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Early seventh-millennium AMS dates from domestic seeds in the Initial Neolithic at Franchthi Cave (Argolid, Greece)

Catherine Perles , Anita Quiles and Helene Valladas

Abstract:

When, and by what route, did farming first reach Europe? A terrestrial model might envisage a gradual advance around the northern fringes of the Aegean, reaching Thrace and Macedonia before continuing southwards to Thessaly and the Peloponnese. New dates from Franchthi Cave in southern Greece, reported here, cast doubt on such a model, indicating that cereal cultivation, involving newly introduced crop species, began during the first half of the seventh millennium BC. This is earlier than in northern Greece and several centuries earlier than in Bulgaria, and suggests that farming spread to southeastern Europe by a number of different routes, including potentially a maritime, island-hopping connection across the Aegean Sea. The results also illustrate the continuing importance of key sites such as Franchthi to our understanding of the European Neolithic transition, and the additional insights that can emerge from the application of new dating projects to these sites.

Keywords: Greece, Franchthi Cave, Initial Neolithic, seventh millennium BC, farming, radiocarbon dating

Introduction

Ever since Clark's pioneering mapping of the earliest Neolithic radiocarbon dates in Europe (Clark 1965), radiocarbon chronology has played an essential role in the development of models for the origins and spread of the Neolithic (Ammerman & Cavalli-Sforza 1971, 1984; Renfrew 1973; Gkiasta *et al.* 2003; Pinhasi *et al.* 2005; Davison *et al.* 2006; Rasse 2008; Bocquet-Appel *et al.* 2009). As Vander Linden observes, "...interpretative models of the spread of the Neolithic are tributary to readings of its temporal structure" (Vander Linden 2011: 29).

Due to its geographical location and early dates for the Neolithic, Greece usually appears in these broad-scale models as the origin of the spread of farming economies in Europe. These models, however, rest on a fragile basis, since there is actually no consensus on the mechanisms, timing and route of penetration of a Neolithic economy in Greece (e.g. Thissen 2000, 2005; Kotsakis 2001; Runnels 2003; Sampson 2005; Kyparissi-Apostolika 2006; Weninger *et al.* 2006; Sef` eriad` es 2007; Perl` es 2010). Depending on the presumed` origin—local, western Anatolian, or multiple origins—and on the postulated mechanisms—indigenous development, spread by terrestrial or maritime routes, reaction to the '6200 cal BC climatic event' (Alley *et al.* 1997)—dates older than 6200 or 6400 cal BC are either rejected or, on the contrary, readily accepted. In the most extreme statements, dates as far apart as 7000 cal BC (Perles 2001) and 6200 cal BC (Weninger` *et al.* 2006) have been defended for the earliest occurrence of the Neolithic in Greece. The late date hypothesis aligns the Greek Neolithic with that of the southern Balkans, thus supporting the view that the Neolithic colonisation of Europe originated

Early seventh-millennium AMS dates from domestic seeds in the Initial Neolithic from western Anatolia and was triggered by the deleterious effects of the '6200 cal BC climatic event'. By contrast, according to the early date hypothesis, no climatic event can be invoked to explain the spread of the farming economy. Furthermore, the early date hypothesis supports a model of multiple origins for the European Neolithic since the early Neolithic in western Anatolia, which is clearly related to that of Bulgaria, may not be earlier than the earliest Greek Neolithic.

The earliest Neolithic in Greece: a debated issue

This debate, however, is relatively recent. When dates of *c.* 7000 cal BC for the early Neolithic of Greece were published in the 1960s and early 1970s, their antiquity posed no major problem. The debate between proponents of traditional 'short' chronologies and proponents of the new, 'long' ¹⁴C-based chronology had abated (Renfrew 1973), and the Greek Neolithic was commonly considered a direct outcome of the Near Eastern Neolithic, itself of greater antiquity (e.g. Weinberg 1970; Theocharis 1973). However, among the four sites with ¹⁴C dates from the first half of the seventh millennium, Nea Nikomedeia (Macedonia) was later re-dated by AMS and none of the new dates, on carbonised seeds, predated 6400 cal BC. The two oldest determinations from Argissa (Thessaly) were made on bone, had no precise provenance, and could be considered unreliable. Knossos (Crete) and Franchthi (Argolid) were thus the only two remaining sites suggesting that the introduction of a farming economy in Greece dated back to the first half of the seventh millennium (see compilations in Reingruber & Thissen 2005, 2009).

The rejection of the early ¹⁴C dates from Franchthi and Knossos only occurred in the late 1990s, after the first settlements in western Anatolia and Thrace—the presumed direct ancestors of the Greek Neolithic—were excavated and dated at the time to the end of the seventh millennium cal BC. Thissen in particular then stated that, since the early Neolithic in western and north-western Turkey did not go back further than *c.* 6200 cal BC, the Greek Neolithic could be no older (Thissen 2000: 161, see also Thissen 2005). He recognised nevertheless that an 'aceramic' Neolithic was represented at Knossos and Franchthi, but he considered these episodes as brief and of strictly local significance. More recently, Reingruber and Thissen (2009), despite abundant stratigraphic and artefactual evidence to the contrary (e.g. Jacobsen & Farrand 1987; Vitelli 1993; Perles 2004), rejected the presence of an Early Neolithic at Franchthi and in the Peloponnese. As a consequence, the earliest Neolithic in Greece would have been that of Thessaly, around 6500/6400 cal BC, in line with the more recent dates from western Anatolia, while the Peloponnese would have lagged behind until about 6000 cal BC (Reingruber & Thissen 2009: 762).

An even more drastic stand was taken by Weninger and his collaborators who rejected all dates older than 6200 cal BC. They concluded that Macedonia (Nea Nikomedeia) and Thessaly (Sesklo and Achilleion) were first settled during 'the 6200 cal BC event' and considered '...that the 8200 cal yr BP aridity triggered the spread of early farmers out of Anatolia into Greek Macedonia as well as in the fertile floodplains of Thessaly...' (Weninger *et al.* 2006: 417). Franchthi and Theopetra (Thessaly), as 'cave sites', had been left out of the discussion.

These readings of the dates are clearly linked to the hypothesis that the Greek Neolithic *must* come from western Anatolia, and, therefore, cannot be older than the latter. In the meantime, however, one of the present authors (CP) had argued that the influence of western Anatolia was limited to Macedonia. Other origins, through repeated episodes of maritime colonisation, had to be sought for the establishment of the Neolithic further south (Perlès 2005, 2010). According to this model, the dates from western Anatolia no longer constituted a *terminus ante quem*, and the multiple origins that were argued for made it possible to accept a wider range of dates.

Given the importance of the site of Franchthi in the debate and the unreliability of radiocarbon dates obtained more than 30 years ago, new dates on the Initial Neolithic at Franchthi were clearly required. We shall report here on a series of charcoal and seed AMS determinations related to the Mesolithic–Neolithic transition at Franchthi, including two dates on seeds of domesticated wheat.

The context

Franchthi Cave and the open-air settlement called ‘Paralia’, overlooking Koiladha Bay in the south-western Argolid (Figure 1), were excavated between 1967 and 1979 under the direction of T.W. Jacobsen of Indiana University (Jacobsen & Farrand 1987). The trenches were excavated in shallow passes (the ‘units’), following variations in the sediment. All trenches were dry-sieved with a mesh of 3mm. Flotation and water-sieving were implemented at trenches FAN, FAS, H1A and H1B, down to a mesh of 1.5mm (Diamant 1979). The exceptional archaeological sequence at Franchthi spans from the early Upper Palaeolithic to the Final Neolithic, but we shall concentrate here on the later Mesolithic and earliest Neolithic deposits.

The cultural phasing and the correlations between the different trenches have been established on an archaeological basis, within the framework of on-going work by Perlès aimed at producing a general synthesis of the site. It takes into account all the data provided by archaeobotanical remains (carbonised seeds), archaeozoological remains (mammal bones,



Figure 1. Map of Greece showing the location of Franchthi Cave and other regions and selected sites mentioned in the text.

fish bones, marine molluscs and land snails), lithic assemblages and ornament assemblages. In the reference trenches, FAN

The Upper Mesolithic was excavated in trenches, FAS, FAN, H, H1B, H1A and G1 (Figure 2). It is characterised by intensive tuna fishing (Rose 1995) and a very specific lithic assemblage, which comprises numerous atypical non-geometric microliths (Perles 1990). It has already been ^{14}C dated by six conventional radiocarbon determinations. With one exception, they give coherent results between *c.* 8400 and 7400 cal BC (2σ) (Table 1). This phase has not been re-dated. (The outlying sample comes from H1A, at the limit between the Lower and Upper Mesolithic. The date clearly indicates a Lower Mesolithic contamination.)

The Final Mesolithic is present *in situ* in FAS and FAN (Stratum X1) but is suspected to be reworked in H1A and H1B, due to deep post-Neolithic excavations (Vitelli 1993: 33). Both tuna vertebrae and non-geometric microliths have virtually disappeared. New transverse arrowheads appear, and the economy relies on a diverse spectrum based on wild fruit, legumes, cereals, a few land snails and the hunting of red deer, hares, turtles and foxes (Munro & Stiner 2012). The Final Mesolithic had not been ^{14}C -dated previously in the reference trenches. Two dates from other trenches (G1 22 and FF1 43A1), around 7500–6700 cal BC, were potentially compatible with the Final Mesolithic but the attribution could not be fully confirmed on an archaeological basis. Three new charcoal samples from reliable contexts, FAN 169 and FAN 166, were thus submitted for analysis.

and FAS, this phasing agrees well with the lithostratigraphic phasing established independently by Farrand (2000) on purely sedimentological criteria. All the archaeobotanical, archaeozoological and archaeological data concur, however, to show that the correlations he then established with other trenches are misleading. As he later recognised himself (Farrand *pers. comm.* 20 September 2003), the ‘rocky red’ *‘eboulis secs* (Stratum X1) from FAN and FAS is not the general marker bed he assumed it was: it follows the episode of intense tuna fishing in FAN and FAS, but precedes it in H1A and H1B. This, in turn, leads to offsets in correlations below and above the ‘rocky red’ deposits. In consequence, we shall refer to the lithostratigraphic phasing for trenches FAN and FAS only.

In the Initial Neolithic, domestic sheep, goats, wheat (*Triticum dicoccum*) and barley (*Hordeum distichum*) appear in small quantities (Payne 1975; Hansen 1991), together with trapezes on pressure-flaked blades (Perles 1990). The Initial Neolithic was labelled

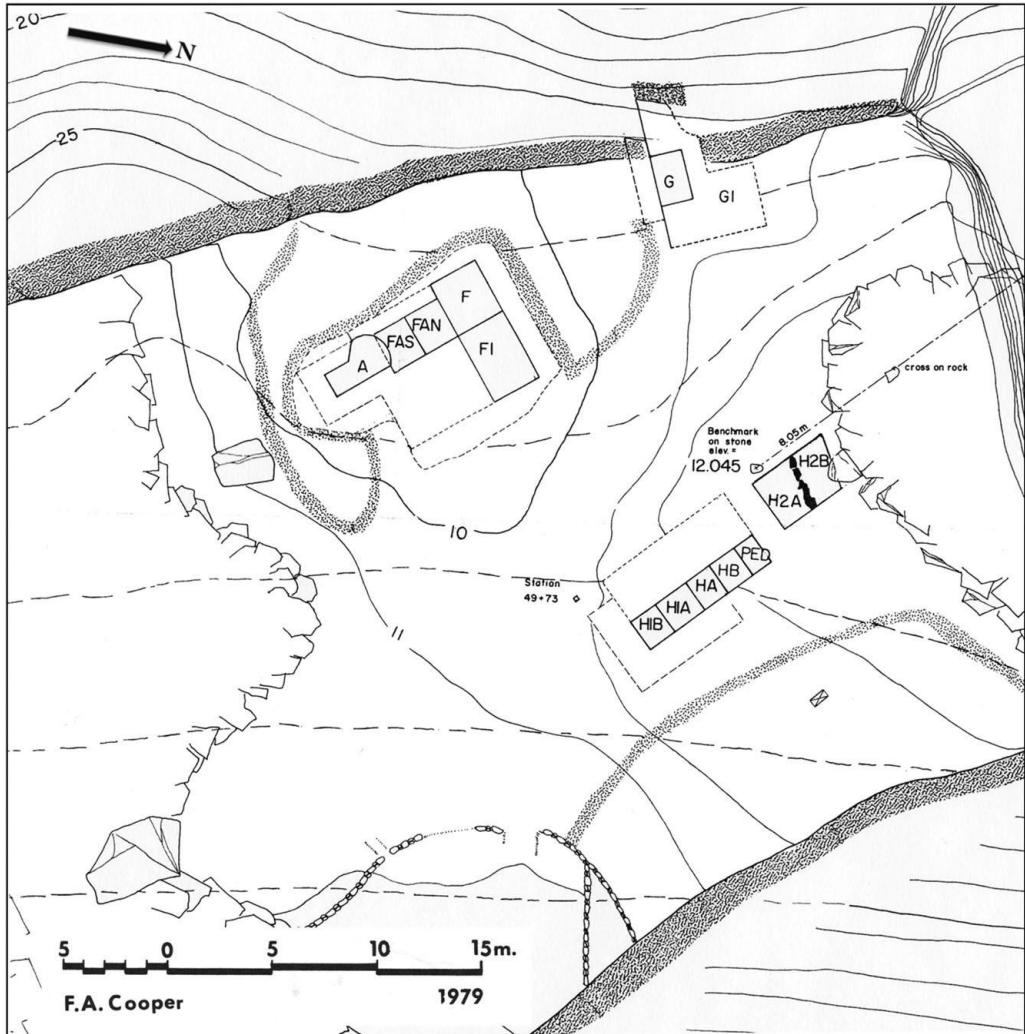


Figure 2. Location of the trenches discussed in the text (after Jacobsen & Farrand 1987).

as “possibly aceramic Neolithic” in a preliminary report (Jacobsen 1969: 352) in view of the very small number and small size of the sherds it contained, but this denomination was not retained subsequently by the Franchthi specialists (see ‘Initial Neolithic’ in Perlès 1990; ‘Interphase 0/1’ in Vitelli 1993). In FAN, FAS and possibly FF1, it corresponds to the well-defined sedimentary stratum called the ‘grey clay’ by the excavators (Farrand 2000: 50–51).

According to Farrand (2000: 50), five dates could be attributed to the 'grey clay' (Stratum X2). Two of them, however, FF1 43A1 and FAS 146, come from units that Farrand himself did not list as included in Stratum X2. Examination of the sections shows that FAS 146 may have cross-cut the underlying rocky deposit. The exact lithostratigraphic position of FF1 43A1 cannot be established, but both Perles (1990) and Vitelli (1993) consider it as`

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Table 2. New AMS radiocarbon dates from the Final Mesolithic and Initial Neolithic at Franchthi Cave. Delta ¹³C values were measured on the Artemis accelerator mass spectrometer.

Sample reference	Unit	Material	mg C	$\delta^{13}\text{C}$	sample pMC	Radiocarbon age BP
GifA 80049/SacA 10946 FAN 169		charcoal	1.42		0.21	8025
GifA 80048/SacA 10945 FAN 166bis		charcoal	1.53		36.82± 36.99± 37.24± +0.19	7990
GifA 80046/SacA 10910 FAN 166		charcoal	1.41		0.19	7935
GifA 11016/SacA 23624 FAN 163A		seed	1.19		0.18	7805
GifA 11455/SacA 26197 FAN 163B		seed	1.29		0.25	±45 ±40 ±40 ±40 ±50 ±40 ±50 ±40 ±407740
GifA 11017/SacA 23625 FAN 162A		seed	0.97		0.19	7780
GifA 11456/SacA 26198 FAN 162B		seed	1.07		37.80_ 38.14± 37.97± 38.60± 39.04± 37.35±0.24	7645
GifA 80044/SacA 10908 FAN 158		charcoal	1.41		0.19	7555
GifA 80043/SacA 10907 FAN 151		charcoal	1.53		0.18	7910

probably Final Mesolithic. A third sample, from trench A, comes from a unit (A 63) with suspected Middle Neolithic contamination (Vitelli 1993: 37). Accordingly, only the dates from FAN 143 and FF1 44B5 could be securely attributed to the ‘grey clay’ stratum and can be considered to date the earliest Neolithic deposits at Franchthi. Both units were devoid of sherds.

We submitted three additional Initial Neolithic charcoal samples for dating (FAN 159, 158 and 151), all included within the ‘grey clay’ stratum. No sherds were found in unit FAN 159, one ‘chip’ was found in unit FAN 158, and 33g of sherds in unit FAN 151 (Vitelli 1993: 226). Of these three Initial Neolithic samples, two (FAN 159 and 151) gave ¹⁴C dates so close to Final Mesolithic dates that the charcoal could be suspected to be intrusive, while the third (FAN 158) gave a date younger by several centuries, corresponding to the Early Neolithic (Table 2). We thus decided to date indisputable carbonised seeds of *Triticum dicoccum* from the same stratigraphic context. However, domestic seeds are not abundant in the Initial Neolithic (Hansen 1991: 139–44) and we

were only allowed to take samples in units with around 10 seeds of wheat. The best potential sample, from FAS 145, could not be located. We thus chose two seeds identified by Hansen as *T. dicocum* from unit FAN 163, at the interface of the rocky layer X1 and the 'grey clay' (X2), and from the overlying unit FAN 162, at the base of the 'grey clay' stratum (Figures 3 and 4). The lithics from both units show some mixing of Final Mesolithic and Initial Neolithic (Perles 1990: 91–93), but there is no wild progenitor of wheat in Greece and wheat was introduced as a domestic species in the Neolithic. These domestic seeds thus necessarily date the Neolithic, not the Mesolithic.

Methods and results

The dated samples were pre-cleaned according to the ABA pre-treatment. They were then oxidised to CO₂, reduced to graphite and compressed into pellets for measurement at the Artemis accelerator mass spectrometer facility (CEA, Saclay) (Arnold *et al.* 1987).

The new AMS dates are given in Table 1 together with the previous ¹⁴C results from Franchthi, and detailed in Table 2. The calibrated ranges (Figure 5) are plotted as a function of time on the IntCal09 calibration curve (Reimer *et al.* 2009). The curve shows

Early seventh-millennium AMS dates from domestic seeds in the Initial Neolithic

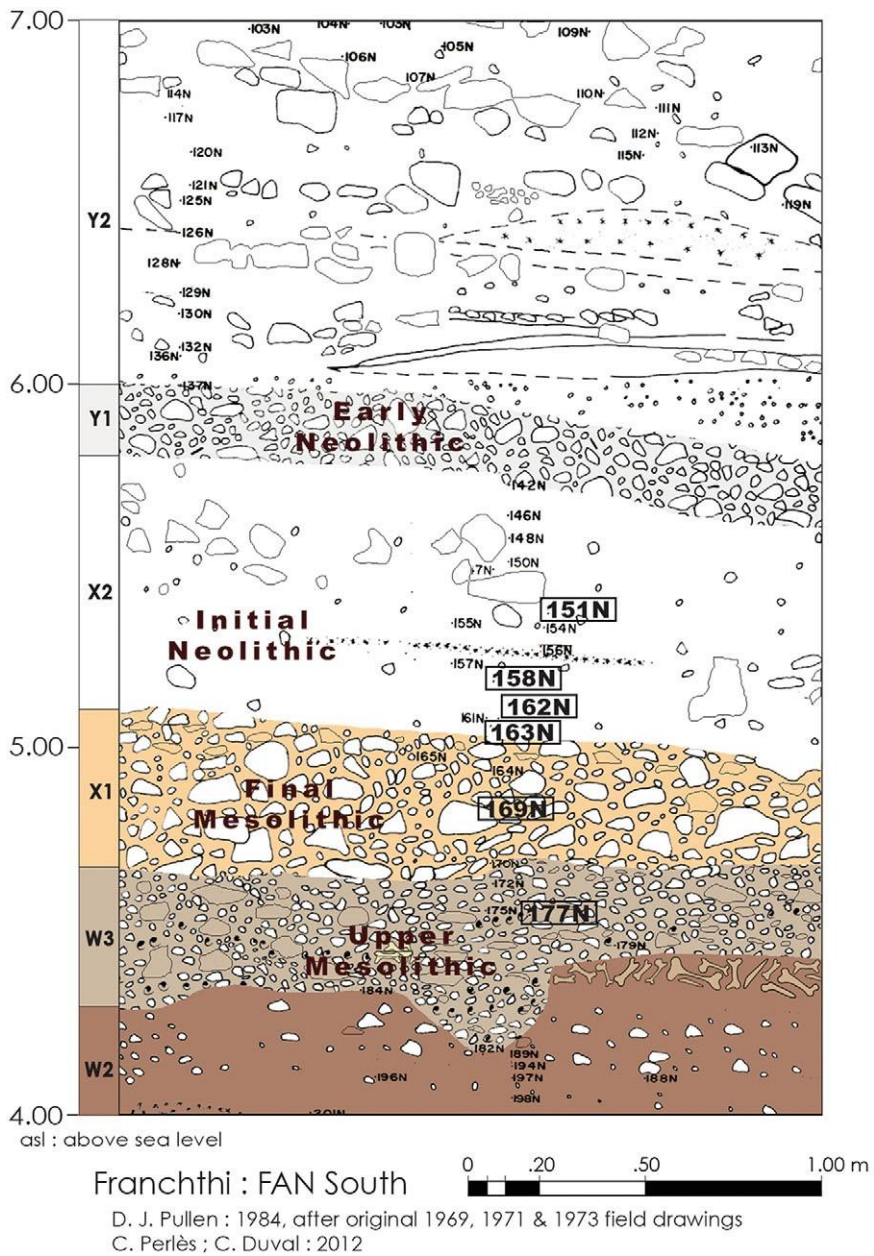
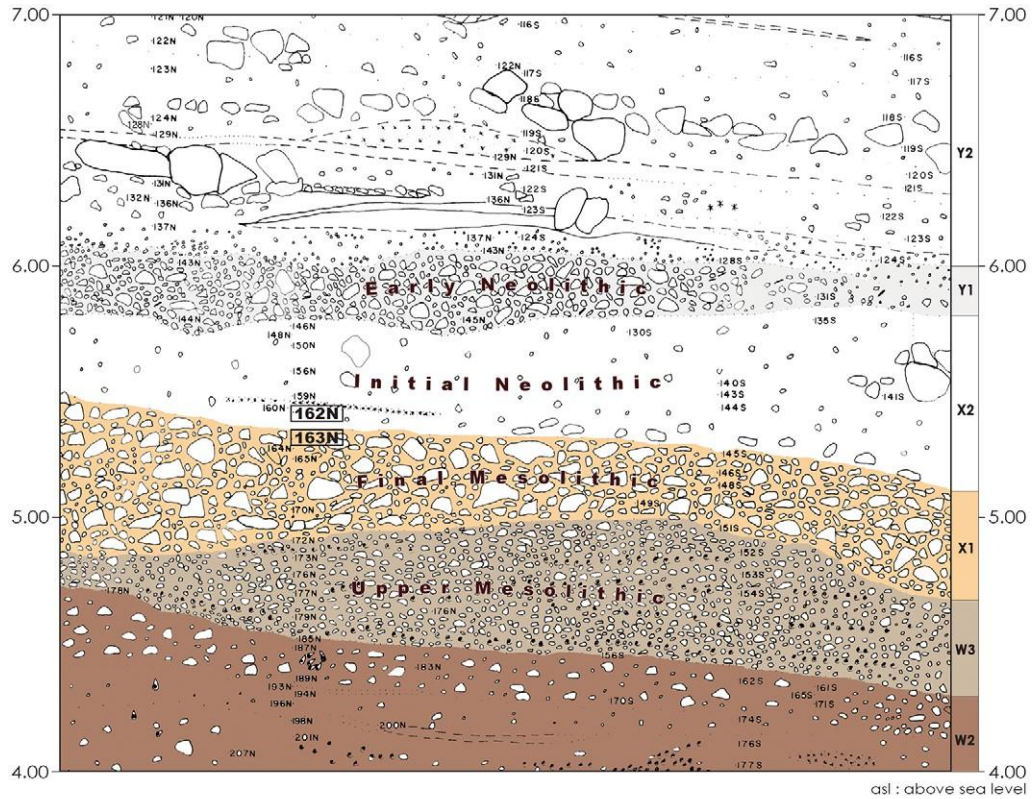


Figure 3. Detail of the south section of trench FAN showing the stratigraphic position of the radiocarbon-dated samples (after Jacobsen & Farrand 1987).

several irregularities that reflect the variability in the level of atmospheric ^{14}C in the period concerned. The first centres around 8700 ^{14}C BP, and corresponds to the cluster of Upper Mesolithic dates. The calendar ages deduced range from 8200 to *c.* 7500 cal BC, an

interval probably much longer than the actual duration of the phase. A second plateau occurs



Franchthi : FA East

D. J. Pullen : 1979, 1985, C. Perlès ; C. Duval : 2012

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Figure 4. Detail of the east section of trench FA showing the position of the two radiocarbon-dated seeds in relation with the lithostratigraphy (after Jacobsen & Farrand 1987).

around 8000–7800 ¹⁴C BP, the interval which contains most of the Final Mesolithic and Initial Neolithic dates. Even AMS dates with standard deviations of *c.* ±40 or 50 years thus correspond to time intervals of several hundred years after calibration (between *c.* 7000 and 6500 cal BC at 2σ).

In order to obtain a more precise picture of the cultural chronology at Franchthi, we used the ¹⁴C dates and the stratigraphic sequence to construct a Bayesian model using the OxCal 4.1.7 software, which incorporates the IntCal09 calibration curve (Bronk Ramsey 2009; Reimer *et al.* 2009).

This approach allows the stratigraphic information from the site to be integrated as *a priori* to the radiocarbon likelihoods in order to determine *a posteriori* probabilities taking

into account all the available information (Bronk Ramsey 2001, 2009). According to the archaeological data, the Upper Mesolithic, Final Mesolithic and Initial Neolithic samples were incorporated into three different phases nesting in a sequence (Figure 6). The very early date from H1A 117 Trench, a unit at the interface of the Upper and Final Mesolithic, was eliminated since it clearly corresponds to the Upper Mesolithic (Table 1). Units

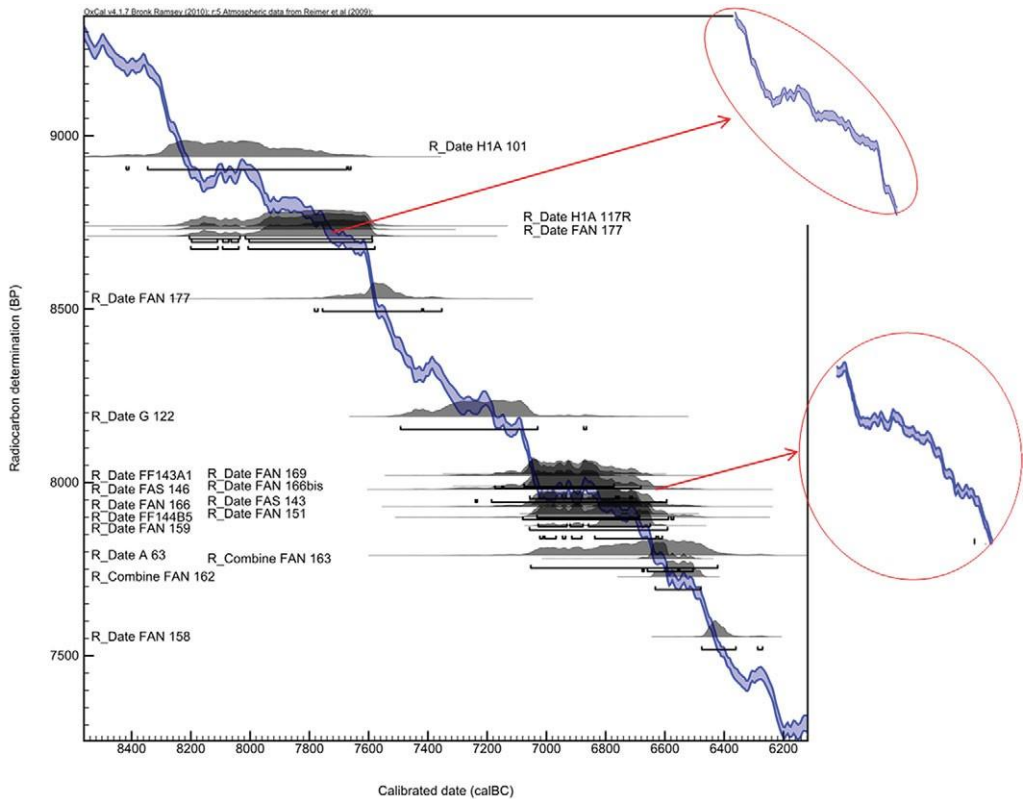


Figure 5. Projection of the Upper Mesolithic, Final Mesolithic and Initial Neolithic dates from Franchthi on the IntCal09 calibration curve (Reimer et al. 2009).

cross-cutting the Final Mesolithic and the Initial Neolithic were grouped as a separate cluster, in its correct stratigraphic position. Units coming from the same trench have been listed in their stratigraphic order within each phase. An outlier test was performed and the model was accepted ($A_{model} = 111$). This confirms that there exist diachronic differences between the three phases, even if the time gap between the Final Mesolithic and the Initial Neolithic is clearly short. In order to exclude the influence of the suspiciously young date from FAN 158 (Initial Neolithic), the model was re-run without this sample. The diachronic model was again confirmed ($A_{model} = 112$): both stratigraphy and radiochronology agree.

Discussion

The dates obtained on the carbonised seeds indicate without any possible doubt that cereal agriculture was practiced in southern Greece during the first half of the seventh millennium. The dates from seeds are younger by about 200 years than the dates obtained on charcoals from the same lithostratigraphic context, a difference usually attributed to the ‘old wood’ effect. Charcoal dates for the Initial Neolithic are very close to Final Mesolithic ones, which may suggest some Final Mesolithic contamination. Looking at the sections, that is

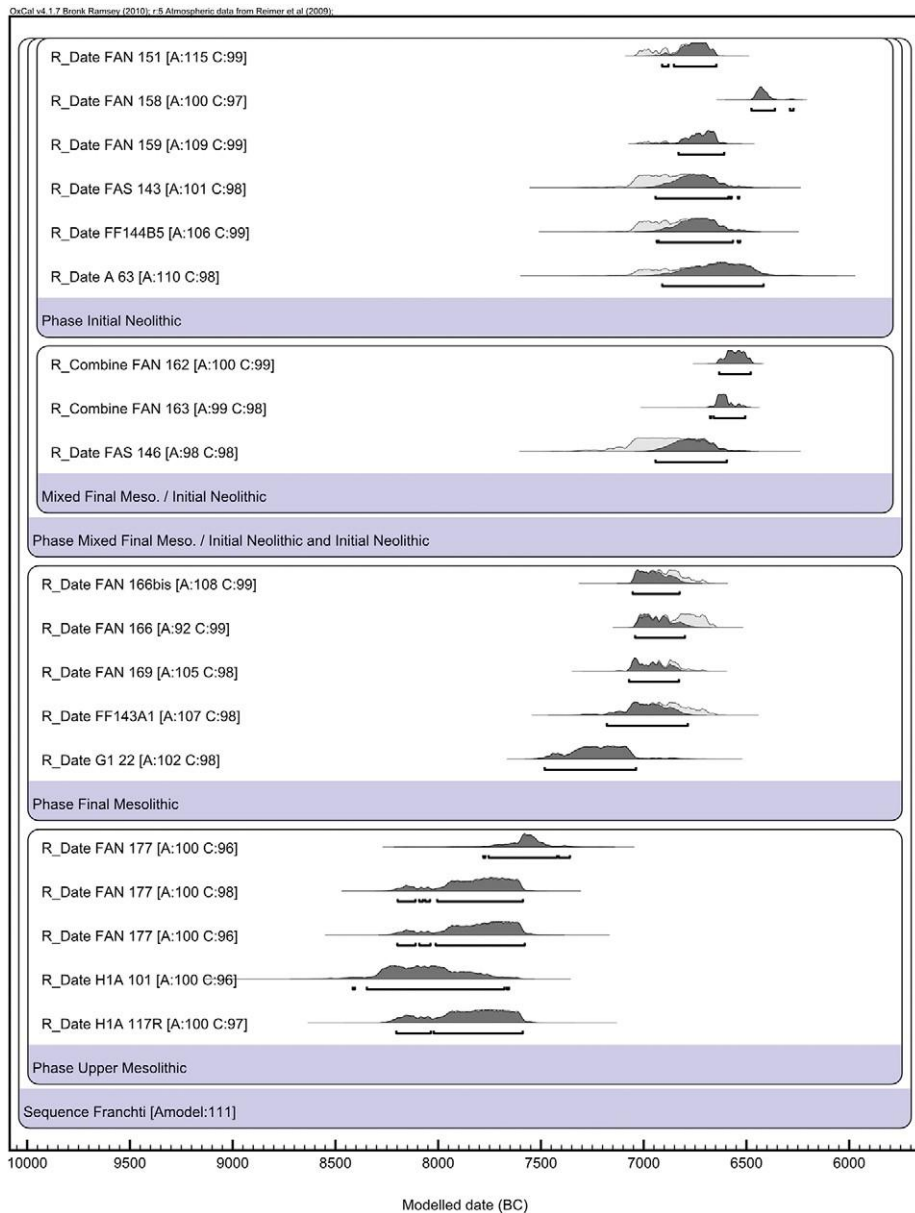


Figure 6. Bayesian modelling of Franchthi Cave occupation phases including all ^{14}C dates from the Upper Mesolithic, Final Mesolithic and Initial Neolithic.

indeed possible for FAS 146 which is included in the rocky layer X1. The other charcoal dates suggest a time gap of around 100 years between the Final Mesolithic and the Initial Neolithic, whereas the dates on seeds suggest an interval of *c.* 200 years. This short interval is probably compatible with both Farrand's observation of some weathering of the Final Mesolithic rocky layer X1 (Farrand 2000: 51) and the strong continuity in the chipped stone tool assemblages, marine molluscs and ornaments between the Final Mesolithic and Initial Neolithic (Shackleton 1988: figs. 3 and 4; Perles 1990:116, 2013). It reinforces the suggestion that the Initial Neolithic reflects a phenomenon of acculturation by local (ex-)hunter-gatherers (Perles 1990). On the other hand, our new dates obviously do not solve the problem of the status, 'aceramic' or 'ceramic', of the Initial Neolithic. The few sherds found in some units of the 'grey clay' stratum in FAN and FAS all belong to dominant Early Neolithic wares. They can be alternatively considered as intrusive, or as evidence for very scarce use of pots (Vitelli 1993: 39). No new data can be added to this ongoing discussion.

The demonstrated presence of Neolithic farmers at or around Franchthi during the first half of the seventh millennium leaves open the possibility of a brief episode of strictly local significance, as suggested early on by Thissen (2000: 191–92). Whether or not the Early Neolithic follows more or less directly at Franchthi cannot be confirmed from the few and unsatisfactory Early Neolithic dates available. The answer to this question requires another dating programme, focusing on the thick Early Neolithic deposits from Paralia and not the shallow and largely disturbed Early Neolithic deposits within the cave (Vitelli 1993: 44).

Conclusion

Our results demonstrate that Franchthi *was* occupied by farmers before 6500 BC, not much later than the earliest occupation of Knossos in Crete, where an oak acorn was recently AMS-dated to 7040–6770 (OxA-9215) (Efstratiou *et al.* 2004). These results suggest that Crete and southern Greece may have been occupied earlier than Thessaly, where the few dates earlier than 6500 cal BC come from charcoals, not seeds. No Early Neolithic site has recently been excavated or dated in Thessaly, however, and earlier settlements may well await discovery. Greece can still produce unexpected results concerning the Early Neolithic, as shown by the recent series of dates from Dikili Tash and Mavropigi which demonstrate that Macedonia may have been settled as early as 6500 cal BC (Karamitrou-Mentessidi *et al.* 2013; Lespez *et al.* 2013).

All these new dates confirm the antiquity of the Neolithic in Greece, which, on presently available evidence, precedes the earliest Neolithic occupations in Bulgaria by three to five centuries (Higham *et al.* 2011), in Italy by five to seven centuries (Binder in

press), and in Spain by at least one millennium (Zilhao 2011). This shows clear phenomena of arrhythmia in the spread of the Neolithic in Europe.

Except for an early seventh millennium date at Ulucak (Derin *pers. comm.* June 2013), the earliest dates from Franchthi are also slightly older than the currently available dates from sites such as Yeşilova, Ege Gubre and Araplı in western Anatolia, Hoca Cesme in Turkish Thrace or Ugurlu on the Aegean island of Gökçeada, which do not go back beyond c. 6500 BC (Reingruber & Thissen 2005; Çilingiroglu & Çilingiroglu 2007; Sağlamtimur 2007; Derin *et al.* 2009; Erdogu 2011). Radiocarbon dates, therefore, cannot be taken to demonstrate the chronological anteriority of the western Anatolian Neolithic over the Greek one. There is no doubt, on the other hand, that the Early Neolithic in Macedonia and Bulgaria shows strong links with western Anatolia and compatible radiocarbon dates.

The radiocarbon chronology, as available today, thus concurs with archaeological data and supports a model of multiple origins for the introduction of the Neolithic in Europe.

Acknowledgements

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