archaeometry

Archaeometry **57**, 1 (2015) 177–216 doi: 10.1111/arcm.12134

RADIOCARBON DATES FROM THE OXFORD AMS SYSTEM: *ARCHAEOMETRY* DATELIST 35*

C. BRONK RAMSEY, T. F. G. HIGHAM,† F. BROCK, D. BAKER, P. DITCHFIELD and R. A. STAFF

Oxford Radiocarbon Accelerator Unit, Research Laboratory for Archaeology and the History of Art, Oxford University, Dyson Perrins Building, South Parks Road, Oxford, OX1 3QY, UK http://c14.arch.ox.ac.uk

This is the 35th list of AMS radiocarbon determinations measured at the Oxford Radiocarbon Accelerator Unit (ORAU). Amongst some of the sites included here are the latest series of determinations from the key sites of Abydos, El Mirón, Ban Chiang, Grotte de Pigeons (Taforalt), Alepotrypa and Oberkassel, as well as others dating to the Palaeolithic, Mesolithic and later periods. Comments on the significance of the results are provided by the submitters of the material.

KEYWORDS: RADIOCARBON, ARCHAEOLOGY, AMS DATING, ABYDOS, EL MIRÓN, BAN CHIANG, GROTTE DE PIGEONS—TAFORALT, ALEPOTRYPA, OBERKASSEL, ULTRAFILTRATION

INTRODUCTION

This is the 35th list of dates measured at the Oxford Radiocarbon Accelerator Unit (ORAU). The dates presented here include those measured through the NERC/AHRC-funded NERC Radiocarbon Dating Service (NRCF, formerly ORADS), those funded by English Heritage and those submitted to the laboratory on a commercial basis.

Methods

All dates have been measured using the procedures outlined by Brock *et al*. (2010). All AMS determinations here were measured after conversion of the pre-treated samples into graphite (Dee and Bronk Ramsey 2000).

In accordance with international radiocarbon convention, all dates are expressed in radiocarbon years before AD 1950 (years BP), using the half-life of 5568 years. Errors are quoted as one standard deviation (1σ) and are based on an assessment of all the contributions to the error in the laboratory isotope ratio measurement. Natural fractionation of carbon isotopes is accounted for by measuring the $\delta^{13}C$ values relative to VPDB (with errors of approximately 0.3‰).

All combining procedures and significance tests are based on Ward and Wilson (1978). All calendrical dates quoted have been calibrated using the OxCal computer program of Bronk Ramsey (2009), using atmospheric data from 'INTCAL13' (Reimer *et al*. 2013), and are quoted to 95.4% probability.

*Received 10 April 2014; accepted 16 June 2014
†Corresponding author: email thomas.higham@rlaha.ox.ac.uk

Previous *Archaeometry* datelists are referred to in the form: *Arch.List* 30.

Details of methods applied are described in detail in our in-house documentation. This is regularly updated and archived, so the exact method used for any sample is always fully recorded.

OxA-X numbers are given when there is an experimental pre-treatment applied, or where the analytical data associated with the measurement is out of expected range. In these latter cases, the sample ought to be viewed with something of a health warning in terms of its accuracy. Usually, this is because of low collagen weights, either less than 10 mg or <1 wt% collagen. These are our minimum thresholds for acceptability.

Laboratory comments are provided without attribution.

ACKNOWLEDGEMENTS

We appreciate sincerely the input of the submitters of the archaeological and environmental samples listed below for providing comments on their dates. Funding for the laboratory comes from the Natural Environment Research Council (NERC). The Arts and Humanities Research Council (AHRC) and English Heritage have also contributed significant funding. The staff of the ORAU, past and present, are gratefully acknowledged for their careful work.

HUMAN REMAINS

Great Britain

Wolf Cave

Samples of human teeth from Site A, Wolf Cave (NGR ST11087280), submitted by Rick Peterson, School of Forensic and Investigative Sciences, University of Central Lancashire, Preston, PR1 2HE, UK.

OxA-X-2423-15 human tooth, A19, $\delta^{13}C = -20.1‰$ 3781 ± 38

Lab Comment: this sample weighed only 150 mg because of the sampling requirements listed by the submitter, and from it 1.6 mg of collagen was extracted. This is below our usual minimum required amount (5 mg). Other measurable parameters were acceptable (C:N ratio) and so we have OxA-X-ed the result. It should be viewed with a health warning; it is very difficult to date samples as small as this and it exposes us to possible error.

OxA-X-2423-16 human tooth, A397, $\delta^{13}C = -19.4‰$ 1391 ± 29

Lab Comment: this sample weighed only 100 mg because of the sampling requirements listed by the submitter, and from it 2.1 mg of collagen was extracted. This is below our usual minimum required amount (5 mg). Other measurable parameters were acceptable (C:N ratio, %carbon) and so we have OxA-X-ed the result. It should be viewed with a health warning.

Comment (R. P.): both results are plausible, as there are documented traditions of both Early Bronze Age and Iron Age cave burial in south-western Britain. However, in view of the fact that no diagnostic material culture of these dates was found at Site A, and the low collagen yield, they should not be regarded as definitive proof of burial at these dates.

Cwm George

Sample of human tooth from Site G at Cwm George (NGR ST11217151), submitted by Rick Peterson, School of Forensic and Investigative Sciences, University of Central Lancashire, Preston, PR1 2HE, UK.

OxA-X-2424-44	human tooth, G835, $\delta^{13}C = -20.0‰$	5083 ± 38

Lab Comment: this sample weighed only 130 mg, and 4.3 mg of collagen was extracted from it; this is less than our minimum required amount (5 mg). Other parameters were acceptable and so the sample has been OxA-X-ed, and should be viewed with slight caution.

Comment (R. P.): this result is entirely consistent with an earlier date on human remains from Site G (OxA-20968: 4929 ± 33 BP) and, despite the slightly low collagen yield, probably provides further evidence for Neolithic cave burial at this site.

St Thomas Head, Somerset

Samples of bone from the site of St Thomas Head, Somerset (ST34756687), submitted by Mr B. Smisson, 16 Woodside Road, Clevedon, BS21 7JY, UK.

OxA-26262	bone, human, $\delta^{13}C = -18.9‰$	583 ± 23
OxA-26263	bone, human, $\delta^{13}C = -18.5‰$	531 ± 22

Comment (B. S.): from the style of the burial, we were hoping that the results would date to the Early Medieval, or Late Antique, period. Dates in the 14th century are consistent instead with a possible association with Kewstoke Priory, founded by two of those who murdered Thomas à Becket, and it is recorded that the original foundation was a chapel to St Thomas at a previously unknown location called 'Dommet', before the new church was built at the present site. It is possible that the earlier chapel might have been on the top of the headland overlooking the Severn Estuary, an emotive spot before it was taken over by the Navy in 1946 as an experimental weapons testing laboratory. Hopefully, as the site is being decommissioned, it will be possible to do more archaeology to see if this chapel is indeed there.

Boxgrove School, Guildford

Sample of bone from Boxgrove School, Guildford, Surrey, submitted by Rob Batchelor from Quest, Wager Building, SHES, Whiteknights, University of Reading, Reading RG6 6AB, UK.

OxA-28335	cremated bone, human skull, Sample 4, $\delta^{13}C = -21.73‰$	5025 ± 29

Comment (R. B): the site produced no firm evidence of Mesolithic activity. Seemingly the only pointer to Early Neolithic activity comes with the radiocarbon date on cremated bone from tree-throw hollow 111 (part 4.5), which has a calibrated date range of 3944–3712 cal BC.

The hollow seems clearly dated to the Late Neolithic/Early Bronze Age from its finds, especially flintwork. It seems improbable that the human bone is from a different period of occupation for which there is no other evidence on site and, therefore, the date seems anomalous.

The earliest closed groups of lithic artefacts, all from features interpreted as tree-throw hollows, can be dated to the Late Neolithic/Early Bronze Age period on technological grounds and by the presence of associated tool forms. With the exception of a single sherd of Beaker ware recovered from the surface of tree-throw hollow 111, there is an absence of associated ceramics. The sherd, together with another from the colluvium, is, however, of particular interest on account of the rarity of such finds from South-East England, and for its occurrence in association with cremated human bone and plentiful unworked burnt flint and oak charcoal. The finds are clearly the result of deliberate deposition of material from a funeral pyre in the tree-throw.

Guernsey

St Tugual's Chapel, Herm

Samples of human skeletal material from St Tugual's Chapel, Herm (49°28′17.61″N, 2°26′57.05″W), Bailiwick of Guernsey, submitted by Dr Philip De Jersey, Guernsey Museum and Art Gallery, Candie Gardens, St Peter Port, Guernsey GY1 1UG, UK.

OxA-27369	bone, human, STC11/003, $\delta^{13}C = -17.1‰$	1030 ± 24
OxA-27370	bone, human, STC11/023, $\delta^{13}C = -18.2‰$	731 ± 23
OxA-27371	bone, human, STC11/024, $\delta^{13}C = -17.4‰$	698 ± 23
OxA-27372	bone, human, STC11/026, $\delta^{13}C = -17.3‰$	917 ± 24
OxA-27373	bone, human, STC11/060, $\delta^{13}C = -18.1‰$	1026 ± 23

Comment (P. D. J): the five dates are in agreement with the stratigraphic sequence of the site. The two earliest dates (OxA-27369 and OxA-27373) were from the lowest level of burials, cut into the natural gravel or bedrock. A date around the end of the 10th century AD or the early 11th century AD would accord with what little information we have on the building of St Tugual's Chapel, the earliest elements of which have been suggested as 10th or 11th century in date. The other three dates come from a complex series of intercut burials. Stratigraphically, 023 (OxA-27370) must be the latest; it had redeposited bones from 024, 025 and 026 placed on its legs. From an archaeological point of view, 024 (OxA-27371) clearly postdated 025 (not analysed) and 026 (OxA-27372), at the bottom of this stack of three burials.

The calendar age ranges of these three are 1031–1178 cal AD for 026, the earliest here; probably AD 1267–1303 for 024; and AD 1251–1295 for 023, the latest. The close match between 023 and 024 suggests that 023 cannot have been interred very long after 024 had been buried. Sample 023 has been confirmed, from osteological analysis, to have been suffering from leprosy; a date in the late 13th century accords well with the believed peak of the disease in Britain.

France

La-Chaize-le Vicomte

Samples of human bone from the site of La-Chaize-le Vicomte (46°40′22″N, 1°17′28″W), France, submitted by R. Bianucci, Laboratory of Anthropology, Department of Human and Animal Biology, Via Accademia Albertina 13, 10123 Turin, Italy.

OxA-20924	human bone, femoral diaphysis, LCLV1, $\delta^{13}C = -18.5‰$	155 ± 25
OxA-20925	human bone, femoral diaphysis, LCLV2, $\delta^{13}C = -18.4‰$	107 ± 25

Comment (R. B.): the archaeologist suggested, prior to the dates being obtained, that these human remains should date to the 17th–18th centuries, most probably to the end of the 18th century. The parish registers for the recent periods are complete and have been fully examined. There is no mention of these two graves, which were excavated in the core of the church, despite the fact that all the graves dating to recent periods are identifiable. The results of the dating show that the specimens date somewhere between AD *c*.1670 and 1950, the broad range being the result of the calibration curve plateau through this modern period, so they are consistent with the expected age.

Ireland

Farta

Sample of tooth found at Farta (53°15′15.98″N, 7°25′6.51″W), County Galway, Ireland, submitted by Dr E. O'Brien, 7 Ailesbury Lawn, Dundrum, Dublin 16, Ireland.

OxA-X-2488-42	human tooth, E1151, $\delta^{13}C = -20.6‰$	1625 ± 26

Lab Comment: this sample has been OxA-X'ed due to low collagen yield (330 mg of bone gave 4.24 mg yield). This is less than our usual threshold of 5 mg.

Comment (E. O. B): the subject of this radiocarbon measurement is an extended female inhumation, which had been inserted, together with a horse and some red deer antler, into the upper levels of a Bronze Age burial mound (with an inverted cinerary urn at its base). The site was excavated in 1903, and the subsequent publication considered this female burial to be Bronze Age. Our suspicion was that the burial was not Bronze Age but, rather, Early Medieval in type, and with the help of the National Museum of Ireland the skeletal material was located, and the radiocarbon date obtained has confirmed that the burial was inserted into the BA mound in the Early Medieval period.

This is an important burial in that it falls within the period during which extended inhumation was introduced into Ireland (i.e., the fifth century AD).

We are currently awaiting the results of strontium and oxygen analysis of teeth, which, we hope, will help to ascertain the origins of this female. Full details of the burial and publications can be accessed via our database at http://www.mappingdeathdb.ie.

Italy

Bingia 'e Monti, Italy

Samples of human bone from Late Holocene sites in Italy, submitted by Luca Lai, N. A. Foxi Murdegu 13/A, 08047 Tertenia (OG), Sardinia, Italy.

OxA-25340	bone, *Homo sapiens sapiens*, BMB562, $\delta^{13}C = -19.2‰$	3683 ± 30
OxA-25341	bone, *Homo sapiens sapiens*, BBA611, $\delta^{13}C = -19.2‰$	3917 ± 30
OxA-25342	bone, *Homo sapiens sapiens*, BMM541, $\delta^{13}C = -19.3‰$	3773 ± 31

Comment (L. L.): these dates confirm the stratigraphic sequence. More specifically, OxA-25340 confirms the range expected for the Early Bronze Age 1 phase, named Bonnannaro, from previous determinations; OxA-25341 confirms the few dates from other decorated-Beaker Sardinian sites, and reinforces the fact that Beakers may have reached Sardinia in an already mature phase after the middle of the third millennium. OxA-25342 dates to the EBA1, a layer lacking cultural markers, lying between the clearly identifiable EBA1 and EBA2 (the latter locally corresponding to the 'S. Iroxi' phase), which contain human remains that now find a more secure placement.

Corti Beccia

OxA-25339	bone, *Homo sapiens sapiens*, CTB174, $\delta^{13}C = -19.4‰$	4589 ± 33

Comment (L. L.): this site, yielding cultural materials and stratigraphic sequences that are largely unpublished, had previously been described as pertaining to the Copper Age Monte Claro phase, dated to the range 2800–2300 BC. This early AMS date elicits two contrasting explanations: either the deposits actually contained human remains from an earlier phase (either without cultural materials, or with non-diagnostic pottery), or this site might represent the earliest, so far undocumented, transitional aspect from previous material traditions to the Monte Claro phase.

Filigosa, Tomb 1

OxA-25337 bone, *Homo sapiens sapiens*, FIL143, $\delta^{13}C = -19.5‰$ 4401 ± 32

Comment (L. L.): this site, devastated by looters, yielded a wealth of pottery several decades ago that allowed us to identify an initial ceramic phase of the Sardinian Copper Age, named after it as Filigosa. However, as the stratigraphic link between items and human remains was problematic, dating was needed to test the fact that the latter pertained to the former. OxA-25337 does this.

Ganni'

OxA-25343 bone, *Homo sapiens sapiens*, GAN122, $\delta^{13}C = -19.1‰$ 3893 ± 30

Comment (L. L.): this date confirms the general range known for the Monte Claro culture, placing the site more specifically in its later section. This will be useful to give clues into understanding the evolution in material culture, up to now considered as a monolithic entity.

S'Iscia 'e sas Piras

OxA-25338 bone, *Homo sapiens sapiens*, ISP219, $\delta^{13}C = -19.4‰$ 2918 ± 28

Comment (L. L.): obtained from a collection recovered on the surface of looted deposits inside a chamber tomb and dated to the MBA on typological grounds, this date enhances the probability that the human remains actually pertain to the hypothesized phase, the Nuragic. In addition, the result also informs us by showing that the burial was still in use until the very end of the Late Bronze/Final Bronze Age.

Czech Republic

Krumlovsky les and Predmosti, southern Moravia
Samples of bone found at Krumlovsky les, Stare Mesto (54°34′19″N, 12°20′17″E) and Predmosti (49°27′36.69″N, 17°25′25.27″E), Czech Republic, submitted by Dr Martin Oliva, Moravian Museum, Zelny trh 7, 659 37 Brno, Czech Republic.

OxA-25894 bone, *Homo sapiens*, Stare Mesto, $\delta^{13}C = -17.9‰$ 1286 ± 28
OxA-27382 bone, *Homo sapiens*, Predmost I, $\delta^{13}C = -19.8‰$ 10 675 ± 45

Comment (M. O.): dates from Krumlovsky les testify to the boom in quarrying in the Late Lengyel and Early Bronze Age. The OxA-25894 date from Stare Mesto is surprising, since the human skeleton had been considered Mesolithic, as confirmed by a fluorine analysis. According to the date, it falls into the very beginning of the Slavonic settlement of the region.

The OxA-27382 date from Predmosti is totally anomalous. The anticipated date would be earlier by *c*.15,000 years, since hitherto only Gravettian occupation has been known at the location.

The find comes from the year 1927 and the bones have perhaps been treated with bone glue, although it is not quite evident. It is possible that this has had a significant impact on the result.

OLD WORLD PALAEOLITHIC AND MESOLITHIC

France

Les Harpons

Sample of the bone and the antler found at Les Harpons (43°14′1″N, 0°40′6″E), France, submitted by Syvain Ducasse, Laboratoire TRACES UMR 5608, Université de Toulouse 2, 5, allées Antonio Machado, 31058 Toulouse, France.

OxA-26875	bone, horse, HARP-7, $\delta^{13}C = -20.5‰$	22 400 ± 150
OxA-26876	antler, reindeer, HARP-1, $\delta^{13}C = -18.6‰$	18 450 ± 100
OxA-26877	antler, reindeer, HARP-5 (85776-37 MAN), $\delta^{13}C = -19.7‰$	15 370 ± 75
OxA-26878	antler, reindeer, HARP-3, $\delta^{13}C = -19.2‰$	18 960 ± 110

Comment (S. D.): the main objective of this work was to test the homogeneity of the Les Harpons layer D assemblage (in the Pre-Pyrenees/Haute-Garonne, France and dating to the Upper Palaeolithic): attributed to the Upper Solutrean by R. de St-Périer in the 1920s. This assemblage yields several indices of Badegoulian, almost unknown in this geographical area (lithic tools such as ‘raclettes’ and characteristic antler flakes linked to the manufacture of antler blanks by knapping), and a few antler blanks made by the groove and splinter technique, suspected to be Magdalenian. Antler and bone waste material from production processes were selected for dating. Only those that illustrated the different types of production were dated in order to test their contemporaneity.

The results confirm the heterogeneity of the assemblage. The antler flake (HARP-3) and the sawn base of antler (HARP-1) gave Badegoulian ages and the antler waste obtained by the groove and splinter technique (HARP-5) gave a Middle Magdalenian age. By contrast, the bone waste interpreted as a preform of long osseous points (HARP-7) gave a Final Gravettian age, which was unexpected and will lead us to discuss the cultural attribution of this kind of bone point. Finally, according to the chronological framework established from other radiocarbon-dated sites from southern France, none of these measurements are compatible with the Solutrean, which is, however, clearly present on the basis of the lithic material.

Germany

Bonn-Oberkassel

Samples of bone from Bonn-Oberkassel (50°42′51.98″N, 7°10′28.95″E), Germany, submitted by L. Giemsch and R. W. Schmitz, Universität Bonn, LVR-LandesMuseum Bonn, Bachstrasse 5–9, 53115 Bonn, Germany.

OxA-28147	bone, ST 20 No. 53, $\delta^{13}C = -21.4‰$	13 560 ± 55
OxA-28148	bone, ST 25 No. 18, $\delta^{13}C = -20.9‰$	896 ± 24

OxA-28149	bone, ST 33 No. 2, $\delta^{13}C = -22.4‰$	207 ± 20
OxA-28150	bone, cattle or deer, ST 23 #1, $\delta^{13}C = -19.3‰$	12 560 ± 55
OxA-28151	bone, cattle or deer, ST 23 #2, $\delta^{13}C = -21.6‰$	166 ± 22

Comment (L. G): the skeletons from Oberkassel were found in 1914 by workers in a basalt quarry. When we started our fieldwork in 2012, we tried to pursue three different aims: first, to explore different profiles to get more information about the geology of the find-area; second, to dig a large section to relocate the original sediments; and, third, to examine some different sediment heaps from the inner side of the basalt quarry to rediscover finds overlooked by the workers.

Sample OxA-28149 was found in a sediment heap, which yielded only modern finds, so for us the latest possible date for this result seems to be right. Samples OxA-28148 and OxA-28151 were found in the blasting debris or the upper part of the slope.

OxA-28147 belongs to a sediment heap that contained finds from different time periods (modern rubbish, ceramic and a fragment of a Late Palaeolithic arrowhead). The date illustrates the long time that is represented by material found in this heap. For us, the most interesting date comes from the sample OxA-28151. We think that it belongs to the relocated find sediments from the primary excavation.

The results seem to support our theory that Oberkassel belongs to the Azilian period (Federmessergruppen). Confirmation of this comes in the form of the fragment of the arrowhead, which is similar to some finds from Kettig with a radiocarbon age of 11 314 ± 50 BP (Baales 2001).

Spain

Cueva de El Cierro

Samples of the shell and the bone found at cave El Cierro in El Carmen village (43°27′34″N, 1°25′15″E), in the municipality of Ribadesella (Asturias, Spain), submitted by Esteban Álvarez-Fernández, Departamento de Prehistoria, Historia Antigua y Arqueología, Facultad de Geografía e Historia, Universidad de Salamanca, C. Cerrada de Serranos s/n, E-37002 Salamanca, Spain.

OxA-27856	shell, *Patella vulgata* (Level C2), 01, $\delta^{13}C = -0.04‰$	11 190 ± 38
OxA-27857	shell, *Littorina littorea* (Level D), 02, $\delta^{13}C = -0.3‰$	11 403 ± 37
OxA-27869	bone, *Cervus elaphus*, (Phalanx 2) (Level F), 03, $\delta^{13}C = -20.6‰$	15 460 ± 75
OxA-27870	bone, *Cervus elaphus*, (Phalanx 2) (Level G), 04, $\delta^{13}C = -20.2‰$	15 580 ± 75
OxA-27871	shell, *Littorina littorea* (Level G′), 05, $\delta^{13}C = 0.2‰$	16 360 ± 55

Comment (E. A.-F.): samples 03, 04 and 05 provide a date for the context of the scapula, with the striated engraving of a red deer hind (Gómez-Fuentes and Bécares Pérez 1979). In the 1976 fieldwork, F. Jordá-Cerdá and A. Gómez-Fuentes cleaned up a section left by previous excavations in the course of a vertical excavation aimed at determining the stratigraphy of the cave deposit. In a later phase, a sample of the shell midden was taken for study and dating.

In 2012, A. Gómez-Fuentes and E. Álvarez-Fernández, from the Prehistory Department at Salamanca University, opted to study and date the different levels in the deposit, in order to establish the Upper Palaeolithic chronological sequence. The dates of Levels C2 (sample 01) and D (simple 02), from the shell-midden sample, attributed to the end of this period, are presented here.

Cova del Parpalló and Coves Santa Maira

Samples of bone from the site Cova del Parpalló (39°8′43″N, 27°4′3″W), Spain and Coves Santa Maira (38°43′52.99″N, 0°12′52.14″W), Spain, submitted by J. Emili Aura Tortosa, Departament de Prehistòria i Arqueologia, Universitat de València, Avda. Blasco Ibáñez 28, E-46010 Valencia, Spain.

Cova del Parpalló

OxA-22629	bone, *Capra pyrenaica*, PT-0B, $\delta^{13}C = -19.4‰$	18 510 ± 100
OxA-22630	bone, *Cervus elaphus*, PT-0C, $\delta^{13}C = -18.1‰$	13 275 ± 55
OxA-22651	bone, indeterminate cranial, PT-0H-T16 528426, $\delta^{13}C = -18.6‰$	19 020 ± 100
OxA-22652	bone, mandible, *Capra pyrenaica*, PT-0J-T27 53166, $\delta^{13}C = -18.7‰$	20 290 ± 120
OxA-22890	bone, *Cervus elaphus*, PT-0E, $\delta^{13}C = -19.2‰$	19 690 ± 110

Coves Santa Maira

OxA-23114	bone, *Cuon cf. alpinus*, SM.E-M7, 5, $\delta^{13}C = -17.9‰$	17 130 ± 80

Comment (J. E. A. T.): radiocarbon dating of bones from the Gravettian to Magdalenian levels of L. Pericot's excavations (1928–31) at Parpalló, curated at the Servicio de Investigaciones Prehistóricas in Valencia, was attempted. Of 45 bones screened for nitrogen content, 12 contained enough to attempt collagen extraction. Of the 10 bones treated with the ultrafiltration protocol, five produced enough collagen for dating, providing a preliminary chronology for the Solutrean and Badegoulian levels (Project HAR 2008-03005). The dates are in stratigraphic order, with the exception of one (OxA-22630) from one of the uppermost Solutrean levels T-13, which is clearly aberrant.

OxA-22629, currently the only radiocarbon date on a Badegoulian deposit in the Mediterranean region of Spain, is somewhat earlier than expected when compared to published measurements for the end of the Solutrean (Aura Tortosa 2007). It is, however, in broad agreement for the age of this industry in southern France (Banks *et al*. 2008). It is hoped that dating work currently in progress will enable this chronology to be resolved further and extended to incorporate the Magdalenian levels.

OxA-23114, a *Cuon cf. alpinus* cranium from the Coves de Santa Maira site in Alacant, has been directly dated to 17 130 ± 80 BP, making it one of the most recent fossils of this species in the Western Mediterranean region. A number of contextual issues arise from this cranium.

Cova del Parpalló and Llonin

Samples of charcoal from Llonin (43°19′48.29″N, 4°38′45.05″W), Asturias, Spain and samples of bone from Cova del Parpallo (39°8′43″N, 27°4′3″W), Valencia, Spain, submitted by Dr J. E. Aura, Departamento de Prehistoria i Arqueologia, Avda. Blasco Ibanez, 28, 46010 Valencia, Spain.

Llonin

OxA-26041	charcoal, *Ericacea* sp., LLO-70, $\delta^{13}C = -24.0‰$	17 610 ± 90
OxA-26042	charcoal, *Juniperous* sp., LLO-71, $\delta^{13}C = -23.6‰$	17 480 ± 130
OxA-26338	charcoal, *Ericacea* sp., LLO-68, $\delta^{13}C = -25.1‰$	17 650 ± 75
OxA-26339	charcoal, *Fabacea* sp., LLO-69, $\delta^{13}C = -25.9‰$	18 345 ± 75
OxA-26340	charcoal, *Juniperus* sp., LLO-71, $\delta^{13}C = -23.7‰$	17 920 ± 80

Cova del Parpalló

OxA-26341	bone, *Capra pyrenaica*, PT 56, $\delta^{13}C = -19.0‰$	16 790 ± 90
OxA-26342	bone, *Cervus elaphus*, PT 58, $\delta^{13}C = -19.1‰$	18 640 ± 100
OxA-26343	bone, *Cervus elaphus*, PT 58, $\delta^{13}C = -19.1‰$	18 520 ± 100
OxA-26344	bone, *Capra pyrenaica*, PT 60, $\delta^{13}C = -19.2‰$	18 560 ± 100
OxA-26345	bone, *Cervus elaphus*, PT 62, $\delta^{13}C = -19.2‰$	21 580 ± 140

Comment (J. E. A.): the results that have been obtained are coherent with each other and allow a first analysis that we hope to compare with other sites.

The Solutrean to Badegoulian 'transition' (*c*.18 500–17 000 BP) is poorly dated in the Cantabrian and Mediterranean regions of Spain. Cave and rock-shelter stratigraphic sequences are frequently characterized by an erosional discontinuity possibly associated with palaeoclimatic variables (Hoyos 1994; Rasilla Vives 1994; Aura Tortosa 1995). Data from these sites reveal dynamic geological processes and complex taphonomic issues.

The dates obtained from Llonín (Asturias, in the Cantabrian region) (OxA-26041, OxA-26042, OxA-26338, OxA-26339 and OxA-26340) are associated with an Archaic Magdalenian context. The same is true for the dates from Parpalló (Valencia, in the Mediterranean region) (OxA-26341, OxA-26342, OxA-26343, OxA-26344 and OxA-26345), which are linked to Badegoulian assemblages (Aura *et al*. 2012).

The results overlap with the chronology of the final superior Solutrean in both of these regions and invite two interpretations or hypotheses. First, the dates of Llonín and Parpalló are coherent with the archaeological contexts dated; therefore a critical revision of the Solutrean chronology should be undertaken before formulating alternative explanations (contemporaneity between the two different technocomplexes, the relationships in terms of the functional variability between the sites etc.). Second, the dates could be considered problematic, as they could be the result of stratigraphic and taphonomic processes that have been mentioned.

The dates obtained for the Solutrean levels at both sites are coherent and this suggests that perhaps the first hypothesis is the most probable.

Hort de la Boquera

Samples of charcoal (*Pinus sylvestris*) from the site of Hort de la Boquera (Margaleg D; 0°45′30″N, 41°17′24″E), Spain, submitted by Josep Fullola, Universitat de Barcelona, Montalegre, 6/8 0801, Barcelona, Spain.

OxA-23645	charcoal, *Pinus sylvestris*, HB09.F6.N.1562, $\delta^{13}C = -23.8‰$	11 775 ± 45
OxA-23646	charcoal, *Pinus sylvestris*, HB09.G6.N.3575, $\delta^{13}C = -24.4‰$	11 850 ± 45

Comment (J. F.): OxA-23645 and OxA-23646 agree perfectly with the age expected. They date the upper part of level 2, a transitional Late Magdalenian level, that in this area of the Montsant valley (southern Catalonia) does not have the classical characteristics of this phase, and the Microlaminar Epipalaeolithic (similar to Azilian, rich in microbladelets), that we have also in the nearby rock shelter of Filador.

In the lower part of this level 2, we already had a date of 12 250 ± 60 BP, a little bit older than the two dates that we have obtained here, as we expected.

Parco cave

Samples of charcoal (*Pinus sylvestris*) from the site of Parco cave, Alos de Balaguer (41°54′31″N, 0°56′31″E), Spain, submitted by Josep Fullola, Universitat de Barcelona, Montalegre, 6/8 0801, Barcelona, Spain.

OxA-23650	charcoal, *Pinus sylvestris*, UBOX50-Parco 11, $\delta^{13}C = -24.1‰$	13 475 ± 50

Comment (J. F.): the date obtained is of charcoal from a fire pit (EC45). It is consistent with the stratigraphic sequence of the site, corresponding in this level to the Upper Magdalenian. The date is related to other Upper Magdalenian fire pits dated in the site previously, by the ORAU, and is consistent with the archaeological record (lithic and bone industries). The sample dates the occupation by Magdalenian people of the external area of the site. The presence of fire pits without a great deal of archaeological evidence in association might suggest that they were used for lighting or signalling.

El Miron

Samples of red deer bone from El Miron cave Ramales de la Victoria (43°14′48″N, 3°27′5″W), Cantabria, Spain, submitted by A. Lister from the Natural History Museum, London SW7 5BD, UK. Comments by L. G. Straus, Department of Anthropology, MSC01 1040, University of New Mexico, Albuquerque, NM 87131-0001, USA, and M. R. González Morales, Instituto Internacional de Investigaciones Prehistóricas, Universidad de Cantabria, Avda. de los Castros s/n, 39005 Santander, Spain.

OxA-22087	bone, *Cervus elaphus*, 54-MM79, $\delta^{13}C = -19.7‰$	11 785 ± 55
OxA-22088	bone, *Cervus elaphus*, 760-MM80, $\delta^{13}C = -19.7‰$	11 205 ± 55
OxA-22089	bone, *Cervus elaphus*, 872-MM82, $\delta^{13}C = -19.2‰$	14 930 ± 70
OxA-22090	bone, *Cervus elaphus*, 908-MM98, $\delta^{13}C = -20.1‰$	15 430 ± 75
OxA-22091	bone, *Cervus elaphus*, 1941-MM93, $\delta^{13}C = -20.6‰$	14 760 ± 70
OxA-22092	bone, *Cervus elaphus*, 1941-MM93, $\delta^{13}C = -20.5‰$	14 795 ± 75
OxA-22093	bone, *Cervus elaphus*, 3465-MM187, $\delta^{13}C = -20.2‰$	15 610 ± 90

Comment (L. S. and M. R. G.-M.): El Mirón is a large cave opening out on to a cliff-face in the Cantabrian Cordillera of eastern Cantabria Province, near the border of Vizcaya and 20 km from the present Atlantic shore at the mouth of the Asón River. It is situated at 43°14′48″N, 3°27′5″W and 260 m a.s.l., and is surrounded by mountain peaks at or above 1000 m a.s.l. The principal excavations since 1996 have been conducted in two block areas connected by a stratigraphic trench in the outer and inner areas of the cave vestibule, which measures 30 m in depth by 8–16 m in width by 13 m in height. The exterior mouth of the cave is 20 m high and faces due west. The full cultural sequence ranges from the final Mousterian (41 000 BP) to the Bronze Age (3700–3200 BP), with evidence (dated torch wood) of medieval visits to the cave. The bulk of the levels pertain to the Solutrean, Magdalenian, Azilian, Neolithic and Chalcolithic periods. Most of the previous dates run by Alexander Cherkinsky at Geochron Labs and the University of Georgia (now totalling over 70) have been published in *Radiocarbon* (Straus and González Morales 2003, 2007, 2010).

Six red deer bones from among a larger sample of bones provided to Adrian Lister for DNA analyses by the excavation directors M. R. González Morales and L. G. Straus, through the initiative of A. B. Marín, were dated by AMS at the Oxford Laboratory.

Assays pertaining to the Terminal Magdalenian/Early Azilian came from the outer vestibule excavation area: OxA-22087 is from Level 11, OxA-22088 is from underlying (hearth?) Lens 11.1. The latter unit is also dated by GX-22132, a conventional assay of 11 720 ± 140 BP, which is almost within the range of the Oxford date at $\pm 2\delta$. No Magdalenian (round-section) or Azilian (flat-section) harpoons have been found in levels 11–11.2, but 11.1 yielded an elongated river pebble stained with red ochre, which is suggestive of the Azilian—an Epipalaeolithic culture that straddled the Pleistocene–Holocene boundary in Western Europe. The Level 11 series is underlain by Level 12, which produced an Upper Magdalenian antler harpoon closely associated with a lump of charcoal AMS-dated to 12 970 ± 70 BP (GX-22132). The clayier and culturally much poorer Level 13, probably pertaining to the Middle Magdalenian, is dated by OxA-22089. This result squares relatively well (within ± 2σ) with a conventional date on bulk bone splinters from several spits of underlying Level 14: 14 600 ± 190 BP (GX-32383). The final Oxford date from the outer vestibule is from the middle of the 30 cm thick, extraordinarily rich Level 17, which contains classic markers of the Lower Cantabrian Magdalenian (red deer scapulae engraved with striation-'shaded' images of red deer hinds, core scrapers and quadrangular-section antler points). It has been dated by four other GX assays ranging between 15 700 and 15 370 BP, fully in line with OxA-22093.

The remainder of the Oxford dates come from the inner vestibule area; all pertain to layers with typical Lower Magdalenian lithic and osseous artefacts and works of portable art.

One bone from Level 110 was dated twice: OxA-22091 and 22092, with statistically identical results. However, two separate dates by Cherkinsky, also on bones from 1 m to the east (one conventional, the other AMS), yielded considerably younger results: 16 130 ± 250 BP (GX-23396) and 16 520 ± 40 BP (UGA-10628). These dates are very close to the base of a huge block that had fallen from the cave ceiling and landed on Level 110, perhaps pushing it down and distorting the stratigraphy, which might help to explain the disparity between these and the Oxford dates. Level 110 provides the *terminus post quem* for engravings that were subsequently done on the western, sheared-off (and subsequently sunlit) surface of the block and for a Lower Magdalenian human burial (directly AMS-dated to one millennium later than the block-fall) that was made behind the block, the eastern face of which was contemporaneously stained with red ochre. The underlying Lower Magdalenian Level 112 is dated by OxA-22090, which is bracketed by conventional bone assay GX-24469 (15 530 ± 230 BP) on overlying Level 111 and AMS bone assay GX-28209 (16 460 ± 50 BP).

Italy

Chiostraccio Cave, Siena

Samples of human bone from the site Grotta del Chiostraccio (43°N, 11°E), Italy, submitted by F. Sandelli. Comments by A. Moroni, Dipartimento di Scienze della Terra, Universitã di Siena, Via Laterina, 8, 53100 Siena, Italy.

OxA-25078	bone, human skull fragment, CH, $\delta^{13}C = -19.2‰$	12 085 ± 55
OxA-25079	bone, human skull fragment, CH, $\delta^{13}C = -19.3‰$	12 120 ± 55

Comment (A. M.): the samples used for ^{14}C dating come from the cranium of a complete skeleton found in 1962 in the Chiostraccio Cave, located in the Montagnola hills about 20 km from Siena (Tuscany, Italy). This skeleton has been conserved at the University of Siena. When the bones were found, they were not covered by deposit but lay on the floor of the cave among stone blocks that had collapsed from the roof some dozen metres from the present-day entrance, which is formed by a vertical well that is 20 m deep. Our previous dating obtained from a cranial fragment was 12 800 ± 50 BP (Beta-293673).

At the moment, we have no useful data for determining the skeleton's temporal context (such as lithic evidence). According to the dating, the Chiostraccio remains date to the late Epigravettian and are therefore the earliest Tuscan *Homo sapiens* findings known to date. Further research in the cave and anthropological studies are in progress.

Czech Republic

Pod Hradem Cave
Samples of charcoal material from southern Moravia, Czech Republic, submitted by L. Nejman from the Department of Anthropology, Vinarska 5, 602 00 Brno, Czech Republic.

OxA-28116	charcoal, *Pinus*, $\delta^{13}C = -23.2‰$	42 100 ± 1000

Comment (L. N.): the dating result of this sample is from layer 10 (Pod Hradem Cave) and is similar in age to previously obtained AMS dates on cave bear teeth.

An important implication of this result is that it is the first result that dates human activity directly (the charcoal is presumably from a dispersed hearth). Previous AMS dates were on cave bear teeth, which do not date human activity directly. A second important implication is the antiquity—the early part of the Middle–Upper Palaeolithic transition.

Little is known about this period in Central Europe, and any information is significant because it is the time when some of the last Neanderthals may have still lived in this area and, at the same time, modern humans were also arriving in this area.

Kůlna Cave
Samples of antler and bone found at Kůlna Cave, Moravian Karst, Czech Republic, submitted by Dr P. Neruda, Anthropos Institute, Moravian Museum, Zelny trh 6, Brno 659 37, Czech Republic.

OxA-25282	antler, *Cervus elphas*, K2011001, $\delta^{13}C = -21.7‰$	6462 ± 34
OxA-25283	bone, *Bos primigenius*, radius, K2011002, $\delta^{13}C = -20.6‰$	11 045 ± 50
OxA-25284	bone, *Alces alces*, metatarsus, K2011003, $\delta^{13}C = -21.2‰$	11 820 ± 50
OxA-25285	bone, *Alces alces*, metatarsus, K2011004, $\delta^{13}C = -20.7‰$	11 770 ± 55
OxA-25286	bone, *Equus* sp., tarsus, K2011005, $\delta^{13}C = -19.9‰$	11 070 ± 50
OxA-25287	bone, K2011006, $\delta^{13}C = -20.1‰$	11 010 ± 50
OxA-25288	bone, K2011007, $\delta^{13}C = -20.4‰$	12 600 ± 60
OxA-25289	bone, *Equus* sp., pelvis, K2011010, $\delta^{13}C = -20.8‰$	12 575 ± 60
OxA-25290	bone, *Equus* sp., tibia, K2011011, $\delta^{13}C = -20.9‰$	12 555 ± 60
OxA-25291	bone, *Rangifer tarandus*, humerus, K2011012, $\delta^{13}C = -19.4‰$	12 620 ± 60
OxA-25292	bone, *Bos primigenius*, metacarpus, K2011013, $\delta^{13}C = -20.7‰$	11 185 ± 50
OxA-25293	bone, *Bos primigenius*, humerus, K2011014, $\delta^{13}C = -21.5‰$	11 340 ± 55
OxA-25294	bone, animal of *Equus* size, long bone K2011015, $\delta^{13}C = -19.9‰$	12 620 ± 55
OxA-25295	bone, animal of *Equus* size, long bone K2011015, $\delta^{13}C = -19.9‰$	12 455 ± 55
OxA-25296	bone, *Mammuthus primigenius*, K2011016, $\delta^{13}C = -20.7‰$	24 510 ± 190
OxA-25297	bone, *Rangifer tarandus*, humerus, K2011018, $\delta^{13}C = -18.7‰$	34 350 ± 600
OxA-25298	bone, K2011019, $\delta^{13}C = -20.1‰$	>47 700
OxA-25299	bone, *Mammuthus primigenius*, K2011020, $\delta^{13}C = -20.4‰$	24 900 ± 200
OxA-25300	bone, size of *Equus/Bos*, K2011021, $\delta^{13}C = -20.4‰$	>47 600
OxA-25301	bone, size of *Equus/Bos*, K2011022, $\delta^{13}C = -19.8‰$	>50 000
OxA-25302	bone, *Rangifer tarandus*, tibia, K2011023, $\delta^{13}C = -19.5‰$	12 585 ± 55
OxA-25303	bone, *Equus* sp., K2011024, $\delta^{13}C = -20.1‰$	>50 500
OxA-25304	bone, *Rangifer tarandus*, metatarsus, K2011026, $\delta^{13}C = -18.7‰$	>45 900

OxA-25308	bone, K2011027, $\delta^{13}C = -19.6‰$	47 000 ± 2800
OxA-25309	bone, size of *Equus*/*Bos*, long bone, K2011028, $\delta^{13}C = -20.0‰$	>50 300
OxA-25310	bone, *Mammuthus primigenius*, K2011029, $\delta^{13}C = -20.6‰$	>47 000
OxA-25311	bone, *Mammuthus primigenius*, K2011030, $\delta^{13}C = -20.6‰$	>50 300
OxA-25312	bone, *Bos primigenius*, metacarpus, K2011031, $\delta^{13}C = -19.7‰$	>50 000
OxA-25313	bone, *Rangifer tarandus*, metatarsus, K2011032, $\delta^{13}C = -17.9‰$	>47 800
OxA-25314	bone, size of *Equus*/*Bos*, K2011033, $\delta^{13}C = -19.8‰$	>49 100
OxA-25315	bone, *Equus* sp., metatarsus, K2011034, $\delta^{13}C = -20.2‰$	45 800 ± 2400
OxA-25316	bone, *Mammuthus primigenius*, K2011035, $\delta^{13}C = -20.7‰$	>45 800
OxA-25317	bone, *Ursus spelaeus*, ulna, K2011036, $\delta^{13}C = -21.0‰$	>47 800
OxA-25318	bone, size of *Equus*/*Bos*, long bone, K2011037, $\delta^{13}C = -20.8‰$	>50 200
OxA-25319	bone, *Rangifer tarandus*, long bone, K2011038, $\delta^{13}C = -18.3‰$	>49 900
OxA-25320	bone, *Mammuthus primigenius*, K2011039, $\delta^{13}C = -20.9‰$	>50 100
OxA-25321	bone, K2011040, $\delta^{13}C = -21.0‰$	>50 100
OxA-25322	bone, *Rangifer tarandus*, tibia, K2011042, $\delta^{13}C = -18.6‰$	>50 000
OxA-25323	bone, *Mammuthus primigenius*, K2011043, $\delta^{13}C = -20.9‰$	>50 200
OxA-25324	bone, K2011044, $\delta^{13}C = -20.9‰$	>49 900
OxA-25325	bone, *Rangifer tarandus*, metatarsus, K2011045, $\delta^{13}C = -18.6‰$	>49 300

Comment (P. N.): the project for dating Kůlna Cave (GACR P405/110406) embraced layers 3 to 7c, levels that capture the development from the younger phase of the Vistula Glacial to the Allerød period. All samples consisted of bone and antler, each bearing evidence for anthropic impacts on their surfaces (scraping, cut marks, retouching etc.). The only items with unequivocally determined spatial locations (sector, unit, depth and layer) were included in the analysis, both from the entrance of the cave and its interior. Geological layers were stated with all of the samples according to the data contained in the field notebook by K. Valoch, the author of the research (see Valoch 1988).

The most recent Palaeolithic stratum in the Kůlna Cave is represented by layer 3. Two samples were taken from this area, where the sediment was best preserved. Because of the scarcity of the material for dating, we also used a fragment of antler (OxA-25282), the presence of which in layer 3 was questionable (it was designated as Layer 3?). The result that correlates with the Neolithic is in conformity with this. The second date (OxA-25283) can be considered acceptable because of its agreement with the assumed position of the Epi-Magdalenian.

The dating of Epi-Magdalenian layer 4 was carried out using three samples. The first two (OxA-25284 and 25285) are older than the overlying layer 3; the third sample (OxA-25286) is more recent and can be correlated with layer 3. In this case we cannot be certain whether a secondary relocation of the artefact occurred between layers 3 and 4, or whether the stratigraphic classification was already erroneous during the archaeological excavations, since the boundary between the two horizons was difficult to distinguish.

Located in the substratum was the younger layer of Magdalenian material (layer 5), from which four samples were analysed, although only two were successfully dated. Unfortunately, the results do not make a reliable chronostratigraphic classification possible because one of the dates corresponds to Epi-Magdalenian layer 3 (OxA-25287), while the other more likely correlates with the chronological position of Magdalenian layer 6 (OxA-25288). However, layer 5 was thin, not well preserved and difficult to identify. Regretfully, both of the dated samples originate from places (Sector C) in which the Late Pleistocene layers were disturbed by amateur archaeological digging carried out previously.

A relatively consistent data set is available for the older Magdalenian layer 6 (OxA-25289-25291). According to these data, the occupation of the cave can be dated to the period around 12 500 BP.

The samples from Sector J, which, according to K. Valoch, includes a Gravettian cultural horizon with lithic artefacts and bones of *Bos primigenius*, provide a problematic group of data. The presence of the Gravettian in Kůlna Cave was proven earlier on by both absolute dating and finds of typical decorated items in Sector G1. Nevertheless, the data resulting from new sampling do not correspond to such cultural and chronological position. The data acquired from *Bos primigenius* bones are more likely to correlate with the Epi-Magdalenian (OxA-25292 and 25293), while another two results from one bone of an *Equus*/*Bos*-sized animal correspond to the position of Magdalenian in layer 6 (OxA-25294 and 25295). According to K. Valoch, the Gravettian and Magdalenian artefacts were found in macroscopically identical sediment—thus possible contaminations cannot be dismissed. Moreover, the concentration of finds near the cave side in Sector J may be caused by secondary deposition, and may thus also contain more recent finds (i.e., Magdalenian items).

One of the key questions of the project was the chronological position of the most recent Micoquian horizon represented by layer 6a in the entrance and the centre of the cave, and layer 6b inside the cave (on the issue of layer 6b; cf., Neruda *et al*. 2011). Fourteen samples were sent for analysis, and finite dates were acquired only for 12 of these. Seven samples yielded infinite ages, testifying that the Micoquian occupation is not younger than the obtained value, which oscillates between 45 900 and 50 500 years BP. The date for OxA-25308, which provided the finite age of 47 300 ± 2800 BP, falls within this framework as well. However, four other samples (OxA-25296, 25297, 25299 and 25302) show that material from more recent phases of occupation of the cave has been added to the collection of the uppermost Micoquian layer. We have to stress that these particular four samples originate exclusively from situations in which the differentiation of geological, and hence also archaeological, layers was difficult. Three items originate from the cave entrance and their ages match up with Gravettian (OxA-25296 and 25299) and Magdalenian (OxA-25302) respectively. Near the entrance to the cave and in Sector J alike, the archaeological horizons could only be differentiated by stone artefacts, not by geological layer, as both the Micoquian and the Magdalenian were located in macroscopically similar loess sediment. Although Gravettian lithic artefacts in the entrance to the cave were not differentiated, some of the animal bones discovered are likely to be connected with the Gravettian occupation. Confusion of finds between archaeological horizons did not occur in such places within the cave, where unequivocal differentiation of the Micoquian layer 6a–6b from the more recent loess sedimentation was possible. The fourth problematic date (OxA-25297) comes from the interior part of the cave, in which Upper Palaeolithic layers were disturbed by recent human activities. The date would fall within the framework of the beginning of the Upper Palaeolithic, yet the layers containing culturally adequate artefacts were not captured anywhere within the cave. Moreover, the selected bone of *Rangifer tarandus* does not bear traces of anthropic impact, and so the possibility that it was a kill brought in by a carnivore cannot be ruled out. Thus, for the dating of the most recent Micoquian horizon, it is important that the bulk of the data fall within the Middle Palaeolithic period (the older phase of MIS 3).

From the underlying Micoquian layer 7a, 14 samples were analysed, of which 13 provided some data on the age of osteological material. Only one date can be calibrated (OxA-25315), and its age comes near the absolute limit obtained earlier on. The remaining data place the occupation into an older period than 45 800–50 300 BP. An indication of contamination from younger layers was not found in any of the cases.

Our assumption that the age of the finds from layer 7c would be beyond the limits of the ^{14}C method has essentially been confirmed by the radiocarbon dating reported here.

Morocco

Grotte de Pigeons, Taforalt

Forty-eight samples of charcoal, bone and ostrich eggshell from Grotte des Pigeons, Taforalt (34°48′38″N, 2°24′30″W), Morocco, submitted by R. N. E. Barton and S. N. Collcutt, Institute of Archaeology, University of Oxford, Oxford OX1 2PG, UK.

Sector 1–2

OxA-14347	charcoal, *Juniperus/Tetraclinus*, TAF04/586, $\delta^{13}C$ = –21.4‰	21 360 ± 90
OxA-16279	charcoal, TAF06/5430, $\delta^{13}C$ = –20.7‰	22 030 ± 100
OxA-16261	charcoal, TAF06/5408, $\delta^{13}C$ = –22.3‰	22 830 ± 100
OxA-14290	charcoal, *Tetraclinus articulate*, TAF04/945, $\delta^{13}C$ = –22.1‰	22 910 ± 100
OxA-16241	charcoal, TAF06/5409, $\delta^{13}C$ = –24.6‰	41 100 ± 600
OxA-14348	charcoal, *Quercus*, TAF04/1681, $\delta^{13}C$ = –24.7‰	37 420 ± 360
OxA-13515	charcoal, conifer, TAF03/28, $\delta^{13}C$ = –23.5‰	42 400 ± 450
OxA-13610	charcoal, dicotyledonous, TAF03/151, $\delta^{13}C$ = –23.1‰	33 600 ± 1000
OxA-13555	charcoal, TAF03/256, $\delta^{13}C$ = –24.4‰	44 600 ± 1100
OxA-13608	charcoal, conifer, TAF03/336, $\delta^{13}C$ = –27.4‰	>57 100

Lab Comment: OxA-13608 had a low per cent carbon combustion value. However, this does not appear to have had an effect on reliability.

Comment (R. N. E. B. and S. N. C.): this cave site is a key location in North-West Africa for dating prehistoric occupation covering the Iberomaurusian (Epipalaeolithic – Late Stone Age) and Aterian (Middle Palaeolithic – Middle Stone Age) cultural stages. Previous excavations at the site had left a number of standing sections (Roche 1963). In order to better understand the chronology of the site, and as part of the present project, a series of metre squares was excavated adjacent to the earlier trenches and next to a central type-section that is still preserved. The new excavation areas are designated by separate sector numbers, and the samples and individual stratigraphic sequences are described according to these sector numbers.

Layers with the prefix R provide cross-references to the original bed nomenclature as proposed by Jean-Pierre Raynal (1980); layer 102 is part of a newly observed lens. Most of the samples were removed from the original type-section. Our description of the lithostratigraphy places these layers within broader sediment groups (Bouzouggar *et al*. 2008). Thus, our Upper Laminated group includes Raynal layers 1–11, the Pink group (R12–15) and the Lower Laminated group (R16–23). The lithic industry recovered from layers R3 and R3/4 contains few diagnostic artefacts and may belong to an early or pre-Iberomaurusian occupation of the cave. The ages of the lower layers are more difficult to intepret. It is possible that the dating of charcoals in the Pink group is broadly correct. The same cannot be true, however, for ages obtained from the underlying Lower Laminated group. Artefacts recovered from these layers include Aterian lithic finds and perforated *Nassarius* shell ornaments (Bouzouggar *et al*. 2008). Based on a much larger series of luminescence and uranium series dates from this site and other sites in Morocco (L. Clark-Balzan pers. comm. in respect of emerging Taforalt determinations; Barton *et al*. 2009; Richter *et al*. 2010), the charcoal dates are certainly underestimates of the true age of these sediments.

Sector 6

OxA-16263	charcoal, TAF06/5411, $\delta^{13}C = -21.4‰$	13 975 ± 60
OxA-16262	charcoal, TAF06/5410, $\delta^{13}C = -21.9‰$	15 995 ± 65

Comment (R. N. E. B. and S. N. C.): the layers dated here belong to the Upper Laminated group but it is not yet certain how they correlate with the sequence in the Raynal type-section in Sector 1.

Sector 9

OxA-16260	charcoal, *Articulata*, TAF06/5407, $\delta^{13}C = -20.7‰$	18 005 ± 75
OxA-16240	charcoal, TAF04/1133, $\delta^{13}C = -21.7‰$	18 185 ± 75

Comment (R. N. E. B. and S. N. C.): this pair of charcoal dates provides ages for well-stratified sediments containing an Iberomaurusian industry. So far, they appear to be the earliest dates for this industry at the site.

Sector 8

OxA-13479	charcoal, *Pinus* sp., TAF03/200, $\delta^{13}C = -23.8‰$	10 935 ± 40
OxA-13480	charcoal, *Pinus* sp., TAF03/202, $\delta^{13}C = -23.3‰$	10 950 ± 45
OxA-13516	charcoal, *Pinus* sp., TAF03/203, $\delta^{13}C = -23.8‰6$	11 065 ± 45
OxA-13517	charcoal, *Dicotyledonou*s, TAF03/204, $\delta^{13}C = -26.8‰$	10 990 ± 45
OxA-13477	charcoal, conifer, TAF03/36, $\delta^{13}C = -21.4‰$	12 675 ± 50
OxA-13478	charcoal, *Juniperus/Thuya*, TAF03/90, $\delta^{13}C = -21.2‰$	12 495 ± 50
OxA-14349	shell, ostrich eggshell, TAF04/659, $\delta^{13}C = -7.4‰$	12 690 ± 55
OxA-16267	charcoal, TAF06/5415, $\delta^{13}C = -21.1‰$	14 005 ± 60
OxA-16268	charcoal, TAF06/5416, $\delta^{13}C = -22.5‰$	14 515 ± 60
OxA-13519	charcoal, *Juniperus/Thuya*, TAF03/317, ** $\delta^{13}C = -20.9‰$	13 905 ± 55
OxA-16272	charcoal, TAF06/5421, $\delta^{13}C = -23.3‰$	14 630 ± 60
OxA-16269	charcoal, TAF06/5417, $\delta^{13}C = -21.1‰$	15 790 ± 60
OxA-14350	shell, ostrich eggshell, TAF04/1734, $\delta^{13}C = -4.9‰$	16 660 ± 70
OxA-14351	shell, ostrich eggshell, TAF04/1927, $\delta^{13}C = -6.4‰$	16 695 ± 70
OxA-16270	charcoal, TAF06/5418, $\delta^{13}C = -23.6‰$	16 285 ± 65
OxA-13518	charcoal, *Quercus* sp., TAF03/316, ** $\delta^{13}C = -20.8‰$	17 085 ± 65
OxA-16242	charcoal, TAF06/5419, $\delta^{13}C = -24.8‰$	16 630 ± 75*
OxA-16273	charcoal, TAF06/5422 $\delta^{13}C = -23.6‰$	17 515 ± 75
OxA-16271	charcoal, TAF06/5420, $\delta^{13}C = -22.1‰$	20 420 ± 90
OxA-16274	charcoal, TAF06/5424, $\delta^{13}C = -21.0‰$	20 630 ± 90
OxA-16275	charcoal, TAF06/5425, $\delta^{13}C = -22.0‰$	20 560 ± 90

OxA-13607	charcoal, *Taxus* sp., TAF03/315, ** $\delta^{13}C = -25.0‰$	22 200 ± 90
OxA-16243	charcoal, TAF06/5426, $\delta^{13}C = -25.4‰$	22 890 ± 120
OxA-16244	charcoal, TAF06/5427, $\delta^{13}C = -22.5‰$	25 860 ± 150*
OxA-13556	charcoal, *Quercus* sp., TAF03/314, ** $\delta^{13}C = -23.0‰$	25 760 ± 140
OxA-16276	charcoal, TAF06/5428, $\delta^{13}C = -21.2‰$	26 550 ± 140
OxA-16277	charcoal, TAF06/5429, $\delta^{13}C = -22.7‰$	29 160 ± 160
OxA-16278	charcoal, TAF06/5429, $\delta^{13}C = -22.4‰$	29 310 ± 160

Lab Comment: OxA-16244 had a low carbon yield when combusted. Sometimes this has been associated with problematic measurements.

Comment (R. N. E. B. and S. N. C.): the sediments in this sector comprise a 4.5 m thick sequence of Iberomaurusian cultural horizons overlying archaeological layers with probable Middle Palaeolithic finds. The layers dated in the Grey Series (G-prefix) consist of ashy stony beds, very rich in Iberomaurusian lithic artefacts, bone, burnt shell and palaeobotanical remains. They overlie sediments of the Yellow Series (Y-prefix), finely and continuously laminated silty to fine sandy loams and finest scree with some finer partings, that is part of the Upper Laminated group (cf., Sector 1). These layers are also very prolific in Iberomaurusian cultural finds, especially in the upper parts of the Yellow Series.

The AMS samples are mainly on wood charcoals and provide a broadly coherent and internally consistent chronological series. The three fragments of ostrich eggshell all produced dates that on stratigraphic and biochemical grounds are slightly 'too old'. Iberomaurusian layers span all of the dated sequence down to OxA-16273 (Bouzouggar *et al.* 2008). The underlying layers, containing different lithic artefacts, are still under study. The charcoals from layer Y6(d) and below were extremely friable and poorly preserved, and their dating is at odds with luminescence ages for the same levels; it is possible that the AMS determinations represent considerable underestimates. *Note that samples above denoted with ** reflect estimated positions within the stratigraphic sequence; they are environmental samples derived from large slots in section. Samples with * denote those with lower than expected per cent carbon values.*

Sector 3

OxA-16264	charcoal, TAF06/5412, $\delta^{13}C = -24.8‰$	15 355 ± 65
OxA-16265	charcoal, TAF06/5413, $\delta^{13}C = -23.4‰$	15 585 ± 65
OxA-16266	charcoal, TAF06/5414, $\delta^{13}C = -21.1‰$	20 500 ± 90

Comment (R. N. E. B. and S. N. C.): this sector is separated from Sector 8 by Roche's excavated trench. Using the brief descriptions and section drawing by Roche (1976), we attempted to correlate his original site layers with our own and to relate the sedimentary sequence on both sides of the trench. The AMS dates confirm the interpretation of the linkage between Sectors 3 and 8.

Sector 10

OxA-15441	bone, *Ovicaprid*, TAF05/2530, $\delta^{13}C = -19.3‰$	12 325 ± 50
OxA-15442	bone, *Ovicaprid*, TAF05/3152, $\delta^{13}C = -20.0‰$	12 400 ± 50
OxA-15443	bone, unidentified, TAF05/3201, $\delta^{13}C = -19.5‰$	12 310 ± 60

Comment (R. N. E. B. and S. N. C): these three AMS dates relate to the area at the back of the cave where previous excavators had reported Iberomaurusian cemetery evidence (Ferembach *et al*. 1962). The samples were taken from a small remnant of Grey Series sediments in Sector 10 that contain formal burial features. They confirm the *in situ* nature of the sediments and, by association, the probable age of human remains from an early phase of the cemetery.

OLD WORLD NEOLITHIC AND LATER

United Kingdom

Barrington
Sample of tooth from the site of Barrington (52°7′45.67″N, 0°2′19.61″E), UK. Submitted by T. J. Legge, MacDonald Institute for Archaeological Research, University of Cambridge, UK, on behalf of C. Chippindale (and I. Gunn; who both provide comments), MAA Museum of Archaeology & Anthropology, University of Cambridge, Downing Street, Cambridge CB2 3DZ, UK.

OxA-25765	tooth, *Canis familiaris*, 1, $\delta^{13}C = -19.2‰$	448 ± 24

Comment (C. C. and I. G): the skull is a large canid, having a penetrating wound in the right parietal. A barbed and tanged arrowhead of Late Neolithic type is associated with this. Examination shows that the ‘wound’ was not inflicted by this arrowhead. The date confirms the skull as probably that of a large dog, and the association was probably contrived by coprolite miners to enhance the value of these artefacts for sale.

Clevedon Court
Sample of oak wood from the site of Clevedon Court (NGR ST4216571620), submitted by Michael Worthington, Oxford Tree-Ring Laboratory, 2 Brookland Road, Bristol BS6 7YH, UK and David Fogden, Clevedon Court, Tickenham Road, Clevedon, North Somerset BS21 6QU, UK.

OxA-23357	wood, oak, ccss3, $\delta^{13}C = -24.2‰$	177 ± 21

Comment (D. F.): the chapel at this site dates to AD *c*.1320, although its original function was hidden, probably in the Tudor period, and it was rediscovered after a fire in 1882. Recent work hinted that the roof might be a possible medieval survival. Dendro-dating failed to establish a date. Because most of the sapwood was absent, an additional uncertainty of 9–41 years was added to the calibrated radiocarbon dates. The overall possible date ranges range from AD 1672 to 1731, from 1737 to 1851 and from 1934 to 1995 when calibrated. The third range can be eliminated with certainty and the second appears improbable. Consideration of other factors narrows the most likely date to 1709–31, but the roof is definitely not medieval.

Ireland

Loghcrew
Sample of bones found at Loghcrew (53°44′40.27″N, 7°6′42.01″W), Ireland, submitted by Mara Vejby, 310 Tilton Road, Sebastopol, CA 95472, USA. New radiocarbon dates for the La Tène bone slips at Loughcrew, County Meath, Ireland.

OxA-27956	bone, *unknown*, E7: 2962, $\delta^{13}C = -21.6‰$	2078 ± 26
OxA-27957	bone, *unknown*, 1911:240:2858, $\delta^{13}C = -22.2‰$	2108 ± 25

Comment (M. V): probably the most famous artefacts uncovered at the Loughcrew megalithic tomb cemetery, in County Meath, Ireland, are the thousands of cattle bone slips excavated from cairn H by Eugene Conwell, and later by Joseph Raftery. The slips were retrieved from the sockets of two different orthostats, as well as from under a large stone basin in the chamber. Cumulatively, these slips may represent 500–600 original pieces, 150 of which were decorated with La Tène style carvings (Raftery 1951, 252). It is the intricate carvings on these highly polished and carefully worked bones that have attracted particular interest since their discovery.

Thirteen of these flakes appear to have been bone combs; however, the use of these combs and the identity of the rest of the flakes remain unclear (Conwell 1864–6, 364). Some have argued that the bone flakes may have been trial pieces belonging to a bronzesmith; that they were knives accompanying burials in the tomb; or that perhaps they were the remains of a Celtic craftsman's workshop (Crawford 1925, 20; Megaw 1970, 152–3). It has also been suggested that they served a ceremonial purpose and that the deposition within the tomb was associated with some Iron Age ritual activity at the site (Raftery 1984, 257).

We may never know for certain what motivated the burial of these bone slips, or indeed why they were carved in the first place; however, the artefactual evidence does indicate a Neolithic construction of Loughcrew H. This construction was later followed either by an intentional disturbance of key structural components of the tomb, namely its orthostats, or by an unintended partial collapse of the structure. The carved slips would then have been placed into the orthostat sockets, after which the orthostats were reset in place and more bone slips were placed under the basin in the chamber. (This is assuming that the chamber may not have been easily accessible if the entrance was even partially collapsed.)

There are three potential components of this interaction that are important to highlight:

(1) At least some, if not all, of the Neolithic remains and grave goods that had been placed in the chamber and passage were left within the tomb.

(2) The carved and uncarved bone slips must have been *intentionally* placed within the sockets of the orthostat and beneath the stone basin in the chamber.

(3) In order to deposit the slips beneath the orthostats, someone must have dug underneath them—if they were still in place—or, if the orthostats had shifted, re-erected them into their sockets after depositing the bone slips beneath them. (Given the size of the orthostats this would have taken a considerable amount of effort and the previous scenario may be more likely.)

In other words, the deposition locations of these slips indicate an interaction that is far more involved than if they had been deposited in front of the tomb or inserted into the covering mound.

The lack of modern excavations at Loughcrew has meant an absence of absolute dates for this site. What we know of its chronology, therefore, has been drawn from the analysis of its artefacts as well as the established chronologies of the Boyne Valley megalithic cemetery, as well as the Mound of the Hostages at Tara, where radiocarbon dating has previously been conducted (O'Kelly 1982, 230–1; O'Sullivan 2005). In 1943 the combination of Iron Age–style carvings and stratigraphic evidence led Joseph Raftery to argue that Loughcrew H itself must have been an Iron Age construction (Raftery 2009, 539–40). However, the Neolithic and Early Bronze Age deposits found within the tomb make this exceedingly unlikely.

In fact, the La Tène–style carvings on these famous bone slips have since led researchers to assume that there was some kind of subsequent activity that took place at this Neolithic site during the Mid-to-Late Iron Age (Conwell 1873, 51; Megaw 1970, 152; Raftery 1984). With this in mind, the goal of this project, funded by a Prehistoric Society Research Grant, was to add to our knowledge of Loughcrew H, and to place the subsequent activity at this tomb within the context of other potentially related activity at nearby sites. To this end, the National Museum of Ireland granted permission to have two of the bone slips radiocarbon-dated.

The results of both determinations suggest an age range of 165–55 BC. This is slightly earlier than the Mid-to-Late Iron Age dates that had been anticipated, but they do fit neatly within the chronological horizon of the Loughcrew–Somerset school of decorative metalwork, which is said to range from the second to the first century BC (Becker 2012, 10). These La Tène carved bones have drawn attention to subsequent Iron Age activity at Loughcrew H to an extent not found at other megalithic tombs with similar evidence. A forthcoming paper will discuss additional material, which may indicate subsequent Iron Age interactions that have been uncovered at other sites in County Meath, and the further significance of these new Loughcrew dates.

Germany

Niederhummel

Samples of charred seeds from the site of Niederhummel (48°26′50″N, 11°53′22″E), Germany, submitted by Sue Colledge, The Institute of Archaeology, 31–34 Gordon Square, London WC1H 0PY, UK. Comments by Alasdair Whittle, Cardiff University, Humanities Building, Room 4.41, Colum Drive, Cardiff CF10 3EU, UK.

OxA-21353	charred seeds, two fragments, N2, $\delta^{13}C = -25.6‰$	6330 ± 38
OxA-21354	charred seeds, three fragments, N3, $\delta^{13}C = -25.2‰$	6347 ± 39
OxA-21408	charred seeds, one indeterminate wheat grain, N1, $\delta^{13}C = -24.4‰$	6292 ± 39

Comment (A. W.): a statistically consistent set of dates on single-entity samples from two pits within a house complex of the earliest LBK in Bavaria, southern Germany. Calibrating to the late 54th century cal BC (at 68.2% confidence), these fall within the predicted range (*c*.5500–5300 cal BC) for the earliest LBK phase in central Europe, though at its lower end. Only the earliest LBK pottery was associated with the excavated (2008, directed by D. Hofmann and A. Whittle) house and pits.

Italy

Sa Osa, Sardinia

Samples of plant remains (grapes) of the Bronze Age from Sa Osa, Sardinia, Italy, submitted by Mr Lee Clare, University of Cologne Institute of Prehistoric Archaeology, Jennerstrasse 8, 50823 Köln, Germany. Comments by A. Usai, Soprintendenza per I Beni Archeologici, per le province di Cagliari e Oristano, Piazza Indipendenza 7, I-09124 Cagliari, Sardinia, Italy.

OxA-25106	plant remains (grape), List No. 22, $\delta^{13}C = -19.7‰$	2981 ± 27
OxA-25107	plant remains (grape), List No. 23, $\delta^{13}C = -21.5‰$	2968 ± 27

Comment (A. U.): in 2010, B. Weninger included two samples from my excavation in Sardinia in his Mediterranean dating programme. Sardinia is recognized in the Mediterranean Bronze Age thanks to its large stone monuments, called *nuraghi*, and its connection to the trade routes between the east and the west. It is well known that there are Mycenaean, Minoan and Cypriot sherds imported and imitated at Nuraghe Antigori, as well as a number of Cypriot copper oxide ingots found throughout the island, more than anywhere else outside of Cyprus itself. On the other hand, there is also Nuragic pottery found in the harbour settlements of Acropolis on Lipari, Cannatello on Sicily and Kommos on Crete.

The excavation carried out at Sa Osa and the research currently under way provides a new picture of the Nuragic civilization, from the Middle Bronze Age 2–3 (in Italian terms, that is roughly the 15th–14th centuries BC) to the Final Bronze Age 3 – Early Iron Age 1 (approximately the 10th–9th centuries BC).

Most of all, this is due to the surprising finding of a significant number of animal and vegetal remains; not only mammal bones and charcoal, as usual, but also fish bones, raw and worked wood and seeds of several wild and cultivated species such as grape and figs.

According to the preliminary results of our archaeological studies, Pit N at Sa Osa was completely filled up with materials (pottery, wood, bones and seeds, as well as animal and vegetal food) belonging to only one archaeological period, which appears to be the Late Bronze Age (in Italian terms, that is roughly the 13th–12th centuries BC).

The pottery is reminiscent of Late Bronze Age deposits at Nuraghe Antigori, which yielded the Aegean and Aegean-type finds mentioned above, although Sa Osa belongs to a west-central cultural group that is slightly different from the southern group of Antigori.

The dating results obtained from superposed layers in Pit N provide a reliable pivot in Sardinian chronology, not only for the pit itself and the central phase of the site but also (or mostly) for the appearance of cultivated grapes (perhaps the earliest in the Western Mediterranean and independent of the Aegean one) and lastly for the Mediterranean cultural links.

The two dates are statistically identical, despite the depth difference, and we think that they are reliable. Calibration indicates results in the 13th–12th centuries BC, which fits perfectly within the Italian Late Bronze Age.

Spain

Cova de la Guineu

Samples of charcoal from the site of Cova de la Guineu, Spain, submitted by Josep Fullola, Universitat de Barcelona, Montalegre, 6/8 0801, Barcelona, Spain.

OxA-23640	charcoal, Gn-E9-378, $\delta^{13}C = -26.0‰$	2941 ± 26
OxA-23641	charcoal, Gn-E9-511, $\delta^{13}C = -24.7‰$	4156 ± 28
OxA-23642	charcoal, Gn-ECA-F7F8, $\delta^{13}C = -26.5‰$	3030 ± 26

Comment (J. F.): OxA-23641 confirms the corrected dates that ORAU re-dated in April 2007. OxA-10799 was re-measured as OxA-16881 (4110 ± 38 BP), and OxA-10800 became OxA-16966 (4385 ± 32 BP). The above dates were aimed at defining the relationship between the inside and outside parts of a collective burial. OxA-23640 and OxA-23642 provide a precise chronology for the Late Bronze Age horizon, almost in the pre-*urnenfelder* vein. In the area we have three urns that are related to the dates obtained.

Cova Colomera

Samples of seeds (*Triticcum aestivum durum*) and bone from the site of Cova Colomera (41°12′22″N, 134°56′39″E), Spain, submitted by Josep Fullola, Universitat de Barcelona, Montalegre, 6/8 0801, Barcelona, Spain.

OxA-23633	seeds, *Triticcum aestivum durum*, CC06-W32-7, $\delta^{13}C = -24.6‰$	3260 ± 26
OxA-23634	seeds, *Triticcum aestivum durum*, CC08-U31-6, $\delta^{13}C = -22.5‰$	6170 ± 30
OxA-23635	bone, CC08-X33-229, $\delta^{13}C = -19.0‰$	37 200 ± 800

Comment (J. F.): OxA-23633 and OxA-23634 appear to be reversed in terms of the expected results. OxA-23633 cannot be a Bronze Age sample, as it comes from the lower part of the stratigraphy, where we clearly have a lot of Neolithic evidence. Following the same reasoning, sample OxA-23634 cannot date to the Early Neolithic, as it comes from the upper part of the stratigraphy, where we have Late Neolithic and Early Bronze Age levels.

Assuming that the samples were inadvertently swapped, we can say that the older date (OxA-23634) fits perfectly with the Early Neolithic that we were dating (i.e., Final Cardial – Early Epicardial).

The other sample, OxA-23633, seems to be a little bit younger than expected. We wanted to date an Upper Neolithic level, but some burrows or other kind of bioturbation elements coming from the Early Bronze Age level above may have affected the sample.

OxA-23635 came from the deepest part of a test pit, where there was no anthropic activity; so, we can consider this level as being probably palaeontological. We sent this sample knowing only that it had a Pleistocene age, but nothing else. Now we know that we have very old levels, but until now, without any anthropic origin.

Cova del Mort

Samples of charcoal (*Pinus sylvestris*) from the site of Cova del Mort (Sant Esteve de) Spain, submitted by Josep Fullola, Universitat de Barcelona, Montalegre, 6/8 0801, Barcelona, Spain.

OxA-23648	charcoal, *Pinus sylvestris*, CM-H18-58, $\delta^{13}C = -24.0‰$	4702 ± 28
OxA-23649	charcoal, *Pinus sylvestris*, CM-H18-7, $\delta^{13}C = -24.8‰$	3320 ± 27

Comment (J. F.): these two dates from Cova del Mort are the first ones to be obtained from this site. We have a short stratigraphy, and we wanted to confirm the ages of two of the occupations of the cave, two archaeological levels situated one on the top of the other.

OxA-23649 comes from stratigraphic level IIa. The date confirms to us that we are in the Early Bronze Age, with a lot of pottery fragments clearly of this chrono-cultural period.

OxA-23648 comes from stratigraphic level IIb; it also confirms what we expected, that we are in the Final Neolithic, with pottery fragments from the Veraza and Treilles horizons.

Greece

Alepotrypa

Samples of charcoal and bone found at Alepotrypa, Mani, Greece, submitted by Dr A. Papathanasiou, 34B Ardittou Street, Athens 11636, Greece.

OxA-X-2468-33	charcoal, B1CS3, $\delta^{13}C = -25.1‰$	5195 ± 75
OxA-26168	bone, human, KSP1, $\delta^{13}C = -18.1‰$	5291 ± 35
OxA-26355	charcoal, B1CS4, $\delta^{13}C = -24.3‰$	5097 ± 31
OxA-26356	charcoal, B1CS7, $\delta^{13}C = -25.5‰$	5791 ± 33
OxA-26357	charcoal, B1CS9, $\delta^{13}C = -26.1‰$	5880 ± 31
OxA-26358	charcoal, B1L807, $\delta^{13}C = -25.4‰$	6417 ± 34
OxA-26359	charcoal, PCCS3, $\delta^{13}C = -23.7‰$	5235 ± 29
OxA-26378	charcoal, B1CS8, $\delta^{13}C = -23.7‰$	5963 ± 33

Comment (A. P.): Alepotrypa Cave is located at Diros Bay on the western coast of the Tainaron Peninsula of southern Greece. It was discovered by the Greek Speleological Society in 1958.

In 1970, the Greek Archaeological Service of the Ministry of Culture assumed management of the site, under the direction of G. Papathanassopoulos. Alepotrypa Cave is about 300 m long and it is situated about 20 m a.s.l., and about 50 m from the present Mediterranean shoreline, in an arid and rocky limestone environment. Based on ceramic typological data, the cave was occupied from approximately 5000 to 3200 BC, which corresponds to the Late and Final Neolithic Periods. More than fifty activity areas have been identified, including both habitation areas and mortuary loci. Artefacts include pottery, obsidian and flint tools, hand axes, grindstones, bone needles, clay spindle whorls, shell and stone beads, jewellery, marble and clay figurines, and a large number of animal bones from domesticated and wild species. As a sealed, single-component, archaeological site, the Neolithic village complex of Alepotrypa Cave promises to yield information critical for understanding the chronology and social organization of later Neolithic societies in the Balkans.

The radiocarbon dates of Alepotrypa were obtained on both charcoal and human bone samples. Sixteen samples yielded valid results ranging between ~6030 and 3890 cal BC, dating the site from the Middle to the Final Neolithic and defining occupational phases and hiatuses. Three or four distinct occupational phases separated by long hiatuses were identified. The first two hiatuses were confirmed by the stratigraphy of trench B1. The groups of dates from the charcoal samples in the trenches are nicely independently tied and confirmed by the dates of the human bones found in different parts of the cave, suggesting that these are the occupation phases and their ages.

Phase C ends at *c*.5400 BP. It includes the deepest excavated part of trench B1 and the associated multiple burial. We do not know its beginning. The date of the human bone of Ossuary I at 6000 BP can be a separate phase or the earliest age of this phase, but the latter explanation needs to be confirmed by excavation deeper in B1.

The so-called Middle Hiatus contains stony layers resulting from a major destruction or collapse of the cave and an abandonment of about 800 years. The B phase appears to date from about 4800 to 4600 cal BC. The so-called Upper Hiatus is actually part of another stony layer of trench B1 that covers and fills a clay storage pit, implying that this is a reorganization/levelling of the area, probably after an abandonment and destruction. Phase A, spanning from about 4200 to 3800 cal BC (its span might well be narrower), is the youngest phase of habitation inside the cave.

These results are crucial to subsequent research in that they can be used to establish and refine both the duration of use of the Alepotrypa Cave and regional artefact chronologies.

Cyprus

Akanthou–Arkosyko (Tatlısu–Çiftlikdüzü)
Sample of charcoal of the Aceramic Neolithic from Akanthou–Arkosyko (Tatlısu–Çiftlikdüzü) (35°24′14.79″N, 33°44′52.52″E), Cyprus, submitted by Dr Muge Sevketoglu, Uluslararasi Kibris Universitesi, Rektorluk Binasi, Haspolat, Mersin 10, Turkey.

OxA-27408	charcoal, TCD10 1345, $\delta^{13}C = -25.1‰$	9050 ± 39

Comment (M. S.): excavation works at Akanthou–Arkosyko (Tatlısu–Çiftlikdüzü) between 1999 and 2005, and again between 2010 and 2012, resulted in the submission of these samples of charcoal, charred seeds and bones for radiocarbon dating. A grant obtained from Tübitak in 2012 was instrumental in this. The samples come from different parts of the site representing various features, deposits and also ‘interesting’ contexts. Here, ‘interesting’ refers to deposits with high numbers of obsidian bladelets, which are of Anatolian origin.

Dating of the site's features and the relationship of the obsidian presence (cultural relation with Anatolia) is important. The majority of the dates from these samples and dates from the previous samples match, giving a clear indication of consistent dates all over the site both horizontally and vertically between 8200 BC and 7550 BC. One sample from this year (OxA-27408) gave a date range of 8302–8231 BC (95.4% probability). This is closer to the Early Phase Aceramic Period (*c*.8400 BC) of Shillourokambos in Limassol, Cyprus. There are still more potentially earlier deposits to be excavated from Akanthou. Nevertheless, as it stands today, it is one of the earliest settlements with prominent architecture, something that is lacking at other sites, and it contains thousands of obsidian blades, clearly indicating a connection between Cyprus and Anatolia as early as 8300 BC.

Esentepe–Ağırsu

Sample of seeds of the ceramic Neolithic from Esentepe–Ağırsu (35°21′11.61″N, 33°35′22.56″E), Cyprus, submitted by Dr Muge Sevketoglu, Uluslararasi Kibris Universitesi, Rektorluk Binasi, Haspolat, Mersin 10, Turkey.

OxA-27792	seeds, EAS12, $\delta^{13}C = -26.6‰$	5367 ± 29

Comment (M. S.): this site was discovered in 1996 and has been under threat since. In 1996, 2007 and finally in 2012, immense destruction by machinery clearing the way for construction took place. Scattered broken pottery and other artefacts from the site surface were generally associated with the Chalcolithic and Late Neolithic. The depth of the deposit was as much as 5 m (extremely rich by Cypriot standards), as was seen from the section left by the soil-removing machinery. The rescue excavations that took place last year produced large amounts of charcoal, but also a carbonized seed from a secure context.

The date (calibrated to 4281–4062 cal BC), confirms our relative dating (from the ceramic motifs, architectural features and other small finds) of the ceramic Neolithic and Early Chalcolithic periods. The site's original rich depth of deposit may have contained an uninterrupted Aceramic–ceramic Neolithic–Chalcolithic sequence.

Bulgaria

Dzhulyunica and Provadia

Samples of bone and charcoal from Dzhulyunica (43°N, 25°E) and Provadia (43°N, 27°E), Bulgaria, submitted by L. Clare, Institute of Prehistoric Archaeology, University of Cologne, Albertus-Magnus-Platz, D-50923 Köln, Germany.

OxA-24931	bone, sub-adult sheep, DZH 21-90, $\delta^{13}C = -20.0‰$	7066 ± 38
OxA-24932	bone, sub-adult sheep, DZH 21-90, $\delta^{13}C = -19.9‰$	7053 ± 35
OxA-24933	bone, adult cattle, DZH 21-116, $\delta^{13}C = -20.3‰$	7084 ± 36
OxA-24934	bone, large juvenile bovide, DZH 21-125, $\delta^{13}C = -19.7‰$	7195 ± 37
OxA-24935	bone, large adult bovide, DZH 21-62, $\delta^{13}C = -20.5‰$	7026 ± 35
OxA-24936	bone, adult cattle, DZH 21-180, $\delta^{13}C = -19.1‰$	7083 ± 36
OxA-24937	bone, wild adult pig, DZH 21-153, $\delta^{13}C = -20.2‰$	7588 ± 37
OxA-24938	bone, large adult bovid, DZH 21-99, $\delta^{13}C = -19.2‰$	7134 ± 35
OxA-24939	bone, sheep, DZH 21-83, $\delta^{13}C = -19.6‰$	7171 ± 36

Yield only 9.8 mg

OxA-24977	bone, large adult bovid, DZH 21-79, $\delta^{13}C = -20.1‰$	7136 ± 40
OxA-24978	bone, sheep, adult, DZH 21-85, $\delta^{13}C = -20.4‰$	7054 ± 39
OxA-24979	bone, large adult bovid, DZH 21-110, $\delta^{13}C = -20.3‰$	7145 ± 38
OxA-24980	bone, large adult bovid, DZH 21-159, $\delta^{13}C = -20.0‰$	7011 ± 38
OxA-24981	bone, large adult bovid, DZH 21-80, $\delta^{13}C = -20.8‰$	7185 ± 40
OxA-25040	charcoal, DZH 21-92, $\delta^{13}C = -24.8‰$	7049 ± 39
OxA-25041	charcoal, DZH 22-7, $\delta^{13}C = -24.3‰$	4854 ± 34
OxA-25042	charcoal, DZH 21-117, $\delta^{13}C = -24.4‰$	7095 ± 40
OxA-25043	charcoal, DZH 21-78, $\delta^{13}C = -25.8‰$	7055 ± 40
OxA-25044	charcoal, DZH 21-105, $\delta^{13}C = -25.9‰$	7095 ± 40
OxA-25045	charcoal, DZH 21-35, $\delta^{13}C = -25.4‰$	6686 ± 39
OxA-25046	charcoal, DZH 21-13, $\delta^{13}C = -25.6‰$	6950 ± 40
OxA-25047	charcoal, DZH 21-51, $\delta^{13}C = -24.4‰$	7140 ± 40
OxA-24905	charcoal, List No. 33, $\delta^{13}C = -23.2‰$	5785 ± 40

Comment (L. C.): the results from Dzhulyunica are somewhat younger than we anticipated. These data stem from our excavations last year at this northern Bulgarian site, where we were in fact hoping for an age some two to three centuries older, perhaps just prior to, or coeval with, the 8.2 ka cal BP event. In other words, we were hopeful that we might have identified at this site a phase of initial Neolithization that had perhaps been curtailed or disrupted by adverse climatic conditions linked to this palaeoclimatic event. However, the data instead imply that settlement commenced following this event. We have no doubt that the data are correct, all the more since—by preliminary wiggle matching—we recognize that they correlate well both with the calibration curve and with the underlying raw data. We are planning to analyse the data more fully in terms of stratigraphic depth in the near future, but we do not antipicate a contradictory result.

Denmark

Lango, Krabbesholm II, Klintes, Havn, Kolind, Kolding Fjord
Samples of bone found at various sites in Denmark, submitted by L. Sorensen, The National Museum, Frederiksholms Kanal 12, 1220 Copenhagen K, Denmark.

Kolding Fjord

OxA-X-2491-24	bone, sheep, P130/2011 KMG, Z.M.K. 7/1889, $\delta^{13}C = -21.7‰$	624 ± 28

Kolind

OxA-X-2491-25	bone, sheep, P40/2012 KMG, Z.M.K. 23/1933, $\delta^{13}C = -21.4‰$	1074 ± 28

Lab Comment: These samples were OxA-X-ed due to their low pre-treatment yield. We flag collagen samples that are less than 5 mg collagen yield as being potentially problematic; these samples therefore come with a ‘health warning’.

Havn

OxA-27064	bone, sheep, P43/2012 KMG, Z.M.K. 61/1997, $\delta^{13}C = -21.4‰$	5329 ± 35

Klintes

OxA-27065	bone, sheep, P128/2011 KMG, Z.M.K. 5/1898, $\delta^{13}C = -21.4‰$	3926 ± 33

Krabbesholm II

OxA-27066	bone, sheep/goat, P126/2011 KMG, Z.M.K. 50/2000, $\delta^{13}C = -21.3‰$	4934 ± 35

Langø

OxA-27067	bone, sheep, P131/2011 KMG, Z.M.K. 4/1928, $\delta^{13}C = -20.1‰$	3514 ± 30

Comment (L. S.): the data suggest that we have to focus on taking samples from sites where the wild fauna dominates, supplemented by a few domesticated animals, in order to date the earliest domesticated animals, which was the goal of the study. Furthermore, we should concentrate on excavations where we have detailed stratigraphic information, but even then—as the results have shown—this does not guarantee a good result. In addition, the work has shown that it is extremely difficult to find suitable bones/teeth with enough collagen to date from the sheep or goat (e.g., Bloksbjerg and Havnelev), because the degree of fragmentation is very high among these animals.

There are positive things to say about these data:

(1) The date from Havnø (OxA-27064) is the earliest sheep/goat bone in southern Scandinavia and perhaps Northern Europe. It tells us that sheep/goats were imported to southern Scandinavia during the Late Ertebølle Culture. Furthermore, we could, in light of this early date, be dealing with a 'herding' phase in certain regions such as the Limfjord area, before the emergence of the TRB culture in southern Scandinavia.

(2) The date from Krabbesholm II (OxA-27066) is at the same age as the rest of the sheep/goat bones in Denmark and is connected to the TRB culture.

And now to the more disappointing results:

(1) The dates from kitchen middens excavated in the last century—Klintesø (OxA-27065), Kolind (OxA-X-2491-25) and Langø (OxA-27067)—suggest that we have to be careful about interpreting the results as belonging to the earliest part of the TRB culture, because the results show that there have been activities at these coastal sites throughout most of the prehistoric period. This is why we have to make more of these radiocarbon dates in the future, if we want to be sure about their age, especially when assuming that everything is TRB, when some of the assemblages could belong to later periods.

(2) The Kolding Fjord site was thought to perhaps belong to an early settlement, but does not appear to.

Norway

Museum of Cultural History

Samples of linen from the Museum of Cultural History (60°N, 10°E), Oslo, Norway, submitted by Peter Porter, 11 Havelock Road, Croydon CR0 6QQ, UK.

OxA-27990	linen, 1, $\delta^{13}C = -24.3‰$	2480 ± 26
OxA-27991	linen, 1, $\delta^{13}C = -24.3‰$	2533 ± 27

Comment (P. P.): the two dates were taken on a piece of linen mummy wrapping from the inner coffin of Dismuenibtes, which is on display in the Museum of Cultural History, Oslo, Norway. The mummy and coffin set came originally from Thebes in southern Egypt and the inner coffin has been stylistically dated to *c*.700 BC (Bettum 2010). The radiocarbon dates are consistent with the stylistic date of the coffin, but the possibility that the coffin was reused for a later burial cannot be excluded.

Estonia

Kavastu

Samples from Kavastu, Estonia, submitted by Ester Oras, Division of Archaeology, Department of Archaeology and Anthropology, University of Cambridge, Downing Street, Cambridge CB2 3DZ, UK.

OxA- V-2515-13	Charred fuel residue, *Kavastu*, $\delta^{13}C = -25.6‰$	2319 ± 31
OxA-27781	Charred fuel residue, *Kavastu*, $\delta^{13}C = -27.2‰$	1561 ± 25

Comment (E. O.): a twin-nozzle Roman bronze lamp from the site of Kavastu is a unique antiquarian discovery from the early 20th century. The bronze lamp was found together with two bronze bars and two other (possibly Roman) bronze artefact fragments in Kavastu peat bog in southern Estonia. It was stored in the archaeological collections in Riga and left unstudied for over a century. The unique find was 'rediscovered' during a Ph.D. project on eastern Baltic first to ninth century AD wealth deposits. Being the northernmost Roman bronze lamp and with no close parallels in Northern Europe, a small project was initiated to answer questions regarding the dating of the last use of the lamp and its possible time of deposition. Two samples taken from the charred fuel residue in one of the two lamp nozzles gave some important and surprising results for interpreting this intentional artefact deposit. Based on artefact chronology, the deposit probably dates from the beginning of the first millennium AD. However, the AMS sample of charred residue gave a much later date; that is, 427–557 cal AD (95.4% probability). This date represents a possible *terminus post quem* before which the depositional act could not have taken place. This result changes considerably the interpretation of the find and its role in the first to ninth century AD depositional practices in the eastern Baltic region. However, the results of the AMS turned out to be even more surprising. This dating—416–355 cal BC (85.5% probability)—is several centuries earlier than the first AMS result.

One possible interpretation of this date is the use of old lamp fuels in later periods. However, as the gap between the two samples is remarkably large, one might also consider possible contamination processes relating to the depositional context in a peat-bog environment. Despite these problems, the two AMS dates pose several new questions and interpretations regarding correlation of the artefact chronology and the time of a depositional act, object biography, and also trade routes and time frames of long-distance movements of imported goods. The detailed results of this small project and further interpretations will be published in a co-authored paper.

Russia

Shaytanka and Chishkho

Samples of wood from Shaytanka (57°35′N, 60°2′E), Urals, Russia and a grain of einkorn wheat from Chishkho (44°59′N, 39°21′E), Caucasus, Russia, submitted by E. N. Chernykh, Institute of Archaeology of the Russian Academy of Sciences, Dm. Ulianova str. 19, 117036 Moscow, Russia.

Shaytanka

OxA-X-2485-57	wood, *Salix/Betula*, $\delta^{13}C = -25.9‰$	2797 ± 28

Lab Comment: This sample was problematic. The base pre-treatment resulted in a high loss of sample, and we tried three times to date the material without success. This sample was dated using a weak pre-treatment chemistry designed to at least leave some material for AMS dating. Therefore, there is a possibility of some error in the measurement. For this reason, we have OxA-X-ed the date.

OxA-26481	wood, *Salix/Betula*, $\delta^{13}C = -22.1‰$	3483 ± 34
OxA-26482	wood, *Salix/Betula*, $\delta^{13}C = -25.9‰$	3452 ± 32
OxA-26595	wood, *Pinus*, $\delta^{13}C = -24.5‰$	3521 ± 28
OxA-26596	wood, *Salix/Betula*, $\delta^{13}C = -21.3‰$	3535 ± 26

Chishkho

OxA-26597	wheat grain, *Triticum monococcum*, $\delta^{13}C = -23.5‰$	3025 ± 26

Comment (E. N. C.): the dating of this archaeology differs considerably from a series of four dates that were previously obtained. Its age also differs from other series of radiocarbon dates with which we could compare all of the samples from Shaytanka. The site is a sacred memorial relating to the so-called Seima–Turbino transcultural phenomenon, which is extremely widely distributed from Xinjiang (China) up to the Baltic Sea. The extremely hi-tech bronze tools and the weapons of this phenomenon meet almost exclusively in the sacral memorials. Burials with human remains are extremely rare. Radiocarbon dates of the Seima–Turbino phenomenon are rare (only five samples); therefore, this Shaytanka series is very important for understanding the Eurasian Early Metal Age (for more, see Chernykh 1992, 2011).

The sample from Chishkho dates a Maikop kurgan and pastoralist behaviour previously attested around the fourth millennium BC. One very important question is the relationship between this stockbreeding culture and settled farming. There has been no clear evidence up to now for the farming occupation of these people. The results confirm the link, because the Maikop complexes in Chishkho overlap with the LBA layer. Hence, in reality the dated grain probably dates to the Late Bronze Age.

Saudi Arabia and Israel

Sihi and Sabya Qadim (Saudi Arabia) and Timna (Israel)
Samples of charred bone from Sihi and Sabya Qadim (Saudi Arabia) and Timna (Israel), submitted by C. Grigson, University College London, Gower St, London WC1E 6BT, UK, R. A. Housley, University of Glasgow, Glasgow G12 8QQ, UK, and J. A. J. Gowlett, University of Liverpool, Liverpool, Merseyside L69 3BX, UK.

Sihi (217/107), Saudi Arabia

OxA-983	charred camel mandible, CB2	8200 ± 200
OxA-2164	charred camel maxilla, CB26, $\delta^{13}C = -15.4‰$	1500 ± 80
OxA-3795	repeat date on the same charred mandible, CB2-2, $\delta^{13}C = -11.1‰$	1535 ± 60
OxA-3796	repeat date on the same charred maxilla, CB26-2, $\delta^{13}C = -13.9‰$	1685 ± 60

Sabya Qadim (217/177), Saudi Arabia

OxA-2163	charred camel mandible, CB23, $\delta^{13}C = -16.7‰$	2110 ± 80

Timna Site 30, Israel

OxA-2165	partially charred proximal phalanx, CB27, $\delta^{13}C = -20.8‰$	2650 ± 90

Comment (C. G., R. A. H. and J. A. J. G.): in 1985, a series of camel bones (both burnt and unburnt) from sites in the Middle East was submitted by C. Grigson, then of the Royal College of Surgeons of England, for AMS dating. A number of specimens (CB6, CB8–10 and CB14) could not be dated since the bones were found to contain inadequate levels of collagen. The results that were obtained were reported in *Arch.List* 6 (Hedges *et al*. 1987), and in a paper by Grigson *et al*. (1989). Subsequently, in 1989–90 and again in 1992, a further series of camel bones was tested. As before, many specimens (CB15–22) proved to be lacking in sufficiently high levels of collagen for successful age determination and it was decided to confine any new tests to charred bone. Four further dates on camel bones recovered from two coastal sites on the Red Sea—Sihi and Sabya Qadim—excavated by J. Zarins were produced (OxA-2163 and OxA-2164, and OxA-3795 and OxA-3796). In two cases the results represent dates on new specimens (CB23 and CB26), but the two others comprise repeat analyses on previously dated bones (CB2-2 and CB26-2). A fifth date (OxA-2165) obtained in 1992 was from a partially charred camel bone from Timna Site 30 (CB-27), at the southern end of the Wadi Arabah in Israel, excavated in 1974–6 by B. Rothenberg (Rothenberg 1980).

Lab Comment: In a sense, the camel bone dating project was always going to be a technically challenging one. In the case of the unburnt specimens, the problem of low-collagen bone, and the influence this has on the radiocarbon dating process, is now well known (Hedges and van Klinken 1992, and references therein) and is especially relevant. The high temperatures associated with the climate of this region are not conducive to high bone protein preservation, and there would be a high expectation that, with the exception of the most recent of faunal specimens, most bones would have low to negligible preserved protein levels. In many cases this has occurred, precluding any age determination from being obtained; however, even where protein preservation was low yet adequate to yield an age, there is no certainty that the determination is reliable. This is because diagenesis of the bone protein causes breakdown of the bone amino acids, permitting chemical cross-linking with carbonaceous molecules in the burial environment that may be of a different age. The result is a biased age, unconnected to the time of death of the animal. Except where results derive from uncharred bones with medium to high collagen levels (thereby almost certainly belonging to comparatively recent specimens), a degree of caution should be exercised when considering the significance of the results.

The situation with charred bones is rather different. One should first realize that charred bones are very variable samples, with examples ranging from very lightly charred specimens to those that are fully burnt, and thus either blackened in oxygen-deficient fires or oxidized to the consistency of cremated bone (i.e., very cracked and blue-white in colour). Apart from climatically elevated temperatures, the heat from the fire may have influenced the state of the chemical fraction that is dated. If, for example, low-collagen bones are burnt in a reducing environment, the resulting 'elemental carbon' could derive from a mixture of indigenous bone collagen and the exogenous soluble and insoluble organic materials, such as dissolved humic and/or fulvic acids, in the groundwater. The result would have a high potential for bias.

It is difficult to be certain what precisely may have happened with each particular camel bone; however, these are the most likely mechanisms that could have affected the camel determinations reported here and in *Arch.List* 6. As regards the repeat measurements, differential contamination would tend to produce variable age results and so consistency between analyses on the same bone would suggest either a uniform level of contamination (inherently improbable) or no contamination. In situations like this, one should then turn to the archaeological context to assess the overall degree of confidence in the age analyses.

Comment (C. G.): Sihi (217/107) and Sabya Qadim (217/177) are shell-midden sites on the northern Tihama coast in Saudi Arabia. The original AMS date (OxA-983, 8200 ± 200 BP) obtained from the Sihi camel mandible, and then calibrated at about 7000 BC, was enthusiastically accepted as the first directly dated Early Holocene camel in Arabia, the fact that the bone was charred adding to its perceived value. Although several other dates had been obtained on marine shell from the site, which indicated its formation during the second millennium BC (Zarins and Zahrani 1985; Zarins and Al-Badr 1986), it was concluded that the camel bones and perhaps a small proportion of the rest of the material derived from a brief Aceramic Neolithic occupation of the late seventh millennium BC (Grigson *et al*. 1989). However, as there was little in the way of artefactual evidence to support a Neolithic attribution, various authorities questioned the early date. It is now thought that Sihi was one of the sites of the Subr/Sihi complex of south-west Arabia and the Yemen, and that the entire complex dates from the late second millennium BC (Edens and Wilkinson 1998; Vogt and Buffa 2005). Zarins omitted the date from his review of radiocarbon dates in the South-West Asia arid zone (Zarins 1992).

The re-run date on the same mandible, as well as two new dates on a burnt maxilla from the same site, are reasonably consistent and when calibrated all fall within the early part of the first millennium AD. One has to conclude that the camel bones were most probably deposited on this very shallow site hundreds of years after its formation. The same may be true of a fragment of a burnt camel mandible from Sabya Qadim (217/177), a similar but unpublished site on the Tihama, which also produced a late date.

Timna

Lab Comment: The Timna sample was initially treated as a burnt bone, but since only the very tip of the bone was burnt, not enough charred bone could be removed to give a date. We therefore decided to sample the unburnt part and found it had a collagen concentration of 7 mg g^{-1}. This is not high, but nor is it very low. One factor that should make this date more reliable than the previous unburnt camel dates is that a better-purified chemical fraction—ion-exchanged gelatin—was dated. The previous pre-treatment method (namely decalcification, acid hydrolysis of the insoluble residue, treatment of the hydrolysed amino acids with activated charcoal and subsequent purification of the amino acids by ion-exchange chromatography) did occasionally give problems when used on bones from certain environments. There are two reasons for this; first, because hydrolysis of the insoluble residue did sometimes release amino acids bound up in humic complexes; and, second, that hydrolysis in the presence of carbohydrates sometimes led to the formation of amino-sugar condensation products that, to an extent, co-eluted with the amino acids during chromatography. In cases where the 'collagen' is low, and/or the bone was heavily contaminated, the result would be a biased date. The methods used on OxA-2165, which centre around the formation of gelatin, enable separation of the collagen from potentially contaminating amino acid-bearing substances and carbohydrates before hydrolysis to amino acids. As far as we can tell, this enabled acceptable gelatin to be obtained and there is a good chance that the date is reliable.

Comment (C. G. 2011): Timna Site 30, a smelting camp, was originally dated by Rothenberg to the Late Bronze/Iron I transition, as it contained some pottery similar to that of another site in the same complex that had been securely dated to this period by the presence of some Egyptian inscriptions (Rothenberg 1980). A large number of camel bones were retrieved (Grigson in prep.) and a partially burnt proximal phalanx submitted for dating. The date (OxA-2165, 2650 ± 90) is Iron II in age; it was rejected by Rothenberg (pers. comm.), who considered that the bone must have been intrusive. However, a large suite of dates has recently been obtained from charcoal in the same site (Ben-Yosef *et al*. 2010), in quite close agreement with the AMS camel date.

If the originally proposed date, of Late Bronze/Iron I, had been confirmed, the camels of Timna would have been amongst the earliest domestic camels identified in the Levant—which, given the recently published information on the domestication of the camel (Uerpmann and Uerpmann 2002 and in press), is inherently unlikely. As things stand, the Iron II date for this particular bone makes perfect sense, as does the dating of the entire site from the charcoal dates to the Late Iron I and Early Iron II periods (Grigson 2012 and in prep.).

Israel

The Castle of Blanchegarde

Samples of human teeth from the Castle of Blanchegarde site (31°N, 35°E), Israel, submitted by Dr P. Mitchell, Deptartment of Biological Anthropology, University of Cambridge, The Henry Wellcome Building, Fitzwilliam Street, Cambridge CB2 1QH, UK.

OxA-19460	human tooth, L.75602 b.936006, $\delta^{13}C = -17.1‰$	143 ± 22
OxA-X-2287-10	human tooth, L.75306 b.750026, $\delta^{13}C = -15.6‰$	194 ± 25

Lab Comment: the latter sample comes with a health warning, owing to a low collagen yield. We treated 250 mg of bone but obtained only 3.0 mg of gelatin. This is less than our 10 mg threshold, although proportionally, the yield is above our minimum of 1 wt% collagen. All other parameters, including the C:N atomic ratio (3.2), were acceptable. To reflect the fact that some of the analytical parameters that we routinely measure are outside the required thresholds, the result has been given an OxA-X rather than OxA result.

Comment (P. M.): based on the architecture of the cesspool, we expected the bone from inside it to date from the Crusader period—the 12th–13th centuries AD. The calibrated radiocarbon date is in the second half of the 13th century, and so confirms our expectations. There is a smaller chance (11% probability) of a later date, in the late 1300s. However, the city of Acre was burned down and destroyed in a siege in 1291, and was not used again as a town for hundreds of years. In the light of this information, the later range seems highly unlikely.

Iraq

Kish

A sample of bone from Kish (32°5′N, 44°7′E), Iraq, submitted by Dr P. Collins, Department of Antiquities, Ashmolean Museum, Beaumont Street, Oxford OX1 2PH, UK.

OxA-28283	bone, 1928.480, $\delta^{13}C = -15.76‰$	3905 ± 27

Comment (P. C.): with the exception of OxA-28283, the results were disappointing. The wood samples had clearly been contaminated, providing dates tens of thousands of years outside their archaeological context, while the shell samples (notoriously problematic) were also far too early to make sense. However, the one bone sample (1930.212) provided a very interesting date, which fits well with its archaeological context in the so-called Early Akkadian period (conventionally dated to around 2350 BC).

Egypt

Abydos, Sedment and others
Samples of wooden combs from Abydos, Sedment and other sites in Egypt, submitted by Ms J. Dawson and S.-A. Ashton, Department of Antiquities, Fitzwilliam Museum, University of Cambridge, Cambridge CB2 1RB, UK.

Abydos

OxA-25667	wood, *Acacia*, E.210.1900, $\delta^{13}C = -22.3‰$	3451 ± 27

Sedment

OxA-25598	wood, *Acacia*, E.85.1921, $\delta^{13}C = -24.1‰$	3858 ± 30
OxA-25773	wood, *Ficus sycomorus*?, E.86.1921, $\delta^{13}C = -27.6‰$	3717 ± 31

Unknown sites

OxA-25599	wood, E.45.1937, $\delta^{13}C = -23.7‰$	2730 ± 29
OxA-25711	wood, *Ficus sycomorus*, E.W.69, $\delta^{13}C = -25.7‰$	3722 ± 28
OxA-25712	wood, E.361a.1932, $\delta^{13}C = -24.9‰$	1601 ± 25
OxA-25713	wood, E.1.1935, $\delta^{13}C = -25.3‰$	126 ± 24
OxA-25714	wood, E.GA.509.1947, $\delta^{13}C = -25.8‰$	3058 ± 26
OxA-25774	wood, ?*Acacia*, E.GA.2916.1943, $\delta^{13}C = -26.0‰$	3642 ± 30
OxA-25775	wood, E.22a.1887, $\delta^{13}C = -22.1‰$	3959 ± 30
OxA-25776	wood, *Acacia*, E.GA.2666.1943, $\delta^{13}C = -21.9‰$	3142 ± 29
OxA-25777	wood, E.22.1887, $\delta^{13}C = -25.4‰$	4047 ± 30
OxA-25778	wood, *Acacia*, E.GA.2915.1943, $\delta^{13}C = -21.5‰$	3903 ± 30
OxA-25779	wood, *Acacia*, E.11.2002, $\delta^{13}C = -24.1‰$	134 ± 24
OxA-25780	wood, E.W.20, $\delta^{13}C = -24.7‰$	1706 ± 26

Comment (S-A. A.): the results tie in with what we had thought, but interestingly make the 'Coptic' comb pre-Islamic at least. The only anomaly is E.W.69 and the date of this was uncertain, but we are happy for it to be earlier. The recent determination is a suspected 20th-century African comb.

Nigeria

Kagalan, Kirfin Sama Hill and Tudun Dangawo
Samples of the charcoal from the site of Kagalan, Kirfin Sama Hill and Tudun Dangawo, a part of a broader archaeological landscape along the Gongola River, north-eastern Nigeria, submitted by A. Haour, Sainsbury Centre For Visual Arts, University of East Anglia, Norwich Research Park, Norwich NR4 7TJ, UK. Dates funded by the NERC–AHRC NRCF programme.

Kagalan, 10°24′17″N, 10°18′21″E, Nigeria

OxA-26214	charcoal, *C. glutinosum*, KGL1104-5b, $\delta^{13}C = -24.5‰$	316 ± 27
OxA-26215	charcoal, *Carissa cf. edulis*, KGL1106-14, $\delta^{13}C = -24.6‰$	667 ± 28

Kirfin Sama Hill, 10°23′45″N, 10°26′10″E, Nigeria

OxA-26212	charcoal, *Pterocarpus*, Fabaceae, KSH1104-13, $\delta^{13}C = -23.1‰$	174 ± 25
OxA-26213	charcoal, *Detarium*, Fabaceae, KSH1105-15, $\delta^{13}C = -26.0‰$	1205 ± 30

Tudun Dangawo, 10°23′45″N, 10°23′10″E, Nigeria

OxA-26211	charcoal, *Feretia* type, Rubiaceae, TDG1106-19, $\delta^{13}C = -22.6‰$	364 ± 25

Comment (A. H.): OxA-26211, at about −130 cm, was from the lower part of a presumed refuse pit, and the date thus gives a *terminus post quem* for the pit infilling. OxA-26212 was recovered in association with an iron blade and fragments of smoking pipe. OxA-26213 (at about −130 cm) was intended to provide a relative age for underlying finds at −160 cm, which did not yield any charcoal. OxA-26214 was from a sample at the base of a large granite platform in a possible potters' workshop. OxA-26215 was recovered in the lowest level and in the same layer as a polished stone artefact.

These dates relate to three sites, which are part of a broader archaeological landscape along the Gongola River valley and adjacent hills, for which there is a considerable amount of written and oral historical evidence. Though disparate, this evidence provided some pointers to the likely chronology of the area. In addition, the analysis of the pottery from the site is now well advanced, which offers another chronological handle. On the whole, the radiocarbon dates are entirely consistent with the expected picture. They also fit well within the general chronology of the wider area (Haour 2003, 2010).

All in all, then, the dates obtained are very much within expectations. That said, two comments are appropriate. The chronological sequence of the three sites, as indicated by the radiocarbon dates, is interesting. The site of Tudun Dangawo might have been assumed to be the earliest, given that no knowledge concerning the site seems to exist in the area. In fact, it is the most recent. This said, only one date could be run on the site, from this rubbish pit fill—insufficient to give a full picture. On the basis of the ceramic analysis, it can be said that the decorative motifs prevalent at Tudun Dangawo are significantly similar to those from the other sites. The suggestion, then, is for a broadly contemporaneous occupation of the three places.

The main inconsistency in the dates is the gap of 1000 years in the two Kirfin Sama samples, which were recovered from depths of 110 and 130 cm respectively. Since obtaining the radiocarbon results, we returned to the site photos and section drawings, which clarified this discrepancy. A thin, reddish-brown layer is apparent at the base of the trench, which went unnoticed in the main section drawing because of its similarity with the sterile basal level immediately below. It is clear that sample 02(15), which yielded a date of 1205 ± 30 BP (OxA-26213), actually originates from this reddish-brown layer, which, like the basal layer, slopes upwards to the east. The much younger date (OxA-26212) comes from the brown layer, Context F, above. There is no confusion in the actual context record, the organization of the data or the relationship of the charcoal samples. The error occurred while trying to represent the sampled charcoals into a single profile. The thin reddish-brown layer yielded only small pottery fragments. The spindle whorl mentioned in the original application may, upon examination of texture and colour, have come in from Context F. The pottery analysis from the site has shown a difference in the materials elements between this thin layer and Context F above it. Most probably, the 1000-year age gap thus reflects two distinct phases of occupation. The lowest layer represented low-intensity human activity, whereas Context F and above evidence an increased accumulation of cultural debris.

Thailand

Ban Chiang

Samples of bone from Ban Chiang, Udorn Province, Thailand, submitted by C. Higham, Department of Anthropology, University of Otago, P.O. Box 56, Dunedin, New Zealand.

OxA-X-2442-24	bone, *Homo sapiens*, BC burial 33 EPII, $\delta^{13}C = -18.6‰$	3063 ± 33
OxA-X-2438-16	bone, *Homo sapiens*, BC burial 45 EPII, $\delta^{13}C = -18.5‰$	2958 ± 29
OxA-X-2438-17	bone, *Homo sapiens*, BC burial 47 EPII, $\delta^{13}C = -18.9‰$	2978 ± 31
OxA-X-2436-53	bone, *Homo sapiens*, BCES burial 47 EPIII, $\delta^{13}C = -18.0‰$	2936 ± 25

Lab Comment: these samples gave very low yields of collagen. This is sometimes associated with low accuracy in the radiocarbon measurement, so we have OxA-X-ed the results.

OxA-25014	bone, *Homo sapiens*, BC burial 43 EPII, $\delta^{13}C = -18.3‰$	2984 ± 26
OxA-25015	bone, *Homo sapiens*, BC burial 44 EPI, $\delta^{13}C = -18.3‰$	3242 ± 26
OxA-25016	bone, *Homo sapiens*, BCES burial 49 EPIII, $\delta^{13}C = -18.3‰$	2789 ± 26
OxA-25017	bone, *Homo sapiens*, BCES burial 49 EPIII, $\delta^{13}C = -18.3‰$	2801 ± 25
OxA-25018	bone, *Homo sapiens*, BCES 65 EPIII-IV, $\delta^{13}C = -18.9‰$	2844 ± 26
OxA-25019	bone, *Homo sapiens*, BCES 72 EPII-III, $\delta^{13}C = -18.4‰$	2810 ± 25

Comment (C. H.): Ban Chiang is a World Heritage prehistoric site in a remote corner of north-east Thailand. It was excavated by Chester Gorman and Pisit Charoenwongsa in 1974–5. It is, with Ban Non Wat, the only site on the Khorat Plateau to have provided a large sample of prehistoric occupation and mortuary data spanning the initial Neolithic settlement, the Bronze and the Iron Age. The initial dating of the Ban Chiang sequence was undertaken on the basis of charcoal samples, many of which were accumulated from grave fill. The results defy rational interpretation, although Gorman and Charoenwongsa (1976) concluded that they placed the start of the Bronze Age in about 3600 cal BC and the Iron Age in the mid-second millennium BC. This would imply the earliest evidence for bronze metallurgy in the world.

The second dating programme, undertaken by Glusker and White (1997) at Oxford, involved the organic fraction of potsherds taken from mortuary vessels. Two principal forms of pretreatment were applied, one involving fragments of organic temper and the other crushed potsherds. The results from both were contradictory, but White chose to publish and employ six determinations on the basis of crushed potsherds combusted at 900°C, and one derived from rice phytoliths. She concluded that the Bronze Age at this site began between 2000 and 1800 cal BC. White and Hamilton (2009) subsequently sought the origins of the metallurgical tradition in the Seima–Turbino transcultural phenomenon of the Urals and beyond to the west.

This suggestion coincided with the publication of 76 determinations from Ban Non Wat, many derived from bivalve shells placed with the dead (Higham and Higham 2009; Higham *et al*. 2011). These indicated that the transition to the Bronze Age at a site only 230 km south-west of Ban Chiang took place in the late 11th century BC. This presented a dilemma that stimulated a third dating programme at Ban Chiang, this time on the basis of human bone treated by ultrafiltration. The results published above reveal a precise match with the chronology of Ban Non Wat, a harmony that permits, first, placing the origins of the Neolithic settlement of the region in the mid-second millennium BC, and, second, identifying the origins of the bronze casting tradition in the Chinese states of the Yangtze and Yellow River valleys.

NEW WORLD

United States

Sierra Madre

Samples of basketry from the Cache Caves of south central California in the Sierra Madre region, submitted by W. Whitby, 126 Tarvin Road, Boughton, Chester CH3 5EE, UK.

OxA-25191	Basketry, probably rush, NA-CA-SBA-XX-4F-11, $\delta^{13}C = -26.3‰$	178 ± 27
OxA-25192	Basketry, probably tule, SBA-1985 Basket No.3, $\delta^{13}C = -22.1‰$	1021 ± 28
OxA-25193	Basketry, probably tule, SBA-2004 360-21, $\delta^{13}C = -25.8‰$	1623 ± 29

Comment (W. W.): these results are a little surprising in that they were all expected to be very similar and all date to the historical period. Certainly, sample OxA-25191 was strongly expected to be historical, so the result fits very well with other information obtained for that sample (association with other objects that must be historical period in date, and a radiocarbon date on associated basketry that was carried out in the early 1960s).

The other samples come from different sites and there are no other clues regarding dating. There has always been an assumption that they probably also date to the historical period, but that was mainly based on a lack of other evidence for earlier occupation of that area plus excellent preservation of perishable artefacts. However, perishable objects can survive for long time periods in dry caves in this region, so it is entirely possible for them to have earlier dates.

Australia

Kudjal Yolgah Cave

Samples of charcoal (*Eucalyptus*) and bone from the site of Kudjal Yolgah Cave (34°4′S, 115°1′E), Australia, submitted by Gavin Prideaux, School of Biological Sciences, Flinders University, Sturt Road, Bedford Park, SA 5042, Australia.

OxA-23686	charcoal, ?*Eucalyptus*, KYC South B Unit 7, $\delta^{13}C = -25.5‰$	1141 ± 25
OxA-23687	charcoal, ?*Eucalyptus*, KYC South C, $\delta^{13}C = -25.7‰$	904 ± 25
OxA-23688	charcoal, ?*Eucalyptus*, KYC South C adj. M.fulig. ad skel, $\delta^{13}C = -7.0‰$	1258 ± 26
OxA-23689	charcoal, ?*Eucalyptus*, KYC South D Unit 7(6) lbs bnth fsto, $\delta^{13}C = -4.9‰$	989 ± 25
OxA-23792	charcoal, ?*Eucalyptus*, KYC North B Unit 6 sample B, $\delta^{13}C = -23.3‰$	4566 ± 32

Comment (G. P.): the Kudjal Yolgah Cave ages are most peculiar, given that they are capped by a flowstone that is tightly U–Th dated to around 30 ka (Roberts *et al*. 2001) and that sediments from these units have been optically dated to 40 ka and older. We will need to think deeply about the implications.

Tight Entrance Cave

Samples of charcoal (*Eucalyptus*) and bone from the site of Tight Entrance Cave (34°4′S, 115°1′E), Australia, submitted by Gavin Prideaux, School of Biological Sciences, Flinders University, Sturt Road, Bedford Park, SA 5042, Australia.

OxA-23681	charcoal, ?*Eucalyptus*, TEC-99, Unit H, $\delta^{13}C = -25.0‰$	25 390 ± 140
OxA-23682	charcoal, ?*Eucalyptus*, TEC-O, Unit F2, $\delta^{13}C = -24.5‰$	46 400 ± 1100
OxA-23683	charcoal, ?*Eucalyptus*, TEC-O, Unit F2, $\delta^{13}C = -25.0‰$	43 400 ± 1000
OxA-23684	charcoal, ?*Eucalyptus*, TEC-K, Unit F1, $\delta^{13}C = -24.8‰$	41 950 ± 800
OxA-23685	charcoal, ?*Eucalyptus*, TEC-O, Unit E*, $\delta^{13}C = -24.1‰$	46 900 ± 1400
OxA-23897	charcoal, ?*Eucalyptus*, TEC, Unit J, $\delta^{13}C = -23.5‰$	23 750 ± 130
OxA-23898	charcoal, ?*Eucalyptus*, TEC-D, Unit H, $\delta^{13}C = -24.8‰$	28 860 ± 180
OxA-24180	charcoal, ?*Eucalyptus*, TEC-E, Unit F1, $\delta^{13}C = -25.8‰$	19 000 ± 200

Comment (G. P.): OxA-23683 produces the same age as that obtained by Professor M. Bird for unit F2. Both OxA-23681 and OxA-23684 produced younger ages than expected. OxA-23685 is almost certainly close enough to the radiocarbon limit to be considered infinite, especially given the optical age of 70 ka for unit E (for more data, see Ayliffe *et al*. 2008; Prideaux *et al*. 2010).

REFERENCES

Previous datelists can be found in the following volumes of *Archaeometry*:

No. 1: *Archaeometry* **26**, 1 (1984), 15–20
No. 2: *Archaeometry* **27**, 2 (1985), 237–46
No. 3: *Archaeometry* **28**, 1 (1986), 116–25
No. 4: *Archaeometry* **28**, 2 (1986), 206–21
No. 5: *Archaeometry* **29**, 1 (1987), 125–55
No. 6: *Archaeometry* **29**, 2 (1987), 289–306
No. 7: *Archaeometry* **30**, 1 (1988), 155–64
No. 8: *Archaeometry* **30**, 2 (1988), 291–305
No. 9: *Archaeometry* **31**, 2 (1989), 207–34
No. 10: *Archaeometry* **32**, 1 (1990), 101–8
No. 11: *Archaeometry* **32**, 2 (1990), 211–37
No. 12: *Archaeometry* **33**, 1 (1991), 121–34
No. 13: *Archaeometry* **33**, 2 (1991), 279–96
No. 14: *Archaeometry* **34**, 1 (1992), 141–59
No. 15: *Archaeometry* **34**, 2 (1992), 337–57
No. 16: *Archaeometry* **35**, 1 (1993), 147–67
No. 17: *Archaeometry* **35**, 2 (1993), 305–26
No. 18: *Archaeometry* **36**, 2 (1994), 337–74
No. 19: *Archaeometry* **37**, 1 (1995), 195–214
No. 20: *Archaeometry* **37**, 2 (1995), 417–30
No. 21: *Archaeometry* **38**, 1 (1996), 181–207
No. 22: *Archaeometry* **38**, 2 (1996), 391–415
No. 23: *Archaeometry* **39**, 1 (1997), 247–62
No. 24: *Archaeometry* **39**, 2 (1997), 445–71
No. 25: *Archaeometry* **40**, 1 (1998), 227–39
No. 26: *Archaeometry* **40**, 2 (1998), 437–55
No. 27: *Archaeometry* **41**, 1 (1999), 197–206
No. 28: *Archaeometry* **41**, 2 (1999), 421–31
No. 29: *Archaeometry* **42**, 1 (2000), 243–54
No. 30: *Archaeometry* **42**, 2 (2000), 459–79
No. 31: *Archaeometry* **44**, 3 (2002), 1–149
No. 32: *Archaeometry* **49**, 3 (2007), S1–60
No. 33: *Archaeometry* **51**, 2 (2009), 323–49
No. 34: *Archaeometry* **53**, 5 (2011), 1067–84

In addition, our website (http://c14.arch.ox.ac.uk) includes a searchable list of all OxA-numbers, sites and links to the *Archaeometry* volume in which comments are published.

Aura, J. E., Tiffagom, M., Jordá Pardo, J. F., Duarte Matías, E., Fernández de la Vega Medina, J., Santamaría Álvarez, D., Rasilla Vives, M. de la, Vadillo, M., and Pérez Ripoll, M., 2012, The Solutrean–Magdalenian transition: a view from Iberia, *Quaternary International*, **272–3**, 75–87.

Aura Tortosa, J. E., 1995, *El Magdaleniense Mediterráneo: la Cova del Parpalló (Gandía, Valencia)*, 216, Trabajos Varios, 91, Servicio de Investigación Prehistórica. Diputación Provincia de Valencia, Valencia.

Aura Tortosa, J. E., 2007, Badegouliens et Magdaléniens du versant méditerranéen espagnol, *Bulletin de la Société Préhistorique Française*, **104**(4), 809–24.

Ayliffe, L. K., Prideaux, G. J., Bird, M. I., Grün, R., Roberts, R. G., Gully, G. A., Jones, R., Fifield, L. K., and Cresswell, R. G., 2008, Age constraints on Pleistocene megafauna at Tight Entrance Cave in southwestern Australia, *Quaternary Science Reviews*, **27**, 1784–8.

Baales, M., 2001, From lithics to spatial and social organization: interpreting the lithic distribution and raw material composition at the Final Palaeolithic site of Kettig (central Rhineland, Germany), *Journal of Archaeological Science*, **28**, 127–41.

Banks, W. E., D'Errico, F., Peterson, A. T., Vanhaeren, M., Kageyama, M., Sepulchre, P., Ramstein, G., Jost, A., and Lunt, D., 2008, Human ecological niches and ranges during the LGM in Europe derived from an application of eco-cultural niche modeling, *Journal of Archaeological Science*, **35**(2), 481–91.

Barton, R. N. E., Bouzouggar, A., Collcutt, S., Schwenninger, J.-L., and Clark-Balzan, L., 2009, OSL dating of the Aterian levels at Dar es-Soltan I (Rabat, Morocco) and implications for the dispersal of modern *Homo sapiens*, *Quaternary Science Reviews*, **28**, 1914–31.

Becker, K., 2012, Redefining the Irish Iron Age, in *Life and death in Iron Age Ireland: in the light of recent archaeological excavations* (eds. C. Corlett and M. Potterton), Wordwell, Dublin.

Ben-Yosef, E., Tauxe, L., and Levy, T. E., 2010, Archaeomagnetic dating of copper smelting site F2 in Timna Valley (Israel) and its implication on modeling ancient technological developments, *Archaeometry*, **52**, 1110–21.

Bettum, A., 2010, Dismutenibtes and Aaiu: two 25th Dynasty coffins in Oslo, *Studien zur Altagyptischen Kultur*, **39**, 51–65.

Bouzouggar, A., Barton, R. N. E., Blockley, S., Bronk Ramsey, C., Collcutt, S. N., Gale, R., Higham, T. F. G., Humphrey, L. T., Parfitt, S., Turner, E., and Ward, S., 2008, Re-evaluating the age of the Iberomaurusian in Morocco, *African Archaeological Review*, **25**, 3–19.

Brock, F., Higham, T. F. G., Ditchfield, P., and Bronk Ramsey, C., 2010, Current pretreatment methods for AMS radiocarbon dating at the Oxford Radiocarbon Accelerator Unit (ORAU), *Radiocarbon*, **52**(1), 103–12.

Bronk Ramsey, C., 2009, Bayesian analysis of radiocarbon dates, *Radiocarbon*, **51**, 337–60.

Chernykh, E. N., 1992, *Ancient metallurgy in the USSR: the early metal age*, 215–23, Cambridge University Press, Cambridge.

Chernykh, E. N., 2011, Eurasian Steppe Belt: radiocarbon chronology and metallurgical provinces, in *Anatolian metal*, V (ed. Ü. Yalçin), 151–72, Der Anschnitt, Beiheft 24, Bochum.

Conwell, E. A., 1864–6, On ancient sepulchral cairns on the Loughcrew Hills, *Proceedings of the Royal Irish Academy*, **9**, 355–79.

Conwell, E. A., 1873, *The discovery of the tomb of Ollamh Fodhla*, McGlashan and Gill, Dublin.

Crawford, H., 1925, The engraved bone objects found at Lough Crew, Co. Meath, *Journal of the Royal Society of Antiquaries of Ireland*, **55**, 15–29.

Dee, M., and Bronk Ramsey, C., 2000, Refinement of graphite target production at ORAU, *Nuclear Instruments and Methods in Physics Research B*, **172**, 449–53.

Edens, C., and Wilkinson, J. J., 1998, Southwest Arabia during the Holocene: recent archaeological developments, *Journal of World Prehistory*, **12**(1), 55–119.

Ferembach, D., Dastugue, J., and Poitrat-Targowla, M. J., 1962, *La nécropole Epipaléolithique de Taforalt (Maroc Oriental): étude des squelettes humains*, Edita Casablanca, Rabat.

Glusker, D., and White, J., 1997, Comment, *Archaeometry*, **39**, 259–60.

Gómez-Fuentes, A., and Bécares Pérez, J., 1979, Un hueso grabado en la cueva de 'El Cierro' (Ribadesella, Asturias), in *XV Congreso Nacional de Arqueología, Lugo 1977*, 83–94, Zaragoza.

Gorman, C. F., and Charoenwongsa, P., 1976, Ban Chiang: a mosaic of impressions from the first two years, *Expedition*, **8**(4), 14–26.

Grigson, C., 2012, Camels, copper and donkeys in the Early Iron Age of the Southern Levant: Timna revisited, *Levant*, **44**(1), 82–100.

Grigson, C., in prep., The camels of Timna Site 30, an Iron Age smelting camp in the Wadi Arabah.

Grigson, C., Gowlett, J. A. J., and Zarins, J., 1989, The camel in Arabia: a direct radiocarbon date calibrated to about 7000 BC, *Journal of Archaeological Science*, **15**, 355–62.

Haour, A., 2003, *Ethnoarchaeology in the Zinder region, Republic of Niger: the site of Kufan Kanawa*, Cambridge Monographs in African Archaeology, **56**, Archaeopress, Oxford.

Haour, A., 2010, Kufan Kanawa: the former Kano? The archaeology of a 600-year old site in Niger, in *Being and becoming Hausa: interdisciplinary perspectives* (eds. A. Haour and B. Rossi), 141–63, Brill, Leiden.

Hedges, R. E. M., and van Klinken, G. J., 1992, A review of current approaches to the pre-treatment of bone form radiocarbon dating by AMS, *Radiocarbon*, **34**(3), 279–91.

Hedges, R. E. M., Housley, R. A., Law, I. A., Perry, C., and Gowlett, J. A. J., 1987, Radiocarbon dates from the Oxford AMS System: datelist 6, *Archaeometry*, **29**, 289–306.

Higham, C. F. W., and Higham, T. F. G., 2009, A new chronological framework for prehistoric Southeast Asia, based on a Bayesian model from Ban Non Wat, *Antiquity*, **83**, 125–44.

Higham, C. F. W., Higham, T. F. G., Ciarla, R., Douka, K., Kijngam, A., and Rispoli, F., 2011, The origins of the Bronze Age of Southeast Asia, *Journal of World Prehistory*, **24**(4), 227–74.

Hoyos, M., 1994, Características sedimentokársticas y paleoclimáticas de los interestadios de Laugerie-Lascaux en la Cornisa Cantábrica, Monográfico El Solutrense en la Península Ibérica, *Férvedes*, **1**, 21–37.

Megaw, J., 1970, *Art of the European Iron Age: a study of the elusive image*, Harper and Row, New York.

Neruda, P., Láznicková-Galetová, M., and Dreslerová, D., 2011, *Retušéry a kosti s rýhami z jeskyně Kůlny v Moravském krasu. Interdisciplinární analýza tvrdých živočišných materiálů ze středopaleolitických horizontů* (*Retouchers and Bones with Grooves from the Kůlna Cave in the Moravian Karst. Interdisciplinary analysis of hard animal material from Middle Palaeolithic horizons)*, Moravské zemské muzeum, Brno.

O'Kelly, M. J., 1982, *Newgrange: archaeology, art, and legend*, Thames and Hudson, London.

O'Sullivan, M., 2005, *Duma Na Ngiall: the mound of the hostages*, Wordwell, Dublin.

Prideaux, G. J., Gully, G. A., Couzens, A. M., Ayliffe, L. K., Jankowski, N. R., Jacobs, Z., Roberts, R. G., Hellstrom, J. C., Gagan, M. K., and Hatcher, L. M., 2010, Timing and dynamics of Late-Pleistocene mammal extinctions in southwestern Australia, *Proceedings of the National Academy of Sciences USA*, **107**, 22 157–62.

Raftery, B., 1984, *La Tène in Ireland: problems of origin and chronology*, Vorgeschichtlichen Seminars Marburg, Marburg.

Raftery, J., 1951, *Prehistoric Ireland,* Batsford, London.

Raftery, J., 2009, Newtown, Loughcrew, Oldcastle, County Meath. Cairn H, August 5–November 10, 1943, in *Relics of old decency: archaeological studies in later prehistory: festschrift for Barry Raftery*, (ed. G. Cooney), Wordwell, Dublin.

Raynal, J.-P., 1980, Taforalt. Mission préhistorique et paleontologique française au Maroc: rapport d'activité pour l'année, *Bulletin d'Archéologie Marocaine*, **12**, 69–71.

Rasilla Vives, M. de la, 1994, El Solutrense en la Cornisa Cantábrica, Monográfico El Solutrense en la Península Ibérica, *Férvedes*, **1**, 9–19.

Reimer, P. J., Bard, E., Bayliss, A., Beck, J. W., Blackwell, P. G., Bronk Ramsey, C., Buck, C. E., Cheng, H., Edwards, R. L., Friedrich, M., Grootes, P. M., Guilderson, T. P., Haflidason, H., Hajdas, I., Hatté, C., Heaton, T. J., Hoffmann, D. L., Hogg, A. G., Hughen, K. A., Kaiser, K. F., Kromer, B., Manning, S. W., Niu, M., Reimer, R. W., Richards, D. A., Scott, E. M., Southon, J. R., Staff, R. A., Turney, C. S. M., and van der Plicht, J., 2013, IntCal13 and Marine13 radiocarbon age calibration curves 0–50,000 years cal BP, *Radiocarbon*, **55**, 1869–87.

Richter, D., Moser, J., Nami, M., Eiwanger, J., and Mikdad, A., 2010, New chronometric data from Ifri n'Ammar (Morocco) and the chronostratigraphy of the Middle Palaeolithic in the Western Maghreb, *Journal of Human Evolution*, **59**(6), 672–9.

Roberts, R. G., Flannery, T. F., Ayliffe, L. K., Yoshida, H., Olley, J. M., Prideaux, G. J., Laslett, G. M., Bayes, A., Smith, M. A., Jones, R., and Smith, B. L., 2001, New ages for the last Australian megafauna: continent-wide extinction about 46,000 years ago, *Science*, **292**(5523), 1888–92.

Roche, J., 1963, *L'Epipaléolithique marocaine*, Fondation Calouste Gulbenkian, Lisbon.

Roche, J., 1976, Cadre chronologique de l'Epipaléolithique marocain, in *Actes du IXè Congrès de l'UISPP: chronologie et synchronisme dans la préhistoire circum-méditerranéenne*, 153–67.

Rothenberg, B., 1980, Die Archäologie des Verhüttunglagers Site 30, in *Antikes Kupfer im Timna-Tal, 4000 Jahre Bergbau und Verhüttung in der Arabah (Israel). Der Anschnitt 1* (eds. H. G. Conrad and B. Rothenberg), 187–214, Vereinigung der Freunde von Kunst und Kultur im Bergbau, Bochum.

Straus, L. G., and González Morales, M. R., 2003, El Miron Cave and the ^{14}C chronology of Cantabrian Spain, *Radiocarbon*, **45**, 41–58.

Straus, L. G., and González Morales, M. R., 2007, Further radiocarbon dates for the Upper Paleolithic of El Miron Cave (Ramales de la Victoria, Cantabria, Spain), *Radiocarbon*, **49**, 1205–14.

Straus, L. G., and González Morales, M. R., 2010, The radiocarbon chronology of El Miron Cave (Cantabria, Spain): new dates for the initial Magdalenian occupations, *Radiocarbon*, **52**, 33–9.

Uerpmann, M., and Uerpmann, H.-P., 2002, The appearance of the domestic camel in South-east Arabia, *Journal of Oman Studies*, **12**, 235–60.

Uerpmann, M., and Uerpmann, H.-P., in press, Archaeozoology of camels in south-eastern Arabia, in *Camels in Asia and North Africa: interdisciplinary perspectives on their significance in past and present* (eds. E. M. Knoll and P. A. Burger), Austrian Academy of Science Press, Vienna.

Valoch, K., 1988, *Die Erforschung der Kůlna-Höhle 1961–1976*, Moravské zemské muzeum, Brno.

Vogt, B., and Buffa, V., 2005, Cultural interactions with the Horn of Africa—a view from early Arabia, in *Afrikas Horn: Akten der Ersten Internationalen Littmann-Konferenz 2* (eds. W. Raunig and S. Wenig), 437–46, Harrassowitz, Wiesbaden.

Ward, G. K., and Wilson, S. R., 1978, Procedures for comparing and combining radiocarbon age determinations: a critique, *Archaeometry*, **20**, 19–31.

White, J. C., and Hamilton, E., 2009, The transmission of Early Bronze Age technology to Thailand: new perspectives. *Journal of World Prehistory*, **22**, 357–97.

Zarins, J. N., 1992, Archaeological and chronological problems within the greater Southwest Asian arid zone, 8500–1850 B.C, in *Chronologies in Old World history*, 3rd edn (ed. R. W. Ehrich), 61–76, University of Chicago Press, Chicago.

Zarins, J. N., and Al-Badr, H., 1986, Archaeological investigation in the southern Tihama Plain II (including Sihi, 217-107 and Sharja, 217-172), 1405/1985, *Atlal, The Journal of Saudi Arabian Archaeology*, **10**(1), 36–57.

Zarins, J. N., and Zahrani, A., 1985, Investigations in the southern Tihama Plain (the sites of Athar and Sihi), 1404/1984, *Atlatl, The Journal of Saudi Arabian Archaeology*, **9**, 65–107.