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RADIOCARBON

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INSTRUCTIONS TO CONTRIBUTORS

Manuscripts of radiocarbon papers should follow the recommendations in *Suggestions to Authors*, 5th ed.* All copy must be typewritten in *double space* (including the bibliography): manuscripts for vol. 14, no. 1 must be submitted in *duplicate* by February 1, 1972, and for vol. 14, no. 2 by August 1, 1972.

Description of samples, in date lists, should follow as closely as possible the style shown in this volume. Each separate entry (date or series) in a date list should be considered an *abstract*, prepared in such a way that descriptive material is distinguished from geologic or archaeologic interpretation, but description and interpretation must be both brief and informative, emphasis placed on significant comments. Date lists should therefore not be preceded by abstracts, but abstracts of the more usual form should accompany all papers (e.g. geochemical contributions) that are directed to specific problems.

Each description should include the following data, if possible in the order given:

1. Laboratory number, descriptive name (ordinarily that of the locality of collection), and the date expressed in years B.P. (before present, *i.e.*, before A.D. 1950) and, for finite dates, in years A.D./B.C. The standard error following the date should express, within limits of $\pm 1\sigma$, the laboratory's estimate of the accuracy of the radiocarbon measurement, *as judged on physicochemical (not geologic or archaeologic) grounds.*

2. Substance of which the sample is composed; if a plant or animal fossil, the scientific name if possible; otherwise the popular name; but not both. Also, where pertinent, the name of the person identifying the specimen.

3. Precise geographic location, *including latitude-longitude coordinates.*

4. Occurrence and stratigraphic position in precise terms; use of metric system exclusively. Stratigraphic sequences should *not* be included. However, references that contain them can be cited.

5. Reference to relevant publications. Citations within a description should be to author and year, with specific pages wherever appropriate. References to published date lists should cite the sample no., journal (R. for Radiocarbon), year, vol., and specific page (e.g., M-1832, R., 1968, v. 10, p. 97). Full bibliographic references are listed alphabetically at the end of the manuscript, in the form recommended in *Suggestions to Authors.*

6. Date of collection and name of collector.

7. Name of person submitting the sample to the laboratory, and name and address of institution or organization with which submitter is affiliated.

8. Comment, usually comparing the date with other relevant dates, for each of which sample numbers and references must be quoted, as prescribed above. Interpretive material, summarizing the significance and implicity showing that the radiocarbon measurement was worth making, belongs here, as do technical matters, e.g., chemical pretreatment, special laboratory difficulties, etc.

Illustrations should not be included unless absolutely essential. They should be original drawings, although photographic reproductions of line drawings are sometimes acceptable, and should accompany the manuscript in any case, if the originals exceed 9 to 12 inches in size.

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* Suggestions to authors of the reports of the United States Geological Survey, 5th ed., Washington, D. C., 1958 (Government Printing Office, $1.75).

NOTICE TO READERS

Half life of C^{14}. In accordance with the decision of the Fifth Radiocarbon Dating Conference, Cambridge, 1962, **all dates published in this volume (as in previous volumes) are based on the Libby value, 5570 ± 30 yr,** for the half life. This decision was reaffirmed at the H^3 and C^{14} Conference, Pullman, Washington, 1965. Because of various uncertainties, when C^{14} measurements are expressed as dates in years B.P. the dates are arbitrary, and refinements that take some but not all uncertainties into account may be misleading. As stated in Professor Harry Godwin's letter to **Nature** (v. 195, no. 4845, p. 984, September 8, 1962), the mean of three new determinations of the half life, 5730 ± 40 yr, is regarded as the best value now obtainable. Published dates can be converted to this basis by multiplying them by 1.03.

A.D./B.C. dates. As agreed at the Cambridge Conference in 1962, A.D. 1950 is accepted as the standard year of reference for all dates, whether B.P. or in the A.D./B.C. system.

Meaning of δC^{14}. In Volume 3, 1961, we indorsed the notation Δ (Lamont VIII, 1961) for geochemically interesting measurements of C^{14} activity, corrected for isotopic fractionation in samples and in the NBS oxalic-acid standard. The value of δC^{14} that entered the calculation of Δ was defined by reference to Lamont VI, 1959, and **was corrected for age.** This fact has been lost sight of, by the editors as well as by authors, and recent papers have used δC^{14} as the **observed** deviation from the standard. This is of course the more logical and self-explanatory meaning, and cannot be abandoned now without confusion; moreover, except in tree-ring-dated material, it is rarely possible to make an age correction that is independent of the C^{14} age. In the rare instances where Δ or δC^{14} are used for samples whose age is both appreciable and known, we assume that authors will take special care to make their meaning clear; reference merely to "Δ as defined by Broecker and Olson (Lamont VIII)" is not adequate.

Radiocarbon Measurements: Comprehensive Index, 1950-1965. This index, covering all published C^{14} measurements through Volume 7 of RADIOCARBON, and incorporating revisions made by all laboratories, has been published. It is available to all subscribers to RADIOCARBON at ten dollars U.S. per copy.

Publication schedule. Volume 10 and subsequent volumes are published in two semi-annual issues, in Winter and in Summer. Deadlines for manuscripts have been changed to 1 August and 1 February. Because of the recent rise in the number of manuscripts and laboratories, our publication schedule may be slightly delayed in the future. Contributors who meet our deadlines will be given priority but not guaranteed publication in the following issue.

List of laboratories. The comprehensive list of laboratories that has appeared hitherto at the end of each issue will now appear only once a year, in the second number of each volume.

Index. Beginning with Volume 11, all dated samples now appear in index form at the end of the second number of each volume.

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Radiocarbon

1971

BIRMINGHAM UNIVERSITY RADIOCARBON DATES V

F. W. SHOTTON and R. E. G. WILLIAMS

The University of Birmingham, Birmingham, England

The following list comprises results obtained during 1970 from both the 1 L and 6 L counters. Results are not corrected for C^{13} fractionation. Errors quoted refer only to the standard deviation calculated from a statistical analysis of sample and background count rates and the Libby half-life of 5570 ± 30 yr. Pretreatment has been continued as described previously (R., 1969, v. 11, p. 263). In cases where sample size was insufficient for full pretreatment, details of the necessary deviations accompany the result.

ACKNOWLEDGMENTS

We acknowledge with pleasure the advice of D. J. Blundell, who has been closely associated with the laboratory since its inception. We thank Mrs. L. Salvini for routine sample preparation and Mrs. J. Clarke for assistance with the counting.

SAMPLE DESCRIPTIONS

I. GEOLOGIC SAMPLES

A. British Isles

+1400
18,000
Birm-146. Cae Gwyn Caves, Tremerchion, N Wales **—1200**
16,050 B.C.

Collagen from carpal bone of mammoth underlying Upper Boulder Clay ca. 200 m ENE of Ffynnon Beuno Farm at entrance to Cae Gwyn cave, Tremerchion, N Wales (53° 14′ N Lat, 3° 22′ W Long, Grid Ref. SJ086724). Coll. 1893-6 by H Hicks; subm. by B. M. Rowlands, Dept. of Geog., Univ. of Liverpool. *Comment*: provides limit to Irish Sea Glaciation which deposited Upper Boulder Clay (Penny, 1964).

Ipsley series, Worcestershire

Samples from alluvium 2.85 m thick which contained an alleged monoxylous boat at Ipsley, Worcestershire (52° 17′ N Lat, 1° 54′ W Long, Grid Ref. SP067652). Birm-160 coll. and subm. by D. J. Tomalin; Birm-163 and Birm-164 coll. by R. E. G. Williams and subm. by F. W. Shotton.

2710 ± 90
Birm-160. **760 B.C.**

Outermost wood from solid boat or drifted trunk of *Quercus*, lying between 1.5 and 1.8 m depth.

Birm-164. **3425 ± 125**
1475 B.C.

Wood fragments in organic silt between 1.75 and 1.93 m depth.

Birm-163. **5075 ± 110**
3125 B.C.

Wood fragments in dark clay between 2.69 and 2.82 m depth.

General Comment: date for alleged solid boat is included with the 2 alluvium samples, as it could be interpreted as a naturally split and eroded trunk of *Quercus*. As a series, the figures are consistent and date the near commencement and progress of alluviation in a tributary of the Warwickshire Avon.

Birm-162. Seisdon, Staffordshire **>44,000**

Plant washed from gray silt at 4.6 m depth at Lowes Pit, Seisdon, Staffordshire (52° 33′ 05″ N Lat, 2° 13′ 34″ W Long, Grid Ref. SO 846949). Coll. 1969 and subm. by A. V. Morgan, Dept. of Geol., Univ. of Birmingham. *Comment*: cf. Birm-114, (R., 1970, v. 12, p. 385) for inner fraction of opercula shells from site ca. 200 m ESE/E and from higher horizon (Morgan, A. V., 1970). Date agrees with evidence of fauna and flora that deposit is interglacial.

Four Ashes series, Staffordshire

Samples from small separated lenses of peat or organic silt in Four Ashes Gravel, Staffordshire (52° 40′ 13″ N Lat, 2° 07′ 24″ W Long, Grid Ref. SJ916082). Coll. 1969 and subm. by A. V. Morgan. The gravel underlies "Irish Sea" till.

General Comment: gravel covers 1st 2/3 of the Devensian (Weichselian) from undatable Ipswichian to 30,000 B.P. at earliest. Other dates from this site: Birm-24, $36{,}340\ {}^{+770}_{-700}$; Birm-25, $30{,}655\ {}^{+765}_{-700}$; Birm-56, $42{,}530\ {}^{+1345}_{-1115}$ (R., 1968, v. 10, p. 200-201) Birm-74, >43,500 (R., 1970, v. 12, p. 385; Shotton, 1967).

Birm-170. $\mathbf{38{,}500\ {}^{+1200}_{-1050}}$
36,550 B.C.

Peat from lens at ca. 4.6 m depth (Site 12). *Comment*: insect fauna includes a few thermophilous species and indicates warmer phase of interstadial.

Birm-171. **>45,000**

Wood from organic silt ca. 25 cm thick at base of Four Ashes Gravel (Site 44). *Comment*: wood, macroflora, and pollen indicate an interglacial, hence Ipswichian.

Birm-195. **30,500 ± 440**
28,550 B.C.

Twigs and plant material washed from gray silt 2.1 to 2.3 m below surface in Four Ashes Gravel (Site 45) laterally close to Birm-171 but 1 m higher. *Comment*: assoc. insect fauna has many arctic *stenotherms* but lacks typical S species of Upton Warren type. Sample from Site 2 (Birm-25) has similar fauna.

Birm-196. **$40{,}000^{+1400}_{-1200}$**
38,050 B.C.

Peat from ca. 2.1 m below surface in Four Ashes Gravel (Site 34). *Comment*: sample lacks arctic *stenotherms* and reaffirms apparent amelioration ca. 38,000 to 42,000 B.P. (A. Morgan, 1970).

Birm-179. Gills Bay, Caithness, Scotland **(a) >40,800**
(b) >34,700

Inner (a) and outer (b) fraction of shells (*Turritella*) from band ca. 1 m wide at depth 2.5 to 3.5 m in exposed till section ca. 6 m thick at Gills Bay, Caithness, Scotland (58° 38′ 44″ N Lat, 3° 09′ 52″ W Long, Grid Ref. ND322733). Coll. 1969 and subm. by D. Omand, Dept. of Geog., Univ. of Strathclyde, Glasgow. *Comment*: confirms date on similar shelly till at Berwick (Sissons, 1967) and compares with Birm-191 below.

Birm-191. Gardenstown, Banffshire, Scotland **(a) >39,500**
(b) >37,350

Inner (a) and outer fraction (b) of bivalve shells from 21 to 30 m below surface (+44 to +53 m alt) in boulder clay 700 m approx. NNW of Findon at Castle Hill, Gardenstown, Banffshire, Scotland (57° 40′ 06″ N Lat, 2° 20′ 42″ W Long, Grid Ref. NJ942439). Coll. 1966 and subm. by J. D. Peacock, Inst. of Geol. Sci., Edinburgh. *Comment* (J.D.P.): sample obtained from beds formerly equated with Coastal Deposits of Banffshire (Jamieson, 1906; Read, 1923) but now referred to Shelly Boulder Clay. Date excludes Late Glacial age as expected, but unfortunately is infinite. Cf. Birm-179 above (>40,800) obtained from Shelly Boulder Clay of Caithness.

Birm-184. Marlow, Buckinghamshire **>31,000**

Plant detritus washed from organic silt in gravel of 3 m terrace of R. Thames at Little Marlow Village, Buckinghamshire (51° 30′ N Lat, 0° 45′ W Long, Grid Ref. SO865874). Coll. 1966 by C. Ranson; subm. by F. G. Bell, Dept. of Geol., Univ. of Birmingham. *Comment*: although infinite, determination agrees with Upton Warren Interstadial age suggested by thermophilous insect assemblage, which contains several species unique to these 2 sites. Pollen diagram indicates treeless conditions (Bell, 1968; 1969).

South West Scotland Coastal series

Samples from organic beds underlying, overlying, or within marine deposits of Flandrian transgression. Coll. and subm. by W. G. Jardine, Dept. of Geol., Univ. of Glasgow. Comments also by W.G.J.

8400 ± 200
Birm-187. 6450 B.C.

Wood, 7.5 cm deep (+1.8 m alt) in gray organic silt ca. 33 cm thick above gray gravel at Girvan Railway Bridge, Ayrshire (55° 15′ N Lat, 4° 51′ W Long, Grid Ref. NX190985). Coll. 1969. *Comment*: sample from base of same gray organic silt dated at 9020 ± 120; (Q-640, R., 1962, v. 4, p. 60).

8420 ± 150
Birm-190. 6470 B.C.

Wood washed from top 5 cm (ca. +6.8 m alt) of peat immediately underlying beach sand of Flandrian transgression at Turnberry Bridge, Ayrshire (55° 18′ N Lat, 4° 50′ W Long, Grid Ref. NS202063). Coll. 1966. *Comment*: dates maximum age at start of Flandrian transgression in Ayrshire (Jardine, 1967).

7960 ± 350
Birm-188. 6010 B.C.

Wood at +6.3 m alt at junction of Flandrian marine/estuarine sediments and underlying fluvioglacial gravel from Bargaly borehole in valley of Palnure Burn S of Newton Stewart (54° 58′ N Lat, 4° 24′ W Long, Grid Ref. NX596589). Coll. 1969. *Comment*: sample obtained by percussive drilling and assoc. with fluvioglacial gravel rather than with marine/estuarine clay above. Date therefore is pre-Flandrian transgression but not necessarily immediately so.

6240 ± 240
Birm-189. 4290 B.C.

Wood at +4.25 m alt at base of thick (ca. 4.73 m) peat overlying estuarine clays in Palnure borehole, Newton Stewart, Kirkcudbrightshire (54° 56′ N Lat, 4° 25′ W Long, Grid Ref. NX45006367). Coll. 1969. *Comment*: dates erosion and terrace deposition in Wigtown Bay area.

7450 ± 200
Birm-219. 5500 B.C.

Wood from thin layer of organic silt at +6.34 m alt within Flandrian estuarine/marine deposits in bank of Palnure Burn, opp. Little Park Farm, Kirkcudbrightshire (54° 57′ N Lat, 4° 24′ W Long, Grid Ref. NX45006576). Coll. 1969. *Comment*: dates early marine deposition (cf. Birm-188 above).

3944 ± 190
Birm-221. 1994 B.C.

Wood from base of thin peat bed at +10.4 m alt overlain by blown sand and underlain by marine sand of Flandrian transgression in excavation at Woodside sandpit, Irvine, Ayrshire (55° 35′ N Lat, 4° 39′ W Long, Grid Ref. NS330367). Coll. 1970. *Comment*: postdates regression of Flandrian sea from its maximum in Irvine area.

Newbie Cottage series, Solway Firth shore, Dumfriesshire

Samples from succession of Flandrian marine deposits overlain by blown sand and underlain by peaty silt.

Birm-218. 140 m SE of Newbie Cottages **3480 ± 110**
1530 B.C.

Charcoal near top of low cliff on N shore Solway Firth, from thin carbonaceous layer at +9.53 m alt within blown sand overlying Flandrian sediments at +7.75 m alt (54° 58′ N Lat, 3° 17′ W Long, Grid Ref. NY168648). Coll. 1970. *Comment*: date is within period of local accumulation of blown sand; cf. Birm-220 below and I-5070 (in press), which antedate accumulation of sand.

Birm-220. 66 m W of Newbie Cottages **5630 ± 116**
3680 B.C.

Wood from lower part of thin peat bed at junction of blown sand above and Flandrian sediments below (+7.78 m alt) at top of low cliff on N shore of Solway Firth (54° 58′ N Lat, 3° 18′ W Long, Grid Ref. NY167649). Coll. 1970. *Comment*: dates approx. beginning of local peat growth, maximum for beginning of accumulation of blown sand, and approx. end of Flandrian marine transgression. At other sites on N shore of Solway Firth, peat growth began before end of marine transgression because of local abnormal conditions (Q-638, 6645 ± 120; R., 1962, v. 4, p. 59, Q-818, 6244 ± 140; R., 1965, v. 7, p. 211; Birm-189 above, 6240 ± 246).

Birm-222. 169 m W of Newbie Cottages **7540 ± 150**
5590 B.C.

Peaty silt at +2.95 m alt taken by auger from top of bed underlying Flandrian marine deposits (54° 58′ N Lat, 3° 18′ W Long, Grid Ref. NY166650). Coll. 1970. *Comment*: dates approx. beginning of Flandrian transgression along Dumfriesshire shore of Solway Firth. Agrees broadly with GU-64, 7254 ± 101 and GU-65, 7426 ± 136 from nearby sites (R., 1969, v. 11, p. 50-51).

Birm-197. Porth Mear Cove, Cornwall **3024 ± 126**
1074 B.C.

Plant washed from organic clay, lower of 2 clay beds in Younger Head at Porth Mear Cove, Cornwall (50° 30′ 15″ N Lat, 5° 02′ 00″ W Long, Grid Ref. SW849715). Coll. 1969 and subm. by Rev. B. B. Clarke. *Comment*: sample from ca. .91 m into cliff face as material at 50 cm in was contaminated with *Cafius*. Date indicates material is alluvial, derived from older head deposits.

(a) 11,700 ± 200
Birm-208. Lea Marston Pit, Coton, Warwickshire **9750 B.C.**
(b) 11,170 ± 160
9220 B.C.

Reed stems and fragments of coarser matted vegetation washed from bed (ca. 0.15 m thick) of gray silt and peat, lying at base of ca. 2.5 m of gravel on Keuper Marl in gravel under alluvial plain of R. Tame at Lea Marston Pit, Coton, Warwickshire (52° 32′ 37″ N Lat, 1° 41′ 24″ W Long, Grid Ref. SO210941). Coll. 1970 and subm. by F. W. Shotton. Sample (a) after alkali pretreatment, (b) humate extract. *Comment* (F.W.S.): dates beginning of sedimentation at site of alluvial plain. Assoc. insect fauna typical of early Zone II.

9510 ± 235
Birm-215. Lea Marston, Warwickshire **7560 B.C.**

Wood from ca. 2.74 m depth at base of peaty silt resting upon gravel referred to in Birm-208, above, at Lea Marston, Warwickshire (52° 32′ 40″ N Lat, 1° 41′ 20″ W Long, Grid Ref. SO212942). Coll. 1970 and subm. by P. J. Osborne, Dept. of Geol., Univ. of Birmingham. *Comment* (P.J.O.): sample contains extensive beetle fauna of thermophilous assemblage suggesting summer temperatures similar to present but no indication of trees. This date and Birm-208 bracket period of gravel deposition.

(a) $38{,}160\ ^{+1600}_{-1330}$
36,210 B.C.
Birm-209. Mullock Bridge, Dale, Pembrokeshire
(b) $35{,}740\ ^{+2250}_{-1760}$
33,790 B.C.

Inner (a) and outer (b) fractions of marine molluscs (*Littorina*) at +18 m alt from Mullock Bridge Gravel pit, ca. 2.4 km from Dale on the Dale-Haverfordwest rd. (51° 43′ 00″ N Lat, 5° 09′ 30″ W Long, Grid Ref. SN811075). Coll. 1970 and subm. by B. S. John, Dept. of Geog., Univ. of Durham. *Comment*: closely agrees with NPL-80, 37,960 $^{+1700}_{-1400}$ (R., 1965, v. 7, p. 158), bulk sample of mollusc fragments from same site (John, 1965).

3610 ± 90
Birm-210. Asfordby, Leicestershire **1660 B.C.**

Wood washed from peat at base of alluvium (1.5 to 2.0 m thick) in flood plain of R. Wreak at Asfordby, Leicestershire (52° 45′ N Lat, 0° 57′ W Long, Grid Ref. SK706185). Sample immediately overlies sand and gravel (2.0 to 2.5 m thick) dated at 37,420 $^{+1670}_{-1390}$; (Birm-78, R., 1969, v. 11, p. 264). Coll. 1969 and subm. by R. J. Rice, Dept. of Geog., Univ. of Leicester. *Comment*: dates local beginning of alluviation along Wreak valley.

Glanllynau series, Caernarvonshire, North Wales

Plant material from base of kettle hole infilling which has a well-documented pollen spectrum and coleopteran spectrum of Late Glacial age, at Glanllynau, Caernarvonshire, N Wales (52° 54′ 45″ N Lat, 2° 22′

45″ W Long, Grid Ref. SH449373). Coll. 1970 and subm. by G. R. Coope, Dept. of Geol., Univ. of Birmingham.

Birm-212. **14,468 ± 300**
12,518 B.C.

Moss washed from silty clay 1.34 m below base of Zone I detritus mud. *Comment* (G.R.C.): dates start of Late Glacial infilling of kettle hole and an arctic/subarctic assemblage of *coleoptera*.

Birm-232. **11,714 ± 255**
9764 B.C.

Plant debris from silty clay 22.5 to 25 cm below base of Zone I detritus mud. *Comment* (G.R.C.): obvious rootlets removed as far as was possible.

Birm-233. **11,617 ± 270**
9667 B.C.

Plant debris washed from silty clay 15 to 17½ cm below base of Zone I detritus mud. *Comment* (G.R.C.): sample penetrated by vertical rootlets. These were removed by hand sorting as well as possible.

Glen Ballyre series, Isle of Man

Samples from Late Glacial sequence at Glen Ballyre near Kirkmichael, Isle of Man (54° 19′ 45″ N Lat, 4° 36′ 00″ W Long, Grid Ref. SC315915). Coll. 1970 and subm. by G. R. Coope.

Birm-213. **18,900 ± 330**
16,950 B.C.

Moss fragments washed from clay at 2.90 to 2.97 m below cliff top. *Comment* (G.R.C.): date is minimum for Orisdale moraine. Sample assoc. with small assemblage of *coleoptera* and lies 25 cm below pollen Zone I deposits (Mitchell, 1965; Dickson, Dickson, and Mitchell, 1970).

Birm-214. **12,645 ± 280**
10,695 B.C.

Plant fragments washed from detritus mud at 2.62 to 2.67 m below cliff top. *Comment* (G.R.C.): sample from early Zone I deposit, 12,210 ± 120 (GRO-1616, R., 1967, v. 9, p. 81), contains temperate insect fauna (alpine valleys).

Birm-217. Langham, near Rawcliffe, Yorkshire **(a) >42,200**
(b) >40,500

Wood, id. by D. D. Bartley, Univ. of Leeds, as coniferous, probably *Pinus*, with other wood fragments including *Quercus*? in sandy and clayey gravel below the 25-Foot Drift of the Vale of York in a borehole 823 m W 41° S of Rawcliffe R.R. Sta. and 21 km NNE of Doncaster, Yorkshire (53° 41′ 01″ N Lat, 0° 58′ 07″ W Long, Grid Ref. SE68122133). Coll. 1970 and subm. by G. D. Gaunt, Inst. of Geol. Sci. *Comment* (G.D.G.): as overlying 25-Foot Drift is almost certainly late Devensian, infinite dates support conclusion from wood identifications that fragments are interglacial. Level of occurrence, −30 to −35 ft alt, is unusually low for an interglacial deposit *in situ*, however; wood possibly was reworked into a Devensian deposit. A palynologic study of deposit is in progress.

General Comment (R.E.G.W.): (a) and (b) represent 2 separate methane preparations using different sources of hydrogen.

Birm-229. River Clarach, Aberystwyth, Cardiganshire **10,100 ± 250**
8150 B.C.

Basal peat lens at ca. –2.0 m alt immediately behind storm beach at mouth of R. Clarach, 2 km N of Aberystwyth, Cardiganshire (52° 25′ 54″ N Lat, 4° 04′ 35″ W Long, Grid Ref. SN587839). Coll. 1970 and subm. by J. A. Taylor, Dept. of Geog., Univ. Coll. of Wales, Aberystwyth. *Comment*: confirms pollen analysis which suggested Late Glacial age (Smith and Taylor, 1969).

12,320 ± 155
Birm-230. Rossall Beach, Fylde, Lancashire **10,370 B.C.**

Fine to medium organic silt rich in macrofossils including *Phragmites* at –0.94 to –0.99 m alt from peat bed in scoured depression in intertidal zone at Rossall Beach, Fylde, Lancashire (53° 53′ 51″ N Lat, 3° 02′ 54″ W Long, Grid Ref. SD3111438). Coll. 1969 and subm. by M. J. Tooley, Dept. of Geog., Univ. of Durham. *Comment*: determination indicates late Zone I, whereas pollen suggests Zone II.

3353 ± 134
Birm-231. Wandle Valley, Mitcham, Surrey **1403 B.C.**

Driftwood from gravel in Wandle Valley at Mitcham, Surrey (51° 24′ N Lat, 0° 09′ W Long, Grid Ref. TQ279682). Coll. 1970 and subm. by D. S. Peake. *Comment*: gravel is clearly late Holocene, unconnected with deposits of Birm-101 (10,130 ± 120; R., 1969, v. 11, p. 265) with Zone III date and arctic fauna.

Birm-234. Scandal Beck, Westmorland **>32,500**

Wood from upper of 2 organic horizons in sandy silt overlain by 1.5 m till ca. 5.8 m depth on W bank Scandal Beck, 64 m SSW Brunt Hill Farm, Ravenstonedale, Westmorland (54° 25′ N Lat, 2° 24′ W Long, Grid Ref. SE743024). Coll. 1970 and subm. by G. A. L. Johnson, Dept. of Geol., Univ. of Durham. *Comment*: earlier measurement on another sample (Birm-161, 36,300 $^{+2160}_{-1700}$; R., 1970, v. 12, p. 386) suggested interstadial of last glaciation, but pollen is claimed to be interglacial. This 2nd sample appeared to be inactive, but was insufficient to give a high value for 4σ.

21,530 ± 480
Birm-238. Lea Valley, Edmonton, Middlesex **19,580 B.C.**

Plant material at +6.25 to +6.86 m alt in sand and gravel overlying London Clay at Deephams Sewage Works, Edmonton, in Lea Valley, Middlesex (51° 37′ 30″ N Lat, 0° 02′ 45″ W Long, Grid Ref. TQ357936). Coll. 1970 by P. Tallon; subm. by G. R. Coope. *Comment*

(G.R.C.): dates arctic insect fauna. Deposit approx. equivalent to "Lea Valley Arctic Bed" (Q-25, 28,000 ± 1500; R., 1960, v. 2, p. 65). Site close to classic locality of this bed at Ponders End (Godwin, 1956).

10,515 ± 195
Birm-239. Drumurcher, Co. Monaghan, Ireland 8565 B.C.

Plant debris (terrestrial) washed from gray silty clay at ca. 2.4 m depth, overlain by brown muddy silt and underlain by gray sand at Drumurcher, Co. Monaghan, Ireland (54° 06′ 00″ N Lat, 7° 13′ 00″ W Long, Grid Ref. H5218). Coll. 1970 and subm. by G. R. Coope. *Comment* (G.R.C.): sample from well below normal water table contains few or no intrusive roots. Establishes age of richest arctic insect fauna yet found in Ireland.

B. Miscellaneous Geologic Samples

British Antarctic Survey series

Samples of whale bone from emerged beaches in South Shetland Is. Coll. 1966 by D. E. Sugden; subm. by B. S. John.

1056 ± 130
Birm-50. A.D. 894

Collagen from interior of *Centrum* solidly embedded in emerged beach at ca. +3 m alt at E end of S beach of Byers Peninsula, Livingston I., Antarctica (62° 40′ S Lat, 60° 56′ W Long).

1390 ± 140
Birm-224. A.D. 560

Collagen from rib lying on emerged beach at ca. +7.6 m alt at S coast of Barton Peninsula, King George I., Antarctica (62° 14′ S Lat, 58° 47′ W Long).
General Comment: possibility of hard-water effect (Broecker, 1963) making these samples indistinguishable from recent animals.

Oberbayern series, Germany

Wood (now strongly compressed to lignite) in sediments which antedate Main Würm glaciation and which are claimed by E. Ebers to belong to mid-Würm interstadial rather than to Riss/Würm interglacial (Ebers, 1965; Reich, 1952; 1953). Coll. between 1967-1969 and subm. by E. Ebers.

35,800 ± 620
Birm-178. Zeifen, Oberbayern, Germany 33,850 B.C.

Lignite lying above Zeifen Riss/Würm interglacial and below Laufen Gravel and drumlinized till of Main Würm at Post Petting, Oberbayern, Germany, in foreland of Bavarian Alps (47° 56′ N Lat, 12° 49′ E Long).

+2000
45,600
−1600
Birm-203. Lech, Oberbayern, Germany 43,650 B.C.

Wood in lacustrine beds of former Lech Glacier in foreland of

Bavarian Alps at Schlogel-Muhle bei Steingaden, Lech, Oberbayern, Germany (47° 42′ N Lat, 10° 52′ E Long).

Birm-237. Grossweil, Oberbayern, Germany **42,365 +1570 −1320** **40,415 B.C.**

Lignite overlain by moraine and underlain by gravel and blue clay in former coal mine at Grossweil, Oberbayern, Germany (47° 40′ N Lat, 11° 18′ E Long).

General Comment (F.W.S.): spread of dates supports interstadial age, around time which, in Britain, was one of mild climate (Upton Warren phase). All samples pretreated with NaOH but appeared uncontaminated.

Birm-180. Tenerife, Canary Islands **(a) >25,200** **(b) >31,000**

Carbonized wood from impermeable ignimbrite overlying extensive air-fall pumice deposit (Granadilla pumice) assoc. with latest massive explosive eruption of Tenerife volcano. Sample from quarry 2 km NE of Los Cristianos on S slope of shield volcano at Tenerife, Canary Is. (28° 03′ N Lat, 16° 41′ W Long). Coll. 1968 and subm. by G. P. L. Walker, Geol. Dept., Imperial College, London. *Comment* (R.E.G.W.): sample partially broke down during acid pretreatment giving a heavy oily organic liquid, which was filtered off and residue, after evaporation, dated as filtrate (a). Remaining solid was insufficient for alkali pretreatment and dated as sample (b).

Azores Volcanic series

Birm-181. San Miguel, Azores **663 ± 105** **A.D. 1287**

Carbonized wood enclosed in pumice ash of crater wall on S flank of Caldeira Secca, 300 m S of center of core of Sete Cidades at W end of I. of San Miguel, Azores (37° 51′ N Lat, 24° 48′ W Long). Coll. 1969 and subm. by G. P. L. Walker. *Comment* (G.P.L.W.): represents one of latest explosive eruptions of Sete Cidades volcano.

Birm-225. Furnas, San Miguel, Azores **2900 ± 120** **950 B.C.**

Fossil wood from permeable ash deposit on rim of Furnas Caldera 0.6 km W of Lagoa Furnas and 1.2 km ENE of peak Cedros, San Miguel, Azores (37° 45′ 30″ N Lat, 25° 21′ 00″ W Long). Coll. 1969 and subm. by G. P. L. Walker. *Comment*: sample younger than Fogo A pumice deposit dated as Birm-35, 4672 ± 100 (R., 1968, v. 10, p. 204) and Birm-90, 4435 ± 99 (R., 1969, v. 11, p. 266).

Baie d'Ecalgrain series, Manche, France

Plant material washed from lower of 2 thin beds of peaty silt at base of cliff, separated by thin head, lying on gravel and rock platform of Normannian beach, and overlain by thick (ca. 30 to 40 m) coarse head at Baie d'Ecalgrain, Manche, France (49° 41′ 30″ N Lat, 1° 56′ 30″ W Long) (Ters and Pinot, 1969).

Birm-183. **>37,000**

Small sample coll. 1969 and subm. by F. W. Shotton.

Birm-211. **(a) 40,750 +2100 −1650** **38,800 B.C.** **(b) >44,500**

Part of much larger sample coll. 1970 and subm. by C. Larsonneur, Dept. of Geol., Univ. of Caen, Calvados, France. Visibly contaminated with modern rootlets. (a) washed sample, all recognizable rootlets removed and alkali treated; (b) was result of gasifying a small quantity of washed-out twigs (uncontaminated) and adding this to gas of (a) in proportions 9/19.

General Comment (F.W.S.): Birm-211(a) clearly still contaminated and date must be early to mid-Weichselian or possibly Eemian. Pollen suggests open country with predominance of *Pinus* and *Betula* (Elhai, 1962) and assoc. beetle fauna indicates cool climate. Earlier date of 12,600 ± 400 must be erroneous (Gif-368, R., 1969, v. 11, p. 328).

Birm-204. Kinabalu, North Borneo **6800 ± 175** **4850 B.C.**

Fine detritus mud from 40 to 45 cm depth below mud surface in sacrificial pool at foot of Low's Peak, Mt. Kinabalu, Sabah, N. Borneo (6° 05′ N Lat, 116° 35′ E Long). Coll. 1969 and subm. by J. R. Flenley, Dept. Geog., Univ. of Hull. *Comment*: date is minimum for start of organic accumulation and for deglaciation at this alt, ca. 4020 m (Koopmans and Stauffer, 1968; Newton-Smith and Wilford, 1969; Stauffer, 1968).

Birm-205. Kuim, Tasek Bera, Malay Peninsula **4496 ± 140** **2546 B.C.**

Course detritus mud from 8.25 to 8.45 m depth below water level at Kuim, Tasek Bera, Pahang, Malay Peninsula (3° 10′ N Lat, 102° 35′ E Long). Coll. 1969 and subm. by J. R. Flenley. *Comment*: date is minimum for start of organic accumulation and also possibly for diversion of R. Pahang.

Tofua Island series, Tonga

Part of carbonized tree trunk from base of pyroclast succession in fine-grained gray andesitic ash 200 m S of Hota'ane on W coast of Tofua I., Tonga (19° 48′ S Lat, 175° 04′ W Long). Coll. 1969 and subm. by P. E. Barker, Dept. of Earth Sci., Univ. of Leeds.

Birm-216. **970 ± 50** **A.D. 980**

Birm-241. **1032 ± 105**
A.D. 918

Comment: estimated age ca. 25,000 B.P. Two separate determinations done on different material of same sample agree, but material clearly intrusive.

Birm-226. Lota Coal Mine, Victoria, Chile **>41,200**

Coalified wood from Pliocene unconformity at 350 m level in Lota Coal Mine ca. 3.2 km W of Lota under Bay of Arauco, Victoria, Chile (37° 08′ S Lat, 73° 00′ W Long). Coll. 1970 by unnamed Chilean miners; subm. by R. H. Allonby, Natl. Coal Bd. *Comment*: miners believed sample part of old pit prop from previous workings but position under sea made this impossible. Determination precludes pit prop theory.

Birm-235. Tongariro, North Island, New Zealand **2070 ± 88**
120 B.C.

Carbonized branch imbedded in Wanganui pumice gravel S side of rd. sec. State Hwy. 47 at Tongariro, North I., New Zealand (39° 03′ 40″ S Lat, 175° 35′ 00″ E Long). Coll. 1969 and subm. by C. A. Fleming. *Comment*: repeat of Birm-145, 2600 ± 100; R., 1970, v. 12, p. 394), made on another piece of wood from same branch, inexplicably discrepant. Pretreatment was the same for both; extraction of rootlets followed by full acid and alkali treatment. Birm-145 very different from Inst. Nuclear Sci., New Zealand date (unpub.) on sample from same branch (1925 ± 66 before arbitrary subtraction of 100 yr for Suess effect). Birm-235 is closer to NZ result but still needs explanation of a significant difference; NZ correction for δC^{13} of −30.2 would account for 83 yr difference, placing the 2 dates into comparative ranges. Birm-145 must be erroneous.

II. ARCHAEOLOGIC SAMPLES

A. British Isles

St. Bertelin's Chapel series, Staffordshire

Samples of wood and charcoal from church yard at St. Bertelin's Chapel, Stafford (52° 49′ N Lat, 2° 07′ W Long, Grid Ref. SJ919235). Coll. 1954 by A. Oswald; subm. by P. H. Robinson.

Birm-137. **770 ± 78**
A.D. 1180

Oak believed part of cruciform coffin of St. Bertelin.

Birm-136. **(a) 1105 ± 90**
A.D. 845
(b) 1120 ± 120
A.D. 830

Charcoal assoc. with wood remains believed cruciform coffin of St. Bertelin. Determinations done on separate portions of same material but methane prepared from different hydrogen sources.

General Comment: close correspondence of Birm-136(a) and (b) suggests validity of date. It could have been a wooden object from a Saxon church, for such material was burnt when no longer required. Unless contaminated, Birm-137, which is probably wood of a coffin, must be later and not connected with St. Bertelin.

Birm-185. Croft Ambrey, Herefordshire **(a) 2410 ± 135**
460 B.C.
(b) 2377 ± 136
427 B.C.

Charcoal from large timbers on rd. at SW gateway of Croft Ambrey Hill Fort, Aymestry, Herefordshire (52° 18′ N Lat, 2° 49′ W Long, Grid Ref. SO445668). Coll. 1964 and subm. by S. C. Stanford, Dept. of Extramural Studies, Univ. of Birmingham. Sample (a) after alkali pretreatment, (b) humate extract. *Comment*: dates destruction of guardrooms of Iron age fort and accords closely with comparable fortification at Midsummer Hill (Birm-142, 2370 ± 190; Birm-143, 2000 ± 100; R., 1970, v. 12, p. 396). Birm-144 from Croft Ambrey still remains anomalously old (3000 ± 200).

Cannington series, Somerset

Collagen extracted from bone samples from different graves in Christian burial ground near mouth of R. Parret, Cannington, Somerset (51° 09′ N Lat, 3° 04′ W Long, Grid Ref. ST252404). Coll. 1963 and subm. by P. A. Rahtz, School of Hist., Univ. of Birmingham.

Birm-186. **(a) 1320 ± 160**
A.D. 630
(a) 1370 ± 230
A.D. 580

Two determinations done on different rib bones from same skeleton (Grave 424) agree with determination from same site (Birm-70, 1220 ± 110; R., 1969, v. 11, p. 268) but different grave (Grave 409).

Birm-193. **1610 ± 105**
A.D. 340

Sample from Grave 402.

Birm-194. **1685 ± 100**
A.D. 305

Sample from Grave 197.

General Comment: Birm-193 and Birm-194 so closely agree and are, apparently, so much younger than Birm-70 and Birm-186, they suggest a cemetery overlapping conversion to Christianity.

Mam Tor series, Derbyshire

Samples from Mam Tor Hill Fort, Derbyshire (53° 21′ 00″ N Lat, 2° 51′ 30″ W Long, Grid Ref. SK128837). Coll. 1968 and subm. by D. G. Coombs, Dept. of Hist., Univ. of Manchester.

3130 ± 132
Birm-202. 1180 B.C.

Charcoal from layer into which gulleys and post holes were cut for hut, in NE corner of site behind rampart.

3080 ± 115
Birm-192. 1130 B.C.

Charcoal from same layer as Birm-202 but E of hut in NE corner of site (Coombs, 1967).
General Comment: dates agree well but are older than expected. Estimated age: 2500 B.P.

1414 ± 107
Birm-198. King's School, Worcester A.D. 536

Collagen from human rib bones of uncoffined burial (Grave 1) below foundations of wall built in 17th century A.D. at Undercroft, College Hall, King's School, Worcester (52° 11′ 20″ N Lat, 2° 13′ 15″ W Long, Grid Ref. SO850545). Coll. 1969 and subm. by P. A. Barker, Dept. of Extramural Studies, Univ. of Birmingham. *Comment*: estimated age very vague, between 400 and 1200 A.D.

Sharpstones Hill series, Shrewsbury

Samples from fill of pit containing cremation debris of supposed Late Bronze age at Sharpstones Hill, Shrewsbury (52° 41′ N Lat, 2° 44′ W Long, Grid Ref. SJ508106). Coll. 1965 and subm. by W. E. Jenks, Shropshire Archaeol. Soc.

3205 ± 130
Birm-206. 1255 B.C.

Charcoal from Site B, F49.

2970 ± 118
Birm-207. 1020 B.C.

Charcoal from Site B, F57.
General Comment: confirms cremation cemetery is of Late Bronze or Middle Bronze age and dates assoc. pottery which is atypical.

Ryton-on-Dunsmore series, Warwickshire

Samples from Bronze/Iron age settlement and cemetery near Ryton Wood at Ryton-on-Dunsmore, Warwickshire (50° 20′ 56″ N Lat, 1° 27′ 22″ W Long, Grid Ref. SP371723) on parish boundary with Bubbenhall. Coll. 1970 and subm. by J. Bateman.

2785 ± 120
Birm-227. 835 B.C.

Charcoal from 0.6 m down in ditch 0.8 m deep. *Comment*: indicates Late Bronze age for sample (see also Birm-26, 2701 ± 41; R., 1968, v. 10, p. 204).

2870 ± 106
Birm-228. 920 B.C.

Charcoal from a cremation pit beneath 40 to 50 cm of plough soil. *Comment*: indicates Late Bronze age for sample.

B. Miscellaneous Archaeologic Samples

5825 ± 145
Birm-182. Ayios Epikitos Vrysi, Cyprus 3875 B.C.

Hearth material underlying yellow clay at 1.8 m depth, 10.5 km E of Kyrenia on coast at Ayios Epikitos Vrysi, Cyprus (35° 40′ N Lat, 33° 26′ E Long). Coll. 1969 and subm. by P. S. Gelling, Dept. of Ancient Hist. and Archaeol., Univ. of Birmingham. *Comment*: agrees well with estimated age of occupation of site of ca. 4000 B.C.

3502 ± 150
Birm-199. Alicante, Spain 1552 B.C.

Charcoal from Catí Foradá, Petrel, Alicante, Spain (38° 30′ 34″ N Lat, 20° 59′ 40″ E Long). Coll. 1969 and subm. by M. J. Walker, Dept. of Anatomy, Univ. Medical School, Edinburgh. *Comment*: estimated age: 3500-4500 B.P.

$\delta C^{14}‰ = -16.7 \pm 13.3$
Birm-200. Murcia, Spain Modern

Charcoal from dry limestone rock shelter at Barranco de los Grajos, Cieza, Murcia, Spain (38° 16′ 00″ N Lat, 2° 18′ 53″ E Long). Coll. 1969 and subm. by M. J. Walker. *Comment*: it was hoped to ascertain date of flint and ceramic industry assoc. with nearby rock paintings of Early Neolithic attribution (estimated age: 5000-8000 B.P.). Sample clearly intrusive and could be explained by evidence of recent disturbance of earth in which sample lay.

REFERENCES

Bell, F. G., 1968, Weichselian glacial floras in Britain: Ph.D. dissert., Univ. of Cambridge.

———— 1969, The occurrence of southern steppe and halophyte elements in Weichselian (last-glacial) floras from southern Britain: New Phytol., v. 68, p. 913-922.

Broecker, W. S., 1963, Radiocarbon ages of Antarctic materials: Polar Record, v. 11, no. 73, p. 473.

Coombs, D. G., 1967, Interim report on 1967 excavation: Derbyshire Archaeol. Jour., v. 87, p. 158-159.

Dickson, C. A., Dickson, J. H., and Mitchell, G. F., 1970, The Late Glacial flora of the Isle of Man: Royal Soc. [London] Philos. Trans., v. 259, p. 31-79.

Ebers, E., 1965, Evidence of an older Würm glacial maximum and a middle Würm Interstadial in the Alps, *in*: Studies in Earth Sci., no. 7, VII INQUA Congress Proc., v. 14, Boulder, Colorado.

Elhai, H., 1962, Analyse pollinique d'un dépôt organique intercalé dans le head d'Ecalgrain: Soc. Linn. de Normandie Bull., v. 10, no. III, p. 93-95.

Godwin, H., 1956, The history of the British flora: Cambridge, Cambridge Univ. Press.

Jamieson, T. F., 1906, The Glacial period in Aberdeenshire and the southern border of the Moray Firth: Quart. Geol. Soc. London Jour., v. 62, p. 13-39.

Jardine, W. G., 1967, The Post-glacial marine transgression at Girvan, Ayrshire: Inst. Br. Geog. Trans., no. 42, p. 181-182.

John, B. S., 1965, A possible Main Würm glaciation in West Pembrokshire: Nature, v. 207, p. 622-623.

Koopmans, B. N. and Stauffer, P. H., 1968, Glacial phenomena on Mount Kinabalu, Sabah: Borneo Region, Malaysia Geol. Survey Bull., v. 8, p. 25-35.

Mitchell, G. F., 1965, The Late Quaternary of the Ballaugh and Kirkmichael districts, Isle of Man: Geol. Soc. London Quart. Jour., v. 21, p. 359-381.

Morgan, A., 1970, Weichselian insect faunas of the English Midlands: Ph.D. dissert., Univ. of Birmingham.

Morgan, A. V., 1970, The glacial geology of the area North and West of Wolverhampton: Ph.D. dissert., Univ. of Birmingham.

Newton-Smith, J. and Wilford, G. E., 1969, Radiocarbon age determination on wood from Kambawangoh, Sabah: Borneo Region, Malaysia Geol. Survey Bull., v. 9, p. 36-7.
Penny, L. F., 1964, A review of the last glaciation in Great Britain: Yorkshire Geol. Soc. Proc., v. 34, pt. 4, no. 20, p. 387-411.
Read, H. H., 1923, The geology of the country round Banff, Huntly and Turriff: Geol. Survey Mem., *Explanation of* Sheets 86 and 96.
Reich, H., 1952, Zur vegetationsentwicklung des interglaziale von Grosswell: Eiszeitalter und Gegenwart, v. 2, p. 108-119.
——— 1953, Die vegetationsentwicklung der interglaziale von Grossweil-Ohlstadt und Pfefferbichl im Bayerischen Alpenvorland: Flora, v. 140, p. 386-443.
Shotton, F. W., 1967, Age of the Irish Sea Glaciation of the Midlands: Nature, v. 215, no. 5108, p. 1366.
Sissons, J. B., 1967, Glacial stages and radiocarbon dates in Scotland: Scot. Jour. Geol., v. 3, pt. 3, p. 375-381.
Smith, R. T. and Taylor, J. A., 1969, Post glacial development of vegetation and soils in North Cardiganshire: Inst. Br. Geog. Trans., no. 48, p. 75-96.
Stauffer, P. H., 1968, Glaciation of Mount Kinabalu: Geol. Soc. Malaysia Bull., no. 1, p. 63.
Ters, M. and Pinot, J. P., 1969, Livret-Guide de l'excursion A.10, Littoral Atlantique: VIII INQUA Congress Proc., Paris.

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BRITISH MUSEUM NATURAL RADIOCARBON MEASUREMENTS VII

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Dates listed below are based on measurements made from June 1968 to May 1970 by the liquid scintillation technique using benzene. In general, the experimental procedure is as described previously (Barker, Burleigh, and Meeks, 1969a) with a few changes in detail. Data are now processed by computer using a comprehensive Algol program written by Andrew Barker, King's College, Univ. of London. There is no need to standardize on any particular sample weight and, as the benzene synthesizer can also deal with samples in the range up to the equivalent of 9 gm of carbon in a single synthesis, the amount of sample available is now less critical. However, for older material, a minimum of 1 gm of carbon is required. Another factor contributing to efficiency of operation is the "bomb" technique for sample combustion (Barker, Burleigh, and Meeks, 1969b), also mentioned in the previous date list. Finally, during 1969, an MS20 double collection mass spectrometer was acquired and all dates (but not all those in this list) are now corrected for isotopic fractionation.

Samples were pretreated for removal of contaminants, with dilute hydrochloric acid and, where appropriate, with dilute alkali also. Bone and antler samples were demineralized in low vacuum with 0.75 N hydrochloric acid at ambient temperature, leaving only the protein fraction (collagen) which was washed and dried before combustion. Dates were calculated using the Libby half-life for C^{14} of 5568 years. Descriptions, comments, and references to publications are based on information supplied by the persons who contributed the samples.

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SAMPLE DESCRIPTIONS

ARCHAEOLOGIC SAMPLES

A. Belgium

BM-372. Moerzeke-Mariekerke figurehead **1598 ± 70**
A.D. 352

Wood (oak) from animal-headed post, probably stem-post from a boat, found ca. 1939, during dredging operations, in the R. Scheldt between Moerzeke and Mariekerke, Belgium (51° 04′ N Lat, 4° 09′ E Long). Subm. by R. L. S. Bruce-Mitford from British Mus. colln. *Comment*: date agrees well with BM-476, below; with which the Moerzeke-Mariekerke head shares some very distinctive stylistic features (Bruce-Mitford, 1967; 1970). Dates show that both heads belong to Migration period.

BM-476. Appels figurehead **1550 ± 105 A.D. 400**

Wood (oak) from animal-headed post, probably stem-post from a boat, found in 1938 in the R. Scheldt near Appels, Belgium (51° 02′ N Lat, 4° 03′ E Long). Subm. by R. L. S. Bruce-Mitford from British Mus. colln. *Comment*: see BM-372, above. Appels figurehead previously assumed to belong to Viking period; date shows that this figurehead belongs to Migration period (Bruce-Mitford, 1967; 1970).

Flint mine chronology series

Antler picks from Neolithic flint mines dated for comparison with similar mines in S England (Barker, Burleigh, and Meeks, 1969a), to be pub. elsewhere (Sieveking, ms. in preparation). Only the protein fractions were used for date measurements. Subm. by G. de G. Sieveking, British Mus.

BM-289. Spiennes **4230 ± 130 2280 B.C.**

Antler pick (ref. 1960, 2.63) from Spiennes, Mons, Prov. of Hainaut, Belgium (50° 26′ N Lat, 3° 59′ E Long). Coll. ca. 1855 by D. Tolliez. Sample is from Tolliez colln. now in Ashmolean Mus., Oxford, originally from surface atelier at top of the mine shaft (de Mortillet, 1868). *Comment*: site is large and mines were evidently in active use for a long period as in the case of Grimes Graves mines, Norfolk, England (Barker and Mackey, 1963). Mining probably began earlier at Spiennes than at Grimes Graves, about same time as at Cissbury area flint mines in S England (Barker, Burleigh, and Meeks, 1969a).

BM-417. Mesvin **5131 ± 123 3181 B.C.**

Antler pick (ref. 2, P. 1, Base N) from base of Shaft I at 4.2 m depth at Sans Pareil mine, Mesvin, Mons, Prov. of Hainaut, Belgium (50° 24′ 53″ N Lat, 3° 57′ 24″ E Long). Coll. 1957 by P. H. Moisin, Soc. Recherche Préhistorique en Hainaut. *Comment*: date agrees well with measurements of 2 charcoal samples from same mine: Lv-65, 5220 ± 170 and Lv-216, 5340 ± 150 (Gilot, Ancion, and Capron, 1966).

BM-638. Eglise des Récollets **705 ± 60 A.D. 1245**

Collagen separated from part of right tibia (ref. Sample C) from human skeleton attributed to Margaret of York from Eglise des Récollets, Mechelen, Belgium (51° 2′ N Lat, 4° 30′ E Long). Coll. 1937 by Winders Max; subm. by F. Twiesselmann, Inst. Royal des Sci. Nat. Belgique. Other samples from bones attributed to Margaret of York dated by Inst. Royal du Patrimoine Artistique (Twiesselmann, 1970, written commun.). *Comment*: date suggests that it did not belong to skeleton of Margaret of York, who died in A.D. 1503, for which a date ca. 240 yr before 1950 would be expected (see Stuiver and Suess, 1966, fig. 1, p. 538 for relation between radiocarbon ages and true ages for last millennium).

B. Egypt

Egyptian chronology series

The following series consists mainly of samples recently coll. by G. T. Martin, Christ's College, Cambridge, from the Egypt Exploration Society's excavations under W. B. Emery at Sakkara and from the British Mus. colln. Extreme care was taken to ensure secure archaeologic dates, and, where possible, material such as reed or fabric of one or only a few seasons growth, was obtained. Samples were subm. by I. E. S. Edwards, British Mus. This series continues our work on discrepancies between radiocarbon and calendar yr previously reported in 1969, v. 11, p. 281-283. Portions of each sample were also measured by Arizona and UCLA labs (Berger, 1970). Wood samples id. by F. R. Richardson, Jodrell Lab., Royal Botanic Gardens, Kew, Surrey (Täckholm and Drar, 1941). Two samples, BM-381 and BM-530, are concerned with general Egyptian chronologic problems and not primarily with C^{14} discrepancies. Radiocarbon dates for materials historically dated to 2nd and 3rd millennia B.C. generally confirm trend of C^{14} discrepancies based on measurements of bristlecone pine wood from SW U.S. reported by Suess (1967, 1970), although fine structure of the bristlecone calibration curve is not resolvable with archaeologic material. (For more detail, see Edwards, 1970; Berger, 1970).

BM-317. Mentuhotep II — **3433 ± 65**, **1483 B.C.**

$\delta C^{13} = -29.0‰$

Wood (*Acacia* sp., probably *A. nilotica* L) from outermost rings of small tree trunk from mortuary temple of Neb-hepet-re-Mentuhotep II (XI Dynasty, ca. 2010 B.C. at Deir el Bahri, Thebes, Egypt (25° 44′ N Lat, 32° 38′ E Long). Coll. 1907 by Egypt Explor. Fund; subm. from British Mus. colln. (E.A. no. 47791). Check on previous gas proportional counter measurement BM-21, 3580 ± 150 (Barker and Mackey, 1959). Age based on 5730 yr half-life 3536 ± 67, 1586 B.C.

Tomb of Wadji

Four wood samples from tomb (3504) of Wadji (Ist Dynasty, ca. 3025 B.C.) at Sakkara Archaic Cemetery, Egypt (29° 51′ N Lat, 31° 14′ E Long). Coll. ca. 1950 by W. B. Emery (1954).

BM-319. Wadji — **4225 ± 70**, **2275 B.C.**

$\delta C^{13} = -28.4‰$

Age based on 5730 yr half-life 4352 ± 72, 2402 B.C. Also dated by GrN-1100, 4360 ± 60, 2410 B.C. and GrN-1109, 4460 ± 55, 2510 B.C. (de Vries and Waterbolk, 1958).

BM-320. Wadji — **4206 ± 80**, **2256 B.C.**

$\delta C^{13} = -25.2‰$

Age based on 5730 yr half-life 4332 ± 83, 2382 B.C.

BM-321. Wadji — **4496 ± 80**
2546 B.C.
δC^{13} = –25.4‰

Age based on 5730 yr half-life 4630 ± 83, 2680 B.C.

BM-322. Wadji — **4349 ± 70**
2399 B.C.
δC^{13} = –24.5‰

Age based on 5730 yr half-life 4479 ± 72, 2529 B.C.

BM-323. Hemaka — **4342 ± 70**
2392 B.C.
δC^{13} = –26.3‰

Wood (*Acacia* sp., probably *A. nilotica* L) from mastaba of a nobleman, Hemaka (reign of Udimu, Ist Dynasty, ca. 3000 B.C.) at Sakkara Archaic Cemetery, Egypt (29° 51′ N Lat, 31° 14′ E Long). Coll. 1937 by W. B. Emery (1938). Check on previous gas proportional counter measurement BM-27, 4100 ± 150 (Barker and Mackey, 1959). Sample also dated by P-214, 4447 ± 150 (Ralph, 1959). Age based on 5730 yr half-life 4472 ± 72, 2522 B.C.

Pyramid of Sneferu

Two wood samples coll. ca. 1950 by Ahmed Fakhry (1959) from S pyramid of Sneferu (IVth Dynasty, ca. 2600 B.C.) at Dahshur, S of Sakkara, Egypt (29° 45′ N Lat, 31° 14′ E Long).

BM-324. Sneferu — **3974 ± 70**
2024 B.C.
δC^{13} = –23.4‰

Wood (*Juniperus* sp., possibly *J. phoenicea* L) from W passage of S pyramid of Sneferu. Age based on 5730 yr half-life 4093 ± 72, 2143 B.C.

BM-325. Sneferu — **3852 ± 80**
1902 B.C.
δC^{13} = –26.0‰

Wood (*Cupressus* sp., probably *C. sempervirens* L) from upper chamber of S pyramid of Sneferu. Age based on 5730 yr half-life 3983 ± 83, 2033 B.C.

BM-330. Mereruka — **3770 ± 115**
1820 B.C.
δC^{13} = –22.9‰

Reed used as bonding between mud-brick courses, W wall of superstructure, tomb of Mereruka at Sakkara, Egypt (29° 51′ N Lat, 31° 14′ E Long). Mereruka was a great official of Teti, 1st king of VIth Dynasty, ca. 2350 B.C. (Duell, 1938). Coll. 1967 by G. T. Martin (Sample 1/67). Age based on 5730 yr half-life 3880 ± 118, 1930 B.C.

BM-331. Teti

3770 ± 85
1820 B.C.
$\delta C^{13} = -22.8‰$

Wood (*Pinus* sp., probably *P. pinea* L) from outermost growth rings of large beam (145 × 19 × 19 cm) supporting royal sarcophagus in pyramid of Teti, ca. 2350 B.C., at Sakkara, Egypt (29° 51′ N Lat, 31° 14′ E Long). Sarcophagus cannot have been moved since it was placed in position (Leclant, 1966). Coll. 1967 by G. T. Martin (Sample 2/67). Age based on 5730 yr half-life 3880 ± 88, 1930 B.C.

BM-332. Cheops boat

3990 ± 105
2040 B.C.
$\delta C^{13} = -16.5‰$

Halfa-grass rope (Nour *et al.*, 1960) from funerary boat of Cheops, S side of Great Pyramid, Giza, Egypt (29° 58′ N Lat, 31° 08′ E Long). Rope is archaeologically sealed to reign of Cheops, 2nd king of IVth Dynasty, ca. 2600 B.C. Coll. 1967 by Zaky Iskander (Sample 3/67). Age based on 5730 yr half-life 4100 ± 108, 2150 B.C.

BM-333. Ramasseum

2940 ± 100
990 B.C.
$\delta C^{13} = -14.0‰$

Reed used as bonding between mud-brick courses of storage magazine in NW corner of Ramasseum enclosure at Thebes, Egypt (25° 41′ N Lat, 32° 40′ E Long). The Ramasseum (Quibell, 1898) is funerary temple of Ramasses II, XIXth Dynasty, so that sample is sealed to reign of Ramasses II (ca. 1290-1224 B.C.). Coll. 1967 by G. T. Martin (Sample 4/67). Age based on 5730 yr. half-life 3020 ± 103, 1070 B.C.

BM-334. Mentuemhat

2450 ± 70
500 B.C.
$\delta C^{13} = -12.4‰$

Reed used as bonding between mud-brick courses of E side of pylon of tomb (No. 34) of Mentuemhat, Fourth Prophet of Amun at Asasif, Thebes, Egypt (25° 41′ N Lat, 32° 40′ E Long). Mentuemhat was a great official in Thebes during reigns of Taharka and Psammetichus I (Leclant, 1961). Sample is archaeologically sealed to period 689 to 610 B.C. (end XXVth–beginning XXVIth Dynasties). Coll. 1967 by G. T. Martin (Sample 5/67). Age based on 5730 yr half-life 2520 ± 72, 570 B.C.

BM-335. Mentuhotep III

3670 ± 75
1720 B.C.
$\delta C^{13} = -27.4‰$

Wood from building ca. 90 m W of chapel of King S'ankh-Ka-rē′ Mentuhotep III, (XIth Dynasty, ca. 2000 B.C.) on hill behind W Thebes, Egypt (25° 41′ N Lat, 32° 40′ E Long). Fragments of wood were lying on ground surface among broken mud-bricks, possibly remains of wooden columns (Petrie, 1909). Comparison of brick sizes suggests building was contemporary with S'ankh-Ka-rē' chapel. Coll. 1967 by G. T. Martin (Sample 6/67). Age based on 5730 yr half-life 3780 ± 77, 1830 B.C.

BM-336. Tjanefer

2890 ± 100
940 B.C.
$\delta C^{13} = -14.4‰$

Reed used as bonding between mud-brick courses of pyramidal chapel of tomb (No. 158) of Tjanefer, Third Prophet of Amun (Seele, 1959) at Dra' Abû el-Naga', Thebes, Egypt (25° 41′ N Lat, 32° 40′ E Long). Tjanefer flourished from reign of Seti II (1214 to 1208 B.C.), XIXth Dynasty to that of Ramasses III (1182 to 1151 B.C.), XXth Dynasty. Coll. 1967 by G. T. Martin (Sample 7/67). Age based on 5730 yr half-life 2970 ± 103, 1020 B.C.

BM-337. Tjanefer

3080 ± 75
1130 B.C.
$\delta C^{13} = -26.9‰$

Wood (*Acacia* sp.) from branch embedded during construction in mud-brick superstructure of tomb (No. 158) of Tjanefer at Dra' Abû el-Naga', Thebes, Egypt (25° 41′ N Lat, 32° 40′ E Long). See BM-336, above. Coll. 1967 by G. T. Martin (Sample 8/67). Age based on 5730 yr half-life 3170 ± 77, 1220 B.C.

BM-338. Roma

3030 ± 85
1080 B.C.
$\delta C^{13} = -28.3‰$

Wood (*Tamarix* sp.) from branch embedded during construction in mud-brick superstructure of pyramidal chapel of tomb (No. 283) of Roma, High Priest of Amun (Fisher, 1924) at Dra' Abû el-Naga', Thebes, Egypt (25° 41′ N Lat, 32° 40′ E Long). Roma flourished during reign of Ramasses II, XIXth Dynasty, ca. 1250 B.C. Coll. 1967 by G. T. Martin (Sample 9/67). Age based on 5730 yr half-life 3120 ± 88, 1170 B.C.

BM-339. Bekenkhons

1210 ± 110
A.D. 740

Reed used as bonding between mud-brick courses, S side of pyramidal chapel, tomb (No. 35) of Bekenkhons, High Priest of Amun (Fisher, 1924) at Dra' Abû el-Naga', Thebes, Egypt (25° 41′ N Lat, 32° 40′ E Long). Bekenkhons was almost certainly the son of Roma (see BM-338, above) and also dates to reign of Ramasses II. Coll. 1967 by G. T. Martin (Sample 10/67). *Comment*: date is ca. 2000 yr later than expected historical age. Re-examination of site revealed that sample came from a later Coptic wall and not from original wall of Tomb 35. Sample has also been checked by Pennsylvania lab., 1125 ± 40, A.D. 835 (Stuckenrath, 1968, written commun.).

BM-340. Nectanebo

2310 ± 80
360 B.C.
$\delta C^{13} = -14.9‰$

Reed used as bonding between mud-brick courses of enclosure wall of Great Temple of Amun (Nims, 1965) at Karnak, Thebes, Egypt (25° 41′ N Lat, 32° 40′ E Long). Dated on evidence of brick stamps to reign of Nectanebo I, XXXth Dynasty, 380 to 363 B.C. Coll. 1967 by G. T. Martin (Sample 11/67). Age based on 5730 yr half-life 2380 ± 83, 430 B.C.

Intef

Five samples from complex of tomb (No. 386) of Overseer of Soldiers, Intef (Arnold and Settgast, 1965) at Asasif, Thebes, Egypt (25° 41′ N Lat, 32° 40′ E Long). Dated to the late XIth to early XIIth Dynasties ca. 2000 B.C. Intef was a contemporary of Neb-hepet-re Mentuhotep I (XIth Dynasty). Coll. 1963-1967 by J. Settgast, Deutsches Archäol. Inst. Wooden dowels, coll. 1966, from debris outside tomb of Intef were dated by UCLA-1211, 3500 ± 60, 1550 B.C. (Berger and Libby, 1967).

3500 ± 70
BM-341. Intef **1550 B.C.**
δC^{13} = –25.5‰

Flax cloth (linen) from entrance to Tomb T, N side of courtyard of tomb of Intef (Sample 12/67). Age based on 5730 yr half-life 3610 ± 72, 1660 B.C.

3660 ± 70
BM-342. Intef **1710 B.C.**
δC^{13} = –27.1‰

Charcoal (Sample 13/67) from entrance to Tomb T, N side of courtyard of tomb of Intef. Age based on 5730 yr half-life 3770 ± 72, 1820 B.C.

3720 ± 85
BM-343. Intef **1770 B.C.**
δC^{13} = –27.6‰

Wood (*Ficus* sp., probably *F. sycamorus* L), probably fragment of a coffin, from inner part of Tomb T, N side of courtyard of tomb of Intef (Sample 14/67). Age based on 5730 yr half-life 3830 ± 88, 1880 B.C.

2610 ± 70
BM-344. Intef **660 B.C.**
δC^{13} = –25.9‰

Fragment of wood (*Pinus* sp., probably *P. pinea* L) from burial chamber of tomb (No. 386) of General Intef (coll. 1963-64, Sample 15/67). Burial chamber was re-used for a later burial of the Saite period (XXVIth Dynasty, ca. 600 B.C.). Age based on 5730 yr half-life 2680 ± 72, 730 B.C. *Comment*: sample is clearly from funerary equipment of the later burial. See BM-345, below.

2580 ± 100
BM-345. Intef **630 B.C.**
δC^{13} = –27.8‰

Fragment of wood (*Ficus* sp., probably *F. sycamorus* L) from burial chamber of tomb (No. 386) of General Intef (coll. 1963-64, Sample 16/

67). Age based on 5730 yr half-life 2650 ± 103, 700 B.C. See BM-344, above.

3860 ± 80
BM-346. Haishetef **1910 B.C.**
$\delta C^{13} = -25.6‰$

Reed (Sample 17/67) used as bonding between mud-brick courses, E side of mastaba of Haishetef near S boundary wall of Zoser enclosure, Unas Pyramid cemetery, Sakkara, Egypt (29° 51′ N Lat, 31° 14′ E Long). Position of tomb in Unas Pyramid cemetery, fine workmanship of false door, and titles of tomb owner, indicate that it probably belongs to time of Unas, last king of the Vth Dynasty, (ca. 2350 B.C., although the last element of the name is typical of names of the First Intermediate Period, ca. 2200 B.C. Age based on 5730 yr half-life 3970 ± 83, 2030 B.C. *Comment*: result supports opinion that tomb dates to Old Kingdom rather than suggested later period for which a still younger date would be expected.

3650 ± 80
BM-347. Gebelein **1700 B.C.**
$\delta C^{13} = -27.8‰$

Wood (*Zizyphus* sp., probably *Z. lotus* Lam) from a Middle Kingdom bow found at Gebelein, near Edfu, S of Luxor, Egypt (24° 58′ N Lat, 32° 50′ E Long). Coll. 1967 by J. Settgast, (Sample 18/67). Tentatively dated to XIth Dynasty, ca. 2100 B.C. Age based on 5730 yr half-life 3750 ± 83, 1800 B.C.

2543 ± 70
BM-381. Tell el Fara'in **593 B.C.**
$\delta C^{13} = -26.7‰$

Reed (ref. Site B, Dd 25) used as bonding between mud-brick courses of temple wall at Tell-el Fara'in, Buto, Egypt (31° 12′ N Lat, 30° 45′ E Long). Coll. 1967 by M. V. Seton-Williams, Egypt Explor. Soc. Age based on 5730 yr half-life 2619 ± 72, 669 B.C. *Comment*: measurement was intended to date construction of wall of Buto considered to belong to Saite period (Seton-Williams, 1965, 1966, 1969). Date is 1st proof of this, apart from a stone fragment bearing the name of a Saite king (Amasis I) found after sample was subm. and confirms expected age of ca. 664-525 B.C.

3892 ± 64
BM-401. Ptahshepses **1942 B.C.**
$\delta C^{13} = -25.5‰$

Wood (*Acacia* sp., probably A. *nilotica* L) forming part of dowel found *in situ* in base of N column of portico of tomb of the vizier Ptahshepses (Vth Dynasty, reign of Niuserre, ca. 2450 B.C.) at Abu Sir, Egypt (29° 54′ N Lat, 31° 12′ E Long). Sample is archaeologically sealed to reign of King Niuserre. Coll. 1961 by Z. Žába, Czech. Inst. of Egyptol. (Sample 19/67). Age based on 5730 yr half-life 4006 ± 66, 2056 B.C.

BM-507. Sakkara

4047 ± 60
2097 B.C.
$\delta C^{13} = -26.4‰$

Reed used as bonding between mud-brick courses of superstructure, Tomb 3518 at Sakkara Archaic Cemetery, Sakkara, Egypt (29° 51′ N Lat, 31° 14′ E Long). Tomb is dated absolutely to reign of Zoser, IIIrd Dynasty, ca. 2650 B.C. Coll. 1969 by G. T. Martin (Sample 1/69). Age based on 5730 yr half-life 4165 ± 61, 2215 B.C.

BM-508. Sakkara

4106 ± 60
2156 B.C.
$\delta C^{13} = -27.0‰$

Flax rope found in undisturbed fill of S shaft of Tomb 3518 at Sakkara Archaic Cemetery, Sakkara, Egypt (29° 51′ N Lat, 31° 14′ E Long). Tomb is dated absolutely to reign of Zoser, IIIrd Dynasty, ca. 2650 B.C. Coll. 1969 by G. T. Martin (Sample 2/69). Age based on 5730 yr half-life 4226 ± 61, 2276 B.C.

BM-509. Sakkara

2243 ± 60
293 B.C.
$\delta C^{13} = -29.1‰$

Cloth wrapped round a papyrus document dated to yr 11 of Darius I (XXVIIth Dynasty, reigned 521-486 B.C.) at Sakkara Archaic Cemetery, Sakkara, Egypt (29° 51′ N Lat, 31° 14′ E Long). Papyrus and wrapping were probably contemporary. Coll. 1968 by G. T. Martin (Sample 3/69). Age based on 5730 yr half-life 2311 ± 61, 361 B.C.

BM-510. Sakkara

2361 ± 60
411 B.C.
$\delta C^{13} = -23.1‰$

Seeds from house from Coptic community built over courtyard of a series of shrines probably dating to Nectanebo II (XXXth Dynasty, ca. 360-343 B.C.) at Sakkara, Egypt (29° 51′ N Lat, 31° 14′ E Long). Adjacent houses were dated on numismatic evidence to last quarter of 4th century A.D. Coll. 1968 by G. T. Martin (Sample 4/69). *Comment*: date is ca. 800 yr earlier than expected; material dated is probably derived from supposed XXXth Dynasty shrines.

BM-511. Sakkara

2972 ± 60
1022 B.C.
$\delta C^{13} = -26.1‰$

Wood (*Pinus* sp.) from sarcophagus from grave cut into superstructure of Tomb 3518 at Sakkara Archaic Cemetery, Sakkara, Egypt (29° 51′ N Lat, 31° 14′ E Long). Grave contained pottery vessels including a fragment of Cypriote Base-ring I juglet, indicating date of early- to mid-XVIIIth Dynasty; also 2 dom-palm nuts. Coll. 1969 by G. T. Martin (Sample 5/69). Age based on 5730 yr half-life 3060 ± 61, 1110 B.C. *Comment*: see BM-512, below.

BM-512. Sakkara **2910 ± 50**
960 B.C.
$\delta C^{13} = -24.8‰$

Dom-palm nut shells from grave cut into superstructure of Tomb 3518, Sakkara Archaic Cemetery, Sakkara, Egypt (29° 51′ N Lat, 31° 14′ E Long). Pottery in grave suggested early- to mid-XVIIIth Dynasty date (see BM-511, above). Coll. 1969 by G. T. Martin (Sample 6/69). Age based on 5730 yr half-life 2997 ± 50, 1047 B.C. *Comment*: although assoc. pottery indicates date of ca. 1400 B.C., there is nothing else to date grave closely. Agreement between BM-511 and BM-512 suggests that Cypriote Base-ring juglet may have been re-used.

BM-530. Fayum **5388 ± 45**
3438 B.C.
$\delta C^{13} = -29.9‰$

Wood from part of a stick from Fayum 'A' neolithic site, Fayum, Egypt (29° 30′ N Lat, 30° 30′ E Long) excavated by Gertrude Caton-Thompson about 1925. Stick is in Dept. of Egyptian Antiquities colln., British Mus., (Caton-Thompson and Gardner, 1934, v. I, p. 45-46; v. II, pl. XXIX (2)). Subm. by I. E. S. Edwards, British Mus. Measurement made as check on original radiocarbon dates for Fayum 'A' (cereal grain, C-457, 6095 ± 250; C-550-551, 6391 ± 180; Libby, 1952, p. 70-71) and for comparison with 6th millennium B.C. dates obtained recently for some similar 'neolithic' cultures of S Libyan and Saharan deserts (Caton-Thompson, 1969, written commun.). Animal bones, the only other organic material now available from excavation (Caton-Thompson and Gardner, 1934, v. I, p. 34) had no remaining organic content. Wood from stick was carefully pretreated for complete removal of paraffin wax used as a preservative. Age based on 5730 yr half-life 5550 ± 46, 3600 B.C. *Comment*: date earlier than 5000 B.C. was suggested for Fayum culture in "The Desert Fayum" (p. 93). This now appears an over-estimate though there is abundant evidence elsewhere for primitive agriculture in 7th and 8th millennia B.C. Fayum 'A' was probably contemporary in part with pre-Dynastic cultures in Nile valley.

C. Ethiopia

BM-636. Debra Damo **198 ± 40**
A.D. 1752

Wood (*Olea* sp., possibly *O. europaea*) from Monastery Church of Debra Damo, N Ethiopia (14° 23′ N Lat, 39° 18′ E Long). Sample is from part of the exposed end of a 'binder' penetrating one of the walls. Coll. 1948 by D. H. Matthews; subm. by D. R. Buxton, Fac. of Oriental Studies, Univ. of Cambridge. *Comment*: the Church, which was founded in early Christian times and had probably assumed its present form by 10th century A.D., appears to have had extremely complicated history with several periods of dilapidation and re-building (Buxton, 1946, 1947; Matthews, 1949; Matthews and Mordini, 1959). Re-building or, at least, repairs were still being done in 18th century.

D. Germany

1480 ± 125

BM-373. Köstritz **A.D. 470**

Collagen separated from a human bone fragment found at ca. 15 m depth in Pleistocene gravels below bones of *Rhinoceros* at Köstritz, Gera Dist., Thüringen, E Germany (50° 56′ N Lat, 12° 01′ E Long). Coll. 1820 by Dr. Schammerring; subm. by K. P. Oakley, British Mus. (Nat. Hist.). *Comment*: sample was dated because specimen is listed in the forthcoming pub. (Oakley and Campbell, in press). It is oldest discovered human bone fragment in colln. of British Mus. (Nat. Hist.) and was formerly considered ancient (Hess von Wichdorff, 1931). Date shows that it was an intrusive fragment only of historic interest in view of early date at which alleged assoc. with a locally extinct animal species was noted (von Schlotheim, 1820).

E. Great Britain

Under this heading, measurements have been divided into groups of period or type of problem. Within each group, dates are listed in BM- number order.

Upper palaeolithic

Anston Stones cave series

Collagen separated from animal bone fragments and reindeer antler (id. by K. Joysey, Dept. of Zool., Univ. of Cambridge) from Creswellian horizons beneath a thick stalagmite layer in Anston Stones cave (Dead Man's cave), Anston, S Yorkshire, England (53° 20′ 41″ N Lat, 1° 12′ 18″ W Long). Natl. Grid Ref. SK 529834. Coll. 1967 and 1968 by G. White and M. Dolby; subm. by P. A. Mellars, Univ. of Newcastle upon Tyne. (See Mellars, 1969.)

9850 ± 115

BM-439. Anston Stones cave **7900 B.C.**

Bone fragments including reindeer (Sample 1, Sec. I, Spit 9), directly assoc. with characteristic Creswellian flint artifacts.

9940 ± 115

BM-440a. Anston Stones cave **7990 B.C.**

Bone fragments (Sample 2, Sec. I, Spit 9) within 0.6 to 1 m of Creswellian flints at same horizon but not in immediate assoc.

9750 ± 110

BM-440b. Anston Stones cave **7800 B.C.**

Reindeer antler fragment (Sample 3, Sec. XVII, Spit 6) not in direct assoc. with Creswellian flints but probably from same horizon.

General Comment (P.A.M.): dates are satisfactory and are 1000-3000 yr older than those previously available from a Creswellian site—Mother Grundy's Parlour, Creswell Crags (Godwin and Willis, 1962, p. 61) and indicate that earlier stages of Creswellian industry belong to early part of postglacial period.

BM-497. Badger Hole **>18,000**

Collagen separated from mammalian bone fragments (ref. Samples I, II, and III) from layer (C3) of firm reddish sandy silt resting on bedrock and probably representing an interstadial formation (possibly end of Upton Warren interstadial complex ca. 23,000 yr B.P.) in cave site of Badger Hole (McBurney, 1960) 70 m S from Wookey Hole, Mendip, Somerset, England (51° 13′ 42″ N Lat, 2° 40′ 12″ W Long). Natl. Grid Ref. ST 532479. Sample assoc. with undisturbed 'proto-Solutrean' point and indirectly with 2 human mandibular fragments. Coll. 1968 and subm. by J. B. Campbell, Jr., Pitt Rivers Mus., Oxford. *Comment* (H.B. and R.B.): small size of sample (<0.5 gm benzene) determined detectable age limit, older than 18,000 yr.

BM-524. Sun Hole **12,378 ± 150**
10,428 B.C.

Collagen separated from humerus of *Ursus arctos* (Find 66) from upper thermoclastic scree in entrance to Sun Hole cave, Cheddar Gorge, Mendip, Somerset, England (51° 16′ 59″ N Lat, 2° 45′ 50″ W Long). Natl. Grid Ref. ST 467541. Same layer of scree previously yielded ca. 50 Creswellian flints (Tratman, 1955). Sample 80 cm from nearest 2 diagnostic flints (including trapezoidal point and borer), was intended to date Creswellian industry at Sun Hole; approx. age of similar industry at Soldier's Hole and more prolific industries at Gough's cave and Flint Jack's cave in same area. Coll. 1968 and subm. by J. B. Campbell, Jr.

Mesolithic

BM-447. Cherhill **7230 ± 140**
5280 B.C.

Charcoal from base of tufa deposit overlying Mesolithic occupation site at Cherhill, Wiltshire, England (51° 26′ N Lat, 1° 57′ W Long). Natl. Grid. Ref. SU 031701. Dates Mesolithic industry of Sauvetterian type, onset of tufa formation, and beginning of Atlantic period (Zone VIIa). Coll. 1967 and subm. by J. G. Evans, Inst. of Archaeol., Univ. of London. *Comment* (J.G.E.): date compares well with Scaleby Moss series for Boreal/Atlantic transition (Zone VI/VIIa) Q-166, 6955 ± 131, Zone VIIa base; Q-165, 7432 ± 350, Zone VI/VII boundary; Q-167, 7361 ± 146, Zone VI top (Godwin *et al.*, 1957). Only Flandrian tufa date (ox bone) is Blashenwell, BM-89, 6450 ± 150, middle zone of tufa (Barker and Mackey, 1961). Date for base of tufa at Cherhill reinforces idea that onset of tufa formation coincided with beginning of Zone VIIa (see Kerney *et al.*, 1964). Preliminary assessment of flint industry suggests that it is of mixed origins and consists of basically Maglemosian assemblage with small proportion of microlithic forms with Sauvetterian affinities (cf. Wainwright, 1963, p. 114). Other relevant dates are: for Sauvetterian industry at Shippea Hill, Cambridgeshire (Zone VIc), Q-587, 7610 ± 150 (Godwin and Willis, 1962, p. 57), and for westward extension of Maglemosian, Freshwater West, Pembrokeshire (Zone VII), Q-530, 5960 ± 120 (Godwin and Willis, 1964, p. 127).

BM-473. Culverwell **7150 ± 135**
5200 B.C.

Charcoal from Mesolithic occupation site at Culverwell, Portland Bill, Isle of Portland, Dorset, England (50° 31′ 27″ N Lat, 2° 26′ W Long). Natl. Grid Ref. SY 685694. Samples were from Level 2, Spit 5 near base of a large shell midden. Level 2 was 30 cm below hut floor of limestone slabs which sealed part of midden (Palmer, 1969). Coll. 1968 and subm. by Susann Palmer. *Comment* (S.P.): Portland site is characterized by numerous pointed chert picks found *in situ* in a Mesolithic context for 1st time in England. Similar picks occur in early phases of Maglemosian culture of Denmark, e.g., in Melstedt group of Bornholm, K-586, 8190 ± 130, 6240 B.C. (Becker, 1951; Tauber, 1960, p. 22). Microlithic industry of site is comparable with Cherhill, BM-447, 7230 ± 140, above, (see also Palmer, 1970).

Neolithic and Beaker

BM-205. Knap Hill **4710 ± 115**
2760 B.C.

Collagen separated from red deer antler (Ref. K/1/6/A1.) from Neolithic causewayed camp at Knap Hill, Alton Priors, Wiltshire, England (51° 22′ N Lat, 1° 50′ W Long). Natl. Grid Ref. SU 121636. From primary silt of rock-cut chalk ditch of Windmill Hill phase, sealed by 1 to 2 m of undisturbed deposits (Connah, 1965). Coll. 1961 and subm. by G. E. Connah. *Comment* (G.E.C.): date agrees well with expected age and compares well with NPL-76, 2790 ± 90 B.C. (Callow *et al.*, 1965, p. 158) for similar site at Hambledon Hill, Dorset and with BM-74, 2580 ± 150 B.C. (Barker and Mackey, 1961, p. 42) for similar site and context at Windmill Hill, Wiltshire (see also Connah, 1969a, b).

BM-208. Knap Hill **3790 ± 130**
1840 B.C.

Charcoal (Ref. K/II/4.) from Neolithic causewayed camp at Knap Hill, Alton Priors, Wiltshire, England (51° 22′ N Lat, 1° 50′ W Long). Natl. Grid Ref. SU 121636. From top of ditch sec. from mixture of rubble and humus with Necked Beaker sherds, sealed by ca. 30 cm undisturbed soil (Connah, 1965). Coll. 1961 and subm. by G. E. Connah. *Comment* (G.E.C.): date agrees well with expected age and compares well with BM-133, 1850 ± 150 B.C. (Barker and Mackey, 1963, p. 105) for a similar Beaker assemblage at Fifty Farm, Suffolk (see also Connah, 1969a, b).

BM-254. Brook **4540 ± 105**
2590 B.C.

Charcoal (converted by Cambridge lab. to $BaCO_3$; Godwin, 1965, written commun.) from Devil's Kneading Trough, Brook, Kent, England (51° 10′ N Nat, 0° 58′ E Long). Natl. Grid Ref. TR 077452. From Horizon C, 81 to 101 cm in weak fossil soil within chalky hill washes filling valley bottom (Kerney *et al.*, 1964, fig. 12). Coll. 1963 by M. P. Kerney, Dept. of Geol., Imperial College, Univ. of London; subm. by H. Godwin. *Comment* (M.P.K.): dates level of drastic vegetational clearance on chalk escarpment, as revealed by changes in a molluscan diagram (Kerney *et al.*, 1964, fig. 14). Horizon assoc. with Neolithic flint industry; sherds of Neolithic A pottery occur at slightly deeper level (id. 1968 by I. H. Longworth). Signs of clearance already appear at these lower levels. No comparably dated Neolithic clearance horizon is yet available in Kent but a pollen diagram and assoc. radiocarbon dates from Wingham, near Canterbury (Godwin, 1962) showed large scale deforestation at least as early as ca. 1700 B.C. when peat formation began locally. Peat appeared to overlie deposit from which Neolithic A pottery was previously obtained.

4830 ± 125
BM-293. Kilham Long Barrow **2880 B.C.**

Charcoal from horizontal timber used as packing material behind vertical posts set in a bedding trench at E end of mortuary enclosure Kilham Long Barrow, Kilham, near Bridlington, Yorkshire, England (54° 03′ N Lat, 0° 23′ W Long). Natl. Grid Ref. TA 055673. Coll. 1965 and subm. by T. G. Manby, Doncaster Mus. *Comment* (T.G.M.): trapezoidal mortuary enclosure at Kilham closely resembles enclosure at Fussell's Lodge Long Barrow (Ashbee, 1966) dated by BM-134, 3230 ± 180 B.C. (Ashbee, 1964).

Abingdon series

Charcoal, bone, and antler from phases of Inner Ditch of Neolithic causewayed camp at Abingdon, Berkshire, England (51° 40′ N Lat, 1° 17′ W Long). Natl. Grid Ref. SU 511983. Coll. 1963-1964 by D. M. E. Avery and H. J. Case; subm. by H. J. Case, Ashmolean Mus., Oxford. (See Leeds, 1927, 1928; Case, 1956.)

4730 ± 135
BM-348. Abingdon **2780 B.C.**

Sample 1, charcoal, Area B, Phase II (AB64, B9 : 4).

6020 ± 110
BM-349. Abingdon **4070 B.C.**

Sample 2, charcoal, Area B, Phase IV (AB 64, B10 : 2).

4910 ± 110
BM-350. Abingdon **2960 B.C.**

Sample 3, charcoal, Area C, Phase IIc (AB, C2 : 29).

5060 ± 130
BM-351. Abingdon **3110 B.C.**

Sample 4, charcoal, Area C, Phase IIe (AB, C2 : 27).

BM-352. Abingdon **4710 ± 135**
2760 B.C.

Sample 5, bone (collagen), Area C, Phase IIe (AB, C2 : 27, Bos).

BM-353. Abingdon **4970 ± 130**
3020 B.C.

Sample 6, charcoal, Area C, Phase IV (AB, C2 : 26).

BM-354. Abingdon **4450 ± 145**
2500 B.C.

Sample 7, bone (collagen), Area C, Phase IV (AB, C2 : 23A, Bos).

BM-355. Abingdon **4460 ± 140**
2510 B.C.

Sample 8, antler (protein), Area C, Phase IV (AB, C2 : 4, Red deer). *General Comment*: several samples from different levels ('phases') in 2 areas, B and C, of Inner Ditch of causewayed camp at Abingdon were dated. Phases of Area B are not the same as those of Area C, Phase II is a primary or early occupation in both areas, probably of ca. 300 yr duration. Phase IV is a later occupation in both areas although date for Sample 6 (BM-353) from this phase is comparable with dates for Phase II. Sample 2 (BM-349, weighted mean of 2 closely comparable measurements) is ca. 1000 yr earlier than any known site of this kind in Britain and must relate to intrusive older material not belonging to causewayed camp. Apart from BM-349, all dates are fully within early to middle Neolithic period (G. de G. Sieveking, British Mus., 1968, written commun.).

South Street Long Barrow

Charcoal, bone, and antler from South Street Long Barrow (G. 68), Avebury, near Marlborough, Wiltshire, England (51° 25′ N Lat, 1° 52′ W Long). Natl. Grid Ref. SU 090692. Samples, from a primary context, date construction of barrow (Smith and Evans, 1968) and Neolithic plough marks beneath it (Fowler and Evans, 1967); also compare antler, bone, and charcoal as dating materials. Coll. 1966 and subm. by J. G. Evans.

BM-356. South Street **4760 ± 130**
2810 B.C.

Charcoal (Ave. G 68 i) from surface of buried soil beneath mound.

BM-357. South Street **4700 ± 135**
2750 B.C.

Collagen separated from cervical vertebra of ox (Ave. G. 68 ii) from coarse primary chalk fill at bottom of N ditch.

BM-358a. South Street **4620 ± 140**
2670 B.C.

Protein separated from red deer antler (Ave. G. 68 iii) from coarse primary chalk fill at bottom of N ditch.

BM-358b. South Street **4530 ± 110**
2580 B.C.

Protein separated from red deer antler (Ave. G. 68 iv) embedded in mound.

General Comment: dates construction of barrow in 1st half of 3rd millennium B.C. and compares well with dates for 2 other long barrows in area, Nutbane, BM-49, 2730 ± 150 B.C. (Vatcher, 1959) and Wayland's Smithy, I-1468, 2830 ± 130 B.C. (Atkinson, 1965). Age is minimum for Neolithic plough marks on buried ground surface beneath barrow. Results for different materials are indistinguishable within limits of error of dates (Evans and Burleigh, 1969).

BM-370. Pinnacle **5020 ± 110**
3070 B.C.

Charcoal assoc. with Danubian type Neolithic pottery from Pinnacle, Jersey, Channel Is. (49° 14′ 55″ N Lat, 2° 15′ 9″ W Long). (See Hawkes, 1937; Godfray and Burdo, 1949.) Coll. ca. 1935 by A. D. B. Godfray; subm. by J. T. Renouf, Soc. Jersiaise Mus.

Durrington Walls

Charcoal, bone, and antler from Neolithic henge monument of Durrington Walls, Wiltshire, England (51° 12′ N Lat, 1° 47′ W Long). Natl. Grid Ref. SU 150437. (See Crawford, 1929; Stone *et al.*, 1954.) Samples date Phase 2 of S Circle and assoc. domestic debris, construction of main henge ditch and assoc. late Neolithic flints, and pottery from bottom of ditch (Wainwright, 1967; 1968). Samples also compare antler, bone, and charcoal as dating materials. Coll. 1967 and subm. by G. J. Wainwright, Min. of Pub. Bldg. and Works.

BM-395. Durrington Walls **3900 ± 90**
1950 B.C.

Fe B 92 : S Circle : Phase 2. Protein separated from Red Deer antler (675028) from packing material of a posthole.

BM-396. Durrington Walls **3950 ± 90**
2000 B.C.

Fe B 92 : S Circle : Phase 2. Oak charcoal (675029) from packing material of a posthole.

BM-397. Durrington Walls **3850 ± 90**
1900 B.C.

Fe B 92 : S Circle : Phase 2. Collagen separated from animal bone (675030) from packing material of a posthole.

BM-398. Durrington Walls **3927 ± 90**
1977 B.C.

Ditch (7). Charcoal (675032) from base of main enclosure ditch.

BM-399. Durrington Walls **3965 ± 90**
2015 B.C.

Ditch (7). Collagen separated from animal bone (675033) from base of main enclosure ditch.

BM-400. Durrington Walls **4000 ± 90**
2050 B.C.

Ditch (7). Protein separated from Red Deer antler (675034) from base of main enclosure ditch.

General Comment: dates conform with expected age and show contemporaneous construction of timber structure known as S Circle and digging of main enclosure ditch. Later hearths and Beaker pottery in main enclosure ditch were dated by BM-285, 1610 ± 120 B.C. and BM-286, 1680 ± 110 B.C. (Barker, Burleigh, and Meeks, 1969a, p. 288). Results for different sample materials are indistinguishable within limits of error of dates. A report of excavation will appear later (Wainwright *et al.*, in press).

BM-442. Embo **3870 ± 100**
1920 B.C.

Collagen separated from various small animal bones (ref. CnIa; id. by A. S. Clark, see Soc. Antiquaries of Scotland Proc., v. 96, p. 35) from a chambered cairn at Embo, Sutherland, Scotland (57° 54′ 28″ N Lat, 3° 59′ 45″ W Long). Natl. Grid Ref. NH 817926. Bones were contemporary with construction of cairn as their location would have been inaccessible after cairn was completed (Henshall and Wallace, 1965). Coll. 1960 by Audrey S. Henshall; subm. by H. McKerrell, Natl. Mus. Antiquities of Scotland, Edinburgh. *Comment* (A.S.H.): 1st radiocarbon date for a Scottish passage grave. Construction date is uncertain and largely inferred from typologic considerations. Embo is relatively simple in plan and early date was expected (1st half of 3rd millennium B.C.) but tombs of this kind were possibly still being built to about beginning of 2nd millennium B.C.

BM-449. Wawcott **5260 ± 130**
3310 B.C.

Decayed wood from hearth in undisturbed Mesolithic pit dwelling at Wawcott Farm, Kintbury, near Newbury, Berkshire, England (51° 24′ 22″ N Lat, 1° 26′ 28″ W Long). Natl. Grid Ref. SU 389676. Coll. 1966 by F. R. Froom; subm. by R. A. Rutland, Reading Mus. *Comment* (R.A.R.): 1st date for this series in Kennet Valley. Only other local Mesolithic dates are for Thatcham (Churchill, 1962) but flint industries at the 2 sites are entirely different (see Wymer, 1962; Froom, 1963; 1964).

BM-450. Playden **3690 ± 115**
1740 B.C.

Charcoal from a Neolithic ring-ditch settlement (Cheney, 1935) at Playden Site 'A', Mockbegger, near Rye, Sussex, England (50° 56′ N Lat, 0° 43′ E Long). Natl. Grid Ref. TQ 920210. Coll. ca. 1930 by H .J.

Cheney; subm. by G. de G. Sieveking, British Mus. *Comment* (G.de G.S.): late Neolithic date agrees well with age indicated by pottery from this site which belongs to a late Neolithic-Beaker assemblage (see Wainwright, 1967, p. 182-183).

4715 ± 90
BM-493. Cherhill **2765 B.C.**

Charcoal (Ref. CH/67/X; *Corylus* sp., id. by Joan Sheldon) from Neolithic Ditch I, possibly a borrow pit for daub, at foot of Chalk escarpment at Cherhill, Wiltshire, England (51° 26′ N Lat, 1° 57′ W Long). Natl. Grid Ref. SU 031701. Charcoal was from large burnt plank in upper levels of fine primary fill of ditch and was assoc. with pottery assemblage of Windmill Hill type (Evans and Smith, 1967). Coll. 1967 and subm. by J. G. Evans. *Comment*: dates assemblage of undecorated Neolithic pottery.

4510 ± 103
BM-505. Normanton Down **2560 B.C.**

Protein separated from antler pick from base of N bedding trench, E entrance, Normanton Down Long Mortuary Enclosure, Normanton Down, near Amesbury, Wiltshire, England (51° 10′ N Lat, 1° 50′ W Long). Natl. Grid Ref. SU 115411. Dates construction of enclosure (Vatcher, 1961, fig. 3, p. 163). Coll. 1959 and subm. by Faith de M. Vatcher, Alexander Keiller Mus., Avebury. *Comment* (F.deM.V.): date is at later end of presently available dates for unchambered long barrows, which are closest parallel, but consistent with sherd of Mortlake pottery near top of one of post trenches.

Beckhampton Road Long Barrow

Protein separated from Red Deer antler (Ref. A.7) from buried soil surface beside inner face of revetment bank, Beckhampton Road Long Barrow (G.76), Bishops Cannings, Wiltshire, England (51° 24′ 30″ N Lat, 1° 54′ 10″ W Long). Natl. Grid Ref. SU 067677. Antler was 15 cm below base of modern plough soil, overlain by a 2nd antler, both covered by undisturbed stacked turves. Dates construction of barrow; was one of many used as picks in quarrying material for mound and buried in it when no longer required. Coll. 1964 and subm. by Isobel F. Smith, Inspectorate of Ancient Monuments, Min. of Pub. Bldg. and Works.

4257 ± 90
BM-506a. Beckhampton Road **2307 B.C.**

Separated protein—no humic extraction.

4467 ± 90
BM-506b. Beckhampton Road **2517 B.C.**

Separated protein—humic extraction with dilute alkali. *Comment*: dates compatible with those for Giants Hills Long Barrow, BM-191, 4410 ± 150; 2460 B.C.; BM-192, 4320 ± 150; 2370 B.C. (Barker, Burleigh, and Meeks, 1969a, p. 287) and South Street Long Barrow, BM-356—BM-358b (Evans and Burleigh, 1969; see also above) and confirm that charcoal from beneath mound (NPL-138, 5200 ± 160, 3250 B.C., unpub.) relates to earlier activity on site well before construction of barrow. Because of difference between BM-506a and NPL-138, a 2nd sample of collagen from same antler was extracted with alkali to remove possible younger contamination. The result, BM-506b, suggests that antler may have been somewhat contaminated, but date is still ca. 750 yr later than NPL-138.

Lussa River

Charcoal from occupation site at Lussa R., Isle of Jura, Argyllshire, Scotland (56° 01′ 18″ N Lat, 5° 46′ 06″ W Long). Natl. Grid Ref. NR 645873. Coll. 1969 and subm. by J. Mercer.

4200 ± 100
BM-555. Lussa River **2250 B.C.**

Sample 1.

4620 ± 140
BM-556. Lussa River **2670 B.C.**

Sample 2. *Comment*: a full report on site will appear later (Mercer, ms. in preparation; see also Mercer, 1969, 1970).

Prehistoric trackways

Westhay

Wood from trackways at Westhay, Somerset, England (51° 11′ N Lat, 2° 50′ W Long). Natl. Grid Ref. ST 428423. Coll. 1967 by J. M. Coles and F. A. Hibbert; subm. by J. M. Coles, Univ. of Cambridge, for comparison with other Neolithic trackways in immediate area (see Godwin, 1960; Dewar and Godwin, 1963; Coles and Hibbert, 1968; Coles *et al.*, 1970). Samples were pretreated with dilute acid and dilute alkali at Cambridge lab.

4266 ± 131
BM-382. Westhay **2316 B.C.**

Wood from stump in Bell track, lower level, in peat. (Sample A, Bell III. Ib, lower.)

4021 ± 103
BM-383. Westhay **2071 B.C.**

Bell track, peg from lower level, in peat. (Sample B, Bell III. Ib, lower.)

3975 ± 92
BM-384. Westhay **2025 B.C.**

Bell track, tranverse bearer, upper level, in peat. (Sample C, Bell III. Ib, upper.)

4450 ± 110
BM-385. Westhay **2500 B.C.**

Peg from un-named trackway in peat. (Sample D, Baker I. 2.)

BM-386. Westhay **3934 ± 111**
1984 B.C.

Abbot's Way track, tranverse bearer in peat. (Sample E, Godwin II. Abbot.)

General Comment: dates agree with stratigraphy and dated sequence of peat development in immediate area. Abbot's Way track also dated by GaK-1940, 4040 ± 90; Lu-298, 3940 ± 65; Q-926, 4018 ± 80 (all unpub.) and by Q-647, 4810 ± 120, 2860 B.C. (Godwin and Switzur, 1966).

Bronze age

Easington

Charcoal and decayed wood from Round Barrow I, Easington, Yorkshire, England (53° 38′ 24″ N Lat, 0° 07′ 48″ E Long). Natl. Grid Ref. TA 409181. Charcoal (Sample A) assoc. with a clay hearth, large posthole, worked and waste flint, and sherds of pottery. Decayed wood (Samples B and C) was from large timbers forming a circle ca. 16 m diam. passing over posthole (Sample A) and sealed by ca. 0.6 m clay hillwash from mound. Barrow contained an inhumation with large 'V' perforated jet button and undecorated beaker (Mackey, ms. in preparation). Coll. 1965 and subm. by R. W. Mackey, Hull Museums.

BM-268. Easington **4354 ± 165**
2404 B.C.

Sample A.

BM-269. Easington **3450 ± 90**
1500 B.C.

Sample B.

BM-270. Easington **3613 ± 100**
1663 B.C.

Sample C. *Comment*: BM-268 relates to Neolithic occupation on site a millennium earlier and is not related to construction of barrow.

Ampleforth Moor

Charcoal from old ground surface beneath a group of round barrows on Ampleforth Moor, N Yorkshire, England (54° 13′ N Lat, 1° 6′ W Long). Natl. Grid Ref. SE 580800. Intended to date Bronze age fabrics and faience bead (Wainwright and Longworth, 1970). Coll. 1967 by G. J. Wainwright, Ministry of Pub. Bldg. and Works; subm. by I. H. Longworth, British Mus.

BM-368. Ampleforth Moor **2487 ± 90**
537 B.C.

Charcoal beneath Barrow 7.

BM-369. Ampleforth Moor **2532 ± 90**
582 B.C.

Charcoal beneath Barrow 3. *Comment* (I.H.L.): expected age of faience bead was ca. 1400 B.C., but expected age of most of coarse ware was ca. 650 B.C. because of comparable pottery from Heathery Burn

(British Mus. Colln.). Dates clearly relate to later coarse ware and not to earlier pottery fabrics (Grimston ware and possible plain Beaker) and faience bead incorporated in buried turf line.

BM-441. Ness of Gruting **3514 ± 120**
1564 B.C.

Carbonized grain (id. by H. Helbaek as barley, partly hulled, partly naked (1 : 3) and probably most northerly European early grain find; see Calder, 1958, p. 353). From cache of 28 lbs. found at base of filling of main stone wall of oval, Shetland-type house (House 1) with adjacent field system at Ness of Gruting, Sansting parish, Shetland (60° 13′ N Lat, 1° 30′ W Long). Natl. Grid Ref. HU 281484. Late Beaker derived pottery and stone implements including 2 miniature battle axes of post-Beaker or early Bronze-age type and a "sponge-finger" stone were found in house (Calder, 1958, p. 381-97) suggesting contemporaneity with Wessex culture of S England. Coll. 1952 by C. S. T. Calder; subm. by R. B. K. Stevenson, Natl. Mus. Antiquities of Scotland, Edinburgh.

Vitrified fort

Cullykhan, Troup Head

Charcoal and wood from Cullykhan vitrified fort, Troup Head, near Pennan, Banffshire, Scotland (57° 41′ 17″ N Lat, 2° 17′ 26″ W Long). Natl. Grid Ref. NJ 616661. Coll. 1967 and 1969 by J. C. Greig, H. McKerrell, and E. W. Mackie; subm. by H. McKerrell, Natl. Mus. Antiquities of Scotland, Edinburgh (see Greig, 1970).

BM-443. Cullykhan **2056 ± 51**
106 B.C.

Charcoal (Sample 2) from surface of cobbled area outside fort.

BM-444. Cullykhan **3136 ± 60**
1186 B.C.

Charcoal (Sample 9) from large beams within fort walls.

BM-445. Cullykhan **1633 ± 40**
A.D. 317

Charcoal (Sample 13) from wooden object in 1st stratified occupation level.

BM-446. Cullykhan **2337 ± 65**
387 B.C.

Charcoal (Samples 14, 15) from narrow burnt layer at top of 1st stratified occupation level.

BM-639. Cullykhan **2347 ± 59**
397 B.C.

Outer wood (Sample 20) from immediately beneath bark of large oak trunk from one of several post-holes originally forming part of massive defensive entrance to fort.

General Comment: BM-443 suggests date of last occupation of Late Bronze age palisaded settlement. BM-444 intended to date timber platform forming a foundation for vitrified wall of expected date ca. 100 B.C., but relates to material from much earlier context. BM-445 dates horizon containing Roman pottery sherds of estimated date ca. 250 to 350 A.D. BM-446 dates occupation level of defensive gateway containing finds of Late Bronze age date, including numerous pottery sherds. BM-639 dates construction of massive Late Bronze age gateway and agrees with BM-446.

Early iron smelting

Minepit Wood

Charcoal from early iron working site at Minepit Wood (Orznash), Withyham, Sussex, England (51° 06′ N Lat, 0° 10′ E Long). Natl. Grid Ref. TQ 523338. Coll. 1964-1967 and subm. by J. H. Money, Sussex Archaeol. Soc. (see Straker, 1931; Money, 1966-1968).

426 ± 40
BM-361. Minepit Wood **A.D. 1524**

Charcoal (C.53) from old land surface near edge of small minepit, securely sealed by dump of clay excavated from pit.

1949 ± 43
BM-363. Minepit Wood **A.D. 1**

Charcoal (C.16) assoc. with Iron age B pottery from bottom of pit covered by dump of clay when pit was filled in by workers of later smelting furnace dated, BM-267, 1610 ± 150, A.D. 340 (Barker, Burleigh, and Meeks, 1969a, p. 283).

532 ± 100
BM-364. Minepit Wood **A.D. 1418**

Charcoal (C.86) from debris of Furnace 5, an ore roasting furnace.

545 ± 40
BM-365. Minepit Wood **A.D. 1405**

Charcoal (C.105) from rectangular masonry and timber structure enclosing Furnaces 2 and 3 and probably contemporary with Furnace 2, a smelting furnace. Charcoal from large undisturbed deposit of prepared fuel.

570 ± 44
BM-366. Minepit Wood **A.D. 1380**

Charcoal (C.87) from upper part of undisturbed deposit of furnace debris on floor of Furnace 4, an ore roasting furnace, sealed by ca. 38 cm of soil.

General Comment (J.H.M.): BM-361 dates this type of small minepit as late Medieval; archaeologically, it could equally be Iron age. BM-363 is convincing, as assoc. type of Iron age pottery is assumed to date from 1st century B.C. to early 1st century A.D.; it also suitably pre-dates Roman furnace, BM-267, 340 ± 100 A.D., built over these earlier workings. BM-364-366 date roasting/smelting complex and are in good agreement. Results will be discussed in more detail later (Money, 1971).

Human skeletons

BM-255. Caerwys skeleton **2100 ± 140**
150 B.C.

Collagen separated from post-cranial human bone from almost complete skeleton (ref. Site G) in extensive tufa deposits near Caerwys, Flintshire, N Wales (53° 14′ N Lat, 3° 22′ W Long). Natl. Grid Ref. SJ 138712. Coll. 1952 by B. H. Chorley; subm. by K. P. Oakley, British Mus. (Nat. Hist.). *Comment*: Caerwys tufa contains microlithic industry; skeleton was previously considered of Mesolithic age; if so would have been an important find and the most complete example known from Britain. At time of discovery original circumstances of burial could not be determined (Jackson, 1956). Date shows burial was relatively recent and most probably intrusive.

BM-282. Branston skeleton **1110 ± 125**
A.D. 840

Collagen separated from part of diaphysis of right femur from skeleton of a young woman (id. by Sir Arthur Keith), discovered in 1943 during commercial gravel excavation at Branston, 3 km SW Burton-on-Trent, Staffordshire, England (52° 47′ N Lat, 1° 40′ W Long). Natl. Grid Ref. SK 212202. Coll. by A. L. Armstrong; subm. by K. P. Oakley, from Coventry Mus. colln. Bones scattered horizontally over ca. 4 m diam. area, were ca. 30 cm from base of peat layer ca. 0.75 m thick overlain by 0.75 m blue clay and 30 cm soil (Bemrose, 1953). Pollen analysis suggested date was Early postglacial (Godwin and Tallantire, 1966, written commun.). Platform of branches and logs with wooden causeway was found ca. 25 m from skeleton. Microliths and split animal bones were evidence of Mesolithic occupation. *Comment*: skeleton, if Mesolithic, would have been important, but it was an intrusive Dark age skeleton and not correlated with surrounding deposits or nearby trackway and platform.

BM-458. Maiden Castle **1315 ± 80**
A.D. 645

Collagen separated from femora of human skeleton from Maiden Castle, Winterborne St. Martin, Dorset, England (50° 42′ N Lat, 2° 28′ W Long). Natl. Grid Ref. SY 669885. Skeleton was considered Neolithic primary burial (Ref. Q1; see Wheeler, 1943, p. 344-346), but injuries to bones are attributed to a metal sword. Coll. ca. 1936 by R. E. M. Wheeler; subm. by D. R. Brothwell, British Mus. (Nat. Hist.) from Dorset County Mus. colln. *Comment*: date, which appears to represent an intrusive Dark Age burial, settles a previous anomaly (Brothwell, ms. in preparation).

BM-471. Aveline's Hole **9114 ± 110**
7164 B.C.

Collagen separated from part of femora of human skeleton from Aveline's Hole, Burrington Combe, Mendip, Somerset, England (51° 19′ N Lat, 2° 45′ W Long). Natl. Grid. Ref. ST 477587. Aveline's Hole skulls were considered possibly of Younger Dryas (Late Upper Palaeolithic) age (ApSimon *et al.*, 1961, p. 100) and are important craniometrically as some of few available which may represent a pre-Neolithic British physical type. Coll. ca. 1920 by Bristol Spelaeol. Soc.; subm. by D. R. Brothwell from Bristol Univ. colln. *Comment*: date compares with stalagmite taken from inside Aveline's Hole skull, GrN-5393, 8110 ± 150 (unpub.) and Cheddar Man (Gough's Cave), BM-525, 9080 ± 150, 7130 B.C. (below). Date will be important for eventual biometric reappraisal of British pre-Neolithic skulls. (See also Oakley and Campbell, in press.)

BM-525. Gough's Cave — **9080 ± 150 7130 B.C.**

Collagen separated from tibia of human skeleton ("Cheddar Man") from Gough's Cave, Cheddar, Mendip, Somerset, England (51° 16′ N Lat, 2° 45′ W Long). Natl. Grid Ref. ST 467539. Burial was in cave earth passing laterally into breccia below Upper Stalagmite (Davies, 1904; Donovan, 1955). Coll. 1903 by R. C. Gough; subm. by K. P. Oakley. *Comment* (K.P.O.): date expected to be later than Cheddarian/Creswellian of Sun Hole (BM-524, 12,378 ± 150, above) and agrees closely with human skeletons from similar archaeologic context in Aveline's Hole, BM-471, 9114 ± 110, 7164 B.C. (above). (See also Oakley and Campbell, in press.)

BM-542. Tormarton — **2927 ± 90 977 B.C.**

Collagen separated from part of tibia of human skeleton (Tormarton skeleton I, Ac. 113/1968) from W Littleton Down, Tormarton parish, Gloucestershire, England (51° 29′ 17″ N Lat, 2° 20′ 6″ W Long). Natl. Grid Ref. ST 767767. Two Middle Bronze age spear heads had penetrated skeleton, one still embedded in pelvis (Grinsell, 1968a, b; 1970). Coll. 1968 by C. Browne; subm. by L. V. Grinsell, City Mus., Bristol.

BM-584. Sutton Hoo — **1204 ± 79 A.D. 746**

Collagen separated from a human skull buried in grave pit at Sutton Hoo, Suffolk, England (52° 5′ N Lat, 1° 20′ E Long). Natl. Grid Ref. TM 287487. Coll. 1969 and subm. by I. H. Longworth, British Mus. *Comment* (I.H.L.): skull was estimated to be from Early Iron age to Anglo-Saxon date. Radiocarbon measurement was made because bone from a prehistoric context at Sutton Hoo would help determine whether there was ever a body assoc. with Dark age Sutton Hoo ship-burial in Barrow I.

Dendrochronology

Wood (oak) from floor joists of Merton College Library, Oxford, England (51° 45′ N Lat, 1° 13′ W Long) and from trusses over vault of nave of Norwich Cathedral, Norwich, Norfolk, England (52° 37′ N Lat, 1° 20′ E Long). Coll. 1968, 1969 and subm. by J. M. Fletcher, Univ. of Oxford. Samples form part of a master chart of annual widths and density variations of oak grown in certain regions of England (Fletcher and Hughes, 1970).

Timbers from other European medieval buildings, some subm. by J. M. Fletcher from N Berkshire and Oxford regions, were radiocarbon-dated (Fergusson and Libby, 1963, 1964; Berger, Fergusson, and Libby, 1965; Berger and Libby, 1966-1969). Interpretation of these dates was discussed by Berger and Libby (R., 1969, v. 11, p. 202-203) and by Fletcher (1968a, 1968b). Historical dates estimated from Stuiver-Suess curve (Stuiver and Suess, 1966) and a growth allowance is made for number of annual rings between point of sampling and bark, to establish likely date of use.

Merton College Library

Ring widths and densities were measured on several joists removed from library, built in A.D. 1377. Because floor was repaired ca. A.D. 1600, it was important to establish origin of beams.

BM-526. Merton College Library — **654 ± 45**, **A.D. 1296**

Sample 116-I. *Comment* (J.M.F.): estimated date of use is ca. A.D. 1426, establishes that beam was part of original flooring of A.D. 1377.

BM-527. Merton College Library — **359 ± 45**, **A.D. 1591**

Sample 116-II. *Comment* (J.M.F.): estimated historic dates are A.D. 1445 to A.D. 1655, as radiocarbon date corresponds to complex region of correction curve. Range suggests that beam formed part of repairs of ca. A.D. 1600. Measurement of a younger or older sample from same beam is desirable.

Norwich Cathedral

Records show that nave roof fell due to arson ca. A.D. 1270 and was replaced ca. A.D. 1275. There was re-roofing again ca. A.D. 1466 following another fire ca. A.D. 1463. Form of trusses from which samples were taken suggested 13th rather than 15th century date. Two samples were dated to help resolve this question and to aid selection of samples for dendrochronology from ca. 500 beams.

BM-528. Norwich Cathedral — **380 ± 45**, **A.D. 1570**

Sample 125-IA. Estimated historic date: ca. A.D. 1530.

BM-529. Norwich Cathedral — **518 ± 40**, **A.D. 1432**

Sample 125-III. Estimated historic date: ca. A.D. 1507. *Comment* (J.M.F.): both historic dates are reasonably consistent (within ca. 50 yr) with a re-roofing following disaster of A.D. 1463.

Faversham

One charcoal and 2 bone samples from excavation of disused chapel at Stone, near Faversham, Kent, England (51° 19′ N Lat, 0° 52′ E Long).

Natl. Grid Ref. TQ 993613. Coll. 1968 and subm. by Sir Eric Fletcher and G. W. Meates. Site was originally Roman temple or mausoleum probably 4th century A.D.), incorporated into Christian church in 7th century and extended and rebuilt in Medieval period (Fletcher and Meats, 1970).

BM-479. Faversham **1490 ± 110**
A.D. 460

Collagen separated from calvarium of juvenile human skull from a burial 1.6 m from S wall of chancel of ruined chapel at depth 8 cm below foundation raft.

BM-480. Faversham **810 ± 110**
A.D. 1140

Collagen separated from human pelvis from a burial immediately E of original E wall of chancel at depth 3.25 m below chancel floor.

BM-481. Faversham **1400 ± 110**
A.D. 550

Charcoal (possibly from "wattle and daub") from within boundary of S wall of chancel at depth 45 cm below Roman floor.

F. Israel

Tel 'Erany series

Eight samples of charred grain, charred olive stones, and charcoal from Tel 'Erany (formerly Tel Gath), E part of S Maritime plain between Askalon and Beth Guvrin (31° 40′ N Lat, 34° 50′ E Long). Coll. 1957 (Area D) and 1961 (Area A, N) by Sh. Levi and Ephrath Yeivin, respectively; subm. by S. Yeivin, Dept. of Antiquities, Jerusalem, Israel (Yeivin, 1960a, 1961, 1967).

BM-387. Tel 'Erany **4500 ± 130**
2550 B.C.

Sample 1. Carbonized wheat from conflagration layer (No. 525, Loc. 2062, Stratum II, level 134.22 m, Area D). Expected date Early Canaanite II, ca. 2700 B.C.

BM-388. Tel 'Erany **4340 ± 130**
2390 B.C.

Sample 2. Carbonized wheat from conflagration layer (No. 505, Loc. 4702, Stratum IV, level 131.20 m, Area D). Expected date, transition period from Chalcolithic to Early Canaanite II, ca. 3000 B.C.

BM-389. Tel 'Erany **4400 ± 130**
2450 B.C.

Sample 3. Carbonized wheat from conflagration layer (No. 555, same context as Sample 2).

BM-390. Tel 'Erany **4200 ± 130**
2250 B.C.

Sample 4. Charcoal from conflagration layer (No. 680, Loc. 2301, Stratum II3, level 133.55 m, Area D). Expected date Early Canaanite II, ca. 2700 B.C.

4430 ± 140
BM-391. Tel 'Erany **2480 B.C.**

Sample 5. Carbonized olive stones from a large pottery vessel (No. 290, Loc. 4533, Stratum IV, level 131.67 m, Area D). Expected date ca. 3000 B.C. (cf. Samples 2, 3).

4470 ± 140
BM-392. Tel 'Erany **2520 B.C.**

Sample 6b. Charcoal from under city wall, level 124.5 to 124.2 m, Area N, L/10. Supposed to represent settlement conquered by Narmer (ca. 3000 to 3100 B.C.).

4450 ± 140
BM-393. Tel 'Erany **2500 B.C.**

Sample 7. Charred grain from level 125.05 m, Area N, E/50, same context as Sample 6b, ca. 3000 to 3100 B.C.

2640 ± 140
BM-394. Tel 'Erany **690 B.C.**

Sample 8. Charcoal from oven, N sec. 145.05 to 144.55 m, Area A. Expected date Middle Israelite layer, ca. 800 to 600 B.C.

General Comment: BM-387-393 appear too young by several hundred yr in agreement with evidence for C^{14} discrepancies. This is of particular interest because of the *in situ* discovery in one level of an ostracon of Narmer which provides tentative cross-check with Egyptian C^{14} chronology (Yeivin, 1960b, 1963, 1967, 1968). BM-394 agrees perfectly with archaeologic evidence that stratum belongs to later period of Middle Iron age.

G. Italy

958 ± 116
BM-496. Castenedolo skeleton **A.D. 992**

Collagen separated from vertebrae and costae of human skeleton (ref. Castenedolo I) found at Castenedolo, Brescia, Italy (45° 28′ N Lat, 10° 18′ E Long). Coll. 1880 by G. Ragazzoni; subm. by K. P. Oakley. Samples made available through Giuseppe Genna, Univ. of Rome. From one of several skeletons found in Pliocene marls at Castenedolo (Ragazzoni, 1880; Boule and Vallois, 1957) and originally interpreted as proof of great antiquity of *Homo sapiens* (Sergi, 1884). *Comment* (K.P.O.): comparison of nitrogen content of Castenedolo bones with range of nitrogen values of bones from Italian sites indicated that these skeletons were intrusive burials in Pliocene marls, but whether end-Pleistocene or Holocene (Recent), as seemed more probable, could only be settled by radiocarbon dating. (See also Oakley and Campbell, in press.)

H. Moldavian SSR

Soroki

Two wood charcoal samples (ref. Excavation 1, House 2, Quads. B1, B2) from excavation of a Tripolje culture settlement at Soroki, Moldavian SSR (48° 08′ N Lat, 28° 12′ E Long). Coll. 1967 by E. K.

Černyš; subm. by R. Tringham, Univ. College, London. Samples date to transition of middle to late period (B2/C) of Tripolje culture in USSR (Passek, 1961).

BM-494. Soroki II — **4792 ± 116** / **2842 B.C.**

Sample 1, depth 1.5 to 1.6 m below surface.

BM-495. Soroki II — **4940 ± 105** / **2990 B.C.**

Sample 2, depth 2.2 m below surface. *Comment* (R.T.): 1st available dates for middle period of Tripolje culture in USSR; expected to be roughly contemporary with date for Valea Lupului, Rumania (Cucuteni B), GrN-1982, 3000 ± 60 B.C. (Vogel and Waterbolk, 1963). Dates fit well with estimated beginning of Late Tripolje culture in E Europe (Gimbutas, 1965).

I. Sweden

BM-410. Kvarnby — **4850 ± 115** / **2900 B.C.**

Protein fraction from antler from a flint mine at Kvarnby, Husie parish, near Malmo, Scania, Sweden (55° 36′ N Lat, 12° 58′ E Long), where erratic large chalk blocks containing flint occur. Coll. ca. 1900; subm. by G. de G. Sieveking, British Mus., from colln. of Natl. Mus., Stockholm, for comparison with dates from flint mines in S England. *Comment*: though generally regarded as Neolithic, it has been claimed that sites were not flint mines and were probably not in use earlier than Roman Iron age (Althin, 1951, 1955). This view is not confirmed by date, which agrees well with dates obtained for Neolithic flint mines in S England (Barker, Burleigh, and Meeks, 1969a; Sieveking, ms. in preparation).

References

Althin, C. A., 1951, The Scanian flint mines: Meddelanden Från Lunds Univ. Historiska Mus., 1950-1951, p. 139-158.

——— 1955, The picks of the Scanian "flint mines": Från Lunds Univ. Historiska Mus. Medd., 1954-1955, p. 224-227.

ApSimon, A. M., Donovan, D. T., and Taylor, H., 1961, The stratigraphy and archaeology of the late-glacial and post-glacial deposits at Brean Down, Somerset: Univ. Bristol Spelaeol. Soc. Proc., v. 9, p. 100-102.

Arnold, D. and Settgast, J., 1965, Erster vorbericht über die vom Deutschen Archäologischen Institut im Asasif unternommenen Arbeiten: Deutsch. Archäol. Inst. Abt. Kairo Mitt., v. 20, p. 47-61.

Ashbee, P., 1964, The radiocarbon dating of Fussell's Lodge long barrow: Antiquity, v. 38, p. 139-140.

——— 1966, The Fussell's Lodge long barrow excavations, 1957: Archaeologia, v. 100, p. 1-80, fig. 2.

Atkinson, R. J., 1965, Wayland's Smithy: Antiquity, v. 39, p. 126-133.

Barker, Harold, Burleigh, Richard, and Meeks, Nigel, 1969a, British Museum natural radiocarbon measurements VI: Radiocarbon, v. 11, p. 278-294.

——— 1969b, New method for the combustion of samples for radiocarbon dating: Nature, v. 221, p. 49-50.

Barker, Harold and Mackey, C. J., 1959, British Museum natural radiocarbon measurements I: Am. Jour. Sci. Radiocarbon Supp., v. 1, p. 81-86.

——— 1961, British Museum natural radiocarbon measurements III: Radiocarbon, v. 3, p. 39-45.

———— 1963, British Museum natural radiocarbon measurements IV: Radiocarbon, v. 5, p. 104-108.
Becker, C. J., 1951, Maglemosekultur på Bornholm: Aarbøger for Nord. Oldkyndighed og Hist., p. 96-177 (English summary, p. 171-177).
Bemrose, G. J. V., 1953-54, Trans. N Staffs. Field Club, Stafford, v. 88, p. 104.
Berger, Rainer, 1970, Ancient Egyptian radiocarbon chronology: Royal Soc. (London) Philos. Trans. A., v. 269, p. 23-36.
Berger, Rainer, Fergusson, G. J., and Libby, W. F., 1965, UCLA radiocarbon dates IV: Radiocarbon, v. 7, p. 336-371.
Berger, Rainer and Libby, W. F., 1966, UCLA radiocarbon dates V: Radiocarbon, v. 8, p. 467-497.
———— 1967, UCLA radiocarbon dates VI: Radiocarbon, v. 9, p. 477-504.
———— 1968a, UCLA radiocarbon dates VII: Radiocarbon, v. 10, p. 149-160.
———— 1968b, UCLA radiocarbon dates VIII: Radiocarbon, v. 10, p. 402-416.
———— 1969, UCLA radiocarbon dates IX: Radiocarbon, v. 11, p. 194-209.
Boule, M. and Vallois, H. V., 1957, Fossil Men: London, Thames and Hudson, p. 107.
Bruce-Mitford, R. L. S., 1967, A new wooden ship's figure-head found in the Scheldt at Moerzeke-Mariekerke: Acta Archaeologica, v. 38, p. 199-209.
———— 1970, Ship's figure-heads in the Migration period and Early Middle ages: Antiquity, v. 44, p. 146-148.
Buxton, D. R., 1946, Ethiopian rock-hewn churches: Antiquity, v. 20, p. 60-69.
———— 1947, The Christian antiquities of Northern Ethiopia: Archaeologia, v. 92, p. 1-42.
Calder, C. S. T., 1958, Report on the discovery of numerous stone age house-sites in Shetland: Soc. Antiquaries of Scotland Proc. 1955-56, v. 89, p. 340-397.
Callow, W. J., Baker, M. J., and Hassall, G. I., 1965, National Physical Laboratory radiocarbon measurements III: Radiocarbon, v. 7, p. 156-161.
Case, H., 1956, The Neolithic causewayed camp at Abingdon, Berks.: Antiquaries Jour., v. 36, p. 11-30.
Caton-Thompson, G. and Gardner, E. W., 1934, The Desert Fayum, v. I-II: London, Royal Anthropol. Inst., p. 45-46, pl. XXIX(2).
Cheney, H. J., 1935, An eneolithic occupation site at Playden near Rye: Antiquaries Jour., v. 15, p. 152-164.
Churchill, D. M., 1962, The stratigraphy of the Mesolithic Sites III and V at Thatcham, Berkshire, England: Prehist. Soc. Proc., v. 28, p. 362-370.
Coles, J. M. and Hibbert, F. A., 1968, Prehistoric roads and tracks in Somerset, England: 1, Neolithic: Prehist. Soc. Proc., v. 34, p. 238-258.
Coles, J. M., Hibbert, F. A., and Clements, C. F., 1970, Prehistoric roads and tracks in Somerset, England: 2, Neolithic: Prehist. Soc. Proc., v. 36, p. 125-151.
Connah, Graham, 1965, Excavations at Knap Hill, Alton Priors, 1961: Wiltshire Archaeol. and Nat. Hist. Mag., v. 60, p. 1-23.
———— 1969a, Radiocarbon dating for Knap Hill: Antiquity, v. 43, p. 304-305.
———— 1969b, Radiocarbon dating and laboratory examinations for Knap Hill: Wilshire Archaeol. and Nat. Hist. Mag., v. 64, p. 113-114.
Crawford, O. G. S., 1929, Durrington Walls: Antiquity, v. 3, p. 49-59.
Davies, H. N., 1904, The discovery of human remains under the stalagmite-floor of Gough's Cavern, Cheddar: Geol. Soc. Quart. Jour., v. 60, p. 335-348.
Dewar, H. S. L. and Godwin, H., 1963, Archaeological discoveries in the raised bogs of the Somerset levels, England: Prehist. Soc. Proc., v. 29, p. 17-49.
Donovan, D. T., 1955, A Pleistocene deposit at Gough's Cave, Cheddar, including an account of recent excavations: Univ. Bristol Spelaeol. Soc. Proc., v. 7, p. 91.
Duell, P., 1938, The Mastaba of Mereruka, pt. I: Chicago, Univ. of Chicago Oriental Inst. pubs., v. 31, p. 5-7.
Edwards, I. E. S., 1970, Absolute dating from Egyptian records and comparison with carbon-14 dating: Royal Soc., (London) Philos. Trans. A., v. 269, p. 11-18.
Emery, W. B., 1938, The Tomb of Hemaka: Excavations at Sakkara, 1938: Cairo, Govt. Press, p. 1-64.
———— 1954, Great Tombs of the First Dynasty II: London, Egypt Explor. Soc., p. 5-38.
Evans, J. G. and Burleigh, R., 1969, Dates for the South Street long barrow, Wiltshire: Antiquity, v. 43, p. 144-145.
Evans, J. G. and Smith, I. F., 1967, Cherhill, Oliver's Hill Field (Neol. Wilts.): Univ. Bristol (Extra Mural Dept.), C. B. A. Archaeol. Rev., Gp. XII and XIII, no. 2, p. 8-9.

Fakhry, A., 1959, The Monuments of Sneferu at Dahshur, v. 1, The Bent Pyramid: Cairo, Govt. Printing Offices, p. 1-123, pl. I-LI.

Fisher, C. S., 1924, A group of Theban tombs: Univ. of Pennsylvania Mus. Jour., v. 15, p. 28-49.

Fergusson, G. J. and Libby, W. F., 1963, UCLA radiocarbon dates II: Radiocarbon, v. 5, p. 1-22.

——— 1964, UCLA radiocarbon dates III: Radiocarbon, v. 6, p. 318-339.

Fletcher, E. and Meates, G. W., 1970, The ruined church of Stone-by-Faversham: Antiquaries Jour., v. 49, p. 273-294.

Fletcher, John, 1968a, Radiocarbon dating for Medieval timber buildings: Antiquity, v. 42, p. 230-231.

——— 1968b, Crucks in the West Berkshire and Oxford region: Oxoniensia, v. 33, p. 71-88, pl. VIII.

Fletcher, J. M. and Hughes, J. F., 1970, Uses of X-rays for density determinations and dendrochronology: Univ. of British Columbia Conf., Vancouver, 19-20 Feb., 1970: Vancouver, Fac. of Forestry Bull. no. 7, p. 41-54.

Fowler, P. J. and Evans, J. G., 1967, Plough-marks, lynchets and early fields: Antiquity, v. 41, p. 289-301.

Froom, F. R., 1963, The Mesolithic around Hungerford: Newbury Dist. Field Club Trans., v. 11, no. 2, p. 62-87.

——— 1964, An axe of Dorset chert from a Mesolithic site at Kintbury: Berkshire Archaeol. Jour., v. 61, 1963-1964, p. 1-3.

Gilot, E., Ancion, N., and Capron, P. C., 1966, Louvain natural radiocarbon measurements IV: Radiocarbon, v. 8, p. 248-255.

Gimbutas, M., 1965, The relative chronology of Neolithic and Chalcolithic cultures in Eastern Europe, *in*: Ehrich, R. W., Chronologies in Old World Archaeology: Chicago and London, Univ. of Chicago Press, p. 459-502.

Godfray, A. D. and Burdo, C., 1949, Excavations at the Pinnacle, parish of St. Ouen, Jersey (1930-1936): Soc. Jersiaise Bull., v. 15, no. 1, p. 21-100.

Godwin, Harry, 1960, Prehistoric wooden trackways of the Somerset levels; their construction, age and relation to climatic change: Prehist. Soc. Proc., v. 26, p. 1-36.

——— 1962, Vegetational history of the Kentish chalk downs as seen at Wingham and Frogholt: Festschrift Franz Firbas, Veröff. Geobot. Inst. Zurich, v. 37, p. 83-99.

Godwin, Harry and Switsur, V. R., 1966, Cambridge University national radiocarbon measurements VIII: Radiocarbon, v. 8, p. 390-400.

Godwin, Harry, Walker, Donald, and Willis, E. H., 1957, Radiocarbon dating and postglacial vegetational history. Scaleby Moss: Royal Soc. (London) Proc., Ser. B, v. 147, p. 352-366.

Godwin, Harry and Willis, E. H., 1962, Cambridge University natural radiocarbon measurements V: Radiocarbon, v. 4, p. 57-70.

——— 1964, Cambridge University natural radiocarbon measurements VI: Radiocarbon, v. 6, p. 116-137.

Greig, C., 1970, Excavations at Castle Point, Troup, Banffshire: Aberdeen Univ. Rev., v. 43, 3, no. 143, p. 274-283.

Grinsell, L. V., 1968a, City Museum, Bristol, recent archaeological accessions: Bristol Archaeol. Res. Group Bull., v. 3, no. 3, Dec. 1968, p. 64.

——— 1968b, Tormarton, West Littleton Down: C. B. A. Archaeol. Rev., Gp. XII and XIII, no. 3, p. 8.

——— 1970, Prehistoric skeletons from Tormarton, Gloucestershire: evidence of a Bronze age murder or skirmish: Bristol City Mus., Inf. Sheet no. A7.70.

Hawkes, J., 1937, The archaeology of the Channel Islands II; the Bailiwick of Jersey: Jersey, Soc. Jersiaise, p. 164.

Henshall, Audrey S. and Wallace, J. C., 1965, The excavation of a chambered cairn at Embo, Sutherland: Soc. Antiquaries of Scotland Proc. 1962-63, v. 96, p. 9-36.

Hess von Wichdorff, H., 1931, *in*: Die Thüringer Hohlen, v. 2, p. 8-22.

Jackson, J. W., 1956, The Caerwys tufa: Liverpool and Manchester Geol. Jour., v. 1, pt. 4, p. xxiv-xxviii.

Kerney, M. P., Brown, E. M., and Chandler, T. J., 1964, The late-glacial and postglacial history of the chalk escarpment near Brook, Kent: Royal Soc. (London) Philos. Trans. B., v. 248, p. 135-204.

Leclant, J., 1961, Montouémhat Quatrième prophète d'Amon: Cairo, Inst. Francais d'Archaéol. Orientale, Bib. d'etude, v. 35, pls. LVI, LVII.

———— 1966, Récentes recherches à la pyramide de Téti à Saqqarah: Soc. Française d'Egyptologie Bull., no. 46, p. 9-16.
Leeds, E. T., 1927, A Neolithic site at Abingdon, Berkshire: Antiquaries Jour., v. 7, p. 438-464.
———— 1928, A Neolithic site at Abingdon, Berkshire: Antiquaries Jour., v. 8, p. 461-477.
Libby, W. F., 1952, Radiocarbon dating, Chicago, Univ. of Chicago Press, p. 70-71.
Matthews, D. H., 1949, The restoration of the monastery church of Debra Damo, Ethiopia: Antiquity, v. 23, p. 180-187.
Matthews, D. H. and Mordini, A., 1959, The monastery of Debra Damo, Ethiopia: Archaeologia, v. 97, p. 1-59.
McBurney, C. B. M., 1960, Two soundings in Badger Hole: Mendip Nature Res. Comm., v. 50-51, p. 19-27.
Mellars, P. A., 1969, Radiocarbon dates for a new Creswellian site: Antiquity, v. 43, p. 308-310.
Mercer, J., 1969, Stone tools from a washing-limit of the highest postglacial transgression, Lealt Bay, Isle of Jura: Soc. Antiquaries of Scotland Proc., 1967-68, v. 100, p. 1-46.
———— 1970, Soc. Antiquaries of Scotland Proc., 1969-70, v. 101, in press
Money, J. H., 1966, Iron working site at Withyham: Kent Archaeol. Res. Gps. Council Newsletter, no. 4, May 1966, p. 12-14.
———— 1967, Minepit Wood, Withyham, Sussex: Hist. Metallurgy Gp. Bull., pt. 8, Jan. 1967, p. 45.
———— 1968, Iron working site at Withyham, Sussex: Kent Archaeol. Rev., no. 11, Feb. 1968, p. 5-7.
———— 1971, Medieval Archaeology, in press.
Mortillet, G. de (ed.), 1868, Silex taillés de Spienne: Materieux pour l'histoire primitif et naturelle de l'homme, v. 4, p. 119-121.
Nims, C. F., 1965, Thebes of the Pharaohs: London, Elek Books, p. 76.
Nour, M. Z., Iskander, Z., Osman, M. S., and Moustafa, A. Y., 1960, The Cheops Boats, pt. 1: Cairo, Govt. Printing Offices, pl. XII.
Oakley, K. P. and Campbell, B. G. (eds.), Catalogue of fossil Hominids, pt. 2: Europe: British Mus. (Nat. Hist.), London, in press.
Palmer, Susann, 1969, Third interim report on the excavation of a Mesolithic site at Portland Bill: Dorset Nat. Hist. and Archaeol. Soc. Proc., v. 90, p. 163.
———— 1970, The stone age industries of the Isle of Portland, Dorset, and the utilisation of Portland chert as artifact material in Southern England: Prehist. Soc. Proc., v. 36, p. 82-115.
Passek, T. S., 1961, Early agricultural Tripolje tribes of the Dneister basin (in Russian): Materialy i Issledovaniya po Arkheologii SSSR (MIA): Akad. Nauk SSSR, Moscow, no. 84, p. 1-224.
Petrie, W. M. F., 1909, Qurneh: London, Bernard Quaritch, p. 6, pl. VIII (plan).
Quibell, J. E., 1898, The Ramasseum: London, Bernard Quaritch, pl. I (top, chamber 1).
Ragazzoni, G., 1880, La collina di Castenedolo: Commentari di Ateneo di Brescia, 1880, p. 120-128.
Ralph, E. K., 1959, University of Pennsylvania radiocarbon dates III: Am. Jour. Sci. Radiocarbon Supp., v. 1, p. 45-58.
Schlotheim, E. F. von, 1820, Die Petrefactenkunde: Gotha, p. 1-4, 8-9.
Seele, K., 1959, The tomb of Tjanefer at Thebes: Chicago, Univ. of Chicago Oriental Inst. pubs., v. 86, pls. 1A, 1B.
Sergi, G., 1884, L'Uomo terziario in Lombardia: Archo. Antrop. Etnol., v. 14, p. 303-318.
Seton-Williams, M. V., 1965, Tell el Fara'in Expedition 1964-65: Jour. Egyptian Archaeol., v. 51, p. 9-15.
———— 1966, Tell el Fara'in Expedition 1966: Jour. Egyptian Archaeol., v. 52, p. 163-171.
———— 1969, Tell el Fara'in Expedition 1968: Jour. Egyptian Archaeol., v. 55, p. 5-22.
Smith, I. F. and Evans, J. G., 1968, Excavation of two long barrows in North Wiltshire: Antiquity, v. 42, p. 138-142.
Stone, J. F. S., Piggott, S., and Booth, A. St. J., 1954, Durrington Walls, Wiltshire; recent excavations at a ceremonial site of the early second millennium B.C.: Antiquaries Jour., v. 34, p. 155-177.

Straker, E., 1931, Wealden Iron: London, Bell and Sons, p. 27, 257.
Stuiver, Minze and Suess, H. E., 1966, On the relationship between radiocarbon dates and true sample ages: Radiocarbon, v. 8, p. 534-540.
Suess, H. E., 1967, Bristlecone pine calibration of the radiocarbon time scale from 4100 B.C. to 1500 B.C. (SM-87/52): Monaco Symposium, Monaco, 2-10 Mar., 1967: Vienna, I.A.E.A., p. 143-151.
Täckholm, V. and Drar, M., 1941, Flora of Egypt, v. I: Cairo, Fouad I Univ., p. 42-79.
Tauber, Henrik, 1960, Copenhagen radiocarbon dates IV: Am. Jour. Sci. Radiocarbon Supp., v. 2, p. 12-25.
Tratman, E. K., 1955, Second report on the excavations at Sun Hole, Cheddar—the Pleistocene levels: Univ. Bristol Spelaeol. Soc. Proc., v. 7, p. 61-75, figs. 7, 8, 10.
Vatcher, F. de M., 1959, The radiocarbon dating of the Nutbane long barrow: Antiquity, v. 33, p. 289.
——— 1961, The excavation of the long mortuary enclosure on Normanton Down, Wilts: Prehist. Soc. Proc., v. 27, p. 160-173.
Vogel, J. C. and Waterbolk, H. T., 1963, Groningen radiocarbon dates IV: Radiocarbon, v. 5, p. 163-202.
Vries, H. de and Waterbolk, H. T., 1958, Groningen radiocarbon dates III: Science, v. 128, p. 1550-1556.
Wainwright, G. J., 1963, A reinterpretation of the microlithic industries of Wales: Prehist. Soc. Proc., v. 29, p. 99-132.
——— 1967, The excavation of the henge monument at Durrington Walls, Wiltshire, 1966: Antiquaries Jour., v. 47, p. 166-184.
——— 1968, Durrington Walls a ceremonial enclosure of the 2nd millennium B.C.: Antiquity, v. 42, p. 20-26.
Wainwright, G. J., *et al.*, 1971, Durrington Walls: Soc. Antiquaries (London), Res. Rept., in press.
Wainwright, G. J. and Longworth, I. H., 1970, The excavation of a group of round barrows on Ampleforth Moor, Yorkshire: Yorkshire Archaeol. Jour., v. 42, pt. 167, 1968, p. 283-284.
Wheeler, R. E. M., 1943, Maiden Castle, Dorset: Soc. Antiquaries (London), Rept. Res. Comm., no. XII, p. 344-346.
White, G. F., 1970, Excavation of the Dead Man's Cave, North Anston: Worksop Pub. Libr. and Mus., p. 1-6, figs. 1-4.
Wymer, J., 1962, Excavations at the Maglemosian sites at Thatcham, Berkshire, England: Prehist. Soc. Proc., v. 28, p. 329-361.
Yeivin, S., 1960a, A decade of archaeology in Israel, 1948-1958: Istanbul, Dutch Hist. Archaeol. Inst., p. 4, fig. 1.
——— 1960b, Early contacts between Canaan and Egypt: Israel Explor. Jour., v. 10, p. 193-203.
——— 1961, First preliminary report on the excavations at Tel "Gat" (seasons 1956-1958): Jerusalem, English pt., p. 1-20.
——— 1963, Further evidence of Narmer at "Gat": Or. Ant., v. 2, p. 205-213.
——— 1967, A new Chalcolithic culture at Tel 'Erany and its implications for early Egypto-Canaanite relations: Jerusalem, Fourth World Cong. of Jewish Studies, Jerusalem, 1967, p. 45-48.
——— 1968, Additional notes on the early relations between Canaan and Egypt: Jour. Near Eastern Studies, v. 27, p. 37-50.

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UNIVERSITY OF BONN
NATURAL RADIOCARBON MEASUREMENTS IV

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Radiocarbon measurements, mainly on soil and water samples have been continued. Sample preparation is carried out following methods described by the authors elsewhere (Scharpenseel and Pietig, 1968/69; 1970a, b).

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SAMPLE DESCRIPTIONS

I. GROUND WATER SAMPLES

A. Halterner/Osterfelder Sande

Samples are dated to aid investigations of aquifer spread in Halterner/Osterfelder Sande, NW fringes of main industrial area; coll. 1969 and subm. by G. Siebert, Geol. Landesamt Northrhine-Westfalia, Krefeld.

BONN-522. Hünxe 1 — 12,150 ± 100; 10,200 B.C.
(51° 39′ N Lat, 6° 48′ E Long)

BONN-523. Hünxe 2 — 16,000 ± 215; 14,050 B.C.
(51° 39′ N Lat, 6° 48′ E Long)

BONN-524. Hünxe 4 — 10,550 ± 120; 8600 B.C.
(51° 40′ N Lat, 6° 49′ E Long)

BONN-525. Schwiese — 15,080 ± 170; 13,130 B.C.
(51° 40′ N Lat, 6° 51′ E Long)

BONN-526. Ziegelei Nelskamp — 12,980 ± 135; 11,030 B.C.
(51° 40′ N Lat, 6° 50′ E Long)

		10,585 ± 110
BONN-527. Hünxe III		8635 B.C.
(51° 40′ N Lat, 6° 49′ E Long)		
		7320 ± 80
BONN-528. Gahlen I		5370 B.C.
(51° 39′ N Lat, 6° 53′ E Long)		

Comment: except for BONN-523 and -525, carbonate correction (Tamers, 1967) shows samples are early Holocene. Tritium measurements for modern recharge check were not wanted.

B. Tunisia

Ground-water dating has been continued in Tunisia (R., 1970, v. 12, p. 22-26). Carbonates of 41 wells were coll. by distillation and precipitation as $SrCO_3$. Bicarbonate titration was carried out immediately at sampling site. C^{14} ages are indicated, uncorrected and corrected for dead carbonate-C contribution (Tamers, 1967). Tritium concentrations were also measured. Samples coll. 1968 and subm. by W. Kerpen, E. Kruse, and H. W. Scharpenseel, Inst. f. Bodenkunde, Bonn Univ., J. Ohling HER Econ. Coop. Proj., Tunis.

Sample	Measured C^{14} age	Corrected C^{14} age
	8400 ± 80	6560 ± 610
BONN-529. Ain Beda 3	6450 B.C.	4610 B.C.
(35° 30′ N Lat, 9° 43′ E Long)		
	2130 ± 60	300 ± 610
BONN-530. El Alem 2	180 B.C.	A.D. 1650
(35° 55′ N Lat, 9° 59′ E Long)		
	3560 ± 60	1890 ± 560
BONN-531. El Alem 1	1610 B.C.	A.D. 60
(35° 55′ N Lat, 10° 2′ E Long)		
	11,410 ± 80	9620 ± 600
BONN-532. Hajeb 9 Aioun	9460 B.C.	7670 B.C.
(35° 24′ N Lat, 9° 31′ E Long)		
	12,500 ± 100	10,790 ± 570
BONN-533. Hajeb 10928 Aioun	10,550 B.C.	8840 B.C.
(35° 23′ N Lat, 9° 33′ E Long)		
	8840 ± 85	7160 ± 560
BONN-534. Abdelhamid gouia	6890 B.C.	5210 B.C.
(35° 23′ N Lat, 9° 31′ E Long)		
	10,930 ± 115	9550 ± 460
BONN-535. Haffouz 2	8980 B.C.	7600 B.C.
(35° 38′ N Lat, 9° 40′ E Long)		
	14,960 ± 140	13,540 ± 470
BONN-536. Haffouz 4	13,050 B.C.	11,590 B.C.
(35° 38′ N Lat, 9° 41′ E Long)		

Sample	Measured C^{14} age	Corrected C^{14} age
BONN-537. Hajeb el Aioun 11758/4 (35° 25′ N Lat, 9° 32′ E Long)	2480 ± 50 530 B.C.	1110 ± 460 A.D. 840
BONN-538. Cherichira 3 (35° 39′ N Lat, 9° 47′ E Long)	4470 ± 60 2520 B.C.	2870 ± 530 920 B.C.
BONN-539. Cooperative Scam chez Tunis (36° 41′ N Lat, 10° 36′ E Long)	2960 ± 60 1010 B.C.	1330 ± 540 A.D. 620
BONN-540. M.B. 8983 (36° 42′ N Lat, 10° 16′ E Long)	7120 ± 120 5170 B.C.	5570 ± 520 3620 B.C.
BONN-541. Ez Zebara 12594/4 (35° 31′ N Lat, 9° 41′ E Long)	4960 ± 55 3010 B.C.	3120 ± 610 1170 B.C.
BONN-542. Zeuss III (33° 31′ N Lat, 10° 21′ E Long)	10,890 ± 110 8940 B.C.	9410 ± 500 7460 B.C.
BONN-543. Mareth 312/5 Source (33° 37′ N Lat, 10° 17′ E Long)	17,470 ± 220 15,520 B.C.	15,890 ± 530 13,940 B.C.
BONN-546. Menchia 1 9316/5 (33° 47′ N Lat, 8° 47′ E Long)	24,820 ± 700 22,870 B.C.	23,050 ± 590 21,100 B.C.
BONN-547. Maunsoura Source (33° 44′ N Lat, 8° 58′ E Long)	19,310 ± 295 17,360 B.C.	17,710 ± 530 15,760 B.C.
BONN-548. Kettaua 5547 (33° 45′ N Lat, 10° 10′ E Long)	17,900 ± 190 15,950 B.C.	16,390 ± 500 14,440 B.C.
BONN-549. Oued Akarit Source 5540/5 (34° 06′ N Lat, 9° 58′ E Long)	17,200 ± 200 15,250 B.C.	15,650 ± 520 13,700 B.C.
BONN-550. Chenini Chott el Ferik (33° 52′ N Lat, 10° 2′ E Long)	17,360 ± 210 15,410 B.C.	15,660 ± 570 13,710 B.C.
BONN-551. Bida Source (10° N Lat, 33° E Long)	17,680 ± 190 15,730 B.C.	16,170 ± 500 14,220 B.C.

Sample	Measured C^{14} age	Corrected C^{14} age
BONN-552. Seftimi 7305/5 (33° 48′ N Lat, 9° 0′ E Long)	27,040 ± 610 25,090 B.C.	25,490 ± 420 23,540 B.C.
BONN-553. Ain Guettara (33° 45′ N Lat, 9° 7′ E Long)	14,340 ± 250 12,390 B.C.	12,740 ± 530 10,790 B.C.
BONN-554. Oun el Ferth 5918/5 (33° 47′ N Lat, 9° 14′ E Long)	24,940 ± 710 22,990 B.C.	23,440 ± 500 21,490 B.C.
BONN-555. Bordj Sai Daue 3 5821ter/5 (33° 47′ N Lat, 9° 18′ E Long)	22,620 ± 460 20,670 B.C.	21,170 ± 480 19,220 B.C.
BONN-556. Nakla 2 6664/5 (33° 51′ N Lat, 9° 29′ E Long)	21,510 ± 500 19,560 B.C.	19,490 ± 670 17,540 B.C.
BONN-557. Ain Tamra (33° 44′ N Lat, 9° 21′ E Long)	22,850 ± 435 20,900 B.C.	20,810 ± 680 18,860 B.C.
BONN-558. C.F. 1 (Saline) (33° 54′ N Lat, 9° 39′ E Long)	28,990 ± 790 27,040 B.C.	27,530 ± 490 25,580 B.C.
BONN-559. Oued el Hamma (33° 51′ N Lat, 9° 47′ E Long)	19,100 ± 230 17,150 B.C.	17,630 ± 490 15,680 B.C.
BONN-560. Oudref 2 (Oued Melak) (33° 59′ N Lat, 9° 58′ E Long)	20,690 ± 350 18,740 B.C.	19,180 ± 510 17,230 B.C.
BONN-561. El Hicha (34° 9′ N Lat, 9° 59′ E Long)	18,330 ± 230 16,380 B.C.	16,700 ± 540 14,750 B.C.
BONN-562. Dehibat Bir el ghab (32° 6′ N Lat, 10° 49′ E Long)	29,830 ± 760 27,880 B.C.	27,970 ± 620 26,020 B.C.
BONN-563. Brega Kibira No. 50 (32° 25′ N Lat, 10° 16′ E Long)	22,490 ± 350 20,540 B.C.	20,860 ± 540 18,910 B.C.
BONN-564. Quargla 1 (32° 0′ N Lat, 5° 19′ E Long)	27,710 ± 760 25,760 B.C.	26,380 ± 440 24,430 B.C.
BONN-565. Ain Louise (31° 56′ N Lat, 5° 20′ E Long)	24,280 ± 630 22,330 B.C.	23,140 ± 380 21,190 B.C.

Sample	Measured C^{14} age	Corrected C^{14} age
BONN-566. Ain Taula Djdida (29° 18′ N Lat, 7° 1′ E Long)	23,100 ± 370 21,150 B.C.	21,280 ± 610 19,330 B.C.
BONN-567. El Oued 33 (29° 54′ N Lat, 8° 11′ E Long)	22,820 ± 650 20,870 B.C.	21,160 ± 550 19,210 B.C.
BONN-568. Bou Merdas 2 8210bis/4 (35° 31′ N Lat, 10° 42′ E Long)	7090 ± 85 5140 B.C.	5340 ± 580 3390 B.C.
BONN-569. Beni Hassen 7 Bis 8204bis/4 (35° 32′ N Lat, 10° 49′ E Long)	6410 ± 70 4460 B.C.	4690 ± 570 2740 B.C.
BONN-570. Sidi Naija 9913/4 (35° 29′ N Lat, 10° 50′ E Long)	5915 ± 80 3965 B.C.	4240 ± 560 2290 B.C.
BONN-571. Sidi Bennour 10626/4 (35° 31′ N Lat, 10° 54′ E Long)	8480 ± 120 6530 B.C.	6700 ± 590 4750 B.C.

Comment: BONN-529-571 are 2nd series of ground-water studies in Tunisia and are follow-up of BONN-229-521. Coll. 1969 from ground-water deposits in Quaternary, Tertiary, and Cretaceous sediments. After completion of 3rd and last series, coll. in 1970, all samples will be evaluated and isochrones drawn.

II. SOIL SAMPLES

To eliminate recent root and organic cell debris, soil samples were pretreated, as described in R. 1968, v. 10, p. 8-28; 1969, v. 11, p. 3-14; and 1970, v. 12, p. 19-39. Mean residence time of carbon in soil profiles was tested.

A. Hungary

Organic matter of individual genetic horizons from different profiles of major soil groups, mainly chernozem and vertisol, in Hungary was measured by natural radiocarbon, as part of general scrutiny of natural radiocarbon concentration in chernozem and vertisol profiles.

Chernozem with pseudomycelia in loess, Erd, SE Budapest

BONN-611. Chernozem, 2.0% C, A_{sz}, 10 to 20 cm	860 ± 60 A.D. 1090
BONN-612. Chernozem, 1.6% C, A, 20 to 30 cm	910 ± 60 A.D. 1040
BONN-613. Chernozem, 1.2% C, B, 30 to 45 cm	1945 ± 60 A.D. 5

BONN-614. Chernozem, 0.6% C, BC, 45 to 59 cm — 2800 ± 50; 850 B.C.

BONN-615. Chernozem, 0.4% C, C_1, 70 to 87 cm — 9680 ± 100; 7730 B.C.

Samples belong to Hungarian Chernozem region with loessic parent material (47° 25′ N Lat, 18° 55′ E Long); coll. 1969 and subm. by W. Kerpen and C. Ronzani, Inst. f. Bodenkunde, Bonn, and I. Lamberger, Research Inst. for Soil Sci. and Agric. Chem., Hungarian Acad. Sci. Budapest.

Chernozem with pseudomycelia in sand loess, Balatonföldvár, SE Budapest, S bank of Plattensee

BONN-625. Chernozem, on Würm sand loess, 0.9% C, A_{hCa1}, 27 to 47 cm — 1860 ± 60; A.D. 90

BONN-626. Chernozem, on Würm sand loess, 0.6% C, CB+BC, 50 to 62 cm — 3450 ± 70; 1490 B.C.

BONN-627. Chernozem, on Würm sand loess, 0.6% C, C_1, 80 to 95 cm — 4690 ± 60; 2740 B.C.

Samples belong to Hungarian Chernozem region (46° 50′ N Lat, 17° 47′ E Long), coll. 1969 and subm. by W. Kerpen, C. Ronzani, and L. Szücz.

Chernozem with pseudomycelia in fine sandy loess Köszàrhegy

BONN-633. Chernozem on fine sandy loess, A_2, 15 to 39 cm — 2940 ± 50; 990 B.C.

BONN-634. Chernozem on fine sandy loess, B, 39 to 54 cm — 3640 ± 70; 1690 B.C.

BONN-635. Chernozem on fine sandy loess, CB, 54 to 80 cm — 3970 ± 90; 2020 B.C.

BONN-636. Chernozem on fine sandy loess, BC, 80 to 100 cm — 4575 ± 60; 2625 B.C.

Samples belong to Hungarian Chernozem region (47° 8′ N Lat, 18° 23′ E Long), coll. 1969 and subm. by W. Kerpen, C. Ronzani, and L. Szücs. Profile taken from slope at rim of tilery.

Wiesenboden, formed in loess, transformed by solifluction, Boconad, ENE Budapest

BONN-616. Wiesenboden solifluction loess, 4.2% C, A_0, 15 to 27 cm — 3060 ± 75; 1110 B.C.

BONN-617. Wiesenboden solifluction loess, 2.3% C, B, 28 to 45 cm — 3120 ± 70; 1170 B.C.

BONN-618. Wiesenboden solifluction loess, 1.5% C, BC_1, 45 to 59 cm — 3730 ± 65; 1780 B.C.

BONN-619. Wiesenboden solifluction loess, 0.35± C, C_1, 69 to 90 cm — 3870 ± 100; 1920 B.C.

BONN-620. Wiesenboden solifluction loess, 0.3% C, C_2, 110 to 120 cm — 5260 ± 70; 3310 B.C.

Wiesenboden is held to be younger than aforementioned chernozems (47° 40′ N Lat, 20° 11′ E Long); coll. 1969 and subm. by W. Kerpen, C. Ronzani, and T. Jankovits.

Brownearth of high base saturation (Eutrochrept) in loess, containing free carbonates, Kapoly, site endangered by erosion

BONN-628. Brownearth in loess, 0.5% C, B_{v1}, 22 to 30 cm — 860 ± 55; 1090 B.C.

BONN-629. Brownearth in loess, 0.5% C, B_{v2}, 31 to 45 cm — 2140 ± 60; 190 B.C.

BONN-630. Brownearth in loess, 0.4% C, CB_v, 45 to 67 cm — 3370 ± 70; 1420 B.C.

BONN-631. Brownearth in loess, 0.3% C, B_vC, 67 to 89 cm — 3650 ± 70; 1700 B.C.

BONN-632. Brownearth in loess, 0.2% C, C, 89 to 120 cm — 3990 ± 70; 2040 B.C.

Kapoly Brownearth, est. Holocene, younger than following parabrownearth (Hapludalf). Eventually formed from parabrownearth, decapitated by erosion, (46° 43′ N Lat, 17° 55′ E Long), coll. 1969 and subm. by W. Kerpen, C. Ronzani, and L. Szücs.

Parabrownearth (hapludalf) with slight clay migration Nagyrécse, slight slope, SE Budapest, near border of Yugoslavia.

BONN-621. Parabrownearth in loess, 0.9% C, A_1, 13 to 23 cm — 610 ± 50; A.D. 1340

BONN-622. Parabrownearth in loess, 0.4% C, B_t, 30 to 61 cm — 1710 ± 70; A.D. 240

BONN-623. Parabrownearth in loess, 0.25% C, B_vB_t, 74 to 112 cm — 2870 ± 115; 920 B.C.

BONN-624. Parabrownearth in loess, 0.25% C, B_tB_v, 112 to 128 cm — 16,750 ± 290; 14,800 B.C.

Soil age est. similar to chernozems (46° 28′ N Lat, 17° 8′ E Long). Abrupt age jump in B_tB_v-horizon is unexplainable. There could be some fossil material in this horizon. Sample to be repeated; coll. 1969 and subm. by W. Kerpen, C. Ronzani, and L. Szücs.

Solonetz soil with shallow A-horizon above deep B-horizon, Hortobagy, E of Budapest, SW Debrecen, pusta plain

BONN-648. Solonetz in pusta plain, 5.5% C, B_2, 15 to 37 cm — 3530 ± 70, 1580 B.C.

BONN-649. Solonetz in pusta plain, 3.7% C, B_3, 37 to 51 cm — 5110 ± 130, 3160 B.C.

BONN-650. Solonetz in pusta plain, 3.5% C, CB, 51 to 60 cm — 4540 ± 100, 2590 B.C.

BONN-651. Solonetz in pusta plain, 2.5% C, C_1, 74 to 108 cm — 10,080 ± 160, 8130 B.C.

Solonetz shows in C_1-horizon abrupt age increase, indicating importance of taking samples through C-horizon (47° 38′ N Lat, 21° 20′ E Long). Coll. 1969 and subm. by W. Kerpen and I. Boros.

Nethermoor (bog) soil Nadasdladany, SE Budapest, NE Plattensee, surface fresh, peat horizons wet.

BONN-637. Nethermoor (bog) soil, 12.2% C, A_h, 20 to 29 cm — 1070 ± 50, A.D. 880

BONN-638. Nethermoor (bog) soil, 23.8% C, O_H, 42 to 52 cm — 3530 ± 65, 1580 B.C.

BONN-639. Nethermoor (bog) soil, 37.2% C, T_1, 60 to 70 cm — 5250 ± 80, 3300 B.C.

BONN-641. Nethermoor (bog) soil, 48.0% C, T_3, 100 to 110 cm — 6880 ± 90, 4930 B.C.

BONN-642. Nethermoor (bog) soil, 52.3% C, T_4, 125 to 130 cm — 7950 ± 80, 6000 B.C.

BONN-643. Nethermoor (bog) soil, 51.1% C, T_5, 145 to 155 cm — 8430 ± 90, 6480 B.C.

BONN-644. Nethermoor (bog) soil, 52.3% C, T_6, 160 to 184 cm — 7980 ± 180, 6030 B.C.

BONN-645. Nethermoor (bog) soil, 55.8% C, T_7, 190 to 200 cm — 8520 ± 120, 6570 B.C.

BONN-646. Nethermoor (bog) soil, 46.5% C, T_8, 225 to 235 cm — 8760 ± 120, 6810 B.C.

BONN-647. Nethermoor (bog) soil, 6.1% C, T_9, 245 to 270 cm — 9300 ± 340, 7350 B.C.

Nethermoor, according to C^{14} dates, was formed in earliest Holocene (47° 9′ N Lat, 18° 12′ E Long). Samples coll. 1969 and subm. by W. Kerpen, C. Ronzani, and T. Yankovits. *Comment on Hungarian series*: series includes soil profiles of following great soil groups: Chernozem, Wiesenboden, Brownearth with high base saturation, Parabrownearth, Solonetz, and Nethermoor. While maximum mean residence time values of humus-carbon in deepest profile spots agree with observed radiocarbon ages in profiles of other European sampling spots, profiles BONN-611-615 (Chernozem), BONN 621-624 (Parabrownearth), and BONN-648-651 (Solonetz) show in deepest horizons ages, that may indicate fossil carbon relics, but may also indicate scarcely "rejuvenated" organic material in deepest weathered zone. These examples emphasize need of great care during sampling procedure to assure total collection of carbon in deepest position. All samples were freed of carbonates by HCl pretreatment.

B. Russia

A late sample, belonging to series BONN-455-470 (R. 1970, v. 12, p. 19-39).

BONN-458. Deep chernozem from loess, Orel, 0.4% C, C_{v1}, 240 to 250 cm **12,470 ± 360** **10,520 B.C.**

(52.5° N Lat, 36.2° E Long), coll. 1967 and subm. by H. Zakosek. *Comment*: age is several thousand yr beyond mean residence times of humus-C, measured in deepest part of other non-buried chernozem profiles. Although measured age of 12,500 B.P. would fit into theory of chernozem origin of some schools, possibility of fossil C-relics at depth 240 to 250 cm should not be excluded.

C. Podsols

Podsol Hauset, between Hauset and Hergenrath, 1 km S German border. Very strongly developed podsol profile, high residence time of humus-C expected.

BONN-652. Podsol Hauset, raw humus cover, surface, 36% C — 800 ± 60, A.D. 1150

BONN-653. Podsol Hauset, 2.4% C, A_{eh}, 15 cm — 980 ± 55, A.D. 970

BONN-654. Podsol Hauset, 0.2% C, A_e, 40 cm — 980 ± 120, A.D. 970

BONN-655. Podsol Hauset, 3.0% C, B_h, 70 to 80 cm — 1640 ± 50, A.D. 310

BONN-656. Podsol Hauset, <.7% C, B_s, 90 cm — 2240 ± 50, 290 B.C.

Coll. 1969 and subm. by H. Butzke, Geol. Landesamt Northrhine-Westfalia, Krefeld (50° 42′ N Lat, 6° 3′ E Long). *Comment*: high mobility of humus in profile causes strong rejuvenation (due to roots, animal transport, and, particularly, percolation) throughout. Mean residence time of max. 2240 yr does not meet expectations and is lower than measurements in less strongly developed podsols (BONN-90, -366; R., 1968, v. 10, p. 8-28; 1969, v. 11, p. 3-14), which approach 3000 B.P.

Bändchenpodsol (string podsol) Schliffkopfhaus, Black Forest (Black Forest "Hochstrasse") very thin, compacted ligands, representing B_{hs}-horizon.

BONN-859. Bändchenpodsol Schliffkopfhaus, 1.4% C, A_h, 38 to 55 cm — 2280 ± 60; 330 B.C.

BONN-860. Bändchenpodsol upper string, 1.4% C, B_{b1}, 78 to 80 cm — 1780 ± 60; A.D. 170

BONN-861. Bändchenpodsol lower string, 0.9% C, B_{b2}, 80 to 83 cm — 2160 ± 60; 210 B.C.

Samples coll. 1969 and subm. by H. W. Scharpenseel and S. Müller, Geol. Landesamt Baden-Württemberg, Stuttgart (48° 32′ N Lat, 5° 53.5′ E Long). *Comment*: "Bändchenpodsols" formation formerly believed a consequence of medieval deforestation. Mean age of >2000 yr requires new explanation of pedogenesis.

D. Plaggen soils

Irish series

Plaggen horizon Donoure, Ardfield, Co. Coak, 0.9% C, A_{p13}, 46 to 56 cm, (51° 36′ N Lat, 8° 57′ W Long).

BONN-660. Donoure, Ardfield — **480 ± 50; A.D. 1470**

Plaggen horizon Cahesetrant, Dingle, 1.3% C, A_{p12}, 40 to 48 cm, (52° 6′ N Lat, 10° 23′ W Long).

BONN-661. Cahesetrant Dingle — **1265 ± 60; A.D. 685**

Plaggen horizon Castlegregory Co. Kesay, (52° 13′ N Lat, 10° 10′ W Long).

BONN-662. 3.0% C, A_{p12}, 50 cm — **1520 ± 50; A.D. 430**

BONN-663. 8.8% C, A_{p2b}, 65 to 75 cm — **2135 ± 50; 185 B.C.**

Samples coll. 1968 and subm. by M. Conry, The Agricultural Inst., Oak Park, Carlow, Ireland. *Comment*: BONN-660 to 662 agree with ages measured on German plaggen horizons. BONN-663 indicates plaggen economy in N Europe in time B.C. Sample should be checked for possible mixing with underlying fossil material.

E. Australian Krasnozems

Krasnozem of Wollongbar, North S Wales, coll. 1943 before bomb carbon contamination.

BONN-664. Krasnozem Wollongbar, 6.5% C, A_h, 20 cm — **1400 ± 60; A.D. 550**

Sample coll. 1943 and subm. by Dr. Swaby, C.S.I.R.O., Adelaide. Sample permits comparison with samples of same soil type, coll. after beginning of bomb carbon production.

Krasnozem of S Queensland. Samples from Gabbinbar and Beechmont taken 1968, from Maleny 1964, from Binjour, Gurgeena, Coulston Lakes, and Memerambi, 1959.

BONN-679.	Babbinbar, old plateau, 600 m alt., 890 mm precipitations, 9.2% C, 0 to 7.5 cm (27° 26′ S Lat, 151° 59′ E Long).	101.7 ± 0.8% Modern
BONN-680.	Same location, 1.33% C, 30 to 40 cm	1280 ± 60 A.D. 670
BONN-766.	Same location, 1.2% C, 60 to 65 cm	6010 ± 100 A.D. 4060
BONN-681.	Beechmont, plateau margin, 585 m alt, 1525 mm precipitations, 6.8% C, 0 to 15 cm, (28° 10′ S Lat, 153° 12′ E Long).	600 ± 60 A.D. 1350
BONN-767.	Same location, 1.2% C, 69 to 122 cm	3850 ± 360 1900 B.C.
BONN-682.	Binjour, Old lateritic plateau, 380 m alt, 760 mm precipitations, 5.9% C, 0 to 7.5 cm, (25° 32′ S Lat, 151° 30′ E Long).	200 ± 50 A.D. 1750
BONN-768.	Same location, 1.0% C, 61 to 91 cm	1780 ± 70 A.D. 170
BONN-683.	Gurgeena, Old lateritic plateau, 400 m alt, 760 mm precipitations, 6.1% C, 0 to 15 cm (25° 29′ S Lat, 151° 21′ E Long).	435 ± 50 A.D. 1515
BONN-769.	Same location, 1.1% C, 29 to 66 cm	570 ± 70 A.D. 1380
BONN-684.	Coulston Lakes 1, Valley plain, 250 m alt, 760 mm precipitations, 4.3% C, 0 to 15 cm, (27° 37′ S Lat, 151° 54′ E Long).	105.1 ± 0.7% Modern
BONN-770.	Same location, 0.9% C, 25 to 41 cm	950 ± 50 A.D. 1000
BONN-685.	Coulston Lakes 2, Valley plain, 207 m alt, 760 mm precipitations, 2.2% C, 0 to 15 cm (25° 39′ S Lat, 151° 53′ E Long).	480 ± 50 A.D. 1470
BONN-771.	Same location, 1.4% C, 28 to 56 cm	980 ± 50 A.D. 970

BONN-686.	Maleny, Hilly-dissected plateau, 450 m alt, 1955 mm precipitations, 5.7% C, 0 to 15 cm (26° 46′ S Lat, 152° 49′ E Long).	150 ± 50 A.D. 1800
BONN-687.	Memerambi, Hilly-dissected plateau, 480 m alt, 760 mm precipitations, 4.1% C, 0 to 15 cm (26° 26′ S Lat, 151° 49′ E Long).	170 ± 60 A.D. 1780
BONN-772.	Same location, 1.2% C, 61 to 91 cm	4000 ± 150 2050 B.C.

Samples coll. and subm. by G. D. Hubble, C.S.I.R.O., Div. of Soils, St. Lucia, SW Queensland. *Comment*: mean residence time of humus-C at various levels of profile is rather young, compared with most other profiles of zonal soils. The only exceptions, BONN-767, BONN-772, and BONN-766, represent rather deep layers. As in most red tropical soils, downward organic matter translocation seems to occur quickly, causing low residence times of humus-C.

F. Argentine Vertisols

Vertisol (Grumusol) from Serie Clara, Conception del Uruguay, Entre Rios, Argentina. Pampas soil formed in loessic parent material, below 120 cm light colored and very low in carbon.

BONN-803.	Vertisol Conception del Uruguay, 3.2% C, 0 to 10 cm	101.5 ± 0.5% Modern
BONN-804.	Same location, 2.7% C, 10 to 20 cm	175 ± 50 A.D. 1775
BONN-805.	Same location, 2.0% C, 20 to 30 cm	580 ± 50 A.D. 1370
BONN-806.	Same location, 1.8% C, 30 to 40 cm	980 ± 55 A.D. 970
BONN-807.	Same location, 1.0% C, 40 to 50 cm	1390 ± 60 A.D. 560
BONN-808.	Same location, 0.8% C, 50 to 60 cm	1510 ± 60 A.D. 440
BONN-809.	Same location, 1.3% C, 60 to 70 cm	1560 ± 60 A.D. 390
BONN-810.	Same location, 1.2% C, 70 to 80 cm	1480 ± 70 A.D. 470
BONN-811.	Same location, 0.7% C, 80 to 90 cm	5850 ± 100 3900 B.C.

BONN-812. Same location, 0.4% C, 90 to 100 cm — 7360 ± 100; 5410 B.C.

BONN-813. Same location, 0.4% C, 100 to 120 cm — 11,160 ± 150; 9210 B.C.

Samples coll. 1968 by M. F. Purnell and N. Hein, Casilla Correo, Conception del Uruguay, and subm. by R. A. Rosell, Inst. de Edafologia, Bahia Blanca, Argentina (30° 30′ S Lat, 58° 20′ W Long). *Comment*: age vs. depth measurements in vertisols reveal interior dynamics of the profile. Down to maximum depth of cracks and self-mulching, mean residence time of humus-C should be about the same. Below the cracks, where the self-mulching (recycling) does not occur, increase of depth should be accompanied by steady increase of mean residence time of humus-C. While many soil profiles held to be vertic have this property less than *a priori* expected, above profile Conception del Uruguay is a typical vertisol with self-mulching down to 80 to 90 cm.

G. Brownearth in volcanic ash

Brownearth in trachyt ash of Alleröd volcanism covering the Neuwied basin. Samples are from profiles in erosion ditches, appearing as darker funnels in street cuts and pits.

Erosion rin profile of brownearth in trachyt ashes, Neuwied basin, 200 m S street Andernach-Kruft (50° 24′ N Lat, 7° 23′ E Long).

BONN-818. Neuwied basin 1, 0.7% C, B_v, 25 to 40 cm — 210 ± 40; A.D. 1740

BONN-819. Same location, 0.6% C, Colluvium, 1 to 1.5 m — 2400 ± 70; 450 B.C.

BONN-820. Same location, 0.3% C, Colluvium, 1.5 to 2 m — 3875 ± 60; 1925 B.C.

BONN-821. Same location, 0.2% C, Colluvium, 2 to 2.4 m — 3640 ± 75; 1690 B.C.

BONN-822. Same location, Britzbank, 2.4 to 2.8 m — 4470 ± 70; 2520 B.C.

Erosion rin profile of brownearth in trachyt ashes, Neuwied basin, 300 m S street Andernach-Kruft (50° 23′ N Lat, 7° 23′ E Long).

BONN-823. Neuwied basin 2, 0.8% C, B_{v1}, 30 to 45 cm — 240 ± 40; A.D. 1710

BONN-824. Same location, 0.4% C, B_{v2}, 80 to 100 cm — 1280 ± 60; A.D. 670

BONN-825. Same location, 0.2% C, Colluvium, 130 to 150 cm — 2470 ± 60; 520 B.C.

BONN-826.	Same location, 0.3% C, Colluvium, 180 to 200 cm	3640 ± 60 1690 B.C.
BONN-827.	Same location, 0.2% C, Colluvium, 215 to 230 cm	4210 ± 80 2260 B.C.
BONN-828.	Same location, 0.1% C, Colluvium, 240 to 250 cm	3900 ± 70 1950 B.C.

Deepest point of large erosion rin near Niedermendig (50° 20′ N Lat, 7° 17′ E Long).

BONN-828. Erosion rin Niedermendig, 6 to 8 m **3990 ± 100**
2040 B.C.

Samples coll. 1969 and subm. by E. Mückenhausen and H. W. Scharpenseel. The 2 brownearth profiles are developed in trachyt ash, superimposing fossil horizon in Würm loess, described by BONN-411 to 416. While this horizon, on emerging into rooted zone (BONN-403 to 407) revealed, by rejuvenation, about half its carbon residence time under trachyt ash cover, about the same mean residence time of maximum 4500 B.P. is measured in recent soil profile developed after burial over this fossil horizon in ash blanket. It also appears, that with rejuvenation, mean residence time, measured in humus-C, amounts to about half true age, known approx. due to Alleröd time spread of the ashes (see R., v. 12, 1970, p. 27-28).

H. Fossil chernozems, buried or in root zone of soil

Two sites of chernozems in Czechoslovakia are being measured for radiocarbon in humus-C; samples belong to 4 distinct periods of soil formation in Pleistocene and Holocene.

Chernozem profile Sedlec near Kutna Hora Czechoslovakia (49° 58′ N Lat, 15° 17′ E Long).

BONN-837.	Holocene chernozem buried, 1.5% C, A_{hca}, 100 to 110 cm	3880 ± 80 1930 B.C.
BONN-838.	Same location, 1.4% C, A_{hca}, 160 to 180 cm	4730 ± 90 2780 B.C.
BONN-839.	Same location, 1.4% C, A_{hca}, 105 to 220 cm	8250 ± 80 6300 B.C.
BONN-840.	Same location, 0.5% C, A_h/C_{ca}, 220 to 235 cm	8900 ± 90 6950 B.C.
BONN-841.	Same location, 0.3% C, C_{ca}, 270 to 280 cm	9850 ± 100 7900 B.C.
BONN-842.	Same location, 0.3% C, C_{ca}, 310 to 320 cm	12,480 ± 110 10,530 B.C.
BONN-843.	Holocene chernozem, not buried, emerging to surface 1.5% C, A_{hca}, 40 to 60 cm	4280 ± 60 2330 B.C.

BONN-844. Same location, 1.3% C, A_{hca}, 70 to 80 cm — **5910 ± 60** / **3960 B.C.**

BONN-845. Same location, 0.8% C, A_h/C_{ca}, 80 to 90 cm — **5810 ± 60** / **3860 B.C.**

BONN-846. Pleistocene chernozem, underlying above Holocene chernozem, 1.5% C, $_fA_h$, 150 to 160 cm — **27,990 ± 710** / **26,040 B.C.**

BONN-847. Same location, 4.3% C, $_fA_h$, 340 to 350 cm — **25,730 ± 550** / **23,780 B.C.**

Samples coll. 1969 and subm. by J. Nemecec, Sec. of Soil Sci. Central Research Inst. of Plant Prod., Praha. *Comment*: the same chernozem horizon, buried, shows maximum radiocarbon age of 12,500 yr. Unburied, emerging to surface, and exposed to rejuvenating agents (root growth, animal transport, percolation) age ca. 6000 yr. Thus, extent of rejuvenation is ca. 100% (cf. BONN-407 and BONN-413, R., v. 12, 1970, p. 27). Below is Pleistocene chernozem with humus-C radiocarbon age of 28,000 yr.

Chernozem profile Chabry, Czechoslovakia (50° 08′ N Lat, 14° 16′ E Long).

BONN-848. Holocene chernozem, buried, 3.1% C, A_{hca}, 250 to 260 cm — **5200 ± 130** / **3250 B.C.**

BONN-849. Same location, 1.8% C, A_h/C_{ca}, 260 to 270 cm — **5810 ± 60** / **3860 B.C.**

BONN-850. Pleistocene chernozem, tilery, dark horizon ascending to present surface, BONN-850 highest, BONN-853 lowest sample, 2.5% C, fA_h — **18,050 ± 300** / **16,100 B.C.**

BONN-851. Same location, 15.9% C, fA_h — **30,380 ± 1180** / **28,430 B.C.**

BONN-852. Same location, 2.3% C, fA_h — **18,270 ± 530** / **16,320 B.C.**

BONN-853. Same location, 2.3% C, fA_h — **17,520 ± 540** / **15,570 B.C.**

BONN-854. Same location, deepest point, perhaps older soil formation, 3.2% C, fA_h — **25,630 ± 710** / **23,680 B.C.**

Samples coll. 1969 and subm. by J. Nemecec. *Comment*: 5800 yr for buried chernozem suggests that this organic matter was exposed to rejuvenation (plant roots, animal transport, and percolation) and sediment cover is much younger. In Pleistocene chernozem series ascending dark horizon in tilery wall shows about equal age, except for 2nd highest sample, BONN-851, which combines exceptionally high C-content with abrupt rise of age. Alien material must be responsible. Dates should help identify 4 assumed fossil soil formations.

I. Charcoal and wood under dune material, Heiligensee near Berlin

Dune cover of region (52° 36′ N Lat, 30° 9′ E Long) was first in studying time; further samples were measured, supplementing information of BONN-609 (R., v. 12, 1970, p. 34).

BONN-855.	Charcoal Heiligensee, under dune sand 30 to 50 cm	1590 ± 60 A.D. 360
BONN-856.	Charcoal Heiligensee, under dune sand 30 to 50 cm	134.1 ± 0.5% Modern
BONN-857.	Charcoal Heiligensee, under dune sand 30 to 50 cm	144.2 ± 0.6% Modern
BONN-858.	Wood sample Heiligensee, under dune sand 30 to 50 cm	102.2 ± 0.6% Modern

Samples coll. 1969 and subm. by U. Schwertmann, Inst. f. Bodenkunde, Tech. Hochschule, München-Weihenstephan. In former study humus-C of same region, BONN-609, deeper dune sand was dated at 760 B.P., suggesting dune cover followed medieval deforestation. Date of charcoal sample, BONN-855, above, increases age of dune cover considerably. Apparently, humus-C of BONN-609 was rejuvenated. Other charcoal and wood samples (BONN-856 -858) are obviously modern. More charcoal lumps should be coll. for final age assessment of dune cover.

J. Buried soil horizon, Scotland

Buried soil horizon, estimated from late Pleistocene, measured for estimate of soil profile development in Scotland. Dark colored horizon, exposed in pit face, from Inchnacardoch Forest, 4 km WSW Ft. Augustus, Inverness-shire (57° 8.5′ N Lat, 4° 45′ W Long).

BONN-863.	**Dark colored horizon, Scotland, 0.3% C, 4.20 m**	**1240 ± 70** **A.D. 710**

Sample coll. 1969 and subm. by R. Glentworth, Macaulay Inst. for Soil Res., Aberdeen. *Comment*: either solifluction material on top of dark horizon is much younger than estimated, or sample is not representative (e.g., taken from outer layer of pit face, open to contamination), since result of 1240 B.P. falls short of estimated > 12,000 yr.

K. Dark layer in rock debris, Vintschgau, Bozen, Italy

Dark layer between loamy rock debris, Vintschgau, prov. Bozen (46° 37′ N Lat, 10° 45′ E Long), probably colluvial material of A-horizon. Sample is pertinent to formation time of dark fossil steppe soils in Vintschgau, est. maximum in old Holocene.

BONN-864. Dark layer of fossil steppe soil in Vintschgau, 2.2% C, 3.00 m **5270 ± 60** **3320 B.C.**

Sample coll. 1969 and subm. by J. Breburda, Inst. f. Auswärtige Landwirtschaft, Giessen. *Comment*: mean residence time agrees well with other results on humus-C of European Holocene steppe soils.

L. Peat in Mardelle, Pirmasens

Peat filling a "Mardelle" (round, doline-like depression, filled with water or gravel, soil peat, rubbish), serves age assessment of Mardelle-formation, Lehmgrube Weppler, Pirmasens (49° 11.5′ N Lat, 7° 35.4′ E Long).

BONN-1132. Mardelle 1.5 km SW center Pirmasens **900 ± 60** **A.D. 1050**

Sample coll. 1964 and subm. 1970 by W. Stöhr, Geol. Landesamt Rheinland-Pfalz, Mainz. *Comment*: result gives residence time of peat-C in Mardelle.

M. Soil organic matter fractions

First series of soil organic matter fractions was pub. in R., v. 12, 1970, p. 35-36 (BONN-6, -138 to -139,, -360 to -370, and -397 to -402). Three more soil profiles have been sampled, and soil organic matter was fractionated into fulvic-, hymatomelanic-, brown humic-, gray humic-acid, humines and humus coal (Scharpenseel, Ronzani, and Pietig, 1968).

BONN-665.	Podsol Haltern-Sinsen, A_h, 8 to 10 cm, (51° 43′ N Lat, 7° 14′ E Long), fulvic acid	140.0 ± 0.2% Modern
BONN-666.	Same location, hymatomelanic acid	114.1 ± 0.7% Modern
BONN-667.	Same location, brown humic acid	925 ± 45 A.D. 1025
BONN-668.	Same location, gray humic acid	1140 ± 70 A.D. 810
BONN-669.	Same location, humine + humus coal	117.2 ± 0.6% Modern
BONN-670.	Chernozem, Söllingen, A_p, 20 cm, (52° 5′ N Lat, 10° 58.5′ E Long), fulvic acid	104.3 ± 0.5% Modern
BONN-671.	Same location, brown and gray humic acid	1560 ± 70 A.D. 390
BONN-672.	Same location, humine + humus coal	2275 ± 60 325 B.C.
BONN-673.	Fossil Chernozem, Michelsberg, scarp, $_fA$, 180 cm, (50° 21′ N Lat, 7° 19′ E Long) fulvic acid	4310 ± 210 2360 B.C.

BONN-674. Same location, brown and gray humic acid — 7600 ± 220, 5650 B.C.

BONN-675. Same location, humines — 6930 ± 80, 4980 B.C.

BONN-676. Same location, humus coal — 6830 ± 100, 4880 B.C.

Samples coll. 1969 and subm. by H. W. Scharpenseel. *Comment*: in all samples, except recent Chernozem A_p-horizon with good aeration and extractibility, humic acid fractions show highest mean residence time. In Chernozem A_p, where most humus is microbial in origin and no hydromorphic conditions can conserve cellulose remnants, humines are highest in mean residence time, as would be expected in all humus fractions. In podsol series, contamination influences modern age in humus coal fraction. The small amount of residual humus coal caught during repeated humic acid extraction, with N/10 NaOH, some modern CO_2 from the air.

N. Soil organic matter, enriched in various gravity fields

Routine sample preparation in our lab. includes carbon-enrichment by a centrifugal process (H. W. Scharpenseel and F. Pietig, 1968/69). Since application of gravity field could exclude certain particle sizes from the carbon-enrichment zone, (that is used for combustion and benzene synthesis), radiocarbon ages from the same material, using different gravity fields for C-enrichment, were compared.

BONN-831. Chernozem Söllingen, fraction passed in suspension through sieve of 0.5 mm ϕ, 3.5% C, 20 cm (52° 5′ N Lat, 10° 5′ E Long), 500 rpm — 2000 ± 50, 50 B.C.

BONN-832. Same location, 3.5% C, 2000 rpm — 1870 ± 70, A.D. 80

BONN-833. Same location, 4.6% C, 3000 rpm — 1680 ± 50, A.D. 270

BONN-834. Same location, 3.1% C, 4000 rpm — 1820 ± 100, A.D. 130

BONN-835. Same location, 3.5% C, 5000 rpm — 1770 ± 60, A.D. 180

BONN-836. Same location, 3.4% C, full speed, ca. 5400 rpm — 1780 ± 50, A.D. 170

Comment: except for fractions rpm 500 and rpm 3000, results are identical. In rpm 3000 sample, a higher C-content is parallel, apparently a chance admixture of younger material; Sample 500 rpm is obsolete due to very slow precipitation of the finest clay particles at this low centrifugal speed. 4000 rpm seems to be about the optimal condition.

O. Comparative measurements in texture fractions of same soil

Since our lab. takes only clay-humus from a soil, *i.e.*, the organic fraction, attached to and locked inside the clay minerals, comparative radiocarbon measurements in diverse texture fractions seem essential. The following measurements were made, using a loessic soil, and especially a fossil A horizon, embedded in a recent B_t horizon of a parabrownearth profile. The clay humus of this source is mainly transported and free from contaminating cellulose remnants.

BONN-1133.	Inden Parabrownearth with fossil A-horizon in B_t-horizon (50° 51′ N Lat, 6° 22′ E Long) 0.3% C, $> 60\mu$	3170 ± 80 1220 B.C.
BONN-1134.	Same location, 0.8% C, 60 to 2μ	3450 ± 80 1500 B.C.
BONN-1135.	Same location, 0.5%, 2 to 1μ	3280 ± 80 1330 B.C.
BONN-1136.	Same location, 0.7% C, 1 to 0.5μ	2790 ± 70 840 B.C.
BONN-1137.	Same location, 0.9% C, 0.5 to 0.25μ	2500 ± 70 550 B.C.

Comment: highest carbon residence times are found in fractions 60 to 2μ and 2 to 1μ, with decreasing tendencies towards fine sand as well as medium and fine clay fractions. Coarser fractions can be expected to be younger, since they contain, if available at all, cellular debris. Apparently, the very fine clay particles are the youngest crystallization product, and thus the youngest to form clay-organic complexes with the youngest, then available, humic matter.

P. Subhydric soils, gyttja

Gyttja in Schalkenmeeren-Maar, Eifel, Profile III (50° 11.5′ N Lat, 6° 50′ E Long). Subhydric soil profiles taken with a "case lot" from a volcanic maar ca. 25 m depth (max.), originating about Alleröd time during eruptions, covering area with trachyt ashes. Mean residence time of measured humus carbon should be compared with approx. known true age of oldest sediments.

BONN-781.	Schallenmeeren Maar, III, 6.8% C, 0 to 10 cm	2360 ± 60 410 B.C.
BONN-782.	Same location, 3.5% C, 10 to 20 cm	2180 ± 80 230 B.C.
BONN-783.	Same location, 1.9% C, 20 to 30 cm	950 ± 90 A.D. 1000
BONN-784.	Same location, 2.3% C, 30 to 40 cm	2110 ± 55 160 B.C.

BONN-785.	Same location, 3.5% C, 40 to 50 cm	2200 ± 60 250 B.C.
BONN-786.	Same location, 4.7% C, 50 to 60 cm	2990 ± 70 1040 B.C.
BONN-787.	Same location, 4.9% C, 60 to 70 cm	3300 ± 70 1350 B.C.
BONN-789.	Same location, 3.5% C, 80 to 90 cm	4600 ± 70 2650 B.C.
BONN-790.	Same location, 3.2% C, 90 to 100 cm	2460 ± 60 510 B.C.
BONN-791.	Same location, 1.9% C, 100 to 110 cm	4540 ± 80 2590 B.C.
BONN-792.	Same location, 1.5% C, 110 to 120 cm	1500 ± 50 A.D. 450
BONN-793.	Same location, 2.7% C, 120 to 130 cm	2430 ± 50 480 B.C.
BONN-794.	Same location, 2.6% C, 130 to 140 cm	2435 ± 50 485 B.C.
BONN-795.	Same location, 3.2% C, 140 to 150 cm	2540 ± 60 590 B.C.
BONN-796.	Same location, 4.3% C, 150 to 160 cm	2050 ± 60 100 B.C.
BONN-797.	Same location, 7.8% C, 160 to 170 cm	2120 ± 60 170 B.C.
BONN-798.	Same location, 16.7% C, 170 to 180 cm	2700 ± 60 750 B.C.
BONN-799.	Same location, 13.4% C, 180 to 190 cm	2920 ± 60 970 B.C.
BONN-800.	Same location, 10.9% C, 190 to 200 cm	3240 ± 60 1290 B.C.
BONN-801.	Same location, 16.2% C, 200 to 215 cm	2950 ± 50 1000 B.C.
BONN-802.	Same location, 20.7% C, 215 to 230 cm	3010 ± 60 1060 B.C.

Samples coll. 1969 and subm. by H. W. Scharpenseel, H. Gewehr, and W. Kerpen. *Comment*: discordant tendencies in age vs. depth increase, particularly in 1st m depth, sometimes also seen in marsh and plaggen soils. Here, probably caused by reworking even under submersion, and by methane bubbles. In lower 130 cm, age vs. depth increase is almost steady. Highest mean residence time of 4600 yr is ca. ½ true age of oldest part of organic sediment.

Gyttja in lake of Selent, E Holsteen, Profile II (54° 41′ N Lat, 10° 35′ E Long). Subhydric soil profiles taken with aid of a "case lot" and with a Livingstone borer from gyttja in lake of Selent, a moraine lake in E Holsteen, 2nd biggest of numerous Holsteen lakes, max. depth ca. 45 m. Long stretches show sediment blanket less than 1 m thickness; basins contain > 5 to 6 m sediment, traced with an echo sounder. E, shallow part of lake believed to cover submerged, prehistoric settlement.

BONN-882.	(Livingstone borer), 20 to 40 cm	110.9 ± 0.8% Modern
BONN-883.	Same location, 40 to 60 cm	109.7 ± 0.8% Modern
BONN-884.	Same location, 60 to 80 cm	710 ± 50 A.D. 1240
BONN-885.	Same location, 80 to 100 cm	104.2 ± 0.8% Modern
BONN-886.	Same location, 100 to 120 cm	101.9 ± 0.8% Modern
BONN-887.	Same location, 120 to 140 cm	1180 ± 50 A.D. 770
BONN-888.	Same location, 140 to 160 cm	1110 ± 80 A.D. 840
BONN-889.	Same location, 160 to 180 cm	1560 ± 80 A.D. 390
BONN-890.	Same location, 180 to 200 cm	940 ± 70 A.D. 1010
BONN-891.	Same location, 200 to 220 cm	1640 ± 80 A.D. 310
BONN-892.	Same location, 220 to 240 cm	2580 ± 50 630 B.C.
BONN-894.	Same location, 260 to 280 cm	2470 ± 50 520 B.C.
BONN-895.	Same location, 280 to 300 cm	2330 ± 60 380 B.C.
BONN-896.	Same location, 300 to 320 cm	2350 ± 50 400 B.C.

BONN-897.	Same location, 320 to 340 cm	3000 ± 60 1050 B.C.
BONN-898.	Same location, 340 to 360 cm	2250 ± 70 300 B.C.
BONN-899.	Same location, 360 to 380 cm	2840 ± 60 890 B.C.
BONN-900.	Same location, 380 to 400 cm	2540 ± 50 590 B.C.
BONN-901.	Same location, 400 to 420 cm	2600 ± 60 650 B.C.
BONN-902.	Same location, 420 to 440 cm	3890 ± 60 1940 B.C.
BONN-903.	Same location, 440 to 460 cm	5060 ± 70 3110 B.C.
BONN-904.	Same location, 460 to 480 cm	5250 ± 70 3300 B.C.
BONN-905.	Same location, 480 to 500 cm	5820 ± 70 3870 B.C.
BONN-906.	Same location, 500 to 520 cm	5210 ± 90 3260 B.C.
BONN-907.	Same location, 520 to 540 cm	6300 ± 90 4350 B.C.
BONN-908.	Same location, 540 to 560 cm	6800 ± 150 4850 B.C.

Samples coll. 1969 and subm. by H. W. Scharpenseel, H. Gewehr, W. Kerpen, and F. R. Averdieck, Inst. f. Ur- und Frühgeschichte, Univ. of Kiel. *Comment*: discordant trends, although available, are less pronounced than in preceding profile, although both should have started to accumulate organic sediment at about Alleröd time. Since gyttja sediments occur in lake basins, strong subsurface currents apparently could not attack and rework them as readily as in Schalkenmeeren Maar. Also, Selent lake is eutrophic, well aerated and probably lacks agitating effect of methane bubbles in most places.

III. ARCHAEOLOGIC SAMPLES

A. Wood samples, Bulgaria

BONN-865. Wood, mine Dolna Kameniza (42° N Lat, 26° E Long) — 1720 ± 50, A.D. 230

BONN-866. Wood, gold mine Negerstiza (42° N Lat, 25° E Long) — 840 ± 70, A.D. 1110

1310 ± 50
BONN-867. Wood, lead/zink mine Bzeikowiza A.D. 640
(43° N Lat, 23° E Long)

1400 ± 60
BONN-868. Wood, gold mine Negerstiza A.D. 550
(43° N Lat, 25° E Long)

Wood samples from old mines in Bulgaria, dated for time of operation, est. ca. A.D. 1500. Samples coll. 1969 and subm. by Mining Mus. Bochum. *Comment*: age of mines much older than expected.

B. Wood sample Ungstein, Pfalz

BONN-862. Wood, "Baugrube Richter" from mud horizon, 2 m **5430 ± 80** **3480 B.C.**

Well-preserved wood, probably deposited by water transport in muddy layer, 2 m deep, containing seeds and ceramic fragments (49° 28′ N Lat, 8° 11′ E Long). Helps date possible pre-Roman civilization. Sample coll. 1969 and subm. by F. Schumann, Ungstein, and G. Strunk-Lichtenberg, Inst. *Comment*: age 5400 yr higher than est. age of ca. 2000 B.P.

C. Wood from boat, Ungstein, Pfalz

BONN-764. Wood from buried boat, Ungstein, 220 cm **25,210 ± 440** **23,260 B.C.**

Wood from boat, from 220 cm under sandy mud and gravel (49° 28′ N Lat, 8° 11′ E Long). Est. age: 2 to 3000 B.P.? Sample coll. 1969 and subm. by F. Schumann, Ungstein. *Comment*: remnant of wood, possibly part of boat, much older than expected. More samples needed for interpretation. Suspected celtic origin of boat is very unlikely.

D. Bones, Michelsberg

10,800 ± 100
BONN-763. Mole bones, Michelsberg, 5 m **8850 B.C.**

Many mole bones from Würm loess (50° 21 N Lat, 7° 19′ E Long), under fossil chernozem (BONN-413 to 416: R., 1970, v. 12, p. 27-28), covered by trachyt ashes of Alleröd origin. Only organic carbon was used for dating sample. Sample coll. 1969 and subm. by E. Kopp of the Inst. *Comment*: date is younger than expected.

E. Elk horns, Dorsten, Westfalia

5270 ± 50
BONN-765. Elk horns, Dorsten, 6 to 8 m **3320 B.C.**

Elk horns found during excavation of Lippe-Seitenkanal, near Dorsten (51° 40′ N Lat, 6° 59′ E Long). Date important for estimate of time, when elks were also living W of Oder River. Estimated age: 60,000 B.P. Sample coll. 1970 and subm. by Dr. Spiecker, Forschungsstelle f. Jagdkunde, Bonn-Beuel. *Comment*: due to scarcity of material, whole bone substance was dated. Age falls short of expectations. Contamination by environmental carbonate unlikely, since sample was lying in non-carbonaceous environment of Lippe-terrasse gravel.

F. Defense ditch, Wallertheim

BONN-777. Ditch Wallertheim, 4.8% C, fA$_h$, 30 to 90 cm **3750 ± 70** **1800 B.C.**

BONN-778. Same location, 0.8% C, fA$_l$+C, 120 to 140 cm **4750 ± 60** **2800 B.C.**

A ditch, used for defense of village by Neolithic man was observed in basin of Mainz, near Wallertheim (49° 50′ N Lat, 8° 3′ E Long). Dating of humus-C important for age of Neolithic settlements in area. Samples coll. 1969 and subm. by G. Strunk-Lichtenberg. *Comment*: BONN-777 is younger than expected, probably due to rejuvenation in surface near position by root growth, animal transport, and percolation. BONN-778, far from rooted zone in fairly dry basin of Mainz, is in full accord with expected age and available information.

IV. MODERN SAMPLE

BONN-830. Gras, Röttgen, September 1969 **151.6 ± 0.5%** **Modern**

To continue modern carbon sample measurements, pub. in R., 1968, v. 10, p. 24-27 as BONN-56 to 77, -143 to 155; 1969, v. 11, p. 10-13, as BONN-172 to 200, -301, to 317; and in 1970, v. 12, p. 38, as BONN-385 to 396, a grass sample from Röttgen near Bonn, (50° 41′ N Lat, 7° 5.5′ E Long), coll. 1969 by H. W. Scharpenseel was measured for its bomb-carbon level. *Comment*: sample fits well into trend of 1968 monthly measurements (BONN-385 to 396).

REFERENCES

Scharpenseel, H. W., and Pietig, F., 1968/69, Einfache Boden- und Wasserdatierung durch Messung der C^{14}-oder Tritiumkonzentration: Geoderma, v. 2, p. 273.

———— 1970a, Altersbestimmung mit dem Flüssigkeits-Szintillations-Spektrometer, Vereinfachte Benzolsynthese, auch aus kleinen CO_2-Mengen: Atompraxis, v. 16, no. 3, p. 1.

———— 1970b, University of Bonn natural radiocarbon measurements III: Radiocarbon, v. 12, p. 19-39.

Scharpenseel, H. W., Pietig, F., and Tamers, M. A., 1968, University of Bonn natural radiocarbon measurements I: Radiocarbon, v. 10, p. 8-28.

———— 1969, University of Bonn natural radiocarbon measurements II: Radiocarbon, v. 11, p. 3-14.

Scharpenseel, H. W., Ronzani, C., and Pietig, F., 1968, Comparative age determination on different humic matter fractions: Isotopes and radiation in soil organic matter studies Proc., Vienna, I.A.E.A., p. 67.

Tamers, M. A., 1967, Radiocarbon ages of ground water in an arid zone unconfined aquifer: Am. Geophys. Union Mon. v. 11, p. 143.

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GIF NATURAL RADIOCARBON MEASUREMENTS VI

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This list consists mainly of dates obtained from analysis during 1967 and 1968 of archaeologic and geologic samples. The last section deals essentially with climatic, palynologic, and sea level variation problems. All measurements of atmospheric CO_2 made periodically from 1962 until end of 1970 are also published here. In agreement with international convention, all dates have been calculated on the basis of the C^{14} half-life of 5568 years and 95% of NBS oxalic acid as the modern reference year.

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SAMPLE DESCRIPTIONS

I. ARCHAEOLOGIC SAMPLES

A. France

1. W. France

2120 ± 110
Gif-1117. Kervéo, Plomelin, Finistère **170 B.C.**

Charcoal from Iron age souterrain, Kervéo, Plomelin (47° 55′ N Lat, 4° 10′ W Long), Finistère. Coll. and subm. 1967 by P. R. Giot, Fac. Sci., Rennes. *Comment*: assoc. ceramics belong to La Tène I period. Date is slightly too young (Giot, 1969; Giot and Ducouret, 1968).

2250 ± 100
Gif-812. Mesperleuch, Plouhinec, Finistère **300 B.C.**

Charcoal from salt-pan brickworks of Iron age, in a clayey block, at Mesperleuch, Plouhinec (48° 00′ N Lat, 4° 30′ W Long), Finistère. Coll. and subm. 1967 by P. L. Gouletquer, Fac. Sci. Rennes. *Comment*: in good agreement (Gouletquer, 1967, 1970; Giot, 1968).

3250 ± 115
Gif-748. Le Hellen, Cleder, Finistère **1300 B.C.**

Charcoal from middle Bronze age barrow at Le Hellen, Cleder (48° 40′ N Lat, 4° 05′ W Long), Finistère (Le Roux, 1966). Coll. and subm. by C. T. Roux, Fac. Sci., Rennes. *Comment*: agrees well with date of monument (Giot, 1968; Le Roux, 1966).

3570 ± 115
Gif-749. Lescongar, Plouhinec, Finistère **1620 B.C.**

Wood from grave of Early Bronze age barrow at Lescongar, Plouhinec (48° 01′ N Lat, 4° 30′ W Long), Finistère (Briard, 1968; Giot, 1968). Coll. and subm. 1966 by J. Briard, Fac. Sci., Rennes. *Comment*: correct age for barrow of this series.

Gif-809. Kerleven, La Forêt-Fouesnant, Finistère **3800 ± 120**
1850 B.C.

Charcoal from Chamber C of megalithic cairn, Kerleven, La Forêt-Fouesnant (47° 42′ N Lat, 3° 48′ W Long), Finistère. Coll. and subm. 1967 by C. T. Le Roux. *Comment*: this cairn, of a type especially found in S Finistère, was dated by Gsy-III: 4825 ± 125 (R., 1966, v. 8, p. 135). Traces Late Neolithic reutilization (Le Roux and l'Helgouach, 1967; Giot, 1968).

Kernonen, Plouvorn series, Finistère

Samples from an Early Bronze age barrow, at Kernonen, Plouvorn (48° 35′ N Lat, 4° 03′ W Long), Finistère. Coll. and subm. 1967 by J. Briard.

Gif-805. Kernonen A **3910 ± 120**
1960 B.C.

Wood from chest containing flat axes.

Gif-806. Kernonen B **3200 ± 120**
1250 B.C.

Charcoal in clayey material of barrow.

Gif-807. Kernonen C **3150 ± 120**
1200 B.C.

Charcoal in soil under barrow.

General Comment: dates for Charcoals B and C are statistically consistent but too young, for an unexplained reason; wood from chest is older than expected; possibly, this one-piece chest is from a big tree trunk (Briard, 1970; Giot, 1968, 1969).

Plouzévédé series, Finistère

Charcoal from middle Bronze age barrow of Ar Reunic (48° 35′ N Lat, 4° 15′ W Long). Coll. and subm. 1967 by J. Briard.

Gif-1113. Plouzévédé A **3200 ± 120**
1250 B.C.

1.40 m depth in barrow, N and E trenches.

Gif-1114. Plouzévédé B **3160 ± 120**
1210 B.C.

1.20 m depth in barrow S trench.

General Comment: barrow without central tomb and without grave goods, only some potsherds of middle Bronze age. Age usually found for this type of monument (Giot, 1969).

Barnenez, Plouézoch series, Finistère

Charcoal from different passage graves of great cairn of Barnenez, Plouézoch (48° 40′ N Lat, 3° 51′ W Long). Coll. and subm. 1967-1969 by P. R. Giot.

Gif-1116. Barnenez, Dolmen F, passage **5100 ± 140**
3150 B.C.

Gif-1309. Barnenez, Dolmen G, chamber **5750 ± 150**
3800 B.C.

Gif-1310. Barnenez, Dolmen A, chamber **5450 ± 150**
3500 B.C.

Gif-1311. Barnenez, Dolmen B, entrance **3200 ± 120**
1250 B.C.

Gif-1556. Barnenez, Chamber F, chamber **5550 ± 140**
3600 B.C.

General Comment: Gif-1311, as Gsy-30 and Gsy-147 (2200 ± 200 and 2690 ± 105, R., 1966, v. 8, p. 137) indicate that Megalithic site of Barnenez was re-used during Bronze and Iron ages. Gif-1116, -1309, -1310, and -1556 date 1st occupation and agree well with established chronology for construction of the different dolmens (Giot, 1969, 1970).

Gif-767. Prajou menhir, Trebeurden, Finistère **5330 ± 150**
3380 B.C.

Charcoal from additional hearth in megalithic monument, Prajou menhir, Trebeurden (48° 47′ 40″ N Lat, 3° 33′ 45″ W Long), Finistère (l'Helgouach, 1966). Coll. and subm. 1966 by J. l'Helgouach, Fac. Sci., Rennes. *Comment*: 2000 yr older than expected. As suggested by P. R. Giot, should be a utilization of fossil wood from nearby peat bog (Giot, 1968; l'Helgouach, 1966).

Gif-804. Le Calais, Saint-Michel-Chef-Chef, Loire Atlantique **800 ± 100**
A.D. 1150

Charcoal from site with "augets", pottery salt-pan, at Le Calais, Saint-Michel-Chef-Chef (47° 10′ N Lat, 2° 09′ W Long), Loire Atlantique (Gouletquer *et al.*, 1968). Coll. by M. Tessier and subm. 1967 by P. L. Gouletquer. *Comment*: expected date: 100 B.C. (Giot, 1968).

Gif-803. Kerlavos, Trégastel, Côtes du Nord **1500 ± 100**
A.D. 450

Charcoal from Hearth 3 in remains of brickworks, from salt industry site, at Kerlavos, Trégastel (48° 48′ N Lat, 3° 32′ W Long), Côtes du Nord (Giot, 1965). Coll. and subm. 1967 by P. R. Giot. *Comment*: much later than assoc. ceramics (Giot, 1968).

Gif-747. Miniou Bonen, Côtes du Nord **2200 ± 105**
250 B.C.

Charcoal from Iron age surface site at Miniou Bonen (40° 12′ N Lat, 3° 15′ W Long). Coll. and subm. 1966 by P. R. Giot (Le Provost and Giot, 1966; Giot, 1968). *Comment*: assoc. with decorated ceramics of La Tène I type. Agrees well with expected age.

Gif-808. Grohan, Quessoy, Côtes du Nord **2290 ± 100**
340 B.C.

Charcoal from Iron age souterrain, Grohan, Quessoy (48° 22′ N Lat, 2° 41′ W Long), Côtes du Nord (Guyader, 1969). Coll. by Y.

Guyader and subm. 1967 by P. R. Giot. *Comment*: correct for age of La Tène I (Giot, 1968).

Gif-814. Cre'h-Quillé, Saint-Quay-Perros, Côtes du Nord, E entrance **3760 ± 120** **1810 B.C.**

Charcoal from blocking of E entrance Crec'h-Quillé grave, Saint-Quay-Perros (48° 47′ N Lat, 3° 23′ W Long), Côtes du Nord (l'Helgouach, 1967). Coll. and subm. 1967 by J. l'Helgouach. *Comment*: to confirm date of Gif-344: 3740 ± 200 (R., 1970, v. 12, p. 430; Giot, 1968).

4500 ± 120
Gif-813. Ile Geignog, Landela, Finistère **2550 B.C.**

Charcoal from Dolmen III-E, Ile Geignog, Landela (48° 35′ N Lat, 4° 35′ W Long). Coll. and subm. 1967 by J. l'Helgouach. *Comment*: this passage grave is later addition to Cairn III; date would indicate utilization during Late Neolithic. Cf. Gsy-164 B (Giot, 1968).

Cap d'Erquy series, Côtes du Nord

Cap d'Erquy (48° 39′ N Lat, 2° 27′ W Long), Côtes du Nord, covered by remains of double entrenched camp of Protohistoric age. Under Fossé Catuélan which blocks way to extreme part of Cap, Neolithic industry was found. Fossé de Plaine-Garenne is 450 m E of this 1st entrenchment (Giot and Briard, 1969). Charcoal coll. and subm. 1967, 1968 by P. R. Giot and J. Briard.

4560 ± 140
Gif-1118. Fossé Catuélan, Erquy **2610 B.C.**

Comment: dates Neolithic forest clearance.

2270 ± 110
Gif-1302. Fossé de Plaine-Garenne, Erquy **320 B.C.**

Comment: Gif-715 (R., 1970, v. 12, p. 432) dates Fossé Catuélan to late Hallstatt age; Fossé de Plaine Garenne has La Tène fortification, with interlaced timber-work.

1620 ± 110
Gif-1115. Moustérian, Séné, Morbihan **A.D. 330**

Charcoal from Kiln c of salt-pan of sta. of Moustérian, Séné (47° 36′ N Lat, 2° 44′ W Long), Morbihan. Coll. and subm. 1967 by P. L. Gouletquer. *Comment*: confirms too early age: 1495 ± 150 B.P. for charcoal coll. in another kiln of same sta. (Gif-229, R., 1966, v. 8, p. 79). Presence of fragments of vases of "La Tène" period makes these dates inexplicable (Gouletquer *et al.*, 1968; Giot, 1969; Gouletquer, 1970).

3900 ± 135
Gif-863. Saint-Fiacre, Melrand, Morbihan **1950 B.C.**

Wood from box of Early Bronze age barrow, Saint-Fiacre, Melrand (47° 58′ N Lat, 3° 07′ W Long), Morbihan. Coll. 1897 by Aveneau de la Grancière and subm. 1967 by H. J. Case, Dept. of Antiquities, Ashmolean Mus., Oxford. *Comment*: in Ashmolean Mus. Colln. since 1925. Compares well with Gif-805 (Giot, 1969).

Gif-458. Le Breuil-sous-Argenton, Deux-Sèvres **1260 ± 100**
A.D. 690

Charcoal from moat at Le Breuil-sous-Argenton, Deux-Sèvres (46° 59′ N Lat, 0° 27′ W Long). Coll. and subm. 1965 by M. Berthod, Paris. *Comment*: too old for feudal moat; charcoal probably dates earlier construction, on same site.

Gif-1119. Jard-sur-Mer, Vendée **3300 ± 120**
1350 B.C.

Charcoal from Late Neolithic barrow of Plage de Légère, Jard-sur-Mer (46° 25′ N Lat, 1° 35′ W Long). Coll. and subm. 1967 by J. Joussaume, Inst. Paleontol. Humaine, Paris. *Comment*: because of assoc. Beaker pottery, somewhat earlier date was expected (Joussaume, 1968; Giot, 1969).

Gif-802. "Moulin du Fâ", Barzan, Charente Maritime **2670 ± 110**
720 B.C.

Charcoal from Layer 0 under Gallo-Roman sta. of "Moulin du Fâ", Barzan (45° 32′ N Lat, 0° 53′ W Long). Coll. and subm. 1967 by J. P. Mohen, Merignac, Dordogne. *Comment*: important ceramics from La Tène I and Hallstatt epochs assoc. Date corresponds with Hallstatt occupation.

Gif-724. Cave of Rancogne, Charente **3150 ± 110**
1200 B.C.

Charcoal A found in clay deposit on walls of a well in cave of Rancogne (45° 41′ N Lat, 0° 24′ E Long), Charente. Coll. 1964 and subm. 1966 by C. Burnez, Gensac-La-Pallue, Charente. *Comment*: dates important Urnfield site, Stage II-III.

Gif-725. La Croix des Sables, Mainxe, Charente **2370 ± 110**
420 B.C.

Charcoal in ditch around settlement site, 1.50 m depth, under refuse deposit with bones, ceramics, and abundant charcoal at La Croix des Sables (45° 38′ N Lat, 0° 11′ W Long), Charente. Coll. 1963 and subm. 1966 by C. Burnez. *Comment*: dates a La Tène site.

2. S. W. France

Roanne series, Villegouge, Gironde

Charcoal from Neolithic sta. of Roanne, Villegouge (44° 57′ N Lat, 0° 22′ W Long), Gironde. Coll. and subm. 1967 by A. Coffyn, Bordeaux.

Gif-782. Roanne F 3, 1961 **3850 ± 135**
1900 B.C.

From hearth found in a pit.

Gif-783. Roanne 1963 **3700 ± 135**
1750 B.C.

In 5 cm charcoal layer, under 1.70 m stratified levels.

Gif-784. Roanne 1966 **4280 ± 140**
2330 B.C.

From same level.

General Comment: according to assoc. ceramics, belongs to Peu-Richard culture defined in Charente, but lithic industry is slightly different. Some hundred yr younger than other dates from Charente (Gsy-32, -71: R., 1966, v. 8, p. 131-132; Gif-474, -475, -313, and -417: R., 1970, v. 12, p. 435).

Auterive series, Haute Garonne

Carbonized wood from Roman site, at Auterive (43° 20′ N Lat, 1° 28′ E Long) Haute Garonne. Coll. and subm. 1966 by L. Latour, Auterive.

Gif-757. Auterive II **1920 ± 110**
A.D. 30

Upper level.

Gif-756. Auterive I **2610 ± 110**
660 B.C.

Deepest level.

General Comment: agrees well with Gif-757; but Gif-756 is several hundred yr older than expected.

Gif-826. Grotte de Puech Ricard, Aveyron **4970 ± 140**
3020 B.C.

Carbonized grains in Late Neolithic grave from grotte de Puech Ricard, la Bastide-Pradines (44° 01′ N Lat, 3° 04′ E Long), Aveyron. Coll. and subm. 1967 by A. Soutou, Toulouse. *Comment*: cf. results obtained for grotte of Sargel, near Puech-Ricard (Gif-444, -445: 4500 and 4570 B.P., R., 1970, v. 12, p. 423).

Gif-827. Puech de Mus, Aveyron **2375 ± 110**
425 B.C.

Charcoal from carbonized cinders from Iron age rampart of wall of Puech de Mus, Sainte-Eulalie de Cernon (43° 59′ N Lat, 3° 08′ E Long), Aveyron. Coll. and subm. by A. Soutou, Toulouse. *Comment*: in good agreement with expected age.

Gif-773. Saint-Pardoux-Le-Neuf, Haute Corrèze **780 ± 90**
A.D. 1170

Charcoal from medieval hypogeum, Saint-Pardoux-Le-Neuf (45° 37′ N Lat, 2° 20′ E Long), Corrèze. Coll. and subm. 1966 by R. Joudoux, Tulle. *Comment*: in expected date range.

3. S. E., S., and Central France

Gif-759. Roc de Las Caichos, Roquefère, Aude **1720 ± 110**
A.D. 230

Charcoal from filling of cist in a dolmen, Sepulcher III, Roc de Las Caichos, Roquefère, Aude (43° 22′ N Lat, 2° 21′ E Long). Coll. and subm. 1966 by J. Guilaine, Carcassonne, Aude. *Comment*: dates reutilization of this Megalithic monument.

Gif-760. Cave of Chataigniers, Casenove, Vingrau, Mediterranean Pyrénées **3120 ± 120** **1170 B.C.**

Charcoal from sepulchral cave of Chataigniers, Casenove, Vingrau (42° 51′ N Lat, 2° 47′ E Long). Coll. by Abbé Abelanet and subm. 1966 by J. Guilaine. *Comment*: assoc. with Early Bronze age industry of W Mediterranean (Guilaine and Abelanet, 1965). Somewhat younger than expected.

Hypogeum of Roaix series, Vaucluse

Charcoal from collective tomb in hypogeum of Roaix (44° 14′ N Lat, 5° 01′ E Long), Vaucluse. Coll. and subm. 1967, 1970 by J. Courtin, C.N.R.S., Marseille.

Gif-857. Roaix, Level 2 **4040 ± 140** **2090 B.C.**

Typical Chalcolithic furniture.

Gif-1620. Roaix, Level 5 **4100 ± 140** **2150 B.C.**

Basal level.

General Comment: same age for these 2 samples is confirmed by presence of copper pearls in both levels.

Gramari series, Methamis, Vaucluse

Charcoal from Sauveterrian site of Gramari (44° 01′ N Lat, 5° 14′ W Long), Methamis, Vaucluse. Coll. and subm. 1966 by M. Paccard, Velleron, Vaucluse (Paccard, 1966).

Gif-752. Gramari, Level 3 A **7740 ± 190** **5790 B.C.**

Industry assoc. with remains of wild horse.

Gif-753. Gramari, Levels 3 B I and 3 B 2 **8000 ± 190** **6050 B.C.**

Underlying level 3 A.

Gif-754. Gramari, Level C 4 **9340 ± 220** **7390 B.C.**

Upper level of Layer C.

Gif-755. Gramari, Level C 5 **10,070 ± 230** **8120 B.C.**

The deepest level, the last one with charcoal.

General Comment (M.C.): do not agree with archaeology: Levels 3 A and 3 B are not within conventional limits of classical Sauveterrian, and Level C 4, which comes from a level above the others, is older. Many questions seem to remain about this site.

Gif-867. Grotte Murée, Gorges du Verdon, Basses Alpes **4740 ± 140** **2790 B.C.**

Charcoal from Layer 10, Grotte Murée, Gorges du Verdon, Montpezat (43° 45′ N Lat, 6° 15′ E Long) (Courtin, 1963). Coll. and subm.

1967 by J. Courtin. *Comment*: dates this layer to Middle Neolithic, as expected from archaeology.

Stantare series, Sartène, Corsica

Charcoal from bottom of 5th monolith of Alignment I of Stantare (41° 31′ N Lat, 8° 53′ E Long), Plateau of Cauria, Sartène, Corsica. Coll. and subm. 1968 by R. Grosjean, C.N.R.S., Paris.

Gif-1397. Stantare, Corsica 5-1968 — **2120 ± 110** / **170 B.C.**

30 cm depth.

Gif-1396. Stantare, Corsica 4-1968 — **2950 ± 110** / **1000 B.C.**

General Comment: Gif-1396 agrees very well with archaeologic expectation, but Gif-1397 is too young.

Bonifacio series, Corsica

Charcoal from hearths in well-defined levels, from surface to 1.30 m depth, in upper part of filling of Araguina rock shelter, at Bonifacio (41° 22′ N Lat, 9° 10′ E Long). Coll. and subm. by R. Grosjean.

Gif-776. Bonifacio, Corsica 1, 1966 — **3040 ± 110** / **1090 B.C.**

Level VI a, Area A 6, A 7, B 7.

Gif-777. Bonifacio, Corsica 2, 1966 — **3300 ± 120** / **1350 B.C.**

Level VI d, Area A 6.

Gif-778. Bonifacio, Corsica 3, 1966 — **3550 ± 120** / **1600 B.C.**

Level VI f, Area A 7, B 7, B 8.

Gif-779. Bonifacio, Corsica 4, 1966 — **3980 ± 140** / **2030 B.C.**

Level VI, Hearth F 3.

General Comment: dates last occupation of site and end of importation of obsidian from Sardinia (Gif-778).

Castello d'Araggio series, Lévie, Sartène, Corsica

Charcoal from a Torre monument, Castello d'Araggio (41° 38′ N Lat, 9° 15′ E Long), San-Gavino di Carbini, Lévie, Sartène, Corsica. Coll. and subm. 1967 by R. Grosjean.

Gif-898. Castello d'Araggio, C-Ar-2 — **2500 ± 110** / **550 B.C.**

On Hearth A, N room.

Gif-899. Castello d'Araggio, C-Ar-3 — **2890 ± 110** / **940 B.C.**

Central Hearth, upper circular E room.

Gif-1000. Castello d'Araggio, C-Ar-4 **5130 ± 130**
3180 B.C.

Central Hearth, S guard room. *Comment*: was supposed to be similar either to Gif-898 or -899.

Gif-1001. Castello d'Araggio, C-Ar-1 **2930 ± 120**
980 B.C.

Under Hearth A, N room.

General Comment: except for Gif-1000, results agree well with ages already obtained for Torre cult monuments in Corsica.

Curacchiaghiu series, Lévie, Corsica

Charcoal from sepulchral cave, Curacchiaghiu (41° 42′ N Lat, 9° 8′ E Long), Levie, Corsica. Coll. and subm. 1966 by R. Grosjean.

Gif-796. Curacchiaghiu, Corsica 6 **7300 ± 160**
5350 B.C.

Level 5, 80 cm depth.

Gif-795. Curacchiaghiu, Corsica 5 **8560 ± 170**
6610 B.C.

Level 5, 117 cm depth.

General Comment: dates arrival, maybe from N Africa, of a Neolithic culture with obsidian lithic industry and stamped and dotted ceramics (de Lanfranchi, 1967). Gives early date for apparition of ceramic in W Mediterranean.

Chaume de Montforgeon series, Courcelles-Fremoy, Côte d'Or

Charcoal from cinders and remains from ancient forge, at Chaume de Montforgeon, Courcelles-Fremoy (47° 26′ N Lat, 4° 10′ E Long). Coll. by C. de la Roncière and subm. 1966 by A. Marelle, Fac. des Lettres et Sci. Humaines, Dakar.

Gif-734. Chaume de Montforgeon, No. 1 **830 ± 90**
A.D. 1120

40 to 80 cm depth.

Gif-735. Chaume de Montforgeon, No. 2 **670 ± 90**
A.D. 1280

80 cm to 1 m depth.

General Comment: the 2 samples probably date same level.

Chaume-les-Baigneux series, Côte d'Or

Charcoal, in a barrow, at Chaume-les-Baigneux (47° 38′ N Lat, 4° 34′ E Long), Côte d'Or. Coll. and subm. 1966 by R. Ratel, Fac. Sci., Dijon, Côte d'Or.

Gif-786. Chaume-les-Baigneux 1 **2710 ± 110**
760 B.C.

From a hearth.

Gif-1109. Chaume-les-Baigneux 2 — **2500 ± 110** **550 B.C.**

Charcoal from incineration.
General Comment: no archaeologic clue to date barrow. Belongs to Late Bronze age—Iron age limit.

Gif-789. Minot, Côte d'Or — **1670 ± 100** **A.D. 280**

Carbonized wood from Gallo-Roman villa, Ferme de Busserolles, Minot (47° 39′ N Lat, 4° 54′ E Long), Côtes d'Or. Coll. by R. Ratel and subm. 1967 by A. Joly, Circonscription des Antiquités Préhistoriques de Dijon. *Comment*: sample very well dated by archaeology at ca. 200 A.D. and used for calibration.

Bressey series, Côte d'Or

Different samples coll. at Bressey (47° 18′ N Lat, 5° 11′ E Long), Côte d'Or and subm. 1966, 1967 by R. Ratel.

Gif-727. Sablière de Bressey, 1 — **2080 ± 100** **130 B.C.**

Charcoal from refuse pit in Sablière de Bressey. *Comment*: assoc. ceramics typically from Hallstatt age. Too young.

Gif-1090. Ferme de Clair Bois, Bressey — **2000 ± 100** **50 B.C.**

Charcoal from incineration in barrow from Late Hallstatt, Ferme de Clair Bois, Bressey. *Comment*: confirms Gif-727 which dates a refuse pit situated some hundred m from barrow.

Gif-788. Sablière de Bressey, 2 — **10,200 ± 230** **8250 B.C.**

Wood from trunk of *Pinus sylvestris*, 3.50 m in sand, at la Sablière de Bressey. *Comment*: tree from same stratigraphic position as Sablière of Couternon, very close by, dated 9440 B.P. (Gif-341, R., 1966, v. 8, p. 89).

Gif-785. Neuvy-en-Dunois 66, Eure et Loir — **5250 ± 100** **3300 B.C.**

Carbonized human bones of 4 skeletons from collective sepulcher found in pit, covered by stones, at Neuvy-en-Dunois (48° 12′ N Lat, 1° 33′ E Long) (Masset, 1968). Coll. and subm. 1966 by C. Masset, Paris. *Comment*: agrees with numerous dates already obtained in Brittany for collective sepulchers.

Chaussée Tirancourt series, Somme

Charcoal from rehandled part of large gallery grave containing remains of ca. 300 skeletons, La Chaussée Tirancourt (49° 58′ N Lat, 2° 10′ E Long), Somme. Coll. and subm. 1968 by C. Masset. Sepulcher archaeologically dated from Chalcolithic age. Later on, large blocks of sandstone covering sepulcher were quarried away.

Gif-1289. La Chaussée Tirancourt, No. 1 — **3350 ± 120** **1400 B.C.**

Gif-1372. La Chaussée Tirancourt, No. 3 **3700 ± 120**
1750 B.C.

Gif-1378. La Chaussée Tirancourt, No. 4 **3650 ± 120**
1700 B.C.

General Comment: this extraction of sandstone began very soon after the sepulcher.

B. Africa

Gif-840. Tisoukai, Tassili n'Ajjer, Sahara **3650 ± 130**
1700 B.C.

Charcoal from refuse layer, with Neolithic implements, potsherds and assoc. with paintings of "Bovidian" period, at Tisoukai (9° 30′ N Lat, 24° 55′ E Long), Tassili n'Ajjer, Sahara. Coll. and subm. 1967 by H. Lhote, Mus. de l'Homme, Paris. *Comment*: youngest date obtained for "Bovidian" period which lasted a few millennia.

Gif-848. Zegag Oued, S Oran **5320 ± 150**
3370 B.C.

Pearls from 9000 ostrich-egg pearls found with 55 Neolithic pots, most undamaged, at Zegag Oued, near Hammaguir, S Oran (30° 49′ N Lat, 2° 55′ W Long). Coll. and subm. 1967 by H. Lhote. *Comment*: correct age for a Neolithic site.

Hassi Messaoud series, E Sahara

Neolithic sites on oil field at Hassi-Messaoud (32° 00′ N Lat, 5° 51′ E Long) E Sahara. Lithic material was studied by H. Brezillon and N. Chavaillon, palynology by F. Beucher. Subm. 1966 by H. Alimen, C.N.R.S., Bellevue.

Gif-731. Hassi Messaoud, "La Touffe", x o **5930 ± 150**
3980 B.C.

Coarse black sand with ash, Level III, 50 cm thick, depth ca. 50 cm. Some gramineae and abundant chenopodiaceae. Presence of fish, batrachia, and fresh-water mollusk indicate proximity of a stretch of water. Neolithic industry and ceramics of Capsian type.

Gif-732. Hassi Messaoud, x 5 **6100 ± 160**
4150 B.C.

Black sand with charcoal and shell fragments, depth: some cm. Same industry as Gif-731.

Gif-733. Hassi Messaoud, o Mn 17 **5490 ± 150**
3540 B.C.

Sandy black ground, 50 cm thick under yellow sand, in a large depression with flat bottom, diam. ca. 1 km; probably an ancient marsh. Ceramic and lithic industry is slightly more recent than for Gif-731 and -732.

General Comment: may be evidence of evolution from Neolithic of Capsian tradition towards pure Saharian Neolithic.

Cave of Bitorri series, Brazzaville, Congo

Samples from Cave of Bitorri, near village of Meya (3° 50′ S Lat, 14° 30′ E Long), 150 km N W of Brazzaville, Congo (Emphoux, 1970). Coll. and subm. 1966 by J. P. Emphoux, O.R.S.T.O.M., Brazzaville.

4030 ± 200
Gif-459. Cave of Bitorri, 1 **2080 B.C.**

Charcoal from Level 17, under 85 cm humic-rich layer with 20 archaeologic levels.

3930 ± 200
Gif-460. Cave of Bitorri, 2 **1980 B.C.**

Shells of gasteropods (kitchen-middens) from Level 14, 70 cm depth. *Comment*: as for Gif-459, presence of chipped flint implements. *General Comment*: dates late "Tshitolian" in Central Africa.

3310 ± 110
Gif-851. Karkarichinkat, Tilemsi, Mali **1360 B.C.**

Human and animal bones from Neolithic site of Karkarichinkat, in Valley of Tilemsi (16° 52′ N Lat, 0° 12′ E Long), 80 km N Gao, Mali. Coll. 1962 by J. Gaussen and subm. 1967 by R. Mauny, Fac. des Lettres et Sci. Humaines, Paris. Karkarichinkat (Mauny, 1955), stretching on some hectares is a site with abundant Neolithic material: axes, heads of arrows, bone tools, ceramics, fauna, etc. (Gaussen and Gaussen, 1960); nearby are very big flint works. *Comment*: Neolithic age lasted till Iron age in W Africa; age is correct (Mauny *et al.*, 1968).

C. Peru

Chilca Canyon series, Peru

Samples from different villages, in upper Chilca Canyon, central coast of Peru. Coll. and subm. 1967 by Frederic Engel, Univ. Nac. Agraria, Lima, Peru (Engel, 1964).

9700 ± 200
Gif-864. Chilca Canyon, V. 2474 **7750 B.C.**

Willow-wood from pillar in a hut, Village 304 (12° 26′ S Lat, 76° 46′ W Long). *Comment*: dates one of most ancient villages of coast of Peru.

3210 ± 110
Gif-1070. Chilca Canyon, V. 2411 **1260 B.C.**

Burnt plant remains from Site 12 B-VII, Village 867 (12° 32′ S Lat, 76° 41′ W Long). *Comment* (F.E.): dates one of large pre-agricultural villages in the "lomas" where food was based on a flora growing from the only atmospheric moisture.

1100 ± 100
Gif-1071. Chilca Canyon, V. 2417 **A.D. 850**

Vegetal debris in Site 12 B-VII, Level I, Village 868 (12° 31′ S Lat, 76° 41′ W Long). *Comment*: important village of maize consumers in gorge presently entirely dried up.

Gif-1072. Chilca Canyon, V. 2444 **2050 ± 110**
100 B.C.

Shells from Site 12 B-VII, Level I, Village 933 (12° 31′ S Lat, 76° 38′ W Long), village of stony houses in the "lomas".

Gif-1296. Chilca Canyon, V. 2415 **6080 ± 150**
4130 B.C.

Carbonized vegetal remains from refuse, ash and shell deposit on Site 12 B-VII, Village 908, Chilca Canyon (12° 28′ S Lat, 76° 46′ W Long), central coast of Peru.

Gif-1297. Chilca Canyon, V. 2532 **1420 ± 100**
A.D. 530

Carbonized vegetal remains from Site 12 B-VII, Village 2050 (12° 29′ S Lat, 76° 40′ W Long), Chilca Canyon, central coast of Peru. Village with semi-subterranean stone houses and store-pits, in the "lomas." *Comment* (F.E.): sample would help date start of potato culture in the village.

Gif-1299. Chilca Canyon, V. 2665 **635 ± 110**
A.D. 1315

Wool cloth, Site 12 B-VII-12, village on left side of Chilca Canyon (12° 29′ S Lat, 76° 43′ W Long). *Comment*: will help date some villages of "Cuculi" phase.

Gif-1298. Bandurria, V. 2664 **470 ± 110**
A.D. 1480

Cotton cloth fragment from corpse buried at 1 m depth under refuse deposit, Site 12 B-VII-61, village of Bandurria (12° 30′ S Lat, 76° 46′ W Long). Coll. and subm. 1967 by F. Engel.

Chavin de Huantar series

Carbonized vegetal remains from Chavin de Huantar complex (9° 35′ S Lat, 77° 10′ W Long), alt 3200 m, Peru. In this monument, signs of a new culture that arrived ca. 1600 B.C. in Peru, were defined and called "Chavin" culture. Coll. and subm. 1967 by F. Engel.

Gif-1077. Chavin de Huantar, V. 2481 **2370 ± 100**
420 B.C.

Site 8 D-X-I, Level 3, in stairs leading to Great Temple. Coll. by L. G. Lumbreras.

Gif-1078. Chavin de Huantar, V. 2482 **2730 ± 110**
780 B.C.

Site 8 D-X-I, Level 3, in so-called "gallery of offerings"; assoc. with ceramics. Coll. by F. Caycho.

Gif-1079. Chavin de Huantar, V. 2483 **2100 ± 100**
150 B.C.

Site 8 D-X-I, Level 5, in atrium of temple, covered by alluvia. Coll. by L. G. Lumbreras. *Comment*: dates reoccupation of site, just after departure of its builders.

3845 ± 200
1895 B.C.

Gif-707. Bay of Paracas, V. 2335

Human excrement from refuse deposit in a pit, covered by eolian sand, Site 14 A-VI-96, near Bay of Paracas, 265 km S of Lima (13° 51′ S Lat, 76° 15′ W Long). Alt. +6 m. Coll. and subm. 1966 by F. Engel. *Comment*: corresponds to Late Preceramic period with cotton, in middle S coast of Peru.

4120 ± 200
2170 B.C.

Gif-708. S of Lima, V. 2336

Human excrement from Site 12 B-VII, Village 613, 58 km S of Lima (12° 25′ S Lat, 76° 45′ W Long), alt 200 m. Found on ground of a "kiwa", an oval stony construction, half underground with 2 steps. Coll. and subm. 1966 by F. Engel. *Comment*: corresponds to last occupation of site during Preceramic period.

4735 ± 140
2785 B.C.

Gif-770. Perro Perdido, Supe Valley, V. 1654

Charcoal from Site 10 A-VIII, II, Perro Perdido, Aspera peninsula, Supe valley (10° 49′ S Lat, 77° 45′ W Long), central coast of Peru. Coll. and subm. 1966 by F. Engel. *Comment*: preceramic site with cotton.

2370 ± 100
420 B.C.

Gif-771. Bermejo, V. 1656

Cloth from Site 10 A-I-20 (I) I-2, at Bermejo (10° 34′ S Lat, 77° 55′ W Long), Peru. Coll. and subm. 1966 by F. Engel. *Comment*: dates re-utilization of a preceramic site during Chavin period.

5175 ± 200
3225 B.C.

Gif-772. Paracas, V. 2450

Feathers found on corpse, in a grave, Site 14 A-VI, Village 96, Paracas Peninsula (13° 51 S Lat, 76° 15′ W Long), S coast of Peru. Coll. and subm. 1966 by F. Engel.

400 ± 90
A.D. 1550

Gif-1073. Quallikani, Puno, V. 2458

Straw used to temper raw bricks, in a funeral tower, Site 171-XI-2, Level I, Quallikani, Puno (16° 13′ S Lat, 19° 54′ W Long), alt 4000 m. Coll. and subm. 1967 by F. Engel.

2890 ± 110
940 B.C.

Gif-1074. Cave of Jankulloni, Puno, V. 2461

Carbonized plants from cave of Jankulloni, Site 18 F-II-I, Level 3 (16° 29′ S Lat, 69° 22′ W Long), Pisacoma dist., Puno, alt 4000 m. Coll. and subm. 1967 by F. Engel. *Comment*: deepest level of site; assoc. with lithic industry.

2700 ± 110
750 B.C.

Gif-1076. Kampa, Puno, V. 2466

Burnt plants from Rock-shelter I of Kampa, Site 171-XI-I, Level 2, (16° 45′ S Lat, 69° 59′ W Long), Pisacoma dist., Puno, alt 4100 m.

Coll. and subm. 1967 by F. Engel. *Comment*: dates occupational period of shelter with walls decorated by paintings.

D. Miscellaneous Countries

Gif-1247. Arta, Majorca, Balearic Is., M.A.J. S.P. **2900 ± 110**
950 B.C.

Charcoal from burning level, 90 cm depth, from House 12, Arta (39° 41′ N Lat, 3° 21′ E Long). Coll. by G. Lilliu and subm. 1968 by R. Grosjean. *Comment*: interesting for chronologic comparison between similar civilizations: Talyotic in Balearic Is., Nuragic in Sardinia and Torre civilizations in Corsica.

Mallia series, Kriti

Charcoal from Mallia (37° 17′ N Lat, 25° 27′ E Long, Kriti.

Gif-447. Mallia 1 **3800 ± 200**
1850 B.C.

Charcoal 70 cm depth in well-sealed layer between stucco ground and close course of bricks. Coll. and subm. 1966 by J. C. Poursat, Ecole Française d'Athènes.

Gif-448. Mallia 2 **3905 ± 200**
1955 B.C.

Carbonized wood, 80 cm depth, in destruction layer. Coll. and subm. 1966 by J. C. Poursat.

Gif-449. Mallia 3 **3420 ± 200**
1470 B.C.

Charcoal, 80 cm depth, at surface of thick layer of potsherds. Coll. and subm. 1966 by J. C. Poursat. *Comment*: date is too young.

Gif-874. Mallia 4 **3350 ± 120**
1400 B.C.

Charcoal, 2.80 m depth. Coll. and subm. 1967 by J. C. Poursat.

Gif-875. Mallia 5 **3780 ± 130**
1830 B.C.

Carbonized wood from a cypress pillar, 90 cm depth, same house as Mallia 4. Coll. and subm. 1967 by J. C. Poursat.

Gif-1277. Mallia 7 **3380 ± 110**
1430 B.C.

Charcoal from destruction layer of the "Petit Palais," 0.50 to 1 m depth, 1 m thick. Coll. and subm. 1968 by O. Pelon, Ecole Française d'Athènes.

Gif-1279. Mallia 6 **3410 ± 110**
1460 B.C.

Charcoal, 1 m depth, under a close course of bricks. Coll. and subm. 1968 by J. G. Poursat.

Gif-1521. Mallia 8 **3100 ± 110**
1150 B.C.

Charcoal, from destruction layer of the "Petit Palais." Coll. and subm. 1968 by O. Pelon.

Mari series, Moyen Euphrate

Samples from palaces of Mari, in Mesopotamia (34° 29′ N Lat, 40° 56′ E Long). Archaeologically well situated in 1st half of 3rd millennium B.C. Coll. 1965 and subm. 1966 by A. Parrot, Archaeol. Mission in Mari.

Gif-496. Mari 1 **4100 ± 150**
2150 B.C.

Fragment of wood from beams of presargonic palace in Mari.

Gif-497. Mari 2 **4075 ± 150**
2125 B.C.

Similar to Gif-496.

Gif-498. Mari 3 **4040 ± 150**
2090 B.C.

Similar to Gif-496.

Gif-721. Mari 6 **4000 ± 150**
2050 B.C.

Fragment of wood from beams from podium of presargonic palace in Mari.

Gif-722. Mari 4 **3820 ± 120**
1870 B.C.

Carbonized wood in central Jar I, Rm. 219, palace in Mari.

Gif-723. Mari 5 **3720 ± 150**
1770 B.C.

Carbonized wood and corns in central Jar 2, Rm. 219, palace in Mari.

General Comment: chronology places level dated by Gif-496, -498 and Gif-727 between 2700 and 2400 B.C. C^{14} dates are at least 400 yr too young. But Gif-722 and -723 come from a palace burnt very probably in 1760 B.C.; C^{14} dates are, thus, very coherent with archaeologic data.

II. GEOLOGIC AND PALYNOLOGIC SAMPLES

A. France

1. W. France

Gif-709. Plage de Corréjou, Plouguerneau, Finistère **935 ± 100**
A.D. 1015

Peat under sand hill, on beach of Corréjou, Plouguerneau (48° 38′ N Lat, 4° 30′ W Long). Coll. and subm. 1966 by M. T. Morzadec, Lab. Geol. Fac. Sci., Rennes. *Comment*: disagreement with pollen analysis; contaminated by rootlets of present vegetation; base level of the peat bog, 1 m deeper, was found 4250 yr old (Gif-282, R., 1966, v. 8, p. 78; Morzadec, 1969).

Gif-712. Lampaul-Plouarzel, Finistère **3020 ± 110**
1070 B.C.

Salt marsh peat from base level of peat bog under sand hill, Plouarzel (48° 28′ N Lat, 4° 46′ W Long), Finistère, 3.50 m above mean sea level. Coll. and subm. 1966 by M. T. Morzadec. *Comment*: Pollen Zone: VII b–VIII transition. Presence of hystrichospheres, at base level only, indicates site was close to seashore, at that time.

Gif-713. Le Scluz, Brignogan, Finistère **1260 ± 100**
A.D. 690

Submerged peat bog on strand, Le Scluz, Brignogan (48° 41′ N Lat, 4° 20′ W Long) 2.50 m above mean sea level. Coll. and subm. by M. T. Morzadec. *Comment*: Pollen Zone VII b; certainly contaminated.

Gif-714. Trezien, Plouarzel, Finistère **3660 ± 115**
1710 B.C.

Fresh water peat, on shore, Trezien, Plouarzel (48° 26′ N Lat, 4° 47′ W Long), Finistère. Coll. and subm. 1966 by M. T. Morzadec; 1.50 m above mean sea level. Pollen Zone: VII b.

Gif-818. Santec, Finistère **2330 ± 105**
380 B.C.

Salty peat, ca. 2 m above m.s. 1, on shore of Santec, N part (48° 43′ N Lat, 4° 02′ W Long), Finistère. Coll. and subm. 1967 by M. T. Morzadec. *Comment*: pollen analysis: Sub-Atlantic, Zone VIII.

Landunvez series, Finistère

Salty peat bog on shore, Gwen-Trez, Landunvez (48° 32′ N Lat, 4° 48′ W Long), N Argenton, Finistère. Coll. and subm. 1967 by M. T. Morzadec.

Gif-815. Landunvez 1 **3620 ± 125**
1670 B.C.

Ca. m.s.l. *Comment*: pollen analysis: Sub-Boreal–Sub-Atlantic transition, VII b–VIII, or just under.

Gif-816. Landunvez 2 **3970 ± 125**
2020 B.C.

0.50 m under m.s.l. Zone VII b.

Gif-817. Landunvez 3 **2180 ± 105**
230 B.C.

4 m above m.s.l. *Comment*: pollen zone: Sub-Atlantic. Zone VIII.

Ploulec'h series, Côtes du Nord

Peat dredged in estuary of Lannion R., Ploulec'h (48° 44′ N Lat, 3° 32′ W Long), Côtes du Nord. Coll. and subm. 1967 by P. R. Giot and M. T. Morzadec.

Gif-819. Ploulec'h 1 **3075 ± 110**
1125 B.C.

Comment: 2 swords were dredged at this place which corresponds to an ancient ford.

Gif-820. Ploulec'h 2 **1600 ± 105**
A.D. 350

Comment: many Roman antiquities are found in this ancient river bed.

General Comment: agree well with archaeologic frequentation of the site. Both Zone VIII, Sub-Atlantic.

Porsguen series, Plouescat, Finistère

Submerged peat bog on strand, Porsguen Beach, Plouescat (48° 41′ N Lat, 4° 13′ W Long), Finistère. Coll. and subm. 1966 by M. T. Morzadec. Pollen Zone: VIIa-VIIb.

Gif-710. Porsguen, Plouescat 1 **3390 ± 120**
1440 B.C.

Peaty silt, +2.50 m bovea m.s.l. *Comment*: many sherds of Bronze age pottery were found in this level. Transition Zone VIIb-VIII.

Gif-711. Porsguen, Plouescat 2 **4120 ± 140**
2170 B.C.

Wood and charred wood from peaty level, +2.00 m above m.s.l. *Comment*: presence of hystrichospheres. Zone VIIb.

Gif-891. Pointe de la Torche, Plomeur, Finistère **1100 ± 90**
A.D. 850

Shells in sandy layer, with gravel, ca. +2 m above sea level, at Pointe de la Torche, Plomeur (44° 31′ N Lat, 4° 22′ W Long), Finistère. Coll. and subm. 1967 by P. R. Giot and A. Guilcher, Fac. des Lettres, Brest. *Comment*: a 1st sample from another level at another point was dated in 1963, 580 B.P. (Gif-238, R., 1966, v. 8, p. 77). Both corroborate existence of very recent sea levels at this place, as expected.

Gif-1100. La Torche, Plomeur, Finistère **2670 ± 110**
720 B.C.

Debris of shells from a lumachelle, 1 m thick, on strand, at low tide sea level, N La Torche, Baie d'Audierne (47° 32′ N Lat, 4° 22′ W Long). Coll. and subm. 1967 by A. Guilcher and P. R. Giot.

Gif-850. Off S. Pointe de Penmarc'h **10,200 ± 230**
8250 B.C.

Shells (*Cyprina Islandica*) dredged in place, between 110 and 120 cm depth, in muddy sediments called "La Grande Vasière", on continental shelf, 45 km off S. Pointe de Penmarc'h (47° 20′ N Lat, 4° 32′ W Long). Coll. and subm. by M. Glemarec, Fac. Sci., Brest. *Comment*: this shell species, at present, occurs only N of 52° N Lat; its presence confirms cold water, S of Bretagne 10,000 yr ago (Glemarec, 1969).

Gif-849. Off estuary of Loire **6350 ± 160**
4400 B.C.

Shells (*Glycymeris*) dredged at 40 m depth, in Atlantic Ocean, off estuary of Loire (47° 00′ N Lat, 2° 40′ W Long). Lying on surface sediment, probably not *in situ*. Coll. and subm. 1967 by M. Glemarec. *Com-*

ment: expected to prove fossil species; different varieties of *Glycymeris*, both fossil and living, were found later on this part of continental shelf.

Gif-876. Loire estuary **4300 ± 140**
2350 B.C.

Wood from a big trunk, 12 to 16 m depth, from bank of Loire, at Nantes (47° 14′ N Lat, 1° 35′ W Long). Subm. 1967 by F. Ottman, Fac. Sci., Nantes. *Comment*: rate of sedimentation in Loire estuary calculated 3 to 4 mm/yr, coherent with other estimates.

Gif-839. Saint-Lumine de Coutais, Loire Atlantique **3970 ± 140**
2020 B.C.

Peat, in a drowned peat bog, 125 to 137 cm depth, at Saint-Lumine de Coutais (47° 04′ N Lat, 3° 02′ W Long). Coll. 1966 and subm. 1967 by N. Planchais. *Comment*: subm. because of abundance of vine pollen at this level, but systematic pollen analysis in region also indicated important mixing of sediments, probably due to a tide-race which devastated country at end of 6th century.

Asnelles series, Calvados

Three borings were made in Quaternary formations, along the coast, at Asnelles, (49° 20′ N Lat, 0° 34′ W Long), Calvados. The 1st one, on the strand, the 2nd, at the top of the beach, 130 m from the 1st and, the 3rd in the marsh behind shoestring sands, ca. 70 m SE of the preceding one. At the bottom, is sandy gravel, becoming finer and then silty with organic remains; peat overlies silty sand. On the top, in Borings 2 and 3, are either brackish or marine sediments, which are probably eroded in Boring 1. Alt of borings relative to m.s.l. is +0.3 m for Boring 1, +2.65 m for Boring 2, and + 3.20 m for Boring 3. Peat or peaty silt were coll. and subm. 1967, 1968 by C. Larsonneur, Fac. Sci., Caen, Calvados. Palynologic study was done by H. Elhai. Depths are given from top of the core.

Gif-1009. Asnelles, Boring 1, As 9 **7000 ± 170**
5050 B.C.

78 cm depth. *Comment*: intercalated level between As 2: 5680 ± 250 and As 13: 8320 ± 200 (R., 1969, v. 11, p. 329).

Gif-1012. Asnelles, Boring 1, As 23 **11,450 ± 270**
9500 B.C.

210 cm depth, base level of peat bog. *Comment*: according to pollen analysis, would correspond to Alleröd.

Gif-1013. Asnelles, Boring 2, As 34 **3950 ± 140**
2000 B.C.

83 cm depth.

Gif-1014. Asnelles, Boring 2, As 36 **5650 ± 150**
3700 B.C.

105 cm depth.

Gif-1015. Asnelles, Boring 2, As 38 **7450 ± 150**
5500 B.C.

126 cm depth.

Gif-1016. Asnelles, Boring 2, As 39 **8700 ± 250**
6750 B.C.

160 cm depth.

Gif-1017. Asnelles, Boring 2, As 40 **8600 ± 200**
6650 B.C.

Gif-1176. Asnelles, Boring 3, As 51 **710 ± 95**
A.D. 1240

50 cm depth.

Gif-1177. Asnelles, Boring 3, As 53 **600 ± 95**
A.D. 1350

70 cm depth.

Gif-1178. Asnelles, Boring 3, As 56 **2710 ± 110**
760 B.C.

110 cm depth.

Gif-1179. Asnelles, Boring 3, As 58 **3400 ± 130**
1450 B.C.

150 cm depth.

Gif-1180. Asnelles, Boring 3, As 64 **8700 ± 200**
6750 B.C.

200 cm depth.

General Comment: good correlation with pollen analysis for the 3 cores. Peat bog was formed while sea was still very low, hence depths cannot be related to former sea level. It is only during the Sub-Boreal that influence of the sea is seen (presence of Chenopodiaceae); by that time sea level was very near the present.

Peat formation was particularly rapid during the Boreal period (10 cm/100 yr) and from the end of Atlantic to Sub-Boreal period (5700 to 2700 B.P.) (Delibrias *et al.*, 1969).

Cherbourg harbor series, Manche

Submerged peat from borings, off Cherbourg. Subm. 1968 by C. Larsonneur. Depths related to m.s.l.

Gif-1020. Cherbourg, 121 C **4950 ± 140**
3000 B.C.

In Becquet bay (49° 40′ N Lat, 1° 32′ W Long). Depth: 34.60 m. *Comment*: very young for such depth.

Gif-1021. Cherbourg, 128 C **9470 ± 130**
7520 B.C.

In Becquet bay (49° 41′ N Lat, 1° 33′ W Long). Depth: 34.40 m.

Gif-1022. Cherbourg, 215 C **8200 ± 190**
6250 B.C.

In outer roadstead (49° 40′ N Lat, 1° 37′ W Long). Depth: 29.10 m.

Gif-1023. Cherbourg, 235 C **9880 ± 230**
7930 B.C.

In outer roadstead (49° 40′ N Lat, 1° 37′ W Long). Depth: 22.90 m. *General Comment*: interesting for studying variations of sea level (Delibrias and Guillier, in press).

Le Havre series, Channel

Peat from sediment cores taken off Le Havre preparatory to construction of a relay-port for super-tankers. Subm. 1966, 1967 by J. P. Michel, Fac. Sci., Paris; P. Larsonneur and M. Guyader, Dir. Autonomous Harbour, Le Havre. Depths related to m.s.l.

Gif-744. Core 289 **9900 ± 300**
7950 B.C.

26.75 m (49° 30′ N Lat, 0° 06′ E Long).

Gif-745. Core 287 bis **9730 ± 300**
7780 B.C.

27.40 m (49° 30′ N Lat, 0° 06′ E Long).

Gif-746. Core 284 **9340 ± 300**
7390 B.C.

27.70 m (49° 30′ N Lat, 0° 06′ E Long).

Gif-1019. Core 9 H **8130 ± 190**
6180 B.C.

19.50 m (49° 28′ N Lat, 0° 17′ W Long).

Gif-1238. Core X **8850 ± 200**
6900 B.C.

29 m (49° 28′ N Lat, 0° 17′ W Long).

Gif-1401. Core 804 **8250 ± 220**
6300 B.C.

21.5 m to 22.7 m (49° 28′ N Lat, 0° 17′ W Long).
General Comment: agrees well with pollen analysis (Michel, 1968). Interesting for studying variation of sea level.

Gif-1067. Saint Sauveur de Pierrepont, Manche **9650 ± 210**
7700 B.C.

Mollusk shells, underlying greensand and pebbles, 16.40 m thick, in boring at Saint Sauveur de Pierrepont (48° 37′ N Lat, 1° 36′ W Long), Manche. Ca. −6.40 m related to m.s.l. Coll. and subm. 1967 by C. Pareyn, Fac. Sci., Caen. *Comment*: impossible to interpret shell bed as old beach.

Gif-1110. Mammoth tooth, Channel **19,300 ± 700**
17,350 B.C.

Collagen from mammoth tooth from Channel, ca. 60 m depth (50° 27′ N Lat, 0° 25′ W Long), from site of numerous mammoth remains. Subm. 1967 by C. Larsonneur. *Comment*: from same site as Sa-342 (8720 ± 300, R., 1966, v. 8, p. 90), of which total carbon (not only collagen) was extracted for dating.

2. N. and Central France

Marquenterre series, Picardie

Peaty samples from Sec. M 21, in peat bog, at Marquenterre (50° 16′ N Lat, 1° 42′ E Long), in maritime plain of Picardie. Alt +4 m. Coll. and subm. 1967 by P. Lefevre, Stat. d'Agronomie, Amiens. Pollen analysis by N. Planchais.

980 ± 100
Gif-841. Marquenterre, 100 cm **A.D. 970**

Sandy brown peat.

3060 ± 110
Gif-842. Marquenterre, 440 to 460 cm **1110 B.C.**

Brown peat with vegetal remains. Pollen zone: late appearance of *Fagus*; Sub-Atlantic.

5080 ± 140
Gif-843. Marquenterre, 580 to 600 cm **3130 B.C.**

Brown peat, with lighter zones. Pollen zone: Atlantic-Sub-Boreal transition.

5520 ± 150
Gif-844. Marquenterre, 640 to 660 cm **3570 B.C.**

Brown peat with shells of small gastropods.

6450 ± 160
Gif-845. Marquenterre, 660 to 670 cm **4500 B.C.**

Brown peat with sandy appearance. Pollen zone: Atlantic period with *Quercus, Titiolum, Ulmus,* and *Alnus* dominant.

General Comment: dates stages of formation of coastal plain of Picardie.

7800 ± 190
Gif-836. Mur de Sologne, Loiret **5850 B.C.**

Silty peat, level 2.62 to 2.75 m, in peat bog near Mur de Sologne (47° 25′ N Lat, 0° 36′ E Long). Coll. 1966 and subm. 1967 by N. Planchais, Fac. Sci., Montpellier. *Comment*: pollen diagram shows frequencies of *Pinus* and *Betula,* rise of *Corylus,* and beginning of *Ulmus.* Corrects age, which was too young, for Sa-235 (R., 1965, v. 7, p. 241) from same level but probably contaminated. Beginning of Boreal.

Rians series, Cher

Peat from bog, Rians (47° 09′ N Lat, 0° 15′ E Long), Cher. Coll. 1966 and subm. 1967 by N. Planchais.

3970 ± 140
Gif-837. Rians, 0.70 m depth **2020 B.C.**

Pollen zone: *Quercus, Tilia,* just before beginning of *Fagus.* Beginning of Sub-Atlantic.

6630 ± 170
Gif-838. Rians, 1.10 to 1.40 m **4680 B.C.**

Pollen zone: *Quercus* and *Ulmus* abundant, *Tilia* at low frequency and *Fraxinus* at beginning. Indicates Boreal-Atlantic boundary.

Mont de l'Espinouse series, Cévennes

Sphagnum peat bogs, lying on gneiss bedrock, from S limit of Massif Central, in Mont de l'Espinouse, Cévennes. Coll. and subm. 1967 by A. Pons, Fac. Sci., Marseille.

850 ± 100
Gif-1101. La Salverguette **A.D. 1100**

75 cm depth, (43° 38′ N Lat, 2° 54′ E Long), alt: 1070 m.

1140 ± 100
Gif-1102. La Salverguette **A.D. 810**

100 cm depth, base level.

350 ± 95
Gif-1103. Font-Salesse **A.D. 1600**

65 cm depth, base level (43° 36′ N Lat, 2° 58′ E Long), alt: 1060 m.

6000 ± 150
Gif-1104. Baissescure **4050 B.C.**

140 cm depth, base level with silt, (43° 32′ N Lat, 2° 48′ E Long), alt: 1000 m.

General Comment: except for Gif-1104, which is dated from Boreal, ages found are surprising and tend to cast doubt on accepted inferences from pollen analysis in this region. This is probably due to geography of region, subject both to Mediterranean and Atlantic influences. Pollen study by de Beaulieu (1969).

3. S. E. and S. W. France

Gif-1129. La Flachère, Isère **⩾35,000**

Black lignite with fragments of wood in clay under fluvial facies of alluvia and glacial sand, at La Flachère (45° 24′ N Lat, 5° 58′ E Long), Isère valley. Coll. and subm. 1968 by G. Montjuvent, Fac. Sci., Grenoble. *Comment*: as expected.

Gif-1130. Bruant, Isère **⩾35,000**

Debris of branches in local moraine of Vercors, Bruant (45° 01′ N Lat, 5° 37′ E Long), Isère. Coll. and subm. 1968 by G. Montjuvent. *Comment*: question was whether this moraine was built recently by local glaciers.

9830 ± 230
Gif-824. Plateau de la Matheysine, Savoie **7880 B.C.**

Submerged peat, from bank of Lac Mort, on Plateau de la Matheysine (45° 02′ N Lat, 5° 47′ E Long), S E Grenoble. Coll. and subm. 1967 by G. Montjuvent. Plateau is a glacial valley, alt: 900 m. During the Würm it was occupied by 2 glacier tongues; the Romanche tongue, at the N, built a series of frontal moraines which now delimit 4 dammed lakes; one is Lac Mort. Age of peat implies that glacier evacuated the valley ca. 10,000 B.P.

Gif-825. Trièves, Savoie **3550 ± 130**
1600 B.C.

Fossil wood in calcareous and marly material transported in a landslide over Würm moraine (44° 47′ N Lat, 5° 44′ E Long). Coll. and subm. 1967 by G. Montjuvent. *Comment*: corrects geologic map on which these sediments were shown as post-Würm alluvium.

Lac de Balcère series, Pyrénées Orientales

Peat from submerged peat bog of Lac de Balcère (42° 35′ N Lat, 2° 03′ E Long), Pyrénées Orientales; alt: 1764 m. Coll. and subm. 1967 by C. Jalut, Lab. de Botanique, Fac. Sci., Toulouse.

Gif-1060. Lac de Balcère, Palyn 6 **3780 ± 135**
1730 B.C.

0.50 m to 0.60 m depth. Pollen analysis: Zone VII b of Sub-Boreal period. *Comment*: too young; superficial levels probably slightly contaminated.

Gif-791. Lac de Balcère, Palyn 1 **9250 ± 210**
7300 B.C.

1.50 m to 1.60 m depth. Pollen analysis: appearance of *Abies*; end of Pre-Boreal period. *Comment*: date in good agreement.

Gif-792. Lac de Balcère, Palyn 2 **11,240 ± 280**
9290 B.C.

2.60 m to 2.70 m depth. Pollen analysis: Zone II of Alleröd. *Comment*: in good agreement.

General Comment: aids study of evolution of flora from Early Dryas to Sub-Atlantic. Alleröd oscillation is shown for 1st time in Pyrénées Orientales (Van Campo and Jalut, 1969).

Mas de la Borde series, Pyrénées Orientales

Peat bog, in Valley of Têt, Mas de la Borde (42° 32′ N Lat, 2° 05′ E Long), alt: 1680 m, Pyrénées Orientales. Coll. and subm. 1967 by G. Jalut.

Gif-868. Mas de la Borde, Palyn 3 **5380 ± 150**
3430 B.C.

0.70 m to 0.80 m depth; from surface to 0.60 m depth, ploughed soil overlies peat bog with sharp contact. Pollen analysis indicates beginning of cultivation.

Gif-869. Mas de la Borde, Palyn 4 **7500 ± 170**
5550 B.C.

2.30 m to 2.40 m depth. Pollen analysis: extension of *Abies*. *Comment*: in good agreement.

Gif-870. Mas de la Borde, Palyn 5 **8300 ± 190**
6350 B.C.

3.50 m to 3.60 m depth.

General Comment: *Abies* is dated here at 7500 B.P. whereas it is dated at 9250 B.P. at Lac de Balcère; these 2 peat bogs, some km apart, have very different exposures, which can explain age difference.

Gurp series, Médoc

Fossil soils in cliff of Gurp (45° 26′ N Lat, 1° 08′ W Lat), Médoc. Coll. and subm. 1967 by P. Dutil, Sta. Agron., Châlons-sur-Marne.

Gif-1032. Gurp, G. U. Paleosol **3300 ± 120**
1350 B.C.

Black organic horizon, A_0 A_1, of a Podzol under a dune, 150 to 170 cm below top of cliff. *Comment*: iron hardpan was without carbon; age similar to other Podzols in region.

Gif-1105. Gurp, G. U., wood **⩾35,000**

Wood from lignite, from foot of cliff, 340 cm depth, just above blue gray silt. *Comment*: too old to be dated by C^{14}, as expected.

4. Mediterranean

Gif-738. Shoal of Méjean **⩾35,000**

Polyparies, 3.90 m below surface; in sediment core C.A.P.P. 58, at 430 m depth, 12 km S of Lérins Is. (43° 23′ N Lat, 7° 1′ E Long) (Pautot, 1967). Coll. and subm. 1966 by G. Pautot, Sta. de Géodynamique sous-marine, Villefranche-sur-Mer, Alpes Maritimes. *Comment*: agrees with known sedimentation rates in W Mediterranean Sea (Labeyrie *et al.*, 1968).

Gif-829. Little Submarine Canyon of Planier **⩾30,000**

Chlamys septemradiatus, 24 km off Cap Couronne, 170 m depth in the little Canyon of Planier (43° 34′ N Lat, 5° 05′ E Long), Mediterranean. Dredged during Mission Calypso 1966 and subm. 1967 by L. Dangeard, Fac. Sci., Caen. *Comment*: *Chlamys septemradiatus* is characteristic of cold water.

Gif-828. Living Chlamys, Marseille $\delta C^{14} = +8.4\%$

Coll. near Marseille, 1967 (43° 05′ N Lat, 5° 06′ E Long).

B. Africa

Tchad series

In low regions of Tchad, between 13th and 17th parallel, 2 lithostratigraphic units may be distinguished: (1) Soulias series forms sandy bars with layers of clay and marl with Ostracods in interdune depression. (2) Labdé series is lacustrine, clayey and diatomaceous, or calcareous, 10 to 15 m thick, in which 2 lacustrine extensions can be distinguished: l_1 and l_2 (Servant *et al.*, 1969). Samples coll. and subm. 1966-1968 by M. Servant. Office de la Recherche Sci. des Territoires d'Outre Mer (O.R.S.T.O.M.), Fort-Lamy, Tchad.

Gif-799. Amakha, Tchad, S-805 **Modern**

Mollusk shells, 1 km S of well of Amakha (13° 51′ N Lat, 15° 28′ E Long), Tchad, in sandy silt with calcareous concretions, 5 m above

Bahr-el-Ghazal. *Comment*: top of recent alluvium of base of Bahr-el-Ghazal.

140 ± 90
Gif-1096. Nedeley, Tchad, S-1106 A.D. 1810

Pila shells in sandstone at top alluvium of floor of Bahr-el-Ghazal, 1 km E of Nedeley well (15° 36′ N Lat, 18° 09′ E Long), Tchad. *Comment*: base at Bahr-el-Ghazal was marshy at very recent period; assoc. with elephant and hippopotamus.

1750 ± 100
Gif-1099. Kosomanga, Tchad, S-1426 A.D. 200

Bulinus shells in interdune depression at Kosomanga (14° 02′ N Lat, 16° 03′ E Long), Tchad. *Comment*: confirms existence of moist pulsation in Tchad ca. 1800 B.P. Sequence l_2 of Labdé.

1760 ± 105
Gif-798. Well of Salal, Tchad, S-731 A.D. 190

Peaty silt in a well of Salal (14° 50′ N Lat, 17° 13′ E Long), 11.60 m depth at base of lacustrine silt. *Comment*: base of alluvium of Bahr-el-Ghazal.

2450 ± 110
Gif-797. Ebeta, Tchad, S-485 500 B.C.

Tufa with Phragmites from upper part of lacustrine sediment, 1 m thick, in 1 unterdune depression, Ebeta (13° 48′ N Lat, 15° 42′ E Long). *Comment*: dates end of a wet period, 2nd sequence of lacustrine Labdé series, l_2.

2500 ± 110
Gif-1230. Largeau, S Sahara, Tchad, K-339 550 B.C.

Valvata shells at base of thin calcareous diatomic layer, on landing field at Largeau (17° 56′ N Lat, 18° 07′ E Long).

3380 ± 130
Gif-1234. Kichi-Kichi, Tchad, K-289 1430 B.C.

Valvata shells at base of calcareous silt with diatoms, 48 km S E of well of Kichi-Kichi (17° 19′ N Lat, 17° 47′ E Long). *Comment*: agrees well with stratigraphy.

3500 ± 150
Gif-1229. Well of Kelba, Tchad, S-1639 1550 B.C.

Organic remains in sand, 4.75 m depth, in well of Kelba (13° 45′ N Lat, 16° 31′ E Long). Comment: inserted in lacustrine series of Labdé (Sequence l_2); to be related to a regressive phase.

6050 ± 150
Gif-1264. Angamma, Tchad, K-32 4100 B.C.

Nodule of calcareous sandstone, atop a deltaic body at Angamma, 32 km E of Kichi-Kichi, Tibesti (17° 34′ N Lat, 17° 38′ E Long). *Comment*: 2 dates for base of this body: 9260 ± 140 (T-731) and 10,160 ± 160 (T-732) (Servant *et al.*, 1969) show that deltaic series is entirely Holocene, when rivers were flowing and this area was in a pluvial zone.

Gif-1231. Largeau, Tchad, K-354 **7000 ± 170**
5050 B.C.

Diatomaceous limestone, at base of minor diatomaceous sequence, in outcrop 5 km ENE landing field at Largeau (17° 57′ N Lat, 19° 11′ E Long).

Gif-1227. Well of Tjéri, Tchad, S-1608 **8750 ± 200**
6800 B.C.

Organic remains in clayey layer with diatoms, depth 7 m, in well of Tjéri (13° 44′ N Lat, 16° 30′ E Long). *Comment*: belongs to 2nd lacustrine cycle of Labdé series.

Gif-1226. Well of Tjéri, Tchad, S-1604 **9000 ± 200**
7050 B.C.

Organic remains in clayey layer with diatoms, depth 7.75 m, in well of Tjéri. *Comment*: same layer as Gif-1227, slightly deeper.

Gif-1095. Koro-Toro, Tchad, S-1165 **9470 ± 220**
7520 B.C.

Melania shell in outcrop of marly layer above sand, at top of cliff, NNE Koro-Toro (16° 05′ N Lat, 18° 29′ E Long), Bahr-el-Ghazal, Tchad. *Comment*: base of diatomaceous Sequence l_2.

Gif-801. Kamala, Tchad, S-826 **10,100 ± 230**
8150 B.C.

Melania shells, in marly layer, 0.10 m thick in basal lacustrine unit, 10.50 m thick, in wall of a well, Kamala (13° 02′ N Lat, 16° 15′ E Long). *Comment*: dates transgression of ancient lake and belongs to lower part of Sequence l_2.

Gif-1094. Nedeley, Tchad, S-1116 **10,100 ± 230**
8150 B.C.

Vegetal debris in silt under remains of Holocene diatomites in outcrop, 2 km S of well at Nedeley (15° 35′ N Lat, 18° 10′ E Long), Bahr-el-Ghazal, Tchad. *Comment*: base of diatomaceous Sequence l_2.

Gif-1097. Nedeley, Tchad, S-1121 **10,900 ± 300**
8950 B.C.

Clayey limestone with diatoms and impressions of reeds on E flank of Bahr-el-Ghazal valley, Nedeley (15° 35′ N Lat, 18° 08′ E Long), Tchad. Coll. and subm. 1967 by M. Servant. *Comment*: end of the 1st Sequence l_2 of lacustrine Labdé series.

Gif-1233. Kichi-kichi, Tchad, K-294 **11,950 ± 280**
10,000 B.C.

Lacustrine shells in sand intercalated between lacustrine sediment with gravel, 48 km SE of Kichi-Kichi well (17° 19′ N Lat, 17° 47′ E Long). *Comment*: belongs in Sequence l_2.

Gif-847. Djazena, Tchad, S-1055 **12,060 ± 380**
10,110 B.C.

Biomphalaria and *Bulinus* shells in marly layer at base of lacustrine sequence, 8.85 m depth in well at Djazena (13° 48′ N Lat, 17° 36′ E Long), Tchad. *Comment*: dates end of Sequence l_2.

21,900 ± 700
Gif-1228. Well of Kelba, Tchad, S-1633 **19,950 B.C.**

Sandy, silty limestone with ostracods between 2 eolian-sand deposits, depth 12.30 m in Kelba well. *Comment*: dates lacustrine unit in Soulias series.

Gif-800. Well of Kamala, Tchad, S-819 **⩾35,000**

Fine limestone from thin calcareous layer in lacustrine sequence between 2 periods of sand reworking; 15.35 m in well of Kamala. *Comment*: upper part of lacustrine unit of Soulias series.
General Comment: 2 lacustrine transgressions were dated in Labdé series; the last one, which corresponds to Sequence l_2, is the longest, characterized by 2 regressive episodes ca. 8500 to 7000 B.P. and 4000 to 3500 B.P. During the 2 last millennia, the lowest regions of Tchad, N of the 16th parallel, connected with Lake Tchad, until 150 B.P.

8220 ± 190
Gif-1028. Chari River, S Lake Tchad, Ref. 23 **6270 B.C.**

Varved silt with vegetal debris, 3 m depth, from left bank of Chari, 65 km SSE Fort-Lamy, S Lake Tchad (11° 34′ N Lat, 15° 17′ E Long). Coll. 1965 and subm. 1967 by B. Dupont, O.R.S.T.O.M., Fort Lamy, Tchad. *Comment*: dates a lacustrine period.

460 ± 95
Gif-1029. Lake Tchad, Ref. 663 **A.D. 1490**

Hardened silt with organic remains, 40 to 50 cm depth in sediments, between lacustrine layers, 2.90 m below surface of Lake Tchad (13° 27′ N Lat, 14° 30′ E Long). Coll. and subm. 1967 by B. Dupont. *Comment*: marks regression of lake; helps to calculate sedimentation rate of 1m/yr (Dupont and Delibrias, 1970).

Sebkha de N'Dramcha series, Mauritania

Shells from coastal Sebkha de N'Dramcha, N of Nouakchott, Mauritania. Stratigraphy of upper Quaternary in region shows 2 marine transgressions separated by a dry period with dune accumulation; last marine episode was followed by evaporation, indicated by a silty-gypsiferous layer. Coll. and subm. 1967 by C. Fontes, Fac. Sci., Paris.

6000 ± 160
Gif-852. Sebkha de N'Dramcha, N. K-171 **4050 B.C.**

Cardium edule, ca. 2 m depth in silty-gypsiferous layer (18° 36′ N Lat, 15° 46′ W Long). *Comment*: dates beginning of evaporation series, following closing of gulf.

6370 ± 160
Gif-853. Sebkha de N'Dramcha, N. K-172 **4420 B.C.**

Shells (*Venus sp.*) of various forms, 90 cm below N.K-171, in quartzose sediment, partly terrigenous (18° 36′ N Lat, 15° 46′ W Long). *Comment*: dates maximum of Nouakchottian transgression.

Gif-856. Sebkha de N'Dramcha, N. K-193 **5900 ± 150**
3950 B.C.

Cardium edule, 25 cm below a sandy crust (18° 50′ N Lat, 15° 29′ W Long). *Comment*: occupies a central position related to supposed outlines of Nouakchottian gulf; expected to be much older.

Gif-854. Sebka de N'Dramcha, N. K-191 **≥35,000**

Arca senilis from lumachelle cropping out from recent formation, NW of Sebkha (18° 55′ N Lat, 15° 23′ W Long). *Comment*: belongs to shell-rich shore of Upper Inchirian.

Gif-855. Sebkha de N'Dramcha, N. K-192 **≥35,000**

Arca senilis, 30 cm below surface (18° 52′ N Lat, 15° 28′ W Long). *General Comment*: dates determine shorelines corresponding to Nouakchottian and Inchirian extensions of gulf.

Delta of Ogooué series, Gabon

Algae and mollusk shells from calcareous submarine layer, off delta of Ogooué, on continental shelf of Gabon. Coll. by dredging and subm. 1965 by P. Giresse, Fac. Sci., Caen.

Gif-456. Delta of Ogooué, G-600-50 **590 ± 95**
A.D. 1360

50 to 60 cm depth (0° 23′ S Lat, 8° 55′ E Long).

Gif-457. Delta of Ogooué, G-300-15 **1540 ± 100**
A.D. 410

10 to 20 m depth (0° 31′ S Lat, 8° 56′ E Long).
General Comment: expected to date an ancient shoreline; but obviously dredged material was not *in situ.*

Gif-871. Terrace of Benoué, N Cameroun **10,160 ± 230**
8250 B.C.

Fossil soil from middle terrace of Benoué R., 10 m above floodplain, near confluence of Benoué and Mayr Kebi Rivers (9° 15′ N Lat, 13° 22′ E Long). Coll. and subm. 1967 by G. Sifferman, Lab. de Géol. et Paléontol., Strasbourg. *Comment*: corresponds to moist period already dated in Tchad.

C. South America

Brazil coast series

Series of shells, along Brazilian littoral, from fossil lines of Vermetidae and uplifted reefs, near Recife and Ila Grande, 2000 km apart. Part of study of variations of sea level in the Holocene. Coll. and subm. 1967 by J. Laborel, Fac. Sci., Abidjan.

Gif-1059. Sitio Forte, Ila Grande, J.L. Br-67-1 **3420 ± 110**
1470 B.C.

Vermets limestone (23° S Lat, 45° W Long), +2.60 m.

Gif-1060. Sitio Forte, Ila Grande, J.L. Br-67-2 **1670 ± 100**
A.D. 280

Vermets and Balanes limestone (23° S Lat, 45° W Long), +1.70 m.

Gif-1061. Sitio Forte, Ila Grande, J.L. Br-67-3 — **380 ± 90 A.D. 1570**

Vermets limestone (23° S Lat, 45° W Long), ca. +0.50 m.

Gif-1062. Reef of Rio Doce, Olinda, Pernambuco, J.L. Br-67-4 — **3100 ± 120 1150 B.C.**

Madreporaire (*Montastrea cavernosa*) (8° S Lat, 37° 10′ W Long), +3 m.

Gif-1066. Reef of Rio Doce, Olinda, Pernambuco, J.L. Br-67-8 — **1830 ± 110 A.D. 120**

Madreporaire (*Siderastrea stellata*), (8° S Lat, 37° 10′ W Long), ca. present sea level.

Gif-1063. Reef of Rio Doce, Olinda, Pernambuco, J.L. Br-67-5 — **390 ± 90 A.D. 1560**

Melobesiees limestone (8° S Lat, 37° 10′ W Long), ca. +50 cm.

Gif-1064. Lagoa de Itahype, Ilheus, Bahia, J.L. Br-67-6 — **4070 ± 140 2120 B.C.**

Madreporaire (*Mussismilia braziliensis*), (14° 30′ S Lat, 39° W Long), ca. present sea level. *Comment*: species not now living in region.

Gif-1065. Ilha de Caieira, Vitoria Bay, Espiritu Santo, J.L. Br-67-7 — **5520 ± 150 3570 B.C.**

Mussismilia harttii (20° 10′ S Lat, 40° 15′ W Long). *Comment*: species not now living in this lat.

General Comment: good correlation between dates and levels for these coastal regions of Brazil, 2000 km apart. Confirms existence in Brazil of recent variations of sea level as indicated by Van Andel and Laborel (1964) and studied by Bigarella (1965). Gif-1064 and -1065 date a climatic optimum because of disappearance of species from region.

Sambaqui da Pedra Oca series, Brazil

Shells from Sambaqui da Pedra Oca, Bahia de Todos (12° 51′ S Lat, 38° 31′ W Long), Santos, Brazil (Calderon, 1964). Coll. and subm. 1969 by J. Labeyrie.

Gif-877. Sambaqui da Pedra Oca 1 — **2180 ± 110 230 B.C.**

Taken from beach rock under sambaqui, ca. +1 m of present sea level.

Gif-878. Sambaqui da Pedra Oca 2 — **2630 ± 110 680 B.C.**

Shell from basal horizon of sambaqui, above beach rock.

General Comment: dates construction of Sambaqui, just after a slight marine transgression.

Rio de la Plata series, Argentina

Marine shells in Rio de la Plata, Argentina, a few km off present littoral, giving ancient position of littoral (Ottman and Urien, 1966). Subm. 1966 by F. Ottman.

3250 ± 110
Gif-736. Rio de la Plata 1 **1300 B.C.**

Shells dredged from black silt under sediment, S Arquimedes bank, (35° 12′ N Lat, 56° 17′ W Long) in lagoon formation, attributed to a slightly regressive episode.

3770 ± 110
Gif-737. Rio de la Plata 2 **1820 B.C.**

Shells from beach ridge farthest inland, a few m above present sea level, Rio de la Plata.

General Comment: no precise indication of alt of samples but in this very flat country, slight variation of sea level can explain penetration of sea a few km inland; Gif-737 may date maximum of a transgression.

D. Miscellaneous Countries

13,500 ± 300
Gif-835. Neutraubling, Bavaria **11,550 B.C.**

Bone, 1.60 m depth in layer of Danube alluvium, 10 m thick, Neutraubling, SE of Regensburg (48° 59′ N Lat, 12° 11′ E Long), Bavaria. Coll. 1962 and subm. 1967 by M. Léger, Inst. de Géog., Paris. *Comment*: date shows upper part of layer belongs to older Dryas and not to end of Würm, as supposed (Léger, 1965). Collagen not extracted for measurement.

2810 ± 150
Gif-780. Aalter, Belgium **860 B.C.**

B_2h horizon of Podzol beneath eolian sand 75 cm thick, Aalter, 20 km NW Gand (50° 50′ N Lat, 3° 29′ E Long), Belgium. Coll. and subm. 1966 by C. Sys, Ruks Univ., Ghent. *Comment*: Roman ceramics overlie the Podzol.

2410 ± 150
Gif-781. Anzegem, Belgium **460 B.C.**

B_2h horizon beneath eolian sands 70 cm thick, Anzegem, 30 km SW Ghent (51° 07′ N Lat, 3° 28′ E Long), Belgium. Coll. and subm. 1966 by C. Sys. *Comment*: like Gif-780, dates overlying sand of sandy region of Flanders.

2150 ± 110
Gif-897. Xivares, Asturias, Spain **200 B.C.**

Shells (*Purpura hoemastoma*), from Xivares beach (43° 34′ N Lat, 2° 02′ W Long), Cabo Penas, Asturias, Spain. Alt +3 m. Coll. and subm. 1967 by G. Mary, Fac. Sci., Univ. Caen. *Comment*: in this region recent crustal movement is not excluded.

Gif-730. S W Madeira Island **14,900 ± 450**
12,950 B.C.

Mollusk shells and calcareous algae from shell rocks, 1900 m depth, 15 km off Funchal, SW Madeira (32° 33′ N Lat, 16° 56′ W Long). Coll. 1966 with bucket of Bathyscaphe by C. Pareyn; subm. 1967 by C. Pareyn and L. Dangeard. *Comment*: considered to be of littoral origin. Possibility of rapid subsidence in this volcanic region is not excluded.

Ile Maré series, New Caledonia

Ile Maré, one of Iles Loyauté, is coral atoll (21° 30′ S Lat, 168° E Long). Coral samples coll. at surface, and subm. 1967 by J. P. Chevalier, Inst. de Paléontol., Paris.

Gif-1024. Maré, M.A.-64 **⩾30,000**

From reef knoll in lagoon. *Comment*: date is infinite, as expected.

Gif-1025. Maré, M.A.-83 **⩾30,000**

From side of La Rocheknoll, on the ring. *Comment*: age expected: Pleistocene.

Gif-1026. Maré, M.A.-133 **⩾30,000**

From Terrace 13, alt +4 m related to highest sea level. *Comment*: Holocene expected.

Gif-1027. Maré, M.A.-172 **⩾30,000**

From Terrace 14, alt +2 m related to highest sea level. *Comment*: Holocene expected.

General Comment: Maré atoll seems to be recently uplifted ancient atoll, because most dated Pacific atolls have surface ages of 3000 to 5000 yr.

Gif-892. Motu Manu, Atoll de Mapelia, French Polynesia, No. 505 **3450 ± 130**
1500 B.C.

Calcareous coral, at Motu Manu, Atoll de Mapelia (16° 47′ S Lat, 153° 59′ W Long), alt +1 m. Coll. and subm. 1967 by A. Guilcher. *Comment*: confirms existence of higher recent sea level, in Pacific, as shown at Mururoa atoll by the authors (R., 1969, v. 11, p. 337-338) and by Thurber *et al.* (1965).

Gif-893. Motu Mote, Bora-Bora, French Polynesia, No. 581 **2250 ± 130**
300 B.C.

Calcareous coral from E passage Motu Mote, Barrier of Bora-Bora, French Polynesia (16° 27′ S Lat, 151° 45′ W Long). Coll. and subm. 1967 by A. Guilcher. *Comment*: same as for Gif-892.

Gif-823. Tapao, Phum Chhuk, Wompong Cham, Cambodia **⩾35,000**

Peaty sample from core at 80 m depth, in alluvium of Mekong, at Tapao, Phum Chhuk (12° 09′ N Lat, 105° 44′ E Long), Kompong Cham, Cambodia. Coll. and subm. by J. P. Carbonnel, C.N.R.S., Paris. *Com-*

ment: corresponds to ancient phase filling of Mekong valley; too old to be precisely placed in history of aggradation.

Mannavanur series, Madras, Madurai dist., India

Peaty sediments from marsh in a swale at Mannavanur (10° 13′ N Lat, 77° 20′ W Long), alt 2100 m, Madras State, Madurai dist., India. Coll. and subm. 1967 by F. Blasco, Inst. Fr., Pondichery, India.

780 ± 90
Gif-1136. Mannavanur, I.F.P.$_1$ **A.D. 1170**

40 to 50 cm depth, black silty mud with 30% organic matter.

900 ± 100
Gif-1137. Mannavanur, I.F.P.$_3$ **A.D. 1050**

110 cm depth, sand with 2.8% organic matter.

General Comment: recent increase of sedimentation in this depression due to erosion related to destruction of vegetation by man. Rapid sedimentation rate explains why there is no change in pollen composition throughout the profile.

780 ± 100
Gif-775. Christmas Harbour, Kerguelen 0-58 **A.D. 1770**

Organic remains, 1.20 m depth, in "peatbog", on a hillside, Bay of Christmas (48° 40′ S Lat, 69° 10′ E Long), Kerguelen. Bog, 1.50 m thick, lies on gravel bed. Coll. 1965 and subm. 1966 by N. Bellair, Fac. Sci., Paris. "Peatbog" on this island designates thick spongy soil containing abundant organic remains. *Comment*: pollen analysis indicates 2 cold periods: one at base of peat bog, and a 2nd one from 40 to 80 cm depth (Bellair and Delibrias, 1967).

III. GROUND WATER SAMPLES

No systematic program for dating ground waters of aquifers exists at the laboratory. Nevertheless, we undertook a short study of aquifers of Saudi Arabia and some preliminary measurements for aquifers of the Paris Basin, now being studied by other laboratories. In Saudi Arabia, water was sampled from aquifers of Wasi-Biyadh and of Minjur and from their respective outcrops; subm. 1967-1968 by Soc. Grenobloise d'Etudes et d'Applications Hydrauliques (SOGREAH) to determine if these aquifers are currently being supplied. Some dates were already obtained by Thatcher *et al.* (1961).

For aquifers of the Paris Basin, samples were subm. by Vuillaume, B.R.G.M., Orléans. Measurements are reported as % of modern, without correction for limestone dilution.

Wasia-Biyadh Aquifer, Saudi Arabia

δC^{14}
(% of modern)
Gif-905. Wadi Nisah, S-9 **36.2 ± 0.8**

150 m below water table, middle Wadi Nisah (24° 10′ N Lat, 46° 42′ E Long).

Gif-906. Bijidiyan-Khardj, S-426 **28.7 ± 0.8**
(24° 14′ N Lat, 47° 33′ E Long).

Gif-908. Khurais, K.S.W.W.J. **11.3 ± 0.6**
50 m depth from top of the aquifer, at Khurais (25° 03′ N Lat, 47° 56′ E Long).

Gif-907. Layla, S-892 **9.2 ± 0.6**
(22° 21′ N Lat, 46° 49′ E Long).

Minjur Aquifer, Saudi Arabia

Gif-910. M_1, Minjur outcrop, S-1524 **16.5 ± 0.7**
Middle part of lower Minjur formation (24° 30′ N Lat, 45° 48′ E Long).

Gif-909. Shaqra, S-1090 **7.2 ± 0.6**
Upper part of the lower Minjur formation (25° 15′ N Lat, 45° 15′ E Long).

Gif-901. Hayr, S-7 **4.7 ± 0.6**
46 m below water table, upper part of upper Minjur formation (24° 26′ N Lat, 46° 47′ E Long).

Gif-912. Majma'ah, S-999 **4.0 ± 0.6**
168 m below water table, middle part of upper Minjur formation (25° 53′ N Lat, 45° 21′ E Long).

Gif-913. W. Bu'ayja, S-8 **1.75 ± 0.4**
(24° 19′ N Lat, 46° 50′ E Long).

Gif-902. Jiza, S-105 **⩽1.2**
117 m below water table, middle part of upper Minjur formation (24° 34′ N Lat, 46° 45′ E Long).

Gif-900. Riyadh Shumeyssi, S-46 **⩽1.2**
197 m below water table, lower part of the upper Minjur formation (24° 39′ N Lat, 46° 43′ E Long).

Gif-904. Dirab, S-431 **⩽1.2**
103 m below water table, middle part of upper Minjur formation (24° 25′ N Lat, 46° 30′ E Long).

Gif-914. Drumah, S-429 **⩽0.5**
(24° 38′ N Lat, 46° 09′ E Long).

General Comment: measurements, accompanied by a classic hydrodynamic study, lead to conclusion that recharge for both aquifers is now very inferior to discharge; hence, these formations are being depleted naturally, without exploitation.

Albian Aquifer of Paris Basin, France

Gif-600. Radio House, Paris **⩽1.2**

Well (48° 52′ N Lat, 2° 20′ E Long).

Gif-604. Issy-les-Moulineaux, Seine **⩽1.2**

Well (48° 49′ N Lat, 2° 17′ E Long).

Gif-605. Fleury-la-Vallée, Yonne, FvH **23 ± 0.8**

Outcrop (47° 53′ N Lat, 3° 26′ E Long).

Gif-606. Chichery-la-Ville, Yonne, ch.v.J **58 ± 0.8**

Outcrop (47° 55′ N Lat, 3° 31′ E Long).

Gif-607. Viry-Châtillon, Essonne, V.c.A **⩽1.2**

Artesian well (48° 40′ N Lat, 2° 23′ E Long).

Gif-601. Dige, Yonne, K_1-K **100 ± 1.05**

Outcrop (47° 43′ N Lat, 3° 22′ E Long).

Gif-602. Dracy, Yonne, (A_1-A_4) **49.5 ± 0.8**

Outcrop (47° 46′ N Lat, 3° 16′ E Long).

Gif-603. Mantes, Yvelines **6.2 ± 0.6**

Well (48° 59′ N Lat, 1° 43′ E Long).

IV. ATMOSPHERIC SAMPLES

All atmospheric CO_2 samples coll. to determine increase of C^{14}/C^{12} ratio due to explosion of nuclear devices, and measured between publication of our first results (R., 1964, v. 6, p. 248-249) and end of 1970, reported here.

Technique for CO_2 collection is the same as used previously, *i.e.,* by bubbling air through solutions of NaOH. Flow-rate is chosen to obtain a quasi-total collection of CO_2.

Recently, δC^{13} measurements have become available for filling gases; corrections are now applied to δC^{14}, taking these values in consideration. For all other measurements, value of −11‰ corresponding to average of measured δC^{13}, was assumed.

Val Joyeux series, France

Scientific sta., Val Joyeux, Univ. of Paris, 10 km from Versailles, in the countryside, until now situated away from large roads (48° 49′ N Lat, 2° 01′ E Long). Mostly level atmosphere comes from W and, therefore, is not contaminated with CO_2 coming from industrial area of Paris which extends 20 km to 70 km E of Val Joyeux. All coll. samples are reported here. In Fig. 1, ΔC^{14} for samples coll. before 1963 (R., 1964, v. 6, p. 248-249) have been recalculated with δC^{13} value equal to −11‰.

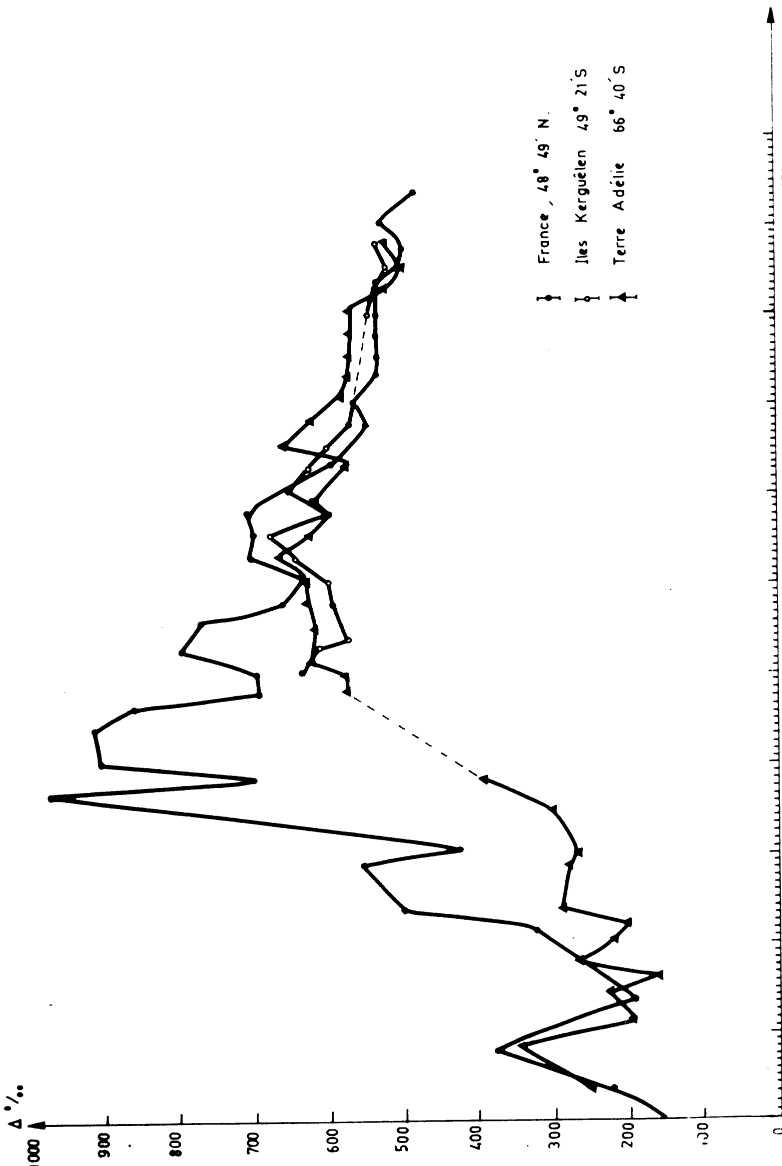

Fig. 1. Per mil C[14] excess over natural concentration at Val Joyeux in France, at Iles Kerguelen (S Indian Ocean) and in Terre Adélie (Antarctica). Statistical errors are given in the legend. Parts of curves with dotted lines correspond to some periods when samplings were not done. All other values have been included.

Date no.	Sample no.	Month	Day	Year	δC^{14}‰	δC^{13}‰	Δ‰
Gif-2000	63-I-A	Jan.	14-31	1963	465	(−11)*	424 ± 14
Gif-2001	63-III-A	Aug.	1-9	1963	1030	(−11)	973 ± 15
Gif-2002	63-IV-A	Oct.	17-24	1963	750	(−11)	701 ± 14
Gif-2003	64-I-A	Jan.	24-31	1964	960	(−11)	905 ± 14
Gif-2004	64-II-A	Apr. May	28 to 6	1964	970	(−11)	915 ± 14
Gif-2005	64-III-A	Aug.	13-25	1964	910	(−11)	857 ± 15
Gif-2006	64-IV-A	Oct. Nov.	28 to 7	1964	740	(−11)	691 ± 13
Gif-2007	65-I-A	Jan.	12-31	1965	750	(−11)	701 ± 13
Gif-2008	65-II-A	Apr.	14-22	1965	850	(−11)	798 ± 14
Gif-2009	65-III-A	July	1-7	1965	820	(−11)	769 ± 14
Gif-2010	65-IV-A	Nov.	10-20	1965	710	(−11)	662 ± 13
Gif-2011	66-I-A	Feb.	1-21	1966	680	(−11)	633 ± 13
Gif-2012	66-II-A	Apr.	18-25	1966	760	(−11)	711 ± 13
Gif-2013	66-III-A	July	1-8	1966	750	(−11)	701 ± 13
Gif-2014	66-IV-A	Oct.	11-17	1966	760	(−11)	711 ± 13
Gif-2015	67-I-A	Jan.	10-18	1967	705	(−11)	658 ± 13
Gif-2016	67-II-A	Apr.	10-14	1967	660	(−11)	614 ± 13
Gif-2017	67-III-A	July Aug.	27 to 7	1967	640	(−11)	594 ± 13
Gif-2018	67-IV-A	Oct.	19-25	1967	590	(−11)	546 ± 12
Gif-2019	68-I-A	Jan.	12-17	1968	609	(−11)	564 ± 12
Gif-2020	68-II-A	Apr.	4-10	1968	577	(−11)	533 ± 13
Gif-2021	68-III-A	July	3-9	1968	580	(−11)	536 ± 13
Gif-2022	68-IV-A	Oct.	15-21	1968	580	(−11)	536 ± 13
Gif-2023	69-I-A	Jan.	24-31	1969	580	(−11)	536 ± 13
Gif-2024	69-II-A	Apr.	25-30	1969	580	(−11)	536 ± 13
Gif-2025	69-III-A	July	10-16	1969	561	− 9.6	513 ± 13
Gif-2026	69-IV-A	Oct.	22-28	1969	540	(−11)	497 ± 13
Gif-2027	70-I-A	Jan.	15-26	1970	577	−10.2	530 ± 13
Gif-2028	70-II-A	Apr.	3-8	1970	515	−13.2	479 ± 13
Gif-2029	70-III-A	July	1-6	1970	556	−10.24	515 ± 13

* δC^{13} assumed

General Comment: variations are similar to those already pub. by many laboratories: rapid increase of Δ C^{14} in 1963, followed by a progressive decrease pulsed by a yearly injection ("Spring injection") which grows less important and disappears completely after 1966.

Iles Kerguelen series

Atmospheric CO_2 coll. at scientific sta. Port aux Français, Iles Kerguelen (49° 21′ N Lat, 70° 13′ E Long) begun in 1965 by technicians of Terres Australes and Antarctiques Françaises. Small building shelter-ing sampling apparatus, away from main sta., was accidentally destroyed in 1968, leaving no samples for April, July, and October 1968. Every year, in January, bottles with NaOH solution are brought back from Kerguelen to Gif with equipment of expedition.

Date no.	Sample no.	Month	Day	Year	δC^{14}‰	δC^{13}‰	Δ‰
Gif-2065	K-I-65	Jan.	8-13	1965	680	(−11)*	633 ± 13
Gif-2066	K-II-65	Apr.	3-7	1965	660	(−11)	614 ± 13
Gif-2067	K-III-65	July	5-9	1965	620	(−11)	575 ± 13
Gif-2068	K-IV-65	Oct.	4-9	1965	640	(−11)	594 ± 13
Gif-2069	K-I-66	Jan.	8-12	1966	647	(−11)	601 ± 13
Gif-2070	K-II-66	Apr.	2-7	1966	697	(−11)	647 ± 13
Gif-2071	K-III-66	July	4-8	1966	730	(−11)	682 ± 14
Gif-2072	K-IV-66	Oct.	5-10	1966	640	(−11)	594 ± 13
Gif-2073	K-I-67	Jan.	9-13	1967	700	−11.6	655 ± 14
Gif-2074	K-II-67	Apr.	8-11	1967	674	−10.3	625 ± 13
Gif-2075	K-III-67	July	1-7	1967	643	−12.0	600 ± 13
Gif-2076	K-IV-67	Oct.	2-7	1967	608	−12.5	568 ± 13
Gif-2077	K-I-68	Jan.	4-8	1968	608	−11.5	565 ± 13
Gif-2078	K-I-69	Jan.	26-30	1969	577	− 9.2	543 ± 13
Gif-2079	K-II-69	Apr.	20-25	1969	582	−10.6	537 ± 13
Gif-2080	K-III-69	July	20-24	1969	557	−12.4	518 ± 13
Gif-2081	K-IV-69	Oct.	20-24	1969	563	−15.2	532 ± 13

* δC^{13} assumed

Terre Adélie, Antarctica series

Atmospheric CO_2 coll. at sta. Dumont Durville in Terre Adélie (66° 40′ S Lat, 140° E Long). Coll. made by Expeditions Polaires Françaises, Paris. Sampling began in 1960 and continued till now, except for 1964, when equipment was lost in Papeete Harbour. As in Kerguelen, samples are brought back every year.

Date no.	Sample no.	Month	Day	Year	δC^{14}‰	δC^{13}‰	Δ‰
Gif-2030	TA-I-60	May	16-18	1960	290	(−11)*	254 ± 11
Gif-2031	TA-II-60	Nov.	10-15	1960	390	(−11)	351 ± 11
Gif-2032	TA-I-61	Feb.	15-17	1961	230	(−11)	194 ± 13
Gif-2033	TA-II-61	June	1-5	1961	260	(−11)	225 ± 11
Gif-2034	TA-III-61	Aug.	9-14	1961	190	(−11)	157 ± 11
Gif-2035	TA-IV-61	Oct.	11-15	1961	305	(−11)	269 ± 11
Gif-2036	TA-I-62	Jan.	7-9	1962	257	(−11)	222 ± 11
Gif-2037	TA-II-62	Feb. Mar.	24 to 10	1962	240	(−11)	205 ± 11

Date no.	Sample no.	Month	Day	Year	δC^{14}‰	δC^{13}‰	Δ‰
Gif-2038	TA-III-62	May	12-25	1962	325	(−11)	288 ± 11
Gif-2039	TA-IV-62	Nov.	9-24	1962	320	(−11)	283 ± 11
Gif-2040	TA-V-62	Dec.	1-5	1962	300	(−11)	264 ± 11
Gif-2041	TA-I-63	June	12-26	1963	340	(−11)	302 ± 11
Gif-2042	TA-II-63	Sept.	24 to				
		Oct.	4	1963	430	(−11)	390 ± 12
Gif-2043	TA-III-63	Dec.	19-26	1963	460	(−11)	419 ± 12
Gif-2044	TA-I-64	Oct.	25-30	1964	620	(−11)	575 ± 12
Gif-2045	TA-II-64	Dec.	2-5	1964	620	(−11)	575 ± 12
Gif-2046	TA-I-65	Feb.	26 to				
		Mar.	2	1965	670	(−11)	623 ± 12
Gif-2047	TA-II-65	July	1-6	1965	660	(−11)	615 ± 13
Gif-2048	TA-III-65	Oct.	1-6	1965	675	(−11)	628 ± 13
Gif-2049	TA-I-66	Jan.	4-10	1966	680	(−11)	633 ± 13
Gif-2050	TA-II-66	Apr.	4-10	1966	715	(−11)	667 ± 13
Gif-2051	TA-III-66	July	1-5	1966	670	(−11)	623 ± 13
Gif-2052	TA-IV-66	Oct.	7-11	1966	640	(−11)	594 ± 13
Gif-2053	TA-V-66	Dec.	28-31	1966	670	(−11)	623 ± 13
Gif-2054	TA-I-67	Apr.	1-3	1967	620	(−11)	575 ± 13
Gif-2055	TA-II-67	July	1-5	1967	710	(−11)	662 ± 14
Gif-2056	TA-III-67	Oct.	1-5	1967	670	−10.20	621 ± 14
Gif-2057	TA-I-68	Jan.	3-5	1968	627	(−11)	582 ± 13
Gif-2058	TA-II-68	Apr.	4-8	1968	617	(−11)	572 ± 13
Gif-2059	TA-III-68	July	3-7	1968	614	−11.4	570 ± 13
Gif-2060	TA-IV-68	Oct.	3-7	1968	616	(−11)	571 ± 13
Gif-2061	TA-I-69	Jan.	4-8	1969	617	(−11)	572 ± 13
Gif-2062	TA-II-69	Apr.	11-15	1969	557	−13.6	522 ± 13
Gif-2063	TA-III-69	July	9-13	1969	537	−12.9	500 ± 13
Gif-2064	TA-IV-69	Oct.	10-14	1969	561	−12.3	521 ± 13

* δC^{13} assumed

General Comment: curves of artificial C^{14} values vs. time obtained in Terre Adélie and in Kerguelen are not as smooth as might be expected if transfer from N to S hemispheres is the sole process. Observed variations seem to indicate stratospheric injections not far from these lats.

There is no significant difference between artificial C^{14} values for Terre Adélie and Kerguelen, these curves are very similar to those obtained, e.g., at Makara, New Zealand (41° 18′ S Lat, 74° 14′ E Long) (Rafter and O'Brien, 1970). Values in 1967 and 1968 are higher in Terre Adélie than in France. Coincidence of Antarctica values with those in N hemisphere appears approximately at end of 1967. Hence it may be estimated that entire troposphere reached fairly uniform C^{14} concentration ca. 5 yr after cessation of main (N hemisphere) nuclear atmospheric tests.

Spitsbergen series

Atmospheric CO_2 samples obtained by G. Lambert, Centre des Faibles Radioactivités, Gif-sur-Yvette, who participated in C.N.R.S. expedition in 1966 at Ny-Alesund, in Spitsbergen (78° 55′ N Lat, 12° 00′ E Long).

Date no.	Sample no.	Month	Day	Year	δC^{14}‰	δC^{13}‰	Δ‰
Gif-2082	SP_1	July	7-8	1966	871	(−11)*	819 ± 14
Gif-2083	SP_2	July	28-29	1966	832	(−11)	781 ± 14
Gif-2084	SP_3	Aug.	4-5	1966	846	(−11)	795 ± 14
Gif-2085	SP_4	Aug.	17-18	1966	826	(−11)	775 ± 14
Gif-2086	SP_5	Aug.	26-27	1966	878	(−11)	824 ± 14

* δC^{13} assumed

Comment: these Spitsbergen values are ca. 10% higher than those of I. Olsson (R., 1970, v. 12, p. 283) during same period. Discrepancy has not yet been explained.

References

Bigarella, J. J., 1965, Subsidios para estuda dos variaçoes de nivel Oceanico no Quaternario Brasileiro: Anais da Academia Brasileira de Siencias, v. 37, p. 263-277.

Bellair, N. and Delibrias, G., 1967, Variations climatiques durant le dernier millénaire aux îles Kerguelen: Acad. sci. [Paris] Comptes rendus, t. 264, p. 2085-2088.

Briard, J., 1968. Un tumulus du Bronze Ancien à Lescongar en Plouhinec: Gallia-Préhistoire, v. 11, p. 247-259.

——— 1970, Un tumulus du Bronze Ancien: Kernonen en Plouvorn (Finistère): L'Anthropologie, t. 74, p. 5-55.

Calderon, V., 1964, O sambaqui da Pedra Oca, officinas da imprensa baiana de economia: Fac. Ciencas Economicas Univ. de Bahia, Salvador, Bahia, Brazil.

Coursaget, J. and Le Run, J., 1966, Gif-sur-Yvette natural radiocarbon measurements I: Radiocarbon, v. 8, p. 128-141.

Courtin, J., 1963, Cahiers ligures de Préhistoire et d'Archéologie: v. 12, p. 214-215.

De Beaulieu, J. L., 1969, Analyses polliniques dans les Monts de l'Espinouse (Hérault): Pollen et spores, v. 11, no. 1, p. 83-96.

De Lanfranchi, F., 1967, La grotte sépulcrale de Curacchiaghiu (Lévie, Corse): Soc. Préhist. Fr. Bull., t. LXIV, p. 587-612.

Delibrias, G. and Guillier, M. T., The sea level on the Atlantic coast and the Channel for the last 10,000 years by the C^{14} method: Quaternaria, in press.

Delibrias, G., Elhai, H., and Larsonneur, C., 1969, Le Flandrien à l'Est d'Arromanches (Calvados): Acad. Sci. [Paris] Comptes rendus, t. 268, p. 247-250.

Delibrias, G., Guillier, M. T., and Labeyrie, J., 1964, Saclay natural radiocarbon measurements I: Radiocarbon, v. 6, p. 233-250.

——— 1965, Saclay natural radiocarbon measurements II: Radiocarbon, v. 7, p. 236-244.

——— 1966, Gif natural radiocarbon measurements II: Radiocarbon, v. 8, p. 74-95.

——— 1970, Gif natural radiocarbon measurements V: Radiocarbon, v. 12, p. 421-443.

Dupont, B. and Delibrias, G., 1970, Note à propos de la datation par le carbone 14 d'un niveau sédimentare de l'archipel du Lac Tchad: Cahiers O.R.S.T.O.M., v. 2, no. 1, p. 49-60.

Emphoux, J. P., 1970, La grotte de Bitorri au Congo-Brazzaville: Cahiers O.R.S.T.O.M., v. 7, no. 1, p. 1-20.

Engel, F., 1964, El preceramico sin algodon en la costa del Perú: Actas y Memorias, v. 3, 35th Cong. Internatl. de Americanistas, Mexico, 1962, p. 141-152.
Gaussen, J. and Gaussen, M., 1960, Les pointes de la basse vallée du Tilemsi: Soc. African Jour., v. 30, p. 123-143.
Giot, P. R., 1965, Le briquetage de Kerlavos: Annales Bretagne, v. 72, p. 87-94.
——— 1968, Chronique des datations radiocarbone armoricaines: Annales Bretagne, v. 75, p. 153-164.
——— 1969, Chronique des datations radiocarbone armoricaines: Annales Bretagne, v. 76, p. 153-162.
——— 1970, Chronique des datations radiocarbone armoricaines: Annales Bretagne, v. 77, p. 155-160.
Giot, P. R. and Briard, J., 1969, Les retranchements du Cap d'Erquy: Annales Bretagne, v. 76, p. 21-36.
Giot, P. R. and Doucouret, J. P., 1968, Le souterrain de l'âge de Fer de Kervéo en Plomelin (Finistère): Annales Bretagne, v. 75, p. 101-116.
Glemarec, M., 1969, La "Grande Vasière", aperçu bionomique: Acad. Sci. [Paris] Comptes rendus, t. 268, p. 155-157.
Gouletquer, P. L., 1967, Le briquetage de Mesperleuch en Plouhinec (Finistère): Annales Bretagne, v. 74, p. 107-119.
——— 1970, Les briquetages armoricains: Doc. Sci. thesis, Fac. Sci., Rennes, 190 p.
Gouletquer, P. L., Lejards, J., and Tessier, M., 1968, Les sites à augets de la côte S. de la Bretagne: Annales Bretagne, v. 75, p. 117-148.
Guilaine, J. and Abelanet, J., 1965, La céramique poladienne du Roussillon et du Bassin de l'Aude: Symposium Prehist. Peninsular Proc., Pamplona.
Guyader, Y., 1969, Fouille d'un souterrain de l'âge du Fer à Grohan en Quessoy, (Côtes du Nord): Annales Bretagne, v. 76, p. 61-84.
Joussaume, R., 1968, Tumulus campaniforme à Jard (Vendée): L'Anthropologie, v. 72, p. 545-551.
Labeyrie, J., Delibrias, G., and Guillier, M. T., 1968, Vitesse moyene de sédimentation depuis la fin du Würm dans la plaine abyssale de la Méditerranée Occidentale: Acad. Sci. [Paris] Comptes rendus, t. 264, p. 1370-1372.
Léger, M., 1965, Les terrasses du Danuble de Regensburg à Pleinting: Assoc. Fr. Etude du Quaternaire Bull., v. 2, p. 153-164.
Le Provost, F. M. and Giot, P. R., 1966, La céramique d'un site de surface au Miniou en Bonen (Côtes du Nord): Annales Bretagne, v. 73, p. 43-49.
Le Roux, C. T., 1966, Le tumulus de l'âge du Bronze du Hellen en Cleder (Finistère): Annales Bretagne, v. 73, p. 32-37.
Le Roux, C. T. et l'Helgouach, J., 1967, Le Cairn mégalithique avec sépultures à chambres compartimentées de Kerleven (Finistère): Annales Bretagne, v. 74, p. 7-52.
l'Helgouach, J., 1966, Fouilles de l'allée ouverte de Prajou-Menhir en Trebeurden (Côtes du Nord): Soc. Préhist. Fr. Bull., v. 63, p. 311-342.
——— 1967, La sépulture mégalithique à entrée latérale de Crec'h-Quillé en Saint-Quay-Perros, (Côtes du Nord): Soc. Préhist. Fr. Bull., v. 65, p. 659-698.
Masset, C., 1968, Les incinérations du Néolithique ancien de Neuvy-en-Dunois: Gallia, t. 11, fasc. 1, p. 205-232.
Mauny, R., 1955, Les gisements néolithiques de Karkarichinkat (Tilemsi, Soudan Français): C. E. II, Panafricain Préhist. Cong. Alger, p. 616-626.
Mauny, R., Gaussen, J., and Gaussen, M., 1968, Commentaires sur la datation au carbone 14 de deux villages néolithiques du Sahara malien I.F.A.N. Bull., v. 30, ser. B, no. 4, p. 1317-1321.
Michel, J. P., 1968, Etude sédimentologique des forages dans l'estuaire de la Seine (Port du Havre): Soc. Géol. de Normandie, Bull., v. 58, p. 9-16.
Morzadec-Kerfourn, M. T., 1969, Variations de la ligne de rivage au cours du post-glaciaire le long de la côte nord du Finistère: Assoc. Fr. Etude Quaternaire Bull., v. 6, p. 285-318.
Olsson, I. U. and Klasson, M., 1970, Uppsala radiocarbon measurements X: Radiocarbon, v. 12, p. 281-284.
Ottman, F. and Urien, M., 1966, Sur quelques problèmes sédimentologiques dans le Rio de Plata: Rev. Géog. Phys. et Géol. Dyn., v. 3, fasc. 3, p. 209-224.
Paccard, M., 1966, Nouvelles découvertes à Gramari (Méthamis, Vaucluse): Soc. Préhist. Fr. Bull., v. 62, p. 150-151.
Pautot, G., 1967, Structure sous-marine du haunt-fond du Méjean, Acad. Sci. [Paris] Comptes rendus, t. 265, p. 1028-1030.

Rafter, T. A. and O'Brien, B. J., 1970, Exchange rates between the atmosphere and the ocean as shown by recent C^{14} measurements in the South Pacific: Nobel symposium 12 on radiocarbon variations and absolute chronology Proc., Uppsala, p. 355-377.

Servant, M., Servant, S., and Delibrias, G., 1969, Chronologie du Quaternaire récent des basses régions du Tchad: Acad. Sci. [Paris] Comptes rendus, t. 269, p. 1603-1606.

Thatcher, L., Rubin, M., and Brown, G. S., 1961, Dating desert ground waters: Science, v. 134, p. 105-106.

Thurber, D. L., Broecker, W. S., Blanchard, R. L., and Potratz, H. A., 1965, Uranium series age of Pacific atoll coral: Science, v. 149, p. 55-58.

Van Andel, T. H. and Laborel, J., 1964, Recent high relative sea-level stand near Recife, Brazil: Science, v. 145, p. 580-581.

Van Campo, M. and Jalut, C., 1969, Analyse pollinique de sédiments des Pyrénées orientales: Lac de Balcère (1764 m): Pollen et Spores, v. 11, no. 1, p. 117-126.

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GEOLOGICAL SURVEY OF CANADA RADIOCARBON DATES XI

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INTRODUCTION

During the past year, 1969-1970, both the 2-L (Dyck and Fyles, 1962) and 5-L (Dyck *et al.*, 1965) counters were routinely operated. A 1-L counter was finally constructed with acceptable characteristics (see description below) and was operated in July in place of the 5-L counter. The 2-L counter was operated exclusively at 2 atm. The 5-L counter was operated at 1 atm, except for October and November, 1969, when it was operated at 4 atm. The 1-L counter was operated at 1 atm.

After six unsuccessful attempts to construct a 1-L counter with an acceptably low background, one was finally fabricated and put into operation in June, 1970. The basic design of the counter is the same as for the 2-L counter described previously (Dyck and Fyles, 1962). A copper tube 18¼″ long, 2⅛″ O.D. with an ⅛″ wall was used for the counter. In an attempt to ensure a low background, 0.03″ was machined from both inner and outer surfaces. Just prior to assembly, the tube and copper end plates were dipped in 30% nitric acid, then rinsed with distilled water and acetone. The copper end plates and quartz insulators were glued in place using Waldor 810 adhesive. The R-C network and coupling capacitor were placed in a separate ground box to simplify the initial selection of values. The more important counting characteristics of the 1-L counter are given in Table 1.

During its first month of operation, July 1970, 4 background samples and 3 oxalic acid standards were counted. The average background counting rate was 1.375 ± .026 and the standard 4.391 ± .051.

Table 2 lists a comparison of results obtained from different counters. All samples were given two 1-day counts except for GSC-1361 in which each result was based on one 3-day count. The figures in parentheses are the uncorrected ages of the samples for which δC^{13} values are given.

Age calculations are carried out monthly by a C.D.C. 3100 computer and are based on a C^{14} half-life of 5568 ± 30 yr and 0.95 of the activity of the NBS oxalic acid standard. Ages are quoted in years before present (B.P.), where "present" is taken to be 1950. Age errors include: counting errors of sample, background, and standard; error in the half-life of C^{14}; and an error term to account for the average variation of ± 1.5% in the C^{14} concentration of the atmosphere during the past 1100 yr. The error assigned to an age is *always* a minimum of ± 100 yr. *Unless otherwise stated in the sample descriptions, all ages are based on two*

*The introduction has been prepared by the first author, who operates the laboratory. The description and testing of the new 1-L counter has been the responsibility of the second author. The date list has been compiled by the third author from descriptions of samples and interpretations of dates by the collectors.

TABLE 1
1-L Counter Characteristics

Volume* (liters)	Oper. press. (atm)	Oper. volt. (K.V.)	Back-ground, B (c/m)	Standard N_0 (c/m)	Figure of merit**	Meson (c/m)	Plateau slopes† Meson	Plateau slopes† C^{14}
0.91 (0.84)	1.0	3.9	1.38 ± .03	4.39 ± .05	3.12	101.2	0.3	1.4

* The values in brackets is the sensitive volume of the counter, *i.e.*, the volume between the anode sleeves.

** The figure of merit is calculated from the expression,

$$\text{Figure of Merit} = C \times V \times \frac{N_0}{\sqrt{B}} \quad \text{where}$$

$$C = \text{counting efficiency} = .90 \text{ (estimated)}$$

$$V = \text{volume efficiency} = \frac{\text{sensitive volume}}{\text{total volume}} = .92$$

N_0 = 0.95 × net counting rate of the NBS oxalic acid standard
B = background counting rate

† The plateau slopes are expressed in % per 100 volts and were measured over a 200 volt interval.

Meson = total rate − (sample + background rate)
C^{14} = oxalic acid standard + background

TABLE 2
Comparison of Results from Different Counters

Sample no.*	δC^{13} (‰)	1-L (1 atm)	2-L (2 atm)	5-L (1 atm)
GSC-1344		13,200 ± 420	13,000 ± 290	
GSC-1345		(6290 ± 250)	(6450 ± 150)	(6340 ± 140)
	−22.0	6340 ± 250	6500 ± 150	6390 ± 140
GSC-1353		10,600 ± 380	10,700 ± 310	
GSC-1361		(570 ± 180)	(410 ± 160)	
	−22.2	620 ± 180	460 ± 160	

* Detailed description of GSC-1345, an inter-laboratory check sample of wood from Svalbard, appears in this date list. All others are deferred to a later list.

1-day counts. Finite dates are based on the 2σ criterion (95.5% probability) and "infinite" dates on the 4σ criterion (99.9% probability).

Average background and standard counting rates over the past 12 months are listed in Tables 3 and 4, respectively.

The 2-L monthly backgrounds are the average of 4 individual daily counts. During the year, one count was omitted for statistical reasons and 9 different background preparations were used. At 4 atm, October-November, the 5-L background is the average of 11 individual daily counts. No results were omitted and 3 preparations were used. At 1 atm the 5-L monthly backgrounds are the average of 4 individual daily counts. No counts were omitted and 4 preparations were used.

For the 2-L counter, the monthly standards are the average of 3 individual daily counts. Four oxalic acid preparations were used and no count had to be omitted. At 1 atm the monthly 5-L standard counting rate is the average of 3 individual daily counts. No counts were omitted and 3 different preparations used. At 4 atm, the standard counting rate is the average of 6 daily counts. No counts were omitted and the same oxalic acid preparation was used.

TABLE 3
Monthly Background (c/m) for Period
October 1, 1969 to September 30, 1970

Month	2-L Counter (2 atm)	5-L Counter (1 atm)	1-L Counter (1 atm)
October, 1969	1.139 ± .019	2.888 ± .021*	
November	1.187 ± .033		
December	1.218 ± .018	2.231 ± .027	
January, 1970	1.261 ± .023	2.318 ± .058	
February	1.308 ± .019	2.401 ± .025	
March	1.294 ± .024	2.404 ± .034	
April	1.303 ± .024	2.373 ± .042	
May	1.312 ± .019	2.385 ± .025	
June	1.338 ± .026	2.343 ± .033	
July	1.404 ± .052		1.375 ± .026
August	1.296 ± .019	2.334 ± .027	
September	1.345 ± .020	2.300 ± .036	

*5-L counter operating at 4 atm.

TABLE 4
Monthly Standard, N_0* (c/m) for Period
October 1, 1969 to September 30, 1970

Month	2-L Counter (2 atm)	5-L Counter (1 atm)	1-L Counter (1 atm)
October, 1969	19.473 ± .095	112.021 ± .186**	
November	19.569 ± .154		
December	19.706 ± .095	28.412 ± .168	
January, 1970	19.591 ± .096	28.606 ± .127	
February	19.668 ± .094	28.700 ± .195	
March	19.690 ± .128	28.620 ± .163	
April	19.652 ± .137	28.718 ± .133	
May	19.635 ± .095	28.787 ± .129	
June	19.651 ± .110	28.525 ± .123	
July	19.478 ± .108		4.391 ± .051
August	19.712 ± .106	28.823 ± .121	
September	19.578 ± .094	28.889 ± .120	

* $N_0 = 0.95 \times$ net counting rate of the NBS oxalic acid standard.
** 5-L counter operating at 4 atm.

No changes have been made in the routine CO_2 preparation and purification techniques described in previous GSC date lists (Lowdon *et al.*, 1969; Lowdon and Blake, 1970). However, a new method for the preparation of CO_2 from bone samples has been attempted. In the past, much time and effort has been spent in purifying the CO_2 gas from bone (collagen) samples. The excess impurities are due, in most part, to the presence of nitrogen compounds which are not readily removed in the purification train. Whereas a typical CO_2 sample from wood, charcoal, peat, or shell requires only from 2 to 4 passes through the hot Cu–Ag wool furnace (850°F), bone samples have required up to 20 passes to achieve the purity required for necessary counting efficiency. It is hoped that this purification problem can be overcome by using the "precipitation" method described below.

Combustion of the bone collagen is carried out in the manner previously described (Lowdon *et al.*, 1969). The CO_2 evolved is then passed through dilute (50%) H_2SO_4 to remove water of combustion, then through 2 traps containing 500 ml each of 3N NH_4OH. The CO_2 is absorbed in this solution, and the remaining gases pass through dilute H_2SO_4 to absorb NH_3 fumes. By addition of SrCl to the NH_4OH traps, $SrCO_3$ is precipitated. CO_2 is then liberated by the action of phosphoric acid. The 2 samples so far prepared by this method required only minimal purification. The main concern with this method is the risk of atmospheric CO_2 being absorbed in the NH_4OH solution. To eliminate this, the NH_4OH solution was prepared, and the $SrCO_3$ precipitation carried out, in a plastic glove bag filled to a positive pressure with ultra-pure nitrogen. By the use of rubber hose connections and clamps, the NH_4OH solution was never exposed to the atmosphere. Table 5 compares the results obtained on the 2 samples prepared by our standard and new precipitation methods. The results agree within statistical limits showing that atmospheric contamination is negligible. The δC^{13} results indicate that little, or no, fractionation has occurred in the laboratory process. Additional samples will be processed by both methods before the method described above is accepted as standard procedure in this laboratory.

In this date list, where δC^{13} measurements are available, a correction for isotopic fractionation has been applied to the date,* and the δC^{13} value reported. Related to the PDB standard, the normal value used for correction is $\delta^{13} = -25.0‰$ for all organic materials (including bones) and 0.0‰ for marine shells. The C^{13}/C^{12} ratios reported were determined by either Isotopes Inc., New Jersey, or the GSC Geochronology Section (Head, R. K. Wanless), on aliquots of the same sample gas used for age determination.

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* Except for terrestrial and fresh-water shells, for which the initial C^{14} content is unknown.

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TABLE 5
Comparison of Results on Bone Samples
By Different Preparation Techniques

Sample no.*	Procedure	Uncorrected age (yr B.P.)	δC^{13} ‰	Corrected age (yr B.P.)
GSC-1219	Standard	2260 ± 130	−21.2	2320 ± 130
GSC-1219-2	$SrCO_3$	2210 ± 130	−21.2	2270 ± 130
GSC-1220	Standard	31,900 ± 630	−18.7	32,000 ± 630
GSC-1220-2	$SrCO_3$	31,600 ± 690	−19.8	31,700 ± 690

* Detailed description of GSC-1220 is deferred to a later date list. Description of GSC-1219 appeared in Lowdon *et al.*, 1970. Basal peat from the same level as GSC-1219 gave an age of 2330 ± 130 yr (GSC-1308, corrected age; δC^{13} = −24.9‰); description of date will appear in a future list.

SAMPLE DESCRIPTIONS

I. GEOLOGIC SAMPLES

A. Eastern Canada

1. Newfoundland

GSC-1413 Peter's River **3600 ± 130**
1650 B.C.

Basal peat (dominated by *Eriophorum* sp., id. by M. Kuc) from 1.8 m thick deposit in kettle in gravel capping a kame-moraine, truncated by wave-cut cliff, off Hwy. 36, 1.6 km N of Peter's River settlement, St. Mary's Bay, Avalon Peninsula, Newfoundland (46° 46.7′ N Lat, 53° 37.4′ W Long), alt ca. 15 m. Coll. 1969 by D. R. Grant and V. K. Prest.** *Comment* (D.R.G.): it was hoped basal peat would date recession of late ice cap on Avalon Peninsula (Henderson, 1960), especially in view of tundra aspect indicated by high proportion of non-arboreal pollen (J. B. Railton, Dalhousie Univ., Halifax, written commun.). Date can, however, be explained in terms of long delay before onset of organic accumulation due to previous substrate. Moreover, region today still cannot support trees owing to exposure and severe climate. NaOH-leach omitted from sample pretreatment. (One 3-day count.)

Ten Mile Lake series

Marine shells from till and postglacial beach gravel in vicinity of

** All persons referred to as collectors or submitters of samples or otherwise cited as sources of data are with the Geological Survey of Canada unless otherwise specified.

Ten Mile Lake, Newfoundland. All samples at alt ca. 60 m. Coll. 1969 by D. R. Grant.

GSC-1277. Ten Mile Lake, moraine, *Mya truncata* **10,900 ± 160**
8950 B.C.
$\delta C^{13} = +1.7‰$

Whole shells and fragments (*Mya truncata*) from till of end moraine crossing S end of Ten Mile Lake, Newfoundland (51° 04.87′ N Lat, 56° 42.63′ W Long). Sample from clean face in wave-cut cliff 6 to 9 m high on peninsula comprising end moraine.

11,000 ± 160
GSC-1324. Ten Mile Lake, moraine, *Balanus* **9050 B.C.**

Barnacle fragments (*Balanus* sp.) occurring as large angular masses in till of end moraine, same location as GSC-1277.

10,100 ± 160
GSC-1270. Ten Mile Lake, beach, *Mya truncata* **8150 B.C.**
$\delta C^{13} = +2.6‰$

Shells (*Mya truncata*), intact and *in situ* (1 valve from each of 2 pairs subm.), in beach gravel, near top of 6 m high bank, exposed on W side of Ten Mile Lake (51° 03.85′ N Lat, 56° 45.00′ W Long). Sample from 2.6 km outside end moraine constructed during a readvance.
General Comment (D.R.G.): shell material in till represents marine sediment plowed up by glacier readvancing, ca. 11,000 yr ago, down from Long Range plateau into a high postglacial sea over lowlands deglaciated <1000 yr earlier. Field relations indicate: 1) encroachment by sea to >120 m and formation of De Geer moraines during initial retreat of ice; 2) readvance of ice to moraine in Ten Mile Lake; 3) fall of sea to ca. 60 m by time (10,100 ± 160 B.P., GSC-1270) glacier had receded from moraine (Grant, 1969a; 1969b). (One 3-day count each).

1730 ± 140
GSC-1266. Bonne Bay **A.D. 220**
$\delta C^{13} = -24.9‰$

Basal peat at 125 to 135 cm depth from deposit assoc. with pool complex ("flarks") in Long Range Mts., S of Bonne Bay, Newfoundland (49° 28′ 10″ N Lat, 57° 57′ 40″ W Long), at alt ca. 260 m. Pool is one of several in depressions in serpentine bedrock, but higher water level is due to development of dam-like peat deposits from which sample was taken. Coll. 1968 with split-tube corer by R. D. Muir, Natl. Parks Branch (now with Canadian Wildlife Service, Ottawa). *Comment* (R.D.M.); date, although younger than expected, supports field evidence that peat deposit was developed *in situ* over >1500 yr period (Muir, 1970). NaOH-leach omitted from sample pretreatment. (One 1-day count.)

7340 ± 220
GSC-1145. Turf Point **5390 B.C.**

Plant detritus in basal sand of peat bog, Turf Point, St. George's

Bay, Newfoundland (48° 26′ N Lat, 58° 28′ W Long). Sample from fresh exposure in wave-cut face of bog at sea level. Sand is eroded surface of massive compact till which also occurs in base of sections elsewhere around St. George's Bay (Brookes, 1969). NE of bog, till is overlain, successively, by marine silts and delta sands and gravels with a flat surface at alt ca. 24 m. Coll. 1968 by I. A. Brookes, York Univ., Toronto, and V. K. Prest. *Comment* (I.A.B.): date is minimum for time when sea level was lower, relative to land, than at present. NaOH-leach omitted from sample pretreatment. Sample mixed with dead gas for counting.

GSC-1187. Port au Port **13,400 ± 290**
11,450 B.C.

Whole clean shells (*Balanus* sp.) 27 m below top of Bay St. George 'Delta' sequence at 'The Gravels',* Port au Port, Newfoundland (48° 33.8′ N Lat, 58° 42.6′ W Long), alt ca. 2 m. Shells *in situ* on pebbles (up to 10 cm diam.) and infilled with bottomset silt and clay of 'Delta' sequence. Interstices of pebbles filled with sand. Coll. 1966 by J. M. Shearer, then at Memorial Univ., St. John's. *Comment* (J.M.S.): dates time of high-energy environment (waves or tidal currents) preceding deposition of bottomset silt assoc. with Bay St. George 'Delta' formation. Because date coincides with numerous others close to marine limit (all approximating time of deglaciation; cf. Brookes, 1969 and GSC-1200, 13,500 ± 210, this list), tidal currents were causal environment. Small sample size (6.5 g) precluded leaching of outer shell material. Sample mixed with dead gas for counting. (One 2-day count.)

Robinsons Head series

Marine shells and organic debris from 2 localities close together at N end Robinsons Head, E side of St. George's Bay, Newfoundland (48° 15′ N Lat, 58° 47.5′ W Long).

GSC-1200. Robinsons Head, marine shells **13,500 ± 210**
11,550 B.C.

Mollusk shell fragments, mainly *Hiatella arctica* and *Mya* sp., some with bits of periostracum attached, from 0.6 m-layer of clayey silt in sea cliff at alt 36 m. Clayey silt occurs ca. 14 m below cliff top and overlies coarse stratified ice-contact gravel and compact gray-pink till, both of St. George's River Drift (MacClintock and Twenhofel, 1940). Shelly layer is overlain by 2 m stratified sand, possibly deltaic in origin, above which less well-stratified, cobbly, kame gravels of Robinsons Head Drift, some 12 m thick, continue to cliff top. Clayey silt marks uppermost limit of identifiable marine deposits at Robinsons Head, but late-glacial sea probably extended up to 6 m higher. Coll. 1968 by I. A. Brookes. *Comment* (I.A.B.): dates maximum marine submergence following deglaciation of present shore area and prior to glacier readvance over a shoaling sea floor (Brookes, 1969; 1970b). Sample mixed with dead gas for counting.

* Single quotation marks used throughout text to indicate unofficial name.

GSC-1350. Robinsons Head, organic debris **10,600 ± 150** **8650 B.C.**

Organic debris transported fragments of tundra species of mosses (at least 16 species of mosses and vascular plants from both wet and dry habitats; *Dryas integrifolia, Potamogeton* sp., and dwarf *Salix* sp.; id. by M. Kuc) from basal 2.5 cm of 1.2 m-thick peaty layer exposed in fresh-cut natural face on side of gully at alt ca. 28 m. Peaty layer overlies marine clay, with an intervening irregular band of iron-stained gravel (correlative? with Robinsons Head Drift) up to 5 cm thick, and is overlain by 0.6 m gray marl and 2 m peat. Clay is probably same as outcropping nearby on Robinsons Head from which shells at alt 36 m were dated at 13,500 ± 210 B.P. (GSC-1200; Brookes, 1969). Coll. 1969 by V. K. Prest. *Comment* (I.A.B.): organic debris postdates maximum marine transgression, (42.5 to 44 m at ca. 13,500 B.P.), and subsequent fall of sea level to <27 m. Local ice readvance that deposited Robinsons Head Drift occurred when sea level was at ca. 27 m. Hypothetical sea-level curve dates readvance at 13,000 B.P. (Brookes, 1970a); organic debris was transported to site ca. 2500 yr later, when sea level was probably ca. 4.5 to 9 m lower, relative to land, than now. NaOH-leach omitted from sample pretreatment. (One 3-day count.)

GSC-1203. Port au Port Bay **5800 ± 210** **3850 B.C.** $\delta C^{13} = +2.5‰$

Shell fragments, including *Cerastoderma pinnulatum* (id. by A. H. Clarke, Jr., Natl. Mus. Nat. Sci., Ottawa), *Hiatella arctica, Mya truncata* and *Balanus* sp., from a gravelly-sand zone in predominantly clay and silt core from West Bay, Port au Port Bay, Newfoundland (48° 43′ N Lat, 58° 50.3′ W Long), at ca. 24 m depth. Shell-bearing zone underlain by blue gray clay; overlain by brown silt similar to type of sediment now being deposited. Coll. 1966 by J. M. Shearer. *Comment* (J.M.S.): date thought minimum for time of greatest postglacial land emergence in area, assuming tidal currents are and were ineffective in basin and that sandy zone is due to wave action. Assuming similar wave energy and thus calculating depth at which orbital velocities are strong enough to transport sandy material, sea level 11 to 14 m lower relative to land is necessary. Small sample size (4.9 g) precluded leaching of outer shell material. Sample mixed with dead gas for counting.

Abrahams Cove series

Marine shells from near E end of Abrahams Cove, S side of Port au Port Peninsula, Newfoundland (48° 31.5′ N Lat, 58° 55′ W Long).

GSC-968. Abrahams Cove, 7.5 m **13,600 ± 180** **11,650 B.C.**

Whole shells and fragments (*Hiatella arctica*), some with ligament and periostracum intact, from sea cliff at E end of Abrahams Cove, at alt 7.5 m. Shells occur in blue-black sandy, pebbly clay overlying a 0.6 m layer of buff sand, a massive compact gray-brown till, and bedrock, and overlain by deltaic gravel. Coll. 1966 by I. A. Brookes. (One 3-day count.)

GSC-1074. Abrahams Cove, 40 to 41 m **13,700 ± 230**
11,750 B.C.

Whole shells and fragments (*Hiatella arctica* and fragments of *Macoma* (?) and *Balanus* sp.), some worn, from working face of borrow pit on rd. 0.4 km E of bridge over stream at Abrahams Cove. Shells coll. at alt 40 to 41 m from bouldery limestone gravel; marine limit at 43 m. Coll. 1968 by I. A. Brookes and J. M. Shearer.

General Comment (I.A.B.): dates maximum marine submergence, following deposition of underlying till and deglaciation of present shoreline, and suggests similar dates on shells in marine deposits close to sea level (e.g., GSC-1187, 13,400 ± 290, this list; GSC-598, 13,420 ± 190, R., 1968, v. 10, p. 210; GSC-937, 13,200 ± 220, R., 1970, v. 12, p. 51) relate closely to age of marine limit. GSC-1074 mixed with dead gas for counting.

GSC-1135. North West River, Labrador **5330 ± 170**
3380 B.C.
$\delta C^{13} = +0.3‰$

Fragments of *Mytilus edulis* (NMC-311) 2 to 3.5 m below reworked surface of end moraine (Blake, 1956) on S side of stream at North West River, Labrador, Newfoundland (53° 31′ 20″ N Lat, 60° 08′ 45″ W Long), alt ca. 33 m above high-water mark. Bed of comminuted shells, exposed in borrow pit NW of school, overlain by stratified sand and gravel and underlain by similar material. Coll. 1968 by W. W. Fitzhugh, Harvard Univ., Cambridge, Massachusetts; now at Smithsonian Inst., Washington, D.C. *Comment* (W.W.F. and W.B., Jr.): dates time during emergence when sea was truncating surface of moraine at North West River, and when Grand Lake to NW was marine. Sample mixed with dead gas for counting.

2. Nova Scotia

Sable Island series (I)

Numerous freshwater peat balls of varying size, presumably from submerged layers of peat on Sable Island Bank, litter beaches of Sable Island, Nova Scotia. Peat and soil layers developed on an enlarged land area at times of lower sea level during and since Wisconsin glaciation. As sea level rose in postglacial time peat was submerged and covered with marine sand. Subsequent shifting of sand exposed peat to erosion, chunks are washed onto island by storm waves. Distribution, composition, and ages of peat balls suggest that numerous disconnected lenses of peat of varying age probably exist beneath present island and surrounding banks (Terasmae and Mott, 1971).

7770 ± 140
GSC-916. South Beach, peat ball **5820 B.C.**

Rounded, wave-washed ball of peat recovered from high-water mark on beach at base of dunes along South Beach E of Lake Wallace (43° 56′ N Lat, 59° 52′ W Long). Coll. 1967 by J. Terasmae and R. J. Mott. *Comment* (R.J.M.): sample yielded pollen assemblage with relatively little tree pollen but with abundant pollen of *Myrica* and Ericaceae, indicating an environment similar to island's present-day heath areas which cannot support trees.

6980 ± 140
GSC-917. South Beach, peat ball **5030 B.C.**

Rounded, wave-washed ball of peat from South Beach W of Lake Wallace (43° 55.5′ N Lat, 60° 02′ W Long). Coll. 1966 by D. J. Stanley; subm. by R. J. Mott. *Comment* (R.J.M.): sample has pollen assemblage rich in tree pollen (*Pinus* sp.), suggesting presence of trees on island or long distance transport of large quantities of *Pinus* pollen. Because non-tree part of pollen spectrum is similar to other spectra from samples of island area and because other evidence for presence of trees is lacking, latter explanation seems more likely. Date is similar to one of 6800 ± 150 (GaK-748) on peat ball dredged from 9 m depth 1.6 km S of island (Clarke *et al.*, 1967; James and Stanley, 1967).

320 ± 130
GSC-1009. West Point, peat slab (top) **A.D. 1630**
$\delta C^{13} = -26.6‰$

One of many large pieces of peat (0.6 m diam., 25 cm thick) washed onto beach at West Point (43° 56.5′ N Lat, 60° 05′ W Long) by storm waves. Sample from top 3.8 cm of peat slab. Coll. 1967 by J. Terasmae and R. J. Mott. *Comment* (R.J.M.): size and unrounded condition of peat slabs preclude long distance transport. Pollen spectrum contains abundant Cyperaceae, *Myrica*, and Ericaceae, indicating environment similar to that of some areas of island today. NaOH-leach omitted from sample pretreatment. (One 3-day count.)

650 ± 130
GSC-1010. West Point, peat slab (base) **A.D. 1300**
$\delta C^{13} = -24.6‰$

Sample from basal 2.5 cm of same peat slab of GSC-1009. *Comment* (R.J.M.): pollen spectrum has relatively little Cyperaceae but abundant *Myrica*, Ericaceae, and Gramineae pollen; environment same as GSC-1009. NaOH-leach omitted from sample pretreatment. Sample mixed with dead gas for counting. (One 3-day count.)

10,900 ± 160
GSC-935. Mobil Oil drill hole, peat **8950 B.C.**

Small piece of sandy peat recovered from top 18 m of sand during washing down of casing for Mobil Oil test hole on Sable I. (43° 56′ N Lat, 59° 55′ W Long). Coll. 1967 by W. H. Munro, Mobil Oil, Ltd., Calgary; subm. by J. Terasmae and R. J. Mott. *Comment* (R.J.M.):

pollen spectrum contains very little tree pollen but abundant Cyperaceae, Gramineae and *Myrica* pollen. Even 11,000 yr ago trees do not appear to have been present on island and environments similar to some on present island were prevalent. NaOH-leach omitted from sample pretreatment.

Sable Island series (II)

Marine shells from North Beach near West Light, Sable I., Nova Scotia (43° 55′ N Lat, 60° 10′ W Long). Coll. 1966 by A. H. Clarke, Jr., Natl. Mus. Nat. Sci., Ottawa.

GSC-634. West Light, oyster **3540 ± 140**
1590 B.C.

Blackened oyster specimen, *Crassostrea virginica* (Gmelin), from beach. Two determinations, after removal of outer 10% of shell and after different-colored layers of shell were separated:

white layers of shell; mixed with dead gas for counting	3540 ± 140
black layers of shell; one 3-day count	3630 ± 130

GSC-635. West Light, oyster (unblackened) **5650 ± 140**
3700 B.C.

Unblackened oysters, *Crassostrea virginica* (Gmelin), from beach. Two determinations, after removal of outer 10% of shell:

outer fraction (21-55% leach), one 4-day count	5320 ± 140
inner fraction (56-100% leach), one 3-day count	5650 ± 140

GSC-699. West Light, bay scallop **1800 ± 130**
A.D. 150

Unblackened bay scallops (*Aequipecten irradians sablensis* Clarke) from beach. (One 3-day count.)

General Comment (A.H.C., Jr.): neither oysters nor bay scallops now live near Sable I.; nor do latter live in E Canada. However, shells are often found on beaches and surrounding Sable I. Bank. GSC-634 and 635 indicate that oysters lived at Sable I. during Hypsithermal. Presence of both taxa suggests lagoon or bay during approx. interval 5650 to 3550 yr B.P. and again from ca. 1800 to 1400 yr B.P. (cf. GX-73, 1430 ± 125, also on bay scallop; Clarke, 1965; R., 1966, v. 8, p. 146; Clarke *et al.*, 1967).

GSC-1395. Ingonish **40 ± 220**
A.D. 1910
$\delta C^{13} = -22.4‰$

Metapodial bone from Woodland Caribou (*Rangifer tarandus caribou*, id. by P. M. Youngman, Natl. Mus. Nat. Sci., Ottawa) excavated from 0.5 m thick forest peat filling kettles in hummocky ice contact gravel deposit 0.8 km W of Keltic Lodge, 1.6 km SE of Ingonish Center, Cape Breton Highlands Natl. Park, Nova Scotia (46° 39.2′ N Lat, 60° 23.7′ W Long), at alt ca. 23 m. Coll. 1969 by F. Seymour, Ingonish; subm. by P. M. Youngman. *Comment* (D.R. Grant): bone originally reported at 5 m depth; since species only became extinct in this century (P. M. Youngman, pers. commun.) a much greater age was possible. Date not surprising in view of shallow burial. Pretreatment of small sample (177 g) included 1-hr NaOH-leach. Sample mixed with dead gas for counting. (One 3-day count.)

Recent submergence series, Maritime Provinces (II)

Sedge peat from intertidal cliff sec. exposing 0 to 9 m salt marsh peat overlying thin layer of sedge peat and humus, with small bushes rooted in till, N bank of Maccan R. 1.6 km S of Amherst Point, Nova Scotia (45° 46.55′ N Lat, 64° 16.95′ W Long). These 4 samples of material known to have formed and been deposited at highest tide level, were chosen to obtain a more precise measure of recent changes of high-tide level in upper Bay of Fundy than was hitherto inferred from single determinations at numerous scattered localities. All depths below local level of Mean Higher High Water at large tides.

1800 ± 130
GSC-1076. Amherst Point, 3.8 m depth **A.D. 150**
$\delta C^{13} = -24.5‰$

1910 ± 130
GSC-1079. Amherst Point, 4.6 m depth **A.D. 40**
$\delta C^{13} = -24.4‰$

2750 ± 150
GSC-1073. Amherst Point, 6.9 m depth **800 B.C.**
$\delta C^{13} = -23.3‰$

2960 ± 130
GSC-1075. Amherst Point, 8.1 m depth **1010 B.C.**
$\delta C^{13} = -24.4‰$

General Comment (D.R.G.): high tide level was elev. by 4.3 m over an 1100 to 1200-yr period, confirming earlier indications that high tide has been rising throughout most of Bay of Fundy at average rate of ca. 30 cm/ century during last 4000 yr (Grant, 1970). (Note: data for GSC-992, 1260 ± 140, R., 1970, v. 12, p. 53, should have read "salt marsh peat at −9.8 ft overlying 8 *in*. . . .", not 26 ft [8 m]). NaOH-leach omitted from pretreatment of samples. GSC-1073 mixed with dead gas for counting; one 1-day count. GSC-1076 and GSC-1079 each based on one 3-day count; GSC-1075, one 5-day count.

60 ± 130
GSC-1288. Nictaux Falls **A.D. 1890**

Marine shells (2 valves of *Mya arenaria*) in gravel of railway borrow pit, E bank of Nictaux R. ca. 0.5 km NE of Nictaux Falls, Nova Scotia (45° 54.75′ N Lat, 65° 01.52′ W Long). Coll. 1923 by E. R. Faribault; subm. by D. R. Grant. *Comment* (D.R.G.): site is at alt 38 m, and geologic evidence suggests marine limit is <30 m; shells were dated in hope they would relate to retreat of late ice cap in S Nova Scotia (Prest and Grant, 1969) and fall of high postglacial sea. Date suggests shells represent remains of a clam bake. Sample mixed with dead gas for counting. (One 3-day count.)

3. Prince Edward Island

GSC-1421. Basin Head **130 ± 130**
A.D. 1820

Compressed humus layer (woody detritus, bark, twigs, fungi; M. Kuc, written commun.) in dune sand, 2.7 m below surface, exposed along tidal channel through barrier beach/dune complex just E of Basin Head, Prince Edward I. (46° 22.8′ N Lat, 62° 06.5′ W Long), at ca. 2 m above high tide level. Coll. 1967 by D. R. Grant. *Comment* (D.R.G.): humus, the lower of 2 organic horizons, is interpreted as buried soil, representing interruption of sand movement; similar to GSC-461 (210 ± 130; R., 1968, v. 10, p. 210) from Sable I., Nova Scotia. NaOH-leach omitted from sample pretreatment. (One 1-day count.)

4. New Brunswick

GSC-1340. Saint John **13,000 ± 170**
11,050 B.C.

Marine shells (mainly *Mya* sp., with *Balanus* sp., *Serripes groenlandicus, Macoma calcarea*) from ca. 9 m above high tide level in cliff face ca. 0.8 km W of Sheldon Point, W of Saint John, New Brunswick (45° 13′ 30″ N Lat, 66° 06′ 20″ W Long), *i.e.*, same locality as I(GSC)-7 (13,325 ± 500; R., 1961, v. 3, p. 50) and GSC-965 (13,200 ± 200; R., 1970, v. 12, p. 55). Red clay forming cliffs interdigitates with gravel. Coll. 1969 by N. R. Gadd. *Comment* (N.R.G.): deposit previously described as deltaic (glaciomarine?) is believed possibly a bar or spit developed on submerged moraine. Sample from higher level in marine sediment than those subm. by Lee and Welsted to show, if possible, time range of marine submergence. Though perhaps younger, date GSC-1340 overlaps previous determinations. (One 3-day count.)

5. Quebec

GSC-1018. New Richmond **12,200 ± 180**
10,250 B.C.

Marine shells (mainly *Mya truncata* and *Hiatella arctica*) exposed in cliff, N shore Chaleur Bay near New Richmond, Quebec (48° 10′ N Lat, 65° 52′ W Long), alt 0.6 m in 3 m thick gray-blue clay overlain by deltaic sand. Coll. 1967 by R. Héroux, Ministère des Terres et Forêts, Quebec. *Comment* (D.R. Grant): shells occur ca. 37 m below marine limit, but date approximates age of highest marine features (*i.e.*, deglaciation) because early postglacial fall of relative sea level is typically several m/per century. Also dates withdrawal of a late glacial lobe from Chaleur Bay (Prest and Grant, 1969). (One 4-day count in 2-L counter at 1 atm.)

12,600 ± 160
GSC-1186. Ruisseau-à-Rebours, Gaspé N. Co. 10,650 B.C.

Shells (*Mya truncata*) from ca. 1 m depth in sandy clay forming terraces in valley of Ruisseau-à-Rebours, Gaspé N. Co., Quebec (49° 13′ 20″ N Lat, 65° 56′ W Long), alt ca. 45 m. From rd. cut 0.4 km from Hwy 6. Pelecypods with joined valves *in situ* included *Mya truncata, Hiatella arctica,* and *Macoma calcarea*. Coll. 1965 by J. C. Dionne, Forest Research Lab., Dept. Forestry and Rural Development, Quebec. *Comment* (J.C.D.): maximum postglacial submergence of N coast Gaspé Peninsula near Mont-St-Pierre did not exceed 60 m. Date thought to refer to early submergence; it agrees with GSC-89; 12,940 ± 180, on Anticosti I. and GSC-102; 12,720 ± 170, at Trois-Pistoles (both in R., 1963, v. 5, p. 42.) (One 3-day count.)

9140 ± 200
GSC-1337. Moisie River 7190 B.C.

Whole shells and fragments of *Macoma calcarea*, id. by V. Condé, McGill Univ., from upper part of silty clay near QNS&L Railway tunnel 17.5 km E of Sept-Îles and 19.5 km N of mouth of Moisie R., Quebec (50° 18′ N Lat, 66° 12′ W Long), alt 76 m. Clay overlain by ca. 30 m sand deposited during marine regression. Coll. 1969 by L. Dredge, McGill Univ., Montreal. *Comments* (L.D.): date should approximate time of maximum marine submergence (alt 128 m) for Sept-Îles area; (W.B., Jr.): date is similar to I-3868, 9150 ± 150, (Sauvé and LaSalle, 1968) on *Balanus* sp., alt 64 m at Manic 2, Manicouagan R., 193 km SE. Sample small (7.2 g), so only outer 5% of shell removed by leaching. Sample mixed with dead gas for counting. (One 3-day count).

12,000 ± 160
GSC-1104. Saint-Donat, Rimouski Co. 10,050 B.C.

Shells (*Hiatella arctica*) *in situ* with joined valves, from 0.6 m depth in silty clay on bedrock, 0.6 km NW of Saint-Donat, Rimouski Co., Quebec (48° 30′ 30″ N Lat, 68° 16′ 10″ W Long), alt ca. 100 m, close to marine limit. Coll. 1965 by J. C. Dionne. *Comment* (J.C.D.): date is minimum for deglaciation and postglacial submergence of Mitis and Neigette Valleys. As it is younger than GSC-89, 12,940 ± 180, Anticosti I. and GSC-102, 12,720 ± 170, Trois-Pistoles (both in R., 1963, v. 5, p. 42) and GSC-1186, 12,600 ± 160 (this list), dead ice may have delayed marine invasion. (One 3-day count.)

9450 ± 150
GSC-1216. Bic, Rimouski Co. 7500 B.C.
$\delta C^{13} = +3.0‰$

Shells (*Mya pseudoarenaria*) from silty sand underlain by marine clay and overlain by beach sand and gravel at 1.5 m depth in rd. cut in terrace, near bridge crossing Bic R. on Hwy 6 (48° 22′ 35″ N Lat, 68° 42′ 25″ W Long), alt ca. 14 m. Shells with joined valves *in situ* from richly fossiliferous site. Coll. 1964 by J. C. Dionne. *Comment* (J.C.D.): maximum postglacial submergence of area did not exceed 100 m. If pelecypods were living on tidal flat, date indicates age of 15 ± 5 m level. GX-1492, 9864 ± 180, at same alt at St. Patrick (Rivière-du-Loup Co.), 113 km SW of Bic, is similar.

GSC-1137. St. Martin **>20,000**

Finely divided plant fragments in lake sediment sheared into till. Coll. 1968 by W. W. Shilts from excavation for foundation of St. Martin École Polyvalente, St. Martin, Quebec (45° 57.6′ N Lat, 70° 39.1′ W Long), at alt ca. 275 m. Sample from 3 m below original surface. *Comments* (W.W.S.): roots present to base of excavation; 46 g organic material concentrated from ca. 200 kg sediment. Sediment included in surface till and thought to correlate with widespread lake sediments underlying surface till in Chaudière River valley (Shilts, 1969; McDonald and Shilts, 1971); (W.B., Jr.): some bits of rootlets (?) or fibers (?) noticed in sample; all visible pieces removed by B. C. McDonald. NaOH-leach omitted from sample pretreatment. Sample mixed (high ratio) with dead gas for counting as 40 g of sample burned after acid treatment yielded only 1.6 cm CO_2. (One 3-day count.)

GSC-1084. Rivière Grande Coulée **>40,000**

Finely disseminated plant detritus and wood fragments up to 1 cm long, from 13 m depth in 1 of several secs. on Rivière Grande Coulée, 5.1 km SW of St. Martin, Quebec (45° 55.8′ N Lat, 70° 42.2′ W Long), at alt ca. 300 m. Enclosing sediment is medium- to coarse-grained, non-calcareous, orange-red, structureless sand; it underlies surface till and lake sediment and overlies till and fluvial gravel. Coll. 1967 and 1968 by W. W. Shilts; subm. by B. C. McDonald. *Comment* (W.W.S.): sediment thought to correlate with St. Pierre sediments on basis of pollen representing climate cooler than present (R. J. Mott, pers. commun.) and stratigraphic position (Shilts, 1969; McDonald and Shilts, 1971). NaOH-leach omitted from sample pretreatment. (One 3-day count.)

GSC-1176. Eaton River **260 ± 130**
A.D. 1690
$\delta C^{13} = -22.0‰$

Wood from borehole on right bank of Eaton R. ca. 400 m downstream from confluence with Clifton R., Quebec (45° 20′ N Lat, 71° 33′ W Long), alt ca. 260 m at collar of hole. Coll. 1968 by G. Simard, Ministère des Richesses Nat., Quebec; subm. by B. C. McDonald. *Comment* (B.C.M.): wood thought to derive from till unit at 10 m depth in hole; young age suggests it came from modern alluvium overlying till. (One 3-day count.)

GSC-1213. Normandin Dunes **7160 ± 140**
5210 B.C.
$\delta C^{13} = -26.5‰$

Sandy peat at 3.9 m depth from boring with Hiller peat sampler in interbedded eolian sand and peat in kettle on delta of former Laflamme Sea, 11.5 km W of Normandin, lac St-Jean area, Quebec (48°

51′ N Lat, 72° 41′ W Long), alt ca. 190 m. Sample from top of basal peat layer. Coll. 1968 by J. Lebuis; subm. by P. P. David, Univ. of Montreal, Montreal. *Comment* (J.L. and P.P.D.): date is minimum for formation of delta in Laflamme Sea at 190 m alt. Date is similar to I-3144, 7750 ± 135 (Lasalle, 1968; 1969), from basal peat at same alt elsewhere in area, but marine invasion occurred >9000 yr ago (Lasalle and Rondot, 1967). Also dates earliest period of dune formation in region (Lebuis, 1971). NaOH-leach omitted from sample pretreatment. (One 3-day count.)

Val St. Gilles series

Wood and peat exposed on flank of esker along W shore of Lac Bissonnette, 4.0 km NNE of Val St. Gilles and ca. 80 km N of Noranda, Quebec (49° 01′ N Lat, 79° 05′ W Long), at alt ca. 290 m.

5030 ± 130
GSC-585. Val St. Gilles, wood **3080 B.C.**

White pine wood (*Pinus strobus* L., id. by R. J. Mott) from log ca. 90 cm diam., under ca. 1.5 m peat. Coll. 1965 by F. Miron, Amos, Quebec; subm. by J. Terasmae, now at Brock Univ., St. Catharines, Ontario. *Comment* (J.T.): sample ca. 96 km N of present limit of white pine, indicating mid-Holocene northward extension of range of this species (Terasmae and Anderson, 1970). (One 3-day count.)

6460 ± 140
GSC-788. Val St. Gilles, peat **4510 B.C.**

Peat from base of 3 m thick sec. overlying stratified sand and gravel. Coll. 1966 by J. Terasmae. *Comment* (J.T.): date is minimum for drainage of Glacial Lake Barlow-Ojibway in area. NaOH-leach omitted from sample pretreatment. (One 3-day count.)

6. Ontario

McKay Lake series, Rockliffe

McKay Lake, at alt 44 m, is a small lake in re-entrant in limestone escarpment on S side of Ottawa R. in Village of Rockcliffe, Ontario (45° 27′ N Lat, 75° 40′ 15″ W Long). Clay deposited by Champlain Sea partly filled basin; lake formed following emergence of area from Champlain Sea and shifting of channels of ancestral Ottawa and/or Rideau Rivers. Coll. 1966 by R. H. McNeely, Queens Univ., Kingston (now at Brock Univ., St. Catharines, Ontario) and R. J. Mott.

8010 ± 180
GSC-621. McKay Lake, basal organic sediment **6060 B.C.**

Laminated, algal gyttja from 458 to 468 cm below mud/water interface in ca. 10.6 m water. *Comment* (R.J.M.): dates start of organic deposition in lake basin and is minimum for abandonment of depression as river channel; cf. GSC-546 (8830 ± 190), GSC-547 (8220 ± 150), and GSC-628 (7870 ± 160), all related to former channels of Ottawa R. (R., 1967, v. 9, p. 161-162). NaOH-leach omitted from sample pretreatment. Sample mixed with dead gas for counting. (One 3-day count.)

GSC-622. McKay Lake, surface ooze **1310 ± 160**
A.D. 640

Ca. 30 cm of dark gray to black ooze overlies normal gray to brown algal gyttja; sample from 25 to 29.5 cm depth below mud/water interface. *Comment* (R.J.M.): surficial dark ooze layer indicates major change in lake environment. NaOH-leach omitted from sample pretreatment. Sample mixed with dead gas for counting.

Roblin Lake series

Samples from Roblin Lake, 0.8 km S of Ameliasburg, Prince Edward Co., Ontario (44° 03′ N Lat, 77° 25′ W Long); alt of lake 109 m; water depth, 13.5 m. Samples coll. winter 1963 by J. Terasmae with Shelby-tube sampler, diam. 5 cm. Palynologic studies were made of core samples (Terasmae and Mirynech, 1964); cf. GSC-156 (7620 ± 170; R., 1964, v. 6, p. 169), was on gyttja from 860 cm below water-sediment interface; it coincided with lower part of a pollen zone in which percentages of hemlock (*Tsuga*), beech (*Fagus*) and elm (*Ulmus*) pollen increased significantly.

GSC-379. Roblin Lake, 220 cm **2120 ± 140**
170 B.C.

Gyttja from 220 cm depth below water-sediment interface. *Comment* (J.T.): dates beginning of late-Holocene rise of spruce pollen percentages in pollen diagram.

GSC-380. Roblin Lake, 480 cm **3330 ± 130**
1380 B.C.

Gyttja from 480 cm depth below water-sediment interface. *Comment* (J.T.): postdates upper boundary of mid-Holocene pollen zone characterized by abundant pine pollen.

GSC-925. Roblin Lake, 1024 to 1035 cm **10,500 ± 150**
8550 B.C.

Silty gyttja (and marl) from 1024 to 1035 cm depth below water-sediment interface. *Comment* (J.T.): dates upper part of zone in which spruce pollen is predominant.

GSC-890. Roblin Lake, 1070 to 1082 cm **10,700 ± 160**
8750 B.C.

Plant detritus in silt and fine sand at 1070 to 1082 cm depth below water-sediment interface. *Comment* (J.T.): dates boundary between zone in which spruce pollen is abundant and next older zone characterized by relative abundance of non-tree pollen. Date is also minimum for establishment of Roblin Lake after drainage of Glacial Lake Iroquois and beginning of deposition of organic sediments in this lake basin (Terasmae and Mirynech, 1964).

General Comment (W.B., Jr.): NaOH-leach omitted from pretreatment of all samples. Dates for GSC-380 and GSC-890 based on one 5-day count and one 4-day count, respectively.

GSC-816. Niagara Falls **22,800 ± 450**
20,850 B.C.

Wood fragments and twigs from 46 m depth in borehole in buried St. Davids gorge, ca. 90 m E of intersection of Whirlpool Rd., and Churches Lane, Niagara Falls, Ontario (43° 07′ 40″ N Lat, 79° 05′ W Long). Approx. alt of drilling site, 180 m. Coll. 1966 by J. Terasmae. *Comment* (J.T.): sample is from approx. middle of 21 m thick unit of stratified sand, silt, and clay. Pollen assemblages recovered from these sediments are characterized by spruce (*Picea*) pine (*Pinus*) and birch (*Betula*); with *Artemisia, Ambrosia,* Compositae, Gramineae, and Cyperaceae present in non-tree component. Cool (boreal) climate is inferred from palynologic evidence, and non-glacial interval is correlated with Plum Point interstadial of Lake Erie region (Hobson and Terasmae, 1969). Non-glacial sediments both underlain and overlain by ca. 30 m glacial deposits in buried gorge of ancient Niagara R. (One 3-day count.)

Cudia Park series, Scarborough

Organic detritus from lens in sand of Thorncliffe Formation, exposed in Scarborough Bluffs at Cudia Park, Ontario (43° 43′ 15″ N Lat, 79° 13′ 30″ W Long). Previous sample from same lens of organics, ca. 0.5 m above top of Early Wisconsin Sunnybrook Till, was 38,900 ± 1300 yr old (GSC-271; R., 1966, v. 8, p. 104).

GSC-534. Cudia Park, Scarborough (II) **48,800 ± 1400**
46,850 B.C.

Coll. 1965 by P. F. Karrow, Univ. of Waterloo, Waterloo, to check reproducibility of GSC-271, coll. 1964. *Comment* (P.F.K.): of 3 dates from same lens of organics, oldest date (GSC-1228, >53,000, this list) is presumed most nearly correct. Conflicting series suggests decreasing contamination farther in from face; GSC-1228 coll. 3 yr after GSC-534. Date as old as GSC-1228 is either due to contamination by reworking of older organic matter (abundant in Scarborough Formation lower in sec.) or to earlier retreat of Early Wisconsinan ice than presently assumed. Organics are stratigraphically of Port Talbot age. (Three 1-day counts in 5-L counter at 4 atm.)

GSC-1228. Cudia Park, Scarborough (III) **>53,000**

Coll. 1968 by A. A. Berti, Univ. of Western Ontario, London, to try to resolve difference between GSC-271 and -534. *Comment* (A.A.B.): macrofossil analysis yielded leaves of *Dryas integrifolia,* a tundra species, and of *Picea* and *Larix*; seeds of *Carex aquatilis, Viola, Potamogeton, Potentilla,* and *Polygonum* were also present, id. by A. A. Berti and by J. H. McAndrews, Royal Ontario Mus., Toronto. Average pollen count of 2 samples yielded (based on sum of trees and shrubs): *Picea* 29%, *Pinus* 60%, *Abies* 1%, *Betula* 1%, *Quercus* 2%, *Ulmus* 0.8%, and herbs 8.3% (mainly Cyperaceae and Gramineae). Macrofossils, particularly leaves, are probably primary and indicate that both forested and barren areas were present. Karrow and Terasmae's contention (Karrow, 1969) that organics are not reworked is supported, since fragile *Dryas* leaves have not been broken beyond recognition; thus, finite dates GSC-271 and GSC-534 probably were obtained on samples containing younger, secondary organic material. Age and stratigraphic position of GSC-1228 indicate this part of Thorncliffe Formation is older than Port Talbot II beds of Lake Erie basin (Dreimanis *et al.*, 1966; Dreimanis, 1969) and is younger than Early Wisconsin Bradtville Till of Lake Erie basin with which Sunnybrook Till is correlated. Pretreatment included *cold* NaOH-leach. (One 2-day and one 3-day count in 5-L counter at 4 atm.)

Scarborough Bluff series

Organic detritus exposed in unoxidized lacustrine silt and clayey silt in upper part of Thorncliffe Formation, Scarborough Bluffs, Toronto. Coll. 1968 (GSC-1082) and 1969 (GSC-1221) by A. A. Berti.

GSC-1082. Hi section **28,300 ± 600**
26,350 B.C.

Fine organic detritus from 1.3 cm thick, contorted, organic horizon exposed in Hi sec. (Karrow, 1967) (43° 41′ 7″ N Lat, 79° 13′ 38″ W Long), from 2.5 m above top of Meadowcliffe Till and ca. 10.5 m below base of Leaside Till. Pollen analysis yielded (based on sum of trees and shrubs): *Picea* 30%, *Pinus* 64%, *Larix* 1.7%, *Betula* 0.9%, and herbs 12.8% (mainly Cyperaceae and Gramineae). Macrofossil analysis yielded leaves of *Dryas integrifolia* (id. by J. H. McAndrews), a tundra species.

GSC-1221. Sunnypoint section **32,000 ± 690**
30,050 B.C.

Fine plant detritus from horizontally bedded lens of organic sediments ca. 8 cm thick and 1+ m in lateral extent, exposed in NW wall of E ravine of Sunnypoint sec. (Karrow, 1967) (43° 43′ 02″ N Lat, 79° 13′ 49″ W Long), ca. 270 m WSW of GSC-1082. Sample from ca. 2 m above top of Meadowcliffe Till. Pollen analysis yielded (based on sum of trees and shrubs): *Picea* 34%, *Pinus* 56%, *Larix* 1%, *Betula* 3%, *Quercus* 4%, and herbs 14% (mainly Cyperaceae). Macrofossil analysis yielded leaves of *Salix herbacea*, an arctic-alpine species, of *Vaccinium vitis-idaea*, a subarctic-boreal species, of *Dryas integrifolia*, a tundra species, and seeds of a wide-ranging sedge, *Carex aquatilis*.

General Comment (A.A.B.): dates record non-glacial interval in Lake Ontario basin ca. 30,000 yr B.P. Macrofossil data suggest treeless conditions, at least in part, for Toronto area at that time. Pollen studies are in progress to decide if dates are contemporaneous or if ice-free interval of ca. 4000 yr duration occurred. Dates support Karrow's (1967) assignment of Leaside Till to Late Wisconsin, but Meadowcliffe Till apparently is Mid-Wisconsin. Dates are slightly older than, but probably belong to, Plum Point Interstade (Dreimanis *et al.*, 1966) of Lake Erie basin. NaOH-leach omitted from pretreatment of both samples. GSC-1082 mixed with dead gas for counting. Dates for GSC-1082 and GSC-1221 based on one 3-day count and one 2-day count, respectively.

North Bay series

Dates based on gyttja from basal organic sediments of small lake basins near North Bay, Ontario, in lowland forming present divide between Lake Nipissing and headwaters of Mattawa R. Samples provide chronologic data on stabilization and subsequent cessation of Upper Great Lakes drainage via North Bay outlet into Ottawa Valley system. Coll. 1966 by C. F. M. Lewis and J. Terasmae with a Livingstone piston corer from deepest water area in each lake. Most dated samples are composites taken from equivalent stratigraphic levels in 2 or more replicate cores. Elevations of lake surfaces were determined by spirit leveling and are given relative to Canadian Geodetic Datum.

8200 ± 160
GSC-815. Dreany Lake **6250 B.C.**

Gyttja from lowermost 6 cm of 6.8 m-thick organic sediment sequence in Dreany Lake, alt 213.5 m, water depth 3.3 m (46° 17′ 26″ N Lat, 79° 21′ 45″ W Long), ca. 4.5 km E of junction of Hwys. 11 and 17. Sample overlay, in turn, 1 cm silty clay, 3 cm medium-grained sand, and stratified fine-grained sand.

8320 ± 170
GSC-821. Lake 'N' **6370 B.C.**

Gyttja from lowermost 5 cm of 4.0 m-thick organic sediment sequence in Lake 'N', alt 211.8 m, water depth 0.6 m (46° 17′ 23″ N Lat, 79° 20′ 06″ W Long), 2.4 km E of junction of Hwys. 11 and 17. Sample overlay, successively, 20 cm silty sand with scattered plant fibers, 8 cm laminated silt and clay, 9 cm sorted fine- and medium-grained sand, 76 cm laminated silt and clay, and varved silty clay.

4580 ± 160
GSC-828. Lake 'G' **2630 B.C.**

Gyttja from lowermost 6 cm of 2.1 m-thick organic sediment sequence in Lake 'G', alt 206.8 m, water depth 5.4 m (46° 18′ 21″ N Lat, 79° 24′ 10″ W Long), 2.4 km E of junction of Hwys. 11 and 17. Sample overlay 18 cm silt with minor gyttja and 10 cm sorted medium-grained sand, over stratified silty sand.

4430 ± 160
GSC-808. Delaney Lake **2480 B.C.**

Gyttja from lowermost 6 cm of 1.5 m-thick organic sediment sequence in Delaney Lake, alt 204.6 m, water depth 4.8 m (46° 18′ 58″ N Lat, 79° 25′ 51″ W Long), 0.8 km NE of Ontario Northland Railway crossing over Hwys. 11 and 17. Sample overlay 24 cm massive silt above sorted fine- to medium-grained sand.

GSC-843. Lake 'H' **4640 ± 160**
2690 B.C.

Gyttja from lowermost 7 cm of 4.4 m-thick organic sediment sequence in Lake 'H', alt 204.2 m, water depth 4.3 m (46° 18′ 04″ N Lat, 79° 24′ 00″ W Long), 2.5 km E of junction of Hwys. 11 and 17. Sample overlay 19 cm clayey silt above sorted fine- to medium-grained sand.

GSC-836. West Jennings Lake **4650 ± 200**
2700 B.C.

Gyttja from lowermost 12 cm of 2.8 m-thick organic sediment sequence in West Jennings Lake, alt 202.2 m, water depth 7.1 m (46° 17′ 54″ N Lat, 79° 25′ 48″ W Long) on W side of Hwy. 11, 0.8 km S of junction of Hwys. 11 and 17. Sample overlay 23 cm silty sand with scattered plant fragments above pebbly sorted medium-grained sand.

GSC-850. Depensier Lake **4490 ± 180**
2540 B.C.

Gyttja from lowermost 6 cm of 2.4 m-thick organic sediment sequence in Depensier Lake, alt 202.3 m, water depth 9 m (46° 18′ 38″ N Lat, 79° 25′ 03″ W Long), 1.9 km E of Ontario Northland Railway crossing over Hwys. 11 and 17. Sample overlay clayey silt.

General Comment (C.F.M.L.): channels holding lake basins functioned, in part, as controlling thresholds for E drainage from early postglacial lakes in Nipissing and Georgian Bay Basins. During this period, water levels were stabilized at Nipissing beach level, here ca. 212 m a.s.l. Dates GSC-815 and -821, on basal gyttja from lakes at, or slightly above, this elevation, indicate that ice retreat and channel downcutting were essentially complete and drainage was stabilized prior to ca. 8300 B.P. All other sites lie in channel bottoms 5 to 10 m below Nipissing beach level; dates on basal organic material in them are minimum for last use of North Bay outlet or close of Nipissing I (3-outlet) phase (Lewis, 1969). NaOH-leach omitted from pretreatment of all samples; all were mixed with dead gas for counting. Date GSC-808 based on one 3-day count.

Montreal River series

Exploratory drilling at site of Ontario Hydro-Electric Comm. Lower Notch dam on Montreal R., Ontario (47° 08′ 30″ N Lat, 79° 28′ 25″ W Long) revealed a thick valley-fill sequence of river alluvium over compact stony gray till over organic sand and silt, and gravel. Date GSC-920 on organic fragments recovered during drilling was apparently spurious, so organic unit was resampled during excavation for dam.

GSC-920. Montreal River (I) **19,800 ± 1060**
17,850 B.C.

Fine organic detritus from layers in sand, recovered from borehole, sample alt ca. 170 m, 34.9 to 35.2 m below surface. Coll. 1967 by H. G. Acres Ltd., Niagara Falls; subm. by J. S. Scott.

GSC-1299. Montreal River (II) **>42,000**

Waterworn wood (*Picea* sp., id by R. J. Mott) from sand and silt unit at alt ca. 182 m, 23 m below original surface. Coll. 1969 by J. S. Scott and R. G. Skinner.

General Comments (R.G.S.): GSC-920 is improbable as ice margin was then in N part of U.S. (Goldthwait *et al.*, 1965). Gyttja clasts with GSC-1299 contained many deciduous pollen including 30% *Quercus* and 6% *Tilia* (Skinner, 1971). Organic material is probably interglacial, but time of burial at Lower Notch is unknown; (W.B., Jr.): filaments and fibers, possibly of textile origin, were noted in GSC-920; although visible ones were removed by hand, remaining small sample (6.0 g, including some sand) may have been contaminated also. GSC-920 mixed with dead gas for counting. (One 3-day count.)

Woodbridge series

Plant detritus and wood fragments from sites near Woodbridge, Ontario.

GSC-629-2. Woodbridge (I) **40,200 ± 480**
38,250 B.C.

Peaty sand and wood from gully eroded in floor of borrow pit, S of CNR bypass, N of Steeles Ave., W of Kysling Ave., near Woodbridge, Ontario (43° 46′ N Lat, 79° 36′ W Long). Borrow pit excavated to ca. 6 m depth in 1962, gully cut in 1965. Site wet but nearly free of vegetation and coll. of peaty layer made away from modern grass, etc. Peat occurs in depression in clayey Sunnybrook till and is overlain, successively, by gravel and 3 tills. Coll. 1966 by P. F. Karrow. Two determinations were made:

GSC-629.	One 3-day count in 5-L counter at 1 atm	>41,000
GSC-629-2.	One 4-day count and one 1-day count in 5-L counter at 4 atm	40,200 ± 480

Comment (W.B., Jr.): as noted previously (Table 3, R., 1970, v. 12, p. 48) GSC-629 was prepared from wood only, whereas GSC-629-2 was prepared from wood plus plant detritus; presence of material younger than wood could account for high counter-pressure age appearing younger than low counter-pressure age. For Woodbridge dates it must be remembered that: 1) only 0.1% contamination of 45,000 yr-old material (cf. GSC-1181, this list) with contemporary carbon would cause an error in age of 2000 yr, and 1% contamination would cause an error of 10,000 yr (Olsson and Blake, 1962); 2) numerous dates show that mid-Wisconsin Port Talbot interstade was of at least 10,000 yr duration (cf. Dreimanis *et al.*, 1966; McDonald, 1971), hence at any site material of varying age may occur. For either or both reasons slight variation between GSC-629-2 and GSC-1181 is not surprising.

GSC-1181. Woodbridge (II) **45,000 ± 900**
43,050 B.C.

Organic sediments, wood fragments, and peat in silt underlying gravel, exposed few cm below surface of borrow pit, ca. 200 m N of Steeles Ave. and ca. 1.6 km S of Woodbridge, Ontario (43° 45′ 39″ N Lat, 79° 35′ 30″ W Long). Borrow pit last operated in 1963; original ground surface est. 5 to 6 m higher than at time of sampling. Coll. 1965 by O. L. White, Univ. of Waterloo, Waterloo, ca. 2 m from site where a partial molar of woolly mammoth (*Elephas* [*Mammuthus*] *primigenius*) was recovered (Churcher, 1968); material believed to be same as that enclosing tooth. Organic material, silt, and overlying gravel appear to fill channels cut in underlying till (Sunnybrook) (cf. White, 1964; Dreimanis and Karrow, 1965). From relation to exposed sec. ca. 150 m N, channel deposits are thought overlain by 3 tills. Some sheet and gully erosion occurred in 2-yr interval between excavation of pit and coll. of sample, but little plant growth developed on surface and sample believed uncontaminated. *Comment* (P.F.K.): date accepted for Thorncliffe Formation and believed better than GSC-629 or GSC-629-2 as GSC-1181 coll. earlier, thus less new plant growth developed in borrow pit. Date confirms assignment of organic to Port Talbot interstade and agrees closely with GrN-4454, 44,600 ± 190, on presumed correlative material from Markham, Ontario (cf. Karrow, 1969). (One 1-day count and one 3-day count in 5-L counter at 4 atm.)

GSC-729. Woodbridge (III) **>49,000**

Plant detritus enclosed in sand and silt from railway cut along N side of CNR tracks, W of Humber R. near Woodbridge, Ontario (43° 45′ 50″ N Lat, 79° 35′ 30″ W Long). Sampled unit overlain by 4 lithologically distinct till sheets, underlain by sand, gravel, and York Till (Illinoian). Coll. 1966 by A. Dreimanis and A. A. Berti, Univ. of Western Ontario, London, and J. Terasmae. *Comment* (J.T.): previous date, >49,700 yr (GSC-203; R., 1965, v. 7, p. 29, incorrectly given as GSC-230 in Karrow, 1969, p. 9) was from base of sampled unit; present sample taken from top of 5 m-thick unit to check possibility of mid-Wisconsin age for these plant-bearing beds (*i.e.*, Port Talbot interstade; cf. Dreimanis *et al.*, 1966). Both dates indicate that beds are equivalent to Scarborough Formation of Toronto area, a conclusion supported by pollen assemblages found in this unit. (One 1-day count and one 3-day count in 5-L counter at 4 atm.)

Manitoulin District series

The following dates on gyttja, coarse plant detritus and stump wood provide a recent history of Manitoulin Dist. emergence from Lake Huron. Gyttja was cored from deepest water of small lakes. Lake sediment samples GSC-558, -559, and -904 coll. with a plastic tube push corer and GSC-568 and -569 taken 1965 with a Hiller peat borer by C. F. M. Lewis and J. Terasmae. All other gyttja samples coll. 1967 by C. F. M. Lewis using a Livingstone piston corer. Most gyttja samples are composites from equivalent stratigraphic levels in 2 or more replicate cores. Elevations of lake water levels and sub-aerial samples determined by spirit levelling, relative to Canadian Geodetic Datum.

GSC-558. Sucker Creek **4350 ± 170**
2400 B.C.

Gyttja from lowermost 15 cm of 1.7 m-thick organic sediment sequence in small lake, alt 193.1 m, water depth 0.3 m, in shallow bedrock depression within Sucker Creek Indian Reserve, 5.6 km SW of Little Current, Ontario (45° 57′ 48″ N Lat, 81° 59′ 28″ W Long). Sample overlay pebbly (limestone) fine- to medium-grained gray sand.

GSC-569. 'Upper Wikwemikongsing' Lake, 2.5 m **3850 ± 160**
1900 B.C.

Coarse detritus gyttja from lowermost 8 cm of 2.0 m-thick organic sediment sequence in 'Upper Wikwemikongsing' Lake, alt 194.7 m, water depth 0.5 m (45° 42′ 04″ N Lat, 81° 41′ 08″ W Long). Lake in depression behind Nipissing gravel bar. Sample overlay shelly lacustrine silty gray clay.

GSC-568. 'Upper Wikwemikongsing' Lake, 3.5 m **5560 ± 190**
3610 B.C.

Fine detritus gyttja from uppermost 8 cm of a lower organic sediment unit underlying 1.0 m of shelly lacustrine silty clay below 2.0 m coarse detritus gyttja, at same location as GSC-569.

GSC-904. 'Lower Wikemikongsing' Lake, 0.7 m **510 ± 180**
A.D. 1440

Silty plant detritus from basal 4 cm of 33 cm-thick organic sediment sequence in 'Lower Wikwemikongsing' Lake, alt 178.0 m, water depth 40 cm (45° 42′ 38″ N Lat, 81° 39′ 48″ W Long), a small lake impounded behind sand bar and beach N of James Bay, Lake Huron. Sample overlay gray silty fine sand. Lake bottom is 50% covered by *Chara* sp.

GSC-559. 'Lower Wikwemikongsing' Lake, 2.0 m **5820 ± 180**
3870 B.C.

Coarse plant detritus from a 2 cm-thick organic unit imbedded in gray silty sand unit at previous (GSC-904) sample site 202 cm beneath lake surface.

GSC-1103. Deer Lake **5770 ± 140**
3820 B.C.
$\delta C^{13} = -25.9‰$

Sandy gyttja and detrital wood fragments from lowermost 5 cm of 2.8 m-thick organic sediment sequence in Deer Lake, alt 196.4 m, water depth 0.3 m (45° 38′ 54″ N Lat, 82° 17′ 44″ W Long). Sample overlay silty sand. Deer Lake basin is impounded by a baymouth bar of Nipissing Great Lakes.

1500 ± 160
GSC-1105. 'Rutherford' Lake **A.D. 450**
$\delta C^{13} = -25.0‰$

Sandy gyttja from basal 10 cm of 1.1 m-thick organic sediment sequence in 'Rutherford' Lake, alt 181.4 m, water depth 1.8 m (45° 59′ 30″ N Lat, 81° 29′ 02″ W Long), ca. 5.8 km NE of Killarney, Ontario beside Hwy 637. Sample overlay hard silt.

1660 ± 150
GSC-1106. 'Lower Dean Bay' Lake **A.D. 290**
$\delta C^{13} = -25.6‰$

Sandy gyttja from basal 3 cm of 36 cm-thick organic sediment sequence in 'Lower Dean Bay' Lake, alt 182.9 m, water depth 1.0 m (45° 41′ 30″ N Lat, 82° 19′ 17″ W Long). Sample overlay pebbly coarse sand. Lake is impounded between sand and shingle beach berms of recently emerged coast.

2690 ± 170
GSC-1107. 'Upper Dean Bay' Lake **740 B.C.**
$\delta C^{13} = -26.6‰$

Sandy gyttja and plant detritus from lowermost 3 cm of 80 cm-thick organic sediment sequence in 'Upper Dean Bay' Lake, alt 186.8 m, water depth 35 cm (45° 41′ 47″ N Lat, 82° 18′ 42″ W Long). Sample overlay pebbly coarse sand. Lake is enclosed between sand and shingle beach berms of recently emerged coast.

10,150 ± 190
GSC-1108. 'Tehkummah' Lake **8200 B.C.**
$\delta C^{13} = -22.1‰$

Silty gyttja from basal 5 cm of 7.4 m-thick organic sediment sequence in 'Tehkummah' Lake, alt 191.7 m, water depth 0.4 m (45° 35′ 58″ N Lat, 81° 59′ 56″ W Long), ca. 7 km NE of South Baymouth. Sample overlay gray silt.

4740 ± 140
GSC-1109. Smokey Hollow Lake **2790 B.C.**
$\delta C^{13} = -25.3‰$

Silty gyttja from basal 10 cm of 3.6 m-thick upper organic sediment sequence in Smokey Hollow Lake, alt 192.7 m, water depth 1.5 m (45° 38′ 04″ N Lat, 82° 04′ 18″ W Long), 4.5 km N of Michael Bay. Sample overlay 2.7 m shelly silt over 0.5 m coarse plant detritus over silty sand. Dates on top (6270 ± 190, I-4037) and bottom (9130 ± 140, I-4036) of lower plant detritus unit are discussed in Lewis (1969).

5530 ± 130
GSC-869. Britainville **3580 B.C.**

Piece of root (*Larix* sp., id. by R. J. Mott) from stump *in situ* on surface of compressed peat and leaf debris ca. 2 km S of Britainville, Ontario, alt 193.9 m (45° 43′ 07″ N Lat, 82° 23′ 50″ W Long). Peat and stump overlain by 3 m stratified sand in a Nipissing Great Lakes baymouth bar, mantled with eolian fine sand. Peat, 1 m thick, is underlain by a sticky gray lacustrine clay containing scattered mollusk shells.

GSC-1102. Dominion Bay **190 ± 130**
A.D. 1760
$\delta C^{13} = -26.2‰$

Plant detritus from 1 cm-thick seam, 108 cm below crest of sandy modern storm beach berm at Dominion Bay, S coast of Manitoulin I., alt 177.4 m (45° 42′ 24″ N Lat, 82° 25′ 14″ W Long). Plant detritus overlies pebbles and cobbles of thin lag deposit developed on eroded surface of underlying till.

General Comment (C.F.M.L.): GSC-1108 and -568 date range, ca. 10,000 to 5500 yr B.P., for emergence of Manitoulin I., establishment of low lake levels, and subsequent rise of Huron Basin waters to Nipissing shoreline during Algonquin to Nipissing interval (Lewis, 1969). GSC-869 and -1103 are intimately related to shore features of Nipissing Great Lakes and provide a good estimate, 5400 to 5900 yr B.P., for maximum transgression of this lake phase in Huron Basin. Remaining dates indicate uniform uplift for Manitoulin I., relative to Lake Huron outlet area at Sarnia, Ontario, of 2.8 ± 0.8 mm/yr during past 5000 radiocarbon yr (Lewis, 1970). NaOH-leach omitted from pretreatment of all samples except GSC-559 and -869. All samples mixed with dead gas for counting except GSC-869, -1102, and -1103. Dates GSC-559, -568, -869, -1103, -1108, and -1109 each based on one 3-day count.

GSC-1185. Albany River **>54,000**

Compressed peat interstratified with "blue" clay from 7.5 m below surface in river-bank exposure on island in Albany R., Ontario (51° 57′ 20″ N Lat, 82° 32′ 00″ W Long), alt ca. 35 m. Peat overlain by 4.5 m of "blue" clayey till, and underlain by at least 4 m of dark brown-black till. Coll. 1968 by R. G. Wilkins, Ontario Water Resources Comm., Toronto; subm. by B. C. McDonald. *Comment* (B.C.M.): peat believed correlative with Quaternary Missinaibi beds, exposed in many places in Hudson Bay Lowland, for which only infinite dates are available (McDonald, 1969; 1971). Pretreatment included *cold* NaOH-leach. (One 1-day count and one 3-day count in 5-L counter at 4 atm.)

B. Western Canada

1. Manitoba

Churchill series

Marine pelecypod shells and peat from near Churchill, Manitoba. GSC-682, -683, -684, -685, -723, -735 on samples coll. 1966 by B. G. Craig from various alts to determine late postglacial rate of isostatic readjustment; all but GSC-735 on *Mytilus edulis* in beach sediments.

3080 ± 130
GSC-245. Churchill, peat **1130 B.C.**

Peat from base of shallow muskeg, overlying alluvial sand and gravel and marine sediments, right bank of Churchill R., near CNR tracks, W of airport and S of town site (ca. 58° 45′ 10″ N Lat, 94° 08′ W Long), alt ca. 4.5 to 5 m. Coll. 1948 by N. W. Radforth, McMaster Univ., Hamilton, now at Univ. of New Brunswick, Fredericton; subm. by J. Terasmae.

3040 ± 130
GSC-261. Churchill, *Mytilus edulis*, 23 m **1090 B.C.**

Whole shells and fragments from gravel and sand, W side of airport (ca. 58° 44′ 30″ N Lat, 94° 04′ 50″ W Long), alt ca. 23 m. Coll. 1948 by E. B. Owen; subm. by J. G. Fyles.

3180 ± 140
GSC-685. Churchill, *Mytilus edulis*, 38.5 m **1230 B.C.**

From gravel in ditch, between Twin Lakes, 26.7 km SE of CNR sta. (58° 37′ 08″ N Lat, 93° 48′ 40″ W Long), alt 38.5 m.

2320 ± 130
GSC-683. Churchill, *Mytilus edulis*, 27 m **370 B.C.**

From sandy gravel in ditch, Twin Lakes rd., 20.3 km ESE of CNR sta. (58° 42′ 10″ N Lat, 93° 50′ 35″ W Long), alt 27 m.

2120 ± 130
GSC-723. Churchill, *Mytilus edulis*, 22 m **170 B.C.**

From sand in gravel pit, Rocket Range rd., 10.9 km E of CNR sta. (58° 45′ 25″ N Lat, 93° 58′ 50″ W Long), alt 22 m.

1240 ± 130
GSC-682. Churchill, *Mytilus edulis*, 10.5 m **A.D. 710**

From gravel in ditch, Rocket Range rd., 19.5 km E of CNR sta. (58° 44′ 45″ N Lat, 93° 50′ 25″ W Long), alt 10.5 m.

1020 ± 140
GSC-684. Churchill, *Mytilus edulis*, 6.5 m **A.D. 930**

From pebbly sand in pit, Rocket Range rd., 13 km E of CNR sta. (58° 45′ 35″ N Lat, 93° 57′ 00″ W Long), alt 6.5 m.

3430 ± 140
GSC-735. Churchill, shells, 4.6 m **1480 B.C.**

Fragments of marine shells (*Chlamys islandicus, Astarte banksii, Clinocardium ciliatum, Mytilus edulis, Hiatella arctica, Mya* sp., *Hemithyris psittacea,* and *Balanus* sp.) from channel in stony silty clay dug in river bed, mouth of Goose Creek, Churchill R., 10.6 km SE of CNR sta. (58° 40′ 15″ N Lat, 94° 10′ 12″ W Long), alt 4.6 m.

GSC-1226. Cape Churchill, *Mytilus edulis*, 0 m **0 ± 130**
A.D. 1950
$\delta C^{13} = +1.9‰$

From bottom in intertidal zone Cape Churchill, 58 km E of Churchill, Manitoba (58° 45′ N Lat, 93° 12′ W Long), alt 0 m. Coll. 1967 by B. G. Craig.

General Comment (B.G.C.): 5 dates on *Mytilus edulis* shells from emerged strandline sediments, GSC-685,- 683, -723, -682, and -684, plus GX-1065, 2800 ± 110, alt 38 m (Wagner, 1967) indicate that for period ca. 3000 to 1000 yr ago land around Churchill rose relative to sea at rate of ca. 1.5 m/100 yr (Craig, 1969). GSC-245, -261, and -735 are anomalous, and may represent deposition in deep water, redeposition of older material, or a mixture of materials of various ages. GSC-1226 confirms modern age of recently living shells (some still attached). GSC-685 and -735 each mixed with dead gas for counting; one 3-day count each. (GSC-682, -683, and -1226 each based on one 3-day count.)

GSC-1319. Rossendale **12,100 ± 160**
10,150 B.C.

Peat moss (*Scorpidium scorpioides*, id. by M. Kuc), S side of reservoir 3.2 km S and 1.6 km E of Rossendale, Manitoba (in E-W rd. allowance, SW ¼, sec. 23, tp. 9, rge. 9, W Prin. Mer. (49° 47.0′ N Lat, 98° 35.6′ W Long), at alt 320 ± 2 m. Sample near W end and 0.3 to 0.6 m below surface on crest of spoil pile made during excavation of reservoir in 1952. Coll. 1969 by J. A. Elson, McGill Univ., Montreal. *Comment* (J.A.E.): sample is duplicate of Y-165, 12,400 ± 420 (Preston *et al.*, 1955), coll. 1952 by Elson and considered too old. Peat on spoil pile is from bottom of reservoir ca. 4 m deep, already filled with water when first visited, a few days after completion. An auger hole just W of reservoir penetrated ca. 1.5 m sandy and silty alluvium, overlying ca. 2 m clay with fragments of wood, charcoal, and snail shells near base, 0.6 m sandy clay, and 0.2 m fine brown sand similar to that assoc. with peat on spoil pile; ingress of water prevented further boring. Peat is typical of subarctic and N parts of Boreal Forest and grows in shallow, trophic, still, rather small ponds surrounded by bogs or fens, but not by forest (M. Kuc, written commun.). Peat accumulated in a gully formed in Assiniboine delta during an early low-water phase of Lake Agassiz (Elson, 1967). Gully was subsequently submerged during a higher stand of lake, possibly at Norcross strandline, and was exposed again as lake receded. Upper part of gully system was later captured by a small tributary of Assiniboine R.; lower part was blocked by sand dunes formed along Campbell strandline. Date confirms Y-165 and supports concept of early extensive phase of Lake Agassiz while stagnant ice existed on plains to W and S. Additional support is given by date I-1682, 12,800 ± 350, on basal gyttja (9.8 m depth) in lake in Tiger Hills 64 km to SW (Ritchie and Lichti-Federovich, 1968).

Brookdale Road series

Humus-rich sand from Ah horizon of 5 buried Chernozem soils exposed in roadcut through N wing of stabilized dune of Brandon Sand Hills along rd. (W side) to Brookdale, 2.56 km N of Trans-Canada Hwy ca. 8 km ENE of Douglas Sta., Manitoba (49° 55′ 30″ N Lat, 99° 35′ 25″ W Long). Paleosols separated by beds of humus-free sands occur in ca. 2.8 m of dune sand overlying sediments of Assiniboine delta of Lake Agassiz (Elson, 1960). Samples coll. 1967 by P. P. David, Univ. of Montreal, Montreal (except GSC-1091, coll. 1968 by L. A. Jaskula, Carleton Univ., Ottawa) to date Holocene eolian activity and to trace past periods of drought.

430 ± 130
GSC-1091. Brookdale Road, 0.52 m depth **A.D. 1520**
$\delta C^{13} = -19.3‰$

Date uncorrected for isotopic fractionation: 340 ± 130.

920 ± 140
GSC-954. Brookdale Road, 0.73 m depth **A.D. 1030**
$\delta C^{13} = -18.4‰$

Uncorrected date: 820 ± 140.

1510 ± 150
GSC-953. Brookdale Road, 1.28 m depth **A.D. 440**
$\delta C^{13} = -22.9‰$

Uncorrected date: 1480 ± 150.

2150 ± 150
GSC-950. Brookdale Road, 1.82 m depth **200 B.C.**
$\delta C^{13} = -22.9‰$

Uncorrected date: 2120 ± 150.

3680 ± 180
GSC-949. Brookdale Road, 2.35 m depth **1730 B.C.**
$\delta C^{13} = -27.0‰$

Uncorrected date: 3710 ± 180.

General Comment (P.P.D.): humic matter extracted by flotation in distilled water, from sandy soil previously cleaned of plant roots under binocular microscope, and excess water evaporated in porcelain dish over bunsen flame producing dry crust of humic concentrate. Each date corrected for isotopic fractionation (cf. R., 1970, v. 12, p. 50; Campbell *et al.*, 1967a; Ruhe, 1969). Uncorrected dates are given because they are used in correlation with other uncorrected dates (David, ms. in preparation; Ritchie, 1969). Samples not chemically pretreated prior to dating; consequently dates represent mean residence time (M.R.T.) of total soil humus of sampled soil layer at time of soil burial (Campbell *et al.*, 1967b). Dates may be slightly older than soil burial; but since all samples, except GSC-949 (5 cm below top of paleosol), were from upper 2 to 3 cm of paleosols, age discrepancy should be small (R., 1968, v. 10, p. 10-11). Soils were buried by subsequent dune activity produced by extended periods of drought (David, 1971). GSC-954 agrees with GSC-976 (this list) and S-286 (R., 1968, v. 10, p. 372); GSC-953 with GSC-761 (R., 1968, v. 10, p. 219) and S-45 (R., 1960, v. 2, p. 80). GSC-950 overlaps with GSC-817 and -969 (this list) and GSC-579 (R., 1967, v. 9, p. 166); however, it dates younger episode of dune building (cf. comments for Harte Road series, below). NaOH-leach omitted from pretreatment of all samples. GSC-954, -953, -950 and -949 mixed with dead gas for counting. (GSC-1091, -954 and -949 each based on one 3-day count.)

Harte Road series

Humus-rich sandy matter from Ah horizon of 2 of 3 buried Chernozem soils exposed in 2 roadcuts through same wing of stabilized dune of Brandon Sand Hills, along opposite sides of road to Harte, Manitoba, 0.88 km N of Trans-Canada Hwy 8 km W of junction with Hwy 258 S to Carberry, Manitoba (49° 54′ 35″ N Lat, 99° 28′ 35″ W Long). GSC-817 coll. 1966, others coll. 1967 by P. P. David.

890 ± 130
GSC-976. Harte Road, 1.3 m depth **A.D. 1060**
$\delta C^{13} = -21.7‰$

Uncorrected date: 830 ± 130. From W roadcut. (One 3-day count.)

2530 ± 140
GSC-981. Harte Road, 2.65 m depth **580 B.C.**
$\delta C^{13} = -21.8‰$

Uncorrected date: 2480 ± 140. From W roadcut.

2320 ± 160
GSC-817. Harte Road, 2.13 m depth **370 B.C.**

From E roadcut.

General Comment (P.P.D.): preparation of GSC-976 and -981 same as for Brookdale Road series (above). GSC-817 based on bulk soil sample cleaned of plant roots. GSC-981 and -817, from stratigraphically same paleosol on opposite sides of road, closely agree. GSC-981 considered more reliable as contamination by humus from younger paleosol (not dated) directly overlying -817 may have rendered latter somewhat younger (R., 1968, v. 10, p. 10). Overlap of GSC-817 (uncorrected date only) with GSC-950 (above) does not indicate age agreement since uncontaminated -981 is beyond age range of -950. GSC-976 agrees with GSC-954 (this list) and S-286 (R., 1968, v. 10, p. 372). GSC-981 and -817 agree with GSC-969 (this list), GSC-579 (R., 1967, v. 9, p. 166) and S-284 or -285 (R., 1968, v. 10, p. 372). Soils buried by subsequent dune activities produced by extended periods of drought. NaOH-leach omitted from pretreatment of GSC-976 and -981; pretreatment of GSC-817 included *cold* NaOH-leach. All samples mixed with dead gas for counting.

Carberry S series

Humus-rich sandy matter from Ah horizon of 2 buried Chernozem soils exposed in roadcut through stabilized dune of Brandon Sand Hills, E side of Hwy 258 ca. 7.36 km S of Carberry, Manitoba (49° 47′ 25″ N Lat, 99° 21′ 00″ W Long). Coll. 1967 by P. P. David.

GSC-970. Carberry S, 2.99 m depth **1910 ± 130**
A.D. 40
$\delta C^{13} = -21.5‰$

Uncorrected date: 1860 ± 130.

GSC-969. Carberry S, 3.20 m depth **2420 ± 140**
470 B.C.
$\delta C^{13} = -21.0‰$

Uncorrected date: 2350 ± 140. From top of lower, composite soil.

General Comment (P.P.D.): sample preparation same as for Brookdale Road series (this list). Paleosols are separated by thin sand layers; contamination of GSC-969, by humus from younger paleosol, may have rendered it younger than true age of burial (R., 1968, v. 10, p. 10). GSC-969 agrees with GSC-817 and -981 (this list), GSC-579 (R., 1967, v. 9, p. 166) and S-284 or S-285 (R., 1968, v. 10, p. 372). GSC-970 agrees with GSC-898 (R., 1970, v. 12, p. 67) and S-164 (R., 1965, v. 7, p. 230). Both soils buried by renewed eolian activity. NaOH-leach omitted from pretreatment of both samples; both mixed with dead gas for counting.

Carberry NE series

Humus-rich sandy matter with finely dispersed charcoal from Ah horizon of upper of 2 paleosols, and bones (*Bison* sp., id. by C. R. Harington, Natl. Mus. Nat. Sci., Ottawa) overlying upper paleosol exposed in roadcut through stabilized dune of Brandon Sand Hills, along N side of Trans-Canada Hwy 7.2 km E of junction with Hwy 258 S to Carberry, Manitoba (49° 54′ 05″ N Lat, 99° 15′ 30″ W Long). Coll. 1967 by P. P. David.

GSC-990. Carberry NE, bones **1260 ± 130**
A.D. 690
$\delta C^{13} = -19.1‰$

Uncorrected date: 1170 ± 130. Used 3 vertebrae (357 g) from dune sand containing some reworked humus. Bones apparently free of root hairs.

GSC-931. Carberry NE, Ahb horizon **1200 ± 140**
A.D. 750
$\delta C^{13} = -25.5‰$

Bulk soil sample, freed from root hairs, at 2.56 m depth in dune.

General Comment (P.P.D.): agreement between ages of stratigraphically related materials is excellent, considering that sand enclosing bones contained humic matter reworked from underlying paleosol. Bone possibly contaminated by older humic matter (R., 1966, v. 8, p. 471). Age of bones suggests they probably belonged to *Bison bison bison* (C. R. Harington, written commun.). Dates renewed eolian activity. NaOH-leach omitted from pretreatment of both samples. GSC-931 mixed with dead gas for counting.

GSC-1081. Virden **11,600 ± 430**
9650 B.C.

Debris consisting of twigs, bark, etc. from Assiniboine R. valley alluvium. Sample, from core 18 m below surface of flood plain near Virden, Manitoba, NW 1/4 LSD 7, sec. 32, tp. 10, rge. 25 W 1 (49° 53′ N Lat, 100° 50′ W Long), is deepest obtained from Assiniboine Valley fill. Coll. 1968 by R. W. Klassen. *Comment* (R.W.K.): dates early phase of valley filling after building of Assiniboine Delta (cf. Klassen, 1969). NaOH-leach omitted from sample pretreatment. Small sample (7.2 g) mixed with dead gas for counting, in 2-L counter at 1 atm.

2. Saskatchewan

GSC-1332. 'Empress Bluff' **10,500 ± 180**
8550 B.C.

Fresh-water gastropod shells (*Lymnaea elodes* Say, id. by A. H. Clarke, Jr., Natl. Mus. Nat. Sci. Ottawa) from E bank South Saskatchewan R., ca. 11.5 km SSE of Empress, Alberta, in LSD 14 of sec. 4, tp. 22, rge. 29, W 3rd mer. (50° 50′ 50″ N Lat, 109° 58′ 00″ W Long), alt ca. 715 m. Shells from 2.1 m below prairie surface, 120 m above river, from lake silt overlying varved silt and clay and 0.3 to 1 m below a thick buried soil. Coll. 1969 by C. S. Churcher, Univ. of Toronto, Toronto, and A. M. Stalker. *Comment* (A.M.S.): dates last phase of proglacial ponding in area and maximum age for postglacial soil. Only outer 5% of shell removed by leaching. Sample mixed with dead gas for counting. (One 3-day count.)

3. Alberta

Elkwater series

Buried soils coll. 1966 by P. D. Jungerius, Univ. of Amsterdam, Amsterdam, The Netherlands.

GSC-753. Elkwater, buried soil, 45 cm **1250 ± 130**
A.D. 700

4A1 surface horizon of buried 5 cm thick black Chernozem soil (lowest of four) overlain by 45 cm alluvium, in streambank on S pediment of Cypress Hills, ca. 16 km S of Elkwater, Alberta in LSD 4 of sec. 4, tp. 7, rge. 2, W 4th mer. (49° 31′ 30″ N Lat, 110° 13′ 48″ W Long), alt 1205 m. *Comments* (P.D.J.): soil not as well developed as at GSC-800 site (this list), but represents period of landscape stability; (W.B., Jr.); cf. GSC-931 (1200 ± 140), Ahb horizon of buried soil, and GSC-990 (1260 ± 130; *Bison* sp. bone) from NE of Carberry, Manitoba (both corrected dates, this list). Pretreatment, made in lab of former Geographical Branch under M. J. J. Bik, involved: addition of solution of sodium pyrophosphate ($Na_2P_2O_7 \cdot 2H_2O$) to soil sample, stirring with ultrasonic stirrer to cause formation of gel, sieving, through 53μ mesh or smaller while ultrasonic stirrer operating (rootlets, etc. being retained on sieve), evaporation of remainder causing organic material to form scale (subm. to C^{14} lab) above clay. NaOH-leach omitted from pretreatment. (One 3-day count).

GSC-800. Elkwater, buried soil, 70 cm **3950 ± 130** **2000 B.C.**

Buried A horizon of paleosol beneath ca. 70 cm alluvium exposed on Battle Creek, ca. 16 km E of Elkwater, Alberta, in LSD 5 of sec. 22, tp. 8, rge. 1, W 4th mer. (49° 39′ 40″ N Lat, 110° 04′ 18″ W Long), alt ca. 1205 m. *Comments* (P.D.J.): date closely agrees with age of charcoal from Indian campsite assoc. with paleosol, 3880 ± 165 (I-2428) and with date, 3610 ± 100 (I-2609), on organic matter of buried black Chernozem ([III] 2A1 horizon, 61 to 69 cm depth) from nearby alluvial fan in Battle Creek valley (Jungerius, 1969; cf. also Andrews, 1967; R., 1970, v. 12, p. 121). Dates time of erosional stability and soil formation; (W.B., Jr.): cf. GSC-949, 3680 ± 180 (corrected), this list, on lowest of 5 buried soils near Brookdale, Manitoba. Pretreatment (NaOH-leach omitted) as described above for GSC-753.

GSC-1101. Elkwater Lake **5100 ± 280** **3150 B.C.**

Clayey organic marl from 365 to 375 cm below mud/water interface in ca. 9 m water, Elkwater Lake, N side of Cypress Hills ca. 48 km SE of Medicine Hat, Alberta (49° 40′ N Lat, 110° 18′ W Long) alt ca. 1235 m. Coll. 1968 by J. Terasmae and R. J. Mott. *Comment* (R.J.M.): date on organic fraction is much younger than anticipated for abandonment of local glacial spillway. Possible explanations are: 1) basal organic sediments were not reached during sampling; 2) organic accumulation did not begin immediately after abandonment of spillway; 3) lake not formed until much later, as evidence of large-scale slumping along spillway suggests lake developed when a slump block dammed drainage. NaOH-leach omitted from sample pretreatment. Sample mixed with dead gas for counting in 2-L counter at 1 atm.

Medicine Hat series (IV)

Samples from 'Bain Bluff' on SE bank S Saskatchewan R., ca. 11 km NE of Medicine Hat, 5 km E of 'Mitchell Bluff', Alberta, on former Bain homestead; LSD 13 of sec. 36, tp. 13, rge. 5, W 4th mer. (50° 08′ 05″ N Lat, 110° 34′ 20″ W Long), alt ca. 745 m. From near top of bluff, in silty alluvium containing 4 well-developed and some less-developed soils, Mazama volcanic ash ca. 6600 yr old between topmost and 2nd youngest of well-developed soils, and an archaeologic site between ash and youngest soil. Alluvium was deposited in 21 m-deep valley tributary to early postglacial stage of South Saskatchewan R.

GSC-1302. 'Bain Bluff', charcoal **1110 ± 140** **A.D. 840**
$\delta C^{13} = -23.4‰$

Charcoal, 3.3 g, from hearth immediately below uppermost well-developed soil, above Mazama ash bed, 0.6 to 1 m below surface. Coll. 1969 by L. O. Lindoe, Medicine Hat, Alberta; subm. by A. M. Stalker.

8120 ± 170
GSC-1341. 'Bain Bluff', upper shells **6170 B.C.**

Gastropod shells from between 2nd and 3rd lowest of 4 well-developed soils, ca. 2.5 m below surface. Coll. 1969 by A. M. Stalker.

10,200 ± 240
GSC-1061. 'Bain Bluff', lower shells **8250 B.C.**

Gastropod shells from between till and lowest of 4 well-developed soils, 3.7 m below surface. Coll. 1968 by A. M. Stalker.

General Comment (A.M.S.): dates and age of ash bed are internally consistent; they give maximum ages for initial development of 1st, 3rd, and 4th (from base) major soil-forming episodes in region and for time of man's occupation of site. They also are minimum for retreat of last glacier, and give level of South Saskatchewan R. when tributary valley was being cut. Pretreatment of GSC-1302 included *cold* NaOH-leach. All 3 samples mixed with dead gas for counting.

Medicine Hat series (V)

25,000 ± 800
GSC-1370. 'Evilsmelling Bluff' **23,050 B.C.**

Wood fragments from E bank of South Saskatchewan R., ca. 5 km N of Medicine Hat, Alberta, in SE ¼ sec. 20, tp. 13, rge 5, W 4th mer. (50° 06′ N Lat, 110° 38′ W Long), alt ca. 690 m. Rare wood and plant fragments scattered in silt and clay ca. 5.5 m below top of 'Evilsmelling Band' and ca. 55 m above river. Band overlain by 18 m drift including 2 tills. Coll. 1969 by A. M. Stalker. *Comment* (A.M.S.): date internally consistent with, and corroborates, GSC-205, 24,490 ± 200 (R., 1965, v. 7, p. 31), from higher in 'Evilsmelling Band', and GSC-578, 28,630 ± 800 (R., 1967, v. 9, p. 168), from ca. 5 m lower. Dates indicate a deposition rate of ca. 15 cm/century for 'Evilsmelling Band', thought to be a flood-plain deposit laid down during very cold conditions. Sample mixed with dead gas for counting. (One 4-day count.)

GSC-1044. 'Mitchell Bluff' **>38,000**

Wood fragments coll. during bulldozing before excavation for bones, at NW end 'Mitchell Bluff', on S bank Saskatchewan R. 9.5 km N of Medicine Hat, Alberta; NE ¼ sec. 32, tp. 13, rge. 5, W 4th mer. (50° 07′ 45″ N Lat, 110° 38′ 40″ W Long) alt ca. 685 m. Wood 5 m below surface, 12 m above so-called 'Artifact Band', and 9 m in from cliff face in inter-till fine silt and clay containing scattered bones. Coll. 1968 by L. M. Kisko, Welland, Ontario, and A. M. Stalker. *Comment* (A.M.S.): 'Artifact band' previously dated at >30,000, (GSC-780; R., 1968, v. 10, p. 219). Other dates in series include GSC-704, -802, and -805 (*ibid.*) and GSC-543 and -578 (R., 1967, v. 9, p. 168-169). (One 3-day count.)

GSC-1233. Taber Bluff **>49,000**

Wood from W bank Oldman R. at Taber Bluff, 14.5 km N of Taber, Alberta; NW ¼ sec. 19, tp. 11, rge. 16, W 4th mer. (49° 55′

45″ N Lat, 112° 11′ W Long), alt ca. 760 m. Wood, 18 m below surface and ca. 30 m above river, from sandy alluvium of Unit F of Taber Sec. described by Stalker (1963), and from beneath one till sheet (Unit G, *ibid*). Coll. 1968 by A. M. Stalker. *Comment* (A.M.S.): sample thought to be from bed that yielded 'Taber Child' at 'Stalker Site', and to give minimum age for those human bones (cf. Stalker, 1969). It also indicates existence of only a single Late Wisconsin till sheet in area. Sample from 90 m N, and 4.5 m below, wood used for S-65, >32,000 (R., 1960, v. 2, p. 75); see also GSC-888, >37,000 (R., 1970, v. 12, p. 67), probably from same bed. (Four 1-day counts in 5-L counter at 4 atm.)

Lofty Lake series

Lake sediment from N bay of Lofty Lake, ca. 21 km E of Donatville, Alberta (54° 44′ N Lat, 112° 29′ W Long), alt 625 m, water depth 6.7 m. Coll. 1968 with Livingstone corer by J. Terasmae and R. J. Mott.

GSC-1201. Lofty Lake, 156 to 164 cm **3460 ± 140**
1510 B.C.
$\delta C^{13} = -23.7‰$

Brown-green algal gyttja.

GSC-1202. Lofty Lake, 290 to 298 cm **5200 ± 140**
3250 B.C.
$\delta C^{13} = -25.1‰$

Buff to dark brown laminated gyttja.

GSC-1234. Lofty Lake, 436 to 444 cm **7420 ± 150**
5470 B.C.
$\delta C^{13} = -28.6‰$

Buff to dark brown laminated gyttja.

GSC-1240. Lofty Lake, 512 to 518 cm **9130 ± 150**
7180 B.C.
$\delta C^{13} = -28.2‰$

Buff to dark brown laminated gyttja.

GSC-1049. Lofty Lake, 549 to 554 cm **11,400 ± 190**
9450 B.C.

Basal gray-brown laminated gyttja overlying light gray silty clay.

General Comments (R.J.M., D.A.St-O.): date on basal gyttja is minimum for deglaciation and is oldest in region; cf. GSC-1093, 10,700 ± 170 (St-Onge, 1970); GSC-1053, 10,400 ± 200, this list; (S. L-F.): GSC-1240 dates spruce decline and birch rise (Zone II/III boundary), GSC-1234 dates rise of grasses and pine (Zone III/IV boundary), GSC-1202 is at Hypsithermal maximum, and GSC-1201 dates Zone IV/V boundary. GSC-1234 and GSC-1240 pub. as 7480 ± 150 and 9180 ± 150, respectively, prior to corrections for isotopic fractionation (Lichti-Federovich, 1970). NaOH-leach omitted from pretreatment of all samples. GSC-1049, -1201, -1202, and -1240 mixed with dead gas for counting. Dates GSC-1049 and GSC-1240 based on one 2-day and one 3-day count, respectively.

10,700 ± 170
GSC-1093. 'Alpen Siding Lake' 8750 B.C.

Basal marly gyttja from 380 to 385 cm below mud/water interface in ca. 1 m water in small lake on fluted till plain, ca. 3 km NW of Alpen Siding and 35 km SE of Athabasca, Alberta (54° 27′ N Lat, 113° 00′ W Long), alt 685 m. Coll. 1968 by J. Terasmae and R. J. Mott. *Comment* (R.J.M.): date is minimum for deglaciation of area (St-Onge, 1970). NaOH-leach omitted from sample pretreatment. Sample mixed with dead gas for counting.

4920 ± 330
GSC-1132. Beverly site, Edmonton 2970 B.C.

Ahg horizon of paleosol (humic gleysol) below 50+ cm of soil and alluvium in gravel pit on terrace of, and 6 to 9 m above, North Saskatchewan R. in NE (Beverly Dist.) Edmonton, Alberta, NW ¼, sec. 6, tp. 53, rge. 23, W 4th mer. (53° 32′ N Lat, 113° 27′ W Long). Exposed face fresh, with no plant growth, but roots from surface penetrated dated horizon. Ahg horizon underlain by alluvium in which Mazama ash layer, ca. 6600 yr old, occurs (Westgate *et al.*, 1970; Pawluk and Dumanski, 1970). Coll. 1968 by S. Pawluk, Univ. of Alberta, Edmonton. *Comment* (S.P.): date agrees with interpretation of ash as Mazama. Pretreatment (by subm., no further treatment in C^{14} lab) to obtain humic acid fraction (~0.8 g) from air-dried paleosol included: 0.1 N Na-pyrophosphate + 0.1N NaOH extraction, precipitation with HCl, purification by dialysis against an H-saturated exchange resin (Dowex W50-X12), then freeze-drying in H-form. Root hairs, etc., removed by flotation prior to sedimentation treatment. Sample mixed with dead gas for counting.

8080 ± 150
GSC-1209. Calgary 6130 B.C.
$\delta C^{13} = -17.4‰$

Bison bone, from partially preserved skeleton, at 2.7 m depth in lacustrine clayey silt; exposed in excavation (Mona Lisa site) at 17th Ave. and 7th St., S.W., Calgary, Alberta (51° 02′ N Lat, 114° 05′ W Long). A 7.5 cm volcanic ash layer (Mazama?) was ca. 0.3 m above bone horizon. Coll. 1968 by N. W. Rutter. *Comment* (N.W.R.): clayey silt probably deposited in lake in former flood plain of Bow R. Pretreatment incl. 24-hr NaOH-leach.

21,700 ± 840
GSC-1129. Duffield, buried soil 19,750 B.C.

Buried Ah horizon at max. 1 m depth, overlain by coarse-textured alluvium and present-day soil. Sample from fresh exposure on upper terrace of Saskatchewan R., 13.7 km SSE of Duffield, Alberta (53° 24′ N Lat, 114° 18′ W Long). Coll. 1968 by S. Pawluk. *Comment* (S.P.): date does not fit geologic setting (cf. GSC-767, 8320 ± 140; R., 1968, v. 10, p. 221) and suggests part of organic contribution may be from lignite that crops out in vicinity. Although coal not discernible in dated sample, humification to form soil humus is very likely. It is impossible to differentiate coal-formed humus from that of decomposed biogenic deposits. Pretreatment (by subm., no further treatment in lab.) to obtain humic acid fraction (0.8 g) from air-dried paleosol as described for GSC-1132, above. Sample mixed with dead gas for counting. (One 5-day count in 2-L counter at 1 atm.)

GSC-1053. Clear Lake **10,400 ± 200**
8450 B.C.

Organic, silty clay from 471 to 476 cm below mud/water interface in Clear Lake, 5 km NNW of Tiger Lily, Alberta (54° 14′ N Lat, 114° 47′ 30″ W Long), alt 700 m. Lake occupies kettle hole in end morainal zone. Coll. 1968 by J. Terasmae and R. J. Mott. *Comment* (R.J.M.): date is minimum for deglaciation and for drainage of small glacial lakes that bordered ice. NaOH-leach omitted from sample pretreatment. Sample mixed with dead gas for counting.

GSC-1019-2. Freeman section, Fort Assiniboine **52,200 ± 1760**
50,250 B.C.

Wood from bed of outwash gravel >5 m thick, above till, and overlain, successively, by sand, till, varved sediments, and sand; exposed in cut on S side Freeman R., 11 km WNW of Fort Assiniboine, ca. 7.5 km upstream from junction of Athabasca R., Alberta (54° 21′ 30″ N Lat, 114° 53′ 00″ W Long). Sample from ca. 5 m above river, 25 m below surface. Coll. 1968 by D. A. St-Onge. Two determinations:

GSC-1019.	(two 1-day counts in 5-L counter)	>40,000
GSC-1019-2.	(one 3-day count and two 1-day counts in 5-L counter at 4 atm)	52,200 ± 1760

Comment (W.B., Jr.): if finite date is valid, it *may* date widespread stratified intertill deposit in area (cf. St-Onge, 1969). Coal fragments, sand, and silt adhered to wood when received. A section was sawed from middle of 0.3 m-long piece, and all outside wood was cut off. Wood may still have been contaminated by this older organic material; cf. GSC-501, >42,500 (R., 1967, v. 9, p. 171) wood in contorted sand below till on Goose R., ca. 120 km to NW.

Freeman River series

Wood and fresh-water gastropods (mainly *Stagnicola palustris* and *Fossaria dalli*; id. by A. H. Clarke, Jr., Natl. Mus. Nat. Sci., Ottawa), from contorted calcareous sandy silt at 6 m depth, N side small creek cutting E bank Freeman R., Alberta (54° 35′ N Lat, 115° 00″ W Long), alt ca. 745 m. Silt unit, 35 m long and at least 3 m thick, is overlain by till-like material. Coll. 1967 by D. A. St-Onge.

GSC-859. Freeman River, wood **10,900 ± 160**
8950 B.C.

GSC-903. Freeman River, shells **12,400 ± 600**
10,450 B.C.

General Comments (D.A.St-O.): dates suggest GSC-859 was contemporary with pond; (W.B., Jr.): discrepancy between dates not resolved, but wood is less subject to contamination. Only outermost 10% of GSC-903 removed due to small sample (6.5 g). Sample mixed with dead gas for counting. (One 4-day count.)

10,200 ± 170
GSC-861. Greencourt **8250 B.C.**

Gastropods from thin lens of silty sand in thick deposit of lacustrine silty clay, from 1 m depth, 10.5 km E of Greencourt, Alberta (54° 00′ 15″ N Lat, 115° 04′ W Long), alt ca. 700 m. Contorted sandy silt is part of a thick lacustrine deposit in area of hummocky topography. Coll. 1967 by D. A. St-Onge. *Comment* (D.A.St-O.): dates phase of Glacial Lake Edmonton (St-Onge, in press). Only outermost 5% of shell removed.

2880 ± 170
GSC-1155. Peyto Glacier **930 B.C.**
$\delta C^{13} = -19.6‰$

Wood fragment (*Picea* or *Larix*, microscopic features like *P. engelmanni*; id. by R. J. Mott) from lateral moraine 60 m NE of Inland Waters Branch Glaciology Camp at Peyto Glacier, Alberta (51° 41′ 15″ N Lat, 116° 32′ 30″ W Long), alt 2010 m (ca. 200 m above present timberline), 40 m above edge of glacier. Specimen contains 180 counted annual rings plus ca. 15 rings toward pith and ca. 50 rings toward bark which are damaged by decay and cannot be counted with certainty. Curvature of rings indicates that sample is weathered fragment from much larger tree trunk (not krumholtz). Annual rings are very small (mean ring width 0.175 mm) but lack width variability required for dendrochronologic cross-dating. Coll. 1968 by H. Smedsrud; subm. by W. Henoch, Inland Waters Branch, Ottawa, and M. L. Parker, now at Univ. of British Columbia, Vancouver. *Comment* (M.L.P.): date, on 10-ring sample ca. 115 rings from outside, indicates time of more favorable climate when timberline was higher than today (cf. dates on wood exposed by glacier retreat in British Columbia, R., 1968, v. 10, p. 226; also dates for California and Nevada, LaMarche and Mooney, 1967). Sample mixed with dead gas for counting.

4. British Columbia

Meadow Creek series (III)

Peat and wood from road cuts near borrow pit on E side of Meadow Creek, 2.4 km W of Duncan Lake Dam, 9.6 km N of Kootenay Lake, British Columbia (50° 15′ N Lat, 116° 59′ W Long). Road cut exposed till overlying interstratified silt and gravel containing peat beds and wood (Fulton, 1968; R., 1968, v. 10, p. 224-225). Two samples described were from beds interpreted as occupying same stratigraphic position. Coll. 1966 by R. J. Fulton. For other dates in same series see R., 1970, v. 12, p. 70-71. One from each of 2 groups of samples dated in 5-L counter at 4 atm was re-run in 1969 to check reproducibility of results obtained in 1967 (GSC-740) and 1968 (GSC-1017), and because the 2 series, though agreeing internally, did not fit as well as hoped.

GSC-740-2. Meadow Creek (I) **43,000 ± 600** **41,050 B.C.**

Root *in situ* 265 cm below top of interstratified silt and gravel. (One 1-day and one 3-day count in 5-L counter at 4 atm.)

GSC-1017-2. Meadow Creek (IX) **43,600 ± 700** **41,650 B.C.**

Peat from 2 cm-thick bed in silt, 3 m below contact with till. (Two 1-day counts and one 3-day count in 5-L counter at 4 atm.)

General Comments (R.J.F.): GSC-740-2 agrees with date obtained for this sample in 1967 (43,800 ± 800). GSC-1017-2 is significantly older than date obtained for part of same sample in 1968 (41,500 ± 520) and fits original stratigraphic interpretation (see comment for GSC-1017, R., 1970, v. 12, p. 70); (W.B., Jr.): discrepancy between GSC-1017 and GSC-1017-2 is unexplained. Rootlet penetration from above was suggested as a possible cause for GSC-1017 being too young, but because GSC-1017-2 fits with other dates, this no longer holds, unless sample was inhomogeneous (e.g,. rootlets having penetrated part used for GSC-1017 and not part used for GSC-1017-2). Any sample of peat or other organic debris can easily be "contaminated" in sense that it contains compacted or detrital material of different ages, and, in this age range only 0.1% contamination by *modern* carbon would cause an error of ca. 2000 yr (Olsson and Blake, 1962).

GSC-1188. Balfour Creek (II) **19,900 ± 230** **17,950 B.C.**

Charcoal scattered through 5 to 10 cm silt and fine-grained sand, underlying thin volcanic ash bed in large pit on N side of Columbia R., 8 km W of Castlegar, British Columbia (49° 21′ 00″ N Lat, 117° 44′ 50″ W Long). Coll. 1968 by R. J. Fulton. *Comment* (R.J.F.): previous sample from same site was dated at 33,000 ± 280 yr (GSC-1008: R., 1970, v. 12, p. 70-71). Volcanic ash was not exposed when original sample was coll. and original site had been destroyed before GSC-1188 was taken. At time of coll. it was thought that GSC-1188 was topographically and stratigraphically lower than GSC-1008. No information is at present available to resolve apparent conflict of dates. (One 3-day count.)

GSC-1119. Rodd Creek **9100 ± 140** **7150 B.C.**

Mucky peat from base, 350 to 360 cm depth, of bog at ca. 1355 m alt near headwaters of Rodd Creek, on E side of Columbia R. valley 17.5 km S of Nakusp, British Columbia (50° 05′ 34″ N Lat, 117° 49′ 14″ W Long). A 10 cm-thick volcanic ash bed occurred at 285 cm depth. Coll. 1968 with Davis sampler by R. J. Fulton and R. A. Achard. *Comment* (R.J.F.): date is minimum for deglaciation, but is considerably younger than basal peat sample at same alt ca. 77 km to S (GSC-855, 10,000 ± 150: R., 1970, v. 12, p. 71). NaOH-leach omitted from sample pretreatment. (One 3-day count.)

5500 ± 140
3550 B.C.
GSC-1183. Mt. Revelstoke
$\delta C^{13} = -24.3‰$

Basal peat at 132 to 137 cm depth, above volcanic ash (Mazama?) overlying bedrock from deposit at N end of pool near Jades Lakes, Mt. Revelstoke Natl. Park, British Columbia (51° 04′ 25″ N Lat, 118° 04′ 15″ W Long), alt 1830 m. Pool is one of several in depressions in quartzitic bedrock, but higher water level is due to development of dam-like peat deposits from which sample was taken. Coll. 1967 with split-tube corer by R. D. Muir, Natl. Parks Branch (now with Canadian Wildlife Service, Ottawa). *Comment* (R.D.M.): date supports field evidence that peat deposit developed *in situ* over a considerable period; plant growth appears to have been continuous for last 5500 yr (Muir, 1970). NaOH-leach omitted from sample pretreatment.

9490 ± 160
7540 B.C.
GSC-1306. Revelstoke

Flakes and flat pieces of wood, some charred, in micaceous sandy matrix recovered from a borehole drilled by C.B.A. Engineering Ltd. for British Columbia Hydro and Power Authority, ca. 300 m downstream from railway and hwy bridge at Revelstoke, British Columbia (51° 00′ N Lat, 118° 12′ W Long). Borehole is on main terrace, alt 455 m, on which city is built, and was 12 m above Columbia R. before construction of Keenleyside (formerly Arrow) Dam; sample from ca. 29 m depth, alt 426 m. Borehole penetrated a succession of sand with some laminated silt to total depth 40 m. *Comment* (H.W.N.): date is maximum for deposition of overlying sand and formation of terrace on which Revelstoke is built. It suggests that level of Arrow Lake (ca. 40 km S) then was higher than lake level in recent time (419 to 427 m). NaOH-leach omitted from sample pretreatment.

21,700 ± 240
19,750 B.C.
GSC-1258. Canoe River valley

Wood (coniferous, id. by R. J. Mott) from stratified blue-gray sandy silt overlying glacial gravel grading down into till. Road cut, ca. 25 m above E bank of Canoe R., 6.6 km N of confluence with Columbia R., British Columbia (52° 11′ 40″ N Lat, 118° 27′ 23″ W Long), alt 615 m. Coll. 1969 by R. A. Achard. *Comment* (R.A.A.): wood samples were rounded and worn, implying probable transport from original setting into sandy silt deposited during retreat of last ice. Date agrees with GSC-173, 21,500 ± 300, on woody plant detritus coll. 12 km S (R., 1965, v. 7, p. 32; Fulton, 1968). Dates indicate that parts of Rocky Mountain Trench were free of ice at end of Olympia Interglaciation (Armstrong *et al.*, 1965), immediately before last major glacial advance. (One 3-day count.)

GSC-947. Three Valley Lake **7640 ± 150**
5690 B.C.

Sandy basal peat from bog on surface of kettled terrace at confluence of Eagle R. and Wap Creek valleys, 21 km W of Revelstoke, British Columbia (50° 55′ N Lat, 118° 28′ W Long). Sample from bottom 10 cm of bog sec. consisting of ca. 315 cm of brown sandy peat and partially decomposed sphagnum peat. Peat overlies an undetermined thickness of gray silt and clay. Coll. 1967 by G. W. Smith, Ohio State Univ., Columbus; now at Ohio Univ., Athens, Ohio, with Hiller sampler. *Comment* (G.W.S.): date, minimum for deglaciation in W end of Eagle R. valley, is considerably younger than GSC-923, 9280 ± 160 (R., 1970, v. 12, p. 72), basal peat in bog near Lusk Lake, ca. 39 km to SSW. NaOH-leach omitted from sample pretreatment.

GSC-1231. 'Dawson Creek slide' **0 ± 140**
A.D. 1950

Wood from broken log among large boulders in center of extensive rock slide (max. est. vol., 25×10^6 m^3) on W slope of Canoe R. valley, opposite mouth of Dawson Creek, British Columbia (52° 15′ N Lat, 118° 32′ W Long), alt ca. 1220 m. Coll. 1969 by R. A. Achard. *Comment* (R.A.A.): slide is most recent in Canoe R. valley. New growth of trees on lower sides and bottom of slide does not seem older than 100 yr; date indicates that slide occurred at earliest ca. 150 yr ago (Achard, 1970). (One 1-day count.)

GSC-946. Trinity Valley **15,000 ± 330**
13,050 B.C.

Basal peaty marl from bog at head of Christian Creek, 19 km N of Lumby, British Columbia (50° 25′ N Lat, 118° 54′ W Long), alt ca. 745 m. Sample from base of marl/peat sequence at 340 cm depth. Bog sec. overlies undetermined thickness of massive gray lacustrine silt. Coll. 1967 by G. W. Smith with Davis sampler. *Comments* (G.W.S.): date is minimum for deglaciation of N uplands of Sugar Lake map-sheet; (R.J.F.): date is 4000 yr older than other bog bottom dates from Interior System (cf. GSC-905, 10,200 ± 190 and GSC-909, 11,000 ± 180: R., 1970, v. 12, p. 71-72). According to Mullineaux *et al.* (1965) Fraser Glaciation ice had not reached its maximum in Puget Lowland 15,000 yr ago; it is unlikely it would have been retreating from interior of British Columbia at this time. Possibly, peaty material dated had picked up carbon from enclosing marly sediments or sample included lignite reworked from local Tertiary sediments. NaOH-leach omitted from sample pretreatment. Sample mixed with dead gas for counting. (One 3-day count.)

Keremeos series

GSC-1390. Keremeos, charcoal **9120 ± 540**
7170 B.C.

Bits of charcoal, up to 2 cm long, mixed with material of buried surface horizon (Ahb), including organic matter of plant origin (humus), silt, and sand, from lower portion of downward-pointing, tongue-like horizon at 50 to 70 cm depth, 2.2 km NE of Lakeview mt. peat, in Ashnola R. drainage near Keremeos, British Columbia (49° 03′ 36″ N Lat, 120° 08′ 28″ W Long), alt ca. 2480 m and ca. 300 m above present tree-line. Coll. 1965 by A. L. van Ryswyk, Canada Dept. of Agr. Res. Sta., Kamloops, B.C., from soil profile pit (Site 37, van Ryswyk, 1969) dug at edge of frost-riven rock ring formation near top edge of a cirque-like slope, on nearly level ground. *Comment* (A.L.v.R.): date indicates that tree or shrub-like vegetation, much larger than present dwarf willow a few cm high, grew at site soon after last ice retreat and was subsequently buried by ice wedge and/or solifluction processes. Evidence of both exists adjacent to site. Charcoal bits picked out of sample. NaOH-leach omitted because of small sample size (4.2 g).

0 ± 130

GSC-1249. Keremeos, peat **A.D. 1950**

Dry (in field) brown moss peat 10 cm thick, on surface in slight hollow and underlain by 10 cm of transition material and thin angular cobbly, gravelly, coarse sandy loam showing features (gleysolic) of permanent wetness, 2.6 km NNE of Lakeview mt. peak, in Ashnola R. drainage near Keremeos, British Columbia (49° 04′ 03″ N Lat, 120° 19′ 00″ W Long), alt ca. 2410 m, ca. 300 m above present tree-line. Topography was undulating on 12% overall slope. Coll. 1966 by A. L. van Ryswyk. *Comment* (A.L.v.R.): date indicates contemporary peat formation. As peat was dry when sampled and showed no signs of living moss at surface, it was hoped deposit indicated a change to dry climate at some time in past. Possibly drainage route of subsurface waters has altered and less water is supplied to site so that peat formation has ceased but gleysolic character is maintained. Sample was ground to pass 2 mm sieve with no further treatment. NaOH-leach omitted because of small sample size (15 g). (One 3-day count.)

2000 ± 130

GSC-1274. Sukunka River **50 B.C.**

$\delta C^{13} = -23.5‰$

Wood (*Salix* sp., id. by R. J. Mott) from river-cut scarp on W side of Sukunka R., ca. 14.5 km S of Chetwynd, British Columbia (55° 35′ 00″ N Lat, 121° 36′ 30″ W Long). Wood from upper part of 2 m contorted silt and pebbly sand, overlain by ca. 6 m undisturbed lacustrine silts. Coll. 1969 by N. W. Rutter. *Comment* (N.W.R.): age is maximum for extensive late postglacial lake in Sukunka R. valley. (One 3-day count.)

Cook Street series, Victoria

Sewer excavation along Cook St., Victoria, British Columbia (48° 24′ 45″ N Lat, 123° 21′ 15″ W Long), in 1968, exposed what appears to be a continuous succession of sediments from late-glacial marine clay through fresh-water sediments to black organic muck (sapropel). Contact between marine clay and fresh water sediments is ca. 1.2 m above present high tide. Fresh-water deposits above contact show no evidence of subsequent marine transgression. Coll. 1968 with Shelby tube by H. W. Nasmith, Thurber Consultants Ltd., Victoria.

GSC-1142. Cook Street, black organic muck **11,200 ± 190**
9250 B.C.
$\delta C^{13} = -24.1‰$

3 cm-long sec. 15 to 18 cm above GSC-1131, 1 cm above base of fine-grained black organic muck, above fresh-water shell zone.

GSC-1131. Cook Street, organic lake deposit **11,500 ± 160**
9550 B.C.
$\delta C^{13} = -21.5‰$

7 cm thick organic material (incl. *Chara* sp., seeds of *Potamogeton* sp., fragments of vascular plants; id. by M. Kuc), enclosing fresh-water shells (GSC-1130), above contact with underlying brown sand and gray clay. (One 3-day count.)

GSC-1130. Cook Street, fresh-water shells **11,200 ± 170**
9250 B.C.
$\delta C^{13} = +1.0‰$

Fresh-water shells (mainly *Gyraulus parvus* and *Lymnaea stagnalis*, id. by A. H. Clarke, Jr., Natl. Mus. Nat. Sci., Ottawa) within organic material (GSC-1131) above contact with underlying brown sand and gray clay. No correction applied to date as initial C^{14} content unknown.

GSC-1114. Cook Street, marine shells **12,100 ± 160**
10,150 B.C.

Marine shells (*Saxidomus giganteus*, an intertidal clam, id. by A. H. Clarke, Jr.) enclosed in gray silty clay from ca. 45 cm below contact with overlying fresh-water shells and organic material.

General Comment (H.W.N.): dates on marine shells in Greater Victoria area range in age and alt from 12,660 ± 160 at 27 m (GSC-246: R., 1965, v. 7, p. 36) to 12,100 ± 160 at +2.2 m geodetic (GSC-1114) and seem to mark rapid regression of sea level from post-glacial maximum at +68.5 to 84 m (Mathews *et al.*, 1970). Sea level fell to present shoreline between 12,100 and 11,200 yr B.P. (dates bracket time at which post-glacial marine submergence ended at S tip Vancouver I.). Other evidence indicates that sea level fell below present shoreline for several thousand yr. Overlap of dates between fresh-water deposits and organic muck suggests fresh-water pond phase was very brief, as also indicated by fresh water shell assemblage, representative of eutrophic, well-vegetated habitat (A. H. Clarke, Jr., 1970, written commun.). NaOH-leach omitted from pretreatment of GSC-1131 and GSC-1142. Due to small size of GSC-1130 no shell removed by leaching.

GSC-1385. Empress Hotel, Victoria **4000 ± 200**
2050 B.C.

Wood (*Picea* sp., prob. *P. sitchensis*, id. by R. J. Mott) from borehole drilled adjacent to S wing of Empress Hotel, Victoria, British Columbia (48° 25′ 15″ N Lat, 123° 22′ 00″ W Long). Wood at 9.3 m depth (surface alt ca. 5.4 m, geodetic datum) is contained in silty clay, a recent estuarine deposit in shallow arm of Victoria Harbour. Mud is covered by 8 m dredged fill, placed 1904, and overlies late-glacial marine clay with a weathered crust (Crawford and Sutherland, 1971). Coll. 1969 with Shelby tube and subm. by C. B. Crawford, NRC, and H. W. Nasmith. *Comment* (H.W.N.): following deposition of marine clay ca. 12,000 to 13,000 yr B.P., relative sea level fell below present sea level and clay was exposed on bottom of Victoria Harbour (cf. Mathews *et al.*, 1970). A crust formed on clay during subaerial weathering. Sea level rise to present position flooded crust, and date is minimum for this event. (One 3-day count.)

Ospika River series

Wood and peat from 2.5 m depth in river-cut terrace on W bank of Ospika R., British Columbia (56° 10′ N Lat, 124° 07′ W Long). Sample from peat at base of marl underlain by sandy silt layer and gravels. These, in turn, are underlain by proglacial lacustrine silt (not observed at this site.) Coll. 1968 by N. W. Rutter.

GSC-1069. Ospika River, wood — **7470 ± 140** / **5520 B.C.**

(One 3-day count.)

GSC-1161. Ospika River, peat — **7480 ± 150** / **5530 B.C.**

Peat, composed mainly of calciphilous mosses (*Scorpidium scorpioides* dominates, *Calliergon trifarium* also present; both id. by M. Kuc), from marl in same zone as GSC-1069 but 1 m distant horizontally *General Comment* (N.W.R.): dates are minimum for underlying proglacial lake deposits and provide close check on different organic materials in same deposit. NaOH-leach omitted from pretreatment of GSC-1161.

Finlay River series

GSC-573. Finlay River, E bank, plant material — **25,940 ± 380** / **23,990 B.C.**

Plant material from sand in exposure on E bank Finlay R., 29 km NW of junction with Ospika R. (56° 18′ N Lat, 124° 21′ W Long). Sample coll. 0.6 m above river at low-water stage (Sept.) from unoxidized lower sand in ca. 4.5 m thick unit (base not seen) of sand grading upward to silty sand and silt, in turn overlain by <2 m boulders and gravel containing till-like lenses, capped by lake silt. Coll. 1965 by J. G. Fyles. *Comment* (J.G.F.): gravel and till-like material inferred to represent glaciation. Finite date is only one available in region (Rutter, 1967); it is farthest N (by ca. 565 km) occurrence of numerous sub-till dates in this range in interior British Columbia (cf. GSC-1258, 21,700 ± 240, this list). Other samples to N (ca. 110 km) in series along Finlay R. are all infinite. NaOH-leach omitted from sample pretreatment.

GSC-837. Finlay River, W bank, wood **>44,000**

Wood fragments from ca. 44 m depth on W bank Finlay R. (57° 11′ N Lat, 125° 20′ W Long), scattered in a sand lens within oxidized sand and gravel, overlain, unconformably, by outwash below 2 tills. Coll. 1967 by N. W. Rutter. *Comment* (N.W.R.): assuming wood is same age as enclosing material, date is minimum for oxidized sand and gravel that may represent interglacial deposit. (One 4-day count).

GSC-841. Finlay River, E bank, "peat-like" **>41,000**

Peat-like material from >20 m depth on E bank Finlay R. (57° 18′ N Lat, 125° 27′ W Long), from gravel within oxidized sand and gravel, overlain unconformably by outwash underlying till and/or ice-contact gravel. Coll. 1967 by N. W. Rutter. *Comment* (N.W.R.): oxidized sand and gravel are probably correlative with similar unit containing GSC-837 (above).

GSC-1057. Finlay River, E bank, wood **>28,000**

Wood fragments from ca. 10 m depth on E bank Finlay R. (57° 18′ N Lat, 125° 27′ W Long), from sand wedge within a unit of oxidized sand and gravel overlain unconformably by postglacial gravel. Coll. 1968 by N. W. Rutter. *Comment* (N.W.R.): enclosing material believed correlative with oxidized sand and gravel in which GSC-837 and GSC-841 were coll. Sample mixed with dead gas for counting.

520 ± 140

GSC-927. Finlay River, E bank, charcoal (I) **A.D. 1430**

$\delta C^{13} = -24.5‰$

Wood, charred wood, and charcoal from ca. 5.5 m below surface of river cut on E side Finlay R. ca. 3 km NW of Del Creek (57° 11′ N Lat, 125° 18′ W Long), from oxidized layer of buried sandy soil overlain by windblown sand. Soil underlain by >75 m of several glacial units. Coll. 1967 by N. W. Rutter. *Comment* (N.W.R.): date does not give maximum age for deposition of sand overlying soil (cf. GSC-944, below). Although sample was hand-picked and all visible rootlets were removed, some rootlets probably remained in wood pieces. NaOH-leach omitted from sample pretreatment.

GSC-944. Finlay River, E bank, **840 ± 140**
charcoal (II) **A.D. 1110**

$\delta C^{13} = -25.8‰$

Same location and sample material as GSC-927. This part of sample underwent nitration and acetone leaching as described by Haynes (1966). *Comments* (N.W.R.): date is probably more accurate than GSC-927; (W.B., Jr. and J.A.L.): as indicated in Table 3, (R., 1970, v. 12, p. 474), wood and charred wood predominated over charcoal in sample. Weight of GSC-927 decreased only from 9.7 g to 7.9 g with acid treatment, but using Haynes' method, GSC-944 decreased in weight from ca. 20 g to 4.5 g, hence it was mixed with dead gas for counting. However, discrepancy between dates probably cannot be explained solely by contamination by modern rootlets. A 40% decrease in age, in this range, would require 20 to 50% contamination by modern material.

Tiedemann Glacier series

Peat and organic muck from 2 bogs on N side Tiedemann Glacier, 24 km E of Mt. Waddington, British Columbia (51° 21′ 00″ N Lat, 124° 56′ 30″ W Long). Coll. 1967 with Davis sampler by R. J. Fulton.

GSC-948. Moraine bog (I) — **2250 ± 130**; **300 B.C.**; $\delta C^{13} = -25.4‰$

Peat overlying 10 cm silt bed at 210 to 217 cm depth. (One 3-day count.)

GSC-938. Moraine bog (II) — **2940 ± 130**; **990 B.C.**; $\delta C^{13} = -26.8‰$

Peat from ca. 227 cm depth, underlying 10 cm silt bed.

GSC-939. Moraine bog (III) — **9510 ± 160**; **7560 B.C.**

Basal peat, 275 to 285 cm depth, from 285 cm-thick sphagnum peat deposit.

GSC-977. Inner moraine bog — **1270 ± 140**; **A.D. 680**; $\delta C^{13} = -26.3‰$

Fibrous organic muck from base of 88 cm-thick bog deposit.

General Comment (R.J.F.): moraine bog lies immediately outside a moraine of Tiedemann Glacier postdating the Fraser Glaciation; a 10 cm-thick silt bed extending throughout bog is thought to have been deposited while ice stood against post-Fraser moraine. GSC-948 and GSC-938 bracket time of advance, GSC-939 is minimum for retreat of Fraser ice from area. Inner moraine bog lies in area of ridges inside oldest post-Fraser moraine; GSC-977 is minimum for retreat of Tiedemann Glacier from area between its post-Fraser maximum and its present position. NaOH-leach omitted from pretreatment of all samples. GSC-939 and GSC-977 mixed with dead gas for counting.

GSC-1124. Aiyansh lava flow — **250 ± 130**; **A.D. 1700**; $\delta C^{13} = -23.5‰$

Cottonwood (*Populus* sp., id. by R. J. Mott) from standing log encased in lava at NE end of flow beside Nass R., British Columbia (55° 13′ N Lat, 129° 08′ W Long). Coll. 1968 by P. Hughan, Aiyansh; subm. by Sutherland Brown, B.C. Dept. Mines and Petroleum Resources, Victoria, and J. G. Souther. *Comments* (A.S.B.): data confirm age of this young basalt flow as suggested by legend and reported age of involuted trees (cf. Sutherland Brown, 1969 and Souther, 1970, where uncorrected date for GSC-1124, 220 ± 130, is reported). (One 3-day count.)

GSC-771. Mt. Edziza (II) **>43,000**

Charred wood, compressed but apparently coniferous (R. J. Mott, pers. commun.), from layer of unconsolidated crystal tuff at base of 240 m-sec. of basalt, Mt. Edziza, British Columbia (57° 41′ N Lat, 130° 47′ W Long), alt ca. 1315 m. Logs up to 25 cm diam. appear to have been killed by and preserved in ash, undisturbed by subsequent erosion. Enclosing tuff is underlain by pre-volcanic erosion surface and overlain by earliest basalt flow from Mt. Edziza. *Comment* (J.G.S.): date is minimum for Mt. Edziza volcanic pile (cf. Souther, 1970 and GSC-566, 1340 ± 130, R., 1967, v. 9, p. 174). (One 4-day count.)

GSC-242. Cape Ball, Queen Charlotte Islands **8620 ± 150**
6670 B.C.

Shells (*Saxidomus giganteus* [Deshayes], id. by F. J. E. Wagner, now at Bedford Inst., Dartmouth, Nova Scotia), from shore cliff 460 m N of mouth of Cape Ball R., E coast of Graham I., Queen Charlotte Is., British Columbia (53° 41′ 30″ N Lat, 131° 53′ 10″ W Long), alt 3 m above present extreme high tide. Shells *in situ* at top of silt beneath ca. 0.6 m gravel and sand of former estuary flat. Coll. 1962 by A. Sutherland Brown. *Comment* (A.S.B.): dates limit of postglacial marine submergence, alt ca. 6 m, on E coast of Queen Charlotte Is. Complete fauna at site indicated shallow marine conditions with water temperature similar to today's (F. J. E. Wagner, written commun.). This contrasts with GSC-292 on W coast (cf. Sutherland Brown, 1968).

GSC-292. Tasu Sound, Queen Charlotte Islands **8060 ± 140**
6110 B.C.

Shell (*Ostrea lurida* [Carpenter], id. by F. J. E. Wagner) from N bank of creek flowing into, and ca. 0.4 km from, N end of Barrier Bay, Tasu Sound, Moresby I., Queen Charlotte Is., British Columbia (52° 47.5′ N Lat, 131° 58′ W Long), est. alt 3.5 m above present mean high sea level. Coll. 1962 by A. Sutherland Brown. *Comment* (A.S.B.): dates postglacial limit of marine submergence on SW coast of Queen Charlotte Is. and indicates uplift of same order as GSC-242 from Cape Ball (above). Fauna at site indicated water temperature warmer than at present and comparable to that of Tillamook Bay, Oregon (F. J. E. Wagner, written commun.), in contrast with GSC-242 on E coast. (One 3-day count.)

C. Northern Canada, Mainland

1. Yukon

GSC-1172. Tombstone Range **9690 ± 200**
7740 B.C.
$\delta C^{13} = -22.7‰$

Organic silt and twigs from 498 to 508 cm depth in permanently frozen bog sediments in tributary valley to North Klondike R., Tombstone Range, Ogilvie Mts., Yukon (64° 27′ N Lat, 138° 27′ W Long), alt between 1370 and 1525 m. Boring on palsa mound from ca. 1.5 m above surrounding surface to 710 cm depth. No core recovered from solid ice at 508 to ca. 509 cm depth or from unfrozen sediments below. Site is inside local limit of widely recognized McConnell Glaciation of central Yukon (Bostock, 1966; Vernon and Hughes, 1966; Hughes *et al.*, 1969), and beyond limit of recent cirque moraines. Coll. 1968 by J. T. Gray, McGill Univ., Montreal. *Comment* (J.T.G.): date is minimum for retreat of last valley glacier from this upper North Klondike tributary to cirque zone above. Date confirms field evidence that no readvance over site occurred since McConnell Glaciation (cf. GSC-470, 11,250 ± 160, ca. 16 km to NE; R., 1968, v. 10, p. 231). NaOH-leach omitted from sample pretreatment. Sample mixed with dead gas for counting.

Antifreeze Pond series

Gyttja, mossy peat, and organic silt in cores retrieved from small lake by Livingstone sampler and bordering bog by Sipre corer; 300 m E of Alaska Hwy. M.P. 1198.5 (62° 21′ N Lat, 140° 50′ W Long), alt 700 m. Coll. 1965 (GSC-496) and 1968 by V. N. Rampton.

GSC-496. Antifreeze Pond, 645 cm **>36,000**

Organic silt from base of 645 cm peat and silt sequence in bog.

29,700 ± 700
GSC-1230. Antifreeze Pond, 622 to 640 cm **27,750 B.C.**

Organic silt from 622 to 640 cm interval of cores from lake.

27,100 ± 390
GSC-1198. Antifreeze Pond, 537 to 552 cm **25,150 B.C.**

Organic silt from 537 to 552 cm interval of cores from lake.

28,500 ± 440
GSC-1257. Antifreeze Pond, 515 to 524 cm **26,550 B.C.**

Organic silt from 515 to 524 cm interval of core from lake.

31,500 ± 700
GSC-1048. Antifreeze Pond, 512 to 532 cm **29,550 B.C.**

Organic silt from 512 to 532 cm interval of core from lake.

13,500 ± 300
GSC-1110. Antifreeze Pond, 398 to 403 cm **11,550 B.C.**

Organic silt from 398 to 403 cm interval of core from lake.

9980 ± 150
GSC-1042. Antifreeze Pond, 317 to 320 cm **8030 B.C.**

Gytjja from 317 to 320 cm interval of core from lake.

GSC-1242. Antifreeze Pond, 293 to 298 cm **8690 ± 160**
6740 B.C.
$\delta C^{13} = -26.5‰$

Gyttja and mossy peat (*Calliergon trifarium, Drepanocladus exannulatus,* and *Scorpidium scorpioides*; id. by M. Kuc) from 293 to 298 cm interval of core from lake. Uncorr. date; 8710 ± 160, used in Rampton (1971b).

GSC-1040. Antifreeze Pond, 250 to 255 cm **5690 ± 140**
3740 B.C.

Gyttja from 250 to 255 cm interval of core from lake.

General Comment (V.N.R.): GSC-496 confirms that drift plain upon which Antifreeze Pond lies is result of pre-late Wisconsin glaciation (cf. Rampton, 1969 and GSC-959; >38,000, R., 1970, v. 12, p. 80). Remaining dates relate to late Quaternary vegetational history of region as reconstructed from pollen assemblages (cf. Rampton, 1969, 1971b). Pollen diagram suggests fell-field or sedge-moss tundra, followed by shrub tundra, was present between ca. 31,000 and 27,000 B.P. (GSC-1230, -1198, -1257, and -1048). Sedge-moss tundra was present until ca. 10,000 B.P. (GSC-1042); pollen percentage of aquatics rose at 13,500 B.P. (GSC-1110). Shrub tundra was present between ca. 10,000 and 8700 B.P. (GSC-1242) when it was replaced by spruce woodland, which was replaced by spruce forest at ca. 5700 B.P. (GSC-1040). Organic silt from pollen-analyzed core was supplemented with material from nearby core to provide enough material for GSC-1230 and GSC-1198. GSC-1257 (from supplemental core) was run as a check on GSC-1048 (from analyzed core). Anomalous dates from below 510 cm interval of cores are believed to result from redeposition of materials via slopewash or thermokarst erosion (cf. Rampton, 1971b). NaOH-leach omitted from pretreatment of all samples except GSC-1230 and GSC-1257, both of which had *cold* NaOH-leach. GSC-1230 and -1110 mixed with dead gas for counting. GSC-496, -1230, and -1042, each based on one 4-day count; GSC-1257 based on one 3-day count.

GSC-1407. Little Scottie Creek **12,000 ± 160**
10,050 B.C.

Peat, ca. 75% undeterminable vascular plant remains, with (*Drepanocladus fluitans, Amblystegium riparium,* and Brachyteciacae cf. *Eurhynchium* sp.; id. by M. Kuc), 8.5 to 8.7 m depth, retrieved by Winkie diamond drill from frozen sediment adjacent to Alaska Hwy. M.P. 1217.5 in valley of Little Scottie Creek, Yukon (62° 34′ N Lat, 140° 57.5′ W Long), alt 575 m. Sample overlain by 7.8 m gyttja and organic silt under 0.7 m surface peat. Coll. 1966 by V. N. Rampton. *Comment* (V.N.R.): although valley is underlain by early Wisconsin outwash (Hughes *et al.*, 1969) date indicates much in-filling occurred in late or post-Wisconsin time. NaOH-leach omitted from sample pretreatment. (One 3-day count.)

GSC-506. Difficult Creek **8860 ± 140** **6910 B.C.**

Wood (*Salix* sp., id. by R. J. Mott) from base of 0.6 m thick peat in old exposure (ground ice slump) on small lake 1.6 km W of head of Difficult Creek, 2.8 km E of Kugaryuk Creek, Yukon (69° 26′ N Lat, 139° 23′ W Long), alt ca. 30 m, ca. 8.8 km SSW of Arctic coast. Coll. 1965 by J. G. Fyles. *Comment* (J.G.F.): date is minimum for mud-flow debris. (One 4-day count.)

2. Northwest Territories

Northwest Garry Island series

Peat and wood from surface blanket of peat up to 1.7 m thick, and from underlying lacustrine sediments ca. 3 m thick, in coastal exposures on NW Garry I., N.W.T. (69° 30′ 05″ N Lat, 135° 47′ 25″ W Long). Deposits occupy small depressions. Peat surface has high-centered polygons. GSC-513 and -517 coll. 1964 by D. E. Kerfoot, Univ. of British Columbia, Vancouver; now at Brock Univ., St. Catharines, Ontario. GSC-516 and -575 coll. 1965 by D. E. Kerfoot, J. R. Mackay, Univ. of British Columbia, Vancouver, and J. G. Fyles.

GSC-513. Garry Island, peat, 1.5 m **4140 ± 140** **2190 B.C.**

Peat from 1.5 m depth in 1.7 m-thick peat sec., top at alt 4.9 m. Sample level, alt 3.4 m, just below change in pollen assemblage suggestive of Hypsithermal Interval (J. C. Ritchie, Scarborough College, West Hill, Ontario, pers. commun.). *Comment* (D.E.K.): polygons show no sign of burial, hence not inundated by sea in last 4000 yr (Kerfoot, 1969). NaOH-leach omitted from sample pretreatment.

GSC-517. Garry Island, peat, 1.1 m **4120 ± 130** **2170 B.C.**

Peat from 1.1 m depth below surface, same site as for GSC-513. Sample, alt 3.8 m, from just above change in pollen sequence which may represent Hypsithermal Interval. *Comment* (J.G.F.): NaOH-leach omitted from sample pretreatment.

GSC-516. Garry Island, peat, 9.4 m **10,330 ± 150** **8380 B.C.**

Peat from 10 cm-thick bed exposed in cliff sec., top alt 13 m, ca. 0.5 km along shore from GSC-513 and -517. Peat, at alt 9.4 m, overlies gravel above stony clay and is overlain, in succession, by 1.2 m marl and silt, 1.5 to 1.8 m gravel (pebble beach), 0.6 m peat, plus some soliflucted material (cf. Kerfoot, 1969, fig. 6). *Comment* (W.B., Jr.): peat is younger than wood from nearby higher-level peat and lacustrine silt deposits on Garry I.: S-278, 11,300 ± 190; S-277, 11,700 ± 250; R., 1968, v. 10, p. 371. NaOH-leach omitted from sample pretreatment. (One 4-day count.)

GSC-575. Garry Island, twigs, 10.7 m **9730 ± 140**
7780 B.C.

Iron-stained twigs and wood fragments from base of gravel, alt 10.7 m, over marl in same sec. as GSC-516. *Comment* (W.B., Jr.): date, with GSC-516, at base of marl and silt unit, indicates time that lacustrine phase existed at site. (One 3-day count).

GSC-562. Northern Garry Island **>35,000**

Marine pelecypod shells (*Astarte borealis, A. montagui* var. *warhami, Mya truncata*; id. by F. J. E. Wagner, Bedford Inst., Dartmouth, N.S.) from top part of sand deposit, 7.5 to 9 m thick, exposed in cliffed headland on N coast Garry I., N.W.T. (69° 30′ N Lat, 135° 40′ W Long). Coll. 1965 by D. E. Kerfoot. *Comments* (D.E.K. and J.G. Fyles): shells well preserved with periostracum intact, not believed reworked despite absence of hinged specimens. Enclosing sands form marine terrace representing relative sea level 9 to 15 m above present, following withdrawal of last glacier to reach outer Mackenzie Delta area. GSC-690 (>37,000, this list) dates shells from terrace at same level 16 km to SE; (W.B., Jr.): due to computer error, date 1st reported as >42,600; cf. Kerfoot (1969). Sample mixed with dead gas for counting. (One 3-day count).

GSC-690. S of Kendall Island **>37,000**

Whole shells and fragments (*Astarte borealis*) with waterworn wood fragments, from sand and gravel 6 to 7.5 m above lake, alt ca. sea level, in terrace deposit on unnamed island 16 km S of Kendall I., N.W.T. (69° 21′ N Lat, 135° 22′ W Long). Terrace, surface alt ca. 9 m, is part of extensive terrace, probably estuarine, along W side Richards I. and at same height as equivalent terrace on NE side Garry I. (cf. GSC-562, >35,000, this list). Coll. 1966 by J. G. Fyles. *Comment* (J.G.F.): shells *probably* not reworked, as they are fresh-appearing with periostracum intact on many, although hinged specimens not found. Assoc. wood probably reworked. Terrace interpreted as representing former sea level ca. 9 m higher (relative to land) than present following withdrawal of last glacier ice to reach outer Mackenzie Delta area (cf. Fyles, 1967). Due to computer error date 1st given as >42,600. (One 3-day count.)

GSC-549. Richards Island **>40,400**

Wood (*Picea* sp.; id. by R. J. Mott) from 143 (?) to 152 (?) m below surface in B.A.-Shell-Imperial Reindeer D-27 oil well ca. 12 km NNE from S tip of Richards I., 1.6 km NW of East Channel, Mackenzie R., N.W.T. (69° 06′ 05″ N Lat, 134° 36′ 54″ W Long). At surface, gravel (esker?) appears to overlie interglacial sand. Coll. 1965 by J. H. Manning, British Am. Oil Ltd., Edmonton; subm. by J. G. Fyles. *Comment* (J.G.F.): date suggests subsurface gravel at S end Richards I. are >40,000 yr old. (One 3-day count.)

GSC-1214. Peninsula Point **12,800 ± 180**
10,850 B.C.
δC^{13} = –25.5‰

Peat, near base of 1.5 m-thick mud flow colluvium overlying sand, underlying 0.6 m lacustrine silt in wave-dissected pingo at Peninsula Point, ca. 7.6 km SW of Tuktoyaktuk, N.W.T. (69° 24.5′ N Lat, 133° 09′ W Long). Coll. 1966 by J. G. Fyles; subm. by V. N. Rampton. *Comment* (V.N.R.): dates local melting of permafrost before deposition of mud-flow debris and start of lake phase. NaOH-leach omitted from sample pretreatment. Sample mixed with dead gas for counting.

GSC-1050. Castle Bluff **4390 ± 130**
2440 B.C.
δC^{13} = –23.4‰

Wood (*Picea* sp. or *Larix* sp..; id. by R. J. Mott) from near base of 3 m colluvium in 15 m-high sea-cliff exposure of drained thaw pond near Castle Bluff, Wood Bay, N.W.T. (69° 47′ 20″; N Lat, 128° 48′ W Long). Coll. 1966 by J. G. Fyles. *Comment* (J.G.F.): dates tree 16 km beyond present N limit of trees. (One 4-day count.)

Cape Bathurst series

Wood and shells from ca. 3 m-thick marine clay unit underlying ca. 1.5 m silty sand and up to 2.5 m surface peat in shore bluff ca. 5 m high 11 km SE of Cape Bathurst, N.W.T. (70° 31′ N Lat, 127° 48′ W Long). Coll. 1965 by J. G. Fyles.

GSC-478. Cape Bathurst (I) **>32,800**

Shells (*Yoldia arctica*). Because of small sample (8.0 g), HCl-leach omitted from pretreatment. Sample mixed with dead gas for counting. (One 3-day count.)

GSC-545. Cape Bathurst (II) **>41,000**

Wood (*Picea* or *Larix*, prob. *Picea* sp.; id. by R. J. Mott) from alt ca. 1.2 m in marine clay. (One 5-day count.)

General Comment (J.G.F.): marine clay exposed above sea level throughout much of unglaciated Cape Bathurst-Baillie I. region (Fyles, 1966; Rampton, 1971a). Assuming wood is not reworked, GSC-545 indicates clays were deposited >41,000 yr ago.

Horton River series

GSC-1100. Horton River **>41,000**

Peat beneath ca. 12 m of till and overlying 2 till units ca. 20 m thick, exposed in 45 m bank along W tributary of Horton R. (69° 13′ N Lat, 127° 03′ W Long), alt ca. 205 m. Coll. 1968 by R. W. Klassen. *Comment* (R.W.K.): date records non-glacial interval of interstadial or interglacial rank preceding at least last glaciation of Smoking Hills

Upland; an early or pre-Wisconsin age for lowest till is suggested. NaOH-leach omitted from sample pretreatment. (One 3-day count.)

GSC-576. Horton River **>38,100**

Wood (*Picea* or *Larix* sp., id. by R. J. Mott) assoc. with peat within interbedded, cross-laminated sand and silt, beneath ca. 18 m clay(?) exposed along W tributary Horton R. (69° 12′ N Lat, 127° 05′ W Long), alt ca. 205 m. Coll. 1965 by D. Waylett, Imperial Oil, Edmonton; subm. by J. G. Fyles. *Comment* (R.W.K.): wood appears to be from same unit as GSC-1100, ca. 1.6 km to E. Overlying 'clay' probably includes at least one till, suggesting unit records a non-glacial interval of interstadial or interglacial rank (Fulton and Klassen, 1969).

GSC-1099. Kelly Lake **8880 ± 150**
6930 B.C.

Wood in peat from surface of lake clay and silt 8 km SW of Kelly Lake, 24 km N of Norman Wells, N.W.T. (65° 29′ N Lat, 126° 34′ W Long), at 1 m depth, overlain by marl and clay, exposed by landslide. Coll. 1968 by R. J. Fulton. *Comment* (R.J.F.): wood and peat appear to have accumulated in a thermokarst lake basin formed in glacial-lake silt. Date is minimum for deglaciation, for draining of a glacial lake, and for penetration of glacial lake sediments by permafrost.

GSC-1251. Paulatuk **1030 ± 140**
A.D. 920
$\delta C^{13} = -26.3‰$

Peat from windblown sand at S side of "water lake" at Paulatuk, N.W.T. (69° 20′ N Lat, 124° 06′ W Long), 1.2 m below surface of hill-slope formed by sand transported by strong N-blowing winter katabatic winds (Mackay, 1958). Upper slopes have excellent ventifacts. Coll. 1968 by J. R. Mackay. *Comment* (J.R.M.): date helps establish rate of deflation and abrasion by gravity winds. NaOH-leach omitted from sample pretreatment. Sample mixed with dead gas for counting. (One 3-day count.)

GSC-1139. Erly Lake **10,800 ± 150**
8850 B.C.

Peaty moss (*Drepanocladus exannulatus, Calliergon sarmentosum,* and *Scorpidium scorpioides*; id. by M. Kuc) enclosed in sandy silt from top of 20 m high pingo 21 km W of Erly Lake, N.W.T. (68° 14′ N Lat, 122° 38′ W Long). Organic material from 2 m thick lake sediment overlying gravelly till. M. Kuc reports (pers. commun.) that bryophytes are assemblage of permanently submerged species. Coll. 1968 by R. J. Fulton. *Comment* (R.J.F.): it was hoped that date would indicate time required for construction of this fresh-appearing pingo; result sheds little light on age of pingo but gives indication of time of deglaciation. (One 3-day count.)

GSC-1086. Amer Lake

2540 ± 130
590 B.C.
$\delta C^{13} = -24.0‰$

Peat, 2.5 m below surface in hillside gully, S shore unnamed lake 16 km SW of Amer Lake, N.W.T. (65° 33′ N Lat, 97° 37′ W Long), alt ca. 140 m. Water pump used to cut gully through permanently frozen sand; local permafrost table at 45 cm. Gully exposed strata-bound peaty lenses. Coll. 1968 by B. C. McDonald. *Comment* (B.C.M.): sediment had been interpreted as subaqueous deposit relating to a higher local water level; date might have approximated time of deglaciation. Young date indicates sand and peat were deposited by solifluction. NaOH-leach omitted from sample pretreatment.

Southampton Island series

Marine shells from 2 localities on Southampton I., N.W.T. Coll. 1966 by J. B. Bird, McGill Univ., Montreal.

GSC-782. Southampton Island (I)

6930 ± 150
4980 B.C.

Pelecypod shell fragments (mainly *Mya truncata*) from surface of crest of end moraine, N-central Southampton I., N.W.T. (64° 43′ N Lat, 84° 46′ W Long), alt 115 m. Sample mixed with dead gas for counting. (One 3-day count.)

GSC-838. Southampton Island (II)

6890 ± 210
4940 B.C.

Shells (*Mya truncata*) in sand and gravel 20 km NE of Coral Harbour, E-central Southampton I., N.W.T. (64° 17′ N Lat, 82° 57′ W Long), alt ca. 145 m. Due to small sample (6.1 g), only outer 10% removed by leaching. Sample mixed with dead gas for counting. (One 4-day count.)

General Comment (J.B.B.): samples, from within 15 m of limit of postglacial marine submergence in both localities, are compatible with similar dated samples on Southampton I. and on mainland to W and NW (Bird, 1970; cf. also Craig, 1965; Wagner, 1967). They indicate most of island was deglaciated between 7500 and 7000 B.P.

GSC-1024. 'Widestrand Bay', Gilmour Island

6450 ± 140
4500 B.C.

Articulated marine shells (*Mytilus edulis*) *in situ* between beds of marine algae on Gilmour I., Ottawa Is., N.W.T. (49° 47′ N Lat, 79° 49.4′ W Long), in stream sec. at alt 33 m; 8 m marine algae overlain by 9 m delta foresets. Coll. 1966 by J. T. Andrews and G. Falconer, Geog. Branch, Ottawa (now at Univ. of Colorado, Boulder, Colorado, and Surveys and Mapping Branch, Ottawa, respectively). *Comment* (J.T.A. and G.F.): age similar to marine shells from 39 m in foreset beds (6580 ± 125, I-2416; Andrews, 1967; Andrews and Falconer, 1969; R., 1970, v. 12, p. 100). Both appear too old for 50-m terrace, compared to date of 4960 ± 130 (I-2547: *ibid.*), believed to date that level and lying on postglacial emergence curve for Ottawa Is. (One 3-day count.)

D. Northern Canada, Arctic Archipelago

1. Baffin Island

GSC-943. Clyde Inlet **1780 ± 130**
170 B.C.
$\delta C^{13} = -27.2‰$

Detrital vegetation among cobbles from base of sequence of peat, sand, and gravel, 0.8 km N of head of Clyde Inlet, Baffin I., N.W.T. (69° 51′ N Lat, 70° 28′ W Long), alt 43 m. Sequence is overlain by a 10 cm-thick layer of bluish clayey silt, and 2.6 m sand and peat, base of which dated 1860 ± 110 (I-1835, Andrews, 1967). Coll. 1965 by D. M. Barnett. *Comment* (D.M.B.): age younger than anticipated, indicating little significance for clayey silt layer, which possibly is slump material. No part of sequence can be marine, as no marine shells were found and dates are incompatible with I-1932, 7940 ± 130, on shells at 47 m (marine limit, 56 m) from adjacent glacio-marine delta (Andrews, 1967; R., 1970, v. 12, p. 98) and with other dates at head of Clyde Inlet: GSC-583 (2770 ± 140), and GSC-584 (3450 ± 170), marine shells and plant debris, respectively, both at alt 6 m, and GSC-631 (6220 ± 140), shells at alt 29 m (all in R., 1968, v. 10, p. 238). NaOH-leach omitted from sample pretreatment. (One 3-day count.)

GSC-796. Clyde Foreland **40,000 ± 1740**
38,050 B.C.

Fragments of marine pelecypods (*Hiatella arctica* and *Mya truncata*) from cliff sec. 10 km SE of mouth of Kogalu R., Baffin I., N.W.T. (70° 38′ N Lat, 68° 45′ W Long), alt 27 to 29 m. Shells occur above highest till; also *Serripes groenlandicus, Astarte elliptica, A. borealis, A. banksii, Macoma calcarea, Chlamys islandicus,* and *Balanus balanus*. In same layer is foraminiferal fauna characterized by high frequency of *Islandiella islandica* with I. *teretis, Buccella frigida, B. tenerrima,* and *Protelphidium orbiculare* commonly represented. Coll. 1966 by R. W. Feyling-Hanssen, Aarhus Univ., Aarhus, Denmark. *Comments* (R.W. F.-H.): fossil faunas and date indicate a Wisconsin interstadial age, more precisely, the Port Talbot interstadial. Absence of overlying till suggests late Wisconsin ice did not reach this locality. Lower layers in Clyde Foreland coastal cliff at Cape Christian dated as >50,000 B.P. (Y-1702; Løken, 1966). (W.B., Jr.): despite finite date, possibility of sample being of infinite age cannot be excluded (cf. Olsson and Blake, 1962; also Ives and Buckley, 1969 for discussion of GSC-796).

Inner Cambridge Fiord series

Marine pelecypod shells from 2 localities near head of Cambridge Fiord, Baffin I., N.W.T. Coll. 1968 by G. M. Haselton, Clemson Univ., Clemson, South Carolina, and D. A. Hodgson.

GSC-1094. Cambridge Fiord (I) **6330 ± 140**
4380 B.C.

Shells (*Hiatella arctica*) from surface and within marine silt forming remnant of marine terrace, alt 32 m on W side of fiord, 8 km from head (71° 15′ N Lat, 74° 58′ W Long). Local marine limit ca. 90 m.

GSC-1163. Cambridge Fiord (II) **5500 ± 180**
3550 B.C.
$\delta C^{13} = +0.7‰$

Whole shells (*Hiatella arctica* and *Mya truncata*) from marine silt band, alt 29 m, within deltaic deposits, surface at ca. 31 m, at E front of sandur on S arm, head of Cambridge Fiord (71° 11′ N Lat, 75° 03′ W Long). Main and highest surface of sandur has alt 44 m at front.

General Comment (D.A.H.): samples are SE (inside) of inner, most distinctive ridge of moraine belt crossing heads of fiords in NE Baffin I.; dates are minimum for deglaciation (Hodgson and Haselton, ms. in preparation). Due to small sample (13.5 g), only outer 10% of GSC-1163 removed by leaching. Both samples mixed with dead gas for counting. (One 3-day count and one 2-day count, respectively.)

'Mid-fiord' series

GSC-1060. Kentra Bay **8090 ± 140**
6140 B.C.

Marine pelecypod shells (*Hiatella arctica* and *Mya truncata*) within marine silt, alt 77 m, 4 km SW of head of Kentra Bay, Royal Society Fiord, Baffin I., N.W.T. (71° 17′ N Lat, 74° 15′ W Long). Local marine limit at alt ca. 90 m. Coll. 1968 by D. A. Hodgson and G. M. Haselton.

GSC-1064. Ranoch Arm **7890 ± 160**
5940 B.C.

Marine pelecypod shells (*Hiatella arctica* and *Mya truncata*) from frost boil in silt on uppermost terrace remnant, alt 74 km at head of Ranoch Arm, Cambridge Fiord, Baffin I. (71° 27′ N Lat, 75° 08′ W Long). Coll. 1968 by G. M. Haselton.

General Comment (D.A.H. and G.M.H.): both samples are from highest remnants of outwash on NE margin (*i.e.*, outside) of moraine belt crossing heads of fiords in NE Baffin I. Dates are minimal for formation of oldest moraines (Hodgson and Haselton, ms. in preparation). Sample GSC-1064 mixed with dead gas for counting. (One 3-day count each.)

GSC-1071. 'Pilik River' **2650 ± 130**
700 B.C.
$\delta C^{13} = -24.1‰$

Plant material from 0.3 m-thick layer, 3 m below rim of gully in stratified sand, downslope from ice-contact delta on N bank of 'Pilik River', Baffin I., N.W.T. (71° 21′ N Lat, 77° 19′ W Long). Coll. 1968 by D. A. Hodgson. *Comment* (D.A.H.): organic bed grades down-gully to laminated silt; material originally thought to have been laid down in proglacial lake. Buds, leaves, and roots (*Salix* sp. and *Empetrum* sp.), 4 mosses and 2 lichens (M. Kuc, pers. commun.), all well-preserved components of dry or moist dwarf shrub tundra, indicate that material is 'fossilized *in situ*' and represents buried tundra. (One 3-day count.)

GSC-1090. Cape Jameson **>28,000**

Thick whole valves of marine pelecypods (*Hiatella arctica*), alt ca. 43 m in river-bank exposure of marine silt, 300 m from present shoreline, 9 km S of Cape Jameson, Baffin I., N.W.T. (72° 00′ N Lat, 74° 10′ W Long). Coll. 1968 by D. A. Hodgson and G. M. Haselton. *Comment* (D.A.H.): surface above river bank dissected by marginal meltwater channels beside ice expanding onto continental shelf and foreland from Coutts Inlet-North Arm. Shells emplaced prior to glaciation. Due to small sample (9.3 g), only outer 10% removed by leaching. Sample mixed with dead gas for counting. Dated in 2-L counter at 1 atm.

Pond Inlet series

Marine pelecypod shells exposed in sea cliffs at 2 localities near Pond Inlet settlement, Baffin I., N.W.T.

GSC-1153. Pond Inlet (I) **33,100 ± 900**
31,150 B.C.

Thick fragments (*Hiatella arctica* and *Mya truncata*) in stratified sand and silt exposed in cliff face, alt 49 m (cliff top alt 54 m), 0.8 km SW of Pond Inlet settlement (72° 41′ N Lat, 78° 00′ W Long). Coll. 1968 by D. A. Hodgson. (One 2-day count.)

GSC-1215. Pond Inlet (II) **>29,000**

Thin fragments (*Mya truncata* and unidentified pelecypod) in unsorted sand and gravel exposed at cliff top, alt 30 m, 7 km, E of Pond Inlet settlement (72° 42′ N Lat, 77° 50′ W Long). Coll. 1968 by D. A. Hodgson and G. M. Haselton. Mixed with dead gas for counting.
General Comment (D.A.H.): both samples probably transported by glacier, then reworked by water as postglacial beach ridges extend to alt 55 m 16 km to W. Cliff material considered outwash from ice front retreating S and W.

2. Devon and North Kent Islands

GSC-1072. Boat Point **5250 ± 130**
3300 B.C.
$\delta C^{13} = -22.2‰$

Driftwood (*Picea* sp., id. by R. J. Mott) embedded in shingle beach 4 km SSW of Boat Point, Devon I., N.W.T. (75° 58.5′ N Lat, 89° 58′ W Long), alt 26.5 m. Coll. 1967 by W. Blake, Jr. *Comment* (W.B., Jr.): wood occurs <0.6 m above pumice piece of type widely distributed around W end of Jones Sound; date, with series for Cape Storm and South Cape Fiord, Ellesmere I. (this list), indicates age of pumice is close to 5000 yr (Blake, 1970). (One 3-day count.)

GSC-1128. Lyall River **8430 ± 140**
6480 B.C.

Marine pelecypod shells (*Mya truncata*) from surface, W side Lyall

R., ca. 10 km SW of Whitmore Point, Grinnell Peninsula, Devon I., N.W.T. (76° 57.5′ N Lat, 95° 22′ W Long), alt 94 ±5 m. Coll. 1967 by W. W. Nassichuk for W. Blake, Jr. *Comment* (W.B., Jr): dated shells, within 30 m of marine limit, are minimum for deglaciation of N Grinnell Peninsula. (One 3-day count.)

GSC-907. North Kent Island **9780 ± 200**
7830 B.C.

Pelecypod-shell fragments (mainly *Hiatella arctica* and *Mya truncata*) in and on surface of reddish brown silt, W side of unnamed river 6.5 km WSW of DeLacy Head, North Kent I., N.W.T. (76° 49′ N Lat, 90° 13′ W Long), alt ca. 95 to 107 m. Coll. 1967 by W. Blake, Jr. *Comment* (W.B., Jr.): shells, poorly preserved (none whole, considerable wearing and pitting) are older than those at Lyall R. (GSC-1128; 8430 ± 140) and Okse Bay (GSC-840; 8590 ± 150), both in this list, although all samples are from similar alt. Possibility that postglacial shells are mixed with older shells plastered onto N coast of island by ice flowing toward SE cannot be excluded. Sample mixed with dead gas for counting.

3. Ellesmere Island

GSC-865. Goose Fiord **>34,000**

Marine shell fragments (mainly *Hiatella arctica*) in till on ground surface ca. 10 km NNW of head of Goose Fiord, Ellesmere I., N.W.T. (76° 54′ N Lat, 88° 38′ W Long), alt ca. 98 to 101 m. Coll. 1967 by W. Blake, Jr. *Comment* (W.B., Jr.): date is minimum for shells believed transported inland by ice flowing through low valley from Norwegian Bay to Goose Fiord during last glacial maximum (Blake, 1970). Sample mixed with dead gas for counting. (One 4-day count.)

Muskox Fiord series (I)

GSC-879. Muskox Fiord, peat **4830 ± 160**
2880 B.C.

Peat (mainly *Drepanocladus badius* [C. J. Hartm.], id. by G. R. Brassard, Univ. of Ottawa, Ottawa), from steeply dipping layers exposed on surface of sand deposit along creek ca. 7.2 m NW of head of Muskox Fiord, Ellesmere I., N.W.T. (76° 40.5′ N Lat, 87° 45′ W Long), alt ca. 95 m. Coll. 1967 by W. Blake, Jr. Two fractions (cf. R., 1970, v. 12, p. 49):

more soluble in NaOH (two 1-day counts)	4830 ± 160
less soluble in NaOH (one 4-day count)	4700 ± 130

Comment (W.B., Jr.): date indicates section of valley above and 0.8 km NW of highest postglacial marine features was ice free by 4800 yr B.P. NaOH-soluble fraction mixed with dead gas for counting.

GSC-864. Muskox Fiord, shells **>28,000**

Fragments of marine pelecypods (*Hiatella arctica, Mya truncata,* and *Macoma* sp.) from surface and embedded in till ca. 1 km NW of head of Muskox Fiord, Ellesmere I., N.W.T. (76° 37′ N Lat, 87° 36′

W Long), alt ca. 165 to 185 m. Coll. 1967 by W. Blake, Jr. *Comment* (W.B., Jr.): dated shells, high above limit of postglacial marine submergence in area (ca. 90 m), were emplaced by valley glacier flowing S across former marine embayment N of head of Muskox Fiord. Due to lab. error for this small sample (11.1 g), outer 40% of shell was removed by leaching instead of 10%. Sample mixed with dead gas for counting. (One 4-day count.)

Cape Storm series (I)

Driftwood logs, id. by R. J. Mott, from emerged beaches ca. 5 to 6.5 km NNE of Cape Storm, Ellesmere I., N.W.T. Coll. 1967 by W. Blake, Jr.

GSC-845. C. Storm, wood, 71.0 m — **8300 ± 140**
6350 B.C.
$\delta C^{13} = -23.5‰$

Picea sp. (76° 24.5′ N Lat, 87° 33′ W Long).

GSC-873. C. Storm, wood, 50.5 m — **7700 ± 140**
5750 B.C.
$\delta C^{13} = -21.4‰$

Picea sp. (76° 23.5′ N Lat, 87° 35′ W Long). Uncertainty mistakenly given as ± 150 in Blake (1970).

GSC-835. C. Storm, wood, 43.5 m — **7280 ± 140**
5330 B.C.
$\delta C^{13} = -20.5‰$

Picea sp. (76° 24′ N Lat, 87° 32′ W Long).

GSC-833. C. Storm, wood, 33.5 m — **6480 ± 140**
4530 B.C.
$\delta C^{13} = -23.2‰$

Picea sp. (76° 24′ N Lat, 87° 31′ W Long).

GSC-1007. C. Storm, wood, 31.5 m — **6150 ± 130**
4200 B.C.
$\delta C^{13} = -21.3‰$

Picea or *Larix* (76° 24.5′ N Lat, 87° 31′ W Long). Two determinations:

one 4-day count in 5-L counter at 1 atm.	6150 ± 130
one 1-day count of same gas in 2-L counter at 1 atm	6120 ± 190

GSC-928. C. Storm, wood, 27.5 m — **5720 ± 140**
3770 B.C.
$\delta C^{13} = -22.7‰$

Picea or *Larix* (76° 24′ N Lat, 87° 31′ W Long).

GSC-986. C. Storm, wood, 24.0 m — **5200 ± 140**
3250 B.C.
$\delta C^{13} = -23.6‰$

Picea or *Larix* (76° 22.5′ N Lat, 87° 32′ W Long).

GSC-826. C. Storm, wood, 22.5 m **5100 ± 130**
3150 B.C.
$\delta C^{13} = -21.7‰$

Picea or *Larix* (76° 24′ N Lat, 87° 30′ W Long). (One 4-day count.)

GSC-921. C. Storm, wood, 20.5 m **4640 ± 130**
2690 B.C.
$\delta C^{13} = -22.9‰$

Picea sp. (76° 22.5′ N Lat, 87° 32′ W Long).

GSC-839. C. Storm, wood, 17.5 m **4390 ± 130**
2440 B.C.
$\delta C^{13} = -23.2‰$

Picea sp. (76° 23′ N Lat, 87° 30′ W Long).

General Comment (W.B., Jr.): dates on logs embedded in shingle beaches show rate of uplift decreasing with time. GSC-826, ca. 0.5 m above level of abundant pumice, indicates (with dates from South Cape Fiord and Boat Point, this list) pumice is ca. 5000 yr old (Blake, 1970). (GSC-835, -845, -921, -928, and -986 each based on one 3-day count.)

'Basement Cove' series

Driftwood and marine algae embedded in shingle beaches at 'Basement Cove', ca. 18 km ESE of mouth of Baad Fiord, Ellesmere I., N.W.T. (76° 21.5′ N Lat, 85° 43′ W Long). Coll. 1967 by W. Blake, Jr.

GSC-823. 'Basement Cove', driftwood **5740 ± 140**
3790 B.C.
$\delta C^{13} = -22.7‰$

Driftwood (*Picea* or *Larix*, id. by R. J. Mott) embedded in surface of beach shingle, alt 19.0 m.

GSC-863. 'Basement Cove', marine algae **4740 ± 140**
2790 B.C.
$\delta C^{13} = -18.4‰$

Marine algae (*Desmarestia* sp., id. by R. K. S. Lee, Natl. Mus. Nat. Sci., Ottawa) embedded in layer at 0.6 to 0.7 m depth in beach gravel, alt 14.0 m.

General Comment (W.B., Jr.): dates indicate that shoreline formed ca. 5000 yr ago (= time of pumice deposition, Blake, 1970) is between alts of 2 samples.

South Cape Fiord series (I)

Driftwood logs, id. by R. J. Mott, on W side of South Cape Fiord, Ellesmere I., N.W.T. (76° 26′ N Lat, 85° 00′ W Long). Coll. 1968 by W. Blake, Jr.

GSC-1225. South Cape Fiord, wood, 42.0 m **7270 ± 140**
5320 B.C.
$\delta C^{13} = -19.0‰$

Picea sp.

GSC-1080. South Cape Fiord, wood, 31.0 m **6680 ± 140**
4730 B.C.
δC^{13} = –24.3‰

Picea sp.

GSC-1047. South Cape Fiord, wood, 17.0 m **4710 ± 140**
2760 B.C.
δC^{13} = –22.7‰

Picea sp.

GSC-1078. South Cape Fiord, wood, 16.0 m **4350 ± 130**
2400 B.C.
δC^{13} = –24.2‰

Picea sp.

GSC-1148. South Cape Fiord, wood, 12.5 m **3690 ± 130**
1740 B.C.
δC^{13} = –21.6‰

Picea or *Larix*.

GSC-1320. South Cape Fiord, wood, 6.0 m **2750 ± 130**
800 B.C.
δC^{13} = –23.6‰

Picea sp.

General Comment (W.B., Jr.): dates on logs embedded in shingle beaches (except for GSC-1320, which was lying loose adjacent to its imprint) show decreasing rate of uplift with time. GSC-1047, ca. 0.3 m below average alt of pumice at locality, corroborates dates from Boat Point and Cape Storm (this list), suggesting pumice is ca. 5000 yr old (Blake, 1970). (GSC-1047, -1078, and -1080 each based on one 3-day count.)

GSC-840. Okse Bay **8590 ± 150**
6640 B.C.

Pelecypod shell fragments (*Hiatella arctica* and *Mya truncata*) from surface and embedded in sand and silt of sorted polygons 1.6 km W of Okse Bay, Ellesmere I., N.W.T. (77° 07′ N Lat, 87° 42′ W Long), alt ca. 107 m. Coll. 1967 by W. Blake, Jr. *Comment* (W.B., Jr.): date on shells, highest coll. in area, is minimum for deglaciation, and is approx. age of highest postglacial marine features.

GSC-1206. Macdonald River **>37,000**

Driftwood, poorly preserved (probably *Thuja* sp., id. by R. J. Mott) 4 cm diam., 30 cm long, from NE side of Macdonald R., Tanquary Fiord, Ellesmere I., N.W.T. (81° 25′ N Lat, 76° 15′ W Long) in postglacial delta, 5 m below top of 78 m high river bank. Wood enclosed in, and 30 cm below top of, foresets dipping downriver, which are overlain by 3.25 m eolian sand and peat, the latter 2970 ± 130 yr old (SI-575; Mielke and Long, 1969). It was hoped that wood age would provide check on dated marine shells in vicinity (Hattersley-Smith and Long, 1967). Coll. 1969 by G. Hattersley-Smith, Defence Research Bd., Ottawa. *Comment* (G.H-S.): driftwood was transported from up-river. Other wood pieces, probably deriving from Beaufort Formation, occur in Macdonald R. valley up to alt 570 m, Hattersley-Smith, 1969).

4. Other Islands

GSC-1138. Thompson Glacier, Axel Heiberg Island **5690 ± 140** **3740 B.C.**

Driftwood embedded in silt and clay of morainic deposits, distal part of push moraine of advancing Thompson Glacier, Axel Heiberg I., N.W.T. (79° 25′ 30″ N Lat, 90° 37′ W Long), alt ca. 95 m. Original location of sample estimated ca. 0.8 km up-valley, in area now covered by Thompson Glacier. Coll. 1968 by A. Gansser, ETH, Zurich, Switzerland; subm. by F. Müller. *Comment* (F.M.): date agrees with others on driftwood (B-431, 5480 ± 100; B-432, 5920 ± 100; GX-0144, 5325 ± 227) assoc. with same push moraine. Some 6000 to 5000 yr ago, sea extended up-valley from present position of Thompson Glacier terminus. Vertical uplift by bulldozing effect of glacier amounts to ca. 50 m (cf. Müller, 1963; 1966).

GSC-619. Meighen Island **8610 ± 190** **6660 B.C.**

Marine pelecypod shells (mainly *Hiatella arctica*) from S of ice-cap on Meighen I., N.W.T. (79° 44.7′ N Lat, 98° 46′ W Long), alt ca. 12 m. Coll. 1962 by K. C. Arnold (now with Inland Waters Branch, Dept. Energy, Mines and Resources, Ottawa); subm. by J. G. Fyles. *Comment* (W.B., Jr.): date, only one from Meighen I. is minimum for deglaciation and is similar to dates on Ellef Ringnes I. to SW (St-Onge, 1965). Date may approx. age of highest postglacial marine features, which, according to Fyles (cf. Blake, 1970), are probably <30 m alt. Sample mixed with dead gas for counting.

GSC-999. Cape Nathorst, Ellef Ringnes Island **8320 ± 140** **6370 B.C.**

Driftwood log (*Picea* or *Larix*, id. by R. J. Mott), ca. 20 cm diam., embedded and frozen in disintegrated shale, 12 km NE of C. Nathorst, Ellef Ringnes I., N.W.T. (77° 52′ 45″ N Lat, 99° 38′ W Long), at alt 25 ±5 m. Coll. 1967 by D. A. St-Onge. *Comment* (D.A. St.-O): date confirms L-643A, 8500 ± 200, on surface shells at ca. 33 m nearby to NE (St-Onge, 1965; Blake, 1970). (One 3-day count.)

GSC-1193. Resolute, Cornwallis Island **7380 ± 140** **5430 B.C.**
$\delta C^{13} = -14.8‰$

Whale bone (vertebra) embedded in sand and gravel of shingle beach ca. 1.6 km NW of Eskimo Village at Resolute, Cornwallis I., N.W.T. (74° 42′ N Lat, 94° 59′ W Long), at alt ca. 50 m. Coll. 1968 by F. Müller, McGill Univ., Montreal. Two determinations:

GSC-1193. Collagen fraction 7380 ± 140

Treated in 0.1 N NaOH for 24 hr.

GSC-1193-2. Collagen fraction 7570 ± 140

Treated in 0.1 N NaOH for 1 hr.

Comment (W.B., Jr.): date, with 2 on shells near Resolute (Blake, 1970), indicates that following deglaciation, rate of uplift has decreased with time. Much of porous and discolored (brown) bone contained fragments of moss, rootlets, and other organic material. Sample cut into small pieces and washed in distilled water to remove organic material by flotation. (One 3-day count each.)

Caledonian River series, Bathurst Island

Shell fragments (*Mya truncata*) from layers containing many paired individuals *in situ*, in exposure on N side Caledonia R., 0.8 km E of head of 'Dartmouth Bight', Bracebridge Inlet, Bathurst I., N.W.T. (75° 41′ N Lat, 98° 48′ W Long). Coll. 1963 by W. Blake, Jr.

GSC-783. Caledonian River, upper shell layer **4750 ± 140**
2800 B.C.

Shells from zone at alt ca. 25 m overlying silt and underlying 0.6 to 2 m sand and gravel.

GSC-736. Caledonian River, lower shell layer **7670 ± 150**
5720 B.C.

Shells from zone at alt ca. 23 m, underlying silt and overlying ca. 5 m gravel above ca. 12 m sand and silt with organic layers in upper part.

General Comment (W.B., Jr.): occurrence of 2 shell-bearing sand and gravel layers separated by silt suggests water depth increased or character of sedimentation changed during 3000 yr interval separating 2 deposits. Shoreline 5000 yr ago was above 25 m (Blake, 1970). GSC-736 mixed with dead gas for counting. (One 3-day count.)

Fitzwilliam Owen Island series

Marine shells and driftwood, S side of Fitzwilliam Owen I., N.W.T. (77° 08′ N Lat, 113° 48′ W Long). Coll. 1968 by M. Kuc.

GSC-1123. Fitzwilliam Owen Island, shells **10,100 ± 150**
8150 B.C.

Whole shells and fragments (*Hiatella arctica*) from horizon, alt ca. 20 m, widespread up to ca. 25 m alt, within summit depression of island (between highest hills, which rise to ca. 37 m). Shell horizon overlain and underlain by marine silt and clay containing sand lentils. (One 3-day count.)

GSC-1171. Fitzwilliam Owen Island, wood **7850 ± 140**
5900 B.C.
$\delta C^{13} = -22.8‰$

Upright driftwood log (*Picea* or *Larix*, probably *Larix* sp.; id. by R. J. Mott), in marine silt and clay, alt ca. 10 m. Occurrence, on flat area partly modified by solifluction at foot of steep slope, is highest driftwood found on island.

General Comment (W. B., Jr.): date on shells indicates island was ice-free 10,000 yr ago; oldest postglacial dates on shells from nearby areas are 11,160 ± 150 (GSC-260) for NE Prince Patrick I. and 10,580 ± 260 (GSC-352) for SE Borden I. (both in R., 1967, v. 9, p. 193). Date on wood indicates considerably less uplift occurred in last 7700 to 8000 yr than in areas to E that were covered by thicker ice (Blake, 1970). For development of vegetation see Kuc (1971).

E. Svalbard

Vestre Tvillingneset series, Nordaustlandet

Driftwood from W side of Vestre Tvillingneset, Nordaustlandet, Svalbard (80° 02.5′ N Lat, 18° 08′ E Long), alt between 7 and 8 m. Coll. 1958 (GSC-1117) and 1966 (GSC-1345) by W. Blake, Jr.

GSC-1117. Vestre Tvillingneset, 8-1958 — **6240 ± 160**, **4290 B.C.**, $\delta C^{13} = -21.2‰$

Driftwood (*Larix* sp.) log embedded in beach gravel and sand, only log coll. at site in 1958. Original date by Uppsala Univ. was 6200 ± 100 (U-107; Olsson, 1960; Blake, 1961); date recalculated using .95 of activity of NBS oxalic acid as standard was 6330 ± 110 (I. U. Olsson, 1966, written commun.). However, age obtained on part of sample sent to Gakushuin Univ., was 6910 ± 140 (Gak-1909; based on one 19-hr count (K. Kigoshi, 1968, written commun.). (Three 1-day counts in 5-L counter at 1 atm.)

GSC-1345. Vestre Tvillingneset, 193-1966 — **6390 ± 140**, **4440 B.C.**, $\delta C^{13} = -22.0‰$

Re-collection of same log (one of several in area, but only one had been sawed and coll. in 1958) in 1966. Three age determinations, all using same gas (cf. Table 2, this list):

two 1-day counts in 5-L counter at 1 atm	6390 ± 140
two 1-day counts in 2-L counter at 2 atm	6500 ± 150
two 1-day counts in 1-L counter at 1 atm	6340 ± 250

Age obtained by Gakushuin on part of sample was 5350 ± 170 (GaK-1409; based on one 19-hr count; K. Kigoshi, 1967, written commun.).

General Comment (W.B., Jr.): agreement between determinations made by Uppsala and GSC on original sample is within limits of error (Uppsala dates are given with ± 1σ and are corrected for isotopic fractionation), but result obtained by Gakushuin is too old. Agreement between 3 GSC determinations on 1966 coll. and original sample is also within limits of error; agreement dispelled doubts which arose on receipt of GaK-1409, 5350 ± 170, that submitter had mixed 1966 samples. Gakushuin determinations on same log are thus 5350 ± 170 (GaK-1409) and 6910 ± 140 (Gak-1909); all GSC and Uppsala dates range between 6080 and 6650. Possibly fact that small amounts of carbon from previous samples were discovered at times to be adhering to walls of stainless steel 'reaction tubes' (K. Kigoshi, 1969, written commun.) is cause of discrepancy between Gakushuin dates and those from other labs.

GSC-1218. Zordragerfjorden, Nordaustlandet **17,700 ± 200** **15,750 B.C.** $\delta C^{13} = +2.7‰$

Marine pelecypod shells and fragments (mainly *Hiatella arctica* and *Mya truncata*) from fines on surface of sorted polygons adjacent to unnamed pond, E side Zordragerfjorden, Nordaustlandet, Svalbard (80° 24.5′ N Lat, 22° 52′ E Long), alt 34 to 35 m. Shells worn, rounded, and mostly fragmented though many were thick; some were chalky, some had slight lichen growth or attached algae(?), and some were discolored (none with incrustations subm.). In general, shells had appearance of "old" type, *i.e.*, those ante-dating last glaciation(>30,000 yr). Coll. 1966 by W. Blake, Jr. *Comment* (W.B., Jr.): date obtained by Gakushuin Univ. on part (45 g) of same sample (142-1966) was 16,240 ± 360 (Gak-1405), based on one 23-hr count after removal of outer ca. 10% of shells (K. Kigoshi, 1967, written commun.). Since alt is below limit of postglacial marine submergence, age should not have exceeded 11,000 yr, judging by other dates from Nordaustlandet. Interpretations possible are: 1) sample is mixture of postglacial shells with "old" shells found in many places on island (Blake, 1961). If so, results from GSC and Gakushuin agree as closely as can be expected; such good agreement is probably fortuitous; 2) sample is composed entirely of "old" shells, contaminated in some way to produce apparent ages of 16,000 to 18,000 yr; e.g., 10% contamination with contemporary carbon of shells ca. 45,000 yr old would cause error in age of 25,000 yr (Olsson and Blake, 1962); 3) sample is made up of shells 16,000 to 18,000 yr old, thus area must have been ice free then. Third alternative seems least likely, despite site location in N-most Nordaustlandet, near margin of former ice sheet; sea level then (close to maximum of last glaciation) is known from evidence elsewhere to have been 8 m or more below its present level (Shepard and Curray, 1967; Milliman and Emery, 1968). Pretreatment of GSC-1218 was standard removal of outer 20% of shell (32 g subm.) in HCl. (One 3-day count.)

References

Achard, R. A., 1970, Quaternary geology, Big Bend-Canoe River, British Columbia, *in*: Report of activities, Part A, April to October, 1969: Canada, Geol. Survey Paper 70-1, pt. A, p. 165-166.

Andrews, J. T., 1967, Radiocarbon dates obtained through Geographical Branch field observations: Canada, Geog. Br., Geog. Bull., v. 9, p. 115-162.

Andrews, J. T. and Falconer, George, 1969, Late glacial and postglacial history and emergence of the Ottawa Islands, Hudson Bay, N.W.T.: Evidence on the deglaciation of Hudson Bay: Canadian Jour. Earth Sci., v. 6, p. 1263-1276.

Armstrong, J. E., Crandell, D. R., Easterbrook, D. J., and Noble, J. B., 1965, Late Pleistocene stratigraphy and chronology in southwestern British Columbia and northwestern Washington: Geol. Soc. America Bull., v. 76, p. 321-330.

Berger, Rainer and Libby, W. F., 1966, UCLA radiocarbon dates V: Radiocarbon, v. 8, p. 467-497.

Bird, J. B., 1970, The final phase of the Pleistocene ice sheet north of Hudson Bay, *in*: Problemy Czwartorzedu (Problèmes du Quaternaire): Acta Geographica Lodziensia no. 24, Lódzkie Towarzystwo Naukowe, ser. III, p. 75-89.

Blake, W., Jr., 1956, Landforms and topography of the Lake Melville area, Labrador, Newfoundland: Canada, Geog. Br., Geog. Bull. no. 9, p. 75-100.

__________ 1961, Radiocarbon dating of raised beaches in Nordaustlandet, Spitsbergen, *in*: Raasch, G. O. (ed.), Geology of the Arctic: 1st internatl. symposium on Arctic Geol. Proc., Calgary, Alberta, 1960: Toronto, Univ. of Toronto Press, p. 133-145.

__________ 1970, Studies of glacial history in Arctic Canada. I. Pumice, radiocarbon dates, and differential postglacial uplift in the eastern Queen Elizabeth Islands: Canadian Jour. Earth Sci., v. 7, p. 634-664.

Bostock, H. S., 1966, Notes on glaciation in central Yukon Territory: Canada, Geol. Survey Paper 65-36, 18 p.

Brookes, I. A., 1969, Late-glacial marine overlap in western Newfoundland: Canadian Jour. Earth Sci., v. 6, p. 1397-1404.

__________ 1970a, The glaciation of southwestern Newfoundland: Ph.D. dissert., McGill Univ., Montreal, Québec, 208 p.

__________ 1970b, New evidence for an independent Wisconsin-age ice cap over Newfoundland: Canadian Jour. Earth Sci., v. 7, p. 1374-1382.

Buckley, J. D. and Willis, E. H., 1970, Isotopes' radiocarbon measurements VIII: Radiocarbon, v. 12, p. 87-129.

Campbell, C. A., Paul, E. A., Rennie, D. A., and McCallum, K. J., 1967a, Factors affecting the accuracy of the carbon-dating method in soil humus studies: Soil Science, v. 104, p. 81-85.

__________ 1967b, Applicability of the carbon-dating method of analysis to soil humus studies: Soil Science, v. 104, p. 217-224.

Churcher, C. S., 1968, Mammoth from the Middle Wisconsin of Woodbridge, Ontario: Canadian Jour. Zool., v. 46, p. 219-221.

Clarke, A. H., Jr., 1965, The scallop superspecies *Aequipecten irradians* (Lamarck): Malacologia, v. 2, p. 161-188.

Clarke, A. H., Jr., Stanley, D. J., Medcof, J. C., and Drinnan, R. E., 1967, Ancient oyster and bay scallop shells from Sable Island: Nature, v. 215, no. 5106, p. 1146-1148.

Craig, B. G., 1965, Notes on moraines and radiocarbon dates in northwest Baffin Island, Melville Peninsula and northeast District of Keewatin: Canada, Geol. Survey Paper 65-20, 7 p.

__________ 1969, Late-glacial and postglacial history of the Hudson Bay region, *in*: Hood, P. J. (ed.), Earth science symposium on Hudson Bay: Canada, Geol. Survey Paper 68-53, p. 63-77.

Crawford, C. B. and Sutherland, J. G., 1971, The Empress Hotel—Sixty-five years of foundation settlements: Canadian Geotech. Jour., v. 8, p. 77-93.

David, P. P., 1971, The Brookdale Road section and its significance in the chronological studies of dune activities in the Brandon Sand Hills of Manitoba: Geol. Assoc. Canada, Spec. Paper no. 9.

David, P. P., Pollen production rates and dune activities on the Canadian Prairies: ms. in preparation.

Dreimanis, Aleksis, 1969, La dernière Glaciation dans la Region orientale des Grand Lacs, Amerique du Nord: Résumés des Commun., 8th cong. INQUA, Paris, p. 192.

Dreimanis, Aleksis and Karrow, P. F., 1965, Southern Ontario, *in* Great Lakes-Ohio River Valley: Guidebook, Field conf. G, 7th cong. INQUA, Boulder and Denver, Colorado, p. 90-110.

Dreimanis, A., Terasmae, J., and McKenzie, G. D., 1966, The Port Talbot Interstade of the Wisconsin Glaciation: Canadian Jour. Earth Sci., v. 3, p. 305-325.

Dyck, Willy and Fyles, J. G., 1962, Geological Survey of Canada radiocarbon dates I: Radiocarbon, v. 4, p. 13-26.

__________ 1963, Geological Survey of Canada radiocarbon dates II: Radiocarbon, v. 5, p. 39-55.

__________ 1964, Geological Survey of Canada radiocarbon dates III: Radiocarbon, v. 6, p. 167-181.

Dyck, Willy, Fyles, J. G., and Blake, W., Jr., 1965, Geological Survey of Canada radiocarbon dates IV: Radiocarbon, v. 7, p. 24-46.

Dyck, Willy, Lowdon, J. A., Fyles, J .G., and Blake, W., Jr., 1966, Geological Survey of Canada radiocarbon dates V: Radiocarbon, v. 8, p. 96-127.

Elson, J. A., 1960, Surficial geology, Brandon, West of Principal Meridian, Manitoba: Canada, Geol. Survey Map 1067A.

———— 1967, Geology of Glacial Lake Agassiz, *in*: Mayer-Oakes, W. J. (ed.), Life, land and water; 1966 conf. on environmental studies of the Glacial Lake Agassiz Region Proc.: Occasional Papers, Dept. of Anthropol., Univ. of Manitoba, no. 1: Winnipeg, Univ. of Manitoba Press, p. 37-95.

Fulton, R. J., 1968, Olympia interglaciation, Purcell trench, British Columbia: Geol. Soc. America Bull., v. 79, p. 1075-1080.

Fulton, R. J. and Klassen, R. W., 1969, Quaternary geology, northwest District of Mackenzie, *in*: Report of activities, Part A, April to October 1968: Canada, Geol. Survey Paper 69-1, pt. A, p. 193-194.

Fyles, J. G., 1966, Quaternary stratigraphy, Mackenzie delta and Arctic coastal plain, *in*: Report of activities, May to October, 1965: Canada, Geol. Surv. Paper 66-1, p. 30-31.

———— 1967, Mackenzie delta and Arctic coastal plain, *in*: Report of activities, Part A, May to October, 1966: Canada Geol. Surv. Paper 67-1, pt. A, p. 34-35.

Goldthwait, R. P., Dreimanis, Aleksis, Forsyth, J. L., Karrow, P. F., and White, G. W., 1965, Pleistocene deposits of the Erie lobe, *in*: Wright, H. E., Jr., and Frey, D. G. (eds.), The Quaternary of the United States: Princeton, New Jersey, Princeton Univ. Press, p. 85-97.

Grant, D. R., 1969a, Surficial deposits, geomorphic features, and late Quaternary history of the terminus of the northern peninsula of Newfoundland and adjacent Quebec-Labrador: Maritime Sediments, v. 5, p. 123-125.

———— 1969b, Late Pleistocene re-advance of piedmont glaciers in western Newfoundland: Maritime Sediments, v. 5, p. 126-128.

———— 1970, Recent coastal submergence of the Maritime Provinces, Canada: Canadian Jour. Earth Sci., v. 7, p. 676-689.

Hattersley-Smith, G., 1969, Glacial features of Tanquary Fiord and adjoining areas of northern Ellesmere Island, N.W.T.: Jour. Glaciol., v. 8, no. 52, p. 23-50.

Hattersley-Smith, G. and Long, Austin, 1967, Postglacial uplift at Tanquary Fiord, northern Ellesmere Island, Northwest Territories: Arctic, v. 20, p. 255-260.

Haynes, C. V., Jr., 1966, Radiocarbon samples: chemical removal of plant contaminants: Science, v. 151, p. 1391-1392.

Henderson, E. P., 1960, Surficial geology, St. John's, Newfoundland: Canada, Geol. Survey Map 35-1959.

Hobson, G. D. and Terasmae, Jaan, 1969, Pleistocene geology of the buried St. Davids gorge, Niagara Falls, Ontario: geophysical and palynological studies: Canada, Geol. Survey Paper 68-67, 16 p.

Hodgson, D. A. and Haselton, G. M., Reconnaissance glacial geology, northeast Baffin Island: Canada, Geol. Survey Paper, ms. in preparation.

Hughes, O. L., Campbell, R. B., Muller, J. E., and Wheeler, J. O., 1969, Glacial limits and flow patterns, Yukon Territory, south of 65 degrees North Latitude: Canada, Geol. Survey Paper 68-34, 9 p.

Ives, J. D. and Buckley, J. T., 1969, Glacial geomorphology of Remote Peninsula, Baffin Island, N.W.T.: Arctic and Alpine Research, v. 1, p. 83-95.

James, N. P. and Stanley, D. J., 1967, Sediment transport on Sable Island, Nova Scotia: Smithsonian Misc. Colln., v. 152, no. 7, pub. 4723, 33 p.

Jungerius, P. D., 1969, Soil evidence of postglacial tree line fluctuations in the Cypress Hills Area, Alberta, Canada: Arctic and Alpine Research, v. 1, p. 235-246.

Karrow, P. F., 1967, Pleistocene geology of the Scarborough area: Ontario Dept. Mines, Geol. rept., no. 46, 108 p.

———— 1969, Stratigraphic studies in the Toronto Pleistocene: Geol. Assoc. Canada Proc., v. 20, p. 4-23.

Kerfoot, D. E., 1969, The geomorphology and permafrost conditions of Garry Island, N.W.T.: Ph.D. dissert., Univ. of British Columbia, Vancouver, British Columbia, 308 p.

Klassen, R. W., 1969, Quaternary stratigraphy and radiocarbon chronology in southwestern Manitoba: Canada, Geol. Survey Paper 69-27, 19 p.

Krueger, H. W. and Weeks, C. F., 1966, Geochron Laboratories, Inc. radiocarbon measurements II: Radiocarbon, v. 8, p. 142-160.

Kuc, Marian, 1971, Additions to the Arctic Flora. V—The role of mosses in plant succession and the development of peat on Fitzwilliam Owen Island (Western Canadian Arctic): Rev. Bryolog. et Lichénolog., v. 37.

LaMarche, V. C., Jr. and Mooney, H. A., 1967, Altithermal timberline advance in western United States: Nature, v. 213, no. 5080, p. 980-982.

LaSalle, Pierre, 1968, Field trip of Quaternary geology, Saguenay River-Lac St-Jean: Contr. to ACFAS cong., 1968, 31 p.

——— 1969, Quaternary geology of the lac Saint-Jean and Saguenay River areas, Field Trip no. 5, *in*: Guidebook, 1969 ann. mtg., Geol. Assoc. Canada—Mineralog. Assoc. Canada, June 1969, Montreal, p. 37-85.

LaSalle, Pierre and Rondot, Jehan, 1967, New ^{14}C dates from the Lac St-Jean area, Quebec: Canadian Jour. Earth Sci., v. 4, p. 568-571.

Lebuis, Jacques, 1971, La géologie des dunes de sable de la région du lac Saint-Jean: M.Sc. thesis, Univ. de Montréal, Montréal, Québec, 70 p.

Lewis, C. F. M., 1969, Late Quaternary history of lake levels in the Huron and Erie Basins: 12th conf. Great Lakes Research 1969 Proc., Internatl. Assoc. Great Lakes Research, p. 250-270.

——— 1970, Recent uplift of Manitoulin Island, Ontario: Canadian Jour. Earth Sci., v. 7, p. 665-675.

Lichti-Federovich, Sigrid, 1970, The pollen stratigraphy of a dated section of Late-Pleistocene lake sediment from central Alberta: Canadian Jour. Earth Sci., v. 7, p. 938-945.

Løken, O. H., 1966, Baffin Island refugia older than 54,000 years: Science, v. 153, p. 1378-1380.

Lowdon, J. A. and Blake, W., Jr., 1968, Geological Survey of Canada radiocarbon dates VII: Radiocarbon, v. 10, p. 207-245.

——— 1970, Geological Survey of Canada radiocarbon dates IX: Radiocarbon, v. 12, p. 46-86.

Lowdon, J. A., Fyles, J. G., and Blake, W., Jr., 1967, Geological Survey of Canada radiocarbon dates VI: Radiocarbon, v. 9, p. 156-197.

Lowdon, J. A., Wilmeth, R., and Blake, W., Jr., 1969, Geological Survey of Canada radiocarbon dates VIII: Radiocarbon, v. 11, p. 22-42.

——— 1970, Geological Survey of Canada radiocarbon dates X: Radiocarbon, v. 12, p. 472-485.

Mackay, J. R., 1958, The Anderson River map-area, N.W.T.: Canada, Geog. Branch, Mem. 5, 137 p.

MacClintock, Paul and Twenhofel, W. H., 1940, Wisconsin glaciation of Newfoundland: Geol. Soc. America Bull., v. 81, p. 1729-1756.

Mathews, W. H., Fyles, J. G., and Nasmith, H. W., 1970, Postglacial crustal movements in southwestern British Columbia and adjacent Washington state: Canadian Jour Earth Sci., v. 7, p. 690-702.

McCallum, K. J. and Dyck, Willy, 1960, University of Saskatchewan radiocarbon dates II: Am. Jour. Sci. Radiocarbon Supp., v. 2, p. 73-81.

McCallum, K. J. and Wittenberg, J., 1965, University of Saskatchewan radiocarbon dates IV: Radiocarbon, v. 7, p. 229-235.

——— 1968, University of Saskatchewan radiocarbon dates V: Radiocarbon, v. 10, p. 365-378.

McDonald, B. C., 1969, Glacial and interglacial stratigraphy, Hudson Bay Lowland, *in*: Hood, P. J. (ed.), Earth science symposium on Hudson Bay: Canada, Geol. Survey Paper 68-53, p. 78-99.

——— 1971, Late Quaternary stratigraphy and deglaciation in Eastern Canada, *in*: Turekian, K. K. (ed.), The Late Cenozoic Glacial ages: New Haven, Yale Univ. Press., p. 331-353.

McDonald, B. C. and Shilts, W. W., 1971, Quaternary stratigraphy and events, southeastern Quebec: Geol. Soc. America Bull., v. 82, p. 683-698.

Mielke, J. E. and Long, Austin, 1969, Smithsonian Institution radiocarbon measurements V: Radiocarbon, v. 11, p. 163-182.

Milliman, J. D. and Emery, K. O., 1968, Sea levels during the past 25,000 years: Science, v. 162, p. 1121-1123.

Muir, D. M., 1970, The origin and development of retention pools and associated organic structures and plant communities in the western Cordillera and in Newfoundland: M.Sc. thesis, Carleton Univ., Ottawa, Ontario, 229 p.

Müller, Fritz, 1963, Radiocarbon dates and notes on the climatic and morphological history, *in*: Axel Heiberg Island research reports: McGill Univ., prelim. rept. 1961-1962, p. 169-172.
———— 1966, Evidence of climatic fluctuations on Axel Heiberg Island, Canadian Arctic Archipelago, *in*: Fletcher, J. O. (ed.), Symposium on Arctic heat budget and atmospheric circulation Proc.: Memo. RM-5233-NSF, The Rand Corporation, Santa Monica, California, p. 135-156.
Mullineaux, D. R., Waldron, H. H., and Rubin, M., 1965, Stratigraphy and chronology of late interglacial and early Vashon glacial time in the Seattle area, Washington: U.S. Geol. Surv. Bull. 1194-0, 10 p.
Olsson, I. U., 1960, Uppsala natural radiocarbon measurements II: Am. Jour. Sci. Radiocarbon Supp., v. 2, p. 112-128.
Olsson, I. U. and Blake, W., Jr., 1962, Problems of radiocarbon dating of raised beaches, based on experience in Spitsbergen: Norsk geog. tidsskr., v. 18, no. 1-2 (1961-1962), p. 47-64.
Pawluk, S. and Dumanski, J., 1970, Notes from the field tour held in conjunction with the symposium, May 14, 1969, *in*: Pawluk, S. (ed.), Pedology and Quaternary research: Edmonton, Univ. of Alberta Press, p. 187-218.
Prest, V. K. and Grant, D. R., 1969, Retreat of the last ice sheet from the Maritime Provinces-Gulf of St. Lawrence Region: Canada, Geol. Survey Paper 69-33, 15 p.
Preston, R. S., Person, Elaine, and Deevey, E. S., 1955, Yale natural radiocarbon measurements II: Science, v. 122, p. 954-960.
Rampton, V. N., 1969, Pleistocene geology of the Snag-Klutlan area, southwestern Yukon Territory, Canada: Ph.D. dissert., Univ. of Minnesota, Minneapolis, Minnesota, 237 p.
———— 1971a, Quaternary geology, Mackenzie delta and arctic coastal plain, District of Mackenzie, *in*: Report of activities, Part A, April to October, 1970: Canada, Geol. Survey Paper 71-1, pt. A, p. 173-177.
———— 1971b, Late Quaternary vegetational and climatic history of the Snag-Klutlan area, southwestern Yukon Territory, Canada: Geol. Soc. America Bull., v. 82, p. 959-978.
Ritchie, J. C., 1969, Absolute pollen frequencies and carbon-14 age of a section of Holocene lake sediment from the Riding Mountain area of Manitoba: Canadian Jour. Bot., v. 47, p. 1345-1349.
Ritchie, J. C. and Lichti-Federovich, Sigrid, 1968: Holocene pollen assemblages from the Tiger Hills, Manitoba: Canadian Jour. Earth Sci., v. 5, p. 873-880.
Ruhe, R. V., 1969, Quaternary landscapes in Iowa: Iowa State Univ. Press, Ames, Iowa, 255 p.
Rutter, N. W., 1967, Surficial geology of the Peace River dam and reservoir area, British Columbia, *in*: Report of activities, Part A, May to October, 1966: Canada, Geol. Survey Paper 67-1, pt. A, p. 87-88.
———— Quaternary geology of the Peace River Reservoir area (Lake Williston): Canada, Geol. Surv. Bull., ms. in preparation.
van Ryswyk, A. L., 1969, Forest and Alpine soils of south-central British Columbia: Ph.D. dissert., Washington State Univ., Pullman, Washington, 178 p.
Sauvé, Pierre and LaSalle, Pierre, 1968, Notes sur la géologie glaciare de la région de Manic 2: Le naturaliste canadien, v. 95, p. 1293-1300.
Scharpenseel, H. W., Pietig, F., and Tamers, M. A., 1968, Bonn radiocarbon measurements I: Radiocarbon, v. 10, p. 8-28.
Shepard, F. P. and Curray, J. F., 1967, Carbon-14 determinations of sea level changes in stable areas, *in*: Sears, M. (ed.), Progress in oceanography, v. 4, The Quaternary history of the ocean basins: Oxford, Pergamon Press, p. 283-291.
Shilts, W. W., 1969, Pleistocene geology of the Lac Mégantic region, southeastern Québec, Canada: Ph.D. dissert., Syracuse Univ., Syracuse, New York, 154 p.
Skinner, R. G., 1971, Glacial-interglacial stratigraphy, Moose River Basin (42), *in*: Report of activities, Part A, April to October 1970: Canada, Geol. Survey Paper 71-1, pt. A, p. 179-180.
Souther, J. G., 1970, Volcanism and its relationship to recent crustal movements in the Canadian Cordillera: Canadian Jour. Earth Sci., v. 7, p. 553-568.
Stalker, A. M., 1963, Quaternary stratigraphy in southern Alberta: Canada, Geol. Survey Paper 62-34, 52 p.
———— 1969, Geology and age of the early man site at Taber, Alberta: American Antiquity, v. 34, p. 425-428.

St-Onge, D. A., 1965, La géomorphologie de l'Île Ellef Ringnes, Territoires du Nord-Ouest, Canada: Canada, Geog. Branch, Geog. Paper 38, 46 p.

———— 1969, Quaternary geology and geomorphology of the Whitecourt and Tawatinaw area, Alberta, *in*: Report of activities, Part A: April to October, 1968: Canada, Geol. Survey Paper 69-1, pt. A, p. 217.

———— 1970, Quaternary geology and geomorphology of the Tawatinaw area, Alberta, *in*: Report of activities, Part A: April to October, 1969: Canada, Geol. Survey Paper 70-1, pt. A, p. 183-184.

———— Sequence of glacial lakes in north-central Alberta: Canada, Geol. Survey Bull., in press.

Sutherland Brown, A., 1968, Geology of the Queen Charlotte Islands: British Columbia Dept. of Mines and Petroleum Resources, Bull. 54, 219 p.

———— 1969, Aiyansh lava flow, British Columbia: Canadian Jour. Earth Sci., v. 6, p. 1460-1468.

Terasmae, Jaan and Anderson, T. W., 1970, Hypsithermal range extension of white pine (*Pinus strobus* L.) in Quebec, Canada: Canadian Jour. Earth Sci., v. 7, p. 406-413.

Terasmae, Jaan and Mirynech, Edward, 1964, Postglacial chronology and the origin of deep lake basins in Prince Edward County, Ontario: Pub. no. 11, Great Lakes Research Div., Univ. of Michigan, Ann Arbor, p. 161-169.

Terasmae, Jaan and Mott, R. J., 1971, Postglacial history and palynology of Sable Island, Nova Scotia: Geoscience and Man (2nd ann. mtg. Proc., Am. Assoc. Stratigraphic Palynologists, Oct. 1969), v. 2.

Vernon, Peter and Hughes, O. L., 1966, Surficial geology of Dawson, Larsen Creek, and Nash Creek map-areas, Yukon Territory: Canada, Geol. Survey Bull. 136, 25 p.

Wagner, F. J. E., 1967, Additional radiocarbon dates, Tyrrell Sea area: Maritime Sediments, v. 3, p. 100-104.

Walton, Alan, Trautman, M. A., and Friend, J. P., 1961, Isotopes, Inc. radiocarbon measurements I: Radiocarbon, v. 3, p. 47-59.

Westgate, J. A., Smith, D. G. W., and Nichols, H., 1970, Late Quaternary pyroclastic layers in the Edmonton area, Alberta, *in*: Pawluk, S. (ed.), Pedology and Quaternary Research: Edmonton, Univ. of Alberta Press, p. 179-186.

White, O. L., 1964, Woodbridge area (Pleistocene): Ontario Dept. Mines, Prelim. Map P-236.

[RADIOCARBON, VOL. 13, No. 2, 1971, P. 325-339]

UNIVERSITY OF KIEL RADIOCARBON MEASUREMENTS VI

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This list contains data obtained during 1970. Age calculations are based on 95% of NBS oxalic acid standard activity with modern value A.D. 1950. Results are calculated using the Libby half-life and are given in the B.P. scale. They are not corrected for δC^{13} variations. Errors correspond to 1σ variation of sample net counting rate including statistics of modern standard and background.

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We thank U.-J. Kock for treatment of series "surface sediments of Plöner See" and F. R. Averdieck and Waldemar Ohle for assistance in supplying these samples. Mrs. H. Metzner measured the C^{13}/C^{12} ratios of the samples. One of us (H.E.) is greatly obliged to Bundesministerium für Bildung und Wissenschaft for financial support.

I. GEOLOGIC SAMPLES

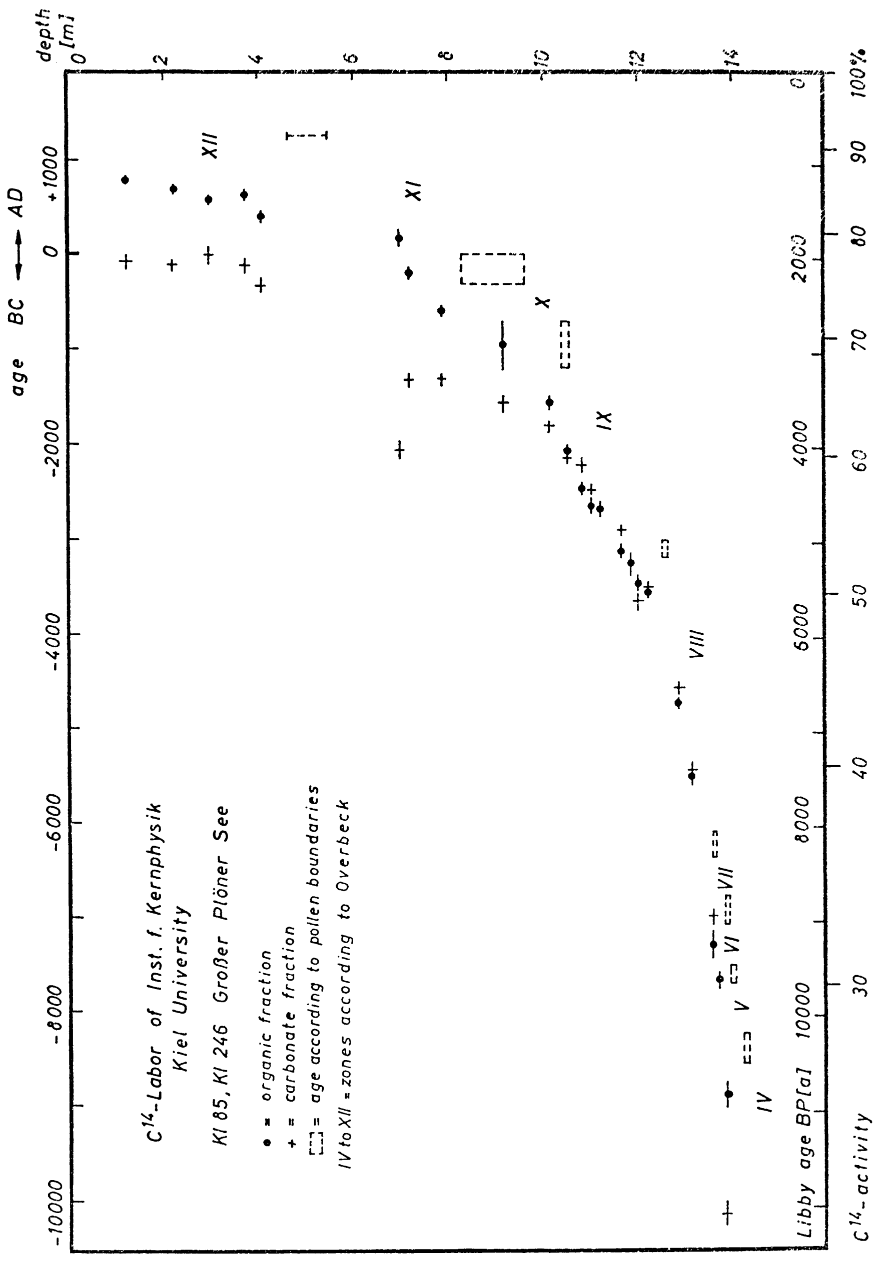
Plöner See series

Lake sediments of the Grosser Plöner See (54° 9.5′ N Lat, 10° 25.1′ E Long), NW Germany. Coll. and subm. 1966 by F. R. Averdieck, Inst. f. Ur- und Frühgeschichte, Univ. Kiel, who also did pollen analysis, and Waldemar Ohle, Max-Planck-Inst. f. Limnol., Plön. Basin of lake was formed during last glaciation. Two cores of sediment (KI-85 and KI-246) were taken with a 4 cm Livingstone corer at the deepest position (water depth 41 m). The longest boring reached glacial sands at 15.03 m under bottom. Depth values of the 2 cores did not correspond exactly. Therefore, depth values of KI-85 are connected pollen-analytically to KI-246.

Samples were treated first with cold 10% HCl to obtain the carbonate fraction. Residues were washed to neutrality, dried again, and burnt to get the organic fraction. For both parts we determined δC^{13} values. Results are given in Table 1 and Fig. 1.

General Comment: linear extrapolation of upper 5 organic values gives 1030 ± 100 B.P. for recent sediment surface corresponding to 88 ± 1% of recent standard activity. Most of lake sediments show such a hard water effect in the range from 600 to 1100 yr (cf. Håkansson, 1968, 1969, 1970; Ogden and Hay, 1964, 1965, 1969; Stuiver, 1969; Willkomm and Erlenkeuser, 1970).

If former sediments also had such a low recent activity, their measured C^{14} ages would be older than that of land plants of the same time. Therefore, we compared the position of boundaries of pollen zones (according to Overbeck, 1950) in the sediment with their Libby ages measured on peat of raised bogs (Overbeck *et al.*, 1957; Kubitzki and Münnich, 1960; Straka, 1961). In Fig. 1 the y values of the dotted rectangles represent the pollen boundaries in the sediment (according to high sedimentation rate, the boundaries X/XI and XI/XII are rather extended) and the



age BC ⟷ AD
depth [m]
Libby age BP[a]
C¹⁴-activity
C¹⁴-Labor of Inst. f. Kernphysik Kiel University
Kl 85, Kl 246 Großer Plöner See
● = organic fraction
+ = carbonate fraction
[ ] = age according to pollen boundaries
IV to XII = zones according to Overbeck

Fig. 1

x values give the Libby ages from peat measurements*). In all sediment levels, rectangles lie ca. 1000 yr of measured Libby ages. Recent activity of sediments must have been ca. 88% during greatest part of Holocene.

Differences between organic age and carbonate age result from dead carbonates, which came into sediment as allochthonous impurities. According to isotopic effects (cf. δC^{13} values), autochthonous carbonates must have 3 to 5% more C^{14} than the organic fraction. Considering this effect, allochthonous components reach 15% (in KI-246.33 even 28%) of total carbonate fraction.

TABLE 1

C^{14} dates of Plöner See sediments

Age calculations were made without δC^{13} corrections

C^{14} Lab. Kiel		Grosser Plöner See		KI-85 and KI-246		
Lab. no.	Depth within sediment (cm)	Organic fraction Libby age $\pm 1\sigma$ B.P.	δC^{13} ‰	Inorganic fraction Libby age $\pm 1\sigma$ B.P.	δC^{13} ‰	Difference of Libby ages (yr)
246.26	91 to 157	1140 ± 45		2030 ± 110		890
246.28	186 to 260	1250 ± 55		2030 ± 65		780
246.29	276 to 350	1340 ± 50		1940 ± 100		600
85.14	360 to 390	1300 ± 65	−30.2	2080 ± 75	−0.9	780
85.15	390 to 420	1520 ± 80		2280 ± 90		760
246.33	682 to 719	1760 ± 90		4010 ± 75	−2.5	2250
85.25	710 to 735	2110 ± 75		3270 ± 75		1160
246.34	777 to 808	2530 ± 40	−30.7	3260 ± 75	−3.4	730
246.05	910 to 935	2900 ± 275		3520 ± 110	−2.0	620
246.36	1000 to 1035	3490 ± 90	−26.6	3750 ± 75	−3.4	260
246.49	1040 to 1069	4010 ± 80	−26.4	4110 ± 70	−2.9	100
246.50	1069 to 1097	4390 ± 75	−24.2	4160 ± 75	−3.7	−230
246.51	1096 to 1116	4590 ± 90	−30.2	4430 ± 65	−3.5	−160
246.04	1114 to 1135	4630 ± 110	−19.9			
246.45	1155 to 1185	5070 ± 100	−23.0	4840 ± 60	−3.2	−230
246.03	1180 to 1197	5200 ± 130	−21.2			
246.46	1195 to 1215	5410 ± 80	−24.9	5600 ± 100	−3.7	190
246.47	1215 to 1235	5480 ± 90	−30.0	5460 ± 80	−2.8	− 20
246.43	1273 to 1305	6680 ± 70	−22.4	6520 ± 90	−3.5	−160
246.44	1305 to 1335	7450 ± 120	−23.2	7380 ± 110	−3.3	− 70
246.40	1354 to 1374	9240 ± 140	−23.3	8920 ± 120	−0.4	−320
246.01	1374 to 1384	9630 ± 90	−21.8			
246.41	1384 to 1404	10,810 ± 170	−28.5	12,080 ± 170	−0.6	1270

* Boundary XI/XII indicates medieval clearing of woods, done in this region in 13th century (Ohle, 1970, ms. in preparation).

Plöner See, surface of sediment

The preceding series does not include upper layers of sediment. To continue this series, we coll. upper 50 cm of sediment with a sampler (diam. 8 cm), which could be closed at its base. For comparison, we measured aquatic plants, coll. and subm. by F. R. Averdieck, lake water, and atmospheric CO_2. KI-318 to KI-321 coll. at Plöner See, Nordtiefe (54° 9.5′ N Lat, 10° 25.1′ E Long). KI-322 and -323 coll. at Plöner See, near Prinzen I., ca. 1 km S of foregoing location. KI-325 coll. at Süseler See (54° 4.7′ N Lat, 10° 40.6′ E Long), NW Germany. KI-326 coll. at Kiel (54° 20.5′ N Lat, 10° 7.3′ E Long), NW Germany. All samples were coll. in Sept. 1969, except KI-320 and KI-321.02, which were coll. in Oct. 1969. Measured values are given in Table 2.

General Comment: C^{14} content and C^{13} value of *Nuphar luteum* confirm assumption that these plants assimilate only atmospheric CO_2. For *Chara*, the C^{14} difference of 3.1% between organic and inorganic fractions is nearly twice the difference of δC^{13} values (19‰) according to pure isotopic fractionation. We expected the effect of atomic weapons within the upper 11 cm of sediments, but only KI-318.01 has an activity greater than 100%. Moreover, following sediments seem older than the following 6 m. There must be a disturbing influence at least on samples 318.02 and 318.06, though no irregularity could be seen in the layers. For more detailed discussion and estimation of exchange times see Kock (1970). Bomb effect in lake sediments was measured by Ogden and Hay (1969, p. 143), who found in Seth's Pond δC^{14} values up to 39%. See also Olsson (1969, p. 541), who found in submerged aquatic plants Δ values up to 550‰.

Eifel series

Samples resume problem of age of volcanic eruptions in SW Eifel area (Straka 1952, 1954, 1958, 1960, 1961a, 1961b) as marked by characteristic horizons of tuff sand embedded in detritus gyttja or peaty deposits of crater lakes (Maare) now overgrown by Flachmoor. Coll. and subm. 1969 by H. Straka, Bot. Inst., Univ. Kiel, who did pollen analysis. Samples taken with Dachnowski corer. Cores were pared by ca. 1 to 2 mm before chemical standard treatment. Dates given are not corrected for δC^{13}.

Schalkenmehrener Maar, Sch A

Gyttja, from E part of Schalkenmehrener Double Maar (50° 10.25′ N Lat, 6° 51.93′ E Long), Germany. Low mineral and carbonate content slightly increasing with depth. There are 2 tuff layers, at 575 to 585 cm depth and below 630 cm depth.

KI-304.01. 565 to 575 cm depth **11,060 ± 140**
9110 B.C.
$\delta C^{13} = -28.3‰$

From above upper tuff layer. Equivalent samples were determined earlier: GRO-458: 10,770 ± 250 B.P. (Straka and de Vries, 1956) and GRO-961: 10,550 ± 100 B.P. (Straka, 1957).

TABLE 2

Surface sediments of Plöner See

C^{14} values are not corrected for δC^{13} variations

Lab. no.	Material	Organic fraction C^{14} content $\pm 1\sigma$ %	Organic fraction δC^{13} ‰	Inorganic fraction C^{14} content $\pm 1\sigma$ %	Inorganic fraction δC^{13} ‰
326	Atmosph. CO_2 absorbed with 4n NaOH, 15 m above ground	155.8±0.7	−21.5		
325	Nuphar luteum (aquatic plants living from atmosph. CO_2 at surface of lake)	152.9±0.8	−25.4		
321.01	Surface water			124.1±0.7	− 8.3
321.02	Surface water			122.0±0.7	− 7.3
320	Depth water (30 m under surface)			124.7±0.7	−10.3
323	*Potamogeton pectinatus,* 1 m under surface	123.4±0.8	−18.7		
322	Chara, 1.5 m under surface	122.8±0.8	−21.0	125.9±0.5	− 2.2
318.01	Sediments, 0 to 2.5 cm under bottom (depth of water 35 m)	107.0±0.7	−28.3	93.4±1.2	− 0.6
		Libby age B.P.		Libby age B.P.	
318.02	2.5 to 8 cm	1940±70	−28.4	1680±55	− 2.0
318.06	21 to 25 cm	2340±55	−26.5	2500±90	− 1.3
318.08	30 to 33 cm	1290±80	−27.9		
319.01	36 to 46 cm	1160±65	−29.3	2210±65	− 1.1
318.11	42 to 52 cm			2080±60	− 1.2

KI-304.02. 585 to 595 cm depth **11,700 ± 150**
9750 B.C.
$\delta C^{13} = -26.9‰$

Sample from below tuff sand layer.

KI-304.04. 610 to 620 cm depth **12,650 ± 170**
10,700 B.C.
$\delta C^{13} = -26.0‰$

KI-304.03. 620 to 630 cm depth **13,420 ± 240**
11,470 B.C.
$\delta C^{13} = -23.4‰$

Sample from above older tuff layer. *Comment*: Libby age of lower edge of upper tuff layer is estimated by interpolation to 11,500 B.P. Pollen analysis gives 10,500 B.P. C^{14} age of upper border of older layer is 13,800 B.C., to be compared with pollen-analytical age, 10,950 B.P. Large difference of latter is probably due to influence of magmatic CO_2, as may be indicated by strikingly high δC^{13} value in view of gross δC^{13} values of Eifel series.

Strohner Maarchen, St

Gyttja from Trockenmaar (50° 7.40′ N Lat, 6° 51.94′ E Long) near Strohn, Germany. Mineral content increasing with depth. Two tuff sand layers at depth 845 to 860 cm and below 902 cm.

KI-305.01. 835 to 845 cm depth **10,940 ± 120**
8990 B.C.
$\delta C^{13} = -27.9‰$

Fine detritus gyttja, above upper tuff sand layer.

KI-305.02. 860 to 870 cm depth **11,670 ± 140**
9720 B.C.
$\delta C^{13} = -27.8‰$

Coarse detritus gyttja, below tuff layer.

KI-305.03. 842 to 902 cm depth **12,240 ± 270**
10,290 B.C.
$\delta C^{13} = -23.5‰$

Coarse detritus gyttja, overlying 2nd tuff layer. *Comment*: C^{14} age of upper tuff sand layer (lower border) estimated at 11,500 B.P., pollen analysis yields 10,300 B.P.; Libby age of older tuff layer (extrapolated to upper border) is 12,400 B.P., whereas pollen analysis gives 10,600 B.P. Noting δC^{13} value of KI-305.03 this large difference may be caused by magmatic CO_2 influence.

Hinkelsmaar, H I

Gyttja from Hinkelsmaar crater (50° 5.42′ N Lat, 6° 51.95′ E Long) near Manderscheid, Germany. Mineral content increasing with depth. Tuff layers at 415 to 425 cm depth and below 478 cm depth.

KI-306.01. 405 to 415 cm depth **10,580 ± 170**
8630 B.C.
δC^{13} = –31.7‰

Fine detritus gyttja, above upper tuff sand layer.

KI-306.02. 425 to 435 cm depth **11,290 ± 140**
9340 B.C.
δC^{13} = –28.0‰

Gyttja (fine detritus), below tuff sand layer.

KI-306.04. 435 to 445 cm depth **11,440 ± 120**
9490 B.C.
δC^{13} = –29.3‰

Fine detritus gyttja.

KI-306.05. 458 to 468 cm depth **12,240 ± 140**
10,290 B.C.
δC^{13} = –26.6‰

Fine detritus gyttja.

KI-306.03. 468 to 478 cm depth **12,190 ± 120**
10,240 B.C.
δC^{13} = –26.4‰

Fine detritus gyttja, above 2nd tuff layer. *Comment*: interpolated C^{14} age for lower edge of upper tuff layer: 11,000 B.P.; pollen analysis: 11,500 B.P. Extrapolated C^{14} age of 2nd tuff layer (upper border): 12,400 B.P., pollen analysis: 12,500 B.P.

Hitsche II, Hi II

Gyttja and peat from Hitsche Trockenmaar (50° 7.50′ N Lat, 6° 52.13′ E Long) W of Gillenfeld, Germany. Mineral content increasing with depth. Traces of carbonate.

KI-307.01. 190 to 200 cm depth **10,630 ± 160**
8680 B.C.
δC^{13} = –29.4‰

Coarse detritus gyttja, above tuff sand layer at 200 to 210 cm depth.

KI-307.04. 220 to 230 cm depth **10,970 ± 90**
9020 B.C.
δC^{13} = –27.5‰

Peat, 10 to 20 cm below tuff layer.

KI-307.03. 280 to 290 cm depth **12,230 ± 150**
10,280 B.C.
δC^{13} = –28.0‰

Fine detritus gyttja, above 2nd tuff layer below 290 cm depth. *Comment*: interpolated C^{14} age of upper tuff layer (lower border) is 10,700 B.P., agreeing with pollen analysis. Upper border of 2nd tuff layer is dated ca. 12,300 B.P. in agreement with pollen date of 12,500 B.P. Possibly, good agreement because atmospheric CO_2 assimilating plants were dated.

Mosbrucher Weiher, M A

Fine detritus gyttja from Mosbrucher Weiher (50° 15.75′ N Lat, 6° 57.23′ E Long), Trockenmaar near Kelberg, Germany. Mineral content increasing with depth, interspersed with numerous mollusk shells.

KI-308.01. 612 to 622 cm depth — **14,480 ± 160**
12,530 B.C.
$\delta C^{13} = -23.2‰$

KI-308.02. 622 to 632 cm depth — **14,380 ± 120**
12,430 B.C.

Comment: samples date upper border of tuff sand layer below 632 cm depth. According to pollen analysis, this layer is dated ca. 11,000 B.P. Here, as in dates of Strohner Maarchen and Schalkenmehrener Maar, C^{14} ages may be influenced by magmatic CO_2.

Booser Weiher, B A

KI-309. 190 to 200 cm depth — **10,830 ± 130**
8880 B.C.
$\delta C^{13} = -30.2‰$

Coarse detritus gyttja, with minerals and possibly some carbonate, from Booser Weiher (50° 18.80′ N Lat, 6° 59.86′ E Long) Trockenmaar near Adenau, Germany. Sample dates tuff layer below 200 cm depth. Expected age from pollen analysis: ca. 10,200 B.P.

Dürres Maar, D A

Fine detritus gyttja with some mineral content and possibly some carbonate, from Dürres Maar (50° 7.43′ N Lat, 6° 52.38 E Long), near Gillenfeld, Germany.

KI-310.01. 1160 to 1170 cm depth — **10,200 ± 140**
8250 B.C.
$\delta C^{13} = -27.3‰$

KI-310.02. 1170 to 1180 cm depth — **10,290 ± 210**
8340 B.C.

Comment: samples date tuff layer below 1180 cm depth. C^{14} age is markedly lower than pollen analytical expectation yielding 12,300 B.P. New cores will be taken for pollen analysis.

Mürmes, Mü I

Coarse detritus gyttja, mineral content increasing with depth, from Mürmes Trockenmaar (50° 9.32′ N Lat, 6° 53.59′ E Long) near Gillenfeld, Germany.

KI-311.01. 375 to 385 cm depth — **10,900 ± 120**
8950 B.C.
$\delta C^{13} = -31.0‰$

Sample from above tuff layer at 385 to 400 cm depth.

KI-311.02. 400 to 410 cm depth

11,500 ± 170
9550 B.C.
$\delta C^{13} = -28.8‰$

Sample from below tuff layer. *Comment*: tuff layer C^{14} age (interpolated to lower edge) is 11,200 B.P., exactly expected from pollen analysis.

Trautzberger Maar T

Mud, mineral content increasing with depth, from Trautzberg Trockenmaar (50° 6.63′ N Lat, 6° 56.78′ E Long) near Manderscheid, Germany.

KI-312.04. 632 to 642 cm

11,170 ± 120
9220 B.C.
$\delta C^{13} = -29.5‰$

KI-312.01. 642 to 652 cm

11,440 ± 150
9490 B.C.
$\delta C^{13} = -31.4‰$

Sample from above tuff sand layer at 652 to 670 cm depth.

KI-312.02. 670 to 680 cm depth

12,080 ± 180
10,130 B.C.
$\delta C^{13} = -32.6‰$

Comment: interpolated tuff layer C^{14} age (lower border) gives ca. 11,900 B.P. Pollen analysis yields 11,100 B.P. Second tuff layer below 690 cm depth. Extrapolation upon upper border gives 12,400 B.P., expected by pollen analysis.

General Comment: (Erlenkeuser *et al.*, 1971) after correction for half-life, C^{14} ages are generally greater, by varying amounts, than expected by pollen analysis, with maximum ca. 1400 yr, if samples KI-310, -304.3, -304.04, -305.03, and -308 are excepted. Differences show effect of lower C^{14} content of ground water supplying Maar lakes, partly cancelled by subsequent CO_2 exchange with atmosphere and/or by atmospheric CO_2-assimilating plants forming part of deposits. Widely deviating samples KI-304, -305, and -308 may be influenced by magmatic CO_2, the amount of which, as calculated from δC^{13} deviation from mean of gross samples, would explain, qualitatively, age differences observed.

Othmarschen series

During excavations for the new Elbtunnel, 2 peaty levels were found at Hamburg-Othmarschen (53° 33.3′ N Lat, 9° 53.8′ E Long), ca. 800 m N of Elbe R. as relics of old landslides. Coll. 1970 by F. Grube, Geol. Staatsinst., Univ. Hamburg; subm. by F. R. Averdieck, who made pollen analysis.

General Comment (F.R.A.): upper Holocene peat layer (Samples 383-385) reaches from 220 cm to 545 cm underground (ground level 25.90 m above sea level). Separated from this level by sands, a layer of interstadial clayish mud (KI-386) follows at 18.75 to 18.40 m above sea level.

KI-385. 303 to 307 cm depth **4870 ± 80**
2920 B.C.
$\delta C^{13} = -27.6‰$

Wood, embedded in peat from older Zone IX.

KI-384. 445 to 450 cm depth **6970 ± 120**
5120 B.C.
$\delta C^{13} = -27.1‰$

Wood, in older part of Pollen Zone VIII b. *Comment* (F.R.A.): C^{14} age seems a little too old compared to measurements on raised bogs.

KI-383. 535 to 545 cm depth **8370 ± 80**
6420 B.C.
$\delta C^{13} = -31.5‰$

Peat gyttja from base of peat layer at Pollen Boundary VII/VIII.

KI-386. 18.40 to 18.75 above sea level **>35,000**
$\delta C^{13} = -27.9‰$

Interstadial clayish mud.

Kieler Bucht series

Peat from bottom of Baltic Sea measured for dating postglacial transgression. Coll. 1969 and subm. 1970 by F. Werner, Geol. Inst., Univ. Kiel. *Comment*: dates confirm former values (cf. R., 1969, v. 11, p. 427). In the following, 1st value is depth of sample below sea bottom, 2nd value is depth of water, important for determination of transgression rate.

KI-375. 10030/A, 108 to 113 cm, 20 m **8070 ± 80**
6120 B.C.
$\delta C^{13} = -28.0‰$

(54° 26.22′ N Lat, 10° 39.91′ E Long)

KI-370. 10030/B, 115 to 125 cm depth **8340 ± 140**
6390 B.C.
$\delta C^{13} = -27.6‰$

Position same as KI-375.

KI-369. 10047/A, 128 to 134 cm, 24 m **8350 ± 120**
6400 B.C.
$\delta C^{13} = -28.3‰$

(54° 30.88′ N Lat, 10° 41.11′ E Long)

KI-374. 10047/B, 134 to 144 cm depth **8100 ± 100**
6150 B.C.
$\delta C^{13} = -27.1‰$

Position same as KI-369. Seems younger than overlying sample, within statistical uncertainty.

KI-380. 10051, 125 to 130 cm, 26 m **8000 ± 160**
6050 B.C.
$\delta C^{13} = -26.4‰$

(54° 31.70′ N Lat, 10° 40.68 E Long)

Sedimentation rate Kieler Bucht

Shells and plant remains from sediment cores for dating sedimentation rate of Baltic sea. Coll. 1969 and subm. 1970 by F. Werner.

KI-368. 10005, 12 cm, 23 m **200 ± 45**
A.D. 1750
$\delta C^{13} = +1.7‰$

Shells (*Cyprina Islandica*), (54° 34.10′ N Lat, 10° 39.86′ E Long).

KI-372. 10058/A + B, Plants 0 to 58 cm, 27 m **2120 ± 75**
170 B.C.

(54° 31.01′ N Lat, 10° 2.29′ E Long)

KI-378. 10058/D, Plants 132 to 152 cm **2220 ± 110**
270 B.C.

Depth and position like KI-372.

KI-371. 10058/F, Plants 232 to 250 cm **3340 ± 80**
1390 B.C.
$\delta C^{13} = -18.4‰$

Depth and position like KI-378.

KI-266. Valsequillo fossils **26,000 ± 530**
24,050 B.C.
$\delta C^{13} = -3.1‰$

Bones, 400 cm below surface, from Valsequillo valley (18° 55′ N Lat, 98° 20′ W Long), Mexico. Coll. 1967 and subm. 1968 by E. W. Guenther, Geol. Inst., Univ. Kiel. *Comment* (E.W.G.): sample was taken for dating fossil horizons of Valsequillo for profile of Pleistocene sediments in this region.

II. BOTANIC SAMPLES

Esterweger Dose, peat development

Peat samples from Esterweger Dose (53° 3.1′ N Lat, 7° 37.1′ E Long), raised bog near Papenburg, NW Germany. Coll. 1969 and subm. by K. Müller, Bot. Inst., Univ. Kiel.
General Comment (K.M.): for age determination and development of water holes in raised bogs, later filled with muddy peat, age of overlying light and muddy peat were determined at several locations.

KI-334. Muddy peat, 124 to 126 cm depth **100.6 ± 0.4%**
$\delta C^{13} = -25.8‰$

KI-335. Light peat, 126 to 128 cm **2030 ± 90**
80 B.C.
$\delta C^{13} = -27.2‰$

Underlying KI-334.

KI-336. Muddy peat, 63 to 65 cm **1300 ± 60**
A.D. 650
$\delta C^{13} = -26.8‰$

KI-338. Muddy peat, 140 to 142 cm

1730 ± 50
A.D. 220
$\delta C^{13} = -24.9‰$

KI-339. Light peat, 142 to 144 cm

1850 ± 45
A.D. 100
$\delta C^{13} = -24.2‰$

KI-340. Light peat, 112 to 114 cm

1050 ± 55
A.D. 900
$\delta C^{13} = -27.3‰$

KI-341. Muddy peat, 114 to 116 cm

1360 ± 70
A.D. 590
$\delta C^{13} = -25.4‰$

KI-342. Muddy peat, 140 to 142 cm

1590 ± 35
A.D. 360
$\delta C^{13} = -25.2‰$

KI-343. Light peat, 142 to 144 cm

1680 ± 50
A.D. 270
$\delta C^{13} = -24.8‰$

General Comment (K.M.): KI-340 to -343 were superimposed. Water hole (KI-341 and -342 was later overgrown by light peat [KI-340]).

III. ARCHAEOLOGIC SAMPLES

Hollenstedt

Squared timber and peat from moat of Saxon castle at Hollenstedt (53° 19.4′ N Lat, 9° 40.1′ E Long) near Hamburg, Germany, probably destroyed by Charlemagne. Coll. 1969 by F. R. Averdieck, Inst. f. Ur- und Frühgeschichte, Univ. Kiel; subm. 1969 by F. R. Averdieck and C. Ahrens, Helms Mus. Hamburg-Harburg.

KI-299. Hollenstedt A

1250 ± 60
A.D. 700
$\delta C^{13} = -30.1‰$

Squared timber, 0.80 m below excavation zero level, 1.50 m below floor.

KI-300. Hollenstedt B

1400 ± 50
A.D. 550
$\delta C^{13} = -29.5‰$

Basal peat from moat, Sec. A, 1.09 m below zero level, 1.79 m below floor.

Rickling

Different oak and charcoal samples from Saxon settlement Rickling (55° 0.8′ N Lat, 10° 10.0′ E Long) near Segeberg, Schleswig-Holstein, Germany. Coll. by G. Schäfer, Landesmus. f. Ur- u. Frühgeschichte Schleswig, Germany, subm. 1968 by H. Hingst, Landesmus. Schleswig and F. R. Averdieck. Samples from House 1; pottery dated to 6th to 8th century A.D.

KI-255. Rickling 1 **1125 ± 45**
A.D. 825
$\delta C^{13} = -27.1‰$

Oak, 1.90 to 2.00 m below floor.

KI-256. Rickling 2 **1100 ± 45**
A.D. 850
$\delta C^{13} = -27.0‰$

Oak, 1.00 to 2.00 m below floor.

KI-257. Rickling 3 **1075 ± 55**
A.D. 885
$\delta C^{13} = -28.0‰$

Oak, 2.00 to 2.30 below floor.

KI-258. Rickling 4 **1180 ± 45**
A.D. 770
$\delta C^{13} = -26.9‰$

Oak, 1.80 to 2.00 m below floor.

KI-260. Rickling 6 **1245 ± 70**
A.D. 705
$\delta C^{13} = -27.0‰$

Charcoal, 120 cm below floor.

KI-83. Oberaden **2540 ± 50**
590 B.C.
$\delta C^{13} = -25.7‰$

Wood (fir) from rim (enclosure) of well in Roman Camp Oberaden (Excavation Ditch 26/1963) (51° 35.6′ N Lat, 6° 36.1′ E Long) near Unna, Germany. Coll. 1963 by H. Jokisch, subm. 1966 by Landesmus. f. Vor- u. Frühgeschichte Münster, Germany. Depth 1.00 to 2.30 m below floor. According to coins found, camp existed from 11 to 8 B.C. only. Wood is from stave of Roman vine cask used later in well construction. Wood might be contaminated by preservatives (polyglycole) (Beck, pers. commun.)

Haithabu

Wood (*Quercus*) from Haithabu (54° 30.0′ N Lat, 9° 34.6′ E Long) Schleswig-Holstein, Germany. Coll. and subm. 1967 by D. Eckstein, and J. Bauch, Lehrstuhl f. Holzwirtschaft, Univ. Hamburg, Reinbek.

KI-241. Haithabu, Pr. 4 **1250 ± 40**
A.D. 700
$\delta C^{13} = -25.7‰$

Sample is dated historically to beginning of 9th century A.D.

KI-242. Haithabu, Pr. 5 **1630 ± 40**
A.D. 320
$\delta C^{13} = -25.9‰$

Wood (*Quercus*) from same piece as KI-241. *Comment*: as dendrochronologically dated by D. Eckstein and J. Bauch, age difference between samples is 280 yr.

Niani series

Charcoal found in different depths of old well, now filled in, in Niani (11° 22′ N Lat, 8° 23′ W Long), W Guinea, Africa. Coll. 1968 by W. Filipowiak, Mus. Pomorza Zachodniego, Stettin, Poland; subm. by K. W. Struve, Landesmus. f. Vor- u. Frühgeschichte, Schleswig, Germany. *General Comment* (W.F.): dates help set up chronology of capital of medieval kingdom Mali (Filipowiak, 1966, p. 116-127).

380 ± 55

KI-292. Sample 4 **A.D. 1570**

First cultural layer, 150 to 160 cm depth. *Comment* (W.F.): layer with waste (debris) of combustion, which may be caused by destruction after invasion of Songhai in A.D. 1545.

1035 ± 35

KI-294. Sample 12 **A.D. 915**

Sixth cultural layer, 277 cm depth.

1090 ± 65

KI-293. Sample 9 **A.D. 860**

Sixth cultural layer, 285 cm depth. *Comment* (W.F.): material of same level dated by Mme. Delibrias (Gif-sur-Yvette, France) at 1200 ± 100 B.P.

2130 ± 60

KI-346. Hoehbeck **180 B.C.**

$\delta C^{13} = -25.9‰$

Carbonized twigs from ca. 250 cm under present surface in former moat surrounding castle at S steep bank of Elbe R. 10 km NW of Schnackenburg (53° 4′ N Lat, 11° 26′ E Long), Niedersachsen, Germany. Coll. by P. Glüsing, Kiel; subm. 1969 by F. R. Averdieck. *Comment* (P.G.): no artifacts or other archaeologic indications to determine if castle was built by Charlemagne or Romans (Sprockhoff, 1958).

2030 ± 65

KI-347. Dangstetten 449 **80 B.C.**

$\delta C^{13} = -28.1‰$

Charcoal of waste pit found 80 to 120 cm below surface of Roman camp 8 km SE of Waldhut (47° 32′ N Lat, 8° 0′ E Long), S Baden, Germany. Coll. by P. Glüsing; subm. 1969 by F. R. Averdieck. *Comment*: camp established 16 or 15 B.C. (during campaign of Drusus and Tiberius across Alps). Coins indicate abandonment as early as 10 B.C. Measured age corresponds to recent variation of $\Delta = -(15 \pm 8)‰$.

References

Erlenkeuser, Helmut, Straka, Herbert, and Willkomm, Horst, 1971, Neue C^{14}-Datierungen zum Alter der Eifelmaare: in press.

Filipowiak, Wladislaw, 1966, Expédition archéologique Polono-Guinéenne á Niani (Guinée): Africana Bull., v. 4, p. 116-127.

Håkansson, Sören, 1968, University of Lund radiocarbon dates I: Radiocarbon, v. 10, p. 36-54.

——— 1969, University of Lund radiocarbon dates II: Radiocarbon, v. 11, p. 430-450.

Håkansson, Sören, 1970, University of Lund radiocarbon dates III: Radiocarbon, v. 12, p. 534-552.

Kock, U.-J., 1970, Untersuchungen mit der C^{14}-methode an Süsswassersedimenten: Staatsexamensarbeit, Kiel.

Kubitzki, K., and Münnich, K. O., 1960, Neue C^{14}-Datierungen zur nacheiszeitlichen Waldgeschichte Nordwestdeutschlands: Ber. Deutschen Bot. Gesell., v. 73, p. 137-146.

Ogden, J. G., III and Hay, R. J., 1964, Ohio Wesleyan University natural radiocarbon measurements I: Radiocarbon, v. 6, p. 340-348.

——— 1965, Ohio Wesleyan University natural radiocarbon measurements II: Radiocarbon, v. 7, p. 166-173.

——— 1969, Ohio Wesleyan University natural radiocarbon measurements IV: Radiocarbon, v. 11, p. 137-149.

Olsson, I. U., El-Gammal, Shawky, and Göksu, Yeter, 1969, Uppsala natural radiocarbon measurements IX: Radiocarbon, v. 11, p. 515-544.

Overbeck, Fritz, 1950, Die Moore Niedersachsens: Bremen-Horn, pub. by Niedersächsisches Amt für Landesplanung und Statistik, p. 65-68.

Overbeck, Fritz, Münnich, K. O., Aletsee, Ludwig, and Averdieck, F. R., 1957, Das Alter des "Grenzhorizontes" norddeutscher Hochmoore nach Radiocarbon-Datierungen: Flora, v. 145, p. 37-71.

Sprockhoff, Ernst, 1958, Neue Ausgrabungen in Deutschland: Berlin, pub. by Gebr. Mann, p. 518-531.

Straka, Herbert, 1952, Zur spätquartären Vegetationsgeschichte der Vulkaneifel: Arb. rhein. Landeskde 1, Dr. dissert., Univ. of Bonn.

——— 1954, Pollenanalytische Datierung zweier Vulkanausbrüche bei Strohn (Eifel): Planta, v. 43, p. 461.

——— 1957, Naturw. Rundschau, p. 109.

——— 1958, Ein spätglaziales Pollendiagramm aus dem Hinkelsmaar bei Manderscheid (Vulkaneifel): Flora, v. 146, p. 412-424.

——— 1960, Spät- und postglaziale Vegetationsgeschichte des Rheinlandes auf Grund pollenanalytischer Untersuchungen: Ber. Deutschen Bot. Gesell., v. 73, p. 307.

——— 1961a, Relative und absolute Datierungen quartärer Ablagerungen: Naturwissenschaften, v. 48, p. 324.

——— 1961b, Pollenanalytische Untersuchungen spät-glazialer Ablagerungen an zwei Maaren westlich Gillenfeld (Vulkaneifel): Pollen et Spores, v. 3, p. 275.

Straka, Herbert and de Vries, H. L., 1956, Eine Radiocarbon-Datierung zum Alter der Eifelmaare: Naturwissenschaften, v. 43, p. 13.

Stuiver, Minze, 1969, Yale natural radiocarbon measurements IX: Radiocarbon, v. 11, p. 545-658.

Willkomm, Horst and Erlenkeuser, Helmut, 1970, University of Kiel radiocarbon measurements V: Radiocarbon, v. 12, p. 526-533.

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UNIVERSITY OF LUND RADIOCARBON DATES IV

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INTRODUCTION

The C^{14} measurements reported here were made in this laboratory between October 1969 and September 1970. The measuring technique and equipment, and the treatment of samples are the same as reported previously (R., 1968, v. 10, p. 36-37; R., 1970, v. 12, p. 534).

The remark, "undersized; diluted", in *Comments* means the sample did not produce enough CO_2 to fill the counter to normal pressure and "dead" CO_2 from anthracite was introduced to make up the pressure. "% sample" indicates amount of CO_2 derived from the sample present in the diluted counting gas; the rest is "dead" CO_2. Organic carbon content reported for bone samples is calculated from yield of CO_2 by combustion of pretreated collagen.

Age calculations are based on a contemporary value equal to 0.950 of the activity of the NBS oxalic-acid standard and on a half-life for C^{14} of 5568 yr. Results are reported in years before 1950 (years B.P.), and in the A.D./B.C. scale. Errors quoted ($\pm 1\sigma$) include the standard deviations of the count rates for the unknown sample, the contemporary standard, and the background. Corrections for deviations from the "normal" C^{13}/C^{12} ratio for terrestrial plants ($\delta C^{13} = -25.0‰$ in the P.D.B. scale) are applied for all samples. δC^{13} values quoted are relative to the P.D.B. standard.

The description of each sample is based on information provided by the person submitting the sample to the laboratory.

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SAMPLE DESCRIPTIONS

I. GEOLOGIC SAMPLES

A. Sweden

Lu-135. Torreberga, peat — **1850 ± 60**, **A.D. 100**, $\delta C^{13} = -27.6‰$

Sandy peat from island in ancient lake at Torreberga, 10 km S of Lund, S Sweden (55° 37′ N Lat, 13° 15′ E Long). Coll. 1967 and subm. by G. Digerfeldt, Dept. Quaternary Geol., Univ. of Lund. Peat was formed during period of rising water level in ancient lake. Pollen-analytical dating Zone SA 1 (Nilsson, 1935, 1961a). Pretreated with HCl and NaOH. *Comment* (G.D.): date confirms pollen-analytical dating. For additional dates from Torreberga, see Torreberga series (R., 1970, v. 12, p. 536-537).

Lu-135A. Torreberga, humic acid **1860 ± 55**
A.D. 90
$\delta C^{13} = -29.2‰$

Acid-precipitated part of NaOH-soluble fraction from material used for Lu-135.

Lu-326. Juleboda **8220 ± 85**
6270 B.C.
$\delta C^{13} = -29.5‰$

Sample from lump of peat, ca. ½ m³ in size, found on shore 50 m N of mouth of small river Julebodaån, Ravlunda parish, E coast of Scania (55° 45′ 30″ N Lat, 14° 12′ 00″ E Long). Coll. 1969 by Y. Cederholm and subm. by T. Nilsson, Dept. Quaternary Geol., Univ. of Lund. *Comment* (T.N.): peat contained small bones (phalanges and os penis) of gray seal (*Halichoerus grypus*) and many macroscopic plant remains, e.g., twigs, pine cones and seeds, hazelnuts, seeds of *Menyanthes trifoliata,* and fruit of *Cornus sanguinea.* It may be characterized as a limnic peat rich in drifted material. Dated by pollen analysis to middle of Scanian pollen zone BO 2. Very good agreement between pollen-analytical date and C^{14} date (cf. Nilsson, 1964). Peat must be derived from submarine peat earlier known to exist as a narrow stretch in very shallow water along Baltic coast near site (Nilsson, 1961b, p. 101-104).

Stordalen series

Peat samples from mire 2 km NW of Stordalen R.R. Sta., Torneträsk area, Torne Lappmark, N Sweden (68° 20′ N Lat, 19° 00′ E Long). Coll. 1963 and subm. by M. Sonesson, Dept. of Plant Ecol., Univ. of Lund. Dating is part of study on vegetational dynamics and peat development in Torneträsk area (Sonesson, 1968, 1969). Depths refer to surface of mire. Lu-333 pretreated with HCl only (small sample); all other samples pretreated with HCl and NaOH.

Lu-331. Stordalen, Sample 1, peat **5240 ± 90**
3290 B.C.
$\delta C^{13} = -28.0‰$

Highly humified peat, depth 60 cm, just above mineral substratum. *Comment*: undersized; diluted; 68% sample.

Lu-331A. Stordalen, Sample 1, humic acid **5070 ± 65**
3120 B.C.
$\delta C^{13} = -26.3‰$

Acid-precipitated part of NaOH-soluble fraction from material used for Lu-331.

Lu-332. Stordalen, Sample 2, peat **2070 ± 55**
120 B.C.
$\delta C^{13} = -21.2‰$

Highly humified peat, depth 22.5 cm, directly below the obviously secondary surface peat.

Lu-332A. Stordalen, Sample 2, humic acid **1890 ± 75**
A.D. 60
$\delta C^{13} = -25.6‰$

Acid-precipitated part of NaOH-soluble fraction from material used for Lu-332.

Lu-435. Stordalen, Sample 4, peat **1110 ± 50**
A.D. 840
$\delta C^{13} = -25.8‰$

Slightly humified peat, depth 20 cm, from lowest part of secondary surface peat (almost exclusively *Dicranum elongatum*).

Lu-435A. Stordalen, Sample 4, humic acid **1200 ± 50**
A.D. 750
$\delta C^{13} = -25.5‰$

Acid-precipitated part of NaOH-soluble fraction from material used for Lu-435.

Lu-333. Stordalen, Sample 3, Bp 133 **4700 ± 70**
2750 B.C.
$\delta C^{13} = -27.7‰$

Highly humified sandy peat, depth 37 to 45 cm, in transition zone from underlying mineral substratum to peat in pals-formation (pals = permafrost mound). *Comment*: sample undersized; diluted; 83% sample. *General Comment*: contamination from penetrating roots was suspected and humic acid fraction from the 3 samples that yielded enough such material was dated for comparison. For Sample 1 and 2, age difference between peat and humic acid fraction is normal, indicating little or no contamination from penetrating roots. For Sample 4, humic acid fraction is slightly older than peat fraction, indicating that such contamination may have caused slight rejuvenation of peat.

Vassijaure series

Peat from mire at Vassijaure, ca. 0.8 km NE of pt. 514.22, Torne Lappmark, N Sweden (68° 25′ N Lat, 18° 20′ E Long). Coll. 1963 and subm. by M. Sonesson. Dating is part of study on vegetational dynamics and peat development in Torneträsk area (Sonesson, 1968, 1969, 1970). Depths given refer to surface of mire. For other dates in same series see R., 1969, v. 11, p. 443-445. All samples pretreated with HCl and NaOH.

Lu-334. Vassijaure, 65 cm, peat **3420 ± 60**
1470 B.C.
$\delta C^{13} = -26.7‰$

Slightly humified peat, depth 65 cm, in transition zone from underlying *Paludella-Calliergon stramineum* peat to *Sphagnum lindbergii* peat. Distinct increase of *Betula* in pollen diagram at this level.

Lu-334A. Vassijaure, 65 cm, humic acid **3370 ± 85**
1420 B.C.
$\delta C^{13} = -27.1‰$

Acid-precipitated part of NaOH-soluble fraction from material used for Lu-334.

Lu-433. Vassijaure, 37.5 cm, peat **1860 ± 55**
A.D. 90
$\delta C^{13} = -26.1‰$

Slightly humified peat, depth 37.5 cm, in transition zone from underlying *Sphagnum fuscum* peat to *Sphagnum lindbergii* peat.

Lu-433A. Vassijaure, 37.5 cm, humic acid **1850 ± 55**
A.D. 100
$\delta C^{13} = -26.6‰$

Acid-precipitated part of NaOH-soluble fraction from material used for Lu-433.

Lu-434. Vassijaure, 27.5 cm, peat **650 ± 75**
A.D. 1300
$\delta C^{13} = -26.4‰$

Slightly humified peat, depth 27.5 cm, in transition zone from underlying *Sphagnum lindbergii* peat to *Sphagnum fuscum* peat.

Lu-434A. Vassijaure, 27.5 cm, humic acid **760 ± 60**
A.D. 1190
$\delta C^{13} = -26.6‰$

Acid-precipitated part of NaOH-soluble fraction from material used for Lu-434.

Lu-335. Luopakte, Bp 140, 115 to 125 cm **7480 ± 115**
5530 B.C.
$\delta C^{13} = -27.1‰$

Highly humified peat from perennially frozen mire at Luopakte, on Mt. Luovare, 1.2 km SSE of pt. 627.89, Torne Lappmark, N Sweden (68° 13′ N Lat, 19° 25′ E Long). Sample from 115 to 125 cm below surface just above mineral substratum. Coll. 1963 and subm. by M. Sonesson. *Comment*: sample undersized; diluted; 53% sample. Date based on 3 1-day counts. Pretreated with HCl only.

Siretorp series

Continuation of samples dated from profile on distal side of complex Littorina beach ridge with brackish lagoon sediments at Siretorp, Sölvesborg, Blekinge (56° 01′ N Lat, 14° 37′ E Long). Coll. 1968 and subm. by B. E. Berglund, Dept. Quaternary Geol., Univ. of Lund. Other dates from this site were reported previously (R., 1970, v. 12, p. 539-541). Pretreated with HCl and NaOH.

Lu-366. Siretorp 14 **5430 ± 65**
3480 B.C.
$\delta C^{13} = -21.8‰$

Brackish gyttja, 90 to 92 cm.

Lu-367. Siretorp 15 **5290 ± 65**
3340 B.C.
$\delta C^{13} = -21.8‰$

Brackish gyttja, 86 to 89 cm.

Bysjön series

Sediment from Lake Bysjön near coast of Central Blekinge, SE Sweden (56° 11′ N Lat, 15° 08′ E Long). Alt 8 m; size 200 × 300 m; max. depth 2.3 m; mean depth 1.7 m. Lacustrine sediments investigated to date some horizons in pollen diagrams and to obtain a value of sedimentation rate. Samples were cut out from cores taken with Livingstone sampler (diam. 60 mm). Water depth 150 cm at sampling point. Depths given in sample titles are below lake water level. Pollen zones according to Berglund (1966b). Coll. 1969 by C. E. Nylander; subm. by B. E. Berglund. All samples except Lu-466 and Lu-467 more or less undersized; diluted. Amount of CO_2 from sample is given in *Comments* below as "% sample".

Lu-374. Bysjön 1, 415 to 420 cm **4430 ± 80**
2480 B.C.
$\delta C^{13} = -33.7‰$

Lacustrine detritus gyttja as in following samples. Pollen spectra indicates middle of SB 1. *Comment*: 75% sample.

Lu-375. Bysjön 2, 410 to 415 cm **4460 ± 70**
2510 B.C.
$\delta C^{13} = -30.7‰$

Dated to check Lu-374. *Comment*: 85% sample.

Lu-376. Bysjön 3, 375 to 380 cm **3680 ± 65**
1730 B.C.
$\delta C^{13} = -31.6‰$

Just at the Zone Boundary SB 1/SB 2. *Comment*: 87% sample.

Lu-377. Bysjön 4, 340 to 345 cm **2660 ± 60**
710 B.C.
$\delta C^{13} = -28.8‰$

In the middle of SB 2, dating Sub-Boreal rise of *Betula* curve and increased human influence. *Comment*: 93% sample.

Lu-378. Bysjön 5, 315 to 320 cm **2360 ± 65**
410 B.C.
$\delta C^{13} = -30.3‰$

In upper part of SB 2, dating a *Juniperus* peak. *Comment*: 82% sample.

Lu-379. Bysjön 6, 305 to 310 cm **2220 ± 55**
270 B.C.
$\delta C^{13} = -31.8‰$

Just at the Zone Boundary SB/SA, dating decrease of *Juniperus*. *Comment*: 72% sample; date based on 3 1-day counts.

Lu-380. Bysjön 7, 290 to 295 cm

1890 ± 55
A.D. 60
$\delta C^{13} = -31.2‰$

In lower part of SA 1, dating minimum of human influence. *Comment*: 67% sample; date based on 3 1-day counts.

Lu-381. Bysjön 8, 255 to 260 cm

1620 ± 60
A.D. 330
$\delta C^{13} = -30.6‰$

In SA 1, dating end of short phase with increased human influence. *Comment*: 81% sample.

Lu-382. Bysjön 9, 245 to 250 cm

1480 ± 65
A.D. 470
$\delta C^{13} = -30.9‰$

In upper part of SA 1, dating rise of *Fagus* curve in period with slight human influence. *Comment*: 64% sample.

Lu-466. Bysjön 13, 230 to 235 cm

1240 ± 50
A.D. 710
$\delta C^{13} = -27.6‰$

At the Zone Boundary SA 1/SA 2; 1st *Fagus* peak lying between this and following sample.

Lu-467. Bysjön 14, 215 to 220 cm

1150 ± 50
A.D. 800
$\delta C^{13} = -30.0‰$

In lower part of SA 2, dating slight rise of *Juniperus* curve and increasing human influence.

Lu-383. Bysjön 10, 195 to 200 cm

1020 ± 70
A.D. 930
$\delta C^{13} = -31.2‰$

Dating starting point of period with strong human influence. *Comment*: 56% sample.

Lu-468. Bysjön 15, 184 to 191 cm

810 ± 50
A.D. 1140
$\delta C^{13} = -31.3‰$

Dating rise of the *Secale* curve. *Comment*: 93% sample.

Lu-384. Bysjön 11, 175 to 180 cm

720 ± 80
A.D. 1230
$\delta C^{13} = -30.6‰$

With following sample, dates a very high *Juniperus* peak and a maximum of human influence. *Comment*: 40% sample.

Lu-415. Bysjön 12, 165 to 170 cm

660 ± 80
A.D. 1290
$\delta C^{13} = -30.3‰$

Comment: 42% sample.

General Comment (B.E.B.): sedimentation rate seems unusually constant and quite high between 2600 and 700 B.P., *i.e.*, ca. 90 mm/100 yr. This makes it possible to express pollen values in absolute numbers.

Mt. Kullen biostratigraphy series

Mt. Kullen is a ridge with summit at 187 m above m.s.l., on peninsula in NW Scania, S Sweden (56° 17′ N Lat, 12° 31′ E Long). Ice left area early, and biostratigraphy of some basins is expected to give valuable information on chronology and vegetational and soil development during Late-glacial time. Studies are concentrated to 2 fens, Björkeröds Mosse on S slope with calcareous sediments in lower part, and Håkulls Mosse on ridge with non-calcareous sediments. Pollen zones according to Nilsson (1961a) and Berglund (1966a). Preliminary results reported by Berglund (1971).

Björkeröds Mosse

A shallow, longish fen basin (ca. 400 × 40 m), alt 75 m in clayey till. Samples from core taken in central part with Digerfeldt sampler (cross section 100 × 100 mm). Sampling point is named BP 3b. Samples 0 to 4 are calcareous, 5 to 9 non-calcareous. Coll. 1969 and subm. by B. E. Berglund. Depths refer to surface of fen. All samples pretreated with HCl for complete removal of carbonates. Carbonate fraction coll. from 2 samples and dated separately for comparison with organic fraction.

Lu-368. Björkeröd 0, 364 to 369 cm — **13,380 ± 120**; **11,430 B.C.**; $\delta C^{13} = -21.5‰$

Muddy calcareous clay, in upper part of DR 1.

Lu-337. Björkeröd 1, 328 to 333 cm — **12,730 ± 135**; **10,780 B.C.**; $\delta C^{13} = -21.2‰$

Clayey calcareous gyttja, in lower part of BÖ.

Lu-338. Björkeröd 2, 320 to 325 cm, organic — **12,700 ± 110**; **10,750 B.C.**; $\delta C^{13} = -22.5‰$

Clayey calcareous gyttja, in middle of BÖ.

Lu-338c. Björkeröd 2, carbonate — **13,160 ± 135**; **11,210 B.C.**; $\delta C^{13} = +0.2‰$

Carbonate fraction extracted from material used for Lu-338. *Comment*: corrections for deviations from "normal" C^{13}/C^{12} ratio for terrestrial plants ($\delta C^{13} = -25.0‰$ in P.D.B. scale) are applied also for carbonate samples.

Lu-339. Björkeröd 3, 310 to 315 cm — **12,770 ± 110**; **10,820 B.C.**; $\delta C^{13} = -21.5‰$

Clayey calcareous gyttja, in upper part of BÖ.

Lu-340. Björkeröd 4, 305 to 310 cm, organic — **12,710 ± 90**; **10,760 B.C.**; $\delta C^{13} = -22.8‰$

Calcareous clay gyttja, in DR 2.

Lu-340c. Björkeröd 4, carbonate **13,500 ± 95**
11,550 B.C.
$\delta C^{13} = -1.3‰$

Carbonate fraction extracted from material used for Lu-340. *Comment*: same as for Lu-338c.

Lu-406. Björkeröd 5, 253 to 255 cm **11,110 ± 115**
9160 B.C.
$\delta C^{13} = -24.9‰$

Clayey fine detritus gyttja, at Zone Boundary AL/DR 3.

Lu-407. Björkeröd 6, 245 to 247 cm **11,010 ± 100**
9060 B.C.
$\delta C^{13} = -25.5‰$

Clayey fine detritus gyttja, in lowest part of DR 3.

Lu-408. Björkeröd 7, 225 to 227 cm **10,320 ± 105**
8370 B.C.
$\delta C^{13} = -21.8‰$

Clayey fine detritus gyttja, in uppermost part of DR 3.

Lu-409. Björkeröd 8, 223 to 225 cm **10,160 ± 105**
8210 B.C.
$\delta C^{13} = -22.7‰$

Clayey fine detritus gyttja, in transition zone DR 3-PB.

Lu-410. Björkeröd 9, 194 to 196 cm **9730 ± 100**
7780 B.C.
$\delta C^{13} = -29.4‰$

Coarse detritus gyttja, in upper part of PB.

General Comment (B.E.B.): dates for samples 0 to 4 have much higher values than expected. The cause must be the carbonate content of the water, which gave submerged plants a mixture of pre-Quaternary inactive carbon and atmospheric carbon with normal radiocarbon content. Consequently, the carbonate fractions have slightly higher values than corresponding organic fractions. Dates for samples 1 to 4 are almost identical, though real age differences exist. Samples 5 to 9 give quite reliable results.

Ryssjön series

Sediment from lake Ryssjön at coast of Central Blekinge, SE Sweden (56° 10′ N Lat, 15° 05′ E Long). Alt 3 m; size 300 × 400 m; max. depth 2.3 m; mean depth 1.7 m. Lake was transgressed by Littorina Sea. Samples taken to date earliest part of transgression. Upper lacustrine part of sediments was studied for vegetational development by C. E. Nylander (R., 1969, v. 11, p. 436-437). Samples from cores taken with Livingstone sampler (diam. 60 mm). Depths given are below water level. Water depth 230 cm at sampling point. Coll. 1969 and subm. by R. Liljegren and B. E. Berglund. All samples somewhat undersized; diluted. Pretreated with HCl only.

Lu-314. Ryssjön 12 **6710 ± 90**
4760 B.C.
$\delta C^{13} = -26.7‰$

Slightly brackish gyttja, 515 to 519 cm. *Comment*: 61% sample; date based on 3 1-day counts.

Lu-315. Ryssjön 13 **6910 ± 90**
4960 B.C.
$\delta C^{13} = -30.1‰$

Limnic gyttja, 521 to 525 cm. *Comment*: 78% sample.

Lu-316. Ryssjön 14 **7200 ± 105**
5250 B.C.
$\delta C^{13} = -25.6‰$

Slightly brackish gyttja, 530 to 534 cm. *Comment*: 55% sample; date based on 3 1-day counts.

Lu-317. Ryssjön 15 **7350 ± 100**
5400 B.C.
$\delta C^{13} = -28.5‰$

Limnic gyttja, 535 to 539 cm. *Comment*: 75% sample.

Färsksjön series

Samples from profile with brackish lagoon sediments from Lake Färsksjön at Eriksberg, Åryd parish, Blekinge (56° 11′ N Lat, 15° 00′ E Long), to study shore displacement in middle parts of Blekinge and compare it with results from E Blekinge (Berglund, 1964). Site was transgressed by Littorina Sea and is presently a partly overgrown lake. Cores taken with Livingstone sampler (60 mm diam.) consist of a series of brackish gyttjas over- and underlain by limnic gyttjas. Pollen diagram covers main part of Atlantic and Early Sub-Boreal zones. Transgressions named according to Berglund (1964). Depths are below water level. Water depth 150 cm. Coll. 1968 and subm. by R. Liljegren and B. E. Berglund. All samples somewhat undersized; diluted. Pretreated with HCl only.

Lu-318. Färsksjön 1 **4840 ± 70**
2890 B.C.
$\delta C^{13} = -27.3‰$

Slightly brackish gyttja, 580 to 584 cm. Beginning of 2nd Sub-Boreal transgression. *Comment*: 88% sample.

Lu-319. Färsksjön 2 **4970 ± 75**
3020 B.C.
$\delta C^{13} = -26.7‰$

Limnic gyttja, 586 to 590 cm. Between 1st and 2nd Sub-Boreal transgression. *Comment*: 83% sample.

Lu-320. Färsksjön 3 **5420 ± 75**
3470 B.C.
$\delta C^{13} = -24.9‰$

Brackish gyttja, 597 to 601 cm. End of 1st Sub-Boreal transgression. *Comment*: 64% sample; date based on 3 1-day counts.

Lu-321. Färsksjön 4

5360 ± 100
3410 B.C.
δC¹³ = −21.0‰

Brackish gyttja, 601 to 605 cm. End of 1st Sub-Boreal transgression. *Comment*: 57% sample.

Lu-322. Färsksjön 5

5990 ± 105
4040 B.C.
δC¹³ = −18.8‰

Brackish gyttja, 659 to 663 cm. Beginning of 2nd Late Atlantic transgression. *Comment*: 60% sample.

Lu-323. Färsksjön 6

5940 ± 100
3990 B.C.
δC¹³ = −19.1‰

Brackish gyttja, 674 to 678 cm. End of 1st Late Atlantic transgression. *Comment*: 61% sample; date based on 3 1-day counts.

Lu-324. Färsksjön 7

6720 ± 80
4770 B.C.
δC¹³ = −25.0‰

Slightly brackish gyttja, 714 to 718 cm. Beginning of Early Atlantic transgression. *Comment*: 96% sample.

Lu-325. Färsksjön 8

6780 ± 85
4830 B.C.
δC¹³ = −26.4‰

Limnic gyttja, 718 to 722 cm. Just before beginning of Early Atlantic transgression. *Comment*: 89% sample.

B. England

Lu-327. Chilton Track, Somerset Levels

4760 ± 65
2810 B.C.
δC¹³ = −26.7‰

Wood (*Corylus*) id. by F. A. Hibbert, from prehistoric trackway in Somerset, England (51° 11′ N Lat, 02° 50′ W Long). Trackway is within fen-wood peat ca. 110 cm above marine clay and ca. 30 cm below transition to ombrogenous peat. Coll. 1969 by J. M. Coles and F. A. Hibbert; subm. by F. A. Hibbert, Sub-Dept. Quaternary Research, Univ. of Cambridge. *Comment*: for other dates from similar trackways in Somerset Levels, see Somerset Levels series and Lu-297, Lu-298 (R., 1970, v. 12, p. 596-597, 549). Pretreated with HCl and NaOH.

Lu-328. Baker Field Platform, Somerset Levels

4280 ± 65
2330 B.C.
δC¹³ = −27.4‰

Wood (*Alnus*) id. by F. A. Hibbert, from prehistoric platform in Somerset, England (51° 11′ N Lat, 02° 50′ W Long). Platform sits in fen-wood peat which overlies *Phragmites* fen peat and is covered by ombrogenous *Sphagnum-Calluna-Eriophorum* peat. Platform is at land-ward edge of Neolithic trackway complex (Coles and Hibbert, 1968). Pretreated with HCl and NaOH. Coll. 1969 and subm. by F. A. Hibbert.

C. Indian Ocean

Lu-336. Indian Ocean, Core 157

26,700 $^{+580}_{-540}$
24,750 B.C.
$\delta C^{13} = \pm 0.0‰$

Foraminifera tests from deep sea core No. 157 (08° 05′ N Lat, 53° 03′ E Long), Indian Ocean; depth 5100 m; depth in core 91.5 to 99.5 cm. Coll. 1948 by Swedish Albatross Expedition; subm. by E. Olausson, Marine Geol. Lab., Univ. of Göteborg. *Comment*: sample ultrasonically washed in distilled acidified water (pH 3 to 4), and sieved by subm. Fraction >65 μ was used. Outermost 20% removed by acid leaching. Date based on two 2-day counts. For previous dates on Indian Ocean core, see Indian Ocean series (R., 1969, v. 11, p. 516-517).

II. ARCHAEOLOGIC SAMPLES

A. Sweden

Hagestad series

Bone, charcoal, and wood from Hagestad, Löderup parish, Scania. Coll. 1969 and subm. by M. Strömberg, Hist. Mus., Univ. of Lund. Several samples were dated previously (R., 1968, v. 10, p. 48-50; 1969, v. 11, p. 447-448; 1970, v. 12, p. 550-552). Charcoal and wood pretreated with HCl and NaOH. Bone samples treated as described previously (R., 1970, v. 12, p. 534).

Lu-329. Hagestad 6^2 A, Trench 1, wood

1960 ± 55
10 B.C.
$\delta C^{13} = -25.9‰$

Wooden peg from Trench 1:1969, on Field S of brook at coast rd., Hagestad 6^2 A (55° 23′ N Lat, 14° 09′ E Long). Peg was sharpened and put into lake sand, forming part of fishing implement. Assoc. with pottery with faceted rim.

Lu-330. Hagestad 6^2 A, Trench 1, bone

2100 ± 55
150 B.C.
$\delta C^{13} = -19.8‰$

Collagen from bone of cattle from lower stratum in Trench 1:1969, on same field as Lu-329. *Comment*: organic carbon content: 5.7%.

Lu-373. Hagestad 6^2 A, charcoal

8650 ± 105
6700 B.C.
$\delta C^{13} = -24.3‰$

Charcoal and partly charred hazelnut shells from pit with solely Mesolithic finds, on same field as Lu-329 and Lu-330. *Comment*: sample undersized; diluted; 81% sample.

Lu-372. Hagestad 22^6, Trench 1 **3850 ± 65**
1900 B.C.
$\delta C^{13} = -24.6‰$

Charcoal from hearth, 70 to 90 cm below surface, Trench 1:1969, at S border of Hagestads Mosse, Hagestad 22^6 (55° 23′ N Lat, 14° 11′ E Long). Assoc. with Neolithic pottery.

Lu-351. Hagestad 2^2 B, bone **4040 ± 65**
2090 B.C.
$\delta C^{13} = -20.1‰$

Collagen from poorly preserved bone fragments from feature W of megalithic grave at Hagestad 2^2 B (55° 25′ N Lat, 14° 08′ E Long). *Comment*: organic carbon content: 3.7%.

General Comment (M.S.): date for Lu-372 is too young, other dates are satisfactory, supporting archaeologic judgment.

Lu-350. Ingelstorp 25 **4140 ± 75**
2190 B.C.
$\delta C^{13} = -19.4‰$

Collagen from poorly preserved human femur from floor in NE niche, Sec. C, in megalithic grave at Ingelstorp 25, Ingelstorp parish, Scania (55° 26′ N Lat, 14° 01′ E Long). Coll. 1969 and subm. by M. Strömberg. *Comments* (M.S.): date indicates burial is not from primary use of megalithic grave but from later in Middle Neolithic. (S.H.): organic content: 2.44%. Sample undersized; diluted; 75% sample.

Östra Tommarp series

Human bones from excavation of grave fields at Östra Tommarp, SE Scania (55° 32′ N Lat, 14° 45′ E Long). Coll. 1967 and 1968 by L. Redin; subm. by E. Cinthio, Hist. Mus., Univ. of Lund. During 1959 and 1960 excavations were carried out in part of area where medieval town of Tumathorp with its monastery was situated (Thun, 1967). Investigations were continued in 1967. Bones dated to support archaeologic dates of monastery and other parts of medieval site. Bone samples treated as described previously (R., 1970, v. 12, p. 534).

Lu-385. Tommarp, Trench HI, Grave 1 **890 ± 50**
A.D. 1060
$\delta C^{13} = -20.0‰$

Collagen from human femur, Trench HI:1967, Grave 1, in dark humus on yellow clay. *Comment*: organic carbon content: 5.3%.

Lu-386. Tommarp, Trench HI, Grave 2 **580 ± 45**
A.D. 1370
$\delta C^{13} = -17.9‰$

Collagen from human femur, Trench HI:1967, Grave 2, in dark humus on yellow clay. *Comment*: organic carbon content: 5.5%.

920 ± 50
Lu-387. Tommarp, Trench AB, Grave 12 **A.D. 1030**
$\delta C^{13} = -20.0‰$

Collagen from human femur, Trench AB:1968, Grave 12, in dark humus on yellow clay. *Comment*: organic carbon content: 4.3%.

890 ± 50
Lu-388. Tommarp, Trench AB, Grave 13 **A.D. 1060**
$\delta C^{13} = -20.7‰$

Collagen from human femur, Trench AB:1968, Grave 13, in dark humus on yellow clay. *Comment*: organic carbon content: 4.0%.

870 ± 50
Lu-389. Tommarp, Trench AB, Grave 15 **A.D. 1080**
$\delta C^{13} = -19.1‰$

Collagen from human femur, Trench AB:1968, Grave 15, in dark humus on yellow clay. *Comment*: organic carbon content: 6.4%. *General Comment* (L.R.): dates support 2 different theories: 1) existence of developed settlement in 11th century, 2) existence of 2 churches in this early period, one of which was situated where later in 12th century a monastery was founded. So far it has not been possible to base these theories on archaeologic observations only.

Gårdlösa series

Charcoal and bone samples from Gårdlösa, Smedstorp parish, SE Scania (55° 34′ N Lat, 14° 08′ E Long). Coll. 1960 to 1969 and subm. by B. Stjernquist, Hist. Mus., Univ. of Lund. Dated for investigation of continuity of settlement in Gårdlösa area (Stjernquist, 1964, 1965). For other dates from this area, see R., 1969, v. 11, p. 445-447. Charcoal samples pretreated with HCl and NaOH. Bone sample treated as described previously (R., 1970, v. 12, p. 534).

1370 ± 50
Lu-390. Gårdlösa No. 3, House II **A.D. 580**
$\delta C^{13} = -24.9‰$

Charcoal from cultural layer in house foundation, Gårdlösa No. 3, House II. Assoc. with sherds of pottery and spindle whorls. Coll. 1960.

1350 ± 50
Lu-391. Gärdlösa No. 3, House IV **A.D. 600**
$\delta C^{13} = -24.3‰$

Charcoal from cultural layer in house foundation, Gårdlösa No. 3, House IV. Assoc. with sherds of pottery. Coll. 1963.

1400 ± 50
Lu-392. Gårdlösa No. 3, House XIII **A.D. 550**
$\delta C^{13} = -23.5‰$

Charcoal from cultural layer in house foundation, Gårdlösa No. 3, House XIII. Assoc. with sherds of pottery, iron objects, and a glass bead. Coll. 1964.

Lu-393. Gårdlösa No. 3, House XLV

1290 ± 50
A.D. 660
$\delta C^{13} = -24.1‰$

Charcoal from cultural layer in house foundation, Gårdlösa No. 3, House XLV. Assoc. with iron key, pottery, and spindle whorls. Coll. 1965.

Lu-394. Gårdlösa No. 3, House L

1250 ± 50
A.D. 700
$\delta C^{13} = -23.6‰$

Charcoal from cultural layer in house foundation, Gårdlösa No. 3, House L. Assoc. with bronze amulet with figural picture. Coll. 1966.

Lu-395. Gårdlösa No. 3, House LII

1350 ± 50
A.D. 600
$\delta C^{13} = -25.2‰$

Charcoal from cultural layer in house foundation, Gårdlösa No. 3, House LII. Assoc. with silver pendant, sherds of pottery, and glass beads. Coll. 1966.

Lu-396. Gårdlösa No. 3, House LIII

1250 ± 50
A.D. 700
$\delta C^{13} = -24.3‰$

Charcoal from cultural layer in house foundation, Gårdlösa No. 3, House LIII. Assoc. with bronze ornament, ring needle, glass beads, and sherds of pottery. Coll. 1969.

Lu-399. Gårdlösa No. 3, Grave 66

1680 ± 80
A.D. 270
$\delta C^{13} = -20.0‰$

Collagen from human bone from Grave 66, Gårdlösa No. 3. Assoc. with iron buckle, iron knife, and pottery. Coll. 1969. *Comment*: organic carbon content: 1.7%. Sample undersized; diluted; 49% sample.

Lu-397. Gårdlösa No. 16, Sample 1

1880 ± 55
A.D. 70
$\delta C^{13} = -25.2‰$

Charcoal from hearth in cultural layer, Gårdlösa No. 16, P. 9-10. Coll. 1966.

Lu-398. Gårdlösa No. 16, Sample 2

1760 ± 55
A.D. 190
$\delta C^{13} = -24.6‰$

Charcoal from hearth in cultural layer, Gårdlösa No. 16, R. 29/30-32/33. Coll. 1966.

General Comment (B.S.): all dates agree well with estimates based on archaeologic material.

Torkö-Östanön series, submarine blocking

Wood samples from artificial blocking at ca. 5 m depth in strait between Torkö and Östanön Is., Listerby, Blekinge (56° 09′ N Lat, 15°

25′ E Long). Coll. 1969 by Blekinge Mus.; subm. by B. E. Berglund. Other dates from similar blockings were reported previously (R., 1968, v. 10, p. 50; 1969, v. 11, p. 448-449). Pretreated with HCl and NaOH.

150 ± 50
Lu-411. Torkö-Östanön 1 **A.D. 1800**
δC^{13} = –24.6‰

Wood from birch pile. Sample taken from 5 youngest annual rings of 14-yr old trunk.

110 ± 50
Lu-412. Torkö-Östanön 2 **A.D. 1840**
δC^{13} = –25.2‰

Wood from spruce pile. Sample taken from 10 youngest annual rings of ca. 30-yr old trunk.

180 ± 50
Lu-413. Torkö-Östanön 3 **A.D. 1770**
δC^{13} = –25.5‰

Wood from birch pile. Sample taken from 5 youngest annual rings of ca. 15-yr old trunk.

General Comment (B.E.B.): other blockings in Blekinge belonging to a defense system were dated to 11th century A.D., but low age of these piles indicates that they may belong to a blocking for fishing used in modern time.

B. Argentina

1410 ± 50
Lu-370. Río Diablo, Site No. 3 **A.D. 540**
δC^{13} = –23.3‰

Charcoal from Grid A, Level 3, Site No. 3, Río Diablo, La Ciénaga, Catamarca Prov., Argentina (27° 26′ 54″ S Lat, 66° 57′ 25″ W Long). Assoc. with material from La Aguada culture, for which only few dates are so far known (González, 1961). Coll. 1969 by A. Risso; subm. by A. Rex González, Dept. of Archaeol., Mus. of La Plata, Argentina. Pretreated with HCl and NaOH. *Comment* (A.R.G.): our guess was 700-850 A.D.; date somewhat early, but within possibilities of Aguada's beginning, especially if we take 2 sigmas.

840 ± 50
Lu-369. Agua Verde, Test No. 2 **A.D. 1110**
δC^{13} = –24.0‰

Charcoal from Test No. 2, Level 1, Site Agua Verde, Puerta de Corral Quemado, Catamarca Prov., Argentina (27° 27′ S Lat, 66° 57′ W Long). Assoc. with material from Hualfín culture, for which no dates are so far known (González, 1964). Coll. 1969 by C. Sempe and M. D. Arena; subm. by A. Rex González. Pretreated with HCl and NaOH. *Comment* (A.R.G.): archaeol. estimation 900-1000 A.D.

Lu-371. Eje de Hualfín, Room 72 **520 ± 50**
A.D. 1430
$\delta C^{13} = -24.6‰$

Charcoal from Room 72, depth 60 cm, Eje de Hualfín, Dept. of Belén, Catamarca Prov., Argentina (27° 16′ 48″ S Lat, 66° 51′ 42″ W Long). Assoc. with material from Belén culture (González, 1963). Coll. 1969 by C. Podestá; subm. by A. Rex González. Pretreated with HCl and NaOH. *Comment* (A.R.G.): date in perfect accordance with our previous calculus and expectations and also with historical information of Inca arrival in Northwest Argentina; it is a good landmark for chronology of beginning of Belen III culture.

III. SOIL SCIENCE SAMPLES

Linnebjer series

Samples from deciduous forest and meadow soil profiles at Linnebjer, S Sandby parish, S Scania, Sweden (55° 44′ N Lat, 13° 18′ E Long). Dated to investigate possibility of using activity measurements as index of rate of turnover of organic matter in forest and meadow eco-systems (cf. Rafter and Stout, 1970). Oats cultivated next to experimental area and living matter from sampling points were used as integrators of activity during growth period 1969. Coll. Dec. 1962 (Lu-365), Nov. 1966 (Lu-364), and Nov. 1969, and subm. by F. Andersson, Dept. of Plant Ecol., Univ. of Lund. Both forest and meadow situated on clayey soil with hydromorphic features. Vegetational and environmental conditions of Linnebjer area are described by submitter (Andersson, 1970a, 1970b). No chemical pretreatment of samples.

Results are given as a difference, Δ, from our radiocarbon standard (95% of the activity of NBS oxalic acid standard, not age corrected to 1950):

$$\Delta = \delta C^{14} - (2\delta C^{13} + 50)\left(1 + \frac{\delta C^{14}}{1000}\right)$$

where δC^{14} is observed deviation from radiocarbon standard in per mil and δC^{13} deviation from P.D.B. standard in per mil.

Final results of investigation will be published later elsewhere.

Forest soil profile

Brown forest soil with mull. Mull layer 10 cm and brown earth layer (B) ca. 25 cm thick. Depths given below refer to surface of mull layer.

Lu-353. Linnebjer 2, Nov. 1969 $\Delta = +575 \pm 7‰$
$\delta C^{13} = -26.6‰$

New litter of oak, hazel, and lime tree.

Lu-354. Linnebjer 3, Nov. 1969 $\Delta = +552 \pm 7‰$
$\delta C^{13} = -27.3‰$

Old litter.

Lu-355. Linnebjer 4, Nov. 1969 $\Delta = +506 \pm 7‰$
$\delta C^{13} = -26.4‰$

Upper mull (dark humus), 0 to 2 cm depth.

Lu-356. Linnebjer 5, Nov. 1969 $\Delta = +41 \pm 6‰$
$\delta C^{13} = -26.4‰$

Mull, 2 to 10 cm depth.

Lu-357. Linnebjer 6, Nov. 1969 $\Delta = -162 \pm 6‰$
$\delta C^{13} = -25.3‰$

Brown earth from lower part of (B) layer, depth ca. 30 cm. *Comment*: $\Delta = -162 \pm 6‰$ corresponds to radiocarbon age 1420 ± 50 B.P.

Lu-364. Linnebjer 15, Nov. 1966 $\Delta = -11 \pm 5‰$
$\delta C^{13} = -25.8‰$

Mull, 0 to 10 cm depth. *Comment*: $\Delta = -11 \pm 5‰$ corresponds to radiocarbon age 80 ± 40 B.P.

Lu-365. Linnebjer 16, Dec. 1962 $\Delta = -14 \pm 5‰$
$\delta C^{13} = -26.4‰$

Mull, 0 to 10 cm depth. *Comment*: $\Delta = -14 \pm 5‰$ corresponds to radiocarbon age 110 ± 40 B.P.

Meadow soil profile

Mullgley soil with ca. 25 cm thick mull layer. Depths given below refer to surface of mull layer.

Lu-359. Linnebjer 9-10, Nov. 1969 $\Delta = +626 \pm 8‰$
$\delta C^{13} = -27.6‰$

Litter of *Filipendula ulmaria*.

Lu-360. Linnebjer 11, Nov. 1969 $\Delta = +171 \pm 7‰$
$\delta C^{13} = -27.7‰$

Mull, 2 to 5 cm depth.

Lu-361. Linnebjer 12, Nov. 1969 $\Delta = +89 \pm 6‰$
$\delta C^{13} = -26.4‰$

Mull, 5 to 15 cm depth.

Lu-362. Linnebjer 13, Nov. 1969 $\Delta = -56 \pm 6‰$
$\delta C^{13} = -24.9‰$

Mull with sand in transition zone from G_o layer to mull layer. Depth ca. 25 cm. *Comment*: $\Delta = -56 \pm 6‰$ corresponds to radiocarbon age 460 ± 50 B.P.

Radiocarbon activity integrators

Lu-352. Linnebjer 1, Nov. 1969 $\Delta = +577 \pm 7‰$
$\delta C^{13} = -29.1‰$

Leaves of hazel coll. Nov. 11, 1969 on shrubs quite close to forest soil profile.

Lu-358. Linnebjer 8, Nov. 1969 $\Delta = +566 \pm 7‰$
$\delta C^{13} = -26.4‰$

Living matter of *Filipendula ulmaria* coll. Nov. 11, 1969 on surface of meadow soil profile.

Lu-363. Linnebjer 14, 1969 $\Delta = +579 \pm 7‰$
$\delta C^{13} = -25.2‰$

Threshed grains of oats cultivated next to experimental area and coll. after harvest 1969.

References

Andersson, Folke, 1970a, Ecological studies in a Scanian woodland and meadow area. I. Vegetational and environmental conditions: Op. Bot. A Soc. Bot. Lundensi, v. 27, 190 p.

——— 1970b, Ecological studies in a Scanian woodland and meadow area. II. Plant biomass, primary production and turn-over of organic matter: Bot. Notiser (Lund), v. 123, p. 8-51.

Berglund, B. E., 1964, The Post-Glacial shore displacement in eastern Blekinge, southeastern Sweden: Sveriges Geol. Unders., ser. C., no. 599, p. 1-47.

——— 1966a, Late-Quaternary vegetation in eastern Blekinge, southeastern Sweden. I. Late-Glacial time: Op. Bot. A Soc. Bot. Lundensi, v. 12, no. 1, 180 p.

——— 1966b, Late-Quaternary vegetation in eastern Blekinge, southeastern Sweden. II. Post-Glacial time: Op. Bot. A Soc. Bot. Lundensi, v. 12, no. 2, 190 p.

——— 1971, Late-Glacial stratigraphy and chronology in South Sweden in the light of biostratigraphic studies on Mt. Kullen, Scania: Geol. För. Stockholm Förh., v. 93, p. 11-45.

Coles, J. M. and Hibbert, F. A., 1968, Prehistoric roads and tracks in Somerset, England: Prehist. Soc. Proc., v. 34, p. 238.

González, A. Rex, 1961, The La Aguada culture of northwestern Argentina, *in*: Essays in Pre-Columbian art and archaeology, Cambridge, Mass., Harvard Univ. Press, p. 389-420.

——— 1963, Cultural development in northwestern Argentina, *in*: Smithsonian Misc. Colln., v. 146, no. 1, p. 103-117.

——— 1964, Nuevas fechas de la cronología Argentina obtenidas por el método de radiocarbón (V): Rev. Inst. Antropol., Córdoba, Argentina, v. 2-3, p. 289-297.

Nilsson, Tage, 1935, Die pollenanalytische Zonengliederung der spät- und postglazialen Bildungen Schonens: Geol. För. Stockholm Förh., v. 57, p. 385-562.

——— 1961a, Ein neues Standardpollendiagramm aus Bjärsjöholmssjön in Schonen: Lunds Univ. Årssk., N.F. avd. 2, v. 56, no. 18, p. 1-34.

——— 1961b, Ravlundafältets geologi: Skånes Natur, 1961, Lund, p. 73-106.

——— 1964, Standardpollendiagramme und C^{14}-Datierungen aus dem Ageröds Mosse im mittleren Schonen: Lunds Univ. Årssk., N.F. avd. 2, v. 59, no. 7, p. 1-52.

Rafter, T. A. and Stout, J. D., 1970, Radiocarbon measurements as an index of the rate of turnover of organic matter in forest and grassland ecosystems in New Zealand, *in*: Olsson, I. U. (ed.), Radiocarbon variations and absolute chronology, 12th Nobel symposium proc., Uppsala, Aug. 1969, p. 407-417.

Sonesson, Mats, 1968, Pollen zones at Abisko, Torne Lappmark, Sweden: Bot Notiser (Lund), v. 121, p. 491-500.

——— 1969, Studies on mire vegetation in the Torneträsk area, northern Sweden. III. Communities of the poor mires: Op. Bot. A Soc. Bot. Lundensi, v. 26, 120 p.

——— 1970, Studies on mire vegetation in the Torneträsk area, northern Sweden. IV. Some habitat conditions of the poor mires: Bot. Notiser (Lund), v. 123, p. 67-111.

Stjernquist, Berta, 1964, New light on spring-cults in Scandinavian prehistory: Archaeology, v. 17, no. 3, p. 180-184.

——— 1965, Gårdlösaundersökningen. En presentation: Ale, Hist. Tidskr. för Skåneland, no. 2, 1965, p. 12-23.

Thun, Egon, 1967, Medieval Tommarp, Archaeological investigations 1959-60: Acta Archaeologica Lundensia, ser. in 8°, no. 5, 91 p.

[RADIOCARBON, VOL. 13, NO. 2, 1971, P. 358-362]

LOUVAIN NATURAL RADIOCARBON MEASUREMENTS XI

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The following list comprises selected measurements obtained by counting methane at 3 atm pressure in a 0.6 L stainless steel counter. Sample preparation, counting procedure, and calculation method are described in previous lists. Dates are reported in terms of the Libby half-life. The quoted errors are the experimental standard deviations including uncertainty on samples and standards.

Descriptions and comments are based on information supplied by the submitters.

Thanks are extended to F. Frix for routine sample preparation and counting, and G. Michotte for electronics maintenance. Financial support is provided by the Fonds de la Recherche Fondamentale Collective, Brussels.

SAMPLE DESCRIPTIONS

I. GEOLOGIC SAMPLES

Les Laubies series, France

Peat from Les Laubies (44° 28′ N Lat, 3° 39′ E Long), Dept. of Lozère, France, alt 1380 m. Holocene peat bog, 135 cm thick, on granitic substratum. Coll. 1969 by A. Pons and J. L. de Beaulieu; subm. by A. Pons, St. Jerôme Sci. Fac., Marseille. C^{14} dates, related to pollen analysis, enable dating of Holocene forest phases on Lozère Mt. and correlation of other pollen diagrams from same region.

1090 ± 110
Lv-514. Les Laubies, 20 cm **A.D. 860**

From 20 cm depth. Dates forest clearance of Lozère Mt. as either early Mediaeval or late Carolingian Empire.

3590 ± 140
Lv-515. Les Laubies, 65 to 70 cm **1640 B.C.**

From 65 to 70 cm depth. At this level, increasing curve of *Fagus* pollen crosses decreasing curve of *Quercus*. C^{14} date indicates that beech-forest expansion occurs earlier than in SW and N of France. But we cannot discard possibility of a stratigraphic hiatus in peat bog.

8460 ± 190
Lv-516. Les Laubies, 135 cm **6510 B.C.**

From bottom of peat bog. Pollen analysis shows typical vegetation of end of Pre-Boreal period. C^{14} date agrees with palynologic results.

2480 ± 85
Lv-458. Braakman, Netherlands **530 B.C.**

Peat from Braakman at Hoek (51° 19′ N Lat, 3° 45′ E Long), Prov. of Zealand, Netherlands, alt 1 m. From 27.5 to 32.5 cm in pollen profile, at 1 m below ground surface. Coll. 1968, pollen analyzed and subm. by

A. V. Munaut, Univ. of Louvain. Dates last peat level before overlying marine sediment. Pollen diagram shows Sub-Atlantic horizon with 1st maximum of *Fagus* at 35 cm depth (Munaut, 1969). C^{14} date agrees with palynology.

Lv-487. Landbruch I **(a) 2580 ± 90** **630 B.C.** **(b) 2620 ± 90** **670 B.C.**

Peat after alkali pretreatment (a) and humate extract (b) from Vallon du Landbruch (49° 40′ N Lat, 5° 43′ E Long) in military field of Lagland-Stockem, Prov. of Luxembourg, Belgium, alt 350 m. From 129 to 135 cm, Sub-Boreal/Sub-Atlantic transition in pollen profile. Coll. 1968, pollen-analyzed, and subm. by G. Woillard, Univ. of Louvain. C^{14} date confirms questionable interpretation of pollen diagram and proves that *Fagus* can also play an important part in Lorrain district. Nearby, at Stockem, it is impossible to precisely locate transition in pollen profile (Coûteaux, 1969).

Herentals series

Peat and humic matter from Herentals (50° 15′ 22″ N Lat, 4° 47′ 58″ E Long), Prov. of Antwerpen, Belgium, alt 10 m. Coll. 1967 by A. V. Munaut and E. Paulissen; subm. by A. V. Munaut.

Lv-459. Herentals GN43/1 **9940 ± 120** **7990 B.C.**

Peat from 50 to 55 cm depth in peat layer. Pollen diagram, by A. V. Munaut, shows, at this level, 1st increase of *Pinus* at beginning of Pre-Boreal period. C^{14} date closely agrees with palynology. *Comment*: NaOH-leach omitted for sample pretreatment.

Lv-460. Herentals GN43/2 **9090 ± 160** **7140 B.C.**

Peat from 10 to 17.5 cm showing beginning of continuous curve of *Corylus* at end of Pre-Boreal period. C^{14} date confirms pollen analytic results. *Comment*: NaOH-leach omitted.

Lv-461. Herentals GN13 **10,640 ± 150** **8690 B.C.**

Humic matter from a humus-rich clay layer overlain by a thin charcoal layer. Taken at 1 m depth, near pollen profile. Sample, 6 cm thick, represents the whole Alleröd horizon, but because of relative importance of charcoal in extracted organic matter, a date close to end of Alleröd would be expected. C^{14} date seems a little too young, probably because of humic contamination, but does not disprove palynologic interpretation.

II. ARCHAEOLOGIC SAMPLES

Lv-499. Tavigny 65.Ta.03 **1130 ± 65** **A.D. 820**

Charcoal from medieval chapel at Tavigny (50° 07′ N Lat, 5° 51′ E

Long), Prov. of Luxembourg, Belgium. From 80 cm depth in Tr. 65.I, Profile AB, nr.7. Coll. 1965 and subm. by J. Mertens, Univ. of Louvain. C^{14} date proves chapel already existed during 9th century A.D., as recorded in archival texts, and agrees with a 1st burning that occurred some time after 1st burials around original chapel (Mertens and Matthijs, 1970).

Alba Fucens series, Italy

Charcoal from Alba Fucens (42° 05′ N Lat, 13° 25′ E Long), Prov. of Aquila, Italy. From Trench 67.VI in N zone of town center. Coll. 1967 and subm. by J. Mertens.

1810 ± 80
Lv-365. Alba Fucens 67.AF.29 **A.D. 140**

Charcoal from 2.00 m depth related to potsherds. Archaeol. context indicates 1st century B.C. to 1st century A.D.

2190 ± 90
Lv-366. Alba Fucens 67.AF.21 **240 B.C.**

From 1.20 m depth. Assoc. material archaeol. dated 2nd century B.C.

Ordona series, Italy

Charcoal samples from Ordona (41° 18′ N Lat, 15° 37′ E Long) Prov. of Foggia, Italy. Coll. 1967 by G. De Boe and 1969 by R. Iker and J. Papeleux; subm. by J. Mertens. Present samples continue previous series within general study of ancient Roman colony at Herdoniae.

2030 ± 75
Lv-355. Ordona 67.OR.33 **80 B.C.**

From 1.83 m depth, under walls of Roman basilica built during 1st century A.D. C^{14} date agrees with archaeol. material.

2170 ± 65
Lv-356. Ordona 67.OR.66 **220 B.C.**

From filling of circular market at 3.10 m depth, built at beginning of 2nd century A.D. C^{14} date proves that materials used for filling are from miscellaneous dates and origin.

1820 ± 75
Lv-357. Ordona 67.OR.55 **A.D. 130**

From under walls of Roman basilica. Date seems too young for basilica building.

1900 ± 60
Lv-371. Ordona 67.OR.154 **A.D. 50**

From 2.50 m depth in Tr. LXVIII, m.154, under Roman wall from 1st century A.D. construction. Charcoal assoc. with archaeol. material dated from 2nd and 1st centuries B.C.

2030 ± 90
Lv-372. Ordona 67.OR.219 **80 B.C.**

From Tr. LXVIII, m.72.50, dug across town. Sample related to archaeol. material from end of 1st century B.C. and 1st century A.D.

Lv-373. Ordona 67.OR.142 **2210 ± 80**
260 B.C.

From Tr. LXVIII, at 3.20 m depth in center of town. C^{14} date agrees with archaeol. context.

Lv-501. Ordona 69.OR.91 **1780 ± 70**
A.D. 170

From Tr. 69.IV at 2.75 m depth near forum. Sample dates 1st occupation after new arrangement of forum. Archaeol. date is A.D. 120.

Lv-500. Ordona 69.OR.35 **1780 ± 70**
A.D. 170

From 1.20 m depth in tavern along Roman forum. Confirms Lv-501.

Cortaillod series, Switzerland

Wood piles from Bronze-age site of Petit Cortaillod (46° 56′ N Lat, 6° 51′ E Long) at Cortaillod, Canton Neuchâtel, Switzerland. From 1.50 m below present lake surface. Coll. 1968 and subm. by E. Borel, Cantonal Archaeol. Mus. of Neuchâtel. Site comprises 2 contiguous palafittic stas. shielded by a pile wall. Sta. 1 is open towards shore and Sta. 2, towards lake. Archaeol. estimations are 1300 to 600 B.C. for Sta. 1 and 1600 to 900 B.C. for Sta. 2 (Neuchateloise Geog. Soc., 1944); samples belong to last dwelling level. C^{14} dates are surprisingly contemporary.

Lv-452. Cortaillod P1 **2510 ± 90**
560 B.C.

Pile from Sta. 1.

Lv-453. Cortaillod P2 **2470 ± 65**
520 B.C.

Other pile from Sta. 1.

Lv-454. Cortaillod P3 **2520 ± 85**
570 B.C.

Pile from Sta. 2.

Lv-455. Cortaillod P4 **2540 ± 85**
590 B.C.

Other pile from Sta. 2.

Apamee series, Syria

Samples from Apamee, now Qualaat-el-Moudiq (35° 25′ N Lat, 36° 24′ E Long), Prov. of Hama, Syria. Coll. 1966-67 by R. Donceel; subm. by J. C. Balty, Belgium Archaeol. Res. at Apamee de Syrie Center, Brussels. The town, built in 4th century B.C. was destroyed in 612 A.D. (Verhoogen, 1964). Excavations were made from 1930 to 1938 and since 1965.

Lv-398. Apamee, Grave 22 **1210 ± 70**
A.D. 740

Human bones from Grave 22 near Atrium church. Grave is built with a few stones, at 2.50 m below present ground surface, in thick filling above flag stones of a street. According to coins and potsherds, filling is dated at 2nd half of 7th century A.D. C^{14} date proves town was not entirely deserted after destruction in A.D. 612 (Lemaire and Balty, 1970).

Lv-399. Apamee 1/11 **1590 ± 60**
A.D. 360

Ashes from NW corner of Atrium church, close to foundation stones of wall of 5th century Christian church built on remains of a synagogue. C^{14} date suggests that mosaics of A.D. 391-392 correspond to general improvement of synagogue rather than only a pavement renewal.

Lv-405. Apamee 1/10 **1980 ± 90**
30 B.C.

Charcoal from S part of Atrium church at 1.26 m below church level. Sampled layer is that of burned subjacent synagogue. Charcoal seems to originate from timber; erection date for synagogue estimated at end of 1st century B.C. or beginning of 1st century A.D. C^{14} date is consistent with archaeol.

Lv-404. Apamee 1/9 **1780 ± 80**
A.D. 170

Ashes from NW corner of Atrium church, synagogue level. Probably from wainscot or door. Confirms 1st century A.D. as erection date of synagogue.

Lv-402. Apamee 1/1 **1640 ± 70**
A.D. 310

Charcoal from burned layer on floor of Rm. M in Triclinos bldg., at 2.50 m below present ground surface. Kind of mosaic work, indicates a 4th century date.

Lv-403. Apamee 1/2 **1700 ± 70**
A.D. 250

Charcoal from Rm. 0 in Triclinos bldg., at 2.50 m depth, from under a tile layer; sample seems to originate from roof timber. Room, enclosed in main building, was reconstructed during middle 5th century A.D. according to stone and mosaic work. C^{14} date suggests that original timber was re-used.

References

Coûteaux, M., 1969, Recherches palynologiques en Gaume, au Pays d'Arlon, en Ardenne Méridionale (Luxembourg belge) et au Gutland (Grand Duché de Luxembourg): Geog. Lovaniensia Acta, v. 8, 193 p.

Lemaire, J. and Balty, J. C., 1970, Fouilles d'Apamée de Syrie, I,1, L'Eglise à Atrium de la Grande Colonnade: Mus. Royaux d'Art et d'Histoire Brussels, 162 p., 80 pl.

Mertens, J. and Matthijs, A., 1970, Tavigny, lieu de culte romain et médiéval: Archaeol. Lovaniensia Acta, v. 3, 65 p.

Munaut, A. V., 1969, L'affleurement tourbeux de Braakman (Flandre Zeelandaise): Les Naturalistes belges Bull., v. 50-10, p. 564-571.

Neuchateloise Geog. Soc., 1944, Cortaillod: Soc. Neuchateloise de Geog. Bull., v. 50, fasc. 1, p. 5-40.

Verhoogen, V., 1964, Apamee de Syrie: Mus. Royaux d'Art et d'Histoire, Brussels, 75 p.

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UNIVERSITY OF PENNSYLVANIA RADIOCARBON DATES XIV

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This date list includes those series of samples completed in this laboratory as of December 1970. The B.P. ages are based upon A.D. 1950, and are calculated with a half-life value of 5568 yr. All samples were counted at least twice for periods of not less than 1000 minutes each. Errors quoted are derived from measurement of samples, background, and modern-age calibration, but do not include any half-life error. All samples were pretreated with 3N HCl, and some, where noted, were given additional pretreatment with 2% NaOH for the removal of possible humic contaminants.

Standard calibration samples are 126-yr-old oak samples which, when corrected for age, have C^{14} contents equal to 95% of the NBS oxalic acid standard. The C^{13} relationship between the Oak standard and NBS limestone standard #20 is $-25.7 \pm 1.3‰$ as measured on the University of Pennsylvania mass spectrograph. Where δC^{13} is reported (cf. P-1621 and P-1544) and the results accordingly corrected for isotopic fractionation, the C^{13} relationship has been measured with respect to the Oak standard.

I wish to thank John Hedrick for his careful work in the processing of these samples.

SAMPLE DESCRIPTIONS

I. ARCHAEOLOGIC SAMPLES

A. Yugoslavia

P-1598. Lepinski Vir **6814 ± 69**
4864 B.C.

Charcoal from hearth construction of House 32, belonging to later phase of proto-neolithic settlement (L.V. Id), at Lepinski Vir, on right bank of Danube 14.5 km up river from Donje Milanovac, Yugoslavia (44° 31′ N Lat, 22° 2′ E Long). Site is noteable for its trapezoidal house floors in the proto-Neolithic levels, stratified beneath typical Starcevo remains. Coll. and subm. 1969 by D. Srejovic, Univ. of Belgrade, Archaeol. Inst., Belgrade, Yugoslavia. For additional dates from this site, see BM-379, 6900 ± 150 (R., 1969, v. 11, p. 292; Srejovic, 1968a, 1968b, 1969; Nandris, 1968).

B. Greece

Kyrenia Wreck series

Kyrenia Wreck lies in 90 ft of water off N coast of Cyprus, Greece, 1.6 km from port of Kyrenia (35° 20′ N Lat, 33° 20′ E Long). This wreck is earliest known example of sheathing hull in lead to keep shipworms from eating into planking. Samples coll. and subm. 1969 by M. L. Katzev, Univ. Mus., Univ. of Pennsylvania (1969, 1970a, 1970b).

P-1621. Almonds **2124 ± 60**
174 B.C.
$\delta C^{13} = -6.48‰$

Almonds found in 12 different amphoras of the last 3rd of the 4th century B.C.

P-1622. Wood from hull of ship **2222 ± 43**
272 B.C.

Franchthi Cave series

Franchthi Cave (37° 26′ N Lat, 23° 8′ E Long) is near W tip of high, rugged headland, directly across bay from village of Koilada near Porto Cheli in S Argolid, Peloponnese, Greece. Site is especially important because of its apparently continuous stratigraphic sequence from late Palaeolithic through Mesolithic and the critical transition to Neolithic. There are no stratified prehistoric remains beyond the Late Neolithic. Samples coll. 1967, 1968, and 1969 during joint excavations by Indiana Univ. and Univ. Mus., Univ. of Pennsylvania; subm. by T. W. Jacobsen and M. H. Jameson, Univ. Mus., Univ. of Pennsylvania (Jacobsen, 1968, 1969a, 1969b, 1969c).

P-1658. Area F/A, Unit 10 **105 ± 44**
A.D. 1845

Charcoal mixed with earth from hearth in Area F/A, Unit 10, ca. 0.60 to 0.75 m below modern surface. Coll. 1969. Date expected to be very recent. *Comment*: NaOH pretreatment.

P-1663. Pit H-1, Unit 22 **36 ± 40**
A.D. 1914

Charcoal, earth, and some splintered wood from hearth belonging to Pit H-1, Unit 22, ca. 2.0 m below modern surface. Coll. 1969. Date expected to be recent. *Comment*: NaOH pretreatment.

P-1659. Area F/A, Unit 39 **5163 ± 78**
3213 B.C.

Charcoal mixed with earth from Area F/A, Unit 39, ca. 1.25 to 1.55 m below modern surface. Coll. 1969. Date expected to be very Late Neolithic. *Comment*: NaOH pretreatment.

P-1660. F/A Balk, Unit 72 S **5261 ± 64**
3311 B.C.

Charcoal mixed with earth from F/A Balk, Unit 72 S, ca. 1.87 to 1.95 m below modern surface. Coll. 1969. Date expected to be Late Neolithic. *Comment*: NaOH pretreatment.

P-1630. F/A Balk, Unit 89 N **6110 ± 86**
4160 B.C.

Charcoal mixed with earth from F/A Balk, Unit 89 N, ca. 2.24 to 2.30 m below modern surface. Coll. 1969. Date expected to be Late Neolithic. *Comment*: NaOH pretreatment.

P-1661. F/A Balk, Unit 97 N **6156 ± 70**
4206 B.C.

Charcoal mixed with earth from F/A Balk, Unit 97 N, ca. 2.35 to 2.40 m below modern surface. Coll. 1969. Date expected to be Late Neolithic. *Comment*: NaOH pretreatment.

P-1662. F/A Balk, Unit 114 N **6691 ± 81**
4741 B.C.

Charcoal mixed with earth from F/A Balk, Unit 114, ca. 2.75 to 2.80 m below modern surface. Coll. 1969. Date expected to be early Late or late Middle Neolithic. *Comment*: NaOH pretreatment.

P-1537. Pit G-1, Unit 11 **6646 ± 79**
4696 B.C.

Charcoal mixed with earth from Pit G-1, Unit 11, ca. 2.80/3.36 to 2.80/3.60 m below modern surface. Coll. 1968. Date expected to be Middle Neolithic. *Comment*: NaOH pretreatment.

P-1399. Pit A, Unit 56 **7194 ± 112**
5244 B.C.

Charcoal mixed with earth from Pit A, Unit 56, ca. 3.95/4.02 to 4.07/4.15 m below modern surface. Coll. 1967. Date expected to be very early Middle Neolithic. *Comment*: NaOH pretreatment.

P-1667. Pit H, Unit 37 Y **7278 ± 86**
5328 B.C.

Charcoal mixed with earth from Pit H, Unit 37 Y, ca. 3.75 m below modern surface. Coll. 1969. Date expected to be Early Neolithic. *Comment*: NaOH pretreatment.

P-1525. Pit F/F-1, Unit 42 B 1 **7704 ± 81**
5754 B.C.

Charcoal mixed with earth from Pit F/F-1, Unit 42 B 1, ca. 4.03/4.16 to 4.07/4.21 m below modern surface. Coll. 1968. Date expected to be Early Neolithic.

P-1392. Pit A, Unit 63 **7794 ± 140**
5844 B.C.

Charcoal mixed with earth from Pit A, Unit 63. Coll. 1967. Date expected to be Aceramic Neolithic. *Comment*: NaOH pretreatment.

P-1398. Pit G, Unit 31 **9098 ± 139**
7148 B.C.

Charcoal mixed with earth from Pit G, Unit 31, ca. 4.47/4.85 to 4.63/4.94 m below modern surface. Coll. 1967. Date expected to be Mesolithic. *Comment*: NaOH pretreatment.

P-1536. Pit G-1, Unit 22 **8189 ± 78**
6239 B.C.

Charcoal mixed with earth from Pit G-1, Unit 22, ca. 4.12/4.60 to 4.39/4.83 m below modern surface. Coll. 1968. Date expected to be Mesolithic. *Comment*: NaOH pretreatment.

P-1527. Pit F/F-1, Unit 44 B 5 **7897 ± 88**
5947 B.C.

Charcoal mixed with earth from Pit F/F-1, Unit 44 B 5, ca. 4.43/4.47 to 4.58/4.60 m below modern surface. Coll. 1968. Date expected to be late Mesolithic. *Comment*: NaOH pretreatment.

P-1526. Pit F/F-1, Unit 43 A 1 **8022 ± 76**
6072 B.C.

Charcoal mixed with earth from Pit F/F-1, Unit 43 A 1, ca. 4.64/4.66 to 4.77/4.83 m below modern surface. Coll. 1968. Date expected to be late Mesolithic. *Comment*: NaOH pretreatment.

P-1664. Pit H-1, Unit A 101 **8941 ± 117**
6991 B.C.

Charcoal mixed with earth from Pit H-1, Unit A 101, ca. 4.23 to 4.30 m below modern surface. Coll. 1969. Date expected to be Mesolithic. *Comment*: NaOH pretreatment.

P-1665. Pit H-1, Unit A 117 P **9477 ± 134**
7527 B.C.

Charcoal mixed with earth from Pit H-1, Unit A 117 P, ca. 4.50 m below modern surface. Coll. 1969, using normal colln. procedures (cf. P-1666). Date expected to be Mesolithic. *Comment*: NaOH pretreatment.

P-1666. Pit H-1, Unit A 117 R **8742 ± 114**
6792 B.C.

Charcoal from Pit H-1, Unit A 117 R, ca. 4.50 m below modern surface. Coll. 1969, using a water-sieving procedure on the fill removed from this unit. Date expected to be comparable to P-1665. *Comment*: NaOH pretreatment.

P-1517. Pit G-1, Unit 39 **9034 ± 108**
7084 B.C.

Charcoal mixed with earth from Pit G-1, Unit 39, ca. 6.06/6.28 to 6.20/6.43 m below modern surface. Coll. 1968. Date expected to be Mesolithic. *Comment*: NaOH pretreatment.

P-1518. Pit G-1, Unit 46 **8938 ± 100**
6988 B.C.

Charcoal mixed with earth from Pit G-1, Unit 46, ca. 6.41/6.69 to 6.47/6.74 m below modern surface. Coll. 1968. Date expected to be Mesolithic. *Comment*: NaOH pretreatment.

P-1518-A. Pit G-1, Unit 46 **8717 ± 110**
6767 B.C.

Portion of same sample as P-1518, but did not receive any pretreatment for removal of possible humic contaminants.

P-1519. Pit G/G-1, Unit 60 **9264 ± 144**
7314 B.C.

Charcoal mixed with earth from Pit G/G-1, Unit 60, ca. 7.35/7.68 to 7.35/7.70 m below modern surface. Coll. 1968. Date expected to be early Mesolithic. *Comment*: NaOH pretreatment.

9298 ± 130
P-1522. Pit H, Unit 61 B 1 **7348 B.C.**

Charcoal mixed with earth from Pit H, Unit 61 B 1, ca. 4.85/5.07 to 4.90/5.14 m below modern surface. Coll. 1968. Date expected to be early Mesolithic. *Comment*: NaOH pretreatment.

11,930 ± 168
P-1668. Pit H, Unit 71 B 2-3 **9980 B.C.**

Charcoal mixed with earth from Pit H, Unit 71 B 2-3, ca. 6.65 m below modern surface. Coll. 1969. Date expected to be roughly comparable to P-1520 (cf.).

11,093 ± 260
P-1520. Pit H, Unit 59 A 1 **9143 B.C.**

Charcoal mixed with earth from Pit H, Unit 59 A 1, ca. 7.10 to 7.15 m below modern surface. Coll. 1968. Sample from Pleistocene level. *Comment*: this sample when processed, was not large enough for our counters, therefore, it was sent to Isotopes for counting (I-4219).

5102 ± 72
P-1397. Halieis **3152 B.C.**

Sea shells including *Murex trunculus, Cerithium vulgatum,* and *Cardium edule,* assoc. with Late Neolithic pottery from pit in bedrock on acropolis at Porto Cheli (ancient Halieis) in S Argolid, Peloponnese, Greece (37° 19′ N Lat, 23° 8′ E Long). Sample coll. 1962 by C. K. Williams; subm. by M. H. Jameson. *Comment* (T. W. Jacobsen): even though this is a shell sample, resulting date seems to coincide nicely with its archaeol. context.

Lorenzo Kiln series

Lorenzo Kiln is 4 km from Porto Cheli in Peloponnese, S Argolid, Greece (37° 17′ N Lat, 23° 10′ E Long). Kiln was submerged in sea water at edge of bay and appears to have been suddenly abandoned after a firing, possibly due to inundation by the sea, to an earthquake, or both. Well-preserved charred brush was found in both stoking chambers. Overlying charcoal was extremely fine-textured blue sea clay, ca. 30 cm thickness, showing varve-like layering with no shells, stones, or coarse sand. Above the blue clay was sand and gravel layer. Kiln was thought to have been used from Late Roman to Mediaeval times.

137 ± 43
P-1427. Stoking Chamber A **A.D. 1813**

Charcoal from Stoking Chamber A, 50 to 60 cm S of G-8, midway between chamber walls, 60 to 73 cm below water level. *Comment*: NaOH pretreatment.

115 ± 43
P-1428. Stoking Chamber B **A.D. 1835**

Charcoal from Stoking Chamber B, 8 m grid line, midway between chamber walls, 54 to 65 cm below water level. *Comment*: NaOH pretreatment.

C. Turkey

Korucu Tepe series

Korucu Tepe is a medium-size mound in the Altimova plain E of Elazig, Turkey (38° 42′ N Lat, 39° 30′ E Long), at elev. ca. +824 m; coll. 1968 and 1969 by joint expedition, Univ. of Chicago, California (Los Angeles) and Amsterdam; subm. by Maurits van Loon, Oriental Inst., Univ. of Chicago (van Loon and Buccellati, 1969; Mellink, 1969, 1970).

2921 ± 71
P-1626. Operation H, Area 6, Level 5B **971 B.C.**

Charcoal, Sample KRC S-370, in and around a crushed pot under Stone Pile M in early Iron age room, coll. by S. Winn. Tentatively dated ca. 1000 to 800 B.C. and represents a non-Hittite culture of unknown affiliation. *Comment*: NaOH pretreatment.

2924 ± 57
P-1611. Operation O 21 NW, Level 2c **974 B.C.**

Charcoal, Sample KRC 68-S112, from Op. O 21 N W, Level 2c, coll. by G. Buccellati, from terminal Hittite Empire levels consisting mainly of pits and dumping areas, one of which yielded 12 clay sealings with impressions of hieroglyphic stamp seals, proving that the area was under Hittite adm. (cf. P-1612). *Comment* (M.v.L.): MASCA corrected new half-life dates for P-1611, 1162 B.C. and P-1612, 1108 B.C. from terminal Hittite Empire levels are only ones that fit historical data for Hittite Empire, which must have come to an end between 1200 and 1150 B.C., perhaps 1189 B.C. when invading "sea peoples" clashed with Egypt. Even uncorrected new half-life dates remain far below expectations from historical sources.

2871 ± 63
P-1612. Operation O 21 NW, Level 2d **921 B.C.**

Charcoal, Sample KRC 68-S113, from Op. O 21 NW, Level 2d, coll. by G. Buccellati (cf. P-1611). *Comment*: NaOH pretreatment.

3221 ± 65
P-1613. Operation V 12, Level 8 **1271 B.C.**

Charcoal, Sample KRC 68-S278, coll. by E. Griffin, from between Walls I and IV from major building at E foot of mound, with walls 1.5 m thick, which had burned and toppled sideways and are contemporary with city wall (cf. P-1614, P-1615, and P-1616).

3321 ± 165
P-1614. Operation V 12 W, Level 8 **1371 B.C.**

Charcoal, Sample KRC 68-S225, coll. by E. Griffin (cf. P-1613, 1627, 1615, and 1616). *Comment*: NaOH pretreatment. Large tolerance due to undersized sample, 86.60% normal pressure.

3270 ± 51
P-1627. Operation U 12, Area 1, Level 9 **1320 B.C.**

Charcoal (probably wood from building), Sample KRC 69-S78, coll. by B. B. Williams from burned debris on ash floor of corridor at time of destruction of "burned building." *Comments*: NaOH pretreatment. (M.v.L.): work in 1969 showed that "burned building" was actually passage through city wall, flanked by a tower.

P-1615. Operation O 23, Area 2, Level 4 **3244 ± 59** **1294 B.C.**

Charcoal, Sample KRC 68-S110, coll. by R. Magnus. Wheelmarked light gray pottery, perhaps continuing same tradition (cf. P-1617 and -1618), was used with Hittite red burnished and cream-slipped wares when town was surrounded by 2 parallel stone foundations packed with loam, which once must have carried a mud brick fortification 5.30 m wide. Sample should date levels built soon after construction of city wall, perhaps ca. 1600 B.C. *Comment*: NaOH pretreatment.

P-1616. Operation O 24 E, Level 8 **3247 ± 63** **1297 B.C.**

Charcoal, sample KRC 68-S68, coll. by E. Griffin (cf. P-1615).

P-1628. Operation N 11, Area 4, Level 4 **3989 ± 63** **2039 B.C.**

Charred wheat (*Triticum aestivum*) id. by W. van Zeist, Univ. of Groningen, Netherlands, Sample KRC 69-S100, coll. by R. I. Christensen from burned floor, containing smashed storage and cooking vessels, within partly walled area with large hearth. Building thought to be 26th to 23rd century B.C. Sample should date destruction which put an end to early Bronze Age II occupation.

P-1629. Operation N 11, Area 3, Level 7 **3963 ± 65** **2013 B.C.**

Charred wheat (*Triticum aestivum*), id. by W. van Zeist, Sample KRC 68-S451/452, coll. by D. J. W. Meijer, from burned material on floor of 26th to 23rd century B.C. establishment, preceding burned early Bronze Age II house and should date earlier establishment.

P-1617. Operation O 11, Area 1, Level 5 **4084 ± 53** **2134 B.C.**

Charcoal, Sample KRC 69-S107, coll. by J. Zarins, should date occupation of Korucu Tepe by "Khirbet Kerak" people (cf. P-1618). *Comment*: half of sample (P-1617-A, 4106 ± 65) received usual 3N HCl pretreatment, other half (P-1617-B, 4074 ± 64) was given additional 2% NaOH pretreatment; difference is not significant, and average of both portions is quoted here.

P-1618. Operation O 10, Area 1, Level 15 **4224 ± 62** **2274 B.C.**

Charcoal, Sample KRC 69-S109, coll. by D. Barbolla, should date occupation of Korucu Tepe by "Khirbet Kerak" people (cf. P-1617).

Aphrodisias series

Aphrodisias, Turkey (37° 43′ N Lat, 28° 48′ E Long) is ca. 153 km SE of present port of Izmir or 129 km E of ancient port of Miletus. All samples are from "Acropolis" mound at Aphrodisias, which lies within much larger area enclosed by Hellenistic/ Roman walls of later classical city. Depths in Trenches 3 to 5 are measured from a subdatum point, 13.86 m above zero datum for entire classical site. Subdatum in Trench 7 is 16.34 m above zero datum. Levels from top are as follows: A-4, A-3, A-2 and A-1, Late Bronze age; A, B′, B, C, and D, Middle Bronze age; E, I, II, III, and IV, Early Bronze age III. Samples coll. 1967-1969; subm. by Barbara Kadish, New York Univ., New York (1969).

3440 ± 69
P-1644. Trench 7, Unit 580 **1490 B.C.**

Wood charcoal from beam lying between opening through stones of Wall L, Trench 7, Level A-1, Unit 580, at depth –3.79 m. Coll. 1969. *Comment*: NaOH pretreatment. Charcoal contained small rootlets, sample chosen to be free of rootlets as possible (cf. P-1656).

3587 ± 82
P-1656. Trench 7, Unit 580 **1637 B.C.**

Portion of Sample P-1644 that received rootlet pretreatment as per Haynes (1966; see discussion, Lowdon *et al.*, 1970). *Comment*: result from pretreated sample seems reasonable, *i.e.*, slightly older than hand-sorted sample.

3339 ± 62
P-1645. Trench 5, Unit 464 **1389 B.C.**

Wood charcoal from floor of Complex B. Coll. 1968. *Comment*: NaOH pretreatment.

3414 ± 69
P-1646. Trench 5, Unit 487 **1464 B.C.**

Wood charcoal from upper part of Complex C, or possible temporary occupation on top of debris of C. Coll. 1968.

3673 ± 73
P-1647. Trench 5, Unit 494 **1723 B.C.**

Wood charcoal from lowest extent of Complex C, at depth –4.44 m. Coll. 1968. *Comment*: NaOH pretreatment.

3543 ± 61
P-1648. Trench 3, Stratum 7A **1593 B.C.**

Wood charcoal above burned debris of Complex II, separated from it by small deposit of brown earth at depth –5.76 m. Charcoal probably assoc. with Complex I. Coll. 1967. *Comment*: NaOH pretreatment.

3561 ± 55
P-1649. Trench 3, Unit 224 **1611 B.C.**

Charred seeds from Pithos II, Rm. 1, Structure A, of Complex II. Seeds appeared at depth –6.81 m inside pithos and continued without earth intervening to bottom of pithos. Coll. 1967.

P-1650. Trench 3, Unit 227 **3715 ± 59**
1765 B.C.

Charred seeds from Pithos I, Rm. 1, Structure A, of Complex II, at depth –6.80 to 7.10 m. Coll. 1967.

P-1651. Trench 3, Unit 221 **3858 ± 64**
1908 B.C.

Wood charcoal from floor of Rm. 2, Structure A, Complex II, at depth –7.15 m. Coll. 1967.

P-1652. Trench 4, Unit 343 **3987 ± 61**
2037 B.C.

Wood charcoal from Structure B, at base of Complex II floor, at depth –6.94 m. Coll. 1968.

P-1653. Trench 3, Unit 267 **3624 ± 55**
1674 B.C.

Wood charcoal from floor level of Structure B, Complex IV, at depth –7.83 m. Coll. 1967. *Comment*: NaOH pretreatment.

P-1654. Trench 4, Unit 348 **3943 ± 86**
1993 B.C.

Wood charcoal from surface of destruction debris of Complex IV, at depth –7.39 m. Coll. 1968. *Comment*: NaOH pretreatment.

P-1655. Pekmez Trench **2249 ± 59**
299 B.C.

Combined small charcoal sample from Level 7, Pekmez Mound, Trench 2. Comparison of material from both mounds led excavators to believe that Levels 5 to 8 of Pekmez Trench 2 are from earlier period than levels so far excavated on Acropolis mound; however, this combined sample does not seem to confirm this.

P-1434. Alaca Huyuk, Level 11-12 **4285 ± 62**
2335 B.C.

Charcoal from Level 11-12 (4th level of Chalcolithic) at Alaca Huyuk, near town of Alaca (40° 10′ N Lat, 34° 52′ E Long), ca. 40 km S of Corum in N Turkey. Coll. 1966 by H. Z. Kosay; Ethnog. Mus., Ankara, Turkey; subm. 1966 by M. J. Mellink (Kosay and Akok, 1966; Arik, 1937). For additional dates from Alaca Huyuk see P-824, 3744 ± 61; P-825, 2540 ± 50; and P-826, 4200 ± 58 (R., 1965, v. 7, p. 191).

Acem Hoyuk series

Acem Höyük (38° 30′ N Lat, 33° 55′ E Long) is a large Bronze age mound NW of Aksaray in central Turkey. Samples coll. by Nimet Özgüc, Univ. of Ankara; subm. by M. J. Mellink (Özgüc, 1968).

P-1555. Charred beam **3611 ± 49**
1661 B.C.

Part of wooden beam in charred condition was part of large palace destroyed by fire.

3391 ± 58
P-1595. Charred crab apples (?) 1441 B.C.

Charred crab apples (?) from jar on floor of magazine in large burnt palace.

D. Other countries

10,731 ± 269
P-1623. Hotu Cave, Iran 8781 B.C.

Charcoal and soil from gray black earth under red Gravel 2 in D trench of Hotu Cave (36° 20′ N Lat, 53° 35′ E Long) 7 km W of Behshahr and 7 km S of present shoreline just E of modern village of Turujan, Iran. Sample coll. 1951 and subm. 1969 by C. S. Coon, Gloucester, Mass. *Comment*: NaOH pretreatment. For additional date from this level see P-39, 11,860 ± 840 (Ralph, 1955). P-1623 was dated because P-39 was from early solid carbon counting days and not pretreated for removal of possible humic contamination. P-1623 was processed at Univ. of Pennsylvania Radiocarbon Lab., but was too small for our counters, therefore, counted by Isotopes (I-4635).

2284 ± 56
P-1633. Nuk, Alaska 334 B.C.

Charcoal from single habitation level of Pit House 1, Nuk (65° N Lat, 165° W Long), 29 km E of Nome, Alaska. Coll. 1969 by J. R. Bockstoce and subm. by F. G. Rainey, Univ. Mus., Univ. of Pennsylvania, Philadelphia.

726 ± 45
P-1544. Puerco Indian Ruin, Arizona A.D. 1224
$C^{13} = +14‰$

Charred corn from Puerco Indian Ruin, Petrified Forest Natl. Park, Apache Co., Arizona (34° 51′ N Lat, 109° 55′ W Long), from 0.30 m deep layer of trash in intimate assoc. with roof material. Assoc. pottery types from previous excavations (Shroeder, 1961) indicate site occupied for span of not more than 100 yr from A.D. 1250 to 1350.

1670 ± 49
P-1625. El Tigre, Mexico A.D. 280

Wood (*Bucida*) id. by B. F. Kukachka, Forest Products Lab., U. S. Dept. of Agri., Madison, Wisconsin, from test pit, sealed beneath excavated ridges of field, 27 m from N bank of Rio Candelaria, across from modern colony of El Tigre, Campeche, Mexico (18° 7′ N Lat, 90° 48″ W Long) and nearby Classic archaeol. ruins which may be Itzamkanac, "capital" of Maya prov. of Acalan. Coll. and subm. 1969 by D. E. Puleston, Univ. of Minnesota. *Comments*: NaOH pretreatment. (D.E.P.): date introduces possibility that Chinampa-type ridged fields may be much earlier in this area than expected. Very limited ceramic data suggest major occupation of nearby archaeol. ruins in classic times which fits very closely to sample date (Andrews, 1943; Scholes and Roys, 1948).

Marcavalle series, Peru

Marcavalle (13° 32′ S Lat, 71° 57′ W Long) is a very low mound, ca. 300 by 200 m, alt. 3314 m, 3 km SE of city of Cuzco, Prov. and Dept. of Cuzco, Peru, Site PCz 6-45 (following Rowe's system of numeration for sites). Samples coll. 1966 and 1968 and subm. by K. L. M. Chávez, Central Michigan Univ., Mt. Pleasant, Michigan (Chavez, 1969; Rowe, 1944; 1956).

2131 ± 55
P-1560. Lot 4, Trench 3 **181 B.C.**

Charcoal, Sample 1F/4, from nat. level ca. 75 to 110 cm below surface, varying in thickness between 15 and 55 cm. Assoc. sherds are Chanapata-like, similar to Pacalla-mocco; carbonized corn cob fragments and beans assoc. (cf. P-1561) (Rowe, 1944).

2096 ± 51
P-1561. Lot 4H, Trench 3 **146 B.C.**

Charcoal, Sample 1F/4H, from lense ca. 2.10 m below surface and ca. 10 cm thick, lying in large pit terminating in nat. earth, ca. 2.50 m below surface. Assoc. sherds are Chanapata-like, similar to Pacalla-mocco; carbonized corn cob fragments and beans assoc. (cf. P-1560).

2571 ± 45
P-1562. Lot 3, 3A, 6, and 12; Trench 2 **621 B.C.**

Charcoal, combined Samples 1C/3, 1C/3A, 1C/6, and 1C/12, represents one nat. level beginning ca. 20 to 35 cm below surface, ca. 45 to 75 cm thick. Assoc. sherds are mostly Marcavalle varieties, including "iridescent" (specular hematite) painted, cream on brown, and dark brown on cream; some polished black grooved; other grooved and incised are also present. Date is derived from same area as is GX-453, 2645 ± 115 (unpub.) and should be date in this series most comparable to it.

2661 ± 46
P-1563. Lot 5, Trench 4 **711 B.C.**

Charcoal, Sample 1J/5, from nat. level beginning ca. 65 to 100 cm below surface, ca. 10 to 30 cm thick. Assoc. sherds include varieties such as in Trench 2 (cf. P-1562), but dark brown on cream are nearly absent. Expected date to be younger than that for P-1564, and comparable to date of P-1562.

2685 ± 49
P-1564. Lot 6, Trench 4 **735 B.C.**

Charcoal, Sample 1J/6, from level just below 1J/5, ca. 1 m below surface and 10 to 30 cm thick. Assoc. sherds include Marcavalle varieties as in Lot 5, Trench 4 (cf. P-1563), but black grooved ceramics are nearly absent. Date expected older than P-1563. *Comment*: NaOH pretreatment.

2860 ± 47
P-1566. Lot 9, Trench 1 **910 B.C.**

Charcoal, Sample 1B/9, from nat. level ca. 1.20 m below surface and ca. 2 to 35 cm thick. Assoc. decorated sherds include Marcavalle incised red or brown; painted styles present in Trench 2 and 4 (cf. P-1562-1564) are absent except for a variety of "irridescent" (specular hematite) painted. Fragment of female figurine is also assoc. Expected date older than those for Trenches 2 and 4 (cf. P-1562-1564), on stylistic evidence from ceramics.

2916 ± 55
966 B.C.

P-1567. Lot 8, Trench 1

Charcoal, Sample 1B/8, from nat. level ca. 1 cm below surface, ca. 20 cm thick. Assoc. ceramics, including fragment of female figurine, are same as for P-1566. Expected date same or younger than P-1566.

Qaluyu series, Peru

Qaluyu (15° 1′ S Lat, 70° 22′ W Long) is ca. 700 by 210 m in altiplano, alt. 3390 m, 4 km N of Pucara, Prov. of Lampa, Dept. of Puno, Peru, Site PPu 5-2 (following Rowe's system of numeration for sites). Samples coll. 1967 and subm. by K. L. M. Chávez (1969; Rowe, 1956; 1963).

1949 ± 52
A.D. 1

P-1581. Lot 3, Trench 5

Charcoal, Sample 2F/3, from ashy, nat. level containing Pucara culture refuse, beginning 50 cm below surface, ca. 30 cm thick, ending in nat. earth. Ceramics include incised outlined red, black, and cream polychrome ware of Pucara style. For dates from Pucara, see: P-152, 2101 ± 108; P-153, 2041 ± 107; P-154, 1847 ± 106; P-170, 2032 ± 106; P-172, 2040 ± 109 and P-217, 1960 ± 90 (R., 1959, v. 1, p. 57). *Comment*: NaOH pretreatment.

2925 ± 61
975 B.C.

P-1582. Lot 4, Trench 1

Charcoal, Sample 2B/4, from nat. level beginning ca. 55 to 75 cm below surface and ca. 30 cm thick. Assoc. Qaluyu ceramics and a few sherds resembling Marcavalle painted varieties such as cream on brown and specular hematite painted (see: P-1562-1564, this list). For 2 previous dates from Qaluyu, see: P-155, 2522 ± 114 and P-156, 2962 ± 120 (R., 1959, v. 1, p. 57).

2945 ± 61
995 B.C.

P-1583. Lot 10, Trench 1

Charcoal, Sample 2B/10, from earth surrounding burial, ca. 1.60 m below surface. Adult is flexed on left side, shows occipital flattening, body painted with red ochre. No decorated Qaluyu ceramics assoc. Expected date to be same as, or earlier than that for P-1582.

3045 ± 56
1095 B.C.

P-1584. Lot 9, Trench 1

Charcoal, Sample 2B/9, from nat. unit beginning 1.60 m below surface, ca. 40 cm thick. No decorated Qaluyu sherds were assoc. Expected date older than P-1582. *Comment*: NaOH pretreatment.

P-1585. Lot 16, Trench 1 **3239 ± 52**
1289 B.C.

Charcoal, Sample 2B/16, from nat. strat. unit beginning ca. 1.60 m below surface and ca. 20 cm max. thickness. No decorated Qalayu sherds in assoc. Date expected to be slightly older or comparable to P-1584.

Pikicallapata series, Peru

Pikicallepata (14° 8′ S Lat, 71° 25′ W Long), is oval-shaped mound ca. 100 by 200 m, alt. ca. 3410 m overlooking Vilcanota R., between Tinta and Combapata, Prov. of Canchis, Dept. of Cuzco, Peru, Site PCz 5-50 (following Rowe's system of numeration of sites). Samples coll. 1967 and subm. by K. L. M. Chávez (1969; Rowe, 1956).

P-1586. Lot 6, Trench 1 **2533 ± 55**
583 B.C.

Charcoal, Sample 8B/6, from level 1 to 1.20 m below surface and 30 cm thick. Assoc. sherds are Chanapata-like in part. Date should be comparable to N-89, 2520 ± 150 and N-90, 2360 ± 760 (R., 1966, v. 8, p. 337). Expected date to be youngest in this series. *Comment*: NaOH pretreatment.

P-1587. Lot 9A, Trench 1 **2705 ± 66**
755 B.C.

Charcoal, Sample 8B/9A, from area of medium-sized stone concentration beginning ca. 1.40 m below surface, ca. 35 cm thick, at same level as Sample 8B/9 (cf. P-1588). Should be equivalent to, or slightly younger than P-1588 and P-1589, and younger than remaining samples listed below, this series. *Comment*: NaOH pretreatment.

P-1588. Lot 9, Trench 1 **2797 ± 58**
847 B.C.

Charcoal, Sample 8B/9, from level arbitrarily beginning 1.30 to 1.40 cm below surface, ca. 30 cm thick, ending in nat. level. Assoc. sherds are Chanapata-like in part.

P-1589. Lot 10, Trench 1 **2627 ± 48**
677 B.C.

Charcoal, Sample 8B/10, from uppermost nat. level of pit beginning ca. 1.55 m below surface and 30 cm max. thickness. Assoc. sherds are Chanapata-like in part. Date expected to be roughly equivalent to P-1587 and P-1588, and younger than remaining samples listed below, this series. *Comment*: NaOH pretreatment.

P-1590. Lot 12A, Trench 1 **2894 ± 51**
944 B.C.

Charcoal, Sample 8B/12A, from level beginning ca. 1.80 m below surface, ca. 50 cm thick. Assoc. sherds are Marcavalle-like in part, such as cream on brown painted and specular hematite painted (cf. Marcavalle series, P-1562-1564, this list). Should be older than samples above, this series.

2775 ± 60
P-1591. Lot 15A, Trench 1 **825 B.C.**

Charcoal, Sample 8B/15A, from level ca. 2.30 cm below surface, ca. 10 cm thick. Assoc. sherds are apparently a local style, including a variety of specular hematite painted. Should be older than P-1590 and younger than P-1592.

2987 ± 57
P-1592. Lot 16, Trench 1 **1037 B.C.**

Charcoal, Sample 8B/16, from necessarily arbitrary level, ca. 2.60 to 2.80 m below surface, 28 cm thick. Assoc. sherds are apparently of local style, including a variety of specular hematite painted. Should be the oldest date in this series. Notable, however, culture-bearing levels with further ceramic differences continue below this level to total depth of trench 3.10 to 4.0 m below surface; these levels should be, stratigraphically and in ceramics, stylistically, older than P-1592.

References

Andrews, E. E., 1943, The archaeol. of southwestern Campeche: Carnegie Inst. Wash., Pub. 546, Contr. 40, v. 8, p. 11-95.

Arik, R. O., 1937, Les fouilles d'Alaça Hüyük, rapport preliminaire dur les travaux en 1935: Ankara, pubs. de la société d'histoire Turque, 199 p.

Barker, Harold, Burleigh, Richard, and Meeks, Nigel, 1969, British Museum natural radiocarbon measurements VI: Radiocarbon, v. 11, p. 278-294.

Chávez, K. L. M., 1969, Excavations in the Cuzco-Puno area of southern highland Peru: Expedition, v. 11, no. 2, p. 48-51.

Haynes, Jr., C. V., 1966, Radiocarbon samples: chemical removal of plant contamination: Science, v. 151, p. 1391-1392.

Jacobsen, T. W., 1968, Investigations at Porto Cheli-Halieis, 1967: Archaiologikon Deltion, v. 23, p. 144-148.

———— 1969a, Investigations at Porto-Cheli, 1968: Archaiologikon Deltion, v. 24, p. 135-129.

———— 1969b, The Franchthi cave: Archaeol., v. 22, no. 1, p. 4-9.

———— 1969c, Excavations at Porto Cheli and vicinity, preliminary report, II: the Franchthi cave: Hesperia, v. 38, no. 3, p. 348-381.

Kadish, Barbara, 1969, Excavations of prehistoric remains at Aphrodisias, 1968: Am. Jour. Archaeol., v. 73, p. 49-65.

Katzev, M. L., 1969, The Kyrenia wreck: Expedition, v. 11, no. 2, p. 55-59.

———— 1970a, Resurrecting the oldest known Greek ship: Natl. Geog., v. 137, no. 6, p. 841-857.

———— 1970b, A Greek ship is raised: Expedition, v. 12, no. 4, p. 6-14.

Kosay, Hamit and Akok, Mahmut, 1966, Ausgrabungen von Alaça Höyük 1940-48: Ankara, Türk tarih kurumi basimevi, 230 p.

Lowdon, J. A., Wilmeth, R., and Blake, Jr., W., 1970, Geol. Survey of Canada radiocarbon dates X: Radiocarbon, v. 12, p. 472-485.

Mellink, M. J., 1969, Archaeol. in Asia Minor: Am. Jour. Archaeol., v. 73, p. 210-211, pl. 57.

———— 1970, Archaeol. in Asia Minor: Am. Jour. Archaeol., v. 74, p. 165, pl. 42, fig. 7.

Nanadris, J. G., 1968, Lepinski Vir: Sci. Jour., v. 4, p. 64-70.

Özgüc, Nimet, 1968, New light on the dating of the levels of the Karem of Kanish and of Acem Höyük near Aksaray: Am. Jour. Archaeol., v. 72, p. 318-320.

Ralph, E. K., 1955, University of Pennsylvania dates I: Science, v. 121, p. 149-151.

———— 1959, University of Pennsylvania radiocarbon dates III: Radiocarbon, v. 1, p. 45-58.

Rowe, J. H., 1944, An introduction to the archaeol. of Cuzco: Papers of the Peabody Mus., v. 27, no. 2, p. 1-69.

———— 1956, Archaeol. explor. in southern Peru, 1954-1955: Am. Antiquity, v. 22, no. 2, p. 135-151.

Rowe, J. H., 1963, Urban settlements in ancient Peru: Nawpa Pacha, v. 1, p. 1-27.
Scholes, V. and Roys, R. L., 1948, The Maya Chontal Indians of Acalan-Tixchel: Norman, Univ. Oklahoma Press, 565 p.
Shroeder, A., 1961, Puerco ruin excavation, Petrified Forest, Natl. Monument, Arizona: Plateau, v. 33, no. 4, p. 93-104.
Srejovic, Dragoslav, 1968a, Lepinski Vir 7,000 years ago: Illus. London News, v. 252, no. 6703, p. 23-25.
———— 1968b, Lepinski Vir pottery and sculptures: Illus. London News, v. 252, no. 6705, p. 27-29.
———— 1969, Lepinski vir: Archaeology, v. 22, no. 1, p. 26-35.
Stuckenrath, Jr., Robert and Ralph, E. K., 1965, Univ. of Pennsylvania radiocarbon dates VIII: Radiocarbon, v. 7, p. 187-199.
van Loon, Maurits and Buccellati, Giorgia, 1969, The 1968 excavation at Korucutepe near Elazig: Turk Arkeol. Dergisi, v. 17, p. 79-82.
Yamasaki, Fumio, Hamada, Tatsuji, and Fujiyama, Chikako, 1966, RIKEN natural radiocarbon measurements II: Radiocarbon, v. 8, p. 324-339.

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PRETORIA RADIOCARBON DATES I

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INTRODUCTION

In 1969 radiocarbon dating facilities were established at the National Physical Research Laboratory of the C.S.I.R. in Pretoria (25° 43′ S Lat, 28° 21′ E Long; alt 1500 m). The counters are situated in an underground room built of selected concrete and covered by ca. 12 m earth. In this room, the nucleonic component of cosmic radiation is practically absent and the meson flux is reduced by a factor of 3.5 as compared to the surface at sea level in Groningen, Netherlands. A neutron monitor which registers 30 cpm on the surface, counts ca. 0.1 cpm in the underground room.

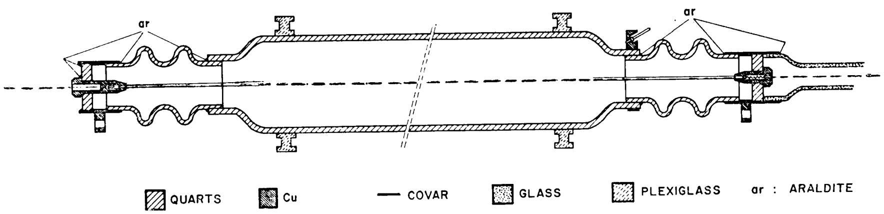

FIG. 1. Radiocarbon counter of quartz glass. Effective length 350 mm, inner diam. 45 mm, wire diam. 0.05 mm.

The two small counters currently in use are of gold-plated quartz glass (Fig. 1). Their construction is designed to incorporate as little foreign material as possible and thus, keep the background, due to radioactive impurities, low. Around the counters are 3 cm old lead, an anticoincidence ring, and 10 cm selected lead. They have an effective volume of 0.56 L and an initial background of 0.5 and 0.65 cpm. No variation in background due to barometric pressure can be detected. At a filling pressure of 3.5 atm the modern count rate is 12.7 cpm; the figure of merit of the best counter is thus $A/\sqrt{B} = 18$. These small counters are extremely useful for routine measurements since only a little more than 1g of pure carbon is needed for an analysis. In two one-day counts a modern sample is measured to an accuracy of 0.54% or ± 43 years.

The counting gas is CO_2 prepared as described by Vogel and Waterbolk (1967), C^{13} analyses are performed on all samples and given with respect to the PDB standard. Corrections for variations in isotopic fractionation are applied to dates on organic material (wood, peat, charcoal, etc.), but not to marine carbonate (sea shells), because the isotopic fractionation is compensated for by the apparent age of surface ocean water. Dates on fresh water carbonate are also not corrected for isotopic fractionation since the initial C^{14} content is variable. In general, 1300

* Natural Isotopes Division, N.P.R.L., P.O. Box 395, Pretoria.

± 500 years are to be subtracted from such dates (Münnich and Vogel, 1959).

Dates are reported in conventional radiocarbon years, *i.e.,* using a half-life of 5568 years for C^{14}. The descriptions are mainly compiled on the basis of information supplied by the submitters.

Thanks are due S. Talma of our laboratory for performing the C^{13} analyses, and to J. Schutte for dating assistance in the initial stages.

SAMPLE DESCRIPTIONS

I. GEOLOGIC SAMPLES

Wolkberg Cave series, Transvaal

Calcite samples from Wolkberg Cave (24° 05′ S Lat, 29° 55′ E Long) 32 km by rd. S of Pietersburg-Tzaneen Rd; on Wolkberg, dist. Pietersburg, Transvaal. Coll. and subm. 1969 by T. C. Partridge, 12 Cluny Rd., Forest Town, Johannesburg.

Pta-285. Wolkberg T2 — **10,370 ± 100**; **8420 B.C.**; $\delta C^{13} = -4.49‰$

Center of 45 cm diam. stalactite in Chamber 1, 50 m from entrance.

Pta-105. Wolkberg T10(a) — **2820 ± 60**; **870 B.C.**; $\delta C^{13} = -1.14‰$

Outer part of younger-generation stalagmite 68 m above water table in Chamber 2, 170 m from entrance.

Pta-106. Wolkberg T11(a) — **4690 ± 65**; **2740 B.C.**; $\delta C^{13} = -0.51‰$

Younger-calcite coating over older redissolved stalactite, 68 m above water table in Chamber 2, 170 m from entrance.

Pta-174. Wolkberg T11(b) — **30,860 ± 600**; **28,910 B.C.**; $\delta C^{13} = +0.75‰$

Surface of same older redissolved stalactite as above.

Pta-169. Wolkberg T9 — **>46,800**; $\delta C^{13} = +1.14‰$

Older redissolved stalactite from 68 m above water table in Chamber 2, 170 m from entrance.

Pta-104. Wolkberg T 20 — **21,100 ± 200**; **19,150 B.C.**; $\delta C^{13} = +1.87‰$

Younger-generation stalactite 38 m above water table, from wall of lower passage, ca. 360 m from entrance.

General Comment: outer layers of all samples etched off with dilute acid and inner carbonate dated. No correction for isotopic fractionation.

Dates of freshwater calcite may be up to 1300 yr too old (Münnich and Vogel, 1959). Varying ages show no indication of discrete periods of precipitation. T11 suggests period of dissolution between 30,860 B.P. and 4690 B.P.

Pta-103. Ficus Cave, Transvaal **330 ± 50**
A.D. 1620
$\delta C^{13} = -3.77‰$

Fragments, younger-generation stalactite, 23 m above water table, from Ficus Cave, Makapan Valley (24° 10′ S Lat, 29° 15′ E Long), 23 km E of Potgietersrust, Transvaal. Coll. and subm. 1969 by T. C. Partridge. *Comment*: outer layers etched off with acid, inner part measured. Calcite precipitation apparently continued to recent times.

Sterkfontein series, Transvaal

Calcite samples from Sterkfontein Cave (26° 02′ S Lat, 27° 42′ E Long), 6 km NW of Krugersdorp, Transvaal. Coll. and subm. 1969 by T. C. Partridge.

Pta-102. Sterkfontein 2 **>48,000**

Sample of younger-generation stalactite, ca. 4.5 m above water table.

Pta-108. Sterkfontein 11(a) **>47,500**

Center part of younger-generation stalagmite, ca. 4.5 m above water table.

Pta-109. Sterkfontein 11(b) **>50,000**

Outer part of same younger-generation stalagmite as above. *General Comment*: outer layer of all samples etched off with acid, inner carbonate measured. Even younger-generation stalactite from this cave underlying Sterkfontein *Australopithecus* cave (and thus of later date) is >50,000 yr.

Morelettaspruit series, Transvaal

Where Morelettaspruit crosses Silverton Ridge, Meyerspark, Pretoria (25° 43′ S Lat, 28° 16′ E Long), Transvaal, 1.4 m peat overlies 0.8 m sand and clay, 0.6 m coarse gravel, peat, and clay. Samples coll. and subm. 1969 by P. Verhoef and J. C. Vogel.

Pta-129. Morelettaspruit 1.4 m **440 ± 40**
A.D. 1510
$\delta C^{13} = -23.3‰$

Sample from bottom of upper peat layer at 1.4 m depth.

Pta-128. Morelettaspruit 2.8 m **5220 ± 55**
3270 B.C.
$\delta C^{13} = -19.6‰$

Sample from top of lower peat layer at 2.8 m depth. *General Comment*: pretreated with acid only. Gravel deposit, common in stream beds in region, deposited between 5220 and 440 yr ago, *i.e.*, apparently before occupation by agriculturalists.

Tietiesbaai series, Cape Province

On coast at Tietiesbaai (31° 10′ S Lat, 17° 45′ E Long), 47 km W of Bitterfontein, Namaqualand, Cape Prov., series of 6 emerged beaches occurs. Lowest 3 at 2, 5, and 7 m are covered by stabilized berm but exposed by prospecting trenches. Shells coll. and subm. 1969 by A. J. Carrington, South African Mus., Cape Town.

Pta-090. Tietiesbaai, 2m — **340 ± 50**
A.D. 1610
$\delta C^{13} = +1.1‰$

Anthropod shell from top of 2 m emerged beach (back-beach environment) below ca. 2 m berm on coastal farm Tietiesbaai. *Comment*: unexpectedly young age suggests sample does not actually date 2 m beach.

Pta-091. Karoetjieskop A, 5 m — **>47,500**
$\delta C^{13} = +1.8‰$

Anthropod and mollusk shells from 5 m emerged beach (back-beach environment) below ca. 3 m berm on coastal farm Karoetjieskop.

Pta-092. Karoetjieskop B, 5 m — **>48,300**
$\delta C^{13} = +0.2‰$

Anthropod and mollusk shells from 5 m emerged beach (back-beach environment) below ca. 4 m berm on farm Karoetjieskop.

Pta-093. Karoetjieskop C, 7 m — **>50,000**
$\delta C^{13} = -0.2‰$

Mollusk shells from 7 m emerged beach (back-beach environment) below ca. 5 m sand and shell midden on farm Karoetjieskop.

General Comment: about half of carbonate removed with dilute acid; the rest dated. No C^{13} corrections made. Results show +5 m and +7 m beaches not of Pleniglacial age but either Early Glacial or Preglacial. Cf. dates for +2 m terrace at Oranjemund of ca. 35,000 and 38,100 B.P. (R., 1970, v. 12, p. 450) and Saldanha Bay series, below.

Pta-161. Anyskop, Cape Province — **35,930 ± 1000**
33,980 B.C.
$\delta C^{13} = -25.2‰$

Carboniferous clay from Anyskop (32° 57′ 30″ S Lat, 18° 05′ E Long), Vredenburg dist., Cape Prov., 4.6 m below surface and +24 m, underlying phosphate layer, sand, and tufa in prospecting pit. Coll. 1969, subm. 1970 by H. N. Visser, Geol. Survey, Pretoria. *Comment*: pretreated with acid only. Date suggests phosphate layer is late Pleistocene.

Saldanha Bay series, Cape Province

Shell samples from emerged beaches at Peninsula, Saldanha Bay (33°

05′ S Lat, 18° 00′ E Long), Cape Prov. Coll. and subm. 1969 by R. J. Parker, Marine Geol. Sec., Inst. of Oceanography, Univ. Cape Town.

Pta-094. Kreeftebaai A

40,200 ± 1300
38,250 B.C.
$\delta C^{13} = +0.33‰$

Shell fragments assoc. with 3 to 5 m emerged beach, from outcrop on emerged wave-cut terrace at Kreeftebaai.

Pta-095. Luisterhoek B

$\mathbf{48{,}200^{+2600}_{-2200}}$
46,250 B.C.
$\delta C^{13} = +2.23‰$

Shell fragments assoc. with 3 to 5 m emerged beach, from outcrop on emerged wave-cut terrace at Luisterhoek.

Pta-096. Churchhaven C

$\mathbf{48{,}500^{+3600}_{-2900}}$
46,550 B.C.
$\delta C^{13} = +1.31‰$

Loose shells assoc. with a 3 to 5 m emerged beach, exposed in unconsolidated dune cliff face at Churchhaven, +4.2 m, 3 m below top of cliff.

Pta-097. Elandspunt D

41,100 ± 1200
39,150 B.C.
$\delta C^{13} = +0.83‰$

Shell fragments assoc. with 15 m emerged beach, exposed in cliff face at Elandspunt, ca. +6.5 m and 6 to 9 m below top of cliff.

Pta-098. Elandspunt E

>49,500
$\delta C^{13} = +2.14‰$

Shell fragments from same layer as Elandspunt D.

General Comment: before being submitted, Samples A, B, D, E were crushed, washed in boiling water, and secondary carbonate was removed with knife. In lab. half of carbonate etched off with acid; inner part measured. As usual, no correction for C^{13}. Dates may be too young since boiling shells in water can introduce contamination. Small amounts of secondary carbonate can also make dates too young: 3 to 5 m beach thus at least 48,000 B.P., and pre-Pleniglacial, while 15 m beach is >49,500 B.P. (Pta-098). Compare Tietiesbaai series, above.

Pta-171. Cape Flats, Cape Province **>40,500**

Piece of wood found at –4 m in Borehole 223, cor. of Klipfontein Rd. and 5th Ave. (33° 57′ 48″ S Lat, 18° 30′ 31″ E Long), Athlone, Cape Town. Coll. by W. R. Ross; subm. 1969 by M. R. Henzen, N.I.W.R., C.S.I.R., Pretoria. *Comment*: pretreated with acid only. Sand filling of Cape Flats Basin thus not of Postglacial date. Compare W-246: >38,000

B.P. (Science, 1956, v. 123, p. 443), Y-49: >38,000 B.P. and Y-106: >36,300 (Science, 1957, v. 126, p. 918) for similar samples.

Pta-250. Bredasdorp, Cape Province **>46,000**
$\delta C^{13} = -25.3‰$

Brown coal 0.6 to 1.8 m deep in lenses in marsh deposit on Malmesbury rocks, exposed during excavation for dam on Tierfontein Farm, Bredasdorp (34° 32′ S Lat, 20° 25′ E Long), Cape Prov. Coll. and subm. 1970 by H. N. Visser. *Comment*: pretreated with acid only. Deposit not of recent date.

Cape St. Francis series, Cape Province

Shell samples dredged from submerged beaches at different depths off Cape St. Francis, Cape Prov. Coll. and subm. 1969 by R. A. Slater, Marine Geol. Sec., Inst. of Oceanog., Univ. Cape Town.

7580 ± 70
Pta-183. Cape St. Francis DR-169 **5630 B.C.**
$\delta C^{13} = +2.4‰$

Oyster shell, −51 m (34° 05.0′ S Lat, 24° 11.8′ E Long).

14,510 ± 120
Pta-265. Cape St. Francis DR-175 **12,560 B.C.**
$\delta C^{13} = +2.5‰$

Oyster shell, −112 m (34° 31.0′ S Lat, 24° 30.0′ E Long).

13,670 ± 120
Pta-254. Cape St. Francis DR-192 **11,720 B.C.**
$\delta C^{13} = +1.5‰$

Calcareous algae, −115 m (34° 24.2′ S Lat, 25° 00.0′ E Long).

12,990 ± 110
Pta-185. Cape St. Francis DR-183(c) **11,040 B.C.**
$\delta C^{13} = +1.6‰$

Calcareous algae, −120 m (34° 28.9′ S Lat, 24° 42.3′ E Long).

16,990 ± 160
Pta-182. Cape St. Francis DR-175(c) **15,040 B.C.**
$\delta C^{13} = +1.8‰$

Pecten shell, −130 m (34° 31.0′ S Lat, 24° 30.0′ E Long).

General Comment: outer half of all samples etched away with acid, inner carbonate measured. Samples date rise in sea level during Late Glacial-Holocene and indicate lowest sea level (−130 m) during Last Glacial occurred ca. 17,000 B.P.

II. ARCHAEOLOGIC SAMPLES

A. Stone Age of Southern Africa

5570 ± 100
Pta-256. Tuinplaas, Transvaal **3620 B.C.**
$\delta C^{13} = +1.1‰$

Calcareous crust on bone from fossil site of Tuinplaas (25° 55′ S Lat, 28° 45′ E Long), 13 km E of Settlers, Springbokvlakte, Transvaal. Bones assoc. with Tuinplaas skeleton buried in 45 cm calcrete at ca. 90 cm depth. Subm. 1969 by A. Hughes, Univ. of Witwatersrand, Johannesburg. *Comment*: since bone contains no collagen, secondary calcite dated, minimum for Middle Stone age skeleton.

Heuningneskrans series, Transvaal

Rock shelter on farm Heuningneskrans No. 476 (24° 36′ S Lat, 30° 39′ E Long), 18 km N of Ohrigstad, Lydenburg dist., Transvaal, excavated by P. Beaumont in 1968. Sediment contains 3 Later Stone age (Smithfield) strata: Stratum 3 from 0 to 76 cm, Stratum 2 from 76 to 152 cm and Stratum 1 from 152 cm, to bedrock at 610 cm. Samples coll. and subm. by P. Beaumont, Bernard Price Inst. for Palaeontol., Univ. of Witwatersrand, Johannesburg.

7200 ± 70
Pta-112. Heuningneskrans 27″ **5250 B.C.**
$\delta C^{13} = -18.6$‰

Charred bone from lower part of Stratum 3 at 45 to 70 cm depth in Sq. AB assoc. with early Later Stone age industry with high percentage of scrapers. *Comment*: pretreated as for charred bone (Vogel and Waterbolk, 1963) and alkali soluble fraction measured.

9780 ± 85
Pta-099. Heuningneskrans 45″ **7830 B.C.**
$\delta C^{13} = -24.3$‰

Charcoal fragments from top of Stratum 2 at 76 to 107 cm depth in Sq. A10 assoc. with early Later Stone age industry. *Comment*: pretreated with acid and alkali.

10,430 ± 150
Pta-114. Heuningneskrans 66″ **8480 B.C.**
$\delta C^{13} = -15.9$‰

Charred bone from top of Stratum 1 at 145 to 168 cm depth in Sq. A9 assoc. with early Later Stone age industry. *Comment*: pretreated as Pta-112 above.

13,100 ± 110
Pta-100. Heuningneskrans 93″ **11,150 B.C.**
$\delta C^{13} = -25.2$‰

Charcoal fragments from Stratum 1 at 220 to 235 cm depth in Sqs. A12 and A13. *Comment*: pretreated with acid and alkali.

11,220 ± 140
Pta-233. Heuningneskrans 172″ **9270 B.C.**
$\delta C^{13} = -9.5$‰

Calcrete cementing soil at 430 to 436 cm depth in Sq. C11. *Comment*: half of carbonate etched away with dilute acid and the rest dated. This is no date for level but average for secondary cementing episode; since apparent age of freshwater carbonate is usually 1300 yr (Münnich and Vogel, 1959), cementing probably took place ca. 10,000 B.P.

Pta-101. Heuningneskrans 174″

24,630 ± 300
22,680 B.C.
$\delta C^{13} = -14.5‰$

Charred bone from hearth at 435 to 442 cm depth in Sq. A12 assoc. with early Later Stone age industry. *Comment*: pretreated as Pta-112 above.

General Comment: dates indicate Stratum 1 top and Stratum 2 contemporaneous with Later Stone age at nearby Bushman Rock Shelter (R., 1970, v. 12, p. 458). Pta-101 shows high antiquity of Later Stone age culture, confirming Rose Cottage series, below.

Pta-004. Mlaula Shelter 2, Swaziland

9570 ± 450
7620 B.C.
$\delta C^{13} = -23.4‰$

Burnt bone fragments, 80 to 100 cm deep, from Later Stone age rock shelter of Mlaula, ca. 8 km SW of Mlaula (26° 12′ S Lat, 32° 01′ E Long), Swaziland. Coll. 1965, subm. 1967 by P. Beaumont. *Comment*: pretreated as for burnt bone. Cf. Y-1996: 9370 ± 160 for same deposit (R., 1969, v. 11, p. 646).

Pta-163. Umhlanga Rocks, Natal

250 ± 35
A.D. 1700
$\delta C^{13} = -26.6‰$

Charcoal 13 cm below surface, from hearth in open midden site, 150 m N of lighthouse, Umhlanga Rocks beach (29° 41.5′ S Lat, 31° 07′ E Long), 18 km NE of Durban, Natal, assoc. with Later Stone age Wilton industry. Coll. by R. C. Walsh; subm. 1969 by O. Davies, Natal Mus., Pietermaritzburg. *Comment*: pretreated with acid and alkali. Date shows Later Stone age people lived on coast after arrival of Bantu in area.

Pta-087. Munro's site skeleton, Orange Free State

850 ± 60
A.D. 1100
$\delta C^{13} = -11.2‰$

Bone from leg of skeleton B 10-20 excavated at Munro's site on Vaal R., 1.6 km upstream from Oppermansdrift dam (24° 42′ S Lat, 25° 33′ E Long), Orange Free State (Mason, 1969). Assoc. with Smithfield Industry. Coll. 1968, subm. 1969 by R. J. Mason, Univ. of Witwatersrand, Johannesburg. *Comment*: inorganic salts removed by repeated treatment with dilute acid and collagen dated. First Later Stone age skeleton dated in area. Cf. Riet R. skeletons, below.

Rose Cottage series, Orange Free State

Further samples from Rose Cottage cave near Ladybrand (29° 15′ S Lat, 27° 30′ E Long), Orange Free State, analyzed (see R., 1970, v. 12, p. 462). Coll. 1962 by P. Beaumont; subm. 1968 by R. J. Mason.

Pta-350. Rose Cottage sherd **610 ± 50**
A.D. 1340
$\delta C^{13} = -20.8‰$

Sherd of grass-tempered pot from 30 to 37 cm depth in Sq. Fh in uppermost Wilton layer. *Comment*: 80 g sherd contained enough charred grass for analysis. Pretreated with acid. Such potsherds should prove useful to date early pottery traditions in S Africa.

Pta-211. Rose Cottage 4′5″ **29,430 ± 520**
27,480 B.C.
$\delta C^{13} = -23.5‰$

Finely dispersed charcoal and ash from Sq. Jf at 135 cm depth in base of pre-Wilton layer. *Comment*: pretreated with acid and alkali. Since all carbon dissolved in hot alkali, this fraction was analyzed. Date could be too young, but, since older than GrN-5300: 25,640 ± 220 B.P. for comparable level at 146 cm (erroneously quoted as 176 cm in R., 1970, v. 12, p. 462) it is considered reliable. Confirms high age of 1st Later Stone age in cave. Both samples overlie primitive Later Stone age assemblage in Malan's (1952) "sterile" layer.

Pta-213. Rose Cottage 10′10″ **>50,200**
$\delta C^{13} = -23.8‰$

Fine charcoal and sand from Sq. Hd at 330 cm depth in top of Upper Magosian layer. *Comment*: pretreated with acid and alkali. Since all carbon dissolved in alkali, this fraction was measured. Date could be too young. Confirms high age of Magosian at site.

Pta-214. Rose Cottage 12′4″ soluble frac. **>42,500**
$\delta C^{13} = -24.6‰$

Pta-231. Rose Cottage 12′4″ insoluble frac. **>48,400**
$\delta C^{13} = -24.7‰$

Charcoal from Sq. Ie at 380 cm depth in lower hearth of Upper Magosian. *Comment*: pretreated with acid and alkali; both alkali soluble and insoluble fractions measured with similar results.

Pta-001. Rose Cottage 12′ **36,100 ± 2000**
34,150 B.C.

Small sample of fine charcoal from outside grid in Upper Magosian layer. *Comment*: pretreated with acid and alkali. On basis of other minimum dates for Magosian, above, this sample too young and must have been contaminated.

General Comment: these dates and those for Heuningneskrans, above, prove that Later Stone age in South Africa goes back beyond 24,000 B.P., double age hitherto assumed, and that "Magosian" of Rose Cottage is older than 50,000 B.P., as at Montagu Cave (R., 1970, v. 12, p. 460).

Riet River series, Orange Free State

Two graves at Site OFD 1 on bank of Riet R., farm Koppieskraal (29° 18′ S Lat, 24° 57′ E Long), 12 km N of Koffiefontein, Orange Free

State, excavated in 1969 (Humphreys and Maggs, 1970). Graves possibly related to nearby stone-built settlement. In past 60 or more graves found here (Van Riet Lowe, 1931). Coll. and subm. 1970 by T. Maggs, Dept. of Archaeol., Univ. Cape Town, and A.J.B. Humphreys, McGregor Mus., Kimberley.

Pta-247. Riet River Skeleton 1 **110 ± 50**
A.D. 1840
$\delta C^{13} = -9.2‰$

Ribs of human skeleton 1.2 m below surface from Burial 1. Ostrich eggshell bead headband of Later Stone age type, and copper pendant found in assoc. Pendant preserved portion of hair and skin of scalp. Hair decorated with specularite. Red ocher used on burial.

Pta-248. Riet River Skeleton 2 **380 ± 50**
A.D. 1570
$\delta C^{13} = -8.0‰$

Ribs of human skeleton from Burial 2, 1 m below surface.

General Comment: inorganic salts removed with cold acid. Collagen measured. From C^{14} calibration curve (Vogel, 1970) most probable historic dates are either A.D. 1845 or A.D. 1690 for Skeleton 1 and either A.D. 1590 or A.D. 1475 for Skeleton 2.

Doornfontein series, Cape Province

Ancient specularite working on farm Doornfontein M82, 10 km NNW of Postmasburg (28° 18′ S Lat, 23° 05′ E Long), Cape Prov., excavated by P. Beaumont and A. K. Boshier. Coll. and subm. 1969 by P. Beaumont.

Pta-186. Doornfontein 27″-39″ **1120 ± 40**
A.D. 830
$\delta C^{13} = -21.7‰$

Scattered charcoal nodules in middle levels of mining rubble in Chamber 3, 70 to 100 cm below surface, assoc. with bush-boskop skeletal remains and crude Later Stone age artifacts and "Hottentot" pottery.

Pta-187. Doornfontein 45″-52″ **1120 ± 40**
A.D. 830
$\delta C^{13} = -24.5‰$

Scattered charcoal nodules from basal levels of mining rubble in Chamber 3, 115 to 130 cm below surface (bedrock), assoc. with skeletal remains and crude Later Stone age artifacts.

General Comment: pretreated with acid and alkali.

Pta-251. Baviaanskloof, Cape Province **12,650 ± 100**
10,700 B.C.
$\delta C^{13} = -23.9‰$

Small charcoal sample from cave in Baviaanskloof Mts. (33° 30′ S Lat, 23° 40′ E Long), ca. 12 km SE of Willowmore, Cape Prov. Middle Stone age industry reported in cave sediment. Coll. and subm. 1969 by

K. Jolly, Cape Town. *Comment*: pretreated with acid only. Too young for Middle Stone age.

Pta-261. Hofmeyer, Cape Province **3020 ± 90**
1070 B.C.
$\delta C^{13} = -3.1‰$

Calcite crust on animal horn assoc. with fossil skull found near Hofmeyer (31° 39′ S Lat, 25° 49′ E Long), Cape Prov. Subm. 1969 by H. de Villiers and A. Hughes, Univ. of Witwatersrand, Johannesburg. *Comment*: since bone contains no collagen, secondary calcite crust date, only minimum for much older skull.

Pta-014. Robberg Cave D, Cape Province **1925 ± 33**
A.D. 50
$\delta C^{13} = +3.4‰$

Patella shell 90 cm below surface at back of Cave D, S side of Robberg Pen. (34° 06.5′ S Lat, 23° 24.5′ E Long), near Cape Seal, Plettenberg Bay, Cape Prov. Four shells found with painted burial stone on human skeleton. Coll. 1917 by W. G. Sharples; subm. 1969 by J. Rudner, S. African Mus., Cape Town. *Comment*: pretreated with acid. Date of 2285 ± 105 B.P. (GX-1397) for shells found with painted burial stone at Klasies R. Mouth (Singer, 1969).

Lower Numas Cave series, SW Africa

Cave with rock paintings in Lower Numas Ravine (21° 08′ S Lat, 14° 26′ E Long), Brandberg, Omaruru dist., SW Africa. Testhole revealed fine Wilton industry without pottery (Rudner, 1957). Samples coll. and subm. 1969 by J. Rudner.

Pta-178. Lower Numas Cave 1 **2890 ± 65**
940 B.C.
$\delta C^{13} = -24.6‰$

Charcoal from hearth 7 cm below surface in testhole.

Pta-179. Lower Numas Cave 2 **2950 ± 65**
1000 B.C.
$\delta C^{13} = -22.0‰$

Charcoal from hearth 15 cm below surface in testhole.

General Comment: both samples pretreated with acid and alkali. Another date from Brandberg for Wilton industry with copper beads and pottery in Numas Entrance shelter is SR-46: 870 ± 100 (MacCalman, 1965). See also Pta-177, below.

Pta-177. Numas Plateau, SW Africa **265 ± 50**
A.D. 1685
$\delta C^{13} = -23.7‰$

Charcoal from fireplace covered with stone cairn, below so-called Okapo frieze, on Numas Plateau (21° 08′ S Lat, 14° 30′ E Long; alt 2250 m), Brandberg, Omaruru dist., SW Africa. Coll. and subm. 1969 by J. Rudner. Potsherds of Bergdama or Hottentot type found in ash. *Comment*: pretreated with acid and alkali.

Pta-212. Benfica, Angola

1810 ± 50
A.D. 140
$\delta C^{13} = -22.8‰$

Charcoal, 35 to 40 cm deep, from Strandloper kitchen midden near coast at Benfica, 17 km S of Luanda (8° 50′ S Lat, 13° 15′ E Long), Angola. Layer also contained shells, bones, and pottery (Dos Santos and Ervedosa, 1970). Coll. and subm. 1970 by J. R. Dos Santos, Jr., Univ. of Luanda, Angola. *Comment*: pretreated with acid and alkali. This early date for pottery on Angolan coast concurs with early pottery tradition in Zambia.

Mungo series, Angola

Rock shelter of Caninguiri, adm. of Mungo (11° 57′ S Lat, 16° 28′ E Long), Nova Lisboa dist., Angola, contains ca. 2 m sediment with Wilton type industry and rock paintings. Samples coll. and subm. 1970 by J. R. Dos Santos, Jr.

Pta-238. Mungo 3

7840 ± 80
5890 B.C.
$\delta C^{13} = -25.4‰$

Charcoal from 85 to 100 cm depth.

Pta-239. Mungo 5

9670 ± 90
7720 B.C.

Charcoal from 160 to 196 cm depth.

Pta-240. Mungo 6

10,410 ± 90
8460 B.C.
$\delta C^{13} = -25.3‰$

Charcoal from 196 to 220 cm depth.

General Comment: all samples pretreated with acid and alkali. Dates comparable with other early Later Stone age dates in Angola, e.g., UCLA-172: 12,970 ± 250 B.P. and UCLA-167: 6830 ± 200 B.P. (R., 1963, v. 5, p. 17).

B. Iron Age of Southern Africa

Pta-136. Klipriviersberg 4, Transvaal

227 ± 46
A.D. 1723
$\delta C^{13} = -23.1‰$

Further sample from lowest level of Iron age stone-wall settlement of Uitkomst culture at Klipriviersberg ca. 7 km S of Johannesburg (26° 11′ S Lat, 28° 02′ E Long), Transvaal (see R., 1967, v. 9, p. 148). Coll. and subm. 1969 by R. J. Mason, Univ. of Witwatersrand, Johannesburg. *Comment*: pretreated with acid only. Corrected most probable date derived from C^{14} calibration curve (Vogel, 1970) is A.D. 1645 in accordance with other dates for similar sites (R., 1970, v. 12, p. 465 ff.).

Pta-002. Ndumu, Zululand

1320 ± 40
A.D. 630
$\delta C^{13} = -12.8‰$

Charcoal found in and around iron furnace in Ndumu Game Reserve, junction of Usutu and Pongola Rivers (32° 20′ E Long, 26° 51′ S

Lat), Zululand (Dutton, 1970). Coll. 1968, subm. 1969 by P. Dutton and P. de Moor, Ndumu, Zululand. *Comment*: pretreated with acid and alkali. For similar early Iron age dates from Swaziland, see Castle Cavern series: GrN-5022: 1530 ± 30; GrN-5315: 1550 ± 30 (R., 1970, v. 12, p. 464).

Pta-162. Blackburn Ridge, Natal — **900 ± 40**
A.D. 1050
$\delta C^{13} = -26.9‰$

Charcoal from hearth 28 to 30 cm below surface, during systematic excavation of hut with NC_2 pottery at Blackburn village site (29° 41′ S Lat, 31° 06′ E Long), near Umhlanga Rocks, Natal. Coll. and subm. 1969 by O. Davies. *Comment*: pretreated with acid and alkali. Minimum date for arrival of Bantu S of Tugela R. Compare Ndumu, above.

Pta-234. Kapako, SW Africa — **1100 ± 50**
A.D. 850
$\delta C^{13} = -25.4‰$

Charcoal at 70 cm depth from test pit at Iron age site of Kapako (17° 55′ S Lat, 19° 40′ E Long), W of Runtu on Okavango R., SW Africa. Assoc. finds were potsherds, bone, isolated stone artifacts. Coll. 1968, subm. 1970 by B. Sandelowsky-Pendleton, State Mus., Windhoek, SW Africa. *Comment*: pretreated with acid and alkali. Compare Benfica, above, which has similar pottery.

Pta-236. Vungu Vungu, SW Africa — **290 ± 45**
A.D. 1660
$\delta C^{13} = -24.9‰$

Charcoal at 25 to 23 cm depth from Iron age site at Vungu Vungu (17° 53′ S Lat, 19° 51′ E Long), E of Runtu, on Okavango R., SW Africa. Potsherds, bone, glass beads, ostrich-eggshell beads, and shells found in assoc. Coll. 1969, subm. 1970 by B. Sandelowsky-Pendleton. *Comment*: pretreated with acid and alkali.

Pta-235. Dikundu B 1973/E, SW Africa — **120 ± 50**
A.D. 1830
$\delta C^{13} = -26.0‰$

Charcoal from bottom of iron-smelting furnace at 75 cm depth, Omuramba Dikundu (18° 06′ S Lat, 21° 40′ E Long), ca. 19 km SW of Andara on Okavango R., SW Africa. Coll. 1969, subm. 1970 by B. Sandelowsky-Pendleton. *Comment*: pretreated with acid and alkali.

C. Varia

Pta-170. Egyptian Mummy — **1775 ± 60**
A.D. 175
$\delta C^{13} = -24.4‰$

Piece from wrap of Egyptian mummy with naturalistic portrait of young man. Exact origin unknown. Now in Nat. Cult. Hist. Mus., Pretoria, South Africa. Subm. 1969 by E. van Rensburg, Nat. Cult. Hist. Mus., Pretoria. *Comment*: pretreated with acid only. Mummies with mummy portraits from Fayum historically dated to 2nd and 3rd centuries A.D. (Zaloscer, 1961).

1090 ± 50

Pta-227. Frauenchiemsee, Germany **A.D. 860**

$\delta C^{13} = -28.2‰$

Outer tree rings of beam to left of entrance, S wall, of medieval building on Frauenchiemsee I. in Chiemsee (47° 52′ N Lat, 12° 27′ W Long), E of Rosenheim, Bavaria, Germany. Coll. and subm. 1970 by V. Milojčić, Inst. f. Ur- u. Frühgeschichte, Univ. Heidelberg, Germany. *Comment*: pretreated with acid and alkali. Dates construction of ground floor of portal, considered built either between A.D. 850 and A.D. 880 or in 11th century. Correction of result with C^{14} calibration curve (Suess, 1970) could make date 60 yr later, still favoring earlier construction date.

III. GEOPHYSICAL SAMPLES

Pretoria series, South Africa

Atmospheric CO_2 coll. at Nat. Physical Research Lab. (25° 43′ S Lat, 28° 21′ E Long), 9 km E of Pretoria, South Africa, by slowly pumping air through 1.5 N NaOH solution.

Sample no.	Date	δC^{13}(‰)	Δ(‰)*
Pta-117	Oct. 7 – Oct. 10, 1968	−7.7	571 ± 7
Pta-121	Nov. 4 – Nov. 18, 1968	−7.6	577 ± 6
Pta-122	Dec. 9 – Dec. 23, 1968	(−7.5)**	561 ± 7
Pta-120	Jan. 20 – Jan. 28, 1969	−8.2	560 ± 8
Pta-123	Feb. 17 – Mar. 4, 1969	−7.0	558 ± 7
Pta-119	Mar. 17 – Mar. 24, 1969	−7.2	541 ± 6
Pta-131	Apr. 15 – Apr. 24, 1969	−7.3	542 ± 7
Pta-130	July 15 – July 28, 1969	(−7.5)**	529 ± 7
Pta-124	Sept. 9 – Oct. 13, 1969	−7.9	545 ± 7
Pta-118	Oct. 28 – Nov. 23, 1969	−8.0	528 ± 6
Pta-142	Jan. 12 – Jan. 26, 1970	−6.7	529 ± 7
Pta-166	Feb. 19 – Feb. 26, 1970	−7.6	541 ± 7
Pta-184	Mar. 9 – Mar. 17, 1970	−7.9	558 ± 7
Pta-199	Apr. 13 – Apr. 20, 1970	−7.6	547 ± 7
Pta-220	May 12 – May 17, 1970	−7.6	533 ± 7
Pta-266	June 6 – June 22, 1970	−7.5	533 ± 9
Pta-264	July 14 – July 20, 1970	−9.7	550 ± 10
Pta-294	July 28 – Aug. 3, 1970	−8.6	517 ± 9
Pta-332	Sept. 21 – Sept. 28, 1970	−7.8	532 ± 8

* C^{14} surplus, adjusted to $\delta C^{13} = -25‰$

** C^{13} value estimated

Comment: no significant rise caused by French nuclear weapon tests in 1968 and 1970 at about same Lat (22°S) in Pacific Ocean. Development of relative C^{14} content in air at Pretoria since 1954 shown in Fig. 2, lower curve. Based on samples measured at Heidelberg, Germany, Groningen, Netherlands (R., 1970, v. 12, p. 468), and Pretoria, above. For period 1966 to 1968, samples from Bariloche, Argentina (R., 1969, v. 11, p. 385) are also included. For comparison, curve for central Europe based mainly on measurements at Heidelberg also given (Münnich and Vogel, 1963; Münnich and Roether, 1967, extended by courtesy K. O. Münnich, Heidelberg). Slight seasonal fluctuation and gradual decrease in S hemisphere since 1965 is apparent.

Ocean Water series

Surface ocean water samples coll. on voyages of MS RSA from Cape Town to Sanae, Antarctica, in Jan. 1969 and Jan. 1970 by officers of Dept.

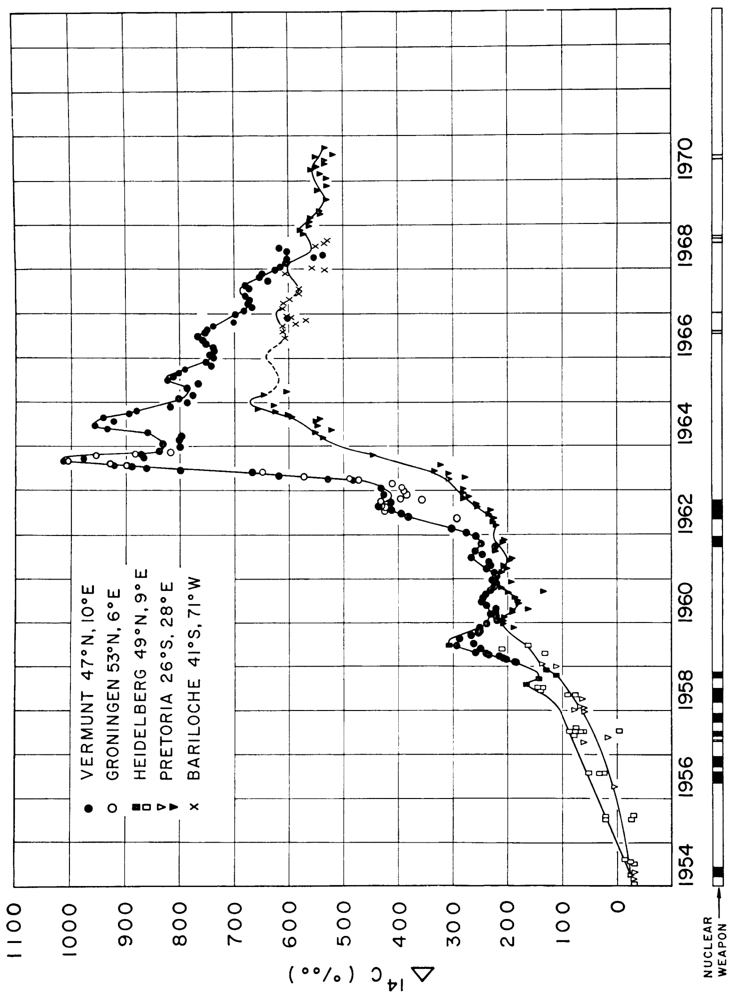

FIG. 2. Radiocarbon content of atmosphere at mid lats in S Hemisphere (lower curve) and N Hemisphere (upper curve). Results adjusted to $\delta C^{13} = -25‰$ according to Lamont normalization. Open squares and triangles are samples of plant material, the rest are direct measurements on atmospheric CO_2. Upper curve based mainly on measurements at Heidelberg (see Comment on Pretoria series).

of Transport, Rep. of South Africa; and on voyage of MS Kaapland in Nov. 1969 and MS Stellenbosch in Jan./Feb. 1970 between Durban and Europe by J. C. Vogel, Sr. with generous help of Capts. Reiche and Rolff, officers, and crews. Inorganic carbon extracted by method described by Vogel (1967).

Sample no.	Date	Lat, Long	δC^{13}(‰)	C^{14} (% modern)
Pta-075	Jan. 1969	40°S, ca. 15°E	−1.4	105.3±.6
Pta-074	Jan. 1969	50°S, ca. 15°E	−6.3	85.9±.5
Pta-073	Jan. 1961	60°S, ca. 10°E	−6.2	79.5±.4
Pta-071	Jan. 1969	65°S, ca. 0°	−6.3	72.2±.4
Pta-156	Nov. 16, 1969	29°18′S, 14°07′E	+1.4	115.7±.5
Pta-180	Nov. 18, 1969	19°11′S, 5°30′E	+2.0	111.7±.6
Pta-173	Nov. 20, 1969	8°20′S, 3°15′W	+1.9	112.8±.6
Pta-157	Nov. 21, 1969	2°31′S, 7°38′W	+1.1	112.6±.5
Pta-158	Nov. 22, 1969	3°16′N, 12°12′W	+2.0	120.3±.6
Pta-160	Nov. 24, 1969	15°55′N, 17°39′W	+1.8	111.9±.6
Pta-176	Nov. 26, 1969	29°26′N, 14°47′W	+2.0	119.8±.5
Pta-159	Nov. 27, 1969	35°38′N, 12°32′W	+2.0	117.0±.6
Pta-164	Nov. 29, 1969	47°35′N, 6°10′W	+1.5	116.1±.6
Pta-175	Jan. 1, 1970	30°01′N, 15°28′W	+1.6	119.6±.6
Pta-155	Feb. 4, 1970	34°08′S, 18°13′E	+1.1	103.5±.5
Pta-153	Feb. 5, 1970	34°35′S, 22°30′E	+1.2	108.5±.6
Pta-154	Feb. 9, 1970	32°54′S, 28°11′E	+2.0	108.3±.6
Pta-222	Jan. 1970	50°S; ca. 15°E	−6.0	80.8±.6
Pta-221	Jan. 1970	60°S; ca. 10°E	−7.1	69.7±.5
Pta-223	Jan. 1970	65°S; ca. 0°	−6.5	76.7±.6

Comment: for series coll. in 1967, see R., 1970, v. 12, p. 469. Unexpectedly low values between 50°S and 65°S indicate water not derived from Atlantic ocean deep water, but rather from Pacific-Antarctic basin. Low values in Atlantic ocean (Pta-160, Pta-155) due to upwelling near African coast. Otherwise low lats in S Atlantic uniform at +12% and N Atlantic at ca. +20%, indicating a rise of 4% since mid 1967. As yet, no explanation for occasional higher values in S hemisphere (Pta-156).

References

Dos Santos, Jr., J. R., and Ervedosa, C. M. N., 1970, A Estacao arqueologica de Benfica, Luanda—Angola: Estudos Biol. Fac. Ciências Univ. Luanda, Angola, v. 1, no. 1, p. 31-51.

Dutton, T. P., 1970, Iron smelting furnace dated 630 ± 40 years A.D. in the Ndumu Game Reserve: Lammergeyer, no. 12, p. 37-40.

Humphreys, A. J. B. and Maggs, T. M. O'C., 1970, Further graves and cultural material from the banks of the Riet River: S. African Archeol. Bull., v. 25, p. 116-135.

Lowe, C. van Riet, 1931, Early graves in the Riet River valley: South African Jour. Sci., v. 27, p. 430-434.

MacCalman, H. R., 1965, Carbon 14 dates from South West Africa: S. African Archaeol. Bull., v. 20, p. 215.

Malan, B. D., 1952, The final phase of the Middle Stone age in South Africa: Pan-African Cong. on Prehistory Proc., Nairobi, 1947, Oxford, p. 188-194.
Mason, J. R., 1969, The Oppermansdrif dam archaeological project—Vaal basin: South African Archaeol. Bull., v. 24, p. 182-192.
Münnich, K. O. and Roether, W., 1967, Transfer of bomb ^{14}C and T from the atmosphere to the ocean, *in*: Radioactive dating and methods of low level counting: I.A.E.A., Vienna, p. 93-104.
Münnich, K. O. and Vogel, J. C., 1959, C14-Altersbestimmung von Süsswasser-Kalkablagerungen: Naturwissenschaften, v. 46, p. 168-169.
——— 1963, Investigation of meridional transport in the troposphere by means of carbon-14 measurements, *in*: Radioactive dating: I.A.E.A., Vienna, p. 189-197.
Rudner, J., 1957, The Brandberg and its archaeological remains: South West African Sci. Soc. Jour., v. 12, p. 7-44.
Singer, R. and Wymer, J., 1969, Radiocarbon date for two painted stones from a coastal cave in South Africa: Nature, v. 224, p. 508-510.
Stuiver, Minze, 1969, Yale natural radiocarbon measurements IX: Radiocarbon, v. 11, p. 545-658.
Suess, H., 1970, Bristlecone pine calibration of the Radiocarbon time scale 5200 B.C. to the present, *in*: Olsson, I. U. (ed.), Radiocarbon variations and absolute chronology, 12th Nobel Symposium Proc., Stockholm, Alonquist, p. 303-311.
Vogel, J. C., 1967, Investigation of groundwater flow with Radiocarbon, *in*: Isotopes in hydrology, I.A.E.A., Vienna, p. 355-369.
——— 1970, Groningen radiocarbon dates IX: Radiocarbon, v. 12, p. 444-471.
Vogel, J. C. and Waterbolk, H. T., 1963, Groningen radiocarbon dates IV: Radiocarbon, v. 5, p. 163-202.
——— 1967, Groningen radiocarbon dates VII: Radiocarbon, v. 9, p. 107-155.
Zaloscer, Hilde, 1961, Porträts aus dem Wüstensand: Wien-München, Verlag A. Schroll.

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UNIVERSITY OF ROME CARBON-14 DATES IX

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This list includes age measurements carried out from November 1969 to December 1970. All archaeologic and geologic samples come from Italian territory. Laboratory equipment, largely unchanged, has been described (Alessio *et al.*, 1970).

The activity of our "modern standard", wood grown near Rome between 1949 and 1953, was checked with 95% of the counting rate of NBS oxalic acid and measurements were found coincident within 1σ. For each sample of CO_2, the counting rate was corrected according to mass-spectrometrically measured C^{13}/C^{12} ratio as described previously (Alessio *et al.*, 1969). Age was calculated using the Libby half-life of 5568 ± 30 yr, with 1950 as the standard year of reference.

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SAMPLE DESCRIPTIONS

I. ARCHAEOLOGIC AND HISTORIC SAMPLES

A. Italy

3270 ± 50
R-667. Lagazzi **1320 B.C.**
$\delta C^{13} = -25.1‰$

Charcoal from inside some vases with original filling from excavations done 1890-1891 at lake dwelling of Lagazzi, between Vho and S. Lorenzo Guazzone, prov. Cremona, Lombardy (45° 06′ 25″ N Lat, 10° 23′ 25″ E Long) and since housed in Mus. Civico of Cremona. Coll. 1967 by G. Cremonesi, Ist. di Paletnol., Univ. of Lecce and subm. 1969 by A. M. Radmilli, Ist. Antropol. e Paleontol. Umana, Univ. of Pisa. Lagazzi lake dwelling is attributable to Bronze age with strong influence from Polada culture (Parazzi, 1891; Cremonesi, 1967). *Comment*: charcoal from vases numbered 12, 18, 25, 36, 40, and 150 and from one unnumbered vase. Late Bronze age is acceptable.

3230 ± 50
R-700α. Monte Madarosa **1280 B.C.**
$\delta C^{13} = -25.3‰$

Charcoal from prehistoric open-air settlement along NE side of Monte Madarosa, a basaltic hill, 561 m, forming part of the divide between Chiampo and Alpone valleys, 2 km SSW Chiampo, prov. Verona, Veneto (45° 31′ 33″ N Lat, 11° 16′ 10″ E Long). Coll. 1960 and subm. 1970 by A. Menin. Archaeol. deposit, evidenced by plentiful flint implements, pottery, and bones, was widely disarranged. Charcoal from undisturbed carbonaceous lens at 1.5 m depth, ca. 40 m from hilltop, containing only arrow-heads. *Comment*: Monte Madarosa pottery is attributable to middle and late phases of Bronze age; only a few elements can be attributed to early and final Bronze age phases. Cultural complex belongs to Berico-Euganea facies, featured by strong influences from central and S Italian cultures. At Madarosa settlement, typical specimens of Apennines culture are present (L. Fasani, pers. commun.). Date is late Bronze age.

3350 ± 50
R-358. Lago di Ledro **1400 B.C.**
$\delta C^{13} = -26.9‰$

Well-preserved wood from wooden pile of large lake dwelling settlement of Bronze age in Ponale effluent area, near Molina di Ledro, Ledro lake, prov. Trento (45° 52′ 30″ N Lat, 10° 45′ 40″ E Long). Coll. 1955 and subm. 1967 by O. Cornaggia Castiglioni, Sopr. Monumenti, Milan. *Comment*: pottery of Polada culture was found at Ponale lake settlement (Battaglia, 1943). R-358 date is practically identical with preceding one measured on charcoal by Rome Lab.: R-7, 3310 ± 210 (R., 1964, v. 6, p. 82); part of other wooden pile dated at Pisa: Pi-88, 3137 ± 105 (R., 1961, v. 3, p. 102); wooden beam dated at Birmingham: Birm-34, 3659 ± 66 and 3642 ± 36 (R., 1968, v. 10, p. 205). Available dates attributed to Polada culture in lake dwellings scattered in Po Plain reported by Alessio *et al.* (R., 1967, v. 9, p. 349), and discussed by both O. Cornaggia Castiglioni (1967) and Barfield (1968).

280 ± 50
R-506α. Lago Fimon **A.D. 1670**
$\delta C^{13} = -24.2‰$

Darkened wood, from wooden post, found on E shore of Fimon Lake, Berici Mts. ca. 9 km S Vicenza, Veneto (45° 28′ 20″ N Lat, 11° 32′ 43″ E Long). Coll. by G. Barioli, Mus. Civici Vicenza; subm. by T. Mantovani. *Comment*: a few other posts were embedded in mud in same area; C^{14} date indicates a relatively modern structure not belonging to prehistoric lake dwelling of Fimon Lake.

3140 ± 60
R-608. Ancarano di Sirolo E **1190 B.C.**
$\delta C^{13} = -25.3‰$

3100 ± 60
R-608α. Ancarano di Sirolo E **1150 B.C.**
$\delta C^{13} = -25.6‰$

3190 ± 50
R-608α/1. Ancarano di Sirolo E **1240 B.C.**
$\delta C^{13} = -25.8‰$

Charcoal from Zone E of prehistoric open-air settlement at Contrada Ancarano, ca. 1.5 km SW Sirolo, prov. Ancona, Marche (43° 30′ 46″ N Lat, 13° 36′ 18″ E Long). Coll. 1961 and subm. 1969 by D. G. Lollini, Sopr. Antichità Marche. Excavations revealed a single cultural horizon under soil; few flint implements and pottery, the latter with some features in common with Bronze age lake dwelling cultures scattered on Po plain (Lollini, 1961). *Comment*: R-608 was given 5% HCl pretreatment only; R-608α and R-608α_1, separately, were given additional leaching with 6% NH_4OH; all dates are consistent and show abundant humic fraction removed was not contaminating. Age rather younger than expected.

Ripoli series

In 1960-65 new excavations were made at large Neolithic village of Ripoli, left side of Vibrata R. valley, prov. Teramo, Abruzzi (42° 49′ 30″ N Lat, 13° 33′ 23″ E Long). Typologic characteristics of Ripoli culture, placed in the Middle and Upper Neolithic, were better identified and, based on different frequency of elements and categories of pottery in various huts and presence of sherds of imported pottery, different phases in development of Ripoli culture and village were determined (Cremonesi, 1965). Charcoal from Huts 6 and 12 coll. 1962-64 by G. Cremonesi and subm. 1969 by A. M. Radmilli.

5560 ± 150
R-665. Ripoli 6 **3610 B.C.**
$\delta C^{13} = -24.7‰$

Charcoal from Hut 6, far E side of village. *Comment*: from type of material, Hut 6 may be attributed to an intermediate stage of settlement. Date agrees with cultural stage.

5630 ± 80
R-664. Ripoli 12 **3680 B.C.**
$\delta C^{13} = -25.0‰$

Charcoal from Hut 12, far W side of so far explored village. *Comment*: Hut 12 is believed to belong to an early stage of village. Date agrees with cultural stage.

General Comment: Hut 3 of Ripoli village was dated by Pisa (unpub.): 5100 ± 120 (Cremonesi, 1965). Dates of other settlements with evidence of similar culture are: Grotta dei Piccioni, upper horizon, Pi-49, 4770 ± 110 (R., 1961, v. 3, p. 100); Grotta Scaloria, trichrome pottery: R-349, 5480 ± 70 (R., 1969, v. 11, p. 485).

800 ± 80
R-614. Grifo, Perugia **A.D. 1150**
$\delta C^{13} = -26.2‰$

Very fine particles of carbonized organic matter in quartz-carbonate clay, forming core mold of a bronze gryphon statue decorating gate of Palazzo dei Priori in Perugia, Umbria; removed for restoration in 1966.

Coll. and subm. 1969 by M. Marabelli, Ist. Centrale del Restauro, Rome. *Comment*: sample pretreatment with 8N HCl. Organic matter used in making clay mold for bronze casting was both animal and vegetable (wool cloth clippings, carding wool waste, animal hair, dung, cut straw, and leaves, etc.) (Theophilus, 1140?; Vannoccio Biringuccio, 1540; Cellini, 1568; Vasari, 1568). Carbonized material in core mold of Gryphon, ca. 3.5% in weight, id. as very fine vegetable particles by M. Follieri, Ist. Botanica, Univ. of Rome (pers. commun.); chemical and mineralogic analyses of clay core were done by M. Marabelli (1971). Dated because of divergent opinions of age of Gryphon, believed Etruscan by one scholar (Caputo, 1961) and Mediaeval by most experts. Age confirms the latter.

1570 ± 50

R-683. Baia **A.D. 380**

$\delta C^{13} = -26.5‰$

Well-preserved wood (*Larix* sp.) id. by M. Follieri (pers. commun.), wooden plank fragment belonging to ancient harbor structure, palisade 20 m long, water depth 4.5 m, in Baia archaeol. area, Pozzuoli Gulf, prov. Naples (40° 49′ 03″ N Lat, 14° 04′ 34″ E Long). Coll. 1968 and subm. 1969 by P. Colantoni, Lab. Geol. Marina C.N.R., Bologna. *Comment*: date confirms expected Roman origin.

B. Elba Island

Golfo di Procchio shipwreck series

1969 excavations in Procchio Gulf, N coast of Elba I. (42° 47′ 31″ N Lat, 10° 14′ 56″ E Long), water depth ca. 1.90 m, revealed partially preserved wooden ship, ca. 20 m long, buried in sandy sediments at depth ca. 40 cm. Wood coll. 1969 by A. Fioravanti and subm. 1969 by L. Ferri-Ricchi.

1610 ± 50

R-678. Golfo di Procchio Wreck 1 **A.D. 340**

$\delta C^{13} = -28.4‰$

Wood from longitudinal structure of ship, level with keelsons.

1670 ± 50

R-679. Golfo di Procchio Wreck 2 **A.D. 280**

$\delta C^{13} = -26.9‰$

Wood (*Quercus* cfr. *ilex*) id. by M. Follieri (pers. commun.) found inside ship, but apparently unconnected with structure.

General Comment: wreck, in view of nature and type of objects inside (amphoras, lamps, glass goblets, etc.) was id. as imperial-age Roman merchant ship (Ferri-Ricchi, 1969; Fioravanti, 1970). Date confirms this.

Hitherto several shipwrecks from sunken ships found at various places along Italian, French, and Sardinian coasts have been dated at Univ. of Pennsylvania Lab. (R., 1966, v. 8, p. 353-355; 1970, v. 12, p. 585).

C. Sardinia

R-609. Grotta del Guano

4830 ± 50
2280 B.C.
$\delta C^{13} = -23.1‰$

R-609α. Grotta del Guano

4900 ± 50
2250 B.C.
$\delta C^{13} = -23.6‰$

Charcoal from lower level of deposit under thick calcareous stalagmitic horizon near N wall of central chamber of Grotta del Guano or di Gonogùsola, kartz cave in mesozoic limestone, right side of Cedrino R., Oliena, prov. Nuoro (40° 17′ 15″ N Lat, 9° 30′ 28″ E Long). Coll. 1961 by B. Piredda, Gruppo Speleol. Nuorese, and subm. 1968 by E. Castaldi, Ist. di Paletnol., Univ. of Rome. Pottery of S. Michele di Ozieri culture was found in deposit (Contu, 1964, 1966). *Comment*: R-609 received standard pretreatment with 5% HCl; R-609α received additional leaching with 6% NH_4OH: 2 measurements were consistent, abundant humic fraction removed should not be regarded as contaminating but as belonging to humic charcoal. S. Michele culture is widespread throughout Sardinia in various settlements (huts, caves and shelters, rock-cut tombs or "domus de janas", etc.) (Lilliu, 1967; Bray, 1963; Ferrarese Ceruti, 1967; Contu, 1969) and it is thought to belong to Chalcolithic of Sardinia but, the culture being prolonged, it probably is even older (Atzeni, 1967; Pinna, 1966-1967). Date, oldest available for Sardinian prehistory, should confirm this opinion, placing S. Michele culture in Guano cave in Upper Neolithic (Castaldi, 1971).

S. Michele di Ozieri culture has some features similar to Peu-Richard culture, which in some neolithic coastal settlements of Charente-Maritime, France, were dated from 2840 ± 250 to 2300 ± 250 B.C. (Thomas, 1965; Mohen, 1967; R., 1966, v. 8, p. 132; 1970, v. 12, p. 434-435). Kidney-shaped earthenware loom-weights are a feature common both to S. Michele and Lagozza culture of Upper Neolithic of Po Plain, repeatedly dated at Rome and Pisa labs, ca. 3000-2800 B.C. (R., 1968, v. 10, p. 356-357; Guerreschi, 1967).

D. Pantelleria Island

Mursia series

Excavations were made during 1966-1968 in Bronze age village of Mursia, on rocky cliff between Cala di Modica and Cala dell'Alca, W coast of Pantelleria I. (36° 48′ 39″ N Lat, 11° 54′ 41″ E Long). Village consists of ellipsoidal stone huts and is protected inland by stone wall. Plentiful implements, mostly of obsidian, were found with pottery, largely atypical, making chronologic and cultural attribution of village difficult; however, an earlier phase was id. (Zone A, Huts 1, 2, 4, 5, and 6) and a later phase (Zone A, Hut 3), separated by an intermediate phase not yet fully distinguished (Radmilli, 1967; Tozzi, 1968). Charcoal from Huts 1, 3, and 4, Zone A of excavations, coll. 1966-67 by C.

Tozzi and subm. 1969 by A. M. Radmilli. Samples were given 5% HCl pretreatment; due to the presence of rootlets and humic fractions, α-labeled samples were given additional leaching with 6% NH_4OH.

R-671. Mursia A, I-b, 7 — **3280 ± 50**; **1330 B.C.**; $\delta C^{13} = -23.3‰$

Charcoal from Zone A, Area I-b, Cut 7, lower stamped-earth floor of Hut 1. *Comment*: C^{14} date agrees with level belonging to earlier phase.

R-669α. Mursia A, I-bc, 5 — **2930 ± 50**; **980 B.C.**; $\delta C^{13} = -22.3‰$

Charcoal from Zone A, Area I-bc, Cut 5, found at level of loose-pebble foundation of upper stamped-earth floor of Hut 1. *Comment*: C^{14} age appears somewhat young; the hut might have been re-used in a more recent phase in village life, or sample might have been mixed with younger material during partial destruction of the hut a few years ago.

R-668α. Mursia A, IV-bc, 4 — **2990 ± 50**; **1040 B.C.**; $\delta C^{13} = -24.0‰$

Charcoal from Zone A, Area IV-bc, Cut 4. *Comment*: C^{14} age is acceptable for late phase of village.

R-670α. Mursia A, V-c′, 3-4 — **3010 ± 50**; **1060 B.C.**; $\delta C^{13} = -24.6‰$

Charcoal from Zone A, Area V-c′, Cuts 3-4, in hearth of Hut 3. *Comment*: C^{14} can be accepted for Hut 3 belonging to late phase of village.

R-673. Mursia A, IV-f′, 3 — **2830 ± 50**; **880 B.C.**; $\delta C^{13} = -24.0‰$

Charcoal from Zone A, Area IV-f′, Cut 3, found inside a cist made of stone slabs in Hut 4. *Comment*: date appears too young: sample presumably got mixed with younger material.

II. GEOLOGIC SAMPLES

Italy

Valli Ferraresi

During reclamation of 2 littoral lagoon valleys in prov. of Ferrara, Mezzano and Giralda salt valleys, S area of Po R. delta, hundreds of subfossil stumps and trunks, relicts of ancient Adriatic littoral forest along Po banks, were found *in situ* in drained alluvium of valleys. Dated of some wood, id. by G. Cellai Ciuffi, Ist. Botan., Univ. of Florence (pers. commun.), were requested for palaeogeographic and palaeobotanic studies of region.

Valle del Mezzano series

Wood, subfossil stumps and trunks, found *in situ*, Mezzano salt valley, between mouth of Primaro Po (Reno) and Volano Po, ca. 14 km W Comacchio, prov. of Ferrara, Emilia (40° 42′ N Lat, 12° 02′ E Long). Coll. by P. Stampi, Ist. Botan., Univ. of Ferrara, and subm. by E. Francini Corti, Ist. Botan., Univ. of Florence. Stumps and trunks covered large area and were partly buried at depth ca. 20 cm to 1 m; latter discovered during tilling (Stampi, 1966).

1460 ± 60
R-390. Valle del Mezzano 1 **A.D. 490**
$\delta C^{13} = -29.1‰$

Darkened wood (*Populus* sp.). *Comment*: sample was pretreated with 10% HCl only because, despite darkening, test with 6% NH_4OH did not disclose humic material.

1890 ± 50
R-391α. Valle del Mezzano 2 **A.D. 60**
$\delta C^{13} = -27.3‰$

Rather darkened wood (*Betula* sp.). *Comment*: sample was pretreated with 10% HCl: no carbonate or Fe^{+++} present, only abundant Fe^{++} was detected, probably ferrous humate; additional leaching with 6% NH_4OH was given.

1620 ± 50
R-392α. Valle del Mezzano 3 **A.D. 330**
$\delta C^{13} = -29.5‰$

Darkened wood (*Populus* sp.). *Comment*: sample was pretreated with 10% HCl: no carbonate or Fe^{+++} present, only abundant Fe^{++} was detected, probably ferrous humate; additional leaching with 6% NH_4OH was given.

1520 ± 120
R-393. Valle del Mezzano 4 **A.D. 430**
$\delta C^{13} = -28.9‰$

Slightly darkened wood (*Alnus* sp.). *Comment*: sample only pretreated with 10% HCl: no carbonate, Fe^{+++} and Fe^{++} present; test with 6% NH_4OH did not reveal humic substances.

1590 ± 50
R-394. Valle del Mezzano 5 **A.D. 360**
$\delta C^{13} = -29.3‰$

Well-preserved wood (*Alnus* sp.). *Comment*: sample pretreated with 10% HCl only: no carbonate, Fe^{+++} or Fe^{++} present.

1510 ± 50
R-395. Valle del Mezzano 6 **A.D. 440**
$\delta C^{13} = -28.1‰$

Well-preserved wood (*Alnus* sp.). *Comment*: sample pretreated with 10% HCl only: no carbonate, Fe^{+++} or Fe^{++} present.

General Comment: no signs exist for reconstruction of original Mezzano salt valley and of Ferrara salt valleys, in general. It is certain, however, that shoals and banks emerged alternately, under vegetative cover, including forest, particularly of coastal type. Poplars and alders (*Populus* sp. and *Alnus* sp.), R-390, 392α, and 393-395 samples, dated A.D. 330-A.D. 490, belong to coastal facies of *Quercetum-Carpinetum* vegetation, which characterized Po R. valley in Sub-Atlantic. The more microthermic birch (*Betula* sp.), R-391α, dated A.D. 60 may be regarded as relict of older forest vegetation, *i.e., Quercetum* with *Abies* and *Alnus* of Sub-Boreal. Evidence of such vegetation still exists in sheltered stations, e.g., in nearby Euganei Mts., whereas other areas have relicts of Mediterranean-type thermophilic and xerophilic vegetation (Lona, 1957; Marchesoni, 1959; Marchesoni and Paganelli, 1966; Govi, 1967; Montanari, 1969).

Valle Giralda series

Wood, subfossil (and modern) stumps and trunks thought to be found during reclamation of Giralda salt valley, between mouth of Volano Po and Goro Po, close to shoreline, ca. 15 km N Comacchio, prov. Ferrara, Emilia (44° 49′ N Lat, 12° 10′ E Long). Coll. 1964 in a wood lot by P. Stampi and subm. 1968 by E. Francini Corti. Samples *in situ* were very numerous, covered a large area, buried to ca. 1 m depth, and were discovered during tilling. Because of their abundance, stumps and trunks are used by local people for firewood (Stampi, 1966, and pers. commun.).

R-386A. Valle Giralda 1 — **740 ± 50**
A.D. 1210
$\delta C^{13} = -26.4‰$

R-386. Valle Giralda 1 — **750 ± 50**
A.D. 1200
$\delta C^{13} = -27.4‰$

Well-preserved wood (cfr. *Fagus* sp.). *Comment*: R-386A was not pretreated, R-386 was pretreated with 10% HCl. *Fagus* sp. likely to belong to relicts of Sub-Boreal forest vegetation which, due to more oceanic and less microthermic character of *Fagus*, as compared to *Betula*, are still more frequent today and widespread in areas with Mediterranean vegetation. Ca. A.D. 1000, region's climate appears to have been favorable for a moderate local re-expansion of *Fagus* sp. (see refs. in Valle del Mezzano, *General Comment*).

R-387. Valle Giralda 2 — **<100**
$\delta C^{13} = -26.2‰$

Well-preserved wood (*Quercus* cfr. *ilex*). *Comment*: see R-389 *Comment.*

R-388. Valle Giralda 3 — **<100**
$\delta C^{13} = -26.0‰$

Well-preserved wood (*Quercus* cfr. *ilex*). *Comment*: see R-389 *Comment.*

R-389A. Valle Giralda 4 **<100**
$\delta C^{13} = -28.0‰$

R-389. Valle Giralda 4 **<100**
$\delta C^{13} = -25.9‰$

Well-preserved wood (*Quercus* sp. *non ilex*). *Comment*: R-389A was given no pretreatment; R-389 was given pretreatment with 10% HCl. Wood R-387 -389, believed subfossil, belong instead to present species from natural forests of region (Stampi, 1967). Sampling error occurred because samples were taken from wood pile at Bosco Mesola village, Giralda V., where reportedly exclusive subfossil wood coll. in preceding years in valley had been stored (Stampi, pers. commun.).

Colle di Pianciano series

Two humified layers (paleosols), respectively at top and base of layered calcitic-fluoritic lacustrine sediment, average thickness 6 m, probably related to late-volcanic hydrothermal activity; interbedded in upper part of La Storta tuff in Sabatini Mts. volcanic region, Colle di Pianciano, ca. 4 km SW Bracciano, Rome (42° 04′ 12″ N Lat, 12° 08′ 58″ E Long) (Spada, 1969; Mattias and Ventriglia, 1970). Coll. and subm. 1969 by M. Fornaseri, Ist. Geochim., Univ. of Rome.

R-702. Colle di Pianciano 1 **>41,000**
$\delta C^{13} = -25.8‰$

Humic acids extracted from humified layer at top of calcitic-fluoritic deposit.

R-701. Colle di Pianciano 2 **28,900 ± 1300**
26,950 B.C.
$\delta C^{13} = -24.1‰$

Humic acids extracted from humified layer at base of calcitic-fluoritic deposit. *Comment*: if compared with R-702, age should show probable contamination of lower humified layer by younger humic material.
General Comment: samples pretreated with 6N HCl; humic acids extracted with 6% NH_4OH and precipitated again by dilute HCl. Calcitic-fluoritic sediment is being studied for correlation with similar sediments from N Rome area (Masi and Turi, 1971). When dating was requested, age of La Storta tuff was unknown. Recently, biotite from latter was dated both by K/Ar (Ambrosetti *et al.*, 1969) and fission tracks (Bonadonna and Bigazzi, 1969): its age lies between 0.225 ± 0.060 million yr and 0.280 ± 0.030 million yr, confirming R-702 date and supposed contamination of R-701.

Campi Flegrei, Napoli

The following series include a 1st group of systematic dates of carbonized wood and humified layers of paleosols interbedded in pyroclasts of Campi Flegrei volcanic region characterized by numerous volcanic vents and complex deposits of tephra. As well known, the long activity of this volcanic system started presumably in Pliocene (Archiphlegrean)

(Rittmann *et al.*, 1950) continuing through Pleistocene and historical times (Mt. Nuovo eruption A.D. 1538). Main periods of activity were recognized by De Lorenzo (1904), and redefined by Rittman (1950). Humified layers, sampled chiefly along sections exposed in phlegrean tuff and pozzolana quarries, are mostly interbedded with pyroclasts belonging to well-identified and significant eruptive events, sometimes extending over vast areas. Samples were pretreated with 8N HCl; humic acids extracted with 6% NH_4OH and precipitated again by dilute HCl. Carbonized wood and humified layers coll. and subm. 1969-1970 by M. Fornaseri, C. Cortesi, and G. Calderoni, Ist. Geochim., Univ. of Rome, and A. Scherillo and E. Franco, Ist. Mineral., Univ. of Naples.

1st Phlegrean period

R-567. Cava dell'Arciprete **>40,000**
$\delta C^{13} = -24.4‰$

Charcoal, 1.5 m above base of "Campanian gray tuff" yellow facies, Arciprete quarry, 77.8 km along state rd. no. 7 bis, prov. Avellino, Campania (40° 54′ 13″ N Lat, 14° 45′ 12″ E Long). *Comment*: sample pretreated with only 5% HCl because humic charcoal was completely soluble in 6% NH_4OH.

Cava Crescenzo series

Carbonized wood and humified layer from Crescenzo tuff quarry, near church of St. Anna, ca. 7 km N Nocera Inferiore, prov. Salerno, Campania (40° 46′ 42″ N Lat, 14° 38′ 58″ E Long).

R-565. Cava Crescenzo I-1 **>40,000**
$\delta C^{13} = -24.7‰$

Carbonized wood, fragment of little trunk or branch, from pumice-lapilli layer, ca. 50 cm thick, underlying "Campanian gray tuff". *Comment*: only 2% HCl pretreatment because humic charcoal completely soluble in 6% NH_4OH.

R-577A. Cava Crescenzo I-2 **33,000 ± 1400**
31,050 B.C.
$\delta C^{13} = -24.5‰$

R-716. Cava Crescenzo I-2 **27,800 ± 800**
25,850 B.C.
$\delta C^{13} = -24.6‰$

R-716A. Cava Crescenzo I-2 **29,300 ± 1000**
27,350 B.C.
$\delta C^{13} = -24.9‰$

Humic acids from humified layer underlying pumice-lapilli layer. *Comment*: humic acids extracted from samples of same layer coll. at 3 different sites of quarry. Owing to date of overlying R-565 charred wood, contamination of old humified layer by younger humic materials can be inferred.

R-717. Cava Crescenzo I-2 **26,900 ± 700**
24,950 B.C.
$\delta C^{13} = -23.8‰$

Small fragments of charred material from above humified layer and gathered from R-716 and -716A. *Comment*: thorough separation of charred fragments from humic material was not possible. Sample pretreated with only 5% HCl since humic charcoal was completely soluble in 6% NH_4OH. Contamination by younger humic substances must be assummed.

General Comment on 1st Phlegrean period: dates relate exclusively to the "Campanian gray tuff" or "Campanian ignimbrite," which constitutes the main formation of ancient Phlegrean activity (Ist. Min., Univ. of Naples, 1968). As expected, age, at least in lower part, exceeds limits of our counting system (see R-567 and 565). Dates for underlying humified layer, owing to assumed contamination, are minimum.

Three K/Ar dates are available prior to 2nd period: two, measured by Gasparini, 0.22 ± 0.06 and 0.19 ± 0.05 million yr (Gasparini and Adams, 1969; Civetta *et al.*, 1970), relate to Piperno formation at Torre di Franco, described by Rittmann *et al.* (1950) underlying Neapolitan yellow tuff of 2nd period. Curtis reported for Sorrento black tuff, belonging to "Companian gray tuff" formation, K/Ar age 30,000 yr (Curtis, 1966). Alleged report attributed by this author to A. G. Segre about C^{14} date of 35,000 yr measured by Rome lab. is untrue; tuff was not dated by this lab. before now.

2nd Phlegrean period

Humified layers interbedded in lower pyroclastic units of 2nd period from various localities in E suburb of Naples area (Scherillo and Franco, 1967).

Vallone dei Ponti Rossi quarries series

Quarries along Ponti Rossi Valley, E suburb of Naples expose tephra of all 3 Phlegrean periods (Scherillo, 1955).

Ponti Rossi Cava Ovest series

Humified layers with embedded "tasso", local name for a typical guide layer composed by thin interbedded levels of lapilli and pumices, in lower unit of 2nd period from sec. of W quarry, Ponti Rossi Valley, E suburb of Naples (40° 52′ 30″ N Lat, 14° 15′ 43″ E Long) U. T. M. system 33T VF 379 254.

R-584. Ponti Rossi, Cava Ovest II-1 **11,910 ± 130**
9960 B.C.
$\delta C^{13} = -26.0‰$

Humic acids from layer overlying "tasso".

R-583. Ponti Rossi, Cava Ovest II-2 **11,770 ± 120**
9820 B.C.
$\delta C^{13} = -26.1‰$

Humic acids from layer underlying "tasso".

R-585. Ponti Rossi, Cava Grande II-1 **11,830 ± 120**
9880 B.C.
$\delta C^{13} = -26.2‰$

Humic acids from humified layer overlying "tasso", lower unit of 2nd period in sec. of Cava Grande, close to W quarry, Ponti Rossi valley. *Comment*: R-583 -585 related to "tasso" are consistent; see also R-705 and -706, this list.

Capodichino, Via F. Provenzale series

Sec. of relict spur, ca. 4 m, in Via F. Provenzale, crossroad of Calata di Capodichino, E suburb of Naples (40° 52′ 30″ N Lat, 14° 16′ 04″ E Long) U.T.M. system 33T VF 384 254, shows under vegetal soil, 5 humified layers thought to be interbedded in lower tephra of 2nd period and perhaps partly underlying them. Only layers 1, 3, and 4 have been dated.

R-580. Via F. Provenzale II-1 **12,280 ± 120**
10,330 B.C.
$\delta C^{13} = -26.6‰$

Humic acids from upper Layer 1.

R-581. Via Francesco Provenzale II-3 **12,280 ± 100**
10,330 B.C.
$\delta C^{13} = -26.3‰$

Humic acids from intermediate Layer 3.

R-582. Via F. Provenzale II-4 **12,680 ± 100**
10,730 B.C.
$\delta C^{13} = -26.0‰$

Humic acids from intermediate Layer 4.

R-578. Capodichino, Cava Alderisio **11,820 ± 120**
9870 B.C.
$\delta C^{13} = -26.0‰$

Middle humified layer from sec. of relict spur, ca. 2 m, in Alderisio quarry, Alderisio crossroad of Calata di Capodichino, E suburb of Naples (40° 52′ 13″ N Lat, 14° 16′ 15″ E Long) U.T.M. system 33T VF 386 249. Sec. exposes 3 humified layers interbedded in pumice of lower units of 2nd period, overlying tephra of 1st period.

Pesole d'Arpino, Cava Masseria Ferrara series

Secs. in Cava Masseria Ferrara e Jorio, a quarry at Pesole d'Arpino, E suburb of Naples (40° 52′ 57″ N Lat, 14° 17′ 47″ E Long) U.T.M. system 33T VF 408 262, show products of 3rd and 2nd Phlegrean periods (Scherillo, 1955).

R-704. Cava Masseria Ferrara II-O **10,740 ± 90**
8790 B.C.
$\delta C^{13} = -26.6‰$

Humic acids from humified layer underlying Agnano products of 3rd period and overlying upper gray pozzolana of 2nd period; coll. from end sec. of quarry.

R-705. Cava Masseria Ferrara II-2 **11,650 ± 90**
9700 B.C.
$\delta C^{13} = -26.1‰$

Humic acids from humified layer underlying "tasso"; sample coll. S side of spur in W sec. of quarry. *Comment*: see R-706, below.

R-706. Cava Masseria Ferrara II-2 **11,800 ± 100**
9850 B.C.
$\delta C^{13} = -25.7‰$

Humic acids from humified layer underlying "tasso" coll. N side of spur in W sec. of quarry. *Comment*: R-705 and -706 agree with ages of humified layers related to "tasso" coll. in secs. of Ponti Rossi quarries (see R-583 -585, this list).

General Comment on 2nd Phlegrean period: dates referring to humified layers interbedded in lower pyroclasts of 2nd period are consistent and date back its early eruptive activity from 12,800 to 11,600 B.P. R-704 is referred to upper part of gray pozzolana of 2nd period and is, therefore, consistent with ages of lower part. This date also agrees with one for Neapolitan yellow tuff, most widespread product of main phase of 2nd period (Scherillo, 1950): Pi-75, 10,090 ± 215 (R., 1961, v. 3, p. 104; Lucini and Tongiorgi, 1959); measurements were made on calcareous fossil wood from facies of Neapolitan yellow tuff during drilling of tunnel through Vomero, Naples.

3rd Phlegrean period

To the 3rd period of Phlegrean activity belong many recognizable vents, e.g., volcanoes of Agnano, Solfatara, Averno, Astroni, Senga, the most recent being Monte Nuovo of historic age. Field observations indicate some well-ascertained sequences of activity but a general relative chronology cannot be established. Palethnologic evidence, from potsherds found in humified layer underlying Astroni ash places eruption after Eneolithic (Perozzi, 1949). Senga eruption, younger than Astroni but still prehistoric, could be between 1500 and 400 B.C. Many humified layers are interbedded in pyroclasts of 3rd period.

R-703. Cava Masseria Ferrara III-1 **4360 ± 50**
2410 B.C.
$\delta C^{13} = -25.4‰$

Humic acids from humified layer underlying pumice of Astroni volcano, upper part of 3rd period in quarry at Pesole d'Arpino, E suburb of Naples (see also Pesole d'Arpino series, Phlegrean 2nd period). *Comment*: sample coll. at end sec. of quarry. Date is consistent with other humified layers underlying Astroni products (see R-596 and 592, this list).

R-682. Via Terracina, Napoli **4000 ± 50**
2050 B.C.
$\delta C^{13} = -25.3‰$

Carbonized wood from small outcrop of pozzolana and pumice at Via Terracina, Nuovo Rione S. Paolo, W suburb of Naples (40° 50′ 22″ N Lat, 14° 11′ 12″ E Long) U.T.M. system 33T VF 315 215. *Comment*: provenance of formation doubtful; date suggests Astroni volcano.

R-708α. Astroni **3520 ± 50**
1570 B.C.
$\delta C^{13} = -23.9‰$

Carbonized wood, fragment of small trunk or branch, from pumice and pozzolana quarry in N side of well-preserved Astroni crater, Campi Flegrei (40° 51′ 15″ N Lat, 14° 08′ 50″ E Long) U.T.M. system 33T VF 282 232. *Comment*: carbonized wood is scattered through Astroni products. Another carbonized branch from Astroni crater pyroclasts dated at Gif lab., unnumbered sample, 3950 ± 120 (Delibrias *et al.*, 1969).

Rione Mofete, Trattoria del Tedesco series

Road cut, ca. 200 m from Trattoria del Tedesco upward, Rione Mofete-Scalandrone, W suburb of Naples (40° 49′ 44″ N Lat, 14° 04′ 33″ E Long) U.T.M. system 33T VF 221 204, reveals 4 humified layers.

R-591. Rione Mofete, Trattoria del Tedesco III-1 **3700 ± 50**
1750 B.C.
$\delta C^{13} = -25.7‰$

Humic acids from upper Layer 1 between Averno and Astroni (?) products. *Comment*: C^{14} age could confirm attribution to Astroni of underlying layer (see also R-597, this list).

R-592. Rione Mofete, Trattoria del Tedesco III-2 **4520 ± 50**
2700 B.C.
$\delta C^{13} = -26.2‰$

Humic acids from intermediate Layer 2 underlying Astroni (?) cinder layer. *Comment*: C^{14} date is consistent with Astroni date of overlying layer (see also R-596 and R-703, this list).

R-593. Rione Mofete, Trattoria del Tedesco III-3 **5270 ± 50**
3320 B.C.
$\delta C^{13} = -25.9‰$

Humic acids from intermediate Layer 3 overlying yellow unconsolidated tuff.

R-594. Rione Mofete, Trattoria del Tedesco III-4

8400 ± 70
6450 B.C.
$\delta C^{13} = -25.9‰$

Humic acids from lower Layer 4 overlying yellow consolidated tuff. *Comment*: date is oldest available for products of 3rd period.

R-595. Rione Mofete, Villa Jannon

5880 ± 50
3930 B.C.
$\delta C^{13} = -24.1‰$

Humic acids from lower of 2 humified layers in quarry at Villa Jannon, Rione Mofete, W suburb of Naples (40° 49′ 27″ N Lat, 14° 04′ 17″ E Long) U.T.M. system 33T VF 218 199. *Comment*: 2 humified layers are interbedded in pyroclasts of doubtful provenance. Date compares with R-593 humified layer in Trattoria del Tedesco series.

Bivio di Quarto series

Sec. ca. 4 m, at junction of Domiziana and Quarto Rds., W Naples (40° 51′ 01″ N Lat, 14° 04′ 18″ E Long) U.T.M. system 33T VF 218 228, reveals 2 humified layers.

R-597. Bivio di Quarto III-1

3820 ± 50
1870 B.C.
$\delta C^{13} = -24.4‰$

Humic acids from upper Layer between Averno and Astroni (?) products. *Comment*: C^{14} age could confirm attribution to Astroni volcano of underlying layer (see also R-591, this list).

R-596. Bivio di Quarto III-2

4720 ± 50
2770 B.C.
$\delta C^{13} = -25.6‰$

Humic acids from lower Layer underlying Astroni (?) products. *Comment*: C^{14} age is consistent with Astroni date of overlying layer (see also R-592 and R-703, this list).

General Comment on 3rd Phlegrean period: dates range from 3500 to 8500 B.P. Carbonized wood in Astroni products place eruptions between 3500 and 4000 B.P. (R-682, R-708α, and Gif samples). Humified layers correlated with Astroni products show consistent ages (R-591, R-597) as do humified layers underlying Astroni products (R-592, R-596, and R-703). In Rione Mofete series, products of 3rd period whose provenance has not yet fully established date back to ca. 8500 B.P. (R-591-R-594).

References

Alessio, M., Bella, F., Bachechi, F., and Cortesi, C., 1967, University of Rome carbon-14 dates V: Radiocarbon, v. 9, p. 346-367.

Alessio, M., Bella, F., and Cortesi, C., 1964, University of Rome carbon-14 dates II: Radiocarbon, v. 6, p. 77-90.

Alessio, M., Bella, F., Cortesi, C., and Graziadei, B., 1968, University of Rome carbon-14 dates VI: Radiocarbon, v. 10, p. 350-364.

Alessio, M., Bella, F., Cortesi, C., and Turi, B., 1969, University of Rome carbon-14 dates VII: Radiocarbon, v. 11, p. 482-498.

Alessio, M., Bella, F., Improta, S., Belluomini, G., Cortesi, C., and Turi, B., 1970, Report on the equipments and the activities of Rome University's carbon-14 dating laboratory: Quaternaria, v. 13, p. 357-376.

Ambrosetti, P., Bonadonna, F. P., and Tolomeo, L., 1969, Studi sul Pleistocene del Lazio. VI–Una nuova data per la Campagna Romana: Soc. Geol. Italiana Boll., v. 88, p. 3-10.
Atzeni, E., 1967, Tombe a forno di cultura Monte Claro nella Via Basilicata di Cagliari: Riv. Sci. Preistoriche, v. 22, p. 177-178.
Barfield, L. H., 1968, Una nuova datazione assoluta per la stazione di Molina di Ledro–Considerazioni sulla cronologia della cultura di Polada: Riv. Sci. Preistoriche, v. 23, p. 261-263.
Battaglia, R., 1943, La palafitta di Ledro nel Trentino: Mus. Storia naturale della Venezia Tridentina Mem., v. 7, p. 3-63.
Bonadonna, F. P. and Bigazzi, G., 1969, Studi sul Pleistocene del Lazio. VII–Età di un livello tufaceo del bacino diatomitico di Riano stabilita con il metodo delle tracce di fissione: Soc. Geol. Italiana Boll., v. 88, p. 439-444.
Bray, W., 1963, The Ozieri culture of Sardinia: Riv. Sci. Preistoriche, v. 18, p. 155-190.
Caputo, G., 1961, La tradizione etrusca del Grifo e l'emblema di Perugia: Studi Etruschi, v. 29, p. 417-422.
Castaldi, E., 1971, Considerazioni su una datazione con il carbonio-14 della Grotta del Guano o di Gonogusola, ms. in preparation.
Cellini, Benvenuto, 1568, Intorno alle otto principali arti dell'Oreficeria e in materia dell'arte della Scultura, trattati due: Firenze, Panizzi e Peri.
Civetta, L., Gasparini, P., and Adams, J. A. S., 1970, Geochronology and geochemical trends of volcanic rocks from Campania S Italy: Eclogae geol. Helveticae, v. 63, p. 63-68.
Contu, E., 1964, Grotta del Guano (Oliena): Riv. Sci. Preistoriche, v. 19, p. 316.
——— 1966, Grotta del Guano (Oliena): Riv. Sci. Preistoriche, v. 21, p. 434.
——— 1969, La Sardegna prenuragica e nuragica: *in*: Sardegna, Electa.
Cornaggia Castiglioni, O., 1967, Quattro eccezionali bronzi preistorici italiani: i diademi enei di Molina di Ledro nel Trentino: Riv. Sci Preistoriche, v. 22, p. 181-267.
Coursaget, J. and Le Run, J., 1966, Gif-sur-Yvette natural radiocarbon measurements I: Radiocarbon, v. 8, p. 128-141.
Cremonesi, G., 1965, Il villaggio di Ripoli alla luce dei recenti scavi: Riv. Sci. Preistoriche, v. 20, p. 85-155.
——— 1967, I materiali provenienti dal territorio di Vho conservati nel Museo Civico di Cremona: Soc. Toscana Sci. Nat. Mem. Atti, v. 74, p. 375-409.
Curtis, G. H., 1966, The problem of contamination in obtaining accurate dates of young geologic rocks, *in*: Shaeffer, O. A. and Zähringer, J. (eds.), Potassium argon dating, Berlin, Springer.
Delibrias, G., Guillier, M. T., and Labeyrie, J., 1970, Gif natural radiocarbon measurements V: Radiocarbon, v. 12, p. 421-443.
Delibrias, G., Kieffer, G., and Pelletier, H., 1969, Datation par la méthode du carbon-14 de l'Astroni, volcan des Champs Phlégréens (Campanie): Acad. sci. [Paris] Comptes rendus, v. 269, p. 2070-2071.
De Lorenzo, G., 1904, L'attività vulcanica dei Campi Flegrei: Accad. Sci. Fis. e Mat. Rend., Napoli, s. 3, v. 10, p. 203-221.
Ferrara, G., Fornaca-Rinaldi, G., and Tongiorgi, E., 1961, Carbon-14 dating in Pisa-II: Radiocarbon, v. 3, p. 99-104.
Ferrarese Ceruti, M. L., 1967, Domus de Janas in località Molimentos (Benetutti-Sassari): Paletnol. Italiana Bull., n.s. 18, v. 76, p. 96-97.
Ferri-Ricchi, L., 1969, Come nuova l'oneraria dell'Elba: Mondo Sommerso, v. 11, p. 989-995.
Fioravanti, A. and Ferri-Ricchi, L., 1970, Naufragio all'Elba: Atlante, v. 11, no. 62, p. 76-83.
Gasparini, P. and Adams, J. A. S., 1969, K/Ar dating of Italian Plio-Pleistocene volcanic rocks: Earth and Planetary Sci. Letters, v. 6, p. 225-230.
Govi, G., 1967, Identificazione del legno di palafitte nella necropli di Spina: Natura e Montagna, s. 3, v. 7, no. 1-2, p. 60-62.
Guerreschi, G., 1967, La Lagozza di Besnate e il Neolitico superiore padano: Como, Tipografia A. Noscola.
Ist. Mineralogia, Univ. di Napoli, 1968, La pianura campana e il suo tufo: XXV congr. Soc. Italiana di Mineral. e Petrol., Naples, 7-11 Oct. 1968.
Lawn, Barbara, 1970, University of Pennsylvania radiocarbon dates XIII: Radiocarbon, v. 12, p. 577-589.
Lilliu, G., 1967, La civiltà dei Sardi dal Neolitico all'età dei Nuraghi: ERI-Ed. RAI, Radio televisione italiana, 2nd ed., Torino.

Lollini, D., 1961, Ancarano di Sirolo: Riv. Sci Preistoriche, v. 16, p. 268.
Lona, F., 1957, I depositi lacustri Euganei, archivio paleontologico del tardo glaciale e del periodo postglaciale: Biogeog. Adriatica Mem., v. 5, p. 1-11.
Lucini, P. and Tongiorgi, E., 1959, Determinazione con il carbonio-14 di un legno fossile dei Campi Flegrei (Napoli): Studi e Ricerche della Div. Geomineraria C.N.E.N., v. 2, p. 97-99.
Marabelli, M., 1971, Esami chimici e mineralogici riguardanti il Grifo e il Leone ornanti il portale del Palazzo dei Priori di Perugia: ms. in preparation.
Marchesoni, V., 1959, Ricerche pollinologiche in sedimenti torbosi della Pianura Padana: Nuovo Gior. Bot. Italiano, n.s., v. 66, p. 336-339.
Marchesoni, V. and Paganelli, A., 1966, Tavola cronologica del Quaternario: Studi Trentini di Sci. Nat., s. B, v. 43, p. 79-188.
Masi, U. and Turi, B., 1971, La composizione isotopica dell'ossigeno e del carbonio del carbonato presente nei depositi calcitico-fluoritici pleistocenici dei Colli della Farnesina (Roma) e di Colle di Pianciano (Bracciano): Periodico di Mineral., in press.
Mattias, P. P. and Ventriglia, U., 1970, La regione vulcanica dei Monti Sabatini e Cimini: Soc. Geol. Italiana Mem., v. 9, p. 331-384.
Mohen, J. P., 1967, Notes préliminaires à propos des fouilles du camp néolithique de "Chez Reine" commune de Semussac (Charente-Maritime): Soc. préhistorique française Bull., v. 64, p. 469-482.
Montanari, F. L., 1969, Lineamenti della vegetazione del litorale Ferrarese e Ravennate: Natura e Montagna, s. 3, v. 9, no. 4, p. 25-34.
Parazzi, A., 1891, Stazione dei Lagazzi fra Vho e S. Lorenzo Guazzone: Paletn. Ital. Bull., v. 18, p. 1-33.
Perozzi, A., 1949, Ritrovamento di resti dell'Eneolitico in provincia di Napoli: Ricerca Sci., v. 19, p. 1025.
Pinna, G., 1966-1967, Statuina fittile di Dea Madre de Puisteris (Mogoro-Cagliari): Studi Sardi, v. 20, p. 68-73.
Radmilli, A. M., 1967, Isola di Pantelleria: Riv. Sci. Preistoriche, v. 22, p. 452.
Rittmann, A. et al., 1950, Rilievo geologico dei Campi Flegrei: Soc. Geol. Italiana Boll., v. 69, p. 117-362.
Scherillo, A., 1950, Petrografia chimica dei tufi flegrei. I—Il tufo giallo: Accad. Sci. Fis. e Mat. Rend. della Soc. Naz. di Sci. Lettere e Arti di Napoli, s. 4, v. 17, p. 343-356.
——— 1955, Petrografia chimica dei tufi flegrei. II—Tufo giallo, mappamonte, pozzolana: Accad. Sci. Fis. e Mat. Rend. della Soc. Naz. di Sci., Lettere e Arti di Napoli, s. 4, v. 22, p. 345-370.
Scherillo, A. and Franco, E., 1967, Introduzione alla carta stratigrafica del suolo di Napoli: Accad. Pontaniana Atti, n.s., v. 26, p. 27-38.
Shotton, F. W., Blundell, D. J., and Williams, R. E. G., 1968, Birmingham University radiocarbon dates II: Radiocarbon, v. 10, p. 200-206.
Spada, A., 1969, Il giacimento di fluorite e baritina esalativo-sedimentario in "facies" lacustre intercalato nei sedimenti piroclastici della zona di Castel Giuliano in prov. di Roma: Industria Mineraria, s. 2, v. 20, p. 501-518.
Stampi, P., 1966, Le antiche selve che vegetavano sul litorale ferrarese (Nota preventiva): Bot. Italiano Gior., v. 73, p. 337-339.
——— 1967, Il gran bosco della Mesola (Ferrara): notizie storiche, floristiche e geobotaniche: Annali Bot., v. 28, p. 599-612.
Stuckenrath, R., Jr., Coe, W. R., and Ralph, E. K., 1966, University of Pennsylvania radiocarbon dates IX: Radiocarbon, v. 8, p. 348-385.
Theophilus, 1140?, De diversis artibus, Nelson's Medieval Tests, 1961.
Thomas, H. F., 1965, The archaeological chronology of Northwestern Europe, *in*: Ehrich, R. W. (ed.), Chronologies of old world archaeology: Chicago, University of Chicago Press.
Tozzi, C., 1968, Relazione preliminare sulla I e II campagna di scavi a Pantelleria: Riv. Sci. Preistoriche, v. 23, p. 315-388.
Vannoccio Biringuccio, 1540, De Pirotechnia, Venezia.
Vasari, Giorgio, 1568, Le vite de' più eccellenti pittori, scultori e architetti: Giunti, Firenze, 2nd ed.

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REHOVOT RADIOCARBON MEASUREMENTS I

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The Rehovot Radiocarbon Laboratory was established in 1968, as an extension of a low-level tritium laboratory, which has been in operation many years. Intended to be a supporting facility in geohydrological studies, the laboratory now offers general services in carbon dating.

For measurements, we use proportional gas counting of ethane, at 2100 torr. The sample counter is a modified RCL counter, of 1.1 L volume; it is operated at 5600 volts. The counter is surrounded, respectively, by a Johnston GRC-13 anticoincidence guard counter, 2 cm old lead, 10 cm boron loaded paraffin, and 25 cm pre-2nd-world-war steel. Samples are counted in four channels, in anticoincidence with the guard counter. The four channels count disintegrations between the following energies: channel 1: 1 to 18 keV, channel 2: 18 to 59 keV, channel 3: 59 to 155 keV, and channel 4: above 155 keV. C^{14} is counted in the two middle channels; channel 1 is rejected against possible tritium contamination, and channel 4 is used to detect Radon contamination. The working point is determined by coincidence counting of charged cosmic particles: the ratio of count rates in the two sample channels is adjusted to 1.

The acquisition and processing of counting data is done automatically by an on-line computer (Carmi and Ashkenazi, 1970).

Background samples are prepared from alabaster or from anthracite. The average of 21 background measurements was $3.77 \pm .08$ cpm. The calibration standard is the NBS oxalic acid standard. The average of 9 standard measurements was 24.40 ± 0.11 cpm (after multiplication by .95). According to convention, the half life used is 5568 years.

The chemical procedure is, first, to prepare the sample so that it can be converted to CO_2. Next, solid or dissolved carbonates are treated by acid, and organic matter is combusted in dry oxygen stream. The CO_2 is purified, and converted to ethane in the following steps: carbidization of lithium (Barker, 1953), hydrolysis to acetylene, and hydrogenation to ethane over palladium catalyst (Bainbridge *et al.*, 1961).

The facility was established with the aid of a grant by the Ford Foundation. C^{13} analyses are performed on an M-86 mass-spectrometer, donated by the Volkswagen Stiftung.

SAMPLE DESCRIPTIONS

I. ATMOSPHERIC SAMPLES

Atmospheric CO_2 is collected weekly at Rehovot, (1460-1315) local grid. Collection is by exposure of concentrated NaOH solution to the

* Left in 1969.

atmosphere. The results of 23 of the samples, collected between 1968 and 1970, are given below. Before 1968, several Rehovot samples were measured by R. Nydal of Trondheim. *Comment*: (I.C.) decrease in the concentrations, beginning in spring 1969, is definitely noticeable.

Sample no.	Exposure dates	$\delta C^{14}\%$
RT-122	March 18, 1968–March 22, 1968	62.2 ± 1.7
RT-123	March 25, 1968–March 31, 1968	58.1 ± 1.2
RT-124	April 15, 1968–April 21, 1968	57.1 ± 1.2
RT-125	April 29, 1968–May 5, 1968	57.1 ± 0.9
RT-126	July 7, 1968–July 12, 1968	55.7 ± 1.2
RT-127	July 22, 1968–July 28, 1968	61.1 ± 1.1
RT-157	Sept. 16, 1968–Sept. 20, 1968	60.7 ± 0.3
RT-158	Sept. 30, 1968–Oct. 4, 1968	67.1 ± 1.3
RT-159	Oct. 15, 1968–Oct. 18, 1968	59.6 ± 1.4
RT-160	Oct. 28, 1968–Nov. 1, 1968	58.8 ± 1.6
RT-161	Nov. 11, 1968–Nov. 17, 1968	60.4 ± 0.9
RT-162	Dec. 9, 1968–Dec. 13, 1968	57.9 ± 1.7
RT-163	Jan. 6, 1969–Jan. 10, 1969	58.7 ± 1.7
RT-164	Feb. 17, 1969–Feb. 21, 1969	59.1 ± 1.4
RT-166	April 14, 1969–April 20, 1969	60.4 ± 1.5
RT-199	June 16, 1969–June 22, 1969	61.2 ± 1.2
RT-200	July 21, 1969–July 25, 1969	59.3 ± 1.5
RT-201	Aug. 18, 1969–Aug. 22, 1969	57.2 ± 1.5
RT-202	Sept. 29, 1969–Oct. 1, 1969	57.8 ± 1.7
RT-203	Oct. 24, 1969–Oct. 24, 1969	57.6 ± 1.5
RT-204	Nov. 11, 1969–Nov. 21, 1969	53.4 ± 1.5
RT-205	Dec. 15, 1969–Dec. 19, 1969	55.4 ± 1.4
RT-206	Jan. 19, 1970–Jan. 23, 1970	45.5 ± 1.3

II. WATER SAMPLES

Water samples are collected for a preliminary survey of the C^{14} concentration distribution in Israel waters, and for possible age estimations. Samples are brought in fiberglass containers from field to laboratory, where the carbonates are precipitated as $BaCO_3$. The coordinates are given in the local grid.

Ages are calculated after Ingerson and Pearson (1964), with $\delta C^{13}{}_{ls}$ = 0 in the mother rock. They should, therefore, be regarded with reservations. *Comment* (I.C.): in the 2 cases that the calculation gave more than 100% concentration, results are supported by tritium data, which shows that the samples contain water components, or are completely, of post-thermonuclear origin.

Sample	Name	Type	Coordinates (local grid)	Depth (m)
	a. Northern Arava (S of the Dead Sea)			
RT-101	Tamar 7	well	0458-1805	345
RT-108	Zin 6	well	0440-1833	50
RT-117	Tamar 3	well	0433-1787	76
RT-131	Tamar 3	well	0433-1787	76
RT-156	Neot Hakikar	well	0388-1863	73
RT-193	Tamar 3	well	0433-1787	400
	b. Southern Arava (N of Eilat)			
RT-107	Yotvata 2	well	9225-1544	50
RT-112	Timna 5	well	9116-1517	116
	c. Negev			
RT-115	Dimona 1	well	0496-1624	89
RT-129	Dimona 1	well	0496-1624	89
RT-136	Beer Sheva 3	well	0716-1289	267
RT-137	Omer	well	0750-1348	539
RT-138	Hatzerim	well	0720-1270	238
RT-196	Makhtesh 3	well	0400-1710	763
	d. Sinai			
RT-140	Nahel	well	9260-0290	15
RT-195	Ein Fourtaga	spring	8290-7070	
	e. Dead Sea Coast (N)			
RT-157	Ein Feshcha	spring	1250-1940	
RT-155	Ein Feshcha	spring	1250-1940	
	f. Central Lowlands			
RT-152	Lod 23	well	1530-1420	276
RT-153	Lod 26	well	1540-1430	76
RT-194	Rosh Ha'ayin	well	1660-1425	119
	g. Tel-Aviv			
RT-167	Reading	well	1680-1290	32
RT-168	Gordon	well	1640-1280	60
	h. Lake Tiberias area			
RT-103	Ein Noon	spring	2497-1982	
RT-106	Hamat Gader	spring	2327-2129	
RT-109	Tiberias Hot Springs	spring	2414-2017	
RT-154	Kineret 8	well	2013-2517	715

Sampling date	Sampled by	δC^{13}‰	C^{14} (% modern)	Age (B.P.)
		a. Northern Arava (S of the Dead Sea)		
March 68	E. Mazor*	− 7.9	4.7± .5	15,300±900
April 68	E. Mazor	−11.3	4.2± .4	19,200±800
Nov. 68	E. Mazor	− 8.4	5.3±1.0	14,800±500
Jan. 69	E. Mazor	− 8.4	5.2± .4	14,900±600
July 69	E. Mazor	−10.4	36.9± .4	980±90
Jan. 70	E. Mazor	− 7.9	.9± .4	28,500±350
		b. Southern Arava (N of Eilat)		
April 68	E. Mazor	− 8.9	6.9± .5	13,200±600
March 68	E. Mazor	− 4.2	2.2± .6	16,300±2200
		c. Negev		
Nov. 68	E. Mazor	−11.8	24.0± .5	5500±150
Jan. 69	E. Mazor	−11.8	24.3± .4	5300±130
Feb. 69	E. Mazor	−13.7	20.0± .9	8100±350
Feb. 69	E. Mazor	−13.7	38.5± .4	2800±100
Feb. 69	E. Mazor	−13.7	18.2± .4	8900±200
July 69	E. Mazor	−14.3	3.9± .4	22,000±1000
		d. Sinai		
Feb. 69	E. Mazor	−12.2	44.8± .7	690±130
Dec. 69	A. Issar**	− 9.8	64.0±1.0	(163%±2.6)
		e. Dead Sea Coast (N)		
March 69	E. Mazor	−12.2	33.1±1.2	3100±300
May 69	R. Schlesinger*	−12.2	35.6± .4	2500±90
		f. Central Lowlands		
May 69	Tahal†	−16.6	45.0± .4	3100±70
May 69	Tahal	−16.6	33.0± .4	4700±90
Jan. 70	M. Ben-David*	−14.0	41.6± .6	2500±120
		g. Tel Aviv		
July 69	M. Ben-David		55.8± .7	
July 69	M. Ben-David		64.0± .9	
		h. Lake Tiberias area		
May 68	E. Mazor	−12.8	64.5±1.0	(126.0%±2.0)
May 68	E. Mazor	−15.2	19.4± .6	9200±250
May 68	E. Mazor	− 5.7	4.8± .5	12,500±900
May 69	Tahal	− 6.7	7.2± .3	11,000±250

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** Geological Survey of Israel, Jerusalem.
† Water Planning for Israel Ltd, Tel Aviv.

III. GEOLOGIC SAMPLES

The coordinates are given in the local grid, and locations are shown in Fig. 1.

A. Secondary calcites

In secondary calcites, it is assumed that the carbon in the carbonate has been affected by interactions between water and country rock. It is possible, therefore to calculate the age of the sample, correcting for the δC^{13} value by the method of Ingerson and Pearson (1964), using the value of the country rock as $\delta C^{13}{}_{ls}$.

Qsalon series

Secondary calcites (Nari) on a dolomite in a Cenomenian stratum near Qsalon (1312-1532), in the Judean Mts., Region k in Fig. 1. Coll. and subm. Feb., 1970 by M. Magaritz, Weizmann Inst. of Sci. For age calculation, $\delta C^{13}{}_{ls} = +1‰$ in the dolomite. *Comment*: to avoid attacking the dolomite, a 4% HCl solution was used for liberating CO_2 from the samples.

Sample		Height above dolomite (cm)	C^{14} (% modern)	δC^{13}(‰)	Age B.P.
RT-211.	Qsalon 2	0	7.5±.5	−10.0	13,700±850
RT-213.	Qsalon 3	40	9.6±.5	− 9.6	12,480±350
RT-197.	Qsalon 1	80	10.7±.4	−10.4	11,200±500
RT-217.	Qsalon 4	120	17.0±.6	−10.4	6600±600

Hermon series

Coarse crystalline calcite in a karst in Jurassic rock on Mt. Hermon. Coll. and subm. April, 1970 by M. Magaritz.

RT-215. Hermon 1

>38,000
$C^{14} = 0.4\% \pm 0.8$
$\delta C^{13} = -11.4‰$

From limestone (2980-2210). For age determination, $\delta C^{13}{}_{ls} = -.5‰$ in the country-rock calcite.

RT-216. Hermon 2

22,000 ± 1000
$C^{14} = 3.5\% \pm 0.4$
$\delta C^{13} = -11.5‰$

From dolomite adjacent to a magmatic dike (2960-2203). For age determination, $\delta C^{13}{}_{ls} = +1.0‰$ in the country-rock dolomite.

Sha'ar Hagai series

Secondary calcite in a Cenomenian stratum near Sha'ar Hagai, on hwy. to Jerusalem (7925-0155), Region k on Fig. 1. Coll. and subm. March, 1970 by M. Magaritz. For age determination, $\delta C^{13}{}_{ls} = -1.0‰$ in the country rock.

RT-195. Sha'ar Hagai 1

>40,000
$C^{14} = 1.1\% \pm 0.4$
$\delta C^{13} = -12.2‰$

RT-192. Sha'ar Hagai 2

29,000 ± 1000
$C^{14} = 1.1\% \pm 0.4$
$\delta C^{13} = -11.4‰$

10 cm from RT-195.

B. Precipitates and shells

These are reported as "per cent of modern" and δC^{13} in per mil. Ages are calculated only where there is an accepted method for the calculation.

RT-182. Qabri Aqueduct

$C^{14} = 71.4\% \pm 0.9$
$\delta C^{13} = -11.0‰$

Precipitate in an aqueduct near Qabri, in W Galilee (2660-1600), in use until late 1940's. Coll. and subm. 1969 by A. Issar.

RT-184. Feiran

$C^{14} = 4.3\% \pm 0.4$
$\delta C^{13} = -8.2‰$

Lacustrine precipitate from upper-mid-Pleistocene in Sinai (7025-0155), coll. and subm. 1969 by A. Issar.

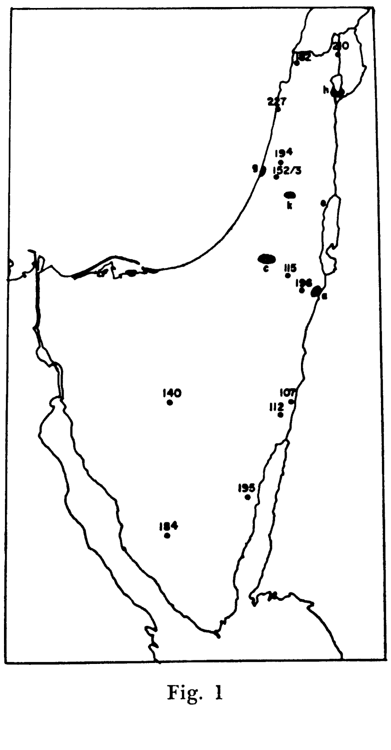

Fig. 1

C^{14} = 2.3% ± 0.4
RT-187. Ein Moreh *δC^{13} = –3.3‰*

Travertine on limestone in Negev (0275-1270), coll. and subm. 1969 by A. Issar.

4600 ± 100
RT-210. Hula shells **C^{14} = 61.0% ± 0.8**
δC^{13} = –14.3‰

Shells (*Unio* sp.) from terrace of ancient Lake Hula, near Bnot Ya'aqov bridge in upper Galilee (2686-2083). Coll. and subm. March, 1970 by A. Horowitz, Geol. Survey of Israel, Jerusalem. *Comment* (A.H.): terrace was formed during last intrusion of Lake Hula into Bnot Ya'aqov region.

C. Organic matter

Dead Sea driftwood

Driftwood from localities higher than surface of Dead Sea (–398.5m). Subm. April, 1970 by Zipora Klein, Jerusalem. *Comment* (I.C.): it is assumed that samples were deposited when sea was at present sample level. Assuming wood was then fresh, it can date change of level of Dead Sea (based on information by Z. Klein).

200 ± 100
A.D. 1750
RT-220. Dead Sea driftwood ZK5 **C^{14} = 97.9% ± 1.1**
δC^{13} = –23.5‰

Driftwood from Nahal More (1858-0750), coll. April 1970 by Z. K. from alt –376.5m.

100 ± 100
A.D. 1850
RT-221. Dead Sea driftwood ZK1 **C^{14} = 100.0% ± 1.0**
δC^{13} = –21.0‰

Driftwood from Mezad Qidron (1920-1211, local coordinates). Loc. is 8th century B.C. Israeli fort; sample was deposited by later flooding. Coll. 1968 by Z. Klein from –385.7 m.

(corr. C^{14} = 100% ± 1.0)
RT-226. Dead Sea driftwood ZK3 **C^{14} = 98.9% ± 3.0**
δC^{13} = –30.8‰

Driftwood from delta of Nahal Haver (1866-0912) coll. 1967 by Z. Klein from alt –394 m. *Comment* (I.C.): sample resembles eroded beach stone. Large error is due to small amount of sample.

General Comment: samples were treated with HCl to remove inorganic deposits.

IV. ARCHAEOLOGIC SAMPLES

18,500 ± 300
RT-227. Khabara 14 **C^{14} = 9.5% ± 0.2**
δC^{13} = –29.0‰

Ash from prehistoric cave in Carmel Mts. (2183-1444, local coordinates) from Layer 26 in stratigraphy which corresponds to Levantine Orignacian A. Coll. and subm. June 1970 by O. Bar-Yossef, Hebrew Univ., Jerusalem. *Comments* (I.C.): age determined on combusted residue of HCl and NaOH treated sample. (O.B-Y): archaeologic determination of ages is between 25,000 and 35,000 yr. B.P. Sample coll. from exposed ditch in excavation.

References

Bainbridge, A. E., Sandoval, P., and Suess, H. E., 1961, Natural tritium measurements by ethane synthesis: Science, v. 134, p. 552.

Barker, H., 1953, Radiocarbon dating: large-scale preparation of acetylene from organic material: Nature, v. 172, p. 631.

Carmi, I. and Y. Ashkenazi, 1970, A computer on-line in low-level counting laboratory: Nuclear Instruments and Methods, in press.

Ingerson, E. and Pearson, F. J., 1964, Estimation of age and rate of motion of ground water. Recent researches in the field of hydrosphere, atmosphere and nuclear geochemistry: Maruzen Co. Ltd.

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RHODESIAN RADIOCARBON MEASUREMENTS IV

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The following list of dates was compiled since 1967 (R., 1967, v. 9, p. 382-386). Procedures of measurements are essentially unchanged from those reported previously (R., 1964, v. 6, p. 31-36; 1966, v. 8, p. 423-429). The only major change in procedure is that the practice adopted in previous date lists of widening the errors due to fluctuations in C^{14} content of the exchange reservoir has been discontinued. This leaves the users free to apply the necessary corrections as they become available, e.g., Stuiver and Suess (1966) and Ralph and Michael (1969). The two gas proportional counters were rebuilt in 1968. It was found that outgassing the polytetrafluoroethylene insulators at 100°C under vacuum for 48 hours prior to reassembling the counters considerably hastened attainment of stable operating conditions.

SAMPLE DESCRIPTIONS

I. ARCHAEOLOGIC SAMPLES

A. Malawi

2125 ± 120
SR-127. Chowo Rock, Nyika Plateau **175 B.C.**

Charcoal from occupation deposit 31 to 46 cm below surface Mwavarambo pottery also occurred in upper 31 cm of deposit (10° 45′ S Lat, 33° 45′ E Long). Coll. and subm. by K. R. Robinson, P. O. Box 170, Bulawayo, Rhodesia. *Comment*: date marks end of Later Stone age at Chowo Rock.

470 ± 95
SR-178. Mawudzu Hill **A.D. 1480**

Charcoal from 41 to 51 cm level (14° 15′ S Lat, 35° 05′ E Long). Coll. and subm. by K. R. Robinson. *Comment*: sample is from Iron age site, being investigated in N Malawi in an effort to confirm work done in 1965-66.

1590 ± 120
SR-174. Nkope Hill **A.D. 360**

Charcoal from 51 to 71 cm depth in assoc. with Early Iron age pottery (14° 12′ S Lat, 35° 02′ E Long). Coll. and subm. by K. R. Robinson. *Comment*: date is average for Early Iron age stratum at site.

1175 ± 100
SR-175. Nkope Hill **A.D. 775**

Charcoal from 61 to 81 cm level. Coll. and subm. by K. R. Robinson.

1655 ± 95
SR-128. Phopo Hill, Lake Kazuni **A.D. 295**

Charcoal from 23 cm below surface in a midden patch assoc. with

Mwavarambo pottery sherds (11° 07′ S Lat, 33° 39′ E Long). Coll. and subm. by K. R. Robinson. *Comment*: date confirms early origin of Mwavarambo pottery in N Malawi.

SR-148. Phopo Hill, Lake Kazuni **1745 ± 170**
A.D. 205

Charcoal from 51 to 66 cm below surface of midden deposit containing sherds and bone. Coll. and subm. by K. R. Robinson. *Comment*: pottery is Mwavarambo ware; the only other date the submitter has for similar pottery is A.D. 1250 (UCLA-1242, R., 1968, v. 10, p. 155). Pottery was found at Karonga, Malawi.

SR-161. Phopo Hill, Lake Kazuni **1445 ± 120**
A.D. 505

Charcoal from 31 to 46 cm below surface assoc. with sherds and bone.

SR-145. Rock shelter on Hora Mt. **16,680 ± 180**
14,730 B.C.

Charcoal from 51 to 71 cm below surface assoc. with artifacts of white quartz (11° 40′ S Lat, 33° 38′ E Long). Coll. and subm. by K. R. Robinson. *Comment*: a further date from a series of sites being investigated in N Malawi.

SR-147. Lumbule Hill, Livingstonia **1385 ± 100**
A.D. 565

Charcoal from 61 to 76 cm below surface in occupation deposit containing sherds and iron (11° 0′ S Lat, 33° 30′ E Long). Coll. and subm. by K. R. Robinson. *Comment*: pottery is Mwavarambo ware as at Phopo Hill.

B. Rhodesia

Chedzurgwe series, Urungwe Dist., Karoi

The site, a large village, contains abundant pottery, copper ingots and other artifacts closely resembling those from Ingome Ilede 113 km to the NW (16° 47′ S Lat, 29° 37′ E Long). Coll. and subm. by P. S. Garlake, Natl. Monuments Comm., Salisbury, Rhodesia. *Comment*: see R., 1966, v. 8, p. 424 for other Ingombe Ilede dates, and Garlake (1970).

SR-162. Chedzurgwe **210 ± 90**
A.D. 1740

Charcoal sample from 11 to 20 cm below surface.

SR-177. Chedzurgwe **415 ± 120**
A.D. 1535

Charcoal from 10 to 15 cm.

SR-179. Chedzurgwe **350 ± 120**
A.D. 1600

Charcoal from 5 to 10 cm.

SR-180. Chedzurgwe **550 ± 95**
A.D. 1440

Charcoal from 8 to 15 cm.

SR-163. Chitope Chiconyora Farm, Sipolilo Dist. **840 ± 95**
A.D. 1110

Charcoal from Early Iron age village site, from surface of a daga floor which has been sealed by daga from a hut collapse (16° 51′ S Lat, 30° 50′ E Long). Coll. and subm. by P. S. Garlake. *Comment*: sample assoc. with pottery at this site, in an area where little archaeol. field work has been done.

SR-119. Cighwa Hill, Chibi Reserve **1540 ± 95**
A.D. 410

Charcoal from test pit excavated at ancient occupation site hidden within a natural enclosure formed by granite hills (20° 21′ S Lat, 30° 53′ E Long). Pottery was of early Iron age tradition. Typologically, A.D. 410 is acceptable. Coll. and subm. by K. R. Robinson. *Comment*: see Robinson (1967).

SR-140. Gaika Gold Mine, Que Que **Modern**

Carbonized wood from 12 m below surface in ancient mine. Sample too recent to date (18° 53′ S Lat, 29° 45′ E Long). Coll. by W. J. Vowles and subm. by R. Summers, both of Natl. Mus., Bulawayo, Rhodesia. *Comment*: direct historical evidence shows that nobody was living in Que Que area in 1868. Measurement shows that the mine was being worked up to the last moment and was not abandoned by ancient workers as unprofitable. Despite apparently negative result, sample provides important information.

SR-143. Geelong Gold Mine, Gwanda **780 ± 95**
A.D. 1170

Charred wood from a firesetting 24 m below surface in filling of an ancient mine (21° 0′ S Lat, 29° 18′ E Long). Coll. and subm. by R. Summers. *Comment*: result falls within range of Samples SR-44, 53, and 58 (R., 1966, v. 8, p. 426) which are of similar cultural status.

SR-153. Green Fish Cave **Modern**

Charcoal from 0 to 10 cm level (22° 40′ S Lat, 30° 45′ E Long). Coll. and subm. by C. K. Cooke, Dir., Hist. Monuments Comm., Bulawayo, Rhodesia. *Comment*: sample too modern to date.

SR-154. Green Fish Cave **Modern**

Charcoal from 2 to 3 m level. *Comment*: sample too modern to date.

SR-117. Kinsale Farm, Lundi River **1410 ± 95**
A.D. 540

Charcoal from test pit at 31 to 46 cm level (20° 18′ S Lat, 30° 18′ E Long). Coll. and subm. by K. R. Robinson. *Comment*: a report of pottery found at Kinsale led to further investigation of site. Pottery was of Gokomere tradition and so, date of A.D. 540 is very reasonable. More extensive excavations are hoped for in the future.

Lekkerwater Ruins series, Theydon

Lekkerwater Ruins were excavated by S. Rudd, 7 Barons Court Greendale, Salisbury, Rhodesia. Site is one most E of Zimbabwe Ruin complex found in Rhodesia (18° 05′ S Lat, 31° 42′ E Long). Subm. by R. Summers.

560 ± 120
SR-108. Lekkerwater Ruins **A.D. 1390**

Charcoal from a main occupation layer. *Comment*: see Rudd (1968).

650 ± 120
SR-109. Lekkerwater Ruins **A.D. 1300**

Charcoal from foundation layer underlying some of the stone structures from site. *Comment*: probably contemporary with SR-108.

440 ± 90
SR-124. Lekkerwater Ruins **A.D. 1510**

Charcoal from base of wall. *Comment*: compare result with M-915 (R., 1961, v. 3, p. 123), earliest date for Zimbabwe Period IV.

500 ± 95
SR-129. Lekkerwater Ruins **A.D. 1450**

Sticks of pure charcoal from daga molds in ruins of a hut.

835 ± 95
SR-181. Lekkerwater Ruins **A.D. 1115**

Charcoal from floor sealed by paving stones. *Comment*: compare with M-914 (R., 1961, v. 3, p. 123), transition between Periods II and III at Zimbabwe.

705 ± 65
SR-194. Lekkerwater Ruins **A.D. 1245**

Charcoal from a destruction layer.

505 ± 45
SR-197. Lekkerwater Ruins **A.D. 1445**

Charred post in Floor 3.

670 ± 95
SR-115. Mapela Hill **A.D. 1280**

Charcoal from basal occupation layer 91 to 107 cm below surface (21° 44′ S Lat, 28° 48′ E Long). Coll. and subm. by P. S. Garlake. *Comment*: sample from excavations to date major Leopard's Kopje site on Shashi R.; see Garlake (1968).

790 ± 95
SR-122. Mapela Hill **A.D. 1160**

Charcoal from sealed occupation horizon at depth 46 cm overlaying that at 91 to 107 cm in same excavation. Coll. and subm. by P. S. Garlake. *Comment*: dates major Leopard's Kopje Phase III site.

490 ± 90
SR-120. Little Mapela Hill **A.D. 1460**

Sample from deposit accumulated at foot of free standing stone enclosure wall during construction (21° 43′ S Lat, 28° 48′ E Long). Coll. and subm. by P. S. Garlake. *Comment*: pottery from dated deposit closely resembles Period IV wares of Zimbabwe, although other deposits in enclosure are of Leopard's Kopje Phase III.

SR-131. Mount Hampden **4415 ± 110**
2465 B.C.

Large carbonized timber 61 cm below ground level 2 m from grave containing Harari ware pottery (17° 42′ S Lat, 30° 56′ E Long). Sample possibly related to this grave, 1 of 3 excavated in same vicinity, though no visible occupation horizon connected the two. Coll. and subm. by P. S. Garlake. *Comment*: date proves that sample is not connected with graves, since very similar pottery to that found in grave was dated at A.D. 1280: Y-722 (R., 1960, v. 2, p. 58).

SR-165. Murahwa Hill, Umtali **Modern**

Charcoal from bottom of occupation layer (18° 26′ S Lat, 32° 53′ E Long). Coll. by F. Bernhard, 127 3rd. St., Umtali, Rhodesia and subm. by P. S. Garlake. *Comment*: dated to determine if Murahwa Hill is Iron age settlement.

SR-176. Murahwa Hill, Umtali **890 ± 120**
A.D. 1060

Charcoal from Ziwa layer 3 m depth. Coll. by F. Bernhard and subm. by P. S. Garlake.

SR-134. Mwala Hill, Umguza River **860 ± 95**
A.D. 1090

Carbonized wood from hut remains (19° 51′ S Lat, 28° 32′ E Long). Sample sealed under daga fragments. Coll. and subm. by K. R. Robinson. *Comment*: pottery from site suggests late Leopard's Kopje industry; date supports conclusion (Robinson, 1968).

SR-146. Redcliff Lime Works **9560 ± 270**
7610 B.C.

Charred bone from 6 m level (19° 0′ S Lat, 29° 40′ E Long). Coll. and subm. by C. K. Cooke. *Comment*: one of a series of dates being measured by several labs; comparative results not yet available.

SR-173. Redcliff, Que Que **10,535 ± 150**
8585 B.C.

Bone from bottom of bone concentration. Coll. and subm. by C. K. Cooke. *Comment*: bone layer contains a Bambata industry, apparently laid down over a very long period.

SR-111. Rhodes-Inyanga Orchards, Inyanga Natl. Park **4950 ± 120**
3000 B.C.

Charcoal from trenches dug for water pipes in new experimental orchards (18° 17′ S Lat, 32° 45′ E Long). Coll. by C. B. Payne, and subm. by O. West, both of Rhodes-Inyanga Orchards, Inyanga Natl. Park, Rhodesia. *Comment*: dated for general interest as there are many sites of archaeologic interest in Inyanga dist.

SR-113. Rhodes-Inyanga Orchards, Inyanga Natl. Park **4020 ± 95**
2070 B.C.

Charcoal from same horizon as SR-111.

1300 ± 95
SR-118. Sinoia Caves **A.D. 650**

Charcoal from occupation site at 51 to 66 cm depth (17° 20′ S Lat, 30° 02′ E Long), assoc. with Ziwa-type pottery which makes date of A.D. 650 acceptable. Coll. and subm. by K. R. Robinson. *Comment*: Robinson (1965). Date should mark beginning of occupation, assoc. with copper smelting.

+750
26,550
−830
SR-164. Sinoia Caves **24,600 B.C.**

Charcoal from floor of cave 61 cm deep in well-stratified deposit (17° 20′ S Lat, 30° 02′ E Long). No assoc. artifacts to indicate age. Coll. and subm. by B. L. Holt, Dept. of Geol., Univ. of Rhodesia, Salisbury, Rhodesia. *Comment*: result will, hopefully date deposit.

+740
26,110
−810
SR-168. Sinoia Caves **24,160 B.C.**

Charcoal from breccia at a depth ca. 122 cm below present floor. Sample assoc. with burnt bone and stone implements. Coll. and subm. by B. L. Holt.

880 ± 90
SR-136. Venzo Kopje **A.D. 1070**

Charcoal from shallow midden close to Shashani R. (21° 38′ S Lat, 28° 44′ E Long). Coll. and subm. by P. S. Garlake. *Comment*: settlement also contains Leopard's Kopje Phase III pottery; see Garlake (1966).

255 ± 55
SR-195. Zaka Ruin, Chiredzi River **A.D. 1695**

Charcoal from midden at 28 to 33 cm level (20° 22′ S Lat, 31° 27′ E Long). Coll. and subm. by P. S. Garlake. *Comment*: wall from this site is identical to outer wall of the Great Enclosure at Zimbabwe. This radiocarbon determination indicates that the ruin was built in the 15th century, and may have been occupied for as long as 2 centuries.

465 ± 50
SR-196. Zaka Ruin, Chiredzi River **A.D. 1485**

Charcoal from the deposit at the foot of wall. Coll. and subm. by P. S. Garlake. *Comment*: see Garlake (1969).

C. South Africa

SR-132. Blydefontein Shelter, Orange River Project **1980 ± 120** **30 B.C.**

Charcoal from 15 cm depth (31° 15′ S Lat, 25° 6′ E Long). Coll. by C. G. Sampson, School of Afr. Studies, Univ. of Cape Town, Cape Province, South Africa, and subm. by C. K. Cooke. *Comment*: result dates Late Stone age and is in correct sequence (Sampson, 1969).

SR-142. Blydefontein Shelter **3090 ± 100** **1140 B.C.**

Charcoal from 31 to 36 cm depth. Coll. by C. G. Sampson and subm. by C. K. Cooke. *Comment*: date is in sequence and substantiates connection with Wilton culture from elsewhere in South Africa.

SR-152. Blydefontein Shelter **3650 ± 120** **1690 B.C.**

Charcoal from 46 to 51 cm depth. Coll. by C. G. Sampson and subm. by C. K. Cooke. *Comment*: dates earliest apeparance of Wilton complex in shelter. Date is in correct sequence and confirms identity of industry.

SR-166. Bonteberg Shelter, Cape Peninsula **2050 ± 95** **100 B.C.**

Shell from a layer containing pottery and lobster remains (34° 12′ S Lat, 18° 23′ E Long). Coll. and subm. by J. R. Grindley, Head Marine Biol. Dept., South Afr., Mus., Cape Town, South Africa. *Comment*: excavation of site provided unique series of remains of Cape rock lobster (*Jasus lalandi*). This appears to be the only case of *Jasus* occurring in archaeol. deposits, and so represents earliest known occurrence of this species (Beaumont 1963; Deacon 1965).

SR-167. Bonteberg Shelter **4690 ± 100** **2740 B.C.**

Marine shell Layer I. Coll. and subm. by J. R. Grindley. *Comment*: indicates total age of deposits.

SR-121. Glen Elliot Shelter, Orange River Project **Modern**

Charcoal from bottom of deposit containing true "Smithfield B", known to be last cultural event in area (30° 44′ S Lat, 25° 37′ E Long). Sample gave result that was too young to be meaningful. Coll. and subm. by C. G. Sampson. *Comment*: dates 1st appearance of bushmen (Sampson, 1967).

SR-130. Marion Island **2685 ± 130** **735 B.C.**

Dark brown peat from swamp 160 to 170 cm below surface (46° 50′ S Lat, 37° 50′ E Long). Coll. and subm. by E. M. van Zinderen Bakker, Univ. of the Orange Free State, Bloemfontein, South Africa. *Comment*: sample dated for correlation of climatic phase, culture and assoc. finds. Result was also required for comparison with pollen analysis.

SR-135. Marion Island **3340 ± 160**
1390 B.C.

Black peat 190 to 200 cm below surface of swamp (46° 50′ S Lat, 39° 50′ E Long). Coll. and subm. by E. M. van Zinderen Bakker. *Comment*: will hopefully correlate culture, climatic phase, and assoc. finds. Comparison with pollen analysis will be made later.

SR-116. Rose Cottage Cave, Orange Free State **50,000**

Charcoal assoc. with artifacts thought to be Upper Magosian in date, (29° 15′ S Lat, 27° 30′ E Long). Coll. and subm. by R. J. Mason, Univ. of Witwatersrand, Johannesburg, South Africa. *Comment*: dated to estimate age of assoc. Upper Magosian-style artifact assemblage for comparisons with similar assemblages from Rhodesia and Cape Province.

SR-133. Zaayfontein Shelter, Orange River Project **430 ± 95**
A.D. 1520

Charcoal from 38 to 43 cm depth (30° 37′ S Lat, 25° 31′ E Long). Coll. and subm. by C. G. Sampson. *Comment*: dates 1st definite appearance of pottery in shelter area; see Sampson (1967).

SR-160. Zaayfontein Shelter **3270 ± 115**
1320 B.C.

Charcoal from 10 to 11 m depth. Coll. and subm. by C. G. Sampson. *Comment*: dates end of Later Stone age at shelter. End of this phase at Zaayfontein Shelter overlaps beginning of Later Stone age at Blydefontein; see SR-132, -142, and -152, this date list.

D. Zambia

SR-110. Dambwa, Livingstone **1290 ± 120**
A.D. 660

Charcoal from Dambwa site (17° 49′ S Lat, 25° 51′ E Long). Coll. and subm. by D. Phillipson, Natl. Monuments Comm., Zambia. *Comment*: see Samples SR-62 (R., 1966, v. 8, p. 425), SR-106, 96-98 (R., 1967, v. 9, p. 385 and 386).

SR-123. Kalundu Mound, Kalomo **1495 ± 95**
A.D. 455

Charcoal from sealed pit on Kalundu Mound (17° 03′ S Lat, 26° 30′ E Long). Coll. by R. Inskeep, Univ. of Cape Town, South Africa, and subm. by D. Phillipson. *Comment*: confirms early date of SR-65 (R., 1966, v. 8, p. 425); see Phillipson (1968) and Inskeep (1962).

SR-139. Kalundu Mound **885 ± 120**
A.D. 1065

Charcoal from 2 to 2.3 m depth. Coll. by B. Fagan, and subm. by D. Phillipson. *Comment*: date falls within range of Kalomo culture dates (Fagan, 1967).

SR-126. Leopard's Hill Cave, Lusaka **1415 ± 125**
A.D. 535

Charcoal, marking end of Late Stone age and is assoc. with a few sherds of Early Iron age (15° 36′ S Lat, 28° 43′ E Long). Coll. and subm.

by D. Phillipson. *Comment*: in excellent agreement with Samples GX-1012 and GX-1013 (Phillipson, 1968).

16,715 ± 95
SR-138. Leopard's Hill Cave **14,765 B.C.**

Charcoal from 184 to 190 cm depth. Coll. and subm. by D. Phillipson. *Comment*: old age partly confirmed by other analyses, GX-0957 and UCLA-1291. Excavation at site appears to provide fairly complete Stone age succession for Lusaka area.

2865 ± 95
SR-141. Leopard's Hill cave **915 B.C.**

Charcoal from 31 to 38 cm depth. Coll. and subm. by D. Phillipson. *Comment*: further date in series which fits into pattern already established by previous 5 dates; SR-126 (this list) SR-38 (R., 1964, v. 6, p. 34), UCLA-1290, GX-0957, and UCLA-1291.

E. Uganda

510 ± 180
SR-137. Magosi Shelter **4560 B.C.**

Bone from a kunkar zone underlying a layer containing Wilton material. Coll. and subm. by G. Cole, Uganda Mus., Kampala, Uganda. *Comment*: see SR-92 (R., 1967, v. 9, p. 383), Wayland and Burkitt (1932), and Posnansky and Cole (1963).

II. GEOLOGIC SAMPLES

37,200 ± 3700
SR-85. Forno Da Cal, Maputo River, Moçambique **33,500 B.C.**

Sample consisting of small pebbles, calcareous concretions, mollusks, and oyster shell (26° 26′ S Lat, 32° 39′ E Long). Coll. and subm. by L. Barradas, Inst. de Investigaçao Cientifica de Moçambique, Lourenço Marques. *Comment*: further date in establishment of transgression of "Gamblian/Makalian" of Moçambique; see Sample SR-29 (R., 1966, v. 8, p. 428).

Mondoro Tribal Trust series

12,760 ± 220
SR-156. Carbonate concretions **10,810 B.C.**

Carbonate nodules from clay 76 to 91 cm below surface (18° 21′ S Lat, 30° 37′ E Long). Coll. and subm. by P. J. Watson, Univ. of Rhodesia, Salisbury. *Comment*: result required to date assoc. sodium-influenced soils, under study.

18,775 ± 300
SR-157. Carbonate nodules **16,825 B.C.**

Carbonate nodules from clay 122 cm below surface.

4322 ± 180
SR-158. Carbonate nodules **2370 B.C.**

Carbonate nodules from 198 to 231 cm depth.

III. TREE SAMPLES

SR-54. *Ocotea Usambarensis*, Kawandoma, Vipya Plateau, Malawi **340 ± 100**
A.D. 1610

Wood from outer shell of E African Camphor tree, central part of tree having been rotted or burnt (12° 02′ S Lat, 33° 51′ E Long). Coll. and subm. by J. Chapman, Commonwealth Forestry Inst., Oxford, England. *Comment*: date required for study on evergreen forests of Malawi.

SR-56. *Ocotea Usambarensis*, Kawandoma **370 ± 90**
A.D. 1580

Wood (12° 02′ S Lat, 33° 51′ E Long). Coll. and subm. by R. Drummond, Federal Herbarium, Salisbury, Rhodesia.

SR-144. Umkondo Copper Mine, Bikita, Rhodesia **320 ± 90**
A.D. 1630

Wood from handle of hoe from base of ancient mine shaft ca. 9 m below surface (20° 20′ S Lat, 32° 10′ E Long). Coll. and subm. by R. Summers. *Comment*: Portuguese reported similar mining techniques in area dated ca. 1510 to 1690.

SR-112. *Khaya Nyasica*, Chirinda Forest, Rhodesia **Modern**

Wood of a very common species that grows along water courses of Chirinda Forest and represents a fair cross section of larger trees (20° 28′ S Lat, 32° 45′ E Long). Coll. and subm. by B. Goldsmith, Gungunyana Forest Reserve, Rhodesia. *Comment*: provides age span for Chirinda Forest.

SR-151. *Parinari* sp., Chirinda Forest, Mount Salinda, Rhodesia **190 ± 110**
A.D. 1760

Tree trunk at ground level, burnt and rotted to about half its width, from sound wood from approx. middle of stem and at ca. 61 cm above ground (20° 25′ S Lat, 32° 41′ E Long). Coll. and subm. by O. West. *Comment*: compare result with SR-112, this list.

SR-149. Baobab Tree, Messina, South Africa **400 ± 120**
A.D. 1550

Wood (*Adonsonia digitata L*) from tree 15 m in girth, from 2 m into tree and 2 m above ground (22° 18′ S Lat, 29° 50′ E Long). Coll. and subm. by G. L. Guy, Natl. Mus., Bulawayo, Rhodesia. *Comment*: one of a plot of trees whose growth rate is known for the last 35 yr, all the big trees are a few cm less in girth since they were first measured in 1931.

SR-150. Baobab Tree, Messina **Modern**

Wood from same tree as SR-149, 107 cm from bark. Coll. and subm. by G. L. Guy. *Comment*: sample was too young to date.

SR-48. *Podocarpus falcatus*, Lottering, South Africa **980 ± 100**
A.D. 970

Heartwood from a large Outeniqua Yellowwood tree (33° 57′ S Lat, 23° 47′ E Long), from stem sec., ca. 305 cm above ground. Under bark girth of tree was 7 m. Coll. and subm. by H. A. Luckhoff, Secretary for Forestry, Pretoria. *Comment* (H.A.L.): dated to compare age of these old trees, as determined by ring counts, with radiocarbon dating. Unfortunately, large areas of decay in the stem made a ring count impossible. A reasonably close correlation exists, however, between radiocarbon age of this tree and age of trees of similar diameter dated by ring counts.

SR-49. *Encephalartos transvenosis*, Modjadji, NE Transvaal, South Africa **450 ± 90** **A.D. 1500**

Wood from sec. 61 cm above ground (23° 6′ S Lat, 31° 00′ E Long). Tree was 175 cm in girth. Coll. and subm. by S. H. Harper, Univ. of Rhodesia, Salisbury, Rhodesia. *Comment* (S.H.H.): Modjadji Palms were reputed of great but unknown age, and were in area when Modjadji Tribe moved into district some 300 yr ago. Older members of Mojadji Tribe regarded trees as sacred and would not fell them.

SR-60. Nyakimya Swamp, Fort Portal, Uganda **4070 ± 120** **2120 B.C.**

Wood from Nyakimya Swamp (0° 39′ N Lat, 30° 16′ E Long). Coll. by H. A. Osmaston, Dept. of Geog., Univ. of Bristol, Bristol, England, and subm. R. Summers. *Comment*: established date for explosion craters near Fort Portal.

References

Beaumont, P., 1963, The Bonteberg shelter: a progress report: Jour. Sci. Soc., Univ. Cape Town, v. 6, p. 20-27.

Deacon, H. J., 1965, An annotated list of radiocarbon dates for sub-Saharan Africa: v. 5, Annals Cape Provincial Mus.

Fagan, B., 1967, Iron age cultures in Zambia, v. I: London.

Garlake, P. S., 1966, Iron age archaeol. in Shashi expedition: Rhodesian Schools Exploration Soc., Bulawayo, Rhodesia.

——— 1967, Iron age burials at Mount Hampden near Salisbury, Rhodesia: Arnoldia, v. 3, no. 10.

——— 1968, Test excavations at Mapela Hill, near Shashi River, Rhodesia: Arnoldia, v. 3, no. 34.

——— 1969, Iron age archaeol. in Bikita expedition: Rhodesian Schools Exploration Soc., Bulawayo, Rhodesia.

——— 1970, Iron age site in the Urungwe District of Rhodesia: S. African Archaeol. Bull. XXV, v. 97, p. 25.

Grindley, J. R., Speed, E., and Maggs, T., 1970, The age of the Bonteberg shelter deposits, Cape Peninsula: S. African Archaeol. Bull. XXV, v. 97, p. 24.

Inskeep, R., 1962, Iron age sites in N. Rhodesia: S. African Archaeol. Bull. XVII, p. 136-180.

Phillipson, D., 1968, The Early Iron age in Zambia: Jour. African Hist., v. IX, p. 191-211.

Posnansky, M. and Cole, G., 1963, Recent excavations at Magosi, Uganda: a preliminary report: Man, p. 133.

Ralph, E. K. and Michael, H. N., 1969, University of Pennsylvania radiocarbon dates XII: Radiocarbon, v. 11, p. 469-481.

Robins, P. A. and Swart, E. R., 1964, Southern Rhodesia radiocarbon measurements I: Radiocarbon, v. 6, p. 31-36.

Robinson, K. R., 1965, The Sinoia Caves, Lomagundi District, Rhodesia: Rhodesian Sci. Assoc. Proc. and Trans., v. 51, p. 131-155.

——— 1967, Further work on Iron age sites in the Chibi District, S. Rhodesia, 1961-1963: Arnoldia, v. 3, no. 1.

——— 1968, An examination of five iron age structures in the Umguza Valley, 14 mi. N. of Bulawayo, Rhodesia: Arnoldia, v. 3, no. 35.

Rudd, S., 1968, Preliminary report of excavations, 1963-66 at Lekkerwater Ruins, Tsindi Hill, Theydon, Rhodesia: Rhodesian Sci. Assoc. Proc. and Trans., v. 52, pt. 2, p. 38-50.

Sampson, C. G., 1967, Excavations at Zaayfontein shelter, Norvalspont: N. Cape. Res. Natl. Mus., v. 2, 4, p. 41-124.

——— 1969, The Smithfield Industrial Complex: Further field results: Natl. Mus. mem., no. 5, in press.

Sheppard, J. G. and Swart, E. R., 1966, Rhodesian radiocarbon measurements II: Radiocarbon, v. 8, p. 423-429.

——— 1967, Rhodesian radiocarbon measurements III: Radiocarbon, v. 9, p. 382-386.

Stuiver, Minze and Suess, H. F., 1966, On the relationship between radiocarbon dates and true sample ages: Radiocarbon, v. 8, p. 534-540.

Wayland, E. J. and Burkitt, M. C., 1932, The Magosian culture of Uganda: Royal Anthropol. Inst. Jour., v. 62, p. 369-390.

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GEOLOGICAL SURVEY OF FINLAND RADIOCARBON MEASUREMENTS V

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The C^{14} measurements reported here were made in this laboratory between July 1969 and September 1970. The dating system consists of a 0.55 L copper-walled proportional counter (adapted from Östlund and Engstrand, 1963, constructed by Outokumpu Oy, Research Lab., Tapiola, Finland) surrounded by a lead cylinder, 1.5 cm thick, placed within an anticoincidence meson detector. The system is encased in selected lead 1.5 cm thick, 7 cm of paraffin wax with ca. 10% boric acid and ca. 20 cm iron. Counter gas is CO_2 with which the counter is filled to 228.6 m Hg at a detector temperature of 20°C. Background is 1.50 cpm and net contemporary value is ca. 10.0 cmp.

The radiocarbon dates in this list are based on 95% activity of NBS oxalic acid as modern standard and they were calculated using Libby half-life of C^{14}. The results are reported in years before 1950 and in the A.D./B.C. scale. Age errors include counting errors of samples, background, and standard, and error in the half-life of C^{14}. Errors smaller than 100 yr have been rounded off to an even 100 years. Mass-spectrometric analyses for fractionation correction were performed by Karolinska Inst., Stockholm. δC^{13} values quoted are relative to the NBS oxalic acid standard.

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SAMPLE DESCRIPTIONS

I. GEOLOGIC SAMPLES

A. Finland

4920 ± 120
Su-68. Inari, N Finland **2970 B.C.**

Wood from base of Morgam bog, surface alt 325 m, in Lemmenjoki (68° 40′ N Lat, 25° 48′ E Long). Coll. 1951 by E. Hyyppä.

5880 ± 200
Su-69. Hattula, S Finland **3930 B.C.**

Pinus wood from *Sphagnum-Eriophorum*-deciduous peat taken with piston drill, depth 3.10 to 3.20 m, surface alt 110 m, Saunasuo bog (60° 45′ N Lat, 24° 13′ E Long). Coll. 1961 by E. Hyyppä. *Comment*: according to pollen analysis, horizon represents rise in *Picea* pollen.

8150 ± 150
Su-70. Hattula, S Finland **6200 B.C.**

Same bog as Su-69, detritus-diatom gyttja, depth 4.85 to 4.90 m. Coll. 1961 by E. Hyyppä. *Comment*: horizon belongs to beginning Atlantic stage (Hyyppä, 1966).

4670 ± 100
Su-73. Porvoo, S Finland **2720 B.C.**
$\delta C^{13} = -6.26‰$

Birch bark, depth 0.65 m, surface alt 28.5 m, Bastuberg (60° 21′ N Lat, 25° 47′ E Long). Coll. 1967 by E. Hyyppä. *Comment*: according to pollen analysis, horizon represents rise in *Picea* pollen (Hyyppä *et al.* 1969).

8510 ± 130
Su-80. Multia, central Finland **6560 B.C.**

Fine detritus gyttja taken with piston drill, depth 5.70 to 5.80 m, surface alt 156.7 m, Kuusilampi bog (62° 27′ N Lat, 24° 49′ E Long). Coll. 1968 by E. Hyyppä. *Comment*: according to pollen analysis, horizon represents last stage of Pre-Boreal period.

9560 ± 280
Su-81. Multia, central Finland **7610 B.C.**

Same sec. as Su-80, fine detritus gyttja, depth 5.80 to 5.95 m. Coll. 1968 by E. Hyyppä. *Comment*: same as Su-80.

8470 ± 100
Su-82. Pylkönmäki, central Finland **6520 B.C.**

Betula wood taken with piston drill, depth 2.60 m, surface alt 149 m, Uodinjärvensuo bog (62° 43′ N Lat, 24° 49′ E Long). Coll. 1968 by E. Hyyppä. *Comment*: according to pollen and diatom analyses, horizon represents Boreal period and lies above Ancylus Lake I level.

3150 ± 100
Su-83. Aura, SW Finland **1200 B.C.**
$\delta C^{13} = +0.62‰$

Deciduous-*Carex* peat from hand-dug sec., depth 3.00 to 3.04 m, surface alt 52 m, Ukuransuo bog (60° 36′ N Lat, 22° 29′ E Long). Coll. 1968 by E. Hyyppä.

3980 ± 160
Su-84. Aura, SW Finland **2030 B.C.**
$\delta C^{13} = -4.07‰$

Same bog as Su-83, deciduous *Carex*-peat, depth 3.04 to 3.07 m. Coll. 1968 by E. Hyyppä. *Comment*: according to pollen analysis, horizon represents Sub-Boreal period.

3500 ± 120
Su-85. Aura, SW Finland **1550 B.C.**
$\delta C^{13} = -5.63‰$

Same bog as Su-83 and Su-84, detritus gyttja, depth 3.07 to 3.10 m. Coll. 1968 by E. Hyyppä. *Comment*: according to pollen analysis, horizon represents Sub-Boreal period.

4210 ± 110
Su-86. Aura, SW Finland **2260 B.C.**
$\delta C^{13} = -8.76‰$

Same bog as Su-83-85, detritus gyttja, depth 3.10 to 3.13 m. Coll. 1968 by E. Hyyppä. *Comment*: according to pollen analysis, horizon represents Sub-Boreal period.

4070 ± 100
Su-100. Aura, SW Finland **2120 B.C.**
$\delta C^{13} = -5.87‰$

Same bog as Su-83-86, peat, depth 2.45 m. Coll. 1968 by E. Hyyppä.

4360 ± 100
Su-101. Aura, SW Finland **2410 B.C.**
$\delta C^{13} = -8.03‰$

Same bog as Su-83-86, and Su-100, peat with clay, depth 2.55 m. Coll. 1968 by E. Hyyppä.

7380 ± 120
Su-87. Uurainen, central Finland **5430 B.C.**

Fine detritus gyttja taken with piston drill, depth 2.10 to 2.20 m, surface alt 229.2 m, Kotanen bog (62° 27′ N Lat, 25° 10′ E Long). Coll. 1968 by E. Hyyppä.

6490 ± 125
Su-88. Haapajärvi, N Finland **4540 B.C.**

Detritus gyttja from hand-dug sec., depth 1.20 to 1.24 m, surface alt 94.2 m, Päivärinta bog (63° 48′ N Lat, 25° 10′ E Long). Coll. 1968 by E. Hyyppä.

9820 ± 150
Su-109. Kytäjä, S Finland **7870 B.C.**

Peat and detritus gyttja taken with piston drill, depth 1.40 to 1.50 m, surface alt 121 m, Jukolansuo bog (60° 35′ N Lat, 24° 36′ E Long). Coll. 1969 by E. Hyyppä.

7620 ± 150
Su-110. Ruovesi, S Finland **5670 B.C.**

Peat taken with piston drill, depth 0.05 to 0.15 m, surface alt 134.5 m, Niemisen sorakuoppa (61° 56′ N Lat, 23° 51′ E Long). Coll. 1969 by E. Hyyppä.

850 ± 150
Su-111. Joensuu, E Finland **A.D. 1100**

Peat, depth 1.60 m, surface alt 78.59 m, Vaneritehdas (62° 36′ N Lat, 29° 47′ E Long). Coll. 1969 by E. Hyyppä.

Su-112. Joensuu, E Finland **6700 ± 100**
4750 B.C.

Same sec. as Su-111, wood, depth 3.75 m. Coll. 1969 by E. Hyyppä.

Su-74. Kittilä, N Finland **8280 ± 130**
6330 B.C.

Bryales peat taken with piston sampler, depth 1.75 to 1.85 m, surface alt 205 m, small bog ca. 5 km S of Sirkka (67° 46′ N Lat, 24° 51′ E Long). Coll. 1967 by Raimo Kujansuu. *Comment*: peat underlain by till-like landslide material; according to pollen analysis, peat is Pre-Boreal in age (*Betula* maximum).

Su-75. Kittilä, N Finland **7840 ± 175**
5890 B.C.

Sphagnum-Carex peat taken with piston sampler, depth 1.25 to 1.35 m, surface alt 205 m, same bog as Su-74. Coll. 1967 by Raimo Kujansuu. *Comment*: pollen analysis shows end of *Betula* maximum.

Su-76. Kittilä, N Finland **2130 ± 110**
180 B.C.

Humified hardwood peat taken with piston sampler, depth 0.55 to 0.65 m, surface alt 205 m, same bog as Su-74. Coll. 1967 by R. Kujansuu. *Comment*: pollen analysis shows rise in *Picea* pollen.

Su-77. Kolari, N Finland **7390 ± 195**
5540 B.C.

Bryales-Sphagnum peat taken with piston sampler, depth 2.05 to 2.15 m, surface alt ca. 180 m, small bog on W flank of Taapaselkä hill (67° 08′ N Lat, 24° 44′ E Long). Coll. 1967 by R. Kujansuu. *Comment*: peat underlain by till-like landslide material; according to pollen analysis sample represents later part of *Betula* maximum.

Su-78. Kittilä, N Finland **6610 ± 175**
4660 B.C.

Sandy accumulation peat taken with piston sampler, depth 1.90 to 2.00 m, surface alt ca. 320 m, Aakkenustunturi (67° 40′ N Lat, 24° 31′ E Long). Coll. 1967 by Raimo Kujansuu. *Comment*: peat underlain by till-like landslide materials; according to pollen analysis sample represents later part of *Betula* maximum. Discrepancy between pollen dating and C^{14} date.

Su-79. Kittilä, N Finland **2610 ± 100**
660 B.C.

Bryales peat taken with piston sampler, depth 0.65 to 0.75 m, surface alt ca. 320 m, same bog as Su-78. Coll. 1967 by Raimo Kujansuu. *Comment*: pollen analysis shows rise in *Picea* pollen.

Su-71. Lavia, W Finland **3750 ± 110**
1800 B.C.

Coarse detritus gyttja with *Trapa* fruits from hand-dug section, depth 0.50 to 0.56 m, surface alt 5.80 m, Huidanlahti tilled peat bog (61° 37′ N Lat, 22° 30′ E Long). Coll. 1967 by V. E. Valovirta. *Comment*: pollen analysis shows middle part of Sub-Boreal period.

Su-72. Lavia, W Finland **4430 ± 100**
2480 B.C.

Same place as Su-71. Coarse detritus gyttja with *Trapa* fruits from hand-dug section, depth 0.85 to 0.92 m. Coll. 1967 by V. E. Valovirta. *Comment*: pollen analysis shows beginning of Sub-Boreal period.

Su-107. Keuruu, central Finland **5220 ± 100**
3270 B.C.
$\delta C^{13} = -2.16‰$

Trapa fruits from hand-dug section, depth 0.6 to 0.7 m, surface alt 113 m, Koskela tilled peat bog (62° 19′ N Lat, 24° 42′ E Long). Coll. 1968 by V. E. Valovirta. *Comment*: pollen analysis shows end of Atlantic period.

Su-108. Petäjävesi, central Finland **5090 ± 100**
3140 B.C.
$\delta C^{13} = -6.80‰$

Trapa fruits taken with piston sampler, depth 1.8 to 1.9 m, surface alt 112 m, Kuristainen bog (62° 13′ N Lat, 25° 14′ E Long). Coll. 1968 by V. E. Valovirta. *Comment*: pollen analysis shows end of Atlantic period.

Su-114. Loppi, S Finland **5010 ± 100**
3060 B.C.

Pinus wood taken with piston sampler, depth 1.25 to 1.30 m, surface alt 123.5 m, Pitkäjärvi bog (60° 41′ N Lat, 24° 33′ E Long). Coll. 1969 by V. E. Valovirta. *Comment*: pollen analysis shows transition from Atlantic to Sub-Boreal period.

Su-115. Loppi, S Finland **5610 ± 100**
3660 B.C.

Same bog as Su-114, peat taken with piston sampler, depth 1.35 to 1.40 m. Coll. 1969 by V. E. Valovirta. *Comment*: pollen analysis shows Atlantic period.

Su-116. Tuusula, S Finland **7030 ± 100**
5080 B.C.

Limnic peat and pieces of wood taken with piston sampler, depth 3.20 to 3.25 m, surface alt 48 m, Vuohikka bog (60° 27′ N Lat, 25° 00′ E Long). Coll. 1969 by V. E. Valovirta. *Comment*: pollen analysis shows transition from Boreal to Atlantic period.

Su-123. Renko, S Finland **9430 ± 130**
7480 B.C.

Detritus gyttja taken with piston sampler, depth 5.80 to 5.84 m, surface alt 118.3 m, Pukkinummenlampi (60° 47′ N Lat, 24° 24′ E Long). Coll. 1969 by V. E. Valovirta. *Comment*: pollen analysis shows transition from Pre-Boreal to Boreal period.

9670 ± 130
Su-124. Renko, S Finland **7720 B.C.**

Detritus gyttja taken with piston sampler, depth 3.85 to 3.90 m, surface alt 132.5 m, Pormestarinsuo bog (60° 58′ N Lat, 24° 18′ E Long). Coll. 1969 by V. E. Valovirta. *Comment*: pollen analysis shows Pre-Boreal period.

6030 ± 110
Su-125. Taipalsaari, SE Finland **4080 B.C.**

Conifer wood taken from submerged stump by sawing, depth of water 1.5 m, level of Lake Saimaa alt 76 m, Kirkkosaari (61° 14.5′ N Lat, 28° 17.2′ E Long). Coll. 1969 by T. Liukkonen. Subm. by K. Virkkala. *Comment*: sample older than transgression of Lake Saimaa.

5210 ± 140
Su-133. Siilinjärvi, central Finland **3260 B.C.**
$\delta C^{13} = -4.94‰$

Trapa fruits from hand-dug section, depth 1.15 to 1.20 m surface alt 103 m, Mikansuo bog (63° 10′ N Lat, 27° 33′ E Long). Coll. 1969 by V. E. Valovirta. *Comment*: pollen analysis shows latter half of Atlantic period.

2440 ± 100
Su-98. Enontekiö, N Finland **490 B.C.**
$\delta C^{13} = -1.54‰$

Pine stem (*Pinus sylvestris*) from bottom of Lake Ropinjärvi (68° 41′ N Lat, 21° 36′ E Long). Coll. 1968 by Eino Lappalainen. *Comment*: organic bottom sediment was insufficient for pollen dating. Sample was ca. 30 km N of present pine forest limit (ref: E. Lappalainen, 1970b).

4850 ± 160
Su-99. Enontekiö, N Finland **2900 B.C.**
$\delta C^{13} = -0.31‰$

Pine stem (*Pinus sylvestris*) from bottom Lake Peerajärvi (68° 53′ N Lat, 21° 06′ E Long). Coll. 1968 by Eino Lappalainen. *Comment*: organic bottom sediment was insufficient for pollen dating. Sample, diam. 30 cm, was ca. 60 km N of present pine forest limit. In zone of pollen diagrams used in Finnish Lapland (e.g., Salmi, 1968), this date coincides with Zone Limit VII/VIII, *i.e.,* beginning of Sub-Boreal period (ref: E. Lappalainen, 1970b, p. 150).

3610 ± 120
Su-102. Pelkosenniemi, N Finland **1660 B.C.**

Bryales-Carex peat taken with piston sampler 1.35 to 1.45 m below bog surface, 163 m, at Sudenvaaranaapa (67° 13′ N Lat, 27° 37′ E Long). Coll. 1965 by Eino Lappalainen. *Comment*: pollen analysis shows rise in

Picea pollen; horizon represents Sub-Boreal period (compare Su-103; ref: E. Lappalainen, 1970a, p. 62).

Su-103. Sodankylä, N Finland **3280 ± 120**
1330 B.C.

Carex-Bryales-Sphagnum peat taken with piston sampler 1.39 to 1.44 m below bog surface at Virttiövuoma, alt 199 m (67° 30′ N Lat, 25° 50′ E Long). Coll. 1965 by Eino Lappalainen. *Comment*: pollen analysis shows rise in *Picea* pollen. Su-102 is 80 km E of Virttiövuoma (ref: E. Lappalainen, 1970a, p. 57).

Su-104. Pelkosenniemi, N Finland **8450 ± 150**
6500 B.C.

Carex-Sphagnum peat taken with piston sampler 4.95 to 5.01 m below bog surface at bog Kairanaapa, alt 151 m (67° 12′ N Lat, 27° 31′ E Long). Coll. 1965 by Eino Lappalainen. *Comment*: pollen analysis shows transition from *Betula* to *Pinus* maximum (ref: E. Lappalainen, 1970a, p. 59).

Su-105. Sodankylä, N Finland **7870 ± 110**
5920 B.C.

Sphagnum-Carex peat taken with piston sampler 3.73 to 3.78 m below the bog surface at Lehonjänkä, alt 182 m (67° 24′ N Lat, 27° 40′ E Long). Coll. by Eino Lappalainen. *Comment*: pollen analysis shows increase in *Alnus* pollen, Zone Boundary V/VI (ref: E. Lappalainen, 1970a, p. 58).

Su-106. Pelkosenniemi, N Finland **9030 ± 120**
7080 B.C.

Carex-Bryales peat taken with piston sampler 4.34 to 4.41 m below bog surface. Same bog as in Su-102. Coll. 1965 by Eino Lappalainen. *Comment*: pollen analysis shows middle Pre-Boreal period, Zone IV (ref: E. Lappalainen, 1970a, p. 61).

Tohmajärvi series

Wood and peat taken with piston sampler from peat bog near Kangasvaara in Tohmajärvi, E Finland (62° 16′ N Lat, 30° 22′ E Long), surface alt 90 m. Coll. 1968 by A. Leino and P. Lindroos.

Su-117. Tohmajärvi **5270 ± 100**
3320 B.C.

Wood from peat bog, depth 160 m. *Comment*: pollen analysis indicates Postglacial climatic optimum.

Su-118. Tohmajärvi **8800 ± 200**
6850 B.C.

Sphagnum-Phragmites peat, depth 2.80 to 2.90 m. *Comment*: pollen analysis shows beginning of Boreal *Pinus* maximum.

Su-120. Tohmajärvi **9200 ± 100**
7250 B.C.

Bryales peat, depth 3.30 to 3.40 m. *Comment*: pollen analysis shows Pre-Boreal *Betula* maximum.

Su-119. Tohmajärvi, Vatala **4180 ± 100**
2230 B.C.

Surface alt 117 m (62° 19′ N Lat, 30° 24′ E Long). *Eriophorum-Sphagnum* peat taken with a piston sampler, depth 0.60 to 0.65 m. Coll. 1968 by A. Leino and P. Lindroos. *Comment*: sample represents Sub-Boreal period.

Su-121. Askola, S Finland **4480 ± 100**
2530 B.C.

Carex peat from hand-dug section, depth 0.65 to 0.75 m, surface alt 32.5 m, Porrassuo bog (60° 31′ N Lat, 25° 31′ E Long). Coll. 1969 by R. Tynni and E. Kukkonen. *Comment*: according to pollen and diatom analyses, sample represents maximum of Littorina III stage, or immediately postdates it, and isolation of bog basin during Sub-Boreal (Tynni, 1966).

Su-122. Askola, S Finland **7000 ± 130**
5050 B.C.

Detritus gyttja from same bog as Su-121 taken with piston sampler, depth 1.05 to 1.15 m. Coll. 1969 by R. Tynni and E. Kukkonen. *Comment*: sample represents maximum of Littorina I b stage.

Su-128. Taipalsaari, SE Finland **6060 ± 100**
4110 B.C.

Submerged stump of *Pinus,* Lake Saimaa, Viskarila (61° 9′ N Lat, 28° 12′ E Long). Sample was taken ca. 0.5 to 1.0 m below lake level, alt +75.8 m. Coll. 1969 by Osmo Hyppönen. *Comments*: sample represents Postglacial transgression of Lake Saimaa (V. Lappalainen, 1962; Saarnisto, 1970).

Su-129. Taipalsaari, SE Finland **2400 ± 100**
450 B.C.

Submerged stem of *Pinus,* Lake Saimaa, Pieni Jänkäsalo (61° 13′ N Lat, 28° 11′ E Long). Sample was taken ca. 2 m below lake level, alt +74 m. Coll. 1970 by Osmo Hyppönen. *Comments*: as C^{14} age of sample is ca. 3600 yr younger than Su-128, pine stem probably is driftwood and not related to Lake Laimaa transgression.

Sedimentation rate series, S Finnish lakes

Su-130. Vihti **690 ± 100**
A.D. 1260
$\delta C^{13} = -4.32‰$

Gyttja clay sediment taken with gravity corer from Lake Hiidenvesi, depth 60 to 70 cm below bottom (60° 24.5′ N Lat, 24° 19′ E Long), lake level alt 31.7 m; water depth at core 4.2 m. Coll. 1969 by H. Harjula. Subm. by Esa Kukkonen. *Comment*: presence of allochthonous humus is possible.

Su-131. Vihti **770 ± 100**
A.D. 1180
$\delta C^{13} = -5.26‰$

Gyttja clay sediment taken with piston corer from Lake Hiidenvesi, depth 60 to 70 cm below bottom (60° 23′ N Lat, 24° 11′ E Long), lake level alt 31.8 m and water depth at core 4.2 m. Coll. 1969 by E. Kukkonen. *Comment*: according to pollen analysis horizon is younger than increase of cereal pollen. Presence of allochthonous humus is possible.

Su-132. Tuusula **860 ± 110**
A.D. 1090
$\delta C^{13} = -8.35‰$

Gyttja clay taken with gravity corer from Lake Tuusulanjärvi, depth 60 to 70 cm below bottom (60° 26′ N Lat, 25° 03′ E Long). Lake level alt 37.8 m; water depth at core 9 m. Coll. 1969 by H. Harjula. Subm. by Esa Kukkonen. *Comment*: presence of allochthonous humus is possible.

B. North America

Su-89. Portland, Maine **450 ± 100**
A.D. 1500

Peat, depth 0.1 to 0.2 m Scarboro, drowned (43° 34′ N Lat, 70° 20′ W Long). Coll. 1959 by E. Hyyppä.

Su-90. Portland, Maine **830 ± 100**
A.D. 1120

Same section as Su-89, root, depth 0 to 0.1 m. Coll. 1959 by E. Hyyppä.

Su-91. Eastport, Maine **4770 ± 120**
2820 B.C.

Stump, depth 1.5 m, surface alt 5 to 6 m, Jones Port, Popplestone Beach (44° 34′ N Lat, 67° 35′ W Long). Coll. 1959 by E. Hyyppä.

Su-92. Kewaunee, Wisconsin **12,200 ± 160**
10,250 B.C.

Wood, depth 4 m, surface alt 195 m, Two Creeks (44° 20′ N Lat, 87° 32′ W Long). Coll. 1959 by E. Hyyppä.

Su-93. Quebec, Canada **>35,000**

Wood and root, depth 20 m, surface alt 33 m, St. Pierre les Becquets (46° 31′ N Lat, 72° 12′ W Long). Coll. 1959 by E. Hyyppä.

Su-94. Quebec, Canada **>40,000**

Same section as Su-93, organic remains, depth 20 m. Coll. 1959 by E. Hyyppä.

Su-95. Rye, New Hampshire **4160 ± 125**
2210 B.C.

Wood and stump from lowest tide limit, Odiornes Point (43° 03′ N Lat, 70° 44′ W Long). Coll. 1959 by E. Hyyppä.

3820 ± 135
Su-96. Rye, New Hampshire **1870 B.C.**

Same section as Su-95, wood and stump. Coll. 1959 by E. Hyyppä.

4230 ± 125
Su-97. Rye, New Hampshire **2280 B.C.**

Same section as SU-95 and -96, peat. Coll. 1959 by E. Hyyppä.

3810 ± 110
Su-113. Sagamore, Massachusetts **1860 B.C.**

Peat, depth 2.10 to 2.30 m, Cape Cod Canal (41° 47′ N Lat, 70° 32′ W Long). Coll. 1938 by E. Hyyppä.

REFERENCES

Hyyppä, Esa, 1966, The late-Quaternary land uplift in the Baltic sphere and the relation diagram of the raised and tilted shore levels: Acad. Sci. Fennicae Annales, A. III, v. 90, p. 153-168.

Hyyppä, E., Heikkinen, A., and Toivonen, V., 1969, Geological Survey of Finland radiocarbon measurements IV: Radiocarbon, v. 11, p. 183-187.

Lappalainen, E., 1970a, Über die spätquartäre Entwicklung der Flussufermoore Mittel-Lapplands: Comm. géol. Finlande Bull., no. 244.

———— 1970b, Subfossil pine stems from northern side of present pine limit in Finnish Lapland: Geologi, v. 22, p. 150-153.

Lappalainen, V., 1962, The shore-line displacement on Southern Lake Saimaa: Acta Bot. Fennica, v. 64.

Östlund, H., G. and Engstrand, L. G., 1963, Stockholm natural radiocarbon measurements V: Radiocarbon, v. 5, p. 203-227.

Saarnisto, Martti, 1970, The Late Weichselian and Flandrian history of the Saimaa Lake complex: Comm. Phys. Math., v. 37.

Salmi, M., 1968, Development of palsas in Finnish Lapland: third internatl. peat Cong. Proc., Quebec, Canada, 1968, sec. 1.

Tynni, Risto, 1966, Über spät-und postglaziale Uferverschiebung in der Gegend von Askola, Südfinnland: Comm. géol. Finlande Bull., no. 223, p. 26.

[RADIOCARBON, VOL. 13, NO. 2, 1971, P. 442-449]

TATA INSTITUTE RADIOCARBON DATE LIST IX

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The C^{14} dates given below are in years B.P. calculated on the basis of $\tau_{1/2} = 5568$ years. For converting to A.D./B.C scale, 1950 was used as reference year. Ninety-five per cent activity of NBS oxalic acid was used as a modern standard.

Radiocarbon activity was counted after converting sample carbon into methane gas (Agrawal *et al.,* 1965). Up to now, we used the synthesis technique developed by Anand and Lal (1964) in which the sample CO_2 and appropriate amounts of zinc and water (tritium-free) are allowed to react in the presence of ruthenium catalyst inside a reaction vessel with temperature zones of 430° and 500°C. In the reaction,

$$CO_2 + 2\ H_2O + 4\ Zn = CH_4 + 4\ ZnO \qquad (1)$$

a continuous hydrogen supply, until completion of the reaction, is provided by water reacting with zinc powder maintained at 430°C. Thus, reaction (1) is, in principle, the same as originally employed by Burke and Meinschein (1955),

$$CO_2 + 4\ H_2 = CH_4 + 2\ H_20 \qquad (2)$$

as far as synthesis of methane for counting C^{14} activity is concerned. Reaction (2) leads to an incomplete conversion of hydrogen and is, therefore, not satisfactory for methane synthesis for H^3 measurement.

Reaction (2) was successfully used for the first time by Fairhall *et al.* (1961) for radiocarbon measurements. Subsequent modifications were reported by Olson and Nickloff (1965) and Polach and Stipp (1967). Techniques employing reaction (2) are in use in several C^{14} laboratories. We now use reaction (2) as such for methane synthesis in our laboratory and briefly describe here apparatus and experimental techniques, since our procedures lead to fairly routine, simple, and quick analyses with yields better than 99%. The prime reason for adopting this system was that we occasionally discovered that synthesized methane was contaminated with artificial tritium used in the TIFR laboratories. The technique adopted for reaction (1) involved opening the reaction vessel for every synthesis for replacing consumed zinc and introducing the water ampule; frequently, it also became necessary to remove spilled fragments of pyrex glass (from the fragmented ampules) and grains of zinc oxide. In the system described below, the reaction vessel is not opened and all that is required is introduction of the sample CO_2 in the reaction vessel; the CO_2 is let in through a cold trap (dry ice + acetone) to remove any traces of water.

Our reactor vessel which, in some respects, resembles that used by Oeschger (pers. commun.) has a volume of 26 L; it is made of hemispherical stainless steel vessels with flanges on their rims (Fig. 1). At the bottom is a stainless steel finger (X), diam. 3.81 cm and length 15.24 cm.

The heater tray (A) for the catalyst consists of a platinum coil encased in quartz tubes and is placed in a perforated silver box (see inset plan of heater tray in Fig. 1). The catalyst is spread over the heater to expose maximum surface area. Electrical heat is provided through 2 ceramic-metal hermetic seals connected to the body of the reactor. The two reactor parts are closed with a teflon O-ring (G), placed in the groove on

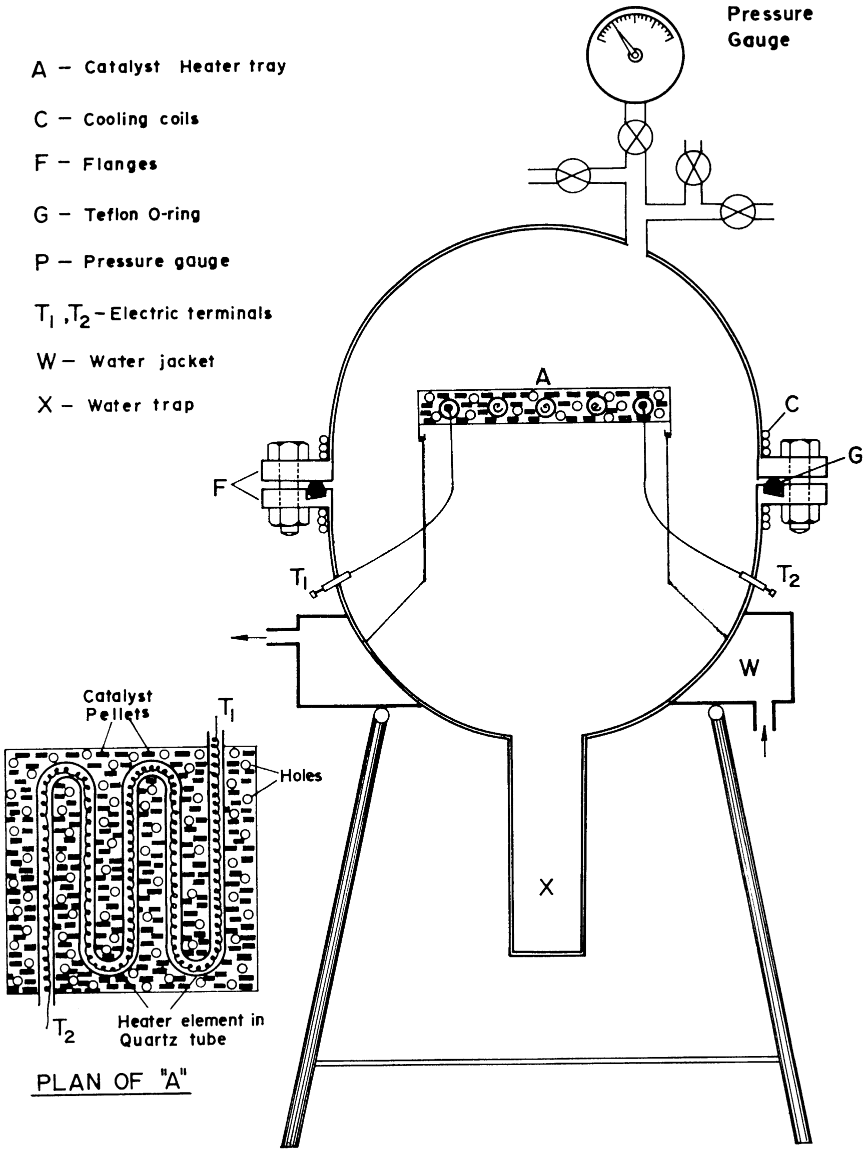

Fig. 1. Diagram showing the construction design of the reactor used for methane synthesis.

the flanges. The flanges are cooled by water circulating through copper tubes brazed on to the flange. The reactor assembly is placed on a water-cooled jacket (W) to speed up condensation of any water draining to the trap X. For a synthesis, CO_2 and H_2 corresponding to 20% excess over the stoichiometric requirement are let into the reactor and the catalyst tray is heated to ca. 450°C.

Reaction rate can be seen from the pressure vs. time curve (Fig. 2). Maximum pressure in the vessel is reached in 20 minutes. At this point, Trap X (Fig. 1) is cooled with dry ice to remove water that is formed. Drop in pressure is very fast after 35 minutes and reaction is complete in about 3 hours, even with a large sample (10 L CO_2).

The reaction products are successively let through 3 dry-ice traps (to remove all traces of H_2O), 2 liquid-N_2-cooled traps and a liquid-N_2-cooled U-tube, filled with silica gel* (12-28 mesh) and here called S. The reactor is fairly quickly emptied by gentle pumping on the leading end of S. No methane is lost from S provided the quantity of silica gel exceeds 7 g per liter of CH_4. For purification of methane, pumping with a rotary pump is continued on the leading end of S for 40 to 50 mins. until most of the hydrogen is removed. Distillation of methane into S from traps 1 and 2 is then allowed to proceed for an hour, with pumping on the leading end of S alternating, at 15-min. intervals, with connection beyond S to a liquid-N_2-cooled activated-charcoal trap. Any remaining hydrogen is completely removed during this procedure.

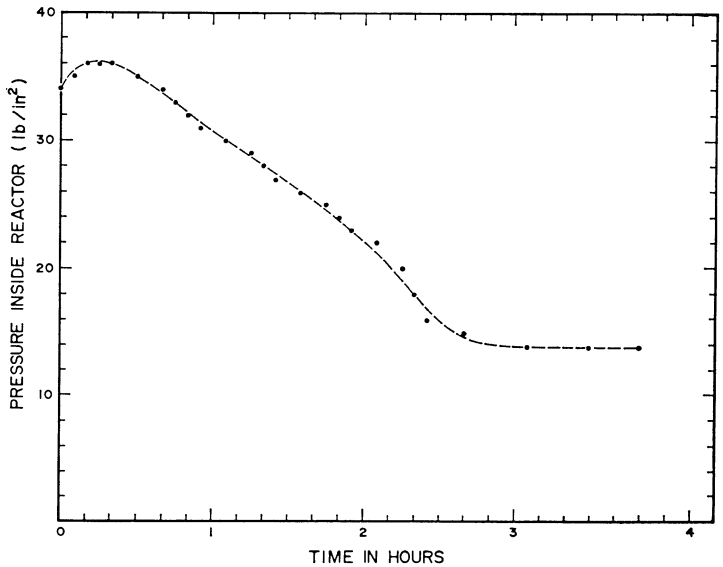

FIG. 2

Fig. 2. Typical pressure vs. time curve for methane synthesis from 9 L CO_2. Initial pressure in the reactor = 34 lbs./sq. in. at t = 0 when the catalyst heater tray is switched on.

* Davison Chemical, Baltimore 3, Maryland, U.S.A.

The methane so purified is then expanded into flasks. Recovery is 98 to 99%; 1 to 2% loss is attributed to pumping and not to incomplete conversion. The undistilled portion remaining in the traps 1 and 2 is less than 0.1% of the original CO_2 sample. In the 3 samples of synthesized methane, analyzed by gas chromatography, CO_2 was less than 0.1% in 2 samples and 0.3% in 1 sample.

Using H_2 from 2 sources*, the synthesized methane from "dead" CO_2 gave a background counting rate of 1.4 c.p.m. (for 1.5 L effective volume in an Oeschger counter, filled to 120 cm Hg)—the same as that found with reaction (1) used so far with "dead" water.

In summary, these procedures enable quick and complete synthesis (3 hrs) of large samples (10 to 12 L) in one operation. Pure methane, free of hydrogen, is obtained easily and has never required extra purification steps. The trouble-free high-efficiency synthesis rests on the fact that we use amounts of H_2 in excess of stoichimetric requirements of 20 to 25%. This amount is an optimum, corresponding to conversion yields close to 100%. We have learned that using <20% excess H_2 for the reaction synthesis results in incomplete synthesis, with yields ca. 95%. If >30% excess H_2 is used, purification of CH_4 from excess H_2 becomes quite problematic. We underline this here, because, either in reactions (1) or (2) eliminating of excess H_2 from the synthesized methane is an acute problem. Recently Buddemier *et al.* (1970) used a palladium alloy hydrogen-diffusion cell to remove excess hydrogen from synthesized methane. Their technique is complicated by self-timed solenoid pumps and palladium cells which are subject to poisoning.

*General Comment***: Bagor, a Neolithic site in Rajasthan, was dated to ca. 4500 B.C. (TF-786), thus far the earliest such site in India. The occurrence of copper, in the form of arrowheads, in the 3rd millennium B.C. (TF-1009) is also the earliest reported in India. The 1st millennium B.C. (TF-987) date for the habitation site of Korkai in Tamilnadu is also of special interest.

Of the Late Quaternary samples, TF-1003 is especially important because it dates Middle Stone Age tools found *in situ* at ca. 20,000 B.C.

The geochemical samples give C^{14} measurements of bicarbonates of deep ground water. Apparent C^{14} ages run into thousands of years, indicating the general antiquity of ground water in the deep part of the alluvium. The data provide limiting estimates on the postulated quantities of underground flow from hilly regions. (Detailed paper to be published elsewhere).

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* From Messrs. Griesheim GMBH, Dusseldorf, W. Germany and Indian Oxygen Ltd., Oxygen House, T/34 Taratal Road, Calcutta 53.

** Dates referred to in this Comment and apparent ages of geochemical samples, are based on $\tau_{1/2} = 5730$ yr. Formal dates for archaeologic and geologic dates are reported by the usual convention, $\tau_{1/2} = 5570$ yr, as stated in the Introduction.

and to S. V. Kerkar for assistance. We thank J. Shankar of Bhabha Atomic Research Centre, Bombay, for gas chromotographic analyses.

SAMPLE DESCRIPTIONS

I. ARCHAEOLOGIC SAMPLES

895 ± 105
TF-1019. Ambari, India, historic **A.D. 1055**

Wood from Ambari (26° 11′ N Lat, 91° 45′ E Long) Dist. Kamrup, an historic site of Gupta and Post-Gupta period, Tr. X 1-2161, Layer 3, depth 1.2 m. Subm. by M. G. Goswami, Dept. of Anthropol., Gauhati Univ., Gauhati. NaOH pretreatment was given.

Bagor series, Rajasthan

Bagor (25° 22′ N Lat, 74° 23′ E Long) Dist. Bhilwara is a Late Stone age site. *Comment*: only inorganic carbon from charred bones was used for dating, which, however, appear fairly consistent. Subm. by H. D. Sankalia, Deccan College, Poona.

6245 ± 200
TF-786. Bagor culture **4295 B.C.**

Charred bones, Tr. BGR/E-IV, Layer 2, depth 1.17 to 1.26 m, Field No. BGR-5. Typical geometric microliths with pottery.

3945 ± 90
TF-1005, -1006. Bagor culture **1995 B.C.**

Charred bones, Tr. E-11 from depths 0.73 to 0.78 m and 0.79 to 0.88 m, were mixed; Field Nos. BGR 1968-9E/II-5 and E II-6.

5620 ± 125
TF-1007. Bagor culture **3670 B.C.**

Charred bones, Tr. E-I, depth 0.99 to 1.1 m, Field No. BGR 1968-9/E 1-4.

4585 ± 105
TF-1009. Bagor culture **2635 B.C.**

Charred bones, Tr. G-III, depth 0.89 to 0.98 m, Field No. BGR 1968-9/G III-12.

5090 ± 85
TF-1011, -1012. Bagor culture **3140 B.C.**

Charred bones, Tr. G-V, from depths 1.21 to 1.3 m and 1.31 to 1.4 m, were mixed, Field Nos. BGR 1968-9/G V-18 and GV-19.

1620 ± 90
TF-989. Bhitari, India, Gupta period **A.D. 330**

Charcoal from Bhitari (25° 32′ N Lat, 83° 15′ N Long), Dist. Ghazipur, Loc. BTR-2/AO′, depth 3.8 m, Field No. BTR-2. Subm. by K. K. Sinha, Banaras Hindu Univ., Varanasi-5. NaOH pretreatment was given.

Chirand series, Bihar

Chirand (25° 45′ N Lat, 84° 45′ E Long), Dist. Saran, is a Black-and-Red ware site. Samples subm. by B. P. Sinha, Dir. Archaeol., Govt. of Bihar, Patna-15. All samples were given NaOH pretreatment.

2915 ± 85
TF-1029. Black-and-Red ware deposits **965 B.C.**

Charcoal, Layer 10, depth 6.5 m, Field No. CRD XI.

3430 ± 100
TF-1030. Black-and-Red ware deposits **1480 B.C.**

Charcoal, Layer 11, depth 6.9 m, Field No. CRD XI.

1775 ± 125
TF-995. Inamgaon, India **A.D. 175**

Charcoal from Inamgaon (18° 35′ N Lat, 74° 32′ E Long), Dist. Poona, Tr. INM-1, Loc. Tr. A_2, Layer 3, Field No. 454, subm. by H. D. Sankalia. NaOH pretreatment was given.

2355 ± 200
TF-957. Kalibangan, India, Pre-Harappa culture (?) **405 B.C.**

Wood from Kalibangan (29° 25′ N Lat, 74° 05′ E Long), Dist. Shri Ganganagar, Loc. ZB8/Qd. 3, 3.15 m, Layer 15, Field No. 1967-68/38/KLB-1, subm. by Dir. Gen. Archaeol., New Delhi-11. *Comment*: date, ca. 2000 yr, younger than expected.

3485 ± 95
TF-974. Kayatha, India, Chalcolithic culture **1535 B.C.**

Charcoal from Kayatha (23° 14′ N Lat, 76° 02′ E Long) Dist. Ujjain, Tr. KTH-B, Layer 19, Field No. KTH-B, 1466, subm. by Z. D. Ansari, Deccan College, Poona-6, NaOH pretreatment was given.

2680 ± 90
TF-987. Korkai, India, habitation site **730 B.C.**

Wood from Korkai, Dist. Tirunelveli, Loc. 0-1, Layer 5, depth 3.17 m, Field No. KRK-1; subm. by Dir. of Archaeol., Madras-25. NaOH pretreatment was given.

II. GEOLOGIC SAMPLES

35,050 $^{+5390}_{-3200}$
TF-902. Porbandar, Pleistocene sediments **33,100 B.C.**

Shells from sediment of an emerged beach near Porbandar Villa (21° 38′ N Lat, 69° 36′ E Long), Dist. Junagadh, Gujarat. Loc. 33, height above high water level 3.5 m. Sample 1, subm. by S. K. Gupta.

TF-1021. Sundernagar, Holocene **2610 ± 95**
660 B.C.

Wood fragments from Sundernagar (31° 32′ N Lat, 76° 33′ E Long), Dist. Mandi, Himachal Pradesh, subm. by C. P. Vora, Geol. Survey India, Chandigarh. NaOH pretreatment was given.

III. GEOCHEMICAL SAMPLES

The following samples were collected by members of our Geophysics Group studying groundwater resources. Dissolved bicarbonates from the water were picked up on IR-45 and IRA-400 anion exchange resins. CO_2 for dating was then extracted from the resins by eluting them with 1 normal HCl. Results are given as percentage of the modern standard.

Gujarat series

Subm. by V. N. Nizampurkar.

Lab. no.	Location	Depth	δC^{14} % of Modern
TF-841	Kalol, Dist. Mehsana	187 m	64.15 ± 0.98
TF-842	Mansa, Dist. Mehsana	131 m	84.31 ± 0.90
TF-843	Pilvai, Dist. Mehsana	135 m	72.76 ± 0.95
TF-845	Dama, Dist. Banaskantha	150 m	80.21 ± 0.94
TF-846	Deesa, Dist. Banaskantha	dug well	115.73 ± 1.25

Rajasthan series

Subm. by V. N. Nizampurkar.

Lab. no.	Location	Well no.	Depth	δC^{14} % of Modern	Aquifer no. of region being pumped by tube-well
TF-1095	Bhairwa, Dist. Jasalmer	3	220 m	37.64 ± 0.72	Third
TF-1096	Bhairwa, Dist. Jasalmer	4	130 m	42.39 ± 0.79	First
TF-1097	Bhairwa, Dist. Jasalmer	5	170 m	42.88 ± 0.60	Second
TF-1121	Ajasar, Dist. Jasalmer	–	88 m	11.91 ± 0.33	First
TF-1120	Ajasar, Dist. Jasalmer	–	160 m	36.27 ± 0.87	Third

Uttar Pradesh series

Subm. by P. S. Daudkhane.

Lab. no.	Location	Depth	δC^{14} % of Modern
TF-1038	Kakragaor, Dist. Meerut (29° N Lat, 77° 12′ E Long)	120 m	8.54 ± 0.33
TF-1039	Shukartal, Dist. Muzaffar Nagar (29° 24′ N Lat, 78° 5′ E Long)	120 m	63.86 ± 1.04
TF-1040	Darhawali, Dist. Aligarh (28° 48′ N Lat, 78° 5′ E Long)	120 m	77.19 ± 0.90
TF-1042	Bhongaon, Dist. Mainpuri (27° 12′ N Lat, 79° 5′ E Long)	120 m	36.14 ± 0.58
TF-1043	Khanda, Dist. Bulandsahar (28° 24′ N Lat, 77° 54′ E Long)	125 m	71.14 ± 1.20

References

Agrawal, D. P., Kusumgar, S., and Lal, D., 1965, The measurement of C^{14} activity and some age determinations of archaeological samples: Current Sci., v. 34, p. 394-397.

Anand, J. S. and Lal, D., 1964, Synthesis of methane from water for tritium measurement: Nature, v. 201, p. 775-777.

Buddemeier, R. W., Young, A. Y., Fairhall, A. W., and Young, J. A., 1970, Improved system of methane synthesis for radiocarbon dating: Rev. Sci. Instruments, v. 41, p. 652-654.

Burke, W. H., Jr. and Meinschein, W. G., 1955, C^{14} dating with a methane proportional counter: Rev. Sci. Instruments, v. 26, p. 1137-1140.

Fairhall, A. W., Schell, W. R. and Takashima, Y., 1961, Apparatus for methane synthesis for radiocarbon dating: Rev. Sci. Instruments, v. 32, p. 323-325.

Olson, E. A. and Nickoloff, N., 1965, A system for methane synthesis: Internatl. C^{14} and H^3 dating conf. Proc., Pullman, Washington, June 7-11, p. 41-52.

Polach, H. A. and Stipp, J. J., 1967, Improved synthesis technique for methane and benzene radiocarbon dating: Internatl. Jour. Appl. Radiation and Isotopes, v. 18, p. 359-364.

[RADIOCARBON, VOL. 13, No. 2, 1971, P. 450-467]

BELFAST RADIOCARBON DATES IV

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INTRODUCTION

The dating equipment and operating conditions remain essentially as previously described. All samples in this list have been counted at a filling pressure equivalent to 152 cm Hg at 20°C. The proportional counter has recently been re-wired, resulting in a lowering of the operating voltage. Electron-microscopic examination of the old counter wire showed considerable thickening due to the accumulation of fine dust particles. A filter is being installed in the filling line to minimize this effect. Pretreatments are as given in previous date lists unless otherwise stated.

The carbon isotope ratios reported in this list were determined on a Vacuum Generators Micromass 6 unit at the Vacuum Generators Ltd. factory. The instrument has now been installed in the Palaeoecology Laboratory. The δC^{13} for our current oxalic acid standard is -1.989% relative to P.D.B. Mass spectrometric results have been corrected to -1.9% for oxalic acid.

Samples in this list are from Ireland unless otherwise specified.

ACKNOWLEDGMENTS

Routine operation of the dating apparatus has been carried out by Florence Qua and Anise Colville to whom we are much indebted. We gratefully acknowledge the continued financial support of the Natural Environment Research Council. We thank the following for financial support for the dating of specific samples: The Hunterian Museum, Glasgow, The New University of Ulster, The Dundrum Field Studies Committee. We thank the archaeologists who have contributed the material described in Section I for their cooperation. A number of determinations have been made related to the work of P. Q. Dresser, Physics Dept., Trinity College, Dublin, and we thank him for contributing his comments to this list.

I. ARCHAEOLOGIC SAMPLES

Craig na Caillich series, Perthshire, Scotland

Peat from above and below stone-axe-working floor in blanket bog at Craig na Caillich, 3.2 km N of Killin, Perthshire, Scotland (56° 30′ N Lat, 4° 20′ W Long; Grid Ref. NN/561368). Coll. and subm. 1969 by E. W. MacKie, Hunterian Mus., Glasgow. (Ritchie, 1968). Acid pretreatment.

4460 ± 90
UB-371. Craig na Caillich, CC/2 **2510 B.C.**

1.5 cm peat, 30 cm above base, underlying axe-making floor.

UB-372. Craig na Caillich, CC/3 **4200 ± 90**
2250 B.C.

1.5 cm peat, 35 cm above base, overlying axe-making floor.

General Comment (E.W.McK.): thin layer of factory debris in peat suggests this part of site was used as working floor for only a short period; the 2 measurements should date this period precisely. They compare well with date 2590 ± 130 B.C. (Q-430) for axe from Craig Llwyd factory from peat at Shapwick Heath, Somerset (Godwin, 1960a; R., 1960, v. 2, p. 62). Date 1144 ± 90 B.C. (Q-387: R., 1961, v. 3, p. 73) for quarry pits at Mynydd Rhiw factory, Caernarvonshire, refers to layer formed after end of factory activity (Houlder, 1961, pp. 121-2, 141). Date 2730 ± 135 B.C. (BM-281) was for charcoal assoc. with Langdale axe factory (R., 1969, v. 11, p. 288).

Dundrum Nature Reserve series, Co. Down

Samples from soil horizons, some with archaeologic material, in sand dunes in Dundrum Nature Reserve, 3.2 km NE of Newcastle, Co. Down (54° 13′ 30″ N Lat, 5° 52′ 30″ W Long) alt. ca. 15 to 23 m O.D. Subm. by N. Stephens, Dept. Geog., Queen's Univ., Belfast.

UB-412. Dundrum hearth, Site 12, Sample 2 **4775 ± 140**
2825 B.C.

Charcoal from pebble-floored hearth; Irish Grid Ref. J 405345. Coll. 1968 by A. E. P. Collins, Archaeol. Survey of N. Ireland.

UB-413. Dundrum hearth, Site 12, Sample 1 **4565 ± 135**
2615 B.C.

Charcoal from same pebble-floored hearth as UB-412 above. Coll. 1967 by R. C. Davidson, Inch, Downpatrick.

UB-352. Dundrum, Slidderyford Hollow **3635 ± 80**
1685 B.C.

Charcoal from fossil soil horizon exposed in side of blow-out; Irish Grid Ref. J 398341. Coll. 1969 by N. Stephens.

UB-461. Dundrum, The Cut **Modern**

Charcoal from fossil soil horizon exposed in erosion gully; Irish Grid Ref. J 400340. Coll. 1970 by I. Shepherd, Dept. Geog., Queen's Univ., Belfast. *Comment*: presumably contaminated by modern charcoal. Soil horizon expected to be prehistoric by comparison with UB-352.
General Comment: hearth assoc. with old land surface producing plain carinated Western Neolithic bowls and worked flints (Collins, 1952; 1959). Dublin date 2860 ± 140 (D-51: R., 1961, v. 3, p. 34) for charcoal from occupation horizon, Grid Ref. J 409388, comparable with UB-412 and 413, was inexplicably too young.

UB-414 E. Scrabo hut circle, Co. Down **2305 ± 70**
355 B.C.

Charcoal from wall slot of round hut on Scrabo hill, 2.4 km W of Newtownards, Co. Down (54° 34′ N Lat, 5° 43′ 30″ W Long; Irish

Grid Ref. J 477727) alt. ca. 150 m O.D. Coll. 1969 by A. G. Smith. Site excavated by Margaret Owens for Ards Historical Soc. Permanganate pretreatment.

UB-414 A. (Un-pretreated) 1925 ± 100

Comment: archaeologic evidence suggests site was occupied at transition between Bronze and Iron ages. Comparable dates from Navan, Co. Armagh (R., 1970, v. 12, p. 287-288) and Lough Gara, Co. Sligo (R., 1961, v. 3, p. 34-35). Un-pretreated sample demonstrates large error that can be due to contamination in superficial soil samples.

5095 ± 120
UB-205. Mad Man's Window, Co. Antrim 3145 B.C.

Charcoal from Neolithic hearth at Mad Man's Window, 1.6 km E of Glenarm, Co. Antrim (54° 57′ 30″ N Lat, 5° 55′ W Long; Irish Grid Ref. D 330150) alt. 11 m O.D. Sample from Neolithic hearth on top of large flat boulder, with Western Neolithic pottery and flints, and 2 crude rough-outs of flint axes. Coll. 1968 by M. G. L. Baillie and P. C. Woodman, Ulster Mus., Belfast. Pretreatment by nitration. *Comment*: hearth and artifacts are early Neolithic; date is comparable with other early Neolithic dates from N Ireland (see R., 1971, v. 13, p. 107). Hearth was in buried soil on possible wave-cut platform.

Newgrange series, Co. Meath

Samples from Neolithic passage grave site at Newgrange, 3.2 km E of Slane, Co. Meath (53° 41′ N Lat, 6° 29′ W Long; Irish Grid Ref. O 006728). Coll. 1969 by P. Q. Dresser. (O'Kelly, 1969).

1650 ± 45
UB-360. Newgrange sod layer, 1 A.D. 300

Humic acid from upper sod layer within mound, 60 to 90 cm above old ground surface.

4535 ± 105
UB-361. Newgrange sod layer, 2 2585 B.C.

Humic acid from basal sod layer, 5 to 20 cm above old ground surface.

General Comment (P.Q.D.): loose stone structure of mound was probably ineffectual in preventing penetration by younger materials. Upper sample (UB-360) may thus be too young but lower (UB-361) agrees with GRN-5462 and GRN-5463 (4500 ± 45 and 4415 ± 40, respectively) from construction material in roof of chamber of cairn (O'Kelly, 1969).

Knowth series, Co. Meath

Samples from Neolithic passage grave site at Knowth, 3.2 km E of Slane, Co. Meath (53° 41′ N Lat, 6° 30′ W Long; Irish Grid Ref. N 996734). Coll. 1967-1969 by G. Eogan and P. Q. Dresser. (Eogan, 1968).

1200 ± 70
UB-299. Knowth, 1 A.D. 750

Charcoal from secondary occupation on summit of mound (Site 1), along E edge. *Comment*: date suggests secondary occupation was in Early Christian times.

4875 ± 150
UB-318. Knowth, 2 **2925 B.C.**

Charcoal from scatter in soil beneath mound of small passage grave to E of main mound, Area 4, Sq. 43. Sample not necessarily contemporary with mound construction.

4795 ± 185
UB-319. Knowth, 3 **2845 B.C.**

Charcoal from similar location to UB-318.

4745 ± 165
UB-357. Knowth, 4 and 5, charcoal **2795 B.C.**

Combined charcoal from Samples 4 and 5 from basal redeposited sod-like layer of mound of main passage grave; Sample 4, coll. 1969 by P. Q. Dresser from cutting 29/30, W face; Sample 5, coll. 1967 by G. Eogan, from Cutting 36.

6835 ± 110
UB-358. Knowth, 5 **4885 B.C.**

Humic acid from basal redeposited sod-like layer of mound of main passage grave, Cutting 36.

General Comment (P.Q.D.): UB-318, -319, and -357 are maximum only for building of megaliths. UB-358 indicates long persistence of humus in soil.

Gortcorbies archaeologic series, Co. Londonderry

Samples from Neolithic and Bronze age sites at Gortcorbies, 6.4 km NE of Limavady, Co. Londonderry (54° 59′ 30″ N Lat, 6° 50′ W Long; Irish Grid Ref. C 743259) alt. 273 m O.D. Sites close to valley bog from which Gortcorbies core series derive (this list). Coll. 1970 by A. G. Smith and I. C. Goddard. (May, 1938; 1950). Pretreatments by P. Q. Dresser.

2080 ± 95
UB-434 E. Gortcorbies, 1 **130 B.C.**

Charcoal from upper black layer between 2 stone mounds over Neolithic hearths.

UB-434 C. (humic acid) 1310 ± 75

1970 ± 95
UB-435 E. Gortcorbies, 2 **20 B.C.**

Charcoal from basal black layer between 2 stone mounds over Neolithic hearths.

UB-435 C. (humic acid) 1945 ± 85

1475 ± 70
UB-436. Gortcorbies, 3 **A.D. 475**

Charcoal (including *Quercus*) id. by A. G. Smith, from clay below, and surrounding, large stone just outside Bronze age stone circle.

General Comment: samples do not refer to Neolithic and Bronze age occupations and indicate Iron age occupation at sites. "Errant" sherd of Iron-age pottery was found at stone circle site by May (1938).

II. PALAEOECOLOGIC SAMPLES

Sluggan bog monolith series, Co. Antrim

Series from organic deposits from which pollen diagram was prepared from Sluggan bog, Ballylurgan Td., 2.4 km NE of Randalstown, Co. Antrim (54° 46′ N Lat, 6° 18′ W Long; Irish Grid Ref. J 009921) alt. 52 m O.D. Samples from 16-cm-sq. sec.; monolith adjacent to large samples used for geochemical research and dated as Sluggan series (this list). Coll. 1968 by A. G. Smith and I. C. Goddard.

1635 ± 75
UB-437. Sluggan monolith, 68 to 70 cm **A.D. 315**

Sphagnum peat. Final decline of elm pollen. Pollen Zone Boundary VIII/IX (Mitchell, 1956). Acid pretreatment.

2930 ± 85
UB-438. Sluggan monolith, 124 to 126 cm **980 B.C.**

Sphagnum peat. Marked minimum in tree pollen curve. *Comment* (I.C.G.): similar vegetational changes seen at this date in pollen diagram from Gortcorbies (UB-386, this list). Acid pretreatment.

3945 ± 85
UB-439. Sluggan monolith, 164 to 166 cm **1995 B.C.**

Sphagnum peat. Decline of pine pollen at Pollen Zone Boundary VII/VIII of Jessen (1949). At decline of tree-pollen curve and elm curve minimum; marked increase of heaths and peak of plantain curve suggestive of forest clearance. Acid pretreatment.

4180 ± 90
UB-440. Sluggan monolith, 184 to 186 cm **2230 B.C.**

Sphagnum peat. Second decline of elm pollen. Acid pretreatment.

4965 ± 75
UB-441. Sluggan monolith, 238 to 240 cm **3015 B.C.**

Sphagnum peat. At marked decline of elm and pine pollen and at level of 1st plantain pollen. Acid pretreatment.

8540 ± 120
UB-442. Sluggan monolith, 406 to 408 cm **6590 B.C.**

Particulate fraction of reedswamp peat with wood. Beginning of oak and elm curves at Pollen Zone Boundary V/VI.

9360 ± 150
UB-443. Sluggan monolith, 426 to 428 cm **7410 B.C.**

Particulate fraction of reedswamp peat with some wood. Marked rise of hazel curve and fall of birch curve marking Pollen Zone Boundary IV/V.

9610 ± 130
UB-444. Sluggan monolith, 460 to 462 cm 7660 B.C.

Particulate fraction of reedy detritus mud. Early postglacial rise of juniper pollen. Pollen Zone Boundary III/III-IV.

9010 ± 115
UB-445. Sluggan monolith, 468 to 470 cm 7060 B.C.

Particulate fraction of fine detritus mud. Immediately above stratigraphic change from clay to organic mud. Towards end of Zone III as defined pollen analytically but base of Zone IV on lithostratigraphic grounds (*cf.* Jessen, 1949). *Comment*: by comparison with UB-444 and UB-225 F and UB-443 higher in profile, which show a consistent trend, date is too young (see comment on fractionated samples, Geochemical Samples, this list).

10,995 ± 160
UB-446. Sluggan monolith, 498 to 500 cm 9045 B.C.

Particulate fraction of fine detritus mud with some moss and reeds. Fall of birch pollen from ca. 5% to ca. 2% of total in middle of Pollen Zone II.

11,635 ± 160
UB-447. Sluggan monolith, 508 to 510 cm 9685 B.C.

Particulate fraction of fine detritus mud with some moss and reeds. Immediately above a major peak of birch pollen in lower part of Pollen Zone II.

11,040 ± 140
UB-448. Sluggan monolith, 514 to 516 cm 9090 B.C.

Particulate fraction of fine detritus mud with some moss and reeds. Below major peak of birch pollen. Just above lower boundary of Pollen Zone II defined pollen analytically.

General Comment: complete series including samples under Geochemical Samples (R., 1970, v. 12, p. 296-297; R., 1971, v. 13, p. 124; and this list) is in sequence as follows: UB-210 A, -211 A, 437, -438-440, -219 A, -441, -220 A, -221 A, -223 D, -442, -443, -225 F, -444, -445, -227 F, -446-448, -229 F. Palynologic and other details not given previously for geochemical samples are:

UB-210 A, 42 to 47 cm, A.D. 965 ± 45 and UB-211 A, 47 to 52 cm, A.D. 725 ± 65. At minimum of tree pollen curve and peak of plantain pollen.

UB-219 A, 230 to 235 cm, 2700 ± 75 B.C. At minimum of elm and pine curves and maximum of plantain curve, immediately above Pollen Zone Boundary VII/VIII (*sensu* Mitchell, 1956) and VIIa/VIIb (*sensu* Jessen, 1949).

UB-220 A, 270 to 275 cm, 3340 ± 65 B.C. In middle of Zone VII (*sensu* Jessen, 1949).

UB-221 A, 295 to 300 cm, 4810 ± 90 B.C. Immediately above rise of alder curve marking Boreal-Atlantic transition, Pollen Zone Boundary VI/VII. Sample includes single grain of plantain pollen.

UB-223 D, 365 to 370 cm, 6410 ± 60 B.C. Just above Pollen Zone Boundary VIa/VIb.

UB-225 F, 445 to 450 cm, 7525 ± 145 B.C. At rise of birch and fall of juniper curves at Pollen Zone Boundary III-IV/IV (*cf.* zonation at Cannon's Lough; Smith, 1961).

UB-227 F, 482 to 487 cm, 8995 ± 145 B.C. Broadly covers Pollen Zone Boundary II/III at top of Allerød deposit and immediately below clay of Younger *Salix herbacea* period (*cf.* Jessen, 1949).

UB-229 F, 515 to 520 cm, 10,520 ± 125 B.C. Base of Allerød deposit: broadly covers Pollen Zone Boundary I/II.

General Comment on samples relevant to dating of Late-Weichselian and early Flandrian pollen zone boundaries (A.G.S. and I.C.G.): Sluggan samples referring to early pollen zone boundaries are:

Zone I/II. UB-229 F: 10,520 ± 125 B.C., comparable with Q-358: 10,000 ± 190 B.C., Q-359: 9895 ± 190 and 9880 ± 190 B.C. (R., 1964, v. 6, p. 117-118) for this boundary at Roddans Port, Co. Down; indistinguishable from I-3589: 10,550 ± 190 B.C. (R., 1970, v. 12, p. 102) for stratigraphically similar position at Blelham Bog, N Lancashire (*cf.* Pennington and Bonny, 1970).

Zone II/III. UB-227 F: 8995 ± 145 B.C., is close to date expected by Godwin (1959) and tends to confirm that Q-364: 9820 ± 190 B.C. and Q-365: 9520 ± 150 (R., 1964, v. 6, p. 118) for similar horizon at Roddans Port, Co. Down are too old; supported by date for base of Younger *Salix herbacea* clay at Roddans Port: UB-401 C: 9200 ± 95 B.C. (this list).

Zone III/III-IV. UB-444: 7660 ± 130 B.C., dates zone boundary defined biostratigraphically, ca. 10 cm above lithostratigraphic boundary. Date appears somewhat younger than lithostratigraphic boundary at Scaleby Moss, Cumberland, dated by Q-151-153 (R., 1959, v. 1, p. 64-65), and early postglacial juniper rise at Blelham Bog, N Lancashire, dated by I-3598: 8540 ± 160 (R., 1970, v. 12, p. 103; *cf.* Pennington and Bonny, 1970). Date is, however, close to Q-697 for apparently similar horizon at Bigholm Burn, Dumfrieshire, 7640 ± 170, 7520 ± 170 B.C. (R., 1964, v. 6, p. 120).

Zone III-IV/IV. UB-225 F: 7525 ± 140 B.C., is younger than Q-368: 8260 ± 150 B.C., (R., 1964, v. 6, p. 118) Roddans Port, Co. Down, from horizon slightly higher Zone IV. Q-699: 6700 ± 165 B.C. is from similar pollen analytic horizon at Bigholm Burn, Dumfriesshire, but was believed too young due to contamination (R., 1965, v. 7, p. 207). Comparable dates from similar horizon at Ballynagilly, Co. Tyrone, UB-260: 7645 ± 80 B.C., and at Slieve Gallion, Co. Tyrone, UB-321: 7260 ± 110 and UB-281, 7265 ± 75 B.C., (R., 1971, v. 13, p. 114).

Zone IV/V. UB-433: 7410 ± 150 B.C., indistinguishable from Q-922: 7506 ± 200 B.C., Red Moss, Lancashire (R., 1970, v. 12, p. 593) and Q-366: 7480 ± 150 B.C., Roddans Port, Co. Down (R., 1964, v. 6, p. 119), at younger end of range of British dates (*cf.* Godwin, 1960b).

Gortcorbies series, Co. Londonderry

Samples from 3 superposed cores, from which pollen diagram was prepared, from valley bog in Gortcorbies Td., 8 km WNW of Limavady, Co. Londonderry (54° 59′ N Lat, 6° 50′ W Long; Irish Grid Ref. C 740256) alt. ca. 210 m O.D. Coll. 1968 by A. G. Smith and I. C. Goddard. Sampling point is few hundred m from site of Neolithic and Beaker occupations (May, 1950; see Gortcorbies archaeologic series, this list). All samples received acid pretreatment. All sample depths are measured from bog surface.

730 ± 65
UB-389. Gortcorbies core, 41 to 44 cm **A.D. 1220**

Blanket peat. Final fall of tree pollen to very low level with striking increase of grass, sedge, heath, and plantain pollen.

1385 ± 65
UB-388. Gortcorbies core, 90 to 93 cm **A.D. 565**

Blanket peat. Mid-point of fall of tree pollen curve from ca. 60% to ca. 20%, immediately below tenfold increase of plantain pollen and rise of grasses and heaths.

2055 ± 65
UB-387. Gortcorbies core, 158 to 161 cm **105 B.C.**

Blanket peat. Fall of tree pollen curve from ca. 60% to ca. 30% and fall of elm curve to insignificant values from which it never recovers (*cf.* Pollen Zone Boundary VIII/IX, Mitchell, 1956). Non-tree pollen, particularly of grasses, sedges, and plantains rises.

3025 ± 70
UB-386. Gortcorbies core, 209 to 212 cm **1075 B.C.**

Amorphous organic deposit. Sharp fall of tree pollen from ca. 35% to ca. 20% at end of general fall from level of UB-385. Grass and plantain pollen increases temporarily; other weed species present.

3605 ± 70
UB-385. Gortcorbies core, 243 to 246 cm **1655 B.C.**

Highly humified reedy peat. Sample at end of presumed reedswamp phase of basin and at beginning of gradual decline of tree pollen from ca. 75% to ca. 35% just below UB-386. Heath, plantain, and other non-tree pollen rises steadily above level of sample.

4070 ± 75
UB-384. Gortcorbies core, 263 to 266 cm **2120 B.C.**

Highly decayed peat with some wood. Beginning of presumed reedswamp phase of basin: decline of pine values to below 2% (*cf.* Pollen Zone Boundary VII/VIII, Jessen, 1949).

3975 ± 75
UB-382. Gortcorbies core, 294 to 297 cm **2025 B.C.**

Highly decayed peat with wood and reeds. Fall of tree pollen from ca. 90% to ca. 60%. Alder and elm curves decline and ash pollen appears;

plantain and heath pollen appears in quantity, and grass pollen rises substantially.

4520 ± 80
UB-237. Gortcorbies core, 312 to 315 cm **2570 B.C.**

Highly decayed peat with wood and reeds. Rise of birch and alder curves; fall of willow, pine, and hazel curves. Total tree pollen maintained ca. 80% to 90%.

4500 ± 55
UB-236. Gortcorbies core, 322 to 325 cm **2550 B.C.**

Highly decayed peat with wood and reeds, containing fine charcoal fragments. Rise of birch and alder and fall of pine and willow curves: trends reverse before level of UB-237. Total tree pollen maintained at ca. 80%.

4750 ± 70
UB-235. Gortcorbies core, 325 to 328 cm **2800 B.C.**

Highly decayed peat with wood and reeds, containing fine charcoal fragments. Rise of pine, elm, and willow curves; fall of birch and alder curves indicate regeneration at end of land-clearance phase (*cf.* Stage C, Pilcher, *et al.*, 1971).

5160 ± 75
UB-234. Gortcorbies core, 331 to 333 cm **3210 B.C.**

Highly decayed peat with wood and reeds. Elm decline, marking Pollen Zone Boundary VIIa/VIIb (Jessen, 1949) and VII/VIII (Mitchell, 1956), in progress. Curves for grasses, birch, and alder rise. Curves for pine and willow fall. Sample includes 1st plantain pollen.

4505 ± 95
UB-233. Gortcorbies core, 333 to 346 cm **2555 B.C.**

Wood (*Alnus*) id. by I.C.G. from peat including wood from level of UB-231 (below). *Comment*: young date compared with adjacent peat (UB-231, -232, and -234) suggest wood is of intrusive root.

5115 ± 85
UB-232. Gortcorbies core, 334 to 336 cm **3165 B.C.**

Highly decayed peat with wood and reeds, containing fine charcoal fragments. Sharp rise of sedge pollen from ca. 15% to ca. 60% of tree pollen. Immediately below beginning of elm decline. Alder and pine curves fall; willow increases.

5805 ± 85
UB-231. Gortcorbies core, 336 to 342 cm **3855 B.C.**

Highly decayed peat with wood and reeds, containing fine charcoal fragments. Fall of tree pollen from ca. 95% to ca. 75%; rise of pine and alder curves. Bulk of wood removed during pretreatment and incorporated in UB-233. Broadly covers Pollen Zone Boundary VI/VII, Boreal-Atlantic, (Jessen, 1949).

UB-230. Gortcorbies core, 365 to 368 cm **7755 ± 90**
5805 B.C.

Highly decayed peat with wood and reeds. Sample at level of 1st appearance of oak pollen, close to Pollen Zone Boundary V/VI (Jessen, 1949).

General Comment (A.G.S. and I.C.G.): samples selected to date pollen-analytically defined stages of forest development and phases of clearance by man. As with Co. Tyrone sites Beaghmore and Ballynagilly (R., 1970, v. 12, p. 293-296), 1st indications of forest clearance are close to expansion of alder. Elm decline above 333 cm bracketed by UB-232 and -233 dates from ca. 3200 B.C., as at other sites. Land clearance phase of type described by Pilcher *et al.*, 1971), starting at this level, is clearly early Neolithic and lasted some 4 centuries, shown by UB-235 at its close.

UB-236 and -237, though separated by ca. 10 cm peat, are indistinguishable. Penetration by roots (UB-233, above) may have affected dates or deposition rate. Fivefold increase of deposition rate above level of UB-384 relative to that below UB-235. Between these samples it may have been irregular. By comparison with adjacent samples, UB-382 appears slightly too young and it may also have contained roots. Deposition rate below UB-235 is ca. 70 yr/cm and above UB-384 is ca. 15 yr/cm.

At level of UB-382: 2025 ± 75 B.C., marked forest clearance is indicated and appears attributable to Beaker peoples (see general comment on Ballynagilly Series I, R., 1971, v. 13, p. 105-108), but date is statistically indistinguishable from UB-384, above. Evidence for considerable Beaker activity close to site found by Herring (1938) and May (1938; 1950). UB-385: 1655 ± 70 B.C., dates beginning of slowly progressive deforestation which probably began in Early Bronze age (R., 1971, v. 13, p. 107), and continued until level of UB-386: 1075 ± 70 B.C., where agricultural activity appears much intensified. This date compares closely with that given by Eogan (1964) for Bishopsland phase of later Bronze age.

UB-387: 105 ± 65 B.C. is at level of extensive forest clearance, which probably occurred in Iron age. Date is indistinguishable from those of nearby charcoal layers above Neolithic hearths, UB-434 and UB-435 (this list). Massive clearance at level of UB-388: A.D. 565 ± 65, presumably largely for pastoralism, probably occurred in Later Iron age (Early Christian times) and final clearance at level of UB-389: A.D. 1220 ± 65, appears to have been in Norman times.

General comment on samples relevant to dating of Flandrian pollen zone boundaries: samples from Gortcorbies (this list) and Sluggan referring to later pollen zone boundaries are:

Zone V/VI. UB-442: 6590 ± 120 B.C., shows that V/VI boundary at Sluggan falls within range established for N Ireland—Q-367: 7140 ± 150 B.C. (Roddans Port; R., 1964, v. 6, p. 119), UB-280; 6810 ± 90 B.C. and UB-258: 6145 ± 80 B.C. (Slieve Gallion and Ballynagilly; R., 1971, v. 13, p. 112-113). Some of these determinations appear younger than determinations for zone boundary in England: Q-161: 7059 ± 194 (Scaleby: R., 1959, v. 1, p. 64) and Q-920: 6840 ± 170 B.C. (Red Moss, Lancs; R., 1970, v. 12, p. 593). UB-230: 5805 ± 90 B.C., which dates this zone boundary at Gortcorbies, is younger still, but comparable with Q-701: 5690 ± 160 B.C. (R., 1964, v. 6, p. 120) for Bigholm Burn, Dumfriesshire, Scotland, which has, however, been held in question.

Zone VI/VII. UB-221 A: 4810 ± 90, for Boreal-Atlantic transition at Sluggan is close to those previously obtained for N Ireland (R., 1971, v. 13, p. 124). UB-231: 3855 ± 85 B.C., however, which broadly covers Zone Boundary VI/VII at Gortcorbies is younger than dates previously obtained, though major rise of alder at some sites is late; e.g., just before 3345 ± 75 B.C., UB-93, at Beaghmore and between 3195 ± 70 B.C., UB-253, and 3625 ± 70 B.C., UB-254, at Ballynagilly, Co. Tyrone (R., 1970, v. 12, p. 294-295).

Zone VIIa/VIIb (sensu Jessen, 1949, VII/VIII, sensu Mitchell, 1956). UB-441: 3015 ± 75 B.C., for the elm decline at Sluggan, and both UB-234: 3210 ± 75 B.C. and UB-232: 3165 ± 85 B.C. for this horizon at Gortcorbies, are close to those summarized in R., 1971, v. 13, p. 122.

Zone VIIb/VIII sensu Jessen (1949). UB-439: 1995 ± 85 B.C., for final pine decline at Sluggan, and UB-384, 2120 ± 75, for a pine decline at Gortcorbies, are indistinguishable. Both are close to UB-111: 2250 ± 85 B.C. (Ballyscullion; R., 1971, v. 13, p. 110) and UB-274: 2215 ± 80 B.C. (Slieve Gallion; R., 1971, v. 13, p. 113). A further pine decline at Gortcorbies is dated to 1075 ± 70 B.C., UB-386; see also R., 1971, v. 13, p. 122.

Zone VIII/IX sensu Mitchell (1956). UB-437: A.D. 315 ± 75, at Sluggan, conforms with other dates for final elm decline: D-18: A.D. 340 ± 120 (Agher, Co. Meath); D-29: A.D. 330 ± 130 (Clonsast, Co. Offaly) and D-8: A.D. 225 ± 130 (Redbog, Co. Louth) (R., 1961, v. 3, p. 28-30). At Gortcorbies, however, final elm decline is dated by UB-387: 105 ± 65 B.C. which parallels date immediately above a similar elm decline at Beaghmore, Co. Tyrone UB-87: 140 ± 70 B.C. (R., 1970, v. 12, p. 293). In both these cases the plantain curve rises, but does not in Mitchell's diagrams. At Gortcorbies and Beaghmore, final decline of elm thus falls in early Iron age, rather than Early Christian (Later Iron age).

Foulshaw Moss series, Westmorland, England

Sphagnum-Eriophorum-(Calluna) peat from pollen-analyzed cores of raised bog, Foulshaw Moss, Westmorland, 8 km NE of Grange-over-Sands, N. Lancashire (54° 14′ N Lat, 2° 50′ W Long; Grid Ref. SD 458837) alt. 7.6 m O.D. Coll. 1969 and subm. by F. Oldfield, School of Biol. and Env. Sci., New Univ., Ulster. All samples received acid pretreatment. (Ref. Smith, 1959; Powell, Oldfield, and Corcoran, 1971).

5065 ± 100
UB-466. Foulshaw Moss, Core III, 133 to 137 cm 3115 B.C.

Peat stratigraphically above Core II, but laterally displaced, less than 5 cm above UB-463 (below). *Comment* (F.O.): sample underlies decline of elm curve. Late Pollen Zone VIIa.

UB-465. Foulshaw Moss, Core II, 0 to 3 cm **4810 ± 95**
2860 B.C.

Peat. *Comment* (F.O.): sample at level of lime pollen maximum immediately below start of elm decline. Late Pollen Zone VIIa.

UB-464. Foulshaw Moss, Core II, 3 to 6 cm **4895 ± 95**
2945 B.C.

Peat, contiguous with UB-465 (above). *Comment* (F.O.): sample at level of high lime pollen frequency, just below maximum. Late Pollen Zone VIIa.

UB-463. Foulshaw Moss, Core II, 17 to 20 cm **5380 ± 100**
3430 B.C.

Peat. *Comment* (F.O.): sample 10 cm below level of lime pollen increase. Level correlated on basis of pollen analysis with artifacts from Storrs Moss (Powell, Oldfield, and Corcoran, 1971). Late Pollen Zone VIIa.

UB-462. Foulshaw Moss, Core II, 20 to 23 cm **5435 ± 100**
3485 B.C.

Peat, contiguous with UB-463 (above). *Comment* (F.O.): sample 14 cm below level of lime pollen increase. Late Pollen Zone VIIa.

General Comment (F.O.): dates form consistent series with possible exception of UB-465, and show that early Neolithic material from Storrs Moss, correlated with present profile on basis of pollen analysis, is ca. 5400 yr. old.

UB-322 D. Ballynagilly core, 376 to 380 cm **9535 ± 110**
7585 B.C.

Further sample from Ballynagilly Series II (R., 1970, v. 12, p. 294 and R., 1971, v. 13, p. 112). Particulate fraction of fine detritus mud from 376 to 380 cm depth in bog adjacent to "The Corbie", Ballynagilly Td., Co. Tyrone (54° 42′ N Lat, 6° 51′ W Long; Irish Grid Ref. H 743837). *Comment*: sample taken to investigate humic acid movement in basal deposits. Date for particulate fraction is indistinguishable from date for whole peat sample, UB-260, contiguous with and below this sample. Date for humic acid is clearly younger showing movement of humic materials as found at Slieve Gallion (R., 1971, v. 13, p. 113-114).

UB-322 C. (humic acid) 9180 ± 110

III. TIMBER SAMPLES

UB-343. Derrykerran South, Bog Oak 367 **4985 ± 100**
3035 B.C.

Bog oak from Derrykerran S Td., 4.8 km N of Portadown, Co. Armagh (54° 28′ N Lat, 6° 27′ W Long; Irish Grid Ref. J 007588) alt. ca. 24 m O.D. Twenty annual rings 10 yr from outside of 350-yr-old tree. Coll. 1968 by M. G. L. Baillie. Pretreatment by bleaching and charring.

UB-342. Cullyhanna, Bog Oak 478 **4685 ± 75**
2735 B.C.

Bog oak from Cullyhanna lake, 4.8 km N of Crossmaglen, Co. Armagh (54° 7′ N Lat, 6° 36′ 30″ W Long; Irish Grid Ref. H 915198) alt. 107 m O.D. Twenty annual rings, 40 yr from outside of 120-yr-old tree. Coll. 1969 by M. G. L. Baillie. Pretreatment by bleaching and charring.

UB-417. Shanes Castle, Bog Oak 509 **3625 ± 80**
1675 B.C.

Bog oak from Shanes Castle estate, 1.6 km SE of Randalstown, Co. Antrim (54° 44′ 30″ N Lat, 6° 18′ W Long; Irish Grid Ref. J 095897) alt. 37 m O.D. Twenty annual rings, 65 yr from outside of 190-yr-old tree. Coll. 1970 by M. G. L. Baillie. Pretreatment by bleaching and charring.

UB-396. Derrycrow, Bog Oak 477 **4305 ± 80**
2355 B.C.

Bog oak from Derrycrow Td., 10.5 km N of Portadown, Co. Armagh (45° 30′ 45″ N Lat, 6° 29′ 30″ W Long; Irish Grid Ref. H 987641) alt. ca. 18 m O.D. From layer of oaks in peat ca. 20 to 30 cm above mineral soil. Coll. 1969 by A. G. S. Pretreatment by bleaching and charring. *Comment*: pollen and macro-remains, analyzed by R. Todd, show that oakwood, represented by tree dated, and which replaced alder carr, was itself replaced by birch.

UB-397. Ballymacombs More, Bog Oak 342 **3955 ± 80**
2005 B.C.

Bog oak from Ballymacombs More, 13 km ESE of Ballymena, Co. Londonderry (53° 48′ N Lat, 6° 28′ W Long; Irish Grid Ref. H 987987) alt. ca. 18 m O.D. Sample from lower layer of stumps. Coll. 1969 by R. Todd. Pretreatment by bleaching and charring. *Comment*: pollen and macro-remains, analyzed by R. Todd, show sample came from 1st phase of oakwood, which succeeded alder carr, and was eventually replaced by birch.

General Comment on timber samples: 5 dates for bog oaks (UB-342, 343, 396, 397, and 417) from lowland mires from 3500 to 5000 yr B.P. One other lowland oak, UB-286, and one upland oak, UB-293, fall in same range (R., 1970, v. 13, p. 123). Concentration in this period suggests general dryness of bog surfaces.

IV. GEOCHEMICAL SAMPLES

Beaghs sandpit series, Co. Antrim

Continuation of series from R., 1970, v. 13, p. 123-125, from W side of sand quarry in Beaghs Td., 3.2 km W of Cushendall, Co. Antrim (55° 5′ N Lat, 6° 11′ W Long; Irish Grid Ref. D 156276). Coll. 1969 by P. Q. Dresser.

UB-289. Beaghs sandpit, No. 3 **5135 ± 100**
3185 B.C.

Root of pine tree from glacial deposit, 20 to 100 cm below blanket peat and directly below Sample 5 (UB-291: R., 1971, v. 13, p. 124). Pretreatment by bleaching and charring.

UB-290. Beaghs sandpit, No. 4 **Modern**

Rootlets impacted against iron pan 20 cm below basal blanket peat. Pretreatment: humic acid removal with 1% NaOH, acidification, washing, and charring.

2980 ± 80
UB-292. Beaghs sandpit, No. 6 **1030 B.C.**

Humic acid from mineral soil below blanket peat, 2 m N of pine stump, UB-291 (R., 1971, v. 13, p. 124).

4155 ± 120
UB-270 E. Beaghs sandpit, No. 1 **2205 B.C.**

Charcoal from basal 2 cm layer of blanket peat (UB-270 A: R., 1971, v. 13, p. 124). *Comment*: sample diluted with inactive methane for counting.

General Comment (P.Q.D.): date for pine root is older than that for pine trunk in base of blanket peat ca. 30 cm above (UB-291: 4905 ± 85, R., 1971, v. 13, p. 124), but number of annual rings in root dated was not determined; root and trunk are not certainly from different trees. These dates are both older than any fraction of basal blanket peat at site (UB-270). Date for humus in sand below blanket peat (UB-292) is much younger than basal blanket peat (UB-270) demonstrating mobility of humic substances. Date for rootlets impacted on pre-peat iron pan (UB-290) shows penetration from near present surface, possibly after exposure of peat face.

Roddans Port series, Co. Down

Samples from Late Weichselian deposits at Roddans Port, 17 km SE of Newtownards, Co. Down (54° 30′ 40″ N Lat, 5° 28′ W Long; Irish Grid Ref. J 640658) alt. 2.4 m O.D. Deposits now exposed at low tide. Coll. 1970 by P. Q. Dresser. Site previously investigated stratigraphically and palynologically by Morrison and Stephens (1965) and extensively dated by Cambridge Lab. (R., 1964, v. 6, p. 117-119). Pollen zones given tentatively here are by stratigraphic comparison. Stratigraphy at sampling point, comparable with Point 3 of Morrison and Stephens, is:

0 to 6 cm	*Phragmites* peat
6 to 16 cm	dark brown muddy peat
16 to 29 cm	light brown muddy peat
29 to 103 cm	gritty clay and pebbles with organic-rich layers at 95 and 100 cm
103 to 113 cm	transitional peaty clay
113 to 160 cm	light brown highly compacted organic detritus mud
160 to —	gray sticky clay

UB-399 A. Roddans Port, No. 2 **10,835 ± 165**
8885 B.C.
$\delta C^{13} = -25.6‰$

Muddy peat from 26 to 29 cm depth. Presumed base of Pollen Zone III-IV.

UB-399 C.	(humic acid)	10,430 ± 150 $\delta C^{13} = -26.1‰$
UB-399 D.	(particulate > 250 μ)	10,190 ± 145 $\delta C^{13} = -24.8‰$
UB-399 F.	(particulate < 250 μ)	9995 ± 145 $\delta C^{13} = -27.3‰$

Comment (P.Q.D.): δC^{13} values are within normal range for organic deposits indicating no appreciable hard-water effect. Relative oldness of the whole sample (A) is inexplicable, as it should be a weighted mean value of the ages of the various fractions. Humic acid fraction (C) is not younger than either of the particulate fractions as it is in some other fractionated samples; this suggests lack of movement of humic materials, though particulate fractions may contain younger rootlet material. If this is true, humic acid (C) is more likely to provide reliable date for sample.

UB-400 A. Roddans Port, No. 3 **10,730 ± 145**
8780 B.C.

Solifluction clay with organic content from 29 to 31 cm depth. Presumed top of Pollen Zone III. Sample had obvious secondary penetration by rootlets.

UB-400 C.	(humic acid)	10,380 ± 80
UB-400 D.	(particulate > 250 μ)	11,140 ± 155
UB-400 F.	(particulate < 250 μ)	10,400 ± 175 $\delta C^{13} = -24.8‰$

Comment (P.Q.D.): whole sample date (A) is acceptably within range of dates for the fractions. D fraction (solids > 250 μ) is clearly older than either of other 2 fractions and thus may contain derived material. If it does, then presumably fine particulate fraction (F) may also contain derived material.

UB-401 A. Roddans Port, No. 4 **11,390 ± 160**
9440 B.C.
$\delta C^{13} = -25.4‰$

Organic layers from solifluction clay from 95 to 100 cm depth. Near presumed base of Pollen Zone III.

UB-401 C.	(humic acid)	11,150 ± 95 $\delta C^{13} = -27.1‰$
UB-401 D.	(particulate > 250 μ)	11,110 ± 125 $\delta C^{13} = -25.5‰$
UB-401 F.	(particulate < 250 μ)	10,740 ± 145 $\delta C^{13} = -28.2‰$

Comment (P.Q.D.): distribution of dates is similar to that for UB-399, though whole sample date (A) is indistinguishable from all except fine particulate fraction (F) date. By comparison with UB-399, humic acid (C) probably provides most reliable date.

General Comment (P.Q.D.): lack of consistency of date distributions of samples probably indicates interplay of various types of error assoc. with sediments. Humic acid (C) fractions possibly more reliable than other fractions, due to their fixation by mineral ions from salt water.

Sluggan series, Co. Antrim

Series continued from R., 1970, v. 13, p. 124-125. Peat samples from Sluggan bog, Ballylurgan Td. (not Magheralane Td., as erroneously stated before), 2.4 km NE of Randalstown, Co. Antrim (54° 46′ N Lat, 6° 18′ W Long; Irish Grid Ref. J 009921) alt. ca. 52 m O.D. Sampling by 5.2 m depth excavation. Coll. 1968 by P. Q. Dresser. (See also Sluggan monolith series, this list).

(1) 9530 ± 140
7580 B.C.

UB-255 A. Sluggan, No. 16, 445 to 450 cm

(2) 9780 ± 150
7830 B.C.

Muddy reedswamp peat with abundant seeds (*Menyanthes*) and some small twigs.

UB-225 B.	(water soluble)	8895 ± 125
UB-225 C.	(humic acid)	9415 ± 130
UB-225 D.	(particulate $> 250\ \mu$)	9130 ± 135
UB-225 F.	(particulate $< 250\ \mu$)	9475 ± 145

Comment (P.Q.D.): dates for whole peat appear inexplicably older than any of fractions though mean of whole peat (A) determinations (9655 ± 115) is not significantly older than dates for fractions C and F. Relatively young dates for fractions B and D indicate mobility of water soluble materials and penetration by rootlets, respectively. Date of F fraction may be taken as most reliable date for sample.

UB-227 A. Sluggan, No. 18, 482 to 487 cm

10,440 ± 110
8490 B.C.
$\delta C^{13} = -30.4‰$

Fine detritus mud with some moss and reeds and a few seeds (*Menyanthes*).

UB-227 C.	(humic acid)	$10{,}795 \pm 140$ $\delta C^{13} = -28.4‰$
UB-227 D.	(particulate $> 250\ \mu$)	$10{,}805 \pm 125$ $\delta C^{13} = -30.7‰$
UB-227 F.	(particulate $< 250\ \mu$)	$10{,}945 \pm 145$ $\delta C^{13} = -30.4‰$

Comment (P.Q.D.): whole peat date is younger than any of fraction dates, which are themselves indistinguishable, possibly due in part to presence of younger water-soluble materials, see UB-225 above.

UB-299 A. Sluggan, No. 20, 515 to 520 cm **12,360 ± 165** **10,410 B.C.**

Fine detritus mud with some moss, seeds (*Menyanthes*), and reeds. Basal layer of organic deposits.

UB-229 C.	(humic acid)	11,225 ± 160
UB-229 D.	(particulate > 250 μ)	12,060 ± 125
UB-229 F.	(particulate < 250 μ)	12,470 ± 125

Comment (P.Q.D.): dates for C and D fractions are younger than date for F fraction indicating they may contain material from higher levels. F fraction appears to provide most reliable date.

V. GEOLOGIC SAMPLES

Woodgrange series, Co. Down

Samples from emerged beach deposit in Woodgrange Td., 4.8 km W of Downpatrick, Co. Down (54° 19′ N Lat, 5° 47′ W Long; Irish Grid Ref. J 438449) alt. 6.4 m O.D. Samples from same deposits as those dated by Isotopes (R., 1966, v. 8, p. 179) to obtain closer date bracket for beach deposit. All samples had obvious rootlet penetration. Coll. 1970 by P. Q. Dresser and A. G. Smith (Ref. Singh and Smith, 1966; Dresser, Smith and Pearson, ms. in preparation.)

UB-429. Woodgrange, 1 **2380 ± 75** **430 B.C.**

Upper 4 cm of organic layer above sand layer of beach.

UB-430 A. Woodgrange, 2 **3160 ± 95** **1210 B.C.**
$\delta C^{13} = -29.8‰$

Basal 4 cm of upper layer, above sand and ca. 13 cm below UB-429.

UB-430 C.	(humic acid)	3245 ± 85 $\delta C^{13} = -31.4‰$
UB-430 F.	(particulate < 250 μ)	2900 ± 65 $\delta C^{13} = -30.5‰$

UB-431. Woodgrange, 3 **6565 ± 105** **4615 B.C.**

Uppermost part, ca. 3 cm, of projections of eroded peaty layer below sand beach.

UB-432. Woodgrange, 4 **6770 ± 105** **4820 B.C.**

Lower part, ca. 4 cm, of projections of eroded peaty layer below sand beach.

UB-433 A. Woodgrange, 5 **6610 ± 115** **4660 B.C.**

Peaty material, 4 cm thick, contiguous with, and below, UB-432.

UB-433 C.	(humic acid)	6720 ± 105
UB-433 F.	(particulate < 250 μ)	5690 ± 85

General Comment (P.Q.D. and A.G.S.): marked age difference between UB-429 and UB-430 indicates lack of physical disturbance. For both UB-430 and UB-433, fine particulate fraction (F) is younger than humic acid fraction suggesting F fractions contained comminuted rootlets. F fraction of UB-430 is probably most reliable *terminus ante quem* for beach and is comparable with I-1199, 3125 ± 150 for similar deposit. Dates for lower organic deposit do not provide close date for beginning of beach deposition because of an erosional unconformity.

References

Collins, A. E. P., 1952, Excavations in the sandhills at Dundrum, Co. Down, 1950-51: Ulster Jour. Archaeol., v. 15, p. 2-26.

——— 1959, Further investigations in the Dundrum sandhills: Ulster Jour. Archaeol., v. 22, p. 5-20.

Eogan, G., 1964, The Later Bronze Age in Ireland in the light of recent research: Prehist. Soc. Proc., v. 30, p. 268-351.

——— 1968, Excavations at Knowth, Co. Meath, 1968: Antiquity, v. 43, p. 8-14.

Godwin, H., 1959, Radiocarbon dating of the Late-glacial period in Britain: Royal Soc. Proc., ser. B, v. 150, p. 199-215.

——— 1960a, Prehistoric wooden trackways of the Somerset Levels; their construction, age and relation to climatic change: Prehist. Soc. Proc., v. 26, p. 1-36.

——— 1960b, Radiocarbon dating and Quaternary history in Britain: Royal Soc. Proc., ser. B, v. 153, p. 287-320.

Herring, I. J., 1938, Cairn excavation at Well Glass Spring, Largantea, Co. Londonderry: Ulster Jour. Archaeol., ser. III, v. 1, p. 164-188.

Houlder, C. H., 1961, The excavation of a Neolithic stone implement factory on Mynydd Rhiw in Caernarvonshire: Prehist. Soc. Proc., v. 27, p. 108-143.

Jessen, Knud, 1949, Studies in Late Quaternary deposits and flora-history of Ireland: Royal Irish Acad. Proc., v. 52B, p. 85-290.

May, A. McL., 1938, Burial mound, circles and cairn, Gortcobies, Co. Londonderry: Ulster Jour. Archaeol., v. 1, p. 5-22.

——— 1950, Two neolithic hearths, Gortcorbies, Co. Londonderry: Ulster Jour. Archaeol. v. 13, p. 28-39.

Mitchell, G. F., 1956, Post-Boreal pollen diagrams from Irish raised bogs: Royal Irish Acad. Proc., v. 57 B, p. 291-314.

Morrison, M. E. S. and Stephens, N., 1965, A submerged Late-Quaternary deposit at Roddans Port on the North East Coast of Ireland: Royal Soc. [London], Philos. Trans., ser. B, v. 249, p. 221-255.

O'Kelly, M. J., 1969, Radiocarbon dates for the Newgrange Passage Grave: Antiquity, v. 43, p. 140-141.

Pennington, W. and Bonny, A. P., 1970, Absolute pollen diagram from the British Late-glacial: Nature, v. 226, p. 871-873.

Pilcher, J. R., Smith, A. G., Pearson, G. W., and Crowder, A., 1971, Land clearance in the Irish Neolithic: new evidence and interpretation: Science, v. 172, p. 560-562.

Powell, T. G. E., Oldfield, F., and Corcoran, J. X. W. P., 1971, Excavations at Storrs Moss: Prehist. Soc. Proc., in press.

Ritchie, P. R., 1968, The stone implement trade in third-millenium Scotland, *in*: Coles, J. M. and Simpson, D. D. A. (eds.), Studies in ancient Europe: Leicester, Leicester Univ. Press, p. 117-136.

Singh, G. and Smith, A. G., 1966, The post-glacial marine transgression in N. Ireland—conclusions from estuarine and 'raised beach' deposits: a contrast: Palaeobotanist, v. 15, p. 230-234.

Smith, A. G., 1959, The mires of south-western Westmorland: stratigraphy and pollen analysis: New Phytol., v. 58, p. 105-127.

——— 1961, Cannons Lough, Kilrea, Co. Derry: stratigraphy and pollen analysis: Royal Irish Acad. Proc., v. 61 B, p. 369-383.

[RADIOCARBON, VOL. 13, No. 2, 1971, P. 468-474]

UNIVERSITY OF GEORGIA RADIOCARBON DATES I

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The Geochronology Laboratory of the University of Georgia was established in the fall of 1969. The laboratory is housed in the basement of the Geology Building and is under the direction of the General Research Department. Radiocarbon dating facilities are the first to be developed in the laboratory. Other methods will be employed to date a wide spectrum of samples over extensive age ranges. Facilities of the laboratory are also available to colleges, universities, and institutions for teaching and research.

Carbon-containing samples are converted to benzene and C^{14} activity is determined by liquid-scintillation spectroscopy. Samples are first converted to lithium carbide and then to acetylene gas as described by Barker (1953). The acetylene is trimerized to benzene with a vanadium alumina catalyst developed at ORINS. Chemical yields for benzene approach 90% with no evidence of chemical impurities in the benzene to cause quenching or of carbon-isotope fractionation occurring in the chemistry. Benzene chemistry, catalyst, benzene purity, and $C^{13}/^{12}$ isotope-fractionation studies are reported by Noakes *et al.* (1965).

The two liquid scintillation spectrometers used are modified Model 220 Picker Nuclear counters. Counting efficiency is approximately 70% at a voltage of 2300 with a discriminator window set above the maximum energy for tritium and radiocarbon. Background count rate is approximately 4 cpm with a 5 cc benzene sample. Shielding consists of 3 inches of lead with coincidence and anti-coincidence systems.

The modern reference standard is 95% of the activity of the NBS oxalic-acid standard (9.55 c/m/g carbon). Ages are calculated on a C^{14} half-life of 5570 as suggested by Godwin (1962). The statistics quoted are one standard deviation (1σ) of the uncertainty involved in counting background, standard, and sample.

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Brian Logan, Geology Department, University of Western Australia, contributed many samples and assisted in their evaluation. John Hoyt, Sapelo Island Marine Laboratory, University of Georgia, made available facilities at his laboratory, contributed samples, and helped in their evaluation. W. C. Ward, Geology Department, Rice University, collected samples.

II. GEOLOGIC SAMPLES

A. Eastern Florida and Georgia Coast, U.S.A.

The following C^{14} dates are from shell material collected to determine the age of Pleistocene coastal deposits.

I. CHECK SAMPLES

Ga. Sample	Ga. Age	Check Sample	Age	Reference
UGa-1	1255±95	(TX-245)	(1270±60)	Texas IV
UGa-2	1270±80	(TX-245)	(1270±60)	Texas IV
UGa-3	12,440±280	(FSU-3)	(11,245±450)	Florida I
		(TX-44)	(10,700±210)	Texas II
		(C-800)	(10,856±410)Avg.	Libby (1955)
		(L-6980)	(11,830±100)	Broecker and Farrand (1963)
UGa-4	2340±85	(UCLA-752)	(3255±80)	UCLA IV
UGa-6	2960±100	(FSU-9)	(2911±110)	Florida I
UGa-53	8845±75	(TX-140)	(8540±120)	Texas III

UGa-7. Marineland, Florida **9110 ± 135**
7160 B.C.

Shells from coquina outcrop on beach S of Marineland (29° 39′ 44″ N Lat, 81° 12′ 35″ W Long) about mean sea level (MSL). Coll. and subm. 1968 by John Hoyt. *Comment*: thought to be Silver Bluff but date shows a more recent deposition.

UGa-8. Merritt Island, Florida **27,760 ± 1200**
25,810 B.C.

Broken shells from coquina 1.33 m above MSL (28° 40′ 55″ N Lat, 80° 43′ 8″ W Long). Coll. and subm. 1968 by John Hoyt. *Comment*: Silver Bluff.

UGa-9. Bon Terra, Florida **>40,000**

Small broken shells, cemented together with quartz sand, from coquina; same location as UGa-11, 0.33 m above MSL. Coll. and subm. 1968 by John Hoyt.

UGa-10. Bon Terra, Florida **29,780 ± 1340**
27,830 B.C.

Shells of *Mulina, Tellina, Donax, Arca,* some broken from coquina; same location as UGa-11, 1.0 m above MSL. Coll. and subm. 1968 by John Hoyt.

UGa-11. Bon Terra, Florida **27,960 ± 1200**
26,010 B.C.

Shells of *Mulina, Tellina, Donax, Arca,* some broken. From coquina, ca. 0.6 m below surface of bluff ca. 3.6 m above MSL (29° 33′ 50″ N Lat, 81° 10′ 58″ W Long). Coll. and subm. 1968 by John Hoyt. *Comment*: UGa-11, 10, and 9 show increasing age with depth in the bluff. UGa-11 and 10 are Silver Bluff in age and UGa-9 is considerably older.

UGa-12. Daytona Beach, Florida **24,330 ± 560**
23,380 B.C.

Small broken shells from coquina, ca. 7.6 m above MSL (29° 13′ 0″ N Lat, 81° 4′ 53″ W Long). Coll. and subm. 1968 by John Hoyt. *Comment*: was thought to be Pamlico but age shows this to be a Silver Bluff deposit.

UGa-15. Flagler Beach, Florida **32,030 ± 1330**
30,080 B.C.

Small broken shells from coquina, from quarry 4.3 km W of Flagler Beach (29° 28′ 36″ N Lat, 81° 12′ 54″ W Long) ca. 7.3 m above MSL. Coll. and subm. by John Hoyt. Silver Bluff deposit.

UGa-17. Rieds Bluff, Florida **>40,000**

Unbroken oyster shells taken from thick gray clay in S bank of St. Mary's R. (30° 43′ 10″ N Lat, 81° 35′ 40″ W Long) ca. 3.7 m above MSL. Coll. and subm. 1968 by John Hoyt. *Comment*: probably Pamlico.

UGa-16. Pumpkin Hammock, Georgia **27,670 ± 1010**
26,720 B.C.

Whole oyster shells from bank of Duplin R. (31° 27′ 15″ N Lat, 81° 17′ 10″ W Long) from blue-gray clay, 0.3 to 0.6 m below MSL. Coll. and subm. by John Hoyt. *Comment*: Silver Bluff.

UGa-19. Pamlico Lagoon, Georgia **>40,000**

Dolostone with some clay from a chalky dolostone bed 25 to 38 mm thick, dense, cherty looking, calcareous and chalky, white to pale yellow, from 8 km W of Brunswick near intersection of Massey Causeway and Buck Swamp-Sandhill R., Glynn Co. (31° 19′ 20″ N Lat, 81° 42′ 30″ W Long). Sample from 38.3 to 39.5 cm below surface, alt. 4.5 m. Overlying material is clay, (oyster shell and shell hash mixture). Coll. and subm. 1969 by T. F. Logan, Jr., Univ. of Georgia. *Comment*: age indicates Pamlico.

General Comment: samples were from deposits that, based on regional maps and alt., were believed Pamlico or Silver Bluff in age. This series dates Silver Bluff shoreline more precisely. "Silver Bluff" applies to 25,000 to 36,000 yr ago; "Pamlico" to an earlier beach, probably Sangamon or last traditional interglacial.

B. Northeast Coast of Yucatan Peninsula, Mexico

The Caribbean coast of the Yucatan Peninsula, Mexico, is the site of a variety of shallow-water and sub-aerial carbonate sediments. In 1967, a group from the Dept. of Geol., Rice Univ., began a study of carbonate sedimentation and diagenesis along the NE part of this coast. Dates were measured to establish ages, and rates of diagenesis, of Holocene and Pleistocene calcareous eolianites.

UGa-18. Isla Cancun **13,590 ± 200**
11,640 B.C.

Whole-rock sample of tan to reddish eolianite, fairly well lithified (21° 8′ 20″ N Lat, 86° 49′ W Long). Coll. and subm. 1967 by W. C. Ward. *Comment*: geomorphology suggests this eolianite, though well lithified, is Holocene. Age probably in error because the whole rock has a high content of reworked limestone fragments.

UGa-20. Isla Cancun **750 ± 80**
A.D. 1200

Oolitic calcarenite from Caribbean Sea 69 m off N end of Isla Cancun (21° 8′ N Lat, 86° 46′ W Long). Sample from beneath 4.5 m water and is the fine fraction passing through #60 sieve. Coll. and subm. 1968 by W. C. Ward. *Comment*: controversy whether the calcareous sand is receiving oolite coatings or whether coated grains reworked from oolitic island and coastal rock. Separated coarser fraction eliminated bulk of the non-coated bioclasts. Date indicates sample is modern.

UGa-22. Isla Cancun **1030 ± 80**
A.D. 920

Shell (*Strombus*) from sea cliff in Caribbean shore off island at base of eolianite (21° 8′ N Lat, 86° 46′ W Long). Coll. and subm. 1967 by W. C. Ward. *Comment* (W.C.W.): *Strombus* is one of few fossils found in area; was taken from a calcarenite deposit which underlies 4.5 m of eolianite equivalent to UGa-18. Early date indicates an intrusion.

1900 ± 90
UGa-21. A.D. 50

Sample of caliche crust from W edge of N Saline Lake (21° 14′ N Lat, 86° 45′ W Long) developed on the Pleistocene eolianite country rock of the island. Coll. and subm. 1968 by W. C. Ward.

C. Western Australia

Shark Bay series

Shark Bay is a lagoonal sea lying between 24° 30′ S and 26° 45′ S Lat on W coast of Australia. Since 1964 a marine-research group from Dept. of Geol., Univ. of Western Australia has conducted a program on sedimentation and diagenesis of carbonate sediments in Shark Bay. The following C^{14} dates are mainly on shell materials obtained from emergent Quaternary sediments in the area.

5370 ± 70
UGa-27. Shark Bay, Western Australia 3420 B.C.

Costacallistra impar from location similar to UGa-30 1 m below surface (26° 29′ S Lat, 113° 30′ E Long). Coll. by B. W. Logan, Univ. of Western Australia.

4040 ± 70
UGa-28. Shark Bay, Western Australia 2090 B.C.

Terebrailia sulcatus specimens from shallow excavation, supratidal flat, Depuch Loop, Shark Bay (26° 36′ S Lat, 113° 33′ 34″ E Long). Coll. by B. W. Logan.

4750 ± 50
UGa-29. Shark Bay, Western Australia 2800 B.C.

Placamen sp. from shallow excavation, supratidal flat, Dupuch Loop, Shark Bay (26° 37′ 15″ S Lat, 113° 35′ 15″ E Long). Coll. by B. W. Logan.

5140 ± 70
UGa-30. Shark Bay, Western Australia 3190 B.C.

Costacallistra impar from 1 m below surface of supratidal flat, Brown Inlet, Shark Bay (26° 28′ 36″ S Lat, 113° 30′ E Long). Coll. by B. W. Logan.

3630 ± 70
UGa-31. Shark Bay, Western Australia 1680 B.C.

Cryptogramma sp. from same location as UGa-30. Coll. by B. W. Logan.

UGa-32. Shark Bay, Western Australia **3650 ± 70**
1700 B.C.

Costacallistra impar from a claypan, 2.4 km W of Biddy Giddy Outcamp, Useless Inlet, Shark Bay (26° 20′ 30″ S Lat, 113° 24′ 57″ E Long). Coll. by F. J. Read, Univ. of Western Australia.

UGa-34. Shark Bay, Western Australia **36,800 ± 1300**
34,850 B.C.

Coral (*Favites* sp.) from 3 m emergent reef, Tetradon Loop, Dirk Hartog I. Shark Bay (25° 56′ 30″ S Lat, 113° 9′ E Long). Coll. by F. J. Read.

UGa-35. Shark Bay, Western Australia **47,200 ± 5200**
45,250 B.C.

Coral (*Montastrea* sp.) from same location as UGa-34. Coll. by F. J. Read.

UGa-36. Shark Bay, Western Australia **39,900 ± 1800**
37,950 B.C.

Coral (*Favia* sp.) from supratidal flats N of Hutchinson I. embayment, Shark Bay (26° 4′ S Lat, 114° 12′ 40″ E Long). Coll. by B. W. Logan.

UGa-37. Shark Bay, Western Australia **42,500 ± 2400**
40,550 B.C.

Coral (*Simplastrea*) from same location as UGa-36. Coll. by B. W. Logan.

UGa-38. Shark Bay, Western Australia **4180 ± 70**
2230 B.C.

Fragum unedo from same location as UGa-32. Coll. by F. J. Read.

UGa-40. Shark Bay, Western Australia **35,900 ± 2100**
33,800 B.C.

Mollusk shells from the upper supratidal zone, Gladstone Embayment, Shark Bay (24° 54′ 30″ S Lat, 114° 13′ 30″ E Long). From base of gypsum dune, mainly of *Pitarina citrina* and *Circe sugillata*. Coll. and id. by G. R. Davies, Univ. of Western Australia.

UGa-42. Shark Bay, Western Australia **4500 ± 70**
2550 B.C.

Mixed mollusk fauna from cores taken in the Gladstone Embayment, Shark Bay (25° 54′ 30″ S Lat, 114° 13′ 30″ E Long). From 2 cores, same horizon, from over 15 cm sample interval at depth −1.2 m. Contains *Circe suggillata, Chama* sp., *Fragum unedo, Circe plicatina, Pitarina citrina,* and a few cerithiids. Coll. and id. by G. R. Davies.

UGa-43. Shark Bay, Western Australia **>40,000**

Coral (*Porites* sp.) from outcrop on intertidal flat, Gladstone Embayment, Shark Bay (25° 54′ 30″ S Lat, 114° 13′ 30″ E Long). Coll. and id. by G. R. Davies.

1310 ± 70
UGa-39. Hamelin Pool, Western Australia **640 B.C.**

Coquina consisting of pelecypod (*Fragum hamelini*) from weakly cemented recent beach-ridge sediments, Hamelin Pool, Western Australia (26° 23′ 30″ S Lat, 114° 10′ E Long). Coll. and id. by B. W. Logan.

88 ± 65
UGa-41. Hamelin Pool, Western Australia **A.D. 1862**

Ooids from SE margin of Anchorage Bank, Hamelin Pool, Western Australia (26° 8′ 30″ S Lat, 113° 56′ 35″ E Long). Depth 1.5 m. Coll. by B. W. Logan.

General Comment: dates from Shark Bay and Hamelin Pool have permitted a view of Quaternary sea levels in this area. The carbon dates establish a higher sea level of 1.5 to 2.5 m during the last 5 to 6000 yr. The older dates on the emergent reefs made a mid-Wisconsin high sea level seem real.

References

Barker, Harold, 1953, Radiocarbon dating: Large scale preparation of acetylene from organic material: Nature, v. 172, p. 631-632.

Berger, Rainer, Fergusson, G. J., and Libby, W. F., 1965, UCLA radiocarbon dates IV: Radiocarbon, v. 7, p. 336-371.

Broecker, W. S. and Farrand, W. R., 1963, Radiocarbon age of the Two Creeks Forest Bed, Wisconsin: Geol. Soc. America Bull., v. 74, p. 795-802.

Godwin, Harry, 1962, Half-life of radiocarbon: Nature, v. 195, p. 984.

Libby, W. F., 1955, Radiocarbon dating, 2nd ed.: Chicago, Univ. Chicago Press, ix, p. 126.

Logan, B. W., 1957, Environments, foraminiferal facies and sediments of Shark Bay, Western Australia: Ph.D. dissert., Dept. Geol., Univ. of W. Australia, 287 p.

Noakes, J. E., Kim, S. M., Stipp, J. J., and Akers, L. K., 1965, Chemical and counting advances in liquid scintillation radiocarbon dating: Sixth internatl. conf. radiocarbon and tritium dating Proc., Pullman, Washington, p. 68-92.

Pearson, F. J., Jr., Davis, E. M., and Tamers, M. A., 1966, Univ. of Texas radiocarbon dates IV: Radiocarbon, v. 8, p. 453-466.

Pearson, F. J., Jr., Davis, E. M., Tamers, M. A., and Johnstone, R. W., 1965, University of Texas radiocarbon dates III: Radiocarbon, v. 7, p. 296-314.

Stipp, J. J., Knauer, G. A., and Goodell, H. G., 1966, Florida State University radiocarbon dates I: Radiocarbon, v. 8, p. 46-53.

Tamers, M. A., Pearson, F. J., Jr., and Davis, E. M., 1964, University of Texas radiocarbon dates II: Radiocarbon, v. 6, p. 138-159.

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UNIVERSITY OF WISCONSIN RADIOCARBON DATES IX

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Radiocarbon dates obtained since December, 1969, are summarized here. Procedures and equipment have been described previously (R., 1966, v. 8, p. 522). Wood, charcoal, and peat samples are pretreated with dilute NaOH and dilute H_3PO_4 before conversion to the counting gas, methane; marls and lake cores are treated with acid only. Very calcareous materials are treated with HCl instead of H_3PO_4.

The dates reported have been calculated using 5568 years as the half-life of C^{14}, with 1950 as the reference year. The standard deviation quoted includes only the 1σ of the counting statistics of background, sample, and standard counts. The C^{13}/C^{12} ratios of the CO_2 samples prepared from NBS oxalic acid are measured and the activity of the methane used as standard is corrected for any deviation of the δC^{13} value of the CO_2 from the $-19‰$ value (compared to the PDB standard) reported by Craig (1961). The dated samples for which δC^{13} values are reported have been corrected to $-25.0‰$ (PDB standard), the "normal" value of terrestrial material.

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I. ARCHAEOLOGIC SAMPLES

A. Illinois

Cahokia, Monk's Mound

Wood charcoal from Monk's Mound, Cahokia site, Madison Co., Illinois (38° 40′ N Lat, 90° 04′ W Long). Coll. 1967 and 1969 and subm. by M. L. Fowler, Univ. of Wisconsin-Milwaukee.

670 ± 55
WIS-443. Cahokia, Monk's Mound A.D. 1280

Sample 69-847 from 1st terrace of Monk's Mound, Feature 113, N74-76, E102-104. Post 1 centered at N72.23, E103.19.

750 ± 55
WIS-444. Cahokia, Monk's Mound A.D. 1200

Sample 67-388, burned post (E461.80-461.87, N327.65-327.70), from Feature 28. Post was found standing upright in trench fill of stockade E of Monk's Mound. This is latest stockade in sequence with open bastion.

WIS-447. Cahokia, Monk's Mound **1015 ± 60**
A.D. 935

Sample 69-900 from pit, Mound 72, S841-845, E58-60, at +126 m. An irregular accumulation of debris, pottery, stone, and bone intruded into the earlier excavation of Feature 205. Pit was later used for burial of 22 individuals.

B. Iowa

WIS-393. A. C. Banks site (13PM40) **3680 ± 65**
1730 B.C.

Charcoal from A. C. Banks site, Plymouth Co., Iowa (42° 42′ N Lat, 96° 37′ W Long). Coll. 1967 by R. Banks and D. A. Baerreis; subm. by D. A. Baerreis. Sample from 196 to 226 cm depth. Previous date, WIS-285, 3860 B.P., was obtained from charcoal of 198 cm depth (R., 1969, v. 11, p. 229). Date confirms earlier run and indicates cultural horizon is Archaic.

WIS-397. Jackson County, Iowa (13JK20) **1130 ± 60**
A.D. 820

Charcoal from Henry Schnoor Rock Shelter on Maquoketa R. in Jackson Co., Iowa (42° 10′ N Lat, 90° 48′ W Long). Coll. 1969 by M. Jaehnig, Univ. of Wisconsin-Madison; subm. by D. A. Baerreis. Sample from Level 5, Sq. N5B, 48.3 to 63.5 cm deep. Dates bundle burial of young child. Other dates from site were pub. previously (R., 1970, v. 12, p. 336).

WIS-406. Robert Battey Rock Shelter (13JK21) **970 ± 60**
A.D. 980

Charcoal from site in town of South Fork, Jackson Co., Iowa (42° 07′ N Lat, 90° 47′ W Long). Coll. 1969 by M. Jaehnig; subm. by D. A. Baerreis. Dates from this site, WIS-398-401, were pub. earlier (R., 1970, v. 12, p. 640-641). Sample from F 17, 259 cm down slope from rock shelter, Level 4, 30.5 to 41 cm below surface. Area seems to be separate occupation from rock shelter and it should date back to Archaic or Early Middle Woodland period. Artifacts are almost exclusively lithic with lanceolate to side-notched projectile points occurring as opposed to large variety of projectile points in shelter itself.

C. Minnesota

Bartron site (21GD2)

Charcoal from Bartron site on S tip of Prairie I. in Mississippi R., Goodhue Co., Minnesota (44° 37′ N Lat, 92° 39′ W Long). Coll. 1969 by Elden Johnson, Univ. of Minnesota; subm. by D. A. Baerreis. Site is Oneota habitation site, classified as Blue Earth focus by Wilford (1955) and related to Silvernale, Bryan, and Mero sites, located within 16 km radius from Bartron.

850 ± 55
WIS-423. Bartron site (21GD2) A.D. 1100

Sample (Accession no. 671-241) from Feature 76, a pit, 20 cm depth, at 39.85 to 41.55N, 3-4.12W. Assoc. with animal bone, sherds, antler.

890 ± 55
WIS-434. Bartron site (21GD2) A.D. 1060

Sample (Accession no. 671) from Feature 39, fire pit, 40 cm depth, 41.65 N, 0.5 E. Assoc. with pottery sherds, clam shell, animal bone, rock.

D. Wisconsin

1890 ± 60
WIS-426. Brogley Rock Shelter (47GT156) A.D. 60

Charcoal from Brogley rock shelter in Grant Co., Wisconsin (42° 45′ N Lat, 90° 37′ W Long) during excavation in 1969 by R. H. Nelson, Platteville, Wisconsin; subm. by D. A. Baerreis. Sample (5W-105) from 112 to 117 cm below surface in Level 5.

E. Oklahoma

730 ± 55
WIS-448. Creek site (D1-41) A.D. 1220

Charcoal from Lillie Creek site (36° 30′ N Lat, 94° 59′ W Long) in Delaware Co., Oklahoma, coll. 1940 and subm. by D. A. Baerreis. Sample from Level 1, 0 to 10 cm below plow zone. Date agrees well with earlier date from site, A.D. 1190, WIS-42 (R., 1965, v. 7, p. 403), and implies rapid construction of subsequent mound addition.

960 ± 60
WIS-449. Weston site (Os 99) A.D. 990

Charcoal from Weston site, Osage Co., Oklahoma (36° 54′ N Lat, 95° 55′ W Long) coll. 1969 by James Howard, Oklahoma State Univ., Stillwater, Oklahoma; subm. by D. A. Baerreis.

F. Texas

Canyon Country Club Cave

Samples from Canyon Country Club Cave, Randall Co., Texas (Panhandle Plains Historical Mus. Site No. A251) (35° 0′ N Lat, 102° 58′ 42″ W Long). Coll. 1956 by Jack T. Hughes; subm. by D. A. Baerreis.

400 ± 60
WIS-410. Canyon Country Club Cave A.D. 1550

Charcoal, Specimen 312, from Sq. N-2/N-S, Level 1.

300 ± 50
WIS-411. Canyon Country Club Cave A.D. 1650

Charcoal, Specimen 183, from Sq. N-1/W-1, Level 1.

670 ± 50
WIS-403. Canyon Country Club Cave A.D. 1280

Charcoal, Specimen 196, from Sq. N-1/W-1, Level 2.

WIS-421. Canyon Country Club Cave **700 ± 60**
A.D. 1250
$\delta C^{13} = -26.2‰$

Charcoal, Specimen 53, from Sq. N-S/N-1, Level 2.

WIS-402. Canyon Country Club Cave **1260 ± 55**
A.D. 690

Charcoal, Specimen 306, from Sq. E-W/W-1, Level 3.

WIS-408. Canyon Country Club Cave **620 ± 45**
A.D. 1330

Charcoal, Specimen 217, from Sq. N-1/W-1, Level 3.

WIS-404. Canyon Country Club Cave **1650 ± 55**
A.D. 300

Charcoal, Specimen 309, from Sq. E-W/W-1, Level 4.

WIS-414. Canyon Country Club Cave **1250 ± 60**
A.D. 700
$\delta C^{13} = -26.4‰$

Charcoal, Specimen 395, from Sq. S-2/W-1, Level 4.

WIS-394. Canyon Country Club Cave **Modern**

Bones (*Bison bison*), A25/W, from Level 4.

WIS-412. Canyon Country Club Cave **1050 ± 50**
A.D. 900

Charcoal, Specimen 440, from Sq. N-2/E-1, Level 5.

WIS-420. Canyon Country Club Cave **2100 ± 60**
150 B.C.
$\delta C^{13} = -25.7‰$

Charcoal, Specimen 231, from Sq. N-1/W-1, Level 5.

WIS-430. Canyon Country Club Cave **2830 ± 60**
880 B.C.

Charcoal, Specimen 311, from Sq. E-W/W-1, Level 5.

II. GEOLOGIC SAMPLES

A. California

WIS-413. San Miguel Island, California **20,130 ± 215**
18,860 B.C.

Sample SMI 178, charcoalized small tree (presumably *Rhus*) id. by R. C. Koeppen, Forest Products Lab., Madison, Wisconsin. Coll. from San Miguel I., California (34° 02′ N Lat, 120° 20′ W Long) 1969 by D. L. Johnson, Univ. of Kansas, Lawrence; subm. by R. A. Bryson. Tree grew on well-developed soil (paleosol) now overlain by 91.5 to 183 cm eolianite, 183 cm weakly developed paleosol with midden, and another eolianite and alluvial unit of variable thickness.

B. Wisconsin

WIS-409. Iron County, Wisconsin **10,100 ± 100**
8150 B.C.

Spruce wood, id. by R. C. Koeppen, from 365 to 426 cm depth in sandy humic layer above clay till at 317 m elev. in Iron Co., Wisconsin

(46° 30′ N Lat, 90° 27′ W Long). Site similar to that of buried wood to NE (Black, 1969, Broecker *et al.*, 1956, Crane, 1956, Hack, 1965) which ranges form ca. 9500 to 12,600 B.P. Coll. 1968 by C. E. Lindsay; subm. by R. F. Black, Univ. of Wisconsin-Madison.

Disterhaft Farm Bog and Seidel Lake, Wisconsin

Undated pollen diagrams from Disterhaft Farm Bog, Green Lake Co., Wisconsin (43° 55′ N Lat, 89° 10′ W Long) and Seidel Lake, Kewaunee Co., Wisconsin (44° 26′ 43″ N Lat, 87° 31′ 36″ W Long) provided 1st detailed pollen stratigraphy for Wisconsin (West, 1961). The Disterhaft site lies on Cary (Woodfordian) till and should date from retreat of Cary ice; the Seidel site lies on what is presumed Valders drift. Disterhaft Farm Bog was cored again in 1965 by H. E. Wright, E. J. Cushing, and J. K. Wasylikowa, and an 878 cm core was given to R. G. Baker for pollen analysis. The new pollen diagram closely supports West's 1961 diagram. Samples date pollen zone boundaries; subm. by R. G. Baker, Univ. of Wisconsin-Madison.

2850 ± 65
WIS-422. Disterhaft Farm Bog 900 B.C.

Brown fibrous peat from 200 to 210 cm of 878 cm core. Dates rise in *Betula, Tsuga,* and *Sphagnum* at base of Pollen Zone 8, uppermost zone.

5370 ± 70
WIS-427. Disterhaft Farm Bog 3420 B.C.

Brown fibrous peat from 390 to 397 cm depth. Dates fall of *Ulmus* pollen and rise of Gramineae and Cyperaceae pollen at base of Pollen Zone 7.

8480 ± 85
WIS-429. Disterhaft Farm Bog 6530 B.C.

Olive-gray gyttja from 520 to 530 cm interval of core. Dates decline of *Pinus* pollen and rise of *Quercus* pollen at base of Pollen Zone 6.

11,150 ± 160
WIS-441. Disterhaft Farm Bog 9200 B.C.

Olive-gray gyttja from 665 to 675 cm interval of core. Dates rise in *Pinus* pollen and decline in *Picea* pollen at base of Pollen Zone 5.

12,520 ± 115
WIS-457. Disterhaft Farm Bog 10,570 B.C.

Sandy calcareous gyttja from 770 to 780 cm interval of core. Dates beginning of slight decline of *Picea* and maximum of *Artemisia* pollen in late-glacial time.

15,560 ± 150
WIS-442. Disterhaft Farm Bog 13,610 B.C.

Sandy olive-gray gyttja from 868 to 878 cm interval. Dates retreat of Woodfordian (Cary?) ice from Green Lake Co., Wisconsin, and initial establishment of late-glacial *Picea* forest.

WIS-462. Seidel Lake **12,360 ± 125**
10,410 B.C.

Silty mud with detritus and nodules of limestone, 1417 to 1442 cm depth from core of 1574 cm. Date is inconsistent with identification of till as Valders.

WIS-445. Cold Spring Peat Mound **10,800 ± 110**
8850 B.C.

Core of 100 cm obtained in 1969 from peat mound in Jefferson Co., Wisconsin (42° 54′ N Lat, 88° 36′ W Long), by T. Webb and R. G. Baker. Sample dated was dark brown bryophytic peat 55 to 58 cm below surface of mound, from just above break in stratigraphy from upper layer of brown bryophytic to black fine-grained peat. Lower layer contains *Picea* pollen and *Picea* wood fragments and extends 42 cm to bottom of mound which rests on layer of sand. Earlier date from base of mound was 12,800 B.P., WIS-48, (R., 1965, v. 7, p. 407).

WIS-425. Lake Wingra Fen **8570 ± 90**
6620 B.C.

Core of 4.5 m obtained 1969 by R. G. Baker and T. Webb, Univ. of Wisconsin-Madison, from Lake Wingra Fen, Dane Co., Wisconsin (43° 03′ N Lat, 89° 26′ W Long). Sample dated was detrital peat with snail shells from 265 to 280 cm interval in core. Sharp contact between peat and marl occurs at 280 cm depth. Pollen evidence indicates that contact represents hiatus of a few thousand yr; late-glacial spruce pollen occurs in marl and mid-postglacial grass-oak occurs in lowest peat.

Lake Mary, Wisconsin

Sediment core, 248 cm length, from center of meromictic Lake Mary, Vilas Co., Wisconsin (46° 15′ N Lat, 89° 54′ W Long) coll. 1962 by G. Likens, Dartmouth College, New Hampshire; subm. by R. A. Bryson. Date, 9460 B.P., WIS-371, (R., 1970, v. 12, p. 335-345) for 186 to 201 cm interval was reported earlier.

WIS-435. Lake Mary, Wisconsin **3650 ± 65**
1700 B.C.

45.5 to 54 cm interval in core at level in pollen stratigraphy where birch and hemlock show distinct rise.

WIS-437. Lake Mary, Wisconsin **8540 ± 90**
6590 B.C.

Sample from 137.5 to 145 cm interval in core at level where ratio of *Pinus strobus* pollen to *Pinus banksiana/resinosa* pollen changes from 1:6 at 145 cm to 9:1 at 135 cm.

Neath site, Wisconsin

Samples obtained during excavation of mastodon skeleton from peat bog on farm of John Neath, Jr., in Dane Co., Wisconsin (43° 04′ N Lat, 89° 07′ W Long). Coll. 1969 and subm. by J. E. Dallman, Univ. of Wisconsin-Madison. Bulldozing activities covered old ground level to depth of 41 cm.

10,790 ± 105
WIS-424. Neath site **8840 B.C.**

Wood (either tamarack or blue spruce), beaver cuttings, from 117 to 119 cm depth below old surface in peat level of bog. May indicate time of shift from spruce to mixed hardwood forest.

13,120 ± 130
WIS-431. Neath site **11,170 B.C.**

Spruce, id. by Botany Dept., Univ. of Wisconsin-Madison, from large deposit of small diam. trees 246 to 257 cm below old surface level in bog. This level is 48 cm below bottom of marl stratum containing mastodon remains.

Blockhouse Creek Drainage Basin

Samples obtained in 1969 and 1970 in peat deposits exposed by stream cuts below alluvial fan at tributary entrance to flood plain in Blockhouse Creek Drainage Basin, Grant Co., Wisconsin (42° 41′ N Lat, 90° 32′ W Long). Coll. and subm. by J. C. Knox, Univ. of Wisconsin-Madison.

6000 ± 80
WIS-450. Blockhouse Creek Drainage Basin **4050 B.C.**

Quercus of white oak group, id. by R. C. Koeppen, at 30.5 cm depth in gravel horizon at base of 229 cm bank at tributary entrance. Gravel deposit assoc. with max. drought of Atlantic time; finer overlying sediment assumed assoc. with increasing precipitation of Sub-Boreal and Sub-Atlantic times.

WIS-454. Blockhouse Creek Drainage Basin **Modern**

Bone fragments from B horizon of well-developed dark black paleosol underlying 46 cm of stratified light colored alluvium exposed in stream bank near center of Blockhouse Creek flood plain. Indicates overlying light colored sediment is related to accelerated hillslope erosion of post-settlement time.

1200 ± 55
WIS-459. Elvers Creek site **A.D. 750**

Wood (*Quercus* sp., red oak) from layer of brushwood peat in paleosol 244 cm below ground surface immediately above gravel in Elvers Creek branch of Blue Mounds Creek, Wisconsin (42° 04′ 03″ N Lat, 89° 47′ 44″ W Long). Coll. 1970 by G. H. Dury, Univ. of Wisconsin-Madison; subm. by G. H. Dury and J. C. Knox. Samples help elucidate probably complex history of cut and fill which includes periglacial sludging before ca. 12,000 B.P. and accumulation of brushwood peat with mainly spruce pollen between ca. 12,000 and 11,000 B.P. At least 2 subsequent episodes of partial re-clearance followed by infilling are tentatively recognized: samples dated appear to represent 2nd of these infillings.

C. Iowa

WIS-465. Amos Ross site (13PM47) **2170 ± 55** **220 B.C.**

400 cm sec. of dried pond silt coll. for seed and mollusk study in 1970 on Amos Ross farm in Plymouth Co., Iowa (42° 37′ 30″ N Lat, 96° 06′ 30″ W Long). Coll. by R. G. Baker and D. A. Baerreis; subm. by D. A. Baerreis. Sample dated was basswood (*Tilia*), id. by R. C. Koeppen, from 377 to 383 cm depth, Level 16, in Col. B.

D. Yellowstone Park

WIS-432. Swan Lake Flats **13,530 ± 130** **11,580 B.C.**

Marly, carbonaceous, laminated lacustrine silt from 402 to 419 cm in 500 cm core from Swan Lake Flats, Yellowstone Park, Wyoming; elev. 2220 m (44° 55′ N Lat, 110° 44′ W Long). Coll. 1969 by K. Pierce and H. Waldrop; subm. by R. G. Baker. Sample from lowest organic sediments overlying laminated glacial lake sediments. Dates local retreat of Pinedale (Late Wisconsin) ice. Pollen analysis indicates a tundra environment at this time.

Cub Lake, Idaho

330 cm core was obtained in 1969 from Cub Lake, Idaho, 6.44 km W of SE corner of Yellowstone Park, elev. 1840 m (44° 7′ 30″ N Lat, 111° 11′ W Long), by R. G. Baker and H. A. Waldrop; subm. by R. G. Baker.

WIS-438. Cub Lake, Idaho **7910 ± 85** **5960 B.C.**

Fibrous sedge peat from 45 to 50 cm interval of core. Dates beginning of *Pseudotsuga-Pinus contorta* dominance in pollen profile. Sediment deposition at site apparently slowed greatly or ceased shortly after this date.

WIS-436. Cub Lake, Idaho **10,620 ± 100** **8670 B.C.**

Dark brown detritus peat from 160 to 165 cm interval of core. Dates decline in *Artemisia* pollen usually assoc. with transition from late- to postglacial deposits in Yellowstone Park.

E. Nevada

Pyramid Lake, Nevada

Sampling during 1968-69 by S. M. Born, Univ. of Wisconsin-Madison, in Truckee R. valley downstream from Nixon, Nevada, near Pyramid Lake (39° 51′ N Lat, 119° 24′ to 119° 26′ W Long), in conjunction with study of lake-level chronology of late Quaternary Pyramid Lake (Born, 1970). Related earlier studies include those of Broecker *et al.* (1958; 1965) and Morrison and Frye (1965). Results indicate 3 separate lacustrine cycles during past 10,000 yr. Sediments of oldest cycle include only declining lake-level deposits, dating to ca. 8000 B.P. A major lowstand is indicated from 8000 to 3500 B.P., resulting in development of a locally prominent angular unconformity and assoc. with widespread deposition of fluvial gravel. This lowstand interval correlates well with high aridity of ca. 6500 B.P. determined by Sears and Roosma (1961) and the Toyeh soil-forming interval which began ca. 5000 B.P. (Morrison and Frye, 1965). A relatively minor lowstand occurred from ca. 2000 B.P. to 1000 yr B.P.; this interval was bracketed by 2 lesser lake-level cycles, from 3500 to 2000 B.P. and from ca. 1000 B.P. to present.

8800 ± 90
WIS-374. Pyramid Lake, Nevada **6850 B.C.**

Wood from foreset beds near lake level, +1168 m.

9720 ± 100
WIS-377. Pyramid Lake, Nevada **7770 B.C.**

Macerated plant debris from deltaic sediments near lake level, +1169 m.

2690 ± 65
WIS-375. Pyramid Lake, Nevada **740 B.C.**

Tree bark (probably Ponderosa pine), id. by B. F. Kukachka, Forest Products Lab., Madison, Wisconsin, from foreset sediments, +1166 m.

2710 ± 60
WIS-361. Pyramid Lake, Nevada **760 B.C.**

Pieces of wood from foreset beds, +1159 m.

2890 ± 50
WIS-376. Pyramid Lake, Nevada **940 B.C.**

Wood from fluvial deposits, +1174 m, short distance upstream from delta.

2270 ± 55
WIS-378. Pyramid Lake, Nevada **320 B.C.**

Wood from fluvial deposits, +1172 m, deposited short distance upstream from delta.

670 ± 55
WIS-363. Pyramid Lake, Nevada **A.D. 1280**

Wood from fluvial gravel +1174 m.

1110 ± 55
WIS-364. Pyramid Lake, Nevada **A.D. 840**

Log from fluvial gravel +1173 m.

F. Northwest Territories

Southwest Keewatin series

Charcoal layers capping paleosols N of tree line in SW Keewatin show 2 periods when forest extended into present tundra: prior to ca. 3500 B.P. and prior to ca. 1000 B.P. (Bryson *et al.*, 1965). During intermediate period, either tree line fluctuated near present tree line, or scattered forest fires occurred (WIS-37, -15, -29, R. 1965, v. 7, p. 405-407).

Distribution of these paleosols and their dates indicate former extension of Boreal forest into present tundra, but do not show southern limit of tundra after fires which terminated soil-forming episodes.

The following dates were obtained in a continuation of this study, to determine extent of paleosols and terminal fires S of present tree line. Three buried charcoal layers capping paleosols were found in blowout on gentle esker side slope in Kasba, N.W.T., Canada (60° 15′ N Lat, 101° 55′ W Long). Coll. 1970 and subm. by C. J. Sorenson and R. A. Bryson. Since soils appeared to have formed under forest, samples believed to be related to fluctuation of forest border to S-ward of present position (Bryson *et al.*, 1965).

WIS-458. Kasba **780 ± 55**
A.D. 1170

Charcoal, (*Picea*) id. by B. F. Kukachka, uppermost of 3 buried charcoal layers in blowout. Matrix was aeolian sand over well-stratified sand and gravel.

WIS-460. Kasba **1810 ± 55**
A.D. 140

Intermediate of 3 buried charcoal layers.

WIS-467. Kasba **2940 ± 50**
990 B.C.

Lowest of 3 buried charcoal layers.

G. India

WIS-405. Lunkaransar Salt Lake, Rajasthan, India **9260 ± 115**
7310 B.C.

Lacustrine silty clay with dispersed charcoal (B.S.I.P. 1023A/RC-12) at depth 230 cm from pit in bed of Lunkaransar Salt Lake, Dist. Bikaner, Rajasthan, India (28° 50′ N Lat, 73° 80′ E Long). Coll. 1968 by Gurdip Singh, Birbal Sahni Inst. of Palaeobot., Lucknow, India; subm. by R. A. Bryson. This level is lowest containing Cerealia pollen. Other dates from same pit have been reported (R., 1970, p. 643).

WIS-415. Didwana Salt Lake, Rajasthan, India **2970 ± 65**
1020 B.C.
$\delta C^{13} = -23.1‰$

Laminated clay with dispersed charcoal, B.S.I.P. 1024/RC-25, coll. at 120 to 130 cm depth from profile exposed in pit in sec. of lake deposit at Didwana Salt Lake, Dist. Nagaur, Rajasthan, India (27° 22′ N Lat, 74° 35′ E Long). Coll. 1968 by Gurdip Singh, Birbal Sahni Inst. of Palaeobot., Lucknow, India; subm. by R. A. Bryson. Sample dated as part of study of postglacial pollen chronology of Rajasthan lake deposits (Singh, 1968) in relation to history of Rajasthan desert (Bryson and Baerreis, 1967).

Khajiar and Rewalsar, Himachal Pradesh, India

Samples from an area glaciated during Pleistocene in NW India were dated to determine time of biostratigraphic and climatic changes during postglacial period in Himachal Pradesh. A 550 cm core was obtained with a Hiller sampler in lake deposit at Khajiar, Dist. Chamba, Himachal Pradesh, India (32° 32′ 30″ N Lat, 76° 03′ 25″ E Long) and a 350 cm core at Rewalsar, Dist. Mandi, Himachal Pradesh, India (31° 38′ N Lat, 76° 50′ E Long). Coll. 1969 by Gurdip Singh; subm. by R. A. Bryson.

520 ± 55
WIS-419. Rewalsar, Himachal Pradesh A.D. 1430

Coarse organic detritus (B.S.I.P. 1172/RC-29) from 135 to 145 cm depth.

1410 ± 60
WIS-417. Rewalsar, Himachal Pradesh A.D. 540
$\delta C^{13} = -27.0‰$

Dark brown coarse organic detritus (B.S.I.P. 1172/RC-30) from 280 to 290 cm depth.

1150 ± 60
WIS-418. Khajiar, Himachal Pradesh A.D. 800
$\delta C^{13} = -28.5‰$

Phragmites peat (B.S.I.P. 1171/RC-26) from 143 to 150 cm depth.

1800 ± 55
WIS-416. Khajiar, Himachal Pradesh A.D. 150

Clay with pieces of charcoal (B.S.I.P. 1171/RC-27) from 512 to 522 cm depth.

1830 ± 50
WIS-428. Khajiar, Himachal Pradesh A.D. 120

Coarse organic detritus (B.S.I.P. 1171/RC-28) from 522 to 532 cm depth.

References

Bender, M. M., Bryson, R. A., and Baerreis, D. A., 1965, University of Wisconsin radiocarbon dates I: Radiocarbon, v. 7, p. 399-407.

———— 1966, University of Wisconsin radiocarbon dates II: Radiocarbon, v. 8, p. 522-533.

———— 1969, University of Wisconsin radiocarbon dates VI: Radiocarbon, v. 11, p. 228-235.

———— 1970, University of Wisconsin radiocarbon dates VII: Radiocarbon, v. 12, p. 335-345.

———— 1970, University of Wisconsin radiocarbon dates VIII: Radiocarbon, v. 12, p. 640-643.

Black, R. F., 1969, Valderan glaciation in western upper Michigan: 12th Conf. Internatl. Assoc. Great Lakes research Proc., p. 116-123.

Born, S. M., 1970, Deltaic sedimentation at Pyramid Lake, Nevada: Ph.D. thesis, Univ. Wisconsin-Madison, 234 pp.

Broecker, W. S. and Kaufman, A., 1965, Radiocarbon chronology of Lake Lahontan and Lake Bonneville II, Great Basin: Geol. Soc. America Bull., v. 76, p. 537-566.

Broecker, W. S., Kulp, J. L., and Tucek, C. S., 1956, Lamont natural radiocarbon measurements III: Science, v. 124, p. 154-165.

Broecker, W. S. and Orr, P. C., 1958, Radiocarbon chronology of Lake Lahontan and Lake Bonneville: Geol. Soc. America Bull., v. 69, p. 1009-1032.

Bryson, R. A. and Baerreis, D. A., 1967, Possibilities of major climatic modifications and their implications: Northwest India, a case for study: Bull. Am. Meteorol. Soc., v. 48, no. 3, p. 136-142.

Bryson, R. A., Irving, W. N., and Larsen, J. A., 1965, Radiocarbon and soils evidence of former forest in the southern Canadian tundra: Science, v. 147, p. 46-48.
Craig, Harmon, 1961, Mass-spectrometer analyses of radiocarbon standards: Radiocarbon, v. 3, p. 1-3.
Crane, H. R., 1956, University of Michigan radiocarbon dates I: Science, v. 124, p. 664-672.
Hack, J. T., 1965, Postglacial drainage evolution and stream geometry in the Ontonagon area, Michigan: U.S.G.S. Prof. Paper 504B, 40 p.
Morrison, R. B. and Frye, J. C., 1965, Correlation of the middle and late Quaternary successions of Lake Lahontan, Lake Bonneville, Rocky Mountain (Wasatch Range), southern Great Plains, and eastern Midwest areas: Nevada Bur. Mines Rept. 9, 45 p.
Sears, P. B. and Roosma, A., 1961, A climatic sequence from two Nevada caves: Am. Jour. Sci., v. 259, p. 669-678.
Singh, G., 1968, A palynological approach towards the resolution of some important desert problems in Rajasthan: Indian Hydrology, v. 3, no. 1, p. 111-126.
West, R. G., 1961, Late and postglacial vegetational history in Wisconsin, particularly changes associated with the Valders readvance: Am. Jour. Sci., v. 259, p. 766-783.
Wilford, L. A., 1955, A revised classification of the prehistoric cultures of Minnesota: Am. Antiquity, v. 21, no. 2, p. 140-141.

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LABORATORIES

* Inactive Laboratories.

[1] The H^3—Laboratorium of this institute (directed by Klaus Fröhlich) should be addressed separately.

[1a] Lists from this laboratory have not been submitted to RADIOCARBON. See Gdansk I, Acta Physica Polonica, vol. 22, p. 189, 1962; Gdansk II, ibid., vol. 32, p. 39, 1967.

[2] This designation Gif supersedes both Sa (Saclay) and Gsy (Gif-sur-Yvette). The only Gsy date list to be published is Gsy I (Coursaget and Le Run, RADIOCARBON, v. 8).

[3] From January 1, 1961 the Gro numbers have been replaced by GrN numbers. "New" dates are referred to the NBS oxalic-acid standard.

[4] Early dates from this laboratory were given a code designation that represents the name of the sponsoring institution, e.g. I ((AGS) for American Geographical Society (Heusser, RADIOCARBON SUPPLEMENT, v. 1).

[5] Formerly Hazelton Nuclear: code designation HNS has been dropped.

[6] Some dates from this laboratory were published with the code designation S (Pringle and others, 1957, Science, v. 125, p. 69-70).

[7] See SM.

[8] See Gif.

[9] Some dates from this laboratory have been published with the code designation RC (Flint and Gale, 1958, AM. JOUR. SCI., v. 256, p. 698-714). The code designation MP published in volume 1 of the RADIOCARBON SUPPLEMENT (1959, p. 216) has been changed to SM in conformity with the wishes of the laboratory, and is explained by the change of the company's name from Magnolia Petroleum Company to Socony Mobil Oil Company, Inc.

[10] Formerly Texas-Bio-Nuclear, then Kaman Instruments. The laboratory is no longer operating.

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