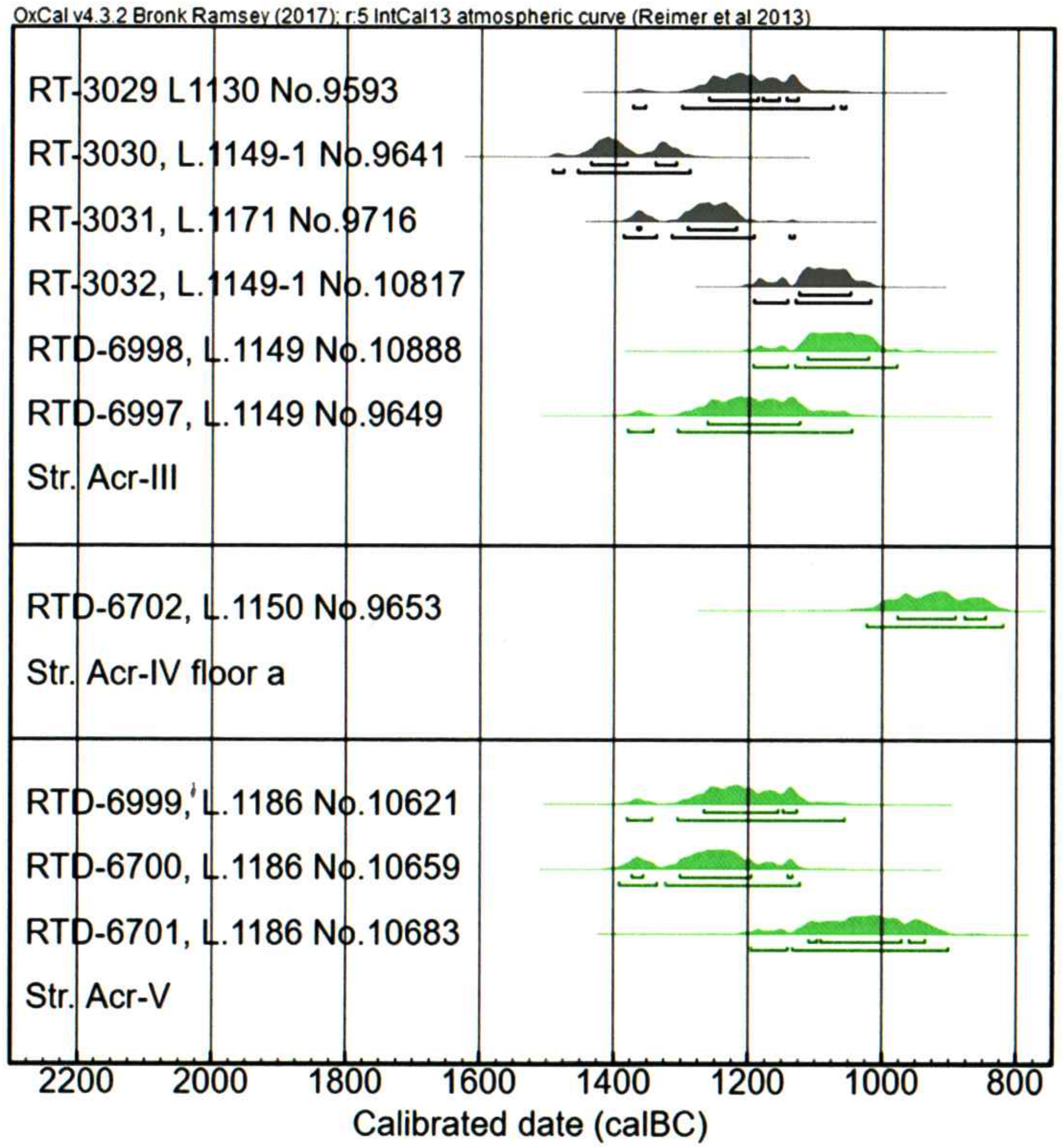

Fig. 23.1. Probability distribution of the calibrated ranges of the dated samples. The order is according to stratigraphy, from the earliest (bottom) to the latest (top). The calibrated ranges for the ±1σ standard deviation (68.2% probability that the right time is included in the interval) and the ±2σ standard deviation (94.5% probability) are indicated below the probability distribution curves as segments. The segment related to ±1σ is the internal one, and the segment related to ±2σ is the external one.

young in comparison to the expected age, although they cover the middle of the 12th century BC if the ±2σ range would be considered.

Based on these set of dates, it would be very difficult to build a chronological frame for the Tel Yarmuth Iron Age acropolis. These dates are not in agreement with their stratigraphic sequence or the expected ages. At large they cover the time frame associated to the cultural material, but it would be difficult to give more precise ranges. If renewed excavation uncovers good contexts with dateable material, then an improvement of the chronology will be possible.

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