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Radiocarbon

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BRITISH MUSEUM NATURAL RADIOCARBON MEASUREMENTS XIV

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The following list consists of dates for archaeologic and some geologic samples, mostly measured from January 1978 to December 1979*. The dates were obtained by liquid scintillation counting of benzene using the laboratory procedures outlined in previous lists (see, eg, BM-VIII, R, 1976, v 18, p 16). The dates are expressed in radiocarbon years relative to AD 1950 based on the Libby half-life for ^{14}C of 5570 yr, and are corrected for isotopic fractionation ($\delta^{13}C$ values are relative to PDB). No corrections have been made for natural ^{14}C variations. The modern reference standard is NBS oxalic acid (SRM 4990). Errors quoted with the dates are based on counting statistics alone and are equivalent to ± 1 standard deviation (± 1σ). Dates in this list reported to submitters or published elsewhere before the introduction of the new guidelines for rounding of computed figures have deliberately been left unrounded. From BM-XV onwards all BM dates will be rounded before publication in conformity with the recently recommended procedures (R, 1977, v 19, p 362). Descriptions, comments, and references to publications are based on information supplied by submitters.

SAMPLE DESCRIPTIONS

ARCHAEOLOGIC SAMPLES

British Isles

Hascombe series, Surrey

Charcoal and carbonized grain samples from Iron age hillfort at Hascombe, 10km S of Guildford, Surrey, England (51° 10′ N, 0° 35′ W, Natl Grid Ref TQ 005386). Coll 1977 and subm by F H Thompson, Soc Antiquaries of London, for comparison of dates for grain and charcoal from same context (Otlet, Burleigh, and Clark, 1979; Thompson, 1979).

BM-1244A. Hascombe **2060 ± 50**
$\delta^{13}C = -23.3‰$

Carbonized grain, ref H77/2, from Pit 1 in Trench 2 (*cf* BM-1244B, below).

* Dates obtained over part of this period for Bronze age samples from the British Isles formed a separate list, BM XII.

1870 ± 80

BM-1244B. Hascombe $\delta^{13}C = -25.2‰$

Charcoal, ref H77/2, separated from carbonized grain sample ref H77/2 (*cf* BM-1244A, above).

2050 ± 50

BM-1485. Hascombe $\delta^{13}C = -24.9‰$

Charcoal, ref H77/6/5, from lowest fill of Pit 2 in Trench 6.

1900 ± 45

BM-1486. Hascombe $\delta^{13}C = -22.9‰$

Carbonized grain, ref H77/12/5, from fill of pit in Trench 12.

2160 ± 45

BM-1487. Hascombe $\delta^{13}C = -26.2‰$

Charcoal, ref H77/2/6, from fill of hearth in Trench 2.

1820 ± 50

BM-1489. Hascombe $\delta^{13}C = -25.2‰$

Charcoal, ref H77/6/5, from upper fill of Pit 2 in Trench 6.

1970 ± 50

BM-1490. Hascombe $\delta^{13}C = -24.4‰$

Charcoal, ref H77/13/5, from lowest fill of pit in Trench 13.

1960 ± 50

BM-1491. Hascombe $\delta^{13}C = -25.0‰$

Charcoal, ref H77/6/4, from lowest fill of Pit 1 in Trench 6.

General Comment (RB): archaeol evidence suggests Hascombe was occupied for short period ca 50 BC; within limits of error radiocarbon results agree with archaeol dating, but dates for grain and charcoal from same context differ (see Otlet, Burleigh, and Clark, 1979 for full discussion).

3656 ± 58

BM-1412. Pilsgate, Lincolnshire $\delta^{13}C = -24.1‰$

Charcoal from cremation burial at Barnack Rd, Pilsgate, Lincolnshire, England (52° 40′ N, 0° 25′ W, Natl Grid Ref TF 049069) assoc with Food Vessel and Collared Urn (Pryor, 1974). Coll 1971 and subm by F M M Pryor for Nene Valley Research Comm. *Comment* (RB): *cf* BM-868, 3522 ± 38 and BM-869, 3296 ± 50 (R, 1979, v 21, p 341) for other charcoal samples from same burial.

3884 ± 46

BM-1413. Sorisdale, Inner Hebrides $\delta^{13}C = -19.8‰$

Collagen from femorae from extended human burial in grave pit dug into sand dunes at Sorisdale, Coll, Inner Hebrides, Scotland (56° 40′ N, 6° 30′ W, Natl Grid Ref NM 273638) assoc with All-Over-Cord ornamented Beaker, and found to one side of fragmentary stone setting, probably remains of house comparable with that at Northton, Harris, Outer Hebrides (Ritchie and Crawford, 1977-78; Simpson, 1976). Coll

1976 and subm by J N G Ritchie, RCAHM Scotland, Edinburgh. *Comment* (JNGR): no material assoc with All-Over-Cord Beakers has previously been dated in W of Scotland where these vessels are common; date is concordant and provides valuable chronol indication for number of sites.

Offham Hill, E Sussex

Charcoal (*Quercus* sp) id by C Cartwright, from causewayed enclosure (Drewett, 1977) at Offham Hill, Lewes, E Sussex, England (50° 50′ N, 0° 0′ E, Natl Grid Ref TQ 398118). Coll 1976 and subm by P L Drewett, Sussex Archaeol Field Unit.

4925 ± 80

BM-1414. Offham Hill $\delta^{13}C = -23.6‰$

Sample 0/II/4/2 from upper silting in segment 4 of inner ditch.

4740 ± 60

BM-1415. Offham Hill $\delta^{13}C = -23.5‰$

Sample 0/II/2/4 from primary silting of segment 2 of inner ditch.

General Comment (PLD): dates fit well with earlier Neolithic pottery found assoc in ditch silts, and show that Offham is broadly contemporary with other dated earlier Neolithic enclosures in Sussex (Trundle, Bury Hill, Whitehawk and Combe Hill; Barkhale, though less well dated, may also be contemporary).

860 ± 60

BM-1442. Swildon's Hole, Mendip, Somerset $\delta^{13}C = -22.2‰$

Collagen from metapodial of *Equus* (ref WSM 1977/62) from cave deposit, 6m below ground and ca 100m from entrance, in Swildon's Hole, 400m NE of Priddy Green, Priddy, Mendip, Somerset, England (51° 15′ N, 2° 40′ W, Natl Grid Ref ST 531513). Coll 1977 by Jane Wilson and subm by P J Andrews, Dept Palaeontol, British Mus (Nat Hist), as part of investigation of rate of movement of bone within cave systems, to help model process of formation of archaeol deposits in caves and fissures. *Comment* (RB): for additional dates, see BM-XV (forthcoming).

1040 ± 40

BM-1506. Brixworth, Northamptonshire $\delta^{13}C = -26.8‰$

Wood sample (scaffolding fragment, ref F17) from put-log hole in S clerestory of All Saints' Church, Brixworth, Northamptonshire, England (52° 20′ N, 0° 50′ W, Natl Grid Ref SP 748712). Coll 1977 and subm by D Parsons, Dept Adult Educ, Univ Leicester, for Brixworth Archaeol Research Comm. *Comment* (DP): sample most probably is from original construction of clerestory, which is thus considerably later than usually accepted late 7th century date (ca AD 680) for body of church.

1850 ± 70

BM-1523. Canterbury, Kent $\delta^{13}C = -19.4‰$

Collagen from right tibia of large domestic dog, id by Juliet Clutton-Brock, Dept Zool, British Mus (Nat Hist), from articulated skeleton

lying on thin layer of silt overlying tessellated floor of 2nd century Roman building and constituting primary fill of 7th century Saxon hut, at Canterbury, Kent, England (51° 15′ N, 1° 5′ E, Natl Grid Ref TR 150570). Coll 1978 by Marion Day and subm by T Tatton-Brown, Dir, Canterbury Archaeol Trust. *Comment* (RB): date is ca 500 yr earlier than expected from stratigraphy; although articulated when found, skeleton may have been redeposited from Romano-British levels in Saxon period.

Bigberry series, Kent

Charcoal samples from brown loam filling (Layer 5) of water-hole in hillfort (Jessup and Cook, 1936) at Bigberry (Bigbury), 3km W of Canterbury, Kent, England (51° 20′ N, 1° 10′ E, Natl Grid Ref TR 116576). Assoc with Belgic pottery and bronze strap-link. Coll 1978 and subm by F H Thompson, Soc Antiquaries of London.

BM-1530. Bigberry **2080 ± 45**
$\delta^{13}C = -24.3‰$

Charcoal, ref Sample 1.

BM-1768. Bigberry **1920 ± 35**
$\delta^{13}C = -25.6‰$

Charcoal, ref Sample 2.

General Comment (FHT): BM-1530 is slightly earlier than expected, perhaps related to initial age of wood, but both results are close to conventional broad archaeol dating for particular style of assoc strap-link, to late 1st century BC-early 1st century AD; Sample 2 (BM-1768) was more closely assoc with strap-link stratigraphically than Sample 1 (BM-1530).

Spong Hill series, Norfolk

Charcoal samples from Neolithic occupation site at Spong Hill, North Elmham, Norfolk, England (52° 40′ N, 1° 0′ E, Natl Grid Ref TG 980197). Coll 1972-1973 by R D Carr and subm by Frances M A Healy, Norfolk Archaeol Unit.

BM-1532. Spong Hill **3810 ± 70**
$\delta^{13}C = -25.6‰$

Charcoal and nutshell from F123, pit containing possible cremation with pot-Beaker/Food Vessel and smaller pot with perforated base.

BM-1533. Spong Hill **4650 ± 80**
$\delta^{13}C = -25.0‰$

Charcoal from Pits F9, F12, F17, F18, and F20, assoc with plain Neolithic bowl and (except F12) Mildenhall-style pottery and related flint work.

4950 ± 120

BM-1534. Spong Hill $\delta^{13}C = -24.7‰$

Charcoal and burned acorns from Pits F3, F4, F7, F8, F16, F24, F32, F36, and F49, assoc with plain Neolithic bowl and Mildenhall-style pottery and related flint work.

4990 ± 80

BM-1535. Spong Hill $\delta^{13}C = -24.1‰$

Charcoal from Pit F118, assoc with plain Neolithic bowl pottery and related flint work.

3700 ± 90

BM-1537. Spong Hill $\delta^{13}C = -22.4‰$

Charcoal and burned acorns from F10, assoc with struck flint.

General Comment (FMAH): BM-1533, -1534 relate to single cluster of pits and post-holes containing apparently homogeneous material. Disparity between these determinations, which overlap only at 2 standard deviations, is surprising and may be attributable to bulked samples. Both dates are consistent with establishment of Mildenhall style of decorated Neolithic bowl by 3000 bc, indicated by date of 3145 ± 49 bc (BM-770; R, 1976, v 18, p 32) for bulked sample of charcoal from pits containing sherds of Mildenhall ware on Eaton Heath, Norwich (Wainwright, 1973).

110 ± 70

BM-1538. Beeswax candle $\delta^{13}C = -25.9‰$

Wax (id as beeswax by IR spectrometry) from large fragment of candle in colln of Dept Greek and Roman Antiquities, British Mus (reg no. 1851 8-13 364; Büll, 1965, fig 332, p 590), reputedly found in marble tomb at Vaison, Vaucluse, France ca 1829 (de Witte, 1840) with another fragment now in Leningrad Mus, and presumed to be Roman. Subm 1979 by D M Bailey, British Mus. *Comment* (RB): date shows candle is not Roman and was made shortly before acquisition by British Mus.

3740 ± 210

BM-1546. Grime's Graves horse $\delta^{13}C = -21.4‰$

Collagen from fragmentary cranial bones from skull of adult domestic horse (mare >35 yr old, id by Juliet Clutton-Brock, ref ARC 79 5017), deliberately buried in pit cut ca 1m into chalk debris from Neolithic flint mine at Grime's Graves, Weeting, Thetford, Norfolk, England (52° 30′ N, 0° 40′ E, Natl Grid Ref TL 816898). Coll 1976 and subm by G de G Sieveking, Dept Prehist and Romano-British Antiquities, British Mus. *Comment* (RB): result dates one of few known examples of domestic horse from late Neolithic to early Bronze age contexts in British Isles (R, 1979, v 21, p 41-47; Clutton-Brock and Burleigh, in press; Burleigh *et al*, ms in preparation).

Stonehenge series, Wiltshire

Red deer antler and human bone from fill of ditch at Stonehenge, Amesbury, Wiltshire, England (51° 10′ N, 1° 50′ W, Natl Grid Ref SU

122422). Coll 1954 by R J C Atkinson (antler) and 1978 by J G Evans (bone), Dept Archaeol, Univ Coll, Cardiff; subm by J G Evans.

3715 ± 70

BM-1582. Stonehenge $\delta^{13}C = -21.8‰$

Collagen from left femur of human skeleton (burial) inserted into upper level of secondary fill of Stonehenge I ditch (1.2m below surface), assoc with 3 barbed-and-tanged flint arrowheads, an archer's stone wrist-guard, and bluestone fragments (Atkinson and Evans, 1978). Sample dates burial, stratigraphically earliest occurrence of bluestone chips on site, and upper part of environmental sequence in fill of ditch.

4410 ± 60

BM-1583. Stonehenge $\delta^{13}C = -22.7‰$

Collagen from beam of red deer antler (*Cervus elaphus* L) from ca 30cm above base of Stonehenge I ditch (Atkinson, 1956). With BM-1617, below, provides initial date for environmental sequence from earliest known constructional phase of site.

4390 ± 60

BM-1617. Stonehenge $\delta^{13}C = -22.7‰$

Collagen from tine of red deer antler (*Cervus elaphus* L) from base of Stonehenge I ditch (Atkinson, 1956). With BM-1583, above (different antler), provides initial date for environmental sequence from earliest known constructional phase of site.

General Comment (JGE): BM-1582 accords well with expected dating of assoc artifacts: archer's stone bracer of A1 type (Clarke, 1970, p 570) and flint arrowheads of Conygar Hill and Sutton C type (Green, 1980). BM-1583, -1617 provide support for view of Stonehenge I as Class 1 henge transitional between earlier causewayed enclosure and fully developed monument (*cf* date for antler from bottom of ditch, I-2328, 4130 ± 105: R, 1968, v 10, p 288-289, and date for antler from Stonehenge Avenue, BM-1164, 3678 ± 68: R, 1979, v 21, p 341-342). BM-1583, -1617 also provide good chronol basis for environmental sequence recovered from ditch sediments.

Experimental dating of shells of terrestrial Mollusca (land snails)

Shell carbonate (aragonite) from terrestrial Mollusca compared with dated charcoal from same context or with independent archaeol evidence, as part of program for investigation of suitability of land snails for dating of sites where more conventional materials are absent, in particular on chalklands of S Britain (Burleigh and Kerney, 1982).

Brook series, Kent

Shells (*Pomatias elegans* [Müller] and *Cepaea nemoralis* [L]) id by M P Kerney, from buried soil containing charcoal dated to 4540 ± 105 (BM-254: R, 1973, v 13, p 169; Kerney, Brown, and Chandler, 1964; Kerney, Preece, and Turner, 1980) at Devil's Kneading Trough, Brook, Kent, England (51° 10′ N, 0° 55′ E, Natl Grid Ref TR 076452). Coll 1976-1977 and subm by M P Kerney, Dept Geol, Imperial Coll, London

and Richard Burleigh. ^{14}C activity expressed as $\Delta‰$ rel BM-254 (4540 ± 105).

BM-1255. Brook

$\Delta = -61.5 \pm 15.0‰$
$\delta^{13}C = -6.6‰$

Shells *(Pomatias elegans)* from 80 to 100cm in buried soil (same level as charcoal dated 4540 ± 105, BM-254). Apparent date 5050 ± 85 bp[1].

BM-1332. Sample B

$\Delta = -182.2 \pm 10.0‰$
$\delta^{13}C = -6.8‰$

Shells *(P elegans)* coll live, AD 1930, S England. Apparent date 1635 ± 55 bp.

BM-1333. Brook

$\Delta = +218.5 \pm 9.0‰$
$\delta^{13}C = -6.4‰$

Shells *(P elegans)* coll live, AD 1976.

BM-1483. Brook

$\Delta = +262.0 \pm 9.0‰$
$\delta^{13}C = -8.9‰$

Shells *(Cepaea nemoralis)* coll live, AD 1977.

BM-1484. Brook

$\Delta = -47.4 \pm 13.0‰$
$\delta^{13}C = -9.9‰$

Shells *(C nemoralis)* from 80 to 100cm in buried soil (same level as charcoal, BM-254, and fossil shells of *P elegans,* BM-1255, above). Apparent date 4930 ± 75 bp.

General Comment (RB): dates for fossil shells suggest incorporation of 5 to 10% dead carbon. This error may be acceptable for some dating applications though not in general for archaeol purposes; more comparisons between shells and charcoal or other materials are needed (see Burleigh and Kerney, 1982, for full discussion).

Blackgang series, Isle of Wight, Hampshire

Shells *(Cernuella virgata* [da Costa]) id by R C Preece, from slope deposit at Gore Cliff, Blackgang, Isle of Wight, Hampshire, England (50° 35′ N, 1° 20′ W, Natl Grid Ref SZ 493764). Coll 1978 and subm by R C Preece, Dept Geol, Imperial Coll, London, in attempt to date 1st appearance of *C virgata* in S Britain, and history of landslipping and early agriculture in Blackgang area (Preece, 1980).

BM-1481. Blackgang

130 ± 50
$\delta^{13}C = -8.1‰$

Shells *(Cernuella virgata)* coll live, AD 1978.

BM-1482. Blackgang

3940 ± 65
$\delta^{13}C = -5.8‰$

Shells *(C virgata)* from 240 to 250cm in slope deposit containing artifacts dating to 1st century BC to late 2nd century AD (see Preece, 1980, p 261-262).

[1] British convention for uncorrected radiocarbon dates

General Comment (RCP): based on these measurements, this sp appears to incorporate high proportion (ca 50%) dead carbon (Preece, 1980, p 262-263).

Late Pleistocene/early Holocene mammalian extinctions

Samples are part of study of latest dates of survival of larger terrestrial mammalian sp now extinct in British Isles (R, 1976, v 18, p 30-31; Clutton-Brock and Burleigh, in press.)

Littleport series, Cambridgeshire

Bone and peat samples from excavation of skeleton of *Bos primigenius* at Lowe's Farm, Littleport, near Ely, Cambridgeshire, England (52° 25′ N, 0° 20′ E, Natl Grid Ref TL 599960). Coll ca 1960 by E S Higgs and F W Shawcross and subm 1978 by G N Bailey, Dept Archaeol, Univ Cambridge (bone samples) and V R Switsur, Sub-Dept Quaternary Research, Univ Cambridge (peat sample).

3850 ± 60

BM-1443. Lowe's Farm, Littleport $\delta^{13}C = -28.4‰$

Humified structureless peat (Fen peat), ref Q-464 (Cambridge Lab no., but sample not previously dated), from 0 to 3cm below skeleton of *Bos primigenius.*

12,170 ± 85

BM-1444. Bone $\delta^{13}C = -23.7‰$

Collagen from sternal bones from colln of Cambridge Mus Archaeol and Anthropol, presumed to be from skeleton of *Bos primigenius* from Lowe's Farm, Littleport, but date indicates bones are from another animal.

3340 ± 45

BM-1469. Lowe's Farm, Littleport $\delta^{13}C = -20.9‰$

Collagen from left horizontal ramus of mandible of *Bos primigenius.* Mandible articulated with skull from Lowe's Farm, identifiable from photograph in excavation rept (Shawcross and Higgs, 1961); sample of bone from occipital region of skull and from mandible had similar $\delta^{13}C$ values (−21.17 ± 0.4‰, −20.85 ± 0.4‰) but $\delta^{13}C$ of misassoc sternal bones (BM-1444, above) differed (−23.72 ± 0.2‰).

General Comment (RB): dates for peat (BM-1443) and mandible of *Bos primigenius* (BM-1469) agree with stratigraphic evidence from site (Shawcross and Higgs, 1961) and BM-1469 provides late date for survival of *Bos primigenius* into Bronze age (Clutton-Brock and Burleigh, in press). BM-1444 evidently dates bones inadvertently misassoc during storage in Cambridge Mus.

3578 ± 48

BM-1445. Beckford, Worcestershire $\delta^{13}C = -22.2‰$

Collagen from 1st thoracic vertebra of *Bos primigenius* (ref BP/IA) from Beckford Iron age site, in gravel pit NE of Beckford village, Worcestershire, England (52° 0′ N, 2° 0′ W, Natl Grid Ref SO 983363). Coll 1973

and subm 1978 by P F Whitehead, Pershore, Worcestershire. Found in loam overlying Devensian gravel aggradation within Iron age enclosure. *Comment* (PFW & RB): antedates Iron age occupation and may derive from fill of Bronze age ditch (Britnell, 1975); latest date so far obtained for *Bos primigenius* in Britain is BM-731, 3245 ± 37 (R, 1982, v 24, p 151; Burleigh and Clutton-Brock, 1977).

3400 ± 100

BM-1524. Wilburton, Cambridgeshire $\delta^{13}C = -23.2‰$

Collagen from right horn core of *Bos primigenius* (ref CMAE 1919 95A) found in assoc with Beaker burial at Wilburton, near Ely, Cambridgeshire, England (52° 20′ N, 0° 10′ E, Natl Grid Ref TL 490750), from colln of Cambridge Mus Archaeol and Anthropol. Coll ca 1847 and subm 1979 by C A Shell, Dept Archaeol, Univ Cambridge. *Comment* (RB): dates assoc Beaker (Shell and Burleigh, in press) and adds to series of late records for *Bos primigenius* in Britain (*cf* BM-731, 3245 ± 37: R, 1982, v 24, p 151; Burleigh and Clutton-Brock, 1977, and BM-1469, above; Clutton-Brock and Burleigh, in press).

4200 ± 220

BM-1525. Burwell, Cambridgeshire $\delta^{13}C = -23.6‰$

Collagen from left horizontal ramus (ref D33665b) of mandible of *Bos primigenius* skull found near village of Reach, Burwell Fen, Burwell, Cambridgeshire, England (52° 15′ N, 0° 20′ E, Natl Grid Ref TL 565665), from colln of Sedgwick Mus, Cambridge. Coll ca 1860 and subm 1979 by C L Forbes, Dept Geol, Univ Cambridge. Broken Neolithic chipped and polished flint axe head lodged in frontal bone of skull (Babington, 1863; Carter, 1874; Godwin, 1978, p 61, pl 17; Hughes, 1896, p 129, 130, figs 3, 4; Reynolds, 1939, p 26).

36,000 ± 1900

BM-1526. Sandford Hill, Mendip, Somerset $\delta^{13}C = -18.3‰$

Collagen from skull of cave hyena *(Crocuta crocuta spelaea),* part of large assemblage of hyena and reindeer remains, from cave earth deposit, Sandford Hill cave, Mendip, Somerset, England (51° 20′ N, 2° 50′ W, Natl Grid Ref ST 422591), from colln of Taunton Mus (Boyd Dawkins, 1874, p 292). Coll ca 1820 by W Beard and subm 1979 by A Turner, Environmental Archaeol Unit, Univ York. *Comment* (AT): faunal remains from other Mendip sites of Wookey Hole and Uphill Cave, indicate abundance of hyena, woolly rhinoceros, and horse in area before last glacial max. Date for hyena skull from Sandford Hill cave falls within same period; reindeer remains from site are ungnawed and probably of later date.

3760 ± 60

BM-1585. Hemp Knoll, Wiltshire $\delta^{13}C = -21.3‰$

Collagen from scapula of *Bos primigenius* from fill of Ditch 1 (eroded chalk capping of barrow, NE Quad, Layer 2), Hemp Knoll round barrow, 5km SW of Avebury, near Marlborough, Wiltshire, England (51° 25′ N, 1° 55′ W, Natl Grid Ref SU 069673). Coll 1965 by Maureen Robertson-Mackay and subm 1979 by Caroline Grigson, Odontological Mus, Royal

Coll Surgeons, London (Grigson, 1980; Robertson-Mackay, 1980). *Comment* (CG): result confirms date of 3745 ± 135 (NPL-139, unpub) for charcoal from central grave in mound, and agrees with archaeol evidence (Robertson-Mackay, 1980, p 147).

Cyprus

Lemba Lakkous series

Charcoal samples from occupation site at Lemba Lakkous, 4.5km NNW of Paphos, Paphos dist (34° 50′ N, 32° 20′ E) assoc with new pottery styles, figurines, metalwork, and architectural units (Peltenburg, 1979a, b; 1980). Samples, together with those from Kissonerga Mylouthkia (below), are part of study on series of 3rd millennium bc sites in W Cyprus, and give 1st ^{14}C determinations from area (Burleigh, 1981a; Peltenburg, 1981). Coll 1976-1977 and subm by E J Peltenburg, Dept Archaeol, Univ Edinburgh.

3890 ± 50

BM-1353. Lemba Lakkous $\delta^{13}C = -26.1‰$

From Area II, floor of House 2 at E end of settlement.

3970 ± 45

BM-1354. Lemba Lakkous $\delta^{13}C = -24.2‰$

From stump (presumed roof-support) in Pit 6, House 2.1.

4000 ± 45

BM-1541. Lemba Lakkous $\delta^{13}C = -23.7‰$

From Area II, Sq L34a, Feature 2.

4050 ± 50

BM-1541A. Lemba Lakkous $\delta^{13}C = -24.0‰$

Repeat of BM-1541, above, with fresh sample.

4090 ± 90

BM-1542. Lemba Lakkous $\delta^{13}C = -25.1‰$

From Area II, Sq L34c.2, Feature 2.

5000 ± 260

BM-1543. Lemba Lakkous $\delta^{13}C = -23.8‰$

From Area I, Bldg 8.1.

General Comment (EJP): dates, with those from Kissonerga Mylouthkia (below), relate to 1st sizeable exposures of Chalcolithic sites in Cyprus and to earliest human settlement and burials in W of island. Dates indicate persistence of Erimi culture for prolonged period, overlapping transition to Bronze age in N of island (Peltenburg, 1981).

Kissonerga Mylouthkia series

Charcoal samples from coastal site at Kissonerga Mylouthkia, 7km NNW of Paphos, Paphos dist (34° 50′ N, 32° 20′ E). Samples are part of Lemba Archaeol Project (*cf* Lemba Lakkous, above). Coll 1977 and subm by E J Peltenburg.

4765 ± 55

BM-1473. Kissonerga Mylouthkia $\delta^{13}C = -24.3‰$

From area around hearth in Feature 1, Level 2.

4665 ± 50

BM-1474. Kissonerga Mylouthkia $\delta^{13}C = -24.2‰$

From Feature 1, Level 11.

4815 ± 60

BM-1475. Kissonerga Mylouthkia $\delta^{13}C = -25.4‰$

From Level 13, an early cut in Feature 1.

4650 ± 50

BM-1476. Kissonerga Mylouthkia $\delta^{13}C = -21.2‰$

From several layers in Feature 16, assoc with specialized bowl bases filled with red ocher.

4790 ± 80

BM-1539. Kissonerga Mylouthkia $\delta^{13}C = -23.1‰$

From Feature 16.1.

4740 ± 50

BM-1540. Kissonerga Mylouthkia $\delta^{13}C = -23.6‰$

From Feature 16.4.

General Comment (EJP): for typologic reasons, these midden holes were thought to vary considerably in age, but these dates assign them to one period, helping to bridge gap of 500 radiocarbon yr between end of late Neolithic (BM-849, 5224 ± 78: R, 1977, v 19, p 146; St-350, 5150 ± 130: R, 1959, v 1, p 43) and part of Chalcolithic Erimi culture (St-202, 4630 ± 80, St-203, 4540 ± 80: Östlund, 1957; St-338, 4480 ± 150: R, 1959, v 1, p 43; Peltenburg, 1981).

Kyrenia ship series

Samples from submerged wreck of Greek merchant ship of 4th century BC found 1.6km NE of Kyrenia (35° 20′ N, 33° 20′ E). Coll 1969 and subm by M L Katzev, Inst Nautical Archaeol, Am School Classical Studies, Athens (Katzev, 1974a, b; 1976; 1978; Swiny and Katsev, 1971).

2210 ± 40

BM-1588. Kyrenia ship $\delta^{13}C = -26.9‰$

Almonds from cargo of ship.

2205 ± 70

BM-1588A. Kyrenia ship $\delta^{13}C = -26.9‰$

Remeasurement of BM-1588, above.

2630 ± 45

BM-1639. Kyrenia ship $\delta^{13}C = -24.7‰$

Wood from strake from stern of ship.

General Comment (MLK): *cf* date for almonds P-1621, 2124 ± 60 and P-1622, 2222 ± 43, date for wood from hull of ship (R, 1971, v 13, p 363-364). BM-1639 is much earlier than expected and may reflect age of

timber (Aleppo pine; life span 400 to 500 yr) at time of use; P-1621 and BM-1588, -1588A date wreck of ship.

Ecuador

6900 ± 250

BM-1584. Punin cranium $\delta^{13}C = -20.2‰$

Collagen from bone removed from vault of human cranium (ref AMNH 99/8271) found in same deposit as extinct Pleistocene fauna in bank of ravine, Quebrada Chalan, near Punin, Riobamba (1° 45′ S, 78° 40′ W). Coll 1923 by G H H Tate and subm 1978 by D R Brothwell, Inst Archaeol, Univ London, from colln of American Mus Nat Hist, New York (Sullivan and Hellman, 1925). *Comment* (RB): although Hoffstetter (1952) concluded Punin cranium postglacial and not assoc with Pleistocene fauna from Punin beds, closer dating had possible bearing on early man in New World (Brothwell and Burleigh, 1980). Result is earliest direct ^{14}C date so far obtained for human skeletal remains from South America, but postdates other evidence for man's presence in subcontinent by at least 5000 radiocarbon yr.

Egypt

Tell Edfu series

Charcoal samples from stratigraphic sequence at Tell Edfu, halfway between Luxor and Aswan, Upper Egypt (25° 0′ N, 32° 50′ E). Coll 1978 and subm by M Bietak, Österreichische Botschaft Kairo, Vienna.

2840 ± 50

BM-1226. Tell Edfu $\delta^{13}C = -25.5‰$

Charcoal, ref Sample C2, Stratum b.

1690 ± 60

BM-1227. Tell Edfu $\delta^{13}C = -24.7‰$

Charcoal, ref Sample C9.

3860 ± 60

BM-1228. Tell Edfu $\delta^{13}C = -25.4‰$

Charcoal, ref Sample C1, Stratum c.

3400 ± 70

BM-1229. Tell Edfu $\delta^{13}C = -25.6‰$

Charcoal, ref Sample C3, Stratum c.

3500 ± 60

BM-1230. Tell Edfu $\delta^{13}C = -26.1‰$

Charcoal, ref Sample C6, later than Stratum f.

4030 ± 60

BM-1231. Tell Edfu $\delta^{13}C = -26.1‰$

Charcoal, ref Sample C4, Stratum e.

3830 ± 60

BM-1232. Tell Edfu $\delta^{13}C = -25.6‰$

Charcoal, ref Sample C5, Stratum f.

3790 ± 70

BM-1233. Tell Edfu $\delta^{13}C = -25.4‰$

Charcoal, ref Sample C8, Stratum f.

3800 ± 60

BM-1234. Tell Edfu $\delta^{13}C = -25.6‰$

Charcoal, ref Sample C7, later than Stratum f.

General Comment (MB): dates are older than expected after calibration, but are in expected sequence.

3420 ± 80

BM-1420. Illahun bull $\delta^{13}C = -17.1‰$

Hair from head of sacrificial bull (ref ARC 1979 5028) from foundation deposit of chapel of Sesostris II, 12th Dynasty (1897-1878 BC), at Illahun, near Cairo (29° 15′ N, 31° 0′ E), from colln of British Mus (Nat Hist). Coll ca 1920 by W M Flinders Petrie and subm 1978 by Juliet Clutton-Brock, to confirm attribution to 12th Dynasty (Petrie, Brunton, and Murray, 1923). Pretreated with methanol, acetone, and dilute acid. *Comment* (RB): calibrated date of ca 1790 ± 110 BC (Clark, 1975) is consistent with 12th Dynasty (Burleigh and Clutton-Brock, 1980a).

Tarkhan tunics series

Samples from two batches of linen, ref UC. 28614B including child's garment (tunic), from Mastaba 2050, and UC. 28616C two tunics, one a child's, from Late Period cemetery at Tarkhan, near Cairo (29° 40′ N, 31° 15′ E). Batches were labeled separately as 1st Dynasty (ca 3100 BC) and Late Period (22nd Dynasty; early 1st millennium BC). Measurements were made to check correct assignment of labels. Coll 1912 by W M Flinders Petrie, but tunics remained undiscovered until 1977 when linen was cleaned and conserved. Subm 1978 by H S Smith and Rosalind Hall, Dept Egyptol, Univ Coll, London.

3700 ± 40

BM-1496. Tarkhan tunic $\delta^{13}C = -24.1‰$

Sample of linen from Batch 28616C. Calibrated date (Clark, 1975) ca 4110 ± 75 BP: 2160 BC.

3850 ± 50

BM-1497. Tarkhan tunic $\delta^{13}C = -24.5‰$

Sample of linen from Batch 28614B. Calibrated date (Clark, 1975) ca 4310 ± 80 BP: 2360 BC.

General Comment (RH): dates fall at end of Old Kingdom and are very unexpected as there is no recorded occupation of site at that time; possibly ransacking of Mastaba 2050 took place in 5th or 6th Dynasties, much earlier than Petrie believed. If so, dates provide closer tie between Tarkhan tunics (Hall, 1982; Landi and Hall, 1979) and nearest parallels, tunics of 5th Dynasty date found by Petrie at Deshasheh (Hall, 1981).

Mummified cats series

Linen wrappings from mummified domestic cats from Gizeh, near Cairo (30° 0′ N, 31° 10′ E), from colln of British Mus (Nat Hist). Coll ca

1905 by W M Flinders Petrie (exact provenance unknown) and subm 1979 by P Armitage and Juliet Clutton-Brock, as part of archaeozool study of mummified domesticated animal remains (Armitage and Clutton-Brock, 1980; 1981).

2220 ± 40

BM-1547. Mummified cat wrapping $\delta^{13}C = -22.2‰$

Linen from wrapping of mummified domestic cat, ref BM(NH) 1979 5022 (pretreated with dilute acid, hydrogen peroxide, and dilute ammonia).

2110 ± 45

BM-1548. Mummified cat wrapping $\delta^{13}C = -22.9‰$

Linen from wrapping of mummified domestic cat, ref BM(NH) 1979 5002 (pretreated with dilute acid, hydrogen peroxide, and dilute ammonia).

General Comment (RB): dates confirm attribution of these cats to late (Ptolemaic) period (Burleigh, 1980a).

Modern

BM-1550. Badari $\delta^{13}C = -19.5‰$

Collagen from right metatarsal of domestic ass from prehistoric site of Badari, near Asyut (27° 05′ N, 31° 25′ E), from colln of British Mus (Nat Hist). Coll ca 1925 by G Caton-Thompson and G Brunton and subm 1979 by Juliet Clutton-Brock. *Comment* (JC-B): Badarian or Predynastic date (ca 5500 bp) for ass remains from Egypt would be important to hist of early animal domestication (Clutton-Brock and Burleigh, in press), but these remains are evidently intrusive.

France

Gare de Couze series, Dordogne

Collagen from samples of fragmentary ungulate bone (principally *Rangifer tarandus*) id by F Prat, from Magdalenian levels at La Gare de Couze, near Lalinde (44° 50′ N, 0° 45′ E). Coll 1962 and subm 1979 by F Bordes, Quaternary Inst, Univ Bordeaux, for comparison with previous measurements for samples from La Gare de Couze, Lv-391, 10,900 ± 230 (R, 1970, v 12, p 554) and Ly-975, 12,430 ± 320; Ly-976, 11,750 ± 310 (R, 1976, v 18, p 78), which suggest high proportion of reindeer surviving into Alleröd in SW France (Bordes, 1973; Bordes and Fitte, 1964; Bordes, Fitte, and Laurent, 1963; Fitte and de Sonneville-Bordes, 1962; Prat, 1962).

8260 ± 130

BM-1613. Gare de Couze $\delta^{13}C = -22.5‰$

Sample from Trench F, Magdalenian VI level.

10,190 ± 200

BM-1614. Gare de Couze $\delta^{13}C = -22.3‰$

Sample from Trench F, Magdalenian VI level.

11,230 ± 180

BM-1615. Gare de Couze $\delta^{13}C = -21.1‰$

Sample from Trench G, Magdalenian VI level.

12,540 ± 75

BM-1616. Gare de Couze $\delta^{13}C = -20.1‰$

Sample from Trench H, Magdalenian V level.

General Comment (RB): dates are in strat sequence, but all are later than expected. BM-1613 seems quite anomalous for Magdalenian culture in France; even BM-1614 is surprisingly late for reindeer fauna and assoc industry (dated bone was fragmentary and id to reindeer, at least for BM-1613, may not be certain). BM-1615 provides min date for engraved stone plaque from base of Level G1 (Bordes and Fitte, 1964; Bordes, Fitte, and Laurent, 1963). BM-1616 agrees with Ly-975 (12,430 ± 320: R, 1976, v 18, p 78) from same provenance. In relation to earlier dating at Gare de Couze, however, BM-1613-1616 do little to elucidate true age of reindeer fauna and assoc Magdalenian industry in Levels B-G1 (abstracted from extended comment by G de G Sieveking, Dept Prehist and Romano-British Antiquities, British Mus).

Greece

Assiros series

Charcoal samples from prehistoric tell site at Assiros Toumba, 25km NE of Thessaloniki (40° 50′ N, 23° 0′ E). Coll 1975-1976 and subm by K A Wardle, British School Archaeol, Athens, and Dept Ancient Hist and Archaeol, Univ Birmingham.

2800 ± 75

BM-1426. Assiros $\delta^{13}C = -25.6‰$

Charcoal, ref 10/HB/1474, early Iron age destruction debris (Phase 2). Expected date ca 950 BC.

2920 ± 75

BM-1427. Assiros $\delta^{13}C = -23.6‰$

Charcoal, ref 24/JF/1288, from final Bronze age destruction level (Phase 5). Expected date ca 1100 BC.

2900 ± 70

BM-1428. Assiros $\delta^{13}C = -24.7‰$

Charcoal, ref 218/JJ/2416, from final Bronze age destruction level (Phase 6), assoc with Mycenaean LHIIIC pottery. Expected date ca 1125 BC.

2940 ± 80

BM-1429. Assiros $\delta^{13}C = -24.1‰$

Charcoal, ref 402/JJ/2453, from late Bronze age occupation level (Phase 7), assoc with Mycenaean LHIIIC pottery. Expected date ca 1175 BC.

2930 ± 50

BM-1430. Assiros $\delta^{13}C = -25.0‰$

Charcoal, ref 77/JA/1451, from late Bronze age occupation level (Phase 8), assoc with Mycenaean LHIIIB pottery. Expected date ca 1250 BC.

2840 ± 45

BM-1431. Assiros $\delta^{13}C = -23.4‰$

Charcoal, ref 439/JA/2023, from late Bronze age occupation level (Phase 11). Expected date older than 1350 BC.

2960 ± 40

BM-1432. Assiros $\delta^{13}C = -24.8‰$

Charcoal, ref 379/JC/2147, from occupation level antedating Mycenaean pottery. Expected date ca 1450 BC.

2930 ± 55

BM-1433. Assiros $\delta^{13}C = -23.8‰$

Charcoal, ref 202/KA/2201, 205/KA/2221, 207/KA/2223, 208/KA/2224, 209/KA/2224, from presumed middle Bronze age occupation levels. Date uncertain, possibly earlier than 1500 BC.

General Comment (KAW): few satisfactory correlations have yet been made between ^{14}C dates for Aegean LBA sites and those established by pottery chronol; at Assiros imported and locally made Mycenaean pottery allows close reference to S Greek sequence (Catling, 1981; Wardle, 1980). After calibration (Clark, 1975) dates from later phases of site lie close to those estimated from pottery; those from earlier phases do not seem sufficiently old (by 250 yr or more). All samples appeared to be from construction timbers.

India

Sultanganj Buddha series

Charcoal (partly rice husks, *Oryza sativa)* separated from clay core of bronze figure of Buddha from Sultanganj, near Bhagalpur, Bihar (25° 15′ N, 87° 0′ E), found during railway construction ca 1860 and now in colln of Birmingham Mus, England. Samples coll and prepared (sieving and hydrofluoric acid treatment to remove silica and concentrate carbon content) by N J Seeley, Inst Archaeol, Univ London, and subm by W Zwalf, Dept Oriental Antiquities, British Mus. Buddha (height 2.4m) is largest surviving bronze from ancient India and is work of outstanding artistic merit presumed to date to Gupta period, ca AD 400. Quartz grains from core of Buddha dated to ca AD 550 by thermoluminescence (Fleming, 1979, p 207).

1280 ± 80

BM-1212. Sultanganj Buddha $\delta^{13}C = -24.5‰$

Sample A, charcoal from core of Buddha (sieved and treated with hydrofluoric acid).

1620 ± 80

BM-1478. Sultanganj Buddha $\delta^{13}C = -22.7‰$

Sample B, charcoal from core of Buddha (sieved and treated with dilute acid to remove carbonates, but not treated with hydrofluoric acid). Sample combusted at Harwell lab.

General Comment (WZ): metal Buddha image found in ruins of monastery at Sultanganj, Bihar, in 1861, is largest surviving metal sculpture of Indian antiquity and probably most important single Indian object outside subcontinent. Before 9th century AD Indian metal sculpture of all sizes is uncommon. Thus, it is difficult to determine how far removed in time this image is from late 5th century stone prototypes, carved at Sarnath in neighboring Uttar Pradesh (Asher, 1980; Ashton, 1950; Chandra, 1972; Cunningham, 1882; Harris, 1864; R Mitra, 1864; S K Mitra, 1979; Smith, 1911; Schroeder, 1981).

Indian Ocean

Indian Ocean series

Samples of bone and eggshell of giant tortoises (*Geochelone* spp) from Indian Ocean region (Aldabra, Assumption, Madagascar (Malagasay Republic), Mauritius, Seychelles). Subm 1977-1979 by E N Arnold, Dept Zool, British Mus (Nat Hist), to elucidate various aspects of hist of giant tortoises in area (Arnold, 1979; Burleigh, 1979; Stoddart and Peake, 1979). Dates listed geographically by island groups rather than in strict lab no. order.

2035 ± 35

BM-1628. Giant tortoise $\delta^{13}C = -27.3‰$

Collagen from humerus of *Geochelone abrupta (cf G gigantea),* from Ampoza, S Madagascar (22° 15′ S, 44° 45′ E). Coll 1931 by E White, Vernay/Archbold Exped (White, 1930).

1250 ± 50

BM-1399. Giant tortoise $\delta^{13}C = -13.9‰$

Collagen from bony carapace of *Geochelone grandidieri,* from near Nossi Ve, SW Madagascar (23° 40′ S, 43° 37′ E). Coll by A Last, ref BMNH(Z) 1978.773.

1490 ± 230

BM-1397. Giant tortoise $\delta^{13}C = -24.8‰$

Collagen from anterior part of plastron of *Geochelone inepta,* from Mare aux Songes, Mauritius (20° 15′ S, 57° 30′ E). Coll ca 1890, probably by T Sauzier.

1580 ± 250

BM-1398. Giant tortoise $\delta^{13}C = -24.6‰$

Collagen from anterior part of plastron of *Geochelone gadowi* (= *G triserrata*), from Mare aux Songes, Mauritius (20° 15′ S, 57° 30′ E). Coll ca 1890, probably by T Sauzier.

1308 ± 85

BM-1331. Giant tortoise eggshell $\delta^{13}C = -2.2‰$

Eggshell of *Geochelone gigantea,* from phosphatized calcareous sands, Dennis I., N rim of Seychelles Bank (3° 50′ S, 55° 40′ E). Coll 1927 by J Hornell.

$\Delta = +356.3 \pm 10.0‰$

BM-1389. Giant tortoise eggshell $\delta^{13}C = -11.1‰$

Eggshell of modern *Geochelone gigantea,* from Aldabra (10° S, 46° E). Coll ca 1976 by I Swingland, Royal Soc Exped. Dated to determine apparent age/^{14}C activity of contemporary tortoise eggshell (see Burleigh, 1979).

1570 ± 120

BM-1514. Giant tortoise eggshell $\delta^{13}C = -7.7‰$

Eggshell of *Geochelone gigantea,* from Assumption I. (9° 45′ S, 46° 30′ E). Coll 1964 by R Honneger.

1530 ± 120

BM-1515. Giant tortoise eggshell $\delta^{13}C = -6.0‰$

Eggshell of *Geochelone gigantea,* from Assumption I. (9° 45′ S, 46° 30′ E). Coll 1964 by R Honneger.

1140 ± 100

BM-1516. Giant tortoise eggshell $\delta^{13}C = -10.6‰$

Eggshell of *Geochelone gigantea,* from Assumption I. (9° 45′ S, 46° 30′ E). Coll 1977 by S Blackmore and M Walker, Royal Soc Exped.

General Comment (ENA): of Madagascar samples, date for *G abrupta* (BM-1628) falls between two dates given by Mahé and Sourdat (1973) for deposits in which this form has been found, and date for *G grandidieri* (BM-1399) is substantially later than that obtained by these authors for this sp (ca 2200 ± 120 bp), increasing possibility that it survived long enough to be exterminated by 1st human colonizers, ca 1100 yr ago. Rothschild (1915) suggested that two extinct Mauritian tortoises were present in different periods, but strat information does not support this view and dates obtained for Mare aux Songes material (BM-1397, -1398) suggest that these two spp were synchronous. Occurrence of *G gigantea* on some islands to N of Madagascar has sometimes been attributed to human agency, but fossil evidence suggests natural presence on at least Aldabra. Dates of material from Dennis I. (BM-1331) and Assumption I. (BM-1514 to -1516) indicate that tortoises were present there long before Europeans reached area.

Indonesia

Leang Burung series

Aragonitic shells of freshwater gastropod *(Brotia perfecta)* id at British Mus (Nat Hist), from cave of Leang Burung 2, Kampung Tompokbalang, Maros dist, S Sulawesi (5° 0′ S, 119° 40′ E). Coll 1975 and subm by I C Glover, Inst Archaeol, Univ London. Samples dated to check whether acceptable results are obtainable from shells in absence of charcoal from archaeol levels (Glover, 1977; 1979).

20,150 ± 250

BM-1492. Leang Burung $\delta^{13}C = -10.4‰$

Sample LB/2 D(10)19, from Trench 10, Sq D, Spit 19, Layer IIIa.

$\Delta = +159.2 \pm 10.0‰$

BM-1493. Leang Burung $\delta^{13}C = -11.0‰$

Living specimens coll from adjacent stream, measured to give estimate of hardwater correction to BM-1492, above.

General Comment (RB): ^{14}C activity of modern shells suggests dead carbon contribution of ca 1350 yr to date for ancient shells (BM-1492), giving corrected archaeol date of ca 18,800 ± 250 bp, broadly consistent with other dates obtained by Groningen lab for shell from Leang Burung 2 and for charcoal and shell from nearby site of Ulu Leang 1 (Burleigh, 1981b; Glover, 1981; Mook, 1981).

Iraq

Tell es-Sawwan series

Charcoal samples from Tell es-Sawwan, 10km S of Samarra, on E bank of R Tigris (34° 10′ N, 43° 50′ E). Coll 1969-1970 by W Yassin and subm by Diana Kirkbride-Helbaek, Inst Archaeol, Univ London.

7069 ± 66

BM-1434. Tell es-Sawwan $\delta^{13}C = -25.4‰$

Sample A, from Sq d/15i, Level III, 70cm from surface.

7015 ± 66

BM-1435. Tell es-Sawwan $\delta^{13}C = -25.3‰$

Sample B, from Sq c/15j, fill between Levels II and III, 90cm from surface.

7052 ± 57

BM-1436. Tell es-Sawwan $\delta^{13}C = -25.8‰$

Sample C, from fill of Room 477, Level IIIA.

7037 ± 69

BM-1437. Tell es-Sawwan $\delta^{13}C = -26.7‰$

Sample D, from fill of Room 441, Level IIIA.

6980 ± 59

BM-1438. Tell es-Sawwan $\delta^{13}C = -26.5‰$

Sample E, from center of Oven no. 1, Sq c/15i, Level III.

General Comment (DK-H): *cf* dates for related sites in Iraq: Choga Mami, BM-483, 6846 ± 182 (R, 1977, v 19, p 151; Oates, 1972); Tell Shimshara, K-951, 7940 ± 150; K-960, 7300 ± 150; K-972, 7820 ± 150; K-981, 10,030 ± 160 (dates based on charred organic temper of potsherds; R, 1968, v 10, p 323; Mortenson, 1970), and for same site: P-855, 7456 ± 73; P-856, 7299 ± 86; P-857, 6808 ± 82.

Ur series

Wood samples (Sample A, *Pinus* sp, *cf P pinea;* Sample B, *Cupressus* sp, *cf C sempervirens*) id by T Lawrence, Royal Botanic Gardens, Kew,

from beams from ziggurat of Nabonidus at Ur (30° 55′ N, 46° 05′ E), from colln of Dept Western Asiatic Antiquities, British Mus, assoc with inscribed cylinder seal dated 555-539 BC. Coll 1854 by J G Taylor and subm 1977 by E Sollberger, British Mus.

2780 ± 40

BM-1446. Ur $\delta^{13}C = -21.7‰$

Sample A, wood (*Pinus* sp).

2010 ± 40

BM-1447. Ur $\delta^{13}C = -23.7‰$

Sample B, wood (*Cupressus* sp).

General Comment (ES): date for Sample A may be consistent with use or re-use in antiquity of older timber, but date ca 600 yr younger than expected for Sample B is inexplicable.

5570 ± 60

BM-1458. Tell Madhhur $\delta^{13}C = -21.5‰$

Carbonized grain (ref 5F:308; *Hordeum* sp) id by Jane Renfrew, from destruction debris in Ubaid bldg (Sq 5Fa) at Tell Madhhur, 15km NW of Jalula, Diyala Governorate (34° 20′ N, 45° 0′ E). Coll 1978 by P J Watson and subm by J N Postgate, British Archaeol Exped to Iraq, Baghdad. *Comment* (JNP): few other radiocarbon dates are available for Ubaid levels in Mesopotamia.

3110 ± 35

BM-1477. Aqar Quf $\delta^{13}C = -23.2‰$

Reed rope from brickwork of 2nd stage of ziggurat at Aqar Quf, 15km W of Baghdad (33° 20′ N, 43° 50′ E). Coll 1976 by T A Fuller and J N Postgate and subm 1978 by J N Postgate as part of program to date Mesopotamian ziggurats and related bldgs using reeds from between mud-brick courses (*cf* BM-1416, 1102 ± 43: R, 1982, v 24, p 164; Burleigh, 1980b; Postgate, 1980). *Comment* (RB): calibrated date for BM-1477, 1450 ± 70 BC (from tables of Clark, 1975) agrees well with date of ca 1400 BC expected on archaeol grounds.

6930 ± 60

BM-1531. Arpachiyah $\delta^{13}C = -24.7‰$

Charcoal (*Tamarix* sp) id by R Hubbard ref Ar 20-d, from Sq III, Level 15, at Arpachiyah, 10 km E of Mosul (36° 20′ N, 43° 10′ E), from levels underlying Middle Halaf deposits excavated ca 1935 by M E L Mallowan (Hijara, 1978; Hijara *et al,* 1980). Coll 1976 by I Hijara and subm by R N L Hubbard, Inst Archaeol, Univ London. *Comment* (RB): no other radiocarbon dates for Early Halaf; *cf* dates for Tell es-Sawwan, BM-1434-1438, this list, above.

Spain

4090 ± 390

BM-1408. Son Matge, Mallorca $\delta^{13}C = -20.2‰$

Collagen from limb bones of extinct goat-like ruminant, myotragus (*Myotragus balearicus* Bate) id by Juliet Clutton-Brock, from 350cm in

fill of rock shelter of Son Matge (ABSM), Estret, Valldemosa, Mallorca, Baleares (39° 35′ N, 2° 25′ E). Coll 1975 and subm by W H Waldren, Donald Baden-Powell Quaternary Research Centre, Pitt Rivers Mus, Univ Oxford and Dir, Deya Archaeol Mus and Research Centre, Deya de Mallorca. *Comment* (RB): myotragus (Bate, 1909) was thought to have become extinct at end of Pleistocene, but remains were later found in archaeol assoc (Waldren, 1966; Kopper and Waldren, 1967); date confirms survival of myotragus into Neolithic period (Burleigh and Clutton-Brock, 1980b).

Rascaño series

Collagen from samples of fragmentary animal bone from habitation levels in cave of Rascaño, Santander Prov (43° 20′ N, 4° 0′ E). Coll 1974 and subm by J G Echegaray, Santander Mus (Barandiarán and Echegaray, 1979). Comment supplied by G de G Sieveking, Dept Prehist and Romano-British Antiquities, British Mus. Dates listed in stratigraphic rather than strict lab no. order.

BM-1448. Rascaño **10,558 ± 244**
$\delta^{13}C = -20.9‰$
Sample 1, Level 1.2, Azilian.

BM-1449. Rascaño **10,486 ± 90**
$\delta^{13}C = -20.0‰$
Sample 2, Level 1.3, Azilian.

BM-1450. Rascaño **12,282 ± 164**
$\delta^{13}C = -19.6‰$
Sample 3, Level 2.1, Magdalenian VI (Final).

BM-1451. Rascaño **12,896 ± 137**
$\delta^{13}C = -19.4‰$
Sample 4, Level 2.3, Magdalenian V (Late).

BM-1452. Rascaño **15,173 ± 160**
$\delta^{13}C = -19.5‰$
Sample 5, Level 3, Magdalenian IV (Middle).

BM-1453. Rascaño **15,988 ± 193**
$\delta^{13}C = -19.4‰$
Sample 6, Level 4, Magdalenian III (Early).

BM-1512. Rascaño **15,540 ± 240**
$\delta^{13}C = -18.8‰$
Sample 6, Level 4, remeasurement of BM-1453, above, using fresh material.

BM-1454. Rascaño **15,191 ± 123**
$\delta^{13}C = -19.5‰$
Sample 7, Level 4B, Magdalenian III (Early).

15,465 ± 204
BM-1479. Rascaño $\delta^{13}C = -19.2‰$

Sample 7, Level 4B, remeasurement of BM-1454, above, using fresh material.

16,560 ± 131
BM-1455. Rascaño $\delta^{13}C = -19.4‰$

Sample 8, Level 5, Magdalenian III (Early; archaic).

15,970 ± 212
BM-1480. Rascaño $\delta^{13}C = -20.4‰$

Sample 8, Level 5, remeasurement of BM-1455, above, using fresh material.

16,530 ± 300
BM-1513. Rascaño $\delta^{13}C = -19.8‰$

Sample 8, Level 5, remeasurement of BM-1455 and BM-1480, above, using fresh material.

+ 1400
29,100
− 1200
BM-1456. Rascaño $\delta^{13}C = -20.4‰$

Sample 9, Level 7.

+ 1287
25,657
− 1109
BM-1456A. Rascaño $\delta^{13}C = -20.4‰$

Repeat measurement of BM-1456, above.

>27,150
BM-1457. Rascaño $\delta^{13}C = -20.1‰$

Sample 10, Level 9, possible Aurignacian level.

General Comment (GdeGS): stratigraphy of Rascaño cave comprises 10 layers (Levels 1-10, numbered downwards from surface; Barandiarán and Echegaray, 1979; Echegaray, 1979; Echegaray and Barandiarán, 1981). These include thick and semi-continuous series of rapidly accumulated Azilian and Magdalenian occupation deposits, including breccia (Level 4B) with assoc Magdalenian industry, and underlying series of cave deposits (Levels 6-10) with fewer traces of human occupation that may have accumulated over longer period (Barandiarán and Echegaray, 1979, fig 1); assemblage in Level 9 may be attributable to Aurignacian period. Dates for these levels are in stratigraphic order except for Levels 4B (breccia) and 5. Level 4B appears to be of same age as Level 4 and is assoc with same stage of Magdalenian industry. Level 5 is earlier than oldest date for Level 4 as result of remeasurement. BM-1456, -1456A, -1457 show that there is considerable stratigraphic disconformity between Azilian and Magdalenian occupations and earlier Levels 6-10 at Rascaño, and confirm that these earlier levels must have accumulated over considerable period. Dates for Azilian and for different stages of Magdalenian

are comparable to dates obtained from other sites in N Spain (*cf* Altamira and el Juyo, Level VI). Dates for Level 4 at Rascaño (Magdalenian III) support conventional dating for this period in preference to later dates for Magdalenian III inferred at el Juyo (I-10,736, 13,920 ± 240; I-10,738, 14,440 ± 180; Klein *et al,* 1981, p 18).

BM-1494. Riera **10,634 ± 121**
$\delta^{13}C = -20.5‰$

Collagen from fragmentary bone, probably *Cervus elaphus,* from Level 3 (Level 27 in final numbering scheme) in cave of La Riera, Posada de Llanes, Asturias (43° 25′ N, 5° 50′ W), assoc with transitional final Magdalenian/early Azilian industry. Coll 1978 and subm by L G Strauss, Univ New Mexico and G A Clark, Univ Arizona. *Comment* (LGS): date confirms chronol sequence established for site by other ^{14}C dates (Ly-1646, 10,340 ± 560; GaK-6982, 10,890 ± 430; Clark and Strauss, 1979; Strauss and Clark, 1978; Strauss *et al,* 1980).

BM-1507. Son Muleta, Mallorca **2360 ± 90**
$\delta^{13}C = -20.4‰$

Collagen from mandibles (less teeth) of domestic goats from upper fill (SMLC-25-50cm) in lower cave of Son Muleta, Soller, Mallorca, Baleares (39° 35′ N, 2° 25′ E). Coll 1965 and subm by W H Waldren, for comparison with date for myotragus, BM-1408, above (Burleigh and Clutton-Brock, 1980b).

Ca'n Sargent series, Ibiza

Collagen from samples of human bone from megalithic tomb of Ca'n Sargent, ca 15km from Ibiza city, SW Ibiza, Baleares (38° 50′ N, 1° 25′ E); 1st monument of pre-Talayotic period excavated on Ibiza (Topp, Fernandez, and Plantalamor, 1976). Coll 1978 and subm by Celia Topp and J Fernandez, Mus Arqueol, Ibiza.

BM-1510. Ca'n Sargent **2500 ± 100**
$\delta^{13}C = -19.8‰$

SW quad of megalith, 0.2m below surface.

BM-1511. Ca'n Sargent **2670 ± 60**
$\delta^{13}C = -20.0‰$

NW quad of megalith, 0.45m below surface. Fractionation correction estimated.

General Comment (CT): dates are ca 1000 yr later than expected.

Son Baronat series, Mallorca

Wood sample (*cf Picea* sp or *Larix* sp) id by D F Cutler, Royal Botanic Gardens, Kew, from one of several wooden sarcophagi from cave of Son Baronat, Calvia, Mallorca, Baleares (39° 30′ N, 2° 30′ E). Coll 1978 and subm by W H Waldren and G Rossello-Bordoy, Dir, Mus Mallorca, Palma.

BM-1517. Son Baronat **2350 ± 35**
$\delta^{13}C = -24.3‰$

Wood sample SB1, pretreated with dilute acid.

2390 ± 45

BM-1518. Son Baronat $\delta^{13}C = -24.6‰$

Wood sample SB1 (same material as BM-1517), additional pretreatment with dilute alkali.

General Comment (WHW): 1st time such burials, only found once before in Baleares, have been chronometrically dated.

Chinflon series

Samples of charcoal and wood from multi-period copper mining and smelting site at Chinflon, Huelva Prov (37° 40′ N, 6° 40′ W). Earliest use tentatively dated to Chalcolithic period (Rothenberg and Blanco Freijeiro, 1980). Coll 1979 and subm by B Rothenberg, Inst Archaeo-Metallurgical Studies, Univ London.

2650 ± 60

BM-1528. Chinflon $\delta^{13}C = -23.7‰$

Charcoal, ref HP270, Sq A1, Level 2, habitation level.

3320 ± 130

BM-1529. Chinflon $\delta^{13}C = -23.6‰$

Charcoal, ref HP267, Sq B1, Level 3, coll from wide area in lower levels of Sq B1.

2830 ± 50

BM-1599. Chinflon $\delta^{13}C = -23.1‰$

Wood (from small branch ca 7.5cm diam of *Quercus* sp) id by D F Cutler, Royal Botanic Gardens, Kew, ref HP436 (cellulose fraction), from Mine 3, Layer 9.

2890 ± 50

BM-1600. Chinflon $\delta^{13}C = -23.4‰$

Charcoal, ref HP435, Sq B, Level 4, Loc 4.

2520 ± 210

BM-1601. Chinflon $\delta^{13}C = -25.4‰$

Charcoal, ref HP434.

General Comment (BR): BM-1528, -1599, and -1600 indicate late Bronze age activity; provenance of BM-1529 is well above lowest deposits in mine. Result suggests extractive metallurgy at Chinflon could have begun considerably before late Bronze age.

3860 ± 70

BM-1603. Pisotilla $\delta^{13}C = -24.3‰$

Charcoal, ref HP437, from Pisotilla, Huelva Prov (37° 40′ N, 6° 40′ W), assoc with Chalcolithic artifacts. Coll 1979 and subm by B Rothenberg for comparison with Chinflon series, BM-1528, -1529, -1599 to -1601, above.

Syria

Tell Abu Hureyra series

Charcoal samples from Tell Abu Hureyra, on R Euphrates, N Syria (35° 50′ N, 38° 25′ E). Samples relate to Mesolithic settlement and

aceramic Neolithic occupation (Moore, 1975). Coll 1973 and subm by A M T Moore, Donald Baden-Powell Quaternary Research Centre, Pitt Rivers Mus, Univ Oxford.

8666 ± 66

BM-1120. Tell Abu Hureyra $\delta^{13}C = -22.4‰$

Charcoal, ref Samples 14, 15, 16, 17, from aceramic Neolithic contexts in Trench E. *Comment* (AMTM): result gives mean date for aceramic Neolithic occupation in Trench E.

10,792 ± 82

BM-1121. Tell Abu Hureyra $\delta^{13}C = -23.5‰$

Charcoal, ref Samples 11, 12, 13, from Mesolithic contexts in Trench E. *Comment* (AMTM): result gives mean date for Mesolithic occupation and indicates Mesolithic settlement was contemporary with Natufian in Palestine as suggested by resemblance of flint assemblages.

9374 ± 72

BM-1122. Tell Abu Hureyra $\delta^{13}C = -25.7‰$

Charcoal, ref Samples 1 and 5, from aceramic Neolithic contexts in Trench B. *Comment* (AMTM): result gives date for early aceramic phase of occupation in Trench B, shortly after founding of Neolithic settlement.

8676 ± 72

BM-1423. Tell Abu Hureyra $\delta^{13}C = -27.4‰$

Charcoal, ref Sample 6, from floor surface just above natural subsoil in Trench C, N of Trench B. *Comment* (AMTM): result dates start of early aceramic occupation in Trench C, apparently several centuries later than in Trench B.

8190 ± 77

BM-1424. Tell Abu Hureyra $\delta^{13}C = -25.0‰$

Charcoal, ref Sample 4, from fill in room belonging to final stages of occupation of building in Trench B. *Comment* (AMTM): result dates building of later aceramic Neolithic phase in Trench B, shortly before transition to ceramic Neolithic.

8393 ± 72

BM-1425. Tell Abu Hureyra $\delta^{13}C = -26.7‰$

Charcoal, ref Samples 8 and 9, from yard outside building in Trench C. *Comment* (AMTM): result gives date for later aceramic Neolithic phase in Trench C; date is consistent with BM-1424, above, for same phase in Trench B.

Yemen

Great Mosque of San'a series

Wood samples from Great Mosque of San'a (15° 30′ N, 44° 10′ W), dated to verify age of mosque and date of inscription and restoration. Coll 1975 by P Costa and subm by R B Lewcock, Fac Oriental Studies, Univ Cambridge.

1160 ± 50

BM-1140. San'a $\delta^{13}C = -24.2‰$

Sample 1, wood from painted ceiling (W Riwaq), expected date, ca AD 1120.

1170 ± 60

BM-1141. San'a $\delta^{13}C = -23.1‰$

Sample 2, wood from old ceiling, W side, expected date, ca AD 870.

1060 ± 50

BM-1142. San'a $\delta^{13}C = -26.2‰$

Sample 3, wood bearing Kufic inscription, expected date, ca AD 870.

Yugoslavia

Late Medieval human skeletal series

Collagen from series of samples of human bone (femorae; except BM-1498, -1499, domestic animal bone) from late Medieval burials in Ras region at Gradina and Trgovište, near Novi Pazar, Serbia (43° 10′ N, 20° 15′ E) and Trnjane-Staro Groblje, near Požarevac, Serbia (44° 40′ N, 21° 10′ E). Coll 1976-1977 and subm by S Živanović, Dept Anatomy, St Bartholomew's Hosp Medical Coll, London, to date burials as part of anthropol study of Medieval population, including some individuals with pathologic lesions (Ercegović-Pavlović, 1975; Marjanović-Vujović, 1980; Popović, 1976; Živanović, 1977; 1978; 1979a, b, c; Živanović and Burleigh, in press).

338 ± 53

BM-1393. Trgovište $\delta^{13}C = -18.9‰$

Adult male (ref 72) with Paget's disease, from grave 1.6m below surface in ancient market place. Expected date, ca AD 1100.

944 ± 55

BM-1498. Gradina $\delta^{13}C = -20.6‰$

Quad G14-15/H14-15, Horizon 4 (domestic animal bone).

836 ± 39

BM-1499. Gradina $\delta^{13}C = -18.9‰$

Quad G16-17/H16-17, Horizon 3, Layer 5 (domestic animal bone).

385 ± 50

BM-1500. Trnjane-Staro Groblje $\delta^{13}C = -17.1‰$

Ref TSG 344. Expected date, ca AD 1200.

950 ± 50

BM-1501. Trnjane-Staro Groblje $\delta^{13}C = -18.5‰$

Ref TSG 342. Expected date, ca AD 1140-1180.

585 ± 40

BM-1502. Trnjane-Staro Groblje $\delta^{13}C = -17.8‰$

Ref TSG 348. Expected date, ca AD 1140-1180.

190 ± 45

BM-1503. Trgovište $\delta^{13}C = -19.2‰$

Ref 114. Expected date, ca AD 1100.

285 ± 50

BM-1504. Trgovište $\delta^{13}C = -19.2‰$

Ref 115. Expected date, ca AD 1100.

General Comment (SZ): later archaeol finds have shown that Trgovište site in Ras region is much later than was originally expected and dates obtained for human remains correspond to those of archaeol finds. Dates of animal bone from Gradina (BM-1498, -1499) have been confirmed by finds of coins in same pit. Dates of human remains from Trnjane do not correspond with archaeol finds in respective graves, but fall within span of use of graveyard.

970 ± 70

BM-1394. Čelarevo $\delta^{13}C = -13.9‰$

Collagen from human bone (humerus, ref 244) from burial site at Čelarevo (45° 30′ N, 20° 10′ E). Coll 1973 and subm by S Živanović. *Comment* (SZ): dates N Mongolian group (Khazars) that settled in Panonian region in early Medieval period (Bunardžić, 1978-1979; Živanović, 1975).

450 ± 45

BM-1505. Vinča $\delta^{13}C = -16.1‰$

Collagen from human bone sample from sec exposed by erosion at prehistoric site of Vinča (44° 50′ N, 21° 10′ E). Coll 1978 and subm by S Živanović. *Comment* (RB): date, ca 6000 bp, expected for Vinča population. Sample represents intrusive late Medieval burial, supported by $\delta^{13}C$ value indicating C_4 plants (sorghum or possibly maize) in diet.

4050 ± 70

BM-1527. Bač $\delta^{13}C = -19.2‰$

Collagen from human bone (ref Sonda 1, Layer 3, Grave 3) from early Neolithic (Starčevo) site at Bač, near Sombor (45° 40′ N, 19° 15′ E). Coll 1979 and subm by S Živanović. *Comment* (RB): result is much younger than expected date, 6500-7000 bp. Burial in Grave 3 belongs to later prehistoric period.

BM-1589. Rudna Glava **6900 ± 1000**

Collagen from antler fragment from 9.3m depth, E channel of Shaft no. 3, in early Eneolithic copper mine at Rudna Glava, NE Serbia (44° 20′ N, 22° 10′ E). Coll 1977 and subm by B Jovanović, Inst Archaeol, Belgrade. *Comment* (RB): practically no material datable by ^{14}C occurs in mines at Rudna Glava. Large error is due to small size of sample. Broadly dates initial phase of mining in Central Balkans and Carpathians and is 1st available date for oldest copper mining in SE Europe (Jovanović, 1976; 1978; 1980), previously dated by finds of Vinča pottery found in shafts.

GEOLOGIC SAMPLES

Amber and copal series

Amber (succinite) and copal (resin) from Baltic (ca 57° N, 19° E), Burma (ca 20° N, 95° E), Lebanon (ca 34° N, 35° E), and E Africa (ca 7° S, 38° E). When copal samples, BM-1243, -1418 below, proved modern, amber from various sources was checked to verify not within ^{14}C age range. Subm by P E S Whalley, Dept Entomol, British Mus (Nat Hist).

BM-1243. E African copal — **Modern**, $\delta^{13}C = -25.7‰$

Suggested Pleistocene age.

BM-1417. Burmese amber — **>40,000**, $\delta^{13}C = -20.2‰$

Ref Ins 19103, Tertiary (Miocene) age.

BM-1418. E African copal — **Modern**, $\delta^{13}C = -23.3‰$

Ref In 25790, shipped from Dar es Salaam, ca 1925. Suggested Pleistocene age.

BM-1439. Baltic amber — **>40,000**, $\delta^{13}C = -24.3‰$

Ref 100, Tertiary (Eocene/Oligocene) age.

BM-1440. Burmese amber — **>40,000**, $\delta^{13}C = -20.4‰$

Ref 19135, Tertiary (Miocene) age.

BM-1441. Lebanese amber — **>40,000**, $\delta^{13}C = -21.5‰$

Possible Lower Cretaceous age.

General Comment (PESW & RB): BM-1243, -1418 confirm suggestion of recent rather than Pleistocene age for some copals; dating of these important for study of insect inclusions. Modern results for copal raised question of age of certain amber specimens (BM-1417, -1439, -1440, -1441), but these proved clearly beyond ^{14}C range, as expected. Few dates previously obtained for copal (A-593, 20 ± 140: R, 1966, v 8, p 18; UCLA-686, 2830 ± 80: R, 1965, v 7, p 357; WIS-41, 3750 ± 100: R, 1965, v 7, p 403; A-593, WIS-41 from Mexico; UCLA-686 from Angola). No other ^{14}C measurements pub for amber.

Mediterranean marine core series

Planktonic foraminiferal shells from sea floor ooze from 850m depth in Cilician basin, N of Cyprus, E Mediterranean (35° 30′ N, 33° 20′ E). Coll 1972 by L R Johnson and subm 1977 by H A Buckley, Dept Mineralogy, British Mus (Nat Hist), to confirm correlation between micropalaeontol and mineralogic changes and Late Glacial and Postglacial climatic change (Buckley, Easton, and Johnson, 1974).

4720 ± 170

BM-1421. Cilician basin core $\delta^{13}C = -1.0‰$

Core BM 1973,0,17, 56 to 68cm, shell carbonate; foraminifera indicate climatic optimum.

10.440 ± 400

BM-1422. Cilician basin core $\delta^{13}C = -1.1‰$

Core BM 1973,0,17, 110 to 120cm, shell carbonate; foraminifera indicate end of glacial conditions.

General Comment (HAB): plankton change from cold to warm water sp correlates with time scale of change from glacial to warmer conditions on land, and with independent palaeomagnetic measurements.

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